TENNESSEE VALLEY AUTHORITY

Resource Development
River Basin Operations
Water Resources

TVA/WR/AB--90/9

DE91 005492

RESULTS OF PCB AND CHLORDANE ANALYSES ON FISH
COLLECTED FROM NICKAJACK RESERVOIR
IN JANUARY AND FEBRUARY 1989

by

Donald L. Dycus
Aquatic Biology Department

Chattanooga, Tennessee

July 1990

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

CONTENTS

	Page
Tables	iii
Executive Summary	iv
Introduction	1
Methods	2
Field Sampling and Handling	2
Laboratory Analyses	3
Data Analysis	3
Results and Discussion	3
Channel Catfish	5
PCB Concentrations	5
Chlordane	8
Correlation Analyses	9
Other Species	10
Status and Recommendations	11
References	12

TABLES

Number	Page
1. Contaminant Levels Used To Make Recommendations Based on Analytical Results from Valleywide Fish Tissue Screening Study	14
2. Physical Characteristics and Concentrations of Chlordane and PCBs in Channel Catfish from Nickajack Reservoir, Collected January and February 1989	15
3. One-Way Analysis of Variance and Duncan's Multiple Range Test on Lipid Content, Length, and Weight of Channel Catfish Among Locations in Nickajack Reservoir	16
4. Results of Analysis of Covariance Comparing Length/Weight Relationship of Channel Catfish from Nickajack Reservoir to Channel Catfish Contained in the TVA Life History Data File for Mainstem Reservoirs of the Tennessee River	16
5. Results of Statistical Tests Used To Compare Location Differences in PCB and Chlordane Concentrations in Channel Catfish from Nickajack Reservoir	17
6. Results of Correlation Analysis on Channel Catfish Data from Nickajack Reservoir, Collected January and February 1989	18
7. Physical Characteristics and Concentrations of Chlordane and PCBs in Largemouth Bass, Crappie, and Smallmouth Buffalo from Nickajack Reservoir, Collected January and February 1989	19

EXECUTIVE SUMMARY

This study on Nickajack Reservoir was conducted because results of the Valleywide Fish Tissue Screening Study in 1987 found sufficiently high concentrations of both PCBs and chlordane (in catfish, the indicator species) to warrant further investigation. This study was planned for autumn 1988, but fish were actually collected in January and February 1989. Up to ten channel catfish were analyzed individually from three locations, and composites of largemouth bass, crappie, and smallmouth buffalo were analyzed by species from one or two of those locations.

The largemouth bass, crappie, and smallmouth buffalo samples had no detectable concentrations of chlordane and relatively low concentrations of PCBs. Concentrations of chlordane and PCBs in channel catfish were slightly lower than observed in the screening study but were still sufficiently high to be potentially of concern.

This information was used to design a follow-up study in autumn 1989. The objective of the autumn 1989 study was to further refine geographical distribution of PCB and chlordane contamination in catfish from Nickajack Reservoir and to investigate concentrations in other important sport species.

RESULTS OF PCB AND CHLORDANE ANALYSES ON FISH
COLLECTED FROM NICKAJACK RESERVOIR
IN JANUARY AND FEBRUARY 1989

INTRODUCTION

This study was conducted because the multiagency program called the Valleywide Fish Tissue Screening Study found relatively high concentrations of PCBs and chlordane in fish from Nickajack Reservoir. Fish to be analyzed for this program are collected from Tennessee River reservoirs once every three years as long as concentrations of contaminants remain low. A more indepth study is undertaken if concentrations are sufficiently high to pose a potential threat to human health or the environment.

Results from the initial year (1987) of the Valleywide Fish Tissue Screening Study found sufficiently high concentrations of both PCBs and chlordanes in catfish (the indicator species) from Nickajack Reservoir to warrant attention. Concentrations of these chlorinated organics exceeded the predetermined "Tier 3" levels (table 1) established to trigger a more indepth study to better define apparent problems. The five-catfish fillet composite sample from the lower reservoir location (Tennessee River mile 425) contained 1.9 µg/g total PCBs and 0.21 µg/g chlordanes, while the composite sample from the upper area (TRM 457) contained 1.3 µg/g PCBs and 0.25 µg/g chlordanes (Dycus 1989a).

