DRAFT

State of Concerns of the
Lake Michigan Toxic Substances Committee
Related to Polychlorinated Biphenyls

July, 1975

MONS 207831

Acknowledgments

This report was prepared by Karl E. Bremer, U. S. Environmental Protection Agency, with the assistance of:

Donald I. Mount, Duluth National Water Quality Laboratory
Ronald Barganz, Illinois Environmental Protection Agency
John Carr, National Oceanic and Atmospheric Administration
John Hesse, Michigan Department of Natural Resources
Tom Kopp, U.S. Environmental Protection Agency
Stanton Kleinert, Wisconsin Department of Natural Resources
Lloyd Lueschow, Wisconsin Department of Natural Resources
Gary Milburn, U.S Environmental Protection Agency
Ned Fogal, Wisconsin Department of Natural Resources
Robert Pearson, U.S. Environmental Protection Agency
Gilman Veith, Duluth National Water Quality Laboratory
Wayne Willford, U.S. Fish and Wildlife Service
John Winters, Indiana State Board of Health

MONS 207832

PREFACE

On May 22-23, 1975, a meeting of the Lake Michigan Toxic Substances Committee was called to discuss the concerns of the states and Federal agencies related to problems with polychlorinated biphenyls (PCBs). The states bordering Lake Michigan (Indiana, Illinois, Michigan, and Wisconsin) the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency (Region V) were represented at this meeting.

At the termination of this meeting a number of concensus conclusions were drawn. It is the purpose of this report to present evidence to support these conclusions.

MONS 207833

TABLE OF CONTENTS

DRAFT

Acknowledgments i

Preface ii

Introduction 1

Presentation of Evidence 2

Effects related to toxicity 2

U.S. Food and Drug Administration Action 5

PCBs in Lake Michigan Fish 6

Conclusions of the Duluth National Water Quality Laboratory 6

Conclusions of the Great Lakes Fishery Laboratory . . 7

Conclusions of the Illinois Environmental Protection Agency 7

Conclusions of the Division of Water Pollution Control, State of Indiana 7

Conclusions of the Michigan Bureau of Water Management, Department of Natural Resources 10

Conclusions of the Wisconsin Department of Natural Resources 10

Comments on economic loss to the Lake Michigan Fishery . . 11

PCBs in water and biological accumulation 12

Manufacture, Policy, and Sales of PCBs as indicated by Monsanto Industrial Chemicals Company 15

Uses and Applications of PCBs 18

Other sources or products containing PCBs as recently (1975) identified by state agencies or the U.S. EPA 19

Replacements 20

Conclusions of the Lake Michigan Toxic Substances Committee . . 20

Recommendation of the Lake Michigan Toxic Substances Committee . 22

Literature cited 24

MONS 207834

I. INTRODUCTION

DRAFT

Polychlorinated biphenyls (PCBs) were first manufactured commercially in 1929. In the United States, PCBs have been manufactured by a single producer, the Monsanto Industrial Chemicals Company. In addition, PCBs are manufactured in Great Britain, France, Germany, the USSR, Japan, Spain, Italy, and Czechoslovakia.[1]

PCBs have been used in the following broad types of applications during the past 40 years:[2]

1. "Open-ended" applications; for example, in paints, specialty inks, paper coatings, plastics, etc.
2. "Nominally closed" applications; for example, as the working fluid in hydraulic or heat transfer systems.
3. "Closed electrical system" applications, specifically as the insulating fluid in certain kinds of transformers and capacitors.

The Monsanto Industrial Chemicals Company has marketed chlorinated biphenyls under the trademarks Aroclor 1221, 1232, 1242, 1248, 1254, 1260, 1262, and 1268. The latter two digits designate the percent chlorine of each formulation.[3] During the period 1963-1971, U.S. domestic sales of Aroclor 1242 and 1254 were higher than other Aroclors. Aroclor 1016 is currently replacing Aroclor 1242 as a capacitor impregnant.[4]

Chlorinated terphenyls have been marketed under the trademark Aroclor 5442 and 5460.[5] As one use, these Aroclors were blended with various waxes for the investment casting industry. Currently, a number of manufacturers of this specialty wax are using imported PCBs, since Aroclor 5442 and 5460 are not available for domestic sale.

Current data for 1974-1975 indicates that PCB concentrations in Lake Michigan coho salmon, lake trout, and chubs exceed the Food and Drug Administration's action guideline of 5 ppm. These concentrations have not decreased since 1972, although Monsanto has indicated limiting sale of PCBs to manufacturers of sealed electrical equipment such as transformers and capacitors. Past and more recent data demonstrate that loss of PCBs to the environment constitute an environmental and human health hazard and are a direct cause of economic loss to the commercial fishery. Because of these concerns, the Lake Michigan Toxic Substances Committee recommends strict regulation or elimination of use of PCBs where other replacements are available.

