Health Consultation

AN EVALUATION OF CONTAMINANT CONCENTRATIONS IN FISH FROM UTAH LAKE FOR 2002

UTAH LAKE, UTAH COUNTY, UTAH

SEPTEMBER 8, 2005

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

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UTAH LAKE, UTAH COUNTY, UTAH

Prepared by:

Utah Department of Health
Office of Epidemiology
Environmental Epidemiology Program
Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Background and Statement of Issues

The Utah Department of Environmental Quality (UDEQ) is cooperating with the Environmental Protection Agency (EPA) in the *National Study of Chemical Residues in Lake Fish Tissue*. The National Fish Tissue Study is a survey of contamination in freshwater fish to estimate the national distribution of selected persistent, bioaccumulative and toxic chemicals in fish tissue from lakes and reservoirs of the contiguous United States (EPA 2004a). The objectives of the study are to provide a national estimate of mean concentration of 268 chemicals in lake fish, define a national baseline to track progress of pollution control activities, and identify where contaminant levels are high enough to warrant further investigation. Fish were collected from 500 lakes and reservoirs randomly selected from the estimated 270,000 lakes and reservoirs in the lower 48 states. The Division of Water Quality requested that the Environmental Epidemiology Program (EEP) review the fish sampling data from fish sampled from Utah lakes and reservoirs. Utah Lake was one of the lakes selected for sampling as part of this national study.

Fish from Utah Lake have been collected and analyzed for chemical contaminants. Fish were analyzed for a few heavy metals, volatiles, semivolatiles, PCBs, dioxins, and furans. Sampling site is shown in Figure 1. The Division of Water Quality requested that the Environmental Epidemiology Program review the data. This health consultation is an evaluation of chemical contaminants in fish from Utah Lake in Utah covering the year of 2002.

Results

All contaminant concentrations are reported as a wet weight concentration in milligrams of contaminant per kg fish tissue (mg/kg). Fish tissue was analyzed as a composite of multiple fish of one species. Contaminant concentrations are for the analyzed composite, not individual fish, therefore, the reported values are average concentrations of the contaminant concentrations of all fish in the composite.

Five white bass and five black bullhead fish were collected from Utah Lake. White bass were filleted and black bullheads were homogenized prior to composite analysis. Mercury, eight pesticides, and three dioxin/furans were detected in white bass (Table 1). Mercury, six pesticides, and nine dioxin/furans were detected in black bullheads (Table 2). Mercury levels were not elevated in either species of fish from Utah Lake, however, PCB levels were elevated in both species. White bass had total PCB levels of 0.028 mg/kg and black bullhead fish had PCB levels of 0.075 mg/kg, which exceed the EPA cancer screening value of 0.02 mg/kg.

Black bullhead fish were found to have elevated levels of total dioxins/furans with a total toxic equivalency concentration (TEQ) of $3x10^{-7}$ mg/kg. The cancer screening value for total TEQ is $2.56x10^{-7}$ mg/kg. Non-carcinogen and carcinogen screening values for all detected chemicals are presented in Tables 3 and 4. Screening values are explained and discussed in the Discussion section. The calculation of the dioxin and dioxin-like compound toxicities is presented in Table 5.

Discussion

To determine whether people are exposed to contaminants related to a site, ATSDR evaluates the environmental and human components that lead to human exposure. This exposure pathways analysis consists of five elements and the exposure pathway can be completed or potential. The five exposure elements include: (1) a source of contamination, (2) transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) receptor population. In a completed exposure pathway, all five elements exist and indicate that exposure to a contaminant has occurred in the past, is occurring, or will occur in the future. Potential exposure pathways require that one of the five elements is missing, but may exist, and indicate that exposure to a contaminant may have occurred in the past, may be occurring, or may occur in the future. An exposure pathway can be eliminated if at least one of the five elements is missing and will never be present [ATSDR 2005]. Since PCBs and dioxins/furans were elevated in fish collected from Utah Lake, people consuming white bass and black bullhead fish from Utah Lake is considered a potential exposure pathway. Because of the limitations of the sample data, as discussed below under limitations, the information is insufficient to eliminate or include the exposure point or exposure route pathways. The source of the PCBs and dioxins/furans is unknown.

