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HUMANS

Organochlorine Contaminants in Human Milk from Slavonia Province, Yugoslavia, 1978

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ABSTRACT

rganochlorine residues were determined in human milk mples from an agricultural area of Slavonia, Yugoslavia. oncentrations of pentachlorobenzene, hexachlorobenzene, , β-, γ-isomers of benzene hexachloride, heptachlor, aldrin, DE, TDE, and DDT were determined by gas chromotogphy (GC). Confirmation was carried out by computerized C–mass spectrometry. The most abundant contaminant as p,p'-*DDE (range, 42.0–418.5 μg/kg (ppb)).*

Introduction

or many years, organochlorine pesticides have been vestigated because of their toxicity and persistence. lthough human milk is the best natural food for babies, can become a primary depository for organochlorine ntaminants. Numerous authors worldwide have reorted relatively high levels of these contaminants in uman milk (*1, 3–7, 11*).

he present work examines the levels of organchlorine ntaminants in the human milk samples from Slavonia rovince, Yugoslavia.

Sampling and Analysis

en human milk samples were collected at Children's ospital of Osijek during the first half of 1978. Volunter donors were lactating mothers, 17 to 41 years old. mples were manually expressed at one to four months ostpartum into precleaned glass bottles. The samples ere stored at −30°C until analysis.

ach 10-g milk sample was extracted twice by shaking for 15 minutes with a mixture of 15 ml acetone and) ml hexane. The extract was centrifuged. The hexane yer was collected by pipetting and was concentrated nder a stream of nitrogen; the lipids were redissolved in hexane. Cleanup was performed with concentrated H_2SO_4 according to the procedure of Veierov and Aharonson (*10*). Cleaned extracts were analyzed by electron-capture gas chromatography (GC) for the following organochlorine contaminants: pentachlorobenzene, hexachlorobenzene (HCB), α-, β-, and γ-isomers of benzene hexachloride (BHC), heptachlor, aldrin, DDE, TDE, and DDT. Instrument parameters and operating conditions were as follows:

Chromatograph:	Varian Series 1400
Detector:	Sc-H^3 electron capture
Column:	glass, capillary, 0.3 mm × 27 meters, coated with OV-101 after HCl treatment
Split ratio:	1:25
Chromatograph:	Tracor 550
Detector:	Ni^{63} electron capture
Column:	glass, 2 mm × 2 meters, packed with 3 percent SE-30 on 80–100-mesh Chromosorb W-AW

Confirmation was carried out by computerized GC–mass spectrometry (MS) with the following instrument parameters and operating conditions:

GC–MS-Computer System:	Hewlett-Packard 5710A GC and Hewlett-Packard 5980A MS interfaced with Hewlett-Packard 5933A Data System	
Column:	glass, 2 mm × 2 meters, packed with 0.2 percent Carbowax 20M on 100–120-mesh Chromosorb W-AW	
Temperatures, °C:	jet separator	350
	ion source	180
	analyzer	110
Electron energy:	70 eV	
Scan rate:	80 amu/second	

In addition to the usual computer program for GC–MS, the authors used a special program called the halo-test (*8*) for searching organochlorine compounds from stored GC–MS data. The search was performed after each GC–MS run.

Results and Discussion

All samples analyzed contained some of the following organochlorine contaminants: pentachlorobenzene, hexachlorobenzene, α- and β-isomers of BHC, *p,p'*-DDE, *p,p'*-TDE, and *p,p'*-DDT. Results of quantitative deter-

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TABLE 1. *Concentrations of organochlorine contaminants in human milk samples from Slavonia Province, Yugoslavia—1978*

Compound	Sample size, g	Residues, μg/kg	
		Range	Av. Concn
Pentachlorobenzene	6	0–3.4	2.0
Hexachlorobenzene	10	1.6–17.1	5.9
α-BHC	5	<0.1	—
β-BHC	10	4.1–18.6	9.1
p,p'-DDE	10	42.0–418.5	175.7
p,p'-TDE	5	<1	—
p,p'-DDT	10	8.0–135.4	50.8

NOTE: Results are not corrected for recovery. Investigated recovery for the procedure in general was 90–98 percent.

minations of pentachlorobenzene, HCB, β-BHC, *p,p'*-DDE, and *p,p'*-DDT are shown in Table 1.

p,p'-DDE was found most frequently and in the highest concentrations (42.0–418.5 μg/kg).

The best separation of BHC isomers and hexachlorobenzene (HCB) was obtained on the column packed with 0.2 percent Carbowax 20M prepared according to Aue et al. (*2*) which separates isomers of other organochlorine compounds (*9*). Levels of β-BHC, HCB, and pentachlorobenzene were significantly lower than *p,p'*-DDE levels but still high in comparison to levels of α-BHC which was found in traces only. γ-BHC was not found in measurable amounts (detection limit 1 pg), although the most used foodstuffs investigated in our laboratory (unpublished data) and in other laboratories (*12*) contained large amounts of it.

Acknowledgment

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FOOD AND FEED

Residue Dynamics of Acephate and Methamidophos in Urban Dooryard Citrus Foliage, Pompano Beach, Florida—August–September 1978 [1]

George E. Fitzpatrick [2] and Michael D. Bogan [2]

ABSTRACT

sidues of acephate and its toxic metabolite methami-
hos, attributable to the State-Federal program for eradi-
ion of the citrus blackfly (CBF) [Aleurocanthus woglumi
hby] on citrus foliage, were assessed in urban areas in
mpano Beach, Florida. Eighteen dooryard citrus trees
re sampled on two line transects, each ca 1.6 km long,
ng two city streets. The trees were sampled twice monthly
five months, beginning before chemical treatments were
lied, continuing through the acephate treatment period,
l ending when residues decreased below the limits of de-
tion. Acephate and methamidophos residues, as high as
?.5 ppm and 15.8 ppm, respectively, were detected on
ves within one day after the first of a series of three
atments. Significant conversion of acephate to methami-
hose was observed. Of the 143 samples collected, 114
ntained measurable residues of both compounds; metha-
dophos accounted for an average of 19 percent of the
al residues. Both compounds degraded rapidly, however,
l residues averaged below 1 ppm approximately four
eks after the third treatment in the series. Average foliar
f-lives for acephate and methamidophos were 8.93 days
) = 2.52) and 8.40 days (SD = 2.55), respectively.

Introduction

e citrus blackfly (CBF), *Aleurocantus woglumi* hby, was the target of an eradication program con-cted jointly by the Florida Department of Agriculture l Consumer Services, Division of Plant Industry PI), and the U.S. Department of Agriculture, Animal l Plant Health Inspection Service (APHIS), in south-Florida during 1976–1979. An aleyrodid insect of ian origin, *A. woglumi* were found as dooryard citrus estations in the Fort Lauderdale area in early 1976. ner infestations were subsequently discovered through-Broward County and in Brevard, Dade, Palm Beach, llier, Martin, Okeechobee, Indian River, and St. Lucie unties, as well.

Although a number of insecticides had been shown to be effective against *A. woglumi* (*2, 3, 7, 8, 11*), acephate was selected for the eradication program because of acceptable efficacy (*7*), very low acute mammalian toxicity (*5*), and its availability in a soluble powder formulation that would reduce real or potential phytotoxic damage to host plants and other adjacent ornamental plants prevalent in urban areas. Moreover, acephate was shown to have relatively low acute negative impact on biological control agents of *A. woglumi* (*1*).

Although acephate was not registered for CBF control, a crisis exemption was granted by the U.S. Environmental Protection Agency (EPA), allowing its application for citrus blackfly eradication. Acephate was to be applied to all citrus plants as well as mango (*Mangifera indica*) and Surinam-cherry (*Eugenia uniflora*) in Palm Beach, Broward, and Dade Counties. In other Florida counties, only the areas infested were sprayed. It was diluted to 0.6 g/liter and applied with hydraulic sprayers twice at ca 21-day intervals. A third application diluted to 1.6 g/liter was made with a portable backpack mistblower ca 21 days after the second dilute spray.

Since acephate was not registered for this type of use, little data were available on its residue behavior. An earlier study conducted under simulated eradication conditions yielded data on residues in fruit (*6*). In the present study, residues of acephate and its toxic metabolite methamidophos were determined in urban dooryard citrus foliage subjected to insecticide applications during the eradication program. Because the acute toxicity of methamidophos is much greater (acute oral LD_{50} in male rats is 21 mg methamidophos/kg compared to 945 mg acephate/kg) (*5*), residue dynamics of both compounds were assessed.

Materials and Methods

Two line transects, each along a city street, were selected in an urban area of Pompano Beach, Florida. Each transect was ca 10 city blocks long (ca 1.6 km), and

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one *Citrus* spp. tree, either *C. sinensis* (orange) or *C. paradisi* (grapefruit), was selected for sampling on each city block. Although homeowner cooperation was secured in advance, there were occasional instances when samples could not be taken due to problems in gaining access to certain backyards.

The trees were sprayed by APHIS or DPI employees as part of their regular duties in the citrus blackfly eradication program. Although APHIS and DPI supervisory personnel cooperated with the residue analysis program, the persons doing the spraying were for the most part unaware of the residue sampling. This was to ensure that the monitoring would be most representative of actual eradication spraying conditions.

Each selected tree was sampled at two-week intervals, from early August until December 1978. Ten to twenty leaves were removed and placed in plastic bags. The filled bags were placed on ice and transported to the laboratory where they were stored at −25°C until analysis. Samples were stored in this manner for 0.5–3.5 months before analysis. The effect of storage on hydrolysis of acephate to methamidophos was not determined.

At the time of analysis, the leaves were thawed and 5-g aliquots were weighed. Each 5-g sample was extracted three times in a Lourdes homogenizer with 50-ml portions of ethyl acetate (150 ml total volume) and 15 g anhydrous Na_2SO_4. Resultant extracts were evaporated to dryness and dissolved in 25 ml ethyl acetate for gas chromatographic (GC) analysis. GC analysis procedures were adapted from earlier studies (*3, 4, 6*). The following instrument parameters and operating conditions were used:

Gas chromatograph:	Tracor Model 222
Detector:	flame photometric in phosphorus mode
Column:	glass, 91 cm long by 4 mm ID, packed with percent Reoplex 400 on 80–100-mesh G Chrom Q
Temperatures:	column: program initiated 2 minutes af injection, to increase from 140° to 190°C at 20°C/minute
	inlet: 190°C
	detector: 160°C
Gases:	nitrogen (carrier) flowing at 50 ml/minu hydrogen at 100 ml/minute; and air at 1 ml/minute

Calculations for decay curves for acephate and meth midophos on each sampled tree were based on tin after the last treatment according to the equation:

$$y = y_o e^{bx} \qquad (1$$

The date of the last treatment was taken from recor kept by the spray crews (Gregory F. Lotorto, Janua 1979; Florida Department of Agriculture and Consum Services, Ft. Lauderdale, Fla., personal communic tion). The decay rates were used to compute $t_{1/2}$ valu for both compounds on each sampled tree when at lea three detectable residues were measured after the la treatment and when the correlation coefficient for Equ tion 1 was at least 0.70 by the equation:

$$t_{1/2} = \frac{\ln(0.5)}{-b} \qquad (2$$

Results and Discussion

The first detectable foliar residues of acephate a methamidophos in transect 1 were determined two trees on August 15 and on the other seven trees August 29 (Table 1). In transect 2, the spraying co menced slightly later; none of the trees had detectal residues on August 15 but all did by August (Table 2).

TABLE 1. *Acephate and methamidophos residues in* Citrus *spp. foliage along N.E. 2nd Street, Pompano Beach, Florida—1978*

Species	Tree No.[1]	Compound	Foliar Residues, ppm Wet Weight									
			Aug. 7	Aug. 15	Aug. 29	Sept. 11	Sept. 26	Oct. 10	Oct. 24	Nov. 7	Nov. 20	Dec. 5	Dec.
Citrus sinensis	1–1	Acephate	ND	20.4	5.88	52.8	6.12	10.4	2.15	0.91	0.36	0.21	<0.0
		Methamidophos	ND	4.40	0.52	15.8	1.28	2.00	0.34	0.07	0.04	<0.03	<0.0
	1–3	Acephate	ND	ND	7.35	1.60	6.60	11.5	2.07	0.82	0.04	0.07	0.0
		Methamidophos	ND	ND	1.24	0.49	2.07	2.56	0.86	0.27	<0.03	<0.03	<0.0
	1–5	Acephate	ND	ND	5.60	1.42	3.97	7.80	0.67	0.12	6.42	0.39	0.
		Methamidophos	ND	ND	1.78	0.25	0.73	0.75	0.22	0.05	1.07	0.12	<0.0
	1–9	Acephate	ND	ND	7.67	M[2]	0.60	2.22	0.44	0.16	0.02	0.17	0.0
		Methamidophos	ND	ND	1.52	M	0.20	0.32	0.12	<0.05	<0.03	0.06	<0.0
Citrus paradisi	1–2	Acephate	ND	ND	9.14	0.87	14.7	19.4	7.25	1.66	0.08	0.06	0.
		Methamidophos	ND	ND	2.15	0.17	3.28	1.97	2.20	0.48	0.04	<0.03	<0.0
	1–4	Acephate	ND	142.5	11.4	1.01	9.65	21.6	2.67	0.63	0.03	0.07	0.0
		Methamidophos	ND	2.93	1.85	0.33	2.65	2.00	0.62	0.09	<0.03	<0.03	<0.0
	1–6	Acephate	ND	ND	9.52	41.3	1.47	7.00	1.34	0.91	0.07	0.07	<0.0
		Methamidophos	ND	ND	1.89	3.60	0.48	0.29	0.49	0.21	<0.03	<0.03	<0.0
	1–8	Acephate	ND	ND	35.3	1.68	4.04	0.69	0.09	0.39	0.01	<0.02	<0.0
		Methamidophos	ND	ND	2.40	0.38	0.84	0.11	0.12	<0.05	<0.03	<0.03	<0.0
	1–10	Acephate	ND	ND	5.54	305.1	6.30	32.7	10.30	1.60	0.76	0.61	<0.
		Methamidophos	ND	ND	1.21	15.0	1.29	4.00	2.70	0.27	0.17	0.15	<0.

NOTE: ND = not detected.
[1] Prefixes 1 or 2 indicate transects 1 or 2.
[2] M = sample not collected.

TABLE 2. *Acephate and methamidophos residues on* Citrus *spp. foliage along N.E. 4th Street, Pompano Beach, Florida—1978*

Species	Tree No.[1]	Compound	Foliar Residues, ppm Wet Weight									
			Aug. 15	Aug. 29	Sept. 11	Sept. 26	Oct. 10	Oct. 24	Nov. 7	Nov. 20	Dec. 5	Dec. 19
s sinensis	2–1	Acephate	ND	4.53	3.49	20.1	12.2	2.42	0.24	0.07	0.09	0.04
		Methamidophos	ND	0.11	1.25	1.90	1.64	1.20	0.12	<0.02	<0.03	<0.03
	2–4	Acephate	ND	302.5	M[2]	3.85	0.13	0.04	0.15	0.09	0.03	0.02
		Methamidophos	ND	11.00	M	1.20	0.03	0.04	0.12	0.06	<0.03	<0.03
	2–5	Acephate	ND	7.14	0.68	6.00	11.3	0.29	0.12	0.07	0.02	<0.02
		Methamidophos	ND	1.20	0.25	1.55	1.29	0.07	<0.03	<0.02	<0.03	<0.03
s paradisi	2–2	Acephate	ND	M	7.72	34.8	8.44	3.07	0.14	0.19	0.07	0.10
		Methamidophos	ND	M	1.18	2.68	1.59	0.97	0.05	<0.02	<0.03	<0.03
	2–3	Acephate	ND	M	1.39	1.83	13.8	3.86	2.15	0.23	0.08	<0.02
		Methamidophos	ND	M	0.32	0.43	2.22	0.59	0.49	<0.02	<0.03	<0.03
	2–6	Acephate	ND	12.3	1.07	13.7	1.06	2.50	0.11	0.18	0.08	<0.02
		Methamidophos	ND	2.17	0.24	1.83	0.22	0.58	0.03	0.05	<0.03	<0.03
	2–7	Acephate	ND	9.93	1.01	3.69	15.8	2.36	0.11	0.14	<0.02	0.02
		Methamidophos	ND	1.86	0.25	1.45	0.63	0.48	0.05	<0.02	<0.03	<0.03
	2–8	Acephate	ND	137.8	8.01	5.44	1.68	3.31	0.70	1.77	0.17	<0.02
		Methamidophos	ND	6.25	1.40	2.35	0.40	1.34	0.18	0.67	0.06	<0.03
	2–9	Acephate	ND	10.7	6.08	3.56	1.85	0.25	0.05	0.05	0.14	<0.02
		Methamidophos	ND	1.91	1.14	1.12	0.33	0.10	<0.03	<0.02	0.05	<0.03

TE: ND = not detected.
fixes 1 or 2 indicate transects 1 or 2.
= sample not collected.

BLE 3. *Acephate application dates for the* Citrus *spp. rees in both transects, Pompano Beach, Florida—1978*

e No.[1]	Species	Application Date		
		First	Second	Third
–1	*Citrus sinensis*	Aug. 10	Sept. 6	Sept. 28
–3		Aug. 18	Sept. 14	Oct. 4
–5		Aug. 17	Oct. 4	Nov. 7
–9		Aug. 18	Sept. 12	Oct. 2
–2	*Citrus paradisi*	Aug. 18	Sept. 14	Oct. 4
–4		Aug. 23	Sept. 19	Oct. 6
–6		Aug. 14	Sept. 7	Sept. 28
–8		Aug. 24	Sept. 15	Oct. 2
–10		Aug. 17	Sept. 11	Sept. 29
–1	*Citrus sinensis*	Aug. 28	Sept. 15	Oct. 5
–4		Aug. 29	Sept. 20	NS[2]
–5		Aug. 21	Sept. 15	Oct. 5
–2	*Citrus paradisi*	Aug. 28	Sept. 15	Oct. 5
–3		Aug. 21	Sept. 13	Oct. 2
–6		Aug. 23	Sept. 19	Oct. 11
–7		Aug. 23	Sept. 19	Oct. 9
–8		Aug. 28	Sept. 22	Oct. 13
–9		Aug. 21	Sept. 13	Oct. 2

TE: Information supplied by G. L. Lotorto, Florida Department of iculture and Consumer Services, Fort Lauderdale, Florida.
efixes 1 or 2 indicate Transect 1 or 2.
= not sprayed.

th one exception, all trees in both transects were ayed during the period August 10 to October 13 regory F. Lotorto, January 1979; Fort Lauderdale, ., personal communication). The actual spray appli- ion dates are shown in Table 3. The one exception tree 1-5 in transect 1, which was apparently over- ked initially by the spray crews and treated later en the oversight was detected. That tree received its d treatment on November 7 and this later treatment ounts for the apparent protraction of its residues evi- nt in Table 1.

most cases, acephate residues remained above 1 ppm ing the two-month treatment period and for ea one month after the treatment period (Tables 1 and 2). The highest concentrations of both compounds were detected in samples taken during the first month of the treatment period, when some trees had residues exceeding 300 ppm acephate and 15 ppm methamidophos. The first month of the treatment period encompassed the two treatments applied as dilute sprays, whereas the third treatment, applied by mist-blower, produced lower residue values. This agrees with earlier work in which acephate and methamidophos were not detected in fruits of citrus plants treated by mist-blower application but were detected in fruits of trees treated with dilute sprays applied by hydraulic equipment (*6*). Apparently, the higher concentration coupled with less aqueous carrier results in less toxicant deposition on leaf surfaces as well as lower uptake into the fruit.

Residue values for both compounds measured after the last of the series of three treatments were used to assess the rates of decay on foliage (Table 4). The average half-lives of acephate and methamidophos on citrus foliage were 8.93 days and 8.40 days, respectively, with no pronounced difference between the two plant species. These values can be compared with half-lives of 10.3 days and 10.5 days for acephate and methamidophos, respectively, in the rind of oranges, grapefruit, lemons, and tangerines, and half-lives of 15.0 days and 6.1 days for acephate and methamidophos, respectively, in citrus pulp (*6*). In contrast, half-lives of acephate and methamidophos in needles of Douglas fir (*Pseudotsuga menziessii*) were reported in one study to be ca three days for each compound (*10*) and in another study, ca five days for each compound (*9*). In all of the above-mentioned studies as in the present study, only acephate was applied, and methamidophos residues, when de-

TABLE 4. *Decay dynamics of acephate and methamidophos on urban dooryard* Citrus *spp. trees, Pompano Beach, Florida—1978*

Tree No.[1]	Species	Acephate $t_{1/2}$, Days	Acephate N	Acephate r	Methamidophos $t_{1/2}$, Days	Methamidophos N	Methamidophos r
1–1	*Citrus sinensis*	−9.90	5	−0.98	−6.98	4	−0.98
1–3		−7.67	4	−0.88	[2]	2	[2]
1–5		−5.31	3	−0.96	[2]	2	[2]
1–9		−11.50	5	−0.75	[2]	2	[2]
2–1		−8.63	6	−0.93	−7.67	3	−0.92
2–4		−13.80	7	−0.79	[2]	5	−0.50
2–5		−6.90	5	−0.93	[2]	2	[2]
		$\bar{x}$ = −9.10			$\bar{x}$ = −7.29		
		SD = 2.89			SD = 0.54		
1–2	*Citrus paradisi*	−8.63	6	−0.90	−6.90	4	−0.91
1–4		−6.27	5	−0.94	−6.27	3	−0.99
1–6		−7.67	5	−0.96	[2]	3	−0.38
1–8		−8.63	4	−0.76	[2]	2	[2]
1–10		−8.63	5	−0.96	−9.86	5	−0.93
2–2		−9.86	6	−0.89	−5.75	3	−0.92
2–3		−6.90	5	−0.98	−13.80	3	−0.92
2–6		−9.86	4	−0.81	−7.67	3	−0.79
2–7		−5.31	4	−0.94	−7.67	3	−0.91
2–8		−11.50	4	−0.81	−11.50	4	−0.76
2–9		−13.80	5	−0.71	[2]	2	[2]
		$\bar{x}$ = −8.82			$\bar{x}$ = −8.68		
		SD = 2.41			SD = 2.81		
	Grand mean	$\bar{\bar{x}}$ = −8.93			$\bar{\bar{x}}$ = −8.40		
		SD = 2.52			SD = 2.55		

NOTE: Correlation coefficients (r) for the decay equation $y = y_0 e^{bx}$ were computed when the number of data points (N) after the last treatment was equal to or greater than 3. Half-life values for each tree ($t_{1/2}$) were computed when $r \geq 0.70$.
[1] Prefixes 1 or 2 indicate transect 1 or 2.
[2] Value not computed. See text for explanation.

tected, were presumed to be the result of hydrolysis of acephate.

In the data shown in Tables 1 and 2, a total of 114 samples contained measurable residues of both acephate and methamidophos. Twenty-nine contained acephate only (generally at levels approaching the limits of detection), and the remainder did not contain any measurable residues of either compound. Since the conversion of acephate to the more toxic methamidophos is a potential environmental problem, attention was given to the relative proportions of each compound expressed as a function of the total residue in each sample (Table 5). On the average, 81 percent of the total residue (acephate plus methamidophos) was in the form of acephate, with an average of 19 percent methamidophos. There were no pronounced differences between citrus species or between plots (Table 5), and the variability was quite low (SD $<<\bar{x}$).

Although there is significant conversion of acephate to its more toxic metabolite, methamidophos, in *Citrus* spp. leaves, the rapid disappearance of both compounds can reduce risk of exposure to dangerous levels of toxicant.

Acknowledgments

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TABLE 5. *Average composition of total residue (acepl plus methamidophos) expressed as either compound, based on residues listed in Tables 1 and 2*

Species	Transect	Acephate $\bar{x}$	Acephate SD	Acephate N	Methamidope $\bar{x}$	Methamidope SD
Citrus sinensis	1	0.81	0.06	27	0.19	0.06
	2	0.77	0.14	17	0.23	0.14
Citrus paradisi	1	0.82	0.10	33	0.18	0.10
	2	0.81	0.07	37	0.19	0.07
Total		0.81	0.09	114	0.19	0.09

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FISH, WILDLIFE, AND ESTUARIES

Organochlorine Residues in Eggs of Loggerhead and Green Sea Turtles Nesting at Merritt Island, Florida—July and August 1976

Donald R. Clark, Jr., and Alexander J. Krynitsky [1]

ABSTRACT

s from nine clutches of loggerhead turtles (Caretta :tta) *and two clutches of green turtles* (Chelonia mydas) *e collected as they were laid on Merritt Island, Florida. s were incubated, frozen, and analyzed for organo- rines.*

els of DDE and PCB, the major contaminants, averaged than 0.08 ppm in loggerhead eggs and were even lower green turtle eggs. These concentrations are far below ls thought to be potentially harmful. Loggerhead eggs e frozen after 43–52 days incubation; both DDE and 3 declined significantly during this interval. Authors esti- e that DDE averaged about 0.2 ppm in loggerhead eggs n they were laid.

E levels in eggs of both turtle species were less than ls in eggs of crocodiles (Crocodylus acutus) *from Ever- les National Park and in eggs of 13 species of aquatic ls nesting on Merritt Island. The remarkably low residues he turtle eggs probably indicate that, when not nesting, turtles live and feed in areas remote from Florida.*

Introduction

Declining populations of marine turtles throughout world are attributable to the taking of both adults eggs for sale or for immediate consumption as food . In the United States, human destruction of nesting ches and predation on eggs by raccoons (*Procyon or*) are also major factors (*3*). Both loggerhead *aretta caretta*) and the green turtle (*Chelonia mydas*) e been classified recently as "threatened," and the rida breeding population of the green turtle has been ed as "endangered" (*11*).

ether chemical pollution threatens marine turtles is ertain. Eggs of the predominantly herbivorous green le from Ascension Island contain only very low or- ochlorine residues (*10*). Residues in eggs of the more carnivorous loggerhead turtle from Georgia and South Carolina appear to be somewhat higher (*8*), but data are presented in such a way that precise comparisons are not possible. The present study examined eggs of loggerhead and green turtles collected in Florida.

Materials and Methods

Entire clutches from nine loggerhead and two green turtles were collected as they were laid on the Canaveral National Seashore and the adjacent Merritt Island National Wildlife Refuge (MINWR), Brevard County, Florida. All 11 clutches were laid between July 13 and August 6, 1976. Clutch size averages more than 100 eggs in both species (*6*). At laying, 20 eggs from each loggerhead clutch and five from each green turtle clutch were selected randomly, weighed, and numbered using India ink so that toxicant levels measured later could be related to original weights of eggs. Each clutch was placed in a plastic container, covered with sand, and incubated in a laboratory (house trailer) which was open to the ambient temperature and humidity of the beach.

Clutches were dug up after intervals of 43, 45, 48, 49, or 52 days. The numbered eggs were weighed again, wrapped individually in aluminum foil, sealed in plastic bags, and frozen. The remainder of each clutch was incubated until all viable eggs had hatched; these hatchlings were released to the ocean. Eggs that did not hatch (3–10 per loggerhead clutch, 8 and 13 for green turtle clutches) were placed with others from the same clutch that had been frozen previously. Eggs were frozen after a 43–52-day incubation period because, after that length of time, eggs with living embryos could be easily distinguished from eggs in which no embryo had developed. The experimental design called for comparison of residue levels in fertile and infertile eggs.

All eggs were packed in Dry Ice and shipped to the Patuxent Wildlife Research Center (PWRC) where they were weighed and opened, and the straight-line carapace

h and Wildlife Service, U.S. Department of the Interior, Patuxent llife Research Center, Laurel, Md. 20811.

length of each embryo was measured with a vernier caliper. Contents of each egg minus the shell were placed in separate, tared glass jars that had been cleaned with acetone and hexane, and the jars and contents were weighed. Subsequently, each sample egg was homogenized in a blender and analyzed for organochlorines.

Loggerhead eggs frozen after 43–52 days of incubation either contained well developed embryos (mean embryo carapace lengths of samples from nine clutches ranged from 32.3 mm to 37.4 mm) or showed no embryonic development and were classified as infertile. The rate of infertility in each 20-egg sample ranged from 5 percent to 25 percent (1–5 eggs) and averaged 12 percent. All 10 green turtle eggs frozen after 43–52 days of incubation contained large embryos. Carapace lengths averaged 37.6 mm and 39.2 mm for the two clutches.

Unhatched loggerhead eggs frozen after viable eggs had hatched also either contained large embryos or were infertile. Percentages of infertile eggs were higher, ranging from 33 percent to 100 percent and averaging 69 percent. Unhatched green turtle eggs frozen after viable eggs had hatched were 90 percent and 100 percent infertile.

To make a statistical comparison of residue levels in fertile versus infertile loggerhead eggs, authors randomly selected and analyzed 10 fertile eggs from among the 20 per clutch that were frozen after 43–52 days of incubation. Then, for comparison, authors analyzed all infertile eggs from that same clutch plus all available infertile eggs frozen after the rest of the clutch hatched to a maximum combined total of 10 eggs. Green turtle clutches were treated similarly except that only five fertile eggs were analyzed from each clutch.

At an analytical sensitivity of 0.1 ppm for organochlorine pesticides and 0.5 ppm for polychlorinated biphenyls (PCBs), 107 of 170 loggerhead eggs (63 percent) and all 28 green turtle eggs contained no measurable residues. Among loggerheads, samples from three clutches contained no measurable residues, samples from two clutches had only one egg with residues, and the sample from one clutch had only three eggs with residues. Measurable residues were limited to DDE and PCB. Authors analyzed a second subsample from one fertile egg of each clutch at a sensitivity of 0.005 ppm for organochlorine pesticides and 0.025 ppm for PCBs. Residues discussed hereafter are from these 11 more sensitive analyses unless indicated otherwise.

For each analysis, a 10-g portion of the homogenized egg was mixed with anhydrous sodium sulfate and extracted for 7 hours in a Soxhlet apparatus. Extraction, sample cleanup, and separation of organochlorine pesticides from PCBs were performed as described by Cromartie et al. (5), except that the SilicAr separation was collected in four fractions to facilitate separation of endrin and dieldrin. The fractions were analyzed on a Hewlett-Packard Model 5753 gas-liquid chromotogra equipped with a ^{63}Ni detector, automatic sampler, a computing integrator. Instrument characteristics and erating conditions follow:

Column:	glass, 1.83 meters, packed with a mixture of percent OV-17 and 1.95 percent QF-1	
Temperatures:	column	200°C
	detector	300°C
	injection port	250°C
Carrier gas:	5 percent methane in argon flowing at 60 ml/r ute; purge flow, 40 ml/minute	

Samples were analyzed for *p,p'*-DDE, *p,p'*-TDE, *p,* DDT, dieldrin, endrin, heptachlor epoxide, mirex, o chlordane, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachl hexachlorobenzene (HCB), toxaphene, and PCBs. 1 covered PCB always resembled Aroclor 1260.

Average percentage recoveries from spiked chicl (*Gallus gallus*) egg tissue ranged from 83 percent 104 percent. Residue data were not adjusted on the b of these recoveries. Authors confirmed residues in of the 11 samples analyzed at high sensitivity, usin Finnigan Model 4000 gas-liquid chromatograph–m spectrometer in the selective ion mode.

Geometric means and 95 percent confidence interv are given for residues because the data were positiv skewed, but they were calculated only for those resid (DDE and PCB) that occurred in a majority of sam in a series. Arithmetic means and standard errors also given where comparison with similarly deri means from other studies is required.

Results and Discussion

GENERAL LEVELS OF RESIDUES

Residues of eight organochlorine compounds were covered from eggs of loggerhead turtles, but only D and DDT were found in eggs of the green turtle (Ta 1). Green turtle eggs from Ascension Island contai

TABLE 1. *Organochlorine residues in nine loggerhead two green turtle eggs from Merritt Island National Wil Refuge, Florida—July and August 1976*

Chemical	Number with Residues	Residues, ppm Wet Weigh Geometric Mean	95% CI	Ran
LOGGERHEAD TURTLE EGGS				
DDE	9	0.047	0.024–0.090	0.018–
DDT	2			ND–
Dieldrin	4			ND–
Heptachlor epoxide	2			ND–
Oxychlordane	2			ND–
trans-Nonachlor	1			ND–
Mirex	1			ND–
PCB (Aroclor 1260)	9	0.078	0.047–0.130	0.032–
GREEN TURTLE EGGS				
DDE	1			ND–
DDT	1			ND–

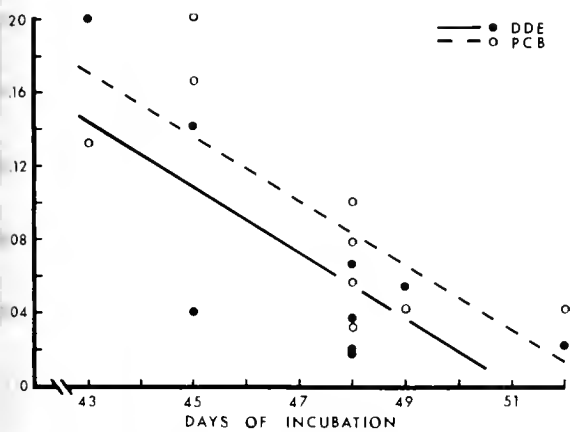
NOTE: CI = confidence interval; ND = not detected.

DDE and PCB residues (*10*). In an unspecified ıber of loggerhead eggs from Georgia and South olina, ΣDDT ranged from 0.058 ppm to 0.305 ppm dieldrin from a trace to 0.056 ppm; embryos ap-ɛntly were not observed (*8*). These latter results n similar to the present results, but precise compari-s are not possible.

ELS OF DDE AND PCB COMPARED TO DAYS OF UBATION

n though the range of incubation periods for logger-d clutches was only nine days (43–52 days of incu-on) the concentrations of DDE and PCB declined ificantly during this time (Fig. 1). Residue data e also plotted as total micrograms per egg and as ı wet weight of the whole egg at laying to avoid the sibility of confusing dilution through the uptake of er by the egg with actual loss of residues; significant ressions similar to Figure 1 were obtained: total μg E, $r = -0.743$, $0.05 > P > 0.02$; total μg PCB, $= -0.850$, $0.01 > P > 0.001$; ppm DDE at laying, $= -0.747$, $0.05 > P > 0.02$; ppm PCB at laying, $= -0.790$, $0.02 > P > 0.01$. Uptake of water during 10-day portion of incubation was probably negligi-because there was no significant increase in egg ghts.

thors believe that DDE and PCB declined because a tion of these compounds present at laying was me-olized by the developing loggerhead embryos to com-ınds not measured by the analytical methods. Such abolism (DDE to DBP, or 4,4′-dichlorobenzophe-ıe) has been demonstrated in developing chicken ɔryos (*1*). If the linear relationships in Figure 1 extrapolated backward, then mean levels at laying be estimated at ca 0.9 ppm. However, because em-os metabolize the stored fat, and hence the DDE l PCB, of the egg more rapidly as they become larger l their needs become greater, the relationships of Fig-



GURE 1. *Relationship of residue concentration to length ncubation period among nine loggerhead turtle eggs, each n a different clutch. For DDE,* r = *−0.753, 0.02* > P *0.01; and for PCB (Aroclor 1260),* r = *−0.772, 0.02* > P *>0.01.*

ure 1 would not be linear over the entire incubation period. That is, the 10-day interval shown in Figure 1 constitutes 15.5 percent of the incubation period; complete incubation averaged 64.5 days (S. Vehrs, 1979, MINWR; personal communication). But the amount of metabolism during the 10 days must have been greater than 15.5 percent. Thus the amount of DDE in eggs at laying must have been less than 0.9 ppm.

To estimate DDE levels in loggerhead eggs at laying, authors used quantifications from infertile eggs because no DDE could have been metabolized. Infertile eggs were analyzed only at the 0.1 ppm sensitivity, so authors selected the three clutches in which DDE was quantified for all eggs in order to assure the most accurate analytical readings. Authors calculated arithmetic means for the infertile eggs in those clutches. The results were 0.252 ± 0.026 ppm ($n = 10$); 0.268 ± 0.057 ppm ($n = 5$); and 0.222 ± 0.040 ppm ($n = 4$). Because these means are an upwardly biased estimate of levels at laying (results are from the three most contaminated clutches), authors believe the actual value was somewhat lower, perhaps ca 0.2 ppm.

DDE LEVELS IN SEA TURTLE EGGS FROM FLORIDA COMPARED WITH DDE LEVELS IN EGGS OF CERTAIN OTHER POPULATIONS

DDE is well known for its adverse effect on the reproduction of several bird species. However, the lowest concentration in eggs known to affect the brown pelican (*Pelecanus occidentalis*), which may be the most sensitive species, is 2.5 ppm (*2*). DDE concentrations in the Florida sea turtle eggs are far below this level (Table 1).

The level of DDE in green turtle eggs in the present study was very similar to that reported for green turtle eggs from Ascension Island (Table 2). However, the eggs from Ascension contained no embryos visible to the naked eye (N. Thompson, 1979, University of Florida, Gainesville, Fla.; personal communication). If eggs in the present study had been analyzed at a similar early stage of development, DDE levels would probably have exceeded those in Ascension Island eggs.

Loggerhead eggs contained substantially more DDE than did green turtle eggs (Table 2). When we consider

TABLE 2. *Residues of DDE in eggs from five reptile and bird populations*

Population	*n*	DDE, ppm Wet Weight: Arithmetic Mean ± SE	DDE, ppm Wet Weight: Range	Ref.
Loggerhead turtle (Florida)	9	0.066 ± 0.021	0.018–0.200	Present study
Green turtle (Florida)	2	0.002 ± 0.002	ND–0.005	Present study
Green turtle (Ascension Island)	10	0.003 ± 0.001	ND–0.009	(*10*)
Crocodile (Florida)	23	1.19 ± 0.15	0.28–3.2	(*7*)
White ibis (Florida)	10	0.29 ± 0.08	ND–0.84	(*9*)

NOTE: SE= standard error; ND = not detected.

the reductions that have probably occurred due to incubation of the Florida eggs, the data in Table 2 suggest that both the contrasting food habits of the two species and the different geographic locations (Ascension Island and Florida) affected DDE levels. The difference in nesting location is related to differences in primary feeding locations. When not nesting, the Ascension Island turtles feed along the Atlantic coast of Brazil (*4*). No one knows where the Florida turtles feed when not nesting, but if organochlorine pollutants in their food species near Florida are high, these pollutants could produce levels in their eggs that exceed levels in eggs from turtles that feed near Brazil.

Eggs of crocodiles (*Crocodylus acutus*) from Everglades National Park contained no visible embryos when prepared for chemical analysis (*7*). DDE concentrations in these eggs (Table 2) were about six times greater than DDE concentrations estimated to have been in loggerhead eggs at laying. The loggerhead eggs had lower DDE residues even though both species are large, carnivorous, marine-estuarine reptiles found in Florida.

Eggs of Florida sea turtles also contained lower residues than did eggs of aquatic birds nesting on MINWR. Eggs of the white ibis (*Eudocimus albus*) contained the lowest DDE residues (Table 2) among 13 species of aquatic birds whose eggs were collected at MINWR (*9*). Most of the white ibis eggs contained small embryos, but the only two with feathered embryos contained 0.12 ppm and 0.18 ppm DDE and three showing no embryonic development contained 0.50, 0.34, and 0.84 ppm DDE (H. Ohlendorf, 1979, PWRC; personal communication). Thus DDE levels in white ibis eggs with large embryos exceeded levels in turtle eggs with large embryos (Table 2), and DDE levels in white ibis eggs showing no embryonic development exceeded levels estimated to have been present in loggerhead eggs at laying.

In summary, the residue concentrations in loggerhead and green turtle eggs from Florida are remarkably low. These low levels probably reflect low dietary intake. The importance of this factor is suggested by the difference in DDE levels in eggs between the two species. Furthermore, the relatively low residue levels in turtle eggs in the present study compared with eggs of crocodiles and aquatic birds probably indicate that when not nesting the turtles live in areas remote from Florida. Such a pattern, with primary feeding sites and nesting sites distant from each other, is common among sea turtles (*3*).

Acknowledgments

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Accumulation of Polychlorinated Biphenyls in American Shad During Their Migration in the Hudson River, Spring 1977

Michael Pastel,[1] Brian Bush,[2] and Jai S. Kim [1]

ABSTRACT

ty-two female American shad (Alosa sapidissima) *were lected during the spring of 1977 at two sites on the lower dson River, 27 miles and 75 miles from the river mouth. e fish were extracted with hexane, and the extracts were lyzed by electron-capture gas chromatography (EC-GC) l by GC/mass spectrometry (MS). PCBs were quantitated EC-GC, and the concentrations were compared by fish gth and by site. Fish collected from the downstream site ntained a mean PCB concentration of 2.0 ± 1.0 μg/g, wet ight; fish from the upstream site contained a mean PCB ncentration of 6.1 ± 2.6 μg/g, wet weight. Aliquots of the ane extracts were fractionated before analysis by /MS. The presence of PCBs was confirmed, and DDE l the alkane series from C_{21} through C_{26} were detected. nerican shad are saltwater fish that only enter fresh water spawn. Because they do not feed in fresh water before wning, they may be used as an indicator of water con-ination.*

Introduction

xic trace contaminants such as polychlorinated bi-enyls (PCBs) permeate the Hudson River (*6*). There : several methods available to monitor this contami-tion, involving the collection of various samples, such water, sediments, plants, turtles, macroinvertebrates, ı, and aquatic mammals. For the present study, mi-ıtory fish were chosen. American shad (*Alosa sapidis-ıa*) are saltwater fish that enter fresh water only to ıwn. They do not eat in fresh water before spawning); therefore any contamination enters their bodies ectly from the water.

is paper presents the results of analyses of fish col-ted during the spring of 1977. Quantitative results for Bs are reported, and other compounds are identified.

Sampling and Analysis

MPLE PREPARATION

ty-two female shad were collected by the New York State Department of Environmental Conservation (DEC) at two sites on the Hudson River and were tagged with an identification number. Twenty were from a site near the Tappan Zee Bridge, and 32 were from a site at Poughkeepsie (27 miles and 75 miles, respectively, from the river mouth), as indicated in Figure 1. Each fish was scaled, beheaded, definned, deboned, gutted, and then homogenized in a Model CFP5 Cuisinart food processor. A 5.0-g subsample from each fish was frozen and lyophilized for 12 hr, and then extracted with 100 ml hexane in a Soxhlet extractor for 2 hr. The extract was quantitatively transferred to a Kuderna-Danish apparatus and concentrated to about 5 ml. The

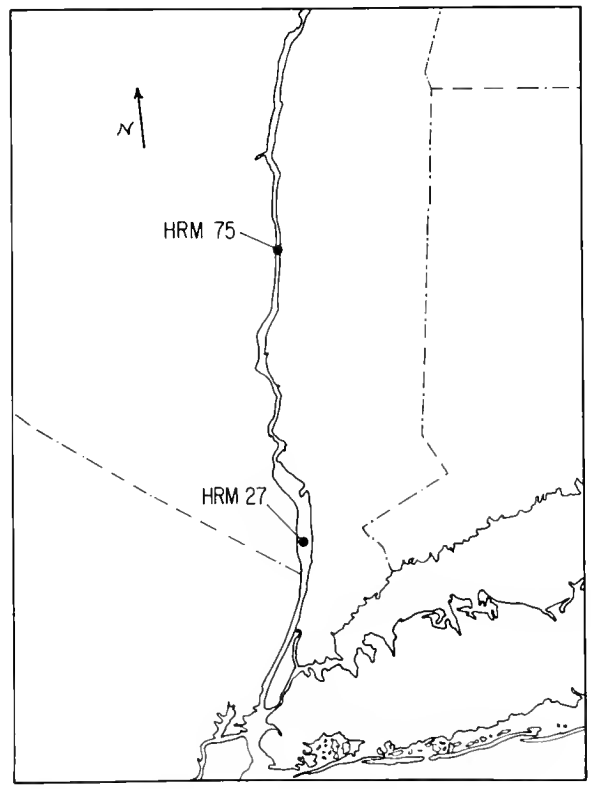


FIGURE 1. *Map of Hudson River sampling sites, for American shad, spring 1977.*

partment of Atmospheric Science, State University of New York at lany, 1400 Washington Ave., Albany, N.Y. 12222.
vision of Laboratories and Research, New York State Department Health, Albany, N.Y. 12201.

concentrate was diluted to 10.0 ml of which 2.0 ml was used for electron-capture gas chromatography (EC–GC) and 8.0 ml was used for GC/mass spectrometry (MS). All of the fish were subjected to EC–GC analysis, and 25 were further analyzed by GC/MS.

CLEANUP

A 2.0-ml aliquot of extract for each fish was passed through a column containing 10.0 g of 2 percent deactivated 60–100-mesh Florisil topped with 2.0 g sodium sulfate. The Florisil was activated by heating at 450°C for 4 hr and was cooled in a desiccator. Fifty-gram aliquots were placed in an Erlenmeyer flask which was mounted on a wrist-action shaker. While the flask was shaken at low speed, 1.0 ml distilled-deionized water was added dropwise. Shaking was continued at high speed for 30 min. The aliquots of 2 percent deactivated Florisil were stored in glass jars which were sealed with Teflon lids. Purity was checked by placing 10.0 g of the combined batches in a glass column and eluting the column with 50 ml hexane. The eluate was collected and concentrated to 1.5 ml in a Kuderna-Danish apparatus, and then analyzed by electron-capture GC as described for the sample analysis.

The extract-charged column was eluted with ca 50 ml hexane, and the first 40 ml of eluate was collected. PCBs are eluted with this volume, but more polar compounds, such as DDT and triglycerides, are retained on the column (*5*). The eluate was concentrated in the same manner as the extract, and diluted to a final volume of 1.5 ml, which was transferred to a 2-ml Wheaton GC vial for analysis.

GC ANALYSIS

GC analysis was performed on a Hewlett-Packard Model 5840A digital gas chromatograph equipped with a ^{63}Ni electron-capture detector and a Model 7617A automatic sampler.

Instrument parameters and operating conditions were as follows:

Column:	glass, 6 ft long by 2 mm ID, packed with 1 percent Apiezon L on 100–120-mesh Supelcoport	
Injection volume:	5.0 µl	
Temperatures, °C:	injection	225
	detector	300
	oven	held 5 min at 160°C, then increased 10°C/minute to 220°C
Carrier gas:	ultra high purity argon–methane (95+5), flowing at 18 ml/minute	
Total run time:	38 minutes	

The microprocessor of the EC–GC was calibrated, using a mixture of 4 µg each of Aroclors 1016, 1221, 1254, and 1260/ml plus 0.2 µg mirex/ml. These four commercial mixtures contain the complete range of PCB homologs and isomers produced by the iron-catalyzed chlorination method (*1*). The inclusion of Aroclors with intermediate chlorine contents, such as 1232, 1242, and 1248, would have resulted in overly complicated patterns. Twenty-six peaks were resolved in the standard mixture (Fig. 2) and assigned to their Aroclors of origin (Table 1) by comparison with individual Aroclor chromatograms. The major PCB isomer component of each peak was determined using the procedure reported previously (*2*) by comparison with the retention time data of Sissons and Welti (*10, 14*) and Jensen and Sundstrom (*7*).

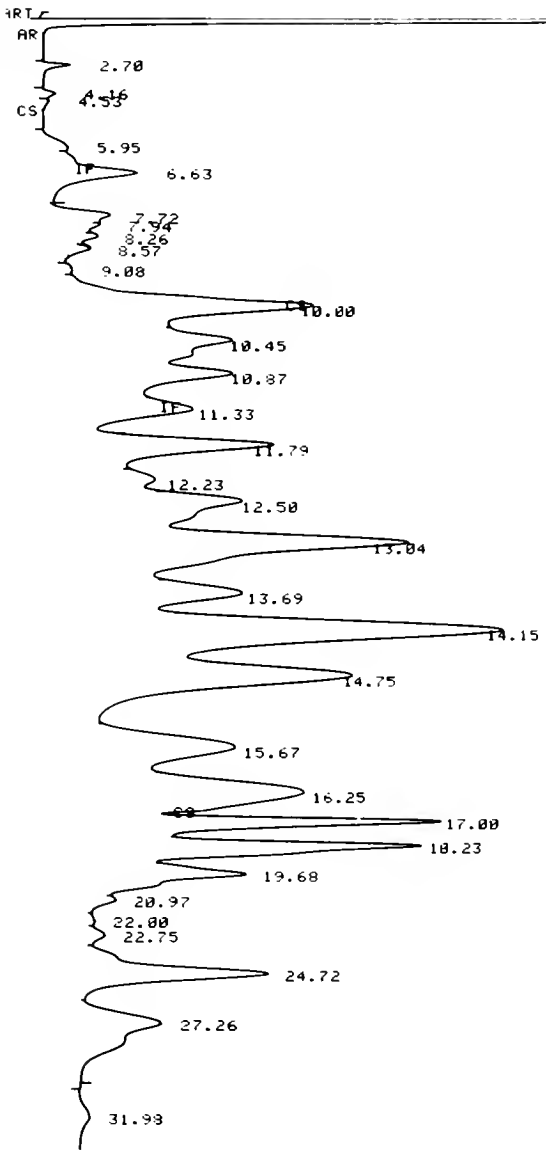
Quantitation was effected on a peak-to-peak basis. Eleven individual homologs, denoted in Table 1, were each analyzed at range of concentrations (0.5–4.0 µg/ml) in order to calculate a response factor. The response factors were normalized as area (integrator counts) per concentration (0.1 µg/ml). The logarithm of the average response factors for each group of isomers (i.e., the same number of chlorine atoms per molecule) was graphed versus the chlorine number (Fig. 3). The resulting curve was nearly linear (correlation factor ρ = 0.95). Analysis by the method of least squares (*9*) yields a straight line which was used to estimate response factors for the remainder of the peaks in the standard mixture. These factors were programmed in the GC microprocessor, and the resulting amounts calculated by the microprocessor were summed and compared to the true value of the standard solution. Standard solutions of each of the four Aroclor mixtures were also analyzed. By use of an iterative approach, the response factors were adjusted, the microprocessor was reprogrammed, and the standard solutions were reanalyzed.

Recovery studies were performed by separately spiking 5.0-g (wet weight) portions of uncontaminated fi

TABLE 1. *Peak assignments for PCB standard, 4 µg/ml each of Aroclors 1016, 1221, 1254, and 1260*

Retention Time, Min.	Cal No.	µg/ml in 16 µg/ml 1221, 1016, 1254, 1260 (1:1:1:1)	Major Component of Peak	Major Contribut Aroclor Mixture
2.73	2	1.47	2*	21
4.21	3	1.55	2,2′*†+4*†	16 + 21
6.64	4	1.46	2,4′*	16 + 21
7.78	5	0.53	2,2′,5′*†	16 + 21
8.30	6	0.48	2,2′,4′	16
8.63	7	0.42	2,2′,3′	16 + 21
10.05	8	1.97	Cl_2	16
10.55	9	0.37	2,5,2′,5′*+2,3,2′,5′*†	16 + 54
10.95	10	0.25	2,3,2′,3′*†	16 + 54
11.41	11	0.17	Cl_4	16 + 54
11.89	13	0.37	2,5,2′,3′,6′	16 + 54 +
12.33	14	0.56	Cl_4	54
12.60	15	0.23	2,5,3′,4′*	16 + 54
13.19	16	0.33	2,5,2′,4′,5′†	54 + 60
13.83	17	0.24	2,5,2′,3′,4′†	54 + 60
14.33	18	1.70	2,3,4,3′,6′+Cl_6	54 + 60
14.96	20	0.93	2,3,6,2′,4′,5′	54 + 60
15.89	21	0.39	2,3,4,2′,3′,6′	54 + 60
16.46	22	1.12	3,4,2′,4′,5′	54
17.35(R)	1	0.52	2,4,5,2′,4′,5′*+ 3,4,2′,3′,4′	54
18.56	23	0.31	2,3,4,2′,4′,5′*	54 + 60
19.25	24	0.59	Cl_2	60
20.05	25	0.27	2,3,4,2′,3′,4′+ 2,3,4,2′,3′,4′,6′	54 + 60
23.45	26	0.20	Mirex	Mirex
25.42	27	0.22	2,4,5,2′,3′,4′,5′	60
27.93	28	0.14	Cl_8	60

NOTE: * = pure compound obtained from Analabs, Inc. (New Haven, Conn.); † = pure compound obtained from RFR Corp. (Hope, R.I.).

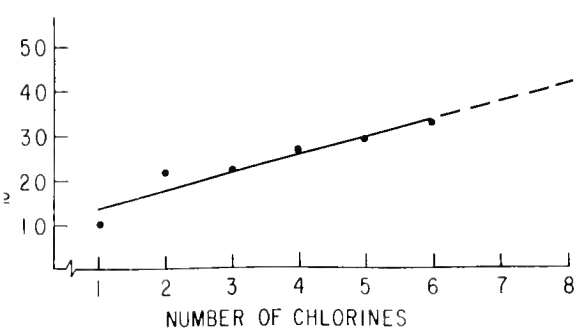


HP RUN # 9 JUN/25/77 TIME 23:25:04
ID: 41577 BOTTLE 9
ESTD

PT	EXP RT	AREA	CAL #	AMT
2.70	2.70	239500	2	1.452
4.16	4.15	108600	3	1.530
6.63	6.62	1098000	4	0.801
7.72	7.71	396500	5	0.542
7.94	7.93	297300	12	0.001
8.26	8.25	324300	6	0.479
8.57	8.57	283700	7	0.419
9.08	9.08	63700	19	0.001
10.00	10.00	2416000	8	1.940
10.45	10.45	1544000	9	0.370
11.33	11.33	704200	11	0.332
11.79	11.79	784200	13	0.407
12.23	12.23	193800	14	0.301
12.50	12.50	1093000	15	0.602
13.04	13.04	2438000	16	0.339
13.69	13.68	1016000	17	0.248
14.15	14.15	3521000	18	1.770
14.75	14.74	2228000	20	0.963
15.67	15.66	1250000	21	0.393
16.25	16.24	2361000	22	1.131
17.00	17.00	5470000	(R) 1	0.525
18.23	18.23	6408000	23	0.315
19.68	19.66	[illegible]	25	0.282
22.75	22.76	[illegible]	26	0.229
24.72	24.72	4133000	27	0.225
27.26	27.26	3228000	28	0.378

DIL FACTOR: 1.0000 E+ 0

FIGURE 2. *EC chromatogram of PCB standard, 4 μg/ml each of Aroclors 1016, 1221, 1254, and 1260.*



GURE 3. *Plot of $\log_{10}$ (response factor) versus number of chlorine atoms on biphenyl.*

homogenate with each of the four Aroclor mixtures, in triplicate. A 100-μl acetone solution of the Aroclor (100 μg/ml) was slowly added as the portion was rehomogenized, thus yielding a concentration in the spiked portion of 2.0 μg/g (wet weight) of the particular Aroclor. Each spiked portion was prepared and analyzed in the same manner as were the samples. The spike recoveries for some major peaks in the four Aroclor mixtures are reported in Table 2. All results are uncorrected for recovery.

Sample concentrations were entered into a PDP 11/45 computer which summed the concentrations and applied the dilution factors, producing a for-

TABLE 2. *Spike recoveries for some major peaks in four Aroclor mixtures*

Aroclor	Peak Component	% Recovery			
		Replicate			
		1	2	3	Average
1221	2	33	33	26	31
	2,2′+4	40	40	43	41
	2,4′	51	49	51	50
1016	2,4′	35	37	35	36
	2,2′,5′	52	52	50	51
	Cl_3	77	80	78	78
	2,5,2′,5′+2,3,2′,5′	95	101	94	97
1254	2,5,2′,5′+2,3,2′,5′	79	79	79	79
	Cl_4	77	87	87	84
	2,5,2′,3′,6′	73	74	74	74
	2,5,3′,4′	96	93	96	95
	2,5,2′,4′,5′	72	71	71	71
	2,3,4,2′,3′,6′	72	72	72	72
	2,4,5,2′,4′,5′+3,4,2′,3′,4′	65	66	66	66
	2,3,4,2′,4′,5′	68	68	65	67
	2,3,4,2′,3′,4′+2,3,4,2′,3′,4′,6′	65	71	77	71
1260	2,5,2′,3′,6′	77	80	80	79
	2,5,2′,4′,5′	70	81	76	76
	2,3,4,2′,3′,6′	70	78	74	74
	2,4,5,2′,4′,5′+3,4,2′,3′,4′	66	77	69	71
	2,3,4,2′,4′,5′	66	73	69	69
	2,3,4,2′,3′,4′+2,3,4,2′.3′,4′,6′	66	74	65	68
	2,4,5,2′,3′,4′,5′	61	67	62	63
	Cl_8	64	71	67	67

matted report (Fig. 4). *p,p′*-DDE was estimated fro the 2,5,2′,3′,4′-pentachlorobiphenyl peak by assumir that its ratio with the 2,5,3′,4′-tetrachlorobiphenyl pea was constant at 1.05:1.00. The following formula w used:

$$\mu g\ p,p'\text{-DDE/g} = \left(A_1 - \frac{A_2}{1.05}\right) \times 0.196 \times 10$$

Where A_1 is the area of the 2,5,2′,3′,4′-pentachlorob phenyl peak; A_2 is the area of the 2,5,3′,4′-tetrachlor biphenyl peak; and the constant represents the respons coefficient of the *p,p′*-DDE peak at a concentration 1.7 μg/ml. Since the relevant PCB concentrations a usually small compared to the *p,p′*-DDE concentratio the approximation was fairly good, with a detection lim of 0.1 μg *p,p′*-DDE/ml. The residual pentachlorob phenyl concentration was included in the sum to obta the total PCB concentration. As a quality control, sol tions designed to mimic the common concentrations PCBs in fish were analyzed frequently to test detect and integrator responses. These quasi-fish contained μg Aroclor 1016/ml, 8 μg 1254/ml, 4 μg 1260/ml, ar 0.33 μg mirex/ml. The detection limit was 0.5 ng tot PCB, which corresponds to 0.2 μg/g (wet wt) in t fish.

SAMPLE: 4:4:4:4 (1016:1221:1254:1260) PCB STND

-PEAK-	-COMPONENT-	-AMOUNT (PPM W/W)-
1	2,4,5,2',4',5' & 3,4,2',3',4'	.525
2	2	1.452
3	2,2' & 4	1.530
4	2,4'	.801
5	2,2',5'	.542
6	2,2',4'	.476
7	2,2',3'	.419
8	CL3	1.940
9	2,5,2',5' & 2,3,2',5'	.370
11	CL4	.332
13	2,5,2',3',6'	.409
14	CL4	.301
15	2,5,3',4'	.602
16	2,5,2',4',5'	.339
17	2,5,2',3',4'	.248
18	2,3,4,3',6' & CL6	1.770
20	2,3,6,2',4',5'	.963
21	2,3,4,2',3',6'	.393
22	3,4,2',4',5'	1.131
23	2,3,4,2',4',5'	.315
25	2,3,4,2',3',4' & 2,3,4,2',3',4',6'	.282
26	MIREX	.229
27	2,4,5,2',3',4',5'	.223
28	CL8	.378
	TOTAL	15.970

FIGURE 4. *Computer output for PCB standard, 4 μg/ml each of Aroclors 1016, 1221, 1254, and 1260.*

S CHROMATOGRAPHY/MASS SPECTROMETRY

e 8.0-ml aliquots of extracts for 13 shad from each e were pooled to form two samples, which were con-ıtrated to 26 ml. For each composite sample, 13 col-ıns containing 10.0 g of 2 percent deactivated Florisil d 2.0 g sodium sulfate were set up. Two ml of the ncentrated composite was applied to each column and ıted with hexane. Forty ml of eluate was collected)m each column, recombined, and concentrated to ml. After the initial cleanup, the final 2 ml was passed ough a column containing 10.0 g activated Florisil d 2.0 g sodium sulfate, and eluted with hexane. Ten ml fractions were collected and each was concentrated 0.1 ml and analyzed separately by GC/MS.

ıalyses were performed on a Finnigan gas chromato-aph/mass spectrometer/Data System Series 9500/ 15D/6000. Instrument parameters and operating con-ions were as follows:

Gas chromatograph:	
injection volume	5 µl
column	glass, 5 ft long by 2 mm id packed with 2 percent Apiezon L on Ultrabond
temperature	190°C
Mass spectrometer:	
ionization energy	70 eV
emission current	400 µamp
pre-amp sensitivity	10^{-6} amp/volt
instrument range	H
Data system:	
mass range	100–500
integration time	10
seconds per scan	4

ıe detection limit was 5 ng 2,4′-dichlorobiphenyl and)0 ng Aroclor 1254.

Results

able 3 lists the quantitative results of EC–GC for CBs. Because the correlation between length and PCB ncentration was investigated, the lengths of the shad e also listed. Those fish with a PCB concentration or a ngth different by more than 2 SD from the mean ere excluded from further computations, and the eans were recalculated. Mean PCB concentrations om the two sites were compared using Student's *t*-test, signing a significance level of 1 percent and without suming equal variability of the two groups (9). The ngths were treated in a similar manner. Both were)und to differ. The mean PCB concentration for shad om the Tappan Zee site (HRM 27) was 2.0 ± 1.0 g/g, wet weight, and for shad from the Poughkeepsie te (HRM 75), the mean PCB concentration was 6.1 ± .6 µg/g, wet weight. The mean length of HRM 27 fish as 48.2 ± 3.0 cm, and of HRM 75, 52.9 ± 4.4 cm. he average length of the upriver fish is about 10 per-ent greater, whereas the average PCB concentration is early three times higher. There is only a weak positive orrelation within each group between length and PCB oncentration. The coefficient for HRM 27 is +0.40, nd for HRM 75, +0.50. Chromatograms of a 16-ppm standard, a 16-ppm quasi-fish, and fish No. 2C–9757 are shown in Figures 2, 5, and 6, and computer outputs for the same samples are shown in Figures 4, 7, and 8. PCB concentrations are recorded by component, as listed in Table 1. Using the algorithm described above, no *p,p′*-DDE was quantitated.

The 25 shad further analyzed by GC/MS were chosen at random and are listed in Table 4. The PCB concen-

TABLE 3. *Length of and total PCB concentration in American shad from the Hudson River, spring 1977*

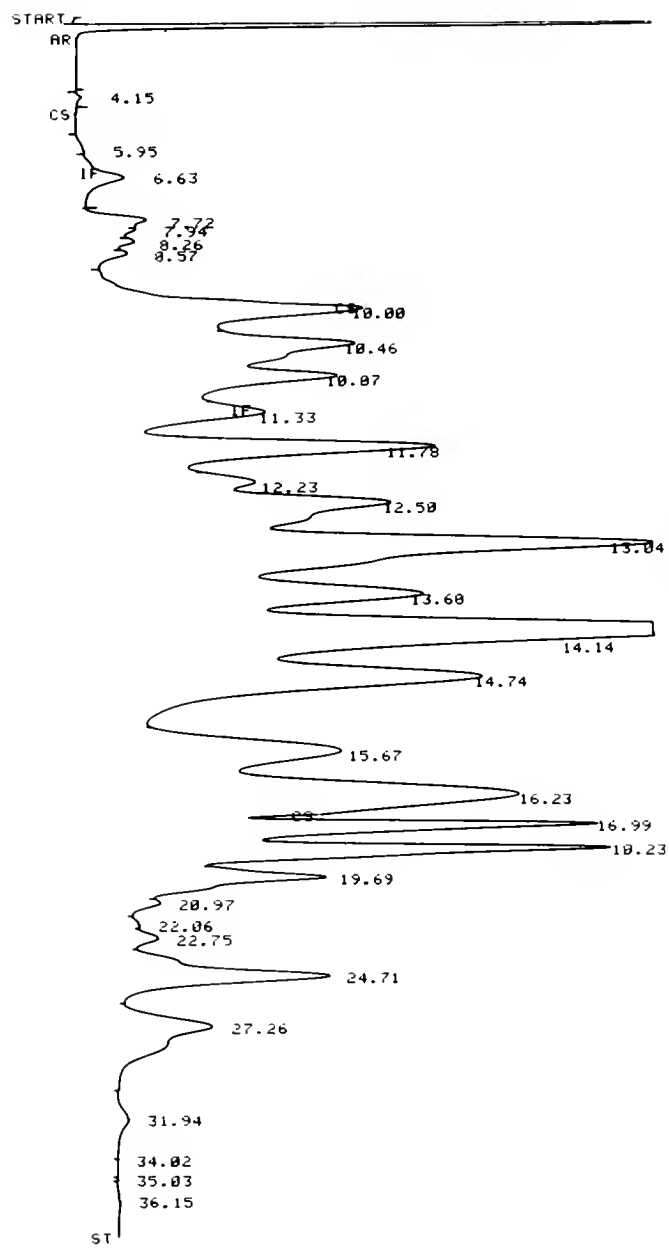
HRM 27 [1]			HRM 75 [2]		
Tag No.	Length, cm	Total PCB Concn., µg/g wet wt	Tag No.	Length, cm	Total PCB Concn., µg/g wet wt
2C–9776	50.8	11.7 [3]	2C–9214	50.0	5.8
2C–9779	48.3	1.1	2C–9215	44.7	5.6
2C–9780	47.0	2.6	2C–9216	49.5	2.7
2C–9781	43.4	2.5	2C–9221	51.6	2.4
2C–9782	54.1	5.5	2C–9222	50.5	2.4
2C–9783	43.2	1.5	2C–9223	51.6	6.9
2C–9784	43.7	2.3	2C–9224	46.7	1.9
2C–9785	45.7	2.0	2C–9225	49.5	6.1
2C–9786	50.8	2.1	2C–9226	47.0	3.3
2C–9787	46.2	1.4	2C–9227	55.6	6.4
2C–9788	45.7	0.9	2C–9228	49.5	2.3
2C–9789	50.8	1.8	2C–9229	49.3	11.2
2C–9790	49.5	1.2	2C–9230	51.1	8.7
2C–9791	50.8	2.0	2C–9231	61.0	6.7
2C–9792	48.8	1.2	2C–9232	50.5	6.3
2C–9793	45.7	1.3	2C–9233	55.4	6.4
2C–9794	47.0	1.6	2C–9234	62.2	12.2
2C–9795	50.8	1.7	2C–9753	58.7	16.1 [3]
2C–9797	48.3	3.1	2C–9754	51.6	4.4
2C–9798	50.8	2.4	2C–9755	53.3	7.7
			2C–9756	54.6	7.3
			2C–9757	55.9	6.3
			2C–9758	54.6	9.0
			2C–9759	40.6 [3]	5.3
			2C–9760	54.6	7.6
			2C–9761	55.9	19.0 [3]
			2C–9762	54.6	4.3
			2C–9763	48.3	4.2
			2C–9764	56.6	9.4
			2C–9765	54.6	4.2
			2C–9766	57.2	8.6
			2C–9767	62.2	6.3
Mean ±SD	47.9 ±3.1	2.0 ±1.0	Mean ±SD	52.9 ±4.4	6.1 ±2.7

[1] Tappan Zee site, 27 miles from the mouth of the Hudson River.
[2] Poughkeepsie site, 75 miles from the mouth of the Hudson River.
[3] Over 2 SD difference.

TABLE 4. *American shad from Hudson River analyzed additionally by GC/MS, spring 1977*

HRM 27 [1]		HRM 75 [2]	
Tag No.	PCB Concn., µg/g	Tag No.	PCB Concn., µg/g
2C–9776	11.7	2C–9216	2.7
2C–9781	2.5	2C–9222	2.4
2C–9782	5.5	2C–9224	1.9
2C–9783	1.5	2C–9225	6.1
2C–9784	2.2 (twice)	2C–9228	2.3
2C–9784	2.3	2C–9229	11.2
2C–9786	2.1	2C–9754	4.4
2C–9787	1.4	2C–9755	7.7
2C–9790	1.2	2C–9756	7.3
2C–9793	1.3	2C–9757	6.3
2C–9795	1.7	2C–9759	5.3
2C–9797	3.1	2C–9761	19.0
2C–9798	2.4	2C–9767	6.3
Mean	3.0	Mean	6.4

[1] Tappan Zee site, 27 miles from the mouth of the Hudson River.
[2] Poughkeepsie site, 75 miles from the mouth of the Hudson River.



HP RUN # 10 JUN/26/77 TIME 00:14:59
ID: 41577 BOTTLE 10
ESTD

PT	EXP RT	AREA	CAL #	AMT
4.15	4.15	37960	3	0.542
6.63	6.62	501700	4	0.356
7.72	7.71	419600	5	0.561
7.94	7.93	309700	12	0.001
8.26	8.25	331500	6	0.491
8.57	8.56	246300	7	0.364
10.00	9.99	2492000	8	2.032
10.46	10.44	2126000	9	0.509
11.33	11.32	850600	11	0.411
11.78	11.78	1253000	13	0.591
12.23	12.22	367800	14	0.437
12.50	12.49	1060000	15	0.953
13.04	13.03	4217000	16	0.571
13.68	13.68	2026000	17	0.479
14.14	14.14	5800000	18	2.800
14.74	14.74	2990000	20	1.248
15.67	15.66	1767000	21	0.551
16.23	16.24	4346000	22	2.062
16.99	17.00	8020000	(R) 1	0.763
18.23	18.21	8704000	23	0.421
19.69	19.66	4372000	25	0.317
22.75	22.73	484900	26	0.386
24.71	24.70	5028000	27	0.263
27.26	27.24	3588000	28	0.156

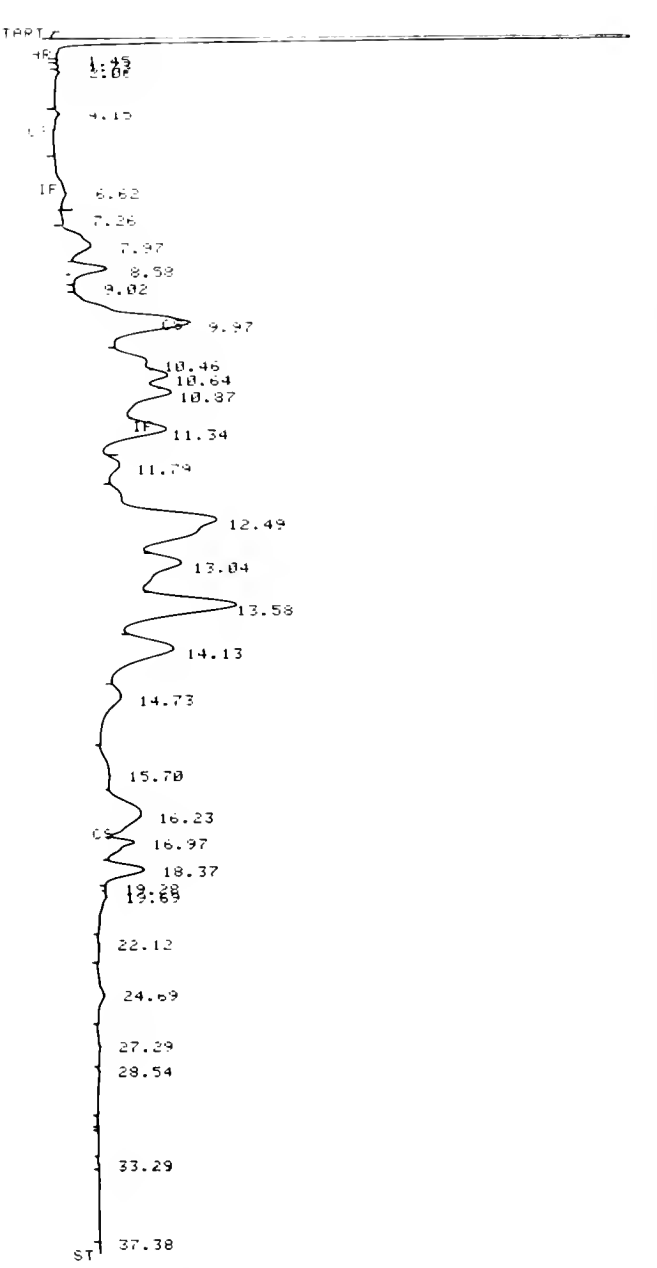
DIL FACTOR: 1.0000 E+ 0

FIGURE 5. *EC chromatograms of PCB quasi-fish: 4 μg/ml each of Aroclors 1016 and 1260; 8 μg/ml Aroclor 1254; and 0.33 μg/ml mirex.*

tration mean did not differ significantly from the respective group means, as determined by the statistical test described above. The compounds identified by MS are listed in Table 5. Nonpolar compounds, which usually interfere with MS determinations of PCBs, elute first from the Florisil column. The alkane series, from C_{22} to C_{26}, were collected in fraction 1. The peaks in the total ion chromatograms (Fig. 9) are quite broad, indicating a mix of isomers for each alkane. PCBs from trichloro- through pentachloro-, were collected in fractions 3–7 (Fig. 10). Consistent with the EC–GC analysis, more PCB components were detected in the fish collected up-river. A notable exception is the polar trichlorobiphenyls detected in fraction 27–7. DDE, which is difficult to quantitate by EC–GC because it tends to overlap a PCB peak, as explained above, was only observed in the fish from HRM 75 (Fig. 11), apparently in a concentration below the EC–GC detection limit.

Discussion

Fractionation of the cleaned extract on activated Florisil aids in the analysis of fish for pesticides and PCBs. The mass spectrometer analyzing chamber does not become



HP RUN # 12 JUN/26 77 TIME 01:45:46
ID: 41577 BOTTLE 12
ESTD

RT	EXP RT	AREA	CHL #	AMT
4.15	4.15	117800	3	1.661
6.62	6.61	61530	4	0.844
7.97	7.92	427700	12	0.001
8.58	8.55	390800	7	0.574
9.02	9.06	51970	19	0.001
9.97	9.98	1487000	8	1.213
10.46	10.43	365300	9	0.088
10.64	10.63	429700	10	0.264
11.34	11.31	454900	11	0.220
11.79	11.76	55010	13	0.026
12.49	12.47	1218000	14	0.624
13.04	13.01	717600	16	0.047
13.58	13.66	1028000	17	0.243
14.13	14.12	651800	18	0.315
14.73	14.72	179000	20	0.075
15.70	15.64	89420	21	0.028
16.23	16.22	486700	22	0.231
16.97	17.00	618900	(R) 1	0.059
18.37	18.19	873200	23	0.042
19.28	19.30	40840	24	0.017
19.69	19.64	164700	25	0.012
24.69	24.67	169600	27	0.009
27.29	27.21	53760	28	0.002

DIL FACTOR: 1.0000 E+ 0

FIGURE 6. *EC chromatogram of American shad No. 2C-9757, Hudson River, spring 1977.*

ntaminated, thus the background noise is reduced. ıe chromatograms are simplified; DDE does not over-) a PCB peak, which facilitates quantitation of both. DDE were present at a higher concentration, as is ; case in fish from Lake Ontario which have concen- tions ranging from 1 ppm to 5 ppm (Brian Bush, 77, personal communication), the DDE would be antitated by the method described above.

ad were analyzed in 1975 by DEC (*11*) during a tewide monitoring program. Fifteen shad were col- ted in the lower Hudson River as far upstream as xsackie/Catskill. The sites were not specifically iden- ed in the report. Several of the fish samples were pooled, so that there were six composites analyzed. Results were reported in terms of the Aroclor 1242/ 1016 and Aroclor 1254 averages, namely 1.35 ppm and 1.14 ppm wet weight, respectively, for an overall aver- age of 2.49 ppm. This is close to the overall average of 5.1 ppm obtained in the present study, although there is not sufficient data for full statistical comparison.

The American shad seems to be a good species of fish with which to monitor water pollution of a river system. The shad ranges throughout the eastern seaboard. It is large enough and of sufficient number to be collected easily and without impairing its population. Direct water analyses are difficult to perform. The only PCB concen-

SAMPLE: 4:8:4 (1016:1254:1260) PCB QUASI-FISH

-PEAK-	-COMPONENT-	-AMOUNT (PPM W/W)-
1	2,4,5,2',4',5' & 3,4,2',3',4'	.763
3	2,2' & 4	.542
4	2,4'	.356
5	2,2',5'	.561
6	2,2',4'	.491
7	2,2',3'	.364
8	CL3	2.032
9	2,5,2',5' & 2,3,2',5'	.509
11	CL4	.411
13	2,5,2',3',6'	.591
14	CL4	.437
15	2,5,3',4'	.953
16	2,5,2',4',5'	.571
17	2,5,2',3',4'	.479
18	2,3,4,3',6' & CL6	2.800
20	2,3,6,2',4',5'	1.248
21	2,3,4,2',3',6'	.551
22	3,4,2',4',5'	2.062
23	2,3,4,2',4',5'	.421
25	2,3,4,2',3',4' & 2,3,4,2',3',4',6'	.317
26	MIREX	.386
27	2,4,5,2',3',4',5'	.263
28	CL8	.156
	TOTAL	16.878

FIGURE 7. *Computer output for PCB quasi-fish, 4 μg/ml each of Aroclors 1016 and 1260, 8 μg/ml Aroclor 1254, and 0.33 μg/ml mirex.*

trations reported in Hudson River waters, from the Troy and Poughkeepsie areas, are in the range of 0.11–1.1 ppb (*6*) which strains the limit of detection. As mentioned in the introduction, shad do not eat in fresh water before spawning. Therefore, any contaminants they contain are due to their ocean feeding or are assimilated directly from the river water. An indication of the water contamination between the river mouth and the point of collection is obtained. This information could not be obtained as conveniently by other means.

There is a chance that the few fish having PCB concentrations significantly higher than the mean levels are repeat spawners (Ronald Sloan, 1979, DEC; private communication). Talbot (*12*) in 1954 estimated that 51 percent of the shad return to spawn again in the Hudson River. This is probably a high estimate, because in 1975 Chittenden (*3*) measured a repeat rate of only 3 percent in the Delaware River. Shad in more southern rivers spawn only once (*13*). The chance of repeat spawners did not prevent the observation of a significant increase in contamination levels in the fish collected up-river, even with only a small sampling.

In addition to the use of these fish for monitoring river contamination, the shad are important in their own right. The Hudson River shad fishery is being redeveloped. The New York State legislature, with the support of the National Oceanic and Atmospheric Administration, administered a study of the fishery (*8*). At that time, the major concerns were over-fishing and low oxygen supply in the river mouth. Those problems have been corrected, and the shad population is increasing. The annual festival held in April to celebrate the shad run has been revitalized. In July 1979, the State Environmental Conservation law was amended to establish a fishery management program for the tidal portion of the Hudson River (i.e., as far north as Troy, New York). The fish should be analyzed periodically as a check on their quality and as an indication of water quality.

SAMPLE: 2C-9757

-PEAK-	-COMPONENT-	-AMOUNT (PPM W/W)-
1	2,4,5,2',4',5' & 3,4,2',3',4'	.089
3	2,2' & 4	.020
4	2,4'	.066
7	2,2',3'	.869
8	CL3	1.819
9	2,5,2',5' & 2,3,2',5'	.132
10	2,3,2',3'	.396
11	CL4	.330
13	2,5,2',3',6'	.039
14	CL4	.936
16	2,5,2',4',5'	.146
17	2,5,2',3',4'	.365
18	2,3,4,3',6' & CL6	.473
20	2,3,6,2',4',5'	.113
21	2,3,4,2',3',6'	.042
22	3,4,2',4',5'	.347
23	2,3,4,2',4',5'	.063
24	CL7	.025
25	2,3,4,2',3',4' & 2,3,4,2',3',4',6'	.018
27	2,4,5,2',3',4',5'	.013
28	CL8	.003
	TOTAL	6.304

FIGURE 8. *Computer output for American shad No. 2C-9757, Hudson River, spring 1977.*

TABLE 5. *Identification of compounds, by fraction, found in composites of American shad from the Hudson River, spring 1977*

HRM 27 Composite [1]			HRM 75 Composite [2]		
Fraction	Scan No.	Compound	Fraction	Scan No.	Compound
7-1	60	Docosane	75-1	12	Pristane
	88	Tricosane		59	Docosane
	129	Tetracosane		85	Tricosane
	194	Pentacosane		125	Tetracosane
	286	Hexacosane		187	Pentacosane
				276	Hexacosane
7-3	47	Trichlorobiphenyl	75-3	50	Tetrachlorobiphenyl
7-4	53	Tetrachlorobiphenyl	75-4	52	Tetrachlorobiphenyl
	65	Tetrachlorobiphenyl		79	Pentachlorobiphenyl
	118	Tetrachlorobiphenyl		101	Pentachlorobiphenyl
7-5	30	Trichlorobiphenyl	75-5	28	Trichlorobiphenyl
	50	Trichlorobiphenyl		37	Trichlorobiphenyl
	56	Tetrachlorobiphenyl		46	Trichlorobiphenyl
	99	Tetrachlorobiphenyl		73	Tetrachlorobiphenyl
	108	Tetrachlorobiphenyl		99	Tetrachlorobiphenyl
	148	Pentachlorobiohenyl		119	DDE
				136	Pentachlorobiphenyl
				219	Pentachlorobiphenyl
7-6	54	Trichlorobiphenyl	75-6	29	Trichlorobiphenyl
	78	Tetrachlorobiphenyl		35	Trichlorobiphenyl
				53	Trichlorobiphenyl
				73	Tetrachlorobiphenyl
				160	Pentachlorobiphenyl
7-7	31	Trichlorobiphenyl	75-7	83	Tetrachlorobiphenyl
	39	Trichlorobiphenyl			
	86	Tetrachlorobiphenyl			

[1] Twelve fish from Tappan Zee site, 27 miles from the Hudson River mouth.

[2] Thirteen fish from Poughkeepsie site, 75 miles from the Hudson River mouth.

Acknowledgments

The authors wish to thank the following persons from the New York State Department of Health, Division of Laboratories and Research: Maria Mahar and Mary Ellen Murphy for technical assistance on this project and Paul Turner for computer assistance.

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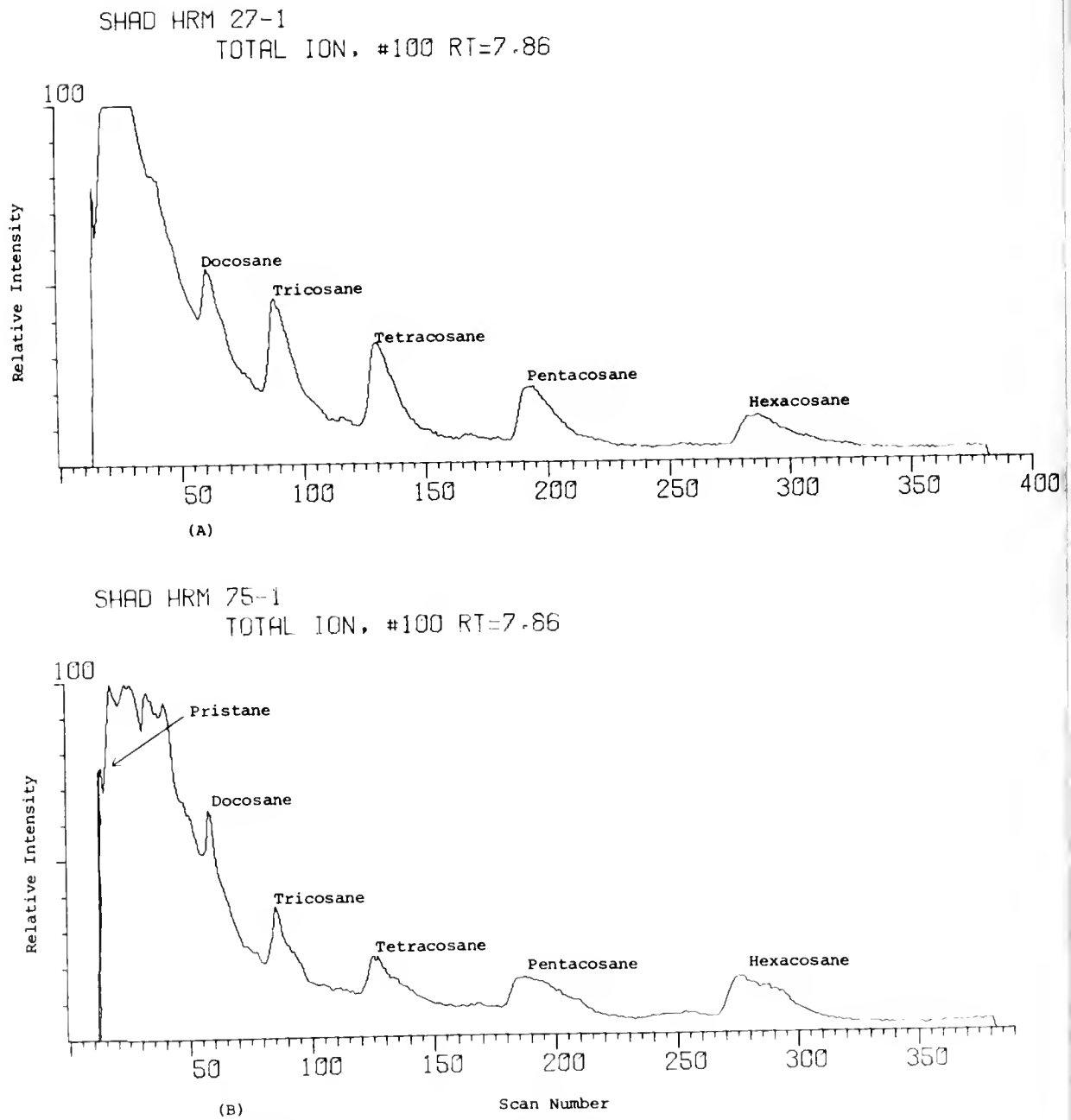
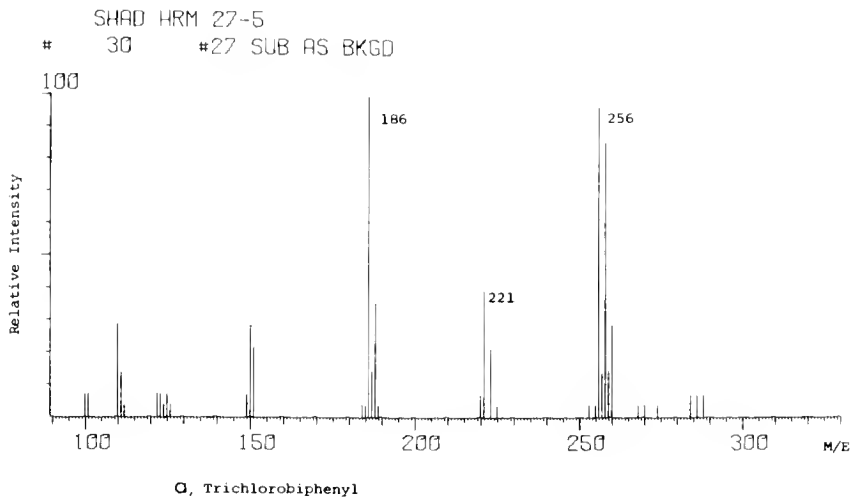
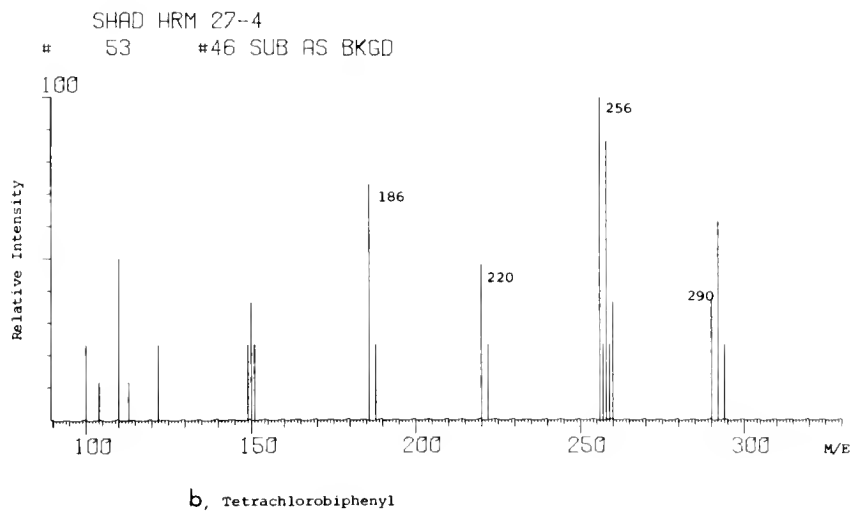


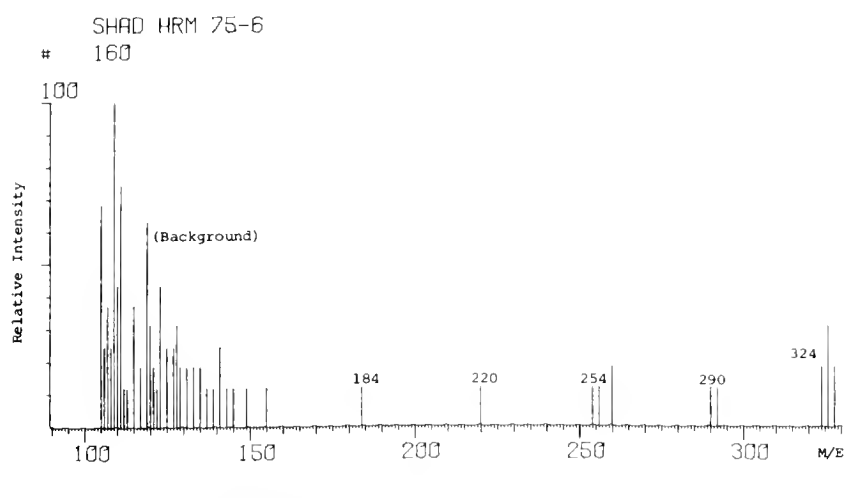
FIGURE 9. *MS total ion chromatograms for (a) Fraction No. 27-1 and (b) Fraction No. 75-1.*



a, Trichlorobiphenyl



b, Tetrachlorobiphenyl



c, Pentachlorobiphenyl

FIGURE 10. *Mass spectra of (a) trichlorobiphenyl, (b) tri- and tetrachlorobiphenyls, and (c) pentachlorobiphenyl.*

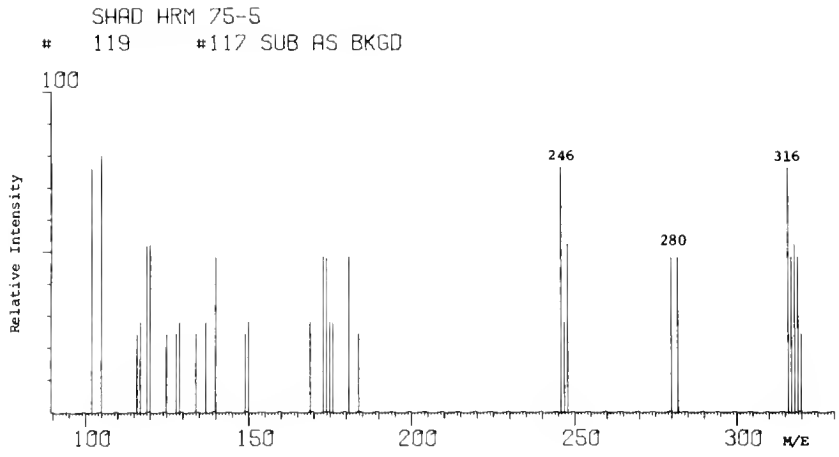


FIGURE 11. *Mass spectrum of DDE.*

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SOILS

Residual Concentrations of Propanil, TCAB, and Other Pesticides in Rice-Growing Soils in the United States, 1972

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ABSTRACT

Ninety-nine soil samples from the rice-growing states of Arkansas, California, Louisiana, Mississippi, and Texas were collected, primarily to monitor the herbicide propanil. No residual concentrations of propanil were detected in any of these samples, but TCAB, a propanil transformation product, was detected in six samples at concentrations ranging from 0.01 ppm to 0.05 ppm. Organochlorine and organphosphorus pesticide determinations were also performed. The compounds dieldrin, aldrin, and DDT and its metabolites were found more frequently; endrin and chlordane were found less frequently. The organophosphorus pesticides diazinon and parathion were detected occasionally.

Introduction

Since 1961, propanil (3',4'-dichloropropionanilide) has been used as a selective, post-emergence herbicide in the major, rice-growing areas of the United States. In the past few years, propanil has been studied because some of its transformation products have chemical structures similar to those of carcinogens (*1, 2, 4, 5, 15*). The formation of azobenzene compounds in soils where aniline-based herbicides have been applied has been documented (*5, 9*). The formation of these compounds from propanil has also been shown to be affected by other pesticides (*10*), by the nutrient status of the soil (*13*), and by physical conditions (*3*). Most of these data have been determined through laboratory studies, but the formation of these azobenzenes has also been documented in limited field studies (*12*). The major objective of the present study was to determine the concentrations of propanil, TCAB (3,3',4,4'-tetrachloroazobenzene, a transformation product of propanil), and other selected organochlorine and organophosphorus pesticides in soil and rice under actual use conditions. All of the soil analyses were completed and only those results are reported here.

Sampling Procedures

Soil samples were collected during late summer 1972 from 99 sites located in Arkansas, California, Louisiana, Mississippi, and Texas. The number of sampling sites within states and counties was proportional to the amount of land used for rice production in those areas. Each site represents approximately 6,073 hectares (15,000 acres). When more than one site was allocated to a county, the county was divided into quadrants, and the required number of sites were randomly selected from among the quandrants. Field personnel were instructed to select fields for sampling where propanil had been applied. Information on the kinds and amounts of pesticides applied to the sampling sites was obtained in a personal interview with the landowner or operator.

Each sampling site was 231 square meters, usually a 15.2 meter by 15.2 meter plot, from which 16 soil cores (5.1 cm in diameter by 7.6 cm deep) were collected on an evenly spaced, 4 x 4 grid. A detailed description of the sampling technique has been reported previously (*9*). The 16 cores were composited, sifted through a 6.3-mm sieve, and shipped to the Toxicant Analysis Center, Bay St. Louis, Mississippi, for analysis.

Analytical Procedures

PROPANIL AND TCAB

From the thoroughly mixed field sample, a 100-g subsample was weighed into a 500-ml Erlenmeyer flask. The sample was extracted by shaking with 200 ml of a 1:1 mixture of acetone:benzene for 2 hr on a reciprocating shaker. The supernatant liquid was decanted into

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a 500-ml separatory funnel and washed three times with 100-ml portions of distilled water to remove the acetone. The benzene extract was dried with anhydrous sodium sulfate and concentrated 10:1 for determination of propanil and TCAB.

Determinations were performed on gas chromatographs equipped with tritium foil electron-affinity detectors. Instrument parameters and operating conditions were as follows:

Gas chromatographs:	Micro Tek 220	
Columns:	Glass, 183 cm long, 6 mm OD by 4 mm ID, packed with one of the following: 3 percent DC-200 on 100–120-mesh Gas-Chrom Q; a mixture of 1.5 percent OV-17 and 1.95 percent OV-210 on 100–120-mesh Supelcoport; or 10 percent DC-200 on 100–120-mesh Gas-Chrom Q	
Temperatures, °C:	detector	200
	injection port	250
	DC-200 columns	195
	mixed column	195
Carrier gases:	5 percent methane in argon flowing at 80 ml/minute	

Propanil and TCAB were identified on the 3 percent DC-200 column with an electron-capture detector. Minimum detectable levels of residues were 0.005 ppm propanil and 0.20 ppb TCAB. Identity was confirmed on the 3 percent mixed column by EC detector; minimum detectable levels were comparable to those on the DC-200 column. Additional confirmation was accomplished with a Dohrmann microcoulometric detector in the halogen mode, on a 10 percent DC-200 column. Minimum detectable levels with the microcoulometric detector were 0.025 ppm propanil and 0.02 ppm TCAB. Recovery averaged 90 percent for propanil and 86 percent for TCAB. All concentrations reported in the tables were corrected for recovery, and were converted to a dry weight basis.

ORGANOCHLORINE AND ORGANOPHOSPHORUS PESTICIDES

The analytical method for determining organochlorine and organophosphorus pesticides has been described previously (*10*). Minimum detectable levels for organochlorines and trifluralin were 0.002–0.03 ppm except for combinations of polychlorinated biphenyls (PCBs), chlordane, toxaphene, and other compounds which had minimum detectable levels of 0.05–0.1 ppm. Minimum detectable levels for organophosphates were 0.01–0.03 ppm. Average recoveries by this procedure were 93 percent for organochlorines and 85 percent for organophosphates. All concentrations reported in the tables were corrected for recovery and were converted to a dry weight basis.

Results and Discussion

Of the 99 sites sampled, 81 sites or 82 percent received applications of propanil ranging from 1.2 kg/ha to 11.2 kg/ha (1.1–10.0 lb/acre) during the sampling year. Ten of the 81 sites had received applications of propanil over a four-year period prior to sampling, seven sites were known to have had no propanil applications, and the pesticide use history was unknown for 11 sites.

The results obtained for propanil and TCAB are presented in Table 1. No residue of propanil was detected in any of the 99 soil samples analyzed, but six of the 99 samples (6.1 percent) contained TCAB. TCAB concentrations ranged from 0.01 ppm to 0.05 ppm. These results indicate that the frequency of occurrence and residue concentrations of TCAB are probably quite low.

The results of analyses of soil samples for organochlorine and organophosphorus pesticides are shown in Table 2. Dieldrin, aldrin, and DDT and its metabolites were found most frequently; endrin and chlordane, less frequently. The organophosphorus pesticides diazinon and parathion were detected occasionally. Polychlorinated biphenyls (PCBs) were detected in one soil sample from Arkansas.

The occurrence of organochlorine residues in the rice-growing region is generally similar to that reported by other residue monitoring studies conducted in the same region (*7, 8*).

TABLE 1. *Concentrations of propanil and ACTB in soils from rice-growing areas of the United States, 1972*

State	No. of Samples	% Positive Samples		Residues, ppm Dry wt			
		Propanil	TCAB	TCAB Arithmetic Mean	TCAB Positive Arithmetic Mean [1]	Detected Values	
						Min.	Max.
Arkansas	24	ND	12.5	0.01	0.01	0.01	
California	19	ND	5.3	0.01	0.01	0.01	
Louisiana	28	ND	7.1	0.01	0.03	0.01	0.05
Mississippi	3	ND	ND	—	—		
Texas	25	ND	ND	—	—		
All states	99	ND	6.1	0.01	0.02	0.01	0.05

NOTE: ND = Not detected.
[1] Positive arithmetic mean = Sum of concentrations of positive samples/number of positive samples.

TABLE 2. *Concentrations of organochlorine and organophosphorus compounds in soils from rice-growing areas of the United States, 1972*

State	No. of Samples	Residues, ppm Dry wt											
		Dieldrin	Aldrin	Endrin	Chlordane	Diazinon	Parathion	PCBs	p,p'-DDT	o,p'-DDT	p,p'-DDE	p,p'-TDE	ΣDDT
Arkansas	24												
Range of detected residues [1]		0.01–0.27	0.01–0.25	ND	ND	ND	0.12	1.13	0.01–0.09	0.02	0.01–0.57	0.01–0.21	0.01–0.57
Arithmetic mean		0.08	0.03	—	—	—	0.01	0.05	0.02	<0.01	0.05	0.03	0.09
% Positive samples		95.8	62.5	—	—	—	4.2	4.2	37.5	4.1	33.3	41.7	54.1
California	19												
Range of detected residues		0.01–0.06	0.01	0.17	ND	ND	0.01	ND	0.01–0.25	ND	0.01–0.15	0.01–0.39	0.01–0.39
Arithmetic mean		0.01	<0.01	<0.01	—	—	<0.01	—	0.02	—	0.05	0.01	0.17
% Positive samples		52.6	5.3	5.3	—	—	10.5	—	52.6	—	89.5	89.5	89.4
Louisiana	28												
Range of detected residues		0.01–0.16	0.01–0.07	ND	0.01–0.27	ND	ND	ND	0.02–0.44	ND	0.02–0.25	0.08–0.94	0.02–0.94
Arithmetic mean		0.04	<0.01	—	0.01	—	—	—	0.02	—	0.01	0.04	0.06
% Positive samples		89.3	25.0	—	7.1	—	—	—	10.7	—	7.1	7.1	7.1
Texas	25												
Range of detected residues		0.01–0.10	0.02–0.12	ND	0.02–0.21	0.01–0.06	ND	ND	0.03–0.06	ND	0.01	0.02	0.01–0.06
Arithmetic mean		0.03	0.02	—	0.06	0.01	—	—	<0.01	—	<0.01	<0.01	<0.01
% Positive samples		92.0	56.0	—	76.0	28.0	—	—	8.0	—	4.0	4.0	12.0
Mississippi	3												
Range of detected residues		0.01–0.09	0.05	ND	ND	ND	ND	ND	0.06–0.07	ND	0.02–0.08	0.02–0.08	0.02–0.08
Arithmetic mean		0.04	0.02	—	—	—	—	—	0.04	—	0.04	0.04	0.13
% Positive samples		100.0	33.3	—	—	—	—	—	66.7	—	100.0	100.0	100.0
All states	99												
Range of detected residues		0.01–0.27	0.01–0.25	0.17	0.01–0.27	0.01–0.06	0.01–0.12	1.13	0.01–0.04	0.02	0.01–0.57	0.01–0.94	0.01–0.94
Arithmetic mean		0.04	0.01	<0.01	0.02	<0.01	<0.01	0.01	0.02	<0.01	0.02	0.05	0.08
% Positive samples		84.8	39.4	1.1	21.2	7.8	3.3	1.1	25.3	1.1	31.3	33.3	38.4

NOTE: ND = none detected.
[1] Range does not include zero values.

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Polychlorinated Biphenyl Contamination of Areas Surrounding Two Transformer Salvage Companies, Colman, South Dakota—September 1977 [1]

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ABSTRACT

Soil, corn plants, and foliage from areas surrounding two electrical salvage companies involved in reconditioning old transformers had unusually high levels of polychlorinated biphenyls (PCBs). Levels decreased as distance from the factories increased. PCBs were dispersed into the air through incineration of waste oils; water and soil contamination was caused by runoff from the factories. PCBs found in the contaminated areas closely resembled Aroclor 1260 as did the PCBs in the waste oil, whereas PCBs in other areas were more similar to Aroclor 1254. PCBs on surface soils taken from an unplowed pasture near the factories also resembled Aroclor 1260, whereas samples taken from depths of 2–4 inches showed degradation of some PCB isomers. PCB concentrations in corn cobs and kernels were < 0.05 ppm, whereas leaves contained PCB levels of up to 2.2 ppm. PCB levels in earthworms and small rodents collected near the factories were considerably higher than levels in the same types of animals collected from other areas.

Introduction

Polychlorinated biphenyls (PCBs) have become significant environmental pollutants which are residual and toxic. Their accumulation in the food chains of many animals produces both acute and chronic effects on reproduction, growth, and behavior (*3, 6, 8*). PCBs have been used extensively in the past as a dielectric base for transformers and capacitors. Although PCBs are no longer manufactured in the United States, the U.S. Environmental Protection Agency (EPA) has estimated that, since their introduction in 1929, 1.25 billion pounds have been used. Of this amount, 60 percent is still in use and 4.4 percent has been destroyed. The rest remains in the environment (*9*). Movement of PCBs through the atmosphere has been demonstrated, and industrial or metropolitan areas are the suspected sources of the PCB contamination (*4, 7*). Ballschmite et al. (*1*) have shown that certain isomers of PCB occurred in the environment in the same ratios as meas ured in commercial PCB mixtures: Aroclors 1254 an 1260. They have presented evidence that the degrada tion of these isomers in the ecosphere, over 20–4 years, has been too small to produce observable changes indicating that these isomers are extremely persistant To further complicate matters, PCBs contain som highly toxic polychlorinated dibenzofurans (*10*). Aro clor 1254 and Aroclor 1260 contain 5.6 ppm and 2. ppm, respectively, of a combination of the tetra-, penta- and hexachlorinated dibenzofurans (*5*).

When the environment has been found to be contami nated with PCBs, several important questions must b considered. If possible, the source of the contaminatio should be located; the method of dispersion into th environment by air, water, soil, etc., needs to be ex amined; and the extent of the area of pollution must b determined. Whether the contamination is of recen and/or past origin, the potential harm to the enviror ment due to accumulation in the food chain of animal should be studied. This paper discusses an incident i which PCBs entered the environment through activitie of two transformer salvage companies, and it presen methods and supporting data for answering the abov questions.

Methods and Materials

During September 1977, two samples each of soil an corn leaves collected near two electrical salvage con panies near Colman, South Dakota, were found to hav unusually high levels of PCBs. Samples were collecte in chemically cleaned glass jars or hexane-washed al minum foil and were frozen until being analyzed. Th samples were extracted and subjected to Florisil colum cleanup according to the method of Greichus et al. (*2* Instrument parameters and operating conditions for g chromatographic analysis were as follows:

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[1] This paper is published with the approval of the Director of the South Dakota Agricultural Experiment Station as Journal Series Publication No. 1645.

[2] Present address: Biochemical Services Division, Rocky Mountain Geochemical Corp., Suite 343, 1400 53rd Street, Emeryville, Calif. 94608.

[3] Station Biochemistry Section, Chemistry Department, South Dakota State University, Brookings, S.D. 57007.

Gas chromatograph:	Varian Aerograph Model 2100
Detectors:	^{63}Ni and Sc-^{3}H electron-capture
Recorders:	Beckman 10-inch, 1 mv
Columns:	6-ft by $\frac{1}{8}$-inch borosilicate glass, packed with 15 percent QF-1 silicone (Fluoro) or a 1:1 mixture of 15 percent QF-1 and 10 percent DC-200 silicone, both on 60–100-mesh Chromosorb W (HP), acid-washed and dimethylchlorosilane-treated
Carrier gas:	nitrogen flowing at 40 ml/minute
Temperatures:	column 210°C injector 220°C detector 290°C ^{63}Ni, or 250°C Sc-^{3}H

lean recovery of PCBs from fortified samples were 90 ercent ± 5 percent standard deviation for all types of mples analyzed. Residue values were corrected for ercent recovery. The earlier findings of PCBs in soil id corn leaves prompted the collection of soil, corn aves, and foliage samples up to 0.25 mile north, 2.5 iles west, and 10 miles south of the factories. Winds i that area are predominantly northwesterly in the fall and winter and southerly in the summer. The town of Colman lies to the east of the factories, and this area was not sampled.

Results and Discussion

Levels of PCBs as Aroclor 1260 on a ppm dry weight basis for the samples collected are shown in Figure 1. Highest PCB levels were found in the samples collected nearest to the factories; PCB levels became progressively lower as distance from the factories increased. An exception was soil samples taken from a drainage ditch to the west of the factory lot where levels reached 46 ppm in a low lying area.

Numerous soil, corn leaf, and foliage samples taken over a number of years from relatively noncontaminated areas of South Dakota have revealed a background level

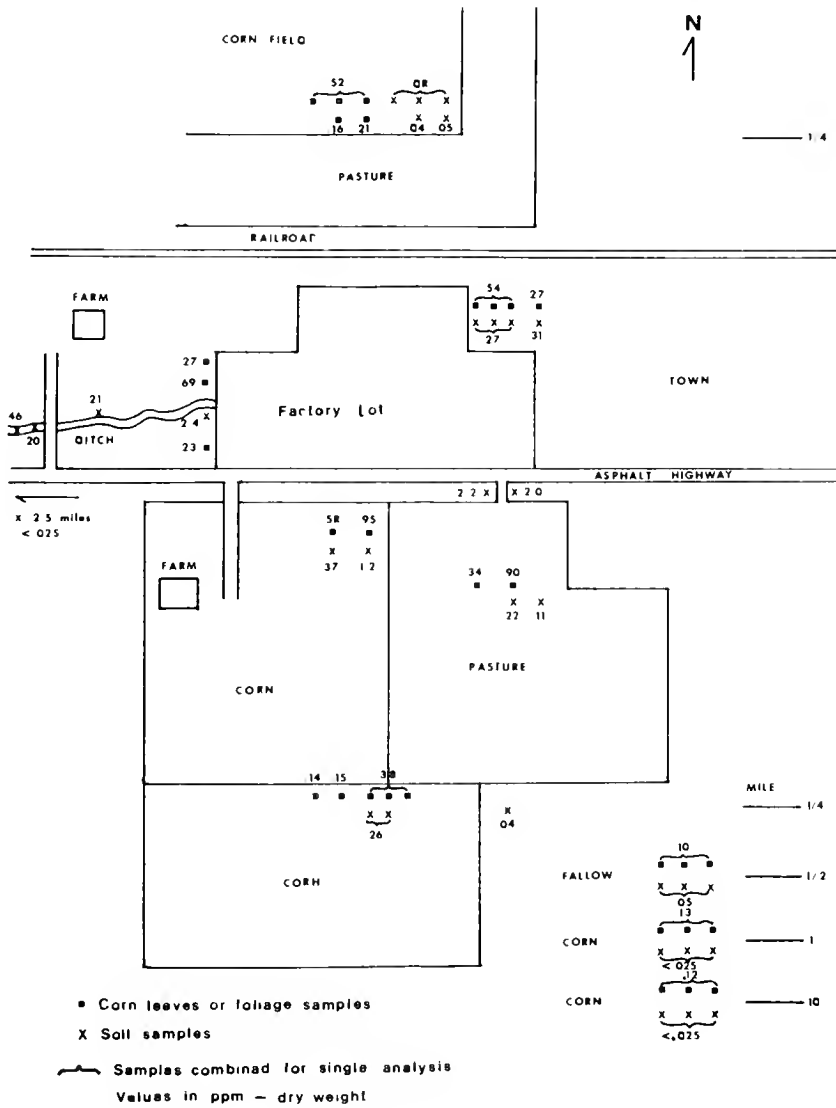

FIGURE 1. *Area surrounding Colman, South Dakota: factory lot consists of two companies adjacent to each other. ppm PCBs as Aroclor 1260.*

of < 0.1 ppm PCBs as Aroclor 1254. Therefore, the PCB levels were above expected concentrations at distances from the factories at least 0.25 mile north, less than 2.5 miles west (soil), and up to 10 miles south (corn leaves) (Fig. 1). One mile south of the factories, the soil contained < 0.025 ppm PCBs, the expected background level, although at 10 miles south of the factories, corn leaves contained 0.12 ppm PCBs, whereas the PCB levels in soil were still < 0.025 ppm, indicating airborne contamination of the leaves. This conclusion was further supported by the analysis of two entire corn plants and the soil on their roots taken 50 yards south of the factory lot (Table 1). The outer leaves contained 1.1 ppm and 2.2 ppm PCBs, the inner leaves contained 0.25 ppm and 0.34 ppm, and the kernels and cobs contained < 0.05 ppm. The 0.29 ppm an 0.53 ppm PCB levels in the roots were somewhat highe than levels in the soil on the roots, but the low levels i the stocks, cobs, and kernels did not indicate significar transport of the PCBs from the roots to the outer leave PCBs in the soil could be due to water drainage fror one of the factories as well as from air and dust-born material, since there was drainage from one factory int this area.