II. PRESENTATION OF EVIDENCE

A. Effects related to toxicity

The following biological and toxicological effects were presented and documented by the Interdepartmental Task Force on PCBs:[5]

1. Acute oral LD_{50} in mammals varies from approximately 2-10 gm/kg. (Apparent increase in mammalian toxicity with decrease in chlorine content.)
2. Generally, enzyme induction increases with increase in chlorination of PCBs.
3. Induction of hepatic hydroxylating microsomal enzymes and increased estrogenic activity in the rat.
4. Enlargement of the liver and vacuolar or fatty degeneration of liver cells in rats, guinea pigs and monkeys.
5. Production of hydropericardial edema in chickens and Japanese quail.
6. Teratogenic effect in chick embryo.
7. Adverse reproductive effects in rats at levels of ca. 100 ppm in diet.
8. Adverse reproductive effects in mink.

MONS 207836

9. Possible implications in aberrations in calcium metabolism and reproduction in ring doves.

10. Effects on hatchability in chickens, Japanese quail.

11. Skin, liver and kidney lesions in rabbits following dermal exposure.

12. Possible immunosuppressive effects in rabbits.

13. Chemical porphrogenic effects in many species.

14. Chloracnegenic and hepatotoxic effects in man.

15. Hyperglyceridemic effects in man.

16. Human miscarriages, still births and transplacental transmission in abnormal pigmentation from "rice-oil disease" ("Yusho").

17. PCB residues in human adipose tissue, serum and milk.

18. Hepatotoxic, chloracnegenic and porphyrogenic effects of chlorinated dibenzofuran contaminants in several species.

19. Chloracnegenic effects of chlorinated naphthalene contaminants in man.

Within the Lake Michigan basin, the effect of PCB contaminated fish on mink has been well documented.[6] It has been demonstrated that 10 ppm of Aroclor 1254 in coho salmon fed to mink produced 71% mortality.[7] In addition, no kits were born alive where the diet contained 5 ppm or greater Aroclor 1254. This evidence suggests that the biological resources of Lake Michigan may seriously endanger other species even though the concentrations are not sufficiently great to produce discernible effects within the aquatic communities.[8]

A serious situation exists with respect to populations of fish-eating birds in the Great Lakes area.[9] Severe reproductive failure has been identified in herring gull colonies around Lake Ontario.[10] There is a positive correlation between early embryonic mortality and PCB contamination.[11] The major effect on young birds is to produce symptoms of chick edema disease. The symptoms are subcutaneous pericardial and abdominal edema, phyrla, liver

MONS 207837

necrosis and high mortality.[12,13,14] Michigan officials have observed unnaturally high mortalities of gulls in recent years from Saginaw Bay and Grand Traverse Bay. Analysis of the liver and brain of a dead Herring Gull from Grand Traverse Bay in 1973 showed the presence of 2600 ppm of Aroclor 1254.

Recently, the effects of PCBs have been demonstrated in subhuman primates (rhesus monkeys).[15] In studies at the University of Wisconsin Medical School, six adult female rhesus monkeys were fed Aroclor 1248 at the level of 25 ppm for 2 months. Facial edema, alopecia, and acne were developed within 1 month, and one animal died as a result of PCB intoxication 2 months after removal from the experimental diet. These observations and others during the 1974 study attest to the toxicity of short-term, low-level exposure to PCBs in subhuman primates. More recent data has been obtained at the 2.5 and 5 ppm level.[16] General observations of subhuman primates subjected to prolonged consumption of Aroclor 1248 at these levels were the following: alopecia, acne lesions, loss of weight, increased secretion of total urinary ketosteroids, irregularities in menstrual cycles, impaired ability to maintain pregnancy, and undersized infants.

A detailed presentation of biological effects on man (metabolism, toxicology, and results of human exposures), and the biological effects on animals other than man has been developed by the Interdepartmental Task Force on PCBs.[17] It is of interest that these and other studies demonstrate that rats tolerate PCB consumption at the 100 ppm level; subhuman primate studies show that the 100 ppm level is lethal and that the effect level is 2.5 - 5 ppm.

B. U.S. Food and Drug Administration (FDA) Action

On January 30, 1974, Donald C. Healton, Regional Director of the FDA, presented a review of the PCB problem in the Great Lakes Area.[18] Mr. Healton indicated that the FDA was prepared to take legal action against all shipments of fish in interstate commerce which exceed the 5 ppm temporary tolerance. Data obtained during the spring of 1975 forced the FDA to sample extensively all Lake Michigan fish in interstate transport.

During 1975, the regional FDA office in Chicago has sampled, seized, and documented the following shipment of Lake Michigan fish:[19]

Lake Michigan Chinook and Coho Salmon were shipped by Tempotech Industries, Holland, Michigan to Point Adams Packing Company, Hammond, Oregon. Fish were seized by the Seattle FDA District Office on the basis that PCBs contained in these canned or frozen fish exceeded the 5 ppm tolerance level. Seizure was accomplished by the FDA on May 30, 1975. A total of 124,812 - 15.5 ounce cans of canned Coho Salmon was seized. PCB levels in these fish ranged from 7.6 - 10.9 ppm. In addition, 6,480 pounds of frozen Lake Michigan salmon were seized from Point Adams Packing Company. PCB levels in these fish ranged from 8.2 - 9.2 ppm.

