

REVIEW OF PCB LEVELS IN THE ENVIRONMENT

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OFFICE OF TOXIC SUBSTANCES
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MONS 053447

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1.0 Introduction

Polychlorinated biphenyls (PCB's) were first manufactured commercially in 1929. They are currently manufactured in the United States, Great Britain, France, Germany, USSR, Spain, Italy and Czechoslovakia. The sole producer of PCB's in the United States is the Monsanto Industrial Chemicals Company, whose products are marketed under the trade name "Aroclor". Various Aroclor products that have been marketed include Aroclor 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268. The latter two digits designate the percent chlorine in each formulation. Since their introduction, PCB's have been used in a variety of commercial and industrial products such as transformers, capacitors, paints, inks, paper, plastics, adhesives, sealants and hydraulic fluids. Through this widening product usage and their resistance to degradation, PCB's have been identified in the environment since 1966 with increasing frequency.

On September 1, 1971 an interdepartmental task force was established in the United States to review the data linking PCB's with adverse health and environmental effects and "to coordinate a government-wide investigation into PCB contamination of food and other products". The task force concluded in its report of May 1972 that PCB's were highly persistent, could bioaccumulate to relatively high levels in fish and could have serious adverse effects on human health. It recommended the discontinuance of all PCB uses except in closed electrical systems. Since the 1972 Task Force Report, environmental sampling and laboratory studies have indicated that PCB's were a more serious and continuing environmental and health threat than had been originally realized. These concerns were highlighted this past November at the National Conference on Polychlorinated Biphenyls held in Chicago, Illinois.

This study reviews the current PCB data base to assess the PCB levels in the environment on a national level; the full spectrum of PCB levels reported in man and the environment were of interest. Data were obtained from a number of national monitoring programs, the literature and many unpublished reports. The data examined was inclusive to December 1, 1975 and it is anticipated that this review will be updated in October 1976.

It should be stressed at the outset, that due to the complexity and difficulty of PCB identification and measurement, that levels reported are not really comparable between different investigators. This aspect could not be compensated for or identified in the data presented. In addition, some of the Aroclor identifications reported may only have been best estimates of the pattern observed and may not have really identified the true Aroclor discharged or the quantitative level of the polychlorinated biphenyl found in the sample. However, the levels reported do give an indication of the contamination levels in different media for a given locality.

Recognizing the faults of combining different data bases, the sheer mass of data supports the conclusion that there is widespread contamination of the environment by PCB's. There are regional variations, but effects are consistent across all media (e.g., water, sediment, fish, birds), generally showing greater concentrations of PCB's in highly developed areas and in areas of industrial activity. Over the years examined, the situation has shown no improvement nationally.

This report is divided into five major sections:

PCB's in the environment

Behavior in the environment

Occurrence in food

Bioaccumulation in man

Environmental trends

Wherever possible, the level of data reported has been greatly reduced over that originally reported, especially for the older studies, however every effort has been made to indicate the locality and the level of contamination originally reported. More recent studies are presented in greater detail. Trend assessments, cross media comparisons and conclusions are drawn where justified.

2.0 PCB Levels in the Environment

2.1 Data from National Monitoring Programs

2.1.1 Water

There is no national monitoring program for PCB's in water. PCB monitoring is a limited activity of the overall National Pesticides Monitoring Program operated by the U.S. Geological Survey. Analysis of the PCB data in EPA's STORET water quality file has provided little information, although scattered whole water measurements have been taken by a number of states over the years. Those states reporting nonzero readings are few in relation to the number of states showing zero concentrations.

At the direction of various local, state and federal agencies, the USGS collects and analyzes water data, producing a data file of uniform integrity. Current data from this file¹ covering the period October 1972 to 1975 provides the best available national data and the basis for the following analyses.

PCB levels, gathered by the USGS during the period January 1971 to June 1972 were reported by Crump-Wiesner, Feltz and Yates². While the data suffers from the lack of representative sampling within states and multiple samples from the same locations, they concluded that significant concentrations of PCBs were widespread in the water resources of the nation. Their published summary of PCB residue data for surface and ground waters has been updated with the 1972-1975 data and is presented in Table 2.1-1.

The preponderance of zero readings in whole water and the low levels of scattered non-zero readings could be masking widespread PCB contamination in the nation's waters. Zero readings are due to the low solubility of PCBs and the analytical procedure commonly used which limits detection to 0.1 ppb.

There is a disparity between whole water and bottom deposit measurements. In almost all cases in which samples of both whole water and bottom sediment were taken simultaneously and the latter reading was non-zero, the whole water concentration was measured at zero ppb. This occurred even when the concentration in bottom sediment was as high as 4000 ppb³. More recent water studies⁴ to the ppt level have consistently shown measurable PCB levels.

Table 2.1-1
Summary of PCB Residue Data for Surface and
Ground Waters, January 1971-(partial) 1975

<u>State</u>	<u>Year</u>	<u>No. of Samples</u>	<u>Occurrences</u>	<u>Concentration (ppb)</u>	<u>Median Concentration (ppb)</u>
Alaska	71	3	0	-----	-----
	73	-	-	-----	-----
Alabama	71	4	0	-----	-----
	74	2	0	-----	-----
Arizona	71	8	0	-----	-----
	72	8	0	-----	-----
	73	38	0	-----	-----
	74	14	0	-----	-----
	75	4	0	-----	-----
Arkansas	71	32	0	-----	-----
	72	8	0	-----	-----
	73	28	1	0.2	-----
	74	22	0	-----	-----
	75	1	0	-----	-----
California	71	161	2	0.1, 0.1	-----
	72	27	0	-----	-----
	73	110	0	-----	-----
	74	99	2	0.1, 0.1	-----
	75	42	0	-----	-----
Colorado	71	32	0	-----	-----
	72	3	0	-----	-----
	73	6	0	-----	-----
	74	9	0	-----	-----
Connecticut	71	13	6	0.1-0.2	0.1
	72	16	6	0.1	0.1
	73	45	1	0.1	-----
Delaware	NO ACTIVITY				
D.C.	NO ACTIVITY				
Florida	72	16	0	-----	-----
	73	106	4	0.1-1.0	0.1
	74	60	0	-----	-----
	75	22	0	-----	-----

Table 2.1-1 (cont.)

State	Year	No. of Samples	Occurrences	Concentration (ppb)	Median Concentration (ppb)
Georgia	73	1	0	----	----
	74	29	0	----	----
Hawaii	71	5	0	----	----
	72	1	0	----	----
	73	1	0	----	----
	74	1	0	----	----
Idaho	72	1	0	----	----
	73	1	0	----	----
	74	6	0	----	----
Illinois	74	1	0	----	----
	75	1	0	----	----
Indiana	74	1	0	----	----
Iowa	71	24	0	----	----
	72	1	0	----	----
	73	27	1	0.1	----
	74	2	0	----	----
Kansas	71	10	0	----	----
	72	4	0	----	----
	73	24	1	0.2	----
	74	3	0	----	----
Kentucky	71	7	0	----	----
Louisiana	71	9	0	----	----
	73	195	0	----	----
	74	147	0	----	----
	75	22	2	0.1-0.2	----
Maine	71	2	0	----	----
	72	1	0	----	----
	73	6	0	----	----
	74	1	0	----	----
Maryland	71	6	1	0.1	----
Massachusetts	71	5	1	0.2	----
	73	5	1	0.1	----
	74	6	1	0.1	----
	75	5	1	0.1	----

Table 2.1-1 (cont.)

<u>State</u>	<u>Year</u>	<u>No. of Samples</u>	<u>Occurences</u>	<u>Concentration (ppb)</u>	<u>Median Concentration (ppb)</u>
Michigan	71	2	0	-----	-----
	72	2	1	0.1	-----
	73	6	0	-----	-----
	74	23	0	-----	-----
	75	18	0	-----	-----
Minnesota	71	3	2	0.1-0.3	-----
	73	1	0	-----	-----
	74	1	0	-----	-----
Mississippi	71	8	0	-----	-----
	73	1	0	-----	-----
	74	52	0	-----	-----
	75	60	0	-----	-----
Missouri	71	21	0	-----	-----
	72	7	0	-----	-----
	73	19	0	-----	-----
Montana	71	47	0	-----	-----
	72	9	0	-----	-----
	73	32	0	-----	-----
	74	8	0	-----	-----
Nebraska	71	44	0	-----	-----
	72	3	0	-----	-----
	73	24	0	-----	-----
	74	17	0	-----	-----
	75	2	0	-----	-----
Nevada	72	4	0	-----	-----
	73	6	0	-----	-----
	74	5	0	-----	-----
New Hampshire	73	3	0	-----	-----
	74	3	0	-----	-----
New Jersey	71	11	3	0.1	0.1
	72	5	1	<0.5	-----
	73	29	2	<0.1, <0.1	-----
	74	29	0	-----	-----
New Mexico	71	36	0	-----	-----
	72	10	0	-----	-----
	73	5	0	-----	-----
	74	5	0	-----	-----

Table 2.1-1 (cont.)

<u>State</u>	<u>Year</u>	<u>No. of Samples</u>	<u>Occurrences</u>	<u>Concentration (ppb)</u>	<u>Median Concentration (ppb)</u>
New York	71	325	52	0.1-4.0	0.3
	73	32	1	0.1	-----
	74	16	0	-----	-----
North Carolina	72	3	0	-----	-----
	73	1	0	-----	-----
	74	1	0	-----	-----
North Dakota	71	40	0	-----	-----
	72	3	0	-----	-----
	73	4	0	-----	-----
	74	3	0	-----	-----
Ohio	72	14	2	0.1-E.2	-----
	73	1	0	-----	-----
	74	3	0	-----	-----
Oklahoma	71	19	0	-----	-----
	72	5	0	-----	-----
	73	77	2	0.1-2.9	-----
	74	37	5	0.1-0.2	0.1
	75	11	2	2.0-3.0	-----
Oregon	71	13	0	-----	-----
	72	2	0	-----	-----
	73	9	0	-----	-----
	74	9	0	-----	-----
	75	1	0	-----	-----
Pennsylvania	71	2	0	-----	-----
	73	1	0	-----	-----
	74	25	0	-----	-----
	75	20	0	-----	-----
Rhode Island	73	3	0	-----	-----
South Carolina	72	2	0	-----	-----
	73	2	0	-----	-----
	74	12	0	-----	-----
South Dakota	71	18	0	-----	-----
	72	1	0	-----	-----
	73	5	0	-----	-----
	74	1	0	-----	-----
Tennessee	73	1	0	-----	-----
	74	2	0	-----	-----

Table 2.1-1 (cont.)

<u>State</u>	<u>Year</u>	<u>No. of Samples</u>	<u>Occurrences</u>	<u>Concentration (ppb)</u>	<u>Median Concentration (ppb)</u>
Texas	71	660	12	0.1-3.0	0.4
	72	82	1	0.1	-----
	73	385	6	0.1-0.6	0.3
	74	297	4	0.2-0.7	0.3
Utah	72	1	0	-----	-----
	73	8	0	-----	-----
	74	16	0	-----	-----
Vermont	73	1	0	-----	-----
Virginia	71	4	1	0.1	-----
	72	12	0	-----	-----
	73	5	0	-----	-----
	74	1	0	-----	-----
Washington	71	25	0	-----	-----
	72	1	0	-----	-----
	73	6	0	-----	-----
	74	6	1	0.1	-----
West Virginia	71	4	0	-----	-----
	74	1	0	-----	-----
Wisconsin	71	3	0	-----	-----
	72	1	0	-----	-----
	73	12	0	-----	-----
	74	30	0	-----	-----
	75	2	0	-----	-----
Wyoming	71	18	0	-----	-----
	72	1	0	-----	-----
	73	6	0	-----	-----
	74	3	0	-----	-----
Puerto Rico	73	34	0	-----	-----
	74	63	1	0.8	-----

E - estimated.

SOURCE: This table is an extension of Table 2 in Crump-Wissner, J.S., H.R. Feltz and M.L. Yates, J. Research USGS, 1, 603-607; (1972) incorporating the newer data of PCB Data Base, October 1972 to (partial) 1975, The U.S. Geological Survey, Quality of Water Branch, Reston, VA.

2.1.2 Sediment

Nationwide sampling of bottom sediments have shown PCB concentrations to have widespread occurrence. Data from Crump-Wiesner, et. al.,⁷ January 1971-June 1972 are summarized in Table 2.1-2. The October 1972 to 1975 USGS data are summarized in Table 2.1-3. Table 2.1-3 permits distinguishing between those states where the non-zero PCB readings were from one or a limited number of stations with multiple readings and those states where the non-zero readings come from a number of stations within the state. The map in Figure 2.1-1 indicates the distribution of PCB contamination from 1972-1974 based on the figures in the tables.

States which monitored sediment concentrations to any appreciable extent detected the presence of PCB's in concentrations often higher than 40 ppb. A greater proportion of states are reporting PCB's in bottom sediment each year, as displayed in Table 2.1-4.

Although the sediment data is meaningful, some caution is necessary in interpretation: measurements may be the result of past contamination, not present discharges; mean readings and ranges are somewhat inadequate to summarize the data - geographic locations are essential since readings show patterns only in particular water basins.

Table 2.1-2
Summary of PCB Residue Data for Bottom Sediments
January 1971 - June 1972

State	No. of Samples	Occur- rences	Concentration (ppb)	Median Concentration (ppb)
Alaska	3	0	-----	-----
Arkansas	23	4	20-2,400	60
California	13	3	20-190	65
Connecticut	1	1	40	-----
Hawaii	4	0	-----	-----
Georgia	12	10	10-1,300	300
Maryland	11	5	10-1,200	30
Mississippi	8	2	50;170	-----
New Jersey	12	10	8-250	20
Oregon	4	2	15;140	-----
Pennsylvania	16	11	10-50	20
South Carolina	11	8	30-200	50
Texas	293	23	7.9-290	80
Virginia	10	8	5-80	40
Washington	10	0	-----	-----
West Virginia	2	1	10	-----

SOURCE: Crump-Wiesner, J.S., N.R. Feltz and M.L. Yates,
J. Research USGS, 1, 603-607, (1972).

Table 2.1-3
Summary of PCB Residue Data for Bottom Sediments
Stations measuring/#Stations with at least one non zero reading
Range of non-zero readings (mean), in pph

STATE	1972	1973	1974	(partial) 1975
Alabama	----	1/0	2/0	----
Alaska	----	1/0	----	----
Arizona	1/0	1/0	1/0	----
Arkansas	6/0	6/0	15/4	----
			<2-29 (12.8)	
California	1/0	15/0	18/2	----
			<2-65 (33.5)	
Colorado	1/0	1/0	1/0	----
Connecticut	16/8	16/11	40/31	----
	<5-800 (127.5)	<5-40 (14.1)	<2-350 (71.5)	
Delaware		NO ACTIVITY		
Florida	27/7	64/34	68/16	20/2
	<5-400 (93.6)	<2-600 (35.8)	<2-530 (43.3)	<140-430 (285)
Georgia	----	1/0	9/7	----
			<1-51 (13.6)	
Hawaii	1/0	1/0	----	----
Idaho	1/0	1/0	1/0	----
Illinois	----	1/1 (20)	----	1/0
Indiana	----	----	4/2	----
			<9-61 (35)	
Iowa	----	2/0	----	----
Kansas	1/0	1/0	2/0	----
Kentucky		NO ACTIVITY		
Louisiana	----	3/0	18/0	4/1 (5)
Maine	1/0	1/0	----	----
Maryland		NO ACTIVITY		
Massachusetts		NO ACTIVITY		
Michigan	1/1		13/8	15/4
	<2)		<4-60 (17.6)	<10-58 (29.5)
Minnesota	----	1/0	1/0	----
Mississippi	----	1/0	50/13	----
			<3-56 (16.4)	
Missouri		NO ACTIVITY		
Montana	4/0	6/0	4/0	----
Nebraska	1/0	3/0	1/0	----
Nevada	3/0	3/0	3/0	----
New Hampshire		NO ACTIVITY		
New Jersey	2/2	20/18	15/7	----
	<5,<10	<3-4000 (230.2)*	<1-800 (172.2)	
New Mexico	3/0	4/0	1/0	----

Table 2.1-3 (cont.)

STATE	1972	1973	1974	1975
New York	----	17/5	17/14	----
		<2-1300 (519)*	<2-450 (95.8)	
North Carolina	----	1/0	----	----
North Dakota	2/0	2/0	----	----
Ohio	----	1/0	----	----
Oklahoma	1/0	3/0	1/0	----
Oregon	1/0	1/0	2/0	----
Pennsylvania	9/7	5/3	23/16	3/3
	<5-8100 (50.7)	<5-20 (11.7)	<6-700 (105.6)	<42-240 (144)
Rhode Island	NO ACTIVITY			
South Carolina	2/0	2/0	5/1 (6)	----
South Dakota	1/0	1/0	----	----
Tennessee	----	1/0	1/0	----
Texas	41/3	58/8	58/17	----
	<4-120 (61.7)	<3-45 (17.6)	<1-153 (45.5)	----
Utah	----	3/0	1/0	----
Vermont	NO ACTIVITY			
Virginia	NO ACTIVITY			
Washington	1/0	3/0	2/0	----
West Virginia	NO ACTIVITY			
Wisconsin	----	9/1 (10)	21/0	2/0
Wyoming	----	3/0	1/0	----
Puerto Rico	----	6/0	16/5	----
			<10-640 (242)	

E - estimated

*mean figure does not include anomalous values

SOURCE: PCB Data Base, October 1972 to (partial) 1975, U.S.
Geological Survey, Quality of Water Branch, Reston, VA.

Table 2.1-4
States Reporting PCB's in Bottom Deposits

<u>1971-72</u>	<u>1973</u>	<u>1974</u>	<u>1975 (partial)</u>
29/15 (51.72%)	39/8 (20.51%)	32/14 (43.75%)	6/4 (66.67%)

states measuring PCB's in bottom sediments/# with at least one non-zero reading

SOURCE: PCB Data Base, October 1972 to (partial) 1975, U.S.
Geological Survey, Quality of Water Branch, Reston, VA.

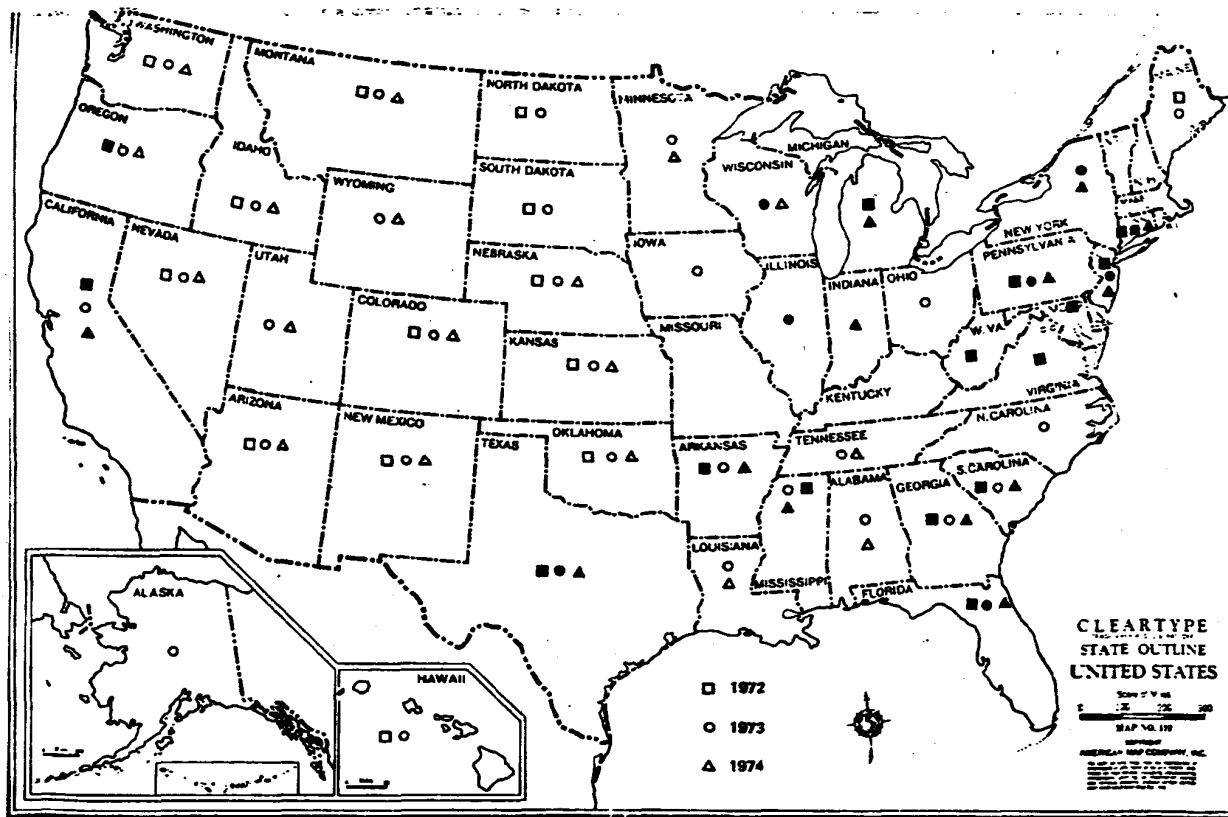


FIGURE 2.1-1 STATES MONITORING PCB's IN BOTTOM SEDIMENTS 1972-1974
 ● DARKENED SYMBOL REPRESENTS AT LEAST ONE DETECTION

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2.1.3 Soils

Two national soils monitoring programs are conducted by EPA as part of its Pesticides Monitoring Program covering both cropland and urban soils. In 1973, the only year in which PCB's were analyzed in cropland soils, virtually no occurrences were detected¹.

The urban soils program is a small one, consisting of 5 different urban locations each year. The sampling design recovers one analytical sample per square mile in the city proper and one per twenty square miles in the suburbs. The results of the program for the years 1971-1973 are summarized in Table 2.1-5 and Figure 2.1-2¹.