PCBs in surface soils and in corn leaves closely resem bled commercial Aroclor 1260 as shown by gas chro matograms in Figure 2. The type of PCB found in wast oils (42 ppm) from one factory also resembled Arocl 1260 (personal communication, U.S. EPA, Denve Colo.), whereas PCBs in soils and bottom sedimen

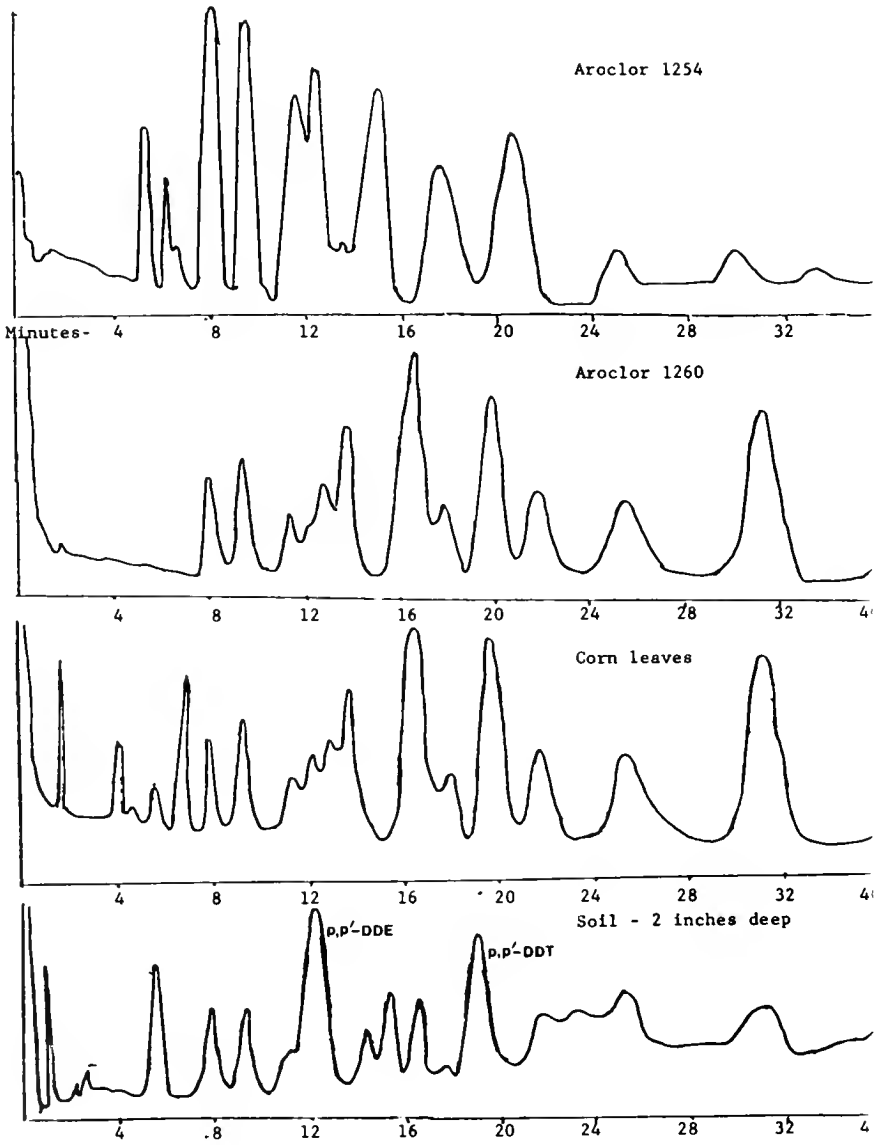

FIGURE 2. *Chromatograms of samples compared to standards of Aroclor 1254 and 1260. See text for instrument parameters and operating conditions.*

ABLE 1. *PCB levels (as Aroclor 1260) in corn plants and soil on roots, 50 yards south of the factory lot, Colman, South Dakota—September 1977*

Sample Type	PCBs, ppm Dry Wt Sample No. 1	Sample No. 2
il on roots	0.22	0.24
ots	0.29	0.53
ck		
Bottom	0.12	<0.1
Middle	0.14	<0.1
Top	0.23	<0.1
b	<0.05	<0.05
rnels	<0.05	<0.05
ner leaves on ear	0.25	0.34
aves on plant	1.1	2.2

OTE: Samples 1 and 2 each consists of one entire corn plant approxitely 10 feet apart.

om other areas in South Dakota did not. Soil taken at -4-inch depths from a pasture across the road from ie factory, which had not been plowed since 1960, eraged 0.16 ppm PCBs. In the past, both factories id disposed of surplus transformer oil by incineration, id one factory used waste oil to heat the office building id the shop area (personal communication, U.S. EPA, enver, Colo.). About four years ago, special furnaces ere equipped with afterburners to destroy the PCBs. owever, the presence of high levels of PCBs on the rn leaves suggests afterburners may not be efficient.

mples taken from around one factory and analyzed the U.S. EPA Laboratory in Denver, Colorado. conined PCBs resembling Aroclor 1260 in the following nounts: water collected from the area behind one shop ilding, 19 ppb; dirt from in front of an incinerator, ppm; and swabs from three windows on a building xt to the incinerator, 14 μg/area. There was no conmination of the Colman drinking water. Soil and vegation taken one mile north of the factories contained 011 ppm PCBs. Sediment and vegetation collected out 20 ft west of a fence around one factory contained 17 ppm and 0.39 ppm PCBs, respectively. Soil and rn foliage taken 1 mile west of the factories, from the rth side of the highway, contained < 0.02 ppm PCBs. o PCBs were detected on corn, cornstalks, and leaves ken about 1 mile east of the factories (personal comunication, Food and Drug Administration, Denver, olo.).

arthworms and small rodents were collected from the rth and south of the factories and from areas near ookings, South Dakota, believed to be relatively free PCBs. Earthworms near the factories and near Brookgs contained average PCB levels of 1.96 ppm and 0.77 m, respectively, with a ratio of levels in the factory ea to levels in the Brookings area of 2.5 (Table 2). CB levels in rodents near the factories ranged from 85 to 17.2 ppm in liver tissues and from 3.42 to 6.87

TABLE 2. *PCB levels in earthworms and rodents collected near Colman factories and in the Brookings, South Dakota, vicinity, September 1977*

Description	PCBs, ppm Factory Area	Brookings Area	Ratio of Factory/ Brookings
Earthworms[1]	1.85	0.84	2.5
(*Oligochaeta terrestrial*)	2.07	0.67	
		0.54	
Vole (*Microtus* sp.)			
Liver	9.17	4.67	1.5
	4.85		
Muscle	5.68	2.60	1.7
	3.42		
Field mouse (*Peromuscus* sp.)			
Liver	9.52	2.95	4.7
	9.10	2.20	
	17.2		
Muscle	3.77	1.80	3.1
	6.87	1.72	
	5.91		
13-Lined ground squirrel (*Spermophilus* sp.)			
Liver	8.71	0.41	8.4
		1.28	
		1.44	
Muscle	2.89	0.72	3.2
		1.11	
		0.86	

[1] Each sample consisted of 2.6 g dry weight of worms.

ppm in muscle tissues. PCB levels in rodents collected near Brookings ranged from 2.20 to 4.67 ppm in liver tissues and from 1.72 to 2.60 ppm in muscle tissues.

Conclusions

The sources of the PCBs in the Colman area were related to operations involved in electrical salvage as evidenced by the predominance of Aroclor 1260 in the factory oil and in surrounding areas and by the fact that the highest levels were near the factories and became increasingly lower as the distance from the factories increased.

PCBs were dispersed by wind, water, and silt runoff in the immediate area. More distant PCB contamination was primarily airborne because PCB levels in outer corn leaves were unexpectedly high whereas soil levels were very low. Airborne contamination extended at least 0.25 mile north and 10 miles south of the factories.

The contamination was of both past and of recent origins. Levels of PCBs (Aroclor 1260) on outer corn leaves proved recent origin, and PCB levels in soil samples taken 2–4 inches deep from a pasture which had not been plowed since 1960 suggested past contamination.

Bioaccumulation is occurring because PCB levels in earthworms and small rodents collected near the factories were considerably higher than levels in the same types of animals collected from other areas.

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APPENDIX

Chemical Names of Compounds Discussed in This Issue

EPHATE	*O,S*-Dimethyl acetylphosphoramidothioate
DRIN	Hexachlorohexahydro-*endo,exo*-dimethanonaphthalene 95% and related compounds 5%
OCLOR 1016 or 1242	PCB, approximately 42% chlorine
OCLOR 1221	PCB, approximately 21% chlorine
OCLOR 1232	PCB, approximately 32% chlorine
OCLOR 1248	PCB, approximately 48% chlorine
OCLOR 1254	PCB, approximately 54% chlorine
OCLOR 1260	PCB, approximately 60% chlorine
C (Benzene Hexachloride)	1,2,3,4,5,6-Hexachlorocyclohexane (mixture of isomers)
LORDANE	1,2,3,4,5,6,7,8,8-Octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene. The technical product is a mixture of several compounds including heptachlor, chlordene, and two isomeric forms of chlordane.
P	Dibutyl phthalate
DE	Dichlorodiphenyldichloroethylene (degradation product of DDT); *p,p'*-DDE: 1,1-Dichloro-2,2-bis(*p*-chlorophenyl) ethylene; *o,p'*-DDE: 1,1-Dichloro-2-(*o*-chlorophenyl)-2-(*p*-chlorophenyl) ethylene
DT	Main component (*p,p'*-DDT): ά-Bis(*p*-chlorophenyl) β,β,β-trichloroethane. Other isomers are possible and some are present in the commercial product. *o,p'*-DDT: [1,1,1-Trichloro-2-(*o*-chlorophenyl)2-(*p*-chlorophenyl) ethane]
AZINON	*O,O*-Diethyl *O*-(2-isopropyl-6-methyl-4-pyrimidinyl) phosphorothioate
ELDRIN	Not less than 85% of 1,2,3,4,10,10-hexachloro-6,7,-epoxy-1,4,4a,5,6,7:8,8a-octahydro-1,4-*endo-exo*-5,8-dimethano-naphthalene
DRIN	Hexachloroepoxyoctahydro-*endo,endo*-dimethanonaphthalene
B	Hexachlorobenzene
PTACHLOR	1,4,5,6,7,8,8-Heptachloro-3a,4,7,7a-tetrahydro-4,7-*endo*-methanoindene
PTACHLOR EPOXIDE	1,4,5,6,7,8,8-Heptachloro-2,3-epoxy-3a,4,7,7a-tetrahydro-4,7-methanoindan
THAMIDOPHOS	*O,S*-Dimethyl phosphoramidothioate
REX	Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta[cd]pentalene
NACHLOR	1,2,3,4,5,6,7,8,8-Nonachlor-3a,4,7,7a-tetrahydro-4,7-methanoindan
YCHLORDANE	2,3,4,5,6,6a,7,7-Octachloro-1a,1b,5,5a,6,6a-hexahydro-2,5-methano-2*H*-indeno(1,2-β)oxirene
RATHION	*O,O*-Diethyl *O*-*p*-nitrophenyl phosphorothioate
Bs (Polychlorinated Biphenyls)	Mixtures of chlorinated biphenyl compounds having various percentages of chlorine
OPANIL	3',4'-Dichloropropionanilide
AB	3,3',4,4'-Tetrachloroazobenzene
E	2,2-Bis(*p*-chlorophenyl)-1,1-dichloroethane (including isomers and dehydrochlorination products)
XAPHENE	Chlorinated camphene (67-69% chlorine). Product is a mixture of polychlor bicyclic terpenes with chlorinated camphenes predominating.
IFLURALIN	α,α,α-Trifluoro-2,6-dinitro-*N,N*-dipropyl *p*-toluidine

ERRATA

PESTICIDES MONITORING JOURNAL, Volume 13, Number 4

Page 138: In the paper "Dieldrin and Heptachlor Residues in Dead Gray Bats, Franklin County, Missouri—1976 versus 1977," by D. R. Clark, Jr., R. K. LaVal, and A. J. Krynitsky, the fourth compound listed in Table 1 should be *cis*-Chlordane.

Page 148: In the paper "Organochlorine Pesticide, PCB, and PBB Residues and Necropsy Data for Bald Eagles from 29 States—1975–77," by T. E. Kaiser, W. L. Reichel, L. N. Locke, E. Cromartie, A. J. Krynitsky, T. G. Lamont, B. M. Mulhern, R. M. Prouty, C. J. Stafford, and D. M. Swineford, the second year listed in Table 4 should be 1975; the second line in the right column should read 1975–77, 20 percent (Table 5).

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CONTENTS

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FISH, WILDLIFE, AND ESTUARIES

Organochlorine Pollutants in Small Cetaceans from the Pacific and South Atlantic Oceans, November 1968–June 1976[1]

Thomas J. O'Shea,[2] Robert L. Brownell, Jr.,[3] Donald R. Clark, Jr.,[2] William A. Walker,[4] Martha L. Gay,[5] and Thair G. Lamont[2]

ABSTRACT

ganochlorine residues were analyzed in blubber, brain, or scle tissues of 69 individuals representing 10 species of all cetaceans. Collections were made from November 68 through June 1976 at localities in the Eastern Tropical ific and along the coasts of California, Hawaii, Japan, l Uruguay. Relations of residue concentrations between ues are described for DDE and PCBs in two dolphin cies. ΣDDT and PCB residues in blubber of most of the individuals of the five southern California species sam- d exceed concentrations that are associated with repro- tive impairment in pinnipeds, although the nature of h associations is not well defined. The ΣDDT residue of 95 ppm in blubber of one California coastal Tursiops ncatus *is one of the highest concentrations reported in ues of members of any population of wild mammals. Ex- t for one rough-toothed dolphin* (Steno bredanensis) *m Maui, Hawaii, all individuals from all localities sur- ed were contaminated with organochlorine compounds. enteen different organochlorines were detected; greatest ersity occurred near Japan and California. This is the t report of several of these compounds in tissues of any cies of marine mammals. The* o,p'*-isomers and metabo- s of DDT were detected unusually frequently. Ratios of '-DDT to* p,p'*-DDE in blubber of cetaceans from waters countries where use of this pesticide has been relatively ent and ongoing were at least an order of magnitude her than in cetaceans from United States waters.*

Introduction

e status of marine mammal populations is a subject much recent interest and concern. Legislation, particularly the U.S. Marine Mammal Protection Act of 1972, and international agreements have been formulated with the intention of safeguarding these populations. It is of continuing importance, therefore, to monitor organochlorine pollutants in tissues of these species, many of which occupy high trophic levels in marine food webs.

Elevated concentrations of pesticides and polychlorinated biphenyls (PCBs) are known to occur in blubber of cetaceans (*1, 15, 23*) and pinnipeds (*14, 18*) in geographical areas subject to contamination with these compounds. The present study represents a survey of organochlorine residues in tissues of 69 individuals of 10 species of small cetaceans collected at one South Atlantic and several Pacific localities from November 1968 through June 1976. These localities have had contrasting histories of exposure to organochlorines, and with the exception of two individual specimens from California (*23*), small cetaceans from these areas have not been previously surveyed for residue concentrations. Lack of such information is due partly to the scarcity and difficulty in obtaining adequate specimens suitable for analysis.

Sampling and Analyses

Tissues were obtained from beach-stranded animals or from free-ranging individuals captured by fishermen. All samples from Hawaii, southern California, and Tokyo Bay were taken from beach-stranded animals, except for two pilot whales (*Globicephala macrorhynchus*) which were caught at sea off Los Angeles County, California. Specimens from the remaining localities were taken at sea. Tissues sampled were blubber, brain, and muscle (*longissimus dorsi*). All dissections were performed by either of the same two investigators, and tissue samples were always taken from the same topo-

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graphic locations on each specimen. All specimens were preserved in 10 percent formalin. However, due to logistical problems inherent in obtaining tissues from marine mammals, the initial methods of preservation varied with the field situation. Specimens from Uruguay and Japan, except finless porpoises (*Neophocaena phocaenoides*), were immediately preserved in formalin. All California specimens, except two coastal bottlenose dolphins (*Tursiops truncatus*) held frozen for 12 and 18 days and five common dolphins (*Delphinus delphis*) frozen for 1–8 months, were also preserved in formalin on dissection. Other specimens were frozen for various lengths of time before transfer to formalin. Hawaiian dolphins were frozen for 1 month, specimens from the Eastern Tropical Pacific for 2–36 months, and Japanese finless porpoises for 4–57 months. All tissues preserved in formalin were stored in glass jars rinsed with acetone and hexane. Lids were lined with Teflon or aluminum foil. Twenty-five samples of the original preservative stored in similar jars were extracted with hexane and analyzed for organochlorine compounds by gas-liquid chromatography; none was detected.

Collection took place in the western South Atlantic off Uruguay during November–December 1974 and in the Eastern Tropical Pacific between April 1973 and February 1976; all California animals were sampled between May 1974 and June 1976. The Hawaiian strandings occurred in June 1976. Samples from Japan were taken between November 1968 and February 1975. External measurements and notes on stomach contents, parasites, relative age, and reproductive condition were obtained for some of the specimens but are not reported here. These data, as well as precise locations of California stranding sites and specific dates, are available from the authors.

Tissues were removed from formalin and patted dry before being weighed. Residues are expressed as wet weight of preserved tissue. A 10-g portion of homogenized tissue was mixed with anhydrous sodium sulfate and extracted for 7 hours with hexane in a Soxhlet apparatus. An aliquot of the hexane extract, equivalent to a 5-g subsample, 2-g equivalent subsample for blubber, was cleaned on a Florisil column. A portion of the eluate was separated into three fractions on a SilicAR column (*5*). The pesticides in each fraction were identified and quantitated with a gas-liquid chromatograph equipped with an electron-capture detector and a column packed with a mixture of 1.5 percent OV–17 and 1.95 percent QF–1. An OV–275 column was used to confirm and/or quantitate *o,p'*-TDE, *o,p'*-DDT, and *o,p'*-DDE. In some samples where both *o,p'*-DDE and *p,p'*DDE overlapped into fraction III, *cis*-chlordane could not be quantitated. PCBs were estimated by comparing total area of PCB peaks with that of Aroclor 1254 or 1260, depending on which pro the sample more closely resembled. The average coveries from spiked tissues ranged from 80 percent 104 percent. Residues were not corrected on the b of these data.

The lower limit of sensitivity was 0.1 ppm for orga chlorines and 0.5 ppm for PCBs. Residues in ab 10 percent of the samples were confirmed on a chromatograph/mass spectrometer. Residue data reported by locality, species, sex, tissue, and total b length (an indication of relative age) for each anim In this way the reader may compute statistics as sired from the original data. Geometric means and percent confidence limits are provided for sample si of five or greater. Not-detected values were conside zero in computations; geometric means were theref calculated on data transformed as $\ln(x + 1)$, with subtracted from the retransformed means.

Results

RESIDUES DETECTED

The principal organochlorine residues detected w PCBs and isomers and metabolites of DDT. Resid of *p,p'*-DDT or its metabolites were detected in all 1 1 of the 69 individuals sampled. In addition, *o,* isomers of these compounds, seldom reported in tis samples of warm-blooded animals from high trop levels, were also found with unusual frequency (Ta 1). One or more of the *o,p'*-isomers were detected representatives of each species from each locali except one striped dolphin (*Stenella coeruleoalba*) tak at 7° 0′N, 86° 30′W. Residues of *o,p'*-DDE rang up to 70 ppm in blubber of common dolphins stranc on southern California beaches. PCBs were also tected in each species at every locality, except for t striped dolphin noted above.

Residues of other organochlorines were present at va ing frequencies and concentrations (Table 2). Dield occurred in the blubber of all species except the Frase dolphin (*Lagenodelphis hosei*), but not in each spec at every locality. Maximum concentrations (up to ppm) were reached in the blubber of finless porpoi from coastal Japan. Hexachlorobenzene (HCB), hep chlor epoxide, and components and metabolites chlordane also occurred in many samples, but usua at levels below 1.0 ppm (Table 2). Toxaphene w detected in blubber of four species of cetaceans fr waters off Japan and in striped dolphins collected 9° 41′N, 98° 7′W. Endrin, mirex, and *cis*-nonach residues (not tabulated) were detected infrequent Endrin occurred at 0.22 ppm in blubber of a m striped dolphin taken at sea at 9° 41′N, 98° 7′W a at 0.24 ppm in blubber of a male common dolph stranded in Tokyo Bay. Mirex was found at 0.18 p

TABLE 1. *Residues of the principal organochlorine compounds (isomers and metabolites of DDT and PCBs) found in blubber, brain, and muscle tissues of small cetaceans from the Pacific and South Atlantic Oceans, November 1968–June 1976*

ALITY AND SPECIES	SEX	TISSUE (N)	TL	*p,p'*-DDE	*p,p'*-TDE	*p,p'*-DDT	*o,p'*-DDE	*o,p'*-TDE	*o,p'*-DDT	PCBs
			URUGUAY							
22'S, 53°46'W										
Franciscana dolphin	F	Blubber (3)	116	2.4	2.4	3.0	ND	7.4	0.56	3.6
			133	2.2	1.2	5.6	ND	ND	0.28	4.0
			138	1.9	0.86	4.2	1.7	7.6	7.6	4.2
		Brain (3)	116	ND	ND	ND	ND	ND	ND	0.35
			133	ND	ND	ND	ND	ND	ND	ND
			138	ND	ND	ND	ND	ND	ND	ND
		Muscle (3)	116	ND	ND	ND	ND	ND	ND	0.25
			133	ND	ND	ND	ND	ND	ND	0.13
			138	ND	ND	ND	ND	ND	ND	ND
	M	Blubber (5)	114	5.0	2.8	6.6	0.14	ND	1.4	18
			116	2.6	4.0	10	1.5	11	1.8	3.2
			130	4.4	2.0	7.0	0.10	ND	0.58	5.8
			140	6.4	2.2	7.6	ND	10	1.3	6.8
			145	4.0	1.8	7.2	1.4	4.8	1.1	5.6
			GM	4.3	2.5	7.6	0.50	2.8	1.2	6.8
			CL	2.8–6.4	1.6–3.6	6.2–9.3	ND–1.6	ND–17	0.7–1.8	2.9–14
		Brain (5)	114	ND	ND	ND	ND	ND	ND	ND
			116	ND	ND	ND	ND	ND	ND	ND
			130	ND	ND	ND	ND	ND	ND	0.65
			140	ND	ND	ND	ND	ND	ND	ND
			145	ND	ND	ND	ND	ND	ND	ND
			GM	ND	ND	ND	ND	ND	ND	0.11
			CL							ND–0.46
		Muscle (5)	CL	ND	ND	ND	ND	ND	ND	ND
			EASTERN TROPICAL PACIFIC							
6'S, 91°41'W										
Fraser's dolphin	M	Blubber (1)	168	7.2	0.72	1.8	ND	1.3	ND	5.2
		Muscle (1)	168	0.17	ND	ND	ND	ND	ND	ND
0'S, 88°12'W										
Striped dolphin	F	Blubber (2)	186	1.6	0.28	0.76	ND	0.74	0.18	ND
			187	4.4	0.26	0.88	ND	ND	ND	ND
		Brain (2)	187	ND	ND	ND	ND	ND	ND	ND
		Muscle (2)	187	ND	ND	ND	ND	ND	ND	ND
	M	Blubber (1)	195	2.8	0.40	1.0	ND	1.0	0.44	5.0
		Brain (1)	195	ND	ND	ND	ND	ND	ND	ND
		Muscle (1)	195	ND	ND	ND	ND	ND	ND	ND
'N, 86°30'W										
Striped dolphin	F	Blubber (1)	192	0.60	ND	0.50	ND	ND	ND	ND
		Muscle (1)	192	ND	ND	ND	ND	ND	ND	ND
6'N, 84°20'W										
Striped dolphin	F	Blubber (1)	131	76	4.0	34	ND	1.9	3.0	9.8
		Muscle (1)	131	0.55	0.13	ND	ND	ND	ND	ND
1'N, 98°7'W										
Striped dolphin	M	Blubber (2)	148	110	6.0	40	1.1	3.0	13	7.6
			160	120	6.4	40	1.1	3.0	12	6.8
		Muscle (2)	148	1.0	0.25	ND	ND	0.12	ND	ND
			160	1.4	0.25	ND	ND	0.13	ND	ND
		Brain (1)	148	1.1	0.16	ND	ND	ND	ND	0.40
53'N, 105°6'W										
Striped dolphin	F	Blubber (1)	180	18	2.0	7.4	ND	1.1	1.6	4.4
		Brain (1)	180	0.2	ND	ND	ND	ND	ND	ND
		Muscle (1)	180	0.19	ND	ND	ND	ND	ND	ND
25'N, 110°48'W										
Striped dolphin	F	Blubber (1)	194	22	0.92	3.4	ND	0.44	0.58	5.6
		Brain (1)	194	0.22	ND	ND	ND	ND	ND	ND
		Muscle (1)	194	0.12	ND	ND	ND	ND	ND	ND
6'N, 110°29'W										
Striped dolphin	F	Blubber (4)	136	6.6	1.1	2.6	ND	0.66	0.46	1.7
			178	19	1.1	3.8	0.10	0.68	1.5	ND
			188	0.46	ND	0.16	ND	ND	ND	ND
			190	18	1.7	4.2	ND	1.1	0.36	12
		Brain (4)	136	0.12	ND	ND	ND	ND	ND	ND
			178	0.20	ND	ND	ND	ND	ND	ND
			188	ND	ND	ND	ND	ND	ND	ND
			190	0.14	ND	ND	ND	ND	ND	ND

TABLE 1. *Continued*

Locality and Species	Sex	Tissue (N)	TL	*p,p'*-DDE	*p,p'*-TDE	*p,p'*-DDT	*o,p'*-DDE	*o,p'*-TDE	*o,p'*-DDT	PCBs
		Muscle (4)	136	0.11	ND	ND	ND	ND	ND	ND
			178	0.25	ND	ND	ND	ND	ND	ND
			188	ND	ND	ND	ND	ND	ND	ND
			190	0.14	ND	ND	ND	ND	ND	ND
	M	Blubber (1)	208	22	0.68	1.6	ND	0.32	0.52	2.6
		Brain (1)	208	0.30	ND	ND	ND	ND	ND	ND
		Muscle (1)	208	0.38	ND	ND	ND	ND	ND	ND
CALIFORNIA										
32°33'N–35°12'N										
Common dolphin	F	Blubber (3)	182	730	22	21	28	6.8	15	80
			192	360	26	19	26	7.4	12	100
			210	950	51	16	43	8.0	10	160
		Brain (2)	179	20	0.40	0.21	0.39	ND	ND	0.65
			192	14	0.65	ND	0.70	ND	ND	2.2
		Muscle (3)	182	5.5	0.17	ND	0.24	0.12	ND	0.60
			192	4.3	0.28	ND	0.20	ND	ND	0.70
			210	13	0.78	ND	6.8	0.20	ND	3.3
	M	Blubber (10)	184	980	32	26	36	8.8	20	110
			184	780	38	19	40	16	15	160
			187	510	26	18	24	13	9.6	110
			190	1,500	98	36	70	26	42	80
			192	740	44	13	34	22	10	160
			195	780	19	14	23	5.8	14	88
			196	560	24	19	28	8.8	13	110
			198	500	19	15	17	8.0	15	92
			201	1,200	54	22	66	24	28	300
			204	1,700	41	26	29	11	24	140
			GM	847	35	20	34	13	17	123
			CL	620–1,160	24–50	16–25	24–46	8.8–18	12–24	92–163
		Brain (8)	184	20	0.50	ND	0.33	ND	ND	0.70
			187	10	0.24	0.28	0.16	ND	ND	ND
			190	45	1.9	ND	1.0	ND	ND	2.7
			192	17	0.60	ND	0.40	ND	ND	2.0
			195	14	0.21	ND	0.48	0.14	0.13	2.4
			196	11	0.30	ND	0.33	ND	ND	1.2
			201	22	0.60	ND	0.60	ND	ND	1.8
			204	41	0.63	0.19	1.4	0.33	0.28	4.2
			GM	20	0.56	0.05	0.55	0.05	0.05	1.6
			CL	12–31	0.2–1.0	ND–0.2	0.3–0.9	ND–0.33	ND–0.28	0.7–3.0
		Muscle (10)	184	16	0.50	ND	0.63	0.28	ND	2.3
			184	11	0.40	ND	0.15	ND	ND	0.43
			187	5.3	0.22	ND	ND	ND	ND	ND
			190	38	1.9	ND	0.78	ND	ND	2.4
			192	10	0.30	ND	0.25	ND	ND	1.2
			195	7.5	0.21	ND	0.30	0.15	ND	0.78
			196	8.3	0.14	ND	0.19	ND	ND	0.78
			198	16	0.43	ND	0.15	ND	ND	0.70
			201	14	0.43	ND	0.38	ND	ND	1.2
			204	14	0.30	ND	0.48	0.25	ND	1.7
			GM	12	0.43	ND	0.31	0.06	ND	1.0
			CL	8.2–18	0.2–0.7		0.2–0.5	ND–0.2		0.5–1.6
Bottlenose dolphin	F	Blubber (2)	211	1,600	100	46	30	11	9.6	420
			255	2,500	130	54	ND	11	ND	450
		Muscle (2)	211	49	3.7	0.11	1.7	0.53	ND	15
			255	18	0.70	ND	ND	ND	ND	5.5
Pilot whale	F	Blubber (1)	457	30	1.1	1.6	1.6	ND	0.78	8.8
		Muscle (1)	457	0.53	ND	ND	ND	ND	ND	ND
	M	Blubber (1)	670	110	3.4	6.4	4.8	1.1	4.4	14
		Muscle (1)	670	6.5	0.30	0.14	0.24	0.18	0.10	0.88
Harbor porpoise	F	Blubber (1)	140	270	36	11	13	2.2	2.6	84
		Brain (1)	140	2.2	0.15	ND	ND	ND	ND	0.65
		Muscle (1)	140	2.0	0.20	ND	ND	ND	ND	0.50
Dall's porpoise	F	Blubber (1)	183	190	16	14	14	5.2	6.6	94
		Muscle (1)	183	3.8	0.17	ND	ND	ND	ND	0.53
HAWAII										
20°48'N, 156°28'W										
Rough-toothed dolphin	F	Blubber (4)	202	24	0.90	2.2	ND	0.60	1.1	38
			209	15	0.94	1.4	ND	0.86	2.0	26
			215	0.28	ND	ND	ND	ND	ND	ND
			218	ND	ND	ND	ND	ND	ND	ND

TABLE 1. *Continued*

ALITY AND SPECIES	SEX	TISSUE (N)	TL	*p,p'*-DDE	*p,p'*-TDE	*p,p'*-DDT	*o,p'*-DDE	*o,p'*-TDE	*o,p'*-DDT	PCBs
		Brain (1)	218	ND	ND	ND	ND	ND	ND	ND
		Muscle (4)	202	0.21	ND	ND	ND	ND	ND	0.45
			209	0.12	ND	ND	ND	ND	ND	0.14
			215	ND	ND	ND	ND	ND	ND	ND
			218	ND	ND	ND	ND	ND	ND	ND
	M	Blubber (3)	211	7.6	0.62	0.70	ND	0.38	1.2	14
			228	4.2	ND	ND	ND	ND	0.32	7.0
			235	4.6	ND	ND	ND	ND	ND	7.2
		Brain (3)	211	ND	ND	ND	ND	ND	ND	ND
			228	0.78	ND	ND	ND	ND	ND	1.3
			235	0.48	ND	ND	ND	ND	ND	0.78
		Muscle (3)	211	ND	ND	ND	ND	ND	ND	ND
			228	0.22	ND	ND	ND	ND	ND	0.38
			235	0.25	ND	ND	ND	ND	ND	0.33
					JAPAN					
15′N, 136°52′E										
Striped dolphin	F	Blubber (4)	210	0.64	ND	0.62	ND	ND	ND	1.8
			211	10	1.0	4.6	0.34	1.0	1.1	4.8
			223	8.2	1.4	3.2	0.28	0.55	1.1	4.0
			229	0.88	0.18	0.96	ND	0.14	ND	1.2
		Brain (4)	210	ND	ND	ND	ND	ND	ND	ND
			211	0.23	ND	ND	ND	ND	ND	ND
			223	0.18	ND	ND	ND	ND	ND	ND
			229	ND	ND	ND	ND	ND	ND	ND
		Muscle (4)	210	ND	ND	ND	ND	ND	ND	ND
			211	1.2	0.17	0.38	ND	ND	ND	0.63
			223	0.30	ND	ND	ND	ND	ND	0.85
			229	ND	ND	ND	ND	ND	ND	ND
	M	Blubber (1)	239	12	0.78	4.4	0.30	0.76	0.68	5.0
		Brain (1)	239	0.80	0.16	ND	ND	ND	ND	ND
		Muscle (1)	239	0.63	0.11	ND	ND	ND	ND	1.6
Pilot whale	F	Blubber (5)	332	3.8	0.78	1.6	0.48	0.36	0.24	32
			348	4.4	0.54	2.6	6.62	ND	0.28	6.2
			354	0.56	0.12	0.40	0.14	ND	ND	1.6
			356	1.9	0.32	1.3	0.62	0.12	0.28	0.60
			362	5.2	0.76	2.8	0.58	0.30	0.62	5.8
			GM	2.7	0.48	1.6	0.48	0.15	0.27	4.8
			CL	0.8–6.5	0.2–0.9	0.6–3.2	0.2–0.8	ND–0.4	0.03–0.57	0.4–24
	M	Blubber (1)	355	0.48	ND	0.40	0.12	ND	ND	2.0
30′N, 135°E										
Finless porpoise	F	Blubber (3)	118	42	42	26	16	3.4	2.4	88
			163	3.4	2.4	2.8	3.0	0.48	ND	18
			164	20	7.8	6.6	17.0	1.6	1.7	74
		Brain (1)	164	0.15	ND	ND	ND	ND	ND	1.8
		Muscle (2)	164	ND	ND	ND	ND	ND	ND	0.43
			163	0.16	ND	ND	ND	ND	ND	0.70
	M	Blubber (1)	167	62	30	15	15.6	5.8	3.6	96
		Muscle (1)	167	0.45	0.20	ND	ND	ND	ND	1.1
30′N, 137°E										
Finless porpoise	F	Blubber (1)	124	14	7.2	7.8	5.6	1.0	1.0	50
		Muscle (1)	124	0.10	ND	0.14	ND	ND	ND	0.63
	M	Blubber (1)	148	32	19	17	10.0	3.4	2.8	64
		Brain (1)	148	0.26	ND	ND	ND	ND	ND	1.3
		Muscle (1)	148	0.35	ND	ND	ND	ND	ND	1.2
30′N, 139°50′E										
Common dolphin	F	Blubber (1)	183	0.54	0.46	0.36	0.12	0.34	ND	2.4
		Muscle (1)	183	ND	ND	ND	ND	ND	ND	0.30
	M	Blubber (1)	144	8.2	1.8	4.0	0.40	1.8	0.72	6.4
		Muscle (1)	144	0.28	ND	ND	ND	ND	ND	0.35
35′N, 145°55′E										
Dall's porpoise	F	Blubber (1)	184	3.0	1.1	1.4	1.0	1.3	0.78	3.4
		Brain (1)	184	ND	ND	ND	ND	ND	ND	ND
		Muscle (1)	184	ND	ND	ND	ND	ND	ND	0.16

TE: (N) = number of individuals sampled; TL = total length of animal in cm; F, M = female, male; ND = not detected; GM = geometric mean; CL = 95% confidence limits.

TABLE 2. *Organochlorine residues other than ΣDDT and PCBs in blubber of small cetaceans from the Pacific and South Atlantic Oceans, November 1968–June 1976*[1]

Locality and Species	Sex (N)	TL	Dieldrin	HCB	Toxaphene	Heptachlor epoxide	*trans*-Nonachlor	Oxychlordane
URUGUAY								
24°22′S, 53°46′W								
Franciscana dolphin	F (3)	116	0.22	0.10	ND	ND	0.12	ND
		133	0.20	ND	ND	ND	ND	ND
		138	0.20	0.10	ND	ND	0.10	ND
	M (5)	114	1.0	ND	ND	ND	0.20	ND
		116	0.52	0.18	ND	ND	0.24	ND
		130	0.38	ND	ND	ND	0.10	ND
		140	0.40	0.12	ND	ND	0.18	ND
		145	0.30	0.10	ND	ND	0.20	ND
		GM	0.50	0.08	ND	ND	0.18	ND
		CL	0.2–0.9	ND–0.2			0.1–0.25	
EASTERN TROPICAL PACIFIC								
3°26′S, 91°41′W								
Fraser's dolphin	M (1)	168	ND	ND	ND	ND	ND	ND
4°50′S, 88°12′W								
Striped dolphin	F (2)	186	0.14	ND	ND	ND	ND	ND
		187	0.14	ND	ND	ND	0.18	ND
	M (1)	195	0.20	ND	ND	ND	ND	ND
7°0′N, 86°30′W								
Striped dolphin	F (1)	192	ND	ND	ND	ND	ND	ND
7°46′N, 84°20′W								
Striped dolphin	F (1)	131	ND	ND	ND	ND	0.22	ND
9°41′N, 98°7′W								
Striped dolphin	M (2)	148	0.84	ND	5.6	0.30	ND	ND
		160	ND	ND	4.0	0.26	ND	ND
17°53′N, 105°6′W								
Striped dolphin	F (1)	180	0.44	ND	ND	ND	0.48	ND
18°25′N, 110°48′W								
Striped dolphin	F (1)	194	ND	ND	ND	ND	ND	ND
20°6′N, 110°29′W								
Striped dolphin	F (4)	136	0.30	ND	ND	ND	0.16	ND
		178	0.40	ND	ND	ND	0.64	ND
		188	ND	ND	ND	ND	ND	ND
		190	0.28	ND	ND	ND	0.24	ND
CALIFORNIA								
32°33′N–35°12′N								
Common dolphin	F (3)	182	ND	0.13	ND	ND	ND	ND
		192	1.1	ND	ND	0.34	ND	0.12
		210	ND	0.24	ND	ND	ND	ND
	M (10)	184	ND	0.18	ND	ND	ND	ND
		184	1.1	0.10	ND	0.30	ND	0.20
		187	ND	0.12	ND	ND	ND	ND
		190	ND	0.34	ND	2.0	ND	1.2
		192	1.4	0.14	ND	ND	10	0.50
		195	ND	0.14	ND	ND	ND	ND
		196	ND	ND	ND	0.12	0.82	0.32
		198	ND	ND	ND	ND	ND	0.20
		201	ND	0.10	ND	0.22	ND	0.20
		204	ND	0.24	ND	ND	ND	ND
		GM	0.18	0.13	ND	0.18	0.35	0.22
		CL	ND–0.5	0.1–0.2		ND–0.5	ND–1.3	0.02–0.5
Bottlenose dolphin	F (2)	211	ND	0.34	ND	0.62	14	3.4
		255	6.4	0.46	ND	ND	21	4.0
Pilot whale	F (1)	457	ND	ND	ND	ND	ND	ND
	M (1)	670	ND	ND	ND	ND	ND	ND
Harbor porpoise	F (1)	140	1.0	0.18	ND	0.18	5.0	ND
Dall's porpoise	F (1)	183	0.40	0.28	ND	ND	0.56	ND

TABLE 2. *Continued*

CALITY AND SPECIES	SEX (N)	TL	DIELDRIN	HCB	TOXAPHENE	HEPTACHLOR EPOXIDE	*trans*-NONACHLOR	OXYCHLORDANE
			HAWAII					
°48′N, 156°28′W								
Rough-toothed dolphin	F (4)	202	0.32	ND	ND	ND	0.64	ND
		209	0.66	ND	ND	ND	1.0	ND
		215	ND	ND	ND	ND	ND	ND
		218	ND	ND	ND	ND	ND	ND
	M (3)	211	0.36	ND	ND	ND	0.50	ND
		228	ND	ND	ND	ND	ND	ND
		235	ND	ND	ND	ND	ND	ND
			JAPAN					
°15′N, 136°52′E								
Striped dolphin	F (4)	210	ND	ND	ND	ND	ND	ND
		211	0.28	0.08	0.18	ND	ND	ND
		223	0.34	ND	ND	ND	0.24	ND
		229	ND	ND	0.12	ND	ND	ND
	M (1)	239	ND	0.10	0.18	ND	0.12	ND
Pilot whale	F (5)	332	ND	ND	0.14	ND	ND	ND
		348	ND	0.06	ND	ND	ND	ND
		354	ND	ND	ND	ND	ND	ND
		356	ND	ND	0.14	ND	ND	ND
		362	1.2	ND	0.14	ND	ND	ND
		GM	0.17	0.01	0.08	ND	ND	ND
		CL	ND–0.8	ND–0.05	ND–0.2			
	M (1)	355	ND	ND	0.12	ND	ND	ND
°30′N, 135°E								
Finless porpoise	F (3)	118	16	0.64	ND	ND	ND	ND
		163	2	ND	ND	ND	ND	ND
		164	12	0.38	0.22	ND	ND	0.36
	M (1)	167	32	0.42	0.16	0.28	1.1	0.12
°30′N, 137°E								
Finless porpoise	F (1)	124	16	0.22	ND	0.34	0.40	ND
	M (1)	148	38	0.34	0.14	0.82	ND	0.46
°30′N, 139°50′E								
Common dolphin	F (1)	183	0.14	0.06	0.14	0.04	ND	ND
	M (1)	144	0.62	0.26	0.36	ND	0.46	ND
°35′N, 145°55′E								
Dall's porpoise	F (1)	184	0.40	0.28	ND	ND	0.56	ND

)TE: (N) = number of individuals sampled; TL = total length of animal in cm; F, M = female, male; ND = not detected; GM = geometric mean; CL = 95% confidence limits.
rain and muscle tissues (sample sizes identical to those in Table 1) had no detectable residues of the compounds listed above except as noted in e text.

blubber of the male common dolphin from Tokyo y and at 0.56 ppm in blubber of a male finless rpoise captured at sea near Himeji, Hyogo Prefecture, pan. Concentrations of *cis*-nonachlor were 2.2 ppm d 10 ppm in blubber of two beach-stranded southern lifornia female bottlenose dolphins. Residues of *cis*-lordane were positively identified in blubber of the lowing cetaceans: two male Franciscana (*Pontoporia inville*) from the western South Atlantic off Uruay (0.94 ppm and 0.12 ppm); a female striped lphin collected at 20° 6′N, 110° 29′W (0.18 ppm); female bottlenose dolphin (13 ppm), a female com-)n dolphin (6.4 ppm), and six male common dol-ins (geometric mean 9.8 ppm, range 5.8–36 ppm))m southern California.

SIDUES BY TISSUES

ubber has a high lipid content, and organochlorine concentrations are therefore consistently higher in this tissue than in brain or muscle. However, statistical comparisons of residue concentrations within locality, species, and sex are possible only for tissues of male common dolphins from southern California. Mean concentrations of *p,p′*-DDE in blubber, brain, and muscle of these animals (Table 1) differed significantly ($P < 0.01$; two-way analysis of variance on ln + 1 transformed data, mean separation by Student-Newman-Keuls test). Mean PCB concentrations in blubber were significantly greater than those in brain or muscle ($P < 0.01$). Brain and muscle PCB concentrations did not differ ($P > 0.05$). Residue levels of DDE in these three tissues were significantly correlated in common dolphins from southern California and in striped dolphins from the Eastern Tropical Pacific (Table 3). PCB residues in common dolphins showed significant correlation only between brain and muscle (Table 3).

TABLE 3. *Simple linear correlation coefficients (r) between blubber, brain, and muscle tissues containing residues of DDE and PCBs in 13 common dolphins collected at southern California beaches and of DDE in 14 striped dolphins from the Eastern Tropical Pacific, November 1968–June 1976*

Species	Residue		Blubber/ Brain	Blubber/ Muscle	Brain/ Muscle
Common dolphins	DDE	*r*	0.92**	0.65*	0.83**
		DF	7	11	7
	PCB	*r*	−0.04	0.09	0.75**
		DF	7	11	7
Striped dolphins	DDE	*r*	0.99**	0.97**	0.99**
		DF	9	12	9

* $P < 0.05$.
** $P < 0.01$.

PCBs were not detected in muscle and occurred in only one brain sample of Eastern Tropical Pacific striped dolphins.

Except in heavily contaminated individuals, the principal organochlorine compounds found in blubber were not detected in brain or muscle at the same frequencies (Table 1). For example, DDE did not appear in brains of Eastern Tropical Pacific striped dolphins except when blubber residues exceeded about 5–10 ppm (Fig. 1). In contrast, all southern California common dolphins had detectable DDE residues in brains, but blubber residues were 360 ppm or greater (Fig. 1). Similarly, only two of the compounds listed in Table 2 that were found in blubber were also found in brain or muscle. Dieldrin occurred at 0.20 ppm in the muscle of a male finless porpoise collected off Himeji, Japan. Brain or muscle tissues of three common dolphins from southern California beaches contained residues of *trans*-nonachlor. The brain of one female contained 0.25 ppm and those of two males contained 0.33 ppm and 0.23 ppm. Muscle of the two males contained *trans*-nonachlor at 0.16 ppm and 0.12 ppm.

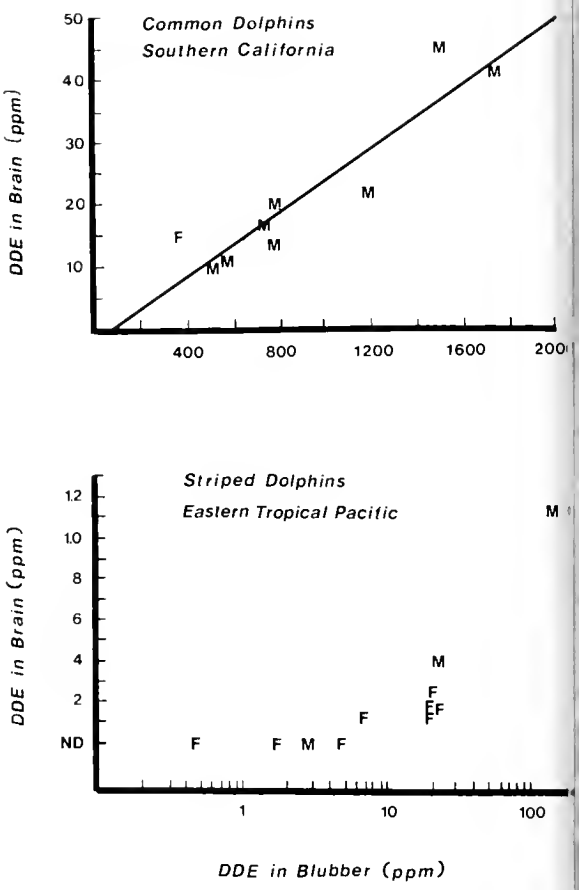

FIGURE 1. *Concentrations of DDE in brains of Southe California common dolphins and Eastern Tropical Paci striped dolphins in relation to DDE concentrations in blu ber (M = male, F = female). Line depicted in top porti of figure is described by equation* $Y = -1.28 + 0.025X$.

RESIDUES BY LOCALITY

Uruguay—Five male and three female Franciscana were collected offshore from Punta del Diablo, Dept. Rocha (34° 22′S, 53° 46′W). Dieldrin, PCBs, and DDT and its metabolities were present in blubber of all individuals (Tables 1 and 2). Other organochlorines present in blubber included HCB, *trans*-nonachlor, and *cis*-chlordane. PCBs were the only organochlorines detected in muscle and brain. This was the only locality in which residues of *p,p′*-DDT exceeded those of *p,p′*-DDE in blubber (Table 4).

Eastern Tropical Pacific—Striped dolphins were collected at sea at latitudes ranging from 4° 50′S to 20° 6′N (Table 1). In general, striped dolphins from these localities had relatively low to moderate blubber concentrations of PCBs and DDT-related compounds (Table 1). Exceptions included two young males collected at 9° 41′N, 98° 7′W, which contained an average of 115 ppm *p,p′*-DDE in blubber as well residues of PCBs, dieldrin, and heptachlor epoxi (Tables 1 and 2); toxaphene residues in these spe mens were the highest reported in this study. Few co pounds other than PCBs and those related to DDT we found in blubber of other striped dolphins. PC were not detected in the two females taken at 4° 50 88° 12′W but were found in the male. With the e ception of *o,p′*-TDE in muscle tissues of the two ma from 9° 41′N, 98° 7′W, brain and muscle tissues Eastern Tropical Pacific striped dolphins did not poss detectable residues of any organochlorines other th *p,p′*-DDE and *p,p′*-TDE.

The blubber of one male Fraser's dolphin collect at 3° 26′S, 91° 41′W contained residues of PCBs a DDT-related compounds. The predominant compou was *p,p′*-DDE at 7.2 ppm (Table 1).

California—Five species of small cetaceans were sa pled on or near southern California beaches at latitu

ABLE 4. *Ratios of* p,p'-*DDT to* p,p'-*DDE in blubber of small cetaceans grouped according to oceanic region or 'e nearest major land masses at the latitudes of collection, November 1968–June 1976*

Species	Sample Size	$\frac{p,p'\text{-DDT}}{p,p'\text{-DDE}} \pm$ Std Dev
SOUTHERN CALIFORNIA		
mmon dolphins	(13)	0.03 ± 0.01
tlenose dophins	(2)	0.03 ± 0.004
ot whales	(2)	0.06 ± 0.004
rbor porpoise	(1)	0.04
ll's porpoise	(1)	0.07
HAWAII		
ugh-toothed dolphins	(6)	0.05 ± 0.05
EASTERN TROPICAL PACIFIC		
ser's dolphin	(1)	0.25
iped dolphins	(14)	0.34 ± 0.18
JAPAN		
iped dolphins	(5)	0.66 ± 0.35
ot whales	(6)	0.63 ± 0.14
less porpoise	(6)	0.52 ± 0.21
mmon dolphins	(2)	0.58 ± 0.13
ll's porpoise	(1)	0.47
URUGUAY		
nciscana	(8)	1.97 ± 0.90

° 33′N and 35° 12′N. These animals were heavily ntaminated with organochlorine residues, including rticularly high concentrations of metabolites and mers of DDT. The inshore-feeding coastal bottle-se dolphins were the most heavily contaminated. ubber from two immature females stranded in San ego County in July and August 1976 contained 2,695 d 1,797 ppm ΣDDT, over 400 ppm PCBs, and ser quantities of dieldrin, heptachlor epoxide, HCB, ychlordane, *trans*-nonachlor, and *cis*-chlordane ables 1 and 2). Blubber of comon dolphins had con-ntrations of up to 1,831 ppm ΣDDT and 300 ppm CBs. Up to 48 ppm ΣDDT occurred in brains. With e exception of dieldrin, HCB, and toxaphene, residues all organochlorines listed in Tables 1 and 2 were gher in these two species in southern California than any species at any other locality.

gh concentrations of organochlorines were also pres-t in the other California specimens. Residues of DDT in blubber reached 335 ppm in an immature male harbor porpoise (*Phocoena phocoena*) stranded San Luis Obispo County and 246 ppm in an adult male Dall's porpoise (*Phocoenoides dalli*) stranded San Diego County. Lowest ΣDDT residues in blubber re 35 ppm in an immature female pilot whale inci-ntally caught off Los Angeles County.

awaii—Tissue samples were analyzed from seven ugh-toothed dolphins (*Steno bredanensis*) that mass-anded at Kihei Beach, Maui (20° 58′N, 156° 28′). One adult female did not possess detectable residues of organochlorine compounds. This was the sole individual in the entire study that was free of contamination. Isomers and metabolites of DDT were present in blubber of other individuals at relatively low concentrations. PCBs reached 38 ppm in one female. Dieldrin and *trans*-nonachlor were the only additional organochlorines detected at this locality. The blubber of a 93-cm near-term fetus (not tabulated) contained one compound, *p,p'*-DDE, at 0.54 ppm. Maternal blubber also contained only *p,p'*-DDE, at a concentration of 0.28 ppm.

Japan—Striped dolphins and pilot whales were caught by fishermen at Taiji, Wakayama Prefecture (34° 15′N, 136° 52′E), and finless porpoises were taken at Ise Bay (34° 30′N, 137° E) and the Seto Inland Sea (34° 30′N, 135° E). These specimens contained a wide range of organochlorine residues (Tables 1 and 2), including the highest blubber concentrations of dieldrin and HCB found in the study (up to 38 ppm and 0.64 ppm, respectively, in finless porpoises). Toxaphene or toxaphene-like compounds were found in tissues of individuals of all three species and in common dolphins stranded in Tokyo Bay (35° 30′N, 139° 50′E). Toxaphene was detected elsewhere only in striped dolphins taken at 9° 41′N, 98° 7′W. As previously noted, the two common dolphins from Tokyo Bay contained mirex and endrin in addition to the compounds listed in Tables 1 and 2. The highest concentrations of *p,p'*-DDE and PCBs among Japanese cetaceans occurred in finless porpoises, which are also the most highly restricted to inshore feeding. Concentrations of PCBs were higher in blubber of Japanese finless porpoises than in cetaceans from all other localities except southern California. Ratios of *p,p'*-DDT to *p,p'*-DDE were higher in Japanese cetaceans than in those from all other localities except the western South Atlantic off Uruguay (Table 4).

Discussion

Small cetaceans may generally be expected to reflect the extent of local organochlorine contamination in marine ecosystems: they occupy high trophic levels, are large nonmigratory, and are relatively long-lived (*21*). This premise is dramatically supported by residue concentrations in animals from southern California waters. The oceanic input of PCBs from five southern California sewage treatment plants was estimated at nearly 20,000 kg per year in 1972 (*20*), and one Los Angeles area pesticide manufacturer was responsible for a continuous discharge of DDT at sewer outfalls for over 20 years (*19*). Shortly before cessation of this latter practice in 1970, the input of ΣDDT (80 percent of which was DDT) to the ocean from this source alone was estimated to be 250 kg per day (*19*). Cetaceans collected in this region during our study show heavy

contamination with these compounds. With the exception of a single immature female pilot whale taken at sea, blubber from all specimens from beaches or waters off southern California contained residues of *p,p'*-DDE in excess of 100 ppm. Mean concentrations of this compound in blubber of male common dolphins were more than seven times greater than the highest individual values in any species from any other locality in the present study. Maximum residues of *p,p'*-DDE in blubber of two immature female coastal bottlenose dolphins were even higher; *p,p'*-DDE residues were more than twice the highest previously published concentrations of this compound in cetaceans (*23*). PCB residues in blubber of the California *Tursiops* also exceeded previously published concentrations for cetaceans from all parts of the world yet investigated except perhaps the Mediterranean coast of France (*1, 25*). Blubber residues of ΣDDT in one of these females reached 2,695 ppm, a value equivalent to the 2,678 ppm reported in an adult male California sea lion (*Zalophus californianus*) collected near Año Nuevo Island, California (37° 5'N, 122° 20'W), in 1970 (*18*). Concentrations of ΣDDT in California pinnipeds and cetaceans are to the authors' knowledge the highest known for any populations of wild mammals.

Cetaceans from other localities had lower concentrations of the principal organochlorine residues (DDT and PCBs), although these compounds were detected in all species at all localities. The use of DDT on neighboring land masses has presumably had varying histories. Direct discharge of DDT at southern California outfalls took place for over 20 years and had been curtailed for several years before specimen collection (*19*). In addition, the general use of DDT in the United States ended in 1972. Mean ratios of *p,p'*-DDT to *p,p'*-DDE are very low, ranging from 0.03 to 0.07 ppm in all species collected in waters off Hawaii and California (Table 4); long-term accumulation of the persistent metabolite DDE in marine ecosystems, as well as a lack of recent input of DDT, contribute to these low ratios. Mean ratios in cetaceans from other localities (Table 4) are at least an order of magnitude higher, ranging from 0.25 ppm to 0.66 ppm in Eastern Tropical Pacific and Japanese waters to the extreme in Franciscana dolphins from the Western South Atlantic, where residues of DDT exceed those of DDE. (Decomposition of DDT during storage of specimens can also influence these ratios (*7*). However, in comparison to geographic effects, this loss appears to have contributed little to the contrasting values seen in the present study: tissues of California cetaceans, for example, were stored for 23.5 ± 4 months whereas Uruguayan specimens were held 23.9 ± 0.3 months before they were analyzed.) Franciscana are very restricted to coastal waters of this region (*4*; R. L. Brownell, Jr., personal observations), and also extensively use the estuary of the Rio de la Plata. Widespre deforestation and agricultural cultivation are rece phenomena in much of the watershed draining into t Rio de la Plata system, particularly in southeaste Brazil (*17*). In addition, sharp increases in the use DDT (and loss of fish and wildlife) have recen occurred near Brazil's extensive Lagoa dos Patos (*16*) The entrance to this lagoon is about 250 km north the Uruguay collection site and the Brazilian Curre in this area moves south along the coast. The introdu tion of DDT into the areas inhabited by Francisca dolphins thus appears to be relatively recent and o going.

Cetaceans from Japanese waters contained a wide a ray of organochlorine compounds. This is particula true of finless porpoises, which are the most restrict inshore feeders of all cetaceans surveyed in Japa Although we know of no accounts documenting t degree of organochlorine contamination in other co ponents of marine ecosystems at these localities, are such as Ise Bay and the Seto Inland Sea possess sor of the most densely industrialized sections of coastli in the world (*22*). This industrialization, along wi intensive agricultural practices, apparently correlat with the diversity of organochlorine compounds se in Japanese cetaceans. Eastern Tropical Pacific strip dolphins usually contained fewer kinds of residues comparison with Japanese striped dolphins, but co centrations of DDT and PCBs were generally highe Sources of contamination in these tropical seas a unknown.

In addition to *o,p'*-isomers of DDT and its metabolite a number of other compounds, which have not be commonly reported in earlier studies, were detected blubber of cetaceans (Table 2). This is the first repo of endrin, toxaphene, *cis*-nonachlor, oxychlordane, *trans*-nonachlor in tissues of cetaceans. Maximum re dues of dieldrin (38 ppm in blubber of Japanese finle porpoises) were more than twice the highest previous reported concentrations (*15*). Residues of *cis*-chlorda in blubber of California common dolphins were near three times greater than those in previous reports (*23* Other than our report of mirex in Japanese cetacear the only other marine mammals in which this co pound has been detected are harbor seals from t Netherlands (*24*).

Although the present study has shown heavy and wid spread contamination of small cetaceans with organ chlorine compounds, the impact of this exposure h not yet been determined. Concentrations of ΣDD and PCBs in blubber lower than those reported he have been associated with impaired reproduction pinnipeds, but cause-and-effect relationships are n well defined. Population declines and uterine patholo

.ve been documented in Baltic Sea ringed seals *'usa hispida)*; nonpregnant females with abnormal eri had significantly higher mean blubber concen- ations of ΣDDT and PCBs (130 ppm and 110 ppm) an pregnant females (88 ppm and 73 ppm) (*13*). n this basis it was concluded that organochlorines ere responsible for the observed effects (*13*). How- er, because loss of organochlorines through lactation id pregnancy is an avenue unavailable to female ammals with imparied reproduction, higher residue ncentrations may be expected to occur in non-repro- icing females regardless of cause of reproductive fail- e. Residues in nonpregnant ringed seals with normal eri, for example, did not differ significantly from ose in nonpregnant females exhibiting the pathological anges [$P < 0.05$, *t*-test calculated from data of Helle al. (*13*)]. A more marked association has been noted tween high blubber residues of both ΣDDT (range 26–1039 ppm) and PCBs (85–145 ppm) and prema- re pupping in California sea lions (*6*). Females pro- icing full-term pups had considerably lower concen- ations of these compounds (51–203 ppm ΣDDT, 12– ppm PCB) (*6*). Although this relationship appears ronger than that implied by the ringed seal data, it is nfounded by additional factors: premature and full- rm parturient females differed in age and probably ed different feeding areas, and abortion-inducing seases were present in the population (*8*). It is cur- ntly hypothesized that interactions between organo- lorines and some of these other factors are responsi- e for premature pupping (*8*).

espite the equivocal nature of field observations of sociations between high concentrations of organo- lorines in blubber and reproduction in pinnipeds, xic effects of PCBs and DDT or its metabolites, in- uding severe reproductive impairment, have been perimentally verified in other mammals and birds *, 11, 12*). Drastic population reductions due to DDE posure have been well documented in fish-eating rds from marine waters off southern California (*2, 16*). Although the impact of organochlorine pol- tants on small cetaceans has not yet been determined, e severe degree of contamination found in cetaceans om these same waters, due largely to what would esently be considered industrial negligence (*19*), ould in itself be cause for serious concern.

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Use of Selected Freshwater Bivalves for Monitoring Organochlorine Pesticide Residues in Major Mississippi Stream Systems, 1972–73

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ABSTRACT

ven species of freshwater Pelecypoda, Amblema costata, *)rbicula manilensis,* Elliptio crassidens, Lampsilis anadon-*ides,* Lampsilis claibornensis, Megalonaias gigantea, *and* ectomerus dombeyanus, *were collected and monitored for sticide content during 1972 and 1973. Thirteen collection es, representing five major river basins in the state of ississippi, were sampled and compared. During the 24-onth study, 26 water samples and 58 claim samples from e five river basins were analyzed. Individual samples eighed from 8 g to 20 g and consisted of 1–30 clams, de-nding on size. Residues of toxaphene and methyl para-ion were found only in 1973 water samples. The study ows that freshwater clams are effective monitors of pesti-de content. The tendency of clams to concentrate pesti-des and their corresponding ability to eliminate them varies 'th species. Significant reductions in DDT and a corre-onding buildup of* p,p'-*TDE were noted in 1973, following e limitations on the use of DDT and large-scale flooding roughout the state.*

Introduction

he tendency of Pelecypoda to accumulate high body vels of pesticides from water containing very small nounts has been demonstrated under laboratory con-tions (*2, 5, 7*). In addition, Butler (*2*) and Fikes 5) have shown that bivalves are able to eliminate rtually all of their body burden of pesticides when aced in pesticide-free water. Other researchers have vestigated pesticide accumulations by marine and eshwater species following periods of spraying or om known pesticides outfalls (*1, 3, 4, 6*).

he present study evaluates the tendency of clams to ccumulate pesticides and their ability to eliminate iem under field conditions. It was felt that a compari-)n of 1972 and 1973 samples should reflect purging f high body concentrations as a result of either or both f these factors: the banning in December 1972 of the idespread use of DDT, and the extensive flooding of ie state of Mississippi during Spring 1973.

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Sampling

A survey of pesticide levels in selected species of freshwater clams in the major stream systems of the state of Mississippi was conducted in Summer 1972 in order to determine body concentrations of pesticides. All collections were made during periods of low stream flow (July through November). In 1973, clams were again collected from the same sites within respective river basins. Seven species of clams, *Amblema costata, Corbicula manilensis, Elliptio crassidens, Lampsilis anadontoides, Lampsilis claibornensis, Megalonaias gigantea,* and *Plectomerus dombeyanus,* were collected from the stream systems. Samples consisted of one to four species. Since species varied in size, sufficient numbers of individuals were collected to provide 8–20 g for extraction.

The 13 sampling sites are shown in Figure 1. Collections were made by hand from shallow water; in deeper areas, dip nets, dredges, and oyster tongs were used. Clams were refrigerated and returned to the laboratory in ice chests. Specimens were then identified, and their soft tissues were removed. Soft tissues were blotted on Whatman No. 1 filter paper to reduce excess water and were frozen at —15°C until extraction could be performed.

Analysis

Pesticides were extracted from clams by a modification of the procedure outlined in *Analysis of Pesticides in the Aquatic Environment* (*8*). Each sample was combined with three times its weight of sodium sulfate and extracted twice with equal portions of redistilled hexane by blending 3 minutes each time. The procedure gave 92 percent recovery for the first extraction and 8 percent recovery for the second.

The extracts were combined and filtered through Whatman No. 1 and No. 3 filter papers. The resulting extract was partitioned into acetonitrile and evaporated to dryness in a Kuderna-Danish concentrator over a steam bath. The residue was dissolved in 25 ml hexane

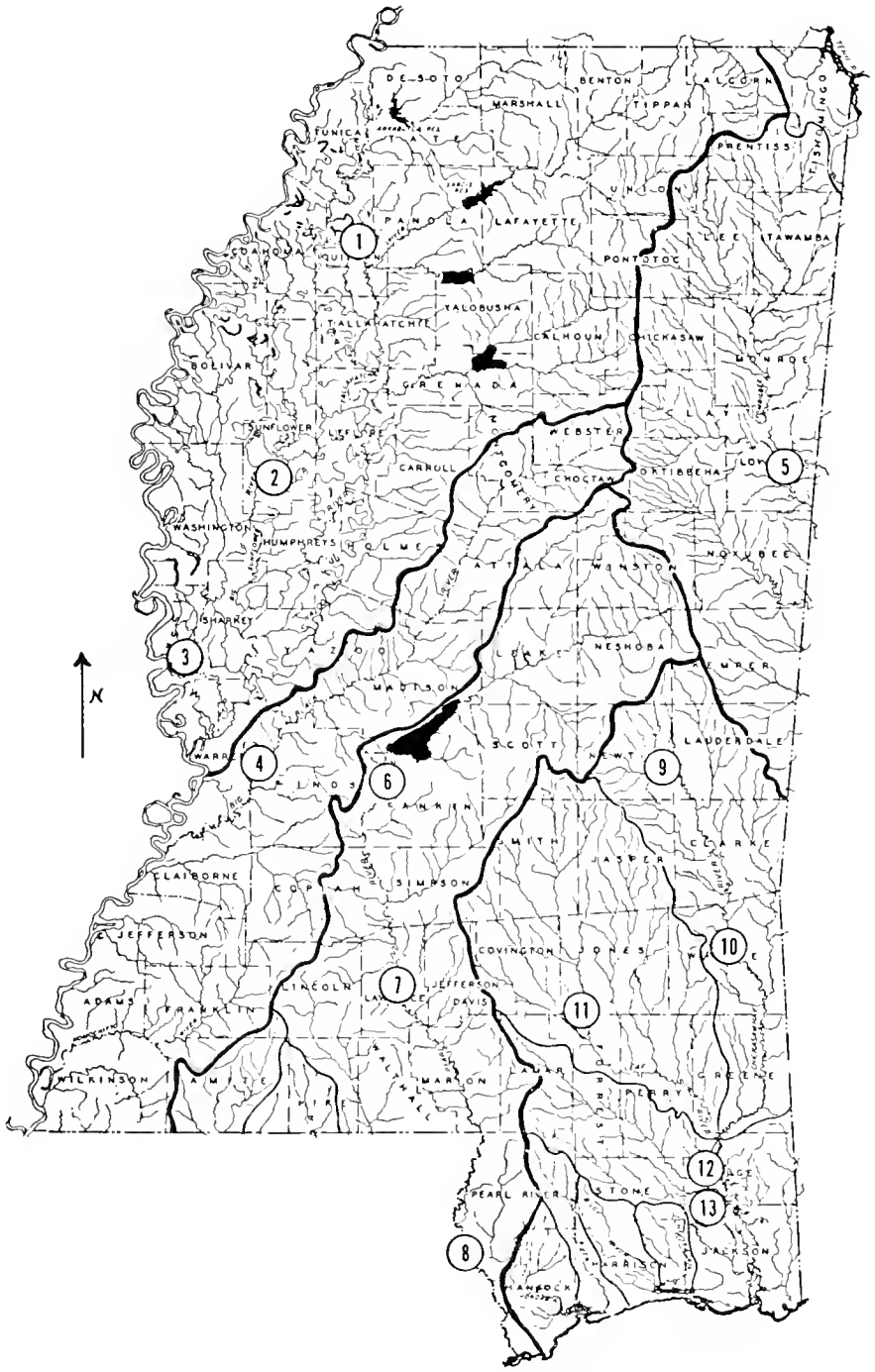

FIGURE 1. *Mississippi River Basin sampling sites, for monitoring pesticide residues in freshwater bivalves, 1972–73. Stations 1–3: Yazoo River Basin; Station 4: Big Black River Basin; Station 5: Tombigbee River Basin; Stations 6–8: Pearl River Basin; Stations 9–13: Pascagoula River Basin.*

nd subjected to Florisil column cleanup: 4 inches Na_2SO_4 bottom layer, 10 g Florisil, 3 inches Na_2SO_4 op layer, ether–hexane (15 + 85) elution mixture.

Water samples were also taken in conjunction with he clam samples. They were collected in glass jars vhich were sealed with aluminum foil-lined screw caps. Samples were refrigerated in ice chests and extracted ipon return to the laboratory, as follows: One liter of unfiltered water was extracted with a 100-ml solution of 85 percent hexane and 15 percent petroleum ether by rolling 1 hr on a concentric rotator. The resulting extract was eluted through approximately 6 inch anhydrous Na_2SO_4 in a size 224 Chromaflex (Kontes, 1 inch D) column using a mixture of hexane–ethyl ether (85 + 15). The extract was concentrated to 5 ml in a Kuderna-Danish apparatus over a steam bath.

All samples were analyzed on a Micro Tek 220 gas chromatograph equipped with ^{63}Ni electron-capture detector. Instrument parameters and operating conditions follow:

Columns:	6 ft × ¼ inch OD glass column packed with a mixture of 1.5 percent OV–17 and 1.95 percent QF–1 (1972 and 1973) 10 percent DC–200 (1972 only) 3 percent OV–1 (1973 only) each on Chromosorb W (AW, DMCS, HP)
Temperatures:	injector 220°C column 185–195°C detector 260°C
Carrier gas:	prepurified nitrogen flowing at ca 60–80 ml/minute

n 1973, a 3 percent OV–1 column was substituted for he 10 percent DC–200 because of its greater sensitivity nd lower retention time.

esidues were qualitatively identified by comparison ith a standard. Quantitative measurements were based n peak height and expressed in μg/g (ppm) for clam mples and μg/liter (ppb) for water samples. Results ere not corrected for recovery.

Results and Discussion

ites from which clams containing the highest levels of esticides were taken corresponded with areas of reatest agricultural usage. Highest detectable levels of oxaphene and DDT and its metabolites were found in ams from sampling sites within the Yazoo, Big Black, nd Tombigbee River Basins (Fig. 1). Watersheds of ese basins are within the most highly exploited agriultural areas of Mississippi (Statistical Reporting ervice, U.S. Department of Agriculture, 1973, personal ommunication). Pesticide residues were also detected clams from the northern areas of the Pearl River asin which drains farmlands. Clams from the Pasagoula River Basin contained the lowest levels of esticides (Table 1).

Pesticide residues were not found in water samples collected during 1972. Residues of toxaphene and/or methyl parathion were detected in water samples collected during 1973 from sites within the Yazoo, Big Black, and Tombigbee River Basins (Table 2). Detectable levels of toxaphene and methyl parathion in water samples taken in 1973 reflect in part the increased use of these pesticides, following the limits imposed on use of DDT. The extreme insolubility of DDT in water may have precluded its detection in trace amounts in the 1972 samples.

Overall pesticide residues in clams from sites within the Yazoo River Basin were less in 1973 than in 1972 (Table 1). With respect to DDT, there were large-scale reductions of both *o,p'*-DDT and *p,p'*-DDT in clams. Residues of *p,p'*-TDE, a first-order breakdown product of DDT, remained constant or changed only slightly in 1973. Increases of *p,p'*-TDE coincided with subsequent decreases in *p,p'*-DDT levels. Residues of *p,p'*-DDE declined slightly or remained constant. Decrease in DDT, an increase in TDE, and an overall elimination of pesticides indicates that the clams may be metabolizing the DDT. This purging would have been accomplished when the entrance of DDT into the streams was reduced. Limited spraying or increased dilution would have caused such a reduction.

A second and possibly better explanation for the variations in observed levels of DDT and its metabolites would be runoff. It is well known that runoff is the strongest contributor of pesticides to streams which drain farmland. During the present two-year study, clams apparently assimilated greater amounts of TDE and lesser amounts of DDT as the levels entering the streams changed.

Flooding of the Mississippi River during Spring 1973, as well as limitations on DDT use, probably influenced these fluctuations of residues in clams throughout the Yazoo River Basin. Sampling sites within this basin are located near the area flooded and also drain more farmland than do any of the previously mentioned basins.

Toxaphene residues in clams were lower at most sites in 1973; however, residues in water increased. Water samples were taken near the surface, and increases in residues are probably the result of local spraying rather than runoff.

Reductions of all metabolites of DDT were observed at the sampling site within the Big Black River Basin. Levels of *p,p'*-TDE decreased, from 0.36 ppm to 0.09 ppm. Decrease in *p,p'*-DDT levels were even greater, from 0.67 ppm to 0.06 ppm; therefore, the same pattern was followed. The single sampling site from this

TABLE 1. *Comparison of 1972 and 1973 organochlorine residues in bivalves from major stream systems of the state of Mississippi*

	Residues µg/g															
	Chlordane		Endrin		Toxaphene		*p,p'*-DDE		*p,p'*-TDE		*p,p'*-DDT		*o,p'*-DDT		ΣDDT	
Yazoo Basin:	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	1973	1972	19
COLDWATER RIVER (QUITMAN COUNTY—R10W, T28N, 35)																
Corbicula manilensis	ND	ND	ND	ND	2.87	1.39	0.25	0.10	0.15	0.14	0.54	0.05	0.13	ND	1.07	0.
Lampsilis anadontoides	ND	ND	ND	ND	TR[1]	0.48	0.08	0.04	0.06	0.04	0.11	0.02	ND	ND	0.25	0.
SUNFLOWER RIVER (SUNFLOWER COUNTY—R4W, T18N, 8)																
Amblema costata	ND	ND	ND	ND	4.02	3.65	0.21	0.24	0.26	0.33	0.11	ND	0.53	0.22	1.11	17
Lampsilis anadontoides	ND	ND	ND	ND	4.86	1.51	0.28	0.12	0.27	0.16	0.22	ND	1.00	0.05	1.78	0.
Plectomerus dombeyanus	ND	ND	ND	ND	1.01	0.75	0.05	0.10	0.10	0.14	ND	ND	0.08	0.03	0.23	0.
STEEL BAYOU (ISSAQUENA COUNTY—R8W, T10N, 12)																
Amblema costata	ND	ND	ND	ND	1.09	0.72	0.12	0.18	0.13	0.16	ND	ND	0.07	0.01	0.32	0.
Corbicula manilensis	ND	ND	ND	ND	7.68	3.62	0.39	0.23	0.40	0.49	ND	ND	0.53	0.10	1.32	0.
Lampsilis anadontoides	ND	ND	ND	ND	1.93	1.11	0.18	0.11	0.21	0.21	ND	ND	0.12	0.04	0.51	0.
Plectomerus dombeyanus	ND	ND	ND	ND	0.84	0.62	0.08	0.08	0.10	0.14	ND	ND	0.07	0.04	0.25	0.
Big Black River Basin:																
BIG BLACK RIVER (WARREN COUNTY—R5W, T6N, 22)																
Corbicula manilensis	ND	ND	ND	ND	4.43	3.78	0.27	0.07	0.36	0.09	0.10	ND	0.67	0.06	1.40	0.
Lampsilis anadontoides	ND	ND	ND	ND	TR[1]	1.01	0.04	0.02	0.05	0.03	ND	ND	0.06	0.02	0.14	0.
Tombigee River Basin:																
TOMBIGBEE RIVER (LOWNDES COUNTY—R18W, T18S, 17)																
Megalonaias gigantea	ND	ND	ND	TR[1]	0.92	0.22	0.08	0.04	0.06	0.02	0.08	0.03	ND	ND	0.22	0.
Pearl River Basin:																
PEARL RIVER (HINDS COUNTY—R1E, T6N, 36)																
Amblema costata	0.01	ND	ND	ND	ND	0.13	0.05	TR[2]	0.02	TR[2]	TR[2]	TR[2]	ND	ND	0.07	TI
Lampsilis anadontoides	0.01	ND	ND	ND	ND	TR[1]	0.03	TR[2]	TR[2]	TR[2]	ND	ND	ND	ND	0.03	TI
Plectomerus dombeyanus	TR[2]	ND	ND	ND	ND	0.13	0.02	0.01	TR[2]	TR[2]	ND	ND	ND	ND	0.02	0.
Corbicula manilensis	ND	ND	ND	ND	ND	TR[1]	0.01	TR[2]	ND	TR[2]	ND	ND	ND	ND	0.01	TI
Lampsilis anadontoides	ND	ND	ND	ND	ND	TR[1]	ND	TR[2]	ND	TR[2]	ND	ND	ND	ND	ND	TI
PEARL RIVER (PEARL RIVER COUNTY—R18W, T5S, 29)																
Corbicula manilensis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N
Pascagoula River Basin:																
CHUNKY RIVER (NEWTON COUNTY—R13E, T6N, 36)																
Corbicula manilensis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N
Elliptio crassidens	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N
Lampsilis anadontoides	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N
CHICKASAWHAY RIVER (WAYNE COUNTY—R7W, T8N, 10)																
Corbicula manilensis	ND	ND	ND	ND	ND	TR[1]	ND	TR[2]	ND	TR[2]	ND	TR[2]	ND	ND	ND	TI
Elliptio crassidens	ND	ND	ND	ND	ND	0.30	ND	TR[2]	ND	TR[2]	ND	0.03	ND	ND	ND	0.
LEAF RIVER (JONES COUNTY—R13W, T6N, 33)																
Corbicula manilensis	ND	ND	ND	ND	ND	TR[1]	0.04	0.02	0.05	0.01	0.05	0.02	ND	ND	0.13	0.
Lampsilis anadontoides	ND	ND	ND	ND	ND	TR[1]	0.01	0.01	TR[2]	TR[2]	TR[2]	TR[2]	ND	ND	0.01	0.
PASCAGOULA RIVER (GEORGE COUNTY—R8W, T2S, 23)																
Corbicula manilensis	ND	ND	ND	ND	ND	ND	TR[2]	TR[2]	TR[2]	TR[2]	ND	ND	ND	ND	TR[2]	TI
Lampsilis anadontoides	ND	ND	ND	ND	ND	ND	ND	TR[2]	ND	TR[2]	ND	TR[2]	ND	ND	ND	TI
Plectomerus dombeyanus	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N
BLACK CREEK (GEORGE COUNTY—R8W, T3S, 14)																
Lampsilis claibornensis	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	N

NOTE: ND = None detected.
[1] Less than 0.1 µg/g for toxaphene.
[2] Less than 0.01 µg/g for DDT and metabolites.

TABLE 2. *Pesticide residues in water samples taken concurrently with Pelecypoda samples from major stream systems in the state of Mississippi, 1973*

AMPLING SITE	ORGANO-CHLORINES	RESIDUES, µG/LITER (PPB)
'AZOO RIVER BASIN:		
Coldwater River (Quitman County—R10W, T28N, 35)	Toxaphene	0.46
	p,p'-DDE	0.01
Sunflower River (Sunflower County—R4W, T18N, 8)	Toxaphene	0.44
Steele Bayou (Issaquena County—R8W, T10N, 12)	Toxaphene	2.11
	Methyl parathion	0.25
IIG BLACK RIVER BASIN:		
Big Black River (Warren County—R5W, T6N, 22)	Toxaphene	1.42
	Methyl parathion	0.46
'OMBIGBEE RIVER BASIN:		
Tombigbee River (Lowndes County—R18W, T18S, 17)	Methyl parathion	0.08
'EARL RIVER BASIN:		
Three sampling sites	None detected	
'ASCAGOULA RIVER BASIN:		
Five sampling sites	None detected	

asin is the lower end of the more highly agricultural, r Delta, region of Mississippi.

he single species collected from the Tombigbee River asin, *M. gigantea*—a large species of clam whose soft arts weigh in excess of 300 g in mature adults—howed reduced levels of all pesticides except endrin etween 1972 and 1973 (Table 1). Trace amounts of ndrin were found in this species in 1973 but not in 972. The Tombigbee River Basin drains away from he Mississippi River, thus agricultural lands are not as xtensive as around the Yazoo and Big Black Basins. s anticipated in this large species from the Tombigbee iver Basin, DDT and toxaphene levels were lower n 1972. Also, its residues were proportionately less educed by 1973 than the residues in other, smaller pecies from the Delta basins. Since 300 g of tissue was oo large an amount to be extracted by this procedure, 0 g of tissue consisting of approximately equal amounts rom the gill, mantle, foot, and visceral mass were ex-racted. Reported levels may have varied slightly because f differences in the amounts of tissues extracted.

n the Pearl River Basin, 1973 residues of DDT and its etabolites in clams and water also decreased in areas here detectable levels had been found the previous ear. Toxaphene residues in clams increased slightly Table 1).

his Pearl River Basin, which is located south of the elta region and east of the Mississippi River, receives ewer pesticides than the Yazoo, Big Black, or Tom-igbee River Basins. The increase in toxaphene residues, lthough slight, is further evidence of the tendency f clams to reflect local fluctuations since no increases in toxaphene were observed in the flooded areas. Chlordane was found in clams in 1972 at one site on the Pearl River near Jackson, Mississippi (Fig. 1, No. 6), but was not found in 1973. Chlordane residues were very low and no residues of chlordane were detected in any other clam or water samples throughout the state.

Results of analysis of clams from the Pascagoula River Basin were similar to the Pearl River Basin results (Table 1). At Stations 10 and 12 (Fig. 1) slight increases in both toxaphene and DDT and its metabolites were recorded. These increases were between 0.005 µg/g and 0.01 µg/g in all but one sample (Table 1). On the Leaf River, Station 11, a decrease in DDT levels was observed between 1972 and 1973. This basin is the farthest from the Delta region, and residues were so low that no other trends in pesticide changes could be determined between 1972 and 1973.

A comparison of these increases and decreases in DDT residues in clams shows that *C. manilensis* is the best indicator of change. In every instance in 1972, *C. manilensis* contained the highest levels of DDT and toxaphene. In 1973, *C. manilensis* again showed the most substantial reductions (Table 1). This imported species, which is taxonomically, anatomically, and physiologically different from the Unionid species tested, might have a greater tendency to concentrate pesticides and a correspondingly greater ability to eliminate them.

Conclusions

Results indicate that freshwater clams are of value in reflecting changes in pesticide levels in streams. In areas where pesticides have been used for many years, once-a-year sampling programs may be sufficient to reflect changes in extremely residual pesticides, such as DDT. At all sampling sites within the Delta region of Mississippi, large reductions, not elimination, of DDT and its metabolites were recorded in clams between 1972 and 1973. In other areas of the state where pesticides were not expected because of lack of large agricultural operations, none were found; therefore the greatest contributor of pesticides to the streams of Mississippi is agricultural usage.

Although it is an indirect means of assessment, monitoring pesticides in freshwater clams may provide additional information on residue occurrence. Analysis of water is not reflective of biological concentrations.

Different species of clams also seem to have varying tendencies to concentrate and varying abilities to eliminate pesticides. *C. manilensis* is apparently the best indicator of the freshwater species sampled.

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Organochlorine and Heavy Metal Residues in Black Duck Eggs from the Atlantic Flyway, 1978 [1]

Susan D. Haseltine, Bernard M. Mulhern, and Charles Stafford

ABSTRACT

Black duck (Anas rubripes) *eggs were collected during 1978 in the Atlantic Flyway. One egg from each of 49 clutches was analyzed for organochlorine compounds and mercury. DDE was detected in 39 eggs, ranging from 0.09 ppm to 3.4 ppm, wet weight. DDE residues were highest in eggs from Delaware, where the mean DDE level was 2.0 ppm. DDT and TDE were present at low levels in only five and four eggs, respectively. PCBs resembling Aroclor 1260 were detected in 24 eggs and ranged from 0.43 ppm to 2.9 ppm. Eggs from Massachusetts and Rhode Island contained an average of >1.0 ppm PCBs, but eggs from Nova Scotia, Pennsylvania, Maryland, and Virginia contained no detectable PCBs. Dieldrin, oxychlordane, and heptachlor epoxide were present in a few samples at low levels. Mercury was detected in 31 eggs, ranging from 0.07 ppm to 0.34 ppm, wet weight. Twenty eggs analyzed for chromium, copper, and arsenic contained averages of 0.64 ppm, 1.7 ppm, and 1.18 ppm, respectively. No geographic pattern was observed in these metal residue levels. Eggshell thickness (0.347 mm) was identical to the pre-1946 norm.*

Introduction

Concern over reports of a declining black duck (*Anas rubripes*) population in the Atlantic Flyway (*7, 11*) led to a survey of organochlorine pesticides in eggs of this species in 1964 (*13*). DDE averaged over 4 ppm in eggs from three states in that survey, and DDT was present in all eggs analyzed. Use of DDT in the United States had declined when another collection of eggs was made in 1971 to see if residues in black duck eggs had also declined (*9*). Although DDT had decreased and there was a general downward trend in DDE residues, individual eggs in 1971 still contained DDE levels comparable to those in 1964.

The egg collection was again repeated in 1978, almost six years after a virtual ban on use of DDT in the Flyway. The 1978 survey was undertaken to determine trends in organochlorine pollutant loads, to gain information on heavy metal residues in black duck eggs, and to generally assess the relationship of these residues to population levels of black ducks in the Atlantic Flyway. The results are reported here.

Sample Collection and Preparation

In 1978, biologists in the Atlantic Flyway located and collected two eggs from each of 49 black duck nests. Eggs were individually wrapped in aluminum foil, packed in foam rubber, and shipped via air freight to the Patuxent Wildlife Research Center, Laurel, Maryland.

Egg measurements included weight, maximum length and breadth, and volume. Volume was measured by water displacement if eggs were whole, and by the formula $V = 0.506315LB^2 + 0.924992442$, where V = volume, ml; L = length, cm; B = breadth, cm, if eggs were cracked (*9*). Because dehydration or loss of lipid occurs in embryonated eggs, a specific gravity of 1.0 was assumed for all eggs, and residue values (ppm) were based on egg volume (*16*).

All dirt was cleaned off eggshells before they were opened at the equator and their contents extruded into a glass jar. Stage of embryonic development was noted and the contents were frozen until time for chemical analysis. One egg per clutch was analyzed for organochlorines and mercury (Hg). Twenty of these eggs were also analyzed for copper (Cu), chromium (Cr), and arsenic (As): two from Nova Scotia, three from Maine, three from New Hampshire, two from Massachusetts, four from Rhode Island, four from Delaware, and two from Virginia. Eggshells were washed with membranes intact and air-dried for two weeks. Four shell thickness measurements were taken at the equator with a Starrett 1010M micrometer with 0.01 mm graduations. The mean of these four values was considered the eggshell thickness for that egg.

Statistical comparison of residue levels in 1971 and 1978 were made, where possible, by a Student *t*-test. Since arithmetic and geometric means were nearly equal, arithmetic rather than geometric means were

[1] Fish and Wildlife Service, U.S. Department of the Interior, Patuxent Wildlife Research Center, Laurel, Md. 20811.

compared. Comparison of mean eggshell thickness measurements from pre-1946, 1964, 1971, and 1978 was made with one-way analysis of variance and Bonferroni multiple comparisons.

Analytical Procedures

ORGANOCHLORINES

Eggs were analyzed for *p,p'*-DDE, *p,p'*TDE, *p,p'*-DDT, dieldrin, heptachlor epoxide, oxychlordane, *cis*-chlordane, *trans*-nonachlor, *cis*-nonachlor, endrin, HCB, mirex, toxaphene, and polychlorinated biphenyl (PCB) residues. Egg contents were homogenized, mixed with anhydrous sodium sulfate, and extracted with hexane in a Soxhlet apparatus for 7 hours. Extracts were cleaned on a partially deactivated Florisil column (*1*). Pesticides and PCBs were separated on a SilicAR column into four fractions as described by Kaiser et al. (*8*).

Residues were quantified on a gas-liquid chromatograph equipped with a electron-capture detector and a column packed with a mixture of 1.5 percent OV–17 and 1.95 percent QF–1, under the conditions described by Kaiser et al. (*8*). Residues in three samples were confirmed on a Finnigan 4000 series gas-liquid chromatograph/mass spectrometer (*8*).

Recoveries of pesticides and PCBs from fortified chicken eggs averaged 94 percent. Residues reported here were not corrected for recovery. The lower limit of quantification was 0.1 ppm for all pesticides and 0.5 ppm for PCBs.

MERCURY

Eggs were homogenized in a Virtis blender, and a 5-g portion was taken for Hg analysis. Samples were digested by a method similar to that described by Monk (*12*). Mercury levels were determined by a cold vapor atomic absorption spectrometry method similar to that of Hatch and Ott (*4*), using a Coleman Model MAS 50 mercury analyzer. A portion of sample was added to a BOD bottle and diluted to 50 ml with water. Five milliliters of 10 percent hydroxylamine hydrochloride and 5 ml of 10 percent stannous chloride were added to the mixture to reduce Hg ions to metallic Hg. The sample was aerated and the Hg was measured in the air stream passing through a gas cell in the path of ultraviolet light at 253.7 nm.

Recoveries of Hg from spiked chicken liver samples averaged 93 percent. The lower limit of quantification was 0.02 ppm. Samples were not corrected for percent recovery.

COPPER, CHROMIUM, AND ARSENIC

A 5-g portion of each homogenized egg was dried for 2 hours at 110°C in a drying oven, then charred 2 hours at 200°C in a muffle furnace. The temperat was raised to 600°C at a rate of 100°C/hour and sample was left to ash overnight. The ash was coo dissolved over a hotplate in approximately 4 ml ni acid and 1 ml hydrochloric acid, transferred to a 50 polypropylene centrifuge tube, and diluted to 10 with distilled deionized water. This solution was u for Cu and Cr analyses.

A 5-g aliquot was digested overnight at room tempe ture in 20 ml concentrated nitric acid. After an ac tion of 5 ml aqueous 1 percent Ni as $Ni(NO_3)_2$, acid was slowly boiled away until the volume in flask was approximately 1–3 ml. The remainder v transferred to a 50-ml polypropylene centrifuge tu and diluted to 25 ml with distilled deionized wa This solution was used for As analysis.

All heavy metal determinations were made by flamel atomic absorption spectrophotometry with a Perk Elmer 460 AAS instrument equipped with an EC 2200 graphite furnace and accessory ramp, a deuteri arc background corrector, an AS 1 autosampler for 20 μl injections, pyrolytically coated graphite tub and a PRS 10 printer. The furnace conditions were follows:

Dry at 110°C for 40 seconds with 30-second ra
Char at 900°C for 40 seconds with 30-second ra
Atomize at 2700°C for 5 seconds with no ramp

The peak height mode was used with an integrati time of 7 seconds.

The Cu and Cr determinations were made by compa son with aqueous standards at wavelengths of 32 nm and 357.8 nm, respectively, using hollow cathc lamps.

The As determination was made by the method additions with the matrix modification of adding a percent solution of Ni as $Ni(NO_3)_2$ to the furnace described by Shum et al. (*14*). An electrodeless d charge lamp and wavelength of 193.7 nm were used.

The lower limits of quantification were 0.05 ppm Cu and Cr and 0.1 ppm for As. Recoveries from for fied chicken livers ranged from 92 percent to 97 p cent; residues were not corrected on the basis of the data.

Results and Discussion

ORGANOCHLORINES

DDE and PCBs were the only organochlorines detect in the majority of the 49 eggs analyzed (Table 1 DDE was present in 39 eggs; the average concenti

TABLE 1. *DDE, PCB, and mercury residues in black duck eggs from the Atlantic Flyway, 1978*

OCATION OLLECTION	NO. OF CLUTCHES	*p,p'*-DDE	AROCLOR 1260	Hg
		CANADA		
ova Scotia	3	0.32 ± 0.15[1] ND–0.58 (2)[3]	ND[2]	0.13 ± 0.03 0.07–0.16 (3)
ew Brunswick	1	ND	0.60 (1)	0.14 (1)
uebec	4	0.64 ± 0.45 0.19–2.0 (4)	0.25 ± 0.20 ND–0.84 (1)	0.12 ± 0.04 ND–0.21 (3)
		UNITED STATES		
laine	6	0.26 ± 0.19 ND–1.2 (4)	0.34 ± 0.29 ND–1.8 (1)	0.18 ± 0.05 ND–0.34 (5)
ew Hampshire	5	0.32 ± 0.15 0.12–0.96 (5)	0.61 ± 0.31 ND–1.7 (3)	0.11 ± 0.03 ND–0.20 (4)
ermont	4	0.44 ± 0.25 0.14–1.2 (4)	0.44 ± 0.23 ND–0.95 (2)	0.10 ± 0.01 0.08–0.14 (4)
lassachusetts	2	0.63 ± 0.37 0.26–1.0 (2)	1.1 ± 0.10 1.0–1.2 (2)	0.08 ± 0.01 0.07–0.09 (2)
hode Island	5	0.36 ± 0.05 0.25–0.50 (5)	1.3 ± 0.21 0.62–1.8 (5)	0.13 ± 0.04 ND–0.25 (4)
ennsylvania	1	0.11 (1)	ND	0.08 (1)
elaware	10	2.0 ± 0.25 0.84–3.4 (10)	0.98 ± 0.23 ND–2.9 (9)	0.09 ± 0.02 ND–0.30 (4)
aryland	2	0.10 ± 0.02 0.09–0.12 (2)	ND	ND
irginia	6	ND	ND	ND
tlantic Flyway	49	0.65 ± 0.12 ND–3.4 (39)	0.56 ± 0.09 ND–2.9 (24)	0.11 ± 0.01 ND–0.34 (31)

[1] Arithmetic mean ± SE. Range of values appears under the mean.

[2] ND—Sample or samples analyzed were below the quantification limit of 0.1 ppm before correction for moisture loss. If no eggs from a sampling unit contained quantifiable residues, ND appears in table. If one or more eggs from the sampling unit contained quantifiable residues, ND samples were used in calculating means as 0.05 ppm. ND samples in flyway means also equaled 0.05 ppm.

[3] Numbers in parentheses are the number of samples containing quantifiable residue levels.

on was 0.65 ppm DDE and the highest concentration as 3.4 ppm. Eggs from New Brunswick and Virginia ontained no DDE. In the nine states and provinces here eggs were collected in both 1971 and 1978, DDE in eggs averaged 1.2 ppm and 0.80 ppm, respecvely ($P > 0.05$). Eggs collected in Delaware in the 971 survey averaged 5.9 ppm DDE and ranged up to 4 ppm. Eggs in the present survey averaged only 2.0 pm DDE, a significant decrease ($P < 0.05$), and the ghest residue level was 3.4 ppm. In contrast, eggs om Vermont contained comparable levels of DDE in 971 and 1978. Mean DDE levels were 0.51 ppm in 971 and 0.44 ppm in 1978; the highest DDE level etected was 1.0 ppm in 1971 and 1.2 ppm in 1978.

It would appear that although states with higher DDE levels in black duck eggs have shown decreases over the last seven years, those states with lower levels are still showing little decline.

The incidence of DDT residues in 1971 and 1978 samples varies significantly. DDT occurred at > 0.1 ppm in 31 of 61 eggs analyzed in 1971, but in only 5 of 49 eggs analyzed in 1978. Three of these eggs were collected in Delaware (0.09–1.3 ppm DDT) and two in Rhode Island (0.14 ppm and 0.17 ppm).

Low levels (0.10–0.15 ppm) of TDE were found in only four of the 49 eggs analyzed in 1978 (two from Delaware and one each from Maine and Quebec). In 1971, TDE was detected at levels > 0.1 ppm in 11 of the 61 eggs.

PCBs resembling Aroclor 1260 were detected in 24 of the 49 black duck eggs. They were not detected in eggs from Nova Scotia, Pennsylvania, Maryland, and Virginia. Average PCB values ranged from 0.25 ppm in Quebec to 1.3 ppm in Rhode Island. The highest PCB residue of 2.9 ppm was detected in an egg from Delaware. These residues cannot be quantitatively compared with 1971 residues because a different analytical technique was used; however, residues were generally lower and occurred in a smaller percentage of samples.

Dieldrin was found at low levels in ony two samples analyzed, one from Delaware (0.09 ppm) and one from Massachusetts (0.17 ppm). Heptachlor epoxide was detected in only one sample, collected in Rhode Island (0.14 ppm). Again these are not comparable to 1971 residue levels. The decreased incidence of residues is related to the increase of detection limit from 0.05 ppm to 0.1 ppm for dieldrin and from 0.01 ppm to 0.1 ppm for heptachlor epoxide. Dieldrin was detected at levels > 0.1 ppm in 13 of the 61 eggs analyzed in 1971 and heptachlor epoxide was present in only two of the 1971 eggs at this level. These residue levels cannot be quantitatively compared because of differences in analytical techniques, but low concentrations were observed in eggs from both surveys. Oxychlordane was present in one black duck egg from Maine (0.12 ppm), two eggs from New Hampshire (0.13 and 0.16 ppm), one egg from Massachusetts (0.08 ppm), and one egg from Maryland (0.05 ppm). No other organochlorine residues were detected.

HEAVY METALS

Mercury was detected in 31 of the 49 eggs analyzed (Table 1). The overall mean was 0.11 ppm Hg, and residues ranged up to 0.34 ppm. No Hg was detected in eggs from the two states, Maryland, and Virginia. Other state and province means ranged from 0.08 ppm in Massachusetts and Pennsylvania to 0.18 ppm in

Maine. These levels are below those usually associated with decreased hatchability or survival of young pheasants (*2, 15*) or mallards (*5, 6*). Captive black ducks on a diet of 3 ppm methylmercury produced eggs containing 4–6 ppm Hg, wet weight, and both hatching and survival of young were depressed (*3*). The residues observed in eggs from the 1978 field collection are below this effect level.

Chromium and copper were detected in all 20 eggs analyzed for heavy metals. Average residue levels (mean ± SE) were 0.64 ± 0.07 ppm Cr and 1.68 ± 0.10 ppm Cu. Arsenic was present in 18 of the 20 eggs analyzed; the average level was 0.18 ± 0.02. Eggs from different sampling sites contained comparable Cu, Cr, and As residues.

EGGSHELL THICKNESS

Eggshell thicknesses of black duck eggs collected before 1946, when DDT use became widespread, and in 1964, 1971, and 1978 are presented in Table 2. Eggshell thickness in 1978 eggs averaged 0.345 mm (N = 49 clutches). Eggs more than 1-week developed were eliminated from the analyses, since embryo development can affect eggshell thickness. The 36 clutches remaining showed an average thickness (mean ± SE) of 0.347 ± 0.003 mm. These eggs were used in comparing 1978 eggshell thickness to thickness during other years. The range of eggshell thickness in 1978 was 0.279–0.389 mm.

There was no difference in eggshell thickness between eggs collected before 1946 (0.347 mm) and those collected in 1978 (0.347 mm). Eggshells collected in 1971 were also of a thickness comparable to those collected before 1946 and during 1978. Eggshells collected in 1964, however, were 7.5 percent thinner than the pre-1946 norm, and significantly thinner ($P <$ 0.01) than eggshells collected in 1971 and 1978. The decrease in 1964 eggshell thickness was perhaps associated with the higher DDE residues found in the black duck eggs during that 1964 survey. DDE has been shown to cause shell thinning and lowered reproductive success in captive black ducks (*10*).

TABLE 2. *Shell thickness of black duck eggs from the Atlantic Flyway*

Parameter	Date of Collection			
	Pre-1946	1964	1971	1978
Eggshell thickness[1] (mm ± SE)	0.347 ± 0.003[2]	0.321 ± 0.004[3]	0.343 ± 0.003[3]	0.347 ± 0.003
N	38[4]	37[5]	52[5]	36[5]
% decrease from pre-1946	—	7.5[6]	1.2	—

[1] Mean of four measurements at the equator, membranes intact, all eggs developed < 7 days.
[2] Data are from H. M. Ohlendorf and E. E. Klaas, U.S.F.W.S., personal communication, July 1979.
[3] Data are from Longcore and Mulhern (9) and J. R. Longcore, U.S.F.W.S., personal communication, July 1979.
[4] N = number of clutches from which all eggs were measured and a clutch mean determined.
[5] N = number of clutches, from which one or two eggshells were measured.
[6] Eggshell thickness is lower than in all other years, one-way analysis of variance, Bonferroni pair-wise comparisons, $P < 0.01$.

Summary

DDE and PCBs were the only organochlorines fou routinely in black duck eggs collected in 1978. D had not decreased significantly from 1971 levels o flyway basis, but residues in more heavily contamina areas had decreased. Mercury was found at low (0 0.3 ppm) levels in the eggs and chromium, copper, arsenic were detected at levels below 2.5 ppm. Eggsl thickness was comparable to pre-1946 measureme organochlorine and mercury residues were below th associated with reproductive problems in captive wa fowl.

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Significance of Organochlorine and Heavy Metal Residues in Wintering Shorebirds at Corpus Christi, Texas, 1976–77

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ABSTRACT

Organochlorine and heavy metal residues were determined in 103 shorebirds of seven species collected at Corpus Christi, Texas, during the winter of 1976–77 to evaluate their potential effects on population survival. DDE and polychlorinated biphenyls (PCBs) were detected in most samples. Chlordane isomers, dieldrin, toxaphene, and heptachlor epoxide also occurred, but less frequently. In general, organochlorine residues were low in skinned carcasses. Geometric means on a wet weight basis ranged from 0.25 ppm to 4.76 ppm for DDE and from 0.67 ppm to 6.64 ppm for PCBs; residues of the other compounds averaged less than 1 ppm in all instances. Mercury, lead, arsenic and vanadium occurred in all shorebird livers, and selenium and cadmium were detected in all kidneys. Residues of these metals, except selenium, were low in most tissue samples. Selenium averages varied from 1.77 ppm to 5.62 ppm (wet weight) in kidneys; residues in this range may be sufficient to inhibit reproduction or to induce other forms of toxicity, especially at the higher levels.

Introduction

During the winter, large numbers of shorebirds of many species use the mudflats and shallow inlets of the bays at Corpus Christi, Texas. The south shore of Nueces Bay is crowded with an industrial complex including oil refineries, a zinc-smelting plant, chemical plants, and other industries; agricultural lands encompass much of the northern shores of Nueces and Corpus Christi Bays (Fig. 1). Sediments from parts of the Bay system are heavily contaminated with zinc and cadmium (*9*), and eggs of some aquatic birds have high levels of DDE (D. H. White, unpublished data). Thus, the potential for pollution problems is high in this area because of industrial effluents and pesticide runoff from surrounding croplands. Conservationists have expressed concern that wintering birds in this area may be accumulating harmful levels of environmental contaminants. This study was conducted to determine the levels of organochlorine and heavy metal resic in tissues of wintering shorebirds and to evaluate significance of contamination on population surviva

Collection Methods

Shorebirds were collected at opportune times fr December 1976 through March 1977 at the locati listed by species on Figure 1. Birds were killed u 12-gauge #4 steel shot so that tissue analyses for l would not be biased. Soon after collection, birds w tagged, placed individually in polyethylene bags, stored frozen until they were prepared for analysis total of 103 shorebirds of seven species was collec for organochlorine and heavy metal analysis.

Analytical Procedure

Organchlorine analyses were conducted at the Patux Wildlife Research Center, Laurel, Maryland. Bef analysis, the birds were skinned, and the feet, be wingtips, and gastrointestinal tracts were remov The kidneys and livers were saved for heavy m analyses. The carcasses were homogenized in a f grinder and a 10-g portion was mixed with anhydr sodium sulfate and extracted 7 hours with hexane i Soxhlet apparatus. Lipids were removed by Flo column chromatography. The procedures used w those described by Cromartie et al. (*3*), except t the organochlorines were separated into four fracti on the SilicAR column rather than three fractions ensure the separation of dieldrin or endrin into individual fraction (*10*).

The pesticides in each fraction were identified quantified with a gas-liquid chromatograph equip with an electron-capture detector and a 1.5 perc OV–17/1.95 percent QF–1 column. Recoveries pesticides and PCBs from spiked samples avera 94 percent; residues were not corrected for recov The lower limit of quantification was 0.1 ppm for pesticides and 0.5 ppm for PCBs. All residues are pressed as ppm wet weight. Residues in 13 percent

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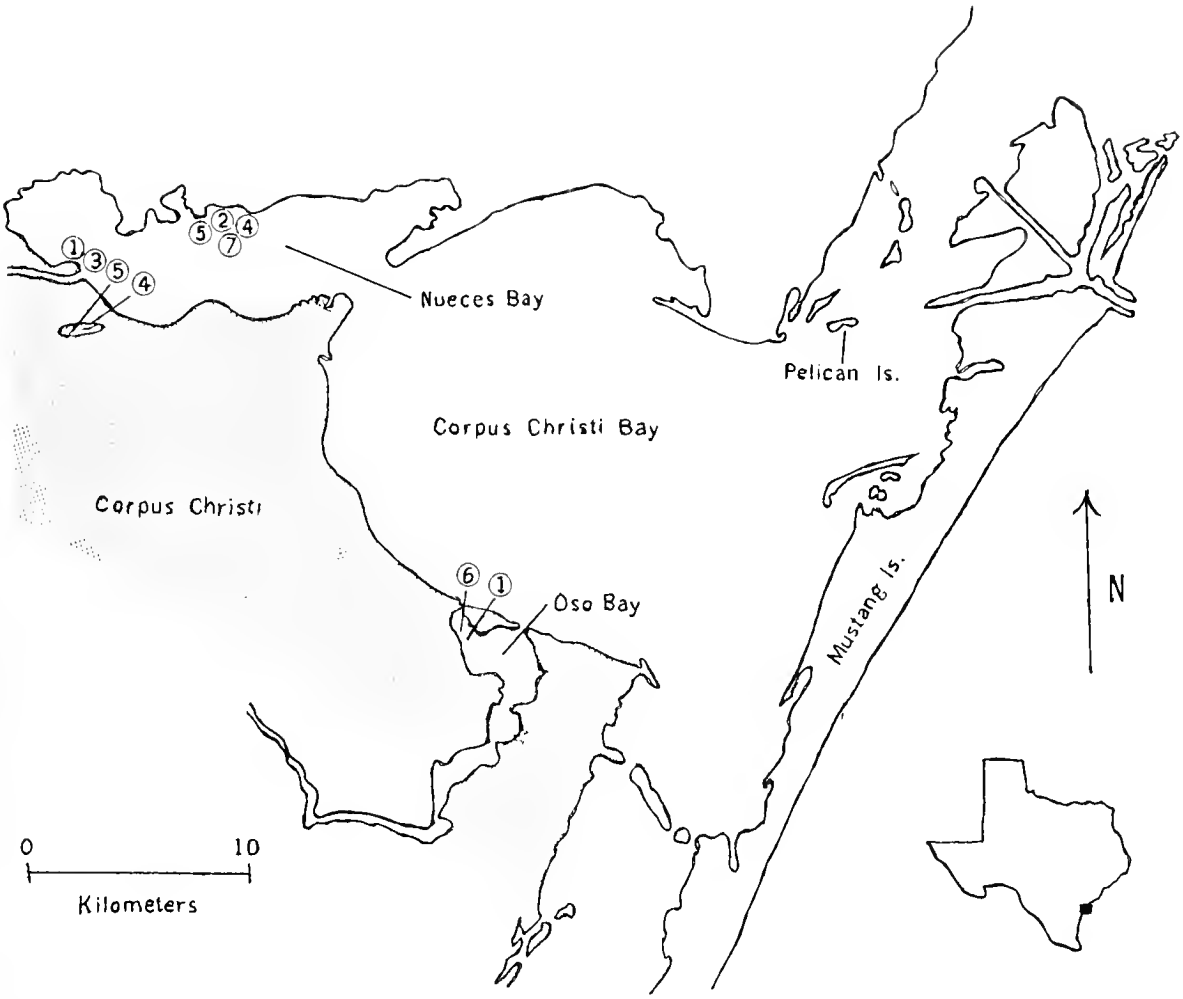

IGURE 1. *Shore bird collection sites at Corpus Christi, Texas, 1976–77. Circled numbers represent sites for separate ecies; 1 = avocet, 2 = dunlin, 3 = greater yellowlegs, 4 = least sandpiper, 5 = lesser yellowlegs, 6 = sanderling, and 7 = western sandpiper.*

ıe samples were confirmed with a Finnigan 4000 series as-liquid chromatograph/mass spectrometer.

ıorebird livers and kidneys were analyzed for certain eavy metals at Analytical Bio Chemistry Laboratories, ıc., Columbia, Missouri. Samples were shipped frozen dry ice in chemically cleaned jars.

ımples were digested with 8 ml concentrated, double-stilled nitric acid for 4 hours on a reflux apparatus. 'ater condensers were used to condense the nitric acid ıring the digestion. Following digestion, the samples ere diluted to 50 ml with 1 percent hydrochloric acid. subsample of this digestate was further digested with tric and nitric:perchloric acid to white fumes of rchloric acid. The sample digestate was then diluted 25 ml with deionized water. The sample was then ıalyzed by atomic absorption or flame emission spec-ophotometry. When graphite furnace techniques were ed, solution concentrations were determined by the ethod of additions. Solution concentrations of those elements where flame techniques were used were determined by comparison of sample and standard peak heights. The standards contained approximately the same acid concentrations as the samples.

