Half-life of Polychlorinated Biphenyl (Aroclor 1254) in Fish From an Alabama Reservoir and Stream

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Data from an eight year (1969-1976) field study for PCB's (Aroclor 1254) in fish along Choccoloco Creek and Logan Martin Reservoir in Alabama were analyzed. Two additional years of collecting field data completed the study. Four fish collecting stations were established. Station #1 was a control station miles above the mouth of Snow Creek (which is known as the discharging point by the PCB's plant of Monsanto Chemical Co.). Station #2 and #3 were downstream along Choccoloco Creek and Station #4 was at the Logan Martin Reservoir. Concentration of PCB's (Aroclor 1254) in fish tissue were analyzed to determine accumulation patterns over time and to calculate the half life of the compound for the various fish species. A decreasing concentration of PCB's (Aroclor 1254) in fish was observed from samples taken in Choccoloco Creek. The half lives for individual species range from 18.0 to 27.8 months with good statistical correlation within individual species. The average half life for PCB's (Aroclor 1254) for all species was 21.2 months. In contrast, fish sampled in Logan Martin Reservoir (Bass and Longear Sunfish) showed increasing PCB concentration over time. Based on uptake data, the projected time for doubling PCB concentration is 46 months for Longear Sunfish and 61 months for Bass. This increasing trend may be due to the availability of PCB's because of transport of suspended and colloidal material downstream from Choccoloco Creek. Different uptake patterns in fish taken from stream and reservoir will be elucidated.

MONS 013947

Not For Publication
Presented Before the Division of Environmental Chemistry
American Chemical Society
Houston, TX March 23-28, 1980

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Data from an eight year (1969-1976) field study for PCB's (Aroclor 1254) in fish along the Choccoloco Creek and Logan Martin Reservoir in Alabama were analyzed. Two additional years of collective field data completed the study. Four fish collecting stations were established. Station #1 was a control station miles above the mouth of Snow Creek (which is known as the discharging point by the PCB's plant of Monsanto Chemical Co.). Station #2 and #3 were downstream along Choccoloco Creek and Station #4 was at the Logan Martin Reservoir.

Concentrations of PCB's (Aroclor 1254) in fish tissue were analyzed to determine accumulation patterns over time and to calculate the half life of the compound for the various fish species.

A decreasing concentration of PCB's (Aroclor 1254) in fish was observed from samples taken in Choccoloco Creek. The half lives among several fish species are given in Table 1. The half lives for individual species range from 18.0 to 27.8 months with good statistical correlation within individual species. The average half life for PCB (Aroclor 1254) for all species was 21.2 months.

Table 1

Fish Species	Half Life in Months	P-Value
Stone Roller (Compostoma anomalum)	18.5	$0.01<p<0.05$
Bluegill (Lepomis macrochirus)	27.8	$0.01<p<0.05$
Longear Sunfish (Lepomis megalotis)	18.0	$0.01<p<0.05$
Bass (Micropterus spp.)	21.2	$0.10>p>0.25$
Blacktail Shiner (Notropus venustus)	20.9	$0.01<p<0.05$
Average	21.2	

MONS 013948

In contrast, the fish sampled in the Logan Martin Reservoir (Bass and Longear Sunfish) showed increasing PCB concentrations over time. Based on uptake data, the projected time for doubling the PCB concentration is 46 months for the Longear Sunfish and 61 months for the Bass (see Table 2). This increasing trend may be due to the availability of PCB's because of transport of suspended and colloidal material downstream from Choccoloco Creek.

Table 2

Fish	Doubling Time in Months	P-Value
Longear Sunfish (Lepomis megalotis)	46	$0.1 > p > 0.25$
Bass (Micropterus spp.)	61	$0.1 > p > 0.25$

The different uptake patterns in fish taken from stream and reservoir will be elucidated, taking into account water quality, flow, and sediment composting.

OBJECTIVES OF STUDY

- TO OBSERVE THE ~~BEHAVIOR OF~~ PCB CONTENTS IN FISH TAKEN FROM RIVER AND RESERVOIR SYSTEM WITH HIGH ~~QUALITIES~~ OF PCB BEING DISCHARGED BETWEEN 1930 - 1968.

- TO EVALUATE THE FACTORS INFLUENCING THE PCB BIO-ACCUMULATION IN THE FISH.

- TO DETERMINE THE BIOLOGICAL HALF-LIFE OF PCB PERSISTING AMONG FISH SPECIES IN THIS SPECIFIC SYSTEM.

MONS 013950

BACKGROUND INFORMATION

TRANSLOCATION OF PCB IN RIVER SYSTEM:

- PCB IS EASILY ADSORBED TO THE SEDIMENT AND ONTO PARTICULATE MATTER.
- ONCE ABSORBED ON THE SEDIMENT, THERE IS LITTLE LEACHING.
- PCB CONCENTRATION IN THE SEDIMENT IS RELATED TO BOTH ORGANIC CONTENT AND PARTICLE SIZE.
- HIGHER PCB CONCENTRATION ASSOCIATED WITH THE SEDIMENT NEAR THE DISCHARGING POINT.
- PCB IS PROBABLY TRANSPORTED BY SUSPENDED SOLID, SEDIMENT, AND PLANKTON.
- FIELD STUDY SHOWED THAT ESCAMBIA BAY HAD LOST MUCH OF ITS CONTAMINATION IN 9 MONTHS.

