

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

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HALF-LIFE OF POLYCHLORINATED BIPHENYL (AROCOR 1254) IN FISH FROM AN ALABAMA
RESERVOIR AND STREAM. Chong-i Paul Lo, Mary W. Vitter, Robert S. Reimers,
Gerald E. Gunning, and Ann C. Anderson. Tulane University School of Public Health and
Tropical Medicine, 1430 Tulane Avenue, New Orleans, LA 70112.

Data from an eight year (1969-1976) field study for PCB's (Aroclor 1254) in fish along Choctoloco 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 Choctoloco 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 Choctoloco 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 Choctoloco Creek. Different uptake patterns in fish taken from stream and reservoir will be elucidated.

DSW 037863

STLCOPCB4021687

Not For Publication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

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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 the Choctoloco 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 Choctoloco 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 Choctoloco 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 (<u>Compostoma anomalum</u>)	18.5	0.01 < p < 0.05
Bluegill (<u>Lepomis macrochirus</u>)	27.8	0.01 < p < 0.05
Longear Sunfish (<u>Lepomis megalotis</u>)	18.0	0.01 < p < 0.05
Bass (<u>Micropterus</u> spp.)	21.2	0.10 < p < 0.25
Blacktail Shiner (<u>Notropis venustus</u>)	20.9	0.01 < p < 0.05
Average	21.2	

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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 (<u>Lepomis megalotis</u>)	46	0.1 < p < 0.25
Bass (<u>Micropterus</u> 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.

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OBJECTIVES OF STUDY

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

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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.
- speculated but not proven* - 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.

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BIOACCUMULATION OF PCB BY FISH

1. UPTAKE FROM SOLUBLE PCB

- FISH MAY ACCUMULATE TO LEVELS OF 10^3 TO 10^5 TIMES WATER CONCENTRATION¹⁰⁰ 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?

(CONT'D.)

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

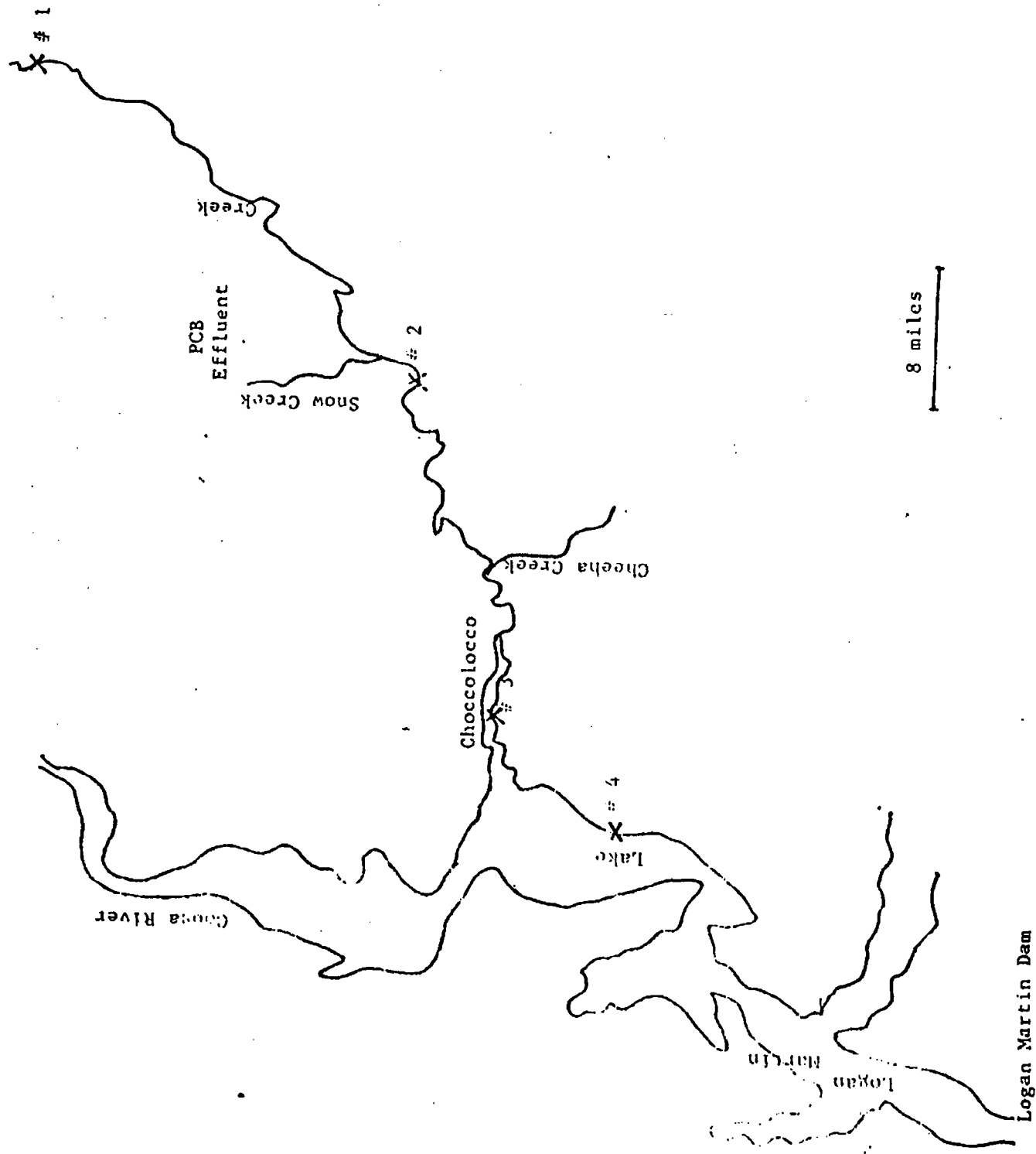
not in nature

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

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COLLECTION STATIONS - ANNISTON, ALABAMA



DSW 037870

METHODS AND ANALYSIS

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



ACETONITRILE - HEXANE EXTRACTION WITH POLYTRON (EPA METHOD)



FLOROSIL CLEANUP



GAS CHROMATOGRAPHY/DETECTION

(CONT'D.)

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2. GAS CHROMATOGRAPHY: MICROTEK 200 WITH Ni^{63} ELECTRON CAPTURE
DETECTOR, 225°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.)