Screening values (SVs) were developed by the U.S. Environmental Protection Agency (EPA) and are used as standards by which levels of contamination can be compared. Screening values are defined as the concentrations of target analytes in fish tissue that can trigger further investigation and/or consideration of fish advisories for the waterbodies and species where such concentrations occur [EPA 2000b].

Carcinogenic Effects

Dioxins/furans

Exposure to chlorinated dibenzo-p-dioxins (CDDs) occurs mainly from eating food that contains the chemicals. One chemical in this group, 2,3,7,8-tetrachlorodibenzo-p-dioxin or 2,3,7,8-TCDD, has been shown to be very toxic in animal studies. Several studies suggest that exposure to 2,3,7,8-TCDD increases the risk of several types of cancer in people. Animal studies have also shown an increased risk of cancer from exposure to 2,3,7,8-TCDD [ATSDR 1998]. EPA lists 2,3,7,8-TCDD as a probable human carcinogen whereas the National Toxicology Program lists it as a known human carcinogen and the International Agency for Research on Cancer considers 2,3,7,8-TCDD carcinogenic to humans based on sufficient human evidence.

Based on their relative toxicity when compared to 2,3,7,8-TCDD, contaminants are assigned a Toxicity Equivalency Factor (TEF). These contaminants include 2,3,7,8-TCDD, related chlorinated dibenzo-p-dioxins (CDDs), chlorinated dibenzofurans (CDFs), and other structurally related groups of chemicals from the family of halogenated aromatic hydrocarbons. The concentration of each CDD detected is multiplied by the TEF to give a Toxic Equivalency Concentration (TEQ). In this health consultation, all of the TEQs are added for a total TEQ value. The total TEQs are used to determine an SV for all dioxins and dioxin-like compounds

detected. Black bullhead fish from Utah Lake exceeded the carcinogenic SV for this group of contaminants.

Concentrations of chemicals such as the most toxic, 2,3,7,8-chlorine substituted CDDs, which are difficult for the animals to break down, usually increase at each step in the food chain. This process, called biomagnification, is the reason why undetectable levels of CDDs in water can result in measurable concentrations in aquatic animals. The food chain is the main route by which CDD concentrations build up in larger fish, although some fish may accumulate CDDs by eating particles containing CDDs directly [ATSDR 1998].

PCBs

Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). Small organisms and fish in water take up PCBs. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water [ATSDR 2000].

Studies of workers provide evidence that PCBs were associated with certain types of cancer in humans, such as cancer of the liver and biliary tract. Rats that ate commercial PCB mixtures throughout their lives developed liver cancer [ATSDR 2000].

EPA classifies PCBs as probable human carcinogens (class B2). More than 150 PCBs were analyzed in the fish collected. To measure their health effects, the concentrations of all detected PCBs were totaled and compared to a total PCB SV. The total PCB SV was calculated from the chronic MRL of aroclor 1254. The carcinogenic SV was exceeded for PCBs in both species of fish analyzed from Utah Lake.

PCBs accumulate at higher concentrations in fatty tissues than in muscle tissue [ATSDR 2000]. The samples of black bullhead fish were analyzed as whole fish, not fillets. Eating only the fillet portions of fish may reduce consumption of PCBs. When compared to predatory fish, higher levels of PCBs are found in bottom-feeders such as the black bullhead fish.

<u>Limitations</u>

Although fish from Utah Lake exceeded the cancer SVs for PCBs and dioxin-like compounds, the fish sampling study design is insufficient to support a fish advisory. The sample size was small and limited to two species, and the quality assurance and quality control of the data is unknown. The preparation of the fish samples will affect the analysis. The analytical result for PCBs and the dioxin-like compounds were estimated values. For total PCBs in white bass, the sample result reported was above the above the method detection limit (MDL), but below the minimum level (ML) of quantitation. For PCBs in the black bullhead, one or more of the PCB congeners contributing to the total was associated with a contaminated blank and one or more of the congeners was reported above the MDL and below the ML. For the dioxin-like compounds in the black bullhead, the sample results reported were above the above the MDL, but below the ML.