Seizures of Lake Michigan Chubs transported in interstate commerce were accomplished by the FDA on May 1 and 7, 1975. These fish were expected to exceed the temporary tolerance level of 5 ppm PCB, however, analyses confirmed that these fish were below the tolerance level. In this case the FDA seized these fish on the basis of dieldrin concentration in excess of the .3 ppm tolerance level. The sources of these shipments were from the Holland, Michig: ports of: Gordon, Charlevoix and Mackinaw City.

Because current fishery regulations allow only a very limited commercial fishery for lake trout and salmon, frequent FDA seizure of these fish in

MONS 207839

interstate transport has not been necessary in 1975 (exception - seizure in Hammond, Oregon).

C. PCBs in Lake Michigan Fish

There has been major concern over PCB contaminated fish in Lake Michigan during the past 5 years. The Duluth National Water Quality Laboratory, U.S. EPA, the Great Lakes Fishery Laboratory, the U.S. FDA, and the state agencies of Illinois, Indiana, Michigan, and Wisconsin have participated in intensive programs related to PCB contamination of Lake Michigan fish.

1. Conclusions of the Duluth National Water Quality Laboratory:[20]

a. During study of Lake Michigan fish (1971), representing 13 species and 14 regions of the lake, mean concentrations of PCBs in fish expressed as Aroclor 1254 ranged from 2.7 ppm in rainbow smelt to 15 ppm in lake trout.

b. PCB concentrations in all trout and salmon greater than 12 inches long exceeded the FDA tolerance level of 5 ppm.

c. PCB concentration in Lake Michigan coho salmon were two to three times greater than that in coho from Lake Huron, approximately 1.5 times greater than that in Lake Ontario coho salmon, and approximately 10 times greater than that in coho from Lakes Erie and Superior.

d. Larger fish, such as brown, lake, and rainbow trout and chinook and coho salmon contained PCBs at two to three times the 5 ppm FDA tolerance level; concentrations increased with the percentage of fat and size of fish.

e. PCB concentration in alewives was greater in southern Lake Michigan than in the northern regions (although some anomalies were present); brown trout suggested a similar trend in that those from Michigan City at the southern end of the lake contained 11.9 ppm PCB, whereas those from Sheboygan and Gills Rock contained 7.9 and 7.6 ppm, respectively.

MONS 207840

2. Conclusions of the Great Lakes Fishery Laboratory:[21]

a. During studies on Lake Michigan fish since 1972, average PCB concentrations in bloaters, lake trout, and coho have consistently exceeded the FDA 5 ppm tolerance level (Table 1).

b. Based on samplings of bloaters, it appears that PCB residue levels have remained "static" since 1972.

c. Analyses of lake trout performed as part of the Great Lakes Environmental Contaminant Study confirm the presence of high PCB residues in those fish and indicate a pattern of greater contamination in the southern portion of the lake.

3. Conclusions of the Illinois Environmental Protection Agency

During the past several years, the Illinois Environmental Protection Agency has been monitoring Lake Michigan fish for PCB residue.[22] In general, large trout and salmon have shown concentrations over the 5.0 ppm FDA tolerance level. Some fish had PCB concentrations 3 to 4 times this level. Through 1974, analyses of Lake Michigan fish have shown no obvious trends, up or down.

4. Conclusions of the Division of Water Pollution Control, State of Indiana:

Since 1971, the Division of Water Pollution Control has been monitoring PCB residues in fish from Lake Michigan and migratory salmonids in its tributary streams. PCBs remain at unacceptably high levels in certain species and are higher in concentration in the southern end than in the northern end of Lake Michigan.[23] Most lake trout far exceed the tolerance level of 5 ppm as set by the FDA (Table 2). The larger fish generally showed higher concentration of PCB residue.

The State Board of Health has advised fishermen (in press release) not to consume certain Lake Michigan species as a staple food source.

Table 1. Concentrations of PCBs in fall collections of Lake Michigan bloaters and lake trout off Sangatuck, Michigan, and coho salmon from between Ludington and Frankfort, Michigan.1/

Species and Year	Number of Fish	Average Length (mm)	Total PCBs (ppm) 2/
Bloaters			
1972	120 3/	255	5.66 (0.95)
1973	160 3/	250	5.24 (0.37)
1974	110 3/	257	5.57 (0.31)
Coho salmon			
1972	10	693	10.93 (2.12)
1973	29	620	12.17 (0.77)
1974	30	665	10.45 (0.92)
Lake trout			
1972	9	648	12.86 (4.75)
1973	30	602	18.93 (2.08)
1974	30	616	22.91 (3.73)

1/ Analysis performed by Great Lakes Fishery Laboratory.

2/ Concentrations in whole fish, wet weight with 95% confidence interval in parentheses.

3/ Composite samples, 10 fish per sample.

