

Health Consultation

AN EVALUATION OF CONTAMINANT CONCENTRATIONS IN FISH
FROM CUTLER RESERVOIR FOR 2003

CUTLER RESERVOIR, CACHE COUNTY, UTAH

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
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Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
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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

AN EVALUATION OF CONTAMINANT CONCENTRATIONS IN FISH FROM CUTLER
RESERVOIR FOR 2003

CUTLER RESERVOIR, CACHE COUNTY, UTAH

Prepared by:

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Office of Epidemiology
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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. Cutler Reservoir was one of the reservoirs selected for sampling as part of this national study.

Fish from Cutler Reservoir 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 Cutler Reservoir in Utah covering the year of 2003.

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.

Four channel catfish and three walleye were collected from Cutler Reservoir. Walleye were filleted and channel catfish were homogenized prior to composite analysis. Mercury, 4,4'-DDE, PCBs and one dioxin/furans were detected in walleye (Table 1). Mercury, nine pesticides, PCBs, and eight dioxin/furans were detected in channel catfish (Table 2). Mercury levels were not elevated in either species of fish from Cutler Reservoir; however, PCB levels were elevated in both catfish and walleye. Channel catfish had total PCB levels of 0.0723 mg/kg and walleye had PCB levels of 0.0231 mg/kg. Total dioxins/furans were also elevated in channel catfish with a total toxic equivalency concentration (TEQ) value of 3.4E-07 mg/kg. The cancer screening value for total TEQ is 2.56E-07 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) a 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 were elevated in fish collected from Cutler Reservoir, people consuming channel catfish and walleye from Cutler Reservoir 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 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. Channel catfish from Cutler Reservoir 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 Cutler Reservoir.

PCBs accumulate at higher concentrations in fatty tissues than in muscle tissue [ATSDR 2000]. The samples of catfish 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 catfish.

Limitations

Although fish from Cutler Reservoir 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. Whole body analysis is generally not realistic from a human health perspective, as the majority of Utah's population will be consuming only muscle tissue. For PCBs, 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. Therefore the total PCB result is an estimated value. The sample results for the dioxin and dioxin like compounds were also estimated values because the sample result reported was above the MDL (detection limit) but below the ML (quantitation limit).

Children's Health Considerations

The Agency of Toxic Substances and Disease Registry recognize 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

PCBs exceeded the screening values in walleye while dioxins/furans and PCBs exceeded the SVs in channel catfish from Cutler Reservoir. Concentrations of PCBs and dioxins/furans in fish from Cutler Reservoir were at levels that may pose a health risk to those who consume either walleye or channel catfish. Based on higher fish consumption rates, the potential for adverse health effects is higher for those consuming fish at a subsistence level. 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 in walleye or channel catfish from Cutler Reservoir are at concentrations of potential public health concern. Due to the limitations of the data quality, consumption of fish from Cutler Reservoir is considered an indeterminate health hazard.

Recommendations

The Utah Department of Health recommends that additional sampling of channel catfish and walleye and other game fish be conducted to further characterize the extent of the concentrations of PCBs and dioxins/furans in fish from Cutler Reservoir. 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 collaborate with the Utah Department of Environmental Quality, the Bear River Health Department, and the Utah Division of Wildlife Resources 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 collaborate 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 Bear River Health Department to monitor fishing at Cutler Reservoir to identify potential subsistence fisher populations affected by contaminants in fish from Cutler Reservoir.

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Certification

This Health Consultation, An Evaluation of Contaminant Concentrations in Fish From Cutler Reservoir for 2003, 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.

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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 walleye fillet composite samples from Cutler Reservoir, Utah (2003).

Analyte	Concentration (mg/kg)*	Non-Cancer Screening Value (mg/kg)	Cancer Screening Value (mg/kg)	SCC Code †
Mercury	0.113	0.3	NA	NA
4,4'-DDE **	0.00532	2.0	0.117	NA
Total PCBs	0.0231	0.08	0.02	J
2,3,7,8-TCDF	2E-07 (2E-08 TEQ)	§	§	NA
Total TEQ	2E-08	4E-06	2.56E-07	NA

* Wet weight concentrations of contaminants from composite analysis.