Analyses were conducted on a PE 305B atomic absorption unit with background correction. Graphite furnace analysis was performed on a PE MHS–10 hydride generation system. Recoveries of the various metals from spiked samples ranged from 74 percent to 106 percent; residues were not corrected for recovery. The lower limit of quantification was 0.1 ppm for mercury, lead, arsenic, selenium, and cadmium, and 0.05 ppm for vanadium. All residues are expressed as ppm wet weight.

Results and Discussion

ORGANOCHLORINE RESIDUES

Residues of DDE, PCBs, chlordane isomers, dieldrin, toxaphene, and heptachlor epoxide in shorebird carcasses are shown in Table 1. Mirex was present in only

TABLE 1. *Organochlorine residues in carcasses of wintering shorebirds from Corpus Christi, Texas, 1976–77*

Species	No.	Residues, ppm Wet Weight					
		DDE	PCBs	Chlordane Isomers	Dieldrin	Toxaphene	Heptachlo Epoxide
Avocet (*Recurvirostra americana*)	4	1.49[1] (4)[2] 0.5–2.6[3]	0.79 (4) 0.1–3.0	0.96 (2) 0.7–1.4	0.47 (3) 0.2–1.0	ND	ND
Dunlin (*Calidris alpina*)	13	3.15 (13) 1.0–9.0	1.19 (13) 0.5–8.0	0.12 (2) —	0.19 (7) 0.1–0.4	0.21 (5) 0.1–0.4	ND
Greater Yellowlegs (*Tringa melanoleucus*)	2	1.90 (2) 1.5–2.4	0.97 (2) 0.8–1.2	ND	ND	ND	ND
Least Sandpiper (*Calidris pusillus*)	30	1.07 (30) 0.2–4.6	0.67 (16) 0.8–3.6	0.16 (3) 0.1–0.7	0.16 (14) 0.1–0.6	0.19 (11) 0.1–0.5	0.32 (2) 0.2–0.5
Lesser Yellowlegs (*Tringa flavipes*)	17	4.55 (17) 1.7–9.0	0.79 (14) 0.5–1.8	0.13 (3) 0.1–0.2	0.16 (9) 0.1–0.3	0.29 (9) 0.2–0.7	0.14 (2) 0.1–0.2
Sanderling (*Calidris alba*)	15	4.76 (15) 1.6–10	6.64 (15) 2.4–18	0.66 (15) 0.2–1.7	0.28 (13) 0.1–0.6	0.14 (1) —	0.19 (14) 0.1–0.3
Western Sandpiper (*Calidris mauri*)	22	0.25 (17) 0.1–0.7	0.95 (22) 0.2–4.3	0.20 (7) 0.1–0.4	0.13 (8) 0.1–0.2	0.24 (9) 0.1–1.9	ND

NOTE: ND = not detected; — = not applicable.
[1] Geometric mean.
[2] Values in parentheses are actual number of samples containing detectable residues. These values were used in calculating means.
[3] Extreme values.

one sample at 0.53 ppm, but no other organochlorine compounds were detected in these samples. DDT metabolites were present in 95 percent of the samples analyzed, with most residues being identified as DDE. DDE concentrations were highly variable among individuals and species, ranging from 0.1 ppm to 10 ppm. Lowest overall DDE concentrations were found in western sandpipers (*Calidris mauri*) and the highest occurred in sanderlings (*Calidris alba*) (Table 1).

In general, DDE residue concentrations in shorebird carcasses were relatively low, and only moderately higher than levels measured in control birds in dietary experiments. Mallards (*Anas platyrhynchos*) fed diets containing 40 ppm DDE for 96 days averaged 33 ppm in carcasses 42 days after cessation of treated food; 11 months after DDE exposure, carcasses averaged 9.6 ppm in treated birds and only 0.5 ppm in controls (*8*). Black ducks (*Anas rubripes*) fed 10 ppm DDE for 7 months averaged 155 ppm in carcasses whereas controls averaged about 0.3 ppm (*12*); 2 years after exposure ceased, DDE levels in black ducks averaged 12 ppm in males and 3.4 ppm in females. Thus, it appears that shorebirds in the area sampled are being exposed to low environmental levels of DDE, if we assume that residue accumulation and loss is directly correlated with exposure (*20*).

PCBs occurred in 83 percent of the samples, ranging from 0.1 ppm to 18 ppm. As with DDE, PCB residue levels were highly variable among individuals and species (Table 1). The geometric mean of PCB concentrations in sanderlings was about seven-fold higher th in any other species; all the sanderlings were collec from Oso Bay (Fig. 1) near the outlet of a sew treatment plant which may account for their eleva levels. Overall, PCB levels in shorebird carcasses w far below those levels known to cause death or rep ductive problems in other avian species (*19*). Carcas of great cormorants (*Phalacrocorax carbo*) suspected dying from PCB poisoning contained residue conc trations ranging from 29 ppm to 460 ppm (*11*). cause PCBs are highly cumulative in avian tissues, is DDE, we believe that shorebirds in the Corp Christi area probably are being exposed to low envir mental levels of these compounds.

Dieldrin occurred in only 52 percent of the samp and levels averaged less than 0.5 ppm in the 6 spec where it was found (Table 1). Although dieldrin much more toxic to birds than is DDE or PCBs, t present levels in shorebirds are not considered to be the danger zone. Residue levels in carcasses of bi known to have died from dieldrin poisoning in expe mental studies ranged from about 10 ppm to 36 pp (*23*), much higher than the carcass levels report in our study.

Chlordane metabolites including oxychlordane, c chlordane, *trans*-nonachlor, and *cis*-nonachlor we found in 32 percent of the samples, mostly in sand lings (Table 1). Residues of all metabolites were lo

they were combined for convenience and reported *chlordane isomers*. Combined residue concentrations individual samples ranged from 0.1 ppm to 1.7 ppm. l the sanderlings and 2 avocets (*Recurvirostra americana*) were collected from Oso Bay (Fig. 1) and this oup of samples contained the highest chlordane resie levels; as stated earlier, the collection site in Oso y was near the outlet of a sewage treatment plant d the residues probably reflect domestic use of lordane on lawns and gardens. Oxychlordane was most persistent and the most toxic chlordane metalite in bird-feeding studies (*21*). The levels in bodies birds that died and in survivors were far above those orted in this study; therefore, the present levels are t suspected of contributing to shorebird mortality. ie sublethal effects of chlordane to birds are unknown *1*).

ptachlor expoxide was present in only 17 percent the samples and, as with other chlordane metabolites, curred mostly in sanderlings (Table 1). Heptachlor oxide found in bird tissues may be the result of posure to either heptachlor or chlordane (*21*). Its verse effects on wildlife have been documented (*20*, ; however, the low levels we report for shorebirds probably insignificant.

AVY METALS

idues of certain heavy metals found in shorebird sues are shown in Table 2. Livers were analyzed for rcury, lead, arsenic, and vanadium and kidneys re analyzed for selenium and cadmium. All the metals ermined are known to be toxic to birds in sufficient antities. All occur naturally in the environment; how-r, the burning of fossil fuels and many industrial, domestic, and agricultural uses of these elements contribute to abnormally high levels in some areas.

In dietary experiments, mercury has been shown to accumulate greatest in feathers, liver, and kidney (*7*, *22*); uptake is rapid and loss is slow. A large proportion of the total body burden of mercury is eliminated in the feathers during molt (*22*). Most of the shorebirds that we analyzed were in full winter plumage; therefore, liver residues should give a fair indication of recent exposure levels. In general, mercury levels in our samples were considerably lower than those reported for some aquatic birds in other studies (*5*, *6*), but were similar to those in shorebirds from a relatively unpolluted area in England (*16*). Mercury levels in our samples ranged from 0.05 ppm to 5.45 ppm, but most were below 0.5 ppm (Table 2). It is believed that these levels are below those suspected of causing toxic effects in other birds (*6*).

Lead residues in liver are considered indicative of current lead exposure, and levels that range between 6 ppm and 20 ppm (wet weight) or greater may be diagnostic of acute intoxication, at least in waterfowl (*13*). Only 3 birds in our study, all western sandpipers, were within this range and residue levels in all but 2 species averaged less than 0.2 ppm (Table 2). However, Dieter (*4*) suggests that birds with liver lead levels between 0.5 ppm and 1 ppm (0.86 ppm average) may exhibit abnormally low activity of plasma delta-aminolevulinic acid dehydratase, an enzyme important in the synthesis of hemoglobin and specifically inhibited by lead. Thirty-six percent of our samples contained lead residues within that range; sanderlings and western sandpipers had the highest residues. It is unknown whether these levels adversely affect shorebirds.

TABLE 2. *Heavy metal residues in livers and kidneys of wintering shorebirds from Corpus Christi, Texas, 1976–77*

cies	No.[1]	Residues, ppm Wet Weight					
		Mercury	Lead	Arsenic	Vanadium	Selenium	Cadmium
cet	4	0.22[2] 0.05–0.53[3]	0.11 0.05–0.19	0.10 0.05–0.26	0.02 0.02–0.05	2.60 2.20–3.90	1.82 0.79–8.20
lin	10	0.47 0.28–0.78	0.19 0.05–0.58	0.07 0.05–0.35	0.06 0.03–0.16	3.55 2.40–5.00	1.94 0.52–7.30
ater Yellowlegs	2	0.83 0.67–1.04	0.11 0.05–0.25	0.05 —	0.03 0.02–0.04	1.77 1.30–2.40	1.47 1.20–1.80
st Sandpiper	16	0.50 0.11–1.69	0.17 0.05–1.28	0.06 0.05–1.50	0.07 0.03–0.23	4.23 1.60–6.90	4.31 0.83–22.7
er Yellowlegs	13	0.21 0.11–0.73	0.18 0.05–1.17	0.10 0.05–0.42	0.04 0.02–0.16	2.43 1.50–4.20	1.33 0.44–2.60
derling	15	0.67 0.12–5.45	0.93 0.24–2.01	0.14 0.05–1.23	0.07 0.02–1.20	3.96 2.10–6.40	1.38 0.33–7.90
tern Sandpiper	15	0.43 0.20–0.86	0.74 0.05–28.5	0.23 0.05–1.10	0.10 0.03–0.58	5.62 2.80–10.2	2.74 0.66–12.0

samples analyzed contained detectable levels of each metal. Livers were analyzed for mercury, lead, arsenic, and vanadium; kidneys were lyzed for selenium and cadmium.
ometric mean.
reme values.

Arsenic is a major by-product of the smelting industry and a component of herbicides and defoliants used in agriculture (*14, 17*), thus the potential for abnormal arsenic accumulation in the environment appeared to be present in the Corpus Christi area. However, residue levels in our samples were quite low overall, averaging less than 0.3 ppm in all instances and ranging up to 1.5 ppm (Table 2). The significance of these low levels in shorebirds is unknown, but the levels probably reflect background contamination and are not suspected of being extremely harmful. Blus et al. (*2*) reported similar arsenic levels in livers of South Carolina brown pelicans (*Pelecanus occidentalis*).

Vanadium concentrations in livers were lowest of all the metals; residues averaged less than 0.1 ppm in most species (Table 2). White and Dieter (*24*) found that very little vanadium accumulated in tissues of mallard ducks fed up to 100 ppm vanadium in the diet; although vanadium accumulated in small amounts, tissue levels increased with treatment level. The liver levels we report here are similar to those reported for control birds in that study and are not suspected of being particularly harmful, overall. However, lipid metabolism may be altered in laying females when vanadium in the liver approaches 0.5 ppm (*24*). Several of our birds had levels of this magnitude.

Selenium levels in shorebird kidneys (Table 2) appeared to be abnormally high when compared with the results of a study involving chickens. Laying hens fed 5, 7, and 9 ppm selenium in the diet accumulated on the average about 2.5 ppm in the kidney while controls averaged less than 1 ppm (*15*). Reproduction was inhibited, especially in those hens fed 7 ppm and 9 ppm; significant decreases occurred in egg weight, egg production, and hatchability. Mean kidney levels in our study varied from 1.77 ppm to 5.62 ppm and ranged up to 10.2 ppm in individual samples (Table 2). Body burdens of this magnitude may be sufficient to impair reproduction in shorebirds as well, or cause other forms of toxicity. Since selenium is a by-product of the smelting industry, it is not surprising that levels in shorebirds from the Corpus Christi area appear abnormally high.

Cadmium residue levels in kidneys were highly variable in individual samples, ranging from 0.33 ppm to 22.7 ppm (Table 2). Mean levels were similar to those reported for ruddy ducks (*Oxyura jamaicensis*) and canvasbacks (*Aythya valisineria*) from the Chesapeake Bay area (*26, 28*) and are considered to be fairly low. Kidneys of mallards fed 2 ppm dietary cadmium contained an average of 1.5 ppm and 2.9 ppm after 30 days and 60 days, respectively (*25*); these levels also are similar to what we report here for shorebirds. Two hundred ppm dietary cadmium produced kidney lesions and inhibited spermatogenesis in adult mallards (*27*), but kidney cadmium levels averaged almost 100 ppm in these birds.

Conclusions

Shorebirds from the Corpus Christi area contained relatively low levels of each of the organochlorine compounds detected; experimental studies with other avian species suggest that these residues, in most instances, probably are below levels known to have an adverse effect on avian reproduction and survival. Some samples, however, did contain amounts of DDE or PCB that approximate the range in which adverse effects may be expected. More important, shorebirds with fairly high residue levels may represent a potential hazard to peregrine falcons (*Falco peregrinus*) and other raptors that occasionally prey on them (*18*). Most residues of mercury, lead, arsenic, vanadium, and cadmium also were below known-effect levels. In contrast, selenium residues in shorebird tissues are cause for concern because residues in most birds were within or above the range known to inhibit reproduction in chickens. In addition, the interactions of organochlorine and heavy metal residues in wild birds are poorly understood; birds with elevated total body burdens of a mixture of pollutants may be more susceptible to disease, stress, and predation than birds with low levels.

Acknowledgments

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HUMANS

Overview of Human Exposure to Dieldrin Residues in the Environment and Current Trends of Residue Levels in Tissue

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ABSTRACT

An overview of available literature indicates that dieldrin residues are still found routinely in soil, air, water, and food, despite the 1974 U.S. Environmental Protection Agency ban on the use of aldrin and dieldrin. Dieldrin residue levels in environmental substrates, which are indicative of aldrin or dieldrin use, have decreased significantly since the mid-1960s, the peak usage years. However, human tissue studies do not show a corresponding decline in dieldrin residue levels. Thirteen studies, conducted between 1963 and 1976, show that average dieldrin levels in human adipose tissue and human milk fat remain between 0.160 ppm and 0.220 ppm. Other studies suggest that an equilibrium exists in the distribution of dieldrin among various tissues in humans, including blood, fat, brain, and liver. This relationship indicates that the concentration of dieldrin in any tissue may be used as an index of total body burden. Thus it appears that the concentration of dieldrin in the human body has reached a constant level at which the amount ingested and absorbed equals the amount metabolized and excreted. The mechanism of the stable concentrations is unknown, as are the possible health effects of chronic, low-level exposure to dieldrin.

Since the original inquiries into organochlorine toxicity and persistence in the 1960s, hundreds of studies have been conducted to determine the presence and effects of these pesticides in the environment and in humans. Organochlorines are unusually persistent due to the stability of their basic structural feature, the chlorinated ring. In virtually every study of residues in soil, air, water, and human tissue, two chemicals have stood out as particularly widespread: DDT and dieldrin. The U.S. Environmental Protection Agency (EPA) banned DDT for commercial use in the United States in 1972, and residue levels have since declined significantly (*26*). Dieldrin was banned in 1974. Despite this action, human exposure to dieldrin has not ended. Dieldrin resid are still found routinely in soil, air, water, and fo

Dieldrin reaches soil either directly, through intentio application, or indirectly, through rain or fallout fr the air. Once incorporated with soil particles, diel becomes so tightly bound that penetration through is negligible (*16*). Adsorption is determined prima by soil type, although pH, temperature, and moist content of the soil are also involved. Adsorption strongest in soils with high clay or organic matter c tent. The high cation exchange capacity causes diel to adsorb to negatively charged sites on the mine (*21*). Lateral movement is insignificant, except un conditions of heavy erosion. Residues are stabilized, they are not readily degraded. The half-life of diel residues in soil is estimated to be 2.8 years, or ei years for 95 percent disappearance (*3*). Measura residues are frequently apparent 11 years after origi use. One study showed 10 percent of a subsoil appli tion remaining 21 years after treatment (*2*). T tenacity is due in part to the paucity of soil organis capable of decomposing dieldrin. To date, only 10 h been identified.

Calculations using the half-life given above and annual sales data given in Table 1 indicate that if dieldrin sold each year from 1960 to 1974 had b distributed evenly over all agricultural acreage in United States, 0.074 pounds per acre would have cumulated in the soil by 1974—more than five tir the amount actually applied that year.

Dieldrin residues circulate constantly from one stor medium to another. Although dieldrin adsorbs tig to soil particles, small amounts may volatilize imm ately after application, thus entering the atmosph Even slow volatilization from the tremendous surf area of treated soil and plants may contribute sig

[1] U.S. Environmental Protection Agency, Office of Pesticide Programs, Benefits and Field Studies Division (TS/768-M), Washington, D.C. 20460.

TABLE 1. *Domestic sales of aldrin and dieldrin (1,000 pounds), 1960–76*

R	Aldrin	Dieldrin	Total	Literature Cited
)	8,109	2,650	10,759	(*46*)
1	9,926	2,764	12,690	(*46*)
2	10,886	2,990	13,876	(*46*)
3	12,152	2,685	14,837	(*46*)
4	12,693	2,052	14,735	(*46*)
5	14,278	1,814	16,092	(*46*)
6	19,327	1,908	21,235	(*46*)
7	18,092	1,473	19,565	(*46*)
8	13,690	1,332	14,022	(*46*)
9	9,902	1,206	11,108	(*46*)
)	8,909	749	9,658	(*46*)
1	11,615	705	12,320	(*46*)
2	11,868	740	12,608	(*46*)
3 (est.)	10,000	576	10,576	(*46*)
4 (usage)	12,398	283	12,681	(*45*)
5 (agr. sage only)	900		900	(*15*)

ıtly to ambient air concentrations. After adsorption, soil/dieldrin complex can be lifted and transported wind erosion. These losses, however, are probably all compared to losses during application. Pesticide ft during treatment seems to be the primary factor luencing the transfer of dieldrin from soil to air (*14*).

borne pesticides have been detected near agricul- al operations, in rural areas, at urban locations, and wilderness regions many thousands of kilometers m known sources of contamination (*28*). The earliest ication that pesticide residues existed in the ambient came from the analysis of air samples collected from ır California sites during 1963 (*47*). Air monitoring ıducted from 1970 to 1972 revealed that dieldrin s present in 94 percent of 2,479 samples taken nation- le, with a mean concentration of 1.6 ng/cu.m (*27*). ldrin levels as high as 29.7 ng/cu.m have been re- ded at rural locations (*41*). The estimated residence e, i.e., rate of removal by dry deposition or rain- , is 28 weeks (*1*).

ınsport through air is probably the most important tor in the appearance of pesticide residues through- the world. The detection of dieldrin residues at h remote sites as Barbados (*38*), the island of nini (*7*), and Antarctica (*43*) suggests that there may no part of the troposphere that remains free of idues transported from distant sources.

ce in the air, dieldrin will eventually be deposited o soil and surface water by rainfall or dust fallout. rough this process of deposition, erosion, and run- residues move through the hydrologic cycle. Rivers, es, and oceans act as sinks for pesticide residues col- ed through surface and underground runoff. The f-life of dieldrin in one cubic meter of surface water, t is, the time required for half the original deposit be lost to the atmosphere, was found to be 1.5 rs (*31*), or six years for 95 percent disappearance.

In a 1964–68 survey of pesticides in water, dieldrin dominated pesticide occurrences in all regions. It appeared in 39 percent of the samples (*29*). Several samples actually exceeded the environmental limit recommended by the Committee on Water Quality Criteria (*36*). In a second study, dieldrin was present in 40 percent of more than 500 drinking water samples taken from the Mississippi and Missouri Rivers (*40*). The extensive distribution of dieldrin in aquatic systems is indicative of environmental loading from nonpoint sources such as rainfall, dust fallout, and erosion, as well as from agricultural point sources (*36*).

Eventually, the small amounts of dieldrin in soil, air, and water collect in the plant and animal tissues that are food for humans. Dieldrin can be removed from the soil by various root crops, including sugar beets, carrots, radishes, and potatoes (*30*). Soybeans and peanuts, high in oil, may also contain residues (*4*). Lower concentrations are found in some cereal crops, corn, oats, barley, and alfalfa (*19*).

Food is probably the primary source of dieldrin residues in human adipose tissue. The Total Diet Studies of the Food and Drug Administration (FDA), U.S. Department of Health and Human Services provide exhaustive information on levels and exact dietary sources of many persistent pesticides. Dietary intake in the Total Diet Studies is based on the total food consumpton of a 15- to 20-year-old male. Unlike DDT, dieldrin concentrations do not differ with age, sex, or race (*13*), so this information applies to the general population.

According to the 1974 diet study, measurable dieldrin residues (greater than 1 ppb) occurred predominantly in meat, fish, and poultry (100 percent positive) and dairy products (97 percent positive) (*18*). This is due to the lipophilic properties of dieldrin. To avoid bioaccumulation of dieldrin residues, animal feed must be carefully monitored. Residues of 1 ppm in soil may be too high for crops destined for animal consumption (*19*). Garden fruits (60 percent positive), potatoes (30 percent positive), leafy vegetables (10 percent positive), oils and fats (10 percent positive), and fruits (7 percent positive) also contribute to man's daily intake.

The health effects of chronic low-level exposure to dieldrin are unknown. It is tremendously difficult to predict future effects on public health. Dieldrin is known to have carcinogenic, teratogenic, and reproductive effects on test animals (46). In one study, autopsies showed significantly elevated concentrations of dieldrin in patients who had suffered from portal cirrhosis, carcinoma of various tissues, and hypertension (*37*). Dieldrin is transferred to the fetus during pregnancy,

and the child receives additional doses after birth either from its mother's milk or from dairy products (*5*). Thus babies born after organochlorines came into common use may have stored substantial amounts of dieldrin within the first few months of life. Children and young animals are often more susceptible than adults to poisons, drugs, and carcinogens (*20*). The extreme persistence of dieldrin residues in the environment and in mammalian tissue may also cause health problems indirectly. In one case, dairy cattle, fed on hay from a field previously used as a cherry orchard to which dieldrin had been applied, produced milk exceeding acceptable dieldrin levels. The milk was withheld from market for three months until the residues dropped to acceptable levels (*34*).

The purpose of this study was to consolidate information from relevant reports on dieldrin residues in humans regarding the quantitative history of residue sources and concentrations, and to compare this information to the findings of EPA's *National Study to Determine Levels of Chlorinated Hydrocarbon Insecticides in Human Milk, 1975–76*. Data describing human exposure to dieldrin associated with the 1974 EPA ban were extracted to determine if any trends are appearing and how long residues may continue to appear in humans.

Evidence indicates that a dynamic equilibrium exists in the distribution of dieldrin among various tissues in humans, including blood, fat, brain, and liver (*23*). This functional relationship among tissues indicates that the concentration of dieldrin in one tissue is a function of the total amount of dieldrin in the body. Consequently, at least in the case of chronic exposures, the concentration of dieldrin in any tissue may be used as an index of the total body burden of dieldrin. Since dieldrin tends to concentrate in lipids, residue levels in human adipose tissue are frequently used to represent relative total body concentrations.

One of the easiest ways to obtain human fat is to extract milk from lactating women, since human milk contains 3–3½ percent fat. In 1975, EPA obtained 1,436 human milk samples for its *National Study to Determine Levels of Chlorinated Hydrocarbon Insecticides in Human Milk, 1975–76* (*44*). The study was carefully designed to include inhabitants of both rural and urban areas, as well as members of different socioeconomic groups, in order to provide a profile of dieldrin distribution in the United States. Residue levels were calculated on a fat-adjusted basis.

Dieldrin levels were ubiquitous in the human milk samples; 96 percent had residues greater than 1 ppb. The mean value of dieldrin in human milk was 0.164 ppm. These findings correspond closely to the results from the *1974 Survey of Pesticide Residues and Their Metabolites in Humans* (*26*), which showed dieldrin residues averaging 0.150 ppm in human adipose tissue. Thus it appears that fat-adjusted milk residue levels do represent a legitimate measure of total body burden. Dieldrin residues reflect exposure to both aldrin and dieldrin, because aldrin is quickly converted to dieldrin in the human body. Statistics on domestic sales of aldrin and dieldrin between 1960 and 1976 appear in Table 1. Dieldrin residues in adipose tissue from several locales between 1963 and 1977 are listed in Table 2. Studies of aldrin/dieldrin dietary intake between 1964 and 1975 are summarized in Table 3. Figure 1 charts data from all three tables.

Total aldrin and dieldrin sales increased constantly until 1966, then decreased until the EPA ban in 1974. The 1975 dietary intake was about 50 percent of that in 1966, the peak year (Table 3). Yet residues in human tissue have remained astonishingly constant. Thirteen studies from the United States, Canada, England and Holland show dieldrin levels between 0.150 ppb and 0.220 ppm between 1963 and 1976 (*6, 26, 39, 48*).

Aldrin residues in food increased dramatically in 1975, after decreasing steadily since 1964. This increase may have been a result of the EPA ban itself. Since dieldrin is no longer manufactured in the United States, aldrin is important for registered use as a subsoil termiticide. An increase of aldrin residues in food would be expected to cause a corresponding increase in dieldrin residues in human tissues. However, no significant increase is apparent.

The exact cause of the unchanging concentrations is unknown. In view of the wide fluctuations in sales and dietary intake, simple persistence and biomagnification seem insufficient explanations. Hunter, et al. (*22*), after many years of research, concluded, that "the rates of increase of body burdens progressively decline in an asymptotic manner, the eventual body burden being a characteristic of a person and his particular

TABLE 2. *Dieldrin residues in human adipose tissue, 1963–76*

Year	No. of Persons Sampled	% Positive	Mean, ppm	Location	Literature Cited
1963			0.15 ± 0.02	USA	(6)
1964			0.16	Canada	(39)
1966	47		0.21	England	(39)
1965–67	146		0.22	USA	(39)
1968	11	100	0.17	Holland	(39)
1970	200	100	0.20	USA	(48)
1970	1,412	97	0.18	USA	(26)
1971	1,615	99	0.22	USA	(26)
1972	1,913	98	0.18	USA	(26)
1973	1,094	99	0.18	USA	(26)
1974	898	99	0.15	USA	(26)
1975	779	96	0.17	USA	(26)
1976	682	94	0.15	USA	(26)

TABLE 3. *Adult dietary intake of aldrin and dieldrin in the United States, 1964–75*[1]

AR	% Positive Food Samples		µg/kg/day			µg/day			Literature Cited
	Aldrin	Dieldrin	Aldrin	Dieldrin	Total	Aldrin	Dieldrin	Total	
–65	5.6	18.5	0.01	0.08	0.09	1.0	5.0	6.0	(*11*)
–66	3.7	21.3	0.04	0.09	0.13	2.0	7.0	9.0	(*11*)
–67	3.3	15.3	0.01	0.05	0.06	1.0	4.0	5.0	(*11*)
–68	3.9	15.6	0.01	0.05	0.06	T	4.0	4.0+	(9, *10*)
–69	1.4	25.3	0.0001	0.07	0.0701	T	5.0	5.0+	(*8*)
–70	0.8	31.3	0.0006	0.07	0.0706	T	5.0	5.0+	(*8*)
–71	—[2]	27.8	—[2]	0.0474	—[2]	—[2]	3.3	—[2]	(*33*)
–72	—[2]	23.6	—[2]	0.022	—[2]	—[2]	1.6	—[2]	(*32*)
–73	—[2]	27.5	—[2]	0.0470	—[2]	—[2]	3.2	—[2]	(*24*)
	0.3	29.7	0.0001	0.0403	0.0404	0.0057	2.8	2.8057	(*17*)
	0.3	25.8	0.0001	0.0441	0.0442	0.0064	3.1	3.1064	(*17*)
	0.4	23.3	0.0022	0.0387	0.0409	0.1500	2.6	2.7500	(*17*)

data on total food consumption for 15- to 20-year-old males.
ta not available.

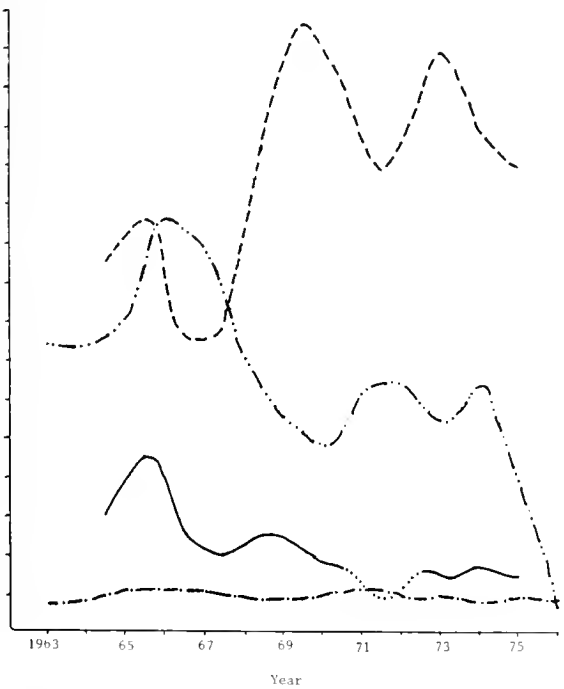

FIGURE 1. *Total domestic sales, percent positive food samples, total United States dietary intake, and human adipose tissue residues of aldrin and dieldrin, 1963–76*

: — — Food samples positive for dieldrin (%); — . . — Domestic s of aldrin and dieldrin (million pounds); —U.S. dietary intake of in and dieldrin (µg/day); . . . . . U.S. dietary intake of dieldrin (µg/day), . — . — Dieldrin residues in international human adipose tissue (ppm × 10)

ly intake." Keane and Zavon (*25*), studying dogs, o found evidence supporting an "equilibrium hypo-sis."

appears that the concentration of dieldrin in the nan body reaches a constant level at which the ount ingested and absorbed equals the amount tabolized and excreted. On the average, the maxi-m residue level maintained by the body seems to be the range of 0.150 ppm to 0.220 ppm.

e metabolic process that allows the body to excrete

TABLE 4. *Number and proportion of nursing mothers with fat-adjusted levels of dieldrin greater than 100 ppb by the number of children previously breastfed*[1]

Number of Children Previously Breastfed	Total Number of Mothers	Number	Proportion
0	664	291	0.438
1	463	166	0.359
2	194	63	0.325
3	71	18	0.254
4	24	5	0.208
5 or more	20	5	0.250
TOTAL	1,436–N[2]	548–T[3]	0.382–p

[1] Reference *44*.
[2] N = Total number of mothers involved in the study.
[3] T = Total number of mothers with more than 100 ppb of the chemical in their milk.
[4] $p = T/N$ = proportion of mothers with level of the chemical higher than 100 ppb.

dieldrin when tissue concentrations reach a given level remains unclear. It does seem, however, that the total body burden of dieldrin in some way depends on the degree of obesity of the individual (*25*). A similar homeostatic mechanism has been described for DDT (*35*).

Of course, there may be any number of unidentified factors affecting the storage levels of dieldrin. Several implications have been made, but no definitive conclusions have been drawn. Some evidence suggests that rats fed diets containing DDT store less dieldrin than do control animals (*42*). Similar effects, if they occur in humans, could be counteracting normal decreases in dieldrin levels as environmental exposure to DDT declines in response to the 1972 EPA ban. Hundreds of other chemicals and drugs presently in use could also be affecting residue levels. A highly significant association ($P < 0.001$) between women with low levels of dieldrin in their milk and women who have nursed several children indicates that lactation is one form of organochlorine excretion (Table 4).

It is also possible that the contribution of respiratory intake to total body burden has been underestimated. Average respiratory intake of an adult during the workday is 1.75 cu.m/hr (*12*). Over a 24-hr period,

inhalation could add 1 μg to the daily intake if ambient air levels reached 20 ng/cu.m. Such levels have been recorded in agricultural areas. The possibility that current sampling techniques do not detect some portion of the pesticides in air must also be considered.

A thorough national drinking water survey has not yet been undertaken, so the contribution to dietary intake from water may be underestimated. The exposure of fetuses and very young children to dieldrin could create a whole generation of individuals with high residue levels, despite decreasing exposure during their lifetimes. Finally, one must consider the existence of pesticide reservoirs not yet identified by existing monitoring programs. Routes of transportation, storage, and degradation not yet quantified may exist.

All indications point toward the continuing presence of dieldrin residues in human milk and adipose tissue. Americans are still exposed to dieldrin constantly, through persisting contamination of soil, air, water, and, therefore, food. Evidence suggests that an equilibrium residue concentration is being maintained by most individuals at an average level between 0.150 ppm and 0.220 ppm. The maximum exposure level at which tissue levels will decrease below the equilibrium level is unknown. Further investigation is clearly required in this area as well as into potential influences on residue concentrations. Until the storage and homeostatic processes are fully understood, predictions regarding trends in human tissue residue levels will remain mere speculation.

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WATER

Pesticides in Ground Water Beneath Irrigated Farmland in Nebraska, August 1978 [1]

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ABSTRACT

During the 1978 irrigation season, 14 ground water samples were collected in the Central Platte region of Nebraska, an area known to have high nitrate-nitrogen (NO_3–N) levels, and analyzed for the presence of 13 pesticide residues. Atrazine levels ranged from 0.06 μg/liter to 3.12 μg/liter and were correlated to NO_3–N concentrations with a coefficient of r = +0.55. Nitrate-nitrogen concentrations were measured as indicators of deep percolation from irrigated lands and ranged from 17.1 mg/liter to 34.3 mg/liter. Alachlor levels ranged from <0.01 μg/liter to 0.71 μg/liter. The amounts of 2,4-D were indeterminate because of experimental problems. Levels of the herbicides silvex and EPTC were below the limits of detectability. Levels of the organochlorine insecticides endrin, γ-BHC (lindane), dieldrin, DDT and its primary metabolite DDE, heptachlor and its primary derivative heptachlor epoxide, and methoxychlor were all below the detectable limits of 0.005–0.010 μg/liter.

Introduction

Monitoring of pesticides used currently in Nebraska has indicated that trace amounts of atrazine are infiltrating into the shallow ground water beneath well drained irrigated soils in Merrick County (*16*) and in the Platte River bottomland of Hall and Buffalo counties (*10*). In isolated cases, alachlor has also been found in ground water from the Platte River bottomland (*10*). In an agricultural state like Nebraska, where almost the entire population depends on subsurface sources for drinking water, knowledge of possible ground water contamination caused by vertical movements of pesticides through the unsaturated layer imperative. Thus, the purpose of this study was measure the levels of selected pesticides in gro water overlain by cropped and irrigated medi textured silt loam soils having a moderately thick saturated layer. Most of the pesticides were selec because of current or past usage, but others w chosen because they have been mentioned in the *F eral Register* (*5*, *6*) in discussions on primary natio drinking water regulations.

Ninety-four percent of the irrigated corn acreage central Nebraska is treated with herbicides. Atrazin the most frequently used herbicide in the study a and alachlor is the second most widely used, accord to Johnson and Byers (*9*). Alachlor is generally plied at pre-emergent rates of about 0.7 kg/ha as alachlor/atrazine mixture.

2,4–D is used on less than 10 percent of the irriga corn acreage and is applied after crop maturity rates of about 0.5 kg/ha. Water solubility of over 9 μg/liter for both the acid and amine forms of 2,4 and relatively low sorption characteristics suggest t some infiltration through well drained soils co occur.

EPTC and simazine are used for weed control o where shattercane is a problem. Usually this occ on less than 3 percent of the corn acreage within t study area.

Silvex is not known to have been used within the stu area but was measured because its use may be regula in the future (*6*).

The γ-isomer of hexachlorocyclohexane (lindane) v one of the earliest used soil insecticides in the stu area and was replaced by aldrin and heptachlor. Bo

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re used extensively for corn rootworm control until 52 when emergence of resistant strains reduced their ctiveness. In the soil, aldrin and heptachlor are nverted rapidly to dieldrin and heptachlor epoxide, pectively (*13*). The occurrence of dieldrin in ground ter beneath Iowa cropland (*14*) and the occurrence other insecticides in ground water beneath South rolina cropland (*1, 15*) also prompted the measure- nt of these insecticides as probable indicators of past ntamination.

e foliage insecticide DDT was applied extensively in study area prior to 1962. Richard et al. (*14*) re- ted trace amounts of DDE in Iowa well water, and hari et al. (*1*) and Sandhu et al. (*15*) reported that DT and its metabolites were the most common pesti- e residues in South Carolina ground water.

thoxychlor and endrin were used either very spar- ly or not at all within the study area but they were o mentioned in the *Federal Register* (*5, 6*).

Methods and Materials

MPLING

ter samples were collected in an area where NO_3–N ncentrations in ground water exceeded 10.0 mg/liter). The well locations shown in Figure 1 are in an a where a low terrace borders the northern bottom- d of the Platter River in central Nebraska. The ter- e appears to be flat but does have a very gentle slope 3.2 m/km, which is also the gradient of the east- theast-flowing Platte River. The wells that were npled are predominantly in irrigated areas of silt loam ls where corn is grown. Soils range from 1 m to 2 m ck and are underlain by an unsaturated layer com- ed of alluvial sand and gravel. Depth to ground water ges from about 6 m on the southern edge of the race to slightly more than 10 m (*4*). Well depths are 20–23 m, which is near the boundary between the upper Pleistocene sand and gravel and the blue clayey silt. None of the wells penetrated into the Ogallala Formation, which lies beneath the clayey silt.

On August 1, 1978, water samples for NO_3–N and pesticide analyses were collected from the 14 irrigation well sites shown in Figure 1. If the well was not already being pumped at the time of sampling, about 20,000 liters of water were exhausted before the sample was collected.

ANALYSES

For the determination of NO_3–N, samples were collected in acid-cleaned, polyethylene bottles and were chilled until they were returned to the laboratory for filtration through 0.45-μm filters; filtered samples were refrigerated at 4°C until the time of analysis. Concentrations were determined by the automated cadmium reduction method of the American Public Health Association (*2*). The waters for pesticide analyses were not filtered. All pesticides were extracted from 4-liter samples, using XAD–2 resin, by the procedure of Junk et al. (*11*). Samples to be analyzed for the phenoxy herbicides were acidified in the field to a pH of 2.0 prior to extraction. Pesticide residues were analyzed by electron-capture gas chromatography and different polarity columns with periodic confirmation by GC/MS.

Results and Discussion

Detectable concentrations of atrazine occurred in all ground water samples, as shown in Table 1. Concentrations ranged from 0.06 μg/liter to 3.12 μg/liter. The significant correlation of +0.05 between atrazine and NO_3–N suggests that where the levels of NO_3–N are higher in the infiltrating water there are correspondingly higher amounts of atrazine. In an earlier study of another Central Platte area having very shallow depth

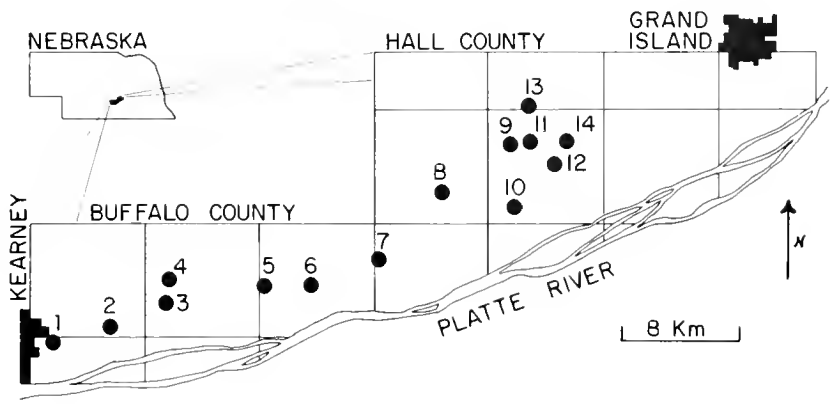

FIGURE 1. *Locations of the irrigation wells, sampled during August 1978 for pesticide analyses, in the Central Platte region, Nebraska, where the NO_3–N levels are >10 mg/liter and the sampled wells are assumed to be representative of over 1000 wells located within the study area.*

TABLE 1. *Pesticide and NO_3–N levels in ground water collected from irrigation wells in Central Nebraska, August 1978*[1]

Well No.	Legal Location[2]	Soil Texture[3]	Unsaturated Thickness, m	NO_3–N, mg/liter	Atrazine µg/liter	Alac µg/L
1	8N–15W–5BB	si l	8.0	23.5	1.23	<0.0
2	9N–15W–35BC	si l	8.3	32.9	3.12	0.0
3	9N–14W–29BA	si l	9.3	34.0	0.82	<0.0
4	9N–14W–17CC	si cl l	8.3	34.4	1.41	0.0
5	9N–13W–19BB	si cl l	6.0	19.8	0.58	<0.0
6	9N–13W–21AB	l	6.0	10.9	0.16	<0.0
7	9N–12W–7CC	l	5.6	17.3	0.06	<0.0
8	10N–12W–27AC	si l	10.0	17.0	0.84	<0.0
9	10N–11W–8CC	si l	9.7	19.0	0.19	<0.0
10	10N–11W–32BB	si cl l	6.7	15.0	0.47	<0.0
11	10N–11W–9CB	si l	9.7	21.9	0.38	<0.0
12	10N–11W–15CD	si l	8.3	31.3	0.21	<0.0
13	11N–11W–33CC	si cl l	10.6	20.5	0.06	<0.0
14	10N–11W–11CD	si l	8.6	17.1	1.00	<0.0

[1]None of the other 11 pesticides searched for in these well waters were found above the detection limits in µg/liter of: 0.001 for lindane; 0.00 heptachlor and heptachlor epoxide; 0.005 for endrin and dieldrin; 0.005–0.010 for DDE and methoxychlor; and 0.010 for DDT, EPTC, 2,4-D, silvex.
[2]See Figure 1 for approximate geographical locations.
[3]si = silt; cl = clay; l = loam.

(<3 m) to ground water (*16*), the significant correlation between NO_3–N and atrazine appeared to be related to differences in soil texture such that higher concentrations were observed generally for ground water overlain by coarse-textured soils. The present data indicate that substantial amounts of atrazine move also in medium-textured soils and this vertical movement is not halted by unsaturated layers of 5.6–m to 10.6–m thickness.

Atrazine levels in ground water collected during the late summer of an irrigation season have been shown previously to be associated with vertical transport of atrazine applied during the same season (*10*). This being the case, an estimated 1 percent of the applied atrazine migrated vertically through the vadose zone (zone of aeration) to the ground water during the 1978 irrigation season. This estimate is based on an average atrazine concentration of 0.75 µg/liter, an average saturated zone thickness of 10.7–m depth with 20 percent porosity, and an average atrazine application rate of 0.75 kg/ha (*9*). Although this leakage estimate is close to that obtained by Lavy (*12*) for sandy loams in Nebraska, it is higher than that reported by Hall and Hartwig (*8*) for atrazine infiltration through silt loams in Pennsylvania. This greater vertical transport of atrazine in this area may be due to irrigation. The reason for the scatter in atrazine concentrations beneath irrigated farmland with soils of equivalent texture and similar unsaturated layer thickness is not obvious but may well be due to differences in water management.

Arachlor levels above 0.01 µg/liter in 2 samples suggest alachlor transport through medium-textured soils. Both samples contained relatively large amounts of atrazine, indicating that a formulation of the two compounds had been used on the upgradient fields.

The 2,4–D in these irrigation well waters could not be determined accurately due to some chromatogra problems. However, all of the present data show 2,4 levels below the detection limit of 0.05 µg/liter. T low level probably reflects limited usage in the st area and rapid degradation rather than poor transp since Asmussen et al. (*3*) report 2,4–D to be one the more mobile herbicides.

Concentrations of the herbicides EPTC and silvex ground water were less than 0.01 µg/liter and 0. µg/liter, respectively. No simazine was detected ever waters that contained the highest levels of atrazine. T observation is consistent with the very limited use these three herbicides within the study area.

Levels of γ-BHC, dieldrin, heptachlor, and heptach epoxide were below the limits of detection of 0.0 0.005, 0.002, and 0.002 µg/liter, respectively. Th insecticides have not contaminated the ground wa or have been sorbed efficiently to the aquifer sedime or have degraded over the past 15 years since their was discontinued.

All DDT and DDE concentrations were less than 0 µg/liter. These levels are similar to those reported Richard et al. (*14*) for ground water in Iowa but significantly lower than levels reported by Sandhu et (*15*) for ground water in South Carolina. The hig amounts probably reflect greater usage of DDT cotton and soybean crop lands in that area.

Concentrations of endrin and methoxychlor were bel detectable limits that varied from 0.005 µg/liter 0.01 µg/liter.

Conclusions

Concentrations of pesticide residues in the grou water surveyed in the present study are well below limits given in the interim primary drinking wa

idards. The pesticide contamination of the ground er in the heavily irrigated study area in Nebraska is than that reported for surface waters from New eans and Iowa (*14*) and for ground water from th Carolina (*15*).

asurable amounts of atrazine in all samples, and hlor amounts greater than 0.010 μg/liter in two ples, indicate that there is some vertical movement the herbicides used extensively in the study area. wide range in atrazine concentrations in water er predominantly silt loam soils suggests vertical sport associated with possible differences in water nagement. Whether this pesticide contamination of ground water could be reduced or even eliminated improved management is debatable.

nough the low levels of atrazine in the ground er are not toxic to humans, Wolfe et al. (*17*) re- that the presence of atrazine and high amounts of $_3$–N in the ground water may evoke a further com- ation. They report formation of *N*-nitrosoatrazine in ogen-fertilized soils. Thus monitoring of nitrosamines their probable precursors in the ground water of Central Platte may be warranted.

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APPENDIX

Chemical Names of Compounds Discussed in This Issue

ALACHLOR	2-Chloro-2′,6′-diethyl-*N*-(methoxymethyl)-acetanilide
ALDRIN	Hexachlorohexahydro-*endo,exo*-dimethanonaphthalene 95% and related compounds 5%
AROCLOR 1254	PCB, approximately 54% chlorine
AROCLOR 1260	PCB, approximately 60% chlorine
ATRAZINE	2-Chloro-4-(ethylamino)-6-(isopropylamino)-*s*-triazine
BHC (Benzene Hexachloride)	1,2,3,4,5,6-Hexachlorocyclohexane (mixture of isomers)
CHLORDANE	Technical: 60% octachloro-4,7-methanotetrahydroindane and 40% related compounds
2,4-D	2,4-Dichlorophenoxyacetic acid
DDE	Dichlorodiphenyldichloroethylene (degradation product of DDT)
DDT	Dichloro diphenyl trichloroethane. Principal isomer present (*p,p′*-DDT; not less than 70%): 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
DIELDRIN	Hexachloroepoxyoctahydro-*endo,exo*-dimethanonaphthalene 85% and related compounds 15%
ENDRIN	Hexachloroepoxyoctahydro-*endo,endo*-dimethanonaphthalene
EPTC	*S*-Ethyl dipropylthiocarbamate
HCB	Hexachlorobenzene
HEPTACHLOR	Heptachlorotetrahydro-4,7-methanoindene
HEPTACHLOR EPOXIDE	1,4,5,6,7,8,8-Heptachloro-2,3-*epoxy*-3a,4,7,7a-tetrahydro-4,7-methanoindan
LINDANE	*Gamma* isomer of benzene hexachloride (BHC)
METHOXYCHLOR	2,2-Bis(*p*-methoxyphenyl)-1,1,1-trichloroethane 88% and related compounds 12%
METHYL PARATHION	*O,O*-Dimethyl *O*-*p*-nitrophenyl phosphorothioate
MIREX	Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta[cd]pentalene
NONACHLOR	1,2,3,4,5,6,7,8,8-Nonachlor-3a,4,7,7a-tetrahydro-4,7-methanoindan
OXYCHLORDANE	1-*exo*-2-*endo*-4,5,6,7,8,8a-Octachloro-2,3-*exo-epoxy*-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene
PCBs (Polychlorinated Biphenyls)	Mixtures of chlorinated biphenyl compounds having various percentages of chlorine
SILVEX	2-(2,4,5-Trichlorophenoxy)propionic acid
SIMAZINE	2-Chloro-4,6-bis(ethylamino)-*s*-triazine
TDE	Dichloro diphenyl dichloroethane (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane, principal component)
TOXAPHENE	Technical chlorinated camphene (67–69% chlorine)

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onitoring is defined here as the repeated sampling and alysis of environmental components to obtain reliable timates of levels of pesticide residues and related mpounds in these components and the changes in ese levels with time. It can include the recording of sidues at a given time and place, or the comparison of sidues in different geographic areas. The Journal will blish results of such investigations and data on levels pesticide residues in all portions of the environment sufficient detail to permit interpretations and con-isions by author and reader alike. Such investigations ould be specifically designed and planned for moni-ring purposes. The Journal does not generally publish iginal research investigations on subjects such as sticide analytical methods, pesticide metabolism, or ld trials (studies in which pesticides are experimen-ly applied to a plot or field and pesticide residue de-tion rates and movement within the treated plot or ld are observed).

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SOILS

DDT Residues in Forest Floors and Soils of Western Oregon, September–November 1966

Duane G. Moore and Bobby R. Loper [1]

ABSTRACT

ween 1945 and 1965, 1.82 million hectares, or about 17 cent of the total commercial forestland in Oregon, were ıted with 2.02 million kg DDT. Detectable residues his insecticide might be present in forest soils, even those ch have never received a direct application of insecticide. est floor and mineral soil samples were collected along r east-west transects across the Coast and Cascade ıges. DDT residues were found in all samples, even ugh all but one site had never received a direct applica- ı of insecticide. In the Coast Ranges, mean concentra- ıs of ΣDDT in forest floor samples were 0.049 ppm at coast and 0.047, 0.064, 0.075, and 0.119 ppm at 16, 32, and 64 km inland, respectively. Mean residue levels in surface layers of mineral soil were much lower, 0.009 ı and 0.006 ppm in the 0 to 7.5-cm and 7.5 to 15-cm ths, respectively.

ıpling sites along the Cascade Range transects were se- ed on the basis of elevation except that the eastern site each transect was located 16 km east of the crest of the cades. Residue concentrations in forest floor samples e three to four times higher than in the Coast Ranges, were still below 0.50 ppm. In general, ΣDDT levels in- ısed with increasing elevation up to 1,372 meters and ı decreased quite sharply east of the crest. Variations can explained on the basis of total rainfall distribution and by ısect location relative to agricultural and metropolitan ters.

Introduction

ensified forest management is essential to meeting the r-increasing demands for forage, recreation, timber, er, and of wildlife on our forested lands. The intensified use of our forest resources necessitated increased use of pesticides in insect, disease, and brush control programs. As a direct result, synthetic organic pesticides have become a chemical fact of life in forest protection and cultural practices.

Many pesticides in current use are rapidly detoxified in the forest environment. DDT, however, is highly resistant to degradation and may persist for extended periods of time. DDT is not currently registered by the U.S. Environmental Protection Agency (EPA) for use in forestry, but it has an extensive history of use and may be proposed to control specific pest outbreaks in the future. The present study was conducted to determine the levels and distribution of DDT residues in the forest floors and soils of western Oregon.

DDT was first applied to Oregon forests in 1945 to control an outbreak of the western hemlock looper in a 931-hectare (ha) aerial spray project near Cannon Beach (Fig. 1). Between 1945 and 1965, 1.82 million hectares, about 17 percent of the total commercial forestland in Oregon, were treated with 2.02 million kg DDT in various spray projects (Table 1). Applications were heaviest between 1949 and 1958 when 1.77 million hectares were treated in various spruce budworm spray projects.

Since 1958, about 104,682 ha have been treated with DDT, the latest project being carried out on 64,822 ha during 1974 under a Section 18 specific exemption from registration requirement granted to the Forest Service, U.S. Department of Agriculture, by the EPA.

DDT enters the forest floor and soil from direct application, drift of spray materials, rain washing through treated canopy, and litterfall, or in precipitation or dust deposited in unsprayed areas. Information on the extent of actual and potential environmental contami-

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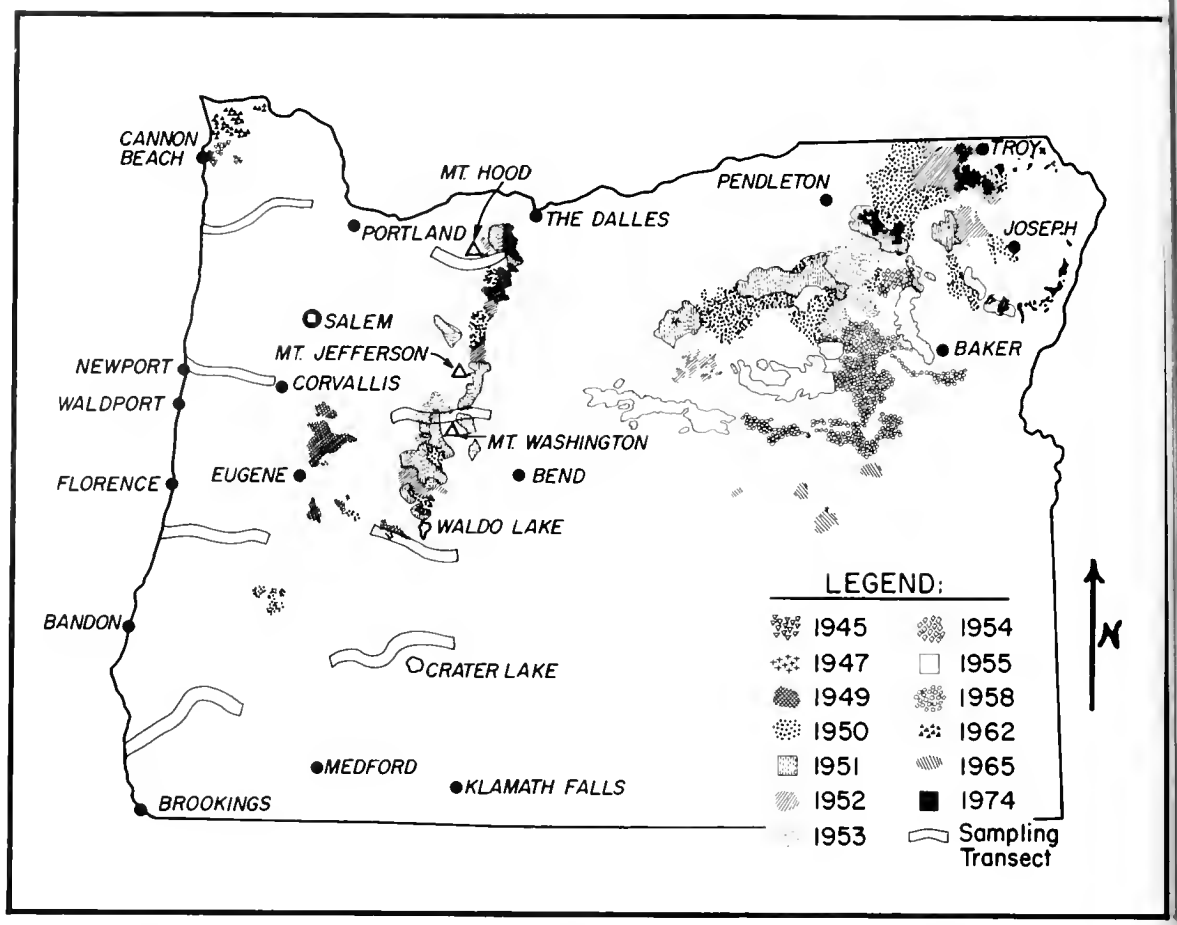

FIGURE 1. *Forest insect aerial spray projects in Oregon, and location of sampling transects*

TABLE 1. *Application of DDT to forests in Oregon, 1945–74*

Year	Hectares	DDT Applied, kg	
		By Year	Cumulative
1945	931	1,043	1,043
1947	5,666	6,350	7,393
1948	1,700	1,905	9,298
1949	109,508	122,742	132,040
1950	367,213	411,590	543,630
1951	319,986	358,656	902,286
1952	211,206	236,730	1,139,016
1953	149,815	167,920	1,306,936
1954	27,397	30,708	1,337,644
1955	251,270	281,636	1,619,280
1958	331,034	371,038	1,990,318
1962	13,152	7,371	1,997,689
1965	26,710	22,453	2,020,142
1974	64,822	54,492	2,074,634
TOTALS	1,880,410	2,074,634	

nation with pesticide residues in the forest is limited. Only a few studies have been concerned with ΣDDT. From a study conducted in a forest in New Brunswick, Canada, Woodwell (*26*) concluded that DDT residues would persist for a maximum of 10 years and that *o,p'*-DDT was leached into the subsoil. The forest had been sprayed with a total of 4.48 kg/ha of DDT between 1952 and 1958. Woodwell and Martin (*27*) reported that DDT residues in soils of heavily spra forests in Maine and New Brunswick had increa over a period of three years after the last applicat They hypothesized that DDT residues persisted in forest canopy and were carried to the soil by rain litterfall.

A study in the same locality refuted Woodwell's gestion that DDT residues were subject to differer weathering and preferential retention of *o,p'*-DDT (2 Yule reported that about 16 percent of the DDT o nally applied still remained in surface soils after aln 20 years, and that the main component of the resi was *p,p'*-DDT. He also demonstrated that these D residues were unavailable to soil insects in t amounts (*28*).

The only environmental change reported from a st in northern Pennsylvania was a significant accum tion of DDT in the forest floor and surface soil (One year after aerial spraying at a rate of 0.56 kg/ no measurable increase in DDT residues was noted fish, crayfish, or stream sediments. Belyea (*5*) m ured DDT residues in soil and a related food chair

rthern Maine forests and concluded that the resi-
es would disappear in 10–12 years. Riekerk and
ssel (*18*) reported that regardless of application rate,
s than 1 percent of the DDT applied to the surface
a gravelly soil beneath a stand of Douglas fir
seudotsuga menziesii (Mirb.) Franco) leached
rough the surface soil over an 18-month period dur-
g which 100 cm of rainfall was recorded.

rrant et al. (*23*) conducted a long-term study of
e behavior and fate of DDT in a forest environment
eastern Oregon after a 1965 aerial spray project.
DT residues were measured in throughfall precipita-
n, fresh litterfall, the forest floor and mineral soil,
d in water samples from two streams draining the
rayed area. They reported that DDT residues in the
rest floor had decreased by more than 50 percent
ter three years and had not leached into the mineral
il. Movement of DDT from the forest canopy to
e forest floor was small and decreased with time.
DDT content of stream samples was only 0.3 ppb
the time of spraying, and this low concentration
creased rapidly to levels below the limit of detection.
nly about one third of the applied chemical, however,
as accounted for; 26 percent reached the forest floor
itially, and another 6 percent reached the forest floor
litterfall over a three-year period. Their study did not
easure the amount of DDT that had reached the forest
nopy, and the extent of chemical loss from drift
uring spraying could not be assessed. It was assumed
at a significant amount of chemical was lost to the
mosphere as drift during application or by volatiliza-
on from the canopy after spraying.

ther studies have reported the loss of significant
nounts of insecticide to the atmosphere (*8, 11*). Acree
al. (*2*) demonstrated that there is significant codis-
lation of DDT with water at 25° to 35°C. Middleton
5) reported DDT residues as high as 1.71 g/1,000
. meters in the air adjacent to application sites. Two
udies on the presence of organochlorine pesticides in
inwater were conducted in England, one in an agri-
ltural area (*24*) and the other in London (*1*). Both
udies reported detectable levels of *p,p'*-DDT and
p'-DDE. Antommaria et al. (*3*) reported minimum
ncentrations of up to 1.14 μg/1,000 cu. meters for
p'-DDT associated with suspended particulate matter
Pittsburgh, Pennsylvania, while Tabor (*22*) reported
gher minimum concentrations of airborne DDT, up
23 μg/1,000 cu. meters, mean of 4 μg/1,000 cu.
eters, in agricultural communities.

ubstantial use of DDT in the past, and research on
position, persistence, and leaching characteristics of
DT, indicate that significant amounts of the insecti-
de may be present in the atmosphere. Rainfall and
position of dust could result in detectable residue
levels in forest soils, even those which have never received a direct application of DDT.

Sampling, Locations and Methods

The general areas sampled were the heavily forested sections of western Oregon. Sampling transects were selected in two subregions, the Coast and the Cascade Ranges. Four east-west transects were sampled in each subregion to cover western Oregon from north to south. In the Coast Ranges, sampling sites were located 0, 16, 32, 48, and 64 km inland along each east-west transect. Elevation was used to locate sampling sites in the Cascade Range. Sampling sites were located at 457, 762, 1,067, and 1,372 meters above sea level along each east-west transect across the Cascades. Sampling sites at the highest elevation, 1,372 meters, were approximately at the crest of the Cascades, and a fifth site on each transect was located 16 km east of the crest. This sampling site is in the rain shadow of the Cascade Range on each transect. Precipitation tends to decrease approximately 25 mm each 1.6 km eastward of the crest.

At each sampling site along the eight transects, four sublocations were sampled north, east, south, and west at 10, 20, 15, and 5 meters, respectively, of an arbitrarily located central point. At each point, the forest floor over a 0.4-sq. meter area was carefully removed, and approximately 1-kg samples of mineral soil were collected at each of two depths, 0 to 7.5 cm and 7.5 to 15 cm. Soil samples were collected by digging shallow soil pits and sampling horizontally into a freshly cleaned vertical face at the desired depth using a square-tipped, flat spade.

Extreme care was taken to avoid contaminating the lower sample with material from above, and all tools were cleaned between samples with acetone. Forest floor samples were placed in new, 10-kg heavyweight Kraft bags, and soil samples were placed in standard soil sample bags. All samples were stored during the day in portable cooler chests and frozen the same day they were collected. In all, 160 sublocations were sampled along the eight transects, resulting in a total of 160 forest floor samples and 320 soil samples. Sampling was accomplished over a three-month period, September–November 1966.

Analytical Procedures

Soil samples were air-dried, ground to pass a 10-mesh sieve, mixed, and subsampled. Forest floor samples were essentially dry when collected, having been collected at the end of the dry season; those containing some moisture were air-dried. All were processed carefully by hand to remove stones, and were then ground in a large Wiley mill. The ground samples were mixed and subsampled for analysis. After being ground and

mixed, the samples were held at 0°F until they could be subsampled and analyzed.

EXTRACTION

Soils—A 100-g subsample was extracted with hexane–acetone (41+59 azeotropic) in a Soxhlet extractor for 16 hr (*16*).

Forest Floor—A 25-g subsample was extracted with acetone in a Soxhlet extractor for 16 hr.

CLEANUP

The soil and forest floor extracts were transferred to individual separatory funnels and water was added to form a water–acetone (2+1) solution. The pesticides were partitioned into hexane by shaking with three 100-ml aliquots of hexane (*10*).

The hexane extracts were dried with anhydrous sodium sulfate, evaporated to 5–10 ml, and transferred to a 15-g Florisil column (*25*). The pesticides were eluted from the column with 100 ml dichloromethane–hexane (1+3). Dichloromethane was removed by evaporation, and samples were transferred with hexane to volumetric flasks for analysis.

ANALYSIS

The concentrations of DDE, *o,p'*-DDT, TDE, and *p,p'*-DDT were quantified in a MicroTek 2000 MF gas chromatograph with a 130-mc tritium electron-capture detector. This system gave good individual peak resolution at the following retention times: DDE, 5.2 minutes; *o,p'*-DDT, 6.8 minutes; TDE, 8.0 minutes; and *p,p'*-DDT, 9.5 minutes. Other instrument parameters and operating conditions were:

Column:	Pyrex, 180 cm × 2 mm ID, packed with 5 percent QF-1 (first 126 cm) and 5 percent DC-11 (last 54 cm) on 60–80-mesh Gas Chrom Q, preconditioned for 48 hr at 220°C	
Temperatures:	column	185°C
	detector	190°C
	injector	205°C
Carrier gas:	Nitrogen flowing at 30 ml/minute	

Minimum residue levels for quantitative determinations were 0.001 ppm for soil and 0.01 ppm for forest floor. Average percent recovery and range for DDT isomers and metabolites were as follows:

Form of DDT	% Recovery (Range)	
	Soil	Forest Floor
DDE	99 (92–103)	97 (93–100)
o,p'-DDT	82 (71–99)	99 (96–100)
TDE	82 (78–91)	85 (80–84)
p,p'-DDT	97 (92–100)	94 (90–97)

CONFIRMATION

Some industrial pollutants are similar to DDT in str ture and properties and can interfere with its detect or identification (*12, 14, 17, 19, 20*); naturally occ ring plant or soil substances may also cause analyti errors (*9, 13*). To confirm apparent DDT residues the present study, about half the samples were analyz by gas-liquid chromatography (GLC) with a chlori specific, microcoulometric detection system. This s confirmed that substances with the same retention ti as the DDT standards detected by the electron-capti detector did contain chlorine, but did not rule out t possible misinterpretation of polychlorinated biphen (PCBs) as DDT isomers and metabolites. Therefo all samples analyzed with the microcoulometric det tor were hydrolyzed with alcoholic potassium hydroxi which would chemically alter DDT and TDE, but r PCBs (*10*). Hydrolyzed samples were then re-analyz by both electron-capture and microcoulometric det tion systems. TDE, *o,p'*-DDT, and *p,p'*-DDT pea disappeared after hydrolysis, indicating that PCBs we not present in detectable quantities and that the qua titative measurement of DDT isomers and metaboli by the electron-capture detection system was correct.

Mass spectrophotometry is the most positive means identifying pesticides in biological samples, but in t present study, only the forest floor samples and a fe of the soil samples contained sufficient DDT to allo use of this technique. Ten forest floor and two so samples were extracted and purified for analysis. T DDT isomers and metabolites were separated by chr matography of the final hexane extract on 500-μm sili gel H thin-layer plates developed with benzene–hexa (4+96). DDT standards were co-chromatographed o both edges of the 20 × 20 cm plates. After develo ment, a 15-cm strip in the middle of the plate w covered, and the DDT standards were located by spra ing the edge of the plate with 0.5 percent silver nitra and exposing the plate to ultraviolet light for 15 minute The *o,p'*-DDT, *p,p'*-DDT, and *p,p'*-DDE were scrape from the appropriate section of the center of the plat extracted from the silica gel with hexane, and analyze by electron-capture gas chromatography. The pesticid separated by the thin-layer method had the same rete tion times as the standards.

Extracts containing the individual pesticides were intr duced into a Varian MAT Model CH 7 mass spectron eter with a direct inlet probe. The mass spectra fo *o,p'*-DDT, *p,p'*-DDT, and *p,p'*-DDE isolated from th forest floor samples agreed with spectra of appropriat standards and with published spectra (*21*). A com parison of sample spectra with published PCB spectr (*4*) showed that no PCBs were present in the isolate pesticides. All confirmation steps gave positive evidenc that the isolated and measured substances were indee

DT isomers and metabolites and that PCBs were not esent in detectable quantities.

Results and Discussion

AST RANGE TRANSECTS

DT residues were found in all samples, even though but one site had never received a direct application insecticide. Mean concentrations of ΣDDT residues the forest floor were 0.049 ppm at the coast and 047, 0.064, 0.075, and 0.119 ppm at 16, 32, 48, and km inland, respectively, over all four transects able 2). These DDT residue levels were quite low d tended to increase progressively from the Oregon ast inland across the coastal mountain range to the stern edge of cultivated inland valleys. The two rthern transects terminate in forested areas adjacent the Willamette Valley. No major insect control ojects have been conducted in the coastal mountain eas of western Oregon, and the only source of DDT hich could have produced these residues appears to aerial drift from agricultural applications and municil spray programs for control of mosquitoes and other sect pests.

TABLE 2. *ΣDDT residues in forest floors and soils of Coast Range transects of western Oregon, September–November 1966*

		Residues, ppm[1]					
		Distance from Coast, km					
Insect	Sample Depth, cm	0	16	32	48	64	Transect Means
lson	Forest floor	0.052	0.056	0.058	0.058	0.132	0.071
River	Soil: 0–7.5	0.005	0.005	0.006	0.009	0.024	0.010
	Soil: 7.5–15	0.006	0.011	0.013	0.003	0.006	0.008
quina	Forest floor	0.037	0.038	0.081	0.098	0.116	0.074
	Soil: 0–7.5	0.007	0.013	0.006	0.009	0.009	0.009
	Soil: 7.5–15	0.006	0.005	0.005	0.004	0.005	0.005
ipqua	Forest floor	0.054	0.046	0.060	0.054	0.130	0.069
	Soil: 0–7.5	0.006	0.006	0.008	0.008	0.013	0.008
	Soil: 7.5–15	0.004	0.004	0.005	0.007	0.008	0.005
gue	Forest floor	0.054	0.049	0.058	0.093	0.098	0.070
	Soil: 0–7.5	0.004	0.011	0.007	0.007	0.012	0.008
	Soil: 7.5–15	0.005	0.006	0.005	0.006	0.010	0.006
s means	Forest floor	0.049	0.047	0.064	0.075	0.119	0.071
	Soil: 0–7.5	0.005	0.009	0.007	0.008	0.015	0.009
	Soil: 7.5–15	0.005	0.006	0.007	0.005	0.007	0.006

TE: ΣDDT residues include *p,p'*-DDE, *o,p'*-DDT, TDE, and *p,p'*-T. TDE could not be quantified in all samples.
ach value represents the mean total residue for four samples from t site on the transect.

ntamination of the forested areas is surprisingly uni-m along the four transects, the highest residue levels curring adjacent to areas of agricultural activity and pulation centers in the inland valleys and then de-easing toward the coast with greater distance from source. Mean annual precipitation varies from 114 to 265 cm between the sampling points, but there no apparent correlation between residue levels and ount of precipitation ($r = 0.16$). Even the lowest amount of precipitation was apparently adequate to bring down any aerially transported residues to the forest floor.

Residue levels of ΣDDT in samples of the surface layers of mineral soil were much lower than levels found in forest floor samples, with average concentrations of 0.009 ppm and 0.006 ppm in the 0 to 7.5- and 7.5 to 15-cm depths, respectively. Residue levels in the mineral soil showed similar but less pronounced trends in distribution compared to those observed in the forest floor. Residues reaching the forest floor were not readily leached into the mineral soil. More than 80 percent of the ΣDDT residues reaching each site remained in the forest floor.

CASCADE RANGE TRANSECTS

Residue levels of ΣDDT in the forest floor and soils at sampling sites along the east-west transects across the Cascade Range in western Oregon appear in Table 3. These sites were selected on the basis of elevation except that for the eastern site on each transect, a location 16 km east of the crest of the passes through the Cascades was selected in order to determine whether the rain shadow had any measurable effect on the level of DDT residues in the forest environment. Residue concentrations in the forest floor were three to five times higher than those found in the Coast Ranges, but were still below 0.50 ppm. Trends in residue distribution patterns are not very distinct, but in general, total residues levels increased with increasing precipitation ($r = 0.67$) and decreased quite sharply east of the crest.

TABLE 3. *ΣDDT residues in forest floors and soils of Cascade Range transects of western Oregon, September–November, 1966*

		Residues, ppm[1]					
		Elevation above Sea Level, Meters					
Transect	Sample Depth, cm	457	762	1067	1372	16 km East[2]	Transect Means
Mt. Hood	Forest floor	0.344	0.433	0.326	0.417	0.271	0.358
	Soil: 0–7.5	0.010	0.009	0.010	0.011	0.013	0.011
	Soil: 7.5–15	0.006	0.007	0.005	0.006	0.010	0.007
Santiam Pass	Forest floor	0.330	0.268	0.391	1.405[3]	0.147	0.508
	Soil: 0–7.5	0.022	0.010	0.013	0.081	0.011	0.027
	Soil: 7.5–15	0.012	0.005	0.006	0.008	0.006	0.007
Willamette Pass	Forest floor	0.383	0.425	0.298	0.225	0.059	0.278
	Soil: 0–7.5	0.010	0.047	0.018	0.005	0.005	0.017
	Soil: 7.5–15	0.007	0.010	0.008	0.004	0.003	0.006
Crater Lake	Forest floor	0.111	0.110	0.138	0.192	0.105	0.131
	Soil: 0–7.5	0.013	0.012	0.007	0.007	0.008	0.009
	Soil: 7.5–15	0.005	0.007	0.004	0.005	0.006	0.006
Site means	Forest floor	0.292	0.309	0.288	0.560	0.145	0.319
	Soil: 0–7.5	0.014	0.020	0.012	0.026	0.009	0.016
	Soil: 7.5–15	0.007	0.007	0.006	0.006	0.006	0.006

[1] Each value represents the mean of four samples at that site.
[2] Eastern sampling point was located 16 km east of the crest of the Cascades.
[3] This sampling site by chance fell in an old spray unit treated in 1953.

Residue levels in the forest floor samples from the Cascade Range varied considerably between sampling sites along each transect, and even between sublocations at each site. This variation can be attributed largely to old spray projects which took place along the crest of the Cascades from Mt. Hood on the north to Waldo Lake on the south (Fig. 1). Only one sampling site was located in an area that had been sprayed with DDT, but several others were close to an old spray project or were at locations that may have received drift from more than one spray application. Spray projects were conducted along the crest of the Cascades every year from 1949 through 1953, and 1.16 million hectares were treated with a total of 1.30 million kg DDT. None of the treated areas was included in more than one control project, but adjacent units were sprayed in consecutive years. The sampling site at 1,372-meter elevation on the Santiam Pass transect was sprayed in 1953, and 13 years later the forest floor at this site still contained an average concentration of 1.405 ppm ΣDDT. The low mean annual temperature at this high-elevation site would greatly reduce the rate of normal degradation.

Levels of ΣDDT residues in the surface of 7.5-cm layer of mineral soil are almost double the concentration found at the same depth in the Coast Range samples, but the mean concentrations at the 7.5–15-cm depth are identical. The resistance of DDT residues in the forest floor against downward transport by leaching, even at mean annual precipitation levels of 305 cm, is markedly evident in these data.

Mean annual precipitation (Table 4) is lower for each site along the Crater Lake transect relative to the three transects to the north. This transect also crosses the Cascade Range approximately 80 km south of any spray project conducted along the crest of the Cascades. The combined effect of these factors has resulted in a mean ΣDDT residue level (0.131 ppm) in the forest floor for this transect that is less than half the mean concentration for the other transects. Yet this residue level is considerably higher than the mean concentration of DDT in the forest floor of any of the transects across the Coast Ranges (Table 2). Aerial drift of DDT residues from the large spray projects conducted 80–322 km to the north has contributed to this level of contamination of unsprayed forests.

DDT ISOMERS AND METABOLITES

Residue levels of each isomer and metabolite of DDT in the forest floor and soil samples show essentially the same relationships and trends along transects of both mountain ranges except for TDE residues in samples from the Coast Ranges. Total residue levels were relatively low in samples from these transects, and the levels of TDE were too low to be quantified in more than half of the forest floor samples and in almost 75 p cent of the soil samples from both depths. In contr residues of TDE could be easily quantified in over 7 percent of all samples from the Cascade Range.

TABLE 4. *Mean annual precipitation at each sampling along transects across the Coast and Cascade Ranges in western Oregon, September–November, 1966* [1]

	Precipitation, cm				
	Distance from Coast, km				
Coast Range Transects	0	16	32	48	64
Wilson River	241	254	267	254	127
Yaquina	152	178	203	216	140
Umpqua	165	203	216	152	114
Rogue	203	229	267	216	203
	Elevation above Sea Level, Meters				
Cascade Range Transects	457	762	1067	1372	16 km
Mt. Hood	190	203	216	229	127
Santiam Pass	267	279	305	190	89
Willamette Pass	114	152	165	165	76
Crater Lake	102	114	127	152	64

[1] Mean annual precipitation levels were estimated from U.S. Geologi Survey isohyetal maps for western Oregon.

The largest proportion of all DDT residues found samples from both sets of transects was present *p,p'*-DDT. Residues of this isomer accounted for a proximately 64 percent of the ΣDDT found in the fore floor (Table 5). The proportion of *p,p'*-DDT decreas with depth, whereas the relative amounts of *o,p'*-DD and *p,p'*-DDE increased with depth. However, mo than 80 percent of the total residues found at all sit remained in the forest floor. The relative proportio of the DDT isomers and metabolites, and the chang in relative distribution with sample depth, indicate th degradation is taking place slowly.

TABLE 5. *Mean residue levels of DDT isomers and metabolites in forest floors and soils of the Coast and Cascade Range transects expressed as a percentage of the mean ΣDDT residue level, September–November 1966*

Sample Depth, cm	*p,p'*-DDE	*o,p'*-DDT	*p,p'*-TDE	*p,p'*-DI
	Coast Range Transects			
Forest floor	14.93	21.35	—[1]	63.72
Soil: 0–7.5	22.38	27.31	—	50.31
Soil: 7.5–15	23.16	35.99	—	40.85
	Cascade Range Transects			
Forest floor	15.82	14.62	4.99	64.57
Soil: 0–7.5	19.70	26.34	4.33	49.63
Soil: 7.5–15	21.48	35.77	2.62	40.13

[1] TDE is not included because this metabolite could only be quan fied in approximately 35 percent of the litter and soil samples fro the Coast Range transects.

SIGNIFICANT EFFECTS OF TRANSECT, SITE, AND SAMPLIN DEPTH

Residue data for each range were analyzed statistical to determine whether sampling transects or samplin

tes (distance from coast or change in elevation) sig-
ficantly influenced the level of DDT residue found.
split-split plot design was used, and the data were
ıalyzed by analysis of variance. The first stage ex-
nined the influence of subsite and site over all three
ımpling depths, and the second stage provided a sepa-
te analysis for each depth. In addition, residue data
r the Cascade Range were analyzed by a factorial
ıalysis of variance using a randomized complete block
esign.

he average ΣDDT residue over all three sampling
epths increased significantly with distance inland from
e coast (Table 6). Average concentrations over all
epths and for all four transects were 20.0, 20.9, 26.0,
).6, and 46.9 ppm DDT for the sampling sites at 0,
5, 32, 48, and 64 km inland, respectively. Since these
eans represent 240 individual samples, this upward
end is not likely to be a chance occurrence. Sampling
epth and the site × depth interaction were also highly
gnificant ($P < 0.01$). These results were not un-
pected since it was anticipated that if any measur-
ble DDT residues were found, the highest concen-
ations would occur in the forest floor which repre-
nts the receiving surface for any atmospheric residues
rought down by precipitation. The site × depth inter-
tion indicates that the upward trend in residues with
stance inland occurs at each depth, but the trend is
ss pronounced at each greater sampling depth.

ABLE 6. *Statistical analysis of the influence of transect, site, and subsite over all sampling depths on the distribution of total residues of DDT in the Coast Ranges, September–November 1966*

Source	DF	Sum of Sq.	Mean Sq.	*F*-value
tal	239	300,147		
ansects	3	160	53	n.s.
e	4	22,888	5,722	16.16**
ror (a)	12	4,250	354	
bsite	3	230	77	n.s.
bsite × site	12	601	50	n.s.
ror (b)	36	3,955	110	
pth	2	215,228	107,614	286.97**
e × depth	8	32,723	4,090	10.91**
bsite × depth	6	483	81	n.s.
ror (c)	24	9,006	375	
ror (d)	72	7,017	97	

)TE: ** = Differences are highly significant ($P < 0.01$); n.s. = ferences are not significant ($P > 0.05$).

ıalysis for each depth did not provide any additional formation. The influence of site showed the same ghly significant increase with distance inland for for-t floor residues. This relationship was only significant $' < 0.05$) for residues in the surface layer of mineral il, and nonsignificant ($P < 0.05$) for residue levels the lower soil samples.

similar series of analyses was conducted for each DT isomer and metabolite. Residue levels of *p,p'*-DDE, *o,p'*-DDT, and *p,p'*-DDT showed the same relationships discussed above and the same levels of significance.

Residue data for the Cascade Range transects were statistically analyzed by the same split-split plot design (Table 7). There were no significant differences among average ΣDDT levels by transect or by sites for a given transect for either forest floor or soil. However, examination of the data presented in Table 3 indicates that residue levels are generally lower at each site located 16 km east of the crest of the Cascades, and that residue levels along the Crater Lake transect are lower than those observed for each of the three transects crossing the Cascade Range closer to the old spray projects. Residue data for the forest floor samples were analyzed by a factorial analysis of variance using a randomized complete block design. Residue levels in the forest floor were significantly lower east of the Cascades, and residues along the Crater Lake transect were significantly lower than residue levels in the forest floor samples from the other three transects (both at $P < 0.01$).

TABLE 7. *Statistical analysis of the influence of transect, site, and subsite over all sampling depths on the distribution of ΣDDT residues in samples from the Cascade Range, September–November 1966*

Source	DF	Sum of Sq.	Mean Sq.	*F*-value
Total	239	15,684,060		
Transects	3	542,593	180,864	1.81 n.s.
Site	4	517,790	129,448	1.29 n.s.
Error (a)	12	1,198,556	99,880	
Subsite	3	103,352	34,451	1.22 n.s.
Subsite × side	12	290,760	24,230	0.86 n.s.
Error (b)	36	1,012,599	28,128	
Depth	2	5,048,995	2,524,498	30.93**
Site × depth	8	922,449	115,306	4.69**
Subsite × depth	6	183,554	30,592	1.24 n.s.
Error (c)	24	1,958,987	81,624	
Error (d)	72	1,771,308	24,601	

NOTE: ** = Differences are highly significant ($P < 0.01$): n.s. = differences are not significant ($P > 0.05$).

This distribution of DDT residues in unsprayed areas is consistent with similar data reported by Cory et al. (7). In a study of the distribution of DDT residues in the Sierra Nevada Mountains, concentrations were markedly lower east of the crest. They also reported higher and more variable residue levels in samples from locations near old spray projects conducted in 1953 and 1956.

Closer examination of the data for each subsite along the Cascade Range transects shows that residue levels from all sampling sites and depths were extremely variable. The standard deviation of the mean for ΣDDT residues in the forest floor samples from the Santiam transect is greater than the mean. The causes of this variation are most likely the relative position of the sampling sites in reference to the location of the old

spray projects and the prevailing climatic conditions at the time those 1.16 million hectares were sprayed with DDT. The one sampling site that unintentionally fell in an old spray unit greatly distorts the residue levels for that site and for the transect, but it does not account for all variation observed among and between sampling sites. This discussion applies equally to all statistical analyses conducted on the Cascade Range residue data for each depth and for each DDT isomer and metabolite.

Conclusions

The primary purposes of this study were to determine to what extent untreated forested areas in western Oregon may have become contaminated through washout of DDT residues known to be present in the atmosphere, and to establish background levels of DDT residues in forest litter and soil. Perhaps the most important result obtained is the fact that measurable quantities of DDT were found at every site sampled along each of the eight transects. Residue levels along transects across the Coast Ranges increased significantly with distance inland from the coast. This trend is readily explained in that each transect ends in a forested area adjacent to agriculturally important inland valleys or population centers which serve as a source of the pesticide residues. Residue levels along transects across the Cascade Range were considerably higher than those found in the Coast Ranges because of the influence of a number of large insect control projects conducted along the crest of the Cascades between 1949 and 1953. Distance and direction of sampling sites from these sprayed areas have produced a wide variation in residue levels which tends to mask the influence of annual rainfall distribution and other local differences in topography.

Although DDT residues were found at every point sampled, the levels of these residues were generally low. Maximum concentrations of DDT in forest floor samples from the Coast Ranges did not exceed 0.17 ppm. Residue levels in forest floor samples from the Cascade transects were generally three to five times higher than those from Coast Ranges, but mean residues still did not exceed 0.50 ppm DDT. Low levels in the surface mineral soils of both sets of transects further substantiate the fact that DDT is not readily leached into forest soils. The tenacity with which the organic horizons of forest soils hold residues of DDT strongly suggests that the levels of residue measured are not likely to become available to nontarget organisms in toxic amounts (*28*).

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FISH, WILDLIFE, AND ESTUARIES

Influence of a Local Source of DDT Pollution on Statewide DDT Residues in Waterfowl Wings, Northern Alabama, 1978–79

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ABSTRACT

Heavy DDT contamination resulting from a former DDT manufacturing plant in northern Alabama has influenced statewide averages of DDT, DDE, and TDE residues in duck wings tested in the National Pesticide Monitoring Program. In states where contaminant levels in duck wings are high, residue analyses of wings categorized by finer geographic subdivision may be useful in defining the areas of heaviest contamination.

Introduction

The Fish and Wildlife Service, U.S. Department of the Interior, began nationwide monitoring of organochlorine residues in the wings of black ducks (*Anas rubripes*) and mallards (*Anas platyrhynchos*) in 1965 as part of the National Pesticide Monitoring Program (*1*). Waterfowl wings submitted to the Fish and Wildlife Service annual Waterfowl Harvest Survey were analyzed for organochlorine residues for the years 1965–67 (*1*), 1969–70 (*2*), 1972–73 (*5*), and 1976–77 (*6*). Analyses were based on sample pools of 25 wings each with the number of pools from each state varying in proportion to the number of wings submitted from each state. Although organochlorine residues in duck wings are reported for individual states, waterfowl are migratory, and it is conceivable that these residues may not accurately reflect the relative degrees of contamination between states. However, consistent outstanding trends in residue data over several collection periods indicate that local organochlorine contamination may be recognizable by monitoring residues in duck wings.

Duck wings from Alabama consistently have shown elevated concentrations of DDT and its metabolites, in comparison to other states. Therefore, duck wings fro Alabama would appear to be prime candidates f determining the usefulness of this type of monitorin in pinpointing local sources of organochlorine contam nation. Alabama and California were the only states which DDE in mallard wings exceeded 1 ppm for least three of the five previous sampling periods. Mallar wings from Alabama had the highest average DD residues of all states in the 1965–66 and 1969–7 surveys (*1, 2*). In 1972, duck wings from Alabam had higher DDT and DDE residues than any othe state (*5*), exceeding national averages by factors o 12.9 and 6.2, respectively. In 1976, Alabama was high est for DDT and third highest for DDE, at 3.2 and 2. times the national averages (*6*).

It seems likely that the high DDT and DDE concen trations observed in duck wings from Alabama wer due largely to industrial contamination of their winte habitat. From 1949 to 1970, a commercial DDT manu facturing plant released its effluent into Huntsville Sprin Branch, a tributary of the Tennessee River in norther Alabama. DDT and its metabolites in sediments of 4-mile portion of Huntsville Spring Branch have bee estimated at 4,000 tons (Tennessee Valley Authority unpublished report, 1978). This heavily contaminate area and the area immediately downstream from thi site are encompassed by the Wheeler National Wildlif Refuge, a major waterfowl wintering area in Alabama The present study examines the influence of this poin source of pollution on statewide averages of DDT, DDE and TDE concentrations in duck wings. Also, the au thors explore the usefulness of subclassifying duc wings by county of collection, for the purpose of iden tifying local sources of organochlorine pollution.

Sampling and Analysis

Mallard wings from Alabama were collected during th 1978–79 Waterfowl Harvest Survey, the same sourc

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: wings used for the National Pesticide Monitoring rogram. Wings were sorted by county of collection id subdivided by age-sex groups. Wings sorted in this shion were then randomly assigned to composite mples or pools of five wings each. Wings from adja-nt counties were pooled in some instances to provide ough wings for analysis. Remaining wings were then mbined into a northern Alabama pool or a southern labama pool. A total of 44 wing pools was analyzed.

Vings were shipped to Raltech Scientific Services, Inc., Madison, Wisconsin, for residue analyses. They were repared and analyzed by the same procedure estab-shed for the Nationwide Pesticide Monitoring Pro-ram (*6*), except that the cleanup solvent was a mix-ire of 15 percent dichloromethane and 85 percent yclohexane. The lower limit of quantification of DDT nd its metabolites was 0.01 ppm. Percent recoveries or spiked samples were 75 for DDT, 93 for DDE, nd 80 for TDE. Data were not corrected for percent ecoveries.

Results and Discussion

DDT in duck wings from Alabama varied consider-bly by region and was highest in counties near the DDT manufacturing plant (Table 1, Fig. 1). Pools of vings from Limestone and Madison Counties had DDT residues that averaged 10.8 and 18 times higher, espectively, than the combined average of all other ounties or county groups ($P < 0.05$). Heaviest con-amination appeared to be localized in these two coun-es; residues in adjoining counties were not greatly levated (Fig. 1). The former DDT manufacturing site is n Madison County, 15 km east of Limestone County. Wheeler National Wildlife Refuge is located in Madi-on, Limestone, and Morgan Counties. Pollution from he DDT plant therefore seems to be the likely source f the high ΣDDT concentrations in waterfowl from Madison and Limestone Counties. Waterfowl banding ecords show that mallards harvested in Madison and Limestone Counties are not members of a nesting popu-ation that is distinct from that of the rest of the state. Therefore, the common link for contaminated birds is heir wintering area and not their breeding grounds.

The high mean concentrations of DDT, DDE, and TDE bserved in duck wings from Alabama during previous nonitoring studies (*1, 2, 4, 6*) have undoubtedly been trongly influenced by this localized contamination; large proportion of the total number of mallard wings rom Alabama was submitted from the northern quar-er of the state and 5–35 percent came from Limestone nd Madison Counties (Table 2). Limestone, Madison, nd Morgan Counties accounted for 27–50 percent of he wings submitted during each of the sampling years. The highest residue concentrations during the five sam-ling periods of the National Pesticide Monitoring Pro-gram (Table 3) occurred when the greatest proportion of wings was harvested in areas in northern Alabama (Table 2).

The lowest statewide residues of ΣDDT occurred when the proportion of wings from Madison and Limestone Counties was lowest. Otherwise there are no apparent simple correlations between specific residue means and proportions of the harvest taken from various areas in northern Alabama. This lack of correlation is undoubtedly due to the small number of pools analyzed each year and the high variation between pools (Table 3). Such variation may be caused by very high residues in a few individuals of a sample pool. For example, if 24 wings in a pool contained 1 ppm ΣDDT and a single wing contained 101 ppm ΣDDT, then the sample pool residue would be 5 ppm. Authors have previously reported residues of up to 480 ppm ΣDDT in mallard carcasses from Huntsville Spring Branch (*4*); therefore, it is likely that extremely high residues in a few wings would contribute materially to the great variation seen in past monitoring studies (Table 3).

The distribution of mallards and black ducks and the proportion of ducks harvested in different localities within a state determine the effectiveness of using organochlorine residues in duck wings to pinpoint polluted environments. States where organochlorine residues in waterfowl wings are above the national average may have waterfowl harvests occurring in contaminated environments. Thus residue analyses of duck wings might be useful in pinpointing local areas of contamination if areas of wing collection are defined by subclassification below the state level. Authors conclude from the present study that the use of duck wings to locate areas of contamination within a state show the greatest promise when residues in composite sample pools from various states are known to be much higher than national averages.

Finally, comparison of the present data with those of experimental studies of black ducks fed DDE (*3*) indicates that the local DDT contamination detected by the present study in Alabama may have serious implications for the reproductive health of waterfowl wintering in this area. Longcore and Stendell (*3*) provided data suggesting that DDE residues of 2–3 ppm in wings can be correlated with eggshell thinning and decreased productivity in female black ducks. DDE residue concentrations exceeded 3 ppm in 6 of 15 pools from Limestone County; in one pool it reached 10 ppm (Tabe 1) but concentrations of DDE may have been slightly overestimated compared to those reported by Longcore and Stendell (*3*) because of possible differences in moisture loss. Although residues in female mallards from Limestone and Madison Counties were less than for males, fewer pools of wings from females

TABLE 1. *DDT, DDE, and TDE residues in pools of mallard wings from Alabama, 1978–79 hunting season* [1]

Desig-nation [2]	County	Statistic	Residues, ppm Wet Weight											
			Immature Females			Immature Males			Adult Females			Adult Males		
			DDE	DDT	TDE	DDE	DDT	TDE	DDE	DDT	TDE	DDE	DDT	TDE
1	Lauderdale, Colbert, Lawrence	Mean±SD	0.32	0.02	0.02	—	—	—	0.31	ND	ND	—	—	—
		Range	—	—	—	—	—	—	—	—	—	—	—	—
		N	1	1	1	—	—	—	1	1	1	—	—	—
2	Limestone	Mean±SD	0.76±0.50	0.03±0.01	0.16±0.20	0.87±1.20	0.05±0.08	0.12±0.17	0.02	ND	ND	4.40±5.10	0.90±0.75	1.80±0.47
		Range	0.40–1.10	0.02–0.04	0.01–0.31	0.16–2.70	0.01–0.17	0.02–0.38	—	—	—	0.11–10.0	0.37–1.40	1.50–2.10
		N	2	2	2	4	4	4	1	1	1	3	3	3
3	Madison	Mean±SD	2.60±3.20	0.21±0.29	0.62±0.71	1.40±0.52	2.70±2.60	0.74±0.98	—	—	—	5.61	0.07	0.41
		Range	0.37–4.80	0.00–0.41	0.12–1.12	1.00–1.70	0.79–4.50	0.04–1.40	—	—	—	—	—	—
		N	2	2	2	2	2	2	—	—	—	1	1	1
4	Jackson, Marshall, Morgan	Mean±SD	0.49	0.03	0.00	—	—	—	0.21	0.09	0.03	0.26±0.06	0.15±0.02	0.03±0.03
		Range	—	—	—	—	—	—	—	—	—	0.21–0.33	0.00–0.03	0.01–0.05
		N	1	1	1	—	—	—	1	1	1	2	2	2
5	Green, Sumter, Choctaw	Mean±SD	—	—	—	0.44±0.44	0.03±0.04	0.01±0.01	—	—	—	—	—	—
		Range	—	—	—	0.13–0.75	0.00–0.06	0.00–0.01	—	—	—	—	—	—
		N	—	—	—	2	2	2	—	—	—	—	—	—
6	Clarke, Wilcox, Washington	Mean±SD	0.03	0.00	0.00	0.02	0.00	0.00	0.07	0.00	0.00	0.16±0.02	0.01±0.01	0.00
		Range	—	—	—	—	—	—	—	—	—	0.14–0.17	0.00–0.01	0.00–0.00
		N	1	1	1	1	1	1	1	1	1	2	2	2
7	Mobile, Baldwin	Mean±SD	—	—	—	0.06	0.00	0.00	—	—	—	0.18	0.01	0.00
		Range	—	—	—	—	—	—	—	—	—	—	—	—
		N	—	—	—	1	1	1	—	—	—	1	1	1
	Northern County Pool	Mean±SD	0.25	0.45	0.11	0.80±0.82	0.35±0.46	0.12±0.12	0.61±0.74	0.06±0.07	0.02±0.02	—	—	—
		Range	—	—	—	0.23–1.70	0.02–0.87	0.03–0.24	0.09–1.13	0.01–0.11	0.00–0.03	—	—	—
		N	1	1	1	3	3	3	2	2	2	—	—	—
	Southern County Pool	Mean±SD	0.08±0.02	0.00	0.00	—	—	—	0.07	0.00	0.00	—	—	—
		Range	0.06–0.09	0.00–0.00	0.00–0.00	—	—	—	—	—	—	—	—	—
		N	2	2	2	—	—	—	1	1	1	—	—	—
	Controls [3]	Mean±SD	0.05±0.04	0.01±0.01	0.01±0.01									
		Range	0.01–0.11	0.00–0.02	0.00–0.03									
		N	5	5	5									

NOTE: SD = standard deviation; ND = not detected.
[1] Each pool consisted of five wings.
[2] See Figure 1.
[3] Control wing pools consisted of wings from five juveniles, without regard to sex. Wing were obtained from pen-raised mallards.

were sampled. Authors have found carcass residues of 480 ppm ΣDDT in female mallards from Wheeler National Wildlife Refuge (*4*), indicating that females also may have high ΣDDT residues.

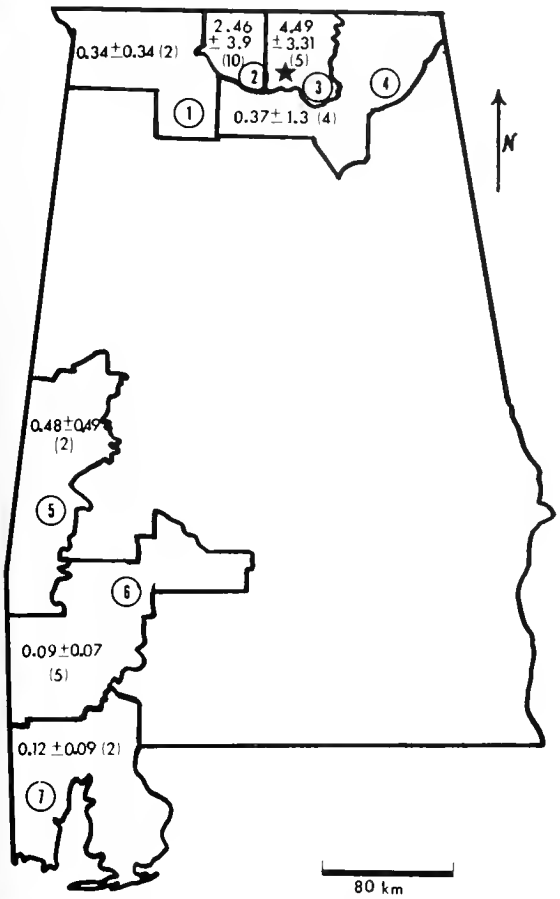

FIGURE 1. *ΣDDT residues in mallard wings from Alabama, 1978–79. Mean ± 1 standard deviation in ppm wet weight for pools of five wings. Number of pools are indicated in parentheses; encircled numbers refer to the county key in Table 1. Star shows location of former DDT manufacturing plant.*

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TABLE 2. *Number of mallard wings submitted from selected areas in Alabama during five years of the National Pesticide Monitoring Program, 1965–76*

	Year									
	1965		1966		1969		1972		1976	
Area	N	%[1]	N	%	N	%	N	%	N	%
Madison and Limestone Counties	27	17	96	35	3	5	60	29	126	23
Madison, Limestone and Morgan Counties	54	34	137	50	16	28	67	33	108	27
Northern quarter of state	100	64	193	71	29	51	140	69	307	67
Entire state	157	100	271	100	57	100	202	100	460	100

[1] Percentage of the total number of wings submitted from Alabama for the year indicated.

TABLE 3. *DDE, DDT, and TDE residues in composite samples of mallard wings from Alabama for the first five years of the National Pesticide Monitoring Program, 1965–76* [1]

		Year				
Chemical	Statistic	1965	1966	1969	1972	1976
DDE	Mean ± SD	0.76	2.62	1.75	1.85 ± 1.53	0.69 ± 0.34
	Range	0.43–5.31 [2]		—	0.79–4.12	0.17–2.39
	N	5	6	1	4	6
DDT	Mean ± SD	0.30	0.35	0.09	1.03 ± 1.31	0.19 ± 0.06
	Range	—	—	—	0.23–2.98	0.01–0.41
	N	5	6	1	4	5
TDE	Mean ± SD	0.11	0.56	2.07	0.44 ± 0.53	0.38 ± 0.33
	Range	—	—	—	0.09–1.23	<0.01–1.72
	N	5	6	1	4	5

[1] Each composite sample consisted of 25 wings.
[2] Range for 1965 and 1966 data combined.

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Organochlorine Residues and Shell Thicknesses in Eggs of the Clapper Rail, Common Gallinule, Purple Gallinule, and Limpkin (Class Aves*), Eastern and Southern United States, 1972–74*

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ABSTRACT

Organochlorine residues and shell thicknesses were surveyed in eggs of the clapper rail (Rallus longirostris), *purple gallinule* (Porphyrula martinica), *common gallinule* (Gallinula chloropas), *and limpkin* (Aramus guarauna) *from the eastern and southern United States. Clapper rail eggs were collected during 1972–73 in New Jersey, Virginia, and South Carolina. During 1973–74, gallinule eggs were collected in Florida, South Carolina, and Louisiana, and limpkin eggs were collected in Florida. Egg contents were analyzed for residues of organochlorine pesticides, including DDT, TDE, DDE, dieldrin, mirex, heptachlor epoxide, oxychlordane,* cis-*chlordane (and/or* trans-*nonachlor),* cis-*nonachlor, hexachlorobenzene (HCB), toxaphene, and endrin, and for polychlorinated biphenyls (PCBs). Shell thicknesses of recent eggs of these species were compared with archival eggs that had been collected before 1947. With the exception of the limpkin, the majority of eggs analyzed contained residues of* p,p'-*DDE and PCBs. Geometric means ranged from 0.10 ppm to 1.3 ppm. Small amounts (<1.0 ppm) of mirex, dieldrin,,* cis-*chlordane (and/or* trans-*nonachlor), TDE, and DDT were detected in a few eggs. No evidence of eggshell thinning was found for any of the species studied. DDE residues in clapper rail eggs were higher in New Jersey and Virginia than in South Carolina.*

Introduction

Organochlorine compounds are well known as persistent environmental contaminants that tend to accumulate in the upper trophic levels of food chains. The occurrence of organochlorine residues in tissues of carnivorous animals and the effects of these contaminants on their reproduction, behavior, and survival has been extensively documented (*14, 16*). However, residues in animals at intermediate levels of food chains are less well known.

Authors report here the results of a survey of residues and shell thicknesses in eggs of four species of the avian order Gruiformes: the clapper rail (*Rallus longirostris*), purple gallinule (*Porphyrula martinica*), common gallinule (*Gallinulla chloropas*), and limpkin (*Aramus guarauna*). Environmental contaminants in these species are of interest because they occupy intermediate positions in the food chains of North American wetland ecosystems, and because rails and gallinules are hunted as game and consumed by humans in many areas. Several species or subspecies of Gruiformes have also been designated as endangered, including the whooping crane (*Grus americana*), Mississippi sandhill crane (*Grus canadensis pulla*), California clapper rail (*Rallus longirostris obsoletus*), light-footed clapper rail (*R. l. levipes*), Yuma clapper rail (*R. l. yumanensis*), and Hawaiian gallinule (*Gallinula chloropus sandvicensis*) (*17*). Moreover, the limpkin, whose distribution in the United States is limited to Florida, has been designated by that state as endangered. It feeds almost exclusively on large freshwater snails, mainly the apple snail (*Pomacea paludosa*) (*12*). This snail is considered also to be the sole source of food for the endangered Everglade kite (*Rostrhamaus sociabilis*) (*3*).

Small amounts of dieldrin (<0.04 ppm), *p,p'*-DDT (<0.06 ppm), *p,p'*-TDE (<0.02–0.59 ppm), and *p,p'*-DDE (0.06–0.20 ppm), have been reported in tissues of the endangered whooping crane (*11*), but eggshell thickness has remained normal in this species (*2*). Notably high levels of dieldrin were found in eggs of purple gallinule and common gallinule collected from rice fields in Louisiana (*5, 9*). However, egg hatchability, chick survival, and eggshell thickness for gallinules nesting in rice fields did not differ significantly from gallinules nesting in marsh areas where residue levels were much lower.

Flickinger and King (*7*) reported 20.0 ppm and 5.5 ppm dieldrin and 21.0 ppm and 1.2 ppm DDT and metabolites in carcasses of two king rails (*Rallus elegans*) in Texas. The carcass of a common gallinule collected in the same area contained only 0.1 ppm ΣDDT and <0.1 ppm dieldrin. Residue levels in one of the king rails

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:re among the highest and those in the gallinule were ıong the lowest reported in 62 specimens of birds presenting 32 species found dead near aldrin-treated :e fields during 1967–71. Foehrenbach et al. (*8*) ported a mean of 0.38 ppm DDT and metabolites four clapper rail eggs from Long Island, New York. ıthors know of no other published data on organo-lorine residues and eggshell thickness among grui-rm birds.

Sampling and Analysis

apper rail eggs were collected during 1972–73 from ıpe May and Atlantic Counties, New Jersey; Acco-ack and Northampton Counties, Virginia; and Charles-n County, South Carolina. Gallinule eggs were col-:ted during 1972–73 from Brevard, Glades, Lee, and arion Counties, Florida; Beaufort County, South ırolina; and Cameron Parish, Louisiana. Limpkin gs were collected during 1973–74 from the north-:st side of Lake Okeechobee, Glades County, Florida.

ɔmplete clutches and addled eggs were collected; two gs from each clutch were wrapped in aluminum foil ıd placed in plastic containers to retard moisture loss. ggs were refrigerated until the contents were removed, aced into chemically cleaned jars, and frozen pending ıemical analysis. Only one egg per clutch was analyzed, ıt shells of all eggs were saved for comparisons of ell thickness. Egg volumes were measured to the :arest 1.0 ml by water displacement before the con-nts were removed. This allowed residues to be ad-sted to fresh wet weight, assuming specific gravity of 0 as suggested by Stickel et al. (*15*).

gg contents were homogenized in a mixer, and a 10-g iquot was blended with sodium sulfate and extracted -8 hours with hexane in a Soxhlet apparatus. Cleanup the extract, and separation and quantitation of ·ganochlorines were similar to the procedures used ɔr the analysis of eagle carcasses (*6*). In summary, e concentrated hexane extract was placed on a Florisil ɔlumn and eluted with 200 ml of 6 percent ethyl ether hexane to remove lipids. The Florisil eluate was ɔncentrated and eluted from a silicic acid column to parate pesticides from polychlorinated biphenyls ²CBs). The organochlorines separated into three licic acid eluates were identified and quantitated by ectron-capture gas chromatography on a 1.83-m glass ɔlumn packed with a mixture of 4 percent SE-30 and percent QF-1 on 100–120-mesh Supelcoport. Pesti-des were quantitated with a computing integrator; CBs were quantitated by comparing total peak area ith that of Aroclor 1254 or 1260, whichever most osely resembled the gas chromatographic profile of e sample. Residues in about 10 percent of the samples ere confirmed by gas chromatography-mass spectrom-ry.

Samples were analyzed for DDT, TDE, DDE, dieldrin, mirex, heptachlor epoxide, oxychlordane, *cis*-chlordane (and/or *trans*-nonachlor), *cis*-nonachlor, hexachlorobenzene (HCB), toxaphene, endrin, and PCBs.

Recoveries of pesticides and PCBs from spiked egg tissue ranged from 83 percent to 104 percent. Residues in the present report were not adjusted on the basis of these recoveries. Sensitivity of detection was 0.1 ppm for pesticides and 0.5 ppm for PCBs. When PCBs were detected in trace amounts (<0.5 ppm), they were considered as 0.25 ppm for purposes of this report. Chemical residue values were transformed to their common logarithms for statistical analysis. A unit of 1.0 was added to each value prior to transformation, to accommodate zero values. Total lipids averaged 8.7 percent in clapper rail eggs, 8.8 percent in limpkin, 10.2 percent in purple gallinule, and 10.4 percent in common gallinule.

For studies of shell thickness, the eggs collected for residue analyses were supplemented by eggs from museum collections. Authors compared shell thicknesses of egg collected since 1946 with shell thicknesses of eggs collected before the widespread use of organochlorine pesticides. Shell thickness was measured to the nearest 0.01 mm with a modified Starrett micrometer after the shells had dried at room temperature for at least one month. Three measurements were taken at the equator of each egg and included the shell and shell membranes. Measurements were averaged to yield a single value for each egg in the clutch, and values for all eggs in a clutch were averaged to yield a clutch mean thickness, the basic unit of measurement for statistical treatment.

For each species, eggshell thickness data for various geographic localities were grouped into time periods pre-1947 and 1947–74. Variations among localities and time periods were subjected to two-way, nonrandom analysis of variance (ANOVA). Statistical testing of differences in mean thicknesses between time periods and geographic locations followed the procedures of Sokal and Rohlf (*13*).

Results and Discussion

CLAPPER RAIL

All 49 eggs analyzed contained *p,p'*-DDE, but mean residue levels were relatively low (Table 1). A mean value of 1.3 ppm in New Jersey eggs was more than three times as high as the mean for eggs from South Carolina. Mean residue levels for Virginia and New Jersey eggs are not significantly different but both are significantly higher than the mean for South Carolina eggs ($P < 0.05$, ANOVA, log-transformed data). Residues of PCBs occurred in 100 percent of the samples

TABLE 1. *DDE and PCB residues in eggs of the clapper rail, purple gallinule, common gallinule, and limpkin from eastern United States, 1972–73*

Locality	Organochlorine	n [1]	ppm, Wet Wt: Geom. Mean	Median	Range	Number with Residues
CLAPPER RAIL						
South Carolina	DDE	10	0.41	0.52	0.10–1.1	10
	PCB	10	<0.5	<0.5	ND–1.2	6
Virginia	DDE	19	0.97	1.0	0.31–2.6	19
	PCB	19	<0.5	<0.5	ND–2.1	16
New Jersey	DDE	20	1.3	1.2	0.47–6.4	20
	PCB	20	<0.5	<0.5	<0.5 –2.7	20
PURPLE GALLINULE						
Florida	DDE	10	0.18	0.13	ND–0.95	6
South Carolina	DDE	1	0.29	—	—	1
COMMON GALLINULE						
Florida	DDE	15	0.21	0.13	ND–0.80	11
Louisiana	DDE	9	<0.10	0.0	ND–0.10	2
South Carolina	DDE	1	0.24	—	—	1
LIMPKIN						
Florida	DDE	14	0.18	0.0	ND–5.6	4

NOTE: ND = not detected.
[1] Number of clutches represented.

from New Jersey, 84 percent from Virginia, and 60 percent from South Carolina. Mean values for PCBs were < 0.5 ppm for all three localities.