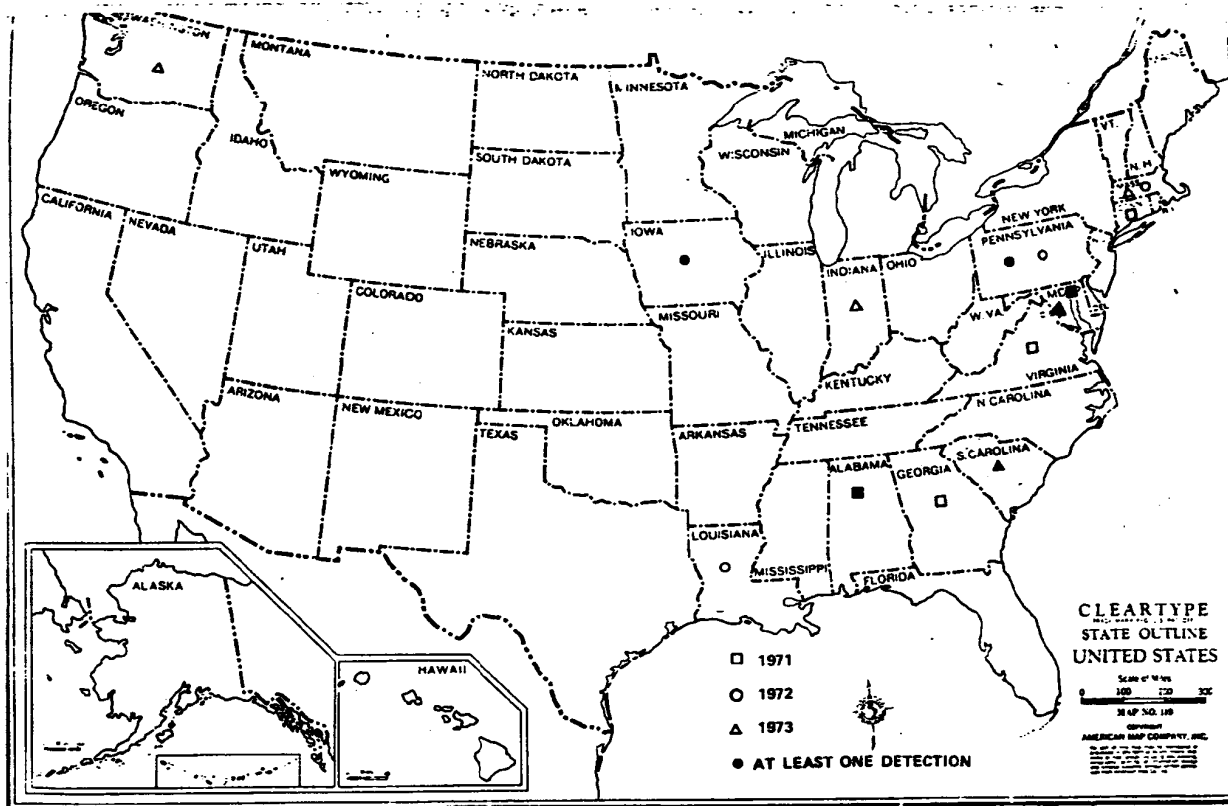
Assuming that sites were randomly selected within the cities sampled, 60% (3 of 5) of the cities sampled each year had at least one positive PCB sample. Over the three years an average of 2.68% of the sites in these cities (roughly corresponding to 2.68% of the total area) showed PCB concentrations in ranges from 0.9-11.94 ppm. The anomalous reading of 11.94 was found in a residential lawn in Cadesden, Alabama. Seventeen of the twenty two positive readings were below 1 ppm.

Table 2.1-5
National Urban Soil Monitoring Program
PCB Detections 1971 - 1973

	Total No. of Sites	No. of Positive Detections	Percent Positive Detections	Range of Positive Detections (ppm)	Arithmetic Mean (ppm)	PCB Type(s)
1971						
Baltimore, MD.	156	6	3.9	0.09 - 0.74	0.02	1260 1-lawn, 5 waste
Gadsden, AL.	55	1	1.8	11.94	0.21	Not identified, residential lawn
Hartford, CT.	48	ND	-			
Macon, GA.	43	ND	-			
Newport News, VA.	78	1	1.3	3.30	0.04	1254 lawn
1972						
Des Moines, IA	82	3	3.7	0.34 - 0.94	0.03	Not identified, 2-lawn 1-waste
Lake Charles, LA.	70	1	1.4	1.31	0.02	1254
Fitchburg, MA	35	ND	-			
Pittsburgh, PA.	189	1	0.5	1.01	0.01	Not identified, lawn
Reading, PA.	49	ND	-			
1973						
Evansville, IN.	82	ND	-			
Greenville, SC	86	3	3.5	0.13 - 1.59	0.02	1254 3-lawn
Pittsfield, MA.	45	ND	-			
Tacoma, WA.	95	6	6.3	0.18 - 0.63	0.03	1-1254, Others not identified, 2 lawn, 4 waste
Washington, D.C.	116	2	1.7	0.32 - 0.80	<0.01	1-1254, Others not identified, 1 lawn, 1 waste

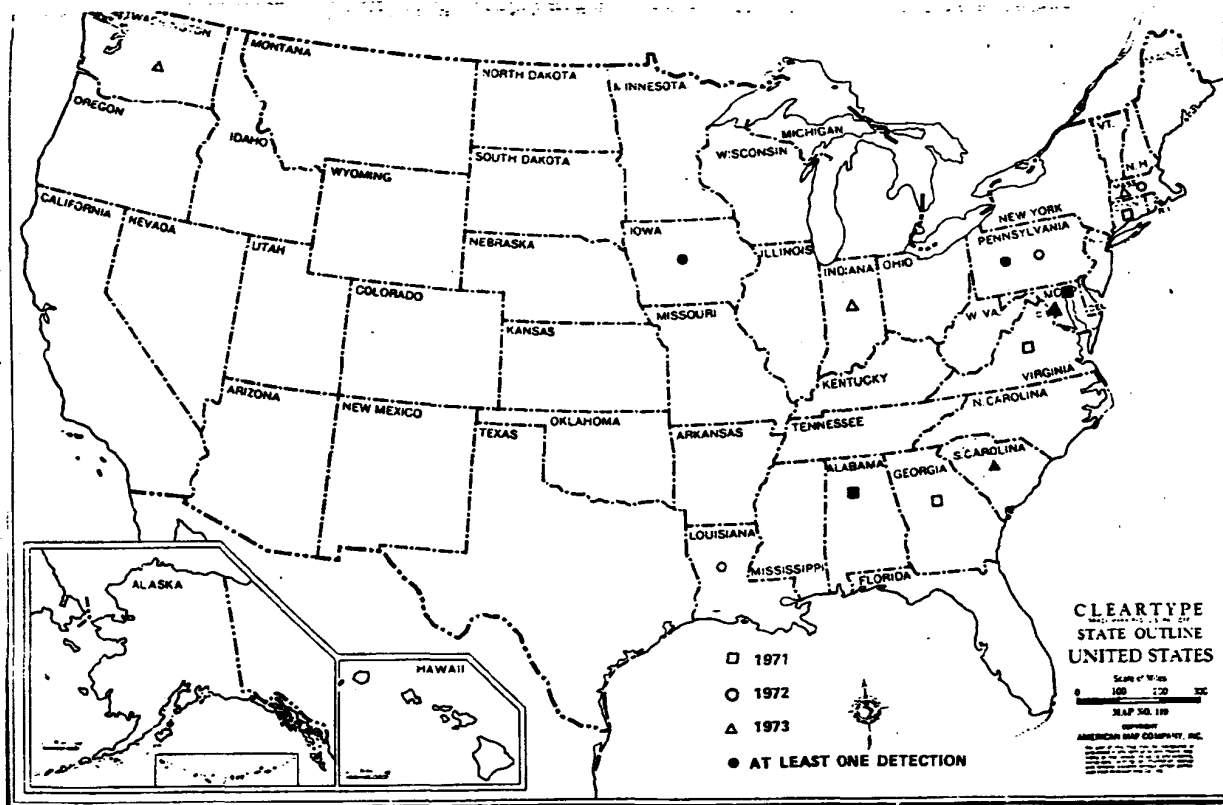
SOURCE: Carey, Ann, 1975, EPA National Soil Monitoring Program, unpublished.

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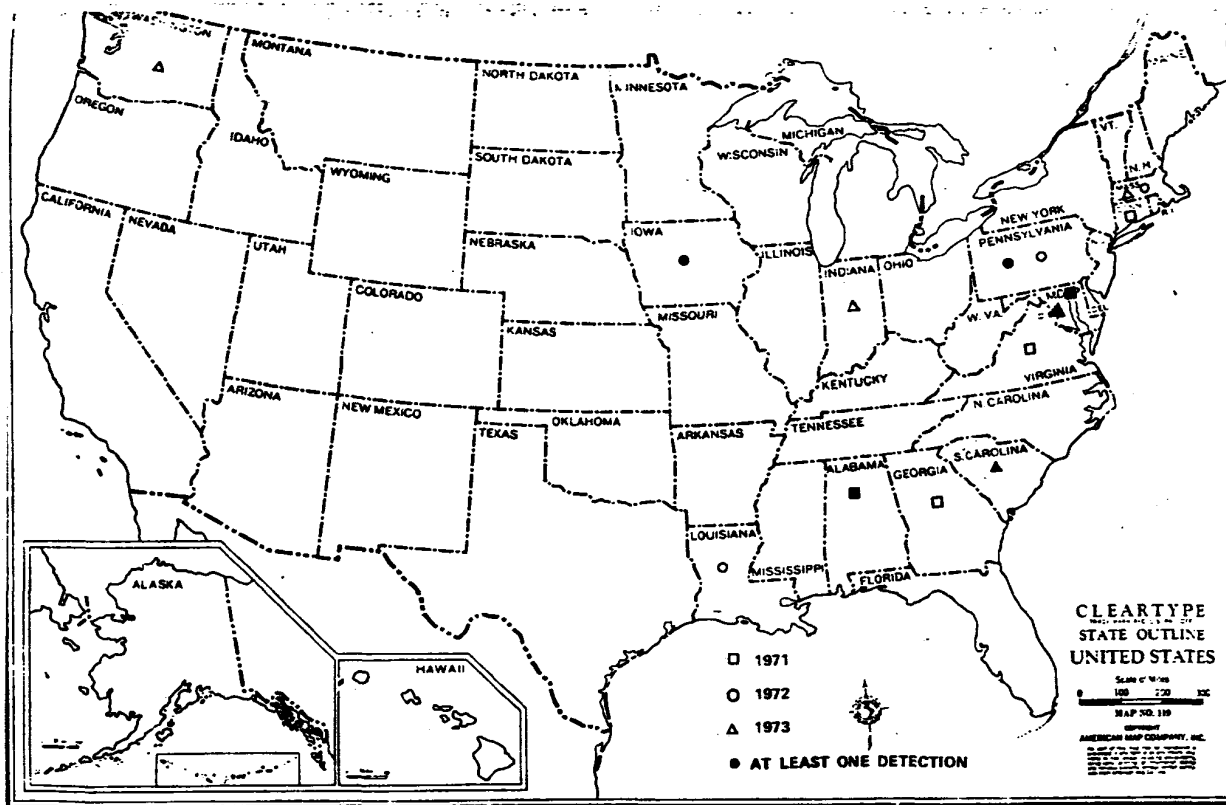
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FIGURE 2.1-2 NATIONAL URBAN SOIL MONITORING PROGRAM-PCB's



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FIGURE 2.1-2 NATIONAL URBAN SOIL MONITORING PROGRAM-PCB's



NONS 053468

FIGURE 2.1-2 NATIONAL URBAN SOIL MONITORING PROGRAM—PCB's

2.1.4 Air

Polychlorinated biphenyls have not been measured in air on a nationwide basis.

2.1.5 Fish

Fish have long been a popular sampling medium for PCB levels primarily due to the minimal difficulties of sampling and analysis relative to other media. Data on residue levels in fish, however, present problems of interpretation: the eating habits, lipid content, age, sex and size affect PCB levels; residue levels in fish, like those in sediment indicate past, not necessarily current, exposure; residue levels in fish are slow to reflect changes in levels of contamination of the water; distinguishing Aroclor 1254 from 1016 is difficult.

The U.S. Fish and Wildlife Service of the Department of the Interior provides the best national overview with the National Fish and Wildlife Monitoring Program. One of the elements of this program is the annual sampling of freshwater fish at 100 stations (as of 1970). Beginning with the 1969 collections, whole fish samples were analyzed for PCB's.

The most recent data from this program are the unpublished results of the 1973 collection. While many species of fish are sampled throughout the country, a reasonable summary of the data is provided in Table 2.1-6, which concentrates on the four most commonly sampled species of fish, largemouth bass, channel catfish, carp and yellow perch.

The great number of stations reporting "no detection" for those four species in 1973 is significant. Generally lower levels were reported for other species in 1973 also. Furthermore, when sampling data is totalled, ignoring both species and geographic location, as in Table 2.1-7, marked declines in both the proportion of composites with some PCB residues and the proportion with residues above the recommended maximum of 0.5 ppm are exhibited. While there is a downward trend in the number of stations reporting significant residue levels, those which have reported high concentrations in the past continue to do so. Walker⁹ notes that PCB residues have been found in forty to sixty percent of the samples in residue concentrations exceeding 0.5 ppm and that the geographic dispersion shows that the higher concentrations appear to be associated with certain river systems having industrial activity: thirty-one of thirty-five stations in the Mississippi river system reported residues in excess of 0.5 ppm in the 1970-73 sampling program; all stations in the Great Lakes drainage area reported concentrations exceeding 0.5 ppm. Several factors related to interpretation of this data must be recognized: the PCB residues prior to 1973 are reported as "estimated", while those for 1973 are the result of the analysis for three Aroclors (1242, 1254 and 1260) totalled; a trend cannot be inferred from the data of one year, regardless of how dramatic it is, although such data may signal a turning point; analytic protocols for sample analysis, especially determination of specific Aroclors, are suspect and the results of cross check analyses show that some laboratories used for the analysis typically expressed PCB levels of only 5 to 20 percent of those discovered by more sophisticated analytic protocols of the Fish Pesticide Research Laboratory⁹.

Table 2.1-6
PCB Residues In Selected Species of Fish
(averages of composite samples, expressed in
ppm, wet weight, whole fish)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969^a</u>	<u>1970^a</u>	<u>1971^a</u>	<u>1972^a</u>	<u>1973¹</u>
AL	Alabama R. Chrysler	Largemouth bass	<0.10	3.70	1.35	6.5	N.D.
		Channel catfish				1.5	
	Tombigbee R. McIntosh	Carp		0.86	0.17		N.D.
		Largemouth bass		1.30	0.93	**	N.D.
		Channel catfish				**	
AZ	Colorado R. Imperial Reservoir	Largemouth bass	0.40	0.11		N.D.	N.D.
		Carp	0.25	0.13	0.03	0.01	N.D.
		Channel catfish	0.64	0.17	0.17		
	Colorado R. L. Havasu	Carp		0.17	0.05	N.D.	N.D.
		Largemouth bass		0.14		N.D.	N.D.
		Channel catfish		0.21	0.14		
	Colorado R. L. Powell	Carp		0.09	0.06	<0.10	N.D.
		Largemouth bass		0.09	0.10	0.16	N.D.
	Gila R. San Carlos Res.	Carp		0.04	0.08	**	N.D.
		Largemouth bass		0.08	0.03	**	N.D.
		Channel catfish			0.21	**	
AR	Arkansas R. Pine Bluff	Carp	1.69	1.25	0.52	**	N.D.
		Channel catfish				N.D.	
CA	Sacramento R. Sacramento	Carp	0.10	2.62	1.04	4.35	2.51
		Largemouth bass	<0.10	0.73	0.28	3.7	
	San Joaquin R. Los Banos	Carp	0.10	3.74	0.12	**	N.D.
		Channel catfish	0.10	1.72	0.21		N.D.
				0.14	0.06		
	Klamath R. Hornbrook	Yellow perch		0.24	0.12		<0.10
		Largemouth bass		0.09			
CO	Rio Grande Alamosa	Carp		0.26	0.06	N.D.	
	Arkansas R. John Martin Res.	Carp		0.09	0.05	0.05	N.D.
		Channel catfish		0.15	0.11		N.D.

Table 2.1-6 (cont.)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969^a</u>	<u>1970^a</u>	<u>1971^a</u>	<u>1972^a</u>	<u>1973¹</u>
CT	Connecticut R. Windsor Locks	Yellow perch	3.40	2.45	17.1	6.6	5.6
RI	St. John's R. Wetake	Channel catfish	0.14	0.18	0.07	N.D.	N.D.
		Largemouth bass	0.31	0.37	0.28	N.D.	N.D.
	St. Lucie Canal Indiantown	Channel catfish	1.25	0.26	0.09	N.D.	N.D.
		Largemouth bass	0.56	0.62	0.08	N.D.	N.D.
	Suwanee R. Old Town	Largemouth bass		0.31	0.5	0.35	0.3
	Apalachicola R. Jim Woodruff Dam	Channel catfish	0.69	0.67	0.62		N.D.
		Largemouth bass	<0.10	0.53	0.12	2.5	N.D.
		Carp	<0.10			N.D.	
GA	Savannah R. Savannah	Largemouth bass	1.18	0.70	0.14	0.64	0.5
		Channel catfish				2.30	
		Carp	0.58	2.92	0.12		3.2
	Altamaha R. Doortortown	Largemouth bass		0.79	0.27	1.20	N.D.
ID	Bear R. Preston	Carp		0.89	0.82	1.9	0.8
		Yellow perch		1.29	0.42	1.0	2.35
	Salmon R. Riggins	Carp		0.14	0.06		
	Snake R. Lewiston	Carp		0.29	0.65	0.11	N.D.
IL	Ohio R. Metropolis	Carp		2.01	3.16	7.1	1.4
		Channel catfish		3.78	6.07	5.7	5.45
	Illinois R. Beardstown	Carp	11.3	0.82	0.64	2.1	1.45
IN	Wabash R. New Harmony	Carp		3.10	1.13	1.6	2.1
		Channel catfish		1.07	3.95	3.3	1.27
IA	Des Moines R. Keosauqua	Carp	0.54	0.22	0.16	1.33	1.00
		Channel catfish		0.40	0.86	1.60	0.90
		Largemouth bass				N.D.	
	Mississippi R. Guttenberg	Carp		0.30	1.21	1.0	1.2
		Largemouth bass	1.41	1.79	1.11	1.25	0.96

Table 2.1-6 (cont.)

State	Waterway/ Station Location	Species	1969 ^a	1970 ^b	1971 ^a	1972 ^a	1973
KS	Kanham R. Bonner Springs	Carp Channel catfish		0.55	1.28 0.77	1.30	1.2
LA	Mississippi R. Luling	Carp Channel catfish	0.46 0.66	0.86 0.58	0.28 1.95	4.5 6.6	
	Red R. Alexandria	Channel catfish Carp				N.D.	0.80
ME	Penobscot R. Old Town	Yellow perch	0.31	0.33	0.30	0.36	0.3
	Kennebec R. Hinckley	Yellow perch		0.23	0.15	0.20	N.D.
MD	Susquehanna R. Conowingo	Carp Channel catfish Yellow perch	0.69 1.21 1.31	2.6 1.77 2.39	0.69 0.94 0.95	1.9 4.5 1.9	0.60 1.2
	Potomac R. Little Falls	Carp Channel catfish Largemouth bass	1.04 1.04	0.63	0.81	1.1	0.5 N.D.
MA	Merrimac R. Lowell	Yellow perch		6.12	21.2	9.5	12.0
MI	L. Huron Bay Port	Carp Channel catfish Yellow perch		2.76 3.80 3.33	5.50 1.53 2.83		4.30 6.6 4.25
MN	Red R. (north) Noyes	Channel catfish		0.68	2.29	0.17	N.D.
MS	Yazoo R. Redwood	Carp Channel catfish		1.95	0.68 1.63	N.D.	N.D. N.D.
MO	Mississippi R. Cape Girardeau	Carp Largemouth bass		5.26 3.51	1.89 3.20	2.42	1.9 1.0
	Missouri R. Hermann	Carp Channel catfish		1.29 0.21	7.6	2.8 2.00	4.6

Table 2.1-6 (cont.)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969^a</u>	<u>1970^a</u>	<u>1971^a</u>	<u>1972^a</u>	<u>1973^b</u>
MT	Big Horn R. Hardin	Carp		0.42	0.05	N.D.	N.D.
		Channel catfish		0.55			N.D.
	Yellowstone R. Sidney	Channel catfish		0.14			0.20
		Carp				0.10	N.D.
NE	Missouri R. Nebraska City	Carp		1.38	0.53	0.67	0.30
		Channel catfish				0.50	
	North Platte R. L. McConaughy	Carp		0.24	0.06	N.D.	N.D.
		Channel catfish		0.21	0.09	N.D.	N.D.
	South Platte R. Brule	Carp		0.08	0.22	1.15	0.50
		Channel catfish		0.71	0.23	1.50	0.33
NV	Colorado R. L. Mead	Carp		0.13	1.68	N.D.	0.20
		Largemouth bass		0.09	0.09	0.26	N.D.
	Truckee R. Fernley	Channel catfish			0.13	0.76	0.20
		Carp	0.54	0.51	1.21	1.8	0.83
NJ	Raritan R. Highland Park	Largemouth bass	<0.10	0.73	0.42	2.1	1.00
		Carp				4.9	2.1
NM	Rio Grande Elephant Butte Res	Channel catfish		0.35	0.52	0.92	N.D.
		Largemouth bass		0.65	0.30	1.54	N.D.
NY	Hudson R. Poughkeepsie	Largemouth bass	4.82	9.37	34.5	13.0	3.2
		Yellow perch		1.45	2.12	3.15	1.1
	St. Lawrence R. Massena	Yellow perch		2.48	7.34	6.2	5.2
		Yellow perch					
NC	Roanoke R. Roanoke Rapids	Largemouth bass	0.10	0.89	0.37	1.40	N.D.
		Carp				0.65	N.D.
	Cape Fear R. Elizabethtown	Channel catfish					N.D.
		Largemouth bass		3.33	0.81	3.90	N.D.

