TENNESSEE DEPARTMENT OF ENVIRONMENT & CONSERVATION

DOE OVERSIGHT DIVISION

REPORT ON TURTLE SAMPLING IN WATTS BAR RESERVOIR AND THE CLINCH RIVER

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for

Tennessee Department of Environment and Conservation
DOE-Oversight Division
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ABSTRACT

This report provides results and discussion from a screening study conducted in the spring and summer of 1996 to determine concentrations of polychlorinated biphenyls (PCBs) in snapping turtles from Watts Bar Reservoir and the Clinch River. In this study, 25 snapping turtles (*Chelydra serpentina*) were collected from ten sites in Watts Bar Reservoir and the Clinch River (Figure 1). Muscle tissue, fat tissue, and eggs (if present) were analyzed for Aroclor 1016/1242, 1221, 1232, 1248, 1254, 1260, 1262. Congener specific analysis including the following congeners as designated by the International Union of Pure and Applied Chemistry (IUPAC) system was performed on two of the larger turtles to determine the specific congener distribution in turtle muscle tissue: (IUPAC#) 8, 18, 28, 44, 52, 66, 77, 81, 101, 105, 110, 118, 126, 128, 138, 153, 169, 170, 180, 187, 195, 206, and 209.

Muscle tissue was also analyzed on all 25 turtles for arsenic, cadmium, chromium, copper, lead, mercury (mercury analysis was performed on only 13 turtles), aldrin, dieldrin, o,p-DDE, o,p-DDD, o,p-DDT, p,p-DDE, p,p-DDD, p,p-DDT, alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, endrin, methoxychlor, alpha-BHC, lindane, and hexachlorobenzene. These analytes were included to use as a comparison with other results from previous fish tissue studies in Watts Bar Reservoir and the Clinch River.

Results indicate that PCB concentrations in snapping turtle fat tissue are considerably higher (0.274-516 ppm) than in muscle tissue (0.032 - 3.38 ppm) or eggs (0.354 - 3.56 ppm). However, levels of PCBs above the Food and Drug Administration (FDA) Guidelines for PCBs in fish (2.0 ppm) were found in the eggs and in the muscle tissue. A comparison of concentrations of PCBs in fish tissue versus turtle tissues indicates that turtles in Watts Bar Reservoir concentrate PCBs at greater levels than

fish in the same area. However, caution should be taken when making comparisons between turtles and fish. Muscle tissue and fat tissue were analyzed separately in this turtle study, whereas the fish studies did not make this distinction. Of the two turtles in which congener specific analysis was performed, ten congeners which are considered of highest concern by the Environmental Protection Agency (EPA) were identified. Because there currently are no toxicity values available for individual PCB congeners, uncertainty in the toxicity of PCB mixtures remains.

Analysis of metals consistently identified only mercury (0.1-0.35 ppm) and copper (0.2-2.6 ppm). Mercury concentrations were below the FDA guidance level of 1.0 ppm for mercury in fish tissue. Copper concentrations in turtle muscle tissue were consistent with fish tissue data collected from the same area (U.S. DOE, 1996). Of the pesticides, trans-nonachlor was consistently identified, but again, in very low concentrations, (0.003 - 0.045 ppm) consistent with fish data collected from the same area.

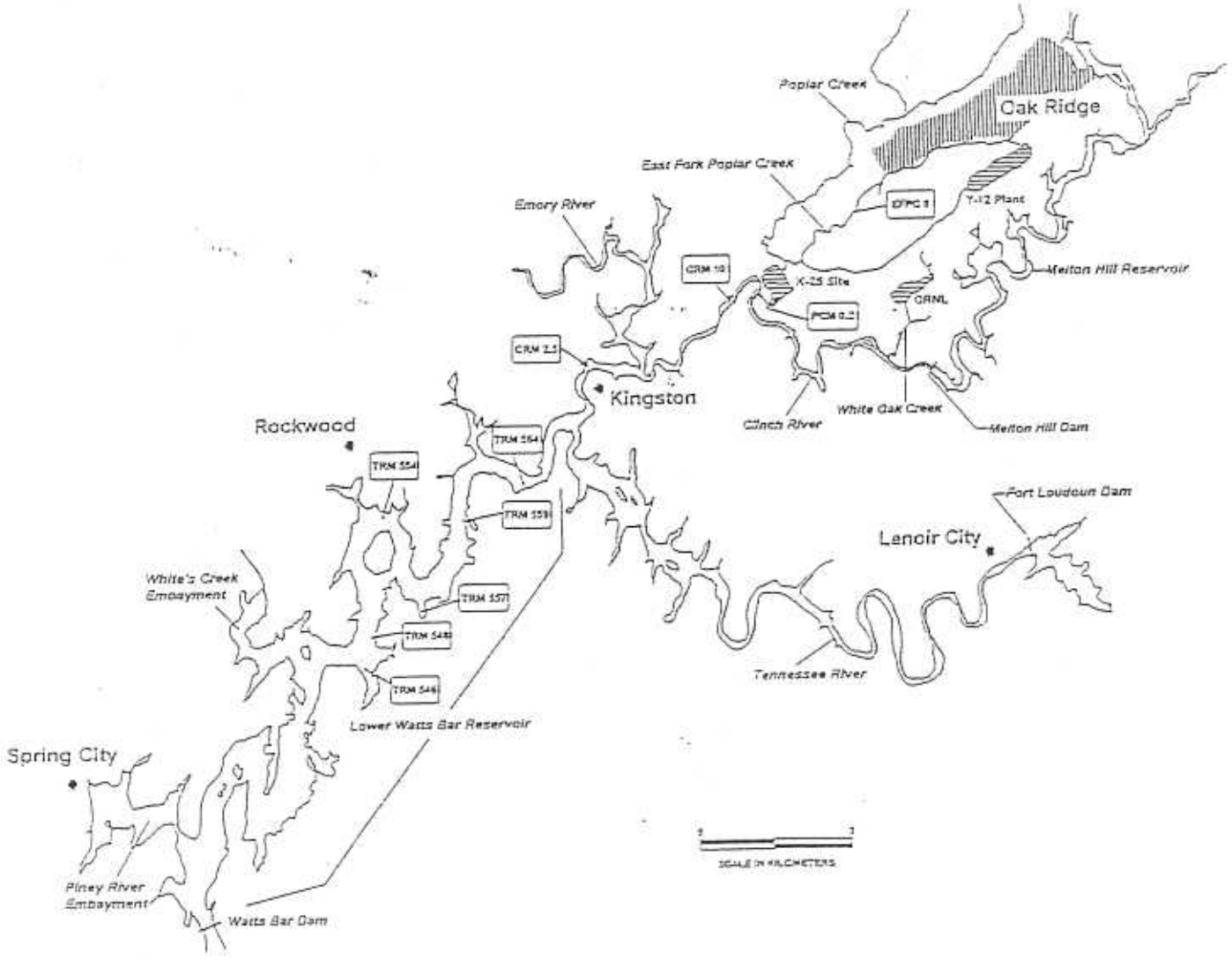

Figure 1. Ten Turtle Collection Locations in Watts Bar Reservoir and the Clinch River/Poplar Creek, Spring 1996.

1. INTRODUCTION

Investigation of Lower Watts Bar Reservoir and the Clinch River/Poplar Creek was mandated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as a result of the Oak Ridge Reservation being placed on the Superfund National Priorities List in 1989. The investigations were performed to determine the risk to human health and the environment resulting from DOE releases. The remedial investigation and feasibility study reports for the Lower Watts Bar Reservoir (U.S. DOE, 1994) and the Clinch River/Poplar Creek (U.S DOE, 1996) documented that areas of these water systems have been contaminated with radioactive and hazardous materials as a result of DOE activities on the Oak Ridge Reservation. Consequently, the record of decision for Lower Watts Bar Reservoir (U.S. DOE, 1995) requires that institutional controls of all sediment-disturbing activities be maintained, that advisories limiting the consumption of contaminated fish species be maintained, and that the reservoir be monitored for any changes in physical or chemical characteristics that could increase or decrease the risks to human health or the environment.