MONS 015951

BIOACCUMULATION OF PCB BY FISH

1. UPTAKE FROM SOLUBLE PCB
   - FISH MAY ACCUMULATE TO LEVELS OF 10^3 TO 10^5 TIMES WATER CONCENTRATION UNDER LABORATORY CONDITION.
   - CHANNEL CATFISH (ICTALURUS PUNCTATUS) CONCENTRATED AROCLOR 1254 TO 6.1×10^4 TIMES THE WATER CONCENTRATION OVER 2 MONTHS.
   - IN GENERAL, PCBs WITH HIGH CHLORINE CONTENTS BIOACCUMULATE MORE THAN ONE WITH LOW CONTENT (DUE TO AFFINITY TO LIPID FRACTION).

2. UPTAKE FROM SUSPENDED SOLID
   - HIGHER PCB LEVELS WERE FOUND IN FISH TAKEN FROM HIGHER TURBIDITY AREAS ALONG THE MISSISSIPPI RIVER.
   - THIS HAS NOT BEEN SUBSTANTIATED (APPEARS TO BE SITE SPECIFIC).

then why present it?

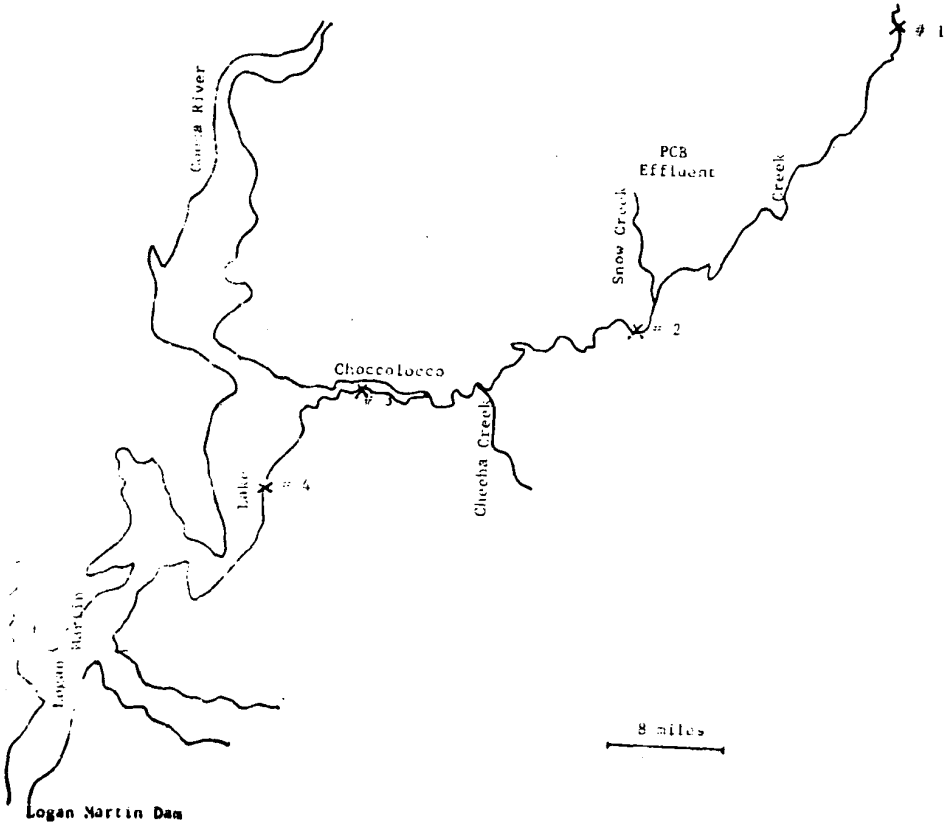
3. UPTAKE FROM THE SEDIMENT BY ORGANISMS
   - UPTAKE OF PCBs BY FISH IS RELATED TO THE AMOUNT OF PCB IN THE SEDIMENT.
   - IN ESCAMBIA BAY BURROWING SHRIMP CONTAIN HIGHER RESIDUE OF PCBs THAN NON-BURROWING ONES.
   - ALONG MILWAUKEE RIVER, FISH SAMPLES COLLECTED FROM STATION WITH HIGHER PCB RESIDUE IN THE SEDIMENT HAD HIGHER PCB CONCENTRATIONS.

4. UPTAKE FROM FOOD

most in nature
   - FOOD IS A MAJOR ROUTE OF BIOACCUMULATION.
   - PCB RESIDUES IN FISH ARE RELATED TO THE FISH'S FEEDING HABITS AND LIPID CONTENTS.