Children's Health Considerations

The Agency of Toxic Substances and Disease Registry recognizes the unique vulnerabilities of infants and children to environmental contaminants. Children are less developed and may have developmental harm from exposure that would not be experienced by a completely developed adult. The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Children's health was considered as part of this health consultation.

Conclusions

White bass and black bullhead fish from Utah Lake exceeded the screening value for total PCBs. Black bullhead also exceeded the screening value for dioxins/furans with a TEQ of $3x10^{-7}$ mg/kg. There are limitations to the usefulness of the data, however, because of the small sample size and the limitations of the quality of the data. Additional fish sampling data is needed to determine if PCBs and dioxins/furans concentrations in game fish from Utah Lake are at concentrations of potential public health concern. Due to the limitations of the data quality, consumption of fish from Utah Lake is considered an indeterminate health hazard.

Recommendations

The Utah Department of Health recommends that additional sampling of game fish be conducted to further characterize the extent of the concentrations of PCBs and dioxins/furans in fish from Utah Lake. Sampling should follow a standard protocol that includes collection of at least five fish of the same species per site. Lab analysis should be standardized such that sample preparation, analysis and QA/QC meet EPA standards. Individual fish fillets should be analyzed instead of composite samples.

Public Health Action Plan

The Environmental Epidemiology Program of the Utah Department of Health will continue to work with the Utah Department of Environmental Quality, the Utah Division of Wildlife Resources, and the Utah County Health Department to notify the public of the findings of this health consultation. A copy of this health consultation will be posted on the Environmental Epidemiology Program web site.

The Environmental Epidemiology Program will continue to work with all applicable agencies to perform additional research on mercury, PCBs, and other chemical contaminants in fish in Utah. The Environmental Epidemiology Program will adjust recommendations as new information becomes available.

The Environmental Epidemiology Program will work with the Utah Department of Environmental Quality, Utah Division of Wildlife Resources and the Utah County Health Department to monitor fishing at Utah Lake to identify potential subsistence fisher populations affected by contaminants in fish from Utah Lake.

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Certification

This Health Consultation, An Evaluation of Contaminant Concentrations in Fish from Utah Lake for 2002, was prepared by the Utah Department of Health, Environmental Epidemiology Program under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the public health consultation was begun. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Alan Yarbrough
Cooperative Agreement Team Leader, DHAC, ATSDR

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Figures and Tables

Figure 1. Location of sampling site on map of Utah.