Table 2.1-6 (cont.)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969^a</u>	<u>1970^a</u>	<u>1971^a</u>	<u>1972^a</u>	<u>1973^b</u>
ND	Missouri R. Garrison Dam	Carp	0.10	0.08		N.D.	N.D.
OH	Ohio R. Marietta	Carp		4.82	5.20	2.5	11.0
		Channel catfish		11.85	14.5	9.75	24.0
		Largemouth bass	8.07		22.65		
	Ohio R. Cincinnati	Carp		24.5	25.8	19.0	25.0
		Channel catfish			27.3	30.0	21.5
OK	Verdigris R. Oologah	Carp		0.61	0.8	**	N.D.
		Largemouth bass		0.40	0.09	**	N.D.
	Canadian R. Eufaula	Carp		0.81	0.31		N.D.
		Largemouth bass		0.14			N.D.
		Channel catfish			0.36		
	White R. DeValls Bluff	Carp		1.77	0.73	1.5	N.D.
		Channel catfish		1.82	2.32		N.D.
	Red R. Lake Texoma	Carp		0.25	0.26	N.D.	N.D.
		Largemouth bass		0.21	0.13	N.D.	N.D.
	Arkansas R. Keystone Res.	Carp	0.24	0.45	0.29	0.5	N.D.
		Largemouth bass	0.66	1.25		**	N.D.
		Channel catfish			1.28		
OR	Willamette R. Oregon City	Carp		1.25			
		Channel catfish				0.44	
	Columbia R. Bonneville	Carp			0.19	<0.1	N.D.
	Rogue R. Gold Ray Dam	Carp		2.60		1.4	5.4
		Largemouth bass		0.87			
PA	L. Erie Erie	Yellow perch		2.40	1.11	1.65	0.75
	Allegheny R. Natrona	Carp		4.59	5.52	4.0	1.75
SC	Pee Dee R. Dongola	Largemouth bass		0.62		3.70	0.5
	Cooper R. Summerton	Carp		1.04	0.35	N.D.	1.5
		Largemouth bass	<0.10	0.45	0.18	3.20	3.3

Table 2.1-6 (cont.)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969^a</u>	<u>1970^a</u>	<u>1971^a</u>	<u>1972^a</u>	<u>1973^b</u>
SD	James R. Olivet	Carp Channel catfish		0.20	0.65 0.20	N.D. 1.20	N.D. <0.10
TN	Cumberland R. Clarksville	Carp Largemouth bass	0.89 3.15	1.67 2.92	0.69 1.19	16.0 5.0	4.1 5.8
	Tennessee R. Savannah	Carp Channel catfish Largemouth bass		1.46 4.32 1.20	0.33 3.18 0.63	4.65 11.0	1.5 9.8 3.1
	Mississippi R. Memphis	Carp Channel catfish		3.26	1.22	10.0 5.4	1.5
TX	Pecos R. Red Bluff Lake	Channel catfish Largemouth bass		1.07 0.06	0.19	0.60	N.D.
	Brazos R. Richmond	Channel catfish		1.17		0.5	
	Colorado R. Wharton	Channel catfish Carp		0.32	0.38	1.1	N.D. N.D.
	Nueces R. Mathis	Channel catfish Largemouth bass		0.03 0.05		N.D.	N.D.
	Rio Grande Brownsville	Channel catfish		0.40	3.62	7.70	3.46
UT	Utah Lake Provo	Carp	0.29	0.18	0.10	**	0.26
	Green R. Vernal	Carp Channel catfish	0.83	0.09 0.10	0.6 0.22	** **	N.D. N.D.
VT	L. Champlain Burlington	Yellow perch		0.78	0.74	1.20	1.21
VA	James R. Richmond	Channel catfish Largemouth		0.79 0.34	0.44 0.33		1.5 1.5
WA	Snoke R. Ice Harbor	Channel catfish Carp		1.00	0.62 0.19	1.3	0.5
	Yakima R. Granger	Carp Largemouth bass		1.24 0.63	0.22	1.70	N.D. N.D.
	Columbus R. Pasco	Carp		0.17	0.19	1.4	N.D.

Table 2.1-6 (cont.)

<u>State</u>	<u>Waterway/ Station Location</u>	<u>Species</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>
WV	Kanawha R. Winfield	Carp	0.31	1.25	0.61	12.0	3.8
WI	L. Michigan Sheboygan	Yellow perch		7.42	11.45	9.3	7.8
	Wisconsin R. Woodman	Carp		1.15	1.44		3.6
		Channel catfish		0.17	1.11		

** - PCB-like compound present

N.D. - Not Detectable

a. estimated PCB levels

b. total of Aroclors 1242, 1254 and 1260

SOURCES:

1969 Data - Henderson, C., A. Inglis and W.L. Johnson, Pesticides Monitoring Journal, 5, 1-11 (1971).

1970-1973 Data - National Fish and Wildlife Monitoring Program, Results of Freshwater Fish Monitoring 1970-1973, U.S. Fish and Wildlife Service, U.S. Department of Interior, Washington, DC (unpublished).

Table 2.1-7
Summary of PCB Residues Detected in Fish from 1969-1973
National Pesticide Monitoring Program

Year	Total	Number of Composites				Range (ppm)
		With Residues		With Residues Above 5 ppm		
		No.	%	No.	%	
1969	147	147	100	89	61	0.10-14.8
1970	393	390	99	239	61	0.03-74.8
1971	587	581	99	284	48	0.02-41.0
1972	401	311	78	215	54	<0.05-30.0
1973	400	202	51	160	40	<0.01-25.0

SOURCES:

1969 - Henderson, C., A. Inglis and W.L. Johnson, Pesticides Monitoring Journal, 5, 1-11 (1971).

1970-1973 Data - National Fish and Wildlife Monitoring Program, Results of Freshwater Fish Monitoring 1970-1973, U.S. Fish and Wildlife Service, U.S. Department of Interior, Washington, DC (unpublished).

2.1.6 Birds

Two of the three elements of the National Fish and Wildlife Monitoring Program mentioned in the previous section are: mallards and black ducks; starlings.

PCB's have been found in all of the starling samples taken in 1970, 1972 and 1974. The level of residues appears to be declining over this period with national arithmetic means of 0.65 ppm, 0.43 ppm and 0.12 ppm for the three years respectively⁹.

Results of sampling of mallards in 1970 and 1972⁹ are shown by flyway on Figure 2.1-3. Residues are highest in the Atlantic flyways, with average concentrations more than double that of any other flyway and more than 10 times greater in some cases. Samples of black ducks were also taken in the Atlantic flyways in 1969 and 1972 and the mean PCB concentration was constant at 1.36 ppm.

In the 1969 mallard study⁹ not only did mallards from the Atlantic flyway show the greatest average PCB concentration, but with the exception of Maryland all of the states in the Atlantic flyway had averages exceeding 0.5 ppm with the highest residues from New Hampshire southward through Delaware. In the Mississippi flyway, residue levels were highest in states bordering the Great Lakes, generally diminishing as sampling moved southward.

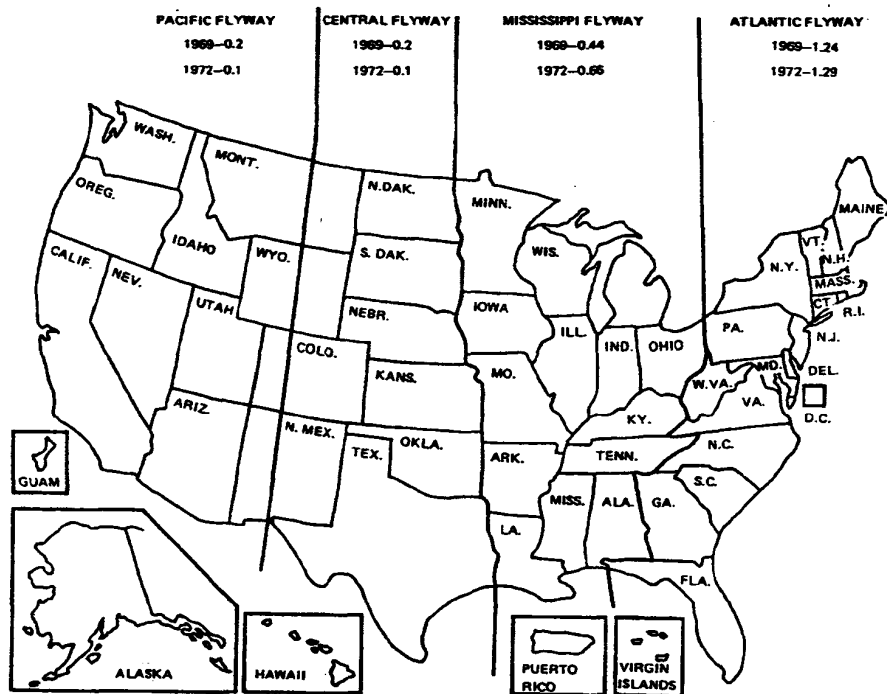


FIGURE 2.1-3 PCB'S IN MALLARDS (AVERAGES, WINGS, PPM, WET WEIGHT BASIS)

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REFERENCES, Section 2.1

1. Carey, Ann, 1975, EPA National Soil Monitoring Program, unpublished.
2. Crump-Wiesner, J.S., H.R. Feltz and M.L. Yates, J. Research USGS, 1, 603-607 (1972).
3. Haile, C.L., G.D. Veith, G.F. Lee and W.C. Boyle, Chlorinated Hydrocarbons in the Lake Ontario Ecosystem (IFYGL 1975), unpublished EPA report, EPA-660/3-75-022.
4. Heath, R.G. and S.A. Hill, Pesticides Monitoring Journal, 7, 153-163 (March 1974).
5. Henderson, C., A. Inglis and W.L. Johnson, Pesticides Monitoring Journal, 5, 1-11 (1971).
6. Martin, W.E. and P.R. Nickerson, Pesticides Monitoring Journal, 6, 33-40 (June 1972).
7. National Fish and Wildlife Monitoring Program, Results of Freshwater Fish Monitoring 1970-1973, U.S. Fish and Wildlife Service, U.S. Department of the Interior, Washington, DC (unpublished).
8. PCB Data Base, October 1972 to (partial) 1975, U.S. Geological Survey, Quality of Water Branch, Reston, VA.
9. Walker, Charles R., The Occurrence of PCB's in the National Fish and Wildlife Monitoring Program, presented at the National Conference on Polychlorinated Biphenyls, Chicago, Illinois, November 19-21, 1975.

2.2 Data from Localized Monitoring Efforts - Lakes

Figure 2.2-1 is provided in order to display the relationship of the different lakes in the Great Lakes region as discussed in 2.2.1 - 2.2.5.

2.2.1 Lake Ontario

Lake Ontario is one of the lesser studied Great Lakes for PCB's. A thorough study of chlorinated hydrocarbons in the Lake Ontario ecosystem was performed in 1972 by Hails, Veith, Lee and Boyle.⁶ Samples of various media were taken from 19 different locations in Lake Ontario during the summer of 1972, as indicated in Figure 2.2-2, and significant concentrations of PCBs were reported in all media. Findings for water, sediment and net plankton are summarized in Table 2.2-1. Other than the south shore areas off Oswego (77 ppt) and the north of the Niagara River (97 ppt), the PCB content of the Lake Ontario water appears relatively uniform in the range of 35 to 56 ppt, with an average of 45 ppt. PCB concentrations in sediments around the south shore areas off the mouths of the Welland Canal and Niagara River and off Oswego averaged more than twice the concentrations found at the four other sites (means of 184 ppb vs. 72 ppb). This led the authors to conclude that the Niagara and Oswego Rivers may be important sources of PCB associated with settleable particulates. Plankton samples were not taken at the south shore sites; lake wide levels averaged 7.2 ppm.

Fish samples selected in the same study found mean PCB concentrations on a whole fish basis in smelt (2.65 ppm) similar to those reported in Lake Michigan smelt. Mean PCB levels in alewives (2.35 ppm) were lower than values reported for Lake Michigan alewives (4.6 ppm). Bottom feeding slimy sculpin, which are less migratory than the latter two species, exhibited greater station to station variability in PCB levels, with a lake wide average of 4.63 ppm. Average concentrations in *Cladophora* were 315 ppb and for benthic fauna were 471 ppb. Samples were not taken consistently across media at stations and the results suffer accordingly, but the authors do draw one of the few estimates of accumulation factors for chlorinated hydrocarbons. They estimate relative concentrations as 1; 2500; 10,000; 150,000; and 300,000 for water, sediment, benthos, net plankton and fish, respectively.

Kaiser¹⁰ shows PCB levels in two 1973 fish samples from northern Lake Ontario as 5.99 ppm (total PCB, fat, northern longnose gar) and 2.38 ppm (total postanal fins, northern pike), magnitudes considered comparable to those of other fishes from Lake Ontario.

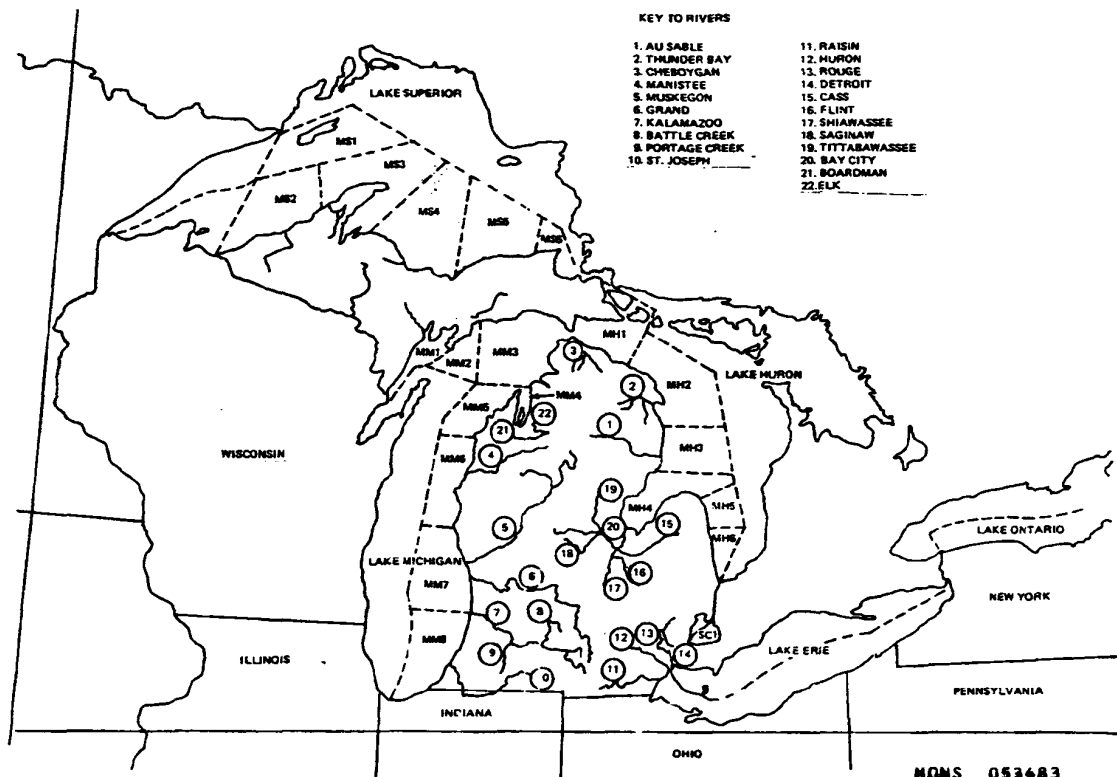


FIGURE 2.2-1 THE GREAT LAKES (AND RIVERS IN MICHIGAN)

Table A-1
PCB Concentrations, Lake Ontario Ecosystem
Summer 1972

<u>Sample Location</u> <u>(map reference)</u>	<u>Water</u> <u>(ppb)</u>	<u>Sediment</u> <u>(ppb dry)</u>	<u>Net Plankton</u> <u>(ppm dry)</u>
1	49		3.4
8	35		
10			10.6
12		285	
13	97	155	
30	44	80	
36	45	43	7.6
45			3.6
46		79	
60	40	84	
75	56		11.8
90	77		
91		158	
96			6.0

SOURCE: Haile, C.L., G.D. Veith, G.F. Lee and W.C. Boyle, Chlorinated Hydrocarbons in the Lake Ontario Ecosystem (IFYGL), EPA Report. EPA 660/3-75-022 (1975).

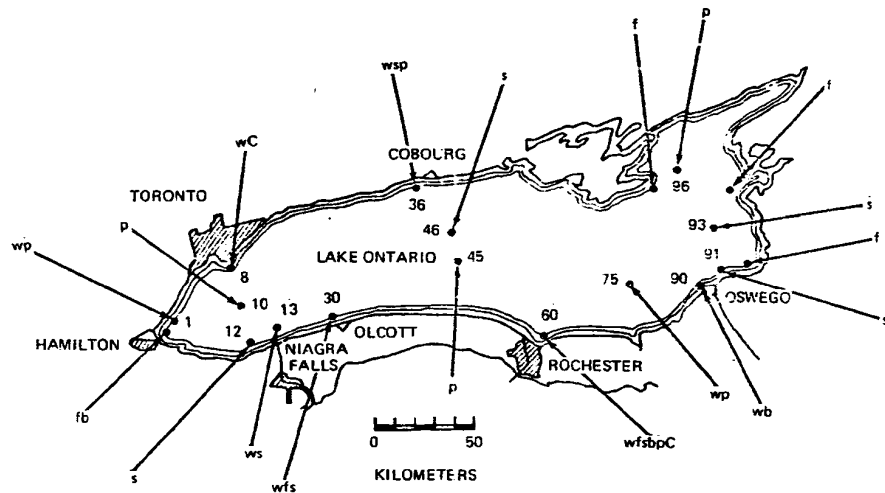


FIGURE 2.2-2 LAKE ONTARIO SAMPLING SITES FOR CHLORINATED HYDROCARBON ANALYSIS. NOTATIONS ARE: f-FISH, w-WATER, s-SEDIMENT, p-PLANKTON, C-CLADOPHORA, b-BENTHOS. STATION NUMBERS ARE IFYGL STATION IDENTIFIERS.

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2.2.2 Lake Erie

Several studies of PCB concentrations in fish samples from Lake Erie are summarized in Table 2.2-2. Levels are generally lower than those reported from Lake Michigan and Lake Superior, but are inconclusive other than demonstrating the presence of PCB's in the lake water. Water measurements in tributaries to Lake Erie including the Rouge river, which is tributary to the Detroit River are in Table 2.2-3, the Raisin and Rouge Rivers show relatively high levels of concentration when contrasted to the concentration levels in fish in the preceding table.

Table 2.2-2

Mean PCB Levels in Fish, Lake Erie
(ppm, whole fish)

<u>Species</u>	<u>1970^a</u>	<u>1972^b</u>	<u>1973^c</u>
Carp	2.0		9.3
Catfish	4.4		
Drum	1.1		0.9
Yellow Perch	0.8	0.25	Trace
Salmon	2.1		
Walleye			0.5
White Bass	2.1	1.07	2.5
Smallmouth Bass		0.71	

SOURCES: ^a Carr, R.L., C.E. Finsterwalder and M.J. Schibl, Pesticides Monitoring Journal, 6, 23-26 (1972).

^b Kelso, J.R.M. and R. Frank, Transactions American Fisheries Society, 103, 577-581 (1974).

^c 1973 Great Lakes Environmental Contaminant Survey - Data Summary and Analysis, Bureau of Consumer Protection, Michigan (1973).

Table 2.2-3

PCB Concentrations in Michigan Tributaries
to Lake Erie in 1971-72 and June 1973 in
ppb as Aroclor 1254

<u>River</u>	<u>Mean PCB Concentration</u>	<u>Range (1971-72)</u>	<u>1973</u>
Raisin	0.210	< 0.068-0.500	< 0.010
Huron	0.012	< 0.010-0.039	< 0.010
Rouge	0.470	0.058-1.600	0.460*
Detroit	0.020	< 0.010-0.053	< 0.010

* Aroclor 1242

SOURCE: Hesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, June 1973.

2.2.3 Lake Superior

The results of several available fish studies are presented in Table 2.2-4 for different species of fish. Lake trout are in the highest trophic level within the lake and biological accumulation should result in this species possessing some of the highest concentrations of PCB's.

The study by Veith and Glass¹³, summarized in the table, drew samples from three areas in the western portion of the lake. There was variability in the levels of PCB's in fish caught in different areas, but no conclusions are drawn in the study. Samples from the Apostle Island region (Wisconsin) had higher mean concentrations for all species than those from the other two regions (Minnesota). Parejko and Johnston¹⁴ note that the biphenyls containing lower percent concentrations of chlorine predominated in the sample. The latter study involved tests for correlation between factors of age, sex, geographical location and concentration level; surprisingly, no significant correlations were discovered.

The geographic distribution of lake trout samples from the 1972-1974 Great Lakes Environmental Contaminant Survey⁵ is detailed in Table 2.2-5. As regards recent screening of fish against the FDA guideline, Kleinert¹⁵ reports that of 64 fish samples collected in the nearshore waters during 1974, none exceeded the 5 ppm guideline and only two exceeded a level of 1 ppm.

Table 2.2-4

Mean PCB Levels in Fish, Lake Superior
(ppm, whole fish)

<u>Species</u>	<u>1971^c</u>	<u>1972^a</u>	<u>1973</u>	<u>1974^e</u>
Burbot		0.7	1.4 ^a	
Chubs		0.9	1.6 ^b	
Herring		2.0	1.8 ^b	
Lake Trout	7.08	0.8	1.8 ^a	2.64 ^d
Long-Nose Sucker			0.9 ^a	1.15
Smelt		0.3	0.4 ^a	
Whitefish			0.3 ^b	

- SOURCES: ^a Veith, G.D. and G.E. Glass, PCBs and DDT in Fish from Western Lake Superior, U.S. EPA National Water Quality Lab., Duluth, Minnesota (1974).
- ^b 1973 Great Lakes Environmental Contaminant Survey - Data Summary and Analysis, Bureau of Consumer Protection, Michigan (1973).
- ^c Parejko, R. and R. Johnston, Uptake of Toxic Water Pollutants, (PCB) by Lake Trout. Project Completion Report, U.S. Dept. of the Interior, Office of Water Resources Research, Contract 14-01-0001-3522 (1973).
- ^d Willford, W.A., Contaminants in Upper Great Lakes Fishes, Presented at Great Lakes Fishery Commission, Upper Great Lakes Committee Meetings, Milwaukee, Wisconsin, March 1975.
- ^e Hesse, J.L., PCB Situation in Great Lake Fish, Report to Michigan Water Resources Commission, April 17, 1975.