After reviewing these results representatives of TVA, the Tennessee Department of Health and Environment (TDHE), and the Tennessee Wildlife Resources Agency (TWRA) met and outlined specifics of this study. The basic concept was to examine individual channel catfish from three

reservoir areas to better describe contamination levels of PCBs and chlordane. In addition, important game species (largemouth bass and crappie) and commercial species (smallmouth buffalo) were examined at the screening level by analyzing five fillet composites from selected reservoir areas.

METHODS

Ten channel catfish were to be collected from three areas: the lower and upper reservoir locations sampled previously (TRMs 425 and 457), plus a transition area where sediment deposition could be expected (TRM 435). Five largemouth bass and five crappie (black and/or white) were to be collected from TRMs 425 and 435 because these areas are heavily fished for these species. Five smallmouth buffalo were to be collected from TRMs 435 and 457. Fish were to be collected during October to December 1988 for comparability to the previous study and to reduce variability introduced by seasonal fluctuations in lipid levels.

Field Sampling and Handling

All fish were collected either by electrofishing or with gill nets, placed on wet ice immediately after collection, and transported to the biological laboratory for processing. Each fish was weighed, measured (total length), examined for external and internal condition, and its sex determined. Fillets (including ribs and bellyflap) were carefully removed from each fish. Skin was removed from catfish (using pliers) but left on other species which, had scales removed. Each fillet

was wrapped in aluminum foil, placed in a labeled plastic bag, and stored frozen until transport to the chemistry laboratory.

Laboratory Analyses

Each fillet was partially thawed, diced with a knife, and thoroughly ground using a mechanical grinder. Samples were composited, as appropriate, by taking an equal aliquot of tissue mass from each of the individually ground fillets. PCBs and chlordane were extracted using petroleum ether and ultrasonication. An aliquot of the resulting extract was cleaned with concentrated sulfuric acid, and analyzed using a pre-calibrated gas chromatograph equipped with a capillary column, an electron capture detector, and an electronic integrator. PCBs were analyzed for Aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. Chlordane analysis was based on the nine congeners composing technical chlordane (cis and trans isomers of chlordane and nonachlor; oxychlordane; chlordene; and alpha, beta and gamma chlordane). Heptachlor and heptachlor epoxide were analyzed also. All chlordane values were confirmed using a dissimilar chromatographic column. Lipid content of all samples was determined gravimetrically.

Data Analysis

Several statistical techniques were used to evaluate channel catfish data. As an indicator of "health", analysis of covariance (described later) was used to compare length/weight relationships of channel catfish from Nickajack Reservoir to length/weight relationships for the channel catfish component of the TVA life history data file for mainstream

reservoirs. A one-way analysis of variance (ANOVA) was used to determine whether lipid content and/or fish size differed among sample locations because these have been found to have an important influence on PCB concentrations in other studies. Simple and partial correlations were used to examine associations between PCB and chlordane concentrations and other variables such as lipid content and fish weight.

Differences in PCB concentrations among locations were examined using either an ANOVA and Duncan's Multiple Range Test or analysis of covariance. Because PCBs and chlordane are lipophilic compounds, these data were examined closely to determine whether covariance analysis was needed to eliminate differences due to variations in lipid content. The first step was to test the null hypothesis that PCB (or chlordane) levels do not depend upon lipid content for one or more stations. This involved regressing PCB (or chlordane) concentration against lipid content simultaneously for each station. If the slopes for all stations were not different from zero (failure to reject the null hypothesis), then no adjustment for lipid content was necessary and the ANOVA was the appropriate test. If the slope for any station was significantly different from zero (rejection of the null hypothesis), then covariance analysis was needed. Prior to proceeding to covariance analysis, data were tested for homogeneity of slopes (parallel lines). If this null hypothesis was accepted, data were analyzed using covariance analysis by comparing adjusted means. If this null hypothesis was rejected, then results were examined qualitatively to determine cause of the non-parallel lines. A similar procedure was used to examine the influence of fish size (weight) on PCB (or chlordane) concentrations.

