Appendix A

United States Department of the Interior
FISH AND WILDLIFE SERVICE
NATIONAL FISHERIES CONTAMINANT RESEARCH CENTER
ROUTE 2
COLUMBIA, MISSOURI 65201

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Dear Randy:

At our last meeting you requested that I provide a brief rationale for using composite fish samples vs individual filets. In addition to addressing this issue, I am also including some information on the influence of size on contaminant residue concentrations, and also the relationship of size (age) with lipid content.

A critical concern for any study is the objective. The objective pretty well dictates the types of methods that can be employed to be successful in the study. Collecting contaminant residue data in fish is commonly used to determine if a body of water has a contaminant problem and whether the levels are sufficiently high to pose a health risk. However, there is some debate and controversy on the proper way to do this.

One area of controversy is whether to use individual filets or composites of filets from several fish. Statistically, individual filet values are, of course, the preferred way to go. Unfortunately, this is generally not possible for economic reasons, and, occasionally, analytical backlogs (laboratory workloads) may preclude analyses of the large numbers of filets required to be of any significance. If monies and lab time are not constraints, then I would recommend individual filets for assessing contaminant problems in water bodies. on the other hand, if monies are of concern, then a viable option is to use composite fish samples. Again, the objective(s) of the study should

be clearly delineated and if composite data will provide the information needed, then proceed. In other words, if it is not necessary to have residue values on individual fish (and the variability among individual fish) then composites are the way to go.

To illustrate the information provided by composite samples, the following examples are-used:

Residue concentrations of contaminant x

	Sample 1	Sample 2	Sample 3
	2.6	3.6	6.4
	25.2	30.2	32.4
	5.4	4.4	8.1
	8.2	1.8	2.2
	3.2	2.2	1.2
mean	8.92	8.44	10.06
S.D.	8.37	10.92	11.46
Var.	70-12	119.25	131.32
SEM	3.74	4.88	5.12
C.V.	93.83	129.38	113.92

These data show the mean, standard error of the mean, and coefficient deviation, variance, standard of variation for each set of samples.

For the composite values, we will use the mean from each of the 3 samples above (it would be better to have filets from individual fish and also have a composite from these same fish for comparison, but I do not have these data). Actual composite values would probably be pretty close to that obtained by averaging individual samples, with the differences due mainly to different size fish filets. If fish were all the same size, the composite value would be very close to the mean of the individual filets. The same would be even more true if the same size aliquot from each filet was combined to form the composite (as suggested in our last meeting).

mean of composites		mean of all individuals	
	8.92		
	8.44		
	10.06		
mean	9.14	mean	9.14
S.D.	0.68	S.D.	10.36
Var.	0.46	Var.	107.35
SEM	0.39	SEM	2.67
C.V.	7.43	C.V.	113.68

As you can see from this example, when using composite samples, the variability shown among individual fish is lost. Variability among individuals can not be determined using composite samples. The variability among individual fish is large, but variability (S.D., Var., SEM, C.V.) among composite samples is substantially smaller (note differences of means and variabilities from the individual samples, composites, and averaging of all individuals together). The variability shown among composite samples, to me, represents the 'environmental' variability -- a variability that normalizes the extremes (highs and lows), but still provides information on sampling variability.

Composites are a practical means of providing a lot of information for a minimum amount of money. Most management people (as well as biologist and other scientists) would be very skeptical about making a decision based on one value (the risks in doing so are enormous, statistically speaking) . If decisions are to be based on 1 value, then all you need is one fish. However, I think nearly everyone would have a problem accepting a plan of action based on 1 single value. For example, I would not be comfortable with the following scenario: if 5 fish were individually analyzed and only 1 of these fish had a residue concentration that exceeded some arbitrary effect level, but the fishery is closed based on that 1 value. To make a management decision with any level of confidence regarding a contaminant problem with fish, a mean calculated from a certain number of values should be required. The problem is, how many values are enough.

It is generally agreed, that at a minimum, 3 values (which provide at least 1 degree of freedom) are needed to do any comparisons or statistical manipulations. So, assuming that 3 is the magic number we need to work with, what 3 values are we going to use? If we select the 1st value from each of the 3 samples above (2.6, 3.6, and 6.4), to illustrate a point, the mean is 4.2 (S.D. = 1.61). This mean value is substantially lower than what we know the residue concentration to be from the population (mean for composites or mean of all individuals = 9.14). In this case, (where the mean is substantially lower than the actual population mean) we would under estimate the contaminant problem. For another scenario, select the 2nd fish down from each sample above (25.2, 30.2, and 32.4). The mean for this set of samples is 29.26 (S.D. = 3.01). In this case, there is a gross over estimation of the contaminant problem. Of course, it is possible, with a little luck, to pick 3 fish at random from the 15 individual values above to give a mean pretty close to the

actual population mean. Nevertheless, you can see how shaky residue data can be with using only three individual values from a particular population.