As a part of the CERCLA process, the Agency for Toxic Substances and Disease Registry (ATSDR) performed an independent public health evaluation of the chemical and radiological contaminants in the Lower Watts Bar Reservoir (ATSDR, 1996). ATSDR concurred with the record of decision but recommended additional sampling of turtles in Lower Watts Bar Reservoir to quantify the concentrations of PCBs in edible tissues. In particular, PCBs were singled out because previous studies from other states indicate that snapping turtles bioaccumulate PCBs and this could potentially pose a risk to humans that consume snapping turtles.

Although there are fish consumption advisories on Lower Watts Bar Reservoir and the Clinch River/Poplar Creek due to PCBs, previously there have been no investigations of snapping turtles in these water systems. Consequently, there are no consumption advisories for snapping turtles on Lower Watts Bar Reservoir or the Clinch River. Harvesting of snapping turtles does occur in Tennessee and it is legal for commercial fishermen to harvest snapping turtles from Lower Watts Bar Reservoir. A recent report (Todd, 1994) shows that no commercial harvesting of turtles is occurring in Lower Watts Bar Reservoir; however, non-commercial fishermen do capture and consume snapping turtles in the area. Because of the possible exposure to these individuals, an investigation to analyze snapping turtles was implemented, prompted by ATSDR's health consultation recommendations.

2. MATERIALS AND METHODS

2.1 SELECTION OF SPECIES

There are several species of turtles in Lower Watts Bar Reservoir and the Clinch River, but according to *Tennessee Fishing Regulations*, there are only three species that can be legally harvested - the Common Snapping Turtle, the Midland Smooth Softshell and the Eastern Spiny Softshell. Of the three, the Common Snapping Turtle (*Chelydra serpentina*) is the most likely species to be consumed by humans and therefore was the species investigated.

This species has been recommended by several researchers as an important bioindicator species (Olafsson et al., 1983; Stone et al., 1980). Because snapping turtles occupy a high trophic position and have a relatively long life span (>20 years), they have the potential to accumulate high levels of lipophilic contaminants through

their diet. The diet of snapping turtles consist of insects, crayfish, clams, worms, frogs, toads, salamanders, snakes, small turtles, birds, and small mammals as well as many plant species (Ernst and Barbour, 1989). Because the snapping turtle is one of the more aquatic species of turtles, it spends most of its time lying on the bottom of a deep pool or buried in the mud in shallow water with only its eyes and nostrils exposed. This behavior and the snapping turtle's diet allows for exposure to the more particulate-associated contaminants such as PCBs.

In addition to selecting species type, turtle size and gender are also important. Generally, the larger turtles are older and this should allow for more contact with contaminated sediment, water, and biota. Size is determined by measuring total carapace length. The carapace length is measured as the straight line distance from the anterior edge of the carapace to the posterior edge of the carapace as diagrammed in Figure 2. According to harvesting laws, the minimum legal length is 9 inches; therefore, only turtles 9 inches or longer were kept.

Studies indicate that PCB accumulation may vary according to gender. Albers et al. (1986) reported that males contained significantly higher concentrations of PCBs than female snapping turtles. Other studies show that PCBs can be transferred from gravid turtles to eggs in utero (Stone et al. 1980; Hebert et al. 1993). PCB concentrations in eggs appear to depend on whether fat reserves are present in the gravid females. Since female turtles fast during the nesting season, this may result in the mobilization of the stored PCBs and influence the gender variability as previously noted (Meyers-Schone, 1990). Because of these considerations, gender identification was noted and recorded during processing.

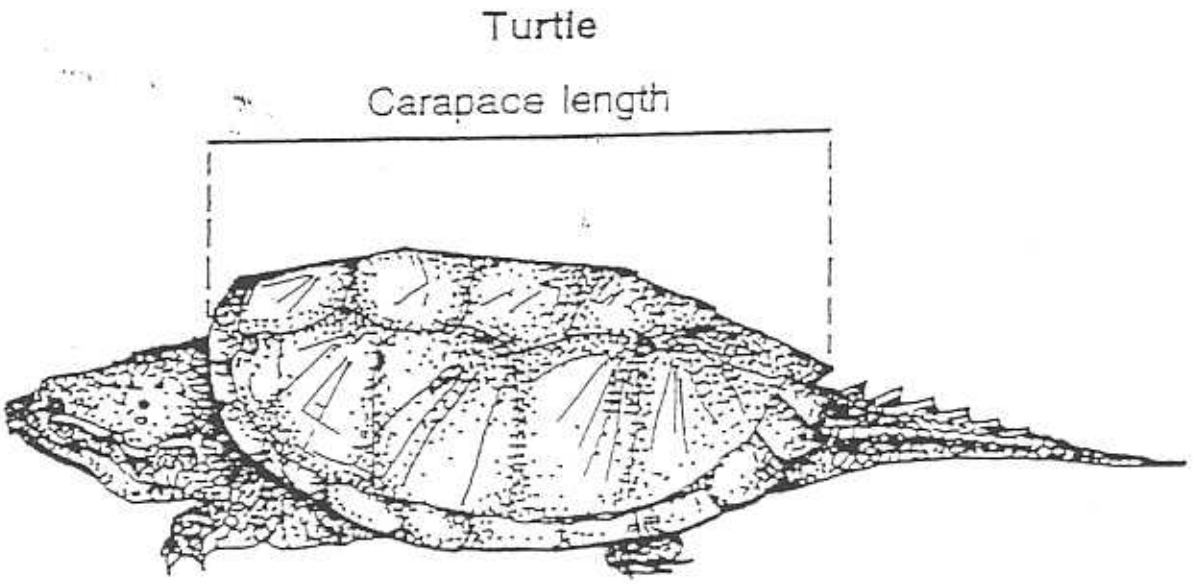

Figure 2. Carapace Length - the straight-line distance from the anterior margin to the posterior margin of the shell. Snapping turtles in Tennessee must be a least 9 inches long to be legally harvested.
Source: Conant and Collins, 1991

2.2 SAMPLING LOCATIONS

Snapping turtles tend to prefer soft muddy banks and often follow the first shoreline break between bays or a deeper channel in a small stream (Quinn, 1996). Younger snapping turtles show a preference for areas with some obstructions that may provide protection or food (U.S. EPA, 1993). Areas with more vegetative cover usually yield more turtles because they often like to ambush their prey. These types of locations in Watts Bar Reservoir and the Clinch River were inspected for turtles prior to collection. Figure 1 shows the actual collection locations.

2.3 COLLECTION AND PROCESSING

Baited hoop nets were employed to capture the turtles. Hoop nets consist of a cylindrical or rectangular frame covered with netting. An inverted funnel with a horizontally flattened opening projects into the body of the trap. The turtle enters the trap through the funnel, but cannot escape. Initially, two types of bait were used in the nets. Some nets had fresh bait (fish) while other nets were baited with canned dog food. Since the canned dog food proved to be very successful, no other types of bait or traps were used. Collection began on April 10, 1996 and ended on June 6, 1996. During that time, several different turtle species and fish species were captured and recorded (Table 1). All turtle species other than *Chelydra serpentina* were released, as well as snapping turtles that were under the legal length for capture. The fish that were collected were used as bait or released.

Once captured, the turtles were inspected for any notable characteristics (e.g. lesions, wounds etc.) and determination of the species and size (carapace length) was recorded. Then, each snapping turtle was placed in a separate labeled burlap bag. Care was taken to keep the turtles separated from each other to prevent injury. The

turtles and the burlap sacks were permanently labeled and a chain-of-custody form was filled out on each turtle.

EPA recommends euthanization by freezing (U.S EPA, 1995); therefore, the turtles were transported to locked frozen storage until transport to the processing laboratory. While still frozen, the turtles were shipped on ice to the processing laboratory where they were placed in a $-\leq 20°C$ freezer until resection.