MONS 207842

Table 2. Concentration of PCBs (as Aroclor 1254) in Lake Michigan and tributary stream fish obtained during 1974.1/

Date of Collection	Species	Number of fish	Total weight (lbs.)	Total PCBs (ppm)2/
4/26/74	Coho salmon	1	9.75	1.5
6/28/74	Brown trout	6	26.5	0 36
7/25/74	Yellow perch	6	2.0	0.11
7/25/74	Yellow perch	6	1.6	0.3
7/14/74	Lake trout	6	31.3	60.0
7/14/74	Lake trout	7	4.1	5.0
7/14/74	Lake trout	6	11.0	0.89
9/26/74	Brown trout	6	36.5	8.0
10/24/74	Lake trout	3	6.0	60
10/24/74	Lake trout	3	9.26	53
10/24/74	Lake trout	3	5.03	35
10/24/74	Lake trout	3	7.8	31
10/24/74	Lake trout	2	3.5	43
11/1/74	Lake trout	3	12.6	37

1/ Fish from Indiana shoreline of Lake Michigan, Trail Creek, and Michigan City as analyzed by Division of Water Pollution Control, State of Indiana.

2/ Concentrations in whole fish.

MONS 207843

5. Conclusions of the Michigan Bureau of Water Management, Department of Natural Resources:

In 1972, Michigan developed a cooperative State-Federal study of the contaminant levels in Great Lakes fish, including lake trout, salmon, whitefish, chubs, menominee, yellow perch, alewife, carp and suckers. This Great Lakes Environmental Contaminant Survey (GLECS) was developed by the Michigan state agencies (Agriculture, Natural Resources, and Health) in cooperation with the U.S. Food and Drug Administration and the U.S. Fish and Wildlife Service. It was designed to systematically sample fish on a annual basis to obtain data on areas where contaminants approach or exceed FDA guidelines for consumer protection. The data for 1972 through 1974 show PCB concentrations in Lake Michigan fish to be exceeding the FDA 5.0 ppm limit in lake trout, coho and chinook salmon, and chubs. Levels in lake trout and salmon have averaged as high as 2 times the FDA limit. A pattern of higher contamination in lake trout was observed in the southern zones of the lake than in the northern areas.

For trend analysis, the Michigan state agencies depend primarily upon the data of the U.S. Fish and Wildlife Service, Ann Arbor Laboratory (pages 6-8, Table 1). The Ann Arbor Laboratory data for chubs show no significant change over the period of 1972 to 1974. The concentrations in lake trout are as much as four times the FDA tolerance level of 5.0 ppm PCB.

In the fall, 1971, the Michigan Department of Public Health issued a health warning against consumption of Lake Michigan trout and salmon more than once a week. This warning remains in effect.[24]

6. Conclusions of the Wisconsin Department of Natural Resources:

The Wisconsin Department of Natural Resources has been actively involved in monitoring of PCB residues in Lake Michigan fish since 1971.[25] A col-

MONS 207844

lection of 39 samples of Lake Michigan lake trout made by the Department in 1971 and 1972 showed that PCB levels exceeded 5 ppm in most fish over 16 inches in length. The older and larger fish contained higher concentrations of PCBs. During the fall of 1974 and the spring of 1975, 97 lake trout, salmon, and white fish were taken in Green Bay and Lake Michigan.[26] Analyses of these whole fish samples (with heads and viscera removed) for PCB residues show that trout and salmon over 24 inches in length will exceed 5 ppm PCB.

The Wisconsin Department of Natural Resources, in a press release dated June 11, 1975, reissued the warning previously given by the State Health Officer. This warning advises fish consumers to limit their consumption of such fish to one meal per week.

D. Comments on economic loss to the Lake Michigan Fishery:

The total dockside value of the commercial fishery (all species) for all of Lake Michigan was in excess of $6 million in FY 74. Although all species are not affected be PCBs, the potential exists for a significant portion of this fishery being curtailed. The presence of PCBs in coho and chinook salmon has been a strong factor in limiting commercial utilization of these species.

Approximately 12 million salmonids were planted in Lake Michigan in FY 75. Large numbers of these fish are harvested at egg taking weirs each year upon their return to spawn. Large amounts of salmon eggs, in excess needed for reproduction, as well as the fish themselves would be available for consumption if not contaminated with PCBs. Although eggs are now utilized for bait, they, as well as the fish, represent considerable economic value which must be largely wasted.

MONS 207845

At the present time, PCBs pose a threat primarily to commercial fishing. No effort is being made to curtail sportfishing, although it is being suggested to anglers that Lake Michigan trout and salmon be consumed at a minimal rate, i.e., not more than one meal per week per person. Recreational fishing in Lake Michigan has resulted in a sport fishery value estimated to be in excess of $15 million/year ($39 million/year is estimated in U.S. waters for all the Great Lakes) not including capital equipment such as fishing gear and boating equipment. In speculation, if it were determined that the presence of PCBs was serious enough to close the sport fisheries services, a greater economic loss would result.