It is possible to calculate the number of samples (values) needed to be within a certain percentage of the actual population mean. Using the information from sample 1 above, the number of samples needed to be within 20% of the actual population mean is 22 (variance [70.12]/precision (0.04]*mean 18.92]2). The number of samples needed, based on all 15 values from the samples above turns out to be 32 (variance (107.35]/precision(O.04]*mean(9.14]2). However, if composites are used, the number of composites needed to provide a mean within 20% of the actual population mean is only 1 (variance CO. 46)/precision [0.04]*mean(9.14]2). The individual variability is normalized within the composite, which reduces the sample variability and allows fewer samples to be taken to assess the population (contaminant levels). In other words, the individual variability inherent in the population is compensated for within the 'super' samples (composites) used to assess the population.

What this boils down to is this. Composite samples provide a lot of information for the money. Most decisions are made on 'means' I not on individual values. To obtain meaningful information (some level of confidence about the data) using individual values, a large number of samples would have to be analyzed and this would be cost prohibitive. Since 'means' are the pertinent end points and composites samples can provide these means economically, then composite samples are the best route to go. The mean from 3 composite (5 fish/composite) samples provides a lot of information for a fraction of the cost needed for individual filets (assuming that the required number of fish are included in the analyses -values from each of 3 individual fish could be very unrepresentative of actual contaminant problems). I believe that composite samples of fish provide a reasonable approach to assessing contaminant problems in aquatic habitats.

In general, there is an increase in lipid content with age (size) in fish, and there is an increase in contaminant residues with an increase in age. But these are only generalities and are not clear cut. These relationships vary with species of fish, season, and with the contaminant. To illustrate these points, I have pulled some information on DDT residues in fish from Huntsville Spring Branch, AL, where Olin Chemical Company discharged high levels of DDT in the past. These data were from one reach of stream (least contaminated) and are from fish collected during one sampling interval.

	Channel catfish		**ppm**	
	length (cm)	lipid (%)	DDT (wet wt)	DDT (lipid wt)
	27	10.0	7.6	67
	31	1.2	2.7	216
	32	1.4	8.6	614
	32	2.2	28.0	1271
	32	2.3	9.3	404
	33	0.8	16.0	200
	33	2.7	100.0	3703
	35	0.5	11.0	2200
	36	0.9	17.0	1888
x=	32.3	2.44	22.13	1173
S.D.=	2.54	2.93	30.11	1153

Significant Pearson Correlation Coefficients

Lipid vs length -0.8351 (P=0.0051)

	44	4.6	93.0	2022
	44	6.0	8.6	143
	45	19.0	150.0	789
	45	3.2	46.0	1437
	47	1.5	45.0	3000
	47	2.2	2.0	-90
x=	45.3	6.08	57 43	1246
S.D.=	1.36	6.55	55:81	1038

Significant Pearson Correlation Coefficients

DDT vs lipid 0.79642 (P=0.0579)

	50	1.9	18.0	947
	51	13.0	3.5	26
	51	2.2	160.0	7272
	52	0.6	68.0	11333
	52	5.9	120.0	2033
	53	5.5	8.2	149
x=	51.5	4.85	62.95	3626
S.D.=	1.04	4.51	65.19	4232

Significant Pearson Correlation Coefficients

None

All age classes combined

x=	41.52	4.17	43.88	1895
S.D.=	8.69	4.66	50.80	2682

Significant Pearson Correlation Coefficients

None

Largemouth bass

	length (cm)	lipid (%)	DDT (wet wt)	DDT (lipid wt)
	26	0.2	9.5	4750
	27	0.5	20.0	4000
	31	0.2	4.7	2350
	32	0.9	10.0	1111
	33	0.8	9.8	1225
	33	1.2	3.2	266
	33	0.3	8.0	2666
	35	1.8	14.0	777
	35	0.3	1.6	533
	38	3.0	7.7	256
x=	32.2	0.92	8.85	1793
S.D.=	3.62	0.89	5.34	1509

Significant Pearson Correlation Coefficients
Length vs lipid 0.68495 (P=0.0288)

These data indicate that the relationships between age vs lipid, age vs DDT concentrations, and lipid vs DDT concentrations are not clear cut. Only the significant correlations are shown below each data set in the above examples. In aquatic systems that we have assessed using individual animals, there has always been a lot of variation within and among size classes f or these variables, and it is not uncommon to have the highest concentrations in the smallest (youngest) individuals.

Another point is the use of lipid weight values (convert residues from wet weight to lipid weight). From the above data, you can see that this solves nothing. There is just as much variation in lipid weight values as the wet weight and all it does is confuse the issue. The data above also indicates that even within a year class there is considerable variation in the lipid content.