FISH AND TURTLE SPECIES COLLECTED IN NETS

FISH:		TURTLES:	
Bluegill	5+ (several partially eaten)	Musk	23
Shad	3	Loggerhead Musk	7
Crappie	3	Stripedneck Musk	1
Catfish	2	Eastern Painted	65
Largemouth Bass	2	Stinkpot	9
Whitesucker	1	Yellow-Bellied Slider	6
Gar	2	Red-Eared	57
Buffalo	1	Pond Slider	8
Red Ear Sunfish	1	Map	3
Yellow Perch	1	Softshell	1
		Common Snapping	32
		Unidentified	30

Table 1. Fish and Turtle species collected in nets from sampling in Watts Bar Reservoir and the Clinch River/Poplar Creek, Spring 1996.

2.4 TISSUE ANALYSIS

In determining what tissues to analyze, the main factor was to identify the tissues most commonly consumed by humans. Personal correspondence with a Tennessee Wildlife Resource Agency representative (R. Todd, Commercial Fishing Coordinator, personal communication) and area residents, indicates that all muscle tissue is edible, especially the neck. However, the fat and eggs may also be consumed and were analyzed in an effort to be conservative. Analysis of the eggs also provides information on the ability of PCBs to mobilize to the eggs. This information could provide an idea of the body burden of PCBs to the newly hatched turtles. Since it is unlawful to capture snapping turtles under nine inches in length, no newly hatched turtles were collected for this study.

Another factor considered was the percentage of fat in the turtles in relation to the time of year. At the beginning of hibernation, turtles generally contain more fat. During hibernation the fat stores are burned which may possibly mobilize highly lipophilic contaminants including PCBs, to other tissues or organs. And, as previously mentioned, females fast during the nesting season which may mobilize stored PCBs. Therefore, an analysis of % lipid was performed on all matrices (i.e. fat, muscle, and eggs).

2.5 SAMPLE PROCESSING

Sample processing was performed following EPA guidance (U.S. EPA, 1995). A wet weight was determined for each turtle. Turtles were weighed in clean, tared, non-contaminating containers. Since liquid from the thawed whole turtle sample may come not only from the muscle tissue but from gut and body cavity, which may not be part of the desired edible tissue sample, this liquid was included with the sample. This

practice may have resulted in an overestimate of target analyte and lipid concentrations in the edible tissue homogenate. As a conservative approach, all liquid from the thawed whole turtle was kept in the container as part of the sample.

General procedures for removing edible tissues from the turtle are illustrated in Appendix A (EPA, 1995). Standard laboratory procedures were followed to prevent cross contamination of samples. Resection occurred by laying the turtle flat on its back and removing the plastron by severing the two bony ridges between the fore and hindlimbs. Care was taken to avoid contaminating edible tissues with material released from the inadvertent puncture of internal organs. Thawing of frozen turtles was kept to a minimum during tissue removal to avoid loss of liquids. Once the plastron was removed, the ovaries or testes could be observed posterior and dorsal to the liver for positive sex determination. Skin on the forelimbs, hindlimbs, neck, and tail was removed. Bones still present in the muscle tissue after resection were removed. Muscle, fat, and eggs were weighed and recorded to the nearest gram.

Turtle tissues were ground and homogenized according to laboratory procedures. Two muscle tissue samples were also analyzed for congener specific analysis. Muscle tissue aliquots for congener specific analysis were shipped frozen to another contract laboratory for analysis.

2.6 ANALYTE LIST

Muscle tissue, fat tissue, and eggs (if present) were analyzed for Aroclor 1016/1242, 1221, 1232, 1248, 1254, 1260, 1262. Muscle tissue was also analyzed for arsenic, cadmium, chromium, copper, lead, mercury, aldrin, dieldrin, o,p-DDE, o,p-DDD, o,p-DDT, p,p-DDE, p,p-DDD, p,p-DDT, alpha-chlordane, gamma-chlordane, cis-nonachlor, trans-nonachlor, endrin, methoxychlor, alpha-BHC, lindane, and hexachlorobenzene. Currently there are no official EPA approved methods for tissue

analysis for these analytes; therefore, tissue equivalent procedures for Methods 8081, 3550, 3640 and 3664 were performed for the pesticides and PCBs. Mercury analysis was performed by EPA Method 245.6 and the remaining metals were analyzed by Method 200.1. Congener specific analysis on muscle tissue for congeners IUPAC# 8, 18, 28, 44, 52, 66, 77, 81, 101, 105, 110, 118, 126, 128, 138, 153, 169, 170, 180, 187, 195, 206, and 209 was performed according to Draft Method 1668 on two of the larger turtles to determine the specific congener distribution in turtle muscle tissue.

3. RESULTS

Table 2 contains descriptive details and contaminant results. Analytes requested but not detected in all twenty-five samples were not included in this table. Table 3 contains results from the congener specific analysis performed on muscle tissue of two turtles. Figure 3 compares the congener "fingerprint" of the two turtles.

#	SAMPLE #	LENGTH (mm)	WEIGHT (kg)	SEX	PCB 1260-MUSCLE	PCB 1260-FAT	PCB 1260-EGGS	Hg	Cu	Cr	p,p-DDE	cis-nonachlor	trans-nonachlor	Endrin	a-chlordane	g-chlordane
1	EFPC 8-1	305	6.4	M	0.032 (J)	3.43	N/A	N/A	U	0.4	U	0.001(J)	0.003(J)	U	0.001(J)	0.001(J)
2	TRM 559-1	393	12.2	M	0.154	7.99	N/A	N/A	0.7	U	U	U	0.003(J)	U	U	U
3	TRM 559-2	254	3	F	0.080 (J)	0.508	0.354	N/A	0.8	U	U	U	0.003(J)	U	U	U
4	TRM 559-3	311	5.4	M	0.462	0.274 (J)	N/A	N/A	U	U	0.002(J)	0.003	0.008	U	U	U
5	PCM 0.2-1	355	9.8	M	3.31	24.2	N/A	N/A	0.2	U	0.008(J)	0.036	0.045	U	U	U
6	PCM 0.2-2	343	9.7	M	3.38	122	N/A	N/A	0.4	U	U	0.012	0.02	U	U	U
7	PCM 0.2-3	310	6.9	F	1.04	8.31	2.47	N/A	0.3	U	U	0.003(J)	0.006(J)	U	U	U
8	PCM 0.2-4	254	2.9	M	0.048 (J)	5.32	N/A	N/A	0.4	U	U	U	U	U	U	U
9	PCM 0.2-5	292	4.8	F	0.177	40.9	3.56	N/A	U	U	U	0.001(J)	0.001(J)	U	0.001(J)	U
10	CRM 10-1	393	12.2	M	0.076 (J)	1.02	N/A	N/A	1	U	U	0.008(J)	0.001(J)	U	U	U
11	CRM 2.5-1	247	3.2	M	0.138	2.39	N/A	N/A	0.5	U	U	0.008(J)	0.003	U	U	U
12	CRM 2.5-2	368	11.2	M	0.814	5.98	N/A	N/A	0.7	U	U	U	0.008(J)	U	U	U
13	TRM 557-1	241	3.6	M	0.106	22.4	N/A	0.13	2.3	U	U	U	0.004(J)	0.001	U	U
14	TRM 557-2	254	3.9	M	0.109	35.5	N/A	0.1	1	U	U	U	0.003	0.003	U	U
15	TRM 548-1	330	7	M	0.171	57.5	N/A	0.17	0.7	U	U	U	0.005	U	U	U
16	TRM 548-2	343	7.8	M	0.361	39.2	N/A	0.17	0.9	U	0.003(J)	U	0.009	0.055(J)	U	U
17	TRM 548-3	380	10.7	M	0.922	516	N/A	0.26	1	U	U	U	0.008	0.065	U	U
18	TRM 564-1	330	9.1	M	0.209	68.1	N/A	0.18	2.3	U	0.002(J)	U	0.005	0.15	U	U
19	TRM 564-2	343	10.5	M	0.14	40.2	N/A	0.23	0.9	U	0.002(J)	U	0.005	0.93	U	U
20	TRM 564-3	368	9.1	M	0.136	112	N/A	0.23	0.8	U	U	U	0.004(J)	0.099	U	U
21	TRM 554-1	254	3.2	F	0.053 (J)	203	2.05	0.15	0.9	U	U	U	U	U	U	U
22	TRM 554-2	324	7	M	0.060 (J)	41.6	N/A	0.13	2.3	U	U	U	0.003(J)	0.043(J)	U	U
23	TRM 546-1	317	6.8	M	0.199	47	N/A	0.24	0.7	U	0.003(J)	U	0.007	0.151	U	U
24	TRM 546-2	393	12.6	M	0.104	94.6	N/A	0.35	2.6	U	U	U	0.004(J)	0.083	U	U
25	TRM 546-3	254	3.7	M	0.129	58.9	N/A	0.12	1.4	U	U	U	0.004(J)	0.101	U	U