Table 2.2-5
Mean PCB Levels in Lake Trout
from Lake Superior (ppm)

Lawn Variety		1-17"	17-20"	20-25"	25"
MS 1**	1972	---	---	---	---
	1973	2.4 (4)*	2.9 (1)	5.6 (3)	4.8 (4)
	1974	---	---	---	---
MS 2	1972	---	---	---	---
	1973	0.5 (3)	1.8 (3)	3.4 (3)	5.2 (2)
	1974	---	---	1.2 (3)	5.2 (1)
MS 3	1972	---	---	2.2 (6)	2.7 (3)
	1973	1.6 (12)	1.9 (7)	4.5 (8)	4.8 (11)
	1974	0.6 (3)	0.1 (2)	0.4 (9)	2.0 (12)
MS 4	1972	---	---	4.6 (3)	5.7 (8)
	1973	---	1.0 (6)	2.0 (6)	4.7 (9)
	1974	0.5 (2)	0.5 (2)	0.7 (4)	1.4 (3)
MS 5	1972	---	---	3.3 (6)	2.1 (3)
	1973	---	1.2 (3)	1.2 (3)	1.9 (3)
	1974	---	1.8 (2)	1.4 (4)	1.5 (6)
MS 6	1972	---	---	1.4 (3)	---
	1973	0.9 (3)	1.0 (3)	1.5 (3)	1.3 (3)
	1974	2.2 (8)	0.4 (2)	2.8 (7)	2.6 (5)

Fat or Siscowet Variety

MS 1	1974	0.5 (3)	3.6 (2)	1.9 (4)	3.8 (3)
MS 2	1974	2.5 (5)	6.2 (10)	11.3 (6)	3.3 (2)
MS 3	1974	4.4 (6)	12.6 (2)	7.4 (7)	6.8 (7)
MS 4	1974	12.7 (2)	5.4 (8)	---	6.1 (6)

*Concentrations in parts per million (ppm) in fillet; wet weight.
Number of samples in parentheses ().

**Refers to geographic area in Figure 2.2-1.

SOURCE: Heese, J.L., Contaminants in Great Lakes Fish, Staff Report,
Michigan Water Resources Commission, Department of Natural
Resources, (1975).

2.2.4 Lake Michigan

Lake Michigan is the most heavily studied of the Great Lakes. It has been established that the lake contains the highest concentrations of agricultural pesticides due, in part, to the large usage in the watershed relative to the flushing period for the lake and to the relatively low biomass density. There were seizures of Lake Michigan fish by the FDA during 1975. Samples from a shipment of Lake Michigan Chinook and Coho Salmon in May 1975 were found to exceed the 5 ppb guideline.² PCB levels in these fish ranged from 7.6-10.9 ppm. Hesse⁷ reports a February 1975 seizure of large, surplus salmon exceeding the FDA guideline. In May 1975² a seizure of chubs resulted in analysis which showed that concentrations did not exceed the guideline. Such activities, however, have dramatized the hazards to both the lake and its fishing industry. In June, 1975, the Secretary of the State of Wisconsin Department of Natural Resources, based on evidence indicating that most large trout and salmon contain PCB's at levels exceeding the 5 ppm tolerance level, concluded that most fish over 24 inches in length appear to have excessive levels.

To provide a broad historical perspective, data from several studies of Lake Michigan fish are assembled in Table 2.2-6. The question of trend in the levels of fish contamination has been addressed by both Hesse⁸ and Willford²¹, referring specifically to the data of Table 2.2-7. Both conclude that the situation has generally remained static since 1972. Statistical analyses show no significant differences in the levels of the three species over the three year period 1972-1974. Data from the Great Lakes Environmental Contaminant Survey for this period for lake trout is detailed, by sampling area, in Table 2.2-8. The sample sizes are generally small and, while not allowing for rigorous statistical analysis, document the presence of a widespread PCB problem in lake trout of larger sizes and an intensification of the problem in southern Lake Michigan. The general conclusions that larger fish such as brown, lake and rainbow trout and chinook and coho salmon contain PCB residues at levels exceeding the FDA guideline, that concentrations increase with the percentage of fat and the size of the fish, and that levels found in the southern portion of the lake exceed those in the northern portion are supported by various studies².

The results of some earlier (1971-72) fish sampling undertaken by the Illinois EPA³ found PCB levels in the edible portion of five species (yellow perch, chub, carp, coho salmon and alewife) generally below the 5 ppm tolerance limit. This is in apparent contradiction to the later studies discussed in the preceding paragraph - especially since the Illinois samples came from the southern portion of the lake. Data from this study is included in Table 2.2-6. There are, of course, many variables which impact on the interpretation of data from fish sampling lipid content, fish size and age, season of capture, location, etc. Thus, mean readings may not be truly representative although this statistic is commonly used to provide broad summarization of an abundance of data.

Measurements taken on Lake Michigan open waters and sediment tend to show results which are consistent with reported sediment data from other sections of the country (see section 2.1.3), and somewhat higher readings for concentrations in whole water. The Illinois EPA has found tributary sediments with higher concentrations than those from open waters (1971): averages of 23.06 ppb as Aroclor 1242 and 14.66 ppb Aroclor 1254 for the former contrasted with 95.77 ppb Aroclor 1242 and 32.27 ppb Aroclor 1254 for the latter⁴. Whole water concentrations in tributaries analyzed as Aroclor 1242 or 1254 ranged from 0.1 to 4.0 ppb during the period 1971-1974². PCB concentrations measured by the Illinois State Board of Health in tributaries to Lake Michigan during 1973-1974 ranged from 0.01 to 0.09 ppb.

The Milwaukee River, a Wisconsin tributary to Lake Michigan was sampled in August 1969 for PCB's²⁰; concentrations of Aroclors 1260 and 1242 were in the ranges trace to 0.26 ppb and trace to 2.07 ppb, respectively. The high Aroclor 1242 reading was validated by a repeat measurement (of 2.80 ppb in February 1970) and attributed to combined sewer outfalls and contaminated industrial cooling waters. Estimates of PCB concentrations in sewage treatment plant effluents in March, 1970, ranged from 0.04 ppb to 0.25 ppb, but the effluent from a chemical plant had a concentration of 2.50 ppb. This led the authors to conclude that PCB's were discharged to natural waters through municipal and industrial wastes and that PCB's in such large ecosystems as Lake Michigan have resulted in part, through water transport from metropolitan areas. This certainly is true; unfortunately no follow-up studies were performed to estimate the effect of both controls and increased attention to the PCB problem.

With the exception of a contamination problem in the Kalamazoo River, most PCB measurements in Lake Michigan tributaries within the state of Michigan are at levels in whole water of less than 0.1 ppb. Data showing levels identified in 1971-1972 are in Table 2.2-9. The Kalamazoo River was the subject of studies in both 1971 and 1972⁸. Concentration levels were higher downstream from Battle Creek, and some sources of contamination were identified.

Fifty four fish samples were collected from 15 stream sections on the Kalamazoo River in July 1971⁴. Measurable concentrations were found in nearly all fish samples tested with concentrations ranging from less than 0.01 to 109.9 ppm in edible portions of fish on a wet weight basis. Those fish from the north and south branches and the main stream of the river down to Battle Creek had low concentrations ranging from 0.01 to 0.33 ppm. Downstream from the Battle Creek wastewater treatment plant the levels in fish increased ranging from 0.82 to 18.75 ppm and remained high downstream with levels below Kalamazoo ranging from 1.35 to 109.9 ppm⁴.

Settleable solids were only sampled at eight stations in 1971 with levels identified ranging from 0.01 to 0.422 ppm⁴. The levels in the main stream were 10 to 20 times higher than those in the north and south branches and gradually increased downstream. The sample from the Battle Creek River had the highest concentration in the watershed indicating that the tributary contributes significantly

to the total problems in the mainstream.

Since the Kalamazoo River is the most polluted input to Lake Michigan further sampling to identify possible sources of PCB load to the environment was conducted in the vicinity of the City of Kalamazoo in 1972⁴. PCB concentrations from the discharge of several industries and a wastewater treatment plant were below the limit of detectability. However, Portage Creek, which receives effluents from several industries including two paper mills, had 0.47 ppb of Aroclor 1242. Settleable solids that were collected showed concentrations ranging from 0.23 to 2.63 ppm at eight of the ten stations. The two stations that did not have significant concentrations were upstream from the paper mill ponds. Sediment core samples taken from the Bryant paper mill ponds had concentrations up to 368.7 ppm as deep as six to eight inches.⁵

Further data collected in the spring of 1973 on settleable solids are presented in Table 2.2-10 demonstrating considerable sensitivity of measurements to sampling intervals. The levels detected in 1975 were also generally higher for the Kalamazoo River than were detected in 1971.

Table 2.2-6
Mean PCB Levels in Lake Michigan Fish
(ppm, whole fish)

<u>Species</u>	<u>1971^b</u>	<u>1972^d</u>	<u>1973^f</u>	<u>1974^e</u>
Alewife	2.84 ^a , 4.6	2.4		
Brown Trout	7.3			
Carp	2.04 ^a , 4.2	3.9		
Chub	2.85 ^a , 6.0	7.0, 2.83 ^a	4.48	
Chinook Salmon	11.4	12.4	6.4	
Coho Salmon	1.68 ^a , 11.5	11.2, 10.93 ^a	4.9, 12.17 ^e	10.45
Lake Trout	13.53 ^c , 15.5	7.4, 12.86 ^a	18.93 ^e	22.91
Perch	5.8	0.4		
Rainbow Trout	9.3			
Red Sucker	3.0			
Smelt	2.7		1.6	
White Sucker	3.9			
Whitefish	3.0	0.7	0.9	
Menominee		1.1	1.0	
Suckers		1.0	0.45	
Steelhead		6.0		
Bloater Chubs		5.66 ^e	5.24 ^e	5.57
Yellow Perch	0.22 ^a	0.3 ^a	0.4	

SOURCES:

^aU.S. EPA, Pesticide Monitoring Programs: Lake Michigan and Tributaries in Illinois, EPA 600/3-74-002.

^bVaith, G.D., Chlorinated Hydrocarbons in Fish from Lake Michigan, University of Wisconsin, Madison, Wisconsin, unpublished report on EPA Project 16020 PBE, (1973).

^cU.S. EPA, An Evaluation of DDT and Dieldrin in Lake Michigan, EPA-R3-72-003, (1972).

^dHesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, (June 1973).

^eBremer, K.E., State of Concerns of the Lake Michigan Toxic Substances Committee Related to Polychlorinated Biphenyls (draft) U.S.EPA, (1975).

^f1973 Great Lakes Environmental Contaminant Survey-Data Summary and Analysis, Bureau of Consumer Protection, Michigan, (1973).

Table 2.2-7
Concentrations of PCBs in fall collections of Lake Michigan
Bloaters and Lake Trout off Saugatuck, Michigan, and
Coho Salmon from between Ludington and Frankfort, Michigan

<u>Species and Year</u>	<u>Number of Fish</u>	<u>Average Length (mm)</u>	<u>Total^b PCBs (ppm)</u>
<u>Bloaters</u>			
1972	120 ^c	255	5.66 (0.95)
1973	160 ^c	250	5.24 (0.37)
1974	110 ^c	257	5.57 (0.31)
<u>Coho salmon</u>			
1972	10	693	10.93 (2.12)
1973	29	620	12.17 (0.77)
1974	30	665	10.45 (0.92)
<u>Lake Trout</u>			
1972	9	648	12.86 (4.75)
1973	30	602	18.93 (2.08)
1974	30	616	22.91 (3.73)

^aAnalysis performed by Great Lakes Fishery Laboratory.

^bConcentrations in whole fish, wet weight with 95% confidence interval in parentheses.

^cComposite samples, 10 fish per sample.

SOURCE: Bremer, K.E., State of Concerns of the Lake Michigan Toxic Substances Committee Related to Polychlorinated Biphenyls (draft) U.S. EPA, (1975).

Table 2.2-8
Mean PCB Levels in Lake Trout
from Lake Michigan (ppm)

		<17"	17-20"	20-25"	>25"
MM 1**	1972	----	----	----	----
	1973	2.2 (1)*	3.6 (2)	----	----
	1974	0.7 (1)	1.6 (2)	----	----
MM 2	1972	----	----	----	----
	1973	----	----	----	----
	1974	----	----	----	----
MM 3	1972	----	----	----	11.1 (3)
	1973	2.6 (3)	2.4 (3)	----	10.6 (3)
	1974	----	----	----	----
MM 4	1972	----	----	----	6.5 (3)
	1973	2.6 (2)	1.8 (1)	----	8.5 (3)
	1974	1.0 (3)	3.1 (3)	----	----
MM 5	1972	----	----	----	----
	1973	----	----	5.8 (1)	7.3 (2)
	1974	----	----	7.5 (6)	9.6 (6)
MM 6	1972	2.4 (1)	----	----	4.1 (1)
	1973	----	6.4 (1)	7.1 (2)	11.0 (3)
	1974	1.1 (9)	2.5 (16)	5.6 (11)	9.6 (18)
MM 7	1972	2.7 (2)	----	6.8 (1)	7.3 (3)
	1973	----	----	----	11.2 (3)
	1974	2.4 (9)	----	8.9 (8)	11.9 (2)
MM 8	1972	----	5.8 (2)	6.4 (1)	12.4 (3)
	1973	5.1 (6)	8.2 (3)	10.1 (4)	12.6 (4)
	1974	----	----	----	----

*Concentrations in parts per million (ppm) in fillet; wet weight.
Number of samples in parentheses ().

**Refer to geographic area in Figure 2.2-1.

SOURCE: Hesse, J.L., Contaminants in Great Lakes Fish, Staff Report,
Michigan Water Resources Commission, Dept. of Natural Resources
(1975).

Table 2.2-9
 Mean PCB Concentrations in Michigan Tributaries to the
 Lake Michigan Basin, 1971-72 and 1973
 (ppb as Aroclor 1254)

<u>River</u>	<u>1972-72</u>		<u>1973</u>
	<u>Average</u>	<u>Range</u>	
St. Joseph	0.013	<0.010-0.039	<0.010
Kalamazoo	0.065	0.019-0.097	0.040
Grand	0.041	0.011-0.080	0.033
Muskegon	0.010	<0.010-0.037	<0.010
Manistee	0.014	<0.010-0.039	0.037
Boardman	0.017	<0.010-0.044	0.018
Elk	0.012	<0.010-0.039	<0.010

SOURCE: Hesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, (June 1973).

Table 2.2-10

Concentrations of PCB's (polychlorinated biphenyls) in the settleable solids collected from the mouths of the Grand, Kalamazoo and St. Joseph Rivers; Spring 1973, for comparison of variable sampling periods. Concentrations in ppm on an oven-dry basis.

River	Sample	Sample Dates																Means
	Type ^a	3/21	3/23	3/30	4/2	4/4	4/6	4/9	4/11	4/13	4/20	4/27	4/30	5/2	5/4	5/11		
Grand	3X	3.24			1.6*	0.95	1.0	<0.1	0.93	1.58			0.83	3.5	0.53		1.43	
	Weekly		1.25	0.94			1.1			1.0	0.55	0.74			0.80	0.77	0.89	
	Biweekly			0.85						0.73		0.50				0.60	0.67	
	Monthly									1.41						0.50	0.96	
																	Mean = 0.99	
Kalamazoo	3X	6.7	27.5		2.08	<0.1	2.52	1.33	3.20	<0.1			3.11	3.50	3.75		4.72	
	Weekly		6.83	3.0			3.54			3.77	3.09	2.98			2.88	4.87	3.87	
	Biweekly			3.77						2.54		2.64				2.50	2.86	
	Monthly									2.11						3.14	2.63	
																	Mean = 3.52	
St. Joseph	3X												0.63	0.82			0.73	
	Weekly							2.13	0.68			0.95		0.83	1.21		1.16	
	Biweekly								0.85			0.75			0.95		1.24	
	Monthly											0.67			0.83		0.75	
																	Mean = 0.97	

^a3X = Sample collected Mon, Wed. and Friday

^bConcentration based upon a 1:1 ratio of Aroclor 1242 and 1251.

All other concentrations calculated as Aroclor 1242.

SOURCE: Monitoring for Polychlorinated Biphenyls in the Aquatic Environment, Michigan Water Resources Commission, (May 1973)

2.2.5 Lake Huron

Levels of PCB's in fish samples from Lake Huron are detailed in Table 2.2-11 from areas as indicated in Figure 2.2-1. The Saginaw Bay area, designated as MU-4 on the map, has been the object of detailed analysis, and significant concentrations have been detected. Water measurements in tributaries to Lake Huron, including the Saginaw Bay area, are in Table 2.2-12. Concentrations in fish taken from the Saginaw River in 1971 were as high as 165 ppm as shown in Table 2.2-13. The waste water treatment plant on the Saginaw River is the Bay City facility. During 1971, this plant had an average effluent concentration of 120 ppb with a high of 340 ppb.

After control measures were initiated by some industrial sources in October 1972, there was a sharp drop in PCB levels at the mouth of the river. Levels measured in 1972 ranged from <0.020 to 0.640 ppb and in 1973 from <0.100 to 0.200 ppb. This is one of the noteworthy examples of controls effecting a marked change in PCB contamination.

Table 2.2-11
Mean PCB Levels, Whole Fish
in Lake Huron (ppm)

<u>Species</u>	<u>1973</u>
Brown Trout	3.6 (MH-2)*
Catfish	4.9 (MH-4)
Menominee	0.4 (MH-1)
Yellow Perch	0.2 (MH-1)
Salmon	8.4 (MH-1,3)
Walleye	1.1 (MH-1)
Smelt	0.6 (MH-3)
Whitefish	0.5 (MH-1)

*Refer to geographic area in Figure 2.2-1

SOURCE: 1973 Great Lakes Environmental Contaminant Survey - Data
Summary and Analysis, Bureau of Consumer Protection, Michigan
(1973).

Table 2.2-12
Mean PCB Concentrations in Michigan Tributaries
to Lake Huron in 1971-72 and 1973
(ppb as Aroclor 1254)

<u>River</u>	<u>1971-72</u>		<u>1973</u>
	<u>Average</u>	<u>Range</u>	
Saginaw	1.100	0.450-2.900	0.210 ^b
Cass	0.014	<0.010-0.048	<0.010
Flint ^a	0.078	0.010-0.150	<0.010
Shiawassee ^a	0.029	<0.010-0.073	<0.010
Tittabawassee ^a	0.140	<0.022-0.230	<0.010
Au Sable	<0.010	<0.010-0.010	0.013
Thunder Bay	0.023	<0.010-0.037	<0.010
Cheboygan	0.032	<0.010-0.053	<0.010

^aTributaries to Saginaw River

^bAroclor 1242

SOURCE: Hesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, (June 1973).

Table 2.2-13
Concentrations of polychlorinated biphenyls (PCB's)
in Fish from Saginaw River, December 7, 1971
(ppm; wet weight)

<u>Species</u>	<u>Location</u>	<u>Length</u>	<u>Percent fat</u>	<u>PCB's based upon 1242 standard</u>
Perch	Karn Weadock Discharge Channel	9.0	1.3	16.3
Carp	" " " "	21.0	0.9	8.8
Catfish	" " " "	8.0	7.0	37.1
Catfish	" " " "	7.5	4.9	47.9
Carp	U.S. Coast Guard Station	23.0	---	48.0
Carp	" " " "	24.0	10.5	20.4
Carp	" " " "	20.0	6.5	15.5
Carp	" " " "	24.0	5.9	45.8
Carp	" " " "	21.0	4.6	30.2
Pike	" " " "	27.0	1.6	16.6
Pike	" " " "	23.0	1.1	6.9
Gizzard Shad	" " " "	14.0	17.5	165.3
Gizzard Shad*	" " " "	6.0	15.3	32.5
Gizzard Shad*	" " " "	4.5	15.0	161.9
Gizzard Shad*	" " " "	5.0	17.0	77.0
Gizzard Shad*	Zilwaukee Bridge	4.5	15.7	24.1
Gizzard Shad*	" " "	5.0	9.6	52.0
Gizzard Shad*	" " "	5.0	8.7	10.4

*Concentration based upon analysis of whole fish. All others based upon edible portion only.

SOURCE: Hesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, (June 1973).

2.2.6 Cayuga Lake

In October 1970 lake trout were collected from Cayuga Lake in Ithaca, New York. Since these fish are marked each year when they are stocked in the lake their ages were accurately known. Table 2.2-14 shows the residues of PCB's identified along with the age, length, weight and sex of each fish. The peak heights of individual PCB isomers did not vary with the age of the fish indicating that there is no selective metabolism or storage of specific PCB isomers as the fish matures. However, the concentration of total PCB's does increase progressively with maturity. The variation in PCB concentrations among individual 11 or 12 year old fish may be due to differences among foraging, metabolic and excretory capabilities of the older fish.¹

Table 2.2-14
Residues of PCB's in Cayuga Lake Trout as a function
of maturity; j. juvenile.

Age (years)	Sex	Length (cm)	Weight (g)	PCB (ppm)
1	J			0.6
1	J			1.6
1	J			0.5
1	J			1.2
2	J	27.7	181	2.0
2	J	28.7	226	1.3
2	J	33.5	407	2.5
3	J	44.5	815	2.2
3	J	44.5	725	2.4
3	J	41.1	770	1.2
4	J	53.8	1310	3.5
4	J	50.3	1160	4.1
4	J	55.1	1359	5.1
5	M	61.0	2030	5.7
6	M	63.5	2440	3.4
6	M	66.4	2850	9.7
6	F	68.3	2310	8.6
7	M	63.5	2260	4.0
7	M	68.9	3300	5.5
7		59.7	1990	10.5
8	F	75.2	3390	17.5
8	M	71.6	2805	13.4
8	F	69.0	3300	4.5
9	F	71.2	3390	30.4
11	M	80.3	4200	12.4
12	M	71.6	2535	13.4
12	M	75.5	3120	26.2
12	F	70.6	3440	7.4

SOURCE: Bache, C.A., F.W. Sarum, W.D. Youngs and D.J. Lisk, Science,
177, 1191-1192, (1972).