Although I did not include these data, whole body residues of DDT in fish from Huntsville Spring Branch averaged between 150 and 200 ppm compared to the 20 to 60 ppm for the filets. This broaches another controversy in contaminant evaluations - whole body vs filets. I recognize that from a 'human food source' perspective that residues in filets may be required, but I am not comfortable in assessing aquatic contaminant problems using only the filets. I think that we are

being pretty narrow in our scope when we restrict our evaluation to filets. The objective should be to determine if there is a contaminant problem in a particular body of water. The best way to do that is to measure whole body residues, and if levels exceed those known to cause environmental degradation, then advisories should be issued for that body of water. In my way of thinking, if contamination exists, it is not just a 'one species' problem, but a contaminant problem of the whole system. I think we owe it to the public to alert them to these contaminant problem areas (public awareness and public reactions are the best ways to solve the problem) . To issue an advisory for only one species from a contaminated system may actually be doing a disservice to the public. Since 'residue effect levels' of most contaminants for humans are not generally known, providing the opportunity (option) to avoid as much as possible may be a prudent (and conservative) approach and should be our objective. Given the amount of harmful materials that people are exposed to every day and the potential cumulative impact of these exposures, avoiding, where possible, any additional exposure is wise. Risk assessment and other advisory information do not include cumulative impacts from multiple contaminants. Economics (reduction in fishing license sales) and politics should not be the driving force of management decisions when human health and well being are concerned.

I hope that this information is helpful to you. If I can be of further assistance, please let me know.

Sincerely,

Parley V. Winger

Appendix B

RfD = reference dose
RSD = risk specific dose
SF = cancer slope or potency factor

RfD_m = RfD for mixtures
RSD_m = risk specific dose for mixtures

E = fish contaminant concentration

Equations 1 through 3 are for calculation of fish intake for non-cancer toxicity.

Eqn 1:

$$\text{Fish Intake (kg/day)} = \frac{\text{RfD (mg/kg-day)} \times \text{bw (70kg)}}{\text{E (mg/kg)}}$$

Eqn 2:

$$\frac{E_1}{RfD_1} + \frac{E_2}{RfD_2} + \ldots + \frac{E_i}{RfD_i} = \frac{\text{Total Contaminants (TC)}}{RfD_m}$$

Eqn 3:

$$\therefore\ RfD_m = \frac{TC}{\sum \frac{E_i}{RfD_i}}$$

Eqn 4:

$$\text{RSD (mg/kg-day)} = \frac{\text{Risk(unit less)}}{\text{SF(mg/kg-day)}^{-1}}$$

For calculation of fish intake for carcinogenic effects, substitute RSD for RfD in equations 1 through 3.

Appendix C

NR NEWS	Georgia Department of Natural Resources 205 Butler Street, S.E., Suite 1258 Atlanta, Georgia 30334 FOR MORE INFORMATION CONTACT: Mose McCall/ 404-656-0772	

Georgia Department of Natural Resources today released the results of a 1990 study of toxics in the Chattahoochee River south of Atlanta and West Point Lake.

Commissioner Joe D. Tanner said several species of fish were found to have concentrations of toxic chemicals exceeding the U. S. Food and Drug Administration standards

"Based on our analysis of fish tissue, we recommend that people not eat certain species of fish from the Chattahoochee River south of Atlanta," Tanner said. "Those species are largemouth bass caught in the vicinity of Georgia Highway 92 and catfish, carp and hybrid bass -1'rom the vicinity of Highway 92 through West Point Lake to the dam

These fish exceeded the Food and Drug Administration standards for chlordane. The fish were also tested for DDE, polychlorinated biphenyls (PCBs) and dieldrin, but no other FDA standards were exceeded

Tanner emphasized that the existence of these toxics in fish has no bearing on water quality in the Chattahoochee River nor in West Point Lake. They are found only in the bottom sediments of the river and lake and were not detected in any water samples taken from the river or from West Point Lake

“The cities and counties which take their drinking water from the river or the lake, from metro Atlanta to LaGrange to Columbus, all meet the state and federal safe drinking water standards," Tanner said. "Water samples were collected16 sites on the Chattahoochee River and in West Point lake during the same period as the fish samples. No chlordane, DDE or PCBs were detected in any of the water samples."

DNR used FDA standards as the basis for evaluating levels of chlordane, PCB and DDT found in fish. Further, the Department used US EPA risk analysis techniques to calculate human lifetime cancer risks associated with the consumption of these fish. The risk analysis techniques are designed very conservatively to assure maximum protection of human health. The calculation methods are based on the consumption of these fish at one meal per month for 70 years.

In addition to the toxins discussed, the pesticide dieldrin was detectable in some fish but in levels below the FDA standard. The fish which contained dieldrin are among those DNR recommends not eating. Dieldrin, once used extensively for termite control, has been banned for a number of years.

The manufacture of PCBs and pesticides containing chlordane has been banned for several years. While the use of PCBs, chlordane and DDT have dramatically declined, they are stable, remaining for years in the environment.

The residuals of these chemicals now in the environment probably resulted from spills or legitimate uses that occurred years ago. DNR has sampled all industrial and municipal dischargers to the Chattahoochee River and found no evidence of these chemicals in wastewater discharges

In conducting the study, DNR analyzed tissue from fish taken at 10 locations between the Gwinnett County water intake on the Chattahoochee River and the West Point Lake dam pool and at one location in Lake Harding. This study follows work by DNR in 1989 which documented the presence of PCBs and chlordane in fish in the Chattahoochee River.

Samples were collected in March and in October. Laboratory analyses were completed in January 1991. Samples of edible flesh (fillets) were taken from each fish collected. Species sampled were trout, largemouth bass, hybrid bass, yellow perch, redear sunfish, catfish, carp, and spotted sucker. Samples of edible flesh from 116 fish were analyzed for 22 organic chemicals. Only the chlordane, PCBs, and DDE were found consistently in fish.