No organochlorine residues other than DDE and PCBs were detected in eggs from South Carolina. Mirex (0.83 ppm) was found in one egg from Accomack County, Virginia, and 0.09 ppm dieldrin and a trace of *trans*-nonachlor were found in another egg from that locality. In New Jersey samples, trace amounts (< 0.10 ppm) of *trans*-nonachlor occurred in nine eggs; mirex was detected in five eggs (mean = 0.34 ppm; range 0.16–0.45 ppm); TDE in three eggs (mean = 0.30 ppm; range 0.20–0.35 ppm); and DDT in one egg (0.25 ppm). Heptachlor epoxide, oxychlordane, *cis*-nonachlor, HCB, toxaphene, and endrin were not detected in any clapper rail eggs analyzed.

Although authors were unable to collect recent samples of clapper rail eggs from Florida for residue analysis, nine clutches (six from the west coast and three from the east coast of Florida) that had been collected after 1946 were present in museum collections. These nine clutches were used in the present comparisons of mean eggshell thicknesses (Table 2).

Within each locality, there were no significant differences ($P > 0.05$ ANOVA) between mean eggshell thicknesses for the two selected time periods (Table 2). However, significant differences ($P < 0.05$) did occur in shell thicknesses between geographic localities; eggshells from Virginia and New Jersey were thicker than those from the southern states. These observed geographic differences probably reflect

TABLE 2. *Variations in shell thicknesses of clapper eggs from eastern United States, 1863–1973*

Locality	1863–1946: n [1]	Mean Th, mm [2]	1947–1973: n	Mean Th, mm	% Change	1863–19: n	Comb Me Th, m
Florida (west)	38	0.241	3	0.242	0	41	0.24
Florida (east)	55	0.244	6	0.257	+5	61	0.24
Georgia, Carolinas	63	0.241	7	0.247	+2	70	0.24
Virginia	57	0.258	22	0.262	+2	79	0.25
New Jersey	25	0.260	18	0.255	−2	43	0.25

NOTE: No significant differences (ANOVA, $P > 0.05$) were det between pre-1947 and recent eggs.
[1] n = Number of complete clutches.
[2] Means for each locality calculated from clutch mean thickness. mated variance (S^2) = 0.000282602 with 274 degrees of freedom.
[3] Among localities, combined means which are not significantly di ent share common letters (SNK test, $P > 0.05$).

environmental differences in the localities or genetic (ferences between species which inhabit these ar Virginia and New Jersey are within the range of northern clapper rail (*R. l. crepitans*). Localities Georgia, North Carolina, South Carolina, and the e coast of Florida are within the range of the Wa clapper rail (*R. l. waynei*). The west coast of Flor is occupied by the Florida clapper rail (*R. l. scot* (*1*). Accordingly, the northern clapper rail has thic eggshells than the other two subspecies. Even w these relatively large numbers of eggs from muse collections, the authors lacked samples for many dividual years and localities, especially the period fr 1940 to 1971 and years prior to 1895. Auth attempted to examine variation in eggshell thickne among time periods of shorter duration than th given in Table 2, but results were inconclusive becau gaps in the data precluded statistical testing.

Clutch sizes in clapper rails averaged 8.5 eggs (ran 5–13) for 237 clutches of pre-1947 eggs and 8.6 (ran 5–13) for 56 clutches of recent eggs.

No significant correlations were found between sh thickness and DDE ($r = -0.08$) or PCBs ($r = 0.04$) but a significant correlation was detected between DD and PCBs ($r = 0.38$, $P < 0.01$).

L. J. Blus (Patuxent Wildlife Research Center, person communication, 1975) collected seven clapper rail eg one from each of seven nests, from Charleston Count South Carolina in 1971. DDE in these eggs averag 1.53 ppm (geometric mean; unpublished data). Th difference in mean DDE residues between 1971 a 1972 (Table 1) is significant ($P < 0.05$) and the d cline is consistent with observed declines in DDE re dues in eggs of brown pelicans (*Pelecanus occidentali* from the same locality during 1969–73 (*4*). Sharp d clines in DDE residues in clapper rail tissues and oth aquatic fauna from New Jersey have also been r ported (*10*).

RPLE GALLINULE

)E was the only organochlorine residue detected in gs of purple gallinules, and levels were low (Table 1). series of 89 clutches of eggs collected in Florida ween 1885 and 1940 averaged 0.218 mm in thickss, and 15 clutches collected in 1948, 1962, and 1973 eraged 0.213 mm. The difference between clutches lected pre-1947 and post-1947 is not significant ($P >$)5). Authors had insufficient samples of recent eggs this species from other localities to compare their ll thicknesses. However, 45 clutches of pre-1947 gs from South Carolina had a mean thickness of 10 mm, and 13 clutches from Louisiana averaged 14 mm. Clutch sizes in the purple gallinule aver-ed 6.0 eggs (range 4–10) for 147 clutches of pre-47 eggs and 5.9 (range 4–9) among 15 clutches of ent eggs.

MMON GALLINULE

)E was the only organochlorine residue detected in gs of the common gallinule with the exception of one g from South Carolina which contained 0.12 ppm rex. Incidence of occurrence and mean residue levels re obviously lower in Louisiana than in Florida able 1).

fficient samples of recent eggs were available for mparison of shell thicknesses from only three regions able 3). Mean differences between time periods were t significant ($P > 0.05$) for any of the three areas. owever, geographic differences in mean thickness did cur (Table 3). The pattern of differences is similar that for the clapper rail: eggs from the southern tes have thinner shells than those from the northeast. owever, common gallinules have not been differentied into more than one subspecies in the United States.

ABLE 3. *Variation in shell thickness of common gallinule eggs from eastern United States, 1884–1973*

	1884–1946		1947–1973			1884–1973	
States	n [1]	Mean Th, mm [2]	n	Mean Th, mm	% Change	n	Combined Mean Th, mm [3]
orgia, outh Carolina	17	0.268	4	0.275	+2	21	0.269 A
rida	39	0.276	23	0.281	+2	62	0.278 B
nois, Iowa, Wisconsin	27	0.280	0	—	—	27	0.280 ABC
uisiana, Texas	4	0.284	9	0.287	+1	13	0.286 BCD
io, Michigan	29	0.288	0	—	—	29	0.288 CD
ssachusetts, New Jersey, New York, Virginia, Pennsylvania [4]	57	0.294	0	—	—	57	0.294 D

TE: No significant differences (ANOVA, $P > 0.05$) were detected ween pre-1947 and recent eggs.
= Number of clutches.
hickness means for each locality calculated from clutch mean thickss. Estimated variance (S^2) = 0.000313214 with 199 degrees of freem (ANOVA).
mong localities, combined means which are not significantly differ- share common letters (SNK test, $P > 0.05$).
orty-eight clutches were from Pennsylvania and New Jersey.

Clutch sizes in the common gallinule averaged 7.8 eggs (range 4–14) for 173 clutches of pre-1947 eggs and 6.7 (range 5–9) among 36 clutches of recent eggs.

LIMPKIN

DDE was detected in only four of 14 clutches of limpkin eggs, and no other organochlorine residues were found in any eggs. One of the four eggs contained 5.6 ppm DDE, but the other three contained 0.23, 0.14, and 0.12 ppm. These low residues are consistent with reported low residues of DDE in apple snails (*9*).

A series of 124 clutches of limpkin eggs collected in Florida between 1882 and 1946 averaged 0.360 mm in thickness; in 151 clutches collected after 1947, shell thickness averaged 0.357 mm. The difference in means is not significant ($P > 0.05$). Of the 151 recent clutches, 100 were collected during 1950 in Dade and Indian River Counties and averaged 0.357 mm. Using analysis-of-variance procedures, no significant differences in shell thickness means were detected in comparisons of limpkin eggs on a yearly or decade basis, and no differences in thickness were found among eggs in different stages of incubation, among eggs of various clutch sizes, or among complete and incomplete clutches.

Clutch sizes of the limpkin averaged 5.5 eggs (range 3–7) for 124 clutches of pre-1947 eggs and 5.3 (range 3–7) among 151 recent clutches.

Conclusions

Eggs of clapper rail, common gallinule, purple gallinule, and limpkin (representing 139 clutches collected in the eastern United States during the early 1970s), contained low residues of DDE and PCBs, with geometric means ranging from <0.10 ppm to 1.3 ppm. Small amounts (<1.0 ppm) of mirex, dieldrin, *cis*-chlordane (and/or *trans*-nonachlor), TDE, and DDT were detected in a few eggs. Heptachlor epoxide, oxychlordane, *cis*-nonachlor, HCB, toxaphene, and endrin were not detected. No changes in eggshell thickness between time periods were evident in any of the four species. Geographic differences in thickness means were found in eggs of clapper rail and common gallinule.

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Mercury Levels in Waterfowl from Manitoba, Canada, 1971–72

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ABSTRACT

om two locations in Manitoba suspected of mercury pol-on, waterfowl were collected during 1971 and 1972 to ermine the incidence and nature of the contamination. 'al mercury concentrations averaged 0.18 ppm and 0.22 n in breast muscle of 169 adult dabbling (Anatini) *and adult diving ducks* (Aythyini, Mergini, *and* Oxyurini), *pectively. Mercury concentrations in breast muscles of nature ducks of these tribes averaged 0.15 ppm total rcury for 70 dabblers and 0.16 ppm for 40 divers. Mean rcury residues in livers were 0.54 ppm and 0.31 ppm, re-ctively, in 60 adults and 30 immature dabblers and 3 ppm and 0.29 ppm, respectively, in 31 adults and 15 nature divers. Primary feathers of 20 adult and 12 imma-e dabblers collected in the Saskatchewan River Delta raged 2.67 ppm and 1.34 ppm, while 10 adult and 7 nature divers averaged 1.48 ppm and 1.11 ppm, respec-ly. Only in 20 ducks, 10 dabblers and 10 divers, did rcury concentrations in the breast muscle exceed 0.50 n. Statistically significant relationships for the concentra-n of mercury in feathers to breast muscle, feathers to r, and breast muscle to liver were found for spring adults for immature dabbling ducks. The only significant rela-ıship for divers was feather to liver concentrations for nature ducks and breast muscle to liver concentrations of ing adults in 1972 in the Saskatchewan River Delta.*

Introduction

1970, Fimreite (*5*) predicted that industrial, domestic, l natural sources of mercury had the potential to iously contaminate aquatic habitats in Canada. Sub-uent studies have verified this prediction, as shown in following taxa: freshwater fish (*1, 7, 8, 20, 22, 23, 34*), waterfowl (*1, 5, 6, 8, 21, 33, 34, 35*), marine mmals (*9, 10, 19, 21, 22, 24, 26, 27*), and fresh-er invertebrates (*12, 13, 25*).

idelines were established in 1970 by the Canadian od and Drug Directorate which banned the sale of ble portions of fish containing in excess of 0.50 ppm mercury (wet weight). Therefore, in Manitoba, 356 ducks were collected during 1971 and 1972 to ascertain whether they contained elevated mercury levels (> 0.50 ppm). Some of the lakes, streams, and marshes of Manitoba may have received mercury inputs from Saskatchewan via the Saskatchewan River (*5, 36*), from Ontario via the English-Winnipeg River (*5*), and from the United States via the Red River, as well as from sources within the province.

The present study was undertaken because studies on mercury residue levels in Canadian prairie ducks (*33*) did not adequately cover Manitoba. Of 210 ducks collected, only 11 were from Manitoba and provided minimal information on potential mercury contamination of areas in Manitoba. In addition to our main concern regarding elevated mercury levels as a potential health hazard, the authors wish to document the concentration of mercury in various tissues of spring and fall migrating waterfowl and the concentration of mercury in waterfowl reared in Manitoba and to determine relationships useful in predicting concentrations of mercury in the liver and breast muscle of waterfowl.

Experimental

STUDY AREA, MATERIALS, AND METHODS

Waterfowl used in total mercury analyses were shot with 12-gauge shotgun on marshes from the Saskatchewan River Delta east of the Pas, Manitoba (Rat Hunting Creek, Summerberry River, Hill Island, Head River, Two Islands, Tom Lamb Wildlife Management Area, Little Frog Creek, and Grand Rapids) and from the Lake Winnipeg Area (Netley Marsh, Riverton, Hodgson, Hecla Island, Stead, Pine Falls, and Gypsumville). These areas were selected because of the occurrence of mercury-contaminated fish (*23*; A. J. Derksen, unpublished data) and the presence of marshes which are important to duck reproduction.

SAMPLING

To compare mercury in liver and breast muscle tissues, 136 ducks were collected. In addition to these tissues, primary feathers were obtained from 49 of the speci-

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mens for mercury analysis. The samples were distributed as follows: 42 ducks in 1971 and 50 in 1972 were collected from the Saskatchewan River Delta. Also in 1971, 44 ducks were collected from the Lake Winnipeg area. Approximately half the samples were collected during April and early May; the remainder were collected during late August in the Saskatchewan River Delta and during October and early November in the Lake Winnipeg area. An additional 220 ducks, from which only breast muscle was taken for analysis, were collected over the two-year period from both areas.

Immature refers to young of the year collected on either natal areas or areas adjacent to natal sites.

TISSUES

The breast muscle, weighing approximately 20 g, was dissected from the left side of the keel of each frozen specimen. A minimum of 10 g sample of liver tissue was removed from the left lobe. Tissue samples were wrapped in aluminum foil, stored in jars, and kept frozen until analysis. The sixth through tenth primary feathers, usually from the left wing, were stored in envelopes until analysis. Before storage, feathers were cleaned according to the method of Kelsall (*18*).

RESIDUE ANALYSIS

Breast muscle, liver, and feather samples from the two study areas were analyzed by the Environmental Management, Winnipeg. Mercury was determined by flameless atomic absorption spectrophotometry (*2*). The method was slightly modified: Only 10 mL $KMnO_4$ reagent was necessary to digest duck flesh. The method was reliable within ±10 percent of the actual value (*6*) and our spiked samples showed total recovery. All values are given as total mercury on a ppm wet weight basis.

Arithmetic means are presented throughout the text for convenience, but statistical comparison of laboratory results were made by the nonparametric Mann-Whitney U method (*28*).

Results and Discussion

RESIDUES IN BREAST MUSCLE

Low concentrations of mercury (Table 1) were found in the breast muscle of adult ducks collected during spring 1971 and 1972 from the Saskatchewan River Delta. Average value for both years was 0.10 ppm mercury for 110 dabbling ducks and 0.19 ppm for 52 diving ducks. The concentration of mercury in breast muscle of dabblers from Lake Winnipeg was comparable at 0.16 ppm ($n = 17$), while mercury concentration in divers was significantly higher [Mann-Whitney U test (*28*), $P < 0.05$] at 0.43 ppm ($n = 7$).

TABLE 1. *Mercury levels in the breast muscle of 16 spec of waterfowl collected in Manitoba during 1971 and 1*

Species/ Season/Age	ppm Hg Wet Wt					
	Saskatchewan River Delta			Lake Winnipeg		
	Number	Mean	Range	Number	Mean	Ran
Mallard						
Spring 1971	12	0.17	0.05–0.45	2	0.11	0.03–0
1972	19	0.12	0.02–0.42			
Fall 1971 Im	11	0.12	0.04–0.48	6	0.12	0.06–0
1971 Ad	3	0.06	0.03–0.09	6	0.16	0.08–0
1972 Im	10	0.19	0.07–0.30			
1972 Ad	7	0.12	0.05–0.22			
Pintail						
Spring 1971	1	0.04		2	0.11	0.10–0
Fall 1971 Im	2	0.15	0.14–0.16	3	0.17	0.04–0
Gadwall						
Spring 1971	10	0.05	0.02–0.08	1	0.04	
Fall 1971 Im	9	0.07	0.04–0.11			
1971 Ad	2	0.08	0.06–0.11			
1972 Ad	1	0.13				
American wigeon						
Spring 1971	10	0.06	0.02–0.08			
1972	1	0.04				
Fall 1971 Im				3	0.06	0.05–0
1971 Ad	3	0.07	0.04–0.08	2	0.03	0.02–0
1971 Ad	1	0.66				
American green winged teal						
Spring 1971	3	0.08	0.06–0.11	3	0.08	0.04–0
1972	10	0.18	0.12–0.23			
Fall 1971 Im				5	0.18	0.09–0
1971 Ad	2	0.30	0.06–0.54			
1972 Im	2	0.25	0.12–0.39			
1972 Ad	1	0.33				
Blue-winged teal						
Spring 1971	12	0.26	0.06–0.65	6	0.20	0.08–0
1972	20	0.23	0.10–0.35			
Fall 1971 Im	1	0.18		3	0.53	0.44–0
1971 Ad	5	0.13	0.09–0.19	3	0.49	0.12–0
1972 Im	11	0.09	0.05–0.16			
1972 Ad	2	0.16	0.13–0.19			
Shoveler						
Spring 1971	11	0.35	0.15–0.51	3	0.29	0.20–0
1972	1	0.37				
Fall 1971 Im	3	0.12	0.10–0.15			
1971 Ad	2	0.19	0.13–0.25	1	0.28	
1972 Im	1	0.13				
1972 Ad	1	0.74				
Redhead						
Fall 1971 Im	1	0.12		1	0.10	
1971 Ad				1	0.04	
Canvasback						
Spring 1971	7	0.08	0.05–0.12			
Fall 1971 Im	8	0.09	0.02–0.26			
1971 Ad				1	0.02	
1972 Im	1	0.12				
Greater scaup						
Fall 1971 Im	2	0.20	0.12–0.27			
Lesser scaup						
Spring 1971	13	0.16	0.08–0.33	3	0.32	0.08–0
1972	21	0.19	0.06–0.70			
Fall 1971 Im	5	0.19	0.11–0.39	6	0.16	0.07–0
1971 Ad	2	0.16	0.10–0.22			
1972 Im	11	0.16	0.09–0.36			
1972 Ad	8	0.24	0.08–0.86			
Ring-necked duck						
Spring 1971	1	0.03				
1972	3	0.08	0.07			
Fall 1971 Im				3	0.08	0.06–0
Common goldeneye						
Spring 1971	2	0.63	0.58–0.67			
Fall 1971 Im				1	0.72	
1971 Ad				2	0.12	0.12–0
Bufflehead						
Spring 1971	5	0.36	0.10–0.79	4	0.52	0.36–0
Fall 1971 Ad				3	0.28	0.10–0
Ruddy duck						
Fall 1971 Im	1	0.08				
Hooded merganser						
Fall 1972 Ad	1	0.26				

:rcury levels in fall adult migrants differed from levels spring migrants in the comparison of 1971 fall ɔblers to 1972 spring migrant dabblers returning to Saskatchewan River Delta. The 1972 spring dabrs averaged 0.18 ppm mercury compared to 0.13 n for 1971 fall dabbler adults ($P < 0.001$). This 'erence may reflect the uptake of mercury on the ıtering grounds, the influence of dabblers originating m other areas, or a minor difference in the composiı of dabbler species in 1971 and 1972.

e mercury in breast muscle of adult ducks collected fall 1971 from Lake Winnipeg sites averaged 0.23 n for 2 dabblers and 0.16 ppm for 7 divers.

llard, pintail, lesser scaup (*Aythya affinis*) and ıvasback (*A. valisineris*) (*33*) collected from west- Canada in late summer or fall 1969 and 1970, when rcury was used extensively in agriculture as a seed ssing for grain and in fungicides (*5*), revealed 'er levels of mercury than the values reported here ıble 1). The present values for breast muscle are nparable to those of Pearce et al. (*21*) for waterfowl lected in eastern Canada during 1971 and 1972. ey reported an average of 0.15 ppm in 146 dabbling :ks and 0.13 ppm mercury in 61 diving ducks. These erences may result from the accumulation and magcation of mercury in large, stream-fed habitats comed to a lower potential for mercury concentration in ıll prairie potholes, and subsequent differing availlity to waterfowl.

nature dabbling ducks from the Delta collections raged 0.13 ppm ($n = 50$) for 1971 and 1972 while :e Winnipeg immatures averaged 0.19 ppm ($n =$. The immature dabblers from both the Saskatcheı River Delta and the Lake Winnipeg area in 1971 relatively lower mercury concentrations in their ast muscles than the adults collected during the ng from these areas, although this difference was significant. There were significant differences been the Delta immatures for 1971 and 1972 (0.15 n, $n = 24$, $P < 0.05$). These differences were ibuted to the higher mercury load in the breast scle of immature blue-winged teal (*Anas discors*) in 1971 Lake Winnipeg sample and in the mallard n the 1972 Saskatchewan River collection. The 1972 nature mallards (0.19 ppm, $n = 10$) had mercury ls that were 58 percent higher than levels in the l immatures (0.12 ppm, $n = 12$). The increase in cury load in the waterfowl suggests an increase in cury contamination within the Saskatchewan River ta, but authors were not able to determine the coination source.

nature lesser scaup, common goldeneye (*Bucephala gula*), bufflehead (*B. albeola*), ring-necked duck (*Aythya collaris*), ruddy duck (*Oxyura jamaicensis*), and canvasback had low levels of mercury in breast muscles; these levels were most similar to those in the immature dabblers. In 1971, immature Lake Winnipeg divers averaged 0.02 ppm ($n = 11$) whereas those from the Delta averaged 0.13 ppm ($n = 14$) in 1971 and 0.15 ppm ($n = 13$) in 1972. There were no significant differences between either years or areas.

Mercury residues in the breast muscle of dabblers exceeded 0.05 ppm in 10 of 239 samples, eight of which were adults. This sample included adult and immature blue-winged teal 1971 fall collections from the Delta and Lake areas, and American wigeon (*Anas americana*) and shoveler collected during fall 1972 from the Saskatchewan River Delta.

These dabblers, shovelers, and blue-winged teal as well as the American green-winged teal (*Anas crecca*) had higher mercury residue concentrations in breast muscle than did other species. The three species do not field-feed so are not directly exposed to treated gain. Thus their mercury uptake must involve aquatic food chains. Feeding studies indicate that these species depend heavily on gastropods and crustaceans (*3, 4, 29, 31*) which are known magnifiers of methyl mercury (*14*). Immatures of these species, which are primarily animal feeders, would be useful indicators of mercury contamination sites. Unfortunately the immature blue-winged teal collected during November 1971 in the Lake Winnipeg area were fledged and therefore may not represent the area of collection.

In 10 of 17 divers, mercury concentration in breast muscle exceeded 0.5 ppm. Goldeneye and bufflehead were collected from both localities during fall 1971. Contaminated lesser scaup were obtained from the Lake area in spring 1971 and from the Delta in fall 1972. Nine of the 10 diver specimens were adult. The percent contamination in divers exceeding 0.5 ppm mercury in breast muscle was higher in goldeneye and buffleheads, 60 percent (3/5) and 33 percent (4/12), respectively, compared to 4 percent (3/69) for lesser scaup.

MERCURY RESIDUES IN LIVER AND FEATHER

Mercury residues in the livers of adult dabbling ducks (Table 2) collected during spring 1971 and 1972 from the Saskatchewan River Delta averaged 0.45 ppm ($n = 12$) and 0.46 ppm ($n = 16$), respectively, whereas the Lake Winnipeg sample of spring 1971 averaged 0.61 ppm ($n = 17$). None of the differences in mercury levels in liver for ducks collected by year, area, or season were significant.

In 1971, livers of immature dabblers from the Lake Winnipeg area contained 0.45 ppm ($n = 9$) while

TABLE 2. *Mercury levels in liver tissue and feathers of 16 species of waterfowl collected in Manitoba during 1971 and 1972*

Species/Season/Age	Saskatchewan River Delta						Lake Winnipeg		
	Liver, ppm Hg			Feathers, ppm Hg			Liver, ppm Hg		
	Number	Mean	Range	Number	Mean	Range	Number	Mean	Range
Mallard									
Spring 1971	3	0.32	0.24–0.43				2	0.35	0.10–0.60
1972	5	0.27	0.17–0.42	5	1.58	1.04–2.51			
Fall 1971 Im	3	0.13	0.05–0.19				2	0.19	0.15–0.21
1971 Ad	1	0.10					1	1.03	
1972 Im	5	0.46	0.06–0.98	5	1.20	0.74–1.83			
Pintail									
Spring 1971							2	0.23	0.20–0.26
Fall 1971 Im	1	0.25					2	0.43	0.21–0.64
1971 Ad	1	0.25							
Gadwall									
Spring 1971	2	0.14	0.13–0.14				1	0.18	
Fall 1971 Im	3	0.17	0.11–0.26						
1971 Ad	1	0.20							
1972 Ad	1	0.40		1	0.80				
American wigeon									
Spring 1971	3	0.13	0.09–0.16						
1972	1	0.04		1	3.06				
Fall 1971 Im	1	0.13					2	0.09	0.05–0.13
1971 Ad	1	0.13					1	0.09	
1972 Ad	1	0.71		1	1.25				
American green-winged teal									
Spring 1971							3	0.34	0.28–0.37
1972	4	0.39	0.31–0.47	4	0.92	0.56–1.37			
Fall 1971 Im							2	0.80	0.66–0.93
1971 Ad	1	0.74							
1972 Im	2	0.31	0.48–1.13	2	2.00	0.79–4.21			
1972 Ad	1	0.66		1	7.02				
Blue-winged teal									
Spring 1971	2	0.84	0.73–0.94				6	0.75	0.25–1.20
1972	5	0.63	0.34–0.94	5	3.16	1.40–6.09			
Fall 1971 Im	1	0.45					1	1.09	
1971 Ad	2	0.43	0.19–0.67				1	1.05	
1972 Im	4	0.16	0.11–0.21	4	1.10	0.39–2.01			
Shoveler									
Spring 1971	2	1.23	0.59–1.86				3	1.18	0.95–1.30
1972	1	1.27		1	10.46				
Fall 1971 Im	1	0.38							
1971 Ad	1	0.39					1	1.02	
1972 Im	1	0.12		1	0.72				
1972 Ad	1	0.97		1	3.44				
Redhead									
Fall 1971 Im	1	0.39							
1971 Ad							1	0.11	
Canvasback									
Spring 1971	2	0.38	0.28–0.48						
Fall 1971 Im	2	0.10	0.07–0.12						
1971 Ad							1	0.06	
1972 Im	1	0.15		1	0.69				
Greater scaup									
Fall 1971 Im							1	0.36	
Lesser scaup									
Spring 1971	3	0.89	0.44–1.40				3	1.00	0.42–2.10
1972	6	0.47	0.16–0.85	6	1.69	1.00–2.98			
Fall 1971 Im	3	0.41	0.31–0.53				1	0.40	
1971 Ad	1	0.55							
1972 Im	5	0.27	0.18–0.37	5	1.25	0.57–2.66			
Ring-necked duck									
Spring 1972	3	0.12	0.05–0.17	3	1.26	0.56–2.33			
Fall 1971 Ad							1	0.58	
Common goldeneye									
Spring 1971	2	3.60	3.60						
Fall 1971 Ad							1	0.58	
Bufflehead									
Spring 1971	1	3.80					4	1.78	1.40–2.40
Fall 1971 Ad							1	0.36	
Ruddy duck									
Fall 1971 Im	1	0.25		1	0.90				
Hooded merganser									
Fall 1972 Ad	1	0.87		1	0.26				

ng from the Delta area carried mercury loads of 2 ppm ($n = 9$) in 1971 and 0.29 ppm ($n = 12$) 972. Manitoba-reared divers exhibited mercury con- trations similar to most immature dabbler species ıpled: Lake Winnipeg samples contained 0.45 ppm = 3) while the Saskatchewan River Delta immatures tained 0.32 ppm ($n = 6$) in 1971 and 0.25 ppm = 7) in 1972. There were no significant differences ween area or within year comparisons of young. ferences did occur between amounts of mercury ried by adults and young within the study areas; 1971 adult divers from both localities contained ıer mercury loads in liver tissue than did the young. nature dabblers reared in the Saskatchewan River ta in 1972 had a lower liver mercury load compared oth the spring ($P < 0.05$) and fall adult dabblers < 0.01), where species composition was nearly ıtical.

rcury levels in livers of dabblers collected at May- d and Sydney Lakes in northwestern Ontario (*6*) e similar to the present results, whereas ducks col- ed on the more contaminated Ball and Clay Lakes eed most of the values recorded for both Manitoba ılities (Table 2). Slightly higher values of total mer- y were recorded in liver of various aged shovelers *ıas clypeata*) and pintail collected in North Dakota , *30*) compared to these species collected in Mani- ı. Vermeer and Armstrong (*33*) reported lower ls of mercury in livers of ducks shot in the three rie provinces than those reported for Manitoba in present study, except in a common merganser *ergus merganser*).

thers collected during spring 1972 at the Delta raged 1.55 ppm mercury ($n = 9$) for divers and 5 ppm ($n = 16$) for dabbling ducks, whereas adult blers shot during fall contained 3.12 ppm ($n = 4$). h the immature dabbling and diving ducks had er mercury residue levels in their primary feathers ı either spring or fall adults. Immature dabblers raged 1.34 ppm ($n = 12$) and divers averaged 1.11 ı mercury ($n = 7$). Approximately the same species ıposition was represented in spring and fall samples.

RELATIONSHIPS BETWEEN MERCURY RESIDUES IN FEATHERS, LIVER, AND BREAST MUSCLE

If the relationship of mercury residues in feathers, liver, or wing muscle to those in breast muscle was known and was reasonably constant, one might use the best indicator in a large-scale sampling program to guard against a potential health hazard.

Several indices have been used: feather to breast muscle, breast muscle to liver (*9, 33*), wing muscle to breast muscle (*2, 34*), and breast muscle to brain (*9*). Authors considered three relationships: feather to breast muscle, feather to liver, and breast muscle to liver. The divers and dabblers were divided by season (spring and fall) and by age (adult or immature) for the data collected from the Saskatchewan River Delta in 1972. Unfortunately, the small size of the sample did not permit comparisons of tissues at the species level.

Dabbler results indicate that feathers containing mercury are ideal for predicting mercury levels in muscle and liver of immatures and spring adults (Table 3). Small sample size and lack of data limit the extent to which data for divers may be appraised. The feather-to-liver relationship was highly significant in immature divers as was the breast-muscle-to-liver comparison of spring adult divers. Flightless young waterfowl, Class IIIa (*11*), would provide an excellent indicator for mercury pollution in natal areas since feather material as illustrated in Table 3 permits the prediction of mercury in tissue such as liver and muscle. Moderate numbers of flightless young are captured each year during banding operations in Canada and the United States (M. Smith, Fish and Wildlife Service, U.S. Department of the Interior and D. Nieman, Canadian Wildlife Service, personal communication, 1977).

Vermeer and Armstrong (*33*) found significant correlation between feather and breast muscle residues in adult pintails collected during fall but not in immatures of the species. This may be a result of the season and availability of food as well as the spatial distribution relative to sources of contamination and to collection sites.

TABLE 3. *Correlation coefficients between mercury levels (ppm) in various tissue combinations for Saskatchewan River Delta waterfowl collected in 1972*

	Dabblers			Divers		
Tissues	Spring Adults	Fall Adults	Immatures	Spring Adults	Fall Adults	Immatures
ıer to liver	0.588* (16)	0	0.665* (12)	0	N.A.[1]	0.821*** (9)
ıer to muscle	0.450* (15)	0	0.814*** (12)	0	N.A.	0
le to liver	0.678** (16)	0	0.617* (12)	0.957** (9)	N.A.	0

E: Sample size is given in parentheses.
$P <$ *0.05; **0.01; ***0.001.
data available.

A comparison of liver mercury levels in Manitoba ducks with experimental results obtained by Heinz (*15–17*) suggests that the reproduction of divers and possibly some dabbler species (*19*) may be affected by mercury contamination. Heinz (*16, 17*) observed that the reproductive success of second and third generations of mallard hens fed a diet containing 0.5 ppm mercury was lower than in the controls. The growth of their ducklings was also slower than that of the control ducklings. The average liver mercury levels in spring divers from Manitoba exceed 1.00 ppm. This mercury load, accompanied by other stresses (parasite load, pesticide residues) could create some subtle population changes. This requires further study, especially between physiologists and population biologists.

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Organochlorine Residues in Fish of Lake Texoma, October 1979

Richard G. Hunter, John H. Carroll, and James C. Randolph [1]

ABSTRACT

Fillets from 99 fish, representing 11 species and three areas within Lake Texoma, were examined for residues of common organochlorines. Statistical analyses were conducted to determine the relationship of residues in fish fillets to trophic level and to geographical location of the sample.

Most species contained PCBs at levels up to 1100 ng/g and p,p′*-DDE as high as 127 ng/g.* p,p′*-TDE and* o,p′*-DDT were not found in carnivores, but were present in herbivores and detritivores in amounts up to 36 ng* p,p′*-TDE/g and 17 ng* o,p′*-DDT/g. Heptachlor also was not found in carnivores, but was present as high as 37 ng/g in the other two classes. Chlordane ranged to 24 ng/g and was detected in all trophic levels. Dieldrin and* p,p′*-DDT were present in detritivores and carnivores up to 144 ng dieldrin/g and 410 ng* p,p′*-DDT/g. Neither substance was found in herbivores. Mirex, endrin, and heptachlor epoxide were present only at low levels. Statistically significant differences* ($P = 0.05$) *were found between trophic levels for seven of the eleven organochlorine compounds. No correlation* ($P = 0.05$) *was found between fillet concentrations of any parameter and geographical location of the sample.*

Introduction

Lake Texoma is a 36,032-hectare (ha) impoundment located at river mile 726 on the Red River. Completed in January 1944 by the U.S. Army Corps of Engineers, the lake occupies portions of both Texas and Oklahoma (Fig. 1). Lake Texoma was constructed for hydropower generation and flood control, and is also used for water supply, navigation flows, sport and commercial fishing, and recreation. At normal pool level, the maximum depth is 34 meters and the mean depth is approximately 9.4 meters. The water has been described as well buffered with carbonates (pH 8.0–8.7), moderately to highly mineralized, and dominated by sodium and calcium salts of sulfates and chlorides (*5*). The lake is thermally stratified during the summer months, and due to the high chloride content of the water, also exhibits haloclines (*3*).

The Lake Texoma watershed covers 102,899 sq. k and is predominantly cropland and pasture. Princ crops grown in the basin are wheat, cotton, and gr sorghum. Except for petroleum production, there little industry in the Texoma drainage.

This study was conducted to determine concentrati of selected organochlorine compounds, including D and metabolites, chlordane, heptachlor, heptacl epoxide, dieldrin, endrin, mirex, and polychlorina biphenyls (PCBs), in fillets from fish of Lake Texo In addition, we wanted to ascertain if concentrati of these substances varied with trophic level of the or geographical location of the sample.

Sampling and Analysis

Ninety-nine fish, representing 11 species, were collec from three areas of Lake Texoma (Fig. 1). Exp mental gill nets and modified fyke traps were used October 2 and 3, 1979, to collect all fish. No atte was made to select for particular sizes of fish in sample, although the sampling equipment was not suited for taking either very large or very small dividuals.

Fish species were grouped into three trophic levels follows:

Herbivores: Gizzard shad (*Dorosoma cepedianum*)
Detritivores: Carp (*Cyprinus carpio*), channel cat (*Ictalurus punctatus*), smallmouth buffalo (*Ictio bubalus*), river carpsucker (*Carpiodes carpio*)
Carnivores: Striped bass (*Morone chrysops*), w crappie (*Pomoxis annularus*), largemouth bass (*cropterus salmoides*), blue catfish (*Ictalurus furcat* flathead catfish (*Pylodictus olivarus*)

Although the feeding habits of some of these spe overlap, these groupings provide general trophic lev These species were chosen not only based on t trophic level, but also because, with the exception gizzard shad, they are prime contributors to the c mercial or sport fishery.

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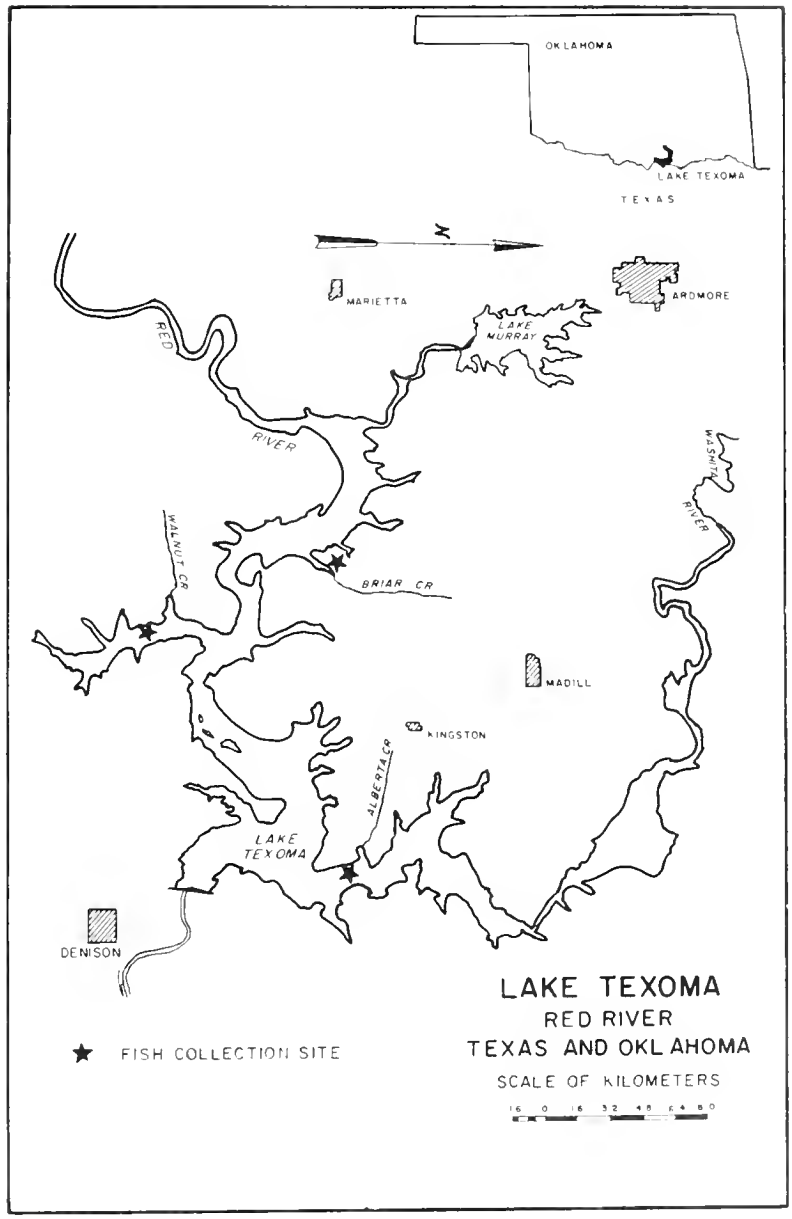

FIGURE 1. *Sampling sites on Lake Texoma, October 1979*

illet was removed from each fish, wrapped in alumi-
n foil, and transported to the laboratory where each
frozen for later analysis.

n fillet samples were analyzed by Texas Instruments
ence Services Division under contract with the Corps
Engineers. Laboratory analysis of the fillets followed
hods recommended by the Food and Drug Adminis-
ion (FDA), U.S. Department of Health and Human
vices (*2*). Approximately 25 g fish flesh, free of skin,
e, and organs, was weighed to four significant figures
placed in a Waring blender with an equal volume of sodium sulfate and 150 ml petroleum ether. The mixture was blended at high speed for 2 minutes. The solution was decanted through E.D. 515 fluted filter paper into a 500-ml flask. The residue was extracted with two additional 150-ml portions of petroleum ether as described above, and the extracts were filtered and combined in the 500-ml flask. The blender, filter paper, and contacts were washed with a final 10-ml portion of petroleum ether, and the total extract was transferred to a 500-ml Kuderna-Danish concentrator. The volume of the extract was reduced to 10 ml over an 80°C water bath, and the concentrated extract was quantitatively trans-

ferred to a 125-ml separatory funnel for acetonitrile partitioning.

The natural fish oils were removed from the extract by washing the petroleum ether three times with 40-ml aliquots of acetonitrile in a 125-ml separatory funnel. The acetonitrile was collected in a 1000-ml separatory funnel, and 700 ml water and 40 g sodium chloride were added. This mixture was then extracted three times with 100-ml aliquots of petroleum ether. The combined petroleum ether fractions were transferred to a 500-ml Kuderna-Danish concentrator through a column of sodium sulfate and were concentrated to 10 ml over an 80°C water bath.

This 10-ml sample concentrate was loaded on a prewashed, 10 mm × 30 cm column packed with 12 g Florisil (PR grade) and topped with 1 inch of sodium sulfate. The sample was then eluted from the column with 300 ml of 6 percent diethyl ether in petroleum ether. Each sample was reduced to a final volume of 5 ml in a Kuderna-Danish concentrator and stored at 4°C in a glass vial with a Teflon-lined cap.

The samples were originally analyzed for PCBs as Aroclor 1254, using a Perkin-Elmer 910 gas chromatograph equipped with a ^{63}Ni electron-capture detector. Instrument parameters and operating conditions were as follows:

Column:	6-ft glass, 2-mm-ID, packed with a mixture of 1.5 percent SP 2250 and 1.95 percent SP 2401 on 100–120-mesh Supelcoport
Temperatures:	injector 250°C column 200°C detector 250°C
Carrier gas:	nitrogen flowing at 30 ml/minute
Injection volume:	2 µl extract in petroleum ether

Because a number of the samples exhibited significant peaks at retention times corresponding to chlorinated pesticides, the samples were subsequently analyzed for pesticides, using a Tracor 560 gas chromatograph equipped with a ^{63}Ni electron-capture detector. Instrument parameters and operating conditions for the pesticide analyses were as follows:

Column:	10 meter, 0.25-mm-ID glass capillary coated with OV–101
Temperatures:	injector 250°C column 200°C detector 350°C
Carrier gas:	Helium flowing at 2.5 ml/minute
Make-up gas:	Nitrogen flowing at 70 ml/minute
Injection:	2 µl extract in petroleum ether plus 1 µl isooctane.

Recorder was zeroed with the column at 200°C. Column temperature was reduced to 50°C and an injection was made in the splitless mode for 30 seconds. The injection port was then purged and the column temperature was increased ballistically to 200°C.

Each sample was analyzed for *p,p'*-DDE, *p,p'*-T *p,p'*-DDT, *o,p'*-DDT, *o,p'*-TDE, heptachlor, heptacl epoxide, dieldrin, mirex, chlordane, and endrin. De tion limit for the above organochlorine pesticide r dues was 1.0 ng/g, and 10.0 ng/g for Aroclor 1254. ensure quality results, a reagent/glassware blank generated and analyzed with each batch of 20 samp Five percent of the samples analyzed were re-analy by a second person and results were within ± 15 cent. In addition, sequential recovery data and spi recovery data were generated for 5 percent of all s ples analyzed. Sequential recovery yielded 99 per recovery from the initial extractions. Spiked recov ranged from 95 to 104 percent. Results were not c rected for recovery.

Statistical comparison of organochlorine residues in of different trophic levels was conducted using Newm Keuls multiple range test. Organochlorine residue the fillets were correlated with geographical locatio the sample by analysis of variance.

Results and Discussion

PCBs (as Aroclor 1254) were found in all species cept largemouth bass, and were present in all tro levels. Eighty-eight percent of the herbivores, 37 per of the carnivores, and 84 percent of the detritivores c tained PCBs. Median and maximum concentration the fillets are shown in Table 1. No significant differe ($P = 0.05$) was found between levels of PCBs in de tivores and those in herbivores. PCB levels in fillets both herbivores and detritivores were significa greater ($P = 0.05$) than those in carnivores. No sig cant correlation ($P = 0.05$) was found between le of PCBs in fillets and geographical location of the sa ple. None of the fish violated either the FDA cur PCB standard of 5 µg/kg or the proposed standard 2 µg/kg (*1*).

CHLORDANE

Chlordane was present in all herbivores and detritiv except channel catfish, but was found in only two ca vorous species, striped bass and flathead catfish. It present in 57 percent of the herbivores, 47 percent the detritivores, and 4 percent of the carnivores. greatest amount found was 24 ng/g in a smallmo buffalo (Table 1). Levels of chlordane in fillets w significantly different ($P = 0.05$) in both detritiv and herbivores when compared to carnivores. There no significant difference ($P = 0.05$) between levels detritivores and herbivores. No significant correlat ($P = 0.05$) was indicated between chlordane levels fillets and sample location. Zitko (*8*) deemed sim levels of chlordane in some marine species not toxi logically significant.

TABLE 1. *Concentrations (ng/g) of selected organochlorine residues in fillets of fish from Lake Texoma, October 1979*

Species	Number	PCBs		Chlordane		Dieldrin		Mirex		Endrin		*p,p'*-DDE		*p,p'*-TDE		*o,p'*-DDT		*p,p'*-DDT		Heptachlor		Heptachlor Epoxide	
		Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.	Med.	Max.
HERBIVORE																							
Gizzard shad	14	105	460	2	17	0	0	0	40	0	0	15	505	0	3	0	11	0	0	0	37	0	0
Total	14	105	460	2	17	0	0	0	40	0	0	14	505	0	3	0	11	0	0	0	37	0	0
CARNIVORES																							
Striped bass	8	50	100	0	8	0	0	0	0	0	0	4	37	0	0	0	0	0	410	0	0	0	0
White bass	14	75	110	0	0	0	144	0	0	0	0	4	12	0	0	0	0	0	0	0	0	0	34
White crappie	19	0	100	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Largemouth bass	3	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0
Blue catfish	2	50	100	0	0	0	0	0	0	0	0	12	20	0	0	0	0	0	0	0	0	0	0
Flathead catfish	1	120	120	5	5	0	0	0	0	0	0	34	34	0	0	0	0	0	0	0	0	0	0
Total	47	0	120	0	8	0	144	0	0	0	0	1	37	0	0	0	0	0	410	0	0	0	34
DETRITIVORES																							
Smallmouth buffalo	13	185	1100	5	24	0	0	0	0	0	13	29	121	0	36	0	14	0	26	0	5	0	0
River carpsucker	11	100	300	1	14	0	0	0	0	0	10	35	127	0	9	0	11	0	10	0	0	0	0
Carp	7	50	100	0	6	0	0	0	0	0	0	8	54	0	0	0	0	0	0	0	0	0	0
Channel catfish	7	50	160	0	0	0	107	0	0	0	0	10	104	0	11	0	0	0	189	0	0	0	11
Total	38	100	1100	0	24	0	107	0	0	0	13	18	127	0	36	0	14	0	189	0	0	0	11

p,p'-DDE

Members of all species and all trophic levels contained *p,p'*-DDE. Levels of this isomer in fillets were as high as 505 ng/g in a gizzard shad (Table 1). By trophic level, 93 percent of the herbivores, 84 percent of the detritivores, and 53 percent of the carnivores contained detectable amounts of *p,p'*-DDE. Levels in fillets were significantly different ($P = 0.05$) between all three groups. No significant correlation ($P = 0.05$) was noted between levels of fillets and the location of the sample.

p,p'-TDE

p,p'-TDE was found in fillets from all species of herbivores and detritivores except carp. Only one shad contained this isomer, but it was found in numerous detritivores at levels up to 36 ng/g (Table 1). It was not found in any carnivores. Detritivores contained significantly higher ($P = 0.05$) levels of *p,p'*-TDE than did either herbivores or carnivores. There was no significant difference ($P = 0.05$) between concentrations of *p,p'*-TDE in fillets of herbivores and those in carnivores. There was also no significant correlation ($P = 0.05$) between levels of *p,p'*-TDE in fillets and geographical location of the sample.

o,p'-DDT

Channel catfish and carp were the only species of detritivores which did not contain *o,p'*-DDT. However, it was found in only one individual herbivore and in no carnivores. The maximum amount found was 14 ng/g in a smallmouth buffalo (Table 1). Significantly different ($P = 0.05$) amounts of this substance were found between all three trophic levels. No significant correlation ($P = 0.05$) was found between levels of *o,p'*-DDT in fillets and sample location. Levels of *o,p'*-DDT found in the present study were similar to levels found by Klassen and Kadoum (*4*) in whole fish samples from a Kansas reservoir. Those authors also found that concentrations were higher in the low trophic levels.

p,p'-DDT

p,p'-DDT was found in all detritivores except carp. It was not found in any herbivores and was present in only one species of carnivore, striped bass. Eleven percent of the detritivores and 4 percent of the carnivores contained *p,p'*-DDT. The largest amount was found in a striped bass fillet, which contained 410 ng/g (Table 1). This high level of DDT suggests recent contamination of this striped bass (*6*). Statistically, there was no significant difference ($P = 0.05$) between *p,p'*-DDT levels in fillets and trophic status. There was also no significant correlation ($P = 0.05$) between *p,p'*-DDT levels and geographical location of the sample.

HEPTACHLOR

Amounts of heptachlor in fillets ranged up to 37 n found in a shad (Table 1). In addition to shad, c smallmouth buffalo contained heptachlor in their fil Heptachlor levels in herbivores were significantly gre ($P = 0.05$) than those in either carnivores or det vores. Levels in carnivores did not differ significa ($P = 0.05$) from those in detritivores. There was significant correlation ($P = 0.05$) between levels heptachlor in fillets and sample location. In a study 20 Indiana impoundments, Vanderford and Hame also observed only small amounts of heptachlor in (*7*). In that study, whole fish samples of largemo bass, sunfish (*Lepomis* sp.), and bullhead (*Ictalu* sp.) at most contained only trace amounts of heptach

HEPTACHLOR EPOXIDE

Heptachlor epoxide was present in fillets from one ca vore (white bass) and one detritivore (channel catfis A fillet from the white bass contained the lar amount, 34 ng/g (Table 1). There was no signific correlation ($P = 0.05$) between fillet content and eit trophic level or sample location. In the previously m tioned Indiana study (*7*), only trace amounts of he chlor epoxide were found in the various fish classes

ENDRIN

Endrin was not detected in any herbivores or carnivo It was present in only 5 percent of the detritivores was limited to smallmouth buffalo and river carpsuc Median and maximum values found in the vari species are shown in Table 1. There was no signific correlation ($P = 0.05$) between endrin content of fil and either trophic class or sample location.

MIREX

No mirex was found in either carnivores or detritivo Fourteen percent of the herbivores contained mire levels up to 40 ng/g (Table 1). Levels in herbiv were significantly greater ($P = 0.05$) than those either carnivores or detritivores. There was no sig cant difference ($P = 0.05$) between levels in detritiv and those in carnivores. No significant correlation (P 0.05) was found between levels of mirex in fillets geographical location of the sample.

DIELDRIN

Dieldrin was found in fillets from only one individua each of two species. A channel catfish contained ng/g and a white bass contained 144 ng/g (Table Neither value approached the FDA action level of ng/g. There was no significant correlation ($P = 0.$ between fillet content and either trophic level or sam location.

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Effects of DDE, TDE, and PCBs on Shell Thickness of Western Grebe Eggs, Bear River Migratory Bird Refuge, Utah—1973–74 [1]

Mark L. Lindvall [2] and Jessop B. Low [3]

ABSTRACT

DDE, TDE, and polychlorinated biphenyls (PCBs) as Aroclors 1260 and 1254 were detected in low concentrations in eggs of western grebes (Aechmophorus occidentalis) *from Bear River Migratory Bird Refuge, Utah. DDE was the only contaminant which was both negatively correlated with eggshell thickness and a significant variable in a multiple regression model for predicting eggshell thickness. The eggshell thickness index for western grebe decreased 2.3 percent from pre- to post-DDT-use periods. Incubation stage appeared to have no measurable correlation with eggshell thickness. The small amount of eggshell thinning seen in western grebe eggs at Bear River Migratory Bird Refuge appeared to have no detectable effect on reproduction.*

Introduction

Field studies on shell thinning in fish-eating birds are extensive. Many authors have compared shell thickness or indexes of shell thickness in fish-eating birds between pre- and post-DDT-use periods and found significant decreases (*1, 2, 4, 5, 8, 18*). Studies have also shown a negative correlation between DDE concentration and shell thickness (*1, 2, 5, 8*). Using stepwise linear regression to analyze their data on brown pelican (*Pelecanus occidentalis*) eggs, Blus et al. (*3*) concluded that, of the contaminants measured, DDE had the greatest adverse influence on shell thickness.

Breeding biology of western grebe (*Aechmophorus occidentalis*) was studied at Bear River Migratory Bird Refuge (MBR), Utah, in 1973 and 1974 (*10*). As part of that study, the relationship between pesticide and polychlorinated biphenyl (PCB) contamination and eggshell thickness and thinning was examined. Eggs collected during pre-DDT and DDT-use periods were compared to determine the change in thickness with advent of DDT use. Multiple regression was used test the relationship of the various contaminants to e shell thickness.

Analytical Methods

Ninety-three eggs were collected at Bear River M between 1973 and 1974. Eggs were placed in egg c tons and immediately frozen. At the time of analy they were allowed to come to room temperature in laboratory.

Vernier calipers were used to measure length and wi (at the widest point) of the eggs to the nearest m meter. Each egg was then cut at the waist with sciss and its contents were removed. The inside of the s was rinsed with water, and the shell was allowed to for at least two weeks before any further measureme were made. Six standardized, equally spaced measu ments of shell thickness were taken at the waist of e egg, using a Starrett Model 1010 micrometer. Thickn was recorded to the nearest 0.01 mm. Shells were t weighed to the nearest 0.01 g on a torsion balan Lengths, widths, and weights of eggs from museu were measured by the same techniques as descri above. Eggs with a 7-mm or larger blow hole were measured.

Samples were analyzed at the Denver Wildlife Resea Center. Samples were prepared for analysis by method of Peterson et al. (*14*). Analyses were p formed on a Varian Aerograph Model 2740 gas ch matograph. Instrument parameters and operating c ditions follow:

Detector:	tritium foil electron-capture
Column:	2-m × 2-mm ID, packed with (1) 3 percent OV-1 on 80–100-mesh Chromosorb W, AW, DMCS; (2) 5 percent on 100–200-mesh Chromosorb W, AW DMCS
Temperatures:	detector 215°C injection port 200°C column 190°C
Carrier gas:	nitrogen flowing at 40 ml/minute

[1] Funding for this project was supplied primarily by the Fish and Wildlife Service, U.S. Department of the Interior, through the Utah Cooperative Wildlife Research Unit. Additional funding was also provided by the Wildlife Society and the Ecology Center, Utah State University.

[2] Present address: Parker River National Wildlife Refuge, Plum Island, Newberryport, Mass. 01950.
[3] Utah Cooperative Wildlife Research Unit, Utah State University, Logan, Utah 84322.

/o dissimilar columns were used to confirm the pres-
:e of the contaminants. Amounts of DDE and TDE
:sent in samples were calculated by comparing sample
ık heights with peak heights of standards. To deter-
ne DDE concentration, the sample was diluted until
: background PCBs were no longer visible. Amounts
Aroclors 1260 and 1254 were calculated by compar-
; peak areas of samples with peak areas of standards.
:ause of peak overlaps, quantities of both TDE and
oclor 1254 are estimates. That is, area or peak height
underlying PCBs was estimated and then deducted
m the observed height or area to obtain the actual
ık height due to TDE or the actual peak area due to
oclor 1254. The lowest quantifiable concentrations
re 0.1 ppm DDE and TDE and 1 ppm Aroclors 1254
1 1260.

Results and Discussion

)E, TDE, and PCBs corresponding to Aroclors 1260
1 1254 were found in various concentrations in west-
grebe eggs from Bear River MBR (Table 1). DDE
s the predominant contaminant detected, averaging
ppm. TDE averaged 1.3 ppm, and both PCBs, less
n 1 ppm; data are recorded on a wet weight basis,
l are not corrected for recovery.

BLE 1. *Organochlorine levels in whole western grebe s collected at Bear River Migratory Bird Refuge, 1973–74*[1]

		Residues, ppm		
ANOCHLORINE	Basis	$\bar{x}$	90% CI	Range
E	wet	6.6	±1.6	1.0–21.4
	lipid	76.5	±17.7	20–275
	wet	1.3	±0.3	0.3–4.7
	lipid	14.9	±3.1	3–52
clor 1260	wet	<1	—	<1–5.4
clor 1254	wet	<1	—	<1–3.8

= 40.

cliffe (*16*) devised an index to eggshell thickness
ıer than a directly measured thickness, and that index
gained wide acceptance because it is useful in meas-
ıg museum specimens in which a direct thickness
asurement cannot be obtained.

cliffe's index is a good estimator of shell thickness in
tern grebe eggs. The thickness index and average
kness of 93 eggs collected at Bear River Migratory
l Refuge were highly correlated ($r^2 = 0.7$).

: average eggshell thickness index of the eggs col-
ed at Bear River MBR during 1973 and 1974 was
ificantly smaller than the same figure for 389 pre-
0 eggs measured in museums ($F = 25.6$, $P < 0.1$).
: average thickness index and standard deviation for
Bear River MBR eggs was 1.898 ± 0.015 mm and
389 pre-1940 museum eggs, 1.989 ± 0.008. This is a
rease of 2.3 percent, a small but significant decrease,
n pre-1940 to present. Pre-1940 eggs were used in the comparison because they represent a sample obtained before the widespread use of DDT. No difference was seen between pre-1940 eggs collected in California and Utah, and thus the two groups were pooled for the comparison.

The average eggshell thickness (direct measurement) and standard deviation of 93 eggs collected in 1973 and 1974 at Bear River is 0.38 ± 0.03 mm. Rudd and Herman (*18*) give 0.33 mm as the average eggshell thickness of eggs collected at Clear Lake, California, after TDE application to the lake. Eggs at Clear Lake had higher levels of contaminants than those collected during the present study at Bear River MBR. Rudd and Herman (*18*) also took direct measurements from pre-1940 eggs and found an average thickness of 0.389 mm, a thickness 3.1 percent greater than the present Bear River Migratory Bird Refuge collections.

The small amount of eggshell thinning seen in western grebe eggshells at Bear River MBR appeared to have little or no effect on reproduction, because no crushed, cracked, or broken eggs were seen during this study. Average brood sizes of 1.6 in 1973 and 1.8 in 1974 from Bear River compare well with the Rudd and Herman determination of a normally reproducing population (*18*).

Multiple regression with stepwise deletion was used to test the relationship of the various contaminants to eggshell thickness and eggshell thicknes index as was done by Blus et al. (*3*).

The original model for the western grebes, with all contaminants included, explained 45 percent of the variability in eggshell thickness index and 51 percent of the variability in eggshell thickness. In this model the contribution of DDE was significant at the $\alpha = 0.05$ level, and the contribution of Aroclor 1260 was significant at the $\alpha = 0.1$ level. The deletion of Aroclor 1254 and TDE from the model did not lessen the predictive power.

The model containing Aroclor 1260 and DDE explained 50 percent of the variability in eggshell thickness and 45 percent of the variability in thickness index. The contribution of DDE in this model was significant at $\alpha = 0.01$ and the contribution of Aroclor 1260 was significant at $\alpha = 0.025$. This model proved to be the best predictor of both eggshell thickness and thickness index. Deleting Aroclor 1260 from the model and forming a model with only DDE resulted in a loss of predictive power. A model with only DDE explained 37 percent of the variability in eggshell thickness and 33 percent of the variability in thickness index. The contribution of DDE was significant at $\alpha = 0.01$. Table 2 summarizes the various models discussed.

TABLE 2. *Multiple regression models for predicting eggshell thickness and thickness indexes in western grebe eggs, using organochlorine concentrations*

Model	Variable [1]	*F* Ratio	r^2 for Model
$Y_1 = 2.15 + 0.10X_1 + 0.01X_2$	1*	3.1	0.45
$- 16X_3 - 0.04X_4$	2	<0.1	
	3**	5.7	
	4	0.3	
$Y_1 = 2.18 = 0.11X_1 - 0.18X_3$	1**	7.3	0.45
	3***	29.0	
$Y_1 = 2.10 - 0.13X_3$	3***	18.9	0.33
$Y_2 = 42.89 = 1.82X_1 = 0.45X_2$	1*	3.8	0.51
$- 3.12X_3 - 0.83X_4$	2	0.2	
	3***	8.4	
	4	0.5	
$Y_2 = 43.45 = 2.19X_1 - 3.58X_3$	1***	9.4	0.50
	3***	35.6	
$Y_2 = 42.02 - 2.62X_3$	3***	21.4	0.37

NOTE: Y_1 = predicted value of eggshell thickness index; Y_2 = predicted value of eggshell thickness; X_1 = log of Aroclor 1260 concentration, values <1.0 ppm counted as log 0.5; X_2 = log of Aroclor 1254 concentration, values < 1.0 ppm counted as log 0.5; X_3 = log of DDE concentration; X_4 = log of TDE concentration.
[1] Significant at *0.1, **0.05, ***0.01.

The best multiple regression model for predicting both eggshell thickness and eggshell thickness index is the one which includes DDE and Aroclor 1260. Interpretation of this model can be aided by examination of the correlation coefficients (*r* values) which are given in Table 3. TDE is significantly negatively correlated with both eggshell parameters. Multiple regression analysis suggests, however, that TDE relationship to eggshell thickness and index is spurious, that it is a result of its correlation with DDE. Correlations between both PCBs and eggshell thickness and thickness index were not significant. The contribution of Aroclor 1260 to a multiple regression model was, however, significant. Interpretation of the multiple regression relationship between Aroclor 1260 and eggshell thickness or thickness index is difficult because of this lack of correlation between Aroclor 1260 and either eggshell parameter. One multiple regression model was also tested in which the log of the sum of the PCB isomers was used. This model differed little from the model in which authors considered the PCBs separately. No conclusion on the effect of Aroclor 1260 on eggshell thickness can be drawn from this analysis. The fact that Aroclor 1260 can explain variability in eggshell thickness and thickness index does, however, suggest that there is a possible interaction between Aroclor 1260 and DDE.

DDE was the only contaminant which was both correlated with and could explain variability in eggshell thickness and eggshell thickness index. Experimental stu have shown that DDE in diet can cause decreas eggshell thickness (*6, 11, 12, 15, 20*). Experime studies in which birds were subjected to PCBs have shown reductions in eggshell thickness (*7, 13, 19*). T experimental results support the finding that DDE be directly correlated to eggshell thinning in the wes grebe, but that Aroclors 1260 and 1254 can not. Pre analyses do, however, suggest an interaction betv Aroclor 1260 and DDE.

TABLE 3. *Correlation coefficients* (r) *comparing organochlorine concentrations and eggshell parameters for western grebe at Bear River Migratory Bird Refuge, 1973–74*

Parameter	DDE	TDE	Aroclor 1254	Aroclor 1260
Thickness	−0.60*	−0.58*	−0.25	−0.01
Thickness index	−0.58*	−0.56*	−0.27	−0.03

NOTE: * Indicates significance at $\alpha = 0.01$.

Incubation stage appears to have no measurable e on eggshell thickness or index in western grebe. I were divided into four classes according to eml development, and analysis of variance was used to for differences between the incubation stages. Gr 1, 2, 3, and 4 contained 50, 19, 8, and 19 eggs, res tively. Significant differences were not detected betw groups in either eggshell thickness or index. Decline eggshell thickness as incubation progressed were ported by Rothstein (*17*) for cedar waxwing (*Bon cella cedrorum*) and by Kreitzer (*9*) for Coturnix q (*Coturnix coturnix*).

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APPENDIX

Chemical Names of Compounds Discussed in This Issue

AROCLOR 1254	PCB, approximately 54% chlorine
AROCLOR 1260	PCB, approximately 60% chlorine
CHLORDANE	Technical: 60% octachloro-4,7-methanotetrahydroindane and 40% related compounds
DDE	Dichlorodiphenyldichloroethylene (degradation product of DDT)
DDT	Dichloro diphenyl trichloroethane. Principal isomer present (*p,p'*-DDT; not less than 70%): 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
DIELDRIN	Hexachloroepoxyoctahydro-*endo,exo*-dimethanonaphthalene 85% and related compounds 15%
ENDRIN	Hexachloroepoxyoctahydro-*endo,endo*-dimethanonaphthalene
HCB	Hexachlorobenzene
HEPTACHLOR	Heptachlorotetrahydro-4,7-methanoindene
HEPTACHLOR EPOXIDE	1,4,5,6,7,8,8-Heptachloro-2,3-*epoxy*-3a,4,7,7a-tetrahydro-4,7-methanoindan
MIREX	Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta[cd]pentalene
NONACHLOR	1,2,3,4,5,6,7,8,8-Nonachlor-3a,4,7,7a-tetrahydro-4,7-methanoindan
OXYCHLORDANE	1-*exo*-2-*endo*-4,5,6,7,8,8a-Octachloro-2,3-*exo*-*epoxy*-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene
PCBs (Polychlorinated Biphenyls)	Mixtures of chlorinated biphenyl compounds having various percentages of chlorine
TDE	Dichloro diphenyl dichloroethane (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane, principal component)
TOXAPHENE	Technical chlorinated camphene (67–69% chlorine)

ıe *Pesticides Monitoring Journal* welcomes from all urces qualified data and interpretative information on sticide monitoring. The publication is distributed incipally to scientists, technicians, and administrators sociated with pesticide monitoring, research, and ıer programs concerned with pesticides in the environ-ıt. Other subscribers work in agriculture, chemical ınufacturing, food processing, medicine, public health, d conservation.

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CONTENTS

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FISH, WILDLIFE, AND ESTUARIES

DDE Residues in Young Wood Ducks (Aix sponsa) *Near a Former DDT Manufacturing Plant*

W. James Fleming and Eugene Cromartie[1]

ABSTRACT

ast muscle DDE residues were as high as 5.8 ppm wet-ght basis and 280 ppm lipid-weight basis in young wood ks (Aix sponsa) *collected on Wheeler National Wildlife uge near a former DDT manufacturing plant in northern bama. The average DDE residue in wood ducks col-ed nearest the plant was 46 times background levels 74 from the plant.*

Introduction

commercial DDT manufacturing plant operating on U.S. Army Redstone Arsenal from 1947 to 1970 eased DDT-contaminated effluent into Huntsville ing Branch, a tributary of the Tennessee River near ntsville, Alabama. River sediments along a 5.5-km tion of Huntsville Spring Branch contain an estimated $\times 10^5$ kg to 3.63 $\times 10^6$ kg DDT and its metabolites DDT) (Tennessee Valley Authority, unpublished re-t; U.S. Army Corps of Engineers, unpublished re-t). The area of heaviest contamination is within the ndaries of Wheeler National Wildlife Refuge WR).

heeler NWR and the surrounding Tennessee River odplain are important wintering areas for waterfowl. rty to sixty thousand waterfowl winter at Wheeler VR each year. Mallards (*Anas platyrhynchos*) from heavily contaminated area of Huntsville Spring nch had carcass residues of up to 480 ppm ΣDDT et-weight basis) in a 1979 survey (*7*). Eleven of mallards in that survey had carcass residues high ough to indicate future reproductive problems. Therefore, waterfowl on some parts of the refuge are acquiring significant amounts of DDT and DDE. Residues mallard wings collected in Alabama indicated that availability of high levels of DDT and DDE to atinae was primarily restricted to the counties encompassing Wheeler NWR (*2*). The present study examines the geographical pattern of DDT contamination of waterfowl within these counties.

sh and Wildlife Service, U.S. Department of the Interior, Patuxent dlife Research Center, Laurel, Md. 20811.

Methods

Juvenile wood ducks (*Aix sponsa*) were collected by trapping and shooting at four locations on Wheeler NWR and at two additional sites in the Tennessee River floodplain about 145 km by water (75 km by air) upstream and 50 km by water (32 km by air) downstream from the confluence of the Huntsville Spring Branch–Indian Creek embayment with the Tennessee River (Fig. 1). Collections were made between July 20 and August 7, 1979 by workers from the U.S. Army, the Tennessee Valley Authority, the Alabama Department of Conservation and Natural Resources, and the U.S. Department of the Interior. In addition, addled wood duck eggs were collected from nest boxes at two locations on Wheeler NWR between July and September 1979. One egg from each of five nests from each of the two locations was analyzed.

Wood duck carcasses were frozen and shipped to Patuxent Wildlife Research Center for preparation and analyses. Eggs were shipped whole and unfrozen. Wood ducks were aged on the basis of plumage development (*3*). About 20 g breast muscle was dissected for analysis from each carcass. Egg contents were removed and chemical residues were adjusted for moisture loss (*8*).

Samples were analyzed for DDT, DDE, TDE, PCBs, heptachlor epoxide, dieldrin, oxychlordane, *cis*-chlordane, *trans*-nonachlor, endrin, HCB, and mirex. A 10-g portion of the homogenized sample of egg or muscle was mixed with anhydrous sodium sulfate, and extracted 7 hours with hexane in a Soxhlet apparatus; the lipids were removed by Florisil column chromatography. Pesticides and PCBs were separated on a SilicAr column into three fractions. The procedures

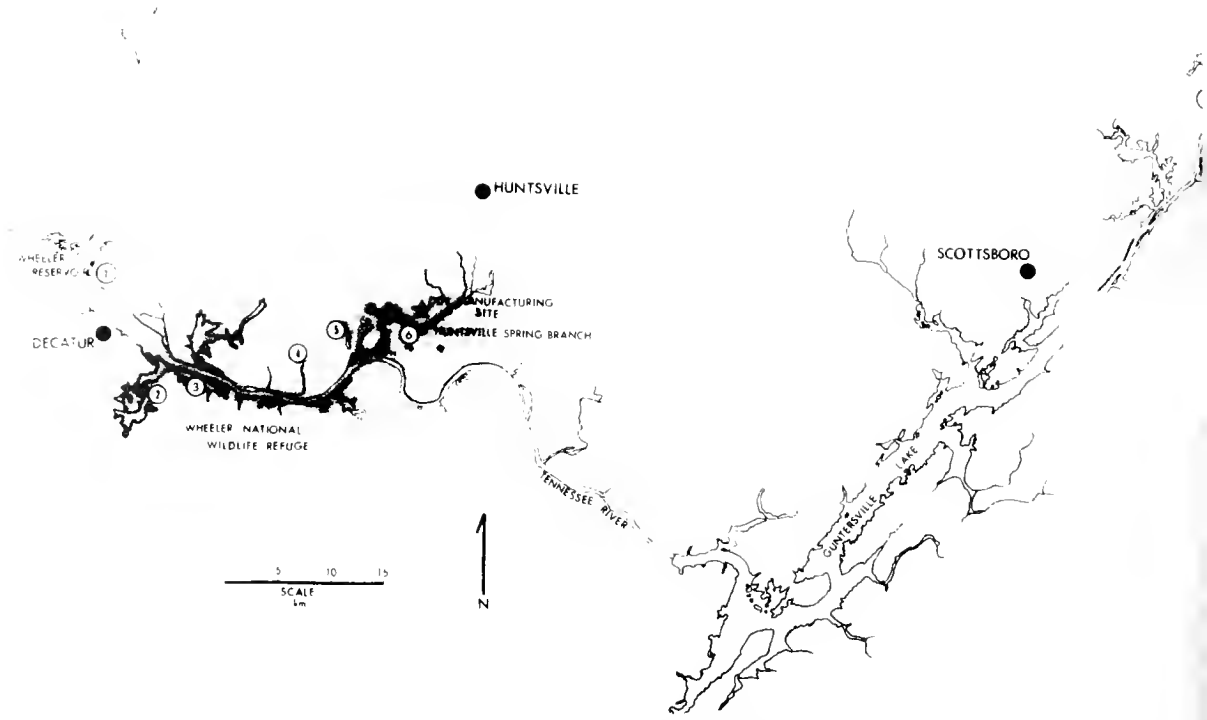

FIGURE 1. *Wood duck and wood duck egg collection sites in the Tennessee River floodplain, northern Alabama. T 1 and 2 identify the collection localities.*

used were those described by Cromartie et al. (*1*). The pesticides in each fraction were quantified with a gas-liquid chromatograph using an electron-capture detector and a 1.5 percent OV-17/1.95 percent QF-1 column. Average recoveries ranged from 83 percent to 104 percent from DDE-spiked tissue. Residues were not corrected for percent recovery.

The lower limit of quantification was 0.1 ppm for pesticides and 0.5 ppm for PCBs. Residues in five samples were confirmed with a Finnigan 4000 series gas chromatograph/mass spectrometer; operating conditions were described by Kaiser et al. (*5*).

Data were analyzed by analysis of variance, Duncan's test of multiple means, and Student's *t*-test. All tests were conducted at $a = 0.05$. Statistical treatment of data used 0 values where residues did not exceed the limit of detection.

Results and Discussion

Results of analyses for DDT and metabolites are presented in Table 1. The low ΣDDT residue levels for the Crow-Saunty Creek Management Area probably represent background levels of contamination for the region. Average residues in ducks from three of the four collection sites on Wheeler NWR exceeded this background level. The highest level of DDE contamination was found in ducks from Huntsville Spring Br although this level was not statistically different samples from Blackwell Springs. The relatively DDE levels in young wood ducks from Hunt Spring Branch were expected because this was collection site closest to the former DDT manufa ing plant. DDE residues from Huntsville Spring Br were as high as 5.8 ppm on a wet-weight basis 280 ppm on a lipid-weight basis. Therefore, it ap that Huntsville Spring Branch is the primary sourc DDT and metabolite residues for resident wood d and probably for other species of waterfowl that w at Wheeler NWR and vicinity. High DDE residue some birds from areas other than Huntsville Sp Branch suggest that movement of these birds may had some influence on mean residue levels for the c collection locations or that small areas of he localized contamination were scattered along the nessee River Valley in northern Alabama.

Bird No. 2 contained 1.0 ppm heptachlor epoxide bird No. 13 contained 0.53 ppm PCBs. Dieldrin, chlordane, *cis*-chlordane, *trans*-nonachlor, endrin, H and mirex were not detected in any muscle samples

All 10 eggs contained residues of DDE and one tained DDT and TDE (Table 2). DDE residue eggs from Blackwell Springs were greater than t from Garth Slough ($P \leq 0.05$) as might be expe

TABLE 1. *DDT and metabolite residues in breast muscle of juvenile wood ducks from northern Alabama, 1979*

Location	Specimen Number	Age, Days	Sex	Residues, ppm wet weight			Percent Lipids
				p,p'-DDE	*p,p'*-DDT	*p,p'*-TDE	
n Creek Management	15	100–120	M	1.4	—	—	1.7
rea	16	100–120	M	0.43	—	—	2.3
	17	100–120	M	0.25	—	—	2.2
	18	100–120	M	—	—	—	2.7
	19	100–120	M	—	—	—	1.8
ın				0.42 [a]	—	—	
t Creek, Wheeler National	23	100–120	F	—	—	—	1.6
Vildlife Refuge	24	100–120	F	—	—	—	1.7
	25	100–120	F	—	—	—	2.4
	26	80–100	F	—	—	—	1.8
	27	80–100	M	—	—	—	2.6
ın				— [a]	—	—	
kwell Springs, Wheeler	1	80–100	F	0.53	—	—	1.8
ational Wildlife Refuge	3	80–100	M	—	—	—	1.7
	4	80–100	M	—	—	—	1.7
	10	100–120	M	4.5	0.48	1.6	2.3
ın				1.3 [ab]	0.12	0.4	
n Pond, Wheeler	6	80–100	M	0.11	—	—	2.3
ational Wildlife Refuge	7	80–100	F	—	—	—	2.2
	8	80–100	F	0.11	—	—	1.4
	9	80–100	F	1.6	—	—	1.8
ın				0.46 [a]	—	—	
ıtsville Spring Branch,	12	80–100	M	0.14	—	—	2.7
Vheeler National Wildlife Refuge	13	80–100	M	1.9	—	0.85	3.4
	14	100–120	F	5.8	—	0.43	2.1
	20	120–140	M	5.8	0.5	1.6	3.1
	21	60– 70	F	2.8	—	0.16	1.4
	22	100–120	F	0.6	—	0.33	2.1
ın				2.8 [b]	0.1	0.56	
w-Saunty Creek	28	80–100	F	0.18	—	—	2.5
lanagement Area	29	80–100	F	—	—	—	3.3
	30	80–100	M	—	—	—	2.5
	31	80–100	M	0.13	—	—	2.8
	32	80–100	F	—	—	—	2.9
ın				0.06 [a]	—	—	

: Number refers to location on Figure 1. Mean DDE residues with different letters are significantly different ($P < 0.05$).

E 2. *DDT and metabolite residues in wood duck from two locations on Wheeler National Wildlife Refuge, Alabama, 1979*

ocation	Specimen Number	Residues, ppm wet weight			Percent Lipids
		p,p'-DDE	*p,p'*-DDT	*p,p'*-TDE	
th Slough	1	0.16	—	—	12.9
	2	0.15	—	—	14.0
	3	0.28	—	—	15.1
	4	0.19	—	—	13.5
	5	0.3	—	—	16.1
ın		0.22	—	—	
kwell Springs	16	4.3	0.37	0.69	12.8
	18	1.3	—	—	15.2
	19	0.48	—	—	11.8
	22	1.8	—	—	16.4
	25	2.2	—	0.16	15.3
ın		2.0	0.07	0.17	

Number refers to location on Figure 1. Mean DDE levels were not significantly different ($P > 0.05$).

e basis of distance from the DDT plant site (Fig. DDE residues in eggs from Blackwell Springs were lower limit at which reproductive and behavioral s have been reported for waterfowl. Black duck (*Anas rubripes*) eggs averaging 4.2 ppm DDE were about 10 percent thinner than control eggs (*6*). Mallard ducklings hatched from eggs containing an average of 5.8 ppm were hyperresponsive to tape-recorded maternal calls but were less responsive to a frightening stimulus (*4*).

Conclusions

The present work, in combination with that of Fleming and O'Shea (*2*), indicates that Huntsville Spring Branch is the primary site in northern Alabama where waterfowl acquire significant amounts of DDT and DDE. Mean muscle values of DDE in wood ducks from Huntsville Spring Branch were 46 times background residues of wood ducks 74 km away.

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Kepone Distribution in the Water Column of the James River Estuary—1976–78

Charles A. Lunsford [1]

ABSTRACT

ntrations of Kepone residues in water collected from mes River estuary in 1976–78 ranged from 0 to 1.20 The majority of water samples collected showed no able residues. Kepone concentrations at the surface ottom of the water column were similar. Water column es varied according to seasonal and spatial differences. peaked during the summer months and averaged in the middle reach of the estuary. Residues in the were 1–5 orders of magnitude lower than reported es in James River bed sediments. There was a sig- nt correlation between water column and underlying ediment residues.

Introduction

nanufacturing of Kepone, an organochlorine pesti- similar to mirex, during the period 1966–75 in well, Virginia, resulted in contamination of the s River estuary. It was estimated that 90,720 kg epone were released to the environment through spheric emissions, wastewater discharges, and bulk sal of off-specification batches (*2*). Finfish, shell- and blue crabs from the James River contained ne residues above the action levels of the Food Drug Administration (FDA), U.S. Department of h and Human Services. As a result of this con- ation, the estuary was closed to commercial and fishing with the exception of taking shad and g (*Alosa* spp.), catfish (*Ictalurus* spp.), and le blue crabs (*Callinectes sapidus*).

mprehensive Kepone monitoring program was es- hed in 1975 as described by Bellanca and Gilley o verify environmental levels and trends in assess- he magnitude of contamination. As part of the toring and surveillance effort, the Virginia State r Control Board (SWCB) has monitored Kepone ues in finfish, bed sediments, and the water column e James River estuary and the Chesapeake Bay. present manuscript reports the results of Kepone column monitoring in the James River estuary g the period 1976–78.

nia State Water Control Board, Division of Ecological Studies, ox 11143, Richmond, Va. 23230.

The objectives of this present study were to determine: (a) if differences exist in Kepone concentrations at the surface versus bottom of the water column, (b) if spatial and temporal differences affect Kepone concentrations in the water column, and (c) if Kepone residues in the water column relate to the amount adsorbed to underlying bed sediments.

DESCRIPTION OF JAMES RIVER ESTUARY

The James River is the southernmost major tributary and the third largest tidal tributary of the Chesapeake Bay, in reference to the volume of river flow. The river discharges at an average rate of 212 m^3/second.

The James is described as a partially stratified estuary. The salt wedge extends approximately 64 km upstream from the river mouth; this distance varies according to the volume of river flow. In the lower estuary, circulation is characterized by a nontidal component driven largely by the mixing of salt water and freshwater (*7*). In the tidal freshwater section, water movement is dominated by freshwater flow and tidal action. The tidal reach extends to Richmond, 180 km upstream from its mouth at the Hampton Roads bridge tunnel.

The estuary has long been used for commercial and sport fishing. Fishery resources are diverse and productive; commercial fishing grounds extend 117 km upstream to the Hopewell area. Anadromous fish extensively use the freshwater and upper portions of brackish water zones as spawning and nursery areas. In addition, brackish water zones provide a nursery area for important commercial species that are taken within the Chesapeake Bay. The lower estuary is a highly productive shellfish and crabbing area. The important commercial species include the hard clam, *Mercenaria mercenaria*, the eastern oyster, *Crassostrea virginica*, and the blue crab, *Callinectes sapidus*. The estuary provides the only major source of seed oysters in Virginia.

Materials and Methods

COLLECTION OF SAMPLES

Samples were collected quarterly at 75 stations from four areas of the estuary as shown in Figure 1. The

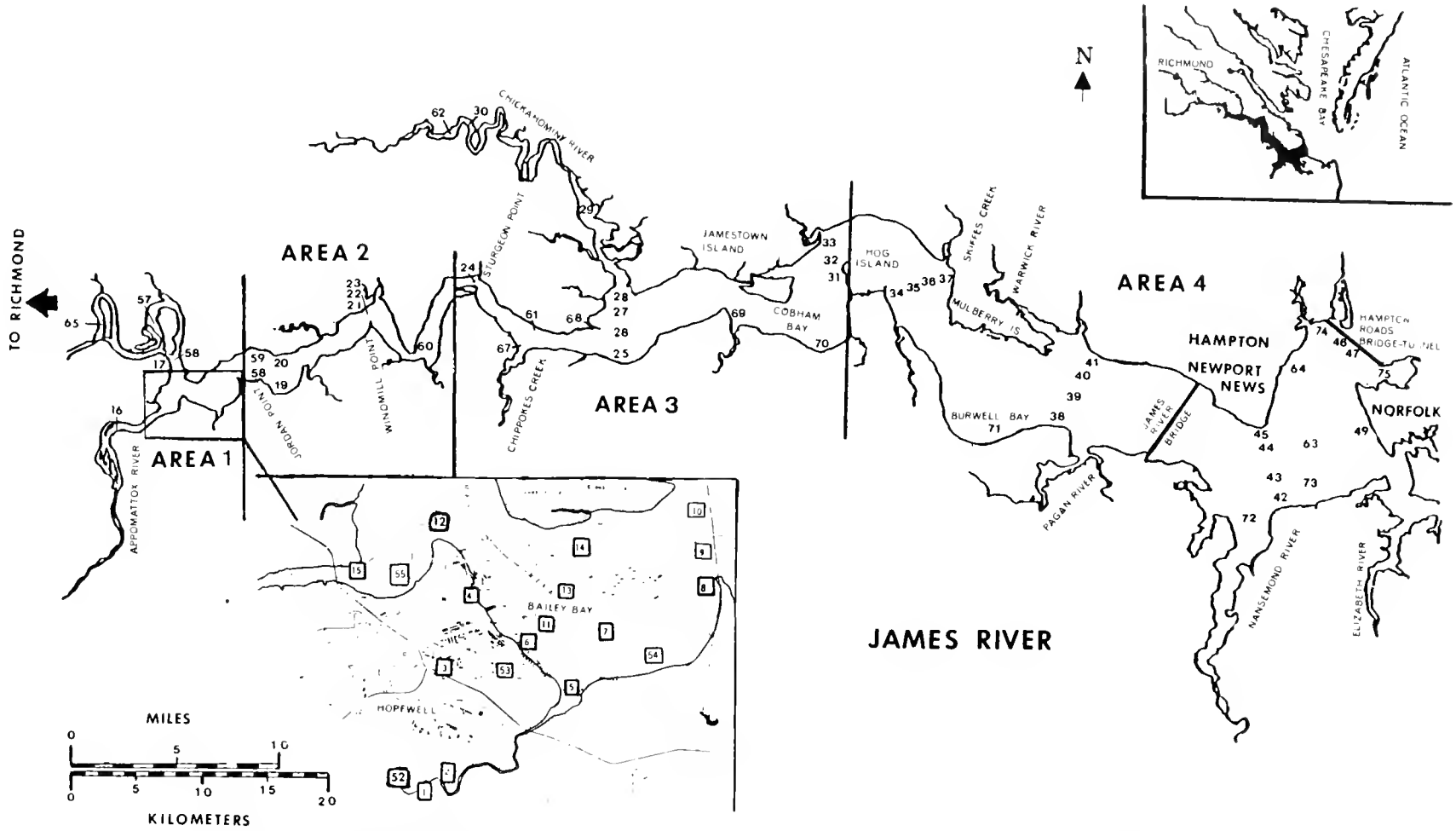

FIGURE 1. *James River estuary from Richmond to Norfolk, Virginia, and stations sampled for Kepone residues, 1976–78.*

as are defined as Area 1, Hopewell area (km 106–
); Area 2, Jordan Point to Sturgeon Point (km 101–
; Area 3, Sturgeon Point to Jamestown Island (km
-48); and Area 4, Jamestown Island to Chesapeake
(km 48–0).

ring 1976 and 1977, samples were taken at both
face and bottom depths at all stations in waters
1.5 meters deep. At shallow water stations (< 1.5
ers deep), only surface samples were collected.
tom sampling was discontinued after 1977.

nples collected at the surface consisted of grab
nples collected in clean, 1.9-liter glass jars. Bottom
nples were collected using a Teel pump and a 1.91-
plastic hose. Before each bottom sample was
ected, the hose and pump were purged for ap-
ximately 1 minute. The glass jars in which the
nples were collected were sealed with aluminum
, capped, and kept refrigerated until delivery to
State Division of Consolidated Laboratory Services
CLS), Richmond, Virginia, for analysis.

ring collections, water quality parameters were
asured. These included water temperature (°C),
olved oxygen, and pH. These parameters were not
ginally chosen to fit into the objectives of the study.
h parameters are measured routinely during ambient
er monitoring by SWCB.

ter temperature determinations were made with a
low Springs Instruments (YSI) salinity-conductivity-
nperature meter, Model No. 33. Dissolved oxygen
s measured with a YSI meter, Model No. 57, cali-
ted by the Winkler-azide method. pH was measured
h a Hach kit, Model No. 17-N.

MPLE ANALYSIS

ter samples were extracted in the glass jars in which
y were collected, using benzene (a liquid-liquid
raction), according to the procedure of DCLS (*5*).
e organic phase was dried over anhydrous sodium
fate and concentrated in a Kuderna-Danish concen-
or. Extracts were analyzed directly in a Hewlett
ckard 5800 Series gas chromatograph equipped with
electron-capture detector (^{63}Ni pulsed), and a 183-
cm × 0.4-cm glass column packed with 4 percent SE-
30/6 percent QF-1 on 80–100 mesh Gas-Chrom Q or
80–100 mesh Chromosorb W-HP. A blank (distilled
water) and a spike were analyzed with each group of
samples (minimum of one each day). Spiking concen-
trations ranged from 0.01 ppb to 1.0 ppb; 0.05 ppb
was the most common. Kepone recoveries from spiked
water ranged from 70 percent to 110 percent. No
corrections were made for recovery. Confirmatory
analyses were conducted using a gas chromatograph
equipped with a Dohrmann Model 2468 microcoulo-
metric detector (GTS–20). Kepone residues are re-
ported as μg/liter (ppb).

The original detection limit for Kepone in water was
0.01 ppb. The detection limit was changed to 0.02 ppb,
the confidence level for this method, during the summer
of 1976. A series of samples were analyzed in the winter
of 1978 at a detection limit of 0.05 ppb. The limit was
changed at this time because of background concentra-
tions of naturally occurring organic interferences in
the water samples.

STATISTICAL ANALYSIS

Because of the skewed data distribution, nonparametric
statistics were used for data analysis. With such a
skewed distribution, the median rather than the
arithmetic mean is a better measure of central tendency.
Both the mean and median values are presented in
the results section of this paper. Statistical analyses
were performed on an IBM 370/158 computer with
programs available in the SAS statistical package (*9*).

Results

A comparison of Kepone concentration in surface and
bottom water samples is presented in Table 1. Wilcoxon's
signed-ranks test was used to determine if significant
differences existed between surface and bottom con-
centrations. Differences were not significant at the 0.05
level for 1976 and 1977.

Seasonal Kepone concentrations are summarized in
Table 2. The median values for the periods fall, 1976;
winter, spring, and fall 1977; and winter 1978 were
0.00 because of the large number of samples with non-
detectable concentrations (a sample with no detectable
residues was treated as a zero value).

ABLE 1. *Comparison of Kepone concentrations in surface and bottom water samples of James River estuary, 1976–77*

	Residues, μg/liter (ppb)							
	1976				1977			
RCE	Sample Size	Median	Mean	Range	Sample Size	Median	Mean	Range
ace	127	0.02	0.04	ND[1]–1.20	90	0.00	0.01	ND[2]–0.11
om	127	0.00	0.02	ND –0.41	90	0.00	0.02	ND –0.19

n-detectable; < 0.01 or 0.02 ppb.
n-detectable; < 0.02 ppb.

TABLE 2. *Seasonal Kepone water column concentrations in James River estuary, 1976–78*

Season	Residues, µg/liter (ppb)											
	1976				1977				1978			
	Sample Size	Median	Mean	Range	Sample Size	Median	Mean	Range	Sample Size	Median	Mean	Ran
Winter	131	0.03	0.05	ND[1]–0.95	9	0.00	0.01	ND –0.04	54	0.00	0.00	ND[3]–(
Spring	76	0.03	0.04	ND –1.20	84	0.00	0.00	ND –0.05	33	0.03	0.04	ND –(
Summer	70	0.03	0.05	ND[2]–0.97	64	0.04	0.04	ND –0.19	52	0.04	0.05	ND –(
Fall	64	0.00	0.01	ND –0.16	60	0.00	0.01	ND –0.07	51	0.02	0.03	ND –(

[1] Non-detectable; < 0.01 ppb.
[2] Non-detectable; < 0.02 ppb.
[3] Non-detectable; < 0.02 or 0.05 ppb.

TABLE 3. *Spatial distribution of Kepone water column concentrations in James River estuary, 1976–78*

Area[1]	Residues, µg/liter (ppb)											
	1976				1977				1978			
	Sample Size	Median	Mean	Range	Sample Size	Median	Mean	Range	Sample Size	Median	Mean	Rang
1. Mile 66–63	68	0.00	0.07	ND[2]–1.20	51	0.00	0.01	ND[3]–0.05	42	0.03	0.05	ND[4]–(
2. Mile 63–48	29	0.05	0.05	ND –0.19	20	0.03	0.03	ND –0.08	35	0.03	0.04	ND –(
3. Mile 48–30	76	0.04	0.05	ND –0.95	37	0.02	0.02	ND –0.09	40	0.02	0.03	ND –(
4. Mile 30–0	135	0.00	0.03	ND –0.59	90	0.00	0.01	ND –0.19	51	0.00	0.01	ND –(

[1] See Figure 1.
[2] Non-detectable; < 0.01 or 0.02 ppb.
[3] Non-detectable; < 0.02 ppb.
[4] Non-detectable; < 0.02 or 0.05 ppb.

There was no consistent temporal reduction in contamination levels during the study period. Levels in 1977 declined; yet during the spring and summer of 1978, levels increased and were similar to 1976 findings. The one prominent trend during the study period was a peak in Kepone concentrations during the summer months (July–September). To detect whether differences in residues existed due to seasonality, the Kruskal-Wallis one-way analysis of variance by ranks test was used. Differences between seasons were significant at the 0.01 level for all three sampling years.

Spatial Kepone concentrations are summarized in Table 3. Overall median concentrations were higher in the middle reaches of the estuary (Areas 2 and 3). Area 3 is generally defined as the turbidity maximum zone of the James River. This zone shifts seaward or landward depending on river inflow. Net current velocity approaches zero at this interface as freshwater moving seaward mixes with saltwater moving landward. According to Nichols and Trotman (*13*), the bulk of the river-borne sediment load in the James River is trapped within this reach.

Area 1, Hopewell area, includes Bailey Bay which is a shallow water bay into which wastewater from the Kepone manufacturers was discharged. Area 4, Jamestown Island to Chesapeake Bay, includes the major portion of commercial fishing grounds for migratory species in the estuary.

To detect whether significant differences in residues existed among the four area reaches, the Kruskal-W one-way analysis of variance by ranks test was u Differences between areas were significant at the level for all three sampling years.

Using water temperature and Kepone bed sediment collected in 1976–78, correlations between these v ables and Kepone water residues were investiga The results are presented as Spearman rank correla coefficients along with levels of significance in Ta 4 and 5. Water temperatures showed a significant

TABLE 4. *Correlation of Kepone residues in water column and water temperature of James River estuary 1976–78*

Statistic	Water Temperature		
	1976	1977	1978
r	0.11	0.32	0.62
s	0.1754	0.0001	0.0001

NOTE: Spearman rank correlation coefficients (*r*) and level of si cance (*s*); $P < 0.05$.

TABLE 5. *Correlation of Kepone residues in water col and bed sediments of James River estuary, 1976–78*

Statistic	Sediments		
	1976 (0–1.27 cm)	1977 (0–9 cm)	1978 (0–9 cm)
r	0.31	0.12	0.38
s	0.0001	0.0483	0.0001

tion with water column residues for 1977 ($r = 0.32$, 0.0001) and 1978 ($r = 0.62$, $s = 0.0001$); whereas correlation for 1976 was not significant. Water peratures for 1976 averaged lower (15.6°C ± 10.4) ı those for 1977 (22.1°C ± 5.0) and 1978 (18.0°C 10.2) and this may explain the lack of a significant elation. Bed sediment residues showed a significant elation with water column residues for all three pling years (see Table 5).

Discussion

ılysis of Kepone residues in water samples collected n the James River estuary in 1976–78 showed a ge of concentrations from 0 ppb to 1.20 ppb. These ıes are one to five orders of magnitude lower than due levels reported in James River bed sediments). Concentrations in James River sediments range n 0 ppm to 5 ppm. Kepone, like many other ɔrinated organic compounds, is only slightly soluble water and has an affinity for particulate matter.

ferences in Kepone concentrations at the surface bottom of the water column were not significant. tom samples were expected to have higher Kepone centrations than surface samples, because bottom er should contain more contaminated particulate tter resuspended from bed sediments. Kepone ched to particulate matter is more concentrated n dissolved amounts (*2*).

trends apparent after monitoring from 1976 to 8 indicate significant seasonal and spatial variations Kepone water column concentrations. Concentraıs reach the highest ambient level during the sum- months, July–September. There may be various lanations for such a seasonal trend. The correlaı coefficients as shown in Table 4 indicate a signifit relationship between water temperature and pone water residues (1977 and 1978). The U.S. ny Corps of Engineers (*15*) suggested that tempera- may affect the partition coefficient of Kepone in er/sediments, and that higher concentrations in the er column during the summer months compared h winter months are the result of temperature affect- Kepone partitioning. Battelle (*2*) reported that temature has no apparent effect on Kepone partitioning.

cording to R. Huggett (Virginia Institute of Marine ence, personal communication), the peak in Kepone ıcentrations during the summer months is most ly caused by increased numbers of phytoplankton the water column. Phytoplankton collected in the ıary contain Kepone residues ranging from nonectable levels to 2.06 ppm (*10*). In a study by de la ız and Lue (*6*), concerning the distribution of mirex ng the Mississippi Gulf Coast, it was reported that concentration of mirex in the seston (suspended tter) exceeded concentrations in water, sediments, fish, or shellfish. Phytoplankton are a major component of seston in the water column. The relationship between Kepone water column concentrations and phytoplankton biomass needs to be investigated.

Increases in ambient Kepone concentrations during the summer may require imposing restrictions on summer dredging in Kepone-contaminated areas of the estuary. Time restrictions, without regard to Kepone contamination, have been imposed in the past by regulatory agencies to limit dredging during spawning and migration periods of important commercial fish and shellfish in the James River. Studies with James River resident species, the eastern oyster, *Crassostrea virginica* (*4*), and the estuarine bivalve, *Rangia cuneata* (*12*), indicated that Kepone body burdens reach the highest levels during the summer months. This is due to increased metabolism and feeding rates corresponding with increased water temperatures. Also during the summer, increased numbers of migratory fish from Chesapeake Bay enter the estuary. Dredging during this period and the resulting resuspension of contaminated sediments may magnify Kepone uptake and result in contamination of greater numbers of organisms.

Another trend indicated by this study was a significant spatial variation in water column residue concentrations; residues averaged higher in the middle reach of the estuary. Kepone was detected at or above 0.022 ppb within all reaches of the estuary sampled. This is the recommended upper limit to result in fish tissue levels below the FDA action level of 0.30 ppm (*2*). From the results of laboratory studies (*1*), it was established that shellfish (eastern oyster, *C. virginica*) and finfish (spot, *Leiostomous xanthurus*) are capable of bioconcentrating Kepone to concentrations near or above the action level when exposed to water with Kepone residues as low as 0.023 ppb.

Kepone residues in the water column are an important component of the overall James River ecosystem contamination. The water column transports dissolved Kepone and contaminated particulate matter which serves as a continual source of Kepone and exposure to aquatic organisms. This exposure is below reported acute and chronic toxicity levels (*8, 14, 16*). However, adverse ecological effects can occur at Kepone concentrations in water as low as 0.004 ppb, which is well below present detectable limits (*2*). Even with low Kepone exposure from the water column, residues in finfish, shellfish, and blue crabs exceed the acceptable FDA action levels as a result of magnification by bioconcentration (uptake from water and sediment) and bioaccumulation (food sources).

The results of this monitoring study indicate that Kepone concentrations in the water column are ex-

tremely low. Detectable concentrations vary according to seasonal and spatial differences. Future investigations should study dissolved and suspended solids phases of Kepone in the water column to better understand the contamination and transport mechanisms.

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Organochlorine Residues and Mortality of Herons

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ABSTRACT

ce 1966, 72 herons found dead or moribund in the field e been analyzed for organochlorine chemicals. In addi-, 36 herons were obtained through systematic collec-s, and carcasses were analyzed to determine sublethal osure to organochlorines. Brains of birds found dead or ribund were analyzed to determine whether the birds died of organochlorine poisoning.

idues of DDE were found most frequently (96 of 105 casses analyzed), PCBs were second (detected in 90 casses), and dieldrin and TDE (detected in 37 and 35 casses, respectively) were about equal as third and rth most frequent. Endrin, mirex, toxaphene, and HCB e found least often (8, 9, 9, and 9 carcasses, respec-ly). At least one organochlorine was found in each car-s, except for six heron chicks found dead in a Maryland onry. DDE and PCBs were present in highest concentra-s; they exceeded 100 ppm in two birds each.

anochlorine concentrations were almost always higher adult herons than in immature birds. All birds that had ardous or lethal concentrations in the brain were adults, most were great blue herons (Ardea herodias). *Dieldrin the chemical most often considered responsible for th. Herons died of suspected DDT and dieldrin poisoning rs after the chemicals were banned in the United States. re than 20 percent of the herons found dead or moribund lethal or hazardous concentrations of organochlorines he brain.*

Introduction

merous individuals have submitted herons of various cies they found dead or moribund to our laboratories learn whether the birds died of diseases or organo-orine poisoning. Other herons were collected in dies planned to determine mercury contamination selected fauna at certain localities (*2*, *4*; E. H. Dust-n and M. A. R. McLane, this laboratory, unpub-ed manuscript). Organochlorine concentrations in casses of birds and mammals are considered the t measure of sublethal exposure, whereas concentrations in the brain are best for diagnosing death by organochlorine chemicals (see reference *5* for review). In the absence of other indications of cause of death, concentrations of 9 ppm or more dieldrin in the brain indicate probable death by dieldrin poisoning (W. H. Stickel, this laboratory, personal communication). Dieldrin concentrations of 5–9 ppm are considered hazardous because some birds died with residues in that range in laboratory studies, although others survived (*19*; W. H. Stickel, personal communication). Birds seldom survive with more than 0.8 ppm endrin in the brain (*18*); those with 0.6–0.8 ppm may die or survive. The lower limit of the lethal range for DDE is about 250 ppm (W. H. Stickel, personal communication). Combined DDT and DDE residue concentrations of 30 ppm represent the practical separation point between dead birds and survivors in laboratory studies (*16*, *17*; W. H. Stickel, personal communication).

The purpose of the present paper is to document the occurrence, sometimes at high concentrations, of organochlorine residues in herons from various areas in the United States. Information on causes of death is presented briefly. Previously (*12*), authors compared residue concentrations in brains of herons collected in this study with laboratory-determined diagnostic lethal concentrations. Authors concluded that some herons were killed by organochlorine poisoning; others were at least seriously endangered by the organochlorines found in the brain.

Methods

SAMPLING

Most herons had been found dead or moribund in the field and were submitted for determination of cause of death. In addition, herons were collected at Lake St. Clair, Michigan ($N = 6$); Mobile Bay, Alabama ($N = 22$); and Lake Champlain, Vermont ($N = 5$) in 1970 to determine mercury contamination (*2*, *4*; E. H. Dustman and M. A. R. McLane, unpublished manuscript). Carcasses of these birds were therefore available for analysis for organochlorines. Three herons were subsequently collected at Lake St. Clair in 1973 to determine the continued occurrence of polychlorinated

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styrene compounds that were detected in the 1970 specimens (*15*).

Sixteen states were represented among the 108 birds analyzed (Table 1). Nine species were included: great blue heron (*Ardea herodias*), green heron (*Butorides striatus*), little blue heron (*Florida caerulea*), cattle egret (*Bubulcus ibis*), great egret (*Casmerodius albus*), snowy egret (*Egretta thula*), Louisiana heron (*Hydranassa tricolor*), black-crowned night heron (*Nycticorax nycticorax*), and yellow-crowned night heron (*Nyctanassa violacea*).

Some specimens were delivered or shipped to our laboratories while they were still fresh. Most, however, were frozen, packed in dry ice, and shipped by air express to the laboratory, where they were stored at — 25°C until processed for analysis.

NECROPSY PROCEDURES

Necropsies were performed on many of the specimens to determine possible causes of death. They were performed at the Patuxent Wildlife Research Center from 1969 until 1975 and at the National Wildlife Health Laboratory after 1975. Some specimens were dissected without complete necropsy or histological examination. Herons were weighed, decapitated, and then skinned. Wings were disarticulated at the olecranon (or "elbow"), and the legs at the tibiotarsal-tarsometata (or "hock") joint. Liver and kidneys were remo and placed in separate, chemically clean (rinsed acetone and hexane) bottles for subsequent analy The entire, intact alimentary canal was removed; was taken to ensure that no portion of its cont spilled onto the carcass. The term "carcass" as use the present paper refers to the remaining portion the body (i.e., after the head, skin, feet, wing tips, l kidneys, and gastrointestinal tract were removed). carcass was wrapped in aluminum foil, placed i plastic bag, and frozen until analyzed.

The brain was removed from the skull, placed in a s rate, chemically clean glass bottle, and frozen u analyzed. Samples for bacteriological and virolog studies were collected at appropriate times du necropsy; observed lesions were cultured and saved later histopathological study. Tissues for microsc study were fixed in buffered 10 percent formalin percent formaldehyde), embedded in paraffin, sectio and stained with either hemotoxylin and eosin, Zi Neelson acid-fast, periodic acid-Schiff (PAS), Gie Perl's Prussian blue, or van Kossa stains.

ANALYTICAL PROCEDURES

The analyses were performed over a period of y and consequently some changes were made in meth

TABLE 1. *Distribution of herons analyzed by state, method of collection, and frequency of organochlorine residue carcasses*

State	Number of Herons		Frequency of Residues														
	Found Dead or Moribund	Shot	DDE	TDE	DDT	Dieldrin	Heptachlor Epoxide	Oxychlordane	*cis*-Chlordane	*trans*-Nonachlor	*cis*-Nonachlor	Endrin	Toxaphene	HCB	Mirex	P
NORTHEASTERN STATES																	
Massachusetts	2		2	1						1							
Vermont		5	5	4	2			1	1								
MID-ATLANTIC STATES																	
Maryland	22		16	6	2	7	2	2	4	8	2		1	1	1		1
Virginia	5		5	4	2	4	3	2	3	4	3	1		2	1		
SOUTHEASTERN STATES[1]																	
Alabama		22	22	2		1									1		2
Florida	3		3	2	1	2	2	1	2	3	2						
Louisiana	5		5			1											
GREAT LAKES STATES																	
Illinois	1		1			1	1	1	1	1	1						
Michigan		9	9	6	1	9		3	8		3			4	2		
Minnesota	19		16	5	4	7	3	4	2	7	2	4	5		3		1
Wisconsin[2]	2		2	2	1	2	2	2	2	2	2	2	1		1		
CENTRAL AND WESTERN STATES																	
California	1		1	1	1	1			1	1	1	1	1	1			
Nebraska	1		1	1		1							1				
Nevada	3		3	1	1	1	1	1		2				1			
New Mexico	5		5														
TOTAL	69[1,2]	36	96	35	15	37	14	17	24	29	16	8	9	9	9		9

[1] In addition, one heron was collected in North Carolina, but only the brain was analyzed.
[2] Two additional herons were collected in Wisconsin, but only the brains were analyzed.

;y. Specimens were analyzed for residues of DDE, E, DDT, dieldrin, heptachlor epoxide, oxychlordane, :hlordane, *trans*-nonachlor, *cis*-nonachlor, endrin, ıphene, HCB, mirex, and PCBs. Analyses will be rred to as Methods I or II.

hod I—Samples were homogenized, extracted in a hlet apparatus, and cleaned up on a Florisil col-ı; pesticides and PCBs were separated into three :tions on a SilicAr column as described previously . The three fractions were analyzed on a gas-id chromatograph equipped with an electron-cap-: detector, automatic sampler, digital processor, and olumn containing 4 percent SE–30/6 percent QF–1 100–120-mesh Supelcoport. Column temperature was °C.

thod II—Samples were analyzed as above except a ımn of 1.5 percent OV–17/1.95 percent QF–1 on –120 mesh Supelcoport was used to separate *cis*-ordane and *trans*-nonachlor. Toxaphene was quanti-d as described by Prouty et al. (*14*). Pesticides and Bs were separated into four fractions on a SilicAr ımn as follows:

Fraction 1—80 ml petroleum either, which elutes HCB and mirex;
Fraction 2—320 ml petroleum ether, which elutes PCBs and DDE;
Fraction 3—275 ml of 15 percent methylene chloride in hexane, which elutes the remaining organochlorine compounds except endrin and dieldrin;
Fraction 4—200 ml of 1 percent acetonitrile + 19 percent hexane in methylene chloride, which elutes endrin and dieldrin.

;idues in 10 percent of the samples were confirmed h an LKB 9000 or Finnigan 4000 series gas-liquid omatograph-mass spectrometer. Operating condi-ıs for the LKB are listed by Cromartie et al. (*3*). The rating conditions for the Finnigan were: flow rate 30 ml/minute helium; column of 1.5 percent OV–1.95 percent QF–1 on 60–80 mesh Supelcoport; ımn temperature-programmed at 2°C/minute from)° to 225°C; separator 235°C; and ion source)°C.

;idue concentrations were not corrected for recovery, ich ranged from 83 to 104 percent. Most tissues were ılyzed at a lower limit of quantification of 0.1 ppm pesticides and 0.5 ppm for PCBs. Residue concen-ions are expressed on a wet-weight basis.
Soxhlet extracts were concentrated to dryness for d determinations.

Results

SIDUES IN CARCASSES

Residues of DDE were found most frequently (96 105 carcasses analyzed), PCBs were second (detected in 90 carcasses), and dieldrin and TDE (37 and 35 carcasses, respectively) were about equal as third and fourth most frequent (Table 1). Endrin, mirex, toxaphene, and HCB were found least often. At least one organochlorine was found in each carcass, except for six chicks (three green herons and three snowy egrets) found dead in a Maryland heronry (Table 2).

Organochlorine concentrations were almost always higher in adult herons than in chicks and fledged immature birds (Table 2). DDE and PCBs were present in highest concentrations; they exceeded 100 ppm in two birds each. A black-crowned night heron from Nevada contained 170 ppm DDE and a great blue heron from Virginia had 130 ppm DDE in the carcass. One of the great blue herons taken at Lake St. Clair, Michigan, had 120 ppm PCBs in the carcass, and a black-crowned night heron from Wisconsin contained 110 ppm PCBs. Several other herons each contained at least 20 ppm DDE or PCBs, or both.

The highest concentration of TDE (78 ppm) was in the great blue heron that also contained 130 ppm DDE (Table 2). TDE exceeded 5 ppm in two other great blue herons, one from Florida (5.5 ppm) and one from Minnesota (6.0 ppm).

Dieldrin concentrations exceeded 5.0 ppm in great blue herons from Illinois (7.9 ppm), Florida (6.5 ppm), and Minnesota (5.6 ppm and 5.5 ppm) (Table 2). Those from Illinois and Minnesota apparently died of dieldrin poisoning, based on residue concentrations in the brains (*12*). Dieldrin was present at 5.0 and 8.3 ppm in carcasses of two cattle egrets in Maryland that apparently died of dieldrin poisoning. Eight other birds had more than 2.0 ppm dieldrin in the carcasses.

Heptachlor epoxide, oxychlordane, and *cis*-nonachlor levels usually did not exceed 0.5 ppm in carcasses (Table 2). However, one great blue heron from Minnesota contained 0.80 ppm heptachlor epoxide, and another from Maryland contained 0.53 ppm. A cattle egret from Maryland contained 0.65 ppm heptachlor epoxide in the carcass. A great blue heron from Minnesota contained 0.85 ppm oxychlordane, and one that was collected at Lake Champlain, Vermont, contained 0.75 ppm in the carcass. Three other herons had at least 0.5 ppm oxychlordane. A great blue heron from Virginia and a cattle egret from Maryland were the only birds that had as much as 0.5 ppm *cis*-nonachlor in the carcass.