LEGEND FOR ANALYTICAL RESULTS

U-analyte requested but not detected

J-estimated value--result is less than sample quantitation limit but greater than zero

B-analyte in blank as well as sample

E-analyte concentration exceeds the calibration range of instrument

N/A - not analyzed

All units = ppm

Table 2. Contaminant concentrations in twenty-five snapping turtles from Watts Bar Reservoir and the Clinch River/Poplar Creek

*IUPAC#	** TRM 559-1	**PCM 0.2-1
8	0.501	0.562
18	0.646	0.468
28	0.556	0.379
52	0.708	0.702
44	0.537	0.535
66	0.767	7.37
81	0.241	0.252
77	0.373	0.242
101	0.506	1.24
110	0.571	2.84
118	10.6	109
114	0.787	11.2
105	0.255	42.1
126	0.337	0.829
153	51.6	290
138	27.4	194
128	7.05	113
156	2.92	51.2
169	0.0708	0.27
187	2.37	83.8
180	37.4	266
170	14.6	197
195	1.96	27.6
206	1.47	19.2
209	0.554	3.99

Table 3. Selected congener concentrations (ppb) in muscle tissue collected from two snapping turtles (TRM 559-1 and PCM 0.2-1) from Watts Bar Reservoir/Poplar Creek in Spring, 1996.

* IUPAC # corresponds to the International Union of Pure and Applied Chemistry system of nomenclature.

**TRM 559-1 denotes Tennessee River Mile 559. PCM 0.2-1 denotes Poplar Creek Mile 0.2

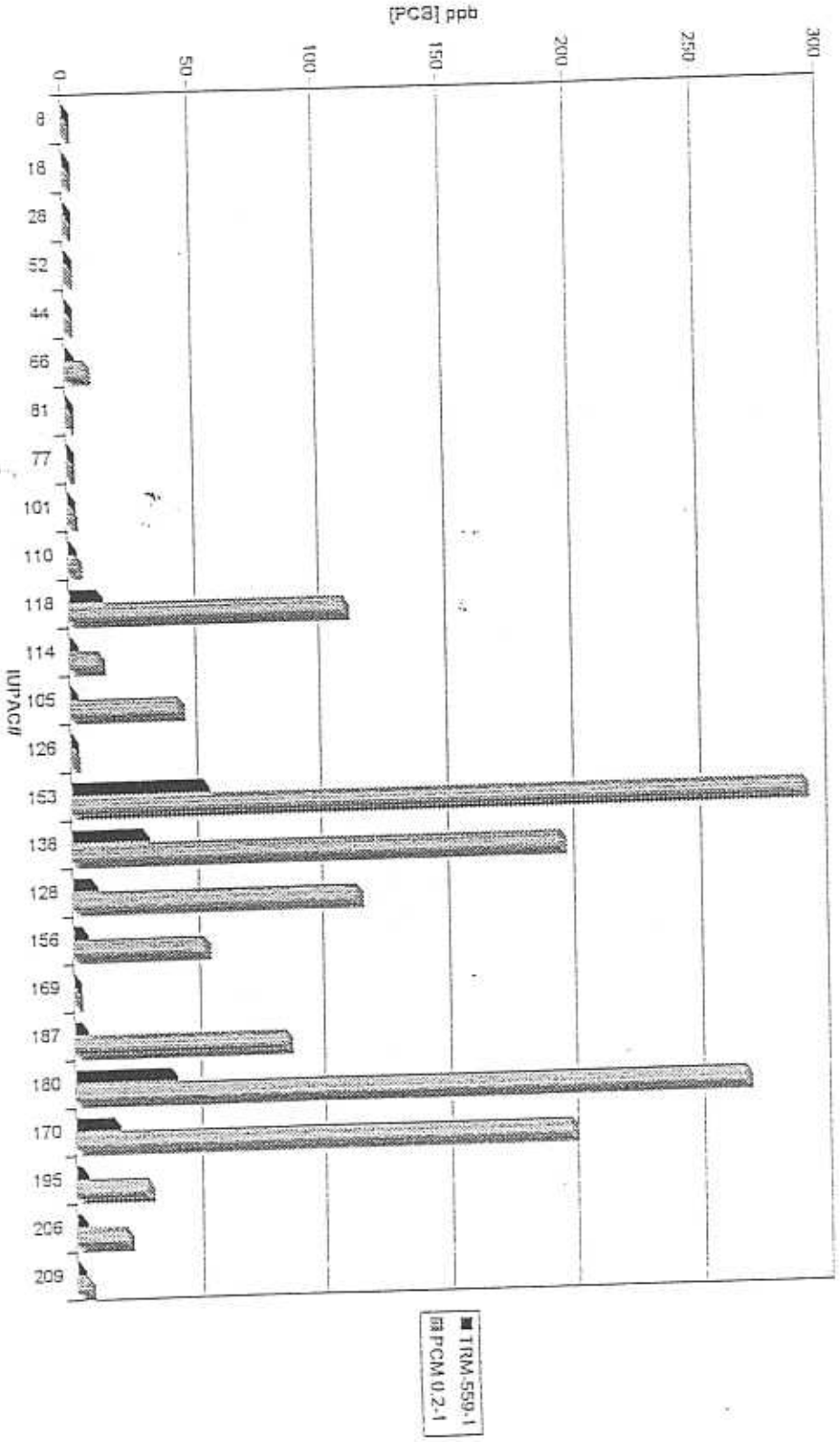

Figure 3. Bar graph of specific congener pattern found in muscle tissue of two different snapping turtles from separate collection locations in Watts Bar Reservoir and the Clinch River/Poplar Creek during Spring, 1996.

4. DISCUSSION

Given the known effects of PCBs, the EPA has devised consumption limit tables for PCBs in fish (tables 4 and 5). Although the Division of Water Pollution Control in Tennessee does not issue advisories in this manner, other states use this method to issue consumption advice. Table 4 illustrates the monthly fish consumption limits for chronic systemic health endpoints in an adult. Table 5 illustrates monthly fish consumption limits for carcinogenic health endpoints in an adult (U.S. EPA, 1994). It should be noted, however, to accurately use these tables for turtle consumption, in contrast to fish consumption, local consumption practices should be investigated. Information determining the most commonly consumed parts of the turtle (i.e. fat vs. muscle) and how frequently consumed are fundamental in accurately assessing any potential human health risk. Appendix B includes recipes selected from available cookbooks which demonstrate that much of the turtle is edible. Again, it is important to note that there is the potential to intentionally or nonintentionally consume fat from snapping turtles as a result of meat preparation, cooking methods or tissue selection.

A comparison of this investigation's data with PCB concentrations in fish tissue collected from fish in Watts Bar Reservoir and the Clinch River from several earlier studies by TVA (1985) and other investigators (Cook, 1992; U. S. DOE, 1995; U. S. DOE, 1996; Dycus, 1989, 1990) reveals that PCBs concentrate at greater levels in turtles than in fish. Figures 4, 5 and 6 summarize data from various reports as presented in the Remedial Investigation/Feasibility Study Reports for Lower Watts Bar Reservoir and the Clinch River/Poplar Creek. These figures show mean PCB concentrations in fish from Watts Bar Reservoir and the Clinch River from 1987-1994. The concentrations in fish tissue are considerably lower than those found in turtle fat

tissue, but are relatively similar to concentrations found in turtle muscle tissue. Again, caution should be taken when making comparisons between turtles and fish. Muscle tissue and fat tissue were analyzed separately in this turtle study, whereas the fish studies did not make this distinction and PCB bioaccumulation varies among different fish species.