MONS 013953

COLLECTION STATIONS - ANNISTON, ALABAMA



MONS 013954

METHODS AND ANALYSIS

1. EXTRACTION: FISH TISSUE (5 - 15 GM WET WEIGHT)

↓

ACETONITRILE - HEXANE EXTRACTION WITH POLYTRON (EPA METHOD)

↓

FLORISIL CLEANUP

↓

GAS CHROMATOGRAPHY DETERMINATION

(CONT'D.)

MONS 013955

2. GAS CHROMATOGRAPHY: MICROTEK 220 WITH Ni^{63} ELECTRON CAPTURE DETECTOR, 220°C, 200°C, AND 350°C FOR INLET, COLUMN, AND DETECTOR TEMPERATURE.

COLUMN: 6 FT. U-SHAPE GLASS COLUMN WITH 3% OV-101 ON GAS-CHROM Q (100-120 MESH)

(CONT'D.)

MONS 013956

3. HALF-LIFE DETERMINATION

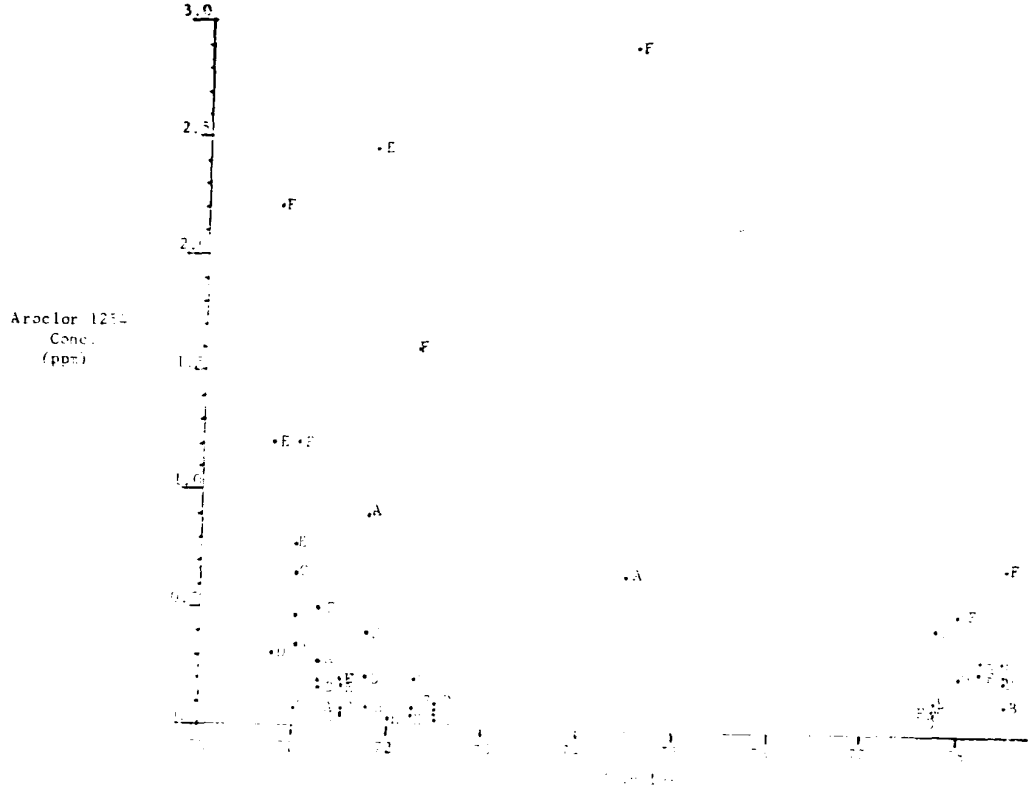
EQUATION: $Y = 10^{A-KT}$

HALF-LIFE = $\frac{LOG\ 2}{K}$

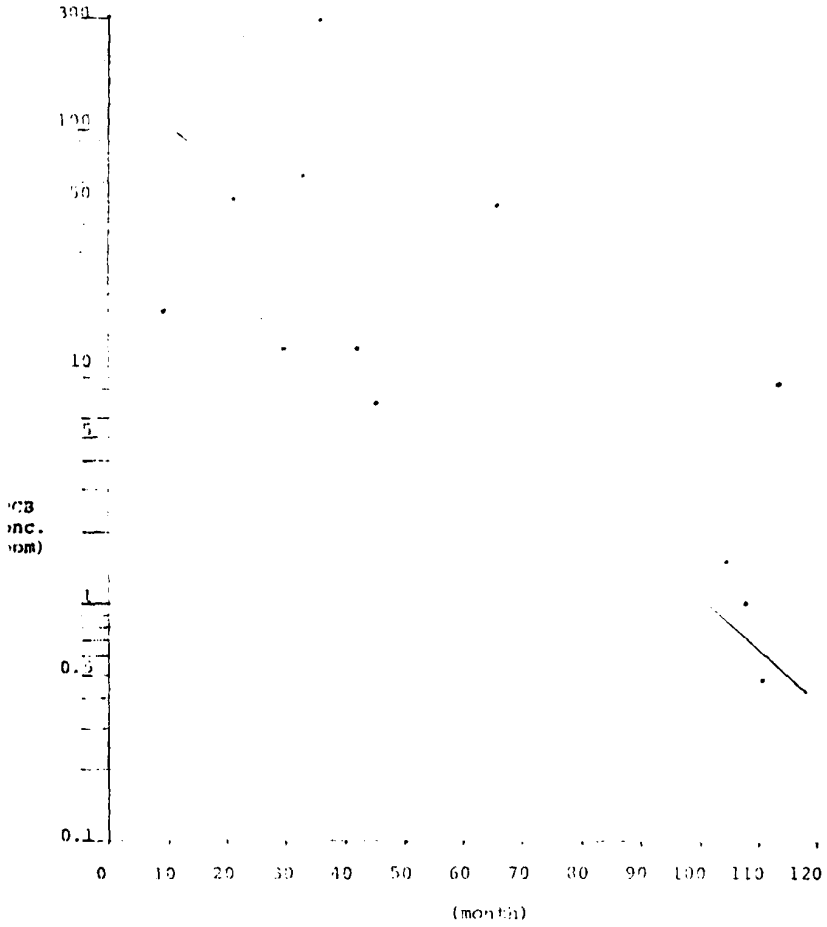
WHERE: Y = THE CONCENTRATION OF [illegible] AT TIME T,
A & K CONSTANTS.

MONS 013957

MONS 013958

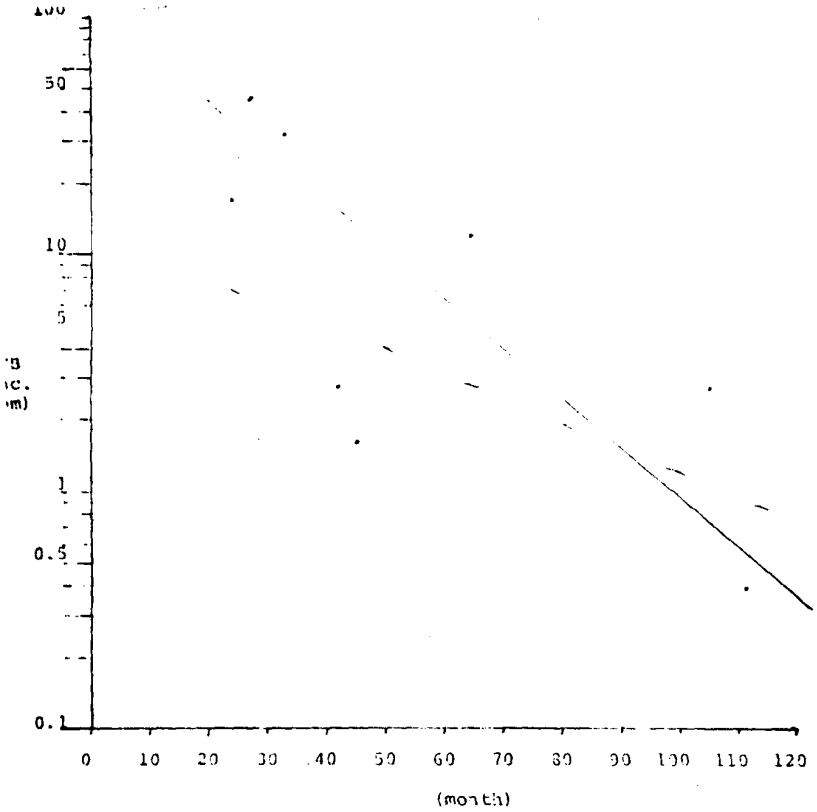


Station # 1 . Concentration of Aroclor vs. time among (A) stone roller (Compostoma anomalum), (B) longear sunfish (Lepomis megalotis), (C) hog sucker (Hypentelium etowanum), (D) bass (Micropterus spp), (E) bluegill (Leponis macrochirus), and (F) blacktail shiner (Notropus venustus).