Concentrations of *cis*-chlordane and *trans*-nonachlor each reached 1.0 ppm in several herons (Table 2). All but two were great blue herons; the others were a black-crowned night heron and a cattle egret. Concentrations of *cis*-chlordane were highest in a great blue heron taken

TABLE 2. *Organochlorine residues in herons*

STATE (COUNTY AND NEAREST TOWN)[1]	DATE	SPECIES[2]	AGE[3]	SEX	WEIGHT[4] (G)	DIAGNOSIS[5]	TISSUE[6]	LIPID (%)	RESIDUES, PPM WET WEIGHT												
									DDE	TDE	DDT	DIELDRIN	HEPTACHLOR EPOXIDE	OXYCHLORDANE	*cis*-CHLORDANE	*trans*-NONACHLOR	*cis*-NONACHLOR	ENDRIN	TOXAPHENE	HCB	MIREX	PBCs
NORTHEASTERN STATES																						
Massachusetts																						
Essex; Parker River NWR	15 Sept. 1972	GH	A	M	226	Paralytic shellfish poisoning(?)	C	3.7	0.45	ND[7]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.65
Same	14 Sept. 1972	BCNH	A	F	775	Paralytic shellfish poisoning(?)	C	2.5	6.8	0.11	ND	ND	ND	ND	ND	0.12	ND	ND	ND	ND	ND	6.3
Vermont																						
Franklin; Highgate	5 Aug. 1970	GBH[8]	I	F(?)	1965	Shot	C	4.6	1.1	0.23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.60
Franklin; Swanton	11 Aug. 1970	GBH[8]	?	F	1130	Shot	C	0.7	1.3	ND	ND	ND	ND	0.75	0.58	ND	ND	ND	ND	ND	ND	0.90
Grand Isle; South Hero	6 Aug. 1970	BCNH[8]	I	M	648	Shot	C	5.6	1.5	0.58	0.16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.0
Same	Same	BCNH[8]	I	F(?)	772	Shot	C	5.1	1.1	0.16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.78
Same	Same	BCNH[8]	I	F	192	Shot	C	8.4	3.8	0.60	0.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	6.5
MID-ATLANTIC STATES																						
Maryland																						
Anne Arundel; West River	11 June 1970	GBH	A	M	2384	Myocarditis; glomerulonephritis	C	7.2	36.0	0.22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	44.0
							B	8.2	4.9	0.25	ND	0.45	ND	ND	ND	ND	ND	ND	ND	ND	0.26	7.4
Calvert; Drum Point	17 Aug. 1972	GBH	I	F	1085	Verminous peritonitis	C	0.3	1.6	0.20	ND	0.76	ND	ND	0.10	0.14	ND	ND	ND	ND	ND	6.4
							B	6.9	9.7	1.2	0.16	3.9	0.36	0.24	0.59	1.0	0.28	ND	0.17	ND	ND	36.0
Queen Anne's; Long Marsh Is.	14 June 1969	GH	C	?	82[9]		C	4.0	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GH	C	?	69[9]		C	1.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GH	C	?	69[9]		C	3.2	0.14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GH	C	?	92[9]		C	5.7	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GH	C	?	88[9]		C	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GH	C	?	104[9]		C	4.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	SE	C	M	311	Pneumonia	C	5.9	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	SE	C	?	132[9]		C	6.0	0.28	ND	ND	ND	ND	ND	ND	0.22	ND	ND	ND	ND	ND	0.13
Same	Same	SE	C	?	111[9]		C	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	SE	C	?	134[9]		C	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	SE	C	?	145[9]		C	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	SE	C	?	144[9]		C	5.0	0.35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Talbot; Poplar Is.	July 1966	GBH	I	?	574[9]	Bacterial infection; bone malformation	C	2.3	1.3	0.28	ND	0.53	ND	ND	ND	0.11	ND	ND	ND	ND	ND	0.90
Talbot;	14 Aug.	GBH	I	?	804[9]		C	1.8	0.75	0.14	ND	0.31	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

State (County and Nearest Town)[1]	Date	Species[2]	Age[3]	Sex	Weight[4] (g)	Diagnosis[5]	Tissue[6]	Lipid (%)	Residues, ppm Wet Weight: DDE	TDE	DDT	Dieldrin	Heptachlor Epoxide	Oxychlordane	*cis*-Chlordane	*trans*-Nonachlor	*cis*-Nonachlor	Drin Endosulfan	Toxaphene	HCB	Mirex	PBCs
Talbot; Wittman	27 Nov. 1972	GBH	1	F	1642	Verminous peritonitis, impact	C	1.9	0.38	ND	ND	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.68
Talbot; Royal Oak	14 Apr. 1973	GBH	A	M	1839		C	0.9	39.0	0.85	0.15	2.3	0.53	0.50	1.2	1.7	0.35	ND	ND	0.08	ND	69.0
Talbot; Bozman	25 June 1978	CE	A	M	335	Dieldrin poisoning	C	1.2	7.3	0.21	0.12	8.3	0.65	0.40	0.80	1.7	0.58	ND	0.16	ND	0.18	1.4
							B	7.6	7.4	ND	ND	11.0	0.54	0.52	0.74	1.5	0.54	ND	0.35	ND	ND	1.7
Talbot; Royal Oak	27 June 1978	CE	A	M	265	Dieldrin poisoning	C	0.8	0.23	ND	ND	5.0	ND	ND	0.13	0.28	ND	ND	ND	ND	ND	0.45
							B	7.5	0.53	ND	ND	10.0	0.19	0.11	0.24	0.47	0.15	ND	0.36	ND	ND	1.1
Worcester; South Point	25 June 1969	GE	?	?	458[9]		C	4.4	0.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GE	?	?	512[9]		C	5.9	0.18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Virginia																						
Culpeper; Brandy Station	11 Jan. 1976	GBH	?	?	946[9]		C	0.7	0.48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.78
Fanfax; Mason Neck NWR	31 May 1974	GBH	A	F	1386	Verminous peritonitis; (Dieldrin poisoning?)	C	0.7	8.0	1.2	ND	2.2	0.43	0.28	1.4	1.7	0.5	ND	ND	0.12	ND	18.0
							B	6.9	20.0	2.4	0.19	5.1	0.63	0.66	2.5	1.3	1.0	0.22	0.22	0.18	0.20	93.0
James City; Jamestown	1970	GBH	A	F	1432	Verminous peritonitis; (Dieldrin poisoning?)	C	1.6	130.0	78.0	0.53	3.8	0.48	ND	ND	2.5	0.33	ND	ND	0.13	ND	45.0
							B	7.8	62.0	22.0	ND	8.9	0.25	0.23	2.3	ND	0.27	0.19	ND	0.11	ND	56.0
James City; Williamsburg	12 Apr. 1972	GBH	A	M	2176	Verminous peritonitis	C	0.2	5.0	1.8	ND	1.2	0.11	0.10	0.50	0.73	0.24	0.19	ND	ND	0.19	7.8
Rappahannock River	16 Mar. 1973	GBH	A	F	2348	Choking	C	19.0	5.3	0.40	0.40	0.35	ND	ND	0.15	0.35	ND	ND	ND	ND	ND	7.0
							B	6.6	0.30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.78
SOUTHEASTERN STATES																						
Alabama																						
Mobile; Chickasaw	22 July 1970	GH[8]	I	F	184	Shot	C	1.3	0.68	ND	ND	0.25	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.60
Same	21 July 1970	GH[8]	A	M	226	Shot	C	4.0	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	9.5
Same	Same	GH[8]	A	F	219	Shot	C	6.4	0.70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.2
Same	Same	GH[8]	A	F	202	Shot	C	2.1	2.5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.62
Same	Same	LBH[8]	I	F(?)	314	Shot	C	6.6	0.35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	LBH[8]	I	F	328	Shot	C	2.9	0.45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	LBH[8]	I	M	358	Shot	C	2.3	0.43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.58
Same	Same	LBH[8]	I	F	296	Shot	C	2.2	1.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	LBH[8]	I	M	348	Shot	C	2.3	0.45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.11	< 0.50
Same	Same	LBH[8]	I	F	267	Shot	C	1.3	0.25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	CE[8]	A	F	368	Shot	C	2.3	0.35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	22 July 1970	SE[8]	I	M	180	Shot	C	0.4	0.38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50

TABLE 2. (cont'd). *Organochlorine residues in herons*

State (County and Nearest Town)[1]	Date	Species[2]	Age[3]	Sex	Weight[4] (g)	Diagnosis[5]	Tissue[6]	Lipid (%)	Residues, ppm Wet Weight: DDE	TDE	DDT	Dieldrin	Heptachlor Epoxide	Oxychlordane	*cis*-Chlordane	*trans*-Nonachlor	*cis*-Nonachlor	Endrin	Toxaphene	HCB	Mirex	PBCs
Same	21 July 1970	LH[8]	I	F	299	Shot	C	1.4	3.0	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	22 July 1970	LH[8]	I	F	252	Shot	C	2.2	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	20 July 1970	BCNH[8]	I	F	553	Shot	C	1.6	0.60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	BCNH[8]	I	F	643	Shot	C	8.2	0.65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	BCNH[8]	I	M	596	Shot	C	2.2	0.68	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	BCNH[8]	I	F	634	Shot	C	3.6	0.65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	BCNH[8]	I	M	595	Shot	C	1.6	0.95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	21 July 1970	YCNH[8]	A	F	747	Shot	C	7.1	1.9	0.15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	20 July 1970	YCNH[8]	I	F	589	Shot	C	1.4	0.35	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	YCNH[8]	I	F	550	Shot	C	2.3	0.25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Florida																						
Dade; Biscayne Bay	15 Feb. 1973	GBH	I	M	1825	Pneumonia	C	1.7	20.0	5.5	ND	6.5	0.30	0.19	1.7	3.0	0.40	ND	ND	ND	ND	3.0
							B	6.8	8.0	2.0	0.15	3.9	ND	0.17	0.75	1.0	0.34	ND	0.71	ND	ND	4.1
Monroe; Everglades NP	1 Feb. 1973	GBH	A	M	1674	Pneumonia; nephritis	C	2.6	4.3	ND	ND	ND	ND	ND	ND	0.17	ND	ND	ND	ND	ND	6.0
							B	7.8	2.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	4.8
Same	28 Feb. 1973	GBH	A	M	1624	Dieldrin poisoning(?)	C	0.8	12.0	1.1	0.11	4.5	0.13	ND	0.35	0.70	0.19	ND	ND	ND	ND	22.0
							B	8.4	28.0	1.5	0.21	6.6	0.26	0.20	0.76	0.87	0.38	0.20	0.23	ND	0.17	80.0
Louisiana																						
Cameron; Sabine NWR	2 July 1971	LBH[8]	I	M	269		C	7.5	0.14	ND	ND	0.40	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	GE[8]	I	M	822		C	3.6	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	GE[8]	I	F	778		C	5.4	0.15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	SE[8]	I	F	335		C	5.1	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
Same	Same	LH[8]	I	M	180		C	0.5	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	< 0.50
North Carolina																						
Hyde; Mattamuskeet NWR	4 Feb. 1976	GBH	A	?	?	DDT poisoning	B	5.1	62.0	21.0	20.0	0.83	0.20	0.79	0.83	2.7	0.93	ND	ND	ND	ND	130.0
GREAT LAKES STATES																						
Illinois																						
McHenry; Harvard	17 June 1977	GBH	A	M	?	Dieldrin poisoning	C	1.1	1.4	ND	ND	7.9	0.19	0.13	0.23	0.45	0.14	ND	ND	ND	ND	3.2
							B	7.2	5.3	0.10	ND	12.0	0.30	0.50	0.33	0.60	0.20	ND	ND	ND	ND	1.3
Michigan																						
St. Clair; Dickinson Is.	22 May 1970	GBH[8,10]	A	M	2830	Shot	C	7.0	26.0	0.79	ND	0.85	ND	0.54	1.8	ND	0.14	ND	ND	1.3	ND	120.0
Same	Same	GBH[8,11]	A	F	2040	Shot	C	4.8	23.0	2.3	ND	0.43	ND	0.15	0.55	ND	0.11	ND	ND	0.18	4.5	8.8

State (County and Nearest Town)[1]	Date	Species[2]	Age[3]	Sex	Weight[4] (g)	Diagnosis[5]	Tissue[6]	Lipid (%)	Residues, ppm Wet Weight												
									DDE	TDE	DDT	Dieldrin	Heptachlor Epoxide	Oxychlordane	*cis*-Chlordane	*trans*-Nonachlor	*cis*-Nonachlor	Endrin	Toxaphene	HCB	Mirex	PBCs
Wayne; Stony Is.	23 May 1970	GE[8]	A	F	1020	Shot	C	9.2	8.5	0.68	ND	0.45	ND	ND	0.21	ND	ND	ND	ND	ND	ND	9.0
Same	Same	BCNH[8]	A	M	908	Shot	C	10.1	6.4	1.4	ND	0.50	ND	ND	0.15	ND	ND	ND	ND	0.13		15.0
Same	14 Aug. 1973	GBH	A	M	1852	Shot	C	0.8	2.1	ND	0.14	0.19	ND	ND	0.15	ND	ND	ND	ND	ND	ND	ND
							B	4.5	0.76	ND	ND	0.11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GBH	1	F	1728	Shot	C	13.3	0.74	ND	ND	0.15	ND	ND	0.11	ND	ND	ND	ND	ND	ND	2.2
							B	4.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GBH	1	F	1781	Shot	C	14.6	0.75	ND	ND	0.14	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.1
							B	4.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Minnesota																						
Benton; St. Cloud	14 May 1973	GBH	A	F	1427	Dieldrin poisoning	C	0.5	0.63	ND	ND	5.6	ND	ND	ND	ND	ND	ND	ND	ND	0.19	1.4
							B	7.1	1.0	ND	ND	14.0	ND	0.14	ND	ND	ND	0.19	ND	ND	0.18	1.1
Big Stone; Ortonville	11 May 1974	GBH	A	M	2728		C	0.5	3.6	ND	0.44	ND	ND	ND	0.12	0.24	ND	ND	0.15	ND	ND	5.2
Grant; Pelican Lake	14 June 1975	GBH	I	M	1124		C	2.5	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.50
							B	4.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.59
Same	21 June 1976	GE	A	M	795		C	7.3	0.18	ND	0.13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.95
							B	5.0	ND	ND	0.10	ND	ND	ND	0.11	ND	ND	ND	ND	ND	ND	0.63
Same	Same	GE	A	M	815		C	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.30
							B	—[13]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.29
Kandiyohi; Big Kandiyohi Lake	30 Mar. 1975	GBH	A	M	1930		C	0.6	2.5	ND	ND	0.25	ND	ND	ND	0.12	ND	ND	0.12	ND	0.13	18.0
							B	7.2	10.0	ND	0.39	1.3	0.39	0.34	ND	0.46	0.10	ND	0.44	ND	0.24	54.0
Pope; Lake Johanna	22 June 1975	GBH	A	M	1617	Dieldrin poisoning	C	0.9	23.0	0.40	0.17	3.5	0.80	0.35	0.24	0.65	0.14	ND	ND	ND	ND	2.8
							B	7.1	42.0	0.25	0.30	9.2	1.9	0.87	0.41	1.1	0.25	ND	ND	ND	ND	4.6
Same	Same	GBH	C	M	55		C	0.8	0.19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.75
							B	—[13]	0.68	ND	ND	ND	ND	ND	0.39	ND	ND	ND	ND	ND	ND	2.2
Same	Same	GBH	C	M	63		C	0.6	0.58	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.14	ND	ND	6.5
							B	—[13]	1.3	ND	ND	ND	ND	ND	0.35	ND	ND	ND	0.39	ND	ND	8.7
Same	Same	GBH	C	M	873		C	0.4	0.19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.68
							B	5.3	0.55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.5
Same	Same	GE	C	F	135		C	0.8	0.22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.83
							B	—[13]	0.47	ND	ND	ND	ND	ND	0.51	ND	ND	ND	ND	ND	ND	2.1
Same	Same	GE	C	M	293		C	0.6	0.13	ND	0.75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.22
							B	—[13]	0.26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.60
Same	22 June 1976	GBH	C	F	673		C	0.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.43
							B	5.2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.57
Same	Same	GBH	C	F	1212		C	2.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.40
							B	6.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	GBH	C	F	844		C	0.5	0.14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
							B	4.3	0.43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.66
Stearns; St. Joseph	13 Apr. 1972	GBH	A	F	1486		C	0.8	34.0	1.4	ND	0.83	ND	ND	ND	0.38	ND	0.10	0.30	ND	ND	6.0
							B	8.5	82.0	1.1	0.24	1.3	0.13	0.16	0.53	ND	ND	0.23	0.74	ND	ND	5.9
Stearns; Sartell	16 Apr. 1972	GBH	A	M	1740	Endrin poisoning	C	0.3	3.8	0.53	ND	1.0	0.23	0.10	ND	0.21	ND	0.55	ND	ND	ND	3.0
							B	7.1	3.0	0.34	0.11	1.2	0.30	0.14	ND	0.21	ND	0.86	ND	ND	ND	2.5
Stearns; Cold Spring	9 May 1972	GBH	A	M	1668	Dieldrin poisoning	C	0.3	3.0	0.11	ND	5.5	ND	0.85	ND	0.14	ND	0.12	ND	ND	ND	30.0
							B	7.2	5.5	0.14	ND	14.0	0.24	ND	0.13	0.33	ND	0.35	ND	0.17	ND	53.0
Stearns; Belgrade	14 May 1973	GBH	A	M	1656		C	0.8	26.0	6.0	ND	1.3	0.22	0.13	ND	1.2	0.11	0.23	0.50	ND	4.0	8.5
							B	6.9	24.0	4.0	ND	1.0	0.29	0.21	ND	1.3	0.11	0.38	0.82	ND	2.9	7.0

Wisconsin																				
Brown; Green Bay	3 Aug. 1978	BCNH	A	M	?		C	5.0	18.0	0.50	0.20	0.83	0.40	0.68	0.43	1.0	0.30	0.23	ND	ND	ND	110.0
							B	7.2	3.4	ND	ND	0.21	ND	0.14	ND	ND	ND	ND	ND	ND	ND	30.0
Dane; Belleville	15 May 1979	GBH	A	M	1525	Dieldrin poisoning(?)	B	7.1	31.0	1.0	0.27	6.0	1.5	0.91	1.4	2.7	1.1	0.19	0.67	0.20	0.69	85.0
Kenosha; Brighton	1 May 1978	GBH	A	M	?	Endrin poisoning(?); trauma	C	0.3	7.5	0.35	ND	1.2	0.28	0.12	0.33	0.40	0.28	0.20	0.28	ND	0.95	15.0
							B	6.3	16.0	0.54	ND	2.4	0.36	0.22	0.42	0.96	0.40	0.60	0.78	0.18	0.94	56.0
Sheboygan; Sheboygan Falls	18 Dec. 1976	GBH	A	M	1780		B	6.5	7.1	0.15	0.07	ND	ND	ND	0.11	0.12	0.04	ND	ND	ND	ND	220.0
CENTRAL AND WESTERN STATES																				
California																				
Imperial; El Centro	29 July 1978	GE	A	M	1200		C	1.2	28.0	1.9	0.40	3.3	ND	ND	0.55	0.78	0.17	0.30	0.58	0.18	ND	3.8
							B	7.4	22.0	1.2	0.30	3.7	ND	ND	0.28	0.78	0.13	0.42	0.54	0.20	ND	2.4
Nebraska																				
Harlan; Alma	8 May 1978	CE	A	F	210	Dieldrin poisoning(?)	C	0.5	15.0	0.15	ND	3.0	ND	ND	ND	ND	ND	ND	0.11	ND	ND	ND
							B	3.4	22.0	ND	0.11	5.6	ND	ND	ND	ND	ND	ND	0.28	ND	ND	ND
Nevada																				
Elko; Ruby Lake NWR	18 July 1975	BCNH	A	?	464[9]	DDE poisoning(?)	C	0.6	170.0	0.80	0.14	ND	ND	ND	ND	0.10	ND	ND	ND	0.05	ND	1.3
							B	7.5	230.0	ND	1.1	ND	ND	0.13	0.32	ND	ND	ND	0.54	ND	ND	5.4
Same	Same	BCNH	A	?	443[9]		C	3.2	7.3	ND	ND	ND	0.22	0.13	ND	ND	ND	ND	ND	ND	ND	1.0
							B	7.5	5.3	ND	ND	0.15	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.5
Same	Same	BCNH	A	?	414[9]		C	1.2	7.0	ND	ND	0.14	ND	ND	ND	0.11	ND	ND	ND	ND	ND	1.3
							B	7.1	1.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.96
New Mexico																				
Bernalillo; Albuquerque	17 June 1977	SE	C	M	343	Impact; out of nest	C	5.6	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.82
							B	9.4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	15 June 1977	CE	C	?	166	Same	C	1.9	0.18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.4
							B	6.4	0.14	0.10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	CE	C	M	248	Same	C	2.7	0.44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0
							B	4.9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	CE	C	M	260	Starvation(?)	C	0.8	0.34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1.7
							B	4.1	0.28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Same	Same	BCNH	C	M	400	Impact; out of nest	C	2.0	0.74	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	3.0
							B	5.9	0.32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	2.0

[1] When appropriate, other identifying locations are shown.
[2] Species are identified by the following abbreviations: GBH = great blue heron; GH = green heron; LBH = little blue heron; CE = cattle egret; GE = great egret; SE = snowy egret; LH = Louisiana heron; BCNH = black-crowned night heron; YCNH = yellow-crowned night heron.
[3] Age is coded as C = chick; I = fledged immature bird; A = adult.
[4] Total body weight, except as noted.
[5] Cause of death is shown when it could be determined.
[6] Tissues include carcass (C) and brain (B).
[7] ND = not detected at the lower limit of quantification.
[8] These specimens analyzed by Method I; residues reported as *cis*-chlordane include *cis*-chlordane and/or *trans*-nonachlor (see Methods). Others were analyzed by Method II.
[9] Carcass weight is shown because total body weight is not known.
[10] Polychlorinated styrene compounds also present in this speciment (see Reichel et al. 1977; their Sample 1).
[11] Polychlorinated styrene compounds also present in this specimen (see Reichel et al. 1977; their Sample 2).
[12] Polychlorinated styrene compounds not detected in this specimen (see Reichel et al. 1977; their Sample 3).
[13] Lipid percentage not determined because of small sample size.

Lake St. Clair, Michigan (1.8 ppm), and another nd dead in Florida (1.7 ppm). The great blue heron n Florida also had the highest concentration of *is*-nonachlor, 3.0 ppm. The great blue heron from ginia that contained high residue concentrations of E, TDE, and DDT also contained 2.5 ppm *trans*-achlor in the carcass.

Irin was highest (0.55 ppm) in the carcass of a at blue heron from Minnesota that apparently died endrin poisoning (*12*) (Table 2).

taphene reached 0.50 ppm in one of the great blue ons from Minnesota (Table 2). HCB was highest 3 ppm) in a great blue heron collected at Lake Clair. Mirex concentrations reached 4.5 ppm in ther of the great blue herons from Lake St. Clair l 4.0 ppm in a great blue heron from Minnesota.

IDUES IN BRAINS

ncentrations of organochlorines in brains and their tion to those in carcasses have been described in re detail elsewhere (*12*). In summary, most herons t apparenlty died of organochlorine poisoning were at blue herons. Dieldrin was the chemical most often sidered responsible for death. All birds that had ardous or lethal concentrations in the brain were lts.

ins of 51 herons found dead or moribund were lyzed. Two cattle egrets from Maryland have been lyzed since the earlier data were published (*12*). sidue concentrations in carcasses of other herons re not high enough to warrant analysis of brains. ght (from Illinois, Nebraska, Maryland, Minnesota, l Wisconsin) probably died of dieldrin poisoning; r others (from Florida and Virginia) had dieldrin ncentrations that were clearly hazardous, but dieldrin y not have been the cause of death.

ldrin concentrations in the brain (wet-weight basis) re related to the concentrations in the carcass (lipid-ight basis) of 25 herons for which both the brain and cass were analyzed:

log brain concentration = log a + b (log carcass concentration).

mmon logarithms were used in the calculations; R^2 s 0.89 (Fig. 1). Substituting the Y intercept (a) d slope of the regression (b) values in the equation, relationship was:

log brain concentration = −1.6071 + 0.8721 (log carcass concentration).

is equation was used to estimate dieldrin concentra-ns in the brain of herons for which only the carcass

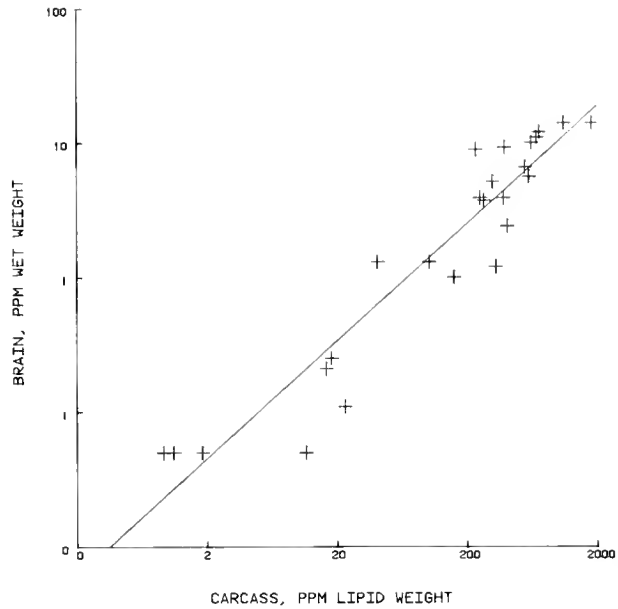

FIGURE 1. *Regression of dieldrin concentration (ppm, wet weight) in the brains of 25 herons on that in the carcass (ppm, lipid weight). R^2 is 0.89; the regression equation is: log brain concentration = −1.6071 + 0.8721 (log carcass concentration).*

was analyzed. The concentration of dieldrin in the brain of one heron collected in Virginia in 1972 (Table 2) was estimated to have been 6.3 ppm, which is in the known lethal range (*19*; W. H. Stickel, personal communication). However, this bird also was infected by nematodes (*Eustrongylides* sp.) that caused verminous peritonitis and contributed to its death.

One heron probably died of endrin poisoning (Minnesota) and another (Wisconsin) had a potentially lethal concentration in the brain. A heron from Nevada had a concentration of DDE in the brain that was clearly hazardous, but perhaps not lethal. However, a heron from North Carolina almost certainly died of DDT poisoning. One heron found dead in Wisconsin had a hazardous, although probably not lethal, concentration of PCBs in the brain.

NECROPSY

Herons dying of dieldrin or endrin poisoning usually exhibited a characteristic set of lesions: The pectoral muscles were greatly atrophied, and the sternal keel bone was quite prominent (a typical "hatchet-breast"); subcutaneous, abdominal, and coronary fat deposits were absent; no grossly visible lesions of necrosis or of hemorrhage were present in the lungs, liver, spleen, or heart. In contrast, the one great blue heron that appeared to have died as the result of toxic levels of DDT and its metabolites had moderate deposits of subcutaneous fat, an enlarged gallbladder, and no obvious

deposits of abdominal fat. The condition of the pectoral muscles was not recorded.

Bacteriological and virological studies (when attempted) were negative or resulted in the isolation of only post-mortem contaminants.

A fairly common lesion observed in great blue herons from the Chesapeake Bay area was a verminous peritonitis (or serositis) caused by nematodes of the genus *Eustrongylides*. These large, reddish nematodes, often 5–10 cm long, were usually found lying in coiled tubules upon the serosal surface of the proventriculus. However, the nematodes (after burrowing through the walls of the proventriculus) often had invaded the liver, intestines, and adjacent organs, resulting in a variable amount of tissue destruction, hemorrhages, and spillage of intestinal contents into the air sacs and "peritoneal cavity." Deaths of herons (*6, 20*) and other fish-eating birds (*7*) have been attributed to these nematodes.

Discussion and Conclusions

The frequency of organochlorine residue occurrence in heron carcasses was similar to that found in eggs of anhingas and wading birds in the eastern United States (*8, 9, 10*). DDE and PCBs are the most common environmental pollutants in herons and in other aquatic birds (see reference *11* for review). Concentrations of organochlorines are usually higher in those birds that feed on other birds or on fish than they are in other species.

Our samples were not collected in a systematic manner, and we usually had only a few specimens of various species from each locality. Therefore, we cannot make statistically valid comparisons of mean organochlorine concentrations in herons throughout the United States. Residue concentrations were relatively high in some birds (especially in adults) from all regions. Great blue herons from Lake St. Clair, Michigan, also had high concentrations of mercury in the carcass (up to 23 ppm) and liver (up to 175 ppm) (*4*). Although most of the herons collected near Mobile Bay, Alabama, were immature birds, residue concentrations in the carcass were lower than anticipated on the basis of organochlorine pesticide use in that general region.

Organochlorine concentrations in many herons were high enough to indicate probable reproductive effects in these individuals and the populations they represent. Eggshell thinning has occurred in several heron species, and embryonic mortality apparently has been caused by organochlorines in some birds (*10, 11*).

Because of the combined effects of their widespread occurrence, high visibility, and dietary exposure to organochlorines, dead or moribund great blue he apparently were more frequently encountered in field than were other herons. The great blue hero one of the most conspicuous and widely distrib heron species in the United States (*13*). Its food ha are somewhat different from the smaller herons, though there is much overlap in prey items becaus seasonal and geographic variations in diet. Great l herons often feed on larger fish of species that ten accumulate relatively high concentrations of org chlorine residues because they represent higher tro levels of the food web.

There can be many causes of death, and several these will result in weight loss and elevated resi concentrations in the brain. Thus, organochlorine r dues at death may be at almost any concentra (W. H. Stickel, personal communication). High resi concentrations in some herons may have been second to emaciation caused by verminous peritonitis or o health factors. In others, the cause of death was apparent.

More than 20 percent of the herons found dead moribund had lethal or hazardous concentrations organochlorines in the brain (see reference *12* further discussion). Dieldrin was banned for use the United States in 1975; DDT was banned in 1 (*1*). However, each of these chemicals appare caused mortality of herons years later.

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Organochlorine Residues in Fish: National Pesticide Monitoring Program, 1970–74

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ABSTRACT

As part of the National Pesticide Monitoring Program, the U.S. Fish and Wildlife Service analyzed organochlorine contaminant residues in fish samples collected from about 100 stations each year from 1970 to 1974. During this period, mean residues of DDT and its metabolites declined nationally but remained widespread, and high concentrations continued to be present in areas where DDT use was extensive. Results of interlaboratory crosscheck analyses supported these conclusions, despite interpretation problems posed by intercompound analytical interferences in 1970 and 1971. Temporal trends in PCB residues were less obvious. Highest PCB residues were found in the industrialized areas of the Northwest and Midwest, and traces were present at most stations. Dieldrin and endrin residues remained essentially unchanged during this period; dieldrin residues were widespread and were highest in Hawaii and in areas of the Midwest where aldrin was used extensively. Toxaphene occurrence increased; it was formerly found only in fish from streams draining cotton-farming regions, but residues were detected in 1974 samples from other areas. According to the recommendation of the National Academy of Sciences' Water Quality Criteria, organochlorine residues in freshwater fish may have represented a hazard to piscivorous fish and wildlife at 71 percent of the stations sampled in 1970 and 66 percent in 1974.

Introduction

The National Pesticide Monitoring Program (NPMP) was established in the mid-1960s to assess temporal and geographic contaminant trends in selected environmental components. The U.S. Fish and Wildlife Service (FWS), U.S. Department of the Interior, contributes to this program by periodically determining contaminant levels in freshwater fish, starlings (*Sturnus vulgaris*), and waterfowl. This report presents and summarizes the results of NPMP organochlorine residue analyses conducted on freshwater fish annually from 1970 through 1974. Previous reports in this journal have presented the results of heavy metal analyses through 1973 (*11,33*) and organochlorine res through 1969 (*10,12*).

Organochlorine monitoring by FWS was expan greatly after 1969 (*15,33*). Initially, only residues persistent pesticides (aldrin, dieldrin, endrin, lind heptachlor and heptachlor epoxide, chlordane (tec cal), toxaphene, and the *p,p'*-isomers of DDT, D and TDE (DDD) were measured. Polychlorinated phenyl (PCB) determinations were begun in 19 reflecting increased national concern over nonagri tural contaminants. Likewise, hexachlorobenz (HCB) determinations were initiated in 1971, other compounds were added or deleted as public c cerns changed and new methodologies evolved.

Originally, fish were collected annually from 50 stati located at key points in major drainages of Haw Alaska, and the conterminous United States (Fig. 1 Appendix A, Stations 1–50). Coverage was doubled v the addition of Stations 51–100 in 1970. In 1974, stations that had histories of low residue levels or w intermittently dry (11, 58, 92, 94, and 95) were del from the program and replaced with Stations 101, 1 105 111, and 113 to better reflect contaminant level these watersheds.

Except for fish collected in Hawaii, common names fish as designated by the American Fisheries Society are used throughout the report. Hawaiian fish incl tilapia (*Tilapia mossambica*), Cuban limia (*Li vittata*), and Chinese catfish (*Clarias fuscus*).

Methods of Study

During the course of this investigation, many agen and laboratories were involved in the collection analysis of samples and in the interpretation of resu Consequently, detailed descriptions of the meth used are spread among numerous documents, publis and unpublished. Although method development been a source of discontinuity within the program has also been a major contribution of NPMP. For th

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asons, we have chosen to summarize the methods of udy.

ELD COLLECTIONS

eld methods have not changed since last reported *0,12)*; from each station, three to five adult speci-ens of two representative species, with at least one ecies replicated, were collected each autumn from 970 to 1974. Collectors were instructed not to use iemical collecting methods; FWS and State biologists ther collected specimens by netting, hook-and-line, or ectrofishing, or purchased them from commercial shermen. After collection each sample was double-rapped in aluminum foil, frozen, packed in dry ice, id shipped air express to the analytical laboratory. ollectors did not always obtain the preferred number fish or species that were indicated in the collection idelines (*15*).

ABORATORY ANALYSES, 1970–71

he Wisconsin Alumni Research Foundation (WARF) as contracted to analyze each 1970 composite sample r DDE, TDE, DDT, dieldrin, aldrin, endrin, BHC -isomer), heptachlor, heptachlor epoxide, and PCBs. 1971, toxaphene was added and BHC was deleted om this list. WARF used procedures detailed in the 968 revision of the U.S. Food and Drug Administra-on (FDA), Department of Health and Human Serv-es, Pesticide Analytical Manual (Sections 211 and 11 for nonfatty foods) (*8*), with the following modifi-itions:

mple Preparation—Each composite sample was awed, chopped into about 0.45-kg pieces, and ground a Hobart 84181 food chopper until it appeared to be mogenous. A 200-g portion was then placed in an oz. (236.5-ml) bottle and refrozen.

xtraction and Cleanup—Before analysis, each 200-g mple was thawed and mixed, and a 20-g subsample as weighed into a 150-ml beaker. Each aliquot was ansferred to a 1-qt (946-ml) Waring blender jar, ended 2 minutes wtih acetonitrile, and filtered through plug of glass wool into a 1-liter separatory funnel ntaining 500 ml tap water. Periodic analyses of re-gent blanks ensured that contaminants in tap water mained below detection limits (personal communica-on, D. L. Hughes, 1980. Raltech Scientific Services, ladison, Wisconsin [formerly WARF]). The sample as then blended about 30 seconds with an additional 0 ml acetonitrile and filtered into the separatory nnel. Petroleum ether (200 ml) was added to the paratory funnel and shaken 2 minutes. After the layers parated, the bottom layer was drawn off. The petro-um ether extract was washed twice more with 600 l tap water, the water layer was discarded both mes, and 10 g Na_2SO_4 was added to the extract. he sample was then filtered into a 300-ml Erlenmeyer flask (the separatory funnel was washed with about 70 ml petroleum ether), concentrated to about 5 ml on a steam bath, and diluted to 25 ml with petroleum ether. A 15-ml subsample was removed and partitioned in acetonitrile-hexane (8). This sample was further partioned on a Florisil column, and analyzed by gas-liquid chromatography (GLC).

For the determination of lipid content, a separate 20-g sample was weighed into a 150-ml beaker and dried at 40°C in a forced-air oven for 36–48 hours. The sample was removed from the oven and ground with 20–50 g Na_2SO_4. The ground sample was placed in a 33-mm × 94-mm Whatman thimble and extracted 8 hours on a Soxhlet apparatus with 70 ml ethyl ether and 170 ml petroleum ether. The extract was concentrated to 10–15 ml on a steam bath and transferred to a tared 50-ml beaker, and the remaining solvent was evaporated on a steam bath. The beaker was placed in a 40°C oven for 4–6 hours, removed, placed in a desiccator, and weighed, and the amount of fat in the sample was calculated.

Gas-Liquid Chromatography—In the determination of residue concentrations, a 10-g equivalent or less of extract was injected into a Barber-Coleman 5360 Pesticide Analyzer with ^{90}Sr detector, and resulting peak heights were measured. Total PCB concentration was estimated by using Aroclor 1254 as a standard and measuring the peak between *p,p'*-DDE and *p,p'*-DDT. The ¼-in. (6.35-mm) ID × 4-ft (1.22-m) glass chromatographic column was packed with 5 percent DC-200 on 80–90 mesh Chromport XXX. Operating temperatures were as follows: column, 195°C; injector, 250°C; detector, 240°C.

The flow rate of nitrogen carrier gas was adjusted either to 100 ml/minute or to a rate that resulted in a retention time of 8–10 minutes for *p,p'*-DDT.

Average recovery rates for all compounds were 75–85 percent. No corrections for recovery were made in the residue values. Detection limits for all organochlorine insecticides were reported as 0.005 mg/g.

LABORATORY ANALYSES, 1972–74

Samples collected from 1972 to 1974 were analyzed by the FWS Denver Wildlife Research Center (DWRC) for residues of PCBs and organochlorine pesticides. DWRC procedures differed from those of WARF, as outlined below:

Sample Preparation—Each composite sample was thawed, and then chopped and ground in a Hobart combination chopper and grinder. A 10-g sample aliquot was blended with 50-g powdered Na_2SO_4.

Extraction and Cleanup—The 60-g mixture of the sample plus Na_2SO_4 was placed in a 125-ml glass-stopper Erlenmeyer flask or similar vessel fitted with a liquid-tight Teflon cap or stopper; 50 ml extraction solvent (20 percent acetone in isooctane) was added. The mixture was shaken vigorously at least 15 minutes, and solids were allowed to settle 3–4 minutes. About 14 ml was decanted into a screw-cap culture tube (15- × 100-mm) and centrifuged 3–4 minutes at 1800 rpm. Exactly 2.0 ml clean supernate was withdrawn, evaporated to dryness in a small, tared beaker, and weighed to determine total extractable lipid. Another 10 ml supernate was likewise removed and placed in a 15- × 100-mm culture tube; the solvent was evaporated with a gentle stream of air, and the sample was diluted to 1.0 ml with cyclohexane before gel permeation chromatography (GPC).

For GPC, 0.5 ml cyclohexane solution was withdrawn and placed on top of a 1-cm (ID) × 30-cm glass column packed with SX-2 gel. Not more than 200 mg lipid was placed on the column; proportionately less than 0.5 ml sample was loaded when the 10-ml sample aliquot contained more than 400 mg lipid. The sample was then eluted from the column with cyclohexane at about 4 psi (0.28 kg/cm²) nitrogen pressure, and the first 20 ml eluate (containing the lipids) was discarded. The next 25 ml was collected, rinsed with 10 ml hexane, and concentrated to 1.0 ml in a Kuderna-Danish evaporator for subsequent analysis by GLC.

Gas-Liquid Chromatography—Organochlorine residue concentrations in the GPC eluate were measured by using electron-capture GLC. In 1972, total PCB concentration was estimated by using Aroclor 1254 as a standard. In 1973 and 1974, separate determinations were made for Aroclors 1242, 1254, and 1260 after the GPC eluates were further cleaned up by using silica gel chromatography (described in the following section on Crosscheck Analyses). Columns used were 5 percent QF-1 and 3 percent OV-1. Operating temperatures were 185°C for the column and 300°C for the detector. Injector temperatures were not reported.

Average recovery rates were: aldrin, 68 percent; DDE, 97 percent; dieldrin, 92 percent; endrin, 88 percent; DDT, 97 percent; and PCBs, 81 prcent. Residue determinations were not corrected for recovery.

CROSSCHECK ANALYSES

Each year, 30–50 samples, either known to contain high residues or collected at stations with a history of high residue levels, were selected for crosscheck analysis by the FWS Columbia National Fisheries Research Laboratory (CNFRL; formerly the Fish-Pesticide Research Laboratory). CNFRL methods differed from those of WARF and DWRC, and included the development and use of improved sample cleanup and PCB separa techniques.

Sample Preparation and Extraction—Techniques u by CNFRL to prepare and extract samples remained changed from 1970 through 1974. Ground tissue re senting each composite sample to be crosschecked sent from the analytical laboratory to CNFRL, wh 20 g sample material was combined with 80 g powde Na_2SO_4 in a preweighed 1-pt (473-ml) mason jar fi with a Teflon seal. The mixture was ground to a powder with an Oster blender and packed int chromatographic column (20-mm ID) for extrac with 200 ml 5 percent diethyl ether in petroleum et (*13*). The extract was retained in a 275-ml Cc porcelain casserole and evaporated to 5 ml.

Sample Cleanup. Gel Permeation Chromatograph Sample cleanup procedures were not changed fi 1970 through 1972, essentially following the procedu of Stalling et al. (*29*). Each concentrated sample extr was diluted to 10 ml with cyclohexane. Of this, 1 was transferred to a vial and evaporated to dryness lipid determination. The rest was concentrated to 5 and then diluted to 10 ml with hexane for GPC fract ation on SX-2 gel in an automated processing unit (3 Of the sample, 5 ml (but not more than 1 g lipid) placed on the GPC column. The eluates were collec in 275-ml casseroles, evaporated to near dryness, diluted to 10 ml before Florisil adsorption chro tography.

The GPC procedure was modified slightly for the 1 samples. Concentrated sample extracts were dilu 1:1 with ethyl acetate instead of cyclohexane bef GPC. After fractionation, the extracts were evapora to near dryness in casseroles, and then 10 ml octane was added. The samples were re-evaporated near dryness and diluted to 10 ml with petrole ether for Florisil chromatography. The solvent again changed for 1974 samples; concentrated extra were diluted 1:1 with 20 percent toluene in et acetate for GPC fractionation.

Florisil Adsorption Chromatography—From 1970 1972, glass columns (20 mm × 40 mm, with g frits) were prepared by adding, in order, 10 g anhydr Na_2SO_4, 10 g Florisil (5 percent deactivated), another 10 g Na_2SO_4. Each prepared column was n washed with 30 ml petroleum ether. When the top the wash solvent reached the top of the upper Na_2S layer, half of the GPC concentrate was transferred the column in 5 ml of the first elution solvent (100 6 percent diethyl ether in petroleum ether). When sample reached the upper Na_2SO_4 layer, the remain first elution solvent was added, and the eluate collected for further separation of pesticides fr

CBs. The second elution solvent was then added (100 15 percent diethyl ether in petroleum ether): this ıate was collected for GLC analysis of strongly polar ;ecticides (e.g., dieldrin and endrin).

orisil procedures remained unchanged for 1973 and 74 samples except for the solvents used. In 1973, tracts were eluted with 6 percent and 11 percent ethyl ether in petroleum ether; in 1974, diethyl ether ncentrations were 10 percent and 20 percent.

sticide-PCB Separation—For crosscheck samples from 70 through 1973, Florisil eluates were separated into sticide and PCB fractions by using a modification (*14*) Armour-Burke (*3*) silicic acid chromatography. mples from 1974 were separated with silica gel.

licic Acid Separation—Silicic acid was activated with etonitrile–methylene chloride (40 + 60), the solvent ıs evaporated, and the adsorbent was uniformly deacti- ted by adding 2 percent water (by weight). After at ıst 24 hours, 20 g of this deactivated silicic acid was ixed with 70 ml petroleum ether and poured into a romatographic column (22 mm ID × 300 mm) with ɔpcock open (column not allowed to drain com- etely). The sides of the column were washed with lditional petroleum ether, and 2–3 psi (0.14–0.21 g/cm²) air pressure was applied to the column. After e silicic acid had settled in the column, it was topped th a layer of about 2 g Na_2SO_4.

ıe chromatographic properties of each silicic acid tch were routinely checked by measuring percent coveries of a mixture of DDE, DDT, and Aroclors 21, 1232, and 1260. When necessary, the amounts of activation water were changed until the desired elu- ɔn profile (10 percent *p,p'*-DDE and 100 percent *p,p'*-DT in the pesticide fraction) was obtained.

ɔr chromatographic separation, a previously cleaned-) sample extract (GPC and Florisil) was added to a epared column in 5 ml or less of petroleum ether, and r pressure was applied until the sample solution was vel with the Na_2SO_4. The sides of the column were ice washed with 5 ml petroleum ether and allowed drain level with the Na_2SO_4, and a 275-ml Coors ɔrcelain casserole was placed under the column.

ıe PCB fraction was eluted from the column with 0 ml of 1 percent benzene in petroleum ether and fficient air pressure to achieve a 4 ml/minute flow te until the solvent level in the column was 1 cm ɔm the top of the Na_2SO_4 layer. The elution was ɔpped, a new casserole was placed under the column, ıd the pesticide fraction was eluted with 200 ml of 20 rcent ethyl ether in benzene. Additional ethyl ether–benzene was added to complete the elution, the casseroles were transferred to a 75°C explosion-proof hot plate in a fume hood, and each fraction was evaporated to 5 ml. The fractions were then rinsed with 5 ml petroleum ether into separate culture tubes, placed in a 55°C Module Blok water bath, and evaporated to 5 ml under nitrogen.

If subsequent GLC of the pesticide fraction revealed the presence of several solvent peaks with retention times less than that of *p,p'*-DDE, an additional cleanup step was used. For removal of impurities, 1 ml 1N NaOH was added to the concentrated pesticide fraction in the culture tube and the mixture was shaken 30 seconds in a Super-mixer (Vortex) and centrifuged, yielding separate organic and inorganic layers. The organic layer was then transferred by pipet to a 25-ml separatory funnel and partitioned by adding 5 ml water. The organic phase was saved for GLC re-analysis.

Silica Gel Separation—The PCBs were separated from pesticides in 1974 crosscheck samples by using silica gel chromatographic techniques modified from Underwood (*32*), in an attempt to reduce the large solvent volumes, pressurized columns, and adsorbent purification steps necessary for silicic acid separation. Small glass columns (10 mm ID) were packed with 4 g Woelm silica gel (activity 1) that had been heated overnight at 130°C. PCBs were eluted with 43 ml of 0.5 with 15 ml of 4 percent ethyl acetate in benzene. In other respects, procedures described for the silicic acid method were used.

Gas-Liquid Chromatography—All samples were analyzed with a Beckman GC-4 gas chromatograph equipped with electron-capture detector. For 1970–71 analyses (except BHC), a 4-ft [1.22 m] × 3-mm (ID) glass column was packed with 5 percent DC-200 on 60–80-mesh Gas-Chrom Q; BHC was analyzed by using a 4-ft (1.22-m) × 4-mm (ID) column packed with 3 percent OV-17 on 60–80-mesh Gas-Chrom Q. Typical operating temperatures were: column, 180°C; injector, 220°C; and detector, 240°C. Nitrogen flow was adjusted to yield a γ-BHC retention time of 1 minute. Average recoveries were: dieldrin, 85 ± 5 percent; DDE, 64 ± 5 percent; TDE, 90 ± 5 percent; and DDT, 81 ± 5 percent. Residue determinations were corrected for percent recovery.

DATA HANDLING AND STATISTICAL ANALYSES

Authors used Statistical Analysis System (SAS) programs (*26*), available through the University of Missouri (Columbia) computer system (IBM 370/168), for all statistical analyses. For trend analyses, the following descriptive statistics were computed for each compound, by year: mean (after appropriate transformation), minimum and maximum concentration, and percentage of stations at which each compound was detected.

Lipid values were normalized by using the angular transformation (*28*). Concentration values were normalized by applying the [$\log_{10}$ (residue concentration) + 1.0] transformation before means were computed. Although complete normalization may have been prevented by the presence of zero values, residue data treated in this manner are easier to interpret biologically. For example, small differences should be more important at very low than at high residue levels—an interpretation supporting the use of this transformation (*23*). In addition to descriptive statistics, we computed annual matrices of product-moment correlation coefficients, using percent lipid and transformed residue concentrations, to illustrate trends in the co-occurrence of compounds.

The NPMP data set is highly heterogeneous; many potentially confounding factors had to be considered when the descriptive statistics were computed and interpreted. Specifically, the number of samples from each station varied from year to year, as did the species collected and the sizes and weights of the individual fish making up the composite samples; also some stations were not sampled every year. The artificial weighting of the national annual means caused by unequal sample numbers at different stations was alleviated by computing least-squares annual means (*26*), which were adjusted for the number of observations per cell. The problem of varying sample composition (fish species, age, sex, size, etc.) was ameliorated by computing and examining correlation matrices and descriptive statistics for lipid-weight residue concentrations [ppm wet weight/(percent lipid/100)] in addition to wet-weight concentrations; much fish-to-fish variability in organochlorine residues is related to differing amounts of lipid in the individual specimens (*24*), and hence in our composite samples.

Data from all stations were considered in examining them for annual minima and maxima. However, to accurately reflect temporal trends, only data from stations where at least one sample was collected every year from 1970 to 1974 were included in computing the annual means, percent occurrence, and correlation matrices.

The NPMP fish tissue data represent whole-body residue levels; consequently they are not directly comparable with standards established for human consumption of fish, which are based on residues in edible portions. However, the NPMP data are representative of the contaminant levels to which piscivorous fish and wildlife would be exposed. To evaluate this potential hazard, we used data from all stations to compute percentages of samples meeting or exceeding criteria of the National Academy of Sciences (NAS) and National Academy of Engineers (NAE) (*22*) for the protection of fish-eating wildlife.

Each year's CNFRL crosscheck results were c pared with corresponding values reported by the a ytical laboratories in several ways. Summary statis were computed for each laboratory after the data w transformed (as described), and percent occurre was compared. For each compound, the prod moment correlation between corresponding values fr each laboratory was computed to give a general ind tion of agreement. Deviations between laborato were compared statistically by two-way analysis variance for paired comparisons (*28*).

Results and Discussion

THE DATA SET

The 1970–74 NPMP freshwater fish data set inclu organochlorine residue concentrations, lipid cont and descriptions of the specimens (species, aver length and weight, location of capture) for each 2,106 composite samples collected from 113 stati Major drainage basins from all 50 states are re sented (Fig. 1; Appendix A). Appendix B is a comp tabulation of the data.

Fish collected for the NPMP represented 71 taxa, which the five most frequently collected species (c channel catfish, largemouth bass, yellow perch, white sucker) accounted for 46–50 percent of the s ples every year (Table 1). The proportional contri tions of the five dominant species to that 46–50 p cent varied little from year to year.

Of the 113 stations, 74 are represented in the data by at least one sample each year and could therefore used in computing national descriptive statistics. T 74-station subset contains 1,604 observations, or 7 percent of the samples (Table 1). Within the subset least one species was present in each year's collect at 65 (88.8 percent) of the stations; two or more spe were common to all years at 32 (43.1 percent) of stations; and there were three species common to years at 12 stations (16.1 percent). Temporal tre could be interpreted clearly at a given station only w at least one species was common to all years.

In general, the NPMP freshwater fish data set is hete geneous with respect to species-station-year continu Most of this heterogeneity results from the lack o single fish species that is common to the major dr ages of all 50 states. The carp, an introduced spec comes closest, being taken at 54 percent of the stati sampled (5-year mean) followed by the channel cat (33 percent), largemouth bass (28 percent), yel perch (13 percent), and white sucker (11 perce (Table 1). Collectively, these five species represen 48 percent of the 2,106 samples collected; consequen they are far from ubiquitous when compared, for ample, with duck wings and starlings used in wild

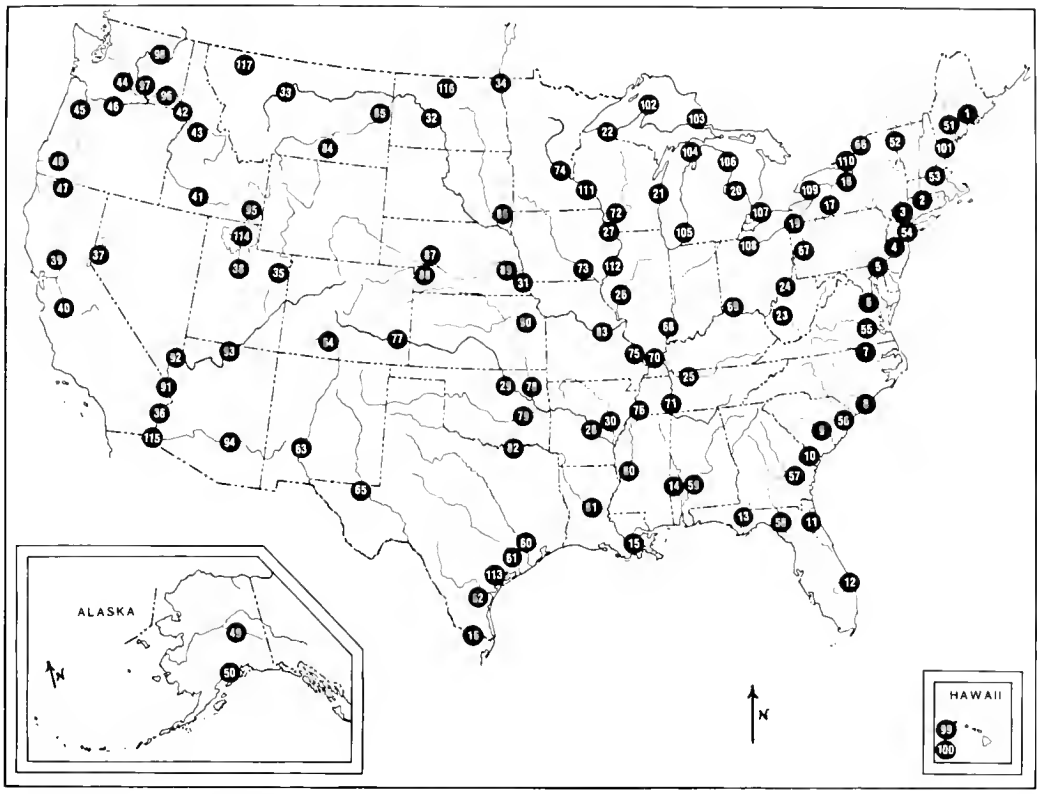


FIGURE 1. *Stations at which freshwater fish were collected for the National Pesticide Monitoring Program* (See Appendix A for descriptions of locations.)

TABLE 1. *Occurrence of the five most frequently collected fish species in the NPMP data set, 1970–74*

		1970		1971		1972		1973		1974		All Years	
CIES	PARAMETER	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
p	All samples	81	20.6	107	18.3	75	19.2	81	20.2	59	17.6	403	19.1
	All stations	49	49.0	55	58.5	55	56.1	61	61.0	42	43.3	262	53.6
	74 stations[1]	42	56.8	41	55.4	41	62.2	46	62.2	37	50.0	207	55.9
nnel catfish	All samples	41	10.4	66	11.3	36	9.2	43	10.7	37	11.0	223	10.6
	All stations	32	32.0	35	37.2	30	30.6	32	32.0	31	32.0	160	32.7
	74 stations	25	33.8	26	35.1	25	33.8	23	31.1	29	39.2	128	34.6
gemouth bass	All samples	38	9.6	49	8.5	33	8.5	40	10.0	25	7.5	185	8.8
	All stations	34	33.0	26	27.7	29	30.0	32	32.0	19	19.6	140	28.6
	74 stations	23	31.1	19	25.7	21	28.4	22	29.7	17	23.0	102	27.6
low perch	All samples	21	5.3	28	4.8	22	5.6	21	5.2	25	7.5	117	5.6
	All stations	13	13.0	14	14.9	12	12.2	12	12.0	14	14.4	65	13.3
	74 stations	11	14.9	12	16.2	11	14.9	10	13.5	9	12.2	53	14.3
ite sucker	All samples	15	3.8	24	4.1	14	3.6	11	2.7	15	4.5	79	3.8
	All stations	10	10.0	12	12.8	11	11.2	9	9.0	12	12.4	54	11.0
	74 stations	6	8.1	7	9.5	7	9.5	6	8.1	9	12.2	35	9.6
jor species (5)	All samples	196	49.7	274	46.8	180	46.2	196	48.8	161	48.1	1,006	47.8
Station Subset[1]	Samples	294	74.6	432	73.8	297	76.2	297	73.9	284	84.8	1,604	76.2
	Stations	74	74.0	74	78.7	74	75.5	74	74.0	74	76.3	370	75.7
data	Samples	394	100.0	585	100.0	390	100.0	402	100.0	335	100.0	2,106	100.0
	Stations	100	100.0	94	100.0	98	100.0	100	100.0	97	100.0	489	100.0

ations where at least one sample was collected each year, 1970–74.

idue monitoring (e.g., *34, 35*). Despite the heterogeneity, the fish tissue data are sufficiently continuous, pecially within given locations, to reflect temporal and gional trends.

INTERLABORATORY CROSSCHECKS

Results of statistical analyses performed on each year's crosschecks are presented in Table 2. Crosscheck re-

TABLE 2. *Statistical comparisons of interlaboratory crosschecks*

Compound	Statistic	Year and No. of Samples				
		1970 (40)	1971 (30)	1972 (34)	1973 (38)	1974 (47)
Lipid (%)	r	0.92	0.94	0.74	0.69	0.97
	X_A	8.8/8.6 NS	8.5/9.1*	6.8/7.0 NS	8.1/8.7 NS	8.1/8.4 NS
DDT homologs						
p,p'-DDE	%	100/100	100/97	76/100	79/97	91/100
	r	0.91	0.90	0.74	0.82	0.55
	X_G	1.25/0.86**	0.97/1.05 NS	0.86/1.12 NS	0.55/0.90**	0.73/0.41**
p,p'-TDE	%	100/100	100/97	88/89	61/92	83/96
	r	0.54	0.52	0.96	0.88	0.68
	X_G	1.08/76*	0.72/0.56 NS	0.42/0.44 NS	0.27/0.22 NS	0.31/0.28 NS
p,p'-DDT	%	100/100	100/97	62/100	87/92	34/85
	r	0.58	0.83	0.91	0.82	0.36
	X_G	0.74/0.42**	0.56/0.43 NS	0.29/0.35 NS	0.14/0.15 NS	0.10/0.11 NS
Total *p,p'*-DDT	%	100/100	100/97	94/100	89/97	96/100
	r	0.68	0.79	0.92	0.87	0.65
	X_G	3.03/1.94**	2.20/1.88 NS	1.42/1.70 NS	0.82/1.19**	1.09/0.73*
PCB components						
Aroclor 1242	%	—	—	—	21/13	0/0
	r	—	—	—	0.13	0.0
	X_G	—	—	—	0.40/0.06*	0/0
Aroclor 1248	%	NA/58	NA/73	NA/48	NA/58	NA/9
	r	—	—	—	—	—
	X_G	NA/1.97	NA/4.13	NA/1.16	NA/0.96	NA/0.15
Aroclor 1254	%	100/100	97/100	67/91	42/92	79/91
	r	0.84	0.71	0.78	0.63	0.68
	X_G	3.68/3.07 NS	3.89/3.68 NS	2.78/2.40 NS	1.38/1.72 NS	2.14/1.23**
Aroclor 1260	%	NA/68	NA/93	NA/79	21/97	28/57
	r	—	—	—	0.02	−0.03
	X_G	NA/2.20	NA/1.81	NA/1.10	0.17/0.85**	0.10/0.44**
Total PCB	%	100/100	97/100	67/91	68/97	85/91
	r	0.82	0.90	0.81	0.76	0.69
	X_G	3.68/6.19**	3.89/10.23**	2.78/4.77**	2.28/3.66**	2.46/1.75*
Other insecticides						
Dieldrin	%	98/100	100/100	55/97	58/92	38/96
	r	0.85	0.94	0.89	0.82	0.34
	X_G	0.16/0.25**	0.20/0.27	0.07/0.11*	0.07/0.20 NS	0.13/0.05 NS
Endrin	%	33/35	47/60	15/42	13/45	4/81
	r	0.89	0.70	0.46	0.12	−0.04
	X_G	0.01/0.01 NS	0.02/0.04*	0.01/0.03*	0.01/0.11*	0.01/0.03 NS
BHC	%	37/29	NA/43	NA/30	NA/63	NA/96
	r	0.55	—	—	—	—
	X_G	0.19/0.13 NS	NA/0.05	NA/0.02	NA/0.03	NA/0.07
Toxaphene	%	NA	13/26	18/36	13/34	13/21
	r	—	0.75	0.89	0.85	0.67
	X_G	—	< 0.01/0.56*	0.53/0.68 NS	0.37/0.63 NS	0.33/0.30 NS

NOTE: r = product-moment correlation between corresponding values; % = percent occurrence; X_A = mean (angular transformation); and X_G = mean (log transformation). For percent and means, values to the left of slant lines are for the analytical laboratories, and values to the right are for CNFRL crosschecks. Significance of differences between laboratories (two-way analysis of variance for paired comparisons): $^{**}P < 0.01$; $^{*}0.01 < P < 0.05$; NS, $P > 0.05$; NA, not analyzed; NC, not compared.

sults for individual samples are tabulated with corresponding monitoring data in Appendix B.

Crosscheck results revealed several types of disagreements between results of the laboratories. Most obvious was the consistent overestimation of DDT components by WARF for 1970 and 1971 samples containing PCB residues (Table 2; Appendix B). During these two years, WARF also significantly underestimated total PCB residues, no doubt as a result of their not separating PCBs from pesticides before GLC, and analyzing only for total PCBs as Aroclor 1254. WARF also reported DDT residues in 100 percent of the cross-checked samples from both 1970 and 1971; CNF reported 100 percent in 1970, and 97 percent in 19 Quantitative interpretation of chromatograms for to phene and chlordane, multi-component compou with GLC peaks that correspond to DDT, was not tiated for routine sample analyses until 1972. Co quently, additional interference with DDT determ tions from toxaphene and chlordane was likely in 1 and 1971 (*4, 16, 19*); DDT concentrations in sam containing significant residues of toxaphene or ch dane were probably overestimated by WARF. Be ning in 1972, when toxaphene and chlordane peaks w measured by DWRC, interference from those c

)unds was no longer a problem. As a result of this ıange and the incorporation of silicic acid PCB-pesti-de separation into routine analyses, interlaboratory greement in the DDT components improved during the riod 1972–74, even though statistically significant dif-rences persisted (Table 2).

greement between the laboratories in PCB determina-)ns was generally acceptable, given the methodological consistencies. Before 1973, WARF and DWRC re-)rted total PCBs as Aroclor 1254; whereas CNFRL easured separate PCB components. Total PCB con-ntrations reported by the analytical laboratories agree ell with the Aroclor 1254 levels reported by CNFRL, ven though the total PCB values themselves disagree; NFRL values for Aroclor 1254 are about the same or ightly lower than those reported for total PCB by the her analytical laboratories (Table 2). In later years, verall agreement was generally better; total PCB resi-ıes agree fairly well, despite differences in the ap-ırent abilities of the laboratories to discriminate and ıantitate PCB mixtures.

rosscheck results for aldrin and dieldrin, endrin, and HC (1970 only) indicated relatively close agreement Table 2). Differences in percent occurrence resulted om each laboratory reporting a different detection reshold; these compounds were found in some sam-es by CNFRL at very low concentrations (Appendix). CNFRL usually reported higher concentrations dieldrin, endrin, and BHC than did the other labora-ries (Table 2). Part of this apparent enhancement ay have been a result of correction for percent re-)very by CNFRL—a correction not made by the other boratories.

lthough WARF began analyzing for toxaphene in 971, residues could not be compared quantitatively ntil 1972 (Table 2). Agreement between laboratories as acceptable in 1972, 1973, and 1974; minor differ-ıces in percent occurrence again were related to dif-rences in detection threshold. However, all reported oxaphene values should be considered estimates; this secticide is a complex and highly variable mixture of any chlorinated terpene compounds, and residues are fficult to quantify by conventional packed-column LC.

general, crosscheck analyses revealed acceptable greement between the analytical laboratories and NFRL for most compounds, considering the methodo-gical differences. Even the 1970–72 total DDT resi-ues can be used for comparisons when the following nditions are met: PCB residues are low and pre-ominantly Aroclor 1254; percent lipid values are milar; and chlordane and toxaphene residues are near r below the detection limit. Similarly, total PCB residues are comparable when Aroclor 1254 is the predominant component. When these conditions are not met, interlaboratory agreement declines. Furthermore, confirmation of both DDT and PCB complexes requires complete sample separation before GLC; no correction factor based on CNFRL results can therefore be applied to the original data. For these reasons, both the original data and the corresponding crosschecks are tabulated in Appendix B.

GEOGRAPHIC AND TEMPORAL TRENDS IN RESIDUE LEVELS

Figure 2 represents a series of correlation matrices for the compounds during each monitoring year. As expected, wet-weight and lipid-weight concentrations of these lipophilic compounds were highly correlated ($r > 0.7$) in all comparisons (Fig. 2), as were the correlations between additive components (total DDT vs. TDE, DDE, and DDT, and total PCBs vs. various Aroclors). Total DDT and its components were significantly correlated ($P < 0.01$) with total PCB concentrations during 1970 and 1971 (Fig. 2), probably reflecting PCB interference in WARF DDT determinations for samples containing high PCB residues. From 1972 to 1974, when the samples were analyzed by DWRC and PCB and pesticide fractions were separated on silicic acid columns, PCB-DDT correlations were lower (Fig. 2).

Significant correlations also occurred among some of the agricultural compounds that tended to be used together. Toxaphene and the DDT homologs, for example, were positively correlated, as were the cyclodiene insecticides (dieldrin, endrin, heptachlor) in some years. Conversely, toxaphene and PCBs were negatively correlated, as might be expected when one measures the co-occurrence of agricultural and industrial compounds. For other residues, sporadically high intercorrelations may be only an artifact of uniformly low levels, especially when many zero values co-occur; such artifacts probably occurred for lipid-weight vs. wet-weight concentrations of heptachlor and Aroclor 1242, for example.

Table 3 presents the annual minimum, maximum, and geometric mean residue concentrations, and annual percent occurrence by station for 13 compounds. These data suggest a general downward trend in average residue concentrations and percent occurrence of DDT and its metabolites from 1970 through 1974. However, the maximum concentrations of the DDT homologs encountered each year either remained high or increased (e.g., DDE, the principal metabolite of DDT), indicating the continued presence of rather heavily contaminated areas despite a general downward trend.

The true magnitude of the downward trend in DDT residues is difficult to interpret because many of the 1970 and 1971 values reported for DDT and TDE

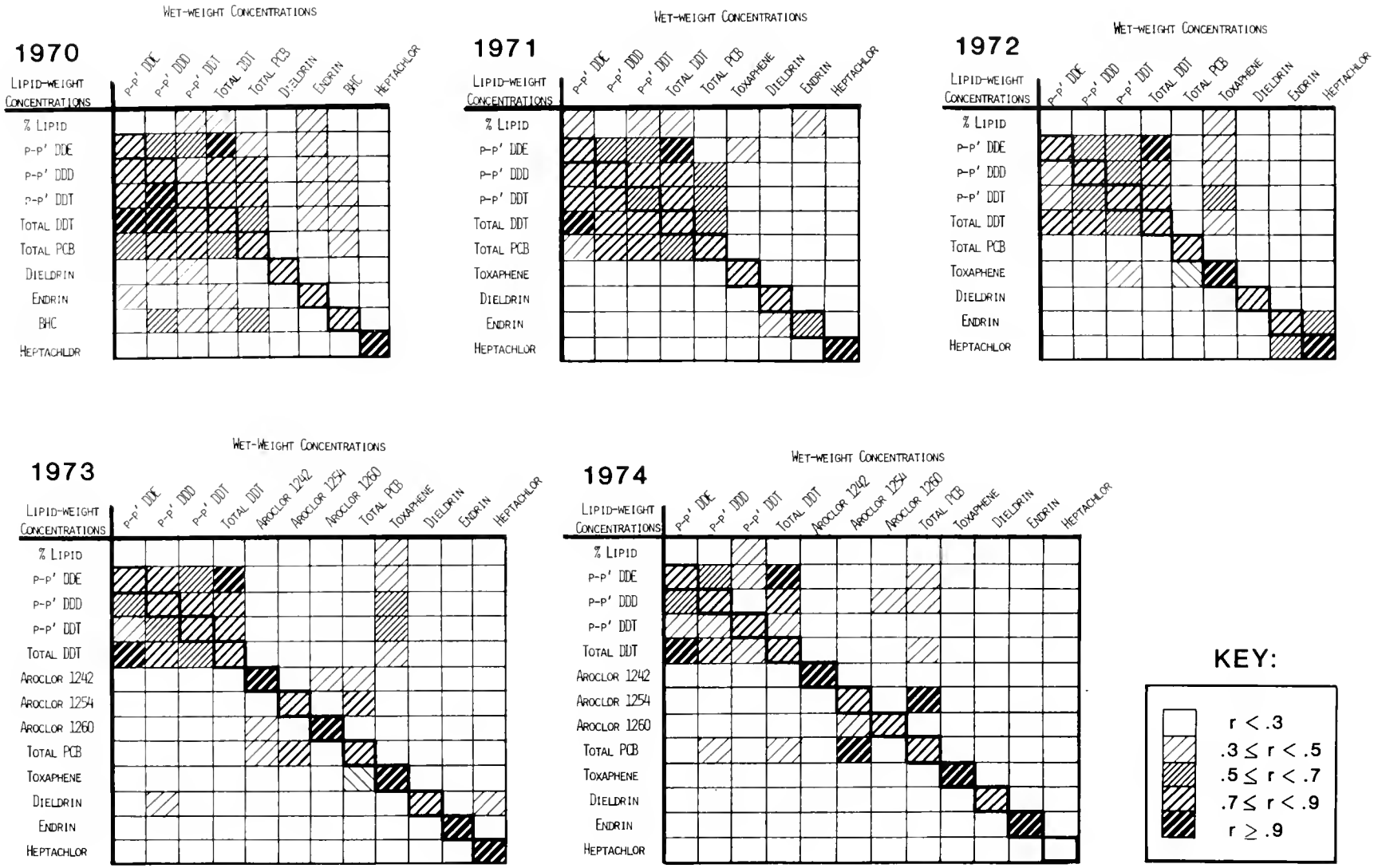


FIGURE 2. *Intercorrelations among organochlorine residues in freshwater fish, 1970–74.*
Wet-weight concentrations above principal diagonal, lipid-weight concentrations below. Coefficients on the principal diagonal illustrate correlations between corresponding wet-weight and lipid-weight values. Right-sloping lines, positive correlations; left-sloping lines, negative correlations.

BLE 3. *Geometric mean, minimum, and maximum wet-weight and lipid-weight residues (μg/g, whole fish), 1970–74, and percent of stations showing detectable residues in at least one sample*

MPOUND AND TATISTIC	1970		1971		1972		1973		1974	
	WET	LIPID	WET	LIPID	WET	LIPID	WET	LIPID	WET	LIPID
'-DDE										
min.	0.01	0.2	ND	ND	ND	ND	ND	ND	ND	ND
max.	7.27	361.8	8.27	236.7	15.0	211.3	32.0	581.8	12.0	517.6
X_G	0.47	6.5	0.35	4.9	0.40	5.2	0.30	3.7	0.37	4.4
%	100.0		98.6		97.2		95.9		95.9	
'-TDE										
min.	0.01	0.13	ND	ND	ND	ND	ND	ND	ND	ND
max.	5.86	208.0	4.04	145.0	7.60	166.7	14.0	90.9	9.0	102.3
X_G	0.34	4.8	0.25	3.6	0.18	2.2	0.12	1.1	0.14	1.3
%	100.0		98.6		97.3		71.6		78.4	
'-DDT										
min.	0.01	0.13	ND	ND	ND	ND	ND	ND	ND	ND
max.	3.72	123.3	5.34	80.9	6.47	55.8	11.0	200.0	2.0	26.9
X_G	0.27	3.6	0.19	2.7	0.11	0.9	0.07	0.5	0.05	0.4
%	100.0		98.6		74.3		41.9		48.6	
al *p,p'*-DDT nd metabolites										
min.	0.03	0.53	ND	ND	ND	ND	ND	ND	ND	ND
max.	13.02	402.7	13.13	401.7	21.8	307.0	48.0	872.7	16.2	517.6
X_G	0.98	15.1	0.73	11.2	0.64	9.0	0.44	5.4	0.52	6.2
%	100.0		98.6		100.0		100.0		97.3	
oclor 1242										
min.	NA		NA		NA		ND	ND	ND	ND
max.	—		—		—		15.0	180.7	4.5	95.5
X_G	—		—		—		0.11	0.3	0.01	< 0.1
%	—		—		—		13.5		5.4	
oclor 1254										
min.	NA		NA		NA		ND	ND	ND	ND
max.	—		—		—		25.0	709.7	75.0	1058.8
X_G	—		—		—		0.58	3.7	0.82	7.0
%	—		—		—		62.2		86.5	
oclor 1260										
min.	NA		NA		NA		ND	ND	ND	ND
max.	—		—		—		5.3	92.3	5.9	78.1
X_G	—		—		—		0.08	0.3	0.06	0.3
%	—		—		—		20.3		18.9	
tal PCB[1]										
min.	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
max.	24.8	1386.7	41.0	885.7	30.0	791.7	25.0	812.5	75.0	1058.8
X_G	-- 1.20	17.8	1.03	13.9	1.20	11.7	0.78	5.7	0.95	9.7
%	98.6		98.6		83.8		70.3		93.2	
xaphene[2]										
min.	NA		ND	ND	ND	ND	ND	ND	ND	ND
max.	—		0.01	1.4	38.0	718.0	31.0	1900.0	51.0	655.2
X_G	—		< 0.01	< 0.1	0.13	0.3	0.17	0.5	0.17	0.5
%	—		13.5		9.5		12.2		14.9	
ldrin										
min.	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
max.	1.35	17.1	4.17	94.4	1.40	42.4	1.20	47.4	9.10	113.8
X_G	0.08	1.1	0.07	0.9	0.07	0.8	0.05	0.6	0.09	0.6
%	100.0		100.0		81.1		70.3		52.7	
IC[4]										
min.	ND	ND	NA		NA		NA		NA	
max.	3.70	69.8	—		—		—		—	
X_G	0.08	0.9	—		—		—		—	
%	100.0		—		—		—		—	
drin										
min.	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
max.	0.16	1.8	0.82	10.0	0.73	8.6	0.51	5.5	0.21	17.3
X_G	0.01	0.1	0.02	0.2	0.01	0.1	0.01	0.1	< 0.01	< 0.1
%	31.1		82.4		10.8		20.3		2.7	
ptachlor[5]										
min.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	ND	ND
max.	0.40	14.3	1.0	25.6	0.23	2.0	0.05	0.7	ND	ND
X_G	0.01	0.1	0.01	0.1	0.01	0.1	0.01	0.1	0.0	0.0
%	1.4		2.7		6.8		4.1		0.0	
Lipid										
min.		0.2		0.1		0.1		0.1		0.6
max.		30.1		24.5		24.1		29.5		24.9
X_G		5.8		5.6		5.2		5.5		5.8

OTE: ND = none detected; NA = not analyzed.
s Aroclor 1254 for 1970–72.
'oxaphene values not quantitative for 1971.
ncludes aldrin for 1973–74.
ncludes α- and γ-isomers.
ncludes heptachlor epoxide.

(and hence, total DDT) were enhanced to an unknown degree by PCB, chlordane, and toxaphene interference. Furthermore, none of the NPMP stations showing evidence of DDT contamination was completely free of PCBs; because the NPMP stations are located on major lakes and rivers, there are no high DDT-low PCB stations to use as "yardsticks." However, DDE quantitation is affected less by failing to separate PCBs from pesticides than is quantitation of TDE and DDT. Note, for instance, that TDE and DDT were more highly correlated with total PCBs than was DDE in 1970 and 1971 (Fig. 2), and that the declines in the means and percent occurrence of DDE were less obvious than the declines for DDT and TDE (Table 3). DDE is formed continuously as the principal breakdown product of DDT. Therefore, stable DDE residues may represent a decline in total environment DDT. These processes are well illustrated, in that the proportion of the total mean *p,p'*-DDT homologs that consisted of DDE increased steadily from 43 percent in 1970 and 1971 to 63 percent in 1972, 68 percent in 1973, and 71 percent in 1974 (Fig. 3). Despite any declines in mean residues, however, DDT and its metabolites remain ubiquitous; as recently as 1974, traces were found in at least one sample at 97 percent of the stations investigated.

As represented by the statistics in Table 3, PCB residues evidenced little change from 1970 to 1974 in either average or maximum concentration or percent occurrence. Like DDT, these compounds have become

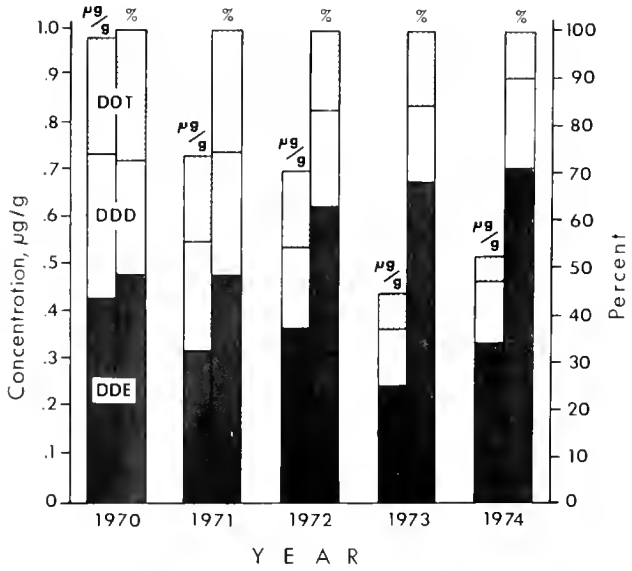


FIGURE 3. *Contributions of three p,p'-DDT homologs to total p,p'-DDT residues in fish tissues, 1970–74.* Left bar of each pair, wet-weight concentration (μg/g); right bar, percent of total.

virtually ubiquitious, occurring at 91 percent of NPMP stations in 1974.

Toxaphene was first measured in NPMP sample 1971, and trace quantities (0.01 μg/g or less) found at 9.5 percent of the stations. After method quantitation were improved, average concentrations creased to 0.1–0.2 μg/g and annual maxima rea 30–40 μg/g from 1972 to 1974. Percent occurre however, remained essentially unchanged until 1 when it increased nearly twofold, to 17.6 percent o stations investigated. These increases in toxaphene centrations and occurrence from 1970 to 1974 are surprising; toxaphene had already become the heavily used agricultural insecticide in the United S by 1971 (*2*), largely as a replacement for DD cotton farming.

Average and maximum dieldrin residues sho little change over the period 1970–74 (Table 3). H ever, the percentage of stations at which dieldri aldrin was detected declined from 100 percent in 1 to 50 percent in 1974 (almost no aldrin was dete it is rapidly metabolized to dieldrin). This decline reflect the replacement of aldrin and dieldrin by persistent soil insecticides, beginning in the late 19

High endrin concentrations were typically found few stations each year at about the same level (a 0.1–0.5 μg/g); little or none was found at most stati Hence, the mean remained consistently low from 1 to 1974 (Table 3). Changes in percent occurrence p ably reflect varying detection thresholds at the analy laboratories. Maximum wet-weight concentrations mained at or near 0.5 μg/g from 1972 to 1974; t are very high levels, considering toxicity of endri fish (*17*).

For the remaining insecticides (BHC and heptachl methodological inconsistencies preclude the discern of temporal trends in the national statistics. BHC, tected at 100 percent of the monitoring stations in 1 (Table 3), was deleted from the routine analyses be ning in 1971 because of difficulties in resolving various isomers. Heptachlor, heptachlor epoxide, several chlordane compounds are rapidly and ir changeably metabolized in natural systems (*21*); he the values reported for heptachlor (Table 3, Appe B) are only estimates. For this reason we also do report values for chlordane in trend monitoring s ples, even though samples were routinely screened "technical chlordane" (a complex and variable ture of compounds) from 1970 to 1974.

The lipid content of NPMP fish samples varied from year to year, but greatly within a year (Table Minimum values were typically 0.5 percent or

rly maxima were 25–35 percent, and means were
5 percent.

e group of 77 CNFRL crosscheck samples, repre-
ting 15 stations, was used to further examine tem-
al trends (Table 4). At least one sample from each
these stations was crosschecked every year from
0 to 1974. All samples were subjected to either
ic acid or silica gel PCB separation and were
ntitatively analyzed for toxaphene and chlordane.
ported residues should therefore be free of inter-
npound interferences. Furthermore, for some of the
tion-year "cells," two or more samples were cross-
cked (Table 4), allowing the computation of vari-
es and more rigorous statistical treatment than could
applied to the NPMP data set as a whole.

t-weight and lipid-weight residues of DDE, TDE,
DT, total DDT, total PCB, dieldrin, endrin, and
aphene were transformed as described previously
l analyzed statistically by 2-way analysis of variance
OVA) for unbalanced data sets, and least-squares
ans (adjusted for the number of observations per
l) were computed by using the SAS General Linear
dels procedure (*26*). The mean for "early" years (1970–72) was then contrasted against the mean for "later" years (1973–74) by using single degree-of-freedom orthogonal comparisons of means.

For wet-weight residues at the 15 stations, "year" main effects were significant only for total DDT ($P < 0.05$), total PCB, ($P < 0.01$), and dieldrin ($P < 0.05$) (Table 5). However, for lipid-weight residues, "year" effects were significant ($P < 0.01$) for all compounds tested except DDE and endrin, but station-year interaction was also significant for toxaphene and dieldrin. Although significant interaction can result from a variety of causes, in this situation it was probably the result of differing temporal trends among the 15 stations. Such a relation would be expected for toxaphene, for example; concentrations remained uniformly low over the 5-year period at some stations, whereas major changes occurred at other locations. As the R^2 values in Table 6 illustrate, relative precision was improved for most compounds when lipid-weight rather than wet-weight residues were compared, an improvement which provides the resolution necessary to detect differences among years for TDE, DDT, dieldrin, and toxaphene (Table 5). Main effects for "stations" were significant

TABLE 4. *Species composition of CNFRL crosscheck samples from 15 NPMP stations, 1970–74*

TION	LOCATION	1970	1971	1972	1973	1974
2	Connecticut R. Windsor Locks, Conn.	yellow perch white perch	yellow perch	white catfish	yellow perch	yellow perch
3	Hudson R. Poughkeepsie, N.Y.	goldfish	goldfish largemouth bass	goldfish largemouth bass	goldfish largemouth bass	largemouth bass
4	Tombigbee R. McIntosh, Ala.	largemouth bass	largemouth bass	largemouth bass	largemouth bass	freshwater drum
5	Mississippi R. Luling, La.	carp	bigmouth buffalo	carp	blue catfish freshwater drum	carp
8	L. Ontario Port Ontario, N.Y.	white perch	white perch	white perch	yellow perch freshwater drum	yellow perch
1	L. Michigan Sheboygan, Wis.	bloater	lake trout	lake trout bloater	lake trout bloater	lake trout
3	Kanawha R. Winfield, W.Va.	brown bullhead	brown bullhead	white crappie	carp	carp
4	Ohio R. Marietta, Ohio	channel catfish channel catfish	largemouth bass	channel catfish	channel catfish carp	channel catfish
8	Arkansas R. Pine Bluff, Ark.	smallmouth buffalo	flathead catfish	smallmouth buffalo channel catfish	smallmouth buffalo flathead catfish	carp
9	Sacramento R. Sacramento, Calif.	carp	carp	carp	white catfish	carp
3	Merrimac R. Lowell, Mass.	yellow perch	yellow perch	yellow perch	yellow perch	yellow perch
7	Allegheny R. Natrona, Pa.	walleye	walleye	walleye	carp	carp
9	Ohio R. Cincinnati, Ohio	white crappie carp	channel catfish	channel catfish carp	channel catfish	channel catfish
0	Yazoo R. Redwood, Miss.	smallmouth buffalo carp	smallmouth buffalo	smallmouth buffalo carp	smallmouth buffalo channel catfish	channel catfish
1	Red R. Alexandria, La.	smallmouth buffalo	white catfish	channel catfish	blue catfish	channel catfish

TABLE 5. *Results of analytical variance* (F-*values based on wet-weight or lipid-weight concentrations*), *1970–74 crosscheck residues from 15 stations* (N = 92)

Source	DF	DDE	TDE	DDT	Total DDT	Total PCB	Dieldrin	Endrin	Toxaphe
Wet weight									
Stations	14	17.53**	4.76**	4.69**	18.36**	33.38**	1.44	2.22	59.52
Years	4	2.82	1.53	2.43	4.22*	28.45**	4.19	0.29	2.55
Stations × Years	56	1.21	0.27	0.49	0.99	1.47	0.90	0.23	1.85
Error MS	17	0.030	0.048	0.035	0.038	0.045	0.003	0.004	0.019
Lipid weight									
Stations	14	12.78**	11.04*	7.38*	15.79**	15.34**	3.62**	9.06**	261.66*
Years	4	1.48	7.32**	5.99*	3.85**	9.55**	11.97**	1.27	21.73*
Stations × Years	56	1.18	0.80	0.75	1.18	0.72	2.39*	0.52	9.51*
Error MS	16[1]	0.11	0.089	0.102	0.088	0.179	0.023	0.022	0.014

NOTE: * $0.01 < P < 0.05$; ** $P < 0.01$.
[1] No lipid value for one observation.

TABLE 6. *Geometric mean wet-weight and lipid-weight contaminant concentrations for "early" (1970–72) and "la (1973–74) monitoring years, based on crosscheck analyses from 15 stations, with corresponding* R^2 *values and* F-*values single-degree-of-freedom contrasts*

	Wet-Weight Concentrations				Lipid-Weight Concentrations			
Compound	1970–72	1973–74	R^2	F	1970–72	1973–74	R^2	F
DDE	1.12	0.78	0.95	3.80	8.78	6.35	0.94	2.6
TDE	0.65	0.10	0.85	5.40*	5.23	2.20	0.94	19.0
DDT	0.52	0.16	0.85	8.32*	3.93	1.29	0.91	21.7
Total DDT	2.07	1.16	0.95	13.73**	19.38	10.12	0.95	14.6
Total PCB	11.19	3.46	0.98	85.34**	116.10	38.08	0.95	25.7
Dieldrin	0.17	0.07	0.84	8.35**	1.56	0.66	0.94	32.0
Endrin	0.04	0.06	0.75	0.42	0.24	0.34	0.91	1.0
Toxaphene	0.74	0.49	0.98	4.57*	2.20	1.64	0.99	12.4

NOTE: * $0.01 < P < 0.05$; ** $P < 0.01$.

for most comparisons (Table 5), as would be expected when comparing such diverse locations with their differing contaminant profiles.

For all compounds where main effects for "years" were significant, the mean for 1973–74 was significantly ($P < 0.01$) lower than that for 1970–72 (Table 6). Furthermore, these decreases were substantial; for example, 50 percent for total DDT and about 65 percent for total PCB at the 15 stations (Table 6).

Residue means based on the 15-station crosscheck data set were generally much higher than the corresponding national means (cf. Tables 3 and 6) because samples from stations with a history of high residues were intentionally selected. To facilitate comparisons of temporal trends between data sets, we expressed the 1973–74 residue means as percentages of the corresponding 1970–72 means for both data sets. As Table 7 illustrates, most of the downward trends noted for the 15 stations were similarly reflected in the 74 station means, supporting many of our earlier conclusions. For example, mean residues of DDE declined less than those of TDE, DDT, and total DDT during 1970–74. Average dieldrin and PCB levels also declined, but to a far greater degree in the 15-station data set than for the nation as a whole. This difference would be expected, considering the higher overall levels and percent occurrence of the compounds in the selected crosscheck samples.

TABLE 7. *Geometric mean wet-weight and lipid-wei contaminant concentrations for 1973–74 as percentages the 1970–72 means, based on 15 crosscheck stations and stations of the National Pesticide Monitoring Progran*

	Wet Weight; Stations		Lipid Weight; Station	
Compound	15 Crosscheck	74 NPMP	15 Crosscheck	74 NPI
DDE	69.6	82.9	72.3	77.7
TDE	15.4	52.0	42.1	36.4
DDT	30.8	72.2	32.8	18.2
Total DDT	56.0	53.2	52.2	44.6
Total PCB	30.9	73.7	32.8	52.5
Dieldrin	41.2	85.7	42.3	66.7
Endrin	150.0	100.0	141.7	50.0
Toxaphene[1]	66.2	130.8	71.6	166.7

[1] 1972 vs. 1973–74 for toxaphene.

Endrin levels remained basically unchanged in b data sets, probably because most residues were n or at the detection threshold (about 0.01 μg/g). To phene residues, however, were not quantitatively e mated in the regular NPMP program until 1972; cordingly, "early" vs. "late" years could not be cc pared. Instead, we chose to compare annual m toxaphene concentrations for the years 1972–74 (Ta 8).

Unlike the previously compared compounds, tempc trends in mean toxaphene residues differed between two data sets; the means from the full complement stations showed a slight (but probably not significa increase, and the 15-station means decreased shar (significant at the 0.01 level for lipid-weight residue

TABLE 8. *Geometric mean toxaphene residues (mg/kg), 1972–74*

o. of ations Data Set	Wet Weight			Lipid Weight		
	1972	1973	1974	1972	1973	1974
15	0.73	0.59	0.41	3.1	1.6	1.0
74	0.13	0.13	0.16	0.3	0.4	0.5

iis apparent contradiction is adequately explained by e composition of the data sets: The sharp decline in e 15-station means represents falling (but still high) erage levels at many of the more heavily con- ninated stations in the southeast Atlantic, Gulf Coast, d lower Mississippi regions, whereas the increasing currence of lower-level toxaphene residues through- t the nation has been sufficient to counteract this gional downward trend in the full data set. This in- 'pretation is supported by significant ($P < 0.01$) tion-year interaction for toxaphene residues in the -station data set, which implies an increase at some tions despite a significant ($P < 0.01$) downward nd in the overall annual means.

1974, 196 million lb (89 million kg) of organo- lorine insecticides were used in agriculture within e conterminous United States; of this total, 55 per- nt was used in corn and cotton production (*18*). eographically, this pattern resulted in over 50 per- nt of the organochlorine insecticides having been used the Southeast and Mid-South (*18*). It is therefore not prising that elevated residues of DDT and its meta- lites (>1.0 μg/g), toxaphene (>0.1 μg/g), and drin (>0.1 μg/g)—insecticides regularly used in cot- n production (*2*)—occurred routinely in fish samples m streams draining the southeastern Atlantic and lf coastal plains and lower Mississippi River valley. DT and its metabolites also occurred routinely during 70–74 in samples from Lake Michigan and Lake ntario, the Delaware and Connecticut Rivers in the rtheast, California's Sacramento River, the agricul- al areas of the Columbia River watershed in Wash- gton, and Hawaii.

most 8 million lb (3.5 million kg) of aldrin were ed in 1971 as a soil insecticide, primarily to combat rn rootworm (*2*). As a result, elevated levels (>0.1 /g) of mostly dieldrin (the primary metabolite of drin) were regularly measured in samples from rivers the Northeast and Mid-Atlantic regions (Connecticut, laware, Susquehanna, and James Rivers), the South- st (Pee Dee, Savannah, and Altamaha Rivers), the ver Mississippi River and some of its tributaries, Lake chigan, many of the rivers and streams draining the orn Belt" (including tributaries of the Ohio, Missis- pi, and lower Missouri River systems), and rivers Hawaii. The significance of the station-year inter- action for lipid-weight dieldrin residues in the 15-station crosscheck data set (Table 5) and the uniformly low annual means for the 74-station trend-monitoring data (Table 3) together point out the significance of these dieldrin "hot spots."

PCBs were encountered at least once in samples from every station during the 1970–74 monitoring period. By 1974, however, no PCBs were detected in samples from some headwaters of the Colorado River system (Stations 35 and 36), the Nueces River, Texas (Station 62), the upper Arkansas and several of its tributaries (Stations 77, 78, 79), and at one of two stations each in Alaska (none at Station 50) and Hawaii (none at Station 99).

High PCB residues in fish from several northeastern rivers, the Ohio River system, and the Great Lakes, have been well publicized. At the other end of the scale, the regular occurrence of trace quantities (≧0.05 μg/g) in fish from relatively remote areas can be explained by recent evidence concerning the vapor behavior and atmospheric transport of PCBs and other chlorinated hydrocarbons (e.g., *5*, *9*, *30*). However, authors were surprised to find relatively high levels of PCBs (≧0.5 μg/g) in fish samples from virtually every station located near a municipal or industrial center, at such geographically diverse locations as Fairbanks, Alaska (Station 49); Honolulu, Hawaii (Station 50); Lake Champlain, Vermont (Station 52); Sacramento, California (Station 40); the Snake, Salmon, and upper Columbia Rivers, Washington (Stations 96–98); the Bear River, Idaho (Station 95); and the Truckee River, Nevada (Station 37).

Relative contributions of the PCB mixture varied among the locations, illustrating different use patterns for these compounds. For example, samples from the Hudson River collected during 1973 and 1974 most closely resembled Aroclor 1254, with little Aroclor 1242 or 1260. Conversely, samples from the Ohio River contained proportionately higher concentrations of mixtures resembling Aroclors 1242 and 1260, and crosscheck analyses revealed significant quantities of Aroclor 1248 in both watersheds (Appendix B). Aroclor 1016, which contains a higher percentage of compounds with low chlorine numbers than do Aroclors 1242, 1248, 1254, or 1260, was the principal mixture released to the Hudson River (*9*). However, NPMP fish samples, collected 190 km downstream from the PCB source, yielded packed-column chromatograms more closely resembling those of Aroclor 1248 standards than either Aroclors 1016 or 1242 (M. Ribick, 1980, unpublished CNFRL data). Skea et al. (*27*) demonstrated significant accumulation of Aroclor 1016 by caged fish held immediately downstream of the Hudson River's PCB source after only 14 days of exposure; their chromatograms closely

resembled those of Aroclor 1016, but they reported slight enhancement of 5- and 6-chlorine components. These data collectively suggest that environmental weathering will eventually degrade the earlier-eluting, low chlorine PCBs, leaving mixtures that resemble residues of Aroclors 1248, 1254, and 1260.

When we listed the stations where the highest concentrations of the 13 monitored compounds occurred each year (Table 9), certain station numbers occurred repeatedly. Station 80, for example, appeared often in the DDT group, and was also the station reporting the highest toxaphene concentration during 1972, 1973, and 1974. This station is located on the Yazoo River near Redwood, Mississippi in a watershed largely devoted to cotton and soybean farming. Annual DDT maxima also occurred at Stations 14 (Tombigbee River, Alabama), 16 (Rio Grande at Mission, Texas), and 57 (Altamaha River, Georgia), which also drain cotton-farming areas. Station 76, on the Mississippi River at Memphis, was the site of the highest endrin levels in three of the five monitoring years and of the highest heptachlor levels in 1973 (Table 9). A major producer of both endrin and heptachlor has a manufacturing facility on a tributary of the Mississippi River at Memphis (*6,7*). Extensive fish kills in the lower Mississippi that followed chemical spills have been attributed to this facility (*25*). Furthermore, CNFRL chemists have detected residues of hexachloronorbornadiene (>5 μg/g) and heptachloronorborn-2-ene (>16 μg/g)—intermediates in the production of cyclodiene insecticides (*36*)—in fish from Station 76 (M. Ribick, 1979, personal communication). These levels are about 100 times the values reported from other stations, even where significant cyclodiene insecticide residues were present. Other workers have found elevated levels of these and related cyclodiene precursors and by-products in fish, sediments, and water from this area of the Mississi River (*20*). Consistently high dieldrin levels at Stat 76 (Appendix Tables A and B) may also be relatec chemical spills; aldrin and dieldrin were also produ by the facility at Memphis (*7*). However, dielc residues were highest at Station 100 (Manoa Stre Honolulu) in all five monitoring years (Table 9).

As expected, the locations at which highest annual P residues occurred most frequently were Stations (Hudson River) and 69 (Ohio River at Cincinn (Table 9). Annual maxima for PCBs also occurrec Stations 67 (Allegheny River, Pennsylvania), 21 (L Michigan), 55 (James River, Virginia), and 2 (C necticut River, Connecticut).

Generally, geographic trends were consistent from y to year. Usually, the compounds found in more tl trace quantities at a given station were identical e year, as would be expected for persistent compounds long-lived organisms. Exceptions appear to be r dues of dieldrin and toxaphene. The occurrence of h dieldrin concentrations appears to be declining, national mean residues declined only slightly, and " spots," such as Hawaii and certain mid-western riv persisted through 1974. Toxaphene residues appear tc generally higher and are becoming more widespread. special concern is the occurrence of toxaphene resid in the Great Lakes. Toxaphene was detected in a 1! trend sample from Lake Michigan (Station 21), and a 1974 CNFRL crosscheck from Lake Superior (S tion 102) (Appendix B). Because relatively little to phene has been used in the Great Lakes drainage ba (V. Saulys, U.S. Environmental Protection Agen Chicago, Illinois, unpublished data), we believe th residues result from the atmospheric transport of to phene from other geographic areas.

TABLE 9. *Stations of the National Pesticide Monitoring Program where maximum contaminant concentrations were recorded during 1970–74*

Compound	Year				
	1970	1971	1972	1973	1974
p-p'-DDE	16	16	14	14	57
p-p'-TDE	80	80	3	80	80
p-p'-DDT	80	80	80	14	21
Total DDT	80	21	14	14	80
Aroclor 1242	—	—	—	24	2
Aroclor 1254	—	—	—	3/69	3
Aroclor 1260	—	—	—	21	55
Total PCB	67	3	69	3/69	3
Toxaphene	—	x[1]	80	80	80
Dieldrin	100[2]	100[2]	100[2]	100[3]	100[3]
BHC	53[4]	—	—	—	—
Endrin	—	76	76	76	83
Heptachlor[5]	26[6]	18[6]	76	90	x[1]

[1] All values reported as either 0.01 or 0.00.
[2] Dieldrin only.
[3] Includes aldrin.
[4] BHC + lindane.
[5] Includes heptachlor epoxide.
[6] Only station where found.

HAZARDS TO PISCIVOROUS FISH AND FISH-EATING WILDLIFE FROM PERSISTENT ORGANOCHLORINE RESIDUES IN FISH

The NPMP residue values represent whole-body c centrations of contaminants. As such, they are not rectly comparable to standards established for consumed as food by humans, which are based residues in edible portions. However, the NPMP d are representative of the contaminant levels to wh piscivorous fishes and wildlife would be exposed.

The revised edition of *Water Quality Criteria* (2 recommended that, for the protection of predatory fis and wildlife, residues of DDT and its metabolites sho not exceed 1.0 μg/g; residues of dieldrin, aldrin, endr BHC, heptachlor epoxide, chlordane, and toxaph should not exceed 0.1 μg/g, either singly or in cc bination; and PCB residues should not exceed 0.5 μg The authors also pointed out that "if fish and wild are to be protected, and where residues exceed recc

ended concentrations, pesticide use should be re-
icted until the recommended concentrations are
ached (except where a substitute pesticide will not
otect human health . . ." Authors computed the per-
ntage of the samples from each station meeting or
ceeding these criteria during 1970–74 and graphically
pulated the results in Figure 4 (trace occurrences of
e various compounds are also illustrated). The far-
ht column (labeled "Net Effect") contains the symbol
presenting the highest percentage occurring each year
a station. This percentage may be thought of as repre-
nting the probability that a meal of adult fish eaten
a piscivorous organism at each location would be
ntaminated by one or more of the compounds meas-
ed to levels deemed dangerous to the predator's well-
ing.

though the trend from 1970 to 1974 was definitely
wnward, the total number of stations where 50
rcent or more of the samples collected contained
idues of one or more compounds exceeding the
commended criteria declined only 5 percent, from 71
100 (71 percent) in 1970 to 64 of 97 (66 percent)
1974 (Fig. 4). For the 74 stations constituting the
mplete" data matrix, the percentages were similar,
clining from 86 percent in 1970 to 76 percent in 1974.
described previously and illustrated by Figure 4, geo-
aphic trends remained fairly consistent from year to
ar.

r whole-body residue values are generally higher
n comparable samples based on edible portions, sim-
because muscle tissue typically contains relatively
v concentrations of these lipophyllic substances, com-
ed with other tissues that have a higher lipid content.
us our values cannot be compared directly with those
veloped by other agencies analyzing edible portions.
r this reason, and because whole fish are far more
ficult to process and analyze than are skinless, bone-
s muscle samples (i.e., fillets), the rationale for using
ole-fish composites is frequently criticized. How-
r, the purpose of our monitoring program is dif-
ent from that of other agencies in that we are at-
pting to assess existing and potential threats to fish
l wildlife resources; although we recognize the sig-
icance of the threats to human health and well-
ng and the fishery resource losses resulting from
tamination, those are not our primary concerns.
ce piscivorous fish and wildlife consume the entire
, and not only the muscle tissue, and since fish fre-
ntly make up a significant part (if not all) of their
t, the higher whole-body residue represents a more
urate assessment of the contaminant levels to which
and wildlife resources are exposed. Furthermore,
NAS-NAE recommendations for the protection of
civorous fish and wildlife (*22*), with which we com-
ed our residues (Fig. 4), were based largely on con-
trolled laboratory studies in which test animals were exposed to contaminants. Authors therefore feel that Figure 4 represents a reasonable assessment of the threat to piscivorous fish and wildlife inhabiting major U.S. rivers and the Great Lakes posed by organochlorine residues in freshwater fish. As this figure illustrates, the threat appears to be significant and widespread.

Samples of adult fish collected periodically from large rivers and lakes yield diluted, time-integrated representations of contaminant levels in broad geographic areas. The longevity of the fish and the tremendous water volumes of major lakes and rivers can mask the effects of locally severe, temporally varying contaminant problems. This phenomenon can be observed in our data by comparing the high residues at Station 80 (Yazoo River, Mississippi) with the much lower corresponding residues at Station 15 (Mississippi River at Luling, Louisiana). Similar comparisons can be made for dieldrin residues at Station 90 (Kansas River at Bonner Springs, Kansas) and at Station 83 (Missouri River at Hermann, Missouri), and for Station 26 (Illinois River at Beardstown, Illinois) and Station 75 (Mississippi River at Cape Girardeau, Missouri). Residues in fish from lower-order streams in some watersheds may be considerably higher than those in our samples, and may therefore represent a greater threat.

Even the tremendous evolution of analytical methods during 1970–74 has yielded techniques for identifying and quantifying only a small percentage of the toxic organic compounds that may now be threatening our fish and wildlife resources. Some residues cannot be determined in fish tissues, and some highly toxic substances are either rapidly metabolized or are not accumulated to levels sufficient for detection. Our current abilities to relate measured residue levels to observed biological effects is similarly limited. Accurate assessment of present and future threats stemming from contaminants associated with continued technological growth therefore requires a continuing commitment to analytical methods development and a priori hazard evaluation.

Summary and Conclusions

Residues of DDT and its metabolites in fishes from the nation's major rivers and lakes showed a continuing downward trend in 1970–74. The steady decrease in total DDT (*p,p'*-homologs) illustrates the effectiveness of the 1972 ban on the use of DDT in the United States. Although DDT residues remain high in some areas where it was used extensively in the past, the overall trend has been downward. Even in areas where total DDT residues remain high, *p,p'*-DDE is present in greater proportions than in the past, indicating substantial degradation of DDT in the environment. Furthermore, interpretation of crosscheck results re-

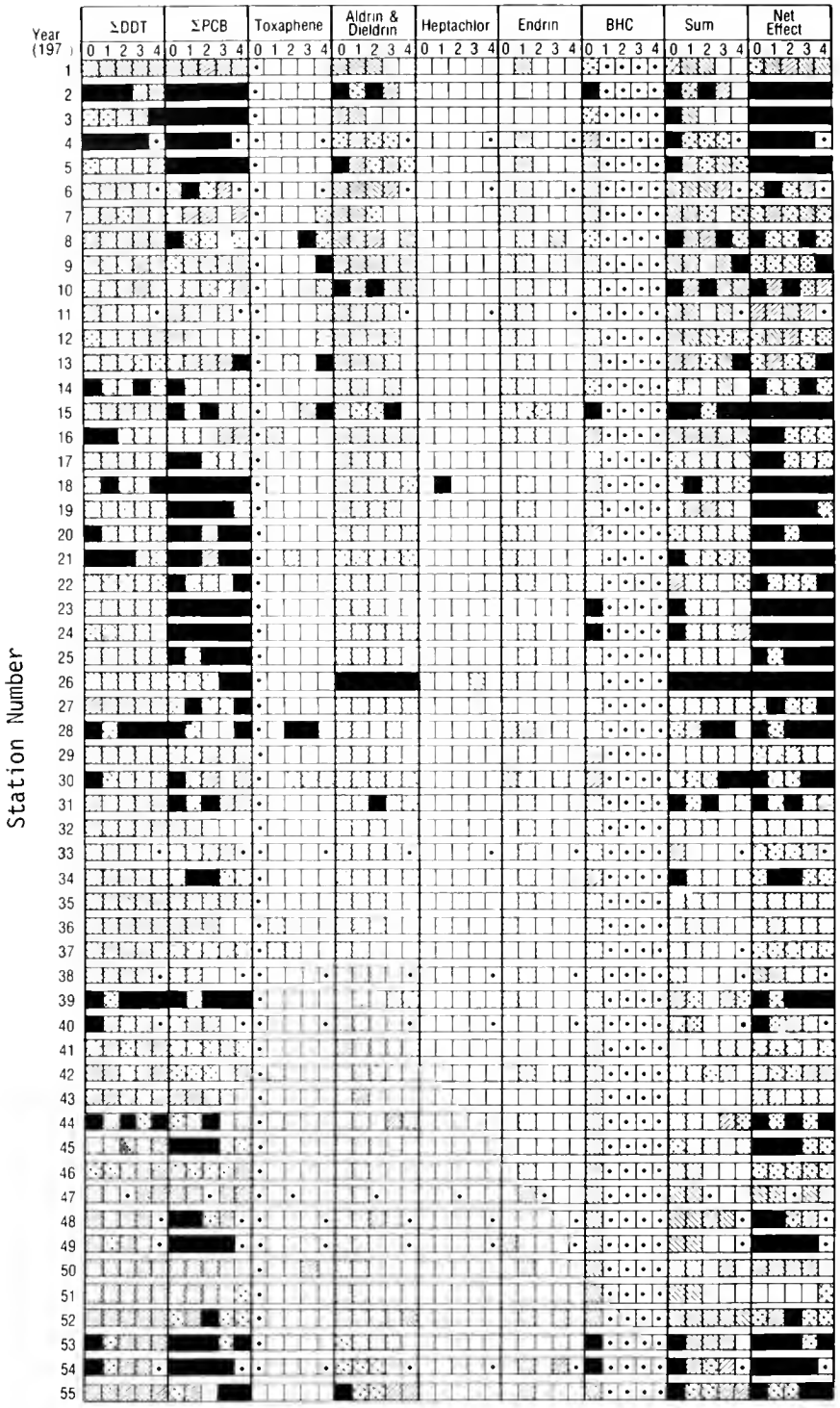
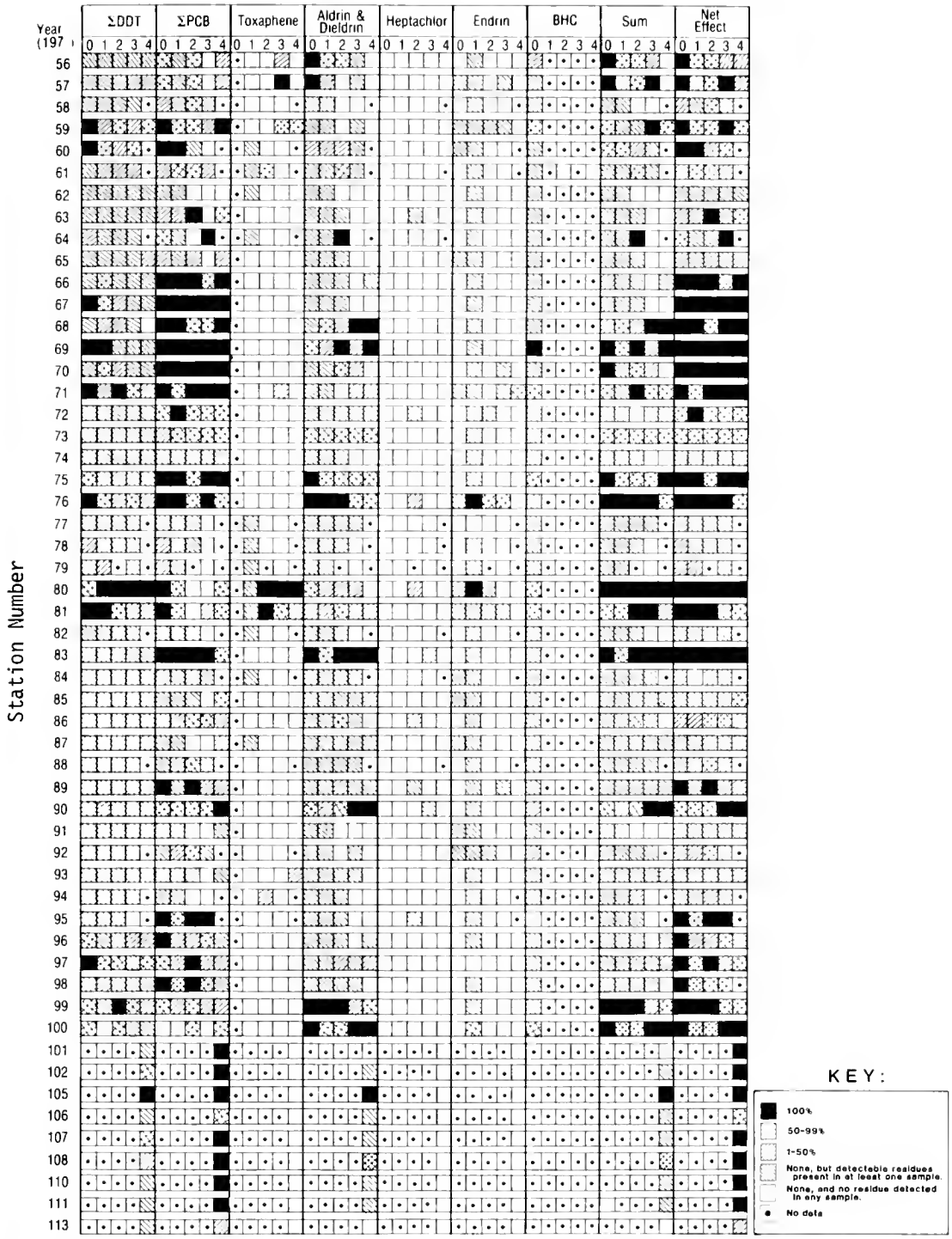


FIGURE 4. *Percentage of samples from NPMP stations (station numbers in left-hand column) equaling or exceed NAS-NAE criteria for minimum acceptable whole-body organochlorine residues, 1970 (0 in box heading) to 1974 (4 box heading)*



DDT = *p,p'*-isomers of TDE, DDE, and DDT; ΣPCB = Aroclor 1254 for 1970–72, Aroclors 1242, 1254, and 1260 for 73, and Aroclors 1242, 1248, 1254, and 1260 for 1974. Sum represents the total of toxaphene, aldrin, dieldrin, endrin, d BHC (total α- and γ-isomers).

vealed a similar decline, suggesting that analytical interferences from other organochlorine compounds were not great enough to mask the temporal trends. The number of collection sites where DDT has been observed in at least one sample has also decreased somewhat from 1970 to 1974. However, significant DDT residues were found in fish from most of the major drainages of the United States through 1974.