Prior to statistical analyses, concentrations of PCBs and chlordanes were transformed to approximate a normal distribution using a $\log_{10}(x+1)$ transformation ($x+1$ was used because some values were between zero and one). Percentage lipid content was transformed using arc sine. An alpha of 0.05 was chosen as the probability of a Type I error. Samples with less than detectable levels (0.1 $\mu\text{g/g}$ for PCBs and 0.01 $\mu\text{g/g}$ for chlordanes) were included at the detection limit in developing averages.

RESULTS AND DISCUSSION

Although the preferred sample period was October to December 1988, fish were not collected until January and February 1989 due to several unavoidable events. The influence of this delayed sample period cannot be specifically determined. It is likely that the delay had little, if any, measurable effect on these results. In a trend study on Fort Loudoun Reservoir the desired autumn sample period has not always been attainable and some collections have been made in winter. Although those data have not been statistically examined to evaluate time of year effects, there are no obvious differences in PCB concentrations in fish collected in autumn and winter samples (Dycus 1989b).

Channel Catfish

Ten channel catfish were collected at TRM 425 and at TRM 435; however, only three of the desired ten individuals were collected from TRM 457. Repeated sampling efforts failed to produce additional catfish there, indicating unsuitable habitat or that the sample gear used was not optimal for this area.

Gross physical examination on these catfish showed 15 were "normal", six had internal parasites, one had a deformed pectoral spine, and one had ulcerations in the mouth. None of these observations indicate an unusual condition for a wild population.

The catfish collected during the previous screening study were rather large: average weights were 1150 g (2.5 lb) at TRM 425 and 1401 g (3.1 lb) at TRM 457 (Dycus 1989a). Comparable size fish were also collected at all locations during this study. The overall range was 945 g (2.1 lb) to 2705 g (6.0 lb), with average weights of 1620 g (3.6 lb), 2175 g (4.8 lb), and 1854 g (4.1 lb) at TRMs 425, 435, and 457, respectively (table 2). Absence of small catfish (minimum size 945 g) is noteworthy and will need further examination in future collection efforts.

As would be expected for large fish, relatively high lipid levels were observed at all sites; averages were 11.4, 12.4 and 13.6 percent at the three locations cited above. A one-way analysis of variance and Duncan's Multiple Range Test were used to test location differences for fish size and lipid content (table 3). Fish weight was significantly higher at TRM 435 than at TRM 425, but weight at neither location was significantly different from that at TRM 457. Lipid content did not differ significantly among locations. These results, coupled with observations on physical condition cited above, indicate catfish from all locations were healthy and generally of comparable size. The influence of weight differences in catfish from TRMs 425 and 435 on PCB and chlordane concentrations will be further examined by other statistical analyses described later.

A one-way analysis of covariance was used to compare the weight per unit length of channel catfish from Nickajack Reservoir to those in the TVA data file for mainstem Tennessee River reservoirs. Test results showed channel catfish from Nickajack Reservoir were significantly heavier than those from other mainstem reservoirs (table 4), indicating favorable conditions for catfish growth in Nickajack Reservoir.

Although the channel catfish sampled for this study appeared healthy, absence of small catfish is of concern and may indicate a recruitment problem. Subsequent sampling efforts will need to closely examine this possibility.

PCB Concentrations. The screening study had found PCB concentrations of 1.9 and 1.3 $\mu\text{g/g}$ in the composite samples from TRMs 425 and 457, respectively. Analysis of individual catfish collected for this more intensive study found lower concentrations at TRM 425 (average 0.9 $\mu\text{g/g}$ and range 0.4 to 1.9 $\mu\text{g/g}$) than in the screening study but similar concentrations at TRM 457 (average 1.3 $\mu\text{g/g}$ and range 0.9 to 1.7 $\mu\text{g/g}$, table 2). Concentrations at TRM 435 averaged 1.2 $\mu\text{g/g}$ and ranged 0.6 to 1.9 $\mu\text{g/g}$. Differences in concentrations between the two studies were not tested statistically because there were no replicate samples in the screening study.