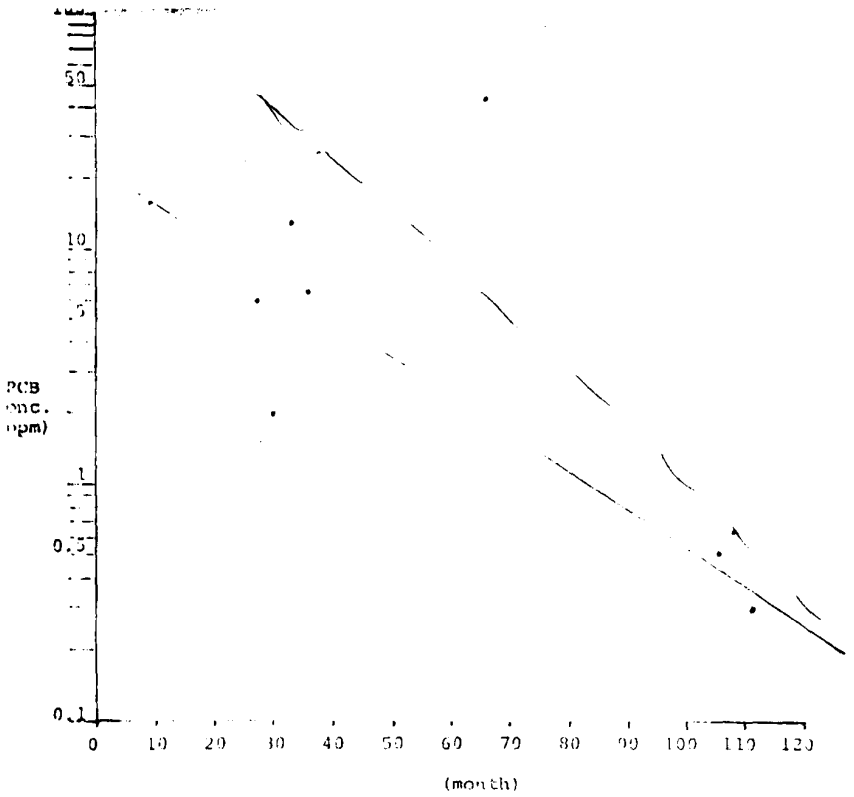
Station # 2. The concentration of PCB vs. month for blacktail shiner (Notropus venustus).

MONS 013959



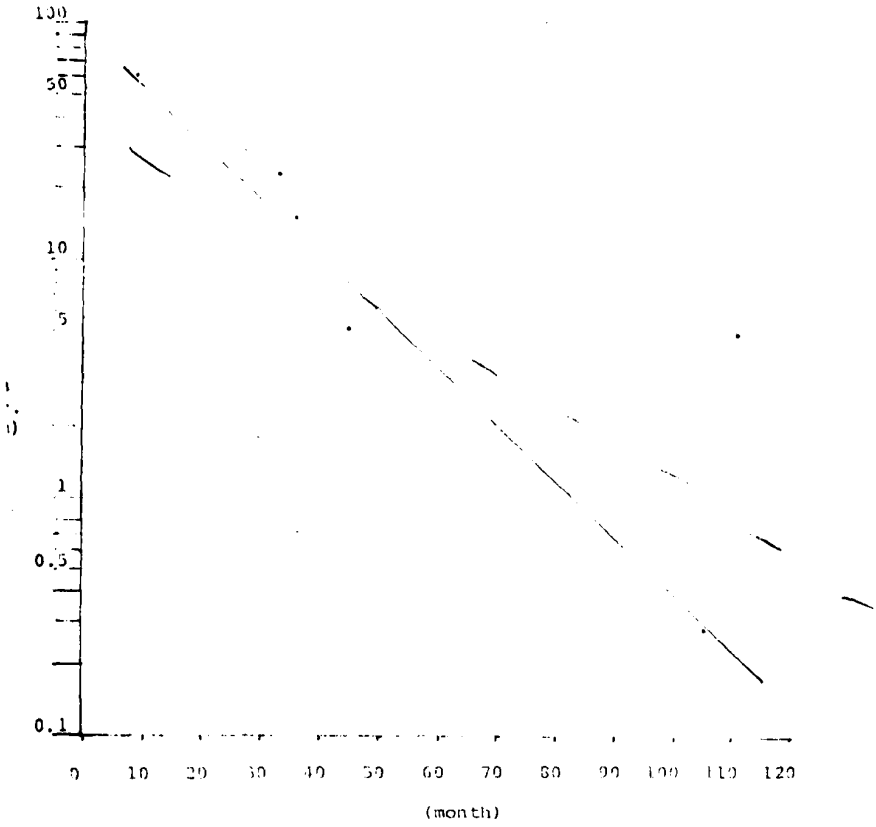
Station # 2. The concentration of PCB vs. month for stoneroller (Compostoma anomalun).