Congener specific analysis of PCBs was performed on muscle tissue of two of the snapping turtles. One turtle was collected from Poplar Creek at PCM 0.2 and the other from Lower Watts Bar Reservoir at TRM 559. The "fingerprint" distribution of congeners looks similar in both of the turtles; however, concentrations of each congener are considerably different. Table 6 illustrates the congeners of highest concern as identified by EPA (U.S. EPA, 1996). Ten congeners present in the turtle muscle tissue are noted as congeners of "highest concern" by EPA. Most of these were categorized as highest or high in toxicity and abundance.

It is difficult to make an accurate comparison of congener analysis done on fish in previous studies to turtles in this study, but it should be noted that congeners IUPAC# 153 and 180 were two of the most prominent congeners in both turtles from this study as well as in catfish from the Clinch River and Poplar Creek in the fall of 1992 to the fall of 1993 (U. S. DOE, 1996) Both of these congeners are noted as high toxicity and abundance by the EPA.

5. CONCLUSIONS

Information regarding local consumption practices should be identified to accurately assess the actual PCB exposure to those who consume snapping turtles. Because the lipophilic nature of PCBs results in greater concentrations of PCBs in fat tissue than muscle tissue, it is assumed that consumption of fat tissue poses a greater human health concern than consumption of muscle tissue. A comparison of the PCB concentrations in fat tissue (mean 64.8 ppm) versus muscle tissue (mean 0.50 ppm) illustrates the importance of understanding consumption practices.

Another factor that must be considered when assessing potential human health risks related to PCBs is the uncertainty of the toxicity values for PCBs. Recently the EPA has revised the dose-response slopes for PCBs to account for partitioning, transformation and bioaccumulation of PCB mixtures in the environment. This revision provides a range of potency estimates that may be applied to different exposure pathways. Additionally, the EPA suggests using site-specific congener information when available. These recent revisions on the dose-response slope for PCBs as well as information on local consumption practices should be considered in any future risk assessments related to PCBs.

[PCB] mg/kg in fish	4 oz.MEAL SIZE	8 oz. MEAL SIZE
<0.006	UNLIM	UNLIM
0.006	UNLIM	UNLIM
0.007	UNLIM	UNLIM
0.008	UNLIM	UNLIM
0.009	UNLIM	UNLIM
0.01	UNLIM	UNLIM
0.02	UNLIM	9
0.03	12	6
0.04	9	4
0.05	7	3
0.06	6	3
0.07	5	2
0.08	4	2
0.09	4	2
0.1	3	1
0.2	1	0.5
0.3	1	0.5
0.4	0.5	NONE
0.5	0.5	NONE
0.6	0.5	NONE
0.7	0.5	NONE

Meal sizes of 4 & 8 ounces correspond to 0.114 & 0.227 kg.
UNLIM = Unlimited consumption; more than 4 meals/ week.
NONE = No consumption; less than 6 meals per year.
Reference Dose based on Aroclor 1254 = 2E-05 mg/kg-d
Population: General
Body Weight: 70 kg

Table 4. Monthly Consumption Limits for Chronic Systemic Health Endpoints. Source: (U.S. EPA, 1994).

Aroclor 1260	4 oz.MEAL SIZE			8 oz. MEAL SIZE		
[PCB] mg/kg	10-4 ARL	10-5 ARL	10-6 ARL	10-4 ARL	10-5 ARL	10-6 ARL
<0.00004	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM
0.00004	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM
0.00006	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM	15
0.00008	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM	12
0.0001	UNLIM	UNLIM	UNLIM	UNLIM	UNLIM	6
0.0002	UNLIM	UNLIM	12	UNLIM	UNLIM	3
0.0004	UNLIM	UNLIM	6	UNLIM	UNLIM	2
0.0006	UNLIM	UNLIM	4	UNLIM	15	1
0.0008	UNLIM	UNLIM	3	UNLIM	12	1
0.001	UNLIM	UNLIM	2	UNLIM	6	0.5
0.002	UNLIM	12	1	UNLIM	3	NONE
0.004	UNLIM	6	0.5	UNLIM	2	NONE
0.006	UNLIM	4	NONE	UNLIM	1	NONE
0.008	UNLIM	3	NONE	15	1	NONE
0.01	UNLIM	2	NONE	12	0.5	NONE
0.02	12	1	NONE	6	NONE	NONE
0.04	6	0.5	NONE	3	NONE	NONE
0.06	4	NONE	NONE	2	NONE	NONE
0.08	3	NONE	NONE	1	NONE	NONE
0.1	2	NONE	NONE	1	NONE	NONE
0.2	1	NONE	NONE	0.5	NONE	NONE
0.4	0.5	NONE	NONE	NONE	NONE	NONE
>0.4	NONE	NONE	NONE	NONE	NONE	NONE

Meal sizes of 4 and 8 ounces correspond to 0.114 and 0.227 kg.
UNLIM = Unlimited consumption; more than 4 meals per week.
NONE = No consumption; less than 6 meals per year.
Cancer potency factor: 7.7 per mg/kg-day
Population: General
Body Weight: 70 kg
ARL = Acceptable Risk Level

Table 5. Monthly Consumption Limits for Carcinogenic Endpoints. Source: (U.S. EPA, 1994).

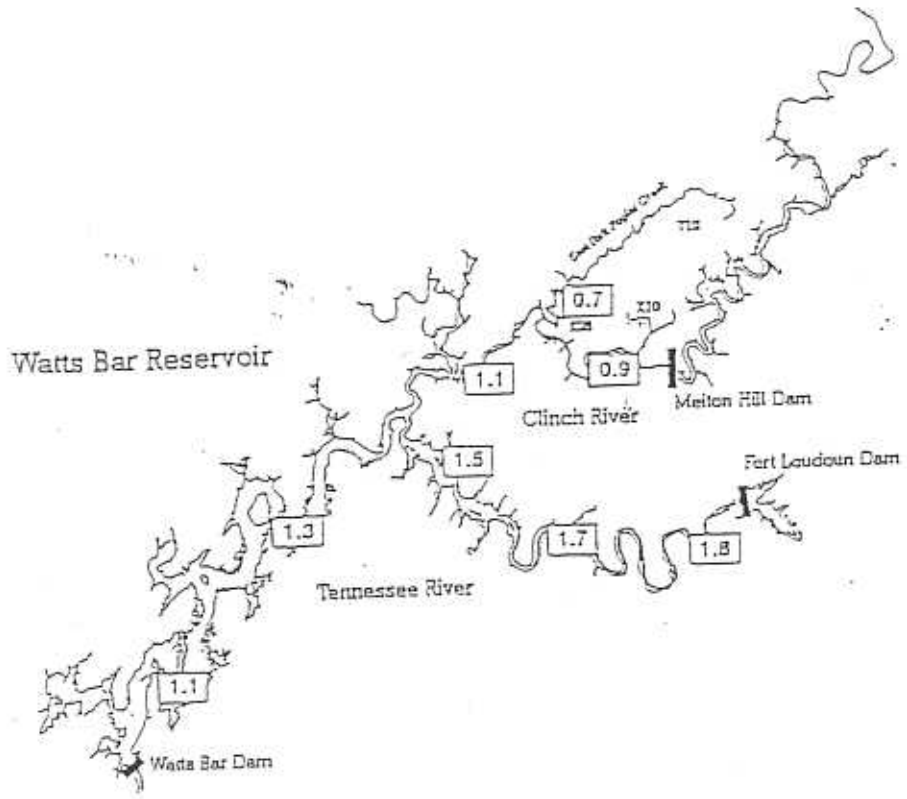

Figure 4. Mean PCB concentrations in catfish from Watts Bar Reservoir from 1987-1992 (458 samples). Source: Data-(TVA and ORNL), Figure-(U.S. DOE, 1995).