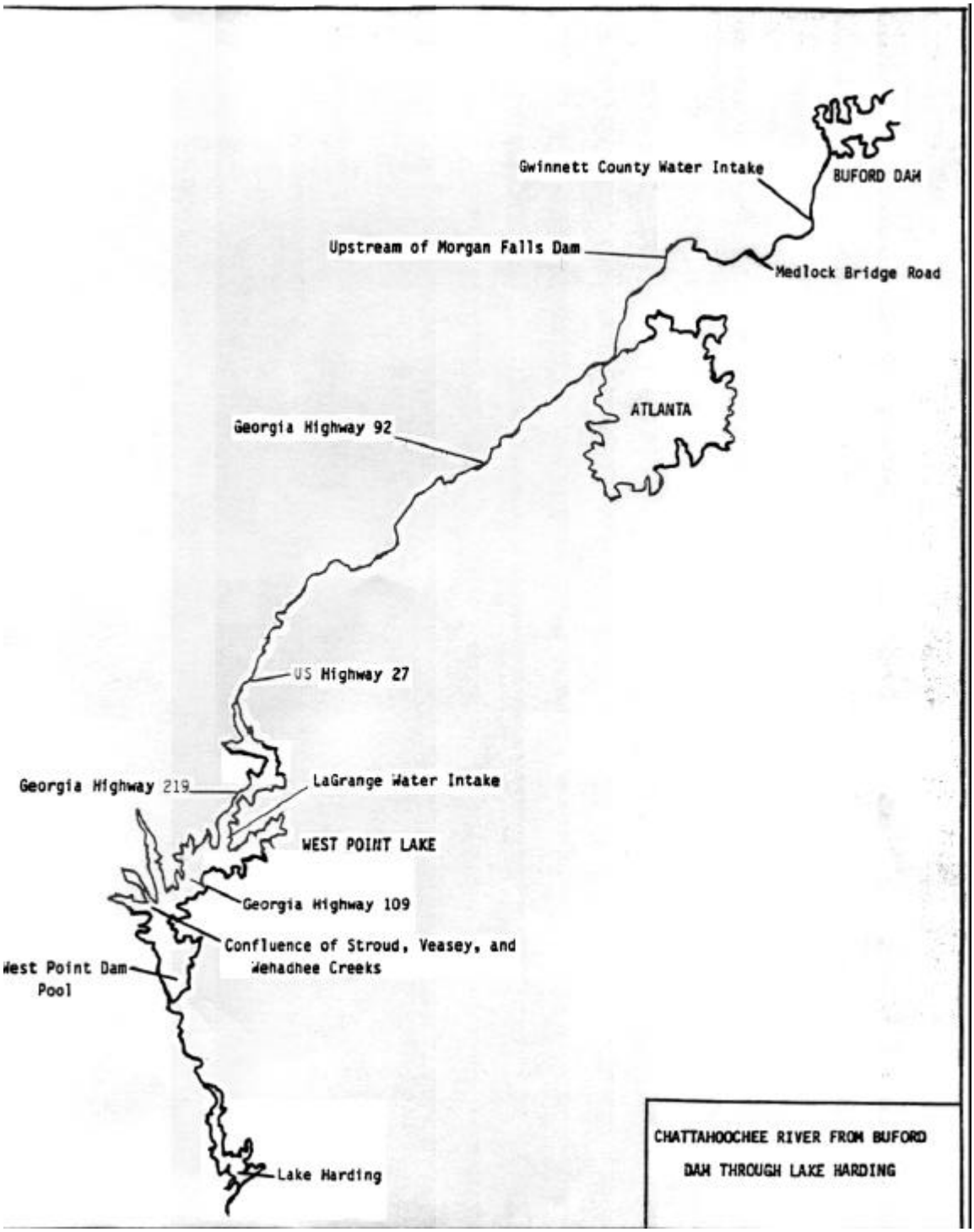
The U. S. Food and Drug Administration has established “action levels” for these chemicals in fish tissue. These are levels at which the FDA recommends steps be taken to protect human health. The action levels are 0.3 parts per million for chlordane and dieldrin, 2.0 parts per million for PCBs and 5.0 ppm for DDT (no level has been set for DDE).

Findings of low but detectable concentrations of these chemicals in fish from the entire study area support the conclusion that chlordane, DDT and PCBs are widespread pollutants as a result of previous extensive agricultural, industrial and residential use

The estimated lifetime cancer risks range from a low of 4 chances in 10,000,000 to a high of 7 chances in 10,000 for the various chemicals, types of fish and locations comparison, a 1987 EPA estimate of lifetime cancer risk from eating fish with PCB, DDE, dieldrin and chlordane found in a nationwide monitoring survey yielded a value of 3 chances in 10,000.

As another comparison, the lifetime cancer risk from smoking is about 1 chance in 10. The estimated lifetime risk of death to an individual from some other activities is as follows: automobile accident -- 1 in 4,000; drowning -- 1 in 30,000; air travel -- 1 in 100,000; lightning -- 1 in 2,000,000

DNR will continue the study of toxics in fish tissue in other sections of the Chattahoochee river and other rivers and lakes of the state.