MONS 013960



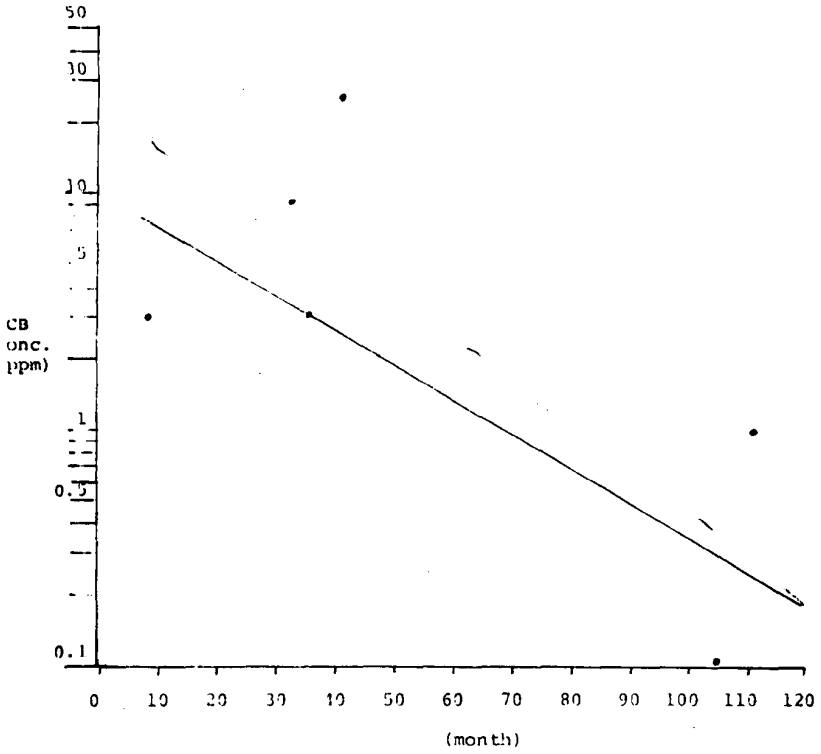
Station 1 2. The concentration of PCB vs. month for bluegill (Lepomis macrochirus).

MONS 013961



Station # 2. The concentration of PCB vs. month for longear sunfish (Lepomis megalotis).

MONS 013962



Station 5 2. The concentration of PCB vs. month for bass (Micropterus spp.).

MONS 013963

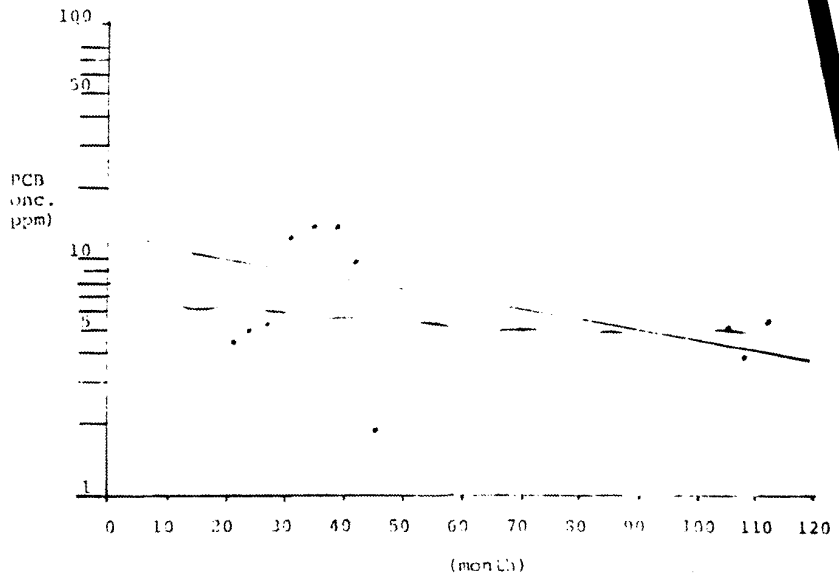
FISH SPECIES	STATION #2 HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (COMPOSTOMA ANOMALUM)	13.5	0.01 P 0.05
BLUE-GILL (LEPOMIS MACROCHIRUS)	27.8	0.01 P 0.05
LONGEAR SUNFISH (LEPOMIS MEGALOTIS)	19.6	0.01 P 0.05
BASS (MICROPTERUS SPP.)	21.2	0.10 P 0.25
BLACKTAIL SHINER (NOTROPIS VENUSTUS)	20.9	0.01 P 0.05

AVERAGE: 21.2

496610 SNOS

FISH SPECIES	STATION #2 HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (COMPOSTOMA ANOMALUM)	18.5	0.01 P 0.05
BLUE-GILL (LEPOMIS MACHROCHIRUS)	27.8	0.01 P 0.05
LONGEAR SUNFISH (LEPOMIS MEGALOTIS)	13.0	0.01 P 0.05
BASS (MICROPTERUS SPP.)	21.2	0.10 P 0.25
LACKTAIL SHINER (NOTROPIS VENUSTUS)	20.9	0.01 P 0.05
	AVERAGE: 21.2	

MONS 013965



Station # 3. The concentration of PCB vs. month for bluegill (Lepomis macrochirus).