YEAR	RIVER MILE	CATFISH	LM-BASS	SHAD	S-BASS
1989	TRM 557	0.33 mg/kg			
1989	TRM 530	0.79 mg/kg			
1991	TRM 561	2.31mg/kg	0.32 mg/kg	0.3 mg/kg	
1991	TRM 530	1.58 mg/kg	0.26 mg/kg	0.28 mg/kg	
1992	TRM 545	1.25 mg/kg		0.25 mg/kg	1.31mg/kg
1993	TRM 555		0.36 mg/kg		
LM-BASS = Largemouth Bass S-BASS = Striped Bass					

Figure 5. Mean annual concentrations of total PCBs in fish flesh, LWBR. Source: U.S. DOE, 1995

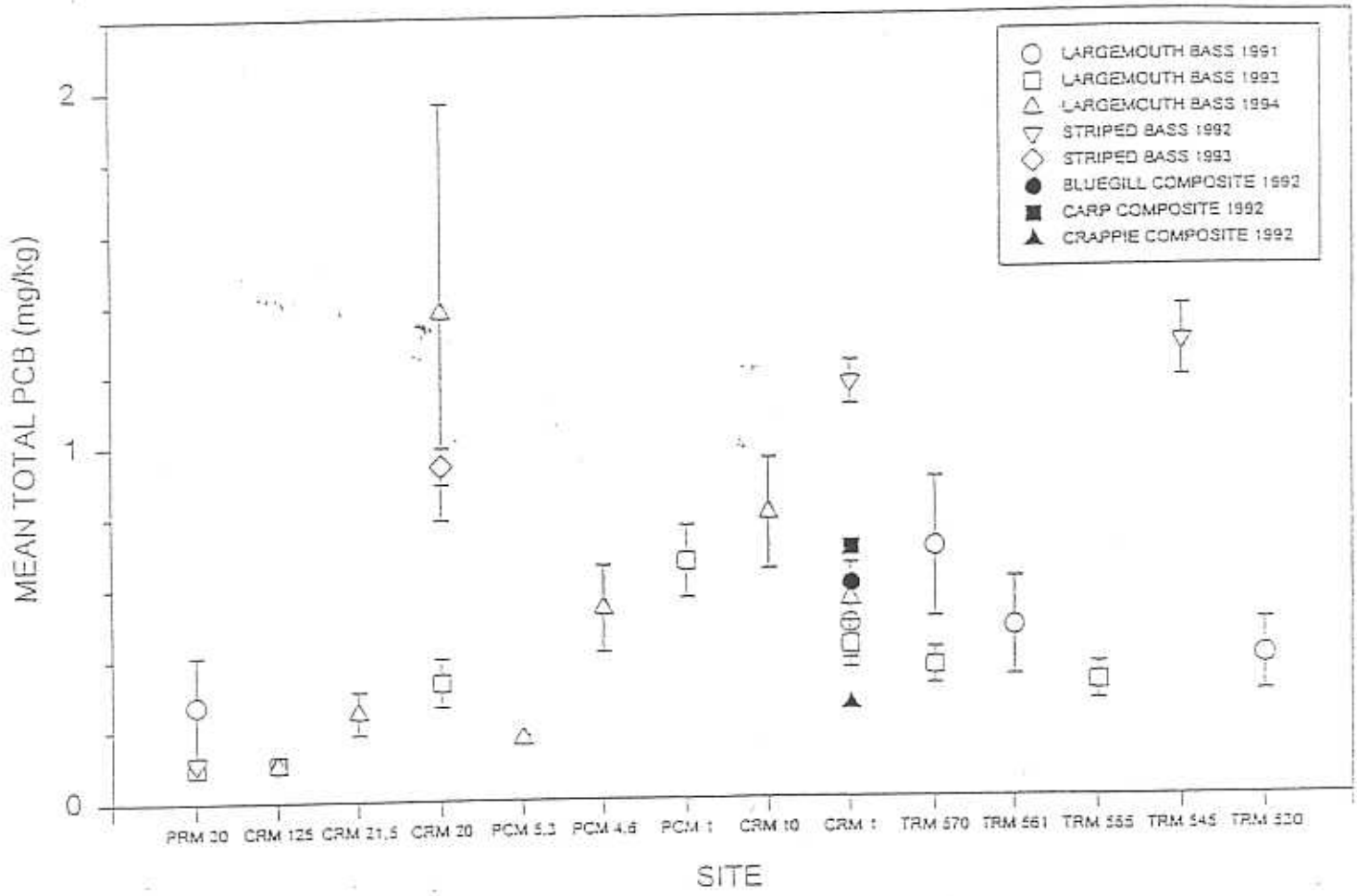

Figure 6. Total PCB concentrations in striped bass, largemouth bass, and other species, Clinch River Remedial Investigation Phase 2 data (mean +SE). Source: (U.S. DOE, 1996)

PCB CONGENERS OF HIGHEST CONCERN

Highest toxicity & abundance[a]	High Toxicity & abundance[b]	Abundant in environment[c]	Potential f or toxicity[d]
3-MC-type inducers 77: 3,4,3',4' - TeCB 126: 3,4,5,3',4' - PeCB 169: 3,4,5,3',4',5' - HxCB Mixed-type inducers: 105: 2,3,4,3',4' -PeCB 118: 2,4,5,3',4' - PeCB 128: 2,3,4,2',3',4' - HxCB 138: 2,3,4,2',4',5' - HxCB 156: 2,3,4,5,3',4' - HxCB 170: 2,3,4,5,2',3',4' - HpCB	PB-type inducers: 87: 2,3,4,2',5' - PeCB 99: 2,4,5,2',4',- PeCB 101: 2,4,5,2',5'-PeCB 153: 2,4,5,2',4',5'-HxCB 180: 2,3,4,5,2',4',5'-HpCB 183: 2,3,4,6,2',4',5'-HpCB 194: 2,3,4,5,2',3',4',5'-OCB	18: 2,5,2'-TrCB 44: 2,3,2',5'-TeCB 49: 2,4,2',5'-TeCB 52: 2,5,2',5'-TeCB 70: 2,5,3',4'-TeCB 74: 2,4,5,4'-TeCB 151: 2,3,4,5,2',5'-HxCB 177: 2,3,5,6,2',3',4'-HpCB 187: 2,3,5,6,2',4',5'-HpCB 201: 2,3,4,5,2',3',5',6'-OCB	37: 3,4,4' - TrCB 81: 3,4,5,4' -TeCB 114: 2,3,4,5,4'-PeCB 119: 2,4,6,3',4'-PeCB 123: 3,4,5,2',4'-PeCB 157: 2,3,4,3',4',5'-HxCB 158: 2,3,4,3',4',6'-HxCB 167: 2,4,5,3',4',5'-HxCB 168: 2,4,6,3',4',5'-HxCB 189: 2,3,4,5,3',4',5'-HpCB

[a] Pure 3-methylcholanthrene-type inducers and mixed type inducers reported frequently in environmental samples.
[b] Phenobarbital-type inducers reported frequently in environmental samples
[c] Weak inducers or noninducers reported frequently in environmental samples.
[d] Mixed-type inducers not reported frequently in environmental samples, but toxicologically active.

Table 6. PCB congeners of highest concern. Source: U.S. EPA, 1996

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7. APPENDICES

APPENDIX A

GENERAL PROCEDURES FOR REMOVING EDIBLE TISSUES FROM FRESHWATER TURTLES (EPA, 1995)

1. Turtles brought to the processing laboratory on wet, blue, or dry ice should be placed in a freezer for a minimum of 48 hours prior to resection. Profound hypothermia can be employed to induce death (Frye, 1994). Decapitation of alert animals is not recommended because there is evidence that decapitation does not produce instantaneous loss of consciousness (Frye, 1994).

2. The turtle should be placed on its back with the plastron (ventral plate) facing upwards. The carapace and plastron are joined by a bony bridge on each side of the body extending between the fore and hindlimbs. Using a bone shears, pliers, or sharp knife, break away the two sides of the carapace from the plastron between the fore and hind legs on each side of the body.