The Great Lakes Fishery Commission has a FY 76 budget of $1.1 million for sea lamprey control in Lake Michigan. The main purpose for this expenditure is to assist the rehabilitation of the Lake Michigan fish stocks. Nonutilization of the fisheries as the result of PCBs would waste this expenditure.

In view of recent state warnings and FDA actions with respect to the fishery, a large economic loss to the Lake Michigan commercial fishery is imminent. Sportfishing economics could suffer an even greater loss.

E. PCBs in water and biological accumulation:

As indicated by data on residual PCBs in Lake Michigan fish, water is a principal sink and transport mechanism for PCBs. Studies during 1971 - 1975 indicate that in industrialized areas, wastewater treatment plant effluents are major point sources of PCB discharge to surface waters. Because biological accumulation of PCBs by fish and other aquatic organisms has been documented as greater than 40,000 and 75,000 times the exposure level respectively [27], it is recommended that PCBs do not enter the receiv-

MONS _ 207846

ing waters of Lake Michigan at detectable concentrations. (Currently detection limits range from .02 - .05 ppb.)

The Illinois Environmental Protection Agency has analyzed tributary and municipal sources of PCBs to Lake Michigan since 1971. PCB concentrations analyzed as Aroclor 1242 or 1254 ranged from <0.1 - 4.0 ppb for these sources during the period 1971 - 1974. It is anticipated that a number of the major sources will be diverted from the lake and will no longer contribute PCB residue to the lake.[28]

The Indiana State Board of Health has analyzed PCB sources on Lake Michigan tributary streams since 1971. In January 1973, a PCB monitoring program was initiated which involved the collection of samples on a regular basis from all Lake Michigan water intakes and all Indiana tributaries to Lake Michigan. This sampling program was intended to determine what levels of PCB (1254) were present and to indicate general areas where more definite sampling was required to identify sources. PCB concentrations during 1973 - 1974 ranged from <.01 to .09 ppb. Concentrations in Lake Michigan remain consistently low. PCB concentrations in the Indiana Harbor Canal and portions of the Grand Calumet are somewhat higher than other tributaries where 1975 data are available.[29]

The Michigan Bureau of Water Management has analyzed approximately 900 industrial and municipal discharges within the Lake Michigan Basin since 1971. Individual industrial discharges have ranged from less than 0.1 ppb to 7.0 ppm PCB with numerous discharges within the 0.1 to 1.0 ppb range.[30] Municipal wastewater treatment plants (WWTP) within the Lake Michigan Basin had effluent concentrations averaging approximately 0.5 ppb PCB for the period 1971 - 1973. These WWTP's have not been resampled.

MONS 207847

With the exception of a contamination problem in the Kalamazoo River, where the paper industry was identified as the source, most PCB inputs to Lake Michigan tributaries within Michigan boundaries appear to be low level inputs (less than 1 ppb). These inputs are difficult to trace back to a particular PCB usage within industries involved. Tributary inputs to Lake Michigan within Michigan boundaries, as measured in whole water samples at river mouths, have shown concentrations since 1971 averaging between 0.01 ppb and 0.06 ppb for individual rivers. No trend can be determined from concentrations in tributary waters due to low frequency of sampling and the many variables which must be considered.

The Wisconsin Department of Natural Resources has analyzed a number of industrial sources and wastewater treatment plants for PCBs within the Lake Michigan Basin. Particular discharges to Green Bay and Lake Michigan during the fall of 1974 ranged from < .1 to 18.5 ppb. In addition, cooling water from aluminum foundries in the Milwaukee area have been found to contain PCB. The source of the PCBs has been identified as hydraulic fluids from die cast machines. The survey is now being expanded to include other foundries.

Because PCB concentrations were high in effluents of waste paper recycling mills, in-plant investigations were requested of the industries. Analysis demonstrated that 7 of 14 waste papers contained PCBs ranging from .1 ppm Aroclor 1254 and .5 ppm Aroclor 1242 in heavy printed bleached Kraft to .4 ppm Aroclor 1254 and 3.6 ppm Aroclor 1242 in sorted office waste paper. The seven waste papers containing PCBs represent 50% of the waste papers recycled at a particular mill.[31]

The Wisconsin Department of Natural Resources studies have also shown that PCBs are deposited on land and water as fallout from the air. Analysis

MONS 207848

of snow melt water from seven locations this past winter were as follows: Green Bay (.01 ppb), Grafton (none), Kewaskum (none), Racine (.17 ppb), Kenosha (.22 ppb), Madison (.24 ppb) and Milwaukee (.20 ppb).

F. Manufacture, Policy, and Sales of PCBs as Indicated by Monsanto Industrial Chemicals Company

When questions about the effect of PCBs on the environment first surfaced, Monsanto reviewed its product line and the applications for these products.[32] As more data was developed concerning the effects of PCBs, Monsanto indicates that steps were taken to reduce the entry of PCB to the environment. Monsanto reports that PCBs manufactured by Monsanto are sold only to the electrical industry for use in closed systems as a dielectric flui in transformers and capacitors - applications for which there exist no acceptable substitutes.