REFERENCES, Section 2.2

1. Besche, C.A., F.W. Sarum, W.D. Youngs and D.J. Lisk, Science, 177, 1191-1192, (1972).
2. Bremer, K.E., State of Concerns of the Lake Michigan Toxic Substances Committee Related to Polychlorinated Biphenyls (draft) U.S. EPA, (1975).
3. Carr, R.L., C.E. Finsterwalder and M.J. Schibi, Pesticides Monitoring Journal, 6, 23-26, (1972).
4. Evaluation of the Aquatic Environment of the Kalamazoo River Watershed, Part A, Biological Survey, June-August 1971, Michigan Water Resources Commission, (May 1972).
5. 1973 Great Lakes Environmental Contaminant Survey - Data Summary and Analysis, Bureau of Consumer Protection, Michigan, (1973).
6. Hnile, C.L., G.D. Veith, G.F. Lee and W.C. Boyle, Chlorinated Hydrocarbons in the Lake Ontario Ecosystem (IFYGL), EPA Report EPA 660/3-75-022, (1975).
7. Hesse, J.L., Contaminants in Great Lakes Fish, Staff Report, Michigan Water Resources Commission, Dept. of Natural Resources, (1975).
8. Hesse, J.L., Status Report on Polychlorobiphenyls in Michigan Waters, Michigan Water Resources Commission, (June 1973).
9. Hesse, J.L., PCB Situation in Great Lake Fish, Report to Michigan Water Resources Commission, April 17, 1975.
10. Kaiser, K.L.E., Science, 185, 523-525, (1974).
11. Kelso, J.R.M. and R. Frank, Transactions American Fisheries Society, 103, 577-581, (1974).
12. Kleinert, S.J., Environmental Status of PCBs in Wisconsin, Wisconsin Dept. of Natural Resources, unpublished, (1975).
13. Monitoring for Polychlorinated Biphenyls in the Aquatic Environment, Michigan Water Resources Commission, (May 1973).
14. Porejko, R. and R. Johnston, Uptake of Toxic Water Pollutants (PCB) by Lake Trout. Project Completion Report; U.S. Dept. of the Interior, Office of Water Resources Research, Contract 14-01-0001-3522, (1973).
15. Polychlorinated Biphenyl Survey of the Kalamazoo River and Portage Creek in the Vicinity of the City of Kalamazoo, 1972, Michigan Water Resources Commission, (January 1973). MONS 053505
16. U.S. EPA, An Evaluation of DDT and Dieldrin in Lake Michigan, EPA-R3-72-003, (1972).

17. U.S. EPA, Pesticide Monitoring Programs: Lake Michigan and Tributaries in Illinois, EPA 600/3-74-002.
18. Veith, G.D., Chlorinated Hydrocarbons in Fish from Lake Michigan, University of Wisconsin, Madison, Wisconsin, unpublished report on EPA Project 16020 PBE, (1973).
19. Veith, G.D. and G.E. Glass, PCBs and DDT in Fish from Western Lake Superior, U.S. EPA National Water Quality Lab., Duluth, Minnesota, (1974).
20. Veith, G.D. and G.F. Lee, Water Research, 5, 1107-1115, (1971).
21. Willford, W.A., Contaminants in Upper Great Lakes Fishes, Presented at Great Lakes Fishery Commission, Upper Great Lakes Committee Meetings, Milwaukee, Wisconsin, (March 1975).

2.3 Data from Localized Monitoring Efforts - Rivers

2.3.1 Iowa - Mississippi River

Monitoring Iowa rivers for pesticides concentrations over a period of years indicated that chlorinated hydrocarbon insecticides used in row crop agriculture were being carried into the rivers by soil erosion. Since fish are excellent biological compositors, measurement of trace elements in their tissues can give a picture of the relative pollution of a river. Therefore a study of the pesticide levels in the eggs of some fish from locations in Iowa was undertaken in the spring of 1971.²

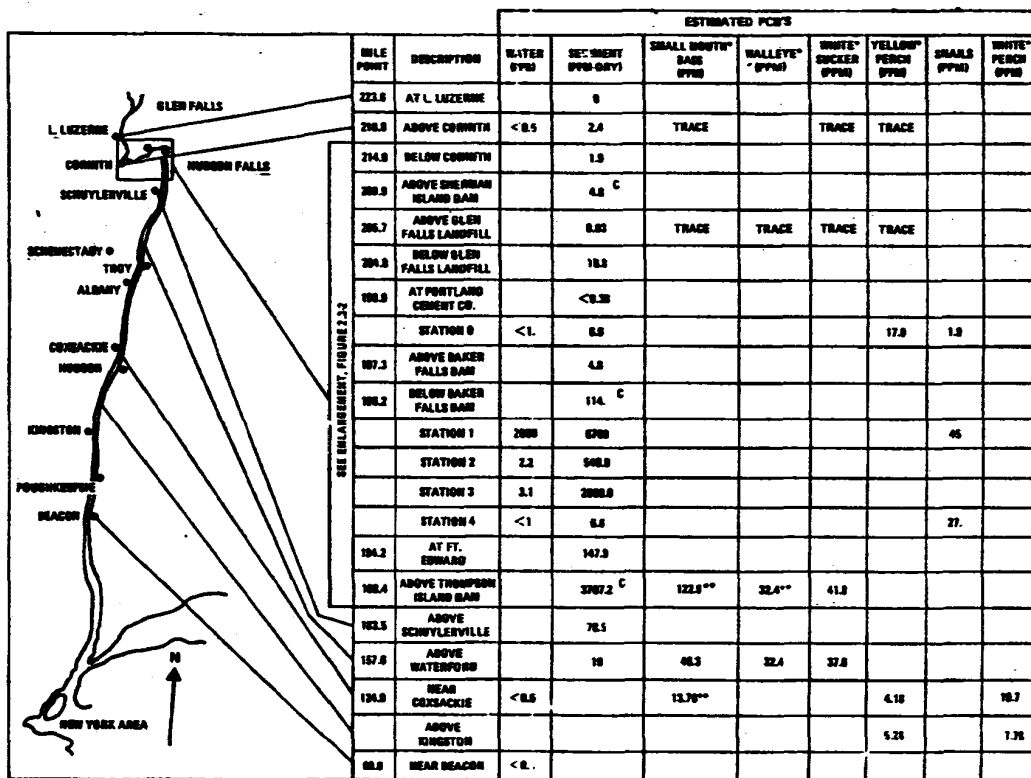
Two of the sites had measurable amounts of polychlorinated biphenyls. The PCB's detected match Aroclor 1254. The concentrations identified in the roe removed from the fish from these sites on the Mississippi were as follows:

<u>Site</u>	<u>Species</u>	<u>Date Collected</u>	<u>Length of Fish</u>	<u>Concentration in 15 grams of roe (ppm)</u>
Near Northern border	Channel Catfish	06-04-71	23.4	1.5
	Largemouth bass	05-20-71	16.4	3.2
	Walleye	04-16-71	27.5	4.2
Near Southern border	Channel Catfish	04-16-71	24.0	0.9
	Largemouth bass	04-15-71	17.5	2.9
	Walleye	04-13-71	24.3	5.5

The levels of PCB's found in the same species from the two locations are approximately the same indicating that the major source of these industrial chemicals is upstream from both of these sites.

2.3.2 New York - Hudson River

The Hudson River in New York State provides an interesting ecosystem in which to study PCB's, primarily because it is the receiving water for effluents from two plants of the General Electric Co., at Hudson Falls and Fort Edward. These plants use PCB's in the production of transformers and capacitors. Summaries of extensive sampling during 1975 of the Hudson River are presented in Figures 2.3-1 and 2.3-2. The GE plants appear to be the major contributors to the PCB residue levels in the river. Although trace levels of PCB's are evident above the GE plant outfall location, levels in water and sediment at Station 1 located at the outfall of the Fort Edward plant were as high as any levels measured in the country. In the immediate area downstream from this outfall, PCB concentrations in water exceed the equilibrium solubility level by more than a factor of 10. Major effects on the levels in sediment are noted more than 35 miles downstream from the outfalls. The data indicate elevated concentrations in aquatic life far from the outfalls: fish samples approximately 40 and 66 miles downstream from the outfalls showed PCB levels in excess of 5 ppm while the same species showed only traces of PCB's directly upstream from the outfalls. Since sediment samples above the plants also show some concentration there does appear to be some PCB source upstream of the plants.



C - MAXIMUM VALUE IN A CORE SAMPLE

** - VALUES ARE WEIGHTED AVERAGES OF SAMPLES OF FISH FROM 3 SIZE GROUPS

EXCEPT AS NOTED TAKEN AT VARIOUS TIMES IN 1976

- ONLY ONE FISH SAMPLED

SOURCES:

STATION 0-4: RADZIM, R.J. AND R.P. DAVID, INVESTIGATION OF POLYCHLORINATED

SUBSTANCES IN THE HUDSON RIVER, 1975, EPA REGION II

OTHER FISH DATA: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION,

DIVISION OF FISH AND WILDLIFE, 1976, ANALYSES OF PCB'S IN FISH FLESH

OTHER WATER DATA: NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION,

DIVISION OF PURE WATER, PCB MONITORING IN THE UPPER HUDSON RIVER BASIN, OCTOBER 1975

FIGURE 2.3.1 MAP OF HUDSON RIVER, NEW YORK, SHOWING DEVELOPED AREAS AND SAMPLING STATIONS WITH PCB LEVELS

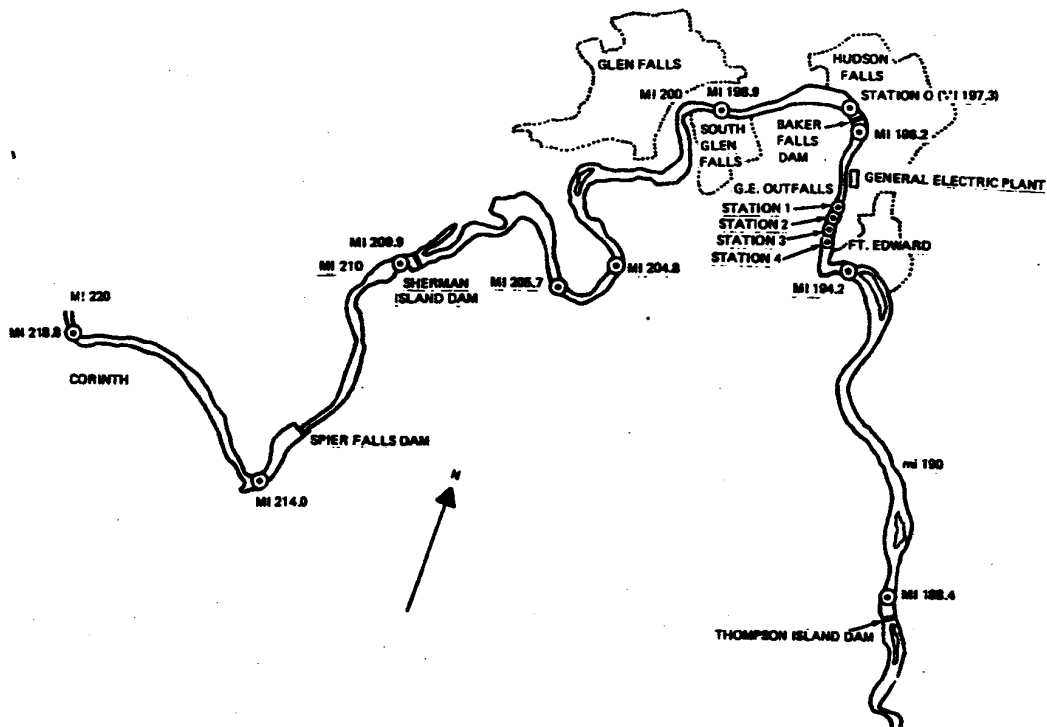


FIGURE 2.3-2 DETAILED MAP OF A PORTION OF THE HUDSON RIVER

2.3.3 Maryland - Chester River

This study was conducted in the Upper Chesapeake Bay in 1971-1972;¹ the study area is shown in Figure 2.3-3. The Bay and its tributaries receive chlorinated hydrocarbons as a result of industrial, agricultural and waste disposal activities occurring along the shorelines of these waterways and within the total watershed.

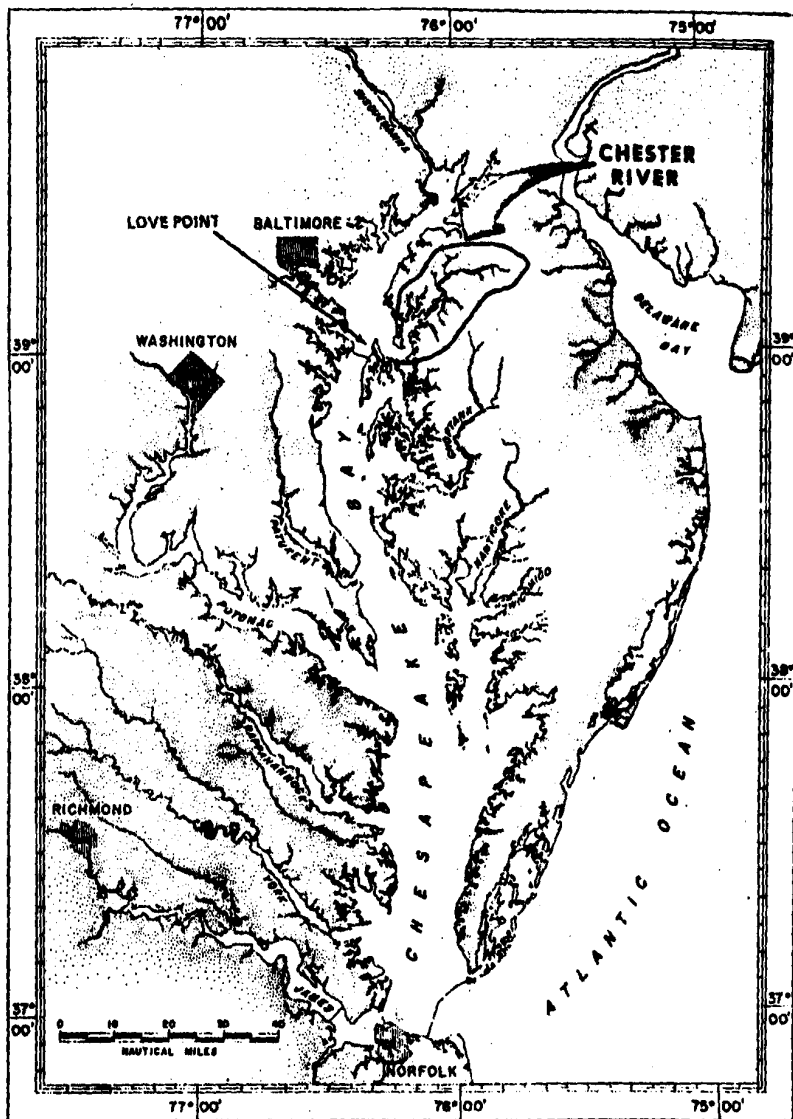
Sediment samples were collected approximately quarterly except for the last set which was taken early in order to collect data shortly after tropical storm "Agnes". The PCB's identified were almost exclusively Aroclor 1242. The first readings, taken in November 1971 ranged from 0-21 ppb with an average of 83 ppb. By April 1972 the average had climbed to 110 ppb with a range from 0-300 ppb. By June the readings taken ranged from 0-150 ppb with the average reduced to 53 ppb. After "Agnes" in July the average had again increased to 96 ppb with readings ranging from 0-180 ppb.

The explanation given for the variations is that during the early spring, massive amounts of suspended sediment from the Susquehanna River entered the Chester River and were carried upstream in the flow of water along the river bottom. The peak sediment loads from the Susquehanna generally come at the end of February, decreasing abruptly after the end of March due to a reduced flow rate of the river. An equilibrium net transport develops in the Chester River in April. In May, fine sediments were transported slowly into the Bay. However, over the year there is a movement of sediment along the river bottom into the river from the Bay. Thus, the upper Chesapeake Bay, i.e., the Susquehanna River is the major source of suspended sediments in the lower tidal portion of the Chester River.

The average values and ranges identified in biota of the Chester River taking into account variability due to seasonal fluctuations, distributional differences resulting from sample location, and species as well as individual uptake differences were as follows:

	<u>Average (ppb)</u>	<u>Range (ppb)</u>
Oysters	55	16-250
Soft shelled clams	58	13-180
Fish	18.5	2-570
Crabs	20	0.4-51

Based on data collected June 6, 1972 from the nine stations along the main river course it was determined that concentrations of PCB's decreased as a function of distance up river from its mouth at Love Point in its upstream direction at the rate of 4.20 ppb/Nautical mile.



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FIGURE 2.3-3 CHART OF CHESAPEAKE BAY SHOWING MAJOR TRIBUTARIES AND LOCATION OF THE CHESTER RIVER.

2.3.4 Connecticut

In October 1974 the State of Connecticut intensively sampled bottom sediment in rivers and lakes throughout the state. The results are shown in Figure 2.3-4, based on a computer mapping provided by the Connecticut District Office of the U.S. Geological Survey.⁶ The data show PCB contamination to be both widespread and at high levels throughout the state, particularly around the highly developed areas of Hartford, New Haven, Stamford-Greenwich and all along the Housatonic River flowing from Massachusetts. The state had sampled mostly whole water for PCB's prior to 1974, with no appreciable residue levels discovered, but now has switched to a yearly bed material determination. The readings for the baseline period of October 1974 are to be updated yearly.

REFERENCES, SECTION 2.3

1. Clarke, W.D. Ed., Chester River Study, A Joint Investigation by the State of Maryland Department of Natural Resources and Westinghouse Electric Corporation, Vol. I-III, November 1972.
2. Johnson, L.G., Morris, R.L., Bulletin of Environmental Contamination and Toxicology, II, 503-510, (1974).
3. Nadeau, R.J. and R.P. Davis, Investigation of Polychlorinated Biphenyls in the Hudson River, 1974, U.S.E.P.A., Washington, D.C., 21 pp.
4. New York State Department of Environmental Conservation, Division of Fish and Wildlife, 1975, Analyses of PCB's in Fish Flesh, unpublished report.
5. New York State Department of Environmental Conservation, Division of Pure Waters, PCB Monitoring in the Upper Hudson River Basin, October 1975, unpublished report.
6. Thomas, Chester E., Assistant District Chief, Connecticut District, U.S. Geological Survey, Water Resources Division, personal communication, July, 1975.

2.4 Data from Localized Monitoring Efforts - Marine Environment

2.4.1 Atlantic Ocean

In addition to the many PCB studies that have been conducted within the United States, a few studies have been carried out investigating the air, water and fish off the east coast of the United States. These studies, conducted between 1971 and 1974 covering Providence, Rhode Island; Grand Banks; Vineyard Sound; Georges Bank and Bermuda show PCB's to be extensively distributed over the Atlantic Ocean. The general sampling area is shown in Figure 2.4-1.

One of the few air studies that has been published was carried out by Harvey and Steinhauer¹¹ in 1973. Table 2.4-1 shows the sampling locations and Aroclor 1254 concentrations identified. The highest concentrations were in Vineyard Sound which is approximately 100-150 miles from the Boston, Hartford, New York, New Jersey complex. Over 1000 miles away at Grand Banks the concentrations were 100 times less than in Vineyard Sound. Figure 2.4-2 shows the relationship of atmospheric PCB levels with distance from these industrial areas. The seaward decrease appears to be exponential.

Later studies on PCB's in surface and subsurface waters were done by Harvey¹³. Although the concentration range across the northern North Atlantic is broad, from 1-150 ppt, the average was about 35 ppt in surface waters and 10 ppt at 200 meters depth. Looking at the lower latitudes it appears that the surface waters of the Sargasso Sea have slightly lower concentrations than other parts of the North Atlantic, averaging 27 ppt. The widespread PCB distribution implicates the atmosphere as a predominant mode of transport in the Atlantic with variations due to the seasicks, localized rainfall or discharges from ships.

During the period of February-June 1973, PCB concentrations in the marine atmosphere of the Bermuda - Sargasso Sea and Providence, Rhode Island area were measured by Bidleman and Olney¹. It is interesting to note that most of the PCB was trapped on the polyurethane foam collection surface suggesting that PCB's are in the atmosphere mainly as vapors rather than adsorbed onto particulate matter, or that they volatilize from the trapped particles collected on the glass fiber pre-filter. Table 2.4-1 gives the locations and levels identified as Aroclor 1242 or 1248.

Sargasso Sea surface water was also measured by Bidleman and Olney¹ in 1973. From Table 2.4-2 it can be seen that the concentrations were higher in the surface layer than in the subsurface samples.

Follow-up by Harvey¹², et. al., indicated that PCB concentrations in North Atlantic surface waters declined forty fold from 1972 to 1974 presumably following the cessation of certain industrial uses of those compounds. However, Longhurst and Radford dispute the decrease stating that either the analytical methods were inaccurate or Harvey's original estimate of the total amount of dissolved PCB's in the upper 200 m was incorrect. Harvey and Steinhauer have agreed¹⁷

that their extrapolation may well have been improper and planned more sampling for 1975.

In 1971 a seafood monitoring program¹⁰ was conducted on the East Coast of the United States. It is difficult to make interspecies comparisons but as can be seen in Table 2.4-3 the highest Aroclor 1260 level was in flounder from Jacksonville, Florida.

Table 2.4-1
PCB Concentrations Over the Western North Atlantic

Station	Sample volume (m ³)	ng/m ³
Bermuda	560	0.5 ^a
	480	0.4 ^a
	820	0.16 ^a
	500	0.15 ^a
	1070	0.59 ^a
	1320	0.30 ^a
	918	0.65 ^a
	1950	0.62 ^a
	1740	0.35 ^a
	732	0.52 ^a
	1300	0.61 ^a
	860	0.21 ^a
33°20'N, 65°14'W	300	1.6 ^a
34°39'N, 66°15'W	267	0.79 ^a
38°48'N, 69°14'W	222	0.72 ^a
40°32'N, 70°20'W	196	0.83 ^a
Georges Bank (41°40'N, 67°30'W)	105	1.4 ^a
	675	0.82 ^a
	660	0.58 ^a
	655	0.61 ^a
	640	0.80 ^a
	650	1.60 ^a
Vineyard Sound (41°20'N, 70°50'W)	105	3.9 ^a
	224	5.3 ^a
Grand Banks (45°16'N, 52°08'W)	780	0.05 ^a
	960	0.07 ^a
	840	0.10 ^a
	940	0.16 ^a
	540	0.05 ^a
Providence, R.I.	392	4.0 ^a
	1071	2.1 ^a
	744	5.8 ^a
	76	9.4 ^a

^aCalculated as Aroclor 1254

^aCalculated as Aroclor 1242 or 1248

SOURCE: Harvey, R.G. and W.G. Steinhauer, Atmospheric Environment,
Nature, 252, 387-388 (November 29, 1974).