3. Remove the plastron to view the interior of the body cavity. At this point, muscle tissue from the forelimbs, hindlimbs, tail (posterior to the anus), and neck can be resected from the body. The muscle tissue should be skinned and the bones should be removed prior to homogenization of the muscle tissue.

4. Several of the tissue types that are considered edible include fatty deposits found in various parts of the body, the heart, liver (usually with the gall bladder removed), and the eggs (if the specimen is a female).

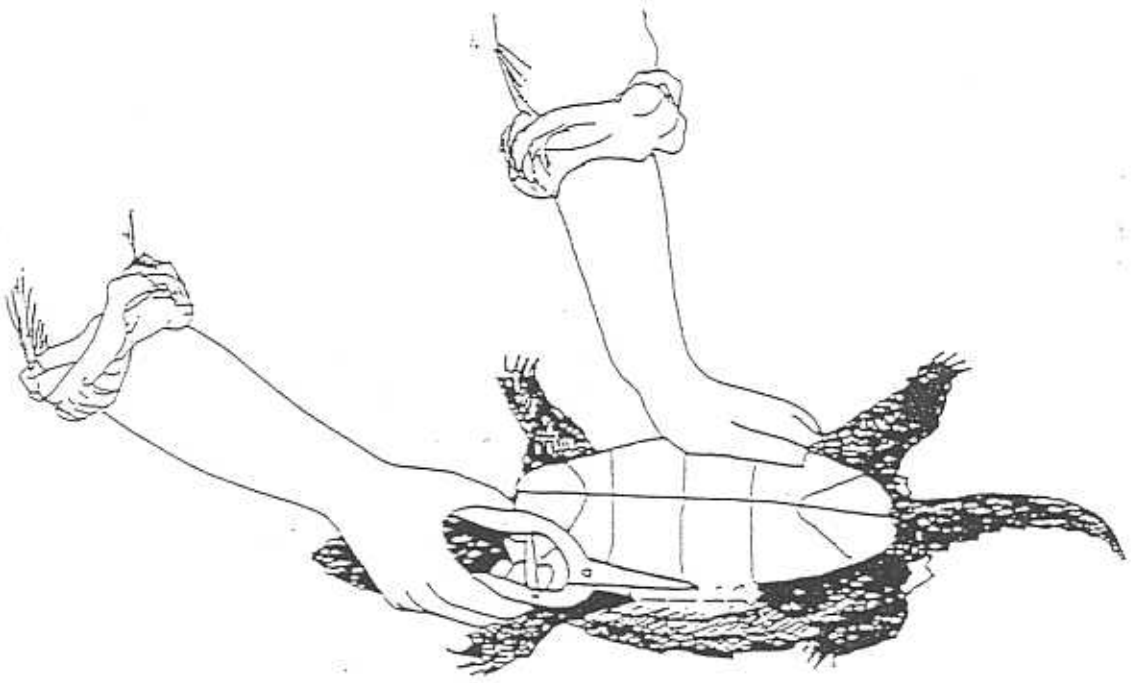
5. Masses of yellowish-green fatty deposits may be removed from above the forelimbs and from above and in front of the hindlimbs. Fatty deposits can also be found at the base of the neck near the point where the neck enters the body cavity.

6. The large brownish liver is the predominant tissue in the body cavity and is an edible tissue eaten by some populations.

7. If the turtle specimen is a female, ovaries containing bright yellow colored spherical eggs of varying sizes are located posterior to the liver and lie against the dorsal body wall.

APPENDIX A

GENERAL PROCEDURES FOR REMOVING EDIBLE TISSUES FROM FRESHWATER TURTLES (EPA, 1995)



Source: Hamerstrom, 1989.

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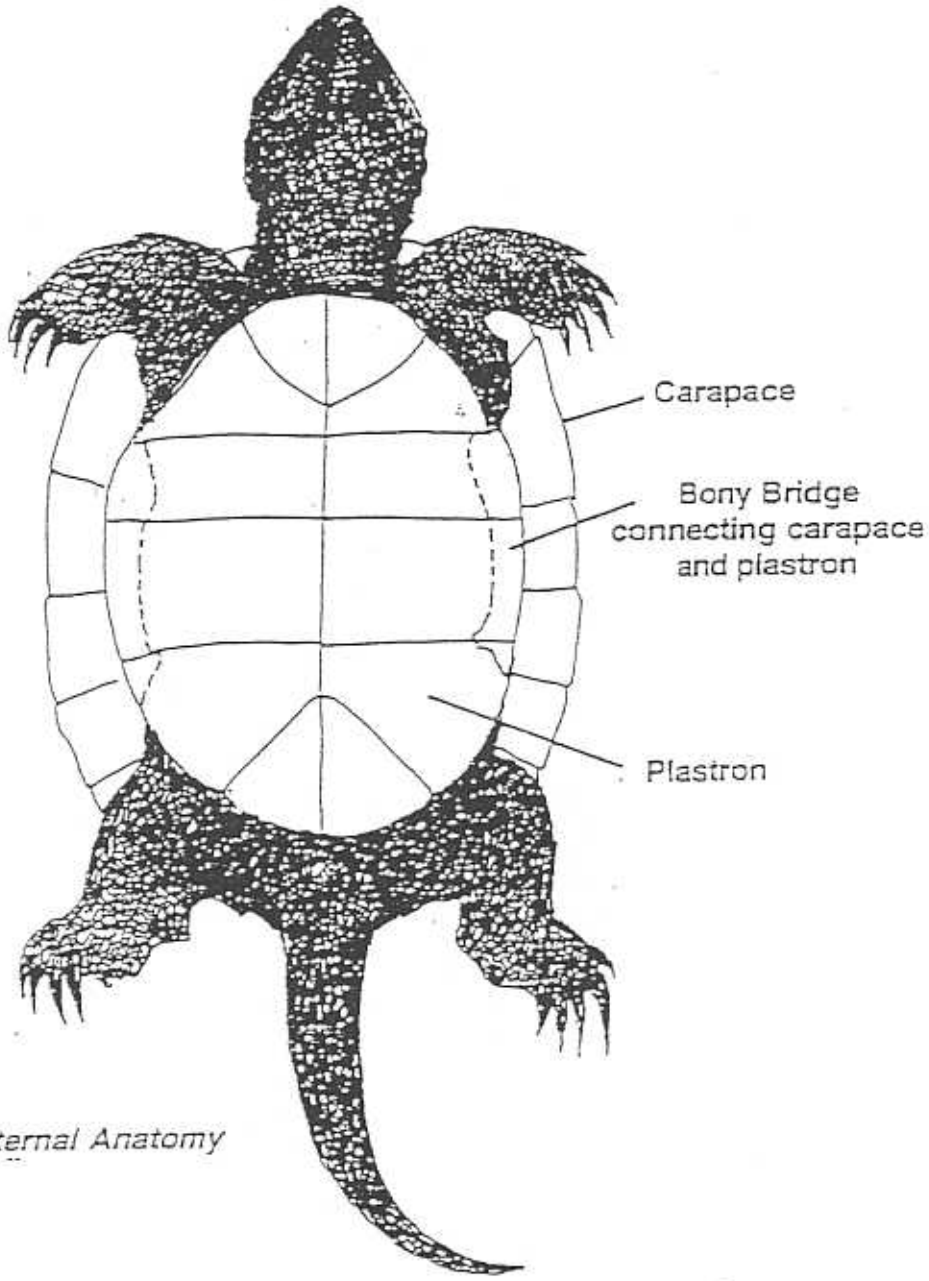

External Anatomy

Source: Ashley, 1962.