Table 3 presents data furnished by Monsanto related to production and sales of PCBs from 1957 - 1974. U.S. sale of Aroclor 1242 has dropped considerably from 1971 to 1974 but has been replaced by Aroclor 1016. Sale of Aroclor 1254 remains about the same for the period 1957 - 1974.

In view of the persistence of Aroclor 1254 and the fact that U.S. sale of this product has not dropped, we may anticipate that Aroclor 1254 residues in Lake Michigan fish will be maintained. In addition the "% degradation" of Aroclor 1242 and 1016 in studies conducted by Monsanto are similar.[33] Since U.S. sale of Aroclor 1016 is replacing 1242, and 1242 is currently persistent in Lake Michigan industrial and municipal discharges (although Monsanto studies indicate Aroclor 1242 degrades to a certain degree under laboratory conditions), we may anticipate Aroclor 1016 in discharges to Lake Michigan.

MONS 207849

TABLE 3 PCB MANUFACTURE AND SALES

MONSANTO INDUSTRIAL CHEMICALS COMPANY

1957 thru 1964

(Thousands of Pounds)

	1957	1958	1959	1960	1961	1962	1963	1964
U.S. PRODUCTION	(1)	(1)	(1)	37919	36515	38353	44734	50833
DOMESTIC SALES (LBS.)	32299	25061	31310	39214	37538	38043	33152	44869
U.S. EXPORT SALES	(2)	(2)	(2)	(2)	(2)	(2)	3647	4054
DOMESTIC SALES BY CATEGORY								
Heat Transfer	-	-	-	-	-	157	582	929
Hydraulics/Lubricants	1612	1549	2685	2523	4110	3915	3945	4374
Misc. Industrial	704	755	1569	1559	2114	1681	1538	1692
Transformer	12955	5719	5984	7921	6281	7984	7290	7997
Capacitor	17028	14099	16499	16967	15935	15362	15606	19540
Plasticizer Applications	(1)	3939	4573	6244	9098	8924	9181	10337
Petroleum Additives	-	-	-	-	-	-	-	-
DOMESTIC SALES BY PCB GRADE								
Aroclor 1221	23	16	254	103	94	140	361	596
Aroclor 1232	196	113	240	155	241	224	13	13
Aroclor 1242	18222	10444	13598	18196	19827	20654	18510	23571
Aroclor 1248	1779	2559	3384	2827	4023	3463	5013	5238
Aroclor 1254	4461	6691	6754	6688	6294	6325	5911	6280
Aroclor 1260	7587	5982	6619	7330	6540	6595	7626	6533
Aroclor 1262	31	154	359	326	361	432	414	446
Aroclor 1268	-	72	102	189	158	210	284	190
Aroclor 1016	-	-	-	-	-	-	-	-

(1) Production figures and Plasticizer Applications figures unavailable during year indic
(2) U.S. Export Sales figures unavailable during year indicated.

TABLE 3 (Con'd) MONSANTO INDUSTRIAL CHEMICALS COMPANY

1965 thru 1974 (Thousands of Pounds)

	1965	1966	1967	1968	1969	1970	1971	1972	1973	197
U.S. PRODUCTION	60480	65849	75309	82654	76389	85054	34994	38600	42178	4045
DOMESTIC SALES	51796	59078	62466	65116	67194	73061	34301	26408	37742	3440
U.S. EXPORT SALES	4234	6852	8124	11231	10624	13561		6308	8346	539
DOMESTIC SALES BY CATEGORY										
Heat Transfer	1237	1766	2262	2529	3050	3958	3060	752		
Hydraulics/ Lubricants	4616	4258	4643	5765	8039	7403	1552	0		
Misc. Industrial	1941	1779	1426	1283	1079	1627	1155	0		
Transformer	8657	8910	11071	11585	12105	13628	11134	25656	37742	3440
Capacitor	23740	28884	29703	29550	25022	26708	14141			
Plasticizer Applications	11696	13481	13361	14404	16460	19537	3259	0		
Petroleum Additives	-	-	-	-	1439	-	-	0		
DOMESTIC SALES BY 10% GRADE										
Aroclor 1221	369	528	442	136	507	1476	2215	171	35	57
Aroclor 1232	7	16	25	90	273	260	171	0	0	0
Aroclor 1242	31533	39567	43055	44853	45491	48568	21981	728	6200	6207
Aroclor 1248	5965	5015	4704	4094	5650	4073	213	807	0	0
Aroclor 1254	7737	7935	6696	8391	9622	12421	4661	3495	7976	6185
Aroclor 1260	5631	5875	6417	5252	4439	4690	1725	305	0	0
Aroclor 1262	553	768	840	720	712	1023	1	0	0	0
Aroclor 1268	196	284	287	280	300	330	0	0	0	0
Aroclor 1016	0	0	0	0	0	0	3334	20902	23531	21955

G. Uses and Applications of PCBs: [34]

PCBs have been or may be currently used for the following applications:

1. As filling agents or impregnants in transformers and power capacitors
2. As hydraulic fluids
3. As a diffusion pump oil
4. In heat transfer applications
5. As plasticizers
6. As adhesives - a) possibly in manufacture of brake linings, clutch faces, and grinding wheels
   b) as a laminating adhesive in preparation of safety and acoustical glass
   c) as a laminate of ceramics and metals
   d) as an addition to washable wall coverings and upholstering materials
   e) as an additive to adhesive compositions used to manufacture envelopes
   f) in self-adhering films
   g) in preparation of coatings of pressure-rupturable capsules for adhesive tape
7. As textile coatings -
   a) as a coating for ironing board covers
   b) as a de-lustering agent for rayons
   c) as a treatment for polyamide (nylon-type) yarns - used as a flame proofer
   d) as an additive to sealing formulation to waterproof canvas
8. As surface coatings -
   a) as an additive in paints and varnishes
   b) as an additive in film casting solutions for electrical types, insulating tapes, and protection lacquers

MONS 207852

c) as an additive to plastic bottles

d) as an additive in epoxy resins for protective coating of metals

9. As sealants -

a) as an additive in sealing and caulking compounds and in putties - yielding a non-hardening compound resistant to moisture and frost

b) as an additive in sealants for concrete and asphalt

10. In the printing industry -

a) as part of formulation of pressure - sensitive record - carbonless carbon paper

b) as a coating in papers used in thermographic duplicating processes

c) as an additive in xerographic transfer process

d) as a plasticizer in printing plates and flexographic plates

11. As fire retardant and flameproofing compositions

a) may be added to sealants and to fireproof sealants for floors, doors, ceilings, and partitions.

H. Other sources or products containing PCBs as recently (1975) identified by state agencies or the U.S. EPA:

1. Xerox toner

2. Waste paper destined for waste paper recycling (represented 50% of the paper recycled at one paper recycling mill and included sorted office waste paper and heavy printed bleached Kraft).

3. Toilet soaps

4. Barrier creams

5. Hydrated lime used in glass manufacture and as water treatment chemical

6. Glass sealant

7. Tapping compound

8. Products for automobile manufacturing

9. Primer paints

10. Hard and soft wood pulps

11. Coloring compounds

12. Degreasers

13. Additive to zinc alloys

14. As additives to waxes destined for investment - casting in the tool and die casting industry.

I. Replacements

With the exception of PCB use in transformer and capacitor application, the Interagency Task Force on PCBs found no evidence that PCBs were indispensable for items 2 through 11 (under G. Uses and Applications). Use of PCBs in transformers and capacitors was continued because various federal, state, and local codes required their continued use in or adjacent to public, commercial, and industrial buildings, which locations present the greatest potential danger (from fire or explosion) to life and property.

For many new and old applications, askarel (PCB) filled transformers can be replaced by oil-filled, open dry-type, or sealed dry-type transformers. In addition, Dow-Corning is currently testing a silicone compound as an askarel replacement (this does not constitute an endorsement of the Dow-Corning product). For the power capacitor industry, Dow Chemical Company is currently testing a replacement for capacitor-grade askarel (this does not constitute an endorsement of the Dow Chemical Company product).

III. CONCLUSIONS OF THE LAKE MICHIGAN TOXIC SUBSTANCES COMMITTEE

Based on the evidence presented in this report and the deliberation of this Committee, the following conclusions have been drawn:

MONS 207854

1. The effect level of PCBs in primates reproduction is recently documented as less than 2.5 ppm and is much lower than has been observed in Standard test mammals (rats).

2. As a result of recent court decisions the FDA is now enforcing tne 5 ppm residue maximum in fish intended for human consumption and is likely to review the 5 ppm maximum allowable based on recent primate toxicological evidence.

3. The concentrations of PCBs in Lake Michigan fish are probably not decreasing and salmonids, particularly larger specimens, currently exceed the 5 ppm maximum allowable levels.

4. Reported efforts by the manufacture to restrict distribution and efforts by the agencies to restrict discharges have not resulted in PCB reductions in the lake.

5. It is probable that wastewater sources of PCBs to Lake Michigan are ubiquitous and at or below detectable levels.

6. An economic loss has already resulted to the commercial fishery as a result of PCB contamination. A much larger economic loss to the commercial and sport fishing industry is imminent in light of current FDA food recommendations and enforcement actions.

7. Non-wastewater PCBs are probably still reaching the environment from incineration, land disposal and careless dumping.

8. The presence of PCBs in many processes and products continues to be widespread in spite of Monsanto Chemical Company policy to restrict sale to closed systems.

9. For many if not for all uses PCBs can be eliminated or replaced by alternative chemicals.

IV. RECOMMENDATION OF THE LAKE MICHIGAN TOXIC SUBSTANCES COMMITTEE

The Interdepartmental Task Force on PCBs drew the following conclusion in 1972:[35]

"The use of PCBs should not be banned entirely. Their continued use for transformers and capacitors in the near future is considered necessary because of the significantly increased risk of fire and explosion and the disruption of electrical service which would result from a ban on PCB use. Also, continued use of PCBs in transformers and capacitors presents a minimal risk of environmental contamination. The Monsanto Company, the sole domestic producer, has reported voluntarily eliminating its distribution of PCBs to all except manufacturers of electrical transformers and capacitors."