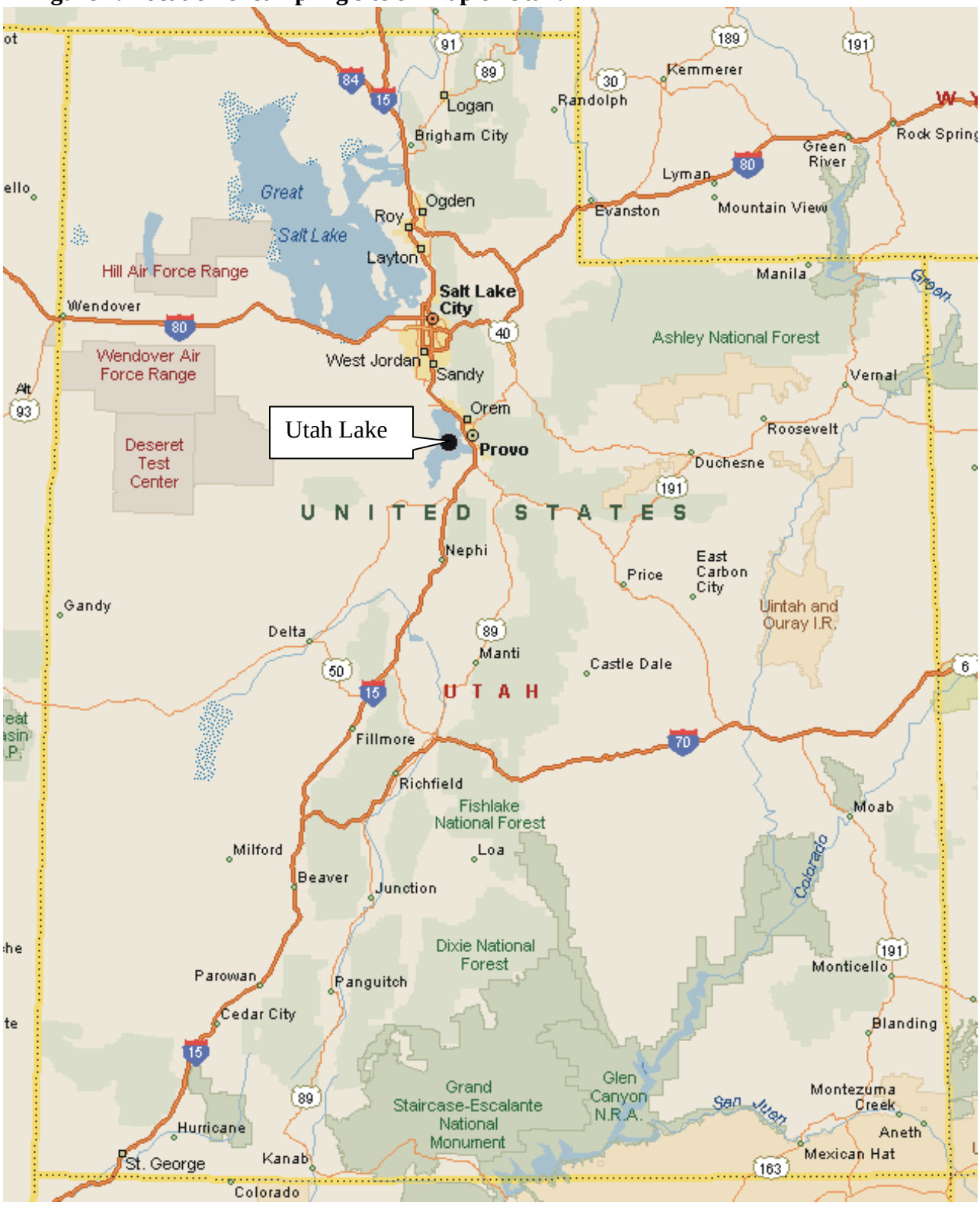

Table 1. Sampling data for chemicals detected in white bass fillet composite samples from Utah Lake, Utah (2002).

Analyte	Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Cancer Screening Value (mg/kg)	SCC Code†
4,-4'-DDE	0.0020	2.0	0.117	NA
beta-BHC	0.0039	2.4	0.022	J, RNF2
Ethalfluralin	0.0017	160	NA	J, LOPR, RNF2
gamma-BHC	0.0016	1.2	0.0307	J, RNF2
Heptachlor	0.0082	2.0	0.0089	RNF2
Isodrin	0.0022	NA	NA	J
Mercury*	0.070	0.3	NA	NA
Oxychlordane	0.0023	2.0	0.114	J
Total PCBs	**0.028**	0.08	**0.02**	J
Trifluralin	0.0050	30	5.2	J, RNF2
2,3,4,7,8-PECDF	6E-08 (3E-08 TEQ)	§	§	J
2,3,7,8-TCDD	4E-08 (4E-08 TEQ)	§	§	J
2,3,7,8-TCDF	8E-08 (8E-09 TEQ)	§	§	J
TOTAL TEQs ‡	2E-08	4E-06	2.56E-07	J

* Based on the chronic oral RfD for methylmercury.
† J = Estimated value; LOPR = Potential low bias; low analyte recovery was observed with the ongoing precision and recover sample associated with the result. RNF2 = Estimated value, analyte was found using two columns but the two columns differed by a factor of more than two.
‡ TEQ = toxic equivalency concentration
§Total TEQs are used to determine an SV for all dioxins and dioxin-like compounds detected. Health guidelines are not available for isodrin.

Table 2. Sampling data for chemicals detected in black bullhead homogenized composite samples from Utah Lake, Utah (2002).