PCB concentrations are often related to both fish size and lipid content. The preliminary test used to determine if these relationships existed did not detect a significant relationship between PCB concentration and lipid content or between PCB concentration and fish weight at any of the locations indicating adjustment was not necessary (table 5). Therefore, a one-way analysis of variance was used to

test location differences. The ANOVA did not find significant differences in PCB concentrations among locations (table 5).

Absence of a significant relationship between PCB concentration and lipid content and/or fish weight is noteworthy. Trend studies on Fort Loudoun and Wilson Reservoirs have shown the importance of evaluating these relationships in comparing PCB concentrations among locations and over time (Dycus and Lowery, 1988; and Dycus, 1989b). The database for Nickajack Reservoir simply may be too small for these relationships to be detected. Subsequent studies including a broader range in fish sizes would shed more light on this situation.

Chlordane. Chlordane concentrations in the composite samples from the screening study were 0.21 $\mu\text{g/g}$ at TRM 425 and 0.25 at TRM 457, both exceeded the Tier 3 level of 0.20 $\mu\text{g/g}$. Concentrations observed in this more intensive study averaged 0.22, 0.11, and 0.16 $\mu\text{g/g}$ at TRMs 425, 435, and 457 (table 2).

The preliminary regression procedure identified a significant relationship between chlordane concentration and lipid content but not between chlordane concentration and fish weight (table 5). Occurrence of a significant relationship in the preliminary test means that the slope of the line regressing chlordane concentration against lipid content for at least one location was significantly different from zero thus showing a need to adjust chlordane concentrations to a common lipid content. However, the test of parallel lines found the regression lines were not parallel indicating lipid content affected chlordane concentration differently at the different sites, thus rendering analysis of covariance inappropriate. Interestingly, the regression lines for both TRMs 425 and

435 had positive slopes, while the line for TRM 457 had a negative slope. Care must be exercised when evaluating these results because the regression line for TRM 457 is based on only three data points. Emphasis in the future will be placed on collecting a larger sample.

Correlation Analysis. Correlation analysis was used to examine associations of several variables (i.e., PCB concentration, chlordane concentration, lipid content, and fish weight) within the population by combining locations. This differs from the regression procedures cited above, which examined the dependence of one variable (either PCB or chlordane concentration) on another (lipid content or fish weight) for each location.

Results of simple correlation analysis found significant associations between PCB concentration and lipid content, between PCB and chlordane concentrations, and between chlordane concentration and lipid content (table 6). Because PCB concentration and chlordane concentration both showed a significant association with lipid content, a partial correlation procedure was used to examine the association of two of these variables while holding the other constant. These results showed that the PCB:lipid content association was no longer significant, the PCB:chlordane association was no longer significant ($P > F$ 0.0647), yet the chlordane:lipid content association was still significant (table 6). These results indicate the chlordane concentration:lipid content association may be the dominant observation, and other associations indicated by simple correlation analysis were due to their tie to these two variables.

Other Species

Five largemouth bass and five crappie were collected at both TRMs 425 and 435, providing the full complement of these species. However, smallmouth buffalo collections were not as successful; only two of the ten (both from TRM 435) were collected. Gross observations on crappie and smallmouth buffalo did not reveal any unusual anomalies. Observations on the 10 largemouth bass showed only three fish were normal, five had parasites (one parasite infested fish was emaciated and had no visceral fat), one was blind in the right eye, and one had a granular kidney and mottled liver. The size of this data set limits strong statements on the condition of largemouth bass in Nickajack Reservoir. If this frequency of anomalies truly exists in the largemouth bass population, it suggests the presence of some type of stress on this species in Nickajack Reservoir. Examination of a larger number of largemouth bass from Nickajack Reservoir in 1989 for a study specifically aimed at evaluating the health of this species rated Nickajack as one of the worst TVA reservoirs for largemouth bass health (Brown and Hickman, 1990 draft). This indicates a need for follow-up studies to identify the stress factor(s).