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3. HALF-LIFE DETERMINATION

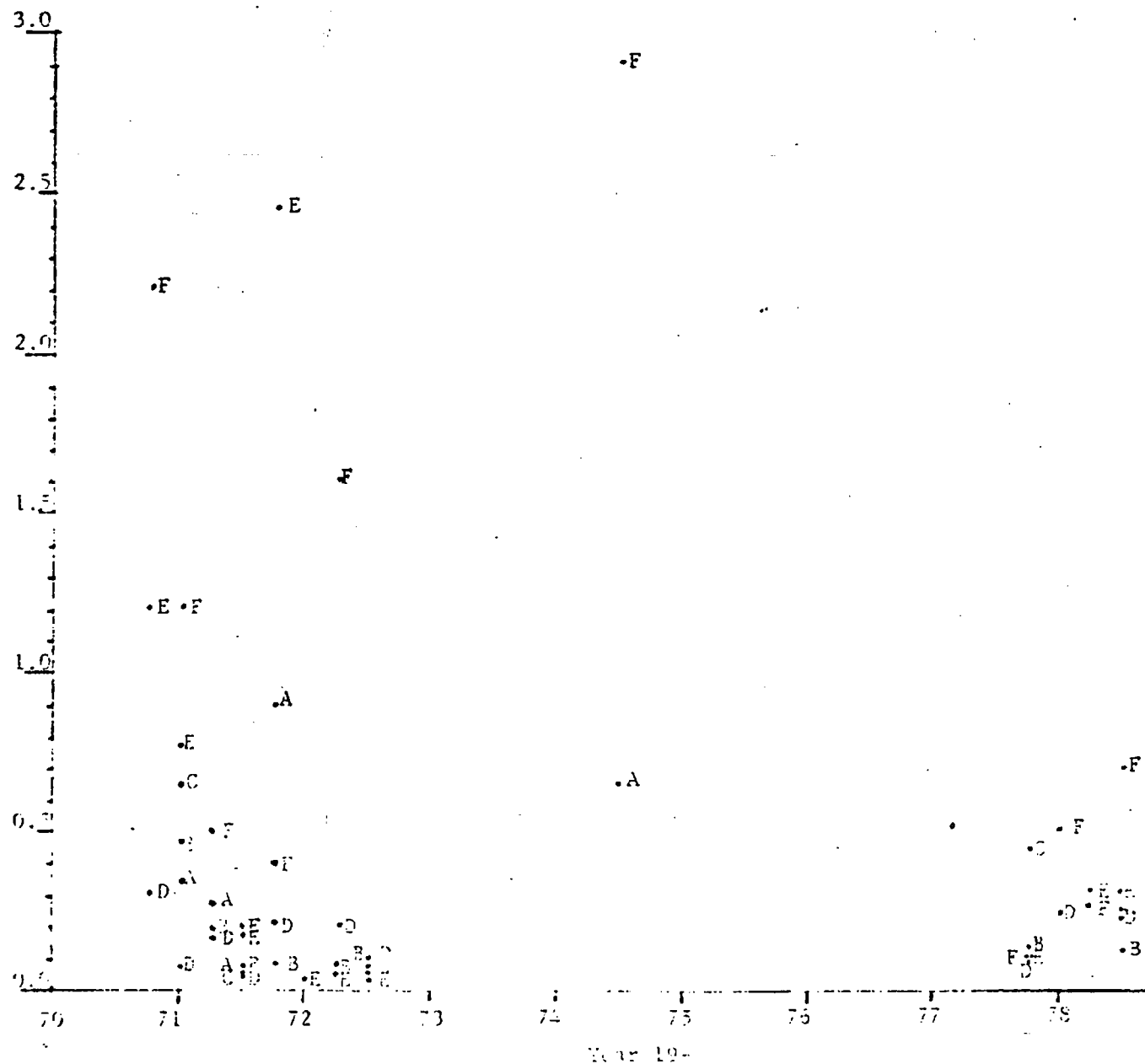
EQUATION: $Y = 10^{A-KT}$

$$\text{HALF-LIFE} = \frac{\log 2}{K}$$

WHERE: Y = THE CONCENTRATION OF ARCCLOP 1254 AT TIME T,
A & K CONSTANTS.

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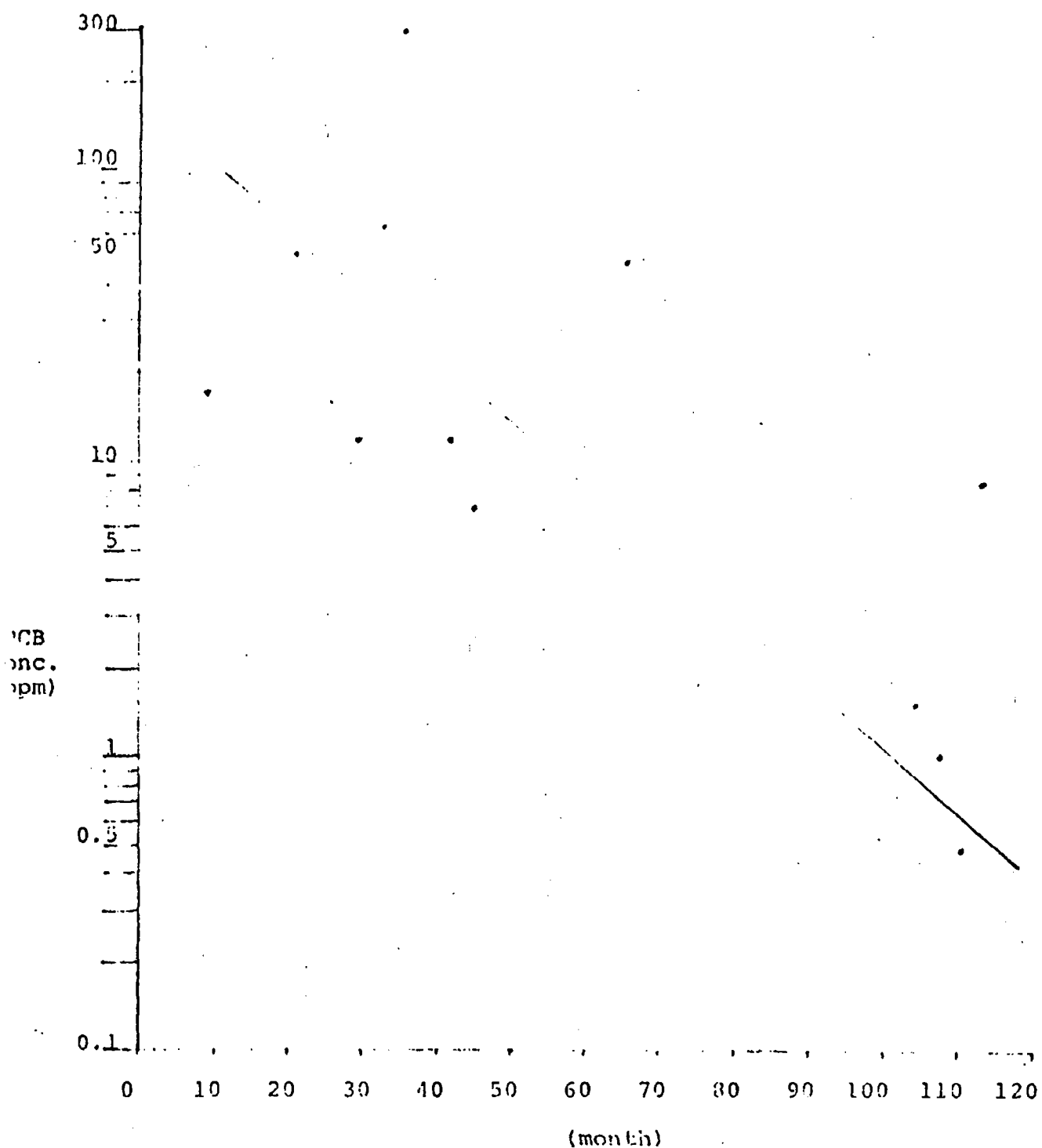
Aroclor 1254
Conc.
(ppm)