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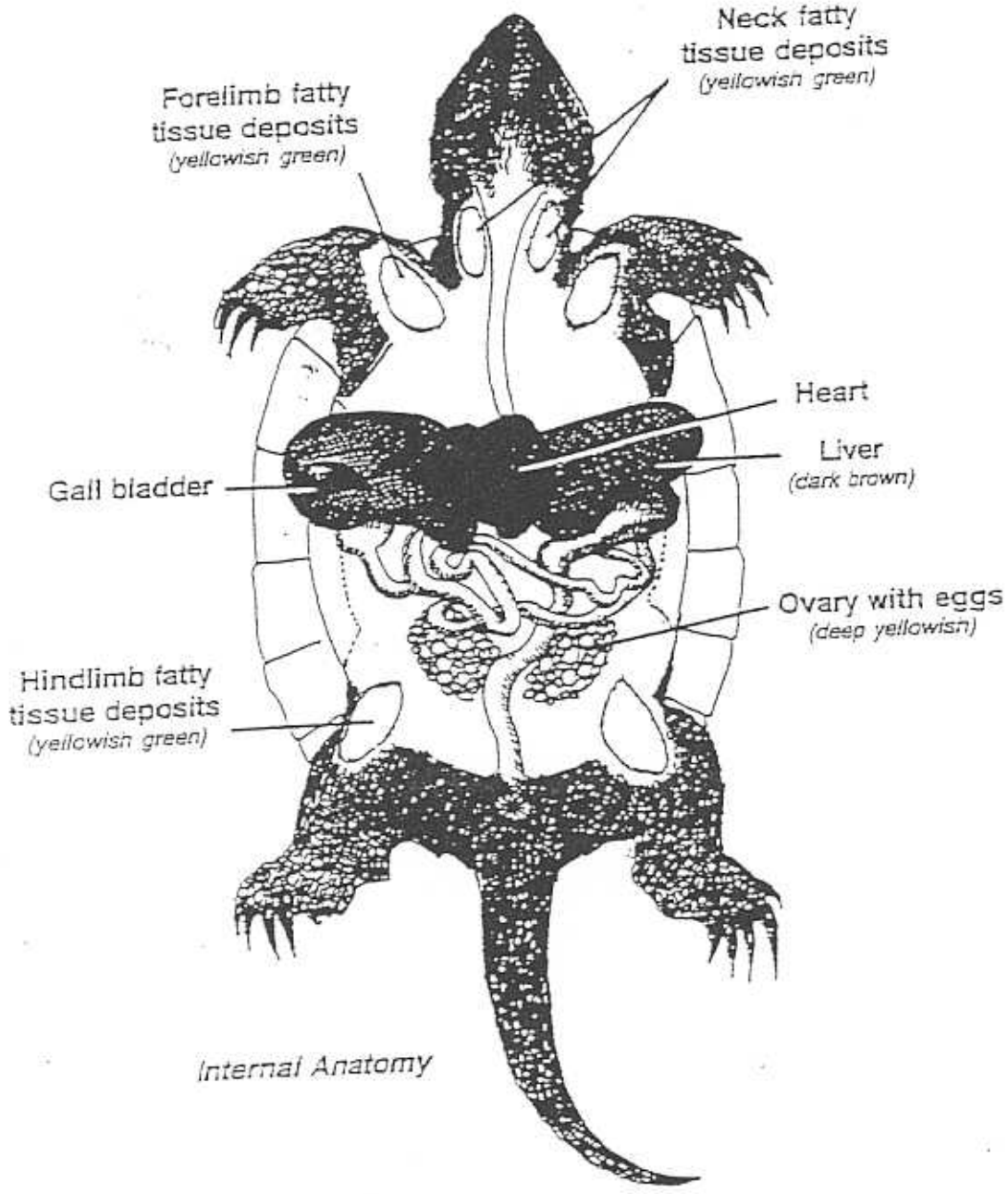

Internal Anatomy

Source: Ashley, 1962.

APPENDIX B

SNAPPING TURTLE RECIPES

Excerpt from *Wildfood Cookbook:*

Snapping Turtle

Snapping turtles occur east of the Rockies and are the largest inland turtles of the United States. Record turtles weigh up to 50 pounds, but 10 to 15 pounders are more commonly found.

They may be identified by the relatively small, roughly cross-shaped plastron or undershell and by the tubercles along the top of the tail.

They bite hard and if teased their attack is sudden and tenacious. To pick up a snapper, seize it by the tail and hold it from you. We have ordinarily caught ours on dry land. Rendall Rhoades (1950) describes underwater catching as follows:

> The accepted method of catching turtles in streams is "noodling". A noodler goes along the bank of the creek and runs his arm back into the muskrat holes and root tangles for these are the favorite haunts of the big snappers. As he touches the turtle, he feels the shell carefully to determine the head end and the tail end and the turtle is removed by the tail. If the noodler pulls out a water snake, a half-grown muskrat or a hell-bender, that's all in a day's work and he goes on to the next hole in search of a turtle. This method is very productive.

DRESSING OUT A TURTLE

(Frank B. Renn)

Scrub the decapitated turtle with laundry soap and a stiff brush until it is clean... and get a container of water, big enough to hold the turtle, boiling. When you have scrubbed off the leeches and green growths, boil the whole turtle for 30 - 40 minutes.

I like to work outdoors, so I take the turtle pot and dump it outside on the grass and leave it until the turtle is cool enough to handle. I turn it upside down and cut out the under shell. Again I let it cool.

There are seven different flavors of turtle meat. Some of the choicest lie along the backbone and it is almost hopeless to get this out if the turtle has not been boiled first. Now is the time to work with two dishpans. I toss the good meat into one and the discards into the other. When in doubt, I taste.

Muscle meat tends to be good, fat is often of low quality, and seek the liver carefully. It is often excellent, but the gall bladder must be cut away and discarded or its acrid taste will permeate, and your friends will wish that you had never come upon a turtle.

Snapping turtles are not only abundant, but also an epicurean delight.

FRIED TURTLE

Fry like chicken or pheasant.

TURTLE SOUP

Cook slowly, simmering over low heat with onions and a little salt. Some include the small intestines in turtle soup. Meat stock or bouillon may be added. Taste the soup when the meat is tender. Now is the time to decide whether to make plain turtle soup seasoned with sherry, or whether to add tomatoes, carrots, celery, etc.

APPENDIX B

SNAPPING TURTLE RECIPES

Excerpt taken from *Joy of Cooking:*

ABOUT TURTLES AND TERRAPIN

While sea turtles are tropical in habitat, those most frequently caught and consumed in temperate North America are freshwater types, such as snapping turtles, which abound in streams and lakes form North Dakota to Florida. As to disposition, they are again a quite different kettle of fish: short-tempered and capable of inflicting nasty bites.

Regardless of the turtle's size, sectioning it for cooking is an irksome job, even if you overcome their worst opposition-as hold hands are wont to do when dealing with snappers-by instantly chopping off the head.

Before preparation, however, it is advisable to rid the turtles of wastes and pollutants. Put them in a deep open box, with well-secured screening on top; give them a dish of water; and feed them for a week or so on 3 or 4 small handouts of ground meat.

→ To cook, place in a pan of cold water:

A 7-inch turtle

Bring water slowly to a boil and parblanch at least 10 minutes. Drain. Plunge into cold water and leave until cool enough to handle. Scrub well. Place the turtle in rapidly boiling water and add:

(A Bouquet Garni)
(An onion stuck with cloves)
(3 stalks of celery)

→ Reduce the heat at once and simmer 35 to 45 minutes or until the claws can be removed by pulling. Drain, reserving the stock. Allow the turtle to cool on its back in order to trap the juices as it cools. When cool, pry the flat plastron free from the curved carapace-easier said than done. Near the head you will find the liver. → Free it carefully from the gall. Discard the gall. Slice the liver thin and reserve it, as well as the eggs, if any. You may or may not want to reserve the small intestines, which may be chopped and added to the meat or sauce. Remove the meat from both the carapace and the skinned legs. When ready to serve, you may toss the meat, including the ground liver and intestines, in :

6 tablespoons hot melted butter

Garnish with:

Parsley

Serve with:

Sherry, as a drink

or you may heat the meat briefly over very low heat or in he top of a double boiler→ over not in-boiling water in a sauce made by combining:

1 cup Brown Sauce
The chopped cooked eggs, if any
1 teaspoon mixed herbs: including basil, sweet marjoram and thyme, with a touch of rosemary, bay, and sage
3 tablespoons Madeira or dry sherry

Garnish with: **Watercress**