Table 2.4-2
PCB's Measured in Sargasso Sea Area, 1973

<u>Location</u>	<u>Sample*</u>	<u>Ppt**</u>
29°56'N, 64°40'W	SM	11.2
	SS	1.6
30°45'N, 66°55'W	SM	4.4
	SS	<0.9
30°34'N, 66°59'W	SM	8.3
	SS	1.0
28°53'N, 65°07'W	SM	42.6 , 19.3
	SS	<0.9 , <0.9
29°56'N, 63°00'W	SM	3.8
	SS	<0.9
30°00'N, 64°30'W	SM	5.6
	SS	1.6
31°34'N, 63°49'W	SM	5.0
	SS	1.8
31°38'N, 63°57'W	SM	8.4
	SS	0.9

*SM - sample is surface microlayer

SS - sample is subsurface water

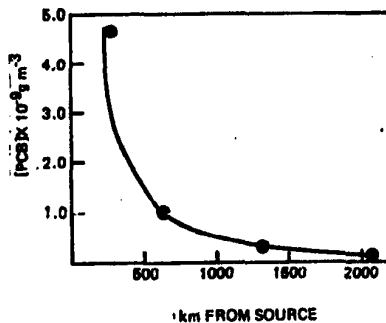
**PCB calculated as Aroclor 1260

SOURCE: Bidleman, T.F., and C.E. Olney, Science, 184, 516-518 (Feb. 8, 1974).



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FIGURE 2.4-1 ATLANTIC OCEAN SAMPLING SITES



SOURCE: HARVEY, G.R. AND W.G. STEINHAEUER, ATMOSPHERIC ENVIRONMENT, 8, 777-782, (1974).

FIGURE 24-2 RELATIONSHIP OF ATMOSPHERIC PCB LEVELS WITH DISTANCE FROM INDUSTRIAL AREAS

Table 2.4-3
PCB Residues in Seafood

<u>Species</u>	<u>Sample Quantity</u>	<u>Aroclor 1260 (ppm)</u>
JACKSONVILLE, FLA.		
Blue crabs	15	0.08
Shrimp	1 kg	0.60
Flounder	3	0.65
Weak fish	5	0.44
Drum	5	0.17
SAVANNAH, GA.		
Blue crabs	16	----
Shrimp	0.5 kg	----
Pilot shrimp	0.5 kg	----
Oysters	15	----
Razorback clams	28	----
Squid	5	----
Flounder	4	----
CHARLESTON, S.C.		
Blue crabs	10	----
Shrimp	1 kg	0.02
Oysters	>15	----
Squid	>15	----
Croaker	1	----
MOREHEAD CITY, N.C.		
Blue crabs	15	----
Shrimp	1 kg	----
Oysters	24	0.02
Clams	20	----
Scallops	12	----
Flounder	3	----
Spanish mackerel	2	----
Weak fish	2	----
Blue fish	2	----
Fish meal	0.5 kg	0.11
CHESAPEAKE BAY		
Blue crabs	25	0.02
Weak fish	3	0.49
Striped sea bass	3	0.02
Spot	5	0.10
Herring	10	----
DELAWARE BAY		
Blue crabs	15	0.13
Flounder	2	0.07
Weak fish	5	0.23
Striped bass	2	0.07
Mullet	5	0.21
Croaker	1	0.50

MCNS 053521

SOURCE: Markin, G.P., J.C. Hawthorne, J.L. Collins and J.H. Ford

2.4.2 Bay of Fundy

As early as 1969, PCB residues were identified in harbour porpoises from the Bay of Fundy, located in the northeast section of Maine³. Zitko, et. al.²⁴, identified Aroclor 1254 in a number of different fish ranging from 0.07 ppm in the muscle of herring and 0.21 ppm in the muscle of sea raven to 3.55 ppm in Herring Oil and 218 ppm in the liver of white shark. The species studied and the levels measured are listed in Table 2.4-4.

Table 2.4-4
PCB and Chlorinated Hydrocarbon Pesticides in Aquatic Animals
from the Bay of Fundy - Gulf of Maine Area.

<u>Species</u>	<u>Tissue</u>	<u>Aroclor 1254, ppm</u>
Herring	whole fish	0.34
Mackerel	muscle	0.35
Plaice	muscle	0.38
White hake	muscle	0.44
Ocean perch	muscle	0.32
Cod	muscle	0.55
Sea raven	muscle	0.21
	viscera	0.73
Banking shark	muscle	0.07
	liver	1.07
White shark	muscle	0.77
	liver	218
Bluefin tuna	muscle	1.54
Herring oil		3.55
Fishmeal		0.54
Double-crested cormorant	eggs	43.5
		17.2
	muscle	3.38
	liver	2.13
	subcutaneous fat	38
	abdominal fat	52
Herring gull	eggs	12.6
		5.54
	muscle liver	5.06
		6.50
	subcutaneous fat	75

SOURCE: Zitko, V., O. Hutzinger and P.M.K. Choi, Environmental Health Perspectives, 47-50, (April 1972).

2.4.3 Gulf of Mexico - Caribbean Sea

Runoff from approximately two-thirds of the United States and one-half of Mexico enters the Gulf of Mexico and is swept generally westward to be trapped in the Western Gulf for as much as 100 years. Therefore a buildup of man-made toxic chemicals is possible in the Western Gulf especially since there is a heavy concentration of chemical manufacturers in Louisiana and Texas.⁷

The earliest samples collected in this area were brown Pelicans collected in 1969 from the Atlantic and Gulf Coast of Florida and in 1970 from Florida Bay. The highest levels, 1.0-7.5 ppm came from the Atlantic Coast while those from the Gulf Coast ranged up to 4.2 ppm and those from the Keys in the Bay only had concentrations up to 2.5 ppm. The birds represented a wide range of ages and both sexes, but the immature and adult birds always had higher residues than the young.²

In 1971 a seafood monitoring program¹⁰ for the insecticide mirex was set up. Three of the stations were located in the Gulf of Mexico and identified Aroclor 1260 as indicated in Table 2.4-5. Due to the different kinds of species involved a comparison of levels is difficult to prepare. However, it is clear that the levels in samples from Mobile Bay, Alabama ranging from 0.01 to 0.40 ppm were higher than those from the Mississippi Sound where the highest level was only 0.20 ppm.

Fish and other marine organisms were collected in the Gulf of Mexico and the Caribbean Sea in May and October 1971 as shown in Figure 2.4-3. While PCB's were detected in nearly all the samples analyzed the levels were generally low. The samples from coastal waters generally had higher levels than samples from open waters. This same observation holds true for sea plankton. Of the six samples containing PCB's above 100 ppb wet weight four of them were near Coastal areas.⁹

Groupers were also collected¹ since they tend to spend their post larval life in one locality and should therefore yield data more representative of a particular area. Figure 2.4-3 shows the sampling locations. The levels are generally low although the highest levels do come from the western Gulf. Note also that at Anton Lizardo the levels in the groupers increase with increasing size as can be expected since the fat content of the fish increases with increasing size and age of the specimen. Table 2.4-6 presents some of the levels identified in 1971.

Giam et. al.⁴ again took measurements from stations in the Gulf of Mexico in 1973-1974 as indicated in Figure 2.4-3 and Table 2.4-7. The concentrations in biota are lower than they were in the 1971 survey with an average according to Giam of about 20 ppb reduced from 60 ppb. It must be noted, however, that these stations were all close to the southern coast of the U.S. with no samples collected in the Western Gulf.

Table 2.4-6
Biota and Plankton from the Gulf of Mexico - 1971

Station	Biota	Weight (lbs.)	Standard Length (mm)	PCB's (ppb)
1	Flounder=			32
2	Flounder=			36
3	Flounder=			59
4	Flounder=			34
	Plankton†			678
5	Crustacean=			151
	Crustacean=			22
6	Shrimp=			167
7	Rock Shrimp=			6
	Squid=			40
8	King Mackerel muscle=			34
	Plankton†			<3
	Tuna muscle=			58
9	Tuna muscle=			36
10	Plankton†			100
11	Plankton†			30
12	Plankton†			<3
13	Plankton†			1035
14	Plankton†			44
15	Plankton†			42
16	Plankton†			191
27	GrouperΩ	3.1	398	110
		2.9	378	32
		1.9	306	14
		1.9	287	14
		0.7	222	12
28	GrouperΩ	4.9	414	33
		4.8	416	12
		2.8	338	10
29	GrouperΩ	10.0	514	7
		3.7	403	7
		2.9	354	6
30	GrouperΩ	6.0	495	5
		4.8	459	3
		1.6	315	3
		3.0	385	14
		2.4	339	6
31	GrouperΩ	3.3	352	81
32	GrouperΩ	18.0	681	220

=Giam, C.S., A.R. Hanks, R.L. Richardson, W.M. Sackett and M.K. Wong, Pesticides Monitoring Journal, 6, 139-143, (Dec. 1972).

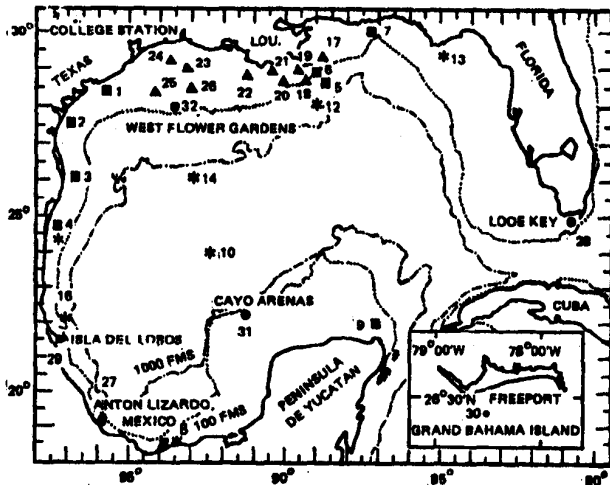
†Giam, C.S., M.K. Wong, A.R. Hanks, W.M. Sackett and R.L. Richardson, Bulletin of Environmental Contamination and Toxicology, 9, 376-382, (1973).

ΩGiam, C.S., R.L. Richardson, D. Taylor and M.K. Wong, Bulletin of Environmental Contamination and Toxicology, 11, 189-192, (1974).

Table 2.4-5
PCB Residues in Seafood

<u>Species</u>	<u>Sample Quantity</u>	<u>Aroclor 1260 (ppm)</u>
MISSISSIPPI SOUND		
Crabs	15	0.07
Shrimp	1 kg	---
Squid	1 kg	0.03
Flounder	3	0.03
Speckled sea trout	3	0.20
Spanish mackerel	3	0.06
Weak fish	5	0.12
Atlantic whiting	5	0.10
Fish oil	1 liter	0.02
Fish meal	1 kg	0.02
Ground fish (unprocessed)	1 kg	0.04
MOBILE BAY, ALA.		
Blue crabs	15	0.12
Shrimp	1.3 kg	0.01
Oysters	20+	0.03
Squid	10	0.04
Flounder	3	0.11
Speckled sea trout	1	0.40
Spanish mackerel	2	0.18
Weak fish	5	0.37
Atlantic whiting	5	0.11
Croaker	3	0.33
Red snapper	2	0.14
Mullet	5	0.11
Anchovy	>20	0.08
Shad	>10	0.09
TAMPA BAY, FLA.		
Crabs	10	0.03
Weak fish	5	0.83
Mullet	5	0.31

SOURCE: Markin, G.P., J.C. Hawthorne, J.L. Collins, and J.H. Ford,
Pesticides Monitoring Journal, 7, 139-143, (March 1974).



- BIOTA 1971
- GROUPERS 1971
- ▲ BIOTA, WATER, SEDIMENT, 1973-1974
- * PLANKTON 1971

FIGURE 2.4-3 GULF OF MEXICO SAMPLING SITES

Table 2.4-7
Concentrations of PCBs in Selected Samples
from the Gulf of Mexico, 1973-74

<u>Station</u>	<u>Biota</u> <u>(ppb)</u>	<u>Water</u> <u>(ppt)</u>	<u>Sediment</u> <u>(ppb)</u>
7	20	4.1	<0.2
18	11	2.1	35.0
19	22	1.7	33.0
20	23	---	<0.2
21	37	1.7	<0.2
22	14	2.1	---
23	6	2.4	---
24	11	1.3	---
25	94	0.8	<0.2
26	68	2.7	---

SOURCE: Giam, C.S., J.S. Chan, J.P. Kakareka and G.S. Neff, Trace Analyses of Phthalates and Chlorinated Hydrocarbons in Gulf of Mexico Samples.

2.4.4 California

According to Hom and Risebrough¹⁴ PCBs have become a significant component of the marine food webs of southern California. They have been associated with a high incidence of premature births among sea lions and eggshell thinning with consequent reproductive failure in fish-eating birds.

One study collected different levels of sediment from the Santa Barbara Basin.¹⁴ The dated and analyzed sediments indicated that the deposition of PCB's began about 1945 probably as a result of the rapid increase in PCB use as electrical insulating fluids and paint additives during World War II. Through 1967 there was no indication of a leveling off in the rate of PCB deposition. Levels in the 1940-1945 layer were 31 ppb increasing to 49 ppb in the 1947-1952 layer, 66 ppb in the 1955-1960 layer and 103 ppb in the 1962-1967 layer.¹⁴

Risebrough²³ has suggested that the observation of PCB's in the sea indicate that they are dispersed by wind currents. Table 2.4-8 shows the distribution of PCB residues in several collections of marine fish collected from the Coastal waters of southern California in late 1965 and early 1966 and in marine birds collected in late 1966. Note that the levels in the birds 0.08-109 ppm were higher than those in fish, N.D.-1.2 ppm. Petrels and shearwaters breed on remote islands spending their entire lives at sea. They do not dive for fish but feed primarily upon organisms obtained at or near the surface where aerial fallout could be expected to retain temporarily the water-insoluble chlorinated hydrocarbons components. Two Peregrine Falcons showed PCB levels ranging from 1.5 ppm, net weight, in the brain of an immature bird to 1,980 ppm lipid weight in the carcass of an adult bird.

Analyses of Western gull eggs²² show that eggs from San Francisco Bay, with levels from 24-950 ppm contained more PCB's than eggs from the Farallon Islands 27 miles west of the Golden Gate Bridge with levels from 12-1010 ppm. These were both higher than eggs from Baja California where the levels were 1.2-471 ppm.

Concern over reproductive failure of the Double Created Cormorant led to a study in 1969 of Cormorant eggs from three locations in southern California. The levels identified ranged from 12-1,100 ppm in the yolk lipids.¹⁸ A similar concern also led to a study of Brown Pelicans on Anacapa Island in May 1969. Fat samples from six adult birds and one immature bird ranged from 77 to 366 mg/gm.¹⁵

Early data collected by Munson¹⁹ in 1970 from San Diego and Orange Counties showed levels in aquatic biota ranging from 2.0 to 8.8 ppm lipid weight (N.D. - 1.0 wet weight) in San Diego and 0.62 - 38 ppm lipid weight (0.008 to 1.4 wet weight) from Orange County. However, the difference in residue levels may be due to a different type of uptake mechanism since the samples from Orange County were invertebrates while those from San Diego were fish.

In addition to the studies of Double Crested Cormorants and Brown Pelicans, Faber et. al.⁴ studied Common Egrets and Great Blue Herons. The PCB levels ranged up to 15 ppm in the brain and 93 ppm in the livers of adult egrets from the Audubon Canyon Ranch. Fish which the birds might feed on from Bolinas Lagoon showed levels from 0.072-0.079 ppm.

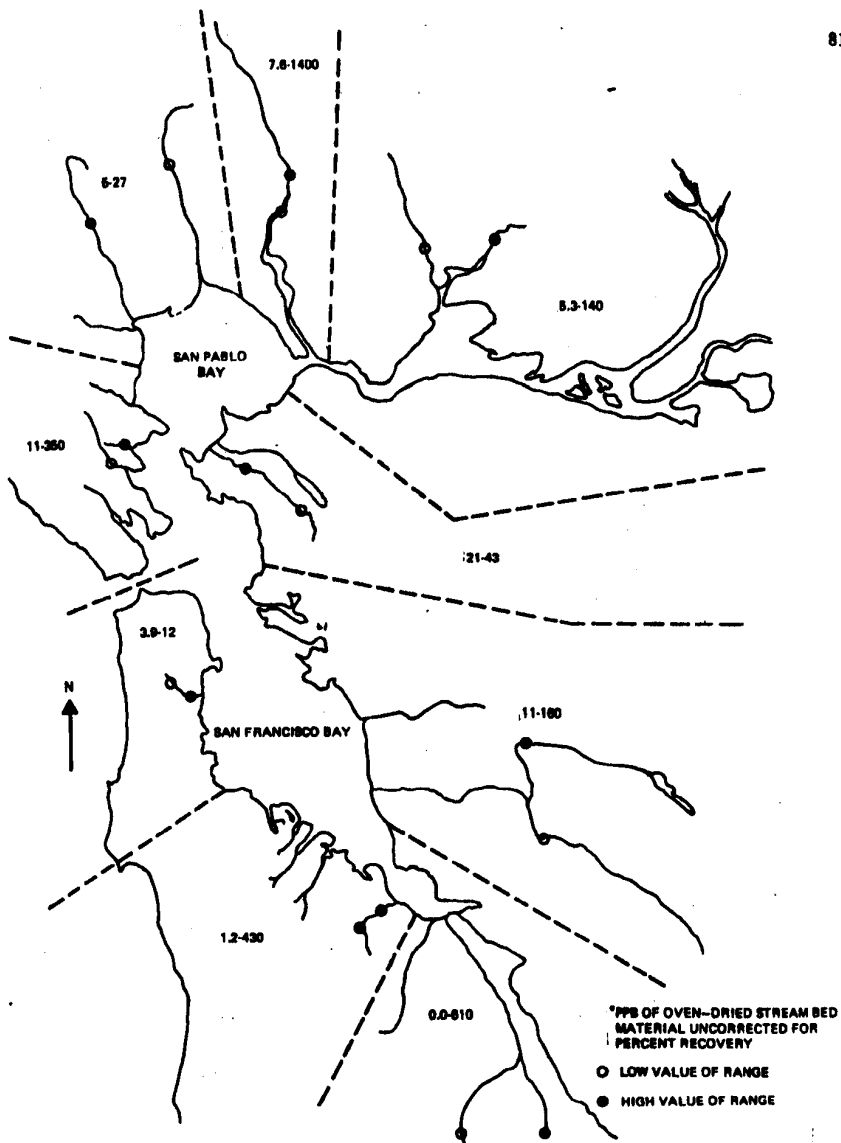
In order to assess the potential contamination from chlorinated hydrocarbons the U.S. Geological Survey initiated a study in February 1972 of the San Francisco Bay. Bottom material was collected from 26 streams that discharge into San Francisco Bay. The results of the analyses are given in Figure 2.4-4 illustrating the widespread distribution of PCB's in the San Francisco Bay area. The readings from Steven Creek of 180 ppb and from Alamitos Creek, of 610 ppb were higher than anticipated since neither area had any apparent industrial or commercial development. Despite the extreme range up to 1400 ppb there was no significant difference between the average residue of streams discharging into the Bay south of San Francisco and those discharging into the Bay north of San Francisco.¹⁸

Studies of Waste Water Treatment Plants in the Southern California area will be presented in Section 2.5.3.4.

Table 2.4-8
Polychlorinated Biphenyl (PCB) Residues
in Marine Fish and Marine Birds, 1965-1966

Species Locality,	PCB
Northern Anchovy	
Terminal Island	1.0
Shiner Perch	
San Francisco Bay	0.4-1.2
English Sole	
San Francisco Bay	0.05-0.11
Monterey	0.04
Jack Mackerel	
Channel Islands	0.02
Hake	
Puget Sound	0.16
Channel Islands	0.12
Bluefin Tuna	
Body muscle	0.04
Liver	0.04
Yellowfin Tuna	
Liver	0.04
Skipjack Tuna	
Liver	0.1
Cassin's Auklet	0.16
Ancient Murrelet	0.15
Fulmar	0.08
Fulmar	0.34
Red Phalarope	0.10
Rhinoceros Auklet	0.36
Slender-billed Shearwater	2.1
Sooty Shearwater	1.2
Sooty Shearwater	0.9
Peregrine Falcon	
Breast muscle, second year	
Female, migrant from Arctic	22
Breast muscle, immature	
California	10.5
Breast muscle, adult	
female, California	109

SOURCE: Risebrough, R.W., Chlorinated Hydrocarbons in Marine Ecosystems.



MONS 053531

FIGURE 2.4.8 PPR'S IN SAN FRANCISCO BAY AREA STREAM BEDS

2.4.5 Escambia Bay, Florida

The first detection of Aroclor 1254 residues in Escambia Bay was in oysters in April 1969.³ Later sampling also showed residues in water, sediment, fish, blue crabs and shrimp as indicated in Table 2.4-9. (One source was apparently an industrial outfall which had had accidental leakage of a heat exchange fluid. Fish, shrimp and crabs contained higher concentrations than oysters but are also more mobile and therefore not as useful as monitors for a particular area.

Figure 2.4-5 identifies the sampling locations (stations 1-7). Less than 0.1 ppb occurred in the water at station 2 but it was not detected in lower bay water. Leaching from sediments is presumably the cause of the continued presence of Aroclor 1254 in the river water. Sediment samples taken near the outfall reached 486 ppm in August 1969.³

Pink shrimp collected at the same time from the bay were found to contain whole body residues of Aroclor 1254 as high as 14 ppm.^{2,9} Residues in seven composite samples of at least five shrimp ranged from 0.6 to 120.0 ppm. Fiddler crabs collected in April 1970 from the lower Escambia River and Upper Escambia Bay had individual whole body residues of 0.45 to 1.5 ppm.