Collection date, weight, length, and sex for individuals of these species are provided in table 7. Also included in table 7 are lipid content, chlordane concentration, and PCB concentration for composite analysis of those fish. PCBs were detected in all samples but varied little among species or locations (range for all species and locations 0.2 to 0.4 $\mu\text{g/g}$). Chlordane was not detected in any samples.

Results from these screening samples indicate little need to more closely examine PCB or chlordane concentrations in largemouth bass or crappie. Because only two smallmouth buffalo were analyzed, similar statements cannot be made for this species.

STATUS AND RECOMMENDATIONS

The study team used information from this study to design a follow-up study in autumn 1989. The objective of the autumn 1989 study was to further refine geographical distribution of PCB and chlordane contamination in fish from Nickajack Reservoir and to investigate concentrations in other important sport fish (sauger and striped bass or striped bass x white bass hybrids). The study was to emphasize collection of all fish during the preferred timeframe of October to December, as well as collection of the desired number of individuals for each species. Specifically, ten channel catfish were to be collected from each of four locations--TRMs 425, 435, 457, and 470 (a new location near Chickamauga Dam). Also, ten sauger and ten striped bass (or striped bass x white bass hybrids) were to be collected from TRM 470. All fish would be analyzed individually.

At the time this report was written, there were no specific plans to further investigate factors possibly responsible for the apparent stressed condition of largemouth bass in Nickajack.

REFERENCES

- Brown, A. M. and G. D. Hickman. 1990 Draft. "Fish Health Program 1989." Tennessee Valley Authority, Water Resources, Norris Tennessee.
- Dycus, D. L. and D. R. Lowery. 1988. "PCB Concentrations in Wilson Reservoir Catfish--1987." Tennessee Valley Authority, Water Resources, Knoxville, Tennessee.
- Dycus, D. L. 1989a. "Results of Fish Tissue Screening Studies from Sites in the Tennessee and Cumberland Rivers in 1987." Tennessee Valley Authority, Water Resources, Chattanooga, Tennessee. TVA/WR/AB--89/5.
- Dycus, D. L. 1989b. "PCB Studies on Fish from Watts Bar, Fort Loudoun, Tellico, and Chilhowee Reservoirs--1987." Tennessee Valley Authority, Water Resources, Chattanooga, Tennessee. TVA/WR/AB--89/10.

TABLES

Table 1. Contaminant Levels^a Used to Make Recommendations Based on Analytical Results from Valleywide Fish Tissue Screening Study

Parameter	Laboratory Detection Limit (µg/g)	Tier 1	Tier 2	Tier 3
		Return to Rotation System (µg/g)	Resample at Screening Level Following Year (µg/g)	Recommend Intensive Study (µg/g)
Antimony	2.0	< 5.0	≥ 5.0	b
Arsenic	0.03	< 0.5	≥ 0.5	≥ 0.7
Beryllium	0.02	< 0.1	≥ 0.1	≥ 0.3
Cadmium	0.001	< 0.5	≥ 0.5	≥ 1.0
Chromium	0.02	< 0.7	≥ 0.7 ^c	≥ 1.5 ^c
Copper	0.2	< 3.0	≥ 3.0	b
Lead	0.2	< 1.5	≥ 1.5	≥ 2.0
Mercury	0.1	< 0.5	≥ 0.5	≥ 0.7
Nickel	1.0	< 2.0	≥ 2.0 ^c	≥ 4.0 ^c
Selenium	0.02	< 1.0	≥ 1.0	≥ 3.0
Silver	0.2	< 12.0	≥ 12.0	b
Thallium	1.0	< 1.0	≥ 1.0	≥ 3.0
Zinc	0.1	< 75.0	≥ 75.0	b
Aldrin	0.01	< 0.1	≥ 0.1	≥ 0.2
Benzene Hexachloride	0.01	< 0.1	≥ 0.1	≥ 0.2
Chlordane	0.01	< 0.1	≥ 0.1	≥ 0.2
DDT	0.01	< 2.0	≥ 2.0	≥ 4.0
Dieldrin	0.01	< 0.1	≥ 0.1	≥ 0.2
Endosulfan	0.01	< 3.0	≥ 3.0	≥ 5.0
Endrin	0.01	< 0.1	≥ 0.1	≥ 0.2
Heptachlor	0.01	< 0.1	≥ 0.1	≥ 0.2
Toxaphene	0.5	< 2.0	≥ 2.0	≥ 3.0
PCB's	0.1	< 1.0	≥ 1.0	≥ 1.5