The virtual ubiquity of PCBs reflects the former widespread use of these persistent industrial compounds as hydraulic fluids and as heat transfer agents in capacitors and other electrical equipment. Fish exceeding the residue criterion established for the protection of piscivorous fish and wildlife (0.5 μg/g wet weight, whole fish) (*22*), were collected regularly from all NPMP stations near urban or industrial areas. Trace levels of PCBs were present in fish from the major watersheds of all 50 states. Definite trends in the overall magnitude of PCB residues are more difficult to discern because of the rapid improvement in analytical methods between 1970 and 1974. Although there appears to be a slight downward trend nationwide, especially in Aroclor 1254 residues, more data produced by better methods are needed to substantiate this trend. Significant PCB residues still occur regularly at the most contaminated sites.

PCBs occur in fish tissues most frequently and at the highest concentrations in the industrial northeastern and midwestern sections of the United States. Although no longer manufactured in the United States, PCBs are still used and continue to contaminate the environment as a result of spills and improper disposal of waste hydraulic fluids and discarded electrical components. Furthermore, the sediments of many major rivers and lakes represent a PCB reservoir of unknown proportions.

Mean toxaphene residues are increasing in freshwater fish of the United States, and residues exceeding 1.0 μg/g are now common. Studies by CNFRL have shown that toxaphene residues of about 1 μg/g may be associated with impaired growth and developmental abnormalities in young fish (*20*).

Toxaphene also occurs much more widely now than it did in past years. Formerly found primarily in fish from the cotton growing regions of the South, it now occurs in fish throughout much of the United States. Its increasing occurrence may be explained by the increased use of toxaphene in other types of agriculture, largely as a substitute for DDT and other compounds that have been banned. However, authors also suspect that atmospheric transport may represent a significant route of transfer to other geographic regions.

Nationally, average residues of dieldrin and endrin fish tissues remained essentially unchanged from 19 to 1974. Dieldrin residues are widespread, reflecting extensive use of this compound and aldrin before 19 The apparent variation in endrin occurrence, howev may merely indicate changing analytical resoluti endrin residues have remained generally low, but re due concentrations were high at some stations.

Comparison of observed residues with levels reco mended for the protection of piscivorous fishes a wildlife reveals relatively little change during 1970– in the potential threat to fish and wildlife resour posed by organochlorine residues in fish. At 66 p cent of the stations sampled every year, over half t samples exceed the recommended criteria in 19 Furthermore, the residues measured represent only small proportion of the toxic chemicals that may present.

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APPENDIX A. NATIONAL PESTICIDE MONITORING PROGRAM, FRESHWATER FISH STATIONS

STATION NO.	LAKE OR RIVER	CITY	STATE
1	PENOBSCOT RIVER	OLDTOWN	ME
2	CONNECTICUT RIVER	WINDSOR LOCKS	CT
3	HUDSON RIVER	POUGHKEEPSIE	NY
4	DELAWARE RIVER	CAMDEN	NJ/PA
5	SUSQUEHANNA RIVER	CONOWINGO DAM	MD
6	POTOMAC RIVER	LITTLE FALLS	MD/VA
7	ROANOKE RIVER	ROANOKE RAPIDS	NC
8	CAPE FEAR RIVER	ELIZABETHTOWN	NC
9	COOPER RIVER	LAKE MOULTRIE,MONCKS CORNER	SC
10	SAVANNAH RIVER	SAVANNAH	GA/SC
11	ST. JOHNS RIVER	WELAKA	FL
12	ST. LUCIE CANAL	INDIANTOWN	FL
13	APALACHICOLA RIVER	J. WOODRUFF DAM	FL
14	TOMBIGBEE RIVER	MCINTOSH	AL
15	MISSISSIPPI RIVER	LULING	LA
16	RIO GRANDE	MISSION	TX
17	GENESEE RIVER	SCOTSVILLE	NY
18	LAKE ONTARIO	PORT ONTARIO	NY
19	LAKE ERIE	ERIE	PA
20	LAKE HURON (SAGINAW BAY)	BAY PORT	MI
21	LAKE MICHIGAN	SHEBOYGAN	WI
22	LAKE SUPERIOR	BAYFIELD	WI
23	KANAWHA RIVER	WINFIELD	WV
24	OHIO RIVER	MARIETTA	OH/WV
25	CUMBERLAND RIVER	CLARKSVILLE	TN
26	ILLINOIS RIVER	BEARDSTOWN	IL
27	MISSISSIPPI RIVER	GUTTENBURG	IA/WI
28	ARKANSAS RIVER	PINE BLUFF	AR
29	ARKANSAS RIVER	KEYSTONE RESERVOIR	OK
30	WHITE RIVER	DEVALLS BLUFF	AR
31	MISSOURI RIVER	NEBRASKA CITY	NE/IA
32	MISSOURI RIVER	GARRISON DAM	ND
33	MISSOURI RIVER	GREAT FALLS	MT
34	RED RIVER OF THE NORTH	NOYES	MN/ND
35	GREEN RIVER	VERNAL	UT
36	COLORADO RIVER	IMPERIAL RESERVOIR	AZ/CA
37	TRUCKEE RIVER	FERNLEY	NV
38	UTAH LAKE	PROVO	UT
39	SACRAMENTO RIVER	SACRAMENTO	CA
40	SAN JOAQUIN RIVER	LOS BANOS	CA
41	SNAKE RIVER	HAGERMAN	ID
42	SNAKE RIVER	LEWISTON	ID/WA
43	SALMON RIVER	RIGGINS	ID
44	YAKIMA RIVER	GRANGER	WA
45	WILLAMETTE RIVER	OREGON CITY	OR
46	COLUMBIA RIVER	CASCADE LOCKS	OR/WA
47	KLAMATH RIVER	HORNBROOK	CA
48	ROGUE RIVER	GOLDRAY DAM	OR
49	CHENA RIVER	FAIRBANKS	AK
50	KENAI RIVER	SOLDATNA	AK
51	KENNEBEC RIVER	HINCKLEY	ME
52	LAKE CHAMPLAIN	BURLINGTON	VT

APPENDIX A (CONT'D)

53	MERRIMAC RIVER	LOWELL	MA
54	RARITAN RIVER	HIGHLAND PARK	NJ
55	JAMES RIVER	RICHMOND	VA
56	PEE DEE RIVER	JOHNSONVILLE	SC
57	ALTAMAHA RIVER	DOCTORTOWN	GA
58	SUWANEE RIVER	OLD TOWN	FL
59	ALABAMA RIVER	CHRYSLER	AL
60	BRAZOS RIVER	RICHMOND	TX
61	COLORADO RIVER	WHARTON	TX
62	NUECES RIVER	MATHIS	TX
63	RIO GRANDE	ELEPHANT BUTTE	NM
64	RIO GRANDE	ALAMOSA	CO
65	PECOS RIVER	RED BLUFF LAKE	TX
66	ST. LAWRENCE RIVER	MASSENA	NY
67	ALLEGHENY RIVER	NATRONA	PA
68	WABASH RIVER	NEW HARMONY	IN/IL
69	OHIO RIVER	CINCINNATI	OH/KY
70	OHIO RIVER	METROPOLIS	IL/KY
71	TENNESSEE RIVER	SAVANNAH	TN
72	WISCONSIN RIVER	WOODMAN	WI
73	DES MOINES RIVER	KEOSAUQUA	IA
74	MISSISSIPPI RIVER	LITTLE FALLS	MN
75	MISSISSIPPI RIVER	CAPE GIRARDEAU	MO/IL
76	MISSISSIPPI RIVER	MEMPHIS	TN/AR
77	ARKANSAS RIVER	JOHN MARTIN RESERVOIR	CO
78	VERDIGRIS RIVER	OOLOGAH	OK
79	CANADIAN RIVER	EUFAULA	OK
80	YAZOO RIVER	REDWOOD	MS
81	RED RIVER	ALEXANDRIA	LA
82	RED RIVER	LAKE TEXOMA	OK/TX
83	MISSOURI RIVER	HERMANN	MO
84	BIG HORN RIVER	HARDIN	MT
85	YELLOWSTONE RIVER	SIDNEY	MT
86	JAMES RIVER	OLIVET	SD
87	NORTH PLATTE RIVER	LAKE MCCONAUGHY	NE
88	SOUTH PLATTE RIVER	BRULE	NE
89	PLATTE RIVER	LOUISVILLE	NE
90	KANSAS RIVER	BONNER SPRINGS	KS
91	COLORADO RIVER	LAKE HAVASU	AZ/CA
92	COLORADO RIVER	LAKE MEAD	NV/AZ
93	COLORADO RIVER	LAKE POWELL,PAGE	AZ
94	GILA RIVER	SAN CARLOS RESERVOIR	AZ
95	BEAR RIVER	PRESTON	ID
96	SNAKE RIVER	ICE HARBOR DAM	WA
97	COLUMBIA RIVER	PASCO	WA
98	COLUMBIA RIVER	GRAND COULEE	WA
99	WAIKELE STREAM	WAIPAHU	HI
100	MANOA STREAM	HONOLULU	HI
101	ANDROSCOGGIN RIVER	LEWISTON	ME
102	LAKE SUPERIOR	KEEWEENAW POINT	MI
103	LAKE SUPERIOR	WHITEFISH POINT	MI
104	LAKE MICHIGAN	BEAVER ISLAND	MI

APPENDIX A (CONT'D)

105	LAKE MICHIGAN	SAUGATUCK	MI
106	LAKE HURON	ALPENA	MI
107	LAKE ST. CLAIR	MT. CLEMENS	MI
108	LAKE ERIE	PORT CLINTON	OH
109	LAKE ONTARIO	ROOSEVELT BEACH	NY
110	LAKE ONTARIO	CAPE VINCENT	NY
111	MISSISSIPPI RIVER	LAKE CITY	MN/WI
112	MISSISSIPPI RIVER	DUBUQUE	IA/IL/WI
113	SAN ANTONIO RIVER	MCFADDIN	TX
114	BEAR CREEK	BRIGHAM CITY	UT
115	COLORADO RIVER	YUMA	AZ/CA
116	SOURIS RIVER	UPHAM	ND
117	FLATHEAD RIVER	CRESTON	MT

ATION 1, PENOBSCOT RIVER AT OLDTOWN, ME

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CHAIN PICKEREL	16.4	1.0	1.2	0.06	0.05	0.05	-	-	0.46	-	0.01	0.00	0.00	-	-	-	-	0.11	-
WHITE SUCKER	15.1	1.3	2.5	0.06	0.06	0.04	-	-	0.34	-	0.00	0.00	0.00	-	-	-	-	0.10	-
WHITE SUCKER	15.3	1.3	2.7	0.04	0.04	0.03	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.08	-
YELLOW PERCH	7.9	0.2	3.5	0.06	0.05	0.04	-	-	0.33	-	0.01	0.00	0.00	-	-	-	-	0.10	-
CHAIN PICKEREL	15.1	0.7	1.7	0.03	0.03	0.03	-	-	0.25	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	15.0	0.7	1.6	0.04	0.04	0.04	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	12.5	0.8	2.2	0.02	0.03	0.02	-	-	0.13	-	0.01	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	12.5	0.8	2.5	0.02	0.02	0.02	-	-	0.18	-	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.5	0.2	3.7	0.04	0.03	0.03	-	-	0.26	-	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.9	0.2	4.1	0.04	0.04	0.03	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	14.1	0.6	1.4	0.00	0.02	0.00	-	-	1.30	-	0.01	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	13.5	1.0	3.2	0.00	0.02	0.01	-	-	0.20	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.9	0.3	3.7	0.03	0.02	0.09	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.9	0.3	3.5	0.02	0.01	0.00	-	-	0.36	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	16.6	1.0	1.9	0.04	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	14.8	1.3	3.3	0.02	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	13.6	1.0	2.1	0.02	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.8	0.3	3.8	0.04	0.00	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	16.3	1.2	2.5	0.04	0.00	0.00	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	15.6	1.5	4.3	0.04	0.00	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.5	0.5	4.4	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	10.5	0.6	4.2	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 51, KENNEBEC RIVER AT HINCKLEY, ME

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
MALLMOUTH BASS	11.3	0.9	4.8	0.09	0.04	0.04	-	-	0.29	-	0.01	0.00	0.00	-	-	-	-	0.01	-
HITE PERCH	8.9	0.5	12.7	0.04	0.03	0.03	-	-	0.17	-	0.01	0.00	0.00	-	-	-	-	0.02	-
ELLOW PERCH	9.3	0.1	3.4	0.05	0.04	0.05	-	-	0.25	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ELLOW PERCH	9.0	0.1	3.0	0.07	0.04	0.05	-	-	0.22	-	0.01	0.00	0.00	-	-	-	-	0.01	-
MALLMOUTH BASS	13.0	1.1	3.7	0.06	0.04	0.03	-	-	0.29	-	0.01	0.00	0.00	-	-	0.00	-	-	-
MALLMOUTH BASS	14.4	1.4	2.6	0.07	0.03	0.05	-	-	0.32	-	0.01	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	12.7	0.8	2.6	0.01	0.02	0.02	-	-	0.13	-	0.01	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	13.8	0.9	2.0	0.03	0.02	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	10.3	0.5	3.9	0.04	0.03	0.04	-	-	0.19	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	9.1	0.3	2.9	0.03	0.03	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	0.00	-	-	-
MALLMOUTH BASS	11.2	0.6	2.1	0.05	0.01	0.02	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE PERCH	8.5	0.3	3.2	0.01	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	9.7	0.4	4.1	0.05	0.01	0.04	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	9.7	0.4	4.7	0.05	0.02	0.02	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
MALLMOUTH BASS	11.4	0.8	2.3	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	10.8	0.5	2.0	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	9.6	0.4	3.5	0.04	0.02	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	10.2	0.5	3.6	0.04	0.03	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	16.3	1.0	1.8	0.05	0.01	0.01	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	13.3	1.0	3.6	0.01	0.01	0.01	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	9.9	0.4	4.2	0.07	0.00	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	10.1	0.4	3.3	0.05	0.02	0.01	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 101, ANDROSCOGGIN RIVER AT LEWISTON, ME

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
HAIN PICKEREL	14.7	0.9	3.8	0.09	0.08	0.03	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	15.1	1.5	7.7	0.06	0.12	0.04	0.0	-	1.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	15.1	1.5	4.3	0.08	0.15	0.00	0.0	-	1.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	8.9	0.4	4.4	0.00	0.04	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	3.9	0.03	0.04	0.01	0.0	0.0	0.30	0.2	0.01	0.00	0.00	0.02	0.00	0.00	0.00	0.06	0.01

STATION 53, MERRIMAC RIVER AT LOWELL, MA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	PUMPKINSEED	5.6	0.1	3.6	0.57	0.34	0.21	-	-	1.87	-	0.02	0.00	0.00	-	-	-	-	0.71
70	WHITE SUCKER	12.0	0.6	4.7	1.04	1.03	0.34	-	-	5.47	-	0.05	0.00	0.00	-	-	-	-	3.22
70	WHITE SUCKER	10.4	0.5	5.3	0.70	0.67	0.40	-	-	4.90	-	0.32	0.00	0.00	-	-	-	-	3.70
70	YELLOW PERCH	7.9	0.2	4.1	1.17	1.13	0.39	-	-	6.12	-	0.32	0.00	0.00	-	-	-	-	2.23
70	CROSSCHECK	-	-	3.4	0.34	0.70	0.32	-	75.0	6.10	3.2	0.71	0.00	0.08	-	-	0.00	-	-
71	PUMPKINSEED	6.2	0.2	4.7	0.29	0.44	0.25	-	-	4.82	-	0.04	0.00	0.00	-	-	0.00	-	-
71	PUMPKINSEED	4.4	0.1	2.3	0.22	0.42	0.25	-	-	4.82	-	0.07	0.00	0.00	-	-	0.00	-	-
71	WHITE SUCKER	12.0	0.7	5.5	0.35	0.66	0.22	-	-	13.30	-	0.06	0.00	0.00	-	-	0.00	-	-
71	WHITE SUCKER	11.1	0.5	4.7	0.55	0.82	0.37	-	-	23.40	-	0.05	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	10.7	0.6	7.6	0.65	1.11	0.29	-	-	21.90	-	0.09	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	10.7	0.6	6.2	0.60	0.82	0.29	-	-	20.60	-	0.08	0.00	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	7.3	0.23	0.34	0.08	-	40.0	3.00	1.6	0.15	0.00	0.06	0.22	-	0.00	0.31	-
72	CARP	10.2	0.5	1.5	0.00	0.06	0.00	-	-	1.20	-	0.00	0.00	0.00	-	-	0.00	-	-
72	WHITE SUCKER	12.5	0.5	3.1	0.47	0.00	0.00	-	-	3.20	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	10.1	0.6	7.7	0.00	0.00	0.00	-	-	10.20	-	0.05	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	7.8	0.51	0.35	0.09	-	3.4	3.50	1.9	0.08	0.00	0.00	0.36	-	0.00	0.02	-
72	YELLOW PERCH	9.3	0.5	6.6	0.00	0.40	0.00	-	-	8.80	-	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	11.6	0.8	3.2	0.10	0.15	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	11.5	0.8	2.6	0.11	0.08	0.00	0.0	-	1.10	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	WHITE SUCKER	12.2	0.7	1.0	0.06	0.02	0.00	0.0	-	0.09	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	11.5	0.9	5.5	0.91	0.22	0.00	0.0	-	12.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	8.7	0.20	0.38	0.05	0.0	4.0	2.50	2.0	0.01	0.00	0.00	0.00	-	0.00	0.09	0.05
74	CHAIN PICKEREL	16.3	1.1	5.3	0.30	0.24	0.00	0.0	-	4.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE SUCKER	11.7	0.6	5.4	0.05	0.17	0.00	0.0	-	1.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE SUCKER	11.4	0.6	4.4	0.05	0.15	0.00	0.0	-	1.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	YELLOW PERCH	8.6	0.4	5.0	0.40	0.22	0.00	0.0	-	5.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	4.7	0.18	0.19	0.03	0.0	0.0	2.20	1.2	0.01	0.01	0.01	0.15	0.03	0.00	0.03	0.53

STATION 2, CONNECTICUT RIVER AT WINDSOR LOCKS, CT

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	WHITE CATFISH	12.6	0.9	5.4	0.64	0.65	0.52	-	-	6.25	-	0.20	0.00	0.00	-	-	-	-	0.15
70	WHITE CATFISH	12.9	1.0	8.0	0.73	0.78	0.57	-	-	7.44	-	0.23	0.00	0.00	-	-	-	-	0.25
70	WHITE PERCH	9.9	0.6	4.6	0.64	0.94	0.89	-	-	9.38	-	0.28	0.00	0.00	-	-	-	-	0.19
70	CROSSCHECK	-	-	4.8	0.18	0.16	0.25	-	6.6	5.00	6.1	0.38	0.00	0.02	-	-	0.00	-	-
70	YELLOW PERCH	10.5	0.6	7.0	0.44	0.46	0.61	-	-	2.45	-	0.44	0.00	0.00	-	-	-	-	0.20
70	CROSSCHECK	-	-	6.4	0.30	0.62	0.94	-	6.4	2.60	1.2	0.99	0.00	0.14	-	-	0.00	-	-
71	WHITE CATFISH	12.1	0.8	5.4	0.76	0.65	0.50	-	-	13.50	-	0.09	0.00	0.00	-	-	0.00	-	-
71	WHITE CATFISH	12.9	1.1	5.9	0.63	0.60	0.50	-	-	9.90	-	0.08	0.00	0.00	-	-	0.00	-	-
71	WHITE PERCH	8.6	0.4	5.1	0.64	0.65	0.65	-	-	14.20	-	0.10	0.00	0.00	-	-	0.00	-	-
71	WHITE PERCH	10.0	0.6	4.4	0.44	0.60	0.61	-	-	12.50	-	0.11	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	8.8	0.3	3.3	0.65	0.63	0.51	-	-	18.90	-	0.15	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	10.0	0.6	4.6	0.83	0.76	0.61	-	-	15.40	-	0.23	0.00	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	3.6	0.31	0.16	0.28	-	9.7	2.60	1.8	0.21	0.00	0.04	0.24	-	0.00	0.02	-
72	WHITE CATFISH	13.5	1.0	5.8	0.93	0.30	0.19	-	-	12.00	-	0.12	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	5.8	0.56	0.23	0.17	-	4.6	4.30	1.6	0.08	0.00	0.00	0.23	-	0.00	0.01	-
72	WHITE CATFISH	13.3	1.0	8.1	0.69	0.48	0.31	-	-	9.10	-	0.31	0.00	0.00	-	-	0.00	-	-
72	WHITE PERCH	10.0	0.5	3.0	0.42	0.67	0.74	-	-	18.00	-	0.48	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	9.0	0.4	6.9	0.42	0.34	0.32	-	-	6.60	-	0.34	0.00	0.00	-	-	0.00	-	-
73	WHITE CATFISH	12.6	1.1	5.3	0.63	0.00	0.00	0.0	-	7.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	10.1	0.6	5.5	0.59	0.00	0.00	0.0	-	7.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	9.5	0.5	4.7	0.59	0.00	0.00	0.0	-	8.10	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	9.3	0.4	6.4	0.18	0.10	0.00	3.0	-	0.00	1.5	0.11	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	6.6	0.18	0.01	0.45	0.0	1.5	1.80	0.6	0.04	0.00	0.00	0.00	-	0.00	0.02	0.01
74	BROWN BULLHEAD	9.7	0.4	2.2	0.07	0.06	0.00	2.1	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE CATFISH	14.4	1.3	5.2	0.23	0.14	0.07	0.0	-	5.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE CATFISH	12.3	0.9	5.8	0.18	0.14	0.08	0.0	-	5.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	YELLOW PERCH	9.7	0.4	5.7	0.14	0.12	0.17	0.0	-	2.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	6.0	0.20	0.14	0.15	0.0	1.4	1.58	0.9	0.02	0.01	0.02	0.15	0.04	0.00	0.02	0.05

ION 3, HUDSON RIVER AT POUGHKEEPSIE, NY

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
GOLDFISH	8.4	0.5	11.5	0.70	0.94	0.65	-	-	5.73	-	0.09	0.00	0.00	-	-	-	-	0.38	-
GOLDFISH	10.5	1.0	16.5	1.02	1.98	1.46	-	-	13.50	-	0.19	0.00	0.00	-	-	-	-	1.21	-
CROSSCHECK	-	-	15.5	0.59	0.85	0.12	-	173.0	32.00	0.0	0.41	0.00	1.28	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.8	1.3	4.0	0.68	1.54	1.22	-	-	9.37	-	0.03	0.00	0.00	-	-	-	-	0.26	-
PUMPKINSEED	6.2	0.2	1.7	0.12	0.23	0.23	-	-	1.77	-	0.03	0.00	0.00	-	-	-	-	0.09	-
GOLDFISH	9.4	0.8	6.9	0.78	1.30	0.61	-	-	40.40	-	0.02	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	8.0	0.04	0.48	0.01	-	66.0	8.00	1.8	0.08	0.00	0.00	0.16	-	0.00	0.00	-	-
GOLDFISH	9.9	0.8	4.7	0.56	0.74	0.46	-	-	13.70	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.9	0.9	3.9	0.12	0.29	0.12	-	-	28.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.8	0.9	4.7	0.52	1.01	0.46	-	-	41.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	5.2	0.02	0.40	0.12	-	78.0	12.00	2.8	0.09	0.00	0.16	0.00	-	0.00	0.00	-	-
PUMPKINSEED	6.1	0.1	0.7	0.13	0.21	0.14	-	-	6.20	-	0.01	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	6.0	0.2	2.0	0.14	0.18	0.09	-	-	0.69	-	0.01	0.00	0.00	-	-	0.00	-	-	-
GOLDFISH	11.9	1.1	15.1	0.00	0.57	0.00	-	-	25.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	17.2	1.24	0.59	0.08	-	108.0	8.00	2.0	0.13	0.00	0.00	0.20	-	0.00	0.00	-	-
GOLDFISH	10.1	0.6	14.8	0.00	1.00	0.00	-	-	17.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.5	0.6	3.3	0.00	0.17	0.00	-	-	13.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	3.6	0.45	0.23	0.19	-	52.0	7.60	1.8	0.03	0.00	0.00	0.13	-	0.00	0.01	-	-
PUMPKINSEED	5.8	0.1	0.7	0.20	0.01	0.00	-	-	2.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GOLDFISH	10.6	1.0	9.3	0.00	0.00	0.00	0.0	-	25.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	11.5	0.17	0.04	0.08	0.0	63.5	4.00	1.6	0.01	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00
LARGEMOUTH BASS	11.9	0.9	3.1	0.00	0.00	0.00	0.0	-	22.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	4.8	0.12	0.12	0.16	0.0	52.0	50.00	2.0	0.03	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00
PUMPKINSEED	5.8	0.1	3.8	0.10	0.00	0.00	0.0	-	3.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	5.6	0.1	3.2	0.20	0.00	0.00	0.0	-	5.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GOLDFISH	10.1	0.9	17.0	5.40	1.40	0.00	0.0	-	75.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GOLDFISH	11.5	1.1	6.8	2.70	4.20	0.00	0.0	-	30.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.1	1.1	5.4	0.78	0.40	0.00	0.0	-	13.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	4.9	0.43	0.27	0.04	0.0	41.3	8.42	0.0	0.04	0.01	0.00	0.10	0.00	0.00	0.00	0.01	0.01
PUMPKINSEED	6.0	0.2	3.2	1.60	0.51	0.00	0.0	-	25.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TATION 54, RARITAN RIVER AT HIGHLAND PARK, NJ

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
GOLDEN SHINER	5.9	0.1	5.4	0.94	2.29	0.52	-	-	7.29	-	0.36	0.00	0.00	-	-	-	-	0.10	-
CROSSCHECK	-	-	4.7	0.11	0.66	0.00	-	3.1	1.50	1.3	0.05	0.00	0.00	-	-	0.00	-	-	-
ROCK BASS	6.9	0.2	6.7	0.40	0.61	0.43	-	-	2.21	-	0.35	0.00	0.00	-	-	-	-	0.20	-
WHITE PERCH	9.1	0.5	7.3	1.08	1.09	0.83	-	-	4.04	-	0.41	0.00	0.00	-	-	-	-	0.20	-
WHITE PERCH	8.3	0.3	5.9	0.91	1.18	0.73	-	-	4.04	-	0.05	0.00	0.00	-	-	-	-	0.19	-
GOLDEN SHINER	7.6	0.2	4.5	0.26	0.38	0.12	-	-	0.89	-	0.06	0.01	0.00	-	-	0.00	-	-	-
GOLDEN SHINER	6.3	0.1	7.1	0.51	0.72	0.28	-	-	1.82	-	0.09	0.00	0.00	-	-	0.00	-	-	-
WHITE PERCH	9.7	0.7	9.8	0.99	1.20	0.59	-	-	3.65	-	0.04	0.00	0.00	-	-	0.00	-	-	-
WHITE PERCH	9.6	0.6	8.9	0.83	0.10	0.51	-	-	2.99	-	0.34	0.01	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	9.1	0.90	0.79	0.75	-	3.3	2.30	1.4	0.31	0.05	0.00	0.00	-	0.00	0.04	-	-
WHITE SUCKER	13.4	1.2	4.7	0.60	0.56	0.26	-	-	2.08	-	0.05	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	12.3	1.0	4.5	0.33	0.47	0.26	-	-	2.08	-	0.06	0.01	0.00	-	-	0.00	-	-	-
GOLDEN SHINER	7.3	0.2	3.5	0.33	0.26	0.00	-	-	1.50	-	0.09	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	9.7	0.5	4.3	0.14	0.23	0.07	-	-	4.90	-	0.13	0.00	0.00	-	-	0.00	-	-	-
WHITE PERCH	7.2	0.3	3.9	0.52	0.30	0.15	-	-	2.30	-	0.09	0.00	0.00	-	-	0.00	-	-	-
WHITE PERCH	6.7	0.3	6.0	0.60	0.63	0.32	-	-	3.20	-	0.11	0.00	0.00	-	-	0.00	-	-	-
CARP	11.5	0.9	3.1	0.00	0.00	0.00	1.3	-	0.00	0.8	0.00	0.00	0.00	-	-	0.00	-	-	-
GOLDEN SHINER	6.7	0.1	5.7	0.18	0.29	0.00	1.4	-	2.10	0.0	0.00	0.07	0.00	-	-	0.00	-	-	-
GOLDEN SHINER	6.6	0.1	4.5	0.40	0.24	0.00	0.0	-	0.00	1.5	0.00	0.05	0.00	-	-	0.00	-	-	-
WHITE PERCH	8.0	0.3	4.9	0.00	0.00	0.00	1.3	-	0.00	2.6	0.00	0.13	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	6.2	0.30	0.26	0.30	1.3	0.0	1.80	0.8	0.07	0.00	0.16	3.40	-	0.00	0.03	0.16	0.00

STATION 4, DELAWARE RIVER AT CAMDEN, NJ/PA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUND TOXA-PHENE	HCB	A-BHC
70	BROWN BULLHEAD	10.6	0.6	13.6	1.28	0.59	0.21	-	-	1.82	-	0.17	0.00	0.00	-	-	-	-	0.10
70	WHITE PERCH	9.8	0.6	10.1	3.65	2.80	0.52	-	-	4.17	-	0.21	0.00	0.00	-	-	-	-	0.05
70	CROSSCHECK	-	-	8.1	3.38	3.75	0.37	-	2.0	7.20	2.6	0.36	0.00	0.00	-	-	0.00	-	-
70	WHITE PERCH	9.7	0.6	10.1	3.84	3.06	0.56	-	-	4.43	-	0.19	0.00	0.00	-	-	-	-	0.05
70	CROSSCHECK	-	-	9.6	6.03	4.37	0.46	-	8.0	6.80	3.9	0.28	0.00	0.01	-	-	0.00	-	-
70	WHITE SUCKER	14.7	1.4	5.8	1.00	1.17	0.45	-	-	3.39	-	0.07	0.00	0.00	-	-	-	-	0.04
71	BROWN BULLHEAD	11.7	0.8	10.4	0.69	0.77	0.16	-	-	1.04	-	0.12	0.01	0.00	-	-	0.00	-	-
71	BROWN BULLHEAD	10.9	0.7	11.1	0.67	0.91	0.13	-	-	0.83	-	0.09	0.01	0.00	-	-	0.00	-	-
71	WHITE PERCH	9.5	0.5	7.4	2.71	1.78	0.29	-	-	2.08	-	0.12	0.01	0.00	-	-	0.00	-	-
71	WHITE PERCH	9.8	0.6	7.7	2.28	1.50	0.37	-	-	3.13	-	0.06	0.01	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	8.4	2.90	1.33	0.33	-	1.9	4.30	2.8	0.16	0.01	0.00	0.00	-	0.00	0.02	-
71	WHITE SUCKER	14.6	1.3	4.8	0.83	0.69	0.20	-	-	1.56	-	0.07	0.01	0.00	-	-	0.00	-	-
71	WHITE SUCKER	13.9	1.2	7.1	0.73	0.56	0.21	-	-	1.56	-	0.06	0.01	0.00	-	-	0.00	-	-
72	BROWN BULLHEAD	11.5	0.9	11.0	0.90	0.90	0.00	-	-	6.00	-	0.16	0.00	0.00	-	-	0.00	-	-
72	WHITE PERCH	11.1	0.5	5.4	2.40	1.20	0.01	-	-	8.00	-	0.10	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	5.4	2.98	1.28	0.28	-	3.0	3.30	2.2	0.17	0.00	0.00	0.17	-	0.00	0.00	-
72	WHITE PERCH	9.9	0.5	6.7	4.00	1.50	0.01	-	-	14.00	-	0.15	0.00	0.00	-	-	0.00	-	-
72	WHITE SUCKER	15.0	1.5	5.5	0.75	0.60	0.04	-	-	7.00	-	0.09	0.00	0.00	-	-	0.00	-	-
73	BROWN BULLHEAD	9.7	0.8	10.5	0.90	1.50	0.00	0.0	-	3.90	0.0	0.10	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	9.0	0.4	5.8	2.30	0.00	0.00	0.0	-	12.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	9.1	0.4	4.9	2.40	1.20	0.00	0.0	-	7.20	0.0	0.24	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	5.1	1.18	0.37	0.12	0.0	1.5	4.50	2.2	0.04	0.00	0.00	0.00	-	0.00	0.04	0.05
73	WHITE SUCKER	14.5	1.3	7.0	0.64	0.54	0.00	0.0	-	5.80	0.0	0.11	0.00	0.00	-	-	0.00	-	-

STATION 5, SUSQUEHANNA RIVER AT CONOWINGO DAM, MD

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUND TOXA-PHENE	HCB	A-BHC
70	CARP	21.6	5.0	7.9	0.52	0.65	0.23	-	-	2.60	-	0.23	0.00	0.00	-	-	-	-	0.06
70	CHANNEL CATFISH	12.1	0.6	7.4	0.24	0.29	0.18	-	-	1.77	-	0.16	0.00	0.00	-	-	-	-	0.06
70	YELLOW PERCH	8.8	0.3	1.4	0.43	0.31	0.25	-	-	2.19	-	0.12	0.00	0.00	-	-	-	-	0.02
70	YELLOW PERCH	7.9	0.2	2.0	0.43	0.39	0.31	-	-	2.60	-	0.13	0.00	0.00	-	-	-	-	0.09
71	CARP	18.0	3.0	5.4	0.23	0.18	0.09	-	-	0.80	-	0.07	0.01	0.00	-	-	0.00	-	-
71	CARP	18.9	3.3	8.5	0.20	0.21	0.07	-	-	0.59	-	0.11	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	15.2	1.1	9.6	0.24	0.20	0.10	-	-	0.92	-	0.09	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	15.4	1.3	9.6	0.34	0.30	0.12	-	-	1.01	-	0.08	0.01	0.00	-	-	0.00	-	-
71	YELLOW PERCH	8.6	0.3	2.7	0.18	0.14	0.11	-	-	0.95	-	0.07	0.01	0.00	-	-	0.00	-	-
71	YELLOW PERCH	8.4	0.3	2.5	0.19	0.14	0.11	-	-	0.95	-	0.06	0.01	0.00	-	-	0.00	-	-
72	CARP	14.8	1.7	1.4	0.18	0.23	0.00	-	-	2.00	-	0.04	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	13.1	0.8	4.5	0.57	0.31	0.07	-	-	4.50	-	0.11	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	7.5	0.2	2.9	0.29	0.05	0.00	-	-	1.90	-	0.12	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	7.5	0.3	2.7	0.22	0.13	0.02	-	-	2.00	-	0.14	0.00	0.00	-	-	0.00	-	-
73	CARP	14.9	1.6	8.8	0.28	0.00	0.00	0.0	-	0.00	0.6	0.00	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	16.1	1.4	9.8	0.00	0.00	0.00	0.4	-	0.00	2.0	0.00	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	7.6	0.2	1.2	0.16	0.00	0.00	0.0	-	0.00	0.7	0.04	0.00	0.00	-	-	0.00	-	-
73	WHITE PERCH	7.5	0.2	4.9	0.10	0.00	0.00	0.0	-	0.00	0.5	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	16.7	2.3	4.9	0.37	0.13	0.00	0.0	-	0.00	1.1	0.07	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	13.2	1.1	13.1	1.50	7.60	0.00	0.0	-	0.00	5.9	3.30	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	15.0	0.18	0.24	0.02	0.0	0.0	0.73	0.7	0.06	0.01	0.02	0.12	0.03	0.00	0.00	0.03
74	CHANNEL CATFISH	13.4	0.8	12.7	0.52	0.51	0.00	0.0	-	0.00	2.8	0.18	0.00	0.00	-	-	0.00	-	-
74	WHITE PERCH	5.8	0.1	7.2	0.54	0.28	0.09	0.0	-	0.00	3.2	0.23	0.00	0.00	-	-	0.00	-	-
74	WHITE PERCH	6.3	0.9	7.2	0.54	0.21	0.08	0.0	-	0.00	3.1	0.20	0.00	0.00	-	-	0.00	-	-

ION 6, POTOMAC RIVER AT LITTLE FALLS, MD/VA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
				DDE	DDD	DDT	1242	1248	1254	1260	DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	TOXA-PHENE	H C B	A-BHC	G-BHC
BLACK CRAPPIE	8.7	0.3	2.5	0.11	0.11	0.08	-	-	0.87	-	0.03	0.00	0.00	-	-	-	-	0.01	-
CARP	13.8	1.3	7.6	0.10	0.13	0.06	-	-	0.68	-	0.05	0.00	0.00	-	-	-	-	0.01	-
CARP	14.1	1.1	7.9	0.11	0.13	0.05	-	-	0.59	-	0.07	0.00	0.00	-	-	-	-	0.01	-
WHITE SUCKER	11.5	0.7	3.8	0.04	0.07	0.04	-	-	0.32	-	0.02	0.00	0.00	-	-	-	-	0.01	-
CARP	17.2	2.6	5.6	0.23	0.14	0.08	-	-	0.87	-	0.02	0.01	0.00	-	-	0.00	-	-	-
CARP	15.7	2.0	6.4	0.18	0.15	0.07	-	-	0.75	-	0.03	0.01	0.00	-	-	0.00	-	-	-
REDHORSE	13.5	1.0	5.9	0.12	0.13	0.09	-	-	0.80	-	0.03	0.01	0.00	-	-	0.00	-	-	-
REDHORSE	14.7	1.2	4.8	0.12	0.11	0.09	-	-	0.96	-	0.02	0.01	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	14.1	1.4	3.6	0.15	0.13	0.12	-	-	1.22	-	0.02	0.01	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	10.2	0.5	1.8	0.10	0.08	0.07	-	-	0.71	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	14.2	1.4	7.1	0.23	0.18	0.00	-	-	1.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
REDHORSE	13.3	2.2	7.6	0.17	0.12	0.04	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
REDHORSE	13.2	1.0	4.2	0.31	0.19	0.18	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	16.2	1.9	4.0	0.16	0.03	0.00	-	-	2.50	-	0.02	0.00	0.00	-	-	0.00	-	-	-
REDBREAST SUNFISH	6.6	0.2	3.4	0.04	0.01	0.00	-	-	0.50	-	0.02	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.4	0.9	10.4	0.13	0.00	0.00	0.0	-	0.60	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	11.2	0.4	2.3	0.13	0.00	0.00	0.0	-	0.00	0.4	0.02	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	7.9	0.2	2.0	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	8.2	0.2	2.4	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
REDHORSE	14.0	1.2	10.0	0.17	0.18	0.00	0.0	-	1.00	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-

TION 55, JAMES RIVER AT RICHMOND, VA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
				DDE	DDD	DDT	1242	1248	1254	1260	DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	TOXA-PHENE	H C B	A-BHC	G-BHC
CHANNEL CATFISH	18.8	2.5	7.9	0.21	0.20	0.16	-	-	0.62	-	0.47	0.00	0.00	-	-	-	-	0.01	-
CROSSCHECK	-	-	8.0	0.16	0.38	0.26	-	1.1	0.70	0.0	0.69	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	17.3	2.5	0.9	0.33	0.11	0.12	-	-	0.97	-	0.10	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	10.0	0.7	2.0	0.13	0.09	0.05	-	-	0.34	-	0.12	0.00	0.00	-	-	-	-	0.01	-
REDHORSE	10.8	0.7	8.7	0.15	0.15	0.10	-	-	0.45	-	0.40	0.00	0.00	-	-	-	-	0.01	-
CHANNEL CATFISH	21.5	3.6	3.2	0.25	0.16	0.14	-	-	0.58	-	0.12	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	17.0	1.4	9.8	0.22	0.12	0.10	-	-	0.30	-	0.21	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.6	0.9	4.7	0.14	0.08	0.07	-	-	0.32	-	0.07	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	8.6	0.3	1.5	0.11	0.06	0.06	-	-	0.35	-	0.06	0.01	0.00	-	-	0.00	-	-	-
REDHORSE	16.5	1.8	11.8	0.33	0.39	0.24	-	-	0.63	-	0.44	0.01	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	12.1	0.54	0.54	0.52	-	0.0	1.40	0.7	0.85	0.02	0.01	0.10	-	0.00	0.01	-	-
REDHORSE	16.0	1.6	10.1	0.15	0.18	0.14	-	-	0.30	-	0.29	0.01	0.00	-	-	0.00	-	-	-
REDHORSE	16.2	1.9	2.7	0.06	0.00	0.00	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	16.2	2.0	3.9	0.04	0.02	0.00	-	-	0.00	-	0.08	0.00	0.00	-	-	0.00	-	-	-
RIVER CHUB	11.5	0.7	4.0	0.09	0.00	0.00	-	-	0.00	-	0.13	0.00	0.00	-	-	0.00	-	-	-
RIVER CHUB	12.5	0.9	4.5	0.29	0.37	0.59	-	-	0.00	-	0.11	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	17.4	1.7	3.4	0.10	0.00	0.00	0.0	-	1.30	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	19.7	2.3	1.8	0.08	0.05	0.03	0.0	-	0.70	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.7	0.9	2.3	0.12	0.04	0.00	0.0	-	1.50	0.0	0.06	0.00	0.00	-	-	0.00	-	-	-
REDHORSE	15.8	1.9	15.9	0.27	0.28	0.00	0.0	-	3.80	0.0	0.24	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.8	2.0	11.0	0.15	0.08	0.08	0.0	-	0.97	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	19.3	3.0	6.1	0.20	0.00	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.8	1.0	3.5	0.11	0.00	0.00	0.0	-	0.67	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
REDHORSE	16.1	2.2	22.1	0.82	0.61	0.65	0.0	-	0.00	4.2	0.39	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	29.0	0.52	0.35	0.33	0.0	0.0	2.06	0.0	0.24	0.03	0.06	0.25	0.00	0.00	0.01	0.13	0.00

STATION 7, ROANOKE RIVER AT ROANOKE RAPIDS, NC

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	BROWN BULLHEAD	9.6	0.3	1.5	0.26	0.13	0.05	-	-	0.19	-	0.03	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	12.0	1.0	2.8	0.62	0.35	0.37	-	-	0.89	-	0.08	0.00	0.00	-	-	-	-	0.01
70	REDHORSE	21.7	3.7	5.8	0.40	0.35	0.19	-	-	0.92	-	0.07	0.00	0.00	-	-	-	-	0.02
70	REDHORSE	20.7	3.2	4.8	0.39	0.34	0.15	-	-	0.60	-	0.07	0.01	0.00	-	-	-	-	0.02
71	BROWN BULLHEAD	9.7	0.3	0.4	0.20	0.05	0.03	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	10.5	0.7	5.0	0.38	0.34	0.46	-	-	0.34	-	0.07	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	9.3	0.5	4.6	0.46	0.38	0.59	-	-	0.40	-	0.07	0.01	0.00	-	-	0.00	-	-
71	REDHORSE	18.7	2.5	6.1	0.34	0.31	0.17	-	-	0.49	-	0.04	0.01	0.00	-	-	0.00	-	-
71	REDHORSE	19.8	2.9	4.4	0.32	0.31	0.21	-	-	0.70	-	0.05	0.01	0.00	-	-	0.00	-	-
72	BLUEGILL	7.2	0.3	4.0	0.60	0.17	0.61	-	-	0.00	-	0.11	0.00	0.00	-	-	0.00	-	-
72	BLUEGILL	6.4	0.2	2.2	0.29	0.09	0.35	-	-	0.00	-	0.06	0.00	0.00	-	-	0.00	-	-
72	CARP	19.4	3.5	5.4	1.20	0.24	0.11	-	-	0.60	-	0.11	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.3	0.9	4.9	0.90	0.37	0.53	-	-	1.40	-	0.22	0.00	0.00	-	-	0.00	-	-
72	WHITE CATFISH	9.3	0.3	1.6	0.34	0.05	0.09	-	-	0.30	-	0.04	0.00	0.00	-	-	0.00	-	-
73	CARP	19.0	3.2	2.7	0.54	0.18	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	17.8	2.4	1.9	0.26	0.10	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	12.9	0.6	2.8	0.52	0.23	0.17	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	9.6	0.4	1.5	0.27	0.13	0.09	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	17.1	2.2	1.5	0.17	0.04	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	16.2	1.9	2.8	0.12	0.02	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	17.3	1.8	5.1	0.53	0.00	0.00	0.0	-	1.10	0.0	0.00	0.00	0.00	-	-	1.80	-	-
74	LARGEMOUTH BASS	12.3	1.0	3.1	0.71	0.00	0.00	0.0	-	0.17	0.0	0.00	0.00	0.00	-	-	1.80	-	-

STATION 8, CAPE FEAR RIVER AT ELIZABETHTOWN, NC

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	BROWN BULLHEAD	8.2	0.3	2.2	0.17	0.20	0.10	-	-	0.68	-	0.03	0.00	0.00	-	-	-	-	0.15
70	BROWN BULLHEAD	8.2	0.3	3.4	0.27	0.30	0.17	-	-	1.38	-	0.04	0.00	0.00	-	-	-	-	0.20
70	GIZZARD SHAD	6.2	0.2	5.4	0.23	0.28	0.12	-	-	1.19	-	0.07	0.00	0.00	-	-	-	-	0.35
70	CROSSCHECK	-	-	6.2	0.15	0.46	0.11	-	0.0	2.60	1.1	0.09	0.00	0.00	-	-	0.00	-	-
70	LARGEMOUTH BASS	13.2	1.3	2.3	0.55	0.55	0.26	-	-	3.33	-	0.07	0.00	0.00	-	-	-	-	0.06
71	BROWN BULLHEAD	9.5	0.3	1.9	0.12	0.12	0.05	-	-	0.19	-	0.01	0.01	0.00	-	-	0.00	-	-
71	BROWN BULLHEAD	9.6	0.3	1.0	0.07	0.07	0.04	-	-	0.20	-	0.01	0.01	0.00	-	-	0.00	-	-
71	GIZZARD SHAD	8.7	0.2	0.3	0.05	0.04	0.02	-	-	0.17	-	0.01	0.01	0.00	-	-	0.00	-	-
71	GIZZARD SHAD	10.0	0.4	0.7	0.17	0.19	0.10	-	-	0.94	-	0.02	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	11.1	3.6	6.4	0.20	0.28	0.15	-	-	0.81	-	0.06	0.01	0.00	-	-	0.00	-	-
72	BROWN BULLHEAD	10.6	0.5	2.3	0.02	0.03	0.01	-	-	0.15	-	0.00	0.00	0.00	-	-	0.00	-	-
72	BROWN BULLHEAD	10.3	0.5	2.3	0.07	0.14	0.04	-	-	0.75	-	0.00	0.00	0.00	-	-	0.00	-	-
72	GIZZARD SHAD	9.6	0.5	1.6	0.07	0.11	0.04	-	-	0.90	-	0.04	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.0	0.8	2.9	0.31	0.45	0.16	-	-	3.90	-	0.11	0.00	0.00	-	-	0.00	-	-
73	GIZZARD SHAD	12.7	1.0	11.9	0.14	0.18	0.00	0.0	-	0.00	0.0	0.00	0.02	0.00	-	-	0.80	-	-
73	LARGEMOUTH BASS	10.3	0.5	3.2	0.16	0.13	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	1.80	-	-
73	WHITE CATFISH	15.6	1.6	3.5	0.45	0.42	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	3.10	-	-
73	YELLOW BULLHEAD	8.4	0.4	1.4	0.08	0.04	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.70	-	-
73	YELLOW BULLHEAD	8.4	0.4	0.1	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	1.90	-	-
74	BROWN BULLHEAD	11.0	0.5	2.1	0.09	0.05	0.00	0.0	-	0.00	0.4	0.02	0.00	0.00	-	-	0.50	-	-
74	GIZZARD SHAD	14.8	1.2	4.1	0.19	0.18	0.00	0.0	-	0.00	1.0	0.07	0.00	0.00	-	-	1.70	-	-
74	GIZZARD SHAD	14.6	1.3	2.4	0.25	0.17	0.00	0.0	-	0.00	1.6	0.06	0.00	0.00	-	-	1.50	-	-
74	LARGEMOUTH BASS	14.1	1.5	3.9	0.57	0.24	0.13	0.0	-	0.00	0.9	0.04	0.00	0.00	-	-	0.00	-	-

ION S6, PEE DEE RIVER AT JOHNSONVILLE, SC

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
LUEGILL	5.2	0.1	3.3	0.14	0.16	0.09	-	-	0.47	-	0.22	0.00	0.00	-	-	-	-	0.05	-
ARGEMOUTH BASS	12.5	1.5	5.4	0.21	0.22	0.17	-	-	0.62	-	0.24	0.00	0.00	-	-	-	-	0.02	-
ROSSCHECK	-	-	6.0	0.28	0.38	0.19	-	0.0	1.20	0.0	0.32	0.01	0.00	-	-	0.00	-	-	-
HITE CATFISH	7.4	0.2	1.9	0.09	0.10	0.07	-	-	0.52	-	0.10	0.00	0.00	-	-	-	-	0.06	-
HITE CATFISH	6.6	0.1	3.2	0.13	0.16	0.07	-	-	0.47	-	0.17	0.00	0.00	-	-	-	-	0.10	-
LUEGILL	5.5	0.2	6.0	0.10	0.13	0.07	-	-	0.06	-	0.12	0.01	0.00	-	-	0.00	-	-	-
HITE CATFISH	14.5	1.6	5.4	0.11	0.12	0.05	-	-	0.06	-	0.07	0.01	0.00	-	-	0.00	-	-	-
HITE CATFISH	14.9	2.0	10.1	0.15	0.15	0.09	-	-	0.22	-	0.15	0.01	0.00	-	-	0.00	-	-	-
OWFIN	18.5	2.5	6.3	0.14	0.11	0.06	-	-	0.08	-	0.17	0.01	0.00	-	-	0.00	-	-	-
OWFIN	17.6	2.1	5.5	0.09	0.07	0.04	-	-	0.08	-	0.08	0.01	0.00	-	-	0.00	-	-	-
LUEGILL	6.8	0.2	3.5	0.13	0.17	0.00	-	-	0.70	-	0.29	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.6	0.2	16.3	0.19	0.14	0.00	-	-	0.80	-	0.19	0.00	0.00	-	-	0.00	-	-	-
ROWN BULLHEAD	12.3	0.7	1.6	0.14	0.08	0.01	-	-	0.30	-	0.06	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	14.3	1.5	3.1	0.44	0.23	0.12	-	-	3.70	-	0.20	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.7	0.2	4.0	0.18	0.06	0.18	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.6	0.2	4.0	0.13	0.10	0.12	0.0	-	0.00	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
ARP	20.9	5.2	10.9	0.48	0.13	0.00	0.0	-	0.00	0.0	0.08	0.00	0.00	-	-	3.30	-	-	-
ARGEMOUTH BASS	13.4	1.6	7.0	0.34	0.18	0.17	0.0	-	0.50	0.0	0.07	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.1	0.3	6.9	0.13	0.09	0.00	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	19.1	3.8	6.5	0.41	0.24	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	5.9	0.33	0.21	0.06	0.0	0.0	0.68	0.0	0.01	0.01	0.01	0.03	0.01	0.57	0.00	0.01	0.01
ARGEMOUTH BASS	9.7	0.6	2.0	0.12	0.06	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARMOUTH	7.7	0.6	1.6	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 9, COOPER RIVER AT LAKE MOULTRIE,MONCKS CORNER, SC

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
LUEGILL	5.6	0.2	0.8	0.21	0.10	0.09	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARP	17.5	3.5	12.6	1.45	0.92	0.14	-	-	1.04	-	0.02	0.02	0.00	-	-	-	-	0.02	-
ARGEMOUTH BASS	11.3	0.6	2.0	1.20	0.53	0.62	-	-	0.52	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARGEMOUTH BASS	12.0	0.7	3.0	0.44	0.28	0.19	-	-	0.79	-	0.02	0.01	0.00	-	-	-	-	0.02	-
LUEGILL	6.5	0.2	0.8	0.13	0.05	0.07	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.2	0.2	1.0	0.16	0.10	0.11	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	23.2	6.8	6.9	0.68	0.42	0.10	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARP	23.5	7.3	0.6	1.42	0.87	0.12	-	-	0.37	-	0.02	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.0	0.6	1.0	0.29	0.23	0.27	-	-	0.17	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.2	0.8	1.4	0.42	0.30	0.31	-	-	0.19	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LUEGILL	6.9	0.2	1.2	0.57	0.12	0.25	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.3	0.2	1.1	0.44	0.09	0.30	-	-	1.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	22.1	5.4	8.9	2.30	1.20	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	13.2	1.2	1.6	1.30	0.52	0.80	-	-	3.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.5	0.1	6.8	0.33	0.06	0.09	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	21.3	3.1	2.4	0.77	0.03	0.00	0.0	-	1.30	0.0	0.00	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	13.7	1.3	3.6	0.40	0.06	0.28	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	13.6	1.3	6.3	0.86	0.30	0.76	0.0	-	3.30	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	9.3	0.5	2.9	0.34	0.12	0.00	0.0	-	0.00	0.2	0.00	0.00	0.00	-	-	5.00	-	-	-
ARGEMOUTH BASS	7.8	0.5	4.4	0.23	0.00	0.00	0.0	-	0.00	0.2	0.06	0.00	0.00	-	-	6.00	-	-	-
EDEAR SUNFISH	7.5	0.5	2.1	0.15	0.03	0.00	0.0	-	0.00	0.1	0.02	0.00	0.00	-	-	1.60	-	-	-

STATION 10, SAVANNAH RIVER AT SAVANNAH, GA/SC

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUND		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	BLUEGILL	8.3	0.5	2.2	0.07	0.06	0.04	-	-	0.25	-	0.17	0.00	0.00	-	-	-	-	0.01
70	CARP	26.0	6.9	2.0	0.47	0.45	0.27	-	-	2.92	-	0.10	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	11.3	1.0	2.3	0.15	0.13	0.10	-	-	0.86	-	0.26	0.00	0.00	-	-	-	-	0.01
70	CROSSCHECK	-	-	2.4	0.05	0.14	0.11	-	0.0	0.90	0.0	0.41	0.00	0.00	-	-	0.00	-	-
70	LARGEMOUTH BASS	9.0	0.5	3.6	0.14	0.08	0.08	-	-	0.55	-	0.23	0.00	0.00	-	-	-	-	0.02
71	BLUEGILL	11.2	1.0	1.4	0.09	0.05	0.05	-	-	0.45	-	0.08	0.01	0.00	-	-	0.00	-	-
71	BLUEGILL	8.8	0.6	2.2	0.08	0.05	0.04	-	-	0.32	-	0.07	0.01	0.00	-	-	0.00	-	-
71	CARP	20.3	4.1	5.1	0.19	0.05	0.01	-	-	0.06	-	0.02	0.00	0.00	-	-	0.00	-	-
71	CARP	20.9	4.4	2.9	0.08	0.06	0.03	-	-	0.18	-	0.03	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	10.9	1.0	3.5	0.06	0.05	0.04	-	-	0.19	-	0.11	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	10.9	0.7	2.4	0.06	0.04	0.03	-	-	0.11	-	0.11	0.01	0.00	-	-	0.00	-	-
72	BLUEGILL	7.1	0.3	4.3	0.08	0.04	0.00	-	-	0.70	-	0.36	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	17.4	2.0	3.3	0.30	0.04	0.01	-	-	2.30	-	0.15	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	13.8	1.4	-	0.24	0.04	0.00	-	-	0.89	-	0.41	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	10.3	0.5	2.2	0.07	0.03	0.00	-	-	0.40	-	0.12	0.00	0.00	-	-	0.00	-	-
73	CARP	23.2	6.4	4.7	1.20	0.31	0.23	0.0	-	3.20	0.0	0.03	0.01	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	11.6	1.0	4.2	0.09	0.05	0.00	0.0	-	0.00	0.5	0.06	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	12.7	1.1	4.2	0.15	0.04	0.08	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	REDBREAST SUNFISH	6.8	0.2	2.8	0.05	0.05	0.10	0.0	-	0.00	0.0	0.03	0.01	0.00	-	-	0.00	-	-
74	BLUEGILL	6.7	0.2	1.9	0.01	0.01	0.02	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-
74	LARGEMOUTH BASS	12.5	1.0	3.6	0.10	0.00	0.00	0.0	-	0.78	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	STRIPED MULLET	13.7	0.9	4.7	0.05	0.04	0.00	0.0	-	0.00	0.1	0.05	0.00	0.00	-	-	0.00	-	-
74	STRIPED MULLET	15.0	1.2	6.6	0.06	0.00	0.00	0.0	-	0.38	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION S7, ALTAMAHA RIVER AT DOCTORTOWN, GA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUND		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	BLUEGILL	8.2	0.4	3.4	0.20	0.16	0.14	-	-	0.89	-	0.23	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	12.2	1.3	3.7	0.35	0.16	0.15	-	-	0.79	-	0.16	0.00	0.00	-	-	-	-	0.01
70	SPOTTED SUCKER	15.2	1.4	7.3	0.40	0.32	0.24	-	-	1.04	-	0.33	0.01	0.00	-	-	-	-	0.07
70	CROSSCHECK	-	-	8.6	0.16	0.32	0.15	-	0.0	0.80	0.0	0.52	0.00	0.00	-	-	0.00	-	-
70	SPOTTED SUCKER	11.2	0.7	1.9	0.15	0.12	0.07	-	-	0.28	-	0.18	0.00	0.00	-	-	-	-	0.02
71	BLUEGILL	7.6	0.4	5.3	0.08	0.08	0.06	-	-	0.17	-	0.04	0.01	0.00	-	-	0.00	-	-
71	BLUEGILL	7.4	0.4	4.4	0.16	0.07	0.05	-	-	0.27	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	13.4	1.3	2.2	0.16	0.13	0.10	-	-	0.30	-	0.06	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	12.2	1.1	4.7	0.21	0.13	0.12	-	-	0.25	-	0.04	0.01	0.00	-	-	0.00	-	-
71	SPOTTED SUCKER	17.2	2.2	9.6	0.15	0.13	0.11	-	-	0.29	-	0.05	0.01	0.00	-	-	0.00	-	-
71	SPOTTED SUCKER	18.2	2.7	11.4	0.19	0.20	0.12	-	-	0.21	-	0.12	0.01	0.00	-	-	0.00	-	-
72	BLUEGILL	5.9	0.2	3.8	0.13	0.05	0.04	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	15.8	2.5	8.6	0.52	0.22	0.00	-	-	1.20	-	0.14	0.00	0.00	-	-	0.00	-	-
72	SPOTTED SUCKER	17.5	2.1	6.9	0.68	0.30	0.36	-	-	1.00	-	0.11	0.00	0.00	-	-	0.00	-	-
72	SPOTTED SUCKER	15.5	1.5	9.9	0.29	0.16	0.12	-	-	0.49	-	0.14	0.00	0.00	-	-	0.00	-	-
73	BLUEGILL	8.4	0.5	6.8	0.47	0.11	0.28	0.0	-	0.00	0.0	0.03	0.01	0.00	-	-	1.40	-	-
73	BLUEGILL	8.2	0.5	9.8	0.29	0.07	0.29	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	1.70	-	-
73	LARGEMOUTH BASS	12.7	1.1	6.4	0.51	0.14	0.28	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	2.30	-	-
73	SPOTTED SUCKER	16.9	2.0	8.4	0.56	0.40	0.28	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	3.00	-	-
74	BLUEGILL	7.8	0.3	4.8	0.08	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BLUEGILL	6.6	0.2	0.8	0.31	0.00	0.00	0.0	-	0.41	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	STRIPED MULLET	13.7	1.1	17.6	0.17	0.00	0.00	0.0	-	0.26	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE CATFISH	8.7	0.3	1.7	8.80	0.00	0.00	0.0	-	18.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	1.4	0.16	0.04	0.00	0.0	0.0	0.29	0.0	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.02

ION 11, ST. JOHNS RIVER AT WELAKA, FL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
HANNEL CATFISH	9.0	0.3	5.0	0.02	0.03	0.02	-	-	0.20	-	0.01	0.00	0.00	-	-	-	-	0.01	-
HANNEL CATFISH	8.0	0.2	3.4	0.02	0.03	0.02	-	-	0.16	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARGEMOUTH BASS	12.5	1.3	7.4	0.07	0.06	0.06	-	-	0.37	-	0.01	0.01	0.00	-	-	-	-	0.01	-
TRIPED MULLET	16.3	1.7	12.9	0.29	0.43	0.39	-	-	3.54	-	0.06	0.00	0.00	-	-	-	-	0.03	-
HANNEL CATFISH	10.7	0.4	7.2	0.01	0.02	0.02	-	-	0.09	-	0.01	0.01	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	11.1	0.4	8.8	0.02	0.03	0.01	-	-	0.06	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	17.1	2.9	8.2	0.04	0.02	0.02	-	-	0.10	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	15.4	2.3	10.3	0.06	0.06	0.05	-	-	0.47	-	0.01	0.01	0.00	-	-	0.00	-	-	-
TRIPED MULLET	21.3	4.1	11.7	0.02	0.03	0.02	-	-	0.11	-	0.01	0.00	0.00	-	-	0.00	-	-	-
TRIPED MULLET	19.1	3.1	10.6	0.05	0.08	0.07	-	-	0.78	-	0.02	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	11.8	0.4	9.5	0.00	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	13.5	1.2	2.8	0.02	0.01	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	10.3	0.5	1.8	0.01	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
TRIPED MULLET	17.1	2.1	8.4	0.01	0.01	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	10.7	0.4	9.6	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	9.2	0.4	1.4	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
TRIPED MULLET	17.6	2.5	10.5	0.00	0.00	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
TRIPED MULLET	16.2	1.7	14.4	0.00	0.00	0.00	0.0	-	0.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-

TION 12, ST. LUCIE CANAL AT INDIANTOWN, FL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BLUEGILL	5.6	0.2	2.2	0.13	0.10	0.04	-	-	0.10	-	0.01	0.01	0.00	-	-	-	-	0.01	-
CHANNEL CATFISH	18.5	2.2	0.2	0.22	0.06	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CHANNEL CATFISH	18.0	2.3	3.3	1.20	0.72	0.36	-	-	0.47	-	0.02	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	11.2	0.9	3.7	0.96	0.47	0.35	-	-	0.62	-	0.03	0.00	0.00	-	-	-	-	0.01	-
BLUEGILL	6.5	0.2	1.8	0.06	0.07	0.09	-	-	0.03	-	0.01	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.4	0.2	2.6	0.12	0.16	0.14	-	-	0.25	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.6	1.8	2.0	0.37	0.45	0.08	-	-	0.14	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	21.8	3.8	1.1	0.19	0.23	0.04	-	-	0.04	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.5	1.2	2.9	0.25	0.22	0.07	-	-	0.09	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.4	1.2	5.3	0.23	0.17	0.06	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	6.1	0.2	1.6	0.05	0.05	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	14.3	1.5	1.7	0.90	0.30	0.15	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE CATFISH	13.5	1.4	7.1	0.13	0.16	0.03	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
WHITE CATFISH	11.6	0.8	7.1	0.26	0.30	0.03	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	8.5	0.4	2.0	0.14	0.07	0.07	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.2	1.6	10.3	0.19	0.20	0.03	0.0	-	0.00	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.6	0.5	4.3	0.18	0.11	0.00	0.0	-	0.00	0.0	0.16	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	13.2	1.0	4.3	0.22	0.34	0.09	0.0	-	0.00	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	8.9	0.4	1.4	2.00	0.03	0.00	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.6	0.9	6.4	0.23	0.12	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.3	1.0	2.6	0.28	0.17	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.70	-	-	-
LARGEMOUTH BASS	10.4	0.5	1.9	0.14	0.05	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.40	-	-	-

STATION 58, SUWANEE RIVER AT OLD TOWN, FL

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUND		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	LARGEMOUTH BASS	9.0	0.4	1.5	0.07	0.06	0.04	-	-	0.31	-	0.01	0.00	0.00	-	-	-	-	0.01
70	SPOTTED SUCKER	15.8	1.7	7.3	0.08	0.09	0.06	-	-	0.52	-	0.01	0.00	0.00	-	-	-	-	0.01
70	REDBREAST SUNFISH	7.0	0.5	6.0	0.09	0.08	0.05	-	-	0.42	-	0.01	0.00	0.00	-	-	-	-	0.01
70	REDBREAST SUNFISH	7.0	0.5	6.2	0.07	0.07	0.04	-	-	0.27	-	0.01	0.00	0.00	-	-	-	-	0.01
71	LARGEMOUTH BASS	13.4	1.6	5.8	0.07	0.07	0.05	-	-	0.26	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	12.1	1.4	5.3	0.12	0.11	0.07	-	-	0.44	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SPOTTED SUCKER	12.5	1.0	7.1	0.05	0.09	0.06	-	-	0.44	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SPOTTED SUCKER	13.8	1.4	7.2	0.05	0.08	0.04	-	-	0.26	-	0.01	0.01	0.00	-	-	0.00	-	-
71	REDBREAST SUNFISH	7.6	0.2	4.3	0.04	0.03	0.03	-	-	0.19	-	0.01	0.01	0.00	-	-	0.00	-	-
71	REDBREAST SUNFISH	7.9	0.3	7.1	0.01	0.04	0.02	-	-	0.10	-	0.01	0.01	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.5	0.7	1.9	0.03	0.00	0.00	-	-	0.50	-	0.00	0.00	0.00	-	-	0.00	-	-
72	SPOTTED SUCKER	16.8	1.8	5.6	0.04	0.00	0.00	-	-	0.60	-	0.00	0.00	0.00	-	-	0.00	-	-
72	SPOTTED SUCKER	14.1	1.2	5.0	0.01	0.00	0.00	-	-	0.30	-	0.00	0.00	0.00	-	-	0.00	-	-
72	REDBREAST SUNFISH	5.9	0.1	2.3	0.02	0.01	0.00	-	-	0.30	-	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	10.7	0.6	4.2	0.06	0.00	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	SPOTTED SUCKER	14.5	1.6	12.2	0.08	0.09	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	SPOTTED SUCKER	14.6	1.6	13.7	0.05	0.06	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	REDBREAST SUNFISH	7.2	0.3	8.7	0.07	0.08	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 13, APALACHICOLA RIVER AT J. WOODRUFF DAM, FL

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUND		
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC
70	CHANNEL CATFISH	11.0	0.7	1.9	0.34	0.24	0.08	-	-	0.67	-	0.03	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	10.8	0.7	3.7	0.31	0.23	0.14	-	-	0.45	-	0.08	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	9.4	0.5	2.0	0.38	0.26	0.14	-	-	0.61	-	0.06	0.00	0.00	-	-	-	-	0.01
70	SPOTTED SUCKER	17.3	2.5	5.6	0.34	0.31	0.21	-	-	0.35	-	0.11	0.00	0.00	-	-	-	-	0.02
71	CHANNEL CATFISH	10.8	0.7	4.3	0.36	0.39	0.14	-	-	0.83	-	0.03	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	9.7	0.5	3.4	0.29	0.25	0.09	-	-	0.42	-	0.02	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	10.0	0.5	2.1	0.02	0.01	0.01	-	-	0.02	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	9.4	0.4	4.6	0.30	0.25	0.13	-	-	0.23	-	0.02	0.01	0.00	-	-	0.00	-	-
71	SPOTTED SUCKER	15.6	2.1	16.8	0.33	0.37	0.19	-	-	0.37	-	0.09	0.01	0.00	-	-	0.00	-	-
72	CARP	22.6	6.9	9.3	2.62	0.91	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	1.00	-	-
72	CARP	25.7	9.0	7.3	1.48	0.59	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	1.38	-	-
72	LARGEMOUTH BASS	14.1	1.4	4.2	1.20	0.00	0.00	-	-	2.50	-	0.01	0.00	0.00	-	-	0.00	-	-
72	SPOTTED SUCKER	19.0	2.9	5.3	0.26	0.22	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.91	-	-
73	CHANNEL CATFISH	11.0	0.4	4.4	0.54	0.25	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	13.5	1.3	5.6	0.78	0.28	0.00	0.0	-	0.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	15.0	1.9	5.3	0.86	0.30	0.00	0.0	-	0.00	0.0	0.04	0.00	0.00	-	-	0.00	-	-
73	SPOTTED SUCKER	19.3	2.7	3.5	0.43	0.18	0.00	0.0	-	0.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BLUEGILL	7.4	0.3	5.2	0.39	0.10	0.00	0.0	-	0.60	0.0	0.00	0.00	0.00	-	-	1.40	-	-
74	CHANNEL CATFISH	15.5	1.3	6.1	0.80	0.24	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	2.20	-	-
74	LARGEMOUTH BASS	12.7	1.4	7.1	0.72	0.13	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	3.50	-	-
74	CROSSCHECK	-	-	7.1	0.30	0.16	0.09	0.0	0.0	0.71	0.5	0.01	0.01	0.01	0.10	0.00	1.41	0.00	0.01
74	LARGEMOUTH BASS	11.0	0.7	3.8	0.58	0.95	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	2.30	-	-

ION 59, ALABAMA RIVER AT CHRYSLER, AL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BLUEGILL	6.6	0.3	1.8	0.63	0.29	0.28	-	-	2.14	-	0.01	0.02	0.00	-	-	-	-	0.02	-
LARGEMOUTH BASS	17.3	2.6	3.3	1.19	0.59	0.66	-	-	3.70	-	0.03	0.02	0.00	-	-	-	-	0.01	-
POSSCHECK	-	-	3.5	0.96	0.62	0.22	-	0.0	4.80	2.1	0.04	0.01	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.0	1.3	4.8	0.53	0.47	0.47	-	-	1.41	-	0.03	0.01	0.00	-	-	-	-	0.12	-
STRIPED MULLET	15.0	1.2	3.8	0.73	0.49	0.34	-	-	1.30	-	0.02	0.01	0.00	-	-	-	-	0.10	-
BLUEGILL	8.0	0.4	6.4	0.33	0.14	0.15	-	-	0.52	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	7.6	0.4	6.6	0.62	0.15	0.16	-	-	0.42	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	17.1	3.2	4.9	1.07	0.46	0.59	-	-	1.56	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	6.1	3.65	0.94	0.20	-	0.0	1.00	1.4	0.00	0.00	0.00	0.00	-	0.00	0.00	-	-
LARGEMOUTH BASS	16.6	2.6	4.5	0.74	0.17	0.25	-	-	1.15	-	0.01	0.01	0.00	-	-	0.00	-	-	-
STRIPED MULLET	16.1	2.0	3.9	0.22	0.18	0.21	-	-	0.68	-	0.01	0.01	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.0	1.7	4.9	0.17	0.18	0.16	-	-	0.42	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	11.8	0.4	3.6	0.13	0.14	0.09	-	-	1.50	-	0.00	0.03	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	9.1	0.2	2.3	0.11	0.10	0.06	-	-	1.00	-	0.00	0.03	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	14.1	1.3	3.0	0.84	0.28	0.19	-	-	4.30	-	0.00	0.04	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	2.9	1.43	0.34	0.39	-	0.0	1.80	1.7	0.03	0.03	0.00	0.00	-	1.00	0.00	-	-
LARGEMOUTH BASS	13.1	1.3	2.9	1.70	0.21	0.28	-	-	8.70	-	0.00	0.00	0.00	-	-	0.00	-	-	-
STRIPED MULLET	12.3	0.7	4.5	1.20	0.29	0.33	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	7.5	0.2	28.6	0.44	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	8.00	-	-	-
BLUEGILL	7.1	0.2	3.5	0.73	0.09	0.20	0.0	-	1.30	0.0	0.04	0.07	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	14.7	1.5	5.5	0.36	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	9.30	-	-	-
STRIPED MULLET	15.9	1.4	3.5	0.19	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	5.60	-	-	-
FRESHWATER DRUM	13.7	1.2	5.7	0.60	0.13	0.00	0.0	-	0.00	0.6	0.00	0.00	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	16.9	2.7	15.5	0.82	0.38	0.43	0.0	-	1.90	0.0	0.00	0.00	0.00	-	-	8.00	-	-	-
CROSSCHECK	-	-	17.8	0.90	0.65	0.35	0.0	0.0	0.00	0.0	0.01	0.01	0.03	0.69	0.00	3.10	0.04	0.21	0.00
SMALLMOUTH BUFFALO	17.8	3.3	10.5	1.30	0.52	0.00	0.0	-	2.70	0.0	0.00	0.00	0.00	-	-	2.90	-	-	-

ION 14, TOMBIGBEE RIVER AT MCINTOSH, AL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CARP	17.0	3.7	6.1	2.13	1.00	0.27	-	-	0.86	-	0.01	0.01	0.00	-	-	-	-	0.12	-
LARGEMOUTH BASS	13.0	1.2	1.3	3.26	1.12	0.77	-	-	1.30	-	0.01	0.01	0.00	-	-	-	-	0.08	-
CROSSCHECK	-	-	2.5	3.64	1.78	0.38	-	0.0	1.50	0.4	0.03	0.00	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.8	1.6	4.4	2.34	0.97	0.73	-	-	1.25	-	0.02	0.01	0.00	-	-	-	-	0.21	-
STRIPED MULLET	15.8	1.6	5.8	1.00	0.59	0.57	-	-	1.07	-	0.02	0.02	0.00	-	-	-	-	0.16	-
CARP	19.7	3.9	3.5	0.43	0.26	0.04	-	-	0.17	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	19.6	3.8	7.0	2.92	1.30	0.09	-	-	0.52	-	0.02	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	15.7	2.0	4.8	4.13	0.80	0.55	-	-	1.04	-	0.03	0.01	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	5.4	3.11	0.85	0.72	-	0.0	10.00	0.8	0.18	0.03	0.00	0.00	-	0.50	0.04	-	-
LARGEMOUTH BASS	14.7	1.6	6.6	1.21	0.68	0.43	-	-	0.83	-	0.02	0.01	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.8	1.9	7.0	0.94	0.46	0.21	-	-	0.37	-	0.02	0.01	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.6	1.8	6.4	3.26	0.82	0.32	-	-	0.37	-	0.02	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.7	0.7	9.2	2.20	0.70	0.24	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	12.7	0.5	6.9	0.90	0.41	0.17	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.6	0.7	7.1	15.00	5.00	1.80	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	8.4	14.10	4.60	1.43	-	0.0	2.70	3.3	0.09	0.00	0.00	0.00	-	0.50	0.22	-	-
STRIPED MULLET	15.6	1.4	3.7	0.26	0.15	0.10	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	21.0	4.6	5.5	32.00	5.00	11.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.6	1.0	3.0	2.80	0.53	0.00	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	3.3	11.56	0.19	0.27	0.0	0.0	1.00	0.5	0.00	0.00	0.00	0.00	-	0.50	4.20	0.02	0.00
LARGEMOUTH BASS	12.0	0.7	3.0	6.80	1.60	1.20	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
STRIPED MULLET	15.5	1.6	5.4	1.30	0.46	0.33	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	20.5	5.3	19.8	0.47	0.00	0.00	0.0	-	0.23	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	22.8	0.78	0.23	0.18	0.0	0.0	0.19	0.2	0.01	0.02	0.02	0.08	0.00	2.78	0.03	0.06	0.01
SMALLMOUTH BUFFALO	17.7	3.2	11.4	0.49	0.31	0.33	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 60, BRAZOS RIVER AT RICHMOND, TX

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC	G BHC
70	CHANNEL CATFISH	20.9	3.4	6.9	1.12	0.40	0.27	-	-	1.25	-	0.09	0.00	0.00	-	-	-	-	0.02	
70	CHANNEL CATFISH	17.1	1.8	8.5	1.45	0.49	0.24	-	-	1.09	-	0.08	0.01	0.00	-	-	-	-	0.02	
70	LONGNOSE GAR	25.1	1.5	0.9	1.67	0.31	0.23	-	-	1.56	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	SMALLMOUTH BUFFALO	17.2	3.2	6.0	1.03	0.56	0.39	-	-	2.34	-	0.10	0.00	0.00	-	-	-	-	0.03	
71	LONGNOSE GAR	25.1	1.6	5.2	2.38	0.42	0.37	-	-	0.94	-	0.09	0.01	0.00	-	-	0.01	-	-	
71	SMALLMOUTH BUFFALO	21.4	7.0	12.2	0.63	0.39	0.25	-	-	0.57	-	0.10	0.01	0.00	-	-	0.01	-	-	
71	SMALLMOUTH BUFFALO	19.1	4.0	7.9	0.45	0.45	0.30	-	-	1.98	-	0.07	0.01	0.00	-	-	0.01	-	-	
71	SPOTTED GAR	22.4	2.1	4.8	2.51	0.55	0.31	-	-	1.09	-	0.63	0.01	0.00	-	-	0.01	-	-	
71	MIXED SPECIES	10.9	0.4	0.7	0.70	0.13	0.13	-	-	0.73	-	0.01	0.01	0.00	-	-	0.01	-	-	
71	BLUE CATFISH	14.3	1.6	6.0	1.17	0.30	0.32	-	-	0.57	-	0.02	0.01	0.00	-	-	0.01	-	-	
72	CHANNEL CATFISH	12.4	0.6	2.5	0.42	0.05	0.05	-	-	0.05	-	0.04	0.00	0.00	-	-	0.00	-	-	
72	LONGNOSE GAR	25.4	0.9	3.9	6.50	0.01	0.46	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	
72	CROSSCHECK	-	-	5.0	5.20	0.32	0.27	-	0.0	2.00	0.8	0.07	0.02	0.00	0.00	-	4.00	0.00	-	
72	RIVER CARPSUCKER	10.4	0.6	7.7	0.40	0.00	0.01	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	
72	BLUE CATFISH	13.9	1.1	4.9	0.14	0.18	0.18	-	-	0.08	-	0.11	0.00	0.00	-	-	0.00	-	-	
73	LONGNOSE GAR	23.8	0.9	1.5	2.10	0.06	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	LONGNOSE GAR	22.2	0.8	1.5	2.00	0.15	0.00	0.0	-	0.00	0.7	0.00	0.00	0.00	-	-	0.00	-	-	
73	RIVER CARPSUCKER	10.0	0.4	0.4	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	BLUE CATFISH	16.1	1.4	9.2	1.70	0.08	0.00	0.0	-	0.00	0.5	0.07	0.00	0.00	-	-	0.00	-	-	
73	CROSSCHECK	-	-	9.7	2.17	0.15	0.08	0.0	0.2	0.20	0.2	0.02	0.02	0.02	0.04	-	5.00	0.00	0.02	

STATION 61, COLORADO RIVER AT WHARTON, TX

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC	G BHC
70	CHANNEL CATFISH	13.7	1.2	6.7	0.25	0.13	0.09	-	-	0.32	-	0.02	0.00	0.00	-	-	-	-	0.01	
70	RIVER CARPSUCKER	13.3	1.5	5.7	0.20	0.12	0.11	-	-	0.31	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	RIVER CARPSUCKER	12.6	1.5	5.4	0.18	0.20	0.13	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	SPOTTED BASS	8.4	0.5	3.9	0.42	0.15	0.11	-	-	0.65	-	0.02	0.00	0.00	-	-	-	-	0.01	
71	CHANNEL CATFISH	15.5	1.0	3.6	0.23	0.22	0.12	-	-	0.38	-	0.01	0.00	0.00	-	-	0.01	-	-	
71	FLATHEAD CATFISH	22.5	4.7	4.2	0.52	0.16	0.23	-	-	0.83	-	0.01	0.00	0.00	-	-	0.01	-	-	
71	LONGNOSE GAR	26.1	1.7	2.7	0.78	0.42	0.21	-	-	1.12	-	0.01	0.01	0.00	-	-	0.01	-	-	
71	LONGNOSE GAR	24.2	1.6	5.3	1.22	0.26	0.16	-	-	0.54	-	0.01	0.00	0.00	-	-	0.01	-	-	
71	RIVER CARPSUCKER	11.8	1.1	1.0	0.21	0.08	0.09	-	-	0.31	-	0.01	0.00	0.00	-	-	0.01	-	-	
71	RIVER CARPSUCKER	14.3	1.4	4.3	0.40	0.34	0.26	-	-	0.62	-	0.03	0.00	0.00	-	-	0.01	-	-	
72	CHANNEL CATFISH	16.7	1.5	3.9	0.44	0.08	0.00	-	-	1.10	-	0.08	0.00	0.00	-	-	0.00	-	-	
72	RIVER CARPSUCKER	13.2	1.0	3.9	0.89	0.00	0.00	-	-	0.00	-	0.03	0.00	0.00	-	-	9.60	-	-	
72	RIVER CARPSUCKER	13.2	1.2	4.4	0.22	0.01	0.00	-	-	0.00	-	0.23	0.00	0.00	-	-	2.70	-	-	
72	SPOTTED GAR	20.5	1.3	3.9	0.41	0.69	0.00	-	-	1.30	-	0.15	0.00	0.00	-	-	0.00	-	-	
73	CARP	20.1	4.1	2.4	0.15	0.03	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	CHANNEL CATFISH	12.1	0.6	2.6	0.25	0.08	0.00	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-	
73	CHANNEL CATFISH	13.0	0.7	2.0	0.12	0.06	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	RIVER CARPSUCKER	15.8	1.6	3.3	1.70	1.60	0.50	0.0	-	2.70	0.0	0.03	0.00	0.00	-	-	0.00	-	-	
73	SPOTTED BASS	12.0	1.0	1.4	0.20	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

STATION 113, SAN ANTONIO RIVER AT MCFADDIN, TX

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
					DDE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC	G BHC
74	CARP	18.3	2.7	3.5	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CHANNEL CATFISH	16.8	1.3	5.3	0.23	0.05	0.00	0.0	-	0.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CROSSCHECK	-	-	5.2	0.18	0.11	0.00	0.0	0.0	0.33	0.3	0.04	0.02	0.02	0.11	0.04	0.00	0.00	0.03	0
74	SMALLMOUTH BASS	15.7	2.5	7.4	0.05	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	SMALLMOUTH BASS	17.1	3.5	8.5	0.07	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

ION 62, NUECES RIVER AT MATHIS, TX

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CHANNEL CATFISH	12.9	0.7	3.3	0.28	0.01	0.01	-	-	0.03	-	0.01	0.00	0.00	-	-	-	-	0.01	-
GIZZARD SHAD	11.4	0.5	3.1	0.17	0.02	0.01	-	-	0.05	-	0.01	0.00	0.00	-	-	-	-	0.03	-
GIZZARD SHAD	10.0	0.4	3.0	0.21	0.02	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	10.9	0.9	1.9	0.29	0.01	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	-	-	0.01	-
BLACK CRAPPIE	7.0	0.3	2.3	0.06	0.02	0.02	-	-	0.06	-	0.01	0.00	0.00	-	-	0.01	-	-	-
GIZZARD SHAD	9.7	0.4	1.3	0.09	0.01	0.02	-	-	0.06	-	0.01	0.00	0.00	-	-	0.01	-	-	-
GIZZARD SHAD	7.3	0.2	1.0	0.04	0.01	0.01	-	-	0.05	-	0.01	0.00	0.00	-	-	0.01	-	-	-
WHITE CRAPPIE	8.7	0.3	1.4	0.14	0.02	0.03	-	-	0.06	-	0.01	0.01	0.00	-	-	0.01	-	-	-
BLUE CATFISH	12.8	0.6	2.5	0.15	0.03	0.03	-	-	0.08	-	0.01	0.00	0.00	-	-	0.01	-	-	-
BLUE CATFISH	11.3	0.4	4.3	0.10	0.02	0.02	-	-	0.06	-	0.01	0.01	0.00	-	-	0.01	-	-	-
CHANNEL CATFISH	10.4	0.3	3.6	0.54	0.03	0.02	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	12.1	0.7	5.0	0.21	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	11.6	0.6	4.8	0.11	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUE CATFISH	12.8	0.8	4.2	0.18	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	10.5	0.4	1.9	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	13.1	1.3	3.7	0.26	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BUFFALO	15.7	2.4	10.3	0.21	0.03	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BUFFALO	14.1	2.0	10.8	0.19	0.01	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	9.4	0.5	2.7	0.09	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUE CATFISH	-	3.4	0.2	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.6	1.5	4.0	0.27	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.7	0.8	2.1	0.18	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BUFFALO	17.6	3.9	19.0	0.35	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 16, RIO GRANDE AT MISSION, TX

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CHANNEL CATFISH	16.8	1.5	8.6	7.27	0.26	0.27	-	-	0.40	-	0.01	0.01	0.00	-	-	-	-	0.11	-
PROSSCHECK	-	-	7.4	7.75	0.41	0.35	-	0.3	0.30	0.0	0.05	0.07	0.16	-	-	0.00	-	-	-
GIZZARD SHAD	10.7	0.4	3.0	4.17	0.26	0.29	-	-	0.36	-	0.02	0.02	0.00	-	-	-	-	0.02	-
GIZZARD SHAD	12.1	0.7	5.5	3.50	0.28	0.34	-	-	0.36	-	0.02	0.04	0.00	-	-	-	-	0.02	-
BLUE CATFISH	16.2	1.3	1.1	3.98	0.09	0.08	-	-	0.17	-	0.02	0.02	0.00	-	-	-	-	0.01	-
CHANNEL CATFISH	13.4	1.1	8.3	4.17	0.18	0.15	-	-	0.15	-	0.04	0.01	0.00	-	-	0.01	-	-	-
CHANNEL CATFISH	11.9	0.6	7.2	2.51	0.13	0.10	-	-	0.13	-	0.04	0.01	0.00	-	-	0.01	-	-	-
GIZZARD SHAD	9.6	0.3	1.8	1.50	0.10	0.15	-	-	0.13	-	0.01	0.00	0.00	-	-	0.01	-	-	-
GIZZARD SHAD	10.6	0.4	6.0	8.27	0.25	0.34	-	-	0.33	-	0.06	0.01	0.00	-	-	0.01	-	-	-
CROSSCHECK	-	-	4.1	10.50	0.45	0.05	-	0.0	0.60	0.0	0.11	0.05	0.00	0.00	-	2.90	0.01	-	-
BLUE CATFISH	13.5	1.4	13.7	3.75	0.24	0.14	-	-	0.15	-	0.08	0.02	0.00	-	-	0.01	-	-	-
BLUE CATFISH	13.0	1.1	9.7	6.18	0.29	0.25	-	-	0.21	-	0.10	0.04	0.00	-	-	0.01	-	-	-
CHANNEL CATFISH	15.2	1.1	6.3	7.20	0.16	0.34	-	-	0.00	-	0.00	0.01	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	8.0	0.2	1.4	1.50	0.04	0.10	-	-	0.00	-	0.00	0.04	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	1.6	0.94	0.06	0.09	-	0.0	0.10	0.0	0.01	0.02	0.00	0.00	-	0.50	0.00	-	-
GIZZARD SHAD	6.9	0.1	2.3	0.75	0.04	0.07	-	-	0.00	-	0.00	0.01	0.00	-	-	0.00	-	-	-
BLUE CATFISH	14.3	1.2	5.0	4.40	0.17	0.12	-	-	0.00	-	0.05	0.06	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.4	0.7	3.5	2.70	0.12	0.12	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	3.9	2.53	0.08	0.03	0.0	0.0	0.40	0.2	0.01	0.02	0.00	0.03	-	0.50	0.00	0.00	0.00
CHANNEL CATFISH	12.1	0.4	2.5	3.10	0.11	0.25	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	12.0	0.5	3.1	1.90	0.00	0.00	0.0	-	9.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	10.0	0.3	0.1	0.49	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	9.5	0.3	2.7	0.21	0.22	0.00	0.0	-	0.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GIZZARD SHAD	10.3	0.4	3.5	12.00	0.58	0.94	0.0	-	0.00	0.0	0.08	0.00	0.00	-	-	0.00	-	-	-
BLUE CATFISH	9.9	0.3	3.2	0.73	0.03	0.03	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUE CATFISH	9.5	0.2	3.0	1.30	0.05	0.04	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 65, PECOS RIVER AT RED BLUFF LAKE, TX

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	CHANNEL CATFISH	15.8	1.4	8.2	0.08	0.14	0.09	-	-	1.07	-	0.03	0.01	0.00	-	-	-	-	0.01	
70	GIZZARD SHAD	12.3	0.8	7.2	0.29	0.11	0.03	-	-	0.07	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	GIZZARD SHAD	12.4	0.8	6.4	0.29	0.11	0.02	-	-	0.07	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	LARGEMOUTH BASS	10.6	0.7	1.6	0.13	0.03	0.02	-	-	0.06	-	0.01	0.01	0.00	-	-	-	-	0.01	
71	CHANNEL CATFISH	15.8	1.3	1.4	0.35	0.06	0.03	-	-	0.20	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	CHANNEL CATFISH	17.3	1.8	2.8	0.49	0.08	0.03	-	-	0.18	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	GIZZARD SHAD	7.4	0.2	2.4	0.06	0.03	0.02	-	-	0.07	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	GIZZARD SHAD	9.2	0.3	9.1	0.14	0.06	0.03	-	-	0.14	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	SMALLMOUTH BUFFALO	14.7	1.2	4.5	0.32	0.09	0.03	-	-	0.14	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	SMALLMOUTH BUFFALO	14.8	1.5	0.5	0.26	0.04	0.02	-	-	0.12	-	0.01	0.01	0.00	-	-	0.00	-	-	
72	CHANNEL CATFISH	14.4	0.9	2.4	0.87	0.08	0.00	-	-	0.60	-	0.02	0.00	0.00	-	-	0.00	-	-	
72	GIZZARD SHAD	10.4	0.4	0.7	0.04	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	
72	SMALLMOUTH BUFFALO	13.6	1.1	0.8	0.49	0.05	0.05	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	
72	SMALLMOUTH BUFFALO	13.7	1.1	0.9	0.26	0.01	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	
73	CHANNEL CATFISH	13.5	0.8	0.9	0.24	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	GIZZARD SHAD	8.2	0.1	2.2	0.14	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	GIZZARD SHAD	9.3	0.3	2.5	0.24	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	SMALLMOUTH BUFFALO	14.4	1.4	5.9	0.23	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CHANNEL CATFISH	11.8	0.5	1.8	0.18	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	GIZZARD SHAD	9.7	0.4	6.2	0.92	0.09	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	GIZZARD SHAD	10.0	0.4	4.2	0.32	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	WHITE BASS	14.7	1.4	5.5	0.47	0.06	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

STATION 63, RIO GRANDE AT ELEPHANT BUTTE, NM

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	BLUEGILL	4.6	0.1	0.8	0.10	0.04	0.05	-	-	0.38	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	BLUEGILL	4.7	0.1	2.4	0.05	0.04	0.04	-	-	0.30	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	CHANNEL CATFISH	23.9	5.9	12.5	0.11	0.10	0.05	-	-	0.35	-	0.01	0.00	0.00	-	-	-	-	0.02	
70	LARGEMOUTH BASS	18.6	4.5	8.1	0.23	0.14	0.09	-	-	0.65	-	0.01	0.00	0.00	-	-	-	-	0.02	
71	CHANNEL CATFISH	13.2	1.3	4.1	0.14	0.08	0.06	-	-	0.52	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	LARGEMOUTH BASS	16.9	2.8	5.2	0.17	0.11	0.05	-	-	0.40	-	0.02	0.01	0.00	-	-	0.00	-	-	
71	LARGEMOUTH BASS	16.6	2.7	4.0	0.14	0.08	0.05	-	-	0.49	-	0.01	0.01	0.00	-	-	0.00	-	-	
71	WHITE BASS	15.8	2.0	9.2	0.17	0.10	0.06	-	-	0.49	-	0.03	0.01	0.00	-	-	0.00	-	-	
71	WHITE BASS	16.2	2.0	9.3	0.17	0.12	0.07	-	-	0.47	-	0.03	0.01	0.00	-	-	0.00	-	-	
71	LONGEAR SUNFISH	4.9	0.1	3.9	0.12	0.06	0.04	-	-	0.38	-	0.01	0.00	0.00	-	-	0.00	-	-	
72	CARP	12.3	1.0	3.3	0.11	0.04	0.00	-	-	0.92	-	0.00	0.00	0.00	-	-	0.00	-	-	
72	CHANNEL CATFISH	10.2	0.6	5.4	0.17	0.14	0.03	-	-	1.29	-	0.00	0.00	0.00	-	-	0.00	-	-	
72	CHANNEL CATFISH	8.9	0.3	4.4	0.09	0.07	0.00	-	-	1.79	-	0.00	0.00	0.01	-	-	0.00	-	-	
72	LARGEMOUTH BASS	15.0	2.0	3.7	0.09	0.04	0.01	-	-	1.47	-	0.01	0.00	0.00	-	-	0.00	-	-	
73	CARP	14.3	1.2	3.8	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	CHANNEL CATFISH	11.9	0.4	2.8	0.08	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	CHANNEL CATFISH	12.8	0.6	3.1	0.08	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	LARGEMOUTH BASS	12.5	1.3	5.8	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	BLUEGILL	6.1	0.2	2.4	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CARP	12.5	0.9	5.3	0.10	0.00	0.00	0.0	-	0.83	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CARP	10.8	0.6	3.9	0.08	0.00	0.00	0.0	-	0.34	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CHANNEL CATFISH	10.4	0.4	3.8	0.09	0.00	0.00	0.0	-	0.57	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

STATION 64, RIO GRANDE AT ALAMOSA, CO

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	BROWN TROUT	10.8	0.5	1.9	0.18	0.19	0.11	-	-	0.92	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	CARP	17.2	2.4	1.8	0.23	0.13	0.04	-	-	0.26	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	WHITE SUCKER	12.7	0.9	3.5	0.13	0.20	0.21	-	-	1.36	-	0.01	0.00	0.00	-	-	-	-	0.02	
70	WHITE SUCKER	13.4	1.0	5.3	0.52	0.74	0.59	-	-	5.31	-	0.01	0.00	0.00	-	-	-	-	0.03	
71	BROWN TROUT	13.6	0.9	3.9	0.08	0.06	0.04	-	-	0.15	-	0.01	0.00	0.00	-	-	0.01	-	-	
71	BROWN TROUT	12.7	0.6	1.4	0.09	0.06	0.04	-	-	0.31	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	CARP	10.1	0.5	1.9	0.11	0.05	0.03	-	-	0.07	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	CARP	10.4	0.5	2.6	0.11	0.05	0.03	-	-	0.05	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	WHITE SUCKER	8.0	0.2	1.6	0.05	0.04	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	WHITE SUCKER	10.7	0.5	1.1	0.06	0.04	0.03	-	-	0.12	-	0.02	0.01	0.00	-	-	0.01	-	-	
72	BROWN TROUT	13.3	0.9	4.1	0.13	0.00	0.00	-	-	0.00	-	0.10	0.00	0.00	-	-	0.00	-	-	
72	CARP	15.4	2.1	1.7	0.24	0.07	0.00	-	-	0.00	-	0.28	0.00	0.00	-	-	0.00	-	-	
72	WHITE SUCKER	11.3	0.6	2.6	0.12	0.06	0.04	-	-	0.00	-	0.52	0.00	0.00	-	-	0.00	-	-	
72	WHITE SUCKER	15.1	1.3	1.8	0.23	0.07	0.14	-	-	0.00	-	0.47	0.00	0.00	-	-	0.00	-	-	
73	BROWN TROUT	13.0	1.0	2.8	0.19	0.00	0.00	0.0	-	2.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	WHITE SUCKER	12.9	0.9	2.5	0.07	0.00	0.00	0.0	-	0.73	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	WHITE SUCKER	12.3	0.7	1.0	0.15	0.00	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

TION 52, LAKE CHAMPLAIN AT BURLINGTON, VT

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CHAIN PICKEREL	16.2	1.1	2.9	0.65	0.21	0.29	-	-	1.22	-	0.01	0.00	0.00	-	-	-	-	0.02	-
PUMPKINSEED	6.5	0.3	3.5	0.09	0.08	0.10	-	-	0.32	-	0.01	0.00	0.00	-	-	-	-	0.01	-
YELLOW PERCH	8.6	0.3	3.2	0.20	0.14	0.16	-	-	0.57	-	0.01	0.00	0.00	-	-	-	-	0.04	-
YELLOW PERCH	9.4	0.5	4.4	0.35	0.20	0.28	-	-	0.99	-	0.01	0.00	0.00	-	-	-	-	0.02	-
CHAIN PICKEREL	16.2	1.0	2.7	0.48	0.25	0.58	-	-	1.35	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	13.8	0.7	1.3	0.14	0.07	0.09	-	-	0.36	-	0.01	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	7.3	0.4	3.7	0.02	0.08	0.07	-	-	0.29	-	0.01	0.01	0.00	-	-	0.00	-	-	-
PUMPKINSEED	6.9	0.3	2.9	0.09	0.09	0.06	-	-	0.45	-	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.9	0.3	2.5	0.24	0.18	0.24	-	-	1.08	-	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	10.0	0.4	3.2	0.14	0.08	0.07	-	-	0.40	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	17.1	1.1	1.6	0.24	0.16	0.21	-	-	0.66	-	0.01	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	7.8	0.5	3.4	0.15	0.06	0.02	-	-	0.60	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	11.0	0.7	3.6	1.00	0.15	0.24	-	-	1.20	-	0.03	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	11.9	1.5	2.5	0.42	0.00	0.11	0.0	-	1.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	7.6	0.4	2.6	0.09	0.01	0.00	0.0	-	0.28	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.5	0.4	2.1	0.48	0.12	0.21	0.0	-	1.80	0.0	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.7	0.3	1.5	0.19	0.06	0.08	0.0	-	0.62	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
CHAIN PICKEREL	16.3	1.0	2.7	0.18	0.00	0.00	0.0	-	0.94	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
PUMPKINSEED	6.9	0.3	3.7	0.08	0.04	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	10.1	0.4	3.3	0.33	0.08	0.07	0.0	-	1.20	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.6	0.4	3.3	0.45	0.00	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 66, ST. LAWRENCE RIVER AT MASSENA, NY

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
NORTHERN PIKE	20.6	2.1	2.4	0.14	0.30	0.36	-	-	5.94	-	0.02	0.00	0.00	-	-	-	-	0.09	-
WHITE SUCKER	17.2	1.5	2.8	0.22	0.17	0.13	-	-	1.22	-	0.01	0.00	0.00	-	-	-	-	0.04	-
YELLOW PERCH	7.0	0.2	2.6	0.24	0.18	0.16	-	-	1.45	-	0.01	0.00	0.00	-	-	-	-	0.03	-
YELLOW PERCH	8.3	0.3	2.6	0.23	0.16	0.14	-	-	1.45	-	0.01	0.00	0.00	-	-	-	-	0.02	-
SMALLMOUTH BASS	12.2	0.9	1.9	0.56	0.47	0.35	-	-	3.39	-	0.02	0.01	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	12.1	0.9	5.2	0.95	0.70	0.59	-	-	6.09	-	0.02	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	13.9	1.1	2.5	0.10	0.11	0.06	-	-	1.43	-	0.01	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	14.1	1.2	3.4	0.10	0.11	0.06	-	-	1.85	-	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.2	0.3	2.4	0.48	0.57	0.24	-	-	2.60	-	0.01	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.4	0.2	2.3	0.13	0.12	0.08	-	-	1.64	-	0.01	0.01	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	24.7	3.5	2.4	0.00	0.18	0.11	-	-	19.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	3.2	1.40	0.14	0.24	-	0.0	3.80	2.1	0.03	0.00	0.00	0.00	-	0.00	0.01	-	-
NORTHERN PIKE	19.6	1.8	1.9	0.11	0.05	0.00	-	-	2.60	-	0.01	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	13.6	1.2	2.9	0.16	0.03	0.00	-	-	1.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.8	0.3	1.9	0.44	0.05	0.02	-	-	3.70	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.7	0.3	1.7	0.63	0.02	0.00	-	-	2.60	-	0.02	0.00	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	21.4	2.3	1.2	0.28	0.00	0.00	0.0	-	2.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	14.8	1.4	1.3	0.10	0.00	0.00	0.0	-	0.48	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.0	0.2	1.9	0.12	0.00	0.00	0.0	-	1.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.2	0.2	1.2	0.20	0.00	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	20.7	2.1	1.9	0.59	0.09	0.08	0.0	-	3.60	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	1.6	0.47	0.12	0.00	0.0	0.0	3.62	1.3	0.02	0.01	0.01	0.04	0.00	0.00	0.00	0.01	0.01
WHITE SUCKER	12.3	0.8	2.3	0.08	0.03	0.00	0.0	-	0.70	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.4	0.2	1.7	0.13	0.03	0.01	0.0	-	1.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.4	0.3	2.0	0.18	0.03	0.01	0.0	-	1.10	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-

TION 110, LAKE ONTARIO AT ROOSEVELT BEACH, NY

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BROWN BULLHEAD	11.4	0.7	6.1	0.37	0.00	0.00	0.0	-	3.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ROCK BASS	8.4	0.5	2.3	0.00	0.03	0.03	0.0	-	1.70	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.1	0.4	4.3	0.00	0.00	0.00	0.0	-	0.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.5	0.3	3.6	0.10	0.04	0.03	0.0	-	1.30	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	3.4	0.12	0.04	0.02	0.0	0.0	1.05	0.3	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.01	0.00

STATION 18, LAKE ONTARIO AT FORT ONTARIO, NY

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	ALPHA-BHC	GAMMA-BHC
70	CARP	14.8	1.6	5.8	1.22	0.29	0.11	-	-	1.01	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	ROCK BASS	6.5	0.2	1.1	0.27	0.37	0.31	-	-	2.60	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	WHITE PERCH	8.3	0.4	10.4	0.62	0.76	0.58	-	-	4.69	-	0.07	0.00	0.00	-	-	-	-	0.25	
70	CROSSCHECK	-	-	11.2	0.28	0.40	0.61	-	0.0	4.60	1.2	0.10	0.00	0.00	-	-	0.00	-	-	
70	YELLOW PERCH	8.5	0.4	6.1	0.24	0.32	0.26	-	-	2.24	-	0.03	0.00	0.00	-	-	-	-	0.08	
70	YELLOW PERCH	8.4	0.4	7.8	0.41	0.54	0.37	-	-	2.71	-	0.06	0.00	0.00	-	-	-	-	0.20	
71	ROCK BASS	8.3	0.5	4.5	0.50	0.47	0.31	-	-	4.17	-	0.02	0.01	0.27	-	-	0.00	-	-	
71	ROCK BASS	8.4	0.6	5.1	0.64	0.52	0.33	-	-	4.43	-	0.02	0.01	0.31	-	-	0.00	-	-	
71	WHITE PERCH	10.0	0.6	11.3	1.43	1.13	0.73	-	-	8.33	-	0.06	0.01	0.88	-	-	0.00	-	-	
71	WHITE PERCH	9.6	0.6	3.9	1.90	1.48	1.03	-	-	11.20	-	0.06	0.01	1.00	-	-	0.00	-	-	
71	CROSSCHECK	-	-	9.8	2.96	0.72	1.54	-	17.0	6.00	5.2	0.10	0.02	0.00	0.00	-	0.00	0.34	-	
71	YELLOW PERCH	11.4	0.8	9.0	1.17	1.03	0.70	-	-	8.20	-	0.10	0.01	0.78	-	-	0.00	-	-	
71	YELLOW PERCH	11.3	0.8	7.8	0.89	0.78	0.55	-	-	6.51	-	0.08	0.01	0.68	-	-	0.00	-	-	
72	ROCK BASS	7.7	0.4	3.9	0.36	0.17	0.03	-	-	5.90	-	0.06	0.00	0.00	-	-	0.00	-	-	
72	WHITE PERCH	8.2	0.4	11.8	0.93	0.14	0.17	-	-	5.60	-	0.07	0.00	0.00	-	-	0.00	-	-	
72	CROSSCHECK	-	-	13.2	1.01	0.15	0.34	-	4.8	3.70	1.3	0.09	0.00	0.00	0.00	-	0.00	0.09	-	
72	YELLOW PERCH	9.1	0.4	6.0	0.55	0.10	0.12	-	-	3.70	-	0.01	0.00	0.00	-	-	0.00	-	-	
72	YELLOW PERCH	9.2	0.4	5.8	0.68	0.15	0.22	-	-	8.70	-	0.06	0.00	0.00	-	-	0.00	-	-	
73	ROCK BASS	8.3	0.5	4.3	0.29	0.02	0.00	0.0	-	2.60	0.0	0.03	0.00	0.00	-	-	0.00	-	-	
73	WHITE PERCH	9.0	0.5	10.2	0.13	0.06	0.00	0.0	-	3.50	0.0	0.06	0.00	0.00	-	-	0.00	-	-	
73	YELLOW PERCH	9.9	0.5	4.2	0.28	0.02	0.00	0.0	-	7.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	YELLOW PERCH	9.6	0.5	3.7	0.37	0.05	0.04	0.0	-	2.80	0.0	0.03	0.00	0.00	-	-	0.00	-	-	
73	CROSSCHECK	-	-	4.4	0.14	0.04	0.03	0.0	1.5	1.50	0.5	0.30	0.01	0.00	0.00	-	0.00	0.02	0.00	0
74	ROCK BASS	8.7	0.5	3.8	1.00	0.17	0.10	0.0	-	7.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	WHITE PERCH	9.3	0.5	13.7	2.50	0.42	0.71	0.0	-	14.10	0.0	0.21	0.00	0.00	-	-	0.00	-	-	
74	YELLOW PERCH	11.1	0.7	5.5	0.87	0.22	0.18	0.0	-	6.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CROSSCHECK	-	-	4.5	0.30	0.13	0.03	0.0	0.0	1.54	0.0	0.05	0.01	0.01	0.05	0.00	0.00	0.01	0.01	0
74	YELLOW PERCH	10.9	0.6	7.3	1.90	0.34	0.33	0.0	-	8.00	0.0	0.13	0.00	0.00	-	-	0.00	-	-	
74	CROSSCHECK	-	-	6.6	0.47	0.29	0.06	0.0	0.0	3.40	0.0	0.07	0.02	0.01	0.09	0.00	0.00	0.04	0.01	0

STATION 17, GENESEE RIVER AT SCOTSVILLE, NY

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	ALPHA-BHC	GAMMA-BHC
70	NORTHERN PIKE	13.7	0.7	1.1	0.07	0.11	0.07	-	-	0.85	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	REDHORSE	13.2	0.9	3.3	0.13	0.23	0.13	-	-	1.80	-	0.03	0.00	0.00	-	-	-	-	0.05	
70	ROCK BASS	8.1	0.5	3.2	0.09	0.22	0.11	-	-	1.54	-	0.11	0.00	0.00	-	-	-	-	0.05	
70	WHITE SUCKER	14.0	1.2	2.4	0.21	0.27	0.21	-	-	1.56	-	0.03	0.00	0.00	-	-	-	-	0.09	
71	ROCK BASS	8.0	0.4	1.4	0.05	0.05	0.05	-	-	0.60	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	ROCK BASS	7.5	0.4	2.1	0.12	0.11	0.09	-	-	0.50	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	WALLEYE	19.3	3.0	7.7	0.49	0.43	0.29	-	-	3.28	-	0.03	0.00	0.00	-	-	0.00	-	-	
71	WALLEYE	13.4	0.9	6.0	0.16	0.14	0.10	-	-	1.04	-	0.03	0.00	0.00	-	-	0.00	-	-	
71	WHITE SUCKER	14.4	1.1	2.3	0.15	0.26	0.20	-	-	1.51	-	0.02	0.00	0.00	-	-	0.00	-	-	
71	WHITE SUCKER	14.1	1.0	1.5	0.08	0.12	0.12	-	-	0.99	-	0.01	0.00	0.00	-	-	0.00	-	-	
72	NORTHERN PIKE	20.7	2.1	2.2	0.12	0.04	0.00	-	-	1.80	-	0.02	0.00	0.00	-	-	0.00	-	-	
72	REDHORSE	15.4	1.5	3.8	0.09	0.05	0.02	-	-	1.40	-	0.04	0.00	0.00	-	-	0.00	-	-	
72	ROCK BASS	7.4	0.4	2.2	0.04	0.01	0.00	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	
73	ROCK BASS	7.6	0.4	2.0	0.01	0.02	0.00	0.0	-	0.28	0.0	0.01	0.00	0.00	-	-	0.00	-	-	
73	WALLEYE	16.1	1.4	6.9	0.29	0.09	0.00	0.0	-	3.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-	
73	WALLEYE	17.0	1.6	5.9	0.27	0.39	0.00	0.0	-	2.10	0.0	0.07	0.00	0.00	-	-	0.00	-	-	
73	WHITE SUCKER	15.4	1.5	2.8	0.00	0.07	0.01	0.0	-	2.20	0.0	0.02	0.00	0.00	-	-	0.00	-	-	
74	BLACK CRAPPIE	7.8	0.3	2.9	0.18	0.00	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	BLACK CRAPPIE	8.1	0.4	3.1	0.15	0.00	0.00	0.0	-	0.57	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	NORTHERN PIKE	20.5	2.0	2.5	0.17	0.14	0.11	0.0	-	0.98	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	REDHORSE	14.2	1.2	2.9	0.07	0.04	0.00	0.0	-	0.42	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