Analyte	Concentration Wet Weight (mg/kg)	Non-Cancer Screening Value (mg/kg)	Cancer Screening Value (mg/kg)	SCC Code†
Dieldrin	0.00066	2.4	0.0025	J
Mercury*	0.014	0.3	NA	NA
2,4'-DDD	0.0013	**	**	J, RNF2
2,4'-DDE	0.0017	**	**	J
2,4'-DDT	0.0015	**	**	J, RNF2
4,4'-DDD	0.0013	**	**	J
4,4'-DDE	0.01	**	**	NA
Total DDT**	0.016	2.0	0.117	NA
Total PCBs	**0.075**	0.08	**0.02**	B, J
1,2,3,4,6,7,8-HPCDD	2E-07 (2E-09 TEQ)	§	§	J
1,2,3,4,7,8 -HXCDD	8E-08 (8E-09 TEQ)	§	§	J
1,2,3,6,7,8-HXCDD	2E-07 (2E-08 TEQ)	§	§	J
1,2,3,7,8,9-HXCDD	4E-08 (4E-09 TEQ)	§	§	J
1,2,3,7,8-PECDD	1E-07 (1E-07 TEQ)	§	§	J
1,2,3,7,8-PECDF	1E-07 (5E-09 TEQ)	§	§	J
2,3,4,6,7,8-HXCDF	8E-08 (8E-09 TEQ)	§	§	J
2,3,4,7,8-PECDF	2E-07 (1E-07 TEQ)	§	§	J
2,3,7,8-TCDF	2E-07 (2E-08)	§	§	NA
TOTAL TEQs ‡	**3E-07**	4E-06	**2.56E-07**	NA

† B = Blank contamination; J = Estimated value; RNF2 = Estimated value, analyte was found using two columns but the two columns differed by a factor of more than two.

‡ TEQ = toxic equivalency concentration.

**Based on the total DDT isomers of DDT, DDE, and DDD [EPA 2000a].

§Total TEQs are used to determine an SV for all dioxins and dioxin-like compounds detected.

Table 3. Non-carcinogen screening value calculations for chemicals detected.

Analyte	MRL/RfD (mg/kg/day)	Source	Screening Value (mg/kg)
beta-BHC	0.0006	Intermediate Oral MRL	2.4
Dieldrin	0.00005	EPA RfD	0.2
Ethalfluralin	0.04	EPA RfD	160
gamma-BHC	0.0003	EPA RfD	1.2
Heptachlor	0.0005	EPA RfD	2.0
Mercury*	0.0001	EPA RfD	0.3
Trifluralin	0.0075	EPA RfD	30
Total Chlordane†	0.0005	EPA RfD	2.0
Total DDTs‡	0.0005	EPA RfD	2.0
Total PCBs§	0.00002	EPA RfD	0.08
Total TEQs	1E-09	Chronic Oral MRL	4E-06

MRL = Minimal Risk Level, RfD = Reference Dose
Health guidelines are not available for isodrin.
SVs based on body weights and fish consumption rates as described in Appendix B.
* Based on the chronic oral RfD for methylmercury.
† EPA considers chlordane the sum of chlordane, oxychlordane, and trans-nonachlor [EPA 2000b].
‡Based on the RfD for total DDT isomers of DDT, DDE, and DDD [EPA 2000a].
§ Total PCBs based on the RfD for aroclor 1254.

Table 4. Carcinogen screening value calculations for chemicals detected.

Analyte	Oral Slope Factor $(mg/kg/day)^{-1}$	Screening Value (mg/kg)
beta-BHC	1.8	0.022
Dieldrin	16	0.0025
gamma-BHC	1.3	0.0307
Heptachlor	4.5	0.0089
Trifluralin	0.0077	5.2
Total Chlordane*	0.35	0.114
Total DDTs	0.34	0.117
Total PCBs	2	0.02
Total TEQs	156000	2.56E-07

SVs based on body weights and fish consumption rates as described in Appendix B.
There are no EPA Oral Slope Factor values for the following detected chemicals: ethalfluralin, gamma-BHC, isodrin, mercury, and TEQs.
* EPA considers chlordane the sum of chlordane, oxychlordane, and trans-nonachlor [EPA 2000b].