- These levels will be used as a general guide. Specific recommendations will be made on a case-by-case basis.
- Selection of a level of this metal which would result in a recommendation to conduct intensive studies cannot be made at this time.
- Chromium and nickel frequently occur as a result of laboratory contamination from the blending process. A suspected source would have to exist before further examination would be recommended based only on these metals.

Table 2. Physical Characteristics and Concentrations ($\mu\text{g/g}$ wet weight) of Chlordane and PCBs in Channel Catfish from Nickajack Reservoir, Collected January and February 1989

Mile	Collection Date	Species	Sex	Length	Weight	Percent Lipid	Cl	PCB
425	02/26/89	CHC	female	558	1968	6.6	0.06	0.8
425	02/26/89	CHC	female	604	2210	3.4	0.04	0.9
425	02/26/89	CHC	male	568	2465	15.0	0.15	1.3
425	02/26/89	CHC	male	609	1954	0.9	0.01	0.8
425	02/26/89	CHC	male	565	1835	12.0	0.08	0.6
425	02/26/89	CHC	male	610	2705	17.0	0.16	1.3
425	02/26/89	CHC	male	650	2532	12.0	0.08	0.4
425	02/26/89	CHC	male	566	2128	17.0	0.15	0.9
425	02/26/89	CHC	female	555	1980	18.0	0.22	1.9
425	02/26/89	CHC	male	<u>580</u>	<u>1975</u>	<u>12.0</u>	<u>0.15</u>	<u>0.5</u>
$\bar{x}$				520	1620	11.4	0.11	0.9
435	02/28/89	CHC	male	552	2027	14.0	0.18	0.6
435	02/28/89	CHC	male	525	1773	18.0	0.13	1.9
435	02/28/89	CHC	male	505	1506	12.0	0.08	0.9
435	02/28/89	CHC	male	532	1565	11.0	0.13	0.8
435	02/28/89	CHC	female	482	1445	7.2	0.23	1.3
435	02/28/89	CHC	male	559	1828	11.0	0.08	0.7
435	02/28/89	CHC	male	467	945	14.0	0.17	1.3
435	02/28/89	CHC	female	552	1943	11.0	0.19	1.8
435	02/28/89	CHC	female	490	1400	13.0	0.17	0.7
435	02/28/89	CHC	female	<u>536</u>	<u>1771</u>	<u>13.0</u>	<u>0.19</u>	<u>1.6</u>
$\bar{x}$				587	2175	12.4	0.16	1.2
457	01/10/89	CHC	female	472	1198	20.0	0.33	1.7
457	01/10/89	CHC	female	546	2340	8.9	0.16	0.9
457	01/10/89	CHC	male	<u>612</u>	<u>2024</u>	<u>12.0</u>	<u>0.17</u>	<u>1.4</u>
$\bar{x}$				540	1854	13.6	0.22	1.3

Table 3. Results of One-Way Analysis of Variance and Duncan's Multiple Range Test on Lipid Content, Length, and Weight of Channel Catfish Among Locations in Nickajack Reservoir

Parameter	P>F	Duncan's Multiple Range Test ^a		
		Location with Lowest Mean	Location with Highest Mean	
Lipid content	0.7531			
Length	0.0023	<u>TRM 425</u>	<u>TRM 457</u>	<u>TRM 435</u>
Weight	0.0116	<u>TRM 425</u>	<u>TRM 457</u>	<u>TRM 435</u>

a. Locations underscored by same line were not significantly different at $\alpha = 0.05$; lines not so underscored were significantly different.