Gwinnett County Water Intake
BUFORD DAM
Upstream of Morgan Falls Dam
Medlock Bridge Road
ATLANTA
Georgia Highway 92
US Highway 27
Georgia Highway 219
LaGrange Water Intake
WEST POINT LAKE
Georgia Highway 109
Confluence of Stroud, Veasey, and Wehadhee Creeks
West Point Dam Pool
Lake Harding
CHATTAHOOCHEE RIVER FROM BUFORD DAM THROUGH LAKE HARDING

CONCENTRATION OF TOXICS IN FISH
AND ESTIMATED LIFETIME CANCER RISKS FOR FISH CONSUMPTION

SITE	SPECIES	CHLORDANE FDA Std. = 0.3 ppm		DDE FDA Std. - 5.0 ppm		PCB 1260 FDA Std. = 2.0 ppm		DIELDRIN FDA Std. = 0.3 ppm	
		ppm[1]	risk[2]	ppm[1]	risk[2]	ppm[1]	risk[2]	ppm[1]	risk[2]
Chattahoochee River, Gwinnett Water Intake	Trout	0.02	2/1,000,000	0.02	6/10,000,000	0.04	3/100,000	0.005	7/1,000,000
	Carp & Sucker	0.08	1/100,000	0.03	9/10,000,000	0.37	3/10,000	0.005	7/1,000,000
Chattahoochee River, Medlock Bridge Road	Trout	0.02	2/1,000,000	10.02	6/10,000,000	0.04	3/100,000	0.005	7/1,000,000
	Largemouth Bass	0.04	5/1,000,000	0.01	4/10,000,000	0.05	4/100,000	0.005	7/1,000,000
	Carp & Sucker	0.14	2/100,000	0.07	2/1,000,000	0.25	2/10,000	0.012	2/100,000
Chattahoochee River, Upstream of Morgan Falls Dam	Largemouth Bass	0.06	7/1,000,000	0.01	4/10,000,000	0.06	4/100,000	0.005	7/1,000,000
	Yellow Parch	0.10	8/1,000,000	0.02	6/10,000,000	0.07	4/100,000	0.005	7/1,000,000
	Redear Sunfish	0.03	7/1,000.000	0.01	4/10,000,000	0.02	1/100,000	0.005	7/1,000,000
	Carp	0.25	3/100,000	0.04	1/1,000,000	0.22	2/10,000	0.005	7/1,000,000
Chattahoochee River, GA Hwy 92	Largemouth Bass	0.46*	6/100,000	0.08	3/1,000,000	0.48	3/10,000	0.020	3/100,000
	Carp	0.28	3/100.000	0.36	1/100,000	0.35	3/10,000	0.007	1/100,000
	Catfish	0.10	1/100,000	0.01	4/10,000,000	0.14	1/10,000	0.007	1/100,000
Chattahoochee River, US Hwy 27	Largemouth Bass	0.06	7/1,000,000	0.01	3/10,000,000	0.03	2/100,000	0.005	7/1,000.000
	Carp	0.21	3/100,000	0.09	3/1,000,000	0.67	5/10,000	0.005	7/1,000,000
	Catfish	0.40*	5/100,000	0.06	2/1,000,000	0.36	3/10,000	0.010	1/100,000
West Point Lake GA Hwy 219	Largemouth Bass	0.08	1/100,000	0.02	6/10,000,000	0.10	7/100,000 10	.005	7/1,000,000
	Hybrid Bass	0.40*	5/100,000	0.06	2/1,000,000	0.03	2/100,000	0.005	7/1,000,000
	Carp	0.15	2/100,000	0.04	1/1,000,000	0.31	2/10,000	0.005	7/1,000,000
	Catfish	0.39*	5/100,000	0.07	2/1,000,000	0.29	2/10,000	0.012	2/100,000
West Point Lake LaGrange Water Intake	Largemouth Bass	0.14	2/100,000	0.02	6/10,000,000	0.12	8/100,000	0.005	7/1,000,000
	Carp	0.06	7/1,000,000	0.07	2/1,000,000	0.13	9/100,000	0.005	7/1,000,000'
	Catfish	0.51*	6/100,000	0.07	2/1,000,000	0.44	3/10,000	0.005	7/1,000,000
West Point Lake GA Hwy 109	Largemouth Bass	0.06	7/1,000,000	0.02	6/10,000,00	0.08	6/100,000	0.005	7/1,000,000
	Carp	0.11	1/100,000	0.30	9/1,000,000	0.32	2/10,000	0.005	7/1,000,000
	Catfish	0.30*	4/100,000	0.06	2/1,000,000	0.24	2/10,000	0.005	7/1,000,000
West Point Lake Wehadkee Creek	Largemouth Bass	0.04	5/1,000,000	0.02	6/10,000,000	0.05	4/100,000	0.005	7/1,000,000
	Carp	0.31*	4/100,000	0.18	6/1,000,000	0.46	3/10,000	0.009	1/100,000
	Catfish	0.07	8/1,000,000	0.02	6/10,000,000	0.04	3/100,000	0.005	17/1,000,000
West Point Lake near the Dam	Largemouth Bass	0.02	2/1,000,000	0.01	3/10,000,000	0.02	1/100,000	0.005	7/1,000,000
	Hybrid Bass	0.07	8/1,000,000	0.04	1/1,000,000	0.05	4/100,000	0.005	7/1,000,000
	Carp	0.09	1/100,000	0.03	9/10,000,000	0.08	6/100,000	0.005	7/1,000,000
	Catfish	0.32*	4/100,000	0.09	2/1,000,000	0.34	2/10,000	0.012	2/100,000
Lake Harding	Largernouth Bass	0.05	6/1,000,000	0.02	6/10,000,000	0.14	1/10,000	0.005	7/1,000,000
	Catfish	0.26	3/100,000	0.12	4/1,000,000	1.00	7/10,000	0.005	7/1,000,000