The largest accumulations were found in the sediments with the maximum residue of 61 ppm observed in the River at the outfall from the industry. The maximum in the Bay of 30 ppm was found near the mouth of the river. Although Aroclor was not detected in sediments collected above the plant, soil samples from the bank near the mouth of the river downstream from the source 6.5 km had 1.4 to 1.7 ppm. Subsequent samplings from three stations in the bay showed little change in the chemical even after nine months. Table 2.4-9 shows the levels identified for these sediment collections as stations 8-20.^{2,9}

The amount of PCB in sediment samples appeared to decrease after the initial February 1970 survey.²¹ The decrease is especially noticeable in December 1970 and October 1971. In general, the residues identified in 1971 were about one-tenth the 1970 values. Coras taken in a 1972 survey generally indicated less PCB than in 1971. Table 2.4-9 identifies the readings taken for these three years as stations 21-23.

Later surveys of biota from the estuary showed levels to remain relatively high. Table 2.4-10 compares residues in the same species or those occupying similar trophic levels captured on the same day in Escambia and East Bays; the East Bay site being about 35 kilometers from the original source of the material. Although sand seatrout and Atlantic cutlassfish could be expected to have the highest residues since they are predators the highest levels were actually found in silversides whose diet consists mainly of plankton. Note also that the concentrations in species from Escambia Bay were 5 to 10 times greater than those found in East Bay but that Aroclor 1254 was found even in species captured distant from the original source of PCB.²¹

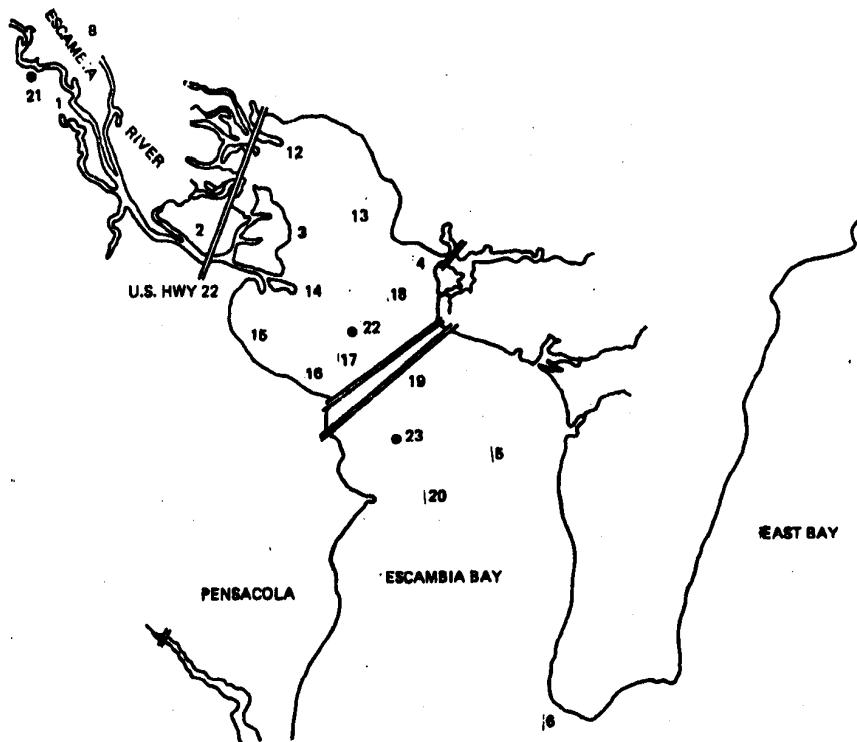


FIGURE 2.4-5 ESCAMBIA BAY SAMPLING STATIONS

Table 2.4-9
Residues of Aroclor 1254 in Samples from Escombia Bay and River

Location	Sample	Residues of Aroclor 1254 (ppm)			
		1969	1970	1971	1972
3	Speckled trout	20.0			
3	Flounder liver	184.0			
4	Menhaden	5.7			
4	Menhaden	11.0			
4	Menhaden	12.0			
4	Flounder liver	76.0			
4	Flounder muscle	4.5			
4	Flounder gills	19.0			
4	Croaker	12.0			
4	Pinfish	10.0			
3	Shrimp	2.5			
3	Blue crab	7.0			
3	Blue crab	6.3			
4	Shrimp	1.5			
4	Blue crab	1.0			
1	Sediment	486			
2	Sediment	<.03			
6	Sediment	1.7			
8	Sediment		N.D.		
9	Sediment		61.0		
10	Sediment		5.7		
11	Sediment		4.1		
12	Sediment		1.9		
13	Sediment		1.8		
14	Sediment		30.0		
15	Sediment		4.2		
16	Sediment		3.3		
17	Sediment		4.9		
18	Sediment		0.6		
19	Sediment		2.5		
20	Sediment		1.4		
21	Sediment 0-2 in.		78.0	8.1	0.97
	Sediment 2-4 in.		30.0	0.12	5.8
	Sediment 4-6 in.		6.1	N.D.	---
	Sediment 6-8 in.		0.4	N.D.	---
22	Sediment 0-2 in.		10.0	0.91	0.14
	Sediment 2-4 in.		11.0	N.D.	N.D.
	Sediment 4-6 in.		15.0	N.D.	N.D.
	Sediment 6-8 in.		20.0	N.D.	---
	Sediment 8-10 in.		18.0	N.D.	---
	Sediment 10-12 in.		1.2	N.D.	---
23	Sediment 0-2 in.		0.19	0.19	---
	Sediment 2-4 in.		0.08	N.D.	---
	Sediment 4-6 in.		0.02	N.D.	---
	Sediment 6-8 in.		N.D.	N.D.	---

SOURCE: Nimmo, D.R., D.J. Hansen, J.A. Couch, N.R. Cooley, P.R. Parrish and J.I. Lowe, Toxicity of Aroclor 1254 and its Physiological Activity in Several Estuarine Organisms, (unpublished).

Table 2.4-10
Comparison of Concentrations of Aroclor 1254 Found in
Species Collected in Escambia and East Bays

<u>Species</u>	<u>Escambia Bay (ppm)</u>	<u>East Bay (ppm)</u>
Spartina	N.D.	N.D.
Zostera	N.D.	N.D.
Olive Nerite	0.49	N.D.
Rangia	N.D.	N.D.
Penaeid Shrimp	0.98	Trace
Blue Crabs	6.90	0.46
Bay Anchovy	3.00	0.68
Catfish	3.80	0.58
Tidewater Silversides	10.00	0.95
Silver Perch	4.50	0.48
Sand Seatrout	1.50	----
Spotted Seatrout	----	0.12
Spot	1.80	Trace
Atlantic Croaker	1.60	Trace
Hogchoker	1.30	N.D.
Atlantic Cutlassfish	2.90	0.72

SOURCE: Nimmo, D.R., D.J. Hansen, J.A. Couch, N.R. Cooley, P.R. Parrish and J.I. Lowe, Toxicity of Aroclor 1254 and its Physiological Activity in Several Estuarine Organisms, (unpublished).

REFERENCES, Section 2.4

1. Bidleman, R.F. and C.E. Olney, Science, 184, 516-518, (Feb. 8, 1974).
2. Blus, L.J., A.A. Belisle and R.M. Prouty, Pesticides Monitoring Journal, 7, 181-194, (March 1974).
3. Duke, R.W., J.J. Lose and A.J. Wilson Jr., Bulletin of Environmental Contamination and Toxicology, 5, 171-180, (1970).
4. Faber, R.A., R.W. Risebrough and H.M. Pratt, Environmental Pollution, 3, 111-122, (1972).
5. Gaskin, D.E., Nature, 233, 499-500, (Oct. 15, 1971).
6. Giam, C.S., J.S. Chan, J.P. Kakareka and G.S. Neff, Trace Analyses of Phthalates and Chlorinated Hydrocarbons in Gulf of Mexico Samples.
7. Giam, C.S., A.R. Hanks, R.L. Richardson, W.M. Sackett and M.K. Wong, Pesticides Monitoring Journal, 6, 139-143, (Dec. 1972).
8. Giam, C.S., R.L. Richardson, D. Taylor and M.K. Wong, Bulletin of Environmental Contamination and Toxicology, 11, 189-192, (1974).
9. Giam, C.S., M.K. Wong, A.R. Hanks, W.M. Sackett and R.L. Richardson, Bulletin of Environmental Contamination and Toxicology, 9, 376-382, (1973).
10. Grass, F., R.W. Risebrough, D.W. Anderson, L.F. Kiff and F.R. Jehl Jr., The Wilson Bulletin, 85, 197-208, (June 1973).
11. Harvey, G.R., and W.G. Steinhauer, Atmospheric Environment, 8, 777-782, (1974).
12. Harvey, G.R., Steinhauer, W.G. and J.P. Miklos, Nature, 252, 387-388, (Nov. 29, 1974).
13. Harvey, G.R., W.G. Steinhauer and J.M. Teal, Science, 180, 643-644, (May 11, 1973).
14. Hom, W., R.W. Risebrough, A. Souter and D.R. Young, Science, 184, 1197-1199, (June 14, 1974).
15. Keith, J.O., L.A. Woods Jr., and E.G. Hunt, Transactions of the North American Wildlife Conference, 35, 56-63, (1970).
16. L.M., Law, and D.F. Goarlitz, Pesticides Monitoring Journal, 8, 33-36, (June 1974).
17. Longhurst, A.R., and P.J. Radford, Nature, 256, 239-240, (July 17, 1975).

18. Markin, G.P., J.C. Hawthorne, J.L. Collins, and J.H. Ford, Pesticides Monitoring Journal, 7, 139-143, (March 1974).
19. Munson, T.O., Bulletin of Environmental Contamination and Toxicology, 7, 223-228 (1972).
20. Nimmo, D.R., P.D. Wilson, R.R. Blackman and A.J. Wilson Jr., Nature, 231, 50-52, (May 7, 1971).
21. Nimmo, D.R., D.J. Hansen, J.A. Couch, W.R. Cooley, P.R. Parrish and J.I. Lowe, Toxicity of Aroclor 1254 and its Physiological Activity in Several Estuarine Organisms, (unpublished).
22. Risebrough, R.W., Chlorinated Hydrocarbons in Marine Ecosystems.
23. Risebrough, R.W. and V. Brodine, Environment, 12, 16-27, (January-February 1970).
24. Zitko, V., O. Hutzinger and F.M.K. Choi, Environmental Health Perspectives, 47-50, (April 1972).
25. Zitko, V., and P.M.K., Bulletin of Environmental Contamination and Toxicology, 7, 63-64, (1972).

2.5 Data from Localized Monitoring Efforts - Industrial Plants, Products, Sewage Treatment Facilities and Landfills

2.5.1 Industrial Plants

2.5.1.1 Monsanto. Co., Sauget, Illinois

The only PCB production facility in the United States is the Monsanto plant at Sauget, Illinois which has produced PCB mixtures ranging from 20 to 68 percent chlorine. Polychlorinated terphenyls have been produced at this facility, but production was suspended in 1971.

Soil contamination studies⁷ were initiated in February 1976. The sampling locations around the Monsanto facility are identified in Figure 2.5-1. The levels of Aroclor 1242, Aroclor 1260 and decachlorobiphenyl found at these sampling sites are listed in Table 2.5-1. The distribution of all PCBs analyzed appears to be higher near the plant site and generally decreasing with distance from the site. There is some evidence that higher concentrations are present in the soils located to the southeast which corresponds with the predominant wind direction in this area.

A typical chromatogram of a soil sample obtained near the plant is shown in Figure 2.5-2 along with the reference chromatograms of Aroclor 1242 and 1260 run under the same instrument conditions. Using these reference spectra, this sample contains 11 ppm Aroclor 1242, 9.3 ppm Aroclor 1260 and 1.0 ppm decachlorobiphenyl.

Table 2.5-1
PCB Levels in Soils, ppm, Monsanto

<u>Sample Station</u>	<u>Aroclor 1260</u>	<u>Aroclor 1242</u>	<u>Decachlorobiphenyl</u>	<u>Total PCB</u>
1	0.05	<0.01	0.097	0.147
2	0.12	<0.01	0.61	0.73
3	1.4	<0.01	0.90	2.3
4	0.31	0.68	0.38	1.37
5	0.20	<0.01	0.27	0.47
6	1.3	0.82	1.6	3.72
7	2.9	3.0	1.3	7.2
8	9.6	6.1	2.4	18.1
9	0.65	<0.01	0.12	7.7
10	0.28	0.45	0.081	0.811
11	0.10	<0.01	0.049	0.145
12	0.26	<0.01	0.081	0.341
13	9.6	10.0	1.1	20.7
14	0.03	<0.01	0.40	0.43
15	0.39	0.46	0.12	0.97

SOURCE: Unpublished Report, Contract 68-01-2978, USEPA, Office of Toxic Substances; July 1975

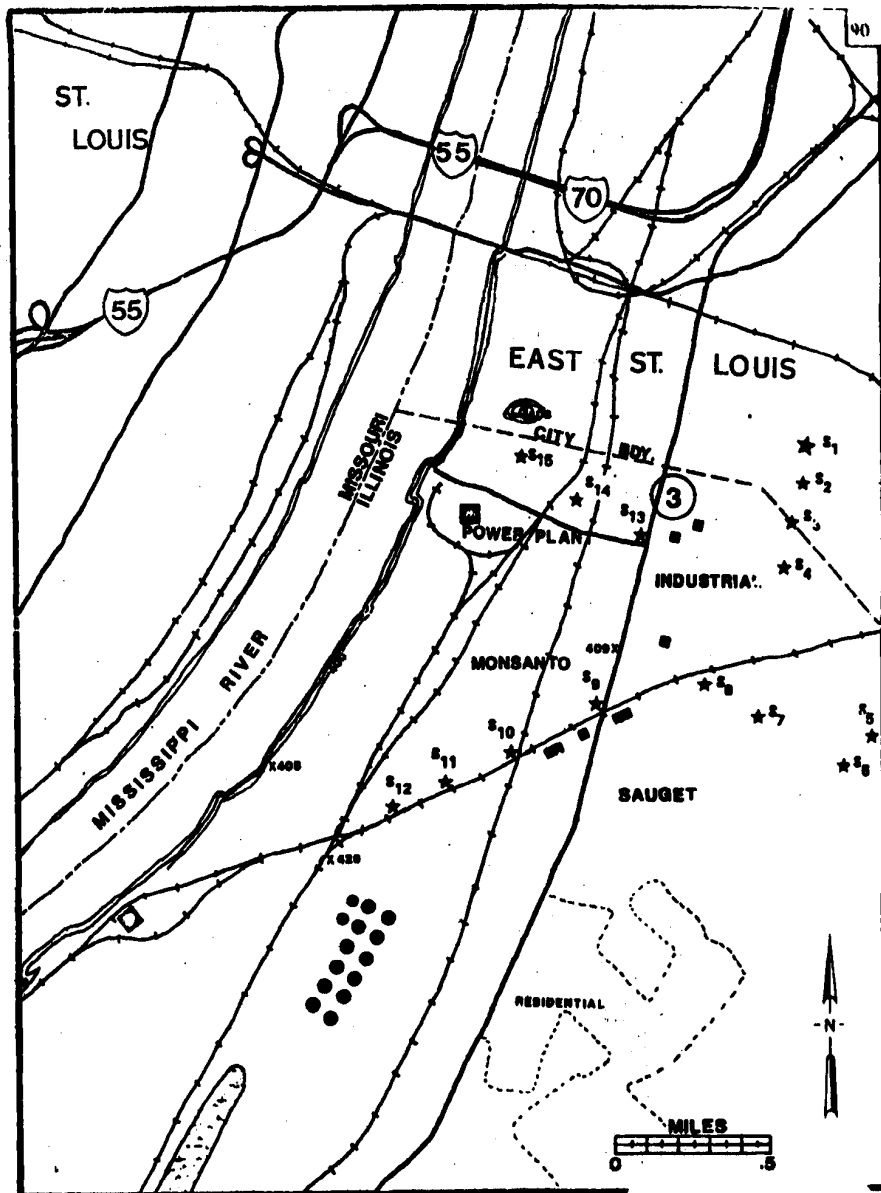
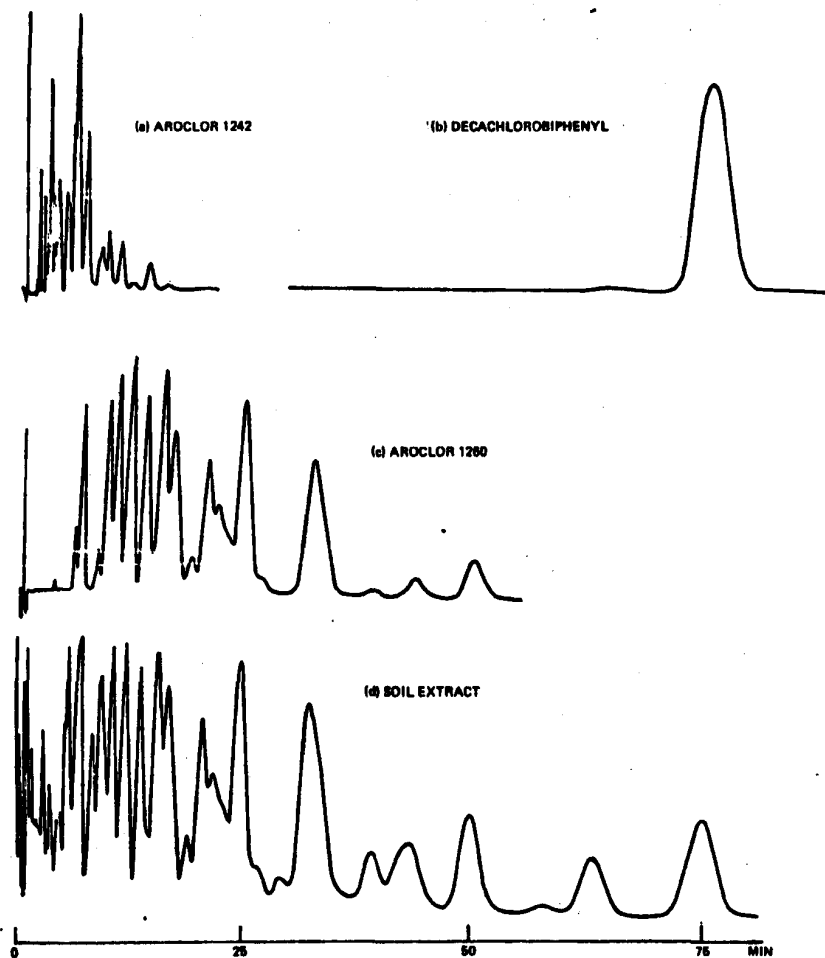


FIGURE 2.5-1 SAMPLING LOCATIONS, MONSANTO

MONS 053540



MONS 053541

FIGURE 2.5-2 TYPICAL CHROMATOGRAMS OF STANDARD AROCLORS, DECACHLOROBIPHENYL AND A SOIL SAMPLE TAKEN IN THE VICINITY OF MONSANTO CO., SAUGET, ILLINOIS

2.5.1.2 Yates Manufacturing Co., Chicago, Illinois

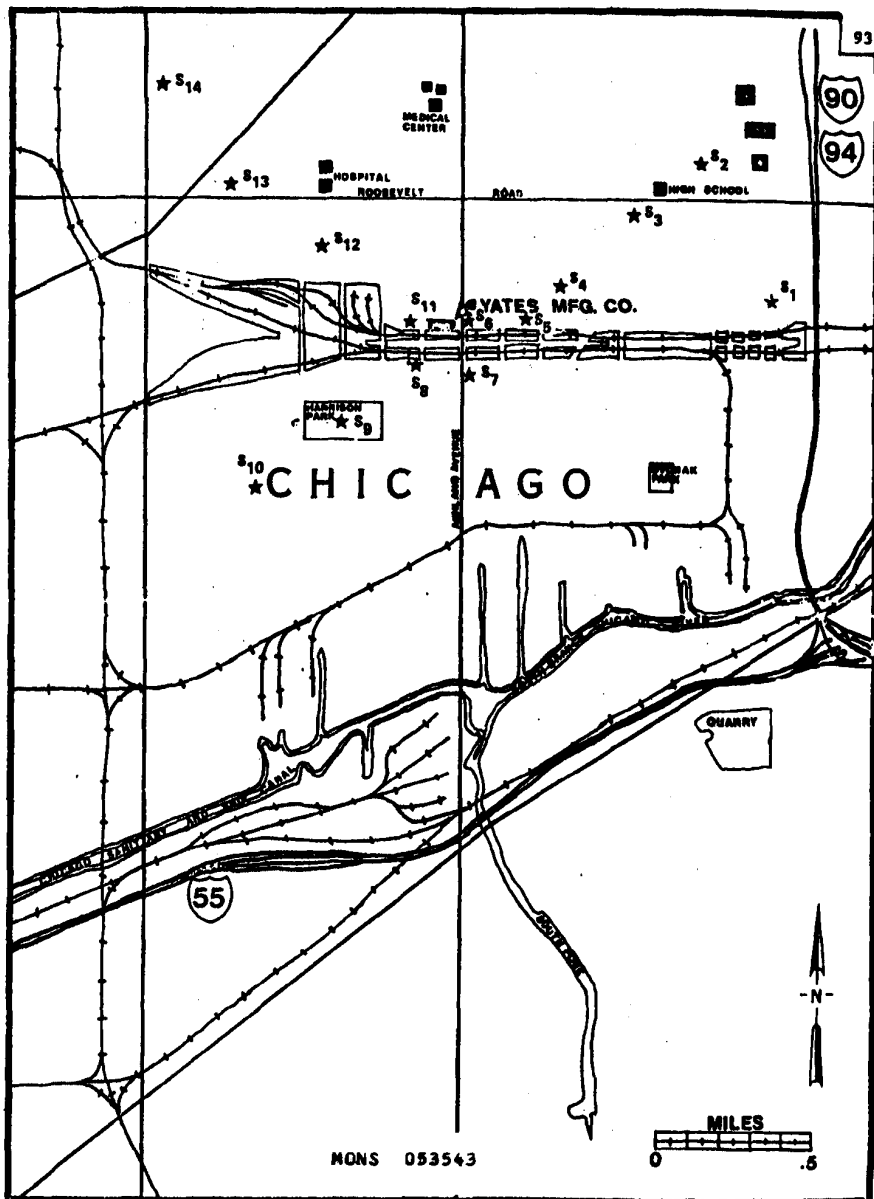
The Yates Manufacturing Co. is an investment casting wax manufacturer. Prior to 1972, Aroclors 5460, 6090 and 5442, mixtures that contain both PCBs and polychlorinated terphenyls, were used. Subsequent to 1972, this company has been purchasing decachlorobiphenyl from foreign sources.