TION 19, LAKE ERIE AT ERIE, PA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
FRESHWATER DRUM	14.1	1.3	7.3	0.18	0.23	0.29	-	-	2.60	-	0.06	0.00	0.00	-	-	-	-	0.01	-
WHITE SUCKER	18.0	2.7	5.9	0.16	0.25	0.19	-	-	2.08	-	0.03	0.00	0.00	-	-	-	-	0.01	-
YELLOW PERCH	9.7	0.4	4.6	0.20	0.26	0.32	-	-	2.45	-	0.06	0.00	0.00	-	-	-	-	0.02	-
YELLOW PERCH	8.9	0.3	5.3	0.23	0.26	0.33	-	-	2.34	-	0.07	0.00	0.00	-	-	-	-	0.01	-
FRESHWATER DRUM	13.3	1.1	4.6	0.13	0.16	0.15	-	-	1.54	-	0.01	0.01	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	13.3	1.3	8.6	0.09	0.10	0.10	-	-	0.73	-	0.03	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	14.6	1.3	5.2	0.08	0.13	0.12	-	-	1.19	-	0.02	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	14.4	1.4	4.5	0.09	0.15	0.14	-	-	1.42	-	0.16	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.5	0.5	4.2	0.06	0.12	0.11	-	-	1.00	-	0.02	0.01	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.0	0.4	3.5	0.10	0.13	0.14	-	-	1.22	-	0.02	0.01	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	13.5	1.1	9.3	0.17	0.13	0.05	-	-	2.60	-	0.11	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	12.6	1.2	2.7	0.07	0.02	0.01	-	-	2.20	-	0.04	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.6	0.3	3.9	0.07	0.05	0.00	-	-	1.50	-	0.07	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.0	0.4	4.5	0.09	0.06	0.01	-	-	1.80	-	0.04	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.7	0.4	3.0	0.10	0.00	0.00	0.0	-	0.80	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.2	0.4	2.4	0.03	0.04	0.00	0.0	-	0.70	0.0	0.02	0.00	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	11.6	0.8	12.1	0.10	0.00	0.00	0.0	-	1.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	13.1	0.9	5.8	0.02	0.00	0.00	0.0	-	0.35	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.8	0.3	4.2	0.05	0.00	0.00	0.0	-	0.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	8.6	0.3	4.9	0.07	0.00	0.00	0.0	-	1.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 108, LAKE ERIE AT PORT CLINTON, OH

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CARP	73.9	2.2	10.3	0.06	0.15	0.00	0.0	-	1.30	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	17.3	2.5	16.4	0.43	0.49	0.06	0.0	-	5.70	0.0	0.14	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	17.7	0.48	0.48	0.06	0.0	0.0	4.19	1.7	0.07	0.01	0.02	0.18	0.04	0.00	0.02	0.06	0.01
WHITE BASS	10.9	1.0	9.8	2.50	0.47	0.34	0.0	-	12.00	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-

TION 107, LAKE ST. CLAIR AT MT. CLEMENS, MI

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CARP	17.7	3.0	11.3	0.45	0.28	0.00	0.0	-	1.90	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
CARP	17.1	3.1	11.9	0.84	0.56	0.00	0.0	-	6.30	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	18.6	2.4	10.7	6.40	0.57	0.72	0.0	-	12.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	9.3	0.54	1.22	0.26	0.0	1.1	3.83	1.6	0.09	0.01	0.06	0.36	0.06	0.00	0.03	0.04	0.00
WHITE BASS	13.8	1.5	9.6	0.64	0.18	0.16	0.0		3.10	0.0	0.07	0.00	0.00	-	-	0.00	-	-	-

STATION 20, LAKE HURON (SAGINAW BAY) AT BAY PORT, MI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CARP	19.6	4.0	15.8	0.58	0.51	0.14	-	-	2.76	-	0.02	0.01	0.00	-	-	-	-	0.3
70	CROSSCHECK	-	-	13.5	0.18	0.38	0.02	-	2.5	0.60	0.0	0.04	0.01	0.00	-	-	0.00	-	-
70	CHANNEL CATFISH	16.2	1.4	15.5	0.90	0.71	0.42	-	-	3.60	-	0.03	0.01	0.00	-	-	-	-	0.0
70	YELLOW PERCH	9.1	0.3	3.4	0.54	0.48	0.35	-	-	3.07	-	0.01	0.01	0.00	-	-	-	-	0.0
70	YELLOW PERCH	9.1	0.3	3.1	0.58	0.56	0.37	-	-	3.59	-	0.01	0.01	0.00	-	-	-	-	0.0
71	CARP	16.7	2.4	9.0	0.37	0.21	0.07	-	-	6.67	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CARP	17.7	2.7	10.4	0.35	0.21	0.08	-	-	4.32	-	0.02	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	17.0	1.6	17.4	0.70	0.24	0.22	-	-	1.35	-	0.04	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	17.3	1.7	17.6	0.85	0.49	0.26	-	-	1.72	-	0.05	0.01	0.00	-	-	0.00	-	-
71	YELLOW PERCH	9.4	0.4	3.5	0.25	0.16	0.09	-	-	2.86	-	0.01	0.01	0.00	-	-	0.00	-	-
71	YELLOW PERCH	9.1	0.3	2.5	0.21	0.15	0.07	-	-	2.81	-	0.01	0.01	0.00	-	-	0.00	-	-
72	YELLOW PERCH	8.6	0.3	-	0.35	0.00	0.00	-	-	0.54	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	8.5	0.3	-	0.26	0.00	0.00	-	-	0.44	-	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	15.2	1.8	7.0	0.16	0.00	0.00	3.3	-	0.00	1.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	8.7	0.17	0.00	0.00	0.0	2.0	1.00	0.5	0.02	0.00	0.00	0.00	-	0.00	0.01	0.00
73	CHANNEL CATFISH	15.6	1.3	29.5	0.23	0.33	0.00	4.8	-	0.00	1.8	0.00	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	13.7	2.88	0.08	0.08	0.0	4.2	3.80	1.8	0.06	0.00	0.00	0.00	-	0.00	0.04	0.00
73	YELLOW PERCH	9.5	0.4	3.1	0.17	0.00	0.00	2.8	-	0.00	1.4	0.00	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	9.1	0.4	5.5	0.21	0.00	0.00	2.3	-	0.00	2.1	0.03	0.00	0.00	-	-	0.00	-	-
74	CARP	18.1	3.0	12.0	0.36	0.08	0.00	0.0	-	2.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	14.0	0.24	0.11	0.01	0.0	3.1	2.00	0.0	0.03	0.01	0.01	0.04	0.00	0.00	0.01	0.02
74	CHANNEL CATFISH	17.1	2.0	13.4	0.28	0.34	0.04	0.0	-	4.70	0.0	0.08	0.00	0.00	-	-	0.00	-	-
74	YELLOW PERCH	9.5	0.4	4.3	0.30	0.08	0.13	0.0	-	2.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	YELLOW PERCH	9.6	0.4	5.4	0.90	0.14	0.19	0.0	-	3.90	0.0	0.06	0.00	0.00	-	-	0.00	-	-

STATION 106, LAKE HURON AT ALPENA, MI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
74	LAKE WHITEFISH	17.3	1.8	10.0	0.22	0.00	0.00	0.0	-	0.51	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE SUCKER	17.7	2.2	5.3	0.07	0.05	0.03	0.0	-	0.46	0.0	0.03	0.00	0.00	-	-	0.00	-	-
74	YELLOW PERCH	11.2	0.7	5.5	0.36	0.14	0.00	0.0	-	0.65	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	5.9	0.15	0.07	0.00	0.0	0.0	0.76	0.3	0.01	0.00	0.01	0.03	0.01	0.00	0.00	0.02
74	YELLOW PERCH	10.5	0.6	5.4	0.19	0.06	0.10	0.0	-	0.73	0.0	0.04	0.00	0.00	-	-	0.00	-	-

STATION 21, LAKE MICHIGAN AT SHEBOYGAN, WI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
70	BLOATER	11.2	0.6	29.3	2.47	0.40	1.83	-	-	3.91	-	0.30	0.03	0.00	-	-	-	-	0.03
70	BLOATER	11.0	0.6	30.1	2.80	0.46	2.16	-	-	4.82	-	0.23	0.04	0.00	-	-	-	-	0.02
70	CROSSCHECK	-	-	24.6	2.09	0.14	2.15	-	1.9	3.20	1.5	0.30	0.03	0.00	-	-	0.00	-	-
70	YELLOW PERCH	9.4	0.4	10.7	0.98	1.03	0.96	-	-	7.42	-	0.08	0.02	0.00	-	-	-	-	0.07
71	BLOATER	9.5	0.5	24.5	3.06	0.40	2.18	-	-	2.81	-	0.11	0.02	0.00	-	-	0.00	-	-
71	BLOATER	9.3	0.4	21.2	2.06	0.32	1.07	-	-	2.08	-	0.12	0.04	0.00	-	-	0.00	-	-
71	LAKE TROUT	26.0	6.4	19.7	7.39	0.78	3.16	-	-	7.03	-	0.21	0.04	0.00	-	-	0.00	-	-
71	LAKE TROUT	25.1	6.6	21.0	7.81	1.02	4.30	-	-	8.59	-	0.25	0.04	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	10.5	15.80	2.40	3.00	-	12.0	30.00	11.0	0.59	0.02	0.14	0.00	-	0.00	0.03	-
71	YELLOW PERCH	9.8	0.3	7.2	1.37	0.85	0.95	-	-	12.20	-	0.09	0.02	0.00	-	-	0.00	-	-
71	YELLOW PERCH	9.6	0.3	6.7	1.60	0.82	0.95	-	-	10.70	-	0.08	0.02	0.00	-	-	0.00	-	-
72	BLOATER	10.7	0.5	20.7	1.10	0.08	0.45	-	-	0.00	-	0.35	0.00	0.00	-	-	3.00	-	-
72	BLOATER	10.9	0.6	22.8	2.50	0.17	2.00	-	-	0.00	-	0.22	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	17.0	1.40	0.29	0.50	-	0.0	1.70	0.9	0.21	0.00	0.00	0.00	-	0.00	0.00	-
72	LAKE TROUT	18.3	2.5	10.2	2.90	0.28	0.56	-	-	0.00	-	0.21	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	5.4	1.90	0.21	0.80	-	1.0	3.20	0.7	0.12	0.00	0.04	0.18	-	0.00	0.01	-
72	LAKE TROUT	19.2	2.5	12.3	2.50	0.18	0.17	-	-	0.00	-	0.16	0.00	0.00	-	-	4.00	-	-
72	YELLOW PERCH	11.0	0.9	6.1	1.80	0.24	1.00	-	-	8.90	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	10.7	0.8	7.4	1.10	0.20	0.61	-	-	9.80	-	0.00	0.00	0.00	-	-	0.00	-	-
73	BLOATER	10.8	0.4	20.6	0.49	0.00	0.00	5.7	-	8.00	0.0	0.27	0.00	0.00	-	-	0.00	-	-
73	BLOATER	11.0	0.4	21.5	0.64	0.00	0.00	5.6	-	5.30	0.0	0.22	0.00	0.00	-	-	0.00	-	-
73	LAKE TROUT	21.4	3.2	14.8	1.90	0.00	0.00	0.0	-	7.90	0.0	0.11	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	16.1	7.85	0.13	0.13	0.0	1.3	1.80	1.3	0.01	0.00	0.00	0.00	-	0.00	0.01	0.02
73	LAKE TROUT	21.7	3.3	15.3	2.80	0.00	0.00	6.4	-	0.00	5.3	0.12	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	9.2	0.3	6.8	0.59	0.00	0.00	0.0	-	8.10	0.0	0.07	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	8.8	0.3	6.6	0.61	0.06	0.00	0.0	-	7.60	0.0	0.07	0.00	0.00	-	-	0.00	-	-
74	BLOATER	9.7	0.4	20.1	0.83	0.50	2.00	0.0	-	3.20	0.0	0.73	0.00	0.00	-	-	0.00	-	-
74	BLOATER	10.1	0.4	20.2	1.20	0.33	0.72	0.0	-	11.00	0.0	0.77	0.00	0.00	-	-	0.00	-	-
74	LAKE TROUT	23.2	3.8	16.6	0.79	0.14	0.00	0.0	-	0.00	0.6	0.11	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	18.0	1.73	0.44	0.13	0.0	0.0	5.14	1.3	0.04	0.00	0.07	0.18	0.00	0.00	0.02	0.02
74	WHITE SUCKER	15.2	1.6	6.2	2.60	0.44	0.00	0.0	-	0.00	1.7	0.13	0.00	0.00	-	-	0.00	-	-
74	WHITE SUCKER	15.8	1.8	7.5	0.30	0.09	0.19	0.0	-	2.00	0.0	0.08	0.00	0.00	-	-	0.00	-	-

ION 105, LAKE MICHIGAN AT SAUGATUCK, MI

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
LOATER	10.5	0.4	16.4	2.10	0.25	0.00	0.0	-	4.20	0.0	0.35	0.00	0.00	-	-	0.00	-	-	-
AKE TROUT	20.2	2.7	15.3	2.40	0.98	1.60	0.0	-	13.00	0.0	0.71	0.00	0.00	-	-	0.00	-	-	-
RDSSCHECK	-	-	16.9	0.57	0.99	0.25	0.0	0.0	2.79	2.1	0.02	0.00	0.09	0.42	0.10	0.00	0.01	0.02	0.00
ELLOW PERCH	10.4	0.5	7.4	0.91	0.33	0.50	0.0	-	7.70	0.0	0.20	0.00	0.00	-	-	0.00	-	-	-
ELLOW PERCH	10.9	0.6	8.2	0.85	0.45	0.55	0.0	-	6.70	0.0	0.23	0.00	0.00	-	-	0.00	-	-	-

ION 102, LAKE SUPERIOR AT KEEWEENAW POINT, MI

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BLOATER	9.4	2.1	16.6	0.28	0.00	0.06	0.0	-	0.79	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
BLOATER	9.9	2.2	15.3	0.23	0.02	0.21	0.0	-	0.61	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SKIPJACK HERRING	11.6	0.7	9.8	0.43	0.09	1.60	0.0	-	1.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LAKE TROUT	24.2	5.6	24.4	3.80	0.24	1.10	0.0	-	4.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	32.0	0.66	0.41	1.08	0.0	0.0	3.65	4.9	0.00	0.00	0.10	0.20	0.00	3.33	0.00	0.09	0.00

TION 22, LAKE SUPERIOR AT BAYFIELD, WI

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BLOATER	10.3	0.3	10.7	0.36	0.11	0.36	-	-	0.89	-	0.02	0.00	0.00	-	-	-	-	0.02	-
LAKE TROUT	23.4	4.0	13.6	0.30	0.12	0.38	-	-	1.29	-	0.04	0.01	0.00	-	-	-	-	0.03	-
LAKE WHITEFISH	17.6	1.7	11.0	0.25	0.10	0.24	-	-	0.55	-	0.04	0.01	0.00	-	-	-	-	0.04	-
LAKE WHITEFISH	18.1	1.9	12.3	0.24	0.10	0.26	-	-	0.60	-	0.07	0.01	0.00	-	-	-	-	0.05	-
BLOATER	8.5	0.5	12.7	0.76	0.06	0.44	-	-	0.68	-	0.02	0.01	0.00	-	-	0.00	-	-	-
BLOATER	8.4	0.4	10.8	0.63	0.12	0.63	-	-	0.83	-	0.02	0.01	0.00	-	-	0.00	-	-	-
LAKE TROUT	19.0	3.2	11.1	0.69	0.08	0.37	-	-	1.10	-	0.03	0.01	0.00	-	-	0.00	-	-	-
LAKE TROUT	22.0	4.4	13.2	1.22	0.11	0.66	-	-	1.72	-	0.03	0.01	0.00	-	-	0.00	-	-	-
LAKE WHITEFISH	19.7	2.4	12.4	0.27	0.07	0.28	-	-	0.38	-	0.05	0.03	0.00	-	-	0.00	-	-	-
LAKE WHITEFISH	20.0	2.8	13.7	0.22	0.14	0.20	-	-	0.24	-	0.05	0.03	0.00	-	-	0.00	-	-	-
BLOATER	10.1	0.3	3.6	0.70	0.03	0.48	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
BLOATER	10.0	0.3	8.5	0.99	0.04	0.71	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
LAKE TROUT	22.9	3.7	14.2	0.52	0.06	0.18	-	-	1.30	-	0.06	0.00	0.00	-	-	0.00	-	-	-
LAKE TROUT	20.9	3.2	16.5	1.20	0.07	0.15	-	-	3.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	16.5	1.01	0.04	0.31	-	0.0	1.90	0.7	0.05	0.01	0.00	0.00	-	0.00	0.00	-	-
LAKE WHITEFISH	21.2	3.2	11.3	0.15	0.02	0.06	-	-	0.00	-	0.05	0.00	0.00	-	-	0.00	-	-	-
BLOATER	10.3	0.3	13.0	0.30	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	20.8	1.44	0.07	0.06	0.0	4.0	6.00	1.3	0.45	0.00	0.04	0.00	-	0.00	0.03	0.02	0.01
BLOATER	10.6	0.3	9.4	0.34	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LAKE TROUT	26.1	5.9	14.0	0.51	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LAKE TROUT	27.0	6.5	14.5	1.80	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LAKE WHITEFISH	21.2	3.3	15.1	0.33	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLOATER	10.8	0.3	14.1	1.00	0.20	0.62	0.0	-	2.70	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-
BLOATER	10.5	0.4	11.4	0.41	0.07	0.25	0.0	-	1.20	0.0	0.05	0.06	0.00	-	-	0.00	-	-	-
LAKE TROUT	25.6	5.2	11.4	0.80	0.44	1.30	0.0	-	2.70	0.0	0.25	0.00	0.00	-	-	0.00	-	-	-
LAKE WHITEFISH	18.5	2.1	12.3	0.40	0.06	0.36	0.0	-	0.70	0.0	0.24	0.07	0.00	-	-	0.00	-	-	-

STATION 15, MISSISSIPPI RIVER AT LULING, LA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
70	CARP	15.3	2.1	15.5	0.08	0.16	0.15	-	-	1.04	-	0.02	0.01	0.00	-	-	-	-	0.42
70	CARP	15.3	2.4	19.5	0.10	0.16	0.11	-	-	0.69	-	0.01	0.01	0.00	-	-	-	-	0.45
70	CROSSCHECK	-	-	23.0	0.09	0.36	0.06	-	0.0	1.50	1.2	0.20	0.05	0.00	-	-	0.00	-	-
70	CHANNEL CATFISH	13.8	1.0	21.1	0.10	0.15	0.14	-	-	0.59	-	0.01	0.01	0.00	-	-	-	-	0.30
70	FRESHWATER DRUM	12.0	0.7	4.3	0.14	0.17	0.24	-	-	1.89	-	0.03	0.00	0.00	-	-	-	-	0.31
71	BIGMOUTH BUFFALO	18.6	4.8	20.7	0.26	0.55	0.37	-	-	1.82	-	0.29	0.21	0.00	-	-	0.00	-	-
71	BIGMOUTH BUFFALO	19.2	4.9	20.3	0.30	0.56	0.43	-	-	1.20	-	0.28	0.19	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	18.9	0.15	0.74	0.42	-	6.0	1.40	3.2	0.47	0.30	0.28	0.94	-	4.00	1.00	-
71	CARP	14.2	2.1	13.9	0.06	0.16	0.05	-	-	0.31	-	0.05	0.07	0.00	-	-	0.00	-	-
71	CARP	14.4	1.9	12.6	0.07	0.18	0.05	-	-	0.26	-	0.07	0.06	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.2	1.3	23.7	0.16	0.39	0.32	-	-	2.66	-	0.06	0.17	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	15.7	1.8	21.0	0.19	0.41	0.32	-	-	1.25	-	0.17	0.17	0.00	-	-	0.00	-	-
72	CARP	23.0	6.1	9.8	0.21	0.00	0.00	-	-	4.50	-	0.03	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	13.4	0.48	0.33	0.11	-	2.0	3.40	1.6	0.16	0.00	0.04	0.19	-	1.00	0.42	-
72	CHANNEL CATFISH	13.8	1.1	24.1	0.00	0.06	0.00	-	-	6.60	-	0.26	0.20	0.00	-	-	0.00	-	-
72	FRESHWATER DRUM	14.2	1.4	9.5	0.13	0.21	0.31	-	-	5.40	-	0.14	0.18	0.00	-	-	0.00	-	-
72	FRESHWATER DRUM	9.8	0.7	6.1	0.35	0.36	0.44	-	-	1.90	-	0.20	0.15	0.00	-	-	0.00	-	-
73	FRESHWATER DRUM	13.4	1.3	10.1	0.72	0.00	0.00	0.0	-	0.43	0.0	0.13	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	10.7	0.85	0.04	0.10	0.0	0.0	2.00	1.0	0.31	0.17	0.00	0.03	-	2.50	0.00	0.00
73	BLUE CATFISH	14.5	1.1	19.6	0.13	0.32	0.26	0.0	-	0.00	0.0	0.25	0.21	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	19.6	0.19	0.11	0.15	0.0	0.0	0.50	0.5	0.34	0.22	0.03	0.04	-	2.00	0.52	0.14
73	BLUE CATFISH	14.5	1.1	21.7	0.18	0.03	0.00	0.0	-	0.00	0.0	0.11	0.05	0.00	-	-	12.90	-	-
74	CARP	19.8	4.5	13.0	0.11	0.00	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	2.50	-	-
74	CROSSCHECK	-	-	16.7	0.17	0.32	0.06	0.0	0.0	0.33	0.0	0.18	0.19	0.05	0.16	0.14	0.00	0.03	0.05
74	SMALLMOUTH BUFFALO	13.6	1.9	17.3	0.00	0.00	0.00	0.0	-	1.40	0.0	0.00	0.00	0.00	-	-	4.10	-	-
74	SMALLMOUTH BUFFALO	15.4	2.4	10.7	0.04	0.00	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	2.30	-	-
74	BLUE CATFISH	13.8	1.0	24.9	0.02	0.00	0.00	0.0	-	0.13	0.0	0.00	0.00	0.00	-	-	4.60	-	-

STATION 81, RED RIVER AT ALEXANDRIA, LA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	FRESHWATER DRUM	13.7	1.1	11.5	0.87	0.51	0.57	-	-	1.77	-	0.15	0.04	0.00	-	-	-	-	0.12
70	SMALLMOUTH BUFFALO	21.0	5.8	15.1	1.91	1.02	0.86	-	-	1.17	-	0.02	0.00	0.00	-	-	-	-	0.02
70	SMALLMOUTH BUFFALO	20.0	5.2	12.8	4.31	1.59	1.30	-	-	1.43	-	0.01	0.00	0.00	-	-	-	-	0.03
70	CROSSCHECK	-	-	9.8	4.33	1.38	1.15	-	0.0	0.10	0.0	0.05	0.00	0.00	-	-	19.00	-	-
70	WHITE CATFISH	13.0	0.6	7.4	0.83	0.65	0.68	-	-	1.25	-	0.04	0.01	0.00	-	-	-	-	0.12
71	FRESHWATER DRUM	13.5	1.2	7.8	0.54	0.38	0.45	-	-	0.94	-	0.07	0.06	0.00	-	-	0.01	-	-
71	FRESHWATER DRUM	14.2	1.3	9.3	0.55	0.25	0.34	-	-	1.46	-	0.09	0.07	0.00	-	-	0.01	-	-
71	SMALLMOUTH BUFFALO	16.1	2.3	7.1	0.38	0.38	0.29	-	-	0.94	-	0.05	0.04	0.00	-	-	0.01	-	-
71	SMALLMOUTH BUFFALO	15.5	1.9	7.1	1.08	0.73	1.20	-	-	0.83	-	0.02	0.01	0.00	-	-	0.01	-	-
71	WHITE CATFISH	14.9	1.2	8.7	0.67	0.42	0.44	-	-	1.46	-	0.50	0.01	0.00	-	-	0.01	-	-
71	CROSSCHECK	-	-	8.8	1.18	0.44	0.58	-	1.0	2.30	0.8	0.08	0.03	0.08	0.16	-	4.00	0.14	-
71	WHITE CATFISH	14.7	1.2	6.5	0.55	0.31	0.37	-	-	0.42	-	0.10	0.01	0.00	-	-	0.01	-	-
72	CHANNEL CATFISH	13.7	0.9	16.0	0.43	0.08	0.00	-	-	0.00	-	0.04	0.00	0.00	-	-	7.60	-	-
72	CROSSCHECK	-	-	19.0	0.70	0.50	0.48	-	0.0	0.40	0.0	0.08	0.01	0.00	0.04	-	5.00	0.00	-
72	FRESHWATER DRUM	13.8	1.3	13.8	0.52	0.26	0.00	-	-	0.00	-	0.17	0.06	0.00	-	-	7.60	-	-
72	FRESHWATER DRUM	13.7	1.2	11.2	0.40	0.56	0.38	-	-	0.00	-	0.20	0.09	0.00	-	-	4.40	-	-
72	SMALLMOUTH BUFFALO	18.2	3.6	14.6	1.31	0.00	0.90	-	-	0.00	-	0.00	0.00	0.00	-	-	13.00	-	-
73	CARP	21.7	3.8	8.6	1.00	0.27	0.00	0.0	-	0.80	0.0	0.11	0.00	0.00	-	-	0.00	-	-
73	FRESHWATER DRUM	13.1	1.0	7.9	0.48	0.27	0.21	0.0	-	2.00	0.0	0.18	0.05	0.00	-	-	0.70	-	-
73	FRESHWATER DRUM	13.0	1.0	6.7	0.45	0.37	0.11	0.0	-	0.00	0.0	0.04	0.02	0.00	-	-	3.00	-	-
73	SMALLMOUTH BUFFALO	17.0	3.9	7.7	1.30	0.25	0.30	0.0	-	0.00	0.0	0.03	0.06	0.00	-	-	0.83	-	-
73	BLUE CATFISH	12.3	0.5	8.5	0.36	0.17	0.07	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	2.50	-	-
73	CROSSCHECK	-	-	9.6	1.44	0.38	0.17	0.0	0.0	0.50	0.3	0.03	0.01	0.00	0.00	-	1.00	0.04	0.04
74	CARP	21.1	4.8	8.7	0.54	0.30	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	13.4	0.7	6.4	0.42	0.10	0.00	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	6.0	0.46	0.16	0.01	0.0	0.0	0.18	0.0	0.02	0.05	0.02	0.05	0.04	0.80	0.06	0.04
74	FRESHWATER DRUM	11.6	0.7	6.8	0.33	0.04	0.00	0.0	-	0.30	0.0	0.03	0.00	0.00	-	-	0.00	-	-
74	FRESHWATER DRUM	12.6	0.9	7.1	0.76	0.20	0.24	0.0	-	0.50	0.0	0.19	0.00	0.00	-	-	3.30	-	-

TION 82, RED RIVER AT LAKE TEXOMA, OK/TX

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
BLUEGILL	6.6	0.4	3.0	0.16	0.04	0.06	-	-	0.29	-	0.02	0.00	0.00	-	-	-	-	0.01	-
CARP	20.5	4.5	9.3	0.39	0.12	0.03	-	-	0.30	-	0.01	0.00	0.00	-	-	-	-	0.02	-
CARP	20.2	4.3	13.3	0.47	0.22	0.05	-	-	0.21	-	0.02	0.00	0.00	-	-	-	-	0.03	-
LARGEMOUTH BASS	13.2	0.9	2.8	0.23	0.06	0.08	-	-	0.21	-	0.02	0.00	0.00	-	-	-	-	0.01	-
BLUEGILL	7.1	0.3	4.0	0.10	0.03	0.03	-	-	0.09	-	0.01	0.01	0.00	-	-	0.01	-	-	-
BLUEGILL	6.8	0.3	2.8	0.09	0.02	0.03	-	-	0.13	-	0.01	0.01	0.00	-	-	0.01	-	-	-
CARP	20.6	3.9	8.5	0.69	0.21	0.05	-	-	0.35	-	0.03	0.01	0.00	-	-	0.01	-	-	-
CARP	19.5	3.4	4.9	0.44	0.09	0.03	-	-	0.18	-	0.02	0.01	0.00	-	-	0.01	-	-	-
LARGEMOUTH BASS	12.5	0.8	2.8	0.22	0.07	0.06	-	-	0.16	-	0.02	0.01	0.00	-	-	0.01	-	-	-
LARGEMOUTH BASS	14.5	1.4	1.5	0.18	0.04	0.05	-	-	0.10	-	0.01	0.01	0.00	-	-	0.01	-	-	-
BLUEGILL	7.4	0.3	0.4	0.05	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	15.1	1.3	3.6	0.04	0.01	0.00	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
CARP	15.9	1.7	3.5	0.04	0.01	0.00	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	16.2	2.2	3.3	0.59	0.06	0.71	-	-	0.01	-	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.3	0.1	1.1	0.10	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.3	0.1	0.7	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	19.2	3.2	7.6	0.35	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.2	0.7	0.8	0.06	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 80, YAZOO RIVER AT REDWOOD, MS

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
CARP	20.0	4.5	9.5	5.68	5.86	1.48	-	-	1.95	-	0.09	0.07	0.00	-	-	-	-	0.07	-
CROSSCHECK	-	-	8.7	9.75	7.70	1.00	-	0.0	1.00	0.0	0.16	0.10	0.00	-	-	34.00	-	-	-
GIZZARD SHAD	5.8	0.1	4.2	0.18	0.24	0.33	-	-	0.63	-	0.12	0.06	0.00	-	-	-	-	0.16	-
SMALLMOUTH BUFFALO	16.5	3.0	10.3	2.16	3.05	3.22	-	-	2.47	-	0.15	0.11	0.00	-	-	-	-	0.20	-
CROSSCHECK	-	-	8.4	1.31	1.75	1.48	-	0.0	1.40	0.0	0.12	0.06	0.00	-	-	31.00	-	-	-
SMALLMOUTH BUFFALO	15.5	2.3	14.7	0.39	1.47	0.70	-	-	1.69	-	0.15	0.08	0.00	-	-	-	-	0.30	-
CARP	18.8	4.0	4.2	6.45	2.38	1.46	-	-	0.98	-	0.13	0.12	0.00	-	-	0.01	-	-	-
CARP	21.4	5.5	10.9	1.51	3.11	0.68	-	-	0.39	-	0.07	0.11	0.00	-	-	0.01	-	-	-
CHANNEL CATFISH	20.1	2.3	16.8	2.38	4.04	2.54	-	-	1.63	-	0.11	0.17	0.00	-	-	0.01	-	-	-
SMALLMOUTH BUFFALO	16.0	2.5	7.0	1.64	1.69	3.10	-	-	0.65	-	0.07	0.12	0.00	-	-	0.01	-	-	-
SMALLMOUTH BUFFALO	16.1	2.5	6.6	3.48	3.52	5.34	-	-	1.63	-	0.09	0.18	0.00	-	-	0.01	-	-	-
CROSSCHECK	-	-	6.7	10.20	4.40	10.60	-	0.0	0.50	1.0	0.15	0.34	0.00	0.01	-	48.00	0.03	-	-
CARP	22.1	5.1	3.9	0.00	6.50	0.76	-	-	0.00	-	0.00	0.00	0.00	-	-	28.00	-	-	-
CROSSCHECK	-	-	4.9	9.60	5.50	1.00	-	0.0	0.00	0.0	0.14	0.13	0.00	0.00	-	24.00	0.00	-	-
FRESHWATER DRUM	16.8	2.6	12.0	0.41	0.23	1.10	-	-	0.00	-	0.22	0.12	0.23	-	-	5.80	-	-	-
SMALLMOUTH BUFFALO	19.5	4.7	11.6	7.66	4.54	6.47	-	-	0.00	-	0.00	0.00	0.00	-	-	32.00	-	-	-
CROSSCHECK	-	-	12.2	8.01	6.45	8.00	-	1.6	2.70	0.8	0.21	0.20	0.00	0.00	-	40.00	0.01	-	-
SMALLMOUTH BUFFALO	16.7	2.9	11.8	3.62	4.26	6.11	-	-	0.00	-	0.00	0.00	0.00	-	-	38.00	-	-	-
CARP	22.7	6.1	10.4	3.10	4.60	0.00	0.0	-	0.00	0.0	0.57	0.00	0.00	-	-	2.70	-	-	-
CHANNEL CATFISH	18.7	1.9	18.0	9.60	14.00	7.50	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	31.00	-	-	-
CROSSCHECK	-	-	15.5	17.00	14.90	5.92	1.0	0.0	1.50	0.5	1.20	1.40	0.00	0.00	-	30.00	0.02	0.03	0.00
SMALLMOUTH BUFFALO	17.3	2.6	12.1	2.90	2.20	3.40	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	16.30	-	-	-
SMALLMOUTH BUFFALO	17.8	2.9	14.8	1.90	2.30	3.50	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	17.80	-	-	-
CROSSCHECK	-	-	16.2	9.92	0.80	0.41	0.0	0.0	0.60	0.3	0.17	0.19	0.00	0.00	-	20.00	1.90	0.00	0.00
CARP	21.1	4.7	5.8	3.50	0.00	0.00	0.0	-	0.00	0.3	0.00	0.00	0.00	-	-	38.00	-	-	-
CROSSCHECK	-	-	5.7	2.98	1.14	0.33	0.0	0.0	0.00	0.0	0.07	0.15	0.10	0.13	0.00	4.20	0.02	0.02	0.00
CHANNEL CATFISH	16.0	1.1	8.8	7.20	9.00	0.00	0.0	-	1.90	0.0	0.00	0.00	0.00	-	-	51.00	-	-	-
CROSSCHECK	-	-	10.0	6.49	8.60	2.60	0.0	0.0	0.53	0.0	0.22	0.87	0.73	0.00	0.00	25.00	0.01	0.00	0.00

STATION 30, WHITE RIVER AT DEVALLS BLUFF, AR

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
70	CARP	18.0	2.9	6.4	1.46	0.47	0.16	-	-	1.77	-	0.02	0.01	0.00	-	-	-	-	0.02
70	CHANNEL CATFISH	15.5	1.4	7.7	0.98	0.78	0.55	-	-	1.82	-	0.07	0.03	0.00	-	-	-	-	0.06
70	SMALLMOUTH BUFFALO	17.0	2.6	10.8	1.29	0.58	0.63	-	-	3.65	-	0.13	0.08	0.00	-	-	-	-	0.13
70	SMALLMOUTH BUFFALO	21.0	4.8	5.7	2.71	1.32	0.82	-	-	1.17	-	0.03	0.03	0.00	-	-	-	-	0.02
70	CROSSCHECK	-	-	6.2	1.22	1.75	0.82	-	0.0	0.60	0.0	0.02	0.01	0.00	-	-	0.00	-	-
71	BIGMOUTH BUFFALO	18.6	3.9	11.6	0.69	0.43	0.52	-	-	1.25	-	0.06	0.57	0.00	-	-	0.00	-	-
71	BIGMOUTH BUFFALO	16.6	2.4	17.7	0.14	0.24	0.09	-	-	0.10	-	0.02	0.03	0.00	-	-	0.00	-	-
71	CARP	19.1	3.5	6.5	0.75	0.26	0.08	-	-	0.94	-	0.07	0.23	0.00	-	-	0.00	-	-
71	CARP	22.4	6.5	6.7	1.19	0.45	0.17	-	-	0.52	-	0.04	0.05	0.00	-	-	0.01	-	-
71	CHANNEL CATFISH	22.9	5.0	10.5	1.08	0.91	0.76	-	-	3.44	-	0.10	0.20	0.00	-	-	0.01	-	-
71	CROSSCHECK	-	-	10.0	0.95	0.57	0.83	-	3.6	3.50	1.7	0.10	0.16	0.03	0.32	-	4.40	0.03	-
71	CHANNEL CATFISH	19.6	3.1	14.0	0.70	0.69	0.69	-	-	1.20	-	0.10	0.14	0.00	-	-	0.01	-	-
72	BIGMOUTH BUFFALO	19.5	4.7	6.6	0.54	0.17	0.36	-	-	0.00	-	0.01	0.00	0.00	-	-	2.60	-	-
72	CROSSCHECK	-	-	11.0	0.59	0.28	0.46	-	0.0	0.00	0.0	0.02	0.08	0.00	0.00	-	1.00	0.00	-
72	CARP	18.5	3.4	7.9	0.78	0.41	0.11	-	-	1.50	-	0.07	0.01	0.00	-	-	0.00	-	-
72	SMALLMOUTH BUFFALO	18.1	2.8	10.6	0.67	0.20	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	2.20	-	-
72	SMALLMOUTH BUFFALO	16.6	2.3	8.8	0.36	0.14	0.25	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-
73	CARP	20.2	4.0	6.9	0.58	0.20	0.06	0.0	-	0.00	0.0	0.10	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	15.2	1.2	10.4	0.59	0.17	0.50	0.0	-	0.00	0.0	0.06	0.00	0.00	-	-	4.40	-	-
73	CHANNEL CATFISH	15.3	1.2	9.1	0.84	0.28	0.45	0.0	-	0.00	0.0	0.04	0.03	0.00	-	-	7.20	-	-
73	SMALLMOUTH BUFFALO	15.8	2.8	14.8	0.36	0.26	0.47	0.0	-	0.00	0.0	0.07	0.00	0.00	-	-	3.50	-	-
74	CHANNEL CATFISH	14.8	1.0	7.6	0.29	0.32	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	1.30	-	-
74	CROSSCHECK	-	-	6.9	0.25	0.20	0.01	0.0	0.0	0.51	0.0	0.03	0.02	0.02	0.01	0.01	0.63	0.00	0.01
74	SMALLMOUTH BUFFALO	12.5	1.2	7.0	0.31	0.25	0.00	0.0	-	0.00	0.0	0.11	0.00	0.00	-	-	0.00	-	-
74	SMALLMOUTH BUFFALO	14.4	1.7	7.8	0.24	0.32	0.00	0.0	-	1.80	0.0	0.26	0.00	0.00	-	-	1.80	-	-

STATION 28, ARKANSAS RIVER AT PINE BLUFF, AR

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	CARP	25.0	8.9	13.9	0.91	0.90	0.22	-	-	1.25	-	0.05	0.03	0.00	-	-	-	-	0.02
70	FLATHEAD CATFISH	23.5	5.5	7.7	1.26	1.19	0.81	-	-	2.08	-	0.07	0.07	0.00	-	-	-	-	0.07
70	SMALLMOUTH BUFFALO	16.5	2.9	12.1	0.83	0.88	0.96	-	-	2.23	-	0.03	0.03	0.00	-	-	-	-	0.05
70	SMALLMOUTH BUFFALO	19.5	4.8	22.4	0.73	1.11	1.26	-	-	6.04	-	0.25	0.16	0.00	-	-	-	-	0.00
70	CROSSCHECK	-	-	17.5	0.95	2.18	3.62	-	0.0	7.50	6.1	0.76	0.20	1.36	-	-	0.00	-	-
71	CARP	16.9	2.1	2.7	0.22	0.09	0.06	-	-	0.47	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CARP	17.7	2.4	2.9	0.11	0.08	0.07	-	-	0.58	-	0.01	0.01	0.00	-	-	0.00	-	-
71	FLATHEAD CATFISH	19.4	2.8	9.3	0.63	0.68	0.56	-	-	2.92	-	0.11	0.23	0.00	-	-	0.00	-	-
71	FLATHEAD CATFISH	21.6	4.8	9.8	0.80	0.80	0.89	-	-	3.91	-	0.15	0.15	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	9.4	0.84	0.50	0.86	-	0.8	0.80	2.0	0.25	0.22	0.02	0.31	-	4.00	0.00	-
71	SMALLMOUTH BUFFALO	17.4	3.3	13.1	0.34	0.48	0.23	-	-	0.31	-	0.02	0.04	0.00	-	-	0.00	-	-
71	SMALLMOUTH BUFFALO	18.3	3.5	13.3	0.37	0.48	0.46	-	-	0.76	-	0.04	0.05	0.00	-	-	0.00	-	-
72	CARP	20.8	5.6	11.9	3.30	1.30	0.60	-	-	0.00	-	0.00	0.00	0.00	-	-	8.30	-	-
72	CHANNEL CATFISH	18.9	2.7	13.2	1.30	1.90	1.10	-	-	0.00	-	0.00	0.00	0.00	-	-	5.60	-	-
72	CROSSCHECK	-	-	-	1.62	0.87	1.00	-	0.0	3.70	0.8	0.07	0.20	0.00	0.10	-	5.00	0.01	-
72	CHANNEL CATFISH	10.5	0.2	3.4	0.62	0.13	1.00	-	-	0.00	-	0.00	0.00	0.00	-	-	1.80	-	-
72	SMALLMOUTH BUFFALO	19.4	5.1	17.2	0.68	0.22	0.47	-	-	0.00	-	0.00	0.00	0.00	-	-	9.50	-	-
72	CROSSCHECK	-	-	17.5	0.58	0.40	0.46	-	0.0	1.30	0.8	0.05	0.21	0.00	0.12	-	2.00	0.00	-
73	CARP	22.9	6.2	7.1	1.70	1.20	0.00	0.0	-	0.00	0.0	0.01	0.01	0.00	-	-	4.60	-	-
73	FLATHEAD CATFISH	22.9	5.6	11.6	1.30	0.83	1.10	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	12.20	-	-
73	CROSSCHECK	-	-	14.1	2.89	0.00	0.13	0.0	0.0	1.80	1.0	0.07	0.45	0.00	0.00	-	3.30	0.04	0.02
73	SMALLMOUTH BUFFALO	17.6	3.2	9.8	0.71	0.70	0.00	0.0	-	0.00	0.0	0.01	0.03	0.00	-	-	4.80	-	-
73	CROSSCHECK	-	-	11.1	0.38	0.00	0.27	0.0	0.0	0.50	0.5	0.01	0.17	0.00	0.00	-	3.00	0.00	0.00
73	SMALLMOUTH BUFFALO	19.2	4.1	11.4	1.30	1.00	1.70	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	13.80	-	-
74	CARP	21.6	4.6	9.5	1.40	0.54	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	8.7	0.62	0.33	0.07	0.0	0.0	0.30	0.0	0.01	0.01	0.02	0.03	0.02	1.12	0.00	0.03

TION 79, CANADIAN RIVER AT EUFAULA, OK

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
BLUEGILL	5.5	0.1	2.8	0.17	0.02	0.04	-	-	0.25	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	13.6	1.1	7.2	0.15	0.08	0.03	-	-	0.27	-	0.03	0.00	0.00	-	-	-	-	0.03	-
CARP	13.2	1.2	11.5	0.16	0.20	0.12	-	-	1.36	-	0.05	0.00	0.00	-	-	-	-	0.02	-
LARGEMOUTH BASS	11.0	0.8	3.2	0.30	0.07	0.06	-	-	0.14	-	0.01	0.00	0.00	-	-	-	-	0.01	-
BLUEGILL	5.8	0.2	2.2	0.12	0.02	0.04	-	-	0.12	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	5.9	0.2	1.7	0.22	0.07	0.17	-	-	0.31	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	13.9	1.3	2.7	0.41	0.07	0.06	-	-	0.42	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	14.9	1.4	2.7	0.32	0.06	0.03	-	-	0.21	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	15.8	1.4	4.0	0.53	0.08	0.07	-	-	0.28	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	15.4	1.4	6.2	1.28	0.22	0.14	-	-	0.45	-	0.01	0.01	0.00	-	-	0.01	-	-	-
BLUEGILL	5.4	0.1	0.8	0.23	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.0	0.1	0.7	0.15	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	13.7	1.1	2.7	0.28	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.0	0.7	4.1	0.26	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 78, VERDIGRIS RIVER AT OOLOGAH, OK

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
BLUEGILL	4.7	0.1	1.4	0.04	0.02	0.03	-	-	0.18	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	15.0	1.7	8.3	0.21	0.08	0.04	-	-	0.21	-	0.03	0.00	0.00	-	-	-	-	0.02	-
CARP	14.8	1.6	5.8	1.22	0.29	0.11	-	-	1.01	-	0.01	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	14.3	2.3	3.8	0.17	0.08	0.09	-	-	0.40	-	0.02	0.00	0.00	-	-	-	-	0.01	-
BLUEGILL	6.8	0.1	4.0	0.02	0.02	0.02	-	-	0.11	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	6.2	0.1	5.3	0.03	0.01	0.01	-	-	0.06	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	10.6	0.5	2.8	0.04	0.02	0.02	-	-	0.11	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	11.1	0.7	2.2	0.02	0.02	0.01	-	-	0.06	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.1	0.7	5.8	0.05	0.04	0.04	-	-	0.10	-	0.03	0.01	0.00	-	-	0.01	-	-	-
LARGEMOUTH BASS	10.3	0.4	4.6	0.06	0.05	0.05	-	-	0.09	-	0.02	0.01	0.00	-	-	0.01	-	-	-
BLUEGILL	6.1	0.2	2.1	0.03	0.00	0.00	-	-	0.30	-	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.1	0.1	2.2	0.02	0.01	0.00	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	17.8	3.0	6.4	0.03	0.02	0.00	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	13.6	1.5	5.2	0.10	0.03	0.03	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.0	0.1	1.9	0.08	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.9	0.1	1.2	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	16.7	2.4	13.3	0.09	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.2	0.5	2.5	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 29, ARKANSAS RIVER AT KEYSTONE RESERVOIR, OK

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
BLUEGILL	5.4	0.1	1.2	0.04	0.03	0.04	-	-	0.33	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	13.4	1.2	3.4	0.12	0.04	0.04	-	-	0.36	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	13.9	1.3	4.0	0.14	0.07	0.06	-	-	0.55	-	0.02	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	14.3	1.7	6.5	0.17	0.18	0.15	-	-	1.25	-	0.04	0.00	0.00	-	-	-	-	0.10	-
BLUEGILL	5.7	0.1	0.8	0.05	0.03	0.04	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	5.6	0.1	1.6	0.05	0.06	0.09	-	-	0.67	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	12.8	0.8	1.8	0.07	0.06	0.04	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	14.6	1.4	1.2	0.04	0.03	0.03	-	-	0.26	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.1	1.1	7.9	0.15	0.18	0.14	-	-	1.32	-	0.04	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	16.7	1.2	10.6	0.15	0.20	0.14	-	-	1.25	-	0.07	0.01	0.00	-	-	0.00	-	-	-
BLUEGILL	6.3	0.3	2.8	0.06	0.02	0.00	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
CARP	11.7	0.8	3.0	0.06	0.02	0.00	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	13.3	1.1	3.3	0.07	0.01	0.00	-	-	0.50	-	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	15.5	2.3	6.1	0.09	0.08	0.00	-	-	0.00	-	0.05	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.6	0.1	1.9	0.06	0.05	0.00	0.0	-	0.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.6	0.1	2.6	0.05	0.00	0.00	0.0	-	0.00	0.4	0.03	0.00	0.00	-	-	0.00	-	-	-
CARP	12.4	0.9	6.9	0.06	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	9.5	0.5	3.1	0.04	0.05	0.00	0.0	-	0.00	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.1	0.1	0.6	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	12.5	0.8	0.7	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	11.3	0.6	0.8	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.7	1.1	3.1	0.05	0.00	0.00	0.0	-	0.31	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 77, ARKANSAS RIVER AT JOHN MARTIN RESERVOIR, CO

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	BLACK BULLHEAD	8.5	0.4	3.2	0.06	0.06	0.04	-	-	0.14	-	0.06	0.00	0.00	-	-	-	-	0.01	-
70	CARP	14.7	1.4	3.2	0.03	0.03	0.02	-	-	0.08	-	0.03	0.00	0.00	-	-	-	-	0.01	-
70	CARP	12.9	1.1	3.7	0.05	0.04	0.02	-	-	0.11	-	0.04	0.00	0.00	-	-	-	-	0.01	-
70	CHANNEL CATFISH	9.2	0.3	9.2	0.06	0.06	0.05	-	-	0.15	-	0.09	0.00	0.00	-	-	-	-	0.03	-
71	BLACK BULLHEAD	9.9	0.6	3.5	0.04	0.03	0.02	-	-	0.09	-	0.02	0.00	0.00	-	-	0.01	-	-	-
71	BLACK BULLHEAD	9.2	0.4	1.1	0.05	0.02	0.02	-	-	0.13	-	0.01	0.00	0.00	-	-	0.01	-	-	-
71	CARP	13.7	1.2	2.4	0.04	0.04	0.02	-	-	0.05	-	0.02	0.00	0.00	-	-	0.01	-	-	-
71	CARP	13.5	1.2	3.0	0.04	0.03	0.02	-	-	0.06	-	0.01	0.00	0.00	-	-	0.01	-	-	-
71	CHANNEL CATFISH	15.0	1.3	8.9	0.04	0.02	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	0.01	-	-	-
71	CHANNEL CATFISH	13.2	0.8	4.9	0.04	0.04	0.03	-	-	0.15	-	0.02	0.00	0.00	-	-	0.01	-	-	-
72	CARP	15.0	1.8	1.7	0.04	0.01	0.00	-	-	0.01	-	0.01	0.00	0.00	-	-	0.00	-	-	-
72	CARP	12.5	1.0	1.8	0.05	0.03	0.00	-	-	0.10	-	0.01	0.00	0.00	-	-	0.00	-	-	-
73	BLACK BULLHEAD	9.8	0.5	0.7	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	14.2	1.4	5.3	0.04	0.01	0.00	0.0	-	0.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-
73	CARP	14.4	1.5	6.0	0.04	0.02	0.00	0.0	-	0.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-
73	CHANNEL CATFISH	14.9	1.0	6.2	0.07	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 76, MISSISSIPPI RIVER AT MEMPHIS, TN/AR

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	CARP	19.0	4.0	6.4	1.02	0.46	0.33	-	-	3.26	-	0.10	0.04	0.00	-	-	-	-	0.01	-
70	CARPSUCKER	16.5	2.4	21.0	0.64	0.99	0.78	-	-	5.73	-	0.25	0.09	0.00	-	-	-	-	0.01	-
70	CARPSUCKER	17.0	2.9	17.3	0.73	0.91	0.65	-	-	4.04	-	0.18	0.05	0.00	-	-	-	-	0.01	-
70	FRESHWATER DRUM	20.0	3.9	17.0	0.96	1.37	1.71	-	-	8.07	-	0.24	0.09	0.00	-	-	-	-	0.01	-
70	CROSSCHECK	-	-	16.6	0.69	1.62	3.20	-	0.0	4.50	3.4	0.42	0.08	0.00	-	-	0.00	-	-	-
71	CARP	21.3	5.2	11.1	0.43	0.28	0.13	-	-	0.94	-	0.14	0.34	0.00	-	-	0.00	-	-	-
71	CARP	20.8	5.0	9.3	0.70	0.42	0.15	-	-	1.51	-	0.20	0.56	0.00	-	-	0.00	-	-	-
71	CARPSUCKER	18.5	4.0	18.9	0.54	0.55	0.64	-	-	1.15	-	0.27	0.82	0.00	-	-	0.00	-	-	-
71	CARPSUCKER	17.0	2.8	19.7	0.80	0.40	0.93	-	-	0.94	-	0.17	0.72	0.00	-	-	0.00	-	-	-
72	CARP	20.2	4.1	8.5	0.40	0.19	0.00	-	-	10.00	-	0.41	0.73	0.17	-	-	0.00	-	-	-
72	CARP	21.1	4.1	13.5	1.00	0.02	0.66	-	-	0.00	-	0.21	0.19	0.00	-	-	0.00	-	-	-
72	CHANNEL CATFISH	15.2	1.1	7.3	0.24	0.21	0.33	-	-	5.40	-	0.20	0.23	0.09	-	-	0.00	-	-	-
72	FRESHWATER DRUM	12.2	0.7	4.1	0.42	0.16	0.07	-	-	6.00	-	0.18	0.06	0.07	-	-	0.00	-	-	-
72	CROSSCHECK	-	-	4.8	0.44	0.00	0.24	-	0.0	2.80	3.0	0.12	0.04	0.00	0.16	-	2.00	0.00	-	-
73	CARP	19.7	4.1	5.5	0.46	0.01	0.00	0.0	-	1.50	0.0	0.11	0.11	0.00	-	-	0.00	-	-	-
73	CROSSCHECK	-	-	6.8	0.24	0.20	0.03	0.0	0.0	1.60	0.8	0.22	0.14	0.00	0.01	-	0.50	0.00	0.00	0.00
73	FLATHEAD CATFISH	15.1	1.6	9.3	1.20	0.16	0.00	0.0	-	13.00	0.0	0.46	0.51	0.00	-	-	0.00	-	-	-
73	FRESHWATER DRUM	14.9	1.8	9.1	0.34	0.44	0.41	0.0	-	5.40	0.0	0.61	0.46	0.00	-	-	0.00	-	-	-
73	FRESHWATER DRUM	10.5	0.8	7.0	0.54	0.88	0.48	0.0	-	5.90	0.0	0.07	0.03	0.00	-	-	0.00	-	-	-
74	CHANNEL CATFISH	17.9	2.1	17.5	0.15	0.25	0.19	0.0	-	0.85	0.0	0.42	0.19	0.00	-	-	0.00	-	-	-
74	CROSSCHECK	-	-	19.0	0.72	0.30	0.24	0.0	0.0	1.00	0.8	0.06	0.01	0.13	0.27	0.18	0.00	0.00	0.39	0.00
74	FRESHWATER DRUM	11.1	0.6	6.2	0.32	0.00	0.21	0.0	-	2.90	0.0	0.53	0.00	0.00	-	-	0.00	-	-	-
74	FRESHWATER DRUM	16.6	2.2	8.8	0.52	0.10	0.00	0.0	-	1.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	SMALLMOUTH BUFFALO	14.6	1.7	11.2	0.90	1.10	0.77	0.0	-	0.00	0.0	0.82	0.00	0.00	-	-	0.00	-	-	-

STATION 75, MISSISSIPPI RIVER AT CAPE GIRARDEAU, MO/IL

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	CARP	18.2	3.0	13.2	0.39	0.73	0.45	-	-	5.26	-	0.50	0.00	0.00	-	-	-	-	0.28	-
70	CROSSCHECK	-	-	12.4	0.32	0.48	0.11	-	12.8	5.40	3.2	1.09	0.00	0.15	-	-	10.00	-	-	-
70	CHANNEL CATFISH	15.4	1.3	12.4	0.20	0.52	0.35	-	-	3.96	-	0.34	0.00	0.00	-	-	-	-	0.30	-
70	CHANNEL CATFISH	15.7	1.2	11.8	0.17	0.40	0.22	-	-	3.07	-	0.26	0.00	0.00	-	-	-	-	0.02	-
70	WHITE CRAPPIE	10.7	0.7	3.0	0.21	0.44	0.30	-	-	3.59	-	0.24	0.00	0.00	-	-	-	-	0.14	-
71	CARP	10.5	3.0	0.5	0.22	0.37	0.17	-	-	2.24	-	0.18	0.01	0.00	-	-	0.00	-	-	-
71	CARP	18.6	3.2	9.1	0.23	0.25	0.11	-	-	1.54	-	0.19	0.01	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	16.0	1.2	5.5	0.21	0.34	0.20	-	-	3.80	-	0.10	0.01	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	16.3	1.3	4.9	0.17	0.28	0.18	-	-	2.60	-	0.09	0.01	0.00	-	-	0.00	-	-	-
71	WHITE CRAPPIE	10.4	0.6	2.5	0.07	0.12	0.08	-	-	1.59	-	0.08	0.01	0.00	-	-	0.00	-	-	-
71	WHITE CRAPPIE	11.8	1.2	5.2	0.12	0.22	0.10	-	-	3.10	-	0.17	0.01	0.00	-	-	0.00	-	-	-
71	CROSSCHECK	-	-	6.3	0.22	0.26	0.10	-	8.2	2.00	2.2	0.44	0.40	0.02	0.22	-	0.00	0.05	-	-
72	CARP	14.4	1.5	4.3	0.16	0.10	0.00	-	-	1.90	-	0.13	0.00	0.00	-	-	0.00	-	-	-
72	CARP	14.3	1.3	2.5	0.65	0.09	0.00	-	-	4.45	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	WHITE CATFISH	14.1	1.4	8.5	0.43	7.60	0.00	-	-	0.18	-	0.27	0.00	0.00	-	-	0.00	-	-	-
72	WHITE CRAPPIE	10.7	0.6	2.5	0.00	0.08	0.00	-	-	1.80	-	0.16	0.00	0.00	-	-	0.00	-	-	-
72	CROSSCHECK	-	-	2.8	0.14	0.07	0.04	-	0.5	1.80	0.8	0.20	0.00	0.00	0.10	-	0.00	0.05	-	-
73	CARP	14.7	1.7	8.2	0.10	0.08	0.00	0.0	-	1.70	0.0	0.27	0.00	0.00	-	-	0.00	-	-	-
73	CARP	12.4	1.1	6.9	0.10	0.06	0.00	0.0	-	2.10	0.0	0.24	0.00	0.00	-	-	0.00	-	-	-
73	CHANNEL CATFISH	12.3	0.7	5.8	0.26	0.00	0.00	0.0	-	0.00	1.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	WHITE CRAPPIE	9.0	0.4	2.6	0.07	0.07	0.00	0.0	-	0.80	0.0	0.19	0.00	0.00	-	-	0.00	-	-	-
74	CARP	11.7	0.9	4.3	0.13	0.20	0.00	0.0	-	2.20	0.0	0.19	0.00	0.00	-	-	0.00	-	-	-
74	CARP	11.8	0.9	3.2	0.15	0.09	0.00	0.0	-	0.00	2.5	0.12	0.00	0.00	-	-	0.00	-	-	-
74	WHITE CRAPPIE	7.7	0.3	1.0	0.09	0.07	0.00	0.0	-	1.20	0.0	0.11	0.00	0.00	-	-	0.00	-	-	-

ATION 26, ILLINOIS RIVER AT BEARDSTOWN, IL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
BIGMOUTH BUFFALO	18.6	3.9	7.9	0.06	0.06	0.03	-	-	0.25	-	0.48	0.01	0.00	-	-	-	-	0.05	-
CARP	14.2	1.4	8.0	0.13	0.11	0.07	-	-	0.73	-	0.36	0.00	0.00	-	-	-	-	0.04	-
CARP	16.3	2.1	7.6	0.27	0.13	0.10	-	-	0.92	-	0.24	0.00	0.00	-	-	-	-	0.03	-
WHITE CRAPPIE	7.3	0.2	2.8	0.06	0.07	0.06	-	-	0.57	-	0.48	0.00	0.40	-	-	-	-	0.01	-
CROSSCHECK	-	-	2.8	0.04	0.08	0.02	-	0.7	0.50	0.0	0.76	0.00	0.00	-	-	0.00	-	-	-
BIGMOUTH BUFFALO	16.4	3.0	4.8	0.07	0.09	0.03	-	-	0.34	-	0.21	0.01	0.00	-	-	0.00	-	-	-
BIGMOUTH BUFFALO	18.7	4.2	7.7	0.13	0.21	0.05	-	-	0.58	-	0.48	0.00	0.00	-	-	0.00	-	-	-
CROSSCHECK	-	-	8.3	0.47	0.23	0.04	-	4.7	0.90	0.4	0.30	0.00	0.05	0.15	-	0.00	0.00	-	-
CARP	15.1	1.6	4.2	0.11	0.12	0.06	-	-	0.72	-	0.12	0.01	0.00	-	-	0.00	-	-	-
CARP	13.9	1.4	5.7	0.11	0.12	0.06	-	-	0.55	-	0.21	0.00	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	8.9	0.4	1.3	0.10	0.11	0.08	-	-	0.89	-	0.13	0.01	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	9.4	0.5	2.2	0.09	0.13	0.07	-	-	0.81	-	0.18	0.01	0.00	-	-	0.00	-	-	-
CARP	14.2	1.3	4.9	0.17	0.16	0.00	-	-	2.10	-	0.31	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BUFFALO	13.2	1.2	4.2	0.10	0.08	0.00	-	-	1.20	-	0.20	0.00	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	10.1	0.6	3.5	0.09	0.09	0.00	-	-	1.40	-	0.18	0.00	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	9.6	0.5	3.8	0.07	0.10	0.00	-	-	0.00	-	0.19	0.00	0.00	-	-	0.00	-	-	-
BLACK CRAPPIE	5.6	0.1	1.2	0.05	0.03	0.00	0.0	-	1.20	0.0	0.10	0.00	0.00	-	-	0.00	-	-	-
CARP	12.2	1.0	4.2	0.05	0.09	0.00	0.0	-	1.00	0.0	0.21	0.00	0.00	-	-	0.00	-	-	-
CARP	12.6	1.1	5.9	0.12	0.08	0.00	0.0	-	1.90	0.0	0.20	0.00	0.00	-	-	0.00	-	-	-
FRESHWATER DRUM	9.4	0.4	7.6	0.08	0.01	0.00	0.0	-	2.00	0.0	0.89	0.00	0.03	-	-	0.00	-	-	-
BIGMOUTH BUFFALO	13.5	1.5	5.4	0.10	0.00	0.00	0.0	-	0.90	0.0	0.56	0.00	0.00	-	-	0.00	-	-	-
BLACK BULLHEAD	8.4	0.4	3.7	0.14	0.00	0.00	0.0	-	1.10	0.0	0.52	0.00	0.00	-	-	0.00	-	-	-
WHITE CRAPPIE	10.0	0.8	3.5	0.43	0.43	0.00	0.0	-	4.70	0.0	0.65	0.00	0.00	-	-	0.00	-	-	-

ATION 73, DES MOINES RIVER AT KEOSAUQUA, IA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
CARP	12.8	1.3	6.2	0.06	0.06	0.02	-	-	0.19	-	0.07	0.00	0.00	-	-	-	-	0.01	-
CARP	12.1	0.9	6.7	0.05	0.05	0.03	-	-	0.26	-	0.07	0.00	0.00	-	-	-	-	0.02	-
CHANNEL CATFISH	10.3	0.4	11.8	0.06	0.09	0.73	-	-	0.40	-	0.15	0.00	0.00	-	-	-	-	0.02	-
WALLEYE	12.6	0.9	6.8	0.15	0.20	0.18	-	-	1.44	-	0.29	0.00	0.00	-	-	-	-	0.03	-
CARP	12.5	0.9	4.7	0.04	0.04	0.02	-	-	0.15	-	0.08	0.01	0.00	-	-	0.00	-	-	-
CARP	13.0	1.2	8.3	0.06	0.05	0.02	-	-	0.17	-	0.06	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	12.6	0.7	11.6	0.13	0.15	0.12	-	-	0.97	-	0.11	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.0	0.7	6.2	0.10	0.13	0.10	-	-	0.74	-	0.11	0.01	0.00	-	-	0.00	-	-	-
SAUGER	13.9	0.9	4.2	0.13	0.13	0.11	-	-	1.12	-	0.10	0.01	0.00	-	-	0.00	-	-	-
WALLEYE	13.6	0.8	0.6	0.06	0.05	0.05	-	-	0.47	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	15.2	1.6	7.4	0.15	0.11	0.00	-	-	1.90	-	0.26	0.00	0.00	-	-	0.00	-	-	-
CARP	13.2	1.0	5.6	0.08	0.00	0.00	-	-	0.60	-	0.12	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.3	0.7	5.1	0.12	0.00	0.00	-	-	1.60	-	0.17	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	13.1	1.2	2.5	0.03	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	14.7	1.3	4.5	0.11	0.00	0.00	-	-	0.30	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	11.8	0.8	2.6	0.11	0.00	0.00	0.0	-	0.60	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-
CARP	11.8	0.8	2.2	0.09	0.09	0.00	0.0	-	0.40	0.0	0.16	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	10.7	0.4	3.0	0.09	0.03	0.00	0.0	-	0.90	0.0	0.15	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	7.4	0.1	0.4	0.01	0.00	0.00	0.0	-	0.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	14.5	1.6	8.3	0.10	0.00	0.00	0.0	-	0.50	0.0	0.60	0.00	0.00	-	-	0.00	-	-	-
CARP	14.8	1.8	9.7	0.21	0.00	0.00	0.0	-	0.80	0.0	0.86	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.6	1.2	7.1	0.19	0.00	0.00	0.0	-	0.90	0.0	0.42	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	11.1	0.5	4.0	0.02	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 27, MISSISSIPPI RIVER AT GUTTENBURG, IA/WI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	BLUEGILL	8.3	0.4	2.5	0.05	0.07	0.06	-	-	0.60	-	0.05	0.00	0.00	-	-	-	-	0.01
70	BLUEGILL	8.0	0.4	2.5	0.07	0.06	0.06	-	-	0.53	-	0.01	0.01	0.00	-	-	-	-	0.00
70	CARP	18.8	2.9	7.2	1.48	0.20	0.05	-	-	0.30	-	0.04	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	15.3	2.1	2.9	0.13	0.18	0.15	-	-	1.79	-	0.02	0.00	0.00	-	-	-	-	0.01
71	BLUEGILL	6.3	0.2	1.9	0.04	0.07	0.06	-	-	0.65	-	0.01	0.00	0.00	-	-	0.00	-	-
71	BLUEGILL	6.7	0.3	3.8	0.03	0.06	0.05	-	-	0.56	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CARP	17.9	3.5	6.8	0.08	0.14	0.11	-	-	1.00	-	0.02	0.00	0.00	-	-	0.00	-	-
71	CARP	19.5	4.4	10.2	0.11	0.18	0.13	-	-	1.42	-	0.05	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	13.8	2.0	3.0	0.06	0.12	0.10	-	-	0.90	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	13.2	1.9	3.0	0.09	0.16	0.15	-	-	1.32	-	0.01	0.00	0.00	-	-	0.00	-	-
72	BLUEGILL	7.3	0.3	3.0	0.00	0.02	0.00	-	-	0.40	-	0.02	0.00	0.00	-	-	0.00	-	-
72	CARP	16.5	2.2	7.7	0.00	0.02	0.00	-	-	1.00	-	0.01	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.6	0.9	2.6	0.00	0.02	0.00	-	-	1.40	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.2	0.8	3.2	0.00	0.00	0.00	-	-	1.10	-	0.00	0.00	0.00	-	-	0.00	-	-
73	BLUEGILL	7.3	0.3	2.6	0.01	0.00	0.00	0.0	-	0.49	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	BLUEGILL	4.7	0.1	1.8	0.01	0.00	0.00	0.0	-	0.37	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	17.8	2.7	8.8	0.03	0.00	0.00	0.0	-	1.20	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	12.2	1.2	3.2	0.01	0.00	0.00	0.0	-	0.96	0.0	0.02	0.00	0.00	-	-	0.00	-	-
74	BLUEGILL	6.4	0.2	2.9	0.09	0.02	0.00	0.0	-	1.10	0.0	0.03	0.00	0.00	-	-	0.00	-	-
74	BLUEGILL	6.3	0.2	3.3	0.06	0.04	0.00	0.0	-	0.60	0.0	0.04	0.00	0.00	-	-	0.00	-	-
74	CARP	16.2	5.2	8.5	0.11	0.06	0.00	0.0	-	1.50	0.0	0.06	0.00	0.00	-	-	0.00	-	-
74	LARGEMOUTH BASS	11.2	0.8	3.7	0.04	0.03	0.00	0.0	-	1.20	0.0	0.05	0.00	0.00	-	-	0.00	-	-

STATION 72, WISCONSIN RIVER AT WOODMAN, WI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUND TOXA-PHENE	HCB	A-BHC
70	CARP	18.2	3.3	7.3	0.09	0.12	0.05	-	-	0.67	-	0.02	0.00	0.00	-	-	-	-	0.01
70	CARP	19.3	4.0	9.9	0.10	0.09	0.04	-	-	0.48	-	0.03	0.00	0.00	-	-	-	-	0.01
70	CHANNEL CATFISH	16.7	2.1	2.7	0.43	0.05	0.02	-	-	0.17	-	0.01	0.00	0.00	-	-	-	-	0.01
70	SMALLMOUTH BASS	11.7	1.0	3.4	0.07	0.11	0.07	-	-	0.82	-	0.02	0.00	0.00	-	-	-	-	0.01
71	CARP	18.7	3.4	5.6	0.05	0.04	0.03	-	-	1.87	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CARP	20.5	4.0	7.4	0.09	0.11	0.04	-	-	1.02	-	0.00	0.00	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	16.3	1.4	10.2	0.10	0.15	0.10	-	-	1.20	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	17.4	1.6	4.9	0.07	0.09	0.06	-	-	1.02	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SAUGER	11.3	0.4	2.1	0.14	0.21	0.18	-	-	3.28	-	0.01	0.01	0.00	-	-	0.00	-	-
71	SAUGER	13.9	1.0	3.0	0.11	0.13	0.10	-	-	3.80	-	0.00	0.01	0.00	-	-	0.00	-	-
71	SMALLMOUTH BASS	10.8	0.7	2.4	0.05	0.10	0.06	-	-	2.55	-	0.01	0.01	0.00	-	-	0.00	-	-
71	SMALLMOUTH BASS	14.6	1.7	2.7	0.05	0.08	0.05	-	-	1.09	-	0.01	0.00	0.00	-	-	0.00	-	-
72	MOONEYE	10.3	0.4	5.8	0.00	0.04	0.00	-	-	2.10	-	0.02	0.00	0.00	-	-	0.00	-	-
72	SMALLMOUTH BUFFALO	15.6	2.3	7.2	0.06	0.08	0.00	-	-	2.90	-	0.03	0.00	0.00	-	-	0.00	-	-
72	WHITE SUCKER	15.2	1.5	2.5	0.03	0.03	0.02	-	-	0.70	-	0.02	0.00	0.00	-	-	0.00	-	-
72	WHITE SUCKER	13.0	1.2	2.7	0.01	0.02	0.01	-	-	0.10	-	0.01	0.05	0.00	-	-	0.00	-	-
73	CARP	21.3	4.6	9.5	0.09	0.00	0.00	1.7	-	0.50	0.0	0.03	0.00	0.00	-	-	0.00	-	-
73	CARP	20.0	4.0	9.5	0.08	0.00	0.00	1.8	-	0.00	0.8	0.04	0.00	0.00	-	-	0.00	-	-
73	SAUGER	14.3	0.7	1.8	0.06	0.00	0.00	0.8	-	0.00	0.8	0.00	0.00	0.00	-	-	0.00	-	-
73	SMALLMOUTH BASS	12.1	1.0	2.2	0.01	0.00	0.00	0.5	-	0.30	0.0	0.01	0.00	0.00	-	-	0.00	-	-
74	CARP	14.7	2.6	9.2	0.23	0.00	0.00	0.0	-	0.57	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	18.2	1.8	2.2	0.13	0.00	0.00	0.0	-	3.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SMALLMOUTH BASS	13.5	1.4	4.2	0.02	0.00	0.00	0.0	-	0.23	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SMALLMOUTH BASS	12.5	1.1	4.1	0.16	0.00	0.00	0.0	-	2.50	0.0	0.04	0.00	0.00	-	-	0.00	-	-

STATION 111, MISSISSIPPI RIVER AT LAKE CITY, MN/WI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-ORIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUND TOXA-PHENE	HCB	A-BHC
74	CARP	17.2	3.0	11.8	0.00	0.00	0.00	0.0	-	7.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SAUGER	15.5	1.5	2.7	0.34	0.00	0.00	0.0	-	14.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SAUGER	16.0	1.6	10.2	0.40	0.44	0.00	0.0	-	15.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	10.7	0.12	0.16	0.02	0.0	0.0	1.95	0.9	0.03	0.02	0.01	0.06	0.02	0.00	0.02	0.08
74	WHITE SUCKER	16.7	0.2	6.0	0.17	0.10	0.00	0.0	-	7.50	0.0	0.05	0.00	0.00	-	-	0.00	-	-

IDN 74, MISSISSIPPI RIVER AT LITTLE FALLS, MN

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES			PCB'S (AROCLOR MIXTURES)				CYCLODIENE INSECTICIDES					OTHER COMPOUNDS			
				ODE	DDD	DDT	1242	1248	1254	1260	DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	TOXAPHENE	HCB	A-BHC	G-BHC
NORTHERN PIKE	14.3	0.8	1.3	0.04	0.03	0.02	-	-	0.22	-	0.01	0.00	0.00	-	-	-	-	0.01	-
WHITE SUCKER	13.5	1.2	1.6	0.03	0.05	0.03	-	-	0.27	-	0.01	0.00	0.00	-	-	-	-	0.01	-
WHITE SUCKER	13.8	1.2	2.0	0.13	0.09	0.06	-	-	0.35	-	0.01	0.00	0.00	-	-	-	-	0.01	-
YELLOW BULLHEAD	10.2	0.8	6.8	0.04	0.12	0.18	-	-	0.31	-	0.01	0.00	0.00	-	-	-	-	0.01	-
BLACK BULLHEAD	7.1	0.3	3.2	0.02	0.02	0.02	-	-	0.11	-	0.01	0.01	0.00	-	-	0.00	-	-	-
BLACK BULLHEAD	7.0	0.3	3.0	0.02	0.02	0.01	-	-	0.08	-	0.01	0.01	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	18.2	1.4	1.3	0.04	0.02	0.02	-	-	0.13	-	0.01	0.01	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	13.7	0.4	0.1	0.02	0.01	0.02	-	-	0.13	-	0.01	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	18.8	2.9	0.4	0.12	0.04	0.06	-	-	0.38	-	0.01	0.01	0.00	-	-	0.00	-	-	-
WHITE SUCKER	18.6	2.8	0.2	0.06	0.02	0.03	-	-	0.19	-	0.01	0.01	0.00	-	-	0.00	-	-	-
NORTHERN PIKE	25.9	3.9	1.0	0.03	0.01	0.01	-	-	0.02	-	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	18.7	3.1	3.0	0.00	0.00	0.00	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	18.5	2.9	2.3	0.00	0.00	0.00	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW BULLHEAD	11.5	2.1	3.7	0.15	0.01	0.01	-	-	0.02	-	0.00	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	10.0	0.4	1.1	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	17.0	2.1	1.8	0.01	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
YELLOW BULLHEAD	9.9	0.6	4.0	0.07	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLACK BULLHEAD	9.6	0.6	4.0	0.03	0.00	0.00	0.0	-	0.23	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLACK BULLHEAD	9.8	0.6	2.4	0.02	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WHITE SUCKER	18.0	2.3	2.4	0.04	0.00	0.00	0.0	-	0.33	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 70, OHIO RIVER AT METROPOLIS, IL/KY

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CARP	15.0	1.8	6.1	0.22	0.28	0.20	-	-	2.01	-	0.08	0.00	0.00	-	-	-	-	0.0
70	CHANNEL CATFISH	11.5	0.5	5.9	0.20	0.37	0.32	-	-	3.78	-	0.04	0.00	0.00	-	-	-	-	0.0
70	WHITE CRAPPIE	9.9	0.5	2.2	0.28	0.34	0.29	-	-	3.12	-	0.08	0.00	0.00	-	-	-	-	0.0
70	WHITE CRAPPIE	10.0	0.4	1.3	0.25	0.27	0.25	-	-	2.39	-	0.06	0.00	0.00	-	-	-	-	0.0
71	CARP	18.4	3.6	5.0	0.60	0.40	0.28	-	-	3.33	-	0.07	0.01	0.00	-	-	0.00	-	-
71	CARP	17.3	2.8	6.8	0.32	0.26	0.14	-	-	2.99	-	0.08	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.1	0.9	8.3	0.26	0.59	0.41	-	-	5.99	-	0.05	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.6	1.0	9.4	0.34	0.57	0.41	-	-	6.15	-	0.04	0.01	0.00	-	-	0.00	-	-
71	WHITE CRAPPIE	10.4	0.7	3.3	0.23	0.30	0.14	-	-	1.38	-	0.05	0.01	0.00	-	-	0.00	-	-
71	WHITE CRAPPIE	10.1	0.6	1.6	0.23	0.28	0.32	-	-	2.99	-	0.05	0.01	0.00	-	-	0.00	-	-
72	CARP	17.7	3.0	8.5	0.48	0.88	0.00	-	-	7.10	-	0.05	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	-	-	9.6	0.00	0.00	0.00	-	-	5.70	-	0.44	0.00	0.00	-	-	0.00	-	-
72	WHITE CRAPPIE	11.4	0.9	4.9	0.15	0.00	0.00	-	-	2.70	-	0.23	0.00	0.00	-	-	0.00	-	-
72	WHITE CRAPPIE	11.2	0.9	4.6	0.15	0.03	0.00	-	-	3.10	-	0.18	0.00	0.00	-	-	0.00	-	-
73	CARP	17.6	2.6	6.4	0.34	0.20	0.00	0.0	-	1.40	0.0	0.05	0.02	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	14.6	1.1	12.6	0.22	0.25	0.00	0.0	-	5.00	0.0	0.15	0.06	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	14.5	0.17	0.16	0.03	0.0	1.3	2.30	5.0	0.19	1.00	0.02	0.03	-	0.00	0.07	0.0
73	WHITE CRAPPIE	10.9	0.6	4.3	0.11	0.16	0.00	0.0	-	1.30	0.0	0.02	0.01	0.00	-	-	0.00	-	-
73	WHITE CRAPPIE	10.0	0.5	4.5	0.09	0.15	0.00	0.0	-	1.20	0.0	0.02	0.01	0.00	-	-	0.00	-	-
74	CARP	15.9	1.8	4.3	0.59	0.25	0.00	0.0	-	2.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	9.6	0.2	7.0	0.00	0.00	0.00	0.0	-	2.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE CRAPPIE	7.8	0.4	1.3	0.21	0.10	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	WHITE CRAPPIE	7.3	0.2	1.9	0.15	0.00	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 71, TENNESSEE RIVER AT SAVANNAH, TN

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CARP	16.0	1.9	4.8	0.89	0.67	0.01	-	-	1.46	-	0.02	0.01	0.00	-	-	-	-	0.1
70	CHANNEL CATFISH	12.8	0.6	7.3	1.02	1.20	0.49	-	-	4.17	-	0.03	0.02	0.00	-	-	-	-	0.2
70	CHANNEL CATFISH	13.0	0.6	7.2	1.12	1.27	0.51	-	-	4.48	-	0.03	0.02	0.00	-	-	-	-	0.2
70	LARGEMOUTH BASS	15.2	2.2	2.3	0.77	0.46	0.18	-	-	1.20	-	0.01	0.01	0.00	-	-	-	-	0.0
71	CARP	17.3	2.4	4.7	0.37	0.38	0.06	-	-	0.34	-	0.01	0.04	0.00	-	-	0.00	-	-
71	CARP	17.3	2.7	2.8	0.33	0.34	0.05	-	-	0.33	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	13.4	0.8	7.5	0.85	0.93	0.28	-	-	3.23	-	0.02	0.01	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	7.6	1.02	1.22	0.30	-	0.0	2.40	1.3	0.02	0.06	0.00	0.00	-	0.00	0.06	-
71	CHANNEL CATFISH	12.5	0.7	7.0	0.77	0.73	0.26	-	-	3.13	-	0.02	0.02	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	12.9	1.2	1.5	0.36	0.23	0.08	-	-	0.63	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	12.9	1.1	1.6	0.30	0.25	0.09	-	-	0.63	-	0.01	0.01	0.00	-	-	0.00	-	-
72	CARP	19.3	3.7	7.0	1.60	1.70	0.00	-	-	6.60	-	0.00	0.19	0.00	-	-	0.00	-	-
72	CARP	18.4	2.7	6.5	1.20	1.40	0.00	-	-	2.70	-	0.00	0.18	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	9.5	0.3	3.3	2.20	1.80	0.40	-	-	11.00	-	0.00	0.21	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	4.7	2.40	1.13	0.52	-	3.2	4.70	7.8	0.05	0.23	0.00	0.00	-	0.00	0.04	-
72	WHITE SUCKER	15.0	1.4	3.1	0.75	0.85	0.00	-	-	3.20	-	0.00	0.15	0.00	-	-	0.00	-	-
73	BLUEGILL	5.5	0.1	2.1	0.31	0.15	0.00	0.0	-	1.20	0.0	0.01	0.02	0.00	-	-	0.00	-	-
73	CARP	17.1	2.6	7.7	0.37	0.38	0.00	0.0	-	1.20	0.0	0.16	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	7.8	0.30	0.12	0.03	0.0	0.0	2.00	1.0	0.03	1.90	0.00	0.00	-	0.50	0.01	0.0
73	CARP	17.9	3.0	6.5	0.89	0.64	0.00	0.0	-	1.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	16.3	2.1	4.5	1.60	0.62	0.00	0.0	-	9.80	0.0	0.01	0.02	0.00	-	-	1.10	-	-
73	LARGEMOUTH BASS	11.1	0.8	1.8	1.40	0.61	0.00	0.0	-	3.10	0.0	0.11	0.00	0.00	-	-	1.40	-	-
74	CARP	16.1	1.8	1.1	0.24	0.33	0.29	0.0	-	1.30	0.0	0.45	0.19	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	1.6	0.30	0.12	0.00	0.0	0.0	0.95	0.3	0.01	0.02	0.00	0.02	0.01	0.00	0.00	0.0
74	CARP	13.6	0.7	1.5	0.65	0.21	0.02	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	17.5	2.3	8.4	0.57	0.65	0.17	0.0	-	1.10	0.0	0.00	0.21	0.00	-	-	0.00	-	-
74	LARGEMOUTH BASS	12.9	1.2	8.1	0.21	0.00	0.00	0.0	-	0.85	0.0	0.00	0.00	0.00	-	-	0.00	-	-

ION 25, CUMBERLAND RIVER AT CLARKSVILLE, TN

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
LUEGILL	5.8	0.1	2.6	0.17	0.18	0.13	-	-	1.20	-	0.01	0.00	0.00	-	-	-	-	0.01	-
LUEGILL	5.8	0.1	1.5	0.09	0.12	0.09	-	-	0.89	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARP	13.5	1.4	2.0	0.23	0.34	0.15	-	-	1.67	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARGEMOUTH BASS	11.0	0.8	3.2	0.26	0.47	0.26	-	-	2.92	-	0.02	0.00	0.00	-	-	-	-	0.02	-
LUEGILL	5.5	0.1	1.8	0.14	0.16	0.15	-	-	1.64	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LUEGILL	6.0	0.1	1.4	0.15	0.17	0.15	-	-	1.64	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	10.8	0.5	0.8	0.05	0.06	0.07	-	-	0.92	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	9.5	0.4	0.9	0.05	0.05	0.05	-	-	0.45	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	9.6	0.6	2.2	0.10	0.14	0.13	-	-	1.19	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LUEGILL	6.5	0.1	2.0	0.25	0.07	0.00	-	-	3.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.2	0.1	2.0	0.19	0.06	0.00	-	-	2.10	-	0.02	0.00	0.00	-	-	0.00	-	-	-
ARP	16.3	1.9	3.7	2.20	0.41	0.00	-	-	16.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	13.4	1.6	3.9	0.43	0.24	0.00	-	-	5.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
LUEGILL	6.0	0.1	1.8	0.07	0.05	0.00	0.0	-	1.60	0.0	0.01	0.01	0.00	-	-	0.00	-	-	-
LUEGILL	5.8	0.1	1.4	0.10	0.00	0.00	0.0	-	1.50	0.0	0.01	0.01	0.00	-	-	0.00	-	-	-
ARP	15.1	1.7	4.3	0.36	0.00	0.00	0.0	-	4.30	0.0	0.01	0.01	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	4.5	0.39	0.36	0.02	0.0	0.0	2.00	0.4	0.01	0.00	0.00	0.01	-	0.50	0.01	0.00	0.00
ARGEMOUTH BASS	15.3	2.3	4.1	0.32	0.19	0.00	0.0	-	5.80	0.0	0.04	0.02	0.00	-	-	0.00	-	-	-
LUEGILL	6.5	0.4	4.6	0.26	0.14	0.00	0.0	-	3.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	15.8	1.7	4.3	0.47	0.20	0.00	0.0	-	4.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	4.9	0.22	0.13	0.01	0.0	0.0	1.52	0.5	0.01	0.01	0.01	0.06	0.02	0.00	0.00	0.02	0.01
ARP	14.8	1.5	6.0	0.55	0.20	0.00	0.0	-	3.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.0	0.7	2.4	0.10	0.00	0.00	0.0	-	0.98	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 68, WABASH RIVER AT NEW HARMONY, IN/IL

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
ARP	16.8	2.3	5.2	0.13	0.33	0.23	-	-	3.10	-	0.08	0.00	0.00	-	-	-	-	0.01	-
HANNEL CATFISH	12.4	0.7	7.0	0.10	0.15	0.08	-	-	1.07	-	0.09	0.00	0.00	-	-	-	-	0.03	-
HITE CRAPPIE	8.6	0.3	0.8	0.07	0.13	0.08	-	-	1.00	-	0.04	0.00	0.00	-	-	-	-	0.01	-
HITE CRAPPIE	7.6	0.2	0.8	0.06	0.11	0.06	-	-	0.82	-	0.04	0.00	0.00	-	-	-	-	0.01	-
ARP	19.8	4.3	7.0	0.31	0.36	0.32	-	-	1.15	-	0.16	0.00	0.00	-	-	0.00	-	-	-
ARP	19.2	3.5	9.3	0.33	0.29	0.11	-	-	1.12	-	0.19	0.01	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	16.0	1.6	8.1	0.32	0.46	0.34	-	-	4.77	-	0.30	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	9.0	0.35	0.08	0.03	-	4.8	8.00	2.6	0.49	0.00	0.00	0.32	-	0.00	0.02	-	-
HANNEL CATFISH	17.7	1.9	5.5	0.22	0.30	0.26	-	-	3.13	-	0.14	0.01	0.00	-	-	0.00	-	-	-
HITE CRAPPIE	9.2	0.4	0.7	0.35	0.43	0.34	-	-	2.48	-	0.24	0.01	0.00	-	-	0.00	-	-	-
HITE CRAPPIE	9.5	0.4	0.7	0.06	0.09	0.05	-	-	0.70	-	0.06	0.01	0.00	-	-	0.00	-	-	-
ARP	17.4	2.8	5.9	0.00	0.03	0.00	-	-	1.60	-	0.13	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	11.3	0.3	3.9	0.00	0.00	0.00	-	-	3.30	-	0.04	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	4.1	0.06	0.00	0.06	-	1.1	1.50	1.0	0.14	0.00	0.00	0.11	-	0.00	0.01	-	-
HITE CRAPPIE	9.3	0.4	1.7	0.05	0.02	0.00	-	-	0.80	-	0.08	0.00	0.00	-	-	0.00	-	-	-
HITE CRAPPIE	8.0	0.4	1.7	1.00	0.01	0.00	-	-	0.00	-	0.09	0.00	0.00	-	-	0.00	-	-	-
ARP	17.5	2.9	6.9	0.30	0.10	0.00	0.0	-	0.40	0.0	0.29	0.00	0.00	-	-	0.00	-	-	-
ARP	18.9	3.6	5.4	0.14	0.10	0.06	0.0	-	1.10	0.0	0.23	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	14.6	0.9	5.1	0.16	0.07	0.04	0.0	-	2.10	0.0	0.17	0.00	0.00	-	-	0.00	-	-	-
HITE CRAPPIE	9.2	0.4	2.6	0.06	0.04	0.00	0.0	-	1.00	0.0	0.17	0.00	0.00	-	-	0.00	-	-	-
ARP	17.0	2.4	5.1	0.00	0.00	0.00	0.0	-	4.50	0.0	0.72	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	15.5	1.1	6.6	0.00	0.00	0.00	0.0	-	1.40	0.0	0.80	0.00	0.00	-	-	0.00	-	-	-
HITE CRAPPIE	7.0	0.2	2.4	0.00	0.00	0.00	0.0	-	0.85	0.0	0.21	0.00	0.00	-	-	0.00	-	-	-

STATION 69, OHIO RIVER AT CINCINNATI, OH/KY

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	CARP	18.5	3.1	14.4	1.28	3.59	2.55	-	-	23.40	-	0.15	0.00	0.00	-	-	-	-	1.77
70	CARP	18.6	3.3	12.7	1.54	4.14	2.99	-	-	24.70	-	0.14	0.00	0.00	-	-	-	-	1.75
70	CROSSCHECK	-	-	10.1	0.38	0.20	0.05	-	75.0	42.00	6.0	0.18	0.02	0.10	-	-	0.00	-	-
70	SAUGER	13.9	0.9	5.2	1.04	2.84	1.93	-	-	18.20	-	0.08	0.00	0.00	-	-	-	-	0.59
70	WHITE CRAPPIE	8.6	0.3	1.5	1.07	3.12	1.85	-	-	20.80	-	0.08	0.00	0.00	-	-	-	-	0.60
70	CROSSCHECK	-	-	11.4	0.08	0.20	0.08	-	17.0	27.00	5.6	0.48	0.00	0.08	-	-	0.00	-	-
71	CARP	15.3	1.9	9.1	0.91	1.07	1.46	-	-	33.90	-	0.16	0.01	0.00	-	-	0.00	-	-
71	CARP	14.4	1.7	10.8	0.62	1.07	0.85	-	-	17.60	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.5	1.3	7.1	1.01	2.77	1.79	-	-	32.60	-	0.10	0.01	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	7.7	0.02	0.24	0.18	-	75.0	67.00	14.0	0.23	0.00	0.00	0.78	-	0.00	0.13	-
71	CHANNEL CATFISH	14.3	0.9	3.7	0.35	1.85	1.11	-	-	22.10	-	0.07	0.01	0.00	-	-	0.00	-	-
71	SAUGER	12.9	0.8	5.7	0.39	0.63	0.48	-	-	13.30	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SAUGER	12.7	0.7	5.4	0.46	0.91	0.59	-	-	9.90	-	0.09	0.01	0.00	-	-	0.00	-	-
72	CARP	14.8	1.6	6.3	0.00	0.17	0.00	-	-	19.00	-	0.16	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	7.5	0.01	0.11	0.05	-	8.4	9.90	2.0	0.15	0.00	0.00	0.28	-	0.00	0.03	-
72	CHANNEL CATFISH	14.9	1.1	5.5	0.00	0.10	0.00	-	-	30.00	-	0.14	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	8.0	1.03	0.07	0.14	-	17.0	23.00	3.0	0.22	0.00	0.04	0.38	-	0.00	0.06	-
72	SAUGER	11.7	0.5	3.3	0.00	0.18	0.00	-	-	16.20	-	0.16	0.00	0.00	-	-	0.00	-	-
72	SAUGER	12.8	0.9	8.5	0.00	0.00	0.00	-	-	30.00	-	0.10	0.00	0.00	-	-	0.00	-	-
73	CARP	16.4	2.2	7.9	0.00	0.08	0.00	0.0	-	25.00	0.0	0.14	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	16.4	1.5	5.0	0.00	0.09	0.00	0.0	-	25.00	0.0	0.08	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	4.4	0.30	0.01	0.03	0.0	2.5	40.00	3.0	0.12	0.00	0.00	0.01	-	0.00	0.04	0.00
73	CHANNEL CATFISH	16.9	1.5	5.9	0.00	0.02	0.00	0.0	-	18.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	SAUGER	10.4	0.4	2.4	0.00	0.00	0.00	0.0	-	2.40	0.0	0.01	0.00	0.00	-	-	0.00	-	-
74	CARP	15.4	1.9	9.3	0.00	0.15	0.00	0.0	-	9.10	0.0	0.17	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	16.7	1.5	4.4	0.00	0.20	0.00	0.0	-	39.00	0.0	0.28	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	3.9	0.32	0.30	0.09	0.0	0.0	14.45	3.9	0.00	0.00	0.00	0.56	0.14	0.00	0.00	0.16
74	CHANNEL CATFISH	13.8	0.8	6.7	0.00	0.16	0.00	0.0	-	26.00	0.0	0.48	0.00	0.00	-	-	0.00	-	-
74	WHITE CRAPPIE	10.1	0.6	5.0	0.00	0.13	0.00	0.0	-	4.10	0.0	0.33	0.00	0.00	-	-	0.00	-	-

STATION 23, KANAWHA RIVER AT WINFIELD, WV

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	BLACK CRAPPIE	6.8	0.2	3.9	0.19	0.39	0.18	-	-	2.45	-	0.03	0.00	0.00	-	-	-	-	0.21
70	BROWN BULLHEAD	6.4	0.2	5.9	0.06	0.19	0.07	-	-	0.62	-	0.03	0.00	0.00	-	-	-	-	0.13
70	BROWN BULLHEAD	6.5	0.2	6.8	0.57	1.82	0.91	-	-	14.30	-	0.06	0.00	0.00	-	-	-	-	0.16
70	CROSSCHECK	-	-	6.2	0.30	0.16	0.05	-	0.0	0.90	0.6	0.01	0.00	0.08	-	-	0.00	-	-
70	CARP	8.9	0.4	5.5	0.23	0.27	0.15	-	-	1.25	-	0.07	0.00	0.00	-	-	-	-	0.11
71	BROWN BULLHEAD	10.9	0.8	6.5	0.19	0.30	0.16	-	-	1.35	-	0.02	0.00	0.00	-	-	0.00	-	-
71	BROWN BULLHEAD	11.5	0.8	6.4	0.23	0.42	0.18	-	-	1.77	-	0.02	0.00	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	7.1	0.16	0.11	0.06	-	3.1	2.40	1.2	0.04	0.00	0.07	0.17	-	2.00	0.08	-
71	CARP	11.3	0.9	6.4	0.05	0.10	0.06	-	-	0.60	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CARP	12.0	1.0	7.9	0.09	0.09	0.02	-	-	0.62	-	0.02	0.00	0.00	-	-	0.00	-	-
71	WHITE CRAPPIE	9.2	0.5	4.6	0.18	0.29	0.17	-	-	1.77	-	0.02	0.00	0.00	-	-	0.00	-	-
71	WHITE CRAPPIE	9.2	0.5	4.6	0.16	0.24	0.15	-	-	1.61	-	0.02	0.00	0.00	-	-	0.00	-	-
72	BROWN BULLHEAD	10.4	0.5	7.6	0.00	0.18	0.00	-	-	2.90	-	0.00	0.00	0.00	-	-	0.00	-	-
72	BROWN BULLHEAD	10.9	0.5	1.8	0.00	0.23	0.00	-	-	3.10	-	0.01	0.00	0.00	-	-	0.00	-	-
72	CARP	10.1	1.4	7.2	0.75	0.00	0.00	-	-	13.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	WHITE CRAPPIE	7.5	0.2	1.1	0.13	0.06	0.00	-	-	2.60	-	0.00	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	1.6	0.07	0.00	0.03	-	0.1	1.00	0.6	0.01	0.00	0.00	0.07	-	0.50	0.02	-
73	BROWN BULLHEAD	11.9	0.8	6.0	0.00	0.00	0.00	3.9	-	3.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	11.4	0.7	2.2	0.00	0.00	0.00	2.3	-	1.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	2.7	0.01	0.00	0.00	0.3	0.0	0.80	0.2	0.01	0.00	0.00	0.03	-	0.00	0.03	0.02
73	PUMPKINSEED	7.6	0.2	2.7	0.00	0.00	0.00	3.7	-	0.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	PUMPKINSEED	9.0	0.4	10.2	0.09	0.00	0.00	0.0	-	2.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BLACK CRAPPIE	9.2	0.4	4.5	0.11	0.05	0.00	0.0	-	6.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BLACK CRAPPIE	7.5	0.2	2.3	0.03	0.03	0.00	0.0	-	1.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BROWN BULLHEAD	9.2	0.4	6.5	0.05	0.09	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	16.2	2.3	4.2	0.05	0.05	0.00	0.0	-	1.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	5.0	0.09	0.06	0.02	0.0	0.0	0.90	0.8	0.03	0.01	0.01	0.10	0.02	0.00	0.02	0.02

ON 24, OHIO RIVER AT MARIETTA, OH/WV

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
ARP	15.1	2.4	8.2	0.56	0.81	0.38	-	-	4.82	-	0.12	0.00	0.00	-	-	-	-	0.13	-
CHANNEL CATFISH	14.8	0.8	8.9	1.04	1.42	0.85	-	-	11.70	-	0.03	0.00	0.00	-	-	-	-	0.13	-
HOGSCHECK	-	-	7.9	0.24	0.26	0.10	-	5.2	12.60	4.6	0.06	0.00	0.02	-	-	0.00	-	-	-
CHANNEL CATFISH	14.9	0.9	10.4	1.30	1.58	0.90	-	-	12.00	-	0.04	0.00	0.00	-	-	-	-	0.16	-
HOGSCHECK	-	-	9.3	0.24	0.22	0.20	-	23.0	11.00	4.9	0.03	0.00	0.00	-	-	0.00	-	-	-
EDHORSE	11.7	0.6	3.4	0.25	0.41	0.26	-	-	2.50	-	0.03	0.00	0.00	-	-	-	-	0.12	-
ARP	19.1	3.9	7.0	0.17	0.22	0.12	-	-	7.16	-	0.03	0.01	0.00	-	-	0.00	-	-	-
ARP	14.0	1.4	7.0	0.09	0.13	0.07	-	-	3.23	-,	0.02	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.8	1.1	11.7	0.46	0.57	0.33	-	-	11.80	-	0.05	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.1	0.7	12.7	0.53	0.81	0.37	-	-	17.20	-	0.05	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.6	1.5	9.9	0.40	0.53	0.27	-	-	20.60	-	0.07	0.01	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	11.0	0.04	0.14	0.12	-	59.0	14.00	3.8	0.14	0.01	0.00	0.54	-	0.00	0.23	-	-
LARGEMOUTH BASS	13.3	1.4	9.9	0.48	0.65	0.33	-	-	24.70	-	0.07	0.01	0.00	-	-	0.00	-	-	-
ARP	13.1	1.2	4.6	0.44	0.04	0.00	-	-	2.50	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	14.6	0.9	6.8	0.45	0.20	0.00	-	-	9.50	-	0.00	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	9.2	0.32	0.05	0.10	-	9.6	5.00	1.3	0.04	0.00	0.00	0.36	-	0.00	0.08	-	-
CHANNEL CATFISH	14.3	0.8	6.1	0.65	0.13	0.11	-	-	11.00	-	0.05	0.00	0.00	-	-	0.00	-	-	-
EDHORSE	10.4	0.8	4.0	0.00	0.00	0.00	-	-	3.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	14.9	1.8	11.8	0.00	0.00	0.00	6.7	-	4.30	0.0	0.06	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	12.8	0.03	0.06	0.05	0.0	4.5	1.00	0.5	0.03	0.02	0.00	0.13	-	0.00	0.08	0.07	0.01
CHANNEL CATFISH	15.0	1.0	8.3	0.00	0.13	0.00	15.0	-	9.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	8.8	0.12	0.06	0.16	0.0	4.5	1.50	1.5	0.03	0.02	0.00	0.19	-	0.00	0.29	0.11	0.00
CHANNEL CATFISH	14.3	0.9	10.4	0.00	0.00	0.00	11.0	-	13.00	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
POTTED SUCKER	12.4	0.7	2.7	0.00	0.00	0.00	1.6	-	1.40	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	13.6	1.5	12.4	0.00	0.00	0.00	0.0	-	2.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	13.8	1.2	10.0	0.00	0.00	0.00	0.0	-	8.70	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	7.8	0.07	0.00	0.02	0.0	0.0	1.64	0.6	0.03	0.01	0.01	0.18	0.06	0.00	0.02	0.02	0.01
POTTED BASS	8.7	0.3	6.3	0.00	0.00	0.00	0.0	-	1.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
POTTED BASS	8.0	0.2	4.3	0.00	0.00	0.00	0.0	-	2.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ON 67, ALLEGHENY RIVER AT NATRONA, PA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
BLUEGILL	5.5	0.2	3.2	0.24	0.89	0.69	-	-	7.45	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARP	14.8	2.0	6.6	0.43	0.65	0.47	-	-	4.38	-	0.01	0.00	0.00	-	-	-	-	0.06	-
ARP	14.8	2.0	8.2	0.42	0.66	0.45	-	-	4.79	-	0.02	0.00	0.00	-	-	-	-	0.09	-
WALLEYE	12.7	0.6	5.0	0.81	2.37	1.91	-	-	24.80	-	0.01	0.00	0.00	-	-	-	-	0.06	-
HOGSCHECK	-	-	4.0	0.08	0.04	0.05	-	5.2	25.00	4.6	0.03	0.00	0.00	-	-	0.00	-	-	-
ARP	16.4	1.9	9.2	0.70	0.80	0.65	-	-	5.47	-	0.02	0.00	0.00	-	-	0.00	-	-	-
ARP	18.8	3.8	10.2	0.51	0.68	0.56	-	-	5.57	-	0.02	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	12.4	0.7	8.4	0.70	1.35	1.16	-	-	13.40	-	0.04	0.01	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	8.3	0.07	0.10	0.05	-	23.0	35.00	6.6	0.07	0.00	0.00	0.42	-	0.00	0.04	-	-
WALLEYE	16.4	1.5	4.7	0.67	0.85	0.83	-	-	9.69	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	9.6	0.5	2.7	0.05	0.11	0.10	-	-	0.92	-	0.01	0.00	0.00	-	-	0.00	-	-	-
YELLOW PERCH	7.9	0.2	2.3	0.08	0.15	0.15	-	-	1.52	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	17.8	2.9	7.0	0.13	0.03	0.00	-	-	4.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	9.9	0.4	3.0	0.12	0.05	0.03	-	-	4.90	-	0.02	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	11.0	0.7	4.3	0.19	0.07	0.01	-	-	6.40	-	0.02	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	15.6	1.0	2.9	1.30	0.11	0.00	-	-	21.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	3.0	0.57	0.00	0.19	-	7.3	13.00	3.1	0.04	0.02	0.00	0.42	-	0.00	0.01	-	-
ARP	16.8	2.3	5.4	0.05	0.00	0.00	0.0	-	2.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	6.2	0.03	0.05	0.02	0.0	0.3	1.00	0.5	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00
ARP	17.2	2.5	5.1	0.13	0.00	0.00	0.0	-	1.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SMALLMOUTH BASS	10.8	0.8	3.7	0.06	0.00	0.00	0.0	-	1.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
WALLEYE	15.3	1.2	5.0	0.17	0.00	0.00	0.0	-	9.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.3	0.2	4.6	0.07	0.09	0.00	0.2	-	1.90	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.2	0.2	3.7	0.11	0.16	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	12.6	2.6	6.4	0.60	0.00	0.00	0.0	-	10.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HOGSCHECK	-	-	4.9	0.21	0.06	0.05	0.0	0.0	5.25	1.2	0.02	0.01	0.01	0.07	0.03	0.00	0.00	0.01	0.01
WALLEYE	13.4	0.8	4.4	0.55	0.16	0.00	0.0	-	10.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 83, MISSOURI RIVER AT HERRMAN, MO

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	BIGMOUTH BUFFALO	17.9	3.7	6.5	0.13	0.20	0.12	-	-	0.94	-	0.40	0.00	0.00	-	-	-	-	0.0
70	CARP	19.4	3.7	9.5	0.15	0.27	0.13	-	-	1.90	-	0.27	0.00	0.00	-	-	-	-	0.0
70	CARP	18.8	2.9	6.8	0.14	0.15	0.07	-	-	0.68	-	0.19	0.00	0.00	-	-	-	-	0.0
70	CHANNEL CATFISH	18.3	2.0	7.9	0.64	0.98	0.44	-	-	3.12	-	0.31	0.00	0.00	-	-	-	-	0.0
70	CROSSCHECK	-	-	4.6	0.30	1.06	0.15	-	0.0	3.10	1.8	0.31	0.00	0.00	-	-	0.00	-	-
71	CARP	17.5	2.4	9.3	0.15	0.17	0.08	-	-	0.90	-	0.17	0.03	0.00	-	-	0.00	-	-
71	CARP	17.2	2.4	17.4	0.48	0.25	0.13	-	-	14.30	-	0.18	0.02	0.00	-	-	0.00	-	-
71	SMALLMOUTH BUFFALO	15.7	2.2	7.8	0.14	0.15	0.11	-	-	1.25	-	0.20	0.01	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	8.2	0.10	0.20	0.08	-	3.9	3.00	1.1	0.18	0.01	0.22	0.09	-	0.00	0.02	-
71	SMALLMOUTH BUFFALO	17.0	2.9	9.3	0.12	0.14	0.09	-	-	0.90	-	0.07	0.01	0.00	-	-	0.00	-	-
72	CARP	20.3	4.0	7.3	0.81	0.47	0.00	-	-	2.10	-	0.31	0.00	0.00	-	-	0.00	-	-
72	CARP	19.2	3.4	7.7	0.25	0.11	0.02	-	-	3.50	-	0.25	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	18.4	2.1	11.0	0.29	0.36	0.00	-	-	2.00	-	0.53	0.00	0.00	-	-	0.00	-	-
72	SMALLMOUTH BUFFALO	16.8	2.7	7.7	0.40	0.22	0.16	-	-	6.00	-	0.60	0.00	0.00	-	-	0.00	-	-
72	BLUE CATFISH	14.7	1.0	10.3	0.75	0.00	0.00	-	-	9.50	-	0.83	0.00	0.00	-	-	0.00	-	-
73	BIGMOUTH BUFFALO	18.5	3.6	5.1	0.02	0.09	0.00	0.0	-	0.00	0.7	0.28	0.00	0.00	-	-	0.00	-	-
73	CARP	19.4	4.0	9.8	0.14	0.00	0.00	0.0	-	0.00	0.6	0.29	0.00	0.02	-	-	0.00	-	-
73	CARP	21.6	4.7	8.0	0.22	0.17	0.00	3.1	-	0.00	1.0	0.22	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	10.2	0.12	0.09	0.05	0.3	0.0	1.00	1.3	0.75	0.01	0.00	0.05	-	0.00	0.00	0.0
73	FRESHWATER DRUM	16.8	3.0	13.8	0.07	0.06	0.00	0.9	-	0.00	0.6	0.41	0.00	0.00	-	-	0.00	-	-
74	CARP	18.4	3.1	7.8	0.30	0.13	0.07	0.0	-	1.70	0.0	0.81	0.00	0.00	-	-	0.00	-	-
74	CARP	18.6	2.9	12.4	0.24	0.06	0.00	0.0	-	0.87	0.0	1.10	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	6.5	0.23	0.30	0.04	0.0	0.0	0.00	0.0	0.11	0.01	0.03	0.04	0.04	0.00	0.01	0.0
74	CHANNEL CATFISH	20.7	2.9	12.3	0.30	0.14	0.11	0.0	-	2.10	0.0	0.81	0.00	0.00	-	-	0.00	-	-
74	FRESHWATER DRUM	12.0	0.8	7.6	0.08	0.01	0.10	0.0	-	0.46	0.0	0.45	0.00	0.00	-	-	0.00	-	-
74	SMALLMOUTH BUFFALO	16.1	2.4	10.3	0.13	0.08	0.12	0.0	-	1.00	0.0	0.40	0.00	0.00	-	-	0.00	-	-

STATION 90, KANSAS RIVER AT BONNER SPRINGS, KS

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CARP	14.8	1.9	8.5	0.11	0.16	0.07	-	-	0.49	-	0.07	0.00	0.00	-	-	-	-	0.0
70	CARP	15.8	2.8	9.0	0.14	0.17	0.09	-	-	0.62	-	0.12	0.00	0.00	-	-	-	-	0.0
70	FRESHWATER DRUM	9.9	0.7	5.5	0.25	0.20	0.25	-	-	0.96	-	0.14	0.00	0.00	-	-	-	-	0.0
70	GIZZARD SHAD	7.2	0.2	12.1	0.10	0.25	0.29	-	-	2.08	-	0.26	0.00	0.00	-	-	-	-	0.1
71	CARP	16.7	3.1	8.1	0.59	0.85	0.95	-	-	2.21	-	0.03	0.00	0.00	-	-	0.00	-	-
71	CARP	13.6	1.4	3.6	0.10	0.12	0.10	-	-	0.36	-	0.05	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	8.1	0.1	2.4	0.10	0.13	0.19	-	-	0.88	-	0.12	0.00	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	7.8	0.1	2.7	0.08	0.12	0.06	-	-	0.67	-	0.02	0.00	0.00	-	-	0.00	-	-
71	GIZZARD SHAD	7.8	0.3	7.5	0.22	0.34	0.30	-	-	1.51	-	0.19	0.00	0.00	-	-	0.00	-	-
71	GIZZARD SHAD	7.2	0.3	8.1	0.21	0.25	0.10	-	-	1.46	-	0.08	0.00	0.00	-	-	0.00	-	-
72	CARP	20.5	4.1	4.9	0.17	0.24	0.02	-	-	1.30	-	0.22	0.00	0.00	-	-	0.00	-	-
72	GIZZARD SHAD	11.3	0.5	2.6	0.12	0.11	0.05	-	-	0.70	-	0.16	0.00	0.00	-	-	0.00	-	-
72	GIZZARD SHAD	9.7	0.3	2.3	0.00	0.12	0.11	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	16.1	2.3	5.0	0.00	0.20	0.00	0.0	-	0.70	0.0	0.20	0.00	0.00	-	-	0.00	-	-
73	CARP	16.5	2.3	5.0	0.08	0.08	0.00	0.0	-	0.00	0.5	0.24	0.00	0.00	-	-	0.00	-	-
73	FRESHWATER DRUM	11.4	0.6	3.1	0.06	0.02	0.00	0.0	-	0.00	0.6	0.10	0.00	0.01	-	-	0.00	-	-
73	GIZZARD SHAD	8.6	0.2	7.6	0.03	0.00	0.00	0.0	-	0.00	0.0	0.75	0.00	0.05	-	-	0.00	-	-
74	CARP	15.2	2.1	10.7	0.09	0.08	0.08	0.0	-	0.50	0.0	0.50	0.00	0.00	-	-	0.00	-	-
74	CARP	14.6	1.8	6.6	0.10	0.04	0.08	0.6	-	0.49	0.0	0.19	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	14.3	1.2	10.0	0.18	0.09	0.09	0.0	-	0.55	0.0	0.32	0.00	0.00	-	-	0.00	-	-
74	FRESHWATER DRUM	10.5	0.6	6.9	0.08	0.03	0.07	0.0	-	0.64	0.0	0.22	0.00	0.00	-	-	0.00	-	-