[1]Average values, For samples below the detection limit a value of one-half the detection limit was used,

[2]An estimated risk of 2/1,000,000 means that if a person consumes one meal of fish per month for 70 years, that person will have 2 chances in 1,000,000 of getting cancer in their lifetime.

*Indicates value exceeds the FDA standard,

U.S. EPA's goal for acceptable lifetime cancer risk is 1 chance in 1,000,000,

A 1987 study by U.S. EPA of more than 1,000 fish samples nationwide showed estimated lifetime cancer risks of 3 chances in 10,000 from the combined effects of Chlordane, DDE, PCB 1260, and Dieldrin.

SITE ABBREVIATIONS

GWI	Chattahoochee River at Gwinnett Water Intake
MBR	Chattahoochee River at Medford Bridge Road
MFD	Chattahoochee River upstream of Morgan Falls Dam
Hwy 92	Chattahoochee River at GA Highway 92
Hwy 27	Chattahoochee River at U.S. Highway 27
WPL Hwy 219	Chattahoochee River at GA Highway 219, upper portion of West Point Lake
WPL LWI	Chattahoochee River at the LaGrange Water Intake in West Point Lake
WPL Hwy 109	Chattahoochee River at GA Highway 109, West Point Lake
WPL Weh.Ck	Chattahoochee River at the confluence of Wehadkee Creek in West Point Lake
WPL Dam	Chattahoochee River at the West Point Lake Dam Pool
Lake Harding	Chattahoochee River at Lake Harding

CHATTAHOOCHEE RIVER DATA, 1990

Site	Species	CHLORINE Conc. mg/kg	DDD Conc. mg/kg	DDE Conc. mg/kg	DIELDRIN Conc. mg/kg	tPCB Conc. mg/kg
GWI	Trout	0.000	0 * 000	0.017	0.000	0.056
	Carp	0.000	0.000	0.336	0.000	0.560
	Sucker	0.088	0.000	0.023	0.000	0.180
MBR	Br-Trout	0.011	0.005	0.018	0.000	0.054
	RB-Trout	0.015	0.000	0.014	0.000	0.106
	LMB	0.023	0.000	0.010	0.000	0.047
	Carp & sucker	0.135	0.000	0.087	0.058	0.459
MFD	LMB	0.056	0.000	0.007	0.000	0.063
	YP	0.089	0.000	0.013	0.000	0.062
	RS	0.017	0.000	0.000	0.000	0.010
	Carp	0.251	0.000	0.037	0.000	0.221
HWY 92	LMB	0.460	0.000	0.080	0.020	0.477
	Carp	0.281	0.077	0.358	0.007	0.349
	Catfish	0.098	0.000	0.007	0.003	0.136
HWY 27	LMB	0.044	0.000	0.007	0.000	0.017
	Carp	0.213	0.000	0.090	0.000	0.667
	Catfish	0.402	0.000	0.058	0.008	0.363
WPL Hwy 219	LMB	0.078	0.000	0.014	0.000	0.094
	HB	0.400	0.000	0.060	0.000	0.293
	Carp	0.153	0.000	0.043	0.000	0.305
	Catfish	0.391	0.000	0.066	0.010	0.326
WPL LWI	LMB	0.133	0.000	0.019	0.000	0.117
	Carp	0.047	0.000	0.068	0.000	0.129
	Catfish	0.507	0.000	0.007	0.007	0.426
WPL Hwy 109	LMB	0.057	0.000	0.019	0.000	0.078
	Carp	0.109	0.000	0.296	0.000	0.321
	Catfish	0.298	0.000	0.061	0.000	0.242
WPL Weh. Ck	LMB	0.043	0.000	0.019	0.000	0.047
	Carp	0.304	0.000	0.179	0.005	0.463
	Catfish	0.061	0.000	0.013	0.000	0.053
WPL Dam	LMB	0.000	0.000	0.007	0.000	0.013
	HB	0.071	0.000	0.010	0.003	0.048
	Carp	0.091	0.000	0.026	0.000	0.101
	Catfish	0.317	0.000	0.010	0.010	0.339
Lake Harding	LMB	0.040	0.000	0.020	0.000	0.140
	Catfish	0.247	0.000	0.117	0.000	1.000

CANCER POTENCY FACTORS and NONCANCER TOXICITY FACTORS from IRIS2

Chemical	**Potency Factor** [1] (mg/kg-day)$^{-1}$	**Oral Reference Dose** [2] (mg/kg-day)
Chlordane	1.3	6.0×10^{-5}
DDD	0.24	$5.0 \times 10^{-4*}$
DDE	0.34	$5.0 \times 10^{-4*}$
DDT	0.34	5.0×10^{-4}
Dieldrin	16.0	5.0×10^{-5}
PCBs (total)	7.7	$1.0 \times 10^{-4*}$

'Target organ for carcinogenicity of these chemicals is the liver.