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 (Lepomis macrochirus), and (F) blacktail shiner (Notropis venustus).

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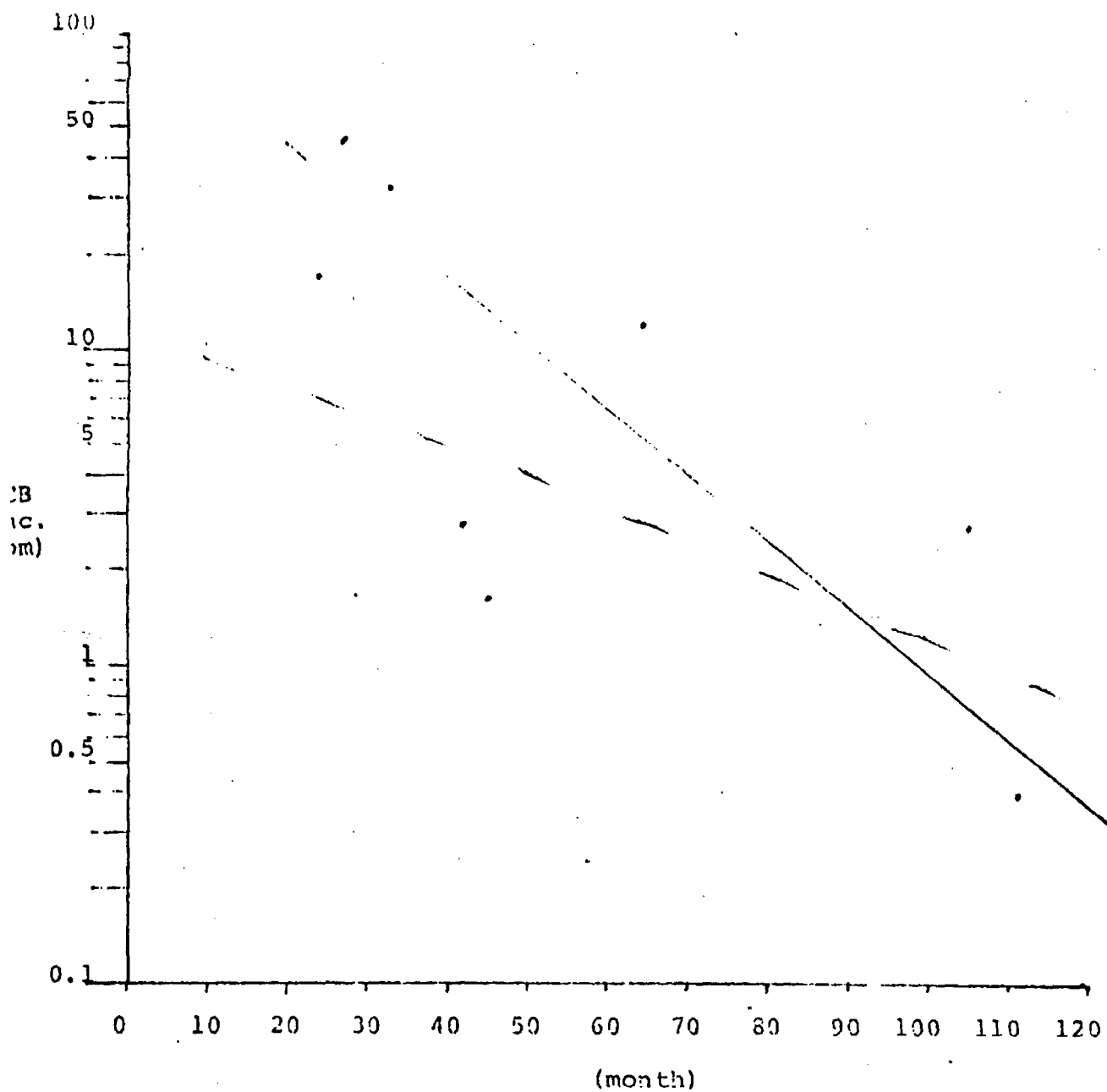