MONS 013966

FISH SPECIES	STATION #2 HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (COMPOSTOMA ANOMALUM)	18.5	0.01 P 0.05
BLUE-GILL (LEPOMIS MACHROCHIRUS)	27.8	0.01 P 0.05
LONGEAR SUNFISH (LEPOMIS MEGALOTIS)	18.0	0.01 P 0.05
BASS (MICROPTERUS SPP.)	21.2	0.10 P 0.25
LACKTAIL SHINER (NOTROPUS VENUSTUS)	20.9	0.01 P 0.05
AVERAGE:	21.2	

tr. plant

MONS 013967

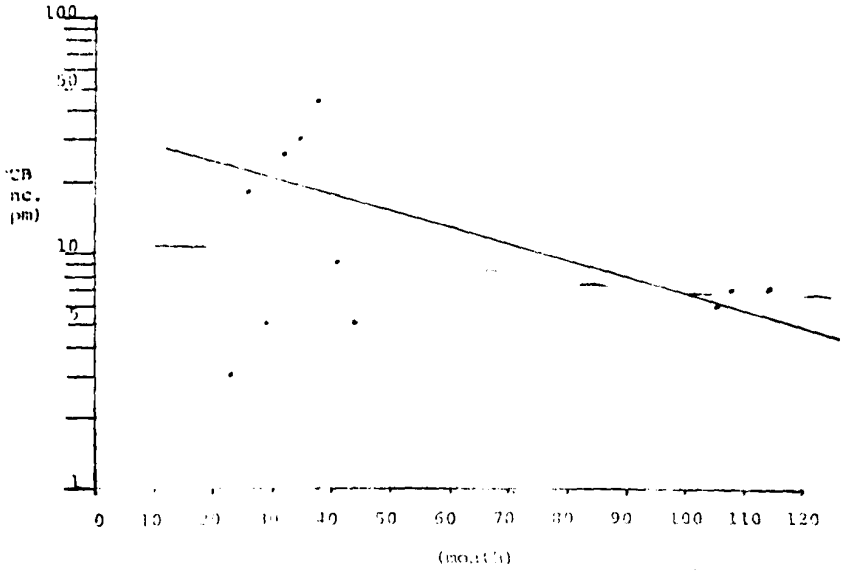
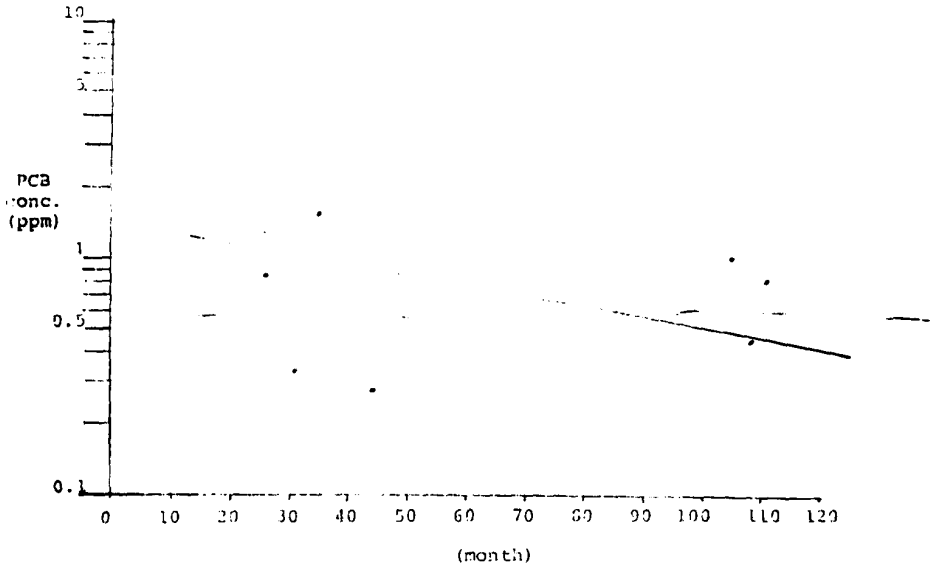


Figure 3. The concentration of PCB vs. month for longear sunfish (Lepomis megalotis).

MONS 013968



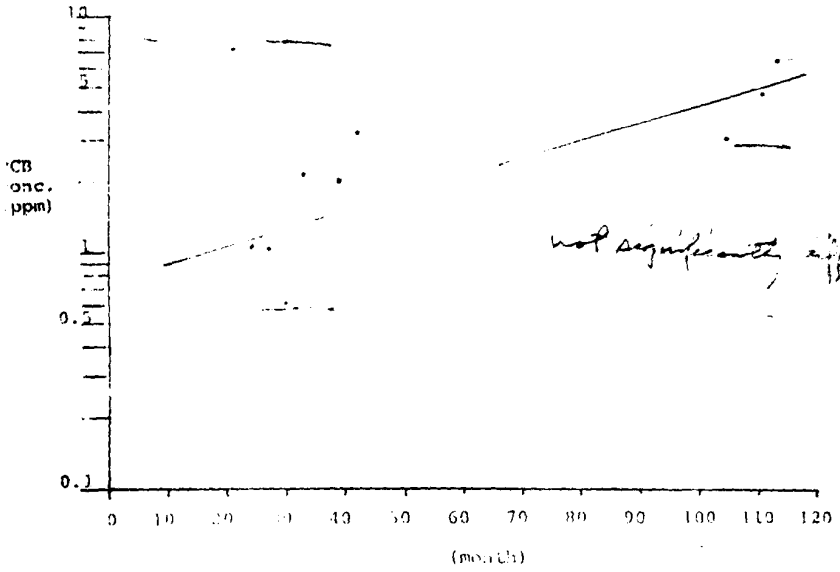
Station # 3. The concentration of PCB vs. month for bass (Micropterus spp.).

slope of line is incorrect!