[2] Critical effect for all of these chemicals is either liver toxicity or necrosis.

*Values are not online in IRIS2, but were estimated in existing EPA documents.

CARCINOGEN ASSESSMENT, 70 YEARS EXPOSURE

SITE	Species	Intake g/day	Est. Excess Risk	Advisory Info meals	fish intake g/day	advisory info. 1/4-1/2 lb. meals
GWI	Trout	16.03183	4E-05	LC,l/wk	0-3	DE
	Carp	1.582437	4E-04	DE	> 3-10	LC,1/mo
	Sucker	4.640876	1E-04	LC,1/mo	> 10-30	LC,l/wk
					> 30-100	LC,3/wk
MBR	Br-Trout	16.00894	4E-05	LC,l/wk	> 100	UL
	RB-Trout	8.333838	8E-05	LC,1/mo		
	LMB	17.71031	4E-05	LC,l/wk		
	Carp & sucker	1.502456	4E-04	DE	DE=	Don't Eat
					LC=	Limit Consumption
MFD	LMB	12.48409	5E-05	LC,l/wk	UL=	Unlimited Consumption
	YP	11.69568	6E-05	LC,l/wk		
	RS	70.49949	9E-06	LC,3/wk		
	Carp	3.426297	2E-04	LC,1/mo		
HWY 92	LMB	1.515302	4E-04	DE		
	Carp	2.116565	3E-04	DE		
	Catfish	5.713660	1E-04	LC,1/mo		
HWY 27	LMB	36.63429	2E-05	LC,3/wk		
	Carp	1.286275	5E-04	DE		
	Catfish	2.018315	3E-04	DE		
WPL Hwy 219	LMB	8.428291	8E-05	LC,1/mo		
	HB	2.499239	3E-04	DE		
	Carp	2.731923	2E-04	DE		
	Catfish	2.185004	3E-04	DE		
WPL LWI	LMB	6.472182	1E-04	LC,1/mo		
	Carp	6.495928	IE-04	LC,1/mo		
	Catfish	1.725177	4E-04	DE		
WPL Hwy 109	LMB	10.27068	6E-05	LC,l/wk		
	Carp	2.578534	3E-04	DE		
	Catfish	3.077358	2E-04	LC,I/mo		
WPL Weh. Ck	LMB	16.48342	4E-05	LC,l/wk		
	Carp	1.706223	4E-04	DE		
	Catfish	14.21498	5E-05	LC,l/wk		
WPL Dam	LMB	68.35016	1E-05	LC,3/wk		
	HB	13.62612	5E-05	LC,l/wk		
	Carp	7.729464	8E-05	LC,1/mo		
	Catfish	2.196439	3E-04	DE		
Lake Harding	LMB	6.159525	1E-04	LC,1/mo		
	Catfish	0.868739	7E-04	DE		

CARCINOGEN ASSESSMENT, 30 YEARS EXPOSURE

SITE	Species	Intake g/day	Est. Excess Risk	Advisory Info meals	fish intake g/day	advisory info. 1/4-1/2 lb. meals
GWI	Trout	37.00440	2E-05	LC,3/wk	0-3	DE
	Carp	3.653295	2E-04	LC,1/mo	> 3-10	LC,1/mo
	Sucker	10.73173	6E-05	LC,l/wk	> 10-30	LC,l/wk
					> 30-100	LC,3/wk
MBR	Br-Trout	36.98452	2E-05	LC,I/wk	> 100	UL
	RB-Trout	19.24528	3E-05	LC,./wk		
	LMB	40.95602	2E-05	LC,I/wk		
	Carp & sucker	3.492211	2E-04	LC,./mo	DE=	Don't Eat
					LC=	Limit Consumption
MFD	LMB	28.90883	2E-05	LC,l/wk	UL=	Unlimited Consumption
	YP	27.12937	2E-05	LC,I/wk		
	RS	163.6363	4E-06	UL		
	Carp	7.940538	8E-05	LC,1/mo		
HWY 92	LMB	3.516433	2E-04	LC,1/mo		
	Carp	4.906718	1E-04	LC,1/mo		
	Catfish	13.23733	5E-05	LC,l/wk		
HWY 27	LMB	85.21981	8E-06	LC,3/wk		
	Carp	2.972522	2E-04	DE		
	Catfish	4.681660	1E-04	LC,1/mo		
WPL Hwy 219	LMB	19.51352	3E-05	LC,l/wk		
	HB	5.796081	1E-04	LC,1/mo		
	Carp	6.317745	!E-04	LC,1/mo		
	Catfish	5.071502	1E-04	LC,1/mo		
WPL LWI	LMB	14.99947	4E-05	LC,l/wk		
	Carp	15.01787	4E-05	LC,l/wk		
	Catfish	4.001457	2E-04	LC,1/mo		
WPL Hwy 109	LMB	23.77226	3E-05	LC,l/wk		
	Carp	5.962089	1E-04	LC,l/mo		
	Catfish	7.134173	9E-05	LC,1/mo		
WPL Weh. Ck	LMB	38.17841	2E-05	LC,3/wk		
	Carp	3.950608	2E-04	LC,I,/mo		
	Catfish	32.94624	2E-05	LC,3/wk		
WPL Dam	LMB	157.7900	4E-06	UL		
	HB	31.68639	2E-05	LC,3/wk		
	Carp	17.90071	4E-05	LC,l/wk		
	Catfish	5.093693	1E-04	LC,1/mo,		
Lake Harding	LMB	14.23255	5E-05	LC,I/wk		
	Catfish	2.007018	DE			