12 fish

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

DSW 037875

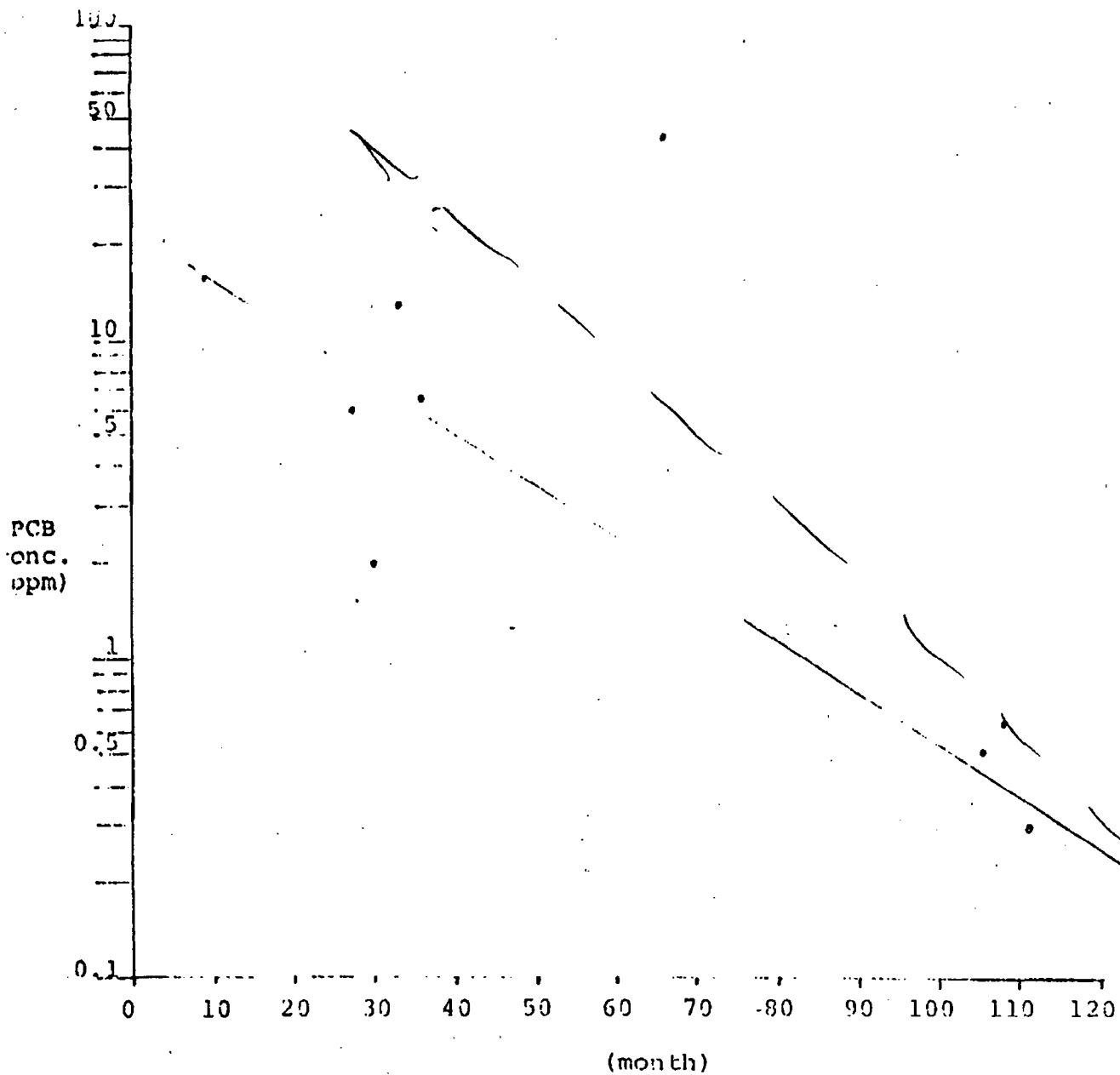
STLCOPCB4021699



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

8 fish

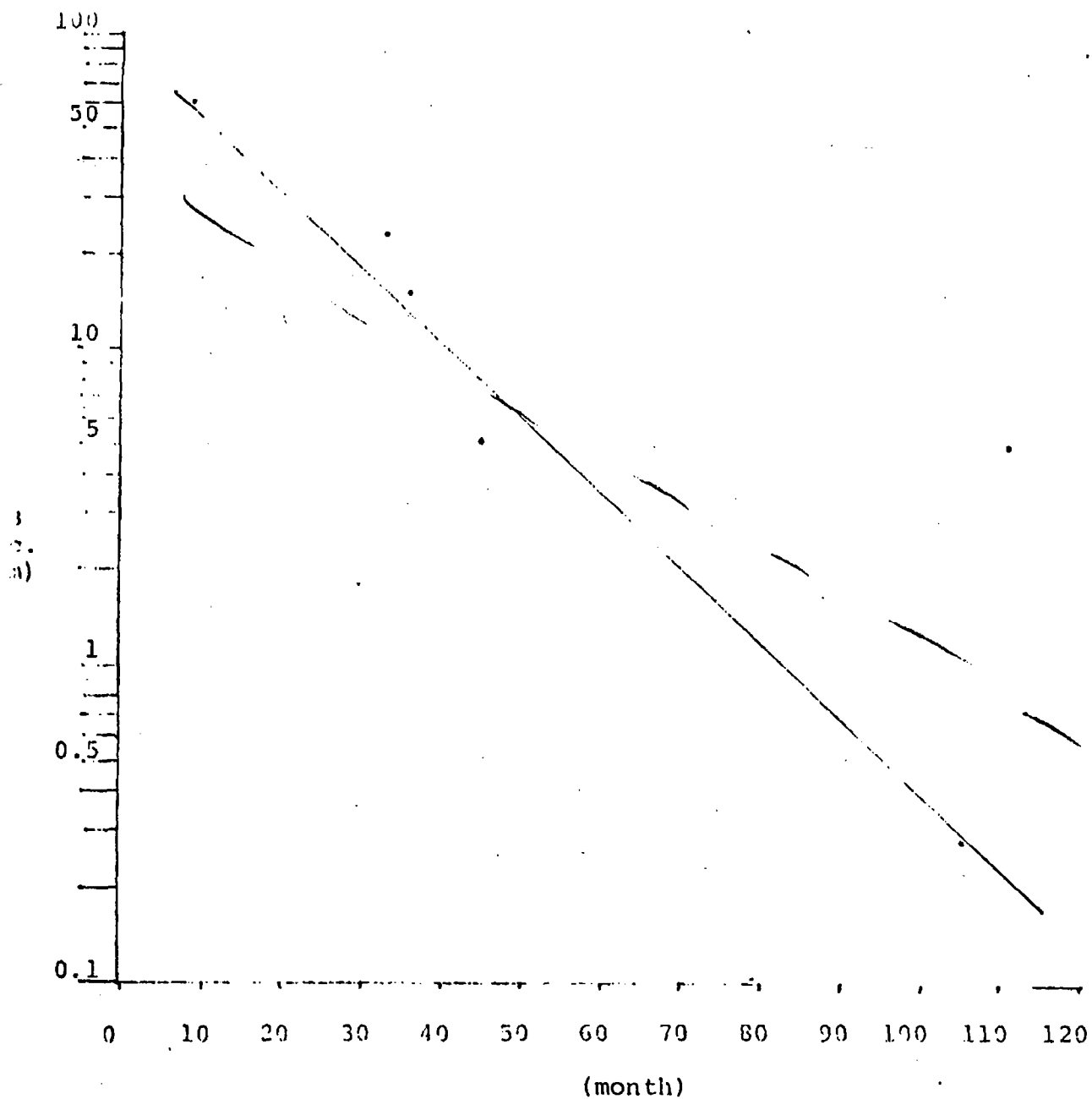
DSW 037876



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

9/10/77

DSW 037877



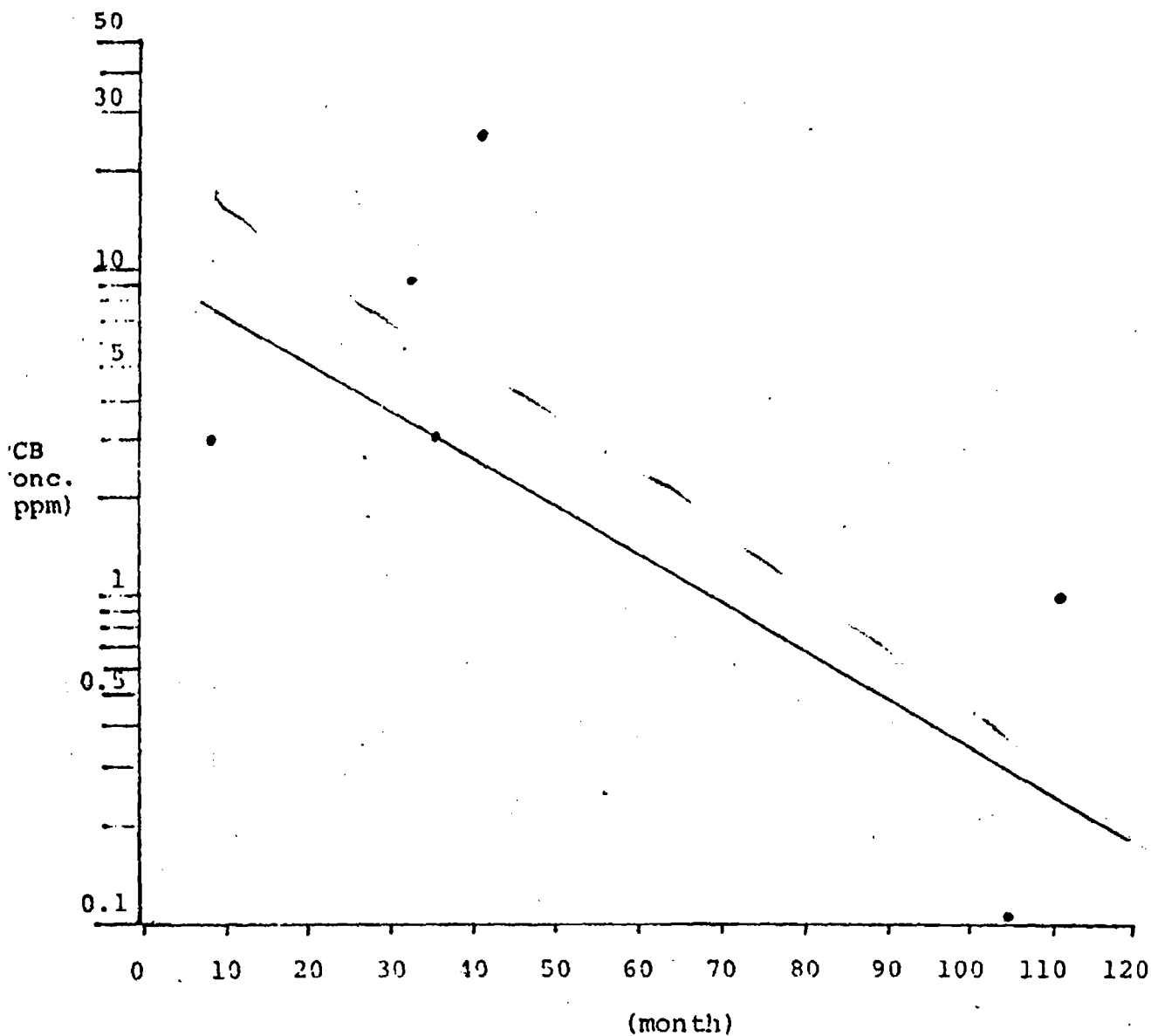
Station # 2. The concentration of PCB vs. month
for longear sunfish (Lepomis megalotis).

6 fish

slope question 33

DSW 037878

STLCOPCB4021702



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

6 fish

DSW 037879

STLCOPCB4021703

STATION #2

FISH SPECIES	HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (<u>COTIGOSTOME ANCFALID</u>)	12.5	0.01 P 0.05
BLUE-GILL (<u>LEPOTIS MACHROCHIRUS</u>)	27.8	0.01 P 0.05
LONGEAR SUNFISH (<u>LEPOTIS MEGALOTIS</u>)	13.0	0.01 P 0.05
BASS (<u>MICROPTERUS</u> spp.)	21.2	0.10 P 0.25
<u>B</u> LACKTAIL SHINER (<u>NOTROPIS VENUSTUS</u>)	<u>20.9</u>	0.01 P 0.05