Soil contamination studies⁷ were initiated in February 1976. The sampling locations around the Yates facility used to study soil contamination are identified in Figure 2.5-3. The concentration levels of Aroclor 1242, Aroclor 1260 and decachlorobiphenyl found at these sampling sites are listed in Table 2.5-2.

Table 2.5-2
PCB Levels in Soils, ppm, Yates Manufacturing

<u>Sample Location</u>	<u>Aroclor 1260</u>	<u>Decachlorobiphenyl</u>	<u>Total PCB</u>
1	0.22	< 0.001	0.22
2	0.24	0.053	0.293
3	0.81	0.033	0.113
4	0.34	0.19	0.53
5	0.51	0.58	1.09
6	0.40	1.2	1.6
7	0.26	0.51	0.77
8	1.5	0.75	2.25
9	0.57	0.040	0.61
10	0.67	0.020	0.69
11	1.6	3.6	5.2
12	0.29	0.001	0.291
13	0.56	0.034	0.594
14	1.8	< 0.001	1.8

SOURCE: Unpublished Report, Contract 68-01-2978, USEPA, Office of Toxic Substances; July 1975



2.5.1.3 Valcast Corp., Troy, Michigan

Valcast Corp. is an investment casting facility located in a small industrial park in suburban Detroit, Michigan. PCBs are a constituent of the wax mold compound used to fashion intricate shapes which are to be cast.

Soil contamination studies⁷ were initiated in February 1976. The sampling locations around the Valcast facility are identified in Figure 2.5-4. The concentration levels of Aroclor 1260 and 1242 found at these sampling sites are listed in Table 2.5-3.

Figure 2.5-5 is a typical chromatogram of a soil sample extract taken from this location. Aroclor 1260 was present in many of the soil samples taken from the Valcast area, but decachlorobiphenyl was absent. The one observed concentration of 18 ppm of Aroclor 1242 appears to be anomalously high, however, replicate analysis yielded values of 16 ppm and 19 ppm, respectively. Aroclor 1242 was not detected in any other soil samples from this area.

A small drainage ditch that passes adjacent to the north boundary of the Valcast facility was sampled. This ditch serves to remove storm-water runoff in the vicinity and receives discharged cooling water from Valcast and other local small industries. Analysis of the Valcast cooling water at the point of discharge and of water in the drainage ditch failed to detect PCB levels greater than the detection limit of 0.1 ppb. Two bottom sediment samples taken from this drainage ditch, however, had concentrations as follows:

Aroclor 1242	2.3 ppm	9.4 ppm
Aroclor 1260	6.7 ppm	8.9 ppm
Decachlorobiphenyl	0.09 ppm	0.11 ppm.

Table 2.5-3

PCB Levels in Soils, ppm, Valcaest

<u>Sample Station</u>	<u>Aroclor 1260</u>	<u>Aroclor 1242</u>
1	< 0.01	
2	< 0.01	18.0
3	0.04	
4	0.06	
5	0.05	
6	0.04	
7	0.14	
8	0.07	
9	< 0.01	
10	0.12	
11	< 0.01	
12	0.12	
13	0.03	
14	< 0.01	
15	0.03	
16	0.02	

SOURCE: Unpublished Report, Contract 68-01-2978, USEPA, Office of Toxic Substances; July 1975

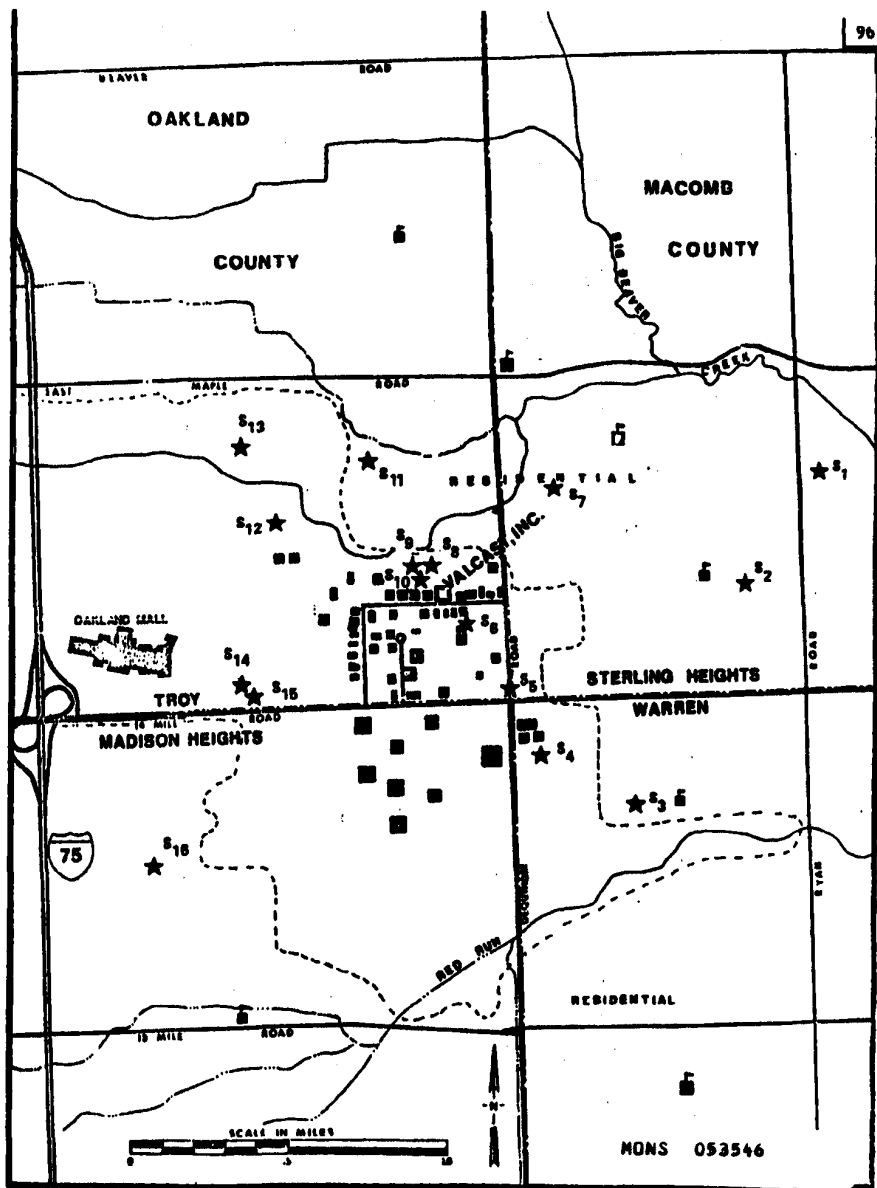


FIGURE 2.5-4 SAMPLING LOCATIONS, VALCAST

MONS 053547

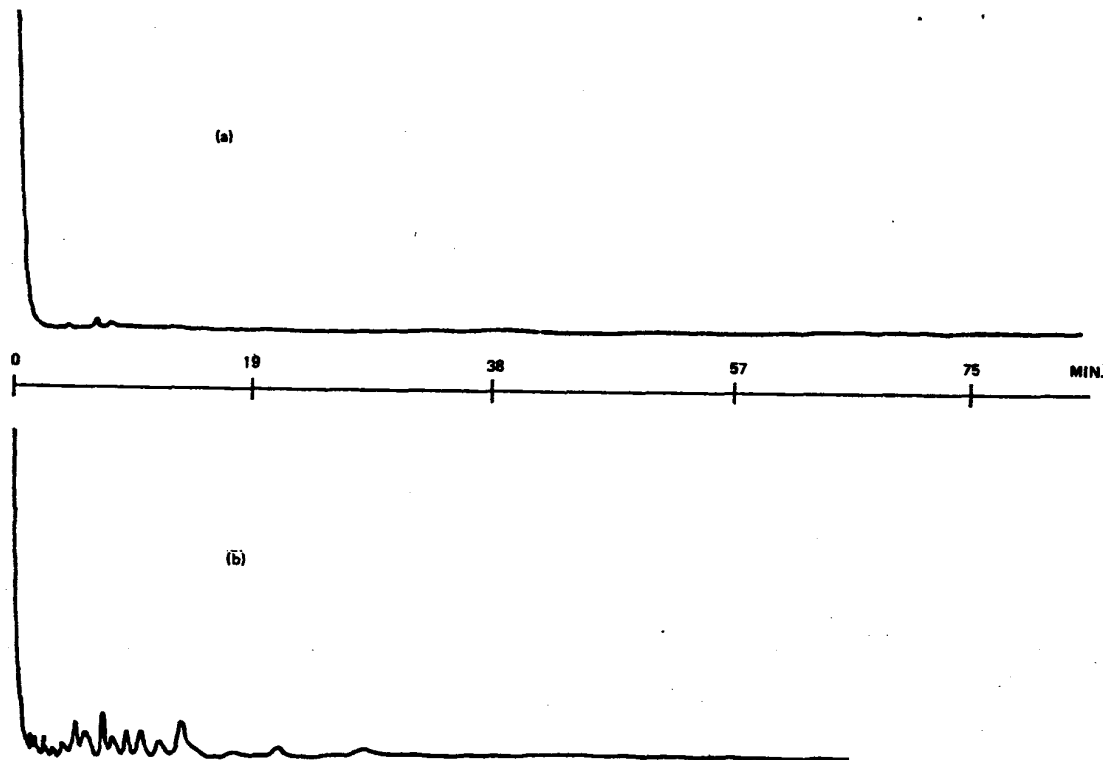


FIGURE 2.5-5 TYPICAL CHROMATOGRAMS OF SOIL SAMPLES TAKEN IN THE VICINITY OF VALCAST CORP., TROY, MICHIGAN - (a) 0.01 ppm, (b) 0.014 ppm AROCLOR 1260

2.5.1.4 General Electric, Hudson Falls - Ft. Edward, N.Y.

The General Electric Plants at Hudson Falls and Ft. Edward use large quantities of PCB's for filling capacitors and transformers. Both plants have chemical waste treatment facilities, but, significant PCB and oil/grease levels are discharged by the waste stream. The NPDES Permit Application lists:

<u>Outfall Location</u>	<u>Daily Average Concentration</u>		<u>Average Daily Loading (lbs.)</u>		<u>Maximum Daily Loading (lbs.)</u>	
	<u>ppm</u>		<u>Oil/Grease</u>	<u>PCB</u>	<u>Oil/Grease</u>	<u>PCB</u>
Hudson Falls	13.7	.5	239.8	10.0	250.9	17.6
Hudson Falls	2.1	---	4.9	---	5.25	---
Ft. Edward	8.9	5.0	38.27	20.0	44.5	30.0

In the summer of 1974, EPA Region II initiated a sampling program in the general vicinity of the General Electric plants.² The five sampling stations established for this program are shown in Figure 2.3-6. Station 0 is upstream from the plants and serves as the control station; station 1 is located at the junction of the outfall stream from the Ft. Edward facility and the Hudson River, station 2 is located about 0.25 miles downstream from the outfall junction, station 3 is about 0.5 miles downstream from station 1, and station 4 is located about 0.75 miles downstream from station 1.

Samples collected included sediment, water, fish and snails; Aroclors identified included 1016, 1254, 1248 and 1242. The levels found at each sampling location are listed in Table 2.3-4.

PCB's identified as Aroclor 1016 were conclusively identified in the water samples at detectable concentrations at all sampling locations except Station 0 (control) and station 4, the furthest downstream.

At all stations the sediments contained higher concentrations of Aroclor 1016 than the water column resulting from adsorption of PCB's on suspended or already settled materials.

The biological samples collected at station 0 contained PCB's characteristic of Aroclor 1254 and Aroclor 1248. Distinctly different from the samples at station 0 were the samples collected in the vicinity of or below the General Electric discharge. Fish data from these areas suggests that Aroclor 1242, Aroclor 1016, or a mixture of these two formulations are present in the Hudson. There are no distinguishing features which can reliably determine whether the mixture is Aroclor 1016 or 1242 at this time.

Table 2.5-4
Environmental PCB Levels from the General Electric,
Hudson Falls - Ft. Edward N.Y. Area

Media	Water (ppb)	Sediment (ppm)	Fish (ppm)		
Aroclor	1016	1016	1254	1248	1242
Station					
0	<1.0	6.9	4.0	13.0	
1	2800	6700			45 ^a
2	2.2	540			
3	3.0	2980			350 ^b
4	<1.0	6.6			78 ^c 27 ^a

^aSnails (composite)

^bRock Bass

^cShiner Minnows

SOURCE: Nadeau R.J., and R.P. Davis, Investigation of Polychlorinated Biphenyls in The Hudson River, USEPA Region II.

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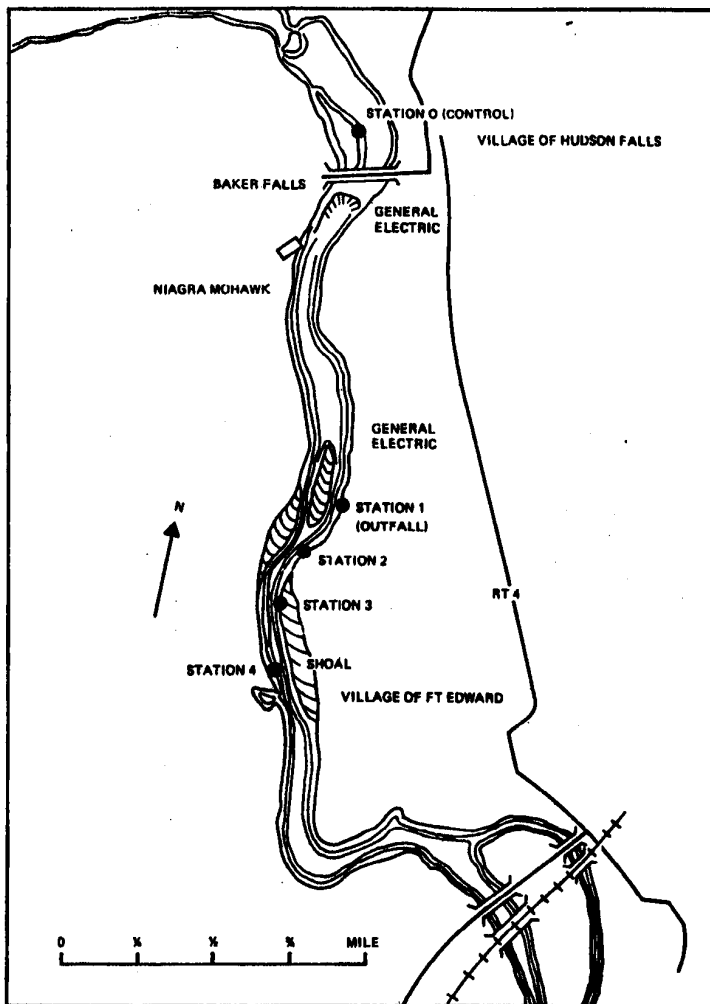


FIGURE 2.5-6 MAP OF HUDSON FALLS-FT. EDWARD, NEW YORK. NOTE LOCATION OF SAMPLING STATIONS RELATIVE TO GENERAL ELECTRIC FACILITIES.

2.5.2 Sewage Treatment Facilities

2.5.2.1 Illinois

An early study⁸ of discharges into Lake Michigan was conducted by the state of Illinois in 1970-1972 from locations as shown in Figure 2.5-7. Only two counties in Illinois border on the lake and all sewage treatment plant effluents and tributary stream sources enter the lake from Lake County. In most cases, sewage treatment plant effluents had higher concentrations of PCB's than the tributary streams.

PCB's were not measured in 1970; however, in 1971, 37 sediment samples were collected from tributary streams and ravines in Lake County and at stations offshore from Lake and Cook counties and analyzed for PCB's. The lake samples were collected 40 to 80 yards offshore from seven North Shore Sanitary District sewage treatment plants and at stations approximately one to three miles offshore. Aroclor 1242 in tributary sediments ranged up to 553 ppb in an unnamed channel in Waukegan and Aroclor 1254 ranged from 1.54 to 232.00 ppb in Pettibone Creek in North Chicago. Samples from open water sediments had Aroclor 1242 concentrations ranging up to 106.07 ppb. The highest level was found 40-80 yards offshore from the North Shore Sanitary District sewage treatment plant at North Chicago. Aroclor 1254 concentrations ranged from 2.48 to 46.92 ppb. Selected values are given in Table 2.5-5.

Water samples were collected in both 1971 and 1972 at the tributary streams and sewage treatment plants. Aroclor 1242 and 1254 ranged from 14.00-1810.0 ppt and 192.0-388.0 ppt in 1971 respectively and up to 653.0 ppt for Aroclor 1242 and 61.0 to 841.0 ppt for Aroclor 1254 in 1972 in tributary streams. However, in samples from sewage treatment plants Aroclor 1242 concentrations ranged from 268.0-4020.0 ppt in 1971 and up to 21.0 ppt in 1972. Aroclor 1254 concentrations ranged from 139.0-568.0 ppt in 1971 and from 97.0 to 178.0 ppt in 1972. The highest readings were from the North Shore Sanitary District at Waukegan in 1971. Table 2.5-6 presents the levels identified in water samples from Illinois Streams and Sewage Plants Tributary to Lake Michigan.

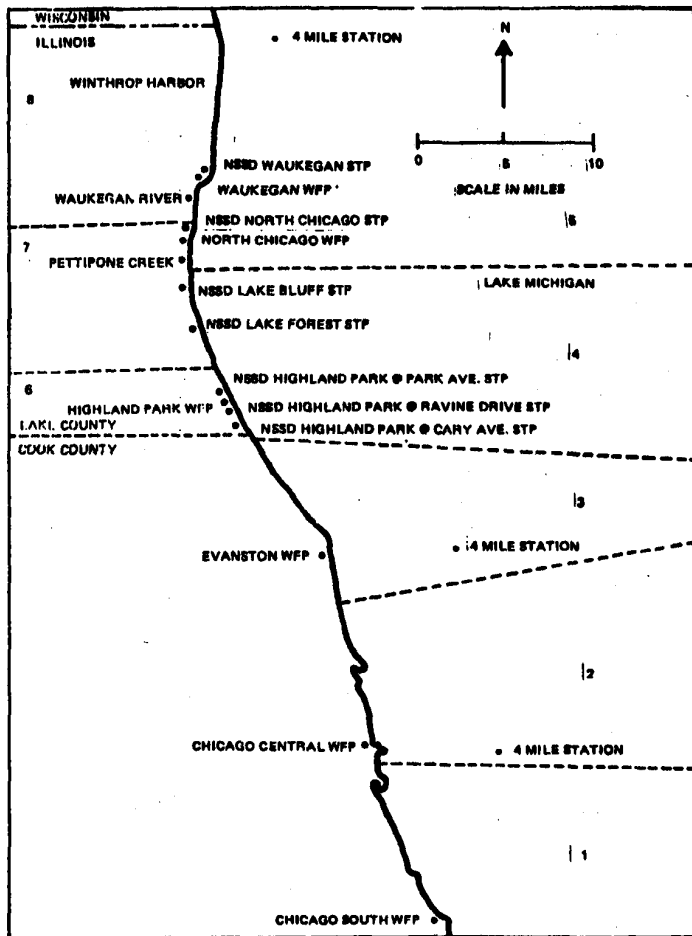


FIGURE 2.5-7 LOCATIONS OF WATER AND SEDIMENT SAMPLING STATIONS

Table 2.5-5
 Polychlorinated Biphenyls in Sediments from Lake Michigan
 and Tributary streams in Illinois 1971
 (ppb) dry weight basis

Location		Aroclor	
		1242	1254
<1 to 3 miles offshore			
Cook County	1	N.D.-18.55	2.48-17.25
	2	17.23-83.35	9.38-46.92
	3	3.58-13.65	3.15-12.42
Lake County	4	7.43-19.25	5.26-17.45
	5	4.98-46.11	8.36-34.52
Highland Park	STP	11.11	12.42
Lake Forest	STP	10.51	7.02
Lake Bluff	STP	44.36	14.45
North Chicago	STP	106.07	26.54
Waukegan	STP	17.32	11.97
10-50 yards upstream from Lake			
Lake County	6	N.D.-4.32	1.54-17.90
	7	1.31-173.40	2.54-232.00
	8	1.77-553.00	2.56-131.00

SOURCE: USEPA, Pesticide Monitoring Programs: Lake Michigan and
 Tributaries in Illinois, EPA 600/3-74-002

Table 2.5-6
 Polychlorinated Biphenyls in Water Samples from
 Illinois Streams and Sewage Plants Tributary to Lake Michigan
 1971 - 1972, (ppt)

<u>Location</u>	<u>Aroclor</u>	
	<u>1242</u>	<u>1254</u>
1971		
Waukegan River	1810.0	388.0
Pettibone Creek	140.0-187.0	192.0-194.0
Waukegan STP	601.0-4020.0	139.0-568.0
North Chicago STP	268.0-1070.0	153.0-260.0
1972		
Waukegan River	57.0-120.0	61.0-136.0
Pettibone Creek	N.D.-653.0	107.0-841.0
Waukegan STP	N.D.-17.0	97.0-139.0
North Chicago STP	N.D.-21.0	100.0-178.0

SOURCE: USEPA, Pesticide Monitoring Programs: Lake Michigan and
 Tributaries in Illinois, EPA 600/3-74-002

2.5.2.2 Michigan

Samples collected in 1971 and 1972 from municipal waste water treatment plant effluents throughout Michigan, indicated these plants as a major source of PCB's with an average concentration of 2.55 ppb for 60 effluents sampled. Only seven of the effluents exceeded 1 ppb but one, the Bay City treatment plant on the Saginaw River, had an average effluent concentration of 120 ppb with a high of 340 ppb.

Samples collected from 58 waste water treatment plants in 1973 averaged 0.52 ppb. The Bay City PCB discharge had been greatly reduced as a result of control measures in industries served by the waste water treatment plant.

Sewage Sludge from 57 of the 58 plants tested in 1973 showed Bay City to have the highest concentration of PCB's in the sludge being removed by the treatment process averaging 352 ppm compared to a state wide average of 15.6 ppm.

The range of values for all waste water treatment plants sampled in 1971-1973 are given in Table 2.5-7.