TOXIC ASSESSMENT

SITE	Species	Intake g/day	Advisory Info meals	fish intake g/day	advisory info. 1/4-1/2 lb. meals
GWI	Trout	117.8451	UL	0-3	DE
	Carp	11.16071	LC,l/wk	> 3-10	LC,1/mo
	Sucker	21.13101	LC,l/wk	> 10-30	LC,l/wk
				> 30-100	LC,3/wk
MBR	Br-Trout	90.98786	LC,3/wk	> 100	UL
	RB-Trout	52-31689	LC,3/wk		
	LMB	80.15267	LC,3/wk		
	Carp & sucker	8.563738	LC,1/mo	DE=	Don't Eat
				LC=	Limit Consumption
MFD	LMB	44.37869	LC,3/wk	UL=	Unlimited Consumption
	YP	32.87413	LC,3/wk		
	RS	182.6086	UL		
	Carp	10.82362	LC,l/wk		
HWY 92	LMB	5.385996	LC,1/mo,		
	Carp	7.622504	LC,1/mo		
	Catfish	22.82112	LC,l/wk		
HWY 27	LMB	76.30813	LC,3/wk		
	Carp	6.730769	LC,1/mo		
	Catfish	6.600037	LC,1/mo		
WPL Hwy 219	LMB	30.86419	LC,3/wk		
	HB	7.204116	LC,1/mo		
	Carp	12.31093	LC,l/wk		
	Catfish	6.924751	LC,1/mo		
WPL LWI	LMB	20.43994	LC,l/wk		
	Carp	31.68376	LC,3/wk		
	Catfish	5.441542	LC,1/mo		
WPL Hwy 109	LMB	39.59276	LC,3/wk		
	Carp	12.45847	LC,l/wk		
	Catfish	9.322560	LC,1/mo		
WPL Weh. Ck	LMB	57.15841	LC,3/wk		
	Carp	6.893382	LC,1/mo		
	Catfish	44.51038	LC,3/wk		
WPL Dam	LMB	486.1111	UL		
	HB	40.15296	LC,3/wk		
	Carp	27.14581	LC,l/wk		
	Catfish	7.871064	LC,1/mo		
Lake Harding	LMB	33.22784	LC,3/wk		
	Catfish	4.877822	LC,1/mo		

Current Advisory (based on FDA action levels)

Gwinnett Water Intake to Morgan Falls Dam	None	
Georgia Highway 92 to U.S. Highway 27	LMB	do not eat
	Catfish	do not eat
	Carp	do not eat
	Hybrid Bass	do not eat
West Point Lake	Catfish	do not eat
	Carp	do not eat
	Hybrid Bass	do not eat
Lake Harding	None	

Proposed Advisory (70 year exposure period)

Gwinnett Water Intake to Morgan Falls Dam	Brook Trout	limit consumption - 1 meal/week
	Rainbow Trout	limit consumption 1 meal/month
	LM13	limit consumption - 1 meal/week
	Carp & Sucker	do not eat
Georgia Highway 92 to U.S. Highway 27	LMB	do not eat
	Catfish	do not eat
	Carp	do not eat
West Point Lake	Catfish	do not eat
	Carp	do not eat
	Hybrid Bass	do not eat
	LMB	limit consumption - 1 meal/month
Lake Harding	Catfish	do not eat
	LMB	limit consumption – 1 meal/month

Proposed Advisory (30 year exposure period)

Gwinnett Water Intake to Morgan Falls Dam	Brook Trout	limit consumption - 3 meals/week
	Rainbow Trout	limit consumption - 1 meal/week
	LM13	limit consumption - 1 meal/week
	Carp & Sucker	limit consumption - 1 meal/month
Georgia Highway 92 to U.S. Highway 27	LMB	limit consumption - 1 meal/month
	Catfish	limit consumption - 1 meal/month
	Carp	do not eat
West Point Lake	Catfish	limit consumption - 1 meal/month
	Carp	limit consumption - 1 meal/month
	Hybrid Bass	limit consumption - 1 meal/month
	LMB	limit consumption - 1 meal/week
Lake Harding	Catfish	do not eat
	LMB	limit consumption - I meal/week