AVERAGE: 21.2

DSW 037880

STLCOPCB4021704

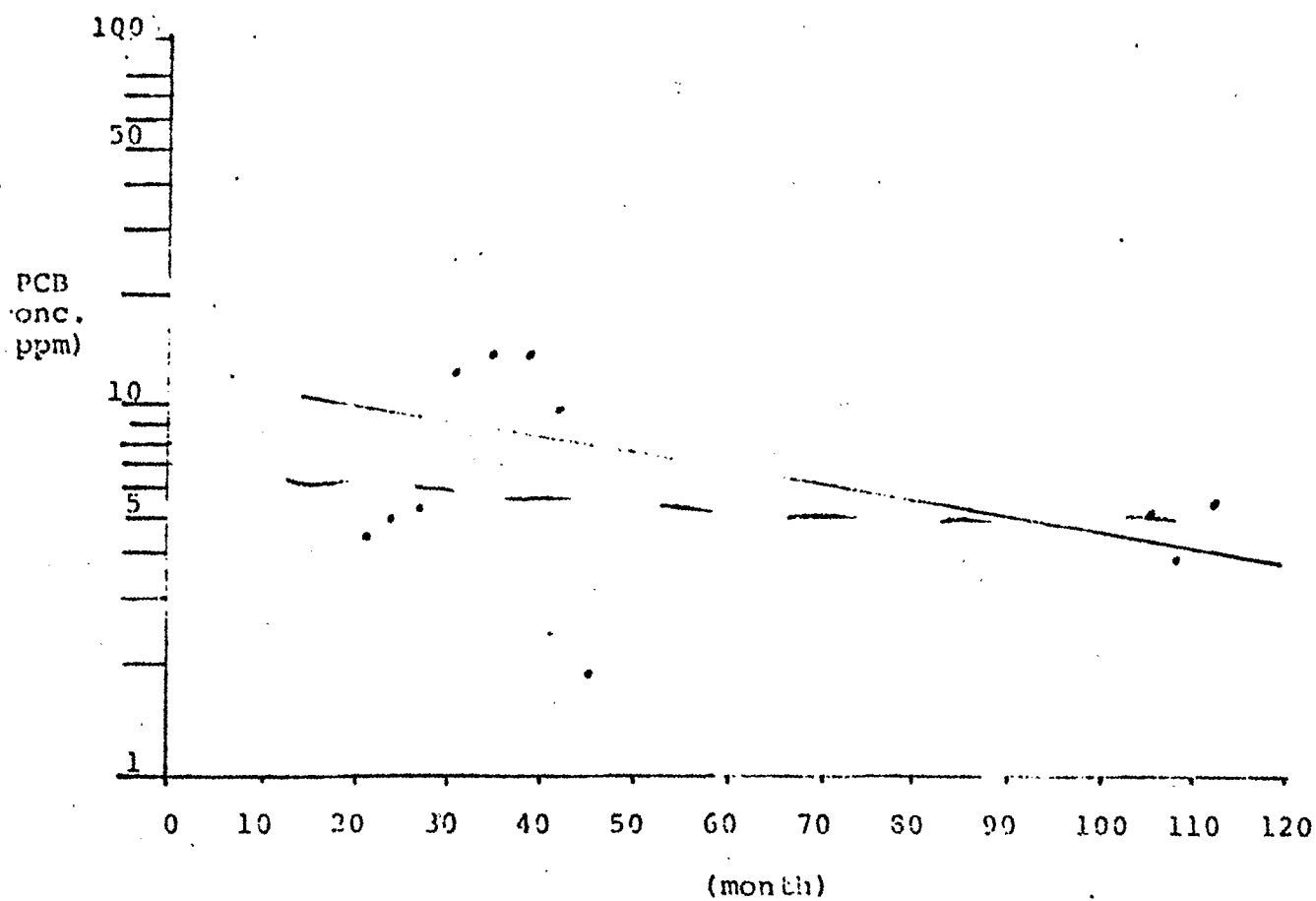
FISH SPECIES	STATION #2	
	HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (<u>COMPOSTOMA ANCHALIND</u>)	18.5	0.01 P 0.05
BLUE-GILL (<u>LEPOMIS MACHROCHIRUS</u>)	27.8	0.01 P 0.05
LONGEAR SUNFISH (<u>LEPOMIS MEGALOTIS</u>)	13.0	0.01 P 0.05
BASS (<u>MICROPTERUS</u> spp.)	21.2	0.10 P 0.25
LACKTAIL SHINER (<u>NOTROPIS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

AVERAGE: 21.2

Duplicate

DSW 037881

STLCOPCB4021705



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

11 fish slope questionable

DSW 037882

STLCOPCB4021706

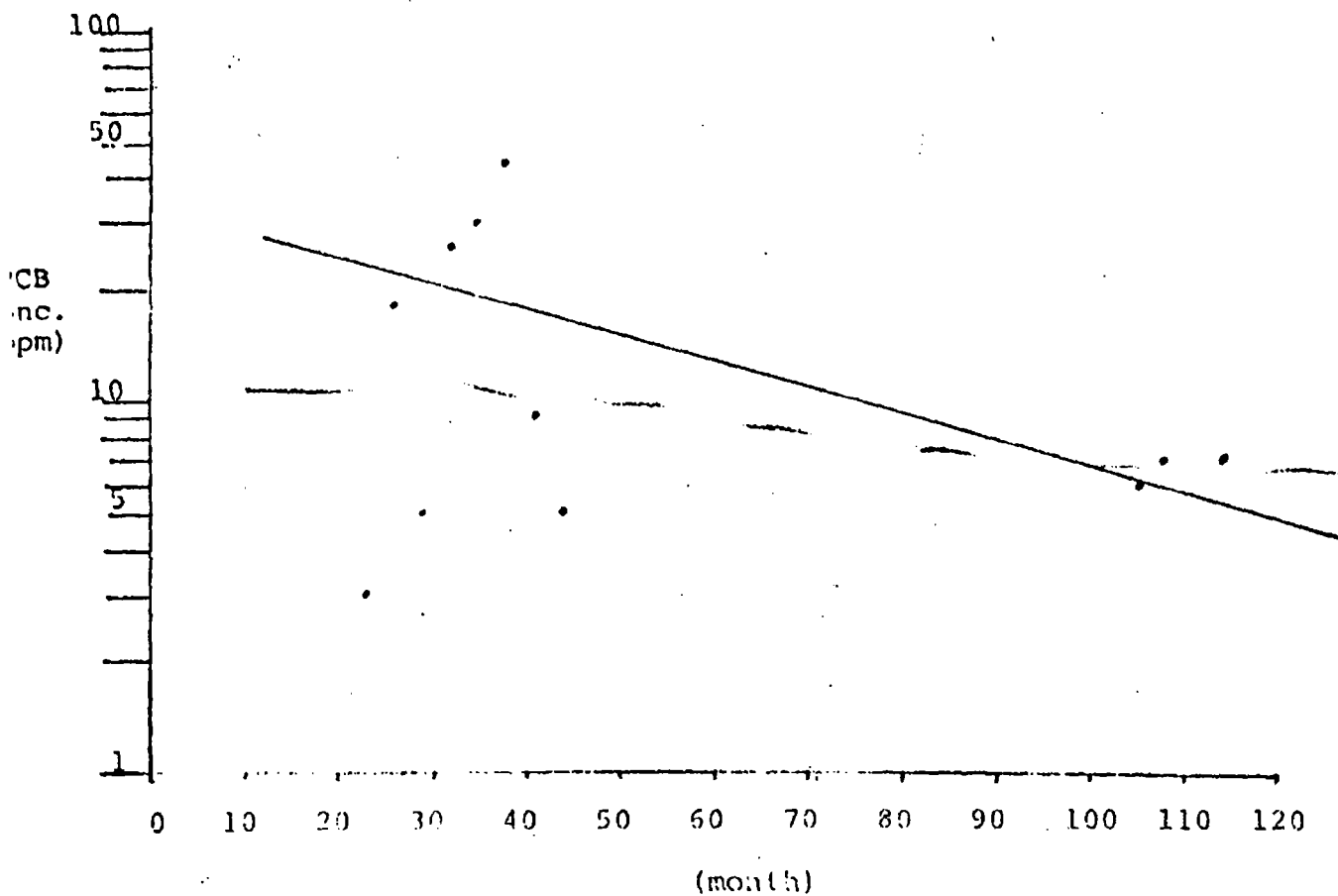
FISH SPECIES	STATION #2	
	HALF-LIFE IN MONTHS	P-VALUE
STONE ROLLER (<u>COMPOSTOMA ANOMALUM</u>)	18.5	0.01 P 0.05
BLUE-GILL (<u>LEPOMIS MACROCHIRUS</u>)	27.8	0.01 P 0.05
LONGEAR SUNFISH (<u>LEPOMIS NEGALOTIS</u>)	13.0	0.01 P 0.05
BASS (<u>MICROPTERUS</u> spp.)	21.2	0.10 P 0.25
LACKTAIL SHINER (<u>NOTROPUS VENUSTUS</u>)	<u>20.9</u>	0.01 P 0.05