Table 5. Dioxin and dioxin-like compound toxicities

White bass		SCC Code	TEF‡	TEQ‡ (mg/kg)
2,3,4,7,8-PECDF	6E-08	J	0.5	3E-08
2,3,7,8-TCDD	4E-08	J	1	4E-08
2,3,7,8-TCDF	8E-08	J	0.1	8E-09
			Total TEQ =	2E-08

Black bullhead		SCC Code†	TEF‡	TEQ‡ (mg/kg)
1,2,3,4,6,7,8-HPCDD	2E-07	J	0.01	2E-09
1,2,3,4,7,8 -HXCDD	8E-08	J	0.1	8E-09
1,2,3,6,7,8-HXCDD	2E-07	J	0.1	2E-08
1,2,3,7,8,9-HXCDD	4E-08	J	0.1	4E-09
1,2,3,7,8-PECDD	1E-07	J	1	1E-07
1,2,3,7,8-PECDF	1E-07	J	0.05	5E-09
2,3,4,6,7,8-HXCDF	8E-08	J	0.1	8E-09
2,3,4,7,8-PECDF	2E-07	J	0.5	1E-07
2,3,7,8-TCDF	2E-07	NA	0.1	2E-08
			Total TEQ =	3E-07

† J = Estimated value

TEF = toxicity equivalency factor. **TEQ** = toxic equivalency concentration.

TEFs have been assigned to dioxins and dioxin-like compounds in order to compare the relative toxicity of each compound to that of TCDD. Toxicity equivalents (TEQs) are then calculated to assess the risk of exposure to a mixture of dioxin-like compounds. A TEQ is defined as the product of the concentration (C) of an individual compound and the corresponding TCDD toxicity equivalency factor (TEF):

TEQ = (C)*(TEF) The total TEQs is the sum of all TEQs for each of the congeners in a given mixture [ATSDR 1998]. In this health consultation, the total TEQs are used to determine an SV for all dioxins and dioxin-like compounds detected.

Appendix A

Screening Value and Consumption Limit Calculations

For Noncarcinogenic Health Effects

$SV = [(MRL)(BW)]/CR$

SV = Screening value for a contaminant (in mg/kg or ppm)
MRL = Minimal risk level (in mg/kg/day)
BW = Mean body weight of the general population or subpopulation of concern (kg)
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

For Carcinogenic Health Effects

$SV_c = [(RL/SF)*BW]/CR$

SV_c = Screening value for a carcinogen (in mg/kg or ppm)
RL = Maximum acceptable risk level (1/100,000 dimensionless)
SF = Oral slope factor $(mg/kg/d)^{-1}$
BW = Mean body weight of the general population or subpopulation of concern (kg)
CR = Mean daily consumption rate of the species of interest by the general population or by the subpopulation of concern averaged over a 70-yr lifetime (in kg/day)

Consumption Rate Calculations for Non-Carcinogenic Health Effects

To calculate the maximum allowable fish consumption rate for a non-carcinogen:

$CR_{lim} = [(RfD)(BW)]/C_m$

Where:

CR_{lim} = maximum allowable fish consumption rate (kg/day)
RfD = reference dose (EPA) or minimal risk level (ATSDR)
BW = mean body weight of the general population or sub-population of concern (kg)
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg)

$CR_{mm} = [(CR_{lim})(T_{ap})]/MS$

Where:

CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 days/12 months = 30.44 days per month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions for Consumption Rate Calculations are as follows:

An average adult weighs 70 kg and eats 227 g of fish per meal.
An average child weighs 16 kg and eats 113 g of fish per meal.

Consumption Rate Calculations for Carcinogenic Health Effects

To calculate the maximum allowable fish consumption rate for a carcinogen:

$CR_{lim} = [(ARL)(BW)]/[(CSF)(C_m)]$

Where:

CR_{lim} = maximum allowable fish consumption rate (kg/day)
ARL = maximum acceptable risk level (dimensionless) = 1/100,000
BW = mean body weight of the general population or sub-population of concern (kg)
CSF = oral slope factor $(mg/kg/d)^{-1}$
C_m = measured concentration of chemical contaminant in a given species of fish (mg/kg)

$CR_{mm} = [(CR_{lim})(T_{ap})]/MS$

Where:

CR_{mm} = maximum allowable fish consumption rate (meals/month)
CR_{lim} = as calculated above
T_{ap} = time averaging period (365.25 days/12 months = 30.44 days per month)
MS = meal size (0.227 kg fish/meal for adults, 0.113 kg fish/meal for children)

Assumptions for Consumption Rate Calculations are as follows:

An average adult weighs 70 kg and eats 227 g of fish per meal.
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