STATION 31, MISSOURI RIVER AT NEBRASKA CITY, NE/IA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	CARP	17.1	2.4	8.5	0.27	0.26	0.11	-	-	1.10	-	0.09	0.00	0.00	-	-	-	-	0.03	-
70	CARP	16.9	2.2	5.4	0.29	0.31	0.15	-	-	1.67	-	0.09	0.00	0.00	-	-	-	-	0.03	-
70	GOLDEYE	13.0	0.9	11.8	5.40	1.13	3.72	-	-	4.82	-	0.19	0.00	0.00	-	-	-	-	0.03	-
70	CROSSCHECK	-	-	10.2	4.63	1.20	3.60	-	2.4	2.30	1.4	0.23	0.00	0.00	-	-	0.00	-	-	-
71	CARP	17.4	2.8	6.4	0.13	0.15	0.07	-	-	0.50	-	0.16	0.01	0.00	-	-	0.00	-	-	-
71	CARP	16.3	2.2	8.2	0.19	0.11	0.08	-	-	0.56	-	0.09	0.01	0.00	-	-	0.00	-	-	-
71	GOLDEYE	14.1	1.0	13.3	0.33	0.28	0.31	-	-	1.43	-	0.08	0.01	0.00	-	-	0.00	-	-	-
71	GOLDEYE	13.7	0.9	14.0	0.20	0.23	0.21	-	-	1.46	-	0.12	0.01	0.00	-	-	0.00	-	-	-
71	CROSSCHECK	-	-	14.4	0.26	0.16	0.22	-	1.7	2.20	0.9	0.27	0.00	0.04	0.10	-	0.00	0.01	-	-
71	WHITE CRAPPIE	9.5	0.5	2.6	0.06	0.09	0.05	-	-	0.35	-	0.05	0.01	0.00	-	-	0.00	-	-	-
71	WHITE CRAPPIE	8.4	0.3	1.5	0.05	0.05	0.03	-	-	0.24	-	0.03	0.01	0.00	-	-	0.00	-	-	-
72	CARP	17.9	2.9	9.1	0.17	0.11	0.00	-	-	0.63	-	0.11	0.00	0.00	-	-	0.00	-	-	-
72	CARP	16.6	2.2	8.3	0.25	0.15	0.00	-	-	0.72	-	0.14	0.00	0.00	-	-	0.00	-	-	-
72	CHANNEL CATFISH	15.0	1.1	9.0	0.13	0.16	0.00	-	-	0.50	-	0.28	0.00	0.00	-	-	0.00	-	-	-
72	GOLDEYE	15.6	0.9	12.3	0.43	0.16	0.00	-	-	3.12	-	0.11	0.00	0.00	-	-	0.00	-	-	-
73	CARP	13.3	1.4	4.7	0.08	0.03	0.00	0.0	-	0.20	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
73	CARP	13.6	1.5	4.3	0.10	0.00	0.00	0.0	-	0.40	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-
73	GOLDEYE	14.3	1.1	12.5	0.23	0.18	0.00	0.0	-	2.40	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-
73	WHITE CRAPPIE	9.7	0.6	2.7	0.08	0.00	0.00	0.0	-	0.30	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-
74	CARP	13.8	1.3	5.8	0.27	0.09	0.05	0.0	-	0.00	0.3	0.10	0.00	0.00	-	-	0.00	-	-	-
74	CROSSCHECK	-	-	9.3	0.10	0.06	0.03	0.0	0.0	0.37	0.0	0.12	0.02	0.02	0.07	0.00	0.00	0.01	0.01	0.00
74	CARP	13.3	1.1	6.7	0.15	0.09	0.00	0.0	-	0.00	0.0	0.06	0.00	0.00	-	-	0.00	-	-	-
74	CROSSCHECK	-	-	8.3	0.09	0.11	0.00	0.0	0.0	0.00	0.0	0.07	0.01	0.01	0.04	0.00	0.00	0.00	0.01	0.00
74	GOLDEYE	11.5	0.5	10.4	1.50	0.17	0.76	0.0	-	0.00	1.3	0.10	0.00	0.00	-	-	0.00	-	-	-
74	WHITE CRAPPIE	7.6	0.2	1.1	0.05	0.00	0.00	0.0	-	0.32	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-

STATION 89, PLATTE RIVER AT LOUISVILLE, NE

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	CARP	19.7	3.7	1.8	0.62	0.18	0.07	-	-	0.75	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	CARP	12.2	0.8	2.2	0.38	0.14	0.08	-	-	0.67	-	0.02	0.00	0.00	-	-	-	-	0.01	-
70	CHANNEL CATFISH	12.6	0.6	4.1	0.22	0.42	0.12	-	-	0.62	-	0.05	0.00	0.00	-	-	-	-	0.01	-
70	WHITE CRAPPIE	7.6	0.3	5.2	0.21	0.27	0.10	-	-	0.82	-	0.05	0.00	0.00	-	-	-	-	0.01	-
71	CARP	16.4	2.0	4.8	0.17	0.23	0.03	-	-	0.21	-	0.05	0.01	0.00	-	-	0.00	-	-	-
71	CARP	16.6	2.0	5.1	0.16	0.15	0.05	-	-	0.26	-	0.06	0.00	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	12.1	0.5	4.7	0.19	0.44	0.08	-	-	0.45	-	0.05	0.01	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	10.2	0.4	5.0	0.24	0.48	0.11	-	-	0.42	-	0.07	0.01	0.00	-	-	0.00	-	-	-
71	WHITE CRAPPIE	9.8	0.5	3.6	0.09	0.14	0.07	-	-	0.35	-	0.04	0.01	0.00	-	-	0.00	-	-	-
71	WHITE CRAPPIE	8.1	0.3	1.4	0.09	0.12	0.03	-	-	0.22	-	0.03	0.01	0.00	-	-	0.00	-	-	-
72	CARP	15.4	1.7	6.2	0.45	0.40	0.00	-	-	1.00	-	0.10	0.00	0.00	-	-	0.00	-	-	-
72	CARP	16.3	16.3	4.9	0.43	0.18	0.00	-	-	2.00	-	0.09	0.00	0.00	-	-	0.00	-	-	-
72	CHANNEL CATFISH	15.4	1.2	4.3	0.62	0.01	0.00	-	-	4.30	-	0.09	0.00	0.00	-	-	0.00	-	-	-
72	WHITE CRAPPIE	5.5	0.4	3.5	0.08	0.12	0.00	-	-	0.81	-	0.02	0.00	0.01	-	-	0.00	-	-	-
73	CARP	13.5	1.5	6.0	0.57	0.14	0.00	0.0	-	0.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	12.9	1.2	4.7	0.04	0.02	0.00	0.0	-	0.20	0.0	0.06	0.00	0.00	-	-	0.00	-	-	-
73	CHANNEL CATFISH	12.5	0.7	8.0	0.10	0.26	0.00	0.0	-	1.70	0.0	0.08	0.00	0.00	-	-	0.00	-	-	-
73	WHITE CRAPPIE	8.6	0.4	3.3	0.00	0.09	0.10	0.0	-	0.40	0.0	0.00	0.02	0.00	-	-	0.00	-	-	-
74	CARP	12.1	1.0	5.8	0.07	0.05	0.07	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	CARP	12.2	0.8	5.2	0.08	0.04	0.06	0.0	-	0.21	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
74	CHANNEL CATFISH	9.6	0.3	2.6	0.09	0.02	0.00	0.0	-	0.26	0.0	0.05	0.00	0.00	-	-	0.00	-	-	-
74	MIXED SPECIES	12.0	0.8	9.2	0.30	0.48	0.00	0.0	-	2.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 88, SOUTH PLATTE RIVER AT BRULE, NE

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	HCB	A-BHC	G-BHC
70	CARP	5.6	0.1	3.4	0.06	0.02	0.01	-	-	0.08	-	0.02	0.00	0.00	-	-	-	-	0.01	-
70	GREEN SUNFISH	4.8	0.1	3.8	0.16	0.04	0.04	-	-	0.21	-	0.02	0.00	0.00	-	-	-	-	0.01	-
70	WHITE SUCKER	12.0	0.7	1.0	0.08	0.02	0.03	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	WHITE SUCKER	10.2	0.5	2.3	0.11	0.04	0.04	-	-	0.24	-	0.01	0.00	0.00	-	-	-	-	0.01	-
71	BLACK BULLHEAD	8.4	0.4	2.0	0.12	0.05	0.05	-	-	0.35	-	0.02	0.01	0.00	-	-	0.00	-	-	-
71	BLACK BULLHEAD	8.3	0.3	2.2	0.09	0.05	0.04	-	-	0.35	-	0.01	0.01	0.00	-	-	0.00	-	-	-
71	CARP	18.1	2.5	4.2	0.08	0.05	0.03	-	-	0.24	-	0.02	0.01	0.00	-	-	0.00	-	-	-
71	CARP	17.3	2.4	4.9	0.05	0.05	0.03	-	-	0.21	-	0.03	0.01	0.00	-	-	0.00	-	-	-
71	WHITE SUCKER	12.8	0.8	1.0	0.11	0.07	0.06	-	-	0.54	-	0.01	0.01	0.00	-	-	0.00	-	-	-
71	WHITE SUCKER	12.3	0.8	2.5	0.04	0.03	0.02	-	-	0.17	-	0.01	0.01	0.00	-	-	0.00	-	-	-
72	CARP	17.0	2.4	2.3	0.26	0.08	0.00	-	-	1.40	-	0.03	0.00	0.00	-	-	0.00	-	-	-
72	CARP	2.4	3.3	3.3	0.21	0.01	0.00	-	-	0.90	-	0.04	0.00	0.00	-	-	0.00	-	-	-
72	GREEN SUNFISH	5.2	0.1	2.8	0.10	0.04	0.01	-	-	0.60	-	0.04	0.00	0.00	-	-	0.00	-	-	-
72	WHITE SUCKER	10.6	0.5	1.0	0.06	0.01	0.00	-	-	0.40	-	0.01	0.00	0.00	-	-	0 00	-	-	-
73	CARP	14.0	1.5	5.4	0.06	0.02	0.00	0.0	-	0.00	0.2	0.03	0.00	0.00	-	-	0.00	-	-	-
73	CARP	13.3	1.4	4.4	0.04	0.00	0.00	0.0	-	0.50	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-
73	GREEN SUNFISH	3.3	0.1	2.5	0.07	0.02	0.00	0.0	-	0.00	0.2	0.03	0.00	0.00	-	-	0 00	-	-	-
73	WHITE SUCKER	7.5	0.3	2.4	0.07	0.02	0.00	0.0	-	0.00	0.3	0.03	0.00	0.00	-	-	0 00	-	-	-

STATION 87, NORTH PLATTE RIVER AT LAKE MCCONAUGHY, NE

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	CARP	15.8	1.2	8.8	0.47	0.12	0.03	-	-	0.24	-	0.02	0.01	0.00	-	-	-	-	0.01
70	CARP	15.9	1.2	14.9	0.35	0.12	0.05	-	-	0.24	-	0.02	0.02	0.00	-	-	-	-	0.01
70	CHANNEL CATFISH	16.5	1.0	14.4	0.43	0.19	0.05	-	-	0.21	-	0.04	0.01	0.00	-	-	-	-	0.04
70	RAINBOW TROUT	19.6	3.2	11.3	0.14	0.05	0.03	-	-	0.08	-	0.02	0.00	0.00	-	-	-	-	0.01
70	WALLEYE	16.2	1.8	8.2	0.14	0.12	0.05	-	-	0.33	-	0.02	0.01	0.00	-	-	-	-	0.05
71	CARP	14.9	2.1	7.3	0.29	0.07	0.02	-	-	0.06	-	0.02	0.01	0.00	-	-	0.01	-	-
71	CARP	16.4	2.1	9.5	0.28	0.07	0.02	-	-	0.06	-	0.02	0.01	0.00	-	-	0.01	-	-
71	CHANNEL CATFISH	17.4	1.8	11.7	0.51	0.13	0.05	-	-	0.08	-	0.06	0.02	0.00	-	-	0.01	-	-
71	CHANNEL CATFISH	19.8	2.4	11.1	0.52	0.11	0.07	-	-	0.10	-	0.05	0.01	0.00	-	-	0.01	-	-
71	WALLEYE	16.5	1.9	9.1	0.15	0.04	0.03	-	-	0.13	-	0.02	0.01	0.00	-	-	0.01	-	-
71	WALLEYE	15.9	1.6	8.0	0.10	0.02	0.02	-	-	0.06	-	0.01	0.01	0.00	-	-	0.01	-	-
72	CARP	18.1	2.9	4.4	0.64	0.08	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	CARP	18.8	3.1	3.7	1.10	0.13	0.00	-	-	0.00	-	0.05	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	16.6	1.6	7.9	0.11	0.09	0.00	-	-	0.00	-	0.07	0.00	0.00	-	-	0.00	-	-
72	WALLEYE	15.6	1.5	4.8	0.22	0.02	0.00	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-
73	CARP	18.1	2.8	4.5	0.53	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	17.2	2.3	3.4	0.55	0.06	0.00	0.0	-	0.00	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	15.0	1.3	11.2	0.47	0.03	0.00	0.0	-	0.00	0.0	0.06	0.00	0.00	-	-	0.00	-	-
73	WALLEYE	16.3	1.2	6.1	0.10	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	18.6	2.8	8.1	0.94	0.11	0.00	0.0	-	0.36	0.0	0.02	0.00	0.00	-	-	0.00	-	-
74	CARP	18.2	2.9	7.6	0.58	0.05	0.00	0.0	-	0.48	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	19.8	2.6	7.3	0.49	0.09	0.08	0.0	-	0.51	0.0	0.04	0.00	0.00	-	-	0.00	-	-
74	WALLEYE	14.0	1.0	6.2	0.20	0.00	0.00	0.0	-	0.08	0.0	0.02	0.00	0.00	-	-	0.00	-	-

STATION 86, JAMES RIVER AT OLIVET, SD

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-ORIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUN TOXA-PHENE	HCB	A-BHC
70	CARP	15.8	1.0	3.1	0.04	0.04	0.02	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.01
70	CARP	15.3	0.9	3.6	0.08	0.04	0.02	-	-	0.20	-	0.01	0.00	0.00	-	-	-	-	0.01
70	FRESHWATER DRUM	9.0	0.3	4.0	0.01	0.02	0.02	-	-	0.15	-	0.01	0.00	0.00	-	-	-	-	0.01
70	GOLDEYE	11.0	0.8	8.7	0.14	0.12	0.10	-	-	0.79	-	0.02	0.00	0.00	-	-	-	-	0.01
71	CARP	18.3	2.7	8.1	0.07	0.07	0.02	-	-	0.12	-	0.03	0.01	0.00	-	-	0.00	-	-
71	CARP	18.0	2.6	9.0	0.09	0.06	0.02	-	-	0.11	-	0.03	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	13.5	1.0	6.2	0.06	0.05	0.03	-	-	0.22	-	0.02	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.5	1.2	2.3	0.06	0.04	0.03	-	-	0.18	-	0.01	0.01	0.00	-	-	0.00	-	-
71	GOLDEYE	13.2	0.9	8.7	0.16	0.17	0.13	-	-	1.19	-	0.04	0.01	0.00	-	-	0.00	-	-
71	GOLDEYE	13.2	0.8	7.3	0.19	0.24	0.12	-	-	1.10	-	0.03	0.01	0.00	-	-	0.00	-	-
72	CARP	17.4	2.5	8.1	0.04	0.04	0.00	-	-	0.00	-	0.06	0.00	0.02	-	-	0.00	-	-
72	CHANNEL CATFISH	16.4	1.7	8.6	0.19	0.18	0.00	-	-	1.20	-	0.29	0.00	0.05	-	-	0.00	-	-
72	GOLDEYE	15.7	1.0	8.5	0.10	0.05	0.00	-	-	3.90	-	0.34	0.00	0.04	-	-	0.00	-	-
72	GOLDEYE	13.7	1.2	7.5	0.10	0.32	0.02	-	-	6.40	-	0.37	0.00	0.10	-	-	0.00	-	-
73	CARP	10.6	0.7	1.9	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	14.8	0.8	3.4	0.05	0.00	0.00	0.0	-	0.10	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	GOLDEYE	13.6	1.0	7.8	0.08	0.00	0.00	0.0	-	1.60	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	GOLDEYE	13.6	0.9	5.9	0.17	0.00	0.00	0.0	-	3.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	7.6	0.13	0.28	0.03	0.0	0.3	1.00	0.8	0.02	0.00	0.00	0.00	-	0.00	0.00	0.04
74	CARP	15.0	1.5	3.0	0.02	0.00	0.00	0.0	-	0.09	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	14.4	0.9	5.0	0.06	0.00	0.00	0.0	-	0.33	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	FRESHWATER DRUM	9.4	0.4	5.8	0.01	0.06	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	GOLDEYE	13.3	0.8	6.6	0.05	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	GOLDEYE	13.6	0.8	8.1	0.30	0.14	0.00	0.0	-	6.30	0.0	0.08	0.00	0.00	-	-	0.00	-	-

ION 32, MISSOURI RIVER AT GARRISON DAM, ND

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
ARP	17.2	2.2	6.0	0.05	0.02	0.02	-	-	0.08	-	0.01	0.00	0.00	-	-	-	-	0.01	-
OLDEYE	12.4	0.5	8.6	0.03	0.02	0.05	-	-	0.18	-	0.01	0.00	0.00	-	-	-	-	0.01	-
OLOEYE	11.9	0.5	10.5	0.02	0.02	0.04	-	-	0.12	-	0.01	0.00	0.00	-	-	-	-	0.02	-
ALLEYE	15.8	1.3	6.0	0.02	0.02	0.04	-	-	0.14	-	0.01	0.00	0.00	-	-	-	-	0.01	-
OLDEYE	12.5	0.5	13.4	0.02	0.02	0.02	-	-	0.08	-	0.01	0.01	0.00	-	-	0.00	-	-	-
OLOEYE	12.2	0.4	12.4	0.01	0.01	0.02	-	-	0.06	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ALLEYE	18.3	2.1	7.2	0.05	0.03	0.03	-	-	0.09	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ALLEYE	18.3	2.2	7.3	0.03	0.02	0.31	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-	-
HITE SUCKER	13.2	0.8	0.6	0.01	0.01	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	13.5	0.8	1.0	0.01	0.01	0.01	-	-	0.04	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	18.1	2.6	9.0	0.11	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	12.5	0.8	12.5	0.02	0.00	0.02	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	13.0	0.8	14.4	0.03	0.05	0.00	-	-	0.00	-	0.05	0.00	0.00	-	-	0.00	-	-	-
ALLEYE	16.9	1.6	3.4	0.30	0.00	0.00	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
ARP	15.2	1.7	8.1	0.00	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	12.8	0.8	16.9	0.00	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	12.6	0.8	16.8	0.00	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLEYE	16.3	1.4	5.8	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	10.5	0.4	13.4	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	11.3	0.4	10.3	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLEYE	11.3	0.5	5.9	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE SUCKER	12.6	0.8	1.2	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 85, YELLOWSTONE RIVER AT SIDNEY, MT

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
ARPSUCKER	11.9	1.0	7.9	0.02	0.02	0.03	-	-	0.09	-	0.01	0.01	0.00	-	-	-	-	0.01	-
HANNEL CATFISH	9.1	0.4	6.2	0.05	0.03	0.02	-	-	0.14	-	0.02	0.00	0.00	-	-	-	-	0.01	-
OLDEYE	11.3	0.5	15.3	0.03	0.03	0.03	-	-	0.14	-	0.02	0.01	0.00	-	-	-	-	0.01	-
OLDEYE	10.3	0.4	10.2	0.04	0.02	0.03	-	-	0.09	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ARPSUCKER	13.2	1.7	12.2	0.02	0.03	0.03	-	-	0.10	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARPSUCKER	11.8	1.2	9.8	0.01	0.01	0.01	-	-	0.05	-	0.01	0.01	0.00	-	-	0.00	-	-	-
OLDEYE	10.8	0.6	22.0	0.01	0.02	0.01	-	-	0.03	-	0.01	0.01	0.00	-	-	0.00	-	-	-
OLOEYE	10.9	0.6	17.8	0.02	0.02	0.02	-	-	0.06	-	0.02	0.01	0.00	-	-	0.00	-	-	-
ALLEYE	13.4	1.2	6.9	0.05	0.02	0.01	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ALLEYE	12.5	0.6	1.8	0.01	0.01	0.01	-	-	0.05	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARP	15.6	2.1	2.6	0.06	0.00	0.00	-	-	0.10	-	0.01	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	12.3	0.7	11.4	0.02	0.02	0.02	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	11.6	0.6	12.9	0.03	0.02	0.01	-	-	0.00	-	0.02	0.00	0.00	-	-	0.00	-	-	-
AUGER	10.5	0.4	2.2	0.01	0.01	0.00	-	-	0.10	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ARP	12.7	0.9	1.0	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	16.7	0.4	10.1	0.03	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	11.3	0.5	19.7	0.01	0.00	0.00	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	10.7	0.4	12.7	0.01	0.00	0.00	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	17.5	1.7	14.7	0.16	0.09	0.05	0.0	-	0.67	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	9.7	0.4	13.8	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	9.1	0.3	12.9	0.02	0.02	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
AUGER	12.7	0.6	1.4	0.26	0.22	0.18	0.0	-	3.00	0.0	0.16	0.00	0.00	-	-	0.00	-	-	-

ON 84, BIG HORN RIVER AT HARDIN, MT

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
ARP	15.5	2.4	9.3	0.10	0.06	0.05	-	-	0.42	-	0.02	0.00	0.00	-	-	-	-	0.01	-
HANNEL CATFISH	19.1	3.7	14.4	0.17	0.10	0.08	-	-	0.55	-	0.03	0.01	0.00	-	-	-	-	0.02	-
OLDEYE	10.6	0.4	3.8	0.15	0.05	0.06	-	-	0.44	-	0.01	0.01	0.00	-	-	-	-	0.01	-
OLDEYE	10.9	0.5	5.4	0.05	0.05	0.05	-	-	0.27	-	0.02	0.00	0.00	-	-	-	-	0.01	-
ARP	15.3	2.4	7.0	0.04	0.01	0.01	-	-	0.05	-	0.02	0.01	0.00	-	-	0.01	-	-	-
ARP	15.8	2.7	9.9	0.04	0.02	0.01	-	-	0.06	-	0.02	0.01	0.00	-	-	0.01	-	-	-
ARPSUCKER	12.0	1.1	7.4	0.05	0.04	0.06	-	-	0.32	-	0.01	0.00	0.00	-	-	0.01	-	-	-
OLDEYE	11.0	0.6	9.5	0.08	0.04	0.04	-	-	0.24	-	0.01	0.01	0.00	-	-	0.01	-	-	-
OLDEYE	10.8	0.5	4.3	0.07	0.04	0.04	-	-	0.38	-	0.01	0.00	0.00	-	-	0.01	-	-	-
ARP	17.2	2.7	5.8	0.05	0.00	0.00	-	-	0.00	-	0.04	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	12.5	0.6	11.3	0.03	0.00	0.00	-	-	0.60	-	0.06	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	12.5	0.7	9.0	0.04	0.00	0.00	-	-	0.20	-	0.03	0.00	0.00	-	-	0.00	-	-	-
ARP	16.9	2.7	7.1	0.06	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	22.5	4.5	15.6	0.16	0.00	0.16	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OLOEYE	12.6	0.7	10.8	0.03	0.00	0.01	0.0	-	0.10	0.0	0.01	0.00	0.00	-	-	0.00	-	-	-
OLDEYE	12.8	0.7	10.2	0.04	0.00	0.01	0.0	-	0.10	0.0	0.03	0.00	0.00	-	-	0.00	-	-	-

STATION 33, MISSOURI RIVER AT GREAT FALLS, MT

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	GOLDEYE	11.2	0.5	4.4	0.08	0.06	0.09	-	-	0.46	-	0.01	0.00	0.00	-	-	-	-	0.01
70	GOLDEYE	11.2	0.5	9.4	0.02	0.02	0.03	-	-	0.11	-	0.01	0.00	0.00	-	-	-	-	0.02
70	REDHORSE	15.9	1.7	13.5	0.26	0.29	0.38	-	-	2.81	-	0.02	0.00	0.00	-	-	-	-	0.07
70	SAUGER	12.5	0.7	4.8	0.26	0.21	0.23	-	-	2.03	-	0.01	0.00	0.00	-	-	-	-	0.09
71	GOLDEYE	11.8	0.6	6.1	0.30	0.05	0.34	-	-	0.27	-	0.01	0.01	0.00	-	-	0.00	-	-
71	GOLDEYE	11.8	0.6	8.8	0.04	0.05	0.06	-	-	0.15	-	0.01	0.01	0.00	-	-	0.00	-	-
71	REDHORSE	17.2	2.2	14.3	0.12	0.26	0.30	-	-	1.41	-	0.01	0.01	0.00	-	-	0.00	-	-
71	REDHORSE	17.5	2.3	13.2	0.21	0.25	0.31	-	-	1.35	-	0.01	0.01	0.00	-	-	0.00	-	-
71	SAUGER	10.8	0.4	3.1	0.10	0.06	0.06	-	-	0.48	-	0.01	0.01	0.00	-	-	0.00	-	-
71	SAUGER	9.9	0.3	1.2	0.05	0.04	0.05	-	-	0.35	-	0.01	0.01	0.00	-	-	0.00	-	-
72	GOLDEYE	12.7	0.6	5.2	0.07	0.02	0.07	-	-	0.32	-	0.01	0.00	0.00	-	-	0.00	-	-
72	GOLDEYE	12.3	0.6	6.9	0.04	0.05	0.08	-	-	0.54	-	0.02	0.00	0.00	-	-	0.00	-	-
72	REDHORSE	16.5	1.9	7.2	0.29	0.13	0.24	-	-	3.70	-	0.03	0.00	0.00	-	-	0.00	-	-
72	SAUGER	17.1	2.0	6.1	0.16	0.07	0.15	-	-	2.80	-	0.02	0.00	0.00	-	-	0.00	-	-
73	GOLDEYE	12.5	0.6	4.0	0.07	0.00	0.00	0.0	-	0.00	1.3	0.00	0.00	0.00	-	-	0.00	-	-
73	GOLDEYE	12.8	0.7	9.2	0.08	0.03	0.00	0.0	-	0.00	0.4	0.03	0.00	0.00	-	-	0.00	-	-
73	LONGNOSE SUCKER	15.6	1.7	9.5	0.08	0.07	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-

HUDSON BAY DRAINAGE

STATION 34, RED RIVER OF THE NORTH AT NOYES, MN/ND

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	CHANNEL CATFISH	15.6	0.7	5.1	0.36	0.28	0.33	-	-	0.68	-	0.15	0.00	0.00	-	-	-	-	0.07
70	GOLDEYE	12.3	0.6	16.6	0.39	0.14	0.13	-	-	0.51	-	0.19	0.00	0.00	-	-	-	-	0.07
70	GOLDEYE	12.4	0.7	16.2	0.32	0.16	0.17	-	-	0.34	-	0.05	0.00	0.00	-	-	-	-	0.08
70	SAUGER	12.2	0.5	2.7	0.26	0.12	0.16	-	-	0.40	-	0.04	0.00	0.00	-	-	-	-	0.10
71	CHANNEL CATFISH	18.0	1.9	13.8	0.36	0.28	0.41	-	-	2.29	-	0.06	0.01	0.00	-	-	0.00	-	-
71	GOLDEYE	13.6	0.8	15.4	0.33	0.21	0.19	-	-	3.98	-	0.03	0.00	0.00	-	-	0.00	-	-
71	GOLDEYE	13.0	0.8	16.0	0.22	0.15	0.12	-	-	3.65	-	0.04	0.01	0.00	-	-	0.00	-	-
71	SAUGER	11.6	0.4	2.4	0.13	0.06	0.07	-	-	0.65	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SAUGER	11.0	0.3	3.2	0.09	0.05	0.04	-	-	0.69	-	0.01	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	19.3	2.9	13.0	0.52	0.00	0.00	-	-	1.70	-	0.07	0.00	0.00	-	-	0.00	-	-
72	REDHORSE	17.6	1.9	5.9	0.70	0.00	0.00	-	-	1.50	-	0.07	0.00	0.00	-	-	0.00	-	-
72	SAUGER	14.8	0.9	4.0	0.34	0.28	0.00	-	-	0.70	-	0.00	0.00	0.00	-	-	0.00	-	-
72	SAUGER	12.2	0.4	3.6	0.22	0.00	0.00	-	-	2.00	-	0.00	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	16.0	1.5	17.5	0.08	0.12	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	GOLDEYE	12.6	0.7	18.5	0.11	0.00	0.00	1.4	-	0.00	0.3	0.00	0.00	0.00	-	-	0.00	-	-
73	SAUGER	12.0	0.5	7.9	0.07	0.11	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	SAUGER	11.8	0.5	7.6	0.07	0.10	0.00	0.3	-	0.00	0.4	0.00	0.00	0.00	-	-	0.00	-	-
74	GOLDEYE	12.6	0.7	11.6	0.33	0.12	0.07	0.0	-	1.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SAUGER	12.3	0.5	6.0	0.24	0.15	0.00	0.0	-	0.92	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	SAUGER	12.3	0.5	8.1	0.27	0.29	0.00	0.0	-	2.60	0.0	0.08	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	6.6	0.12	0.00	0.05	0.0	0.0	0.76	0.4	0.02	0.01	0.01	0.03	0.02	0.00	0.00	0.02
74	WHITE SUCKER	14.5	1.4	6.1	0.07	0.06	0.00	0.0	-	0.23	0.0	0.00	0.00	0.00	-	-	0.00	-	-

TION 94, GILA RIVER AT SAN CARLOS RESERVOIR, AZ

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	ODD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
BLUEGILL	4.7	0.1	2.3	0.15	0.02	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	14.5	1.1	1.8	0.16	0.02	0.01	-	-	0.04	-	0.01	0.00	0.00	-	-	-	-	0.01	-
LARGEMOUTH BASS	13.1	1.2	6.5	0.17	0.04	0.04	-	-	0.08	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	12.8	0.9	2.1	0.11	0.02	0.02	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	11.7	0.7	3.9	0.10	0.03	0.02	-	-	0.10	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	9.2	0.2	4.1	0.12	0.04	0.04	-	-	0.19	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CHANNEL CATFISH	12.6	0.5	3.1	0.15	0.05	0.05	-	-	0.23	-	0.01	0.01	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	14.4	1.4	3.8	0.14	0.03	0.03	-	-	0.03	-	0.01	0.01	0.00	-	-	0.00	-	-	-
CARP	13.0	0.9	5.2	0.19	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	11.9	0.7	3.1	0.26	0.04	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.80	-	-	-
CHANNEL CATFISH	13.5	0.7	3.5	0.16	0.00	0.02	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	14.8	2.1	4.9	0.30	0.04	0.04	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.2	0.2	1.5	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	12.8	1.0	9.5	0.16	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.9	1.3	6.5	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	12.6	1.1	7.8	0.09	0.00	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

TION 36, COLORADO RIVER AT IMPERIAL RESERVOIR, AZ/CA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	ODD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
CARP	16.4	3.9	5.2	0.14	0.05	0.03	-	-	0.14	-	0.01	0.01	0.00	-	-	-	-	0.01	-
CARP	14.8	2.5	5.0	0.11	0.05	0.03	-	-	0.13	-	0.01	0.01	0.00	-	-	-	-	0.01	-
CHANNEL CATFISH	12.3	0.9	4.8	0.13	0.05	0.06	-	-	0.17	-	0.01	0.01	0.00	-	-	-	-	0.07	-
LARGEMOUTH BASS	14.5	0.9	1.1	0.12	0.04	0.04	-	-	0.11	-	0.01	0.00	0.00	-	-	-	-	0.01	-
CARP	15.9	2.3	2.8	0.05	0.02	0.01	-	-	0.03	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	8.7	0.4	1.4	1.05	0.02	0.02	-	-	0.02	-	0.02	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	10.2	0.5	5.4	0.13	0.09	0.05	-	-	0.33	-	0.12	0.00	0.00	-	-	0.01	-	-	-
REDEAR SUNFISH	7.6	0.3	2.1	1.01	0.01	0.01	-	-	0.03	-	0.01	0.00	0.00	-	-	0.00	-	-	-
REDEAR SUNFISH	7.7	0.3	2.3	0.02	0.02	0.02	-	-	0.07	-	0.02	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.1	0.2	2.0	0.11	0.01	0.02	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
CARP	17.9	3.0	4.0	0.23	0.02	0.01	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CARP	17.7	2.9	5.1	0.25	0.04	0.01	-	-	0.01	-	0.01	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	9.6	0.5	1.7	0.10	0.02	0.03	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
CRDSSCHECK	-	-	1.8	0.07	0.02	0.03	-	0.0	0.00	0.0	0.00	0.00	0.00	0.00	-	0.00	0.00	-	-
BLUEGILL	5.8	0.2	2.5	0.12	0.00	0.03	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.9	0.2	1.2	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	18.1	2.8	4.5	0.25	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	11.3	0.9	3.4	0.15	0.00	0.04	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	5.8	0.2	2.5	0.06	0.01	0.03	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
BLUEGILL	6.3	0.2	2.0	0.06	0.01	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
CARP	12.7	1.2	5.8	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
LARGEMOUTH BASS	7.7	0.3	1.8	0.06	0.01	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 91, COLORADO RIVER AT LAKE HAVASU, AZ/CA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	CARP	14.1	1.4	5.3	0.18	0.04	0.03	-	-	0.14	-	0.01	0.01	0.00	-	-	-	-	0.01
70	CARP	14.1	1.4	5.0	0.10	0.04	0.03	-	-	0.20	-	0.01	0.01	0.00	-	-	-	-	0.01
70	CHANNEL CATFISH	10.6	0.7	5.8	0.11	0.05	0.03	-	-	0.21	-	0.01	0.01	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	13.1	0.7	1.9	0.10	0.04	0.04	-	-	0.14	-	0.01	0.01	0.00	-	-	-	-	0.01
71	BLACK CRAPPIE	7.8	0.3	2.8	0.04	0.01	0.01	-	-	0.05	-	0.01	0.00	0.00	-	-	0.00	-	-
71	BLACK CRAPPIE	8.6	0.4	2.2	0.04	0.02	0.02	-	-	0.04	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CARP	13.7	1.5	2.0	0.10	0.02	0.01	-	-	0.06	-	0.03	0.01	0.00	-	-	0.00	-	-
71	CARP	14.1	1.3	5.4	0.15	0.03	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	16.5	1.4	9.7	0.14	0.04	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	15.8	1.2	9.2	0.36	0.05	0.04	-	-	0.16	-	0.01	0.00	0.00	-	-	0.00	-	-
72	CARP	12.5	1.0	1.7	0.10	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	CARP	13.9	1.5	1.9	0.09	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	11.4	1.0	2.3	0.29	0.01	0.03	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW BULLHEAD	8.9	0.4	1.4	0.06	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
73	BLACK CRAPPIE	12.9	1.3	2.9	0.06	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	17.4	3.1	3.2	0.16	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	9.8	0.5	2.8	0.13	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	15.6	1.9	1.2	0.11	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	17.1	2.5	3.6	0.10	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CHANNEL CATFISH	22.1	3.4	10.9	0.47	0.10	0.00	0.0	-	0.24	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	LARGEMOUTH BASS	9.5	0.5	4.0	0.14	0.02	0.03	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 92, COLORADO RIVER AT LAKE MEAD, NV/AZ

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	CARP	15.8	2.8	7.5	0.08	0.02	0.01	-	-	0.08	-	0.01	0.01	0.00	-	-	-	-	0.01
70	CARP	16.1	3.0	10.8	0.10	0.05	0.03	-	-	0.18	-	0.01	0.01	0.00	-	-	-	-	0.25
70	LARGEMOUTH BASS	14.7	2.0	3.8	0.06	0.02	0.04	-	-	0.09	-	0.01	0.01	0.00	-	-	-	-	0.01
71	CARP	18.0	2.8	9.6	0.11	0.13	0.14	-	-	1.68	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	14.9	1.1	6.8	0.11	0.04	0.04	-	-	0.18	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CHANNEL CATFISH	13.9	0.8	6.6	0.08	0.03	0.04	-	-	0.13	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	13.1	1.5	6.6	0.04	0.03	0.02	-	-	0.10	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	11.3	0.4	4.1	0.04	0.02	0.03	-	-	0.09	-	0.01	0.01	0.00	-	-	0.00	-	-
72	CARP	15.4	1.6	6.6	0.09	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	CHANNEL CATFISH	14.6	0.7	5.6	0.13	0.04	0.00	-	-	0.71	-	0.00	0.01	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	8.5	0.20	0.07	0.05	-	0.0	0.30	0.0	0.01	0.01	0.00	0.00	-	0.00	0.00	-
72	CHANNEL CATFISH	14.5	0.6	5.9	0.19	0.00	0.00	-	-	0.81	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	12.4	1.0	4.0	0.06	0.03	0.08	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	16.8	2.4	14.1	0.07	0.00	0.00	0.0	-	0.20	0.0	0.02	0.00	0.00	-	-	0.00	-	-
73	CHANNEL CATFISH	15.9	1.2	6.6	0.13	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	12.6	1.1	8.0	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	12.0	1.0	5.4	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 93, COLORADO RIVER AT LAKE POWELL,PAGE, AZ

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUND TOXAPHENE	HCB	A-BHC
70	CARP	12.7	0.5	0.9	0.06	0.01	0.01	-	-	0.09	-	0.01	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	13.9	1.2	6.2	0.05	0.02	0.02	-	-	0.11	-	0.01	0.00	0.00	-	-	-	-	0.01
70	LARGEMOUTH BASS	13.0	0.9	5.3	0.04	0.02	0.02	-	-	0.08	-	0.01	0.00	0.00	-	-	-	-	0.01
70	RAINBOW TROUT	13.4	1.1	7.5	0.02	0.01	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	-	-	0.01
71	CARP	13.2	0.9	0.9	0.03	0.01	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CARP	13.0	0.8	0.9	0.03	0.01	0.01	-	-	0.05	-	0.00	0.00	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	13.3	1.4	6.5	0.01	0.01	0.01	-	-	0.03	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGEMOUTH BASS	15.2	2.3	8.5	0.03	0.02	0.03	-	-	0.17	-	0.01	0.01	0.00	-	-	0.00	-	-
71	RAINBOW TROUT	21.1	4.9	9.0	0.03	0.02	0.02	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-
71	RAINBOW TROUT	19.4	3.7	11.3	0.03	0.02	0.02	-	-	0.07	-	0.01	0.01	0.00	-	-	0.00	-	-
72	CARP	14.2	1.1	1.2	0.04	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	CARP	13.4	0.9	1.9	0.06	0.00	0.00	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGEMOUTH BASS	15.5	2.3	7.5	0.07	0.02	0.03	-	-	0.16	-	0.01	0.00	0.00	-	-	0.00	-	-
72	RAINBOW TROUT	17.4	2.2	9.9	0.03	0.01	0.03	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-
73	CARP	13.6	1.1	3.4	0.03	0.00	0.01	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	13.8	1.1	2.5	0.03	0.00	0.00	0.0	-	0.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	LARGEMOUTH BASS	14.7	2.3	7.3	0.03	0.00	0.03	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	RAINBOW TROUT	16.7	2.3	9.0	0.02	0.00	0.04	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	14.5	1.2	2.5	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	LARGEMOUTH BASS	12.9	1.3	6.4	0.41	0.40	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	3.00	-	-
74	LARGEMOUTH BASS	12.9	1.2	7.2	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	RAINBOW TROUT	16.4	2.0	12.2	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 35, GREEN RIVER AT VERNAL, UT

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	CARP	10.8	0.6	3.4	0.04	0.02	0.01	-	-	0.09	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	CHANNEL CATFISH	9.2	0.3	1.8	0.09	0.02	0.01	-	-	0.10	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	FLANNELMOUTH SUCKE	16.7	1.4	5.0	0.07	0.03	0.04	-	-	0.10	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	FLANNELMOUTH SUCKE	16.6	1.5	4.5	0.08	0.04	0.04	-	-	0.16	-	0.01	0.00	0.00	-	-	-	-	0.01	-
71	CARP	13.7	1.5	5.2	0.01	0.01	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	CARP	15.2	2.0	4.6	0.01	0.01	0.01	-	-	0.05	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	8.3	0.2	7.5	0.02	0.02	0.02	-	-	0.12	-	0.01	0.01	0.00	-	-	0.00	-	-	-
71	CHANNEL CATFISH	8.6	0.2	7.0	0.02	0.03	0.05	-	-	0.30	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	FLANNELMOUTH SUCKE	16.4	1.4	5.5	0.02	0.01	0.01	-	-	0.03	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	FLANNELMOUTH SUCKE	16.1	1.4	7.1	0.04	0.03	0.04	-	-	0.24	-	0.01	0.01	0.00	-	-	0.00	-	-	-
72	CARP	15.3	2.1	4.9	0.12	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	CHANNEL CATFISH	10.8	0.3	5.5	0.11	0.00	0.02	-	-	0.00	-	0.01	0.00	0.00	-	-	0.00	-	-	-
72	FLANNELMOUTH SUCKE	12.7	1.5	3.7	0.07	0.00	0.00	-	-	0.00	-	0.03	0.00	0.00	-	-	0.00	-	-	-
72	FLANNELMOUTH SUCKE	17.5	1.9	4.5	0.05	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	15.9	2.2	2.4	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CHANNEL CATFISH	11.6	0.5	8.0	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CHANNEL CATFISH	11.9	0.4	4.9	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	FLANNELMOUTH SUCKE	17.8	1.9	10.2	0.09	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	CARP	16.5	2.6	4.4	0.04	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	CHANNEL CATFISH	10.6	0.3	7.7	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	CHANNEL CATFISH	11.1	0.4	3.6	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	FLANNELMOUTH SUCKE	17.1	1.7	7.5	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 37, TRUCKEE RIVER AT FERNLEY, NV

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	BROWN BULLHEAD	10.1	0.6	2.8	0.08	0.05	0.03	-	-	0.24	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	CARP	13.2	1.1	6.4	0.13	0.12	0.06	-	-	0.53	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	CARP	12.7	1.1	5.4	0.11	0.11	0.06	-	-	0.50	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	LARGEMOUTH BASS	11.5	1.1	7.3	0.13	0.15	0.08	-	-	0.73	-	0.03	0.00	0.00	-	-	-	-	0.02	-
71	BROWN BULLHEAD	8.9	0.4	2.2	0.09	0.15	0.05	-	-	0.83	-	0.01	0.00	0.00	-	-	0.01	-	-	-
71	BROWN BULLHEAD	9.0	0.4	1.6	0.07	0.09	0.03	-	-	0.21	-	0.00	0.00	0.00	-	-	0.01	-	-	-
71	CARP	15.5	1.7	3.8	0.47	0.42	0.15	-	-	1.46	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	CARP	14.5	1.5	1.8	0.12	0.33	0.10	-	-	0.96	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	LARGEMOUTH BASS	10.7	0.8	5.5	0.25	0.45	0.80	-	-	0.50	-	0.02	0.00	0.00	-	-	0.01	-	-	-
71	LARGEMOUTH BASS	11.4	1.0	6.4	0.14	0.25	0.05	-	-	0.35	-	0.01	0.00	0.00	-	-	0.01	-	-	-
72	BROWN BULLHEAD	8.9	0.8	0.1	0.01	0.00	0.00	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	CARP	17.3	2.4	5.3	0.41	0.30	0.00	-	-	2.80	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	CARP	13.3	1.2	4.2	0.20	0.13	0.00	-	-	0.80	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	LARGEMOUTH BASS	12.7	1.2	8.9	0.21	0.00	0.00	-	-	2.10	-	0.00	0.00	0.00	-	-	0.02	-	-	-
73	BROWN BULLHEAD	10.3	0.7	4.4	0.00	0.00	0.00	0.0	-	0.22	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	15.2	1.7	4.6	0.05	0.00	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	17.6	2.6	5.9	0.04	0.00	0.00	0.0	-	0.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	LARGEMOUTH BASS	12.6	1.3	7.8	0.00	0.00	0.00	0.0	-	1.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	BROWN BULLHEAD	10.8	0.8	2.3	0.07	0.06	0.00	0.0	-	0.15	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	LARGESCALE SUCKER	13.5	1.1	9.0	0.10	0.15	0.00	0.0	-	0.44	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	LARGESCALE SUCKER	13.1	1.1	9.6	0.15	0.18	0.00	0.0	-	0.53	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	LARGEMOUTH BASS	16.4	2.9	6.9	0.41	0.46	0.12	0.0	-	0.81	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
74	CROSSCHECK	-	-	6.2	0.18	0.32	0.08	0.0	0.0	1.22	0.5	0.04	0.01	0.00	0.34	0.06	0.00	0.00	0.01	0.00

STATION 38, UTAH LAKE AT PROVO, UT

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
70	BLACK BULLHEAD	10.2	0.6	4.7	0.05	0.06	0.02	-	-	0.13	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	BLACK BULLHEAD	9.9	0.6	4.4	0.05	0.04	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	-	-	0.01	-
70	CARP	16.7	2.4	8.7	0.06	0.05	0.02	-	-	0.18	-	0.01	0.00	0.00	-	-	-	-	0.02	-
70	WHITE BASS	10.4	0.5	1.9	0.04	0.04	0.02	-	-	0.12	-	0.01	0.00	0.00	-	-	-	-	0.01	-
71	BLACK BULLHEAD	10.1	0.6	4.9	0.03	0.15	0.26	-	-	1.96	-	0.01	0.01	0.00	-	-	0.00	-	-	-
71	BLACK BULLHEAD	10.9	0.7	4.6	0.03	0.06	0.07	-	-	0.42	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	CARP	15.2	1.8	8.0	0.04	0.05	0.01	-	-	0.08	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	CARP	13.5	1.3	4.1	0.02	0.02	0.02	-	-	0.13	-	0.01	0.00	0.00	-	-	0.00	-	-	-
71	WHITE BASS	8.9	0.3	4.2	0.02	0.03	0.02	-	-	0.09	-	0.01	0.01	0.00	-	-	0.00	-	-	-
71	WHITE BASS	8.4	0.3	4.2	0.02	0.06	0.04	-	-	0.27	-	0.01	0.01	0.00	-	-	0.00	-	-	-
72	BLACK BULLHEAD	9.7	0.5	3.0	0.03	0.03	0.00	-	-	0.12	-	0.01	0.00	0.00	-	-	0.00	-	-	-
72	BLACK BULLHEAD	10.7	0.8	2.2	0.04	0.03	0.00	-	-	0.23	-	0.01	0.00	0.00	-	-	0.00	-	-	-
72	CARP	17.1	1.9	6.5	0.09	0.00	0.01	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
72	WHITE BASS	10.3	0.4	1.9	0.03	0.04	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
73	BLACK BULLHEAD	11.1	0.7	3.8	0.06	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	BLACK BULLHEAD	11.3	0.7	2.4	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	CARP	17.9	2.6	10.8	0.12	0.00	0.00	0.0	-	0.26	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
73	WHITE BASS	10.4	0.4	4.3	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 95, BEAR RIVER AT PRESTON, ID

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC
70	CARP	18.6	3.8	6.5	0.12	0.12	0.09	-	-	0.89	-	0.01	0.00	0.00	-	-	-	-	0.01
70	LARGESCALE SUCKER	17.1	2.7	14.7	0.10	0.15	0.11	-	-	1.06	-	0.01	0.00	0.00	-	-	-	-	0.01
70	LARGESCALE SUCKER	16.1	1.9	8.5	0.06	0.11	0.07	-	-	0.70	-	0.01	0.00	0.00	-	-	-	-	0.01
70	YELLOW PERCH	7.9	0.3	3.9	0.07	0.17	0.13	-	-	1.29	-	0.01	0.00	0.00	-	-	-	-	0.01
71	CARP	14.3	2.1	6.2	0.05	0.12	0.10	-	-	0.77	-	0.01	0.00	0.00	-	-	0.00	-	-
71	CARP	14.4	2.3	6.0	0.05	0.12	0.11	-	-	0.87	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	16.6	2.2	12.2	0.10	0.13	0.10	-	-	0.70	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	17.5	2.4	7.1	0.10	0.15	0.10	-	-	0.90	-	0.01	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	8.0	0.3	3.5	0.03	0.09	0.08	-	-	0.44	-	0.01	0.00	0.00	-	-	0.00	-	-
71	YELLOW PERCH	8.1	0.3	3.9	0.02	0.06	0.06	-	-	0.40	-	0.01	0.00	0.00	-	-	0.00	-	-
72	CARP	17.6	4.1	11.6	0.00	0.00	0.00	-	-	1.90	-	0.01	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	15.1	1.6	7.0	0.00	0.02	0.00	-	-	1.20	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	5.2	0.1	3.9	0.00	0.02	0.00	-	-	1.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	YELLOW PERCH	6.0	0.1	4.5	0.00	0.02	0.02	-	-	1.00	-	0.01	0.00	0.01	-	-	0.00	-	-
73	CARP	14.1	1.6	6.7	0.00	0.00	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGESCALE SUCKER	18.6	2.6	13.5	0.00	0.00	0.00	0.0	-	2.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	8.9	0.3	4.3	0.00	0.00	0.00	0.0	-	1.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	YELLOW PERCH	7.9	0.2	4.0	0.00	0.00	0.00	0.0	-	0.00	1.3	0.00	0.00	0.00	-	-	0.00	-	-

ION 39, SACRAMENTO RIVER AT SACRAMENTO, CA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
ARP	10.9	0.8	2.2	2.92	0.37	0.09	-	-	1.20	-	0.02	0.01	0.00	-	-	-	-	0.01	-
ARP	12.3	1.2	7.2	3.58	1.15	0.34	-	-	4.04	-	0.04	0.01	0.00	-	-	-	-	0.02	-
ROSSCHECK	-	-	7.6	1.44	1.12	0.01	-	2.5	2.00	1.1	0.09	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.9	1.0	3.1	2.51	1.30	0.33	-	-	0.73	-	0.10	0.01	0.00	-	-	-	-	0.01	-
HITE CATFISH	8.3	0.3	4.7	1.46	0.57	0.40	-	-	3.78	-	0.03	0.00	0.00	-	-	-	-	0.01	-
ARP	13.0	1.4	8.8	2.43	0.78	0.18	-	-	1.04	-	0.11	0.01	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	10.0	6.44	1.72	0.22	-	0.5	3.00	1.7	0.13	0.02	0.00	0.42	-	0.00	0.01	-	-
ARP	12.7	1.3	9.5	3.26	0.81	0.16	-	-	1.04	-	0.10	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	12.5	1.3	5.2	0.86	0.43	0.19	-	-	0.39	-	0.01	0.01	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.3	1.0	3.9	1.03	0.68	0.13	-	-	0.17	-	0.18	0.00	0.00	-	-	0.00	-	-	-
HITE CATFISH	9.1	0.4	6.6	1.04	0.41	0.16	-	-	0.63	-	0.05	0.01	0.00	-	-	0.00	-	-	-
HITE CATFISH	9.4	0.5	5.9	0.58	0.25	0.13	-	-	0.63	-	0.03	0.01	0.00	-	-	0.00	-	-	-
ARP	11.6	1.0	4.6	1.20	0.30	0.01	-	-	2.60	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	4.6	1.67	0.34	0.03	-	0.0	1.20	0.6	0.03	0.00	0.00	0.09	-	0.00	0.00	-	-
ARP	11.5	1.0	6.4	2.00	0.60	0.01	-	-	6.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.3	0.9	5.1	2.30	0.87	0.15	-	-	3.70	-	0.00	0.00	0.00	-	-	0.00	-	-	-
HITE CATFISH	10.2	0.5	6.5	3.50	0.60	0.10	-	-	8.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	18.8	2.9	12.4	3.20	0.51	0.00	0.5	-	0.00	3.0	0.29	0.00	0.00	-	-	0.00	-	-	-
ARP	20.3	4.2	9.0	1.70	0.40	0.00	0.0	-	0.00	1.5	0.06	0.00	0.00	-	-	0.00	-	-	-
HITE CATFISH	11.8	0.6	2.6	1.20	0.24	0.00	0.0	-	0.00	1.0	0.05	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	3.3	0.99	0.18	0.06	0.2	0.8	1.40	1.1	0.10	0.00	0.00	0.05	-	0.00	0.00	0.02	0.00
ARP	16.6	1.4	7.5	2.20	0.68	0.00	0.0	-	2.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	7.7	0.30	0.20	0.03	0.0	0.0	0.91	0.5	0.03	0.01	0.01	0.17	0.07	0.00	0.00	0.01	0.00
ARGEMOUTH BASS	11.7	0.9	5.7	1.10	0.43	0.09	0.0	-	0.56	0.0	0.13	0.00	0.00	-	-	0.00	-	-	-
ARGEMOUTH BASS	11.7	0.9	6.5	1.10	0.40	0.09	0.0	-	0.81	0.0	0.12	0.00	0.00	-	-	0.00	-	-	-
HITE CATFISH	10.0	0.4	6.2	1.20	0.29	0.10	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

ION 40, SAN JOAQUIN RIVER AT LOS BANOS, CA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
LACK CRAPPIE	11.6	1.2	9.5	0.70	0.84	0.44	-	-	0.60	-	0.35	0.00	0.00	-	-	-	-	0.02	-
ROSSCHECK	-	-	9.6	0.34	1.00	0.71	-	0.0	0.10	0.0	0.42	0.01	0.00	-	-	3.80	-	-	-
LACK CRAPPIE	10.8	1.1	8.7	0.67	0.71	0.39	-	-	0.42	-	0.29	0.00	0.00	-	-	-	-	0.01	-
ARP	15.1	1.7	4.8	1.52	0.60	0.42	-	-	3.74	-	0.04	0.00	0.00	-	-	-	-	0.01	-
HANNEL CATFISH	16.6	2.3	6.7	1.21	0.98	0.59	-	-	1.72	-	0.22	0.00	0.00	-	-	-	-	0.01	-
LACK CRAPPIE	10.2	0.8	7.7	0.24	0.46	0.07	-	-	0.14	-	0.13	0.00	0.00	-	-	0.00	-	-	-
LACK CRAPPIE	10.0	0.8	7.1	0.22	0.45	0.06	-	-	0.08	-	0.21	0.00	0.00	-	-	0.00	-	-	-
ROSSCHECK	-	-	7.7	0.27	0.35	0.09	-	0.0	0.50	0.3	0.18	0.00	0.00	0.00	-	0.00	0.00	-	-
ARP	12.9	1.4	2.3	0.62	0.21	0.04	-	-	0.17	-	0.04	0.00	0.00	-	-	0.00	-	-	-
ARP	11.9	1.4	2.6	0.14	0.11	0.02	-	-	0.07	-	0.02	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	15.6	2.4	7.7	0.41	0.59	0.21	-	-	0.18	-	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	14.2	2.1	8.3	0.72	0.91	0.39	-	-	0.24	-	0.20	0.00	0.00	-	-	0.00	-	-	-
LACK CRAPPIE	11.0	0.9	6.3	0.39	0.33	0.01	-	-	1.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	11.6	1.0	2.8	0.18	0.10	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	12.0	1.2	2.9	0.25	0.20	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ACRAMENTO BLACKFI	11.4	0.8	12.4	0.20	0.11	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ARP	13.7	1.2	1.1	0.07	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	10.4	0.3	2.4	0.13	0.07	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
HANNEL CATFISH	12.7	0.6	3.1	0.22	0.14	0.00	0.0	-	0.00	0.0	0.08	0.00	0.00	-	-	0.00	-	-	-
HITE CATFISH	12.0	0.7	1.3	0.35	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 47, KLAMATH RIVER AT HORNBROOK, CA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G E
70	KLAMATH SUCKER	15.7	2.1	8.1	0.05	0.03	0.03	-	-	0.12	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	LARGEMOUTH BASS	8.4	0.3	2.8	0.02	0.01	0.02	-	-	0.09	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	YELLOW PERCH	7.9	0.3	2.8	0.05	0.06	0.05	-	-	0.30	-	0.01	0.00	0.00	-	-	-	-	0.01	
70	YELLOW PERCH	8.2	0.3	2.9	0.03	0.25	0.28	-	-	0.18	-	0.01	0.00	0.00	-	-	-	-	0.01	
71	BROWN BULLHEAD	8.6	0.4	4.3	0.01	0.01	0.01	-	-	0.17	-	0.01	0.00	-	-	-	0.00	-	-	
71	BROWN BULLHEAD	8.6	0.3	4.5	0.01	0.01	0.01	-	-	0.10	-	0.01	0.00	-	-	-	0.00	-	-	
71	KLAMATH SUCKER	15.5	2.2	6.1	0.03	0.02	0.03	-	-	0.20	-	0.00	0.00	-	-	-	0.00	-	-	
71	KLAMATH SUCKER	14.3	1.6	5.1	0.02	0.02	0.02	-	-	0.12	-	0.00	0.00	-	-	-	0.00	-	-	
71	YELLOW PERCH	7.7	0.2	4.3	0.01	0.02	0.03	-	-	0.18	-	0.01	0.01	-	-	-	0.00	-	-	
71	YELLOW PERCH	7.6	0.2	3.6	0.01	0.01	0.01	-	-	0.06	-	0.01	0.01	-	-	-	0.00	-	-	
73	KLAMATH SUCKER	14.9	1.6	4.2	0.38	0.21	0.04	0.0	-	0.00	0.3	0.00	0.00	0.00	-	-	0.00	-	-	
73	LARGEMOUTH BASS	7.7	0.3	4.0	0.01	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	YELLOW PERCH	8.1	0.3	5.7	0.01	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	YELLOW PERCH	8.0	0.2	5.2	0.01	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	KLAMATH SUCKER	15.8	1.7	5.9	1.10	0.05	0.07	0.0	-	0.07	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	LARGEMOUTH BASS	10.2	0.5	3.1	0.52	0.27	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	YELLOW PERCH	7.9	0.2	3.2	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	YELLOW PERCH	7.7	0.2	3.1	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	

STATION 48, ROGUE RIVER AT GOLDRAY DAM, OR

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G B
70	BROWN BULLHEAD	10.8	0.7	3.4	0.50	0.34	0.23	-	-	1.04	-	0.03	0.00	0.00	-	-	-	-	0.05	
70	BROWN BULLHEAD	10.8	0.6	3.7	0.36	0.31	0.25	-	-	1.23	-	0.02	0.00	0.00	-	-	-	-	0.02	
70	CARP	15.2	2.6	8.9	0.46	0.22	0.25	-	-	2.60	-	0.01	0.00	0.00	-	-	-	-	0.02	
70	LARGEMOUTH BASS	9.5	0.6	5.1	0.37	0.23	0.17	-	-	0.87	-	0.02	0.00	0.00	-	-	-	-	0.01	
71	BLACK CRAPPIE	9.0	0.5	5.6	0.28	0.21	0.17	-	-	1.04	-	0.02	0.00	-	-	-	0.00	-	-	
71	BLACK CRAPPIE	9.0	0.6	7.4	0.52	0.25	0.19	-	-	1.56	-	0.03	0.00	-	-	-	0.00	-	-	
71	BRIDGELIP SUCKER	12.7	1.2	6.4	0.21	0.20	0.20	-	-	1.09	-	0.02	0.00	-	-	-	0.00	-	-	
71	BRIDGELIP SUCKER	13.8	1.4	5.9	0.20	0.18	0.18	-	-	1.04	-	0.02	0.00	-	-	-	0.00	-	-	
71	BROWN BULLHEAD	10.4	0.6	7.4	0.32	0.23	0.10	-	-	0.50	-	0.02	0.00	-	-	-	0.00	-	-	
71	BROWN BULLHEAD	10.2	0.5	2.8	0.27	0.20	0.10	-	-	0.50	-	0.01	0.00	-	-	-	0.00	-	-	
72	BROWN BULLHEAD	10.6	0.6	3.3	0.30	0.13	0.07	-	-	0.00	-	1.40	0.00	0.00	-	-	0.00	-	-	
72	BROWN BULLHEAD	10.4	0.6	3.1	0.24	0.11	0.04	-	-	0.60	-	0.00	0.00	0.00	-	-	0.00	-	-	
72	CARP	12.8	1.4	3.4	0.75	0.24	0.00	-	-	1.40	-	0.00	0.00	0.00	-	-	0.00	-	-	
73	BLACK CRAPPIE	10.3	0.7	8.7	1.30	0.31	0.00	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-	
73	BROWN BULLHEAD	9.4	0.4	2.8	0.25	0.15	0.02	0.4	-	0.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-	
73	BROWN BULLHEAD	9.0	0.4	2.3	0.32	0.10	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	CARP	11.9	1.4	9.4	0.23	0.14	0.00	2.7	-	2.70	0.0	0.03	0.00	0.00	-	-	0.00	-	-	

STATION 45, WILLAMETTE RIVER AT OREGON CITY, OR

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G B
70	CARP	19.0	5.0	15.1	0.34	0.35	0.11	-	-	1.25	-	0.07	0.00	0.00	-	-	-	-	0.06	
70	LARGESCALE SUCKER	15.3	1.8	7.2	0.57	0.72	0.81	-	-	2.40	-	0.04	0.00	0.00	-	-	-	-	0.06	
70	LARGESCALE SUCKER	15.9	1.7	2.5	0.64	0.77	0.44	-	-	4.58	-	0.04	0.00	0.00	-	-	-	-	0.04	
70	CROSSCHECK	-	-	4.5	0.20	0.46	0.05	-	3.6	5.20	0.8	0.04	0.00	0.00	-	-	0.00	-	-	
71	LARGESCALE SUCKER	15.9	1.8	4.8	0.25	0.32	0.21	-	-	1.67	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	LARGESCALE SUCKER	15.8	1.8	6.4	0.25	0.35	0.18	-	-	1.35	-	0.02	0.00	0.00	-	-	0.00	-	-	
71	NORTHERN SQUAWFISH	13.7	1.2	3.7	0.37	0.41	0.14	-	-	2.37	-	0.01	0.00	0.00	-	-	0.00	-	-	
71	NORTHERN SQUAWFISH	13.5	1.1	4.4	0.33	0.24	0.21	-	-	2.60	-	0.01	0.00	0.00	-	-	0.00	-	-	
72	LARGESCALE SUCKER	14.6	1.4	5.3	0.40	0.16	0.00	-	-	2.80	-	0.02	0.00	0.00	-	-	0.00	-	-	
72	LARGESCALE SUCKER	14.8	1.3	5.7	0.50	0.29	0.51	-	-	5.40	-	0.00	0.00	0.00	-	-	0.00	-	-	
72	CHANNEL CATFISH	13.7	1.0	12.1	0.57	0.28	0.15	-	-	4.40	-	0.06	0.00	0.00	-	-	0.00	-	-	
72	NORTHERN SQUAWFISH	14.3	1.2	4.1	0.57	0.13	0.00	-	-	3.00	-	0.02	0.00	0.00	-	-	0.00	-	-	
73	CARP	14.3	1.3	5.6	0.35	0.00	0.00	0.0	-	0.20	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	LARGESCALE SUCKER	16.1	1.5	4.8	0.31	0.15	0.00	0.0	-	2.40	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	CROSSCHECK	-	-	3.7	0.16	0.26	0.05	0.0	0.8	0.80	0.4	0.01	0.00	0.00	0.04	-	0.00	0.00	0.01	0
73	LARGESCALE SUCKER	16.7	1.6	3.2	0.21	0.11	0.00	0.0	-	1.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
73	NORTHERN SQUAWFISH	16.0	1.6	5.4	0.53	0.14	0.00	0.0	-	2.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	CARP	12.8	0.9	6.0	0.88	0.33	0.00	0.0	-	0.00	0.1	0.03	0.00	0.00	-	-	0.00	-	-	
74	LARGESCALE SUCKER	17.2	1.9	3.1	0.15	0.03	0.02	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	
74	LARGESCALE SUCKER	14.4	1.5	8.1	0.50	0.15	0.17	4.5	-	2.70	0.0	0.04	0.00	0.00	-	-	0.00	-	-	
74	NORTHERN SQUAWFISH	18.3	2.3	6.4	0.19	0.06	0.00	0.0	-	2.30	0.0	0.03	0.00	0.00	-	-	0.00	-	-	
74	CROSSCHECK	-	-	6.8	0.27	0.06	0.00	0.0	0.0	1.07	0.0	0.01	0.00	0.01	0.03	0.00	0.00	0.00	0.01	0

N 46, COLUMBIA RIVER AT CASCADE LOCKS, OR/WA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
GESCALE SUCKER	16.9	2.0	6.4	0.22	0.12	0.08	-	-	0.44	-	0.01	0.00	0.00	-	-	-	-	0.01	-
THERN SQUAWFISH	12.7	0.8	5.6	1.41	0.51	0.23	-	-	2.08	-	0.01	0.00	0.00	-	-	-	-	0.01	-
THERN SQUAWFISH	13.8	1.1	5.6	0.93	0.34	0.18	-	-	1.41	-	0.01	0.00	0.00	-	-	-	-	0.01	-
SSCHECK	-	-	5.3	1.38	0.48	0.00	-	0.6	0.40	1.0	0.02	0.00	0.00	-	-	0.00	-	-	-
P	11.7	1.0	4.5	0.11	0.03	0.02	-	-	0.13	-	0.01	0.01	0.00	-	-	0.00	-	-	-
P	11.3	0.9	1.7	0.25	0.10	0.03	-	-	0.25	-	0.01	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	16.2	1.8	3.2	0.32	0.22	0.20	-	-	0.29	-	0.01	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	15.8	1.8	5.4	0.47	0.37	0.27	-	-	0.95	-	0.01	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	13.6	1.3	4.8	0.94	0.24	0.08	-	-	0.98	-	0.01	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	14.6	4.4	4.3	0.85	0.19	0.06	-	-	0.83	-	0.01	0.01	0.00	-	-	0.00	-	-	-
P	11.9	1.0	5.0	0.50	0.18	0.00	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	16.0	1.7	4.7	0.47	0.38	0.24	-	-	1.40	-	0.00	0.00	0.00	-	-	0.00	-	-	-
P	13.7	1.1	7.4	0.23	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	17.7	1.9	3.6	0.28	0.11	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	17.6	1.8	6.0	0.22	0.17	0.00	0.0	-	0.93	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	11.9	0.6	3.6	0.24	0.00	0.00	0.0	-	0.50	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
P	14.1	1.2	6.4	0.32	0.12	0.00	0.0	-	0.18	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	16.3	1.4	3.0	2.00	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	17.8	1.7	2.5	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	16.5	1.5	6.8	1.20	0.28	0.00	0.0	-	2.60	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SSCHECK	-	-	8.5	0.36	0.23	0.02	0.0	0.0	1.21	0.5	0.01	0.00	0.01	0.03	0.01	0.00	0.00	0.01	0.01

N 96, SNAKE RIVER AT ICE HARBOR DAM, WA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
OGELIP SUCKER	12.1	0.8	4.9	0.44	0.27	0.19	-	-	0.50	-	0.01	0.00	0.00	-	-	-	-	0.03	-
NNEL CATFISH	13.1	1.2	9.8	0.75	0.24	0.12	-	-	0.65	-	0.01	0.00	0.00	-	-	-	-	0.03	-
NNEL CATFISH	14.3	1.3	8.6	1.05	0.42	0.22	-	-	1.35	-	0.03	0.00	0.00	-	-	-	-	0.04	-
THERN SQUAWFISH	12.6	0.7	5.3	2.23	0.43	0.16	-	-	2.50	-	0.03	0.00	0.00	-	-	-	-	0.01	-
SSCHECK	-	-	5.2	1.10	0.30	0.01	-	0.4	1.60	0.8	0.02	0.00	0.00	-	-	0.00	-	-	-
P	13.1	1.6	4.0	0.53	0.21	0.03	-	-	0.16	-	0.01	0.00	0.00	-	-	0.00	-	-	-
P	12.4	1.6	6.4	0.31	0.14	0.05	-	-	0.22	-	0.01	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	14.1	1.1	4.0	0.24	0.16	0.06	-	-	0.32	-	0.01	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	13.5	1.0	2.4	0.13	0.06	0.05	-	-	0.15	-	0.01	0.00	0.00	-	-	0.00	-	-	-
NNEL CATFISH	14.3	1.6	3.2	0.56	0.18	0.10	-	-	0.77	-	0.01	0.01	0.00	-	-	0.00	-	-	-
NNEL CATFISH	14.7	1.9	9.1	0.46	0.19	0.11	-	-	0.47	-	0.02	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	13.5	1.0	4.7	0.16	0.07	0.08	-	-	0.22	-	0.03	0.00	0.00	-	-	0.00	-	-	-
NNEL CATFISH	12.5	0.9	9.4	0.00	0.45	0.16	-	-	1.30	-	0.00	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	8.7	0.3	8.3	0.36	0.08	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
THERN SQUAWFISH	8.5	0.3	9.8	0.31	0.12	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	14.0	1.0	4.3	0.20	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	14.6	1.0	2.6	0.21	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
NNEL CATFISH	16.3	1.4	8.0	0.57	0.00	0.00	0.0	-	0.00	0.5	0.00	0.00	0.00	-	-	0.00	-	-	-
SSCHECK	-	-	9.7	1.59	0.18	0.12	0.0	0.2	0.00	0.6	0.03	0.00	0.00	0.00	-	0.00	0.02	0.02	0.00
THERN SQUAWFISH	16.2	1.6	2.8	1.80	0.16	0.00	0.0	-	3.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OGELIP SUCKER	12.9	0.7	10.7	0.34	0.29	0.20	0.0	-	0.00	0.0	0.09	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	13.6	0.6	4.3	0.28	0.07	0.04	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
GESCALE SUCKER	14.1	0.9	5.0	0.36	0.11	0.06	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
NNEL CATFISH	12.8	0.7	11.3	0.80	0.22	0.08	0.0	-	0.45	0.0	0.04	0.00	0.00	-	-	0.00	-	-	-

STATION 42, SNAKE RIVER AT LEWISTON, ID/WA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CARP	15.3	2.3	10.8	0.47	0.15	0.07	-	-	0.29	-	0.05	0.00	0.00	-	-	-	-	0.0
70	LARGESCALE SUCKER	15.8	1.8	7.8	0.24	0.14	0.15	-	-	0.23	-	0.03	0.00	0.00	-	-	-	-	0.0
70	LARGESCALE SUCKER	15.3	1.6	8.8	0.16	0.11	0.13	-	-	0.40	-	0.03	0.00	0.00	-	-	-	-	0.0
70	SMALLMOUTH BASS	11.0	0.8	5.0	0.33	0.09	0.08	-	-	0.53	-	0.04	0.00	0.00	-	-	-	-	0.0
71	CARP	14.9	2.0	5.7	0.14	0.09	0.10	-	-	1.06	-	0.01	0.01	0.00	-	-	0.00	-	-
71	CARP	14.5	2.4	3.6	0.18	0.05	0.04	-	-	0.25	-	0.01	0.00	0.00	-	-	0.01	-	-
71	NORTHERN SQUAWFISH	14.0	1.2	4.6	1.07	0.10	0.16	-	-	0.98	-	0.02	0.00	0.00	-	-	0.01	-	-
71	NORTHERN SQUAWFISH	14.0	1.2	2.8	0.93	0.19	0.19	-	-	1.31	-	0.02	0.00	0.00	-	-	0.00	-	-
71	SMALLMOUTH BASS	11.2	1.1	7.4	0.54	0.14	0.17	-	-	0.47	-	0.01	0.00	0.00	-	-	0.00	-	-
71	SMALLMOUTH BASS	10.4	0.7	6.3	0.69	0.13	0.17	-	-	0.58	-	0.03	0.01	0.00	-	-	0.00	-	-
72	CARP	17.1	3.1	5.3	1.10	0.29	0.08	-	-	2.10	-	0.11	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	14.1	1.2	5.8	0.21	0.09	0.07	-	-	0.41	-	0.07	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	15.0	1.4	4.2	0.26	0.15	0.18	-	-	0.50	-	0.07	0.00	0.00	-	-	0.00	-	-
72	NORTHERN SQUAWFISH	15.4	1.6	6.3	1.60	0.26	0.01	-	-	1.70	-	0.26	0.00	0.00	-	-	0.00	-	-
73	BLACK CRAPPIE	9.6	0.7	7.5	0.27	0.12	0.00	0.0	-	0.00	0.0	0.00	0.06	0.00	-	-	0.00	-	-
73	BLACK CRAPPIE	9.8	0.6	6.6	0.41	0.15	0.19	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CARP	17.3	2.7	7.3	0.31	0.31	0.19	0.0	-	0.00	0.0	0.12	0.00	0.00	-	-	0.00	-	-
73	LARGESCALE SUCKER	17.2	1.9	7.7	0.19	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	BLACK CRAPPIE	-	-	7.5	0.50	0.00	0.00	0.0	-	0.27	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	LARGESCALE SUCKER	13.7	1.0	8.4	0.21	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	LARGESCALE SUCKER	16.3	1.5	8.1	0.21	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	NORTHERN SQUAWFISH	0.0	0.0	4.7	1.00	0.00	0.00	0.0	-	1.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-

STATION 41, SNAKE RIVER AT HAGERMAN, ID

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	LARGESCALE SUCKER	13.0	1.0	5.4	0.21	0.08	0.06	-	-	0.31	-	0.01	0.00	0.00	-	-	-	-	0.0
70	LARGESCALE SUCKER	12.6	0.9	4.6	0.30	0.10	0.07	-	-	0.29	-	0.02	0.00	0.00	-	-	-	-	0.0
70	NORTHERN SQUAWFISH	15.4	1.7	3.9	1.64	0.26	0.13	-	-	1.16	-	0.02	0.00	0.00	-	-	-	-	0.0
70	RAINBOW TROUT	14.2	1.3	5.8	2.54	0.21	0.21	-	-	0.12	-	0.02	0.00	0.00	-	-	-	-	0.0
71	LARGESCALE SUCKER	12.6	1.0	5.5	0.09	0.08	0.06	-	-	0.15	-	0.04	0.00	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	13.0	1.0	3.6	0.17	0.07	0.06	-	-	0.33	-	0.01	0.00	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	14.4	1.3	4.0	1.87	0.32	0.22	-	-	1.67	-	0.00	0.00	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	14.3	1.3	3.2	1.59	0.32	0.19	-	-	1.80	-	0.02	0.00	0.00	-	-	0.00	-	-
71	PEAMOUTH	9.4	0.3	6.0	0.34	0.15	0.10	-	-	0.69	-	0.02	0.00	0.00	-	-	0.00	-	-
71	PEAMOUTH	9.5	0.4	5.3	0.60	0.13	0.08	-	-	0.56	-	0.02	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	11.3	0.7	5.9	0.32	0.12	0.06	-	-	0.50	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	12.1	0.9	8.1	0.44	0.23	0.44	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	NORTHERN SQUAWFISH	10.6	0.6	3.7	2.50	0.15	0.00	-	-	3.70	-	0.04	0.00	0.00	-	-	0.00	-	-
72	PEAMOUTH	9.2	0.3	7.5	0.66	0.10	0.00	-	-	1.40	-	0.07	0.00	0.00	-	-	0.00	-	-
73	LARGESCALE SUCKER	15.9	1.7	8.0	0.46	0.00	0.11	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	LARGESCALE SUCKER	16.1	1.5	6.2	0.23	0.00	0.13	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	NORTHERN SQUAWFISH	15.4	1.4	7.6	0.93	0.00	0.00	0.0	-	0.31	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	RAINBOW TROUT	14.8	1.5	8.7	0.30	0.00	0.00	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-
74	CARP	12.6	1.2	8.8	0.34	0.08	0.00	0.0	-	0.14	0.0	0.03	0.00	0.00	-	-	0.00	-	-
74	CARP	11.2	0.9	6.7	0.29	0.09	0.00	0.0	-	0.11	0.0	0.02	0.00	0.00	-	-	0.00	-	-
74	NORTHERN SQUAWFISH	17.2	1.7	3.3	4.30	0.30	0.00	0.0	-	3.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	RAINBOW TROUT	11.4	0.6	2.0	0.59	0.09	0.00	0.0	-	0.53	0.0	0.01	0.00	0.00	-	-	0.00	-	-

DN 43, SALMON RIVER AT RIGGINS, ID

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
RP	13.1	1.5	3.1	0.09	0.03	0.02	-	-	0.14	-	0.01	0.00	0.00	-	-	-	-	0.01	-
RGESCALE SUCKER	17.4	2.3	5.4	0.12	0.04	0.04	-	-	0.21	-	0.01	0.00	0.00	-	-	-	-	0.01	-
RGESCALE SUCKER	17.7	2.3	3.5	0.10	0.05	0.06	-	-	0.42	-	0.01	0.00	0.00	-	-	-	-	0.01	-
RTHERN SQUAWFISH	13.1	1.0	5.2	0.74	0.08	0.05	-	-	0.55	-	0.01	0.00	0.00	-	-	-	-	0.01	-
RP	15.4	2.4	4.8	0.06	0.02	0.01	-	-	0.06	-	0.01	0.00	0.00	-	-	0.00	-	-	-
NGNOSE SUCKER	15.3	1.7	3.7	0.07	0.02	0.02	-	-	0.05	-	0.01	0.00	0.00	-	-	0.00	-	-	-
NGNOSE SUCKER	15.8	1.8	5.1	0.75	0.21	0.10	-	-	0.24	-	0.03	0.00	0.00	-	-	0.00	-	-	-
RTHERN SQUAWFISH	11.2	0.6	4.8	0.81	0.05	0.05	-	-	0.52	-	0.01	0.00	0.00	-	-	0.00	-	-	-
RTHERN SQUAWFISH	13.9	1.2	5.2	0.12	0.04	0.03	-	-	0.02	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLMOUTH BASS	11.3	1.0	6.2	0.14	0.02	0.04	-	-	0.15	-	0.01	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	14.5	1.3	5.2	0.09	0.03	0.06	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	13.7	1.2	2.9	0.12	0.04	0.05	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RTHERN SQUAWFISH	9.3	0.3	5.1	0.22	0.03	0.02	-	-	0.40	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLMOUTH BASS	9.6	0.6	2.5	0.36	0.02	0.00	-	-	0.40	-	0.00	0.00	0.00	-	-	0.00	-	-	-
OWN BULLHEAD	7.5	0.2	7.5	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
OWN BULLHEAD	8.3	0.3	1.0	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	17.5	1.8	4.3	0.12	0.01	0.04	0.0	-	0.15	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLMOUTH BASS	13.2	1.4	6.9	0.14	0.05	0.10	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RP	13.4	1.2	3.1	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	17.8	2.0	5.6	0.18	0.04	0.04	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ALLMOUTH BASS	8.2	0.2	2.1	0.05	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

DN 44, YAKIMA RIVER AT GRANGER, WA

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIEL-DRIN	EN-DRIN	HEPTA-CHLOR	CIS CHLOR-DANE	TRANS CHLOR-DANE	OTHER COMPOUNDS TOXA-PHENE	H C B	A-BHC	G-BHC
IDGELIP SUCKER	14.0	1.2	7.9	0.66	0.48	1.03	-	-	0.44	-	0.06	0.00	0.00	-	-	-	-	0.02	-
RP	11.2	1.1	5.6	0.89	0.03	0.15	-	-	1.93	-	0.03	0.00	0.00	-	-	-	-	0.01	-
RP	11.3	1.0	5.0	1.70	0.35	0.17	-	-	0.56	-	0.02	0.00	0.00	-	-	-	-	0.01	-
RGEMOUTH BASS	12.3	1.4	3.9	1.66	0.51	0.42	-	-	0.63	-	0.08	0.00	0.00	-	-	-	-	0.01	-
ACK CRAPPIE	7.4	0.3	1.9	0.49	0.14	0.18	-	-	0.28	-	0.01	0.00	0.00	-	-	0.00	-	-	-
ACK CRAPPIE	7.4	0.3	2.3	0.55	0.14	0.16	-	-	0.21	-	0.03	0.00	0.00	-	-	0.00	-	-	-
RP	11.9	1.1	4.4	1.07	0.25	0.17	-	-	0.15	-	0.01	0.01	0.00	-	-	0.01	-	-	-
RP	11.9	1.2	5.0	1.02	0.38	0.08	-	-	0.30	-	0.02	0.01	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	14.0	1.2	4.9	1.12	0.52	1.04	-	-	0.33	-	0.01	0.01	0.00	-	-	0.01	-	-	-
RGESCALE SUCKER	14.1	1.2	5.4	0.71	0.38	0.55	-	-	0.34	-	0.02	0.01	0.00	-	-	0.00	-	-	-
RP	10.5	0.8	6.4	2.20	0.42	0.14	-	-	1.70	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	14.6	1.1	4.3	0.92	0.44	0.64	-	-	1.40	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	14.0	1.0	4.2	1.10	0.55	0.78	-	-	1.70	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RTHERN SQUAWFISH	10.8	0.5	3.8	2.70	0.34	0.01	-	-	3.00	-	0.00	0.00	0.00	-	-	0.00	-	-	-
RP	13.4	1.2	5.4	0.52	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	15.3	1.3	6.0	0.88	0.39	0.51	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	14.4	1.2	12.0	1.00	0.47	0.67	0.0	-	0.00	0.0	0.16	0.00	0.00	-	-	0.00	-	-	-
RGEMOUTH BASS	13.8	1.7	4.2	0.77	0.14	0.11	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
RP	13.2	1.1	4.9	3.10	0.80	0.44	0.0	-	0.00	0.2	0.17	0.00	0.00	-	-	0.00	-	-	-
RP	12.2	0.9	4.9	2.20	0.55	0.19	0.0	-	0.00	0.1	0.12	0.00	0.00	-	-	0.00	-	-	-
RGESCALE SUCKER	13.1	0.8	5.1	1.10	0.69	0.54	0.0	-	0.00	0.2	0.08	0.00	0.00	-	-	0.00	-	-	-
ALLMOUTH BASS	12.2	1.1	4.8	1.40	0.39	0.31	0.0	-	0.00	0.2	0.08	0.00	0.00	-	-	0.00	-	-	-

STATION 97, COLUMBIA RIVER AT PASCO, WA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
70	CARP	12.6	1.3	5.0	1.12	0.24	0.06	-	-	0.17	-	0.02	0.00	0.00	-	-	-	-	0.01
70	LARGESCALE SUCKER	17.2	2.6	7.6	0.57	0.34	0.42	-	-	1.20	-	0.02	0.00	0.00	-	-	-	-	0.02
70	LARGESCALE SUCKER	16.3	2.1	8.9	0.74	0.55	0.38	-	-	0.94	-	0.02	0.00	0.00	-	-	-	-	0.03
70	MOUNTAIN WHITEFISH	12.0	0.5	7.6	1.41	0.47	0.35	-	-	0.83	-	0.03	0.00	0.00	-	-	-	-	0.04
71	CARP	12.3	1.3	5.9	0.53	0.15	0.02	-	-	0.22	-	0.01	0.00	0.02	-	-	0.00	-	-
71	CARP	12.1	1.3	4.4	0.21	0.10	0.02	-	-	0.17	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	17.2	2.0	4.8	0.71	0.34	0.20	-	-	0.38	-	0.01	0.00	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	17.1	2.1	8.2	0.65	0.52	0.43	-	-	0.23	-	0.01	0.00	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	12.2	0.8	4.5	1.76	0.52	0.08	-	-	1.10	-	0.01	0.00	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	11.6	0.7	5.0	1.23	0.27	0.10	-	-	1.18	-	0.01	0.00	0.00	-	-	0.00	-	-
72	CARP	12.2	1.0	4.5	0.67	0.25	0.01	-	-	1.40	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	14.7	1.2	4.6	1.10	0.45	0.12	-	-	2.30	-	0.00	0.00	0.00	-	-	0.00	-	-
72	LARGESCALE SUCKER	14.7	1.2	4.9	0.91	0.59	0.12	-	-	3.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	NORTHERN SQUAWFISH	13.5	1.0	2.1	3.00	0.37	0.00	-	-	2.70	-	0.14	0.00	0.00	-	-	0.00	-	-
73	CARP	11.7	0.8	2.1	0.24	0.07	0.01	0.0	-	0.00	0.0	0.01	0.00	0.00	-	-	0.00	-	-
73	CARP	12.2	0.8	3.5	0.27	0.07	0.00	0.0	-	0.00	0.0	0.06	0.00	0.00	-	-	0.00	-	-
73	LARGESCALE SUCKER	14.2	1.1	4.9	0.02	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	NORTHERN SQUAWFISH	13.6	0.9	8.0	0.18	0.35	0.00	0.0	-	1.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	CARP	12.8	1.0	5.6	1.40	0.80	0.16	0.0	-	0.00	0.2	0.10	0.00	0.00	-	-	0.00	-	-
74	CARP	13.0	0.9	5.2	1.70	0.42	0.06	0.0	-	0.00	0.2	0.06	0.00	0.00	-	-	0.00	-	-
74	LARGESCALE SUCKER	13.7	0.9	4.4	0.20	0.07	0.04	0.0	-	0.21	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	NORTHERN SQUAWFISH	14.6	1.1	2.4	1.70	0.12	0.00	0.0	-	0.00	1.2	0.00	0.00	0.00	-	-	0.00	-	-

STATION 98, COLUMBIA RIVER AT GRAND COULEE, WA

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DDE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUN TOXAPHENE	HCB	A-BHC
70	BRIDGELIP SUCKER	14.1	1.2	6.8	0.04	0.05	0.06	-	-	0.55	-	0.01	0.00	0.00	-	-	-	-	0.01
70	NORTHERN SQUAWFISH	12.6	0.9	1.3	0.06	0.04	0.04	-	-	0.62	-	0.01	0.00	0.00	-	-	-	-	0.01
70	WALLEYE	14.3	1.1	4.9	0.10	0.07	0.07	-	-	0.89	-	0.01	0.00	0.00	-	-	-	-	0.01
70	WALLEYE	14.8	1.3	4.9	0.12	0.08	0.07	-	-	0.89	-	0.01	0.00	0.00	-	-	-	-	0.01
71	LARGESCALE SUCKER	13.1	1.0	5.2	0.09	0.06	0.07	-	-	0.42	-	0.01	0.01	0.00	-	-	0.00	-	-
71	LARGESCALE SUCKER	13.5	1.1	5.1	0.03	0.04	0.04	-	-	0.36	-	0.01	0.01	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	14.2	1.4	4.9	0.15	0.09	0.09	-	-	1.19	-	0.01	0.00	0.00	-	-	0.00	-	-
71	NORTHERN SQUAWFISH	14.0	1.2	10.6	1.19	0.45	0.07	-	-	0.42	-	0.01	0.00	0.00	-	-	0.00	-	-
71	WALLEYE	16.1	2.0	8.3	0.10	0.08	0.08	-	-	0.80	-	0.01	0.01	0.00	-	-	0.00	-	-
71	WALLEYE	16.9	2.1	9.2	0.12	0.08	0.07	-	-	1.04	-	0.00	0.00	0.00	-	-	0.00	-	-
72	BRIDGELIP SUCKER	15.3	1.4	6.2	0.03	0.02	0.00	-	-	0.70	-	0.01	0.00	0.00	-	-	0.00	-	-
72	NORTHERN SQUAWFISH	15.0	1.1	1.5	0.21	0.01	0.00	-	-	4.60	-	0.01	0.00	0.00	-	-	0.00	-	-
72	WALLEYE	14.9	1.0	3.9	0.08	0.01	0.01	-	-	3.60	-	0.02	0.00	0.00	-	-	0.00	-	-
72	WALLEYE	14.2	0.8	3.6	0.10	0.02	0.01	-	-	2.20	-	0.01	0.00	0.00	-	-	0.00	-	-
73	BRIDGELIP SUCKER	14.3	1.1	5.2	0.00	0.00	0.00	0.0	-	0.00	4.8	0.01	0.00	0.00	-	-	0.00	-	-
73	BRIDGELIP SUCKER	13.7	0.9	3.3	0.01	0.00	0.01	0.0	-	0.00	0.5	0.01	0.00	0.00	-	-	0.00	-	-
73	NORTHERN SQUAWFISH	13.0	0.9	13.4	0.00	0.00	0.00	0.0	-	0.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	WALLEYE	14.4	1.1	10.1	0.10	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	5.1	0.06	0.01	0.03	0.0	0.2	1.40	0.8	0.00	0.00	0.00	0.00	-	0.00	0.00	0.11
74	BRIDGELIP SUCKER	14.2	0.9	7.1	0.00	0.01	0.02	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-
74	NORTHERN SQUAWFISH	14.0	0.9	1.8	0.13	0.02	0.00	0.0	-	0.00	0.3	0.00	0.00	0.00	-	-	0.00	-	-
74	WALLEYE	12.6	0.7	3.8	0.06	0.01	0.04	0.0	-	0.00	0.2	0.00	0.00	0.00	-	-	0.00	-	-
74	WALLEYE	13.2	0.7	5.2	0.07	0.02	0.05	0.0	-	0.00	0.4	0.00	0.00	0.00	-	-	0.00	-	-

N 49, CHENA RIVER AT FAIRBANKS, AK

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
TIC GRAYLING	10.2	0.6	4.1	0.22	0.19	0.22	-	-	1.80	-	0.01	0.00	0.00	-	-	-	-	0.01	-
GNOSE SUCKER	13.5	1.7	6.8	0.16	0.16	0.22	-	-	1.48	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ND WHITEFISH	11.7	1.0	2.8	0.37	0.36	0.35	-	-	3.07	-	0.01	0.01	0.00	-	-	-	-	0.01	-
TIC GRAYLING	11.5	0.7	5.1	0.39	0.42	0.42	-	-	3.18	-	0.01	0.00	-	-	-	0.00	-	-	-
TIC GRAYLING	12.4	0.9	3.4	0.25	0.18	0.24	-	-	1.46	-	0.01	0.00	-	-	-	0.00	-	-	-
GNOSE SUCKER	14.1	1.6	4.0	0.34	0.29	0.42	-	-	2.40	-	0.01	0.00	-	-	-	0.00	-	-	-
GNOSE SUCKER	14.4	1.6	4.4	0.31	0.24	0.34	-	-	1.56	-	0.01	0.00	-	-	-	0.00	-	-	-
ND WHITEFISH	10.9	0.5	1.7	0.23	0.38	0.40	-	-	3.13	-	0.01	0.00	-	-	-	0.00	-	-	-
ND WHITEFISH	12.5	0.7	2.6	0.23	0.34	0.34	-	-	2.66	-	0.01	0.00	-	-	-	0.00	-	-	-
TIC GRAYLING	10.9	0.7	4.7	0.40	0.00	0.00	-	-	5.30	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GNOSE SUCKER	16.2	2.0	4.6	0.57	0.12	0.41	-	-	3.60	-	0.00	0.00	0.00	-	-	0.00	-	-	-
GNOSE SUCKER	15.5	1.8	5.4	0.33	0.09	0.41	-	-	3.40	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	9.7	0.5	5.0	0.13	0.22	0.36	-	-	2.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
TIC GRAYLING	11.6	0.6	3.8	0.12	0.00	0.00	0.0	-	1.70	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
SSCHECK	-	-	3.5	1.68	0.28	0.03	0.0	0.2	0.80	0.5	0.02	0.00	0.00	0.05	-	0.00	0.00	0.01	0.00
GNOSE SUCKER	14.3	1.3	3.6	0.12	0.00	0.00	0.0	-	2.10	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	11.1	0.4	1.6	0.12	0.00	0.00	0.0	-	1.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	11.3	0.4	2.4	0.06	0.00	0.00	0.0	-	0.80	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

N 50, KENAI RIVER AT SOLDATNA, AK

SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES ODE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOUNDS TOXAPHENE	HCB	A-BHC	G-BHC
E TROUT	13.7	0.9	1.8	0.05	0.01	0.01	-	-	0.15	-	0.01	0.00	0.00	-	-	-	-	0.01	-
NBOW TROUT	16.3	1.5	5.8	0.06	0.02	0.02	-	-	0.13	-	0.01	0.00	0.00	-	-	-	-	0.01	-
ND WHITEFISH	12.1	0.7	4.4	0.01	0.01	0.01	-	-	0.06	-	0.01	0.00	0.00	-	-	-	-	0.04	-
E TROUT	16.7	1.2	1.5	0.04	0.01	0.03	-	-	0.13	-	0.01	0.01	-	-	-	0.00	-	-	-
E TROUT	16.4	1.2	1.5	0.06	0.01	0.03	-	-	0.14	-	0.01	0.01	-	-	-	0.00	-	-	-
NBOW TROUT	10.4	0.5	3.5	0.01	0.01	0.01	-	-	0.12	-	0.00	0.00	-	-	-	0.00	-	-	-
NBOW TROUT	11.1	0.6	7.4	0.03	0.02	0.01	-	-	0.18	-	0.00	0.00	-	-	-	0.00	-	-	-
ND WHITEFISH	11.7	0.5	2.6	0.01	0.02	0.04	-	-	0.34	-	0.01	0.00	-	-	-	0.00	-	-	-
ND WHITEFISH	13.8	0.8	1.8	0.01	0.01	0.01	-	-	0.04	-	0.01	0.00	-	-	-	0.00	-	-	-
E TROUT	14.0	0.9	3.4	0.06	0.01	0.01	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
E TROUT	14.6	1.0	2.0	0.03	0.01	0.01	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
NBOW TROUT	9.8	0.4	10.6	0.06	0.00	0.00	-	-	0.20	-	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	12.0	0.5	2.7	0.01	0.00	0.00	-	-	0.10	-	0.00	0.00	0.00	-	-	0.00	-	-	-
E TROUT	15.2	1.0	6.0	0.02	0.00	0.00	0.0	-	0.30	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
E TROUT	14.9	0.9	2.2	0.02	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
NBOW TROUT	13.4	1.1	7.4	0.01	0.00	0.00	0.0	-	0.10	0.0	0.00	0.00	0.00	-	-	0.10	-	-	-
ND WHITEFISH	10.8	0.4	3.3	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
E TROUT	15.8	1.2	9.5	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
NBOW TROUT	13.0	0.9	12.6	0.03	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	12.0	0.5	1.9	0.01	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-
ND WHITEFISH	11.8	0.6	3.8	0.00	0.00	0.00	0.0	-	0.00	0.0	0.00	0.00	0.00	-	-	0.00	-	-	-

STATION 99, HAIKELE STREAM AT WAIPAHU, HI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DOE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CUBAN LIMIA	2.6	0.1	8.4	0.25	0.42	0.44	-	-	1.20	-	0.74	0.00	0.00	-	-	-	-	0.0
70	TILAPIA	6.1	0.1	5.7	0.12	0.14	0.13	-	-	0.40	-	0.20	0.00	0.00	-	-	-	-	0.0
70	CHINESE CATFISH	8.1	0.1	5.1	1.76	0.94	0.38	-	-	1.46	-	0.34	0.00	0.00	-	-	-	-	0.0
70	CHINESE CATFISH	9.4	0.2	2.5	0.88	0.47	0.22	-	-	1.20	-	0.18	0.00	0.00	-	-	-	-	0.0
71	CUBAN LIMIA	3.3	-	8.1	0.18	0.30	0.26	-	-	0.51	-	0.09	0.00	0.00	-	-	0.00	-	-
71	CUBAN LIMIA	3.2	-	9.4	0.21	0.25	0.31	-	-	0.62	-	0.43	0.01	0.00	-	-	0.00	-	-
71	TILAPIA	5.5	0.1	4.3	0.11	0.13	0.11	-	-	0.33	-	0.15	0.00	0.00	-	-	0.00	-	-
71	TILAPIA	5.2	0.1	4.0	0.10	0.12	0.13	-	-	0.35	-	0.18	0.00	0.00	-	-	0.00	-	-
71	CHINESE CATFISH	8.0	0.2	6.0	0.26	0.20	0.17	-	-	0.42	-	0.19	0.00	0.00	-	-	0.00	-	-
71	CHINESE CATFISH	7.9	0.2	6.9	0.16	0.14	0.09	-	-	0.35	-	0.14	0.00	0.00	-	-	0.00	-	-
72	CUBAN LIMIA	3.4	-	5.5	0.68	0.94	0.89	-	-	0.00	-	0.26	0.00	0.00	-	-	0.00	-	-
72	TILAPIA	5.0	0.1	4.1	0.46	0.92	0.01	-	-	0.00	-	0.16	0.00	0.00	-	-	0.00	-	-
72	CHINESE CATFISH	8.5	0.2	3.1	0.67	0.69	0.20	-	-	1.70	-	0.21	0.00	0.00	-	-	0.00	-	-
72	CHINESE CATFISH	8.3	0.2	3.3	0.62	0.45	0.11	-	-	1.00	-	0.14	0.00	0.00	-	-	0.00	-	-
73	CUBAN LIMIA	3.0	0.1	1.1	0.56	0.43	1.10	0.0	-	0.00	0.0	0.06	0.00	0.00	-	-	0.00	-	-
73	TILAPIA	5.8	0.1	0.8	0.17	0.25	0.36	0.0	-	0.00	0.0	0.03	0.00	0.00	-	-	0.00	-	-
73	CHINESE CATFISH	8.9	0.2	2.2	0.53	0.50	0.67	0.0	-	0.00	1.6	0.09	0.00	0.00	-	-	0.00	-	-
73	CHINESE CATFISH	8.4	0.2	4.2	0.52	0.73	0.50	0.0	-	0.00	0.0	0.19	0.00	0.00	-	-	0.00	-	-
74	CUBAN LIMIA	2.5	0.1	4.3	0.51	0.21	0.40	0.0	-	0.00	0.0	0.77	0.00	0.00	-	-	0.00	-	-
74	TILAPIA	6.2	0.2	1.5	0.10	0.00	0.00	0.0	-	0.00	0.0	0.05	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	1.1	0.09	0.05	0.02	0.0	0.0	0.37	0.0	0.01	0.01	0.01	0.02	0.01	0.00	0.01	0.0
74	CHINESE CATFISH	8.3	0.2	5.6	0.81	0.00	0.00	0.0	-	0.00	0.0	0.39	0.00	0.00	-	-	0.00	-	-
74	CHINESE CATFISH	8.8	0.2	5.4	0.12	0.40	0.44	0.0	-	1.60	0.0	0.22	0.00	0.00	-	-	0.00	-	-

STATION 100, MANOA STREAM AT HONOLULU, HI

YEAR	SPECIES	MEAN TL (IN)	MEAN WT (LB)	LIPID (%)	P,P'-DDT HOMOLOGUES DOE	DDD	DDT	PCB'S (AROCLOR MIXTURES) 1242	1248	1254	1260	CYCLODIENE INSECTICIDES DIELDRIN	ENDRIN	HEPTACHLOR	CIS CHLORDANE	TRANS CHLORDANE	OTHER COMPOU TOXAPHENE	HCB	A-BHC
70	CUBAN LIMIA	3.5	0.1	8.9	0.52	0.73	0.62	-	-	0.00	-	1.35	0.00	0.00	-	-	-	-	0.0
70	TILAPIA	8.0	0.3	4.0	0.11	0.21	0.11	-	-	0.00	-	0.32	0.00	0.00	-	-	-	-	0.
70	CHINESE CATFISH	10.3	0.3	9.5	2.21	1.04	0.65	-	-	0.00	-	0.85	0.00	0.00	-	-	-	-	0.
70	CHINESE CATFISH	8.8	0.2	7.0	1.43	0.85	0.48	-	-	0.00	-	0.65	0.00	0.00	-	-	-	-	0.
71	CUBAN LIMIA	3.3	-	-	0.00	0.00	0.00	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
71	CUBAN LIMIA	3.1	-	7.6	0.00	0.00	0.00	-	-	0.00	-	3.78	0.14	0.00	-	-	0.00	-	-
71	TILAPIA	9.2	0.6	7.4	0.00	0.00	0.00	-	-	0.00	-	2.77	0.16	0.00	-	-	0.00	-	-
71	CROSSCHECK	-	-	8.7	0.00	0.00	0.00	-	0.0	0.50	0.0	4.36	0.10	0.00	0.30	-	0.00	0.00	-
71	TILAPIA	9.5	0.5	3.4	0.00	0.00	0.00	-	-	0.00	-	2.60	0.13	0.00	-	-	0.00	-	-
71	CHINESE CATFISH	10.3	0.4	3.1	0.00	0.00	0.00	-	-	0.00	-	1.50	0.04	0.00	-	-	0.00	-	-
71	CHINESE CATFISH	9.8	0.3	3.6	0.00	0.00	0.00	-	-	0.00	-	1.43	0.07	0.00	-	-	0.00	-	-
72	CUBAN LIMIA	3.2	0.1	8.5	0.21	0.65	0.80	-	-	0.00	-	0.00	0.00	0.00	-	-	0.00	-	-
72	TILAPIA	6.3	0.3	6.0	0.07	0.00	0.23	-	-	0.00	-	0.87	0.00	0.00	-	-	0.00	-	-
72	CROSSCHECK	-	-	7.6	0.05	0.00	0.00	-	0.0	0.30	0.0	0.94	0.00	0.10	0.44	-	0.00	0.00	-
72	CHINESE CATFISH	8.6	0.2	4.9	0.73	0.08	0.11	-	-	2.30	-	1.20	0.00	0.00	-	-	0.00	-	-
72	CHINESE CATFISH	9.2	0.3	4.6	0.47	0.42	0.36	-	-	2.00	-	0.87	0.00	0.00	-	-	0.00	-	-
73	CUBAN LIMIA	2.7	0.1	3.8	0.00	0.70	0.00	0.0	-	0.00	0.0	1.20	0.00	0.00	-	-	0.00	-	-
73	TILAPIA	9.8	0.5	1.9	0.00	0.23	0.00	0.0	-	0.00	0.0	0.90	0.00	0.00	-	-	0.00	-	-
73	CROSSCHECK	-	-	1.9	0.00	0.00	0.00	0.0	0.0	0.00	0.0	18.00	0.02	0.02	7.10	-	0.00	0.00	0.
73	CHINESE CATFISH	9.3	0.3	3.9	0.00	0.00	0.00	0.0	-	0.00	0.0	0.41	0.00	0.00	-	-	0.00	-	-
73	CHINESE CATFISH	10.0	0.3	3.9	0.00	0.45	0.00	0.0	-	0.00	0.0	0.80	0.00	0.00	-	-	0.00	-	-
74	CUBAN LIMIA	2.7	0.1	8.0	0.00	0.00	0.00	0.0	-	0.00	0.0	9.10	0.00	0.00	-	-	0.00	-	-
74	TILAPIA	7.7	0.3	2.6	0.00	0.00	0.00	0.0	-	0.00	0.0	1.00	0.00	0.00	-	-	0.00	-	-
74	CROSSCHECK	-	-	2.7	0.56	0.00	0.03	0.0	0.0	0.14	0.0	0.37	0.04	0.12	0.60	0.08	0.00	0.00	0.
74	CHINESE CATFISH	9.2	0.2	6.0	0.46	0.00	0.00	0.0	-	1.00	0.0	2.00	0.00	0.00	-	-	0.00	-	-
74	CHINESE CATFISH	9.3	0.2	2.6	0.18	0.00	0.00	0.0	-	0.50	0.0	0.67	0.00	0.00	-	-	0.00	-	-

APPENDIX

Chemical Names of Compounds Discussed in This Issue

OCLOR 1016 or 1242	PCB, approximately 42% chlorine
OCLOR 1248	PCB, approximately 48% chlorine
OCLOR 1254	PCB, approximately 54% chlorine
OCLOR 1260	PCB, approximately 60% chlorine
DRIN	Hexachlorohexahydro-*endo*, *exo*-dimethanonaphthalene 95% and related compounds 5%
C (Benzene Hexachloride)	1,2,3,4,5,6-Hexachlorocyclohexane (mixture of isomers)
LORDANE	Technical: 60% octachloro-4,7-methanotetrahydroindane and 40% related compounds
E	Dichlorodiphenyldichloroethylene (degradation product of DDT)
T	Dichloro diphenyl trichloroethane. Principal isomer present (*p,p'*-DDT; not less than 70%): 1,1,1-trichloro-2,2-bis(*p*-chlorophenyl)ethane
ELDRIN	Hexachloroepoxyoctahydro-*endo,exo*-dimethanonaphthalene 85% and related compounds 15%
DRIN	Hexachloroepoxyoctahydro-*endo,endo*-dimethanonaphthalene
B	Hexachlorobenzene
PTACHLOR	Heptachlorotetrahydro-4,7 methanoindene
PTACHLOR EPOXIDE	1,4,5,6,7,8,8-Heptachloro-2,3-*epoxy*-3a,4,7,7a-tetrahydro-4,7-methanoindan
PONE	Decachlorooctahydro-1,3,4-metheno-2*H*-cyclobuta[cd]pentalen-2-one
NDANE	*Gamma* isomer of benzene hexachloride (BHC)
REX	Dodecachlorooctahydro-1,3,4-metheno-1*H*-cyclobuta[cd]pentalene
NACHLOR	1,2,3,4,5,6,7,8,8-Nonachlor-3a,4,7,7a-tetrahydro-4,7-methanoindan
YCHLORDANE	1-*exo*-2-*endo*-4,5,6,7,8,8a-Octachloro-2,3-*exo*-*epoxy*-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene
Bs (Polychlorinated Biphenyls)	Mixtures of chlorinated biphenyl compounds having various percentages of chlorine
E	Dichloro diphenyl dichloroethane (1,1-dichloro-2,2-bis(*p*-chlorophenyl)ethane, principal component)
XAPHENE	Technical chlorinated camphene (67–69% chlorine)

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Sidney Williams
Martin P. Yurawecz

SUBJECT AND AUTHOR INDEXES

Volume 14, June 1980—March 1981

Preface

Primary headings in the subject index include pesticide compounds, media in which pesticide residues are monitored, and major concepts related to the monitoring of pesticides in the environment. Pesticide compounds are listed by common names; trade names are used for those which have no common names.

Secondary headings cross-reference the primary headings. For a paper which discusses five or more organochlorines or organophosphates the compounds are grouped by class under media and concept headings but each compound appears individually under the primary headings for pesticide compounds.

In the author index all information on a paper appears in the senior author's citations: associate authors, title of the paper, and volume, issue, and pages where the article was published. Names of associate authors are cross-referenced as minor headings, but the reader is referred to the senior author's entry for the paper's complete citation.

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P

Parathion

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Silvex

Simazine

Soil

T

TCAB

TDE

Toxaphene

Trifluralin

V

Vanadium

W

Water

Wildlife

AUTHOR INDEX

: *Pesticides Monitoring Journal* welcomes from all rces qualified data and interpretative information on icide monitoring. The publication is distributed icipally to scientists, technicians, and administrators ciated with pesticide monitoring, research, and r programs concerned with pesticides in the environ- it. Other subscribers work in agriculture, chemical ufacturing, food processing, medicine, public health, conservation.

icles are grouped under seven headings. Five follow basic environmental components of the National ticide Monitoring Program: Pesticide Residues in ple; Pesticide Residues in Water; Pesticide Residues Soil; Pesticide Residues in Food and Feed; and ticide Residues in Fish, Wildlife, and Estuaries. The h is a general heading; the seventh encompasses fs.

nitoring is defined here as the repeated sampling and lysis of environmental components to obtain reliable mates of levels of pesticide residues and related pounds in these components and the changes in e levels with time. It can include the recording of dues at a given time and place, or the comparison of dues in different geographic areas. The Journal will lish results of such investigations and data on levels esticide residues in all portions of the environment sufficient detail to permit interpretations and con- ions by author and reader alike. Such investigations uld be specifically designed and planned for moni- ng purposes. The Journal does not generally publish inal research investigations on subjects such as icide analytical methods, pesticide metabolism, or l trials (studies in which pesticides are experimen- applied to a plot or field and pesticide residue de- ion rates and movement within the treated plot or l are observed).

hors are responsible for the accuracy and validity heir data and interpretations, including tables, charts, references. Pesticides ordinarily should be identi- by common or generic names approved by national international scientific societies. Trade names are ptable for compounds which have no common es. Structural chemical formulas should be used n appropriate. Accuracy, reliability, and limitations ampling and analytical methods employed must be ribed thoroughly, indicating procedures and con- s used, such as recovery experiments at appropriate ls, confirmatory tests, and application of internal dards and interlaboratory checks. The procedure loyed should be described in detail. If reference is le to procedures in another paper, crucial points or lifications should be noted. Sensitivity of the method limits of detection should be given, particularly when very low levels of pesticide residues are being reported. Specific note should be made regarding correction of data for percent recoveries. Numerical data, plot dimensions, and instrument measurements should be reported in metric units.

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