AVERAGE: 21.2

triplicates

DSM 037883

STLCOPCB4021707



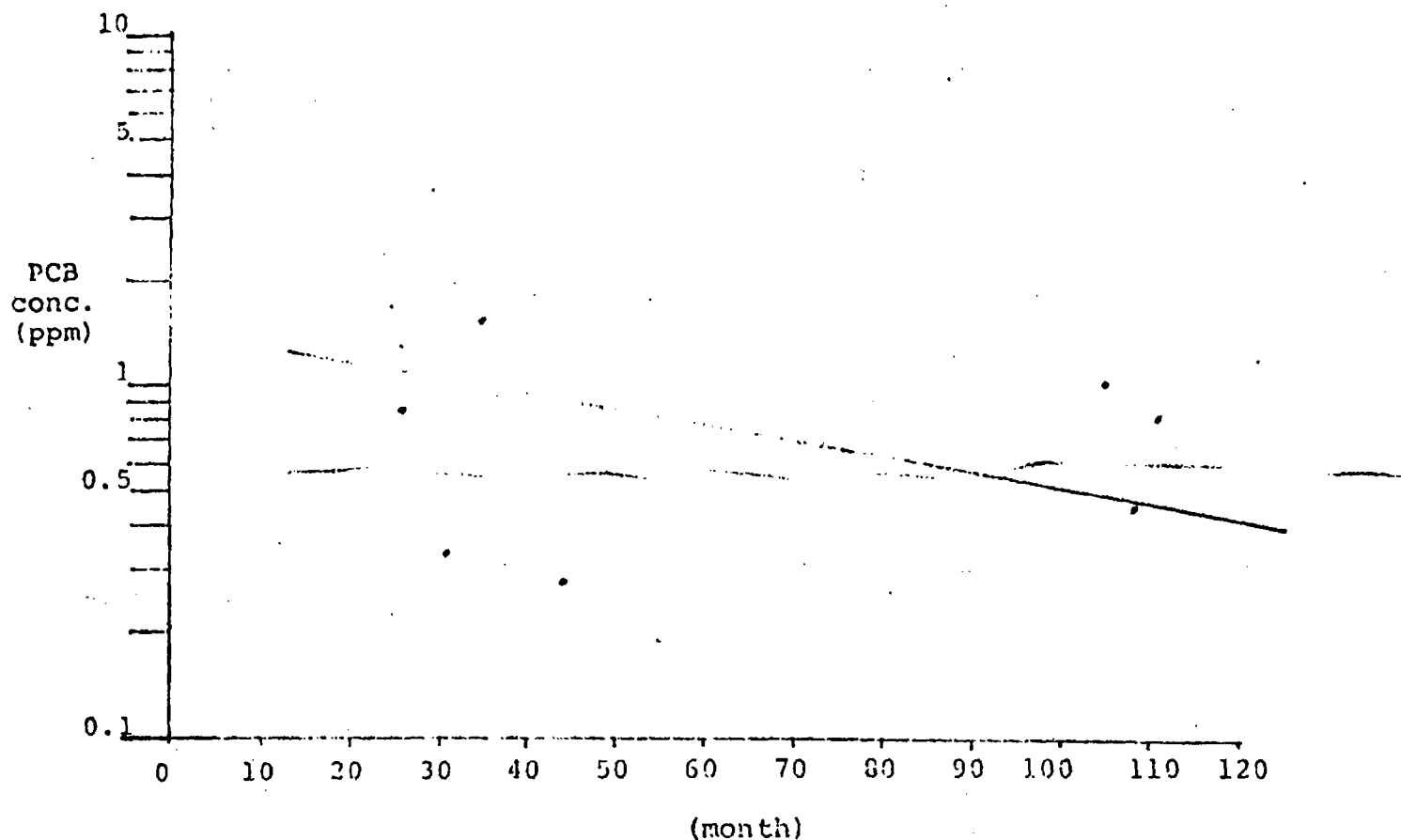
Station # 3. The concentration of PCB vs. month for longear sunfish (Lepomis megalotis).

11 fish

slope invariant

DSW 037884

STLCOPCB4021708



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

? fish

slope of line is incorrect!