Table 4. Results of Analysis of Covariance Comparing Length/Weight Relationship of Channel Catfish from Nickajack Reservoir to Channel Catfish Contained in the TVA Life History Data File for Mainstem Reservoirs on the Tennessee River

Preliminary Test Used To Determine Need to Adjust Weight to Common Length	Decision	Test of Parallel Lines	Results of Analyses of Covariance
Sign; $P>F = 0.0001$	Use analysis of covariance	Lines parallel; use of analysis of covariance appropriate	Nickajack > Life History ($P>F = 0.0001$)

Table 5. Results of Statistical Tests Used To Compare Location Differences in PCB and Chlordane Concentrations in Channel Catfish from Nickajack Reservoir

Analyte	Parameter	Preliminary Test		Decision based on preliminary test	If ANOVA (P>F)	If analysis of covariance (test of parallel lines)	Analysis of covariance results
		(Is there a significant relationship between analyte and parameter)	(Is there a significant relationship between analyte and parameter)				
PCB	Lipid content	No ($P > F = 0.3868$)	No ($P > F = 0.3799$)	Use ANOVA	0.3296	N/A	N/A
	Weight	No ($P > F = 0.3799$)	No ($P > F = 0.3799$)	Use ANOVA	0.3296	N/A	N/A
Chlordane	Lipid content	Yes ($P > F = 0.0003$)	Yes ($P > F = 0.0003$)	Use analysis of covariance	N/A	Lines not parallel; use of analysis of covariance not appropriate ($P > F = 0.0220$)	
	Weight	No ($P > F = 0.1027$)	No ($P > F = 0.1027$)	Weight adjustment not needed, but must use analysis of covariance to adjust for lipid content	N/A	N/A	N/A

Table 6. Results of Correlation Analysis on Channel Catfish Data
from Nickajack Reservoir, Collected January and February
1989

	P>F	Correlation Coefficients
<u>Simple Correlations</u>		
PCB:Weight	0.3374	-0.2095
PCB:Lipid Content ^a	0.0448	0.4152
PCB:Chlordane ^a	0.0042	0.5739
Chlordane:Weight	0.1010	-0.3506
Chlordane:Lipid Content ^a	0.0007	0.6559
Weight:Lipid Content	0.5551	-0.1298
<u>Partial Correlations</u>		
PCB:Weight	0.0936	
PCB:Lipid Content	0.7795	
PCB:Chlordane	0.0647	
Chlordane:Weight	0.1640	
Chlordane:Lipid Content ^a	0.0068	

a. Significant at $\alpha=0.05$.

Table 7. Physical Characteristics and Concentrations ($\mu\text{g/g}$ wet weight) of Chlordane and PCBs in Largemouth bass, Crappie, and Smallmouth Buffalo from Nickajack Reservoir, Collected January and February 1989

Mile	Species ^a	Collection Date	Sex	Length (mm)	Weight (g)	Percent	Chlordane ($\mu\text{g/g}$)	PCBs ($\mu\text{g/g}$)
						Lipid (%)		
TRM 425	LMB	01-11-89	female	362	700			
	LMB	01-19-89	female	436	1446			
	LMB	01-19-89	female	393	840			
	LMB	02-21-89	female	402	1048			
	LMB	02-21-89	female	374	855	2.7	<0.01	0.2
	BCR	01-19-89	female	328	738			
	BCR	01-19-89	female	294	508			
	BCR	01-19-89	male	265	349			
	BCR	01-19-89	female	259	360			
	BCR	02-19-89	female	272	367	2.7	<0.01	0.3
TRM 435	LMB	01-24-89	male	381	1075			
	LMB	01-24-89	female	370	674			
	LMB	01-24-89	female	365	725			
	LMB	01-24-89	male	353	715			
	LMB	02-26-89	male	410	1061	1.6	<0.01	0.4
	BCR	01-24-89	female	289	520			
	BCR	02-26-89	male	297	514			
	BCR	02-26-89	male	277	405			
	BCR	02-26-89	male	235	228			
	BCR	02-26-89	female	378	933	1.7	<0.01	0.4
	SBU	02-26-89	male	493	2303			
	SBU	02-26-89	male	396	1048	16	<0.01	0.3

a. LMB = largemouth bass; BCR = black crappie; SBU = smallmouth buffalo.

END

DATE FILMED

02 / 19 / 91