MONS 013969

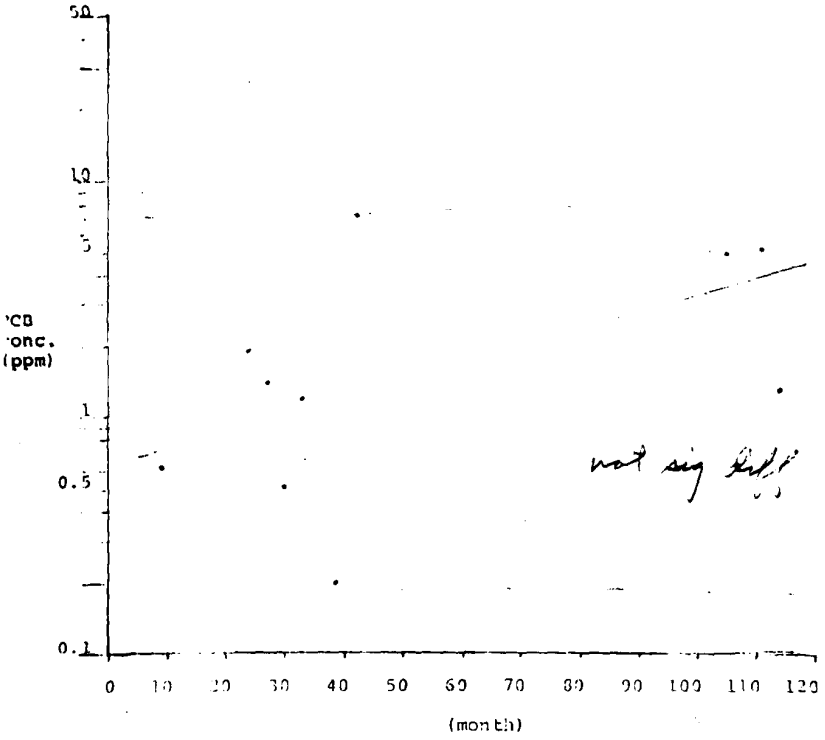
FISH SPECIES	STATION #3 HALF-LIFE IN MONTHS	P-VALUE
BLUEGILL (LEPOMIS MACROCHIRUS)	125	P 0.25
LONGEAR SUNFISH (LEPOMIS MEGALOTIS)	143	P 0.25
BASS (MICROPTERUS SPP.)	230	P 0.25

MONS 013970



Station 4. The concentration of PCB vs. month for longear sunfish (Lepomis megalotis).

MONS 013971



Station # 4. The concentration of PCB vs. month for bass (Micropterus spp.).

MONS 013972

FISH SPECIES	STATION #4 DOUBLING TIME IN MONTHS	P-VALUE
LONGEAR SUNFISH (LEPOMIS MEGALOTIS)	46	0.1 P 0.25
BASS (MICROPTERUS SPP.)	51	0.1 P 0.25

MOMS 013923

FISH	PERCENT DECREASE*		
	JANUARY 1978	APRIL 1978	AUGUST 1978
SUNFISH (LEPOMIS SPP.)	-	47	71
BASS (MICROPTERUS SPP.)	97	73	-

* PERCENT DECREASE IS THE DIFFERENCE IN TOTAL FOR CONCENTRATION BETWEEN FISH COLLECTED FROM STATION #2 AND STATION #4 IN THE LAST YEAR OF STUDY, 1978.

MDNS 013974

SUMMARY

1. IN THE RIVER SYSTEM, PCB IN FISH DECREASE WITH TIME.

2. THE AVERAGE HALF-LIFE OF PCB IN FISH SPECIES TAKEN FROM HIGHLY POLLUTION POINT IS AROUND 21 MONTHS IN THIS SITE.

no evidence 3. THE PCB CONTENT IN THE RESERVOIR DOUBLED OVER APPROXIMATELY 50 TO 70 MONTHS.

4. THE PCB CONTENT IN FISH DROPPED FROM APPROXIMATELY 10 PPM AT DISCHARGE POINT TO 1 PPM IN RESERVOIR OR 90% REDUCTION.

no evidence 5. THE INFLUENCE OF WATER QUALITY APPEARS TO BE A FUNCTION OF TDS, CHLORIDE, SULFATES WHICH APPARENTLY INFLUENCE THE AVAILABILITY OF PCBs ON SEDIMENTS.

not enough data to verify 6. THERE WAS NO INFLUENCE DUE TO TURBIDITY AND SUSPENDED SOLIDS WHICH MIGHT BE DUE TO THE VARYING LIPID CONTENT OF THE FISH THROUGHOUT THE YEAR.

MONS 013975