The Lake Michigan Toxic Substances Committee feels that the Interdepartmental Task Force on PCBs drew the best conclusion it could based on available information and technology in 1972. The decision to distribute PCBs for "closed systems" use was practical and it was anticipated that PCBs in the environment would decline.

The Committee, however, has not observed a decline in PCB residuals within Lake Michigan and its basin from 1971 - 1975. PCBs have remained at high levels in fish and in industrial and municipal effluents in spite of programs to locate sources, eliminate discharges, and recommend proper handling and disposal procedures for PCBs. In addition, the foreign import of PCBs, and the impact of PCBs related to human health have added to the concerns of the Committee.

In view of these concerns, the Lake Michigan Toxic Substances Committee recommends a national ban on all domestic and imported PCBs destined for

MONS 207856

use other than in transformers and capacitors and that the critical or essential use of PCBs in transformers and capacitors be immediately and critically reviewed in light of current potential replacement products.

MONS 207857

LITERATURE CITED

1. Polychlorinated Biphenyls and the Environment, Interdepartmental Task Force on PCBs, Washington, D.C., May (1972).

2. American National Standard Guidelines for Handling and Disposal of Capacitor-and Transformer-Grade Askarels Containing Polychlorinated Biphenyls, American National Standards Institute, Inc., January 9 (1974).

3. Broadhurst, Martin G., Use and Replaceability of Polychlorinated Biphenyls, Environmental Health Perspectives, October (1972).

4. American National Standard Guidelines, op. cit.

5. Ibid.

6. Ibid.

7. Ringer, R. K., et al., Effect of Dietary Polychlorinated Biphenyls on Growth and Reproduction of Mink, American Chemical Society National Meeting Preprints of Papers, (1972).

8. Veith, Gilman D., Baseline Concentrations of PCBs and DDT in Lake Michigan Fish, U.S. Environmental Protection Agency, Duluth National Water Quality Laboratory (1971).

9. Hesse, John L., Contaminants in Great Lakes Fish, Staff Report, Michigan Water Resources Commission, Department of Natural Resources, June (1975).

10. International Joint Commission Water Quality Objectives Report, May (1975).

11. Gilbertson, M. and G.A. Fox, Pollutant Associated Pathogenesis of Embryos of Great Lakes Herring Gulls, Science (in press) (1975).

12. Gilbertson, M., Pollutants in Breeding Herring Gulls in the Lower Great Lakes, The Canadian Field Naturalist (1974).

13. Gilbertson, M., and R. Hale, Early Embryonic Mortality in a Herring Gull Colony in Lake Ontario, The Canadian Field Naturalist (1974).

14. Gilbertson and Fox, op. cit.

15. Allen, J. R., et al., Residual Effects of Short-Term, Low-Level Exposure of Nonhuman Primates to Polychlorinated Biphenyls, Toxicology and Applied Pharmacology (1974).

16. Barsotti, D. A., and J. R. Allen, Effects of Polychlorinated Biphenyls on Reproduction in the Primate, Presented at the Meeting of the Federation of American Societies for Experimental Biology, Atlantic City, New Jersey, April 18 (1975).

MONS 207858

17. Interdepartmental Task Force on PCBs, op. cit.

18. Healton, Donald C., A Review of PCBs in the Great Lakes Area, U.S. Food and Drug Administration, Presented at the Governor's Great Lakes Regional Interdisciplinary Pesticide Council, Chicago, Illinois, January 30 (1974).

19. Stanley, Eugene, U.S. Food and Drug Administration, Personal Communication, June 20 (1975).

20. Veith, op. cit.

21. Willford, Wayne A., Contaminants in Upper Great Lakes Fishes, Great Lakes Fishery Commission Upper Great Lakes Committee Meetings, Milwaukee, Wisconsin, March 25 - 26 (1975).

22. Barganz, Ronald, Illinois Environmental Protection Agency, Personal Communication, June 23 (1975).

23. Winters, John, Indiana Department of Health, Personal Communication, June 23 (1975).

24. Hesse, op. cit.

25. Kleinert, Stanton, Wisconsin Department of Natural Resources, June 30 (1975).

26. Kleinert, op. cit.

27. Stalling, David L., Foster Lee Mayer, Jr., Toxicities of PCBs to Fish and Environmental Residues, Environmental Health Perspectives, April (1972).

28. Barganz, op. cit.

29. Winter, op. cit.

30. Hesse, op. cit.

31. Kleinert, op. cit.

32. Policy Letter of Monsanto Company's Program of Restricted Sales and Controlled Manufacturing Practices, October (1974).

33. Tucker, E. Scott, Victor W. Saeger, and Orville Hicks, Biodegradation of Polychlorinated Biphenyls, Monsanto Company (Publication in progress).

34. Interdepartmental Task Force on PCBs op. cit.

35. Ibid.

MONS 207859