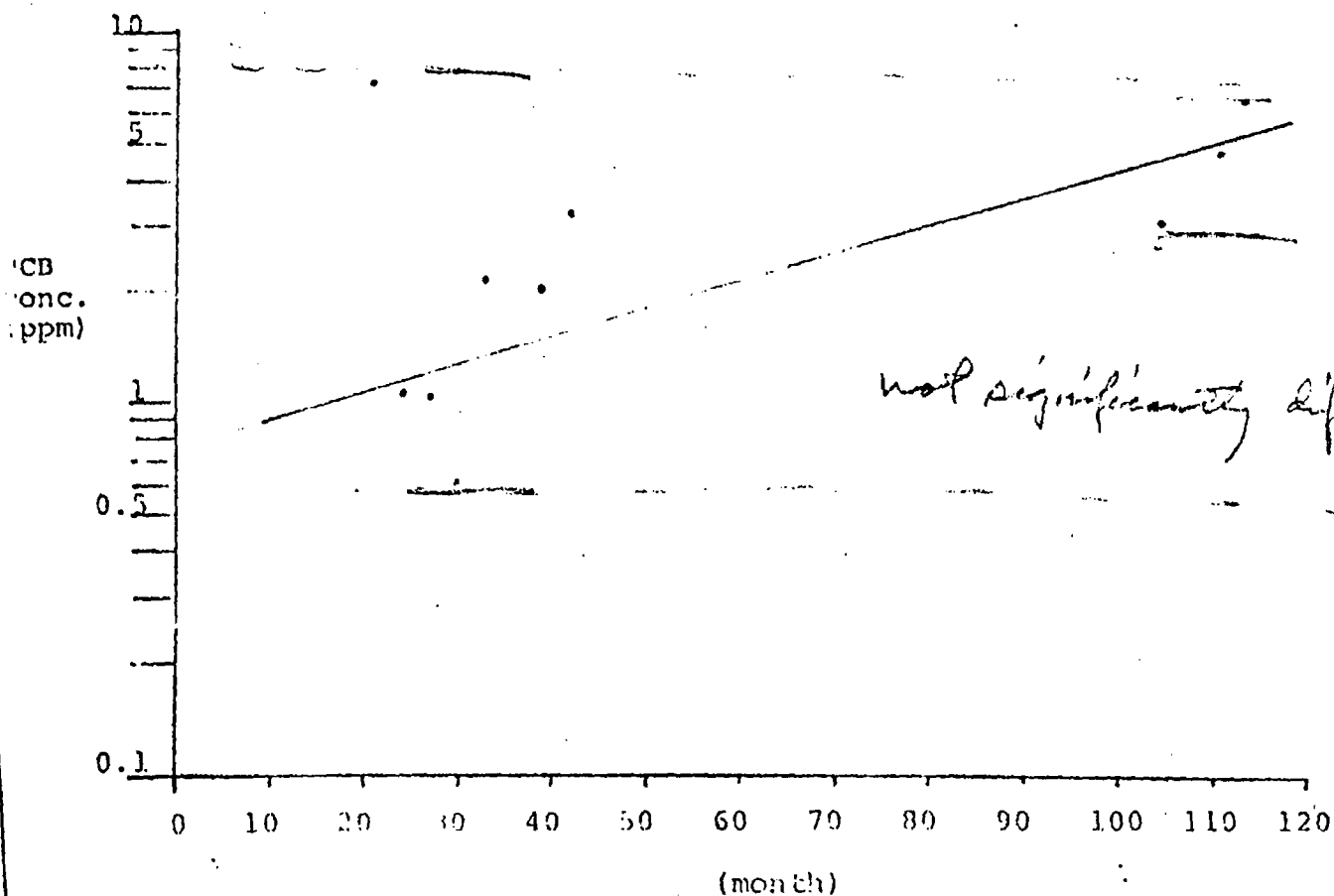
DSW 037885

STLCOPCB4021709

STATION #3

FISH SPECIES	HALF-LIFE IN MONTHS	P-VALUE
BLUE-GILL (<u>LEPOMIS MACROCHIRUS</u>)	125	P 0.25
LONGEAR SUNFISH (<u>LEPOMIS MEGALOTIS</u>)	143	P 0.25
BASS (<u>MICROPTERUS</u> spp.)	230	P 0.25

DSW 037886

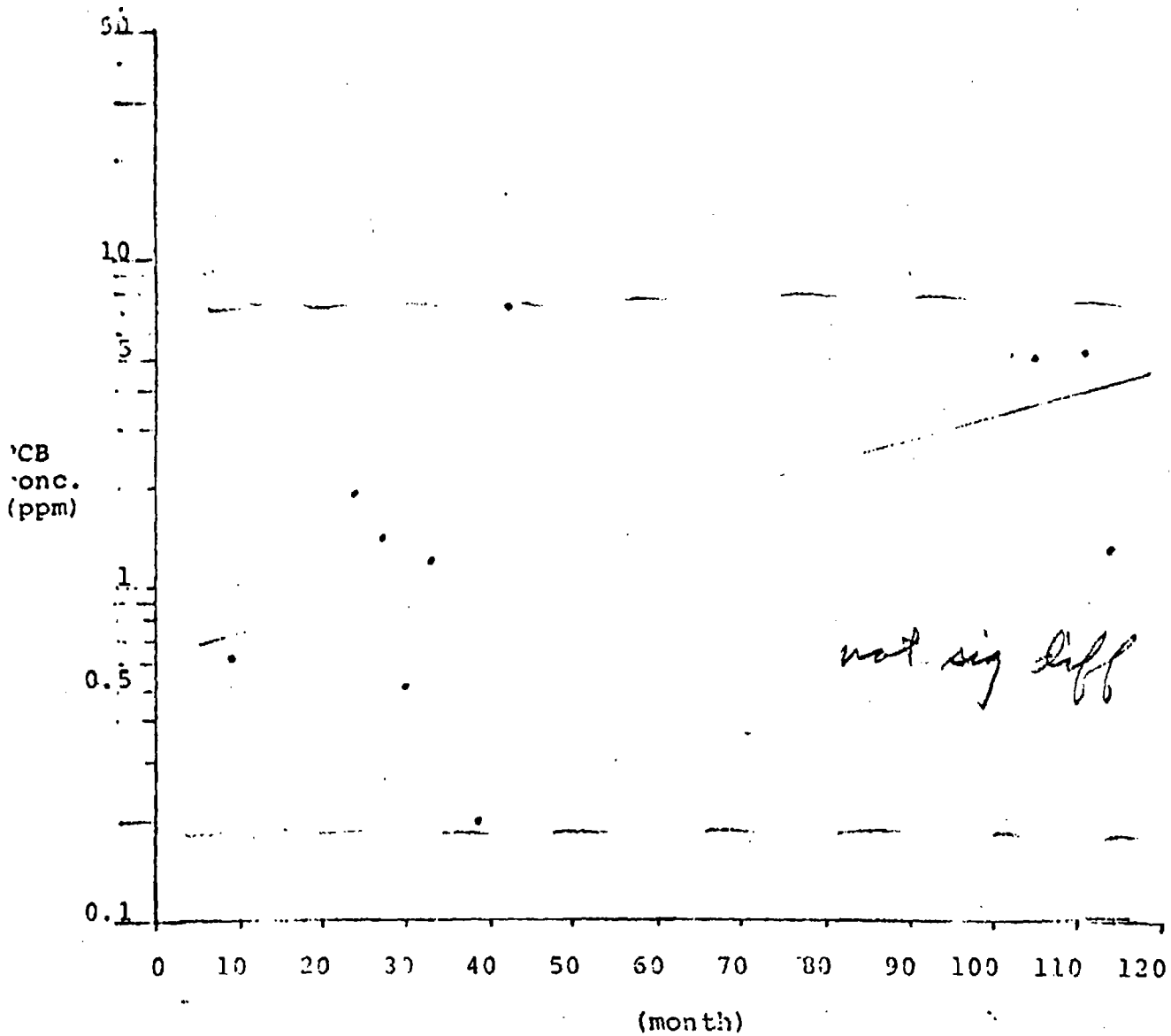


Station 4. The concentration of PCB vs. month for longear sunfish (Lepomis megalotis).

10 fish slope questionable

DSW 037887

STLCOPCB4021711



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

12 fish

DSW 037888

STATION #4

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

DSW 037889

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

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

DSW 037890

STLCOPCB4021714

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.

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