† J = Estimated value.

§TEQ = toxic equivalency concentration; Total TEQs are used to determine an SV for all dioxins and dioxin-like compounds detected.

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

Total PCBs based on the RfD for aroclor 1254

Table 2. Sampling data for chemicals detected in channel catfish homogenized composite samples from Cutler Reservoir, Utah (2003).

Analyte	Concentration (mg/kg)*	Non-Cancer Screening Value (mg/kg)	Cancer Screening Value (mg/kg)	SCC Code †
alpha-Chlordane	0.00278	†	†	J
4,4'-DDD	0.00269	**	**	NA
4,4'-DDE	0.0286	**	**	NA
2,4'-DDE	0.00208	**	**	NA
n-Hexadecane	0.1790	NA	NA	J
Mercury	0.127	0.3	NA	NA
cis-Nonachlor	0.00814	†	†	NA
trans-Nonachlor	0.00328	†	†	J
Oxychlordane	0.0025	†	†	J
Pentachloroanisole	0.00465	NA	NA	NA
Total Chlordane †	0.0167	2.0	0.114	NA
Total DDT ‡	0.03337	2.0	0.117	NA
Total PCBs §	0.0723	0.08	0.02	B, J
2,3,7,8-TCDD	9E-08 (9E-08 TEQ)	§	§	J
1,2,3,7,8-PECDD	1E-07 (1E-07 TEQ)	§	§	J
1,2,3,4,7,8-HXCDD	6E-08 (6E-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
2,3,7,8-TCDF	2E-07 (2E-08 TEQ)	§	§	NA
1,2,3,7,8-PECDF	6E-08 (3E-09 TEQ)	§	§	J
2,3,4,7,8-PECDF	2E-07 (1E-07 TEQ)	§	§	J
Total TEQ	3.4E-07	4E-06	2.56E-07	NA

* Wet weight concentrations of contaminants from composite analysis.

† B = Blank contamination; J = Estimated value. §TEQ = toxic equivalency concentration

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

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

‡Based on the RfD for total DDT isomers of DDT, DDE, and DDD [EPA 2000a]

§Total PCBs based on the RfD for aroclor 1254.

†EPA considers chlordane the sum of chlordane, oxychlordane, and trans-nonachlor [EPA 2000b].

Health guidelines are not available for n-hexadecane and pentachloroanisole.

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

Analyte	MRL/RfD (mg/kg/day)	Source	Screening Value (mg/kg)
Mercury*	0.0001	EPA RfD	0.3
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 n-hexadecane and pentachloroanisole.

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)
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: n-hexadecane, mercury, pentachloroanisole.

* EPA considers chlordane the sum of chlordane, oxychlordane, and trans-nonachlor [EPA 2000b].

† Based on EPA oral slope factor for DDT.

‡ Based on EPA oral slope factor for total PCBs.

Table 5. Dioxin and dioxin-like compound toxicities.

Walleye

Analyte	Concentration (mg/kg)	SCC Code	TEF [‡]	TEQ [‡] (mg/kg)
2,3,7,8-TCDF	2E-07	J	0.1	8E-09
Total TEQ =				8E-09

Channel catfish

Analyte	Concentration (mg/kg)	SCC Code	TEF [‡]	TEQ [‡] (mg/kg)
2,3,7,8-TCDD	9E-08	J	1	9E-08
1,2,3,7,8-PECDD	1E-07	J	1	1E-07
1,2,3,4,7,8-HXCDD	6E-08	J	0.1	6E-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
2,3,7,8-TCDF	2E-07	NA	0.1	2E-08
1,2,3,7,8-PECDF	6E-08	J	0.05	3E-09
2,3,4,7,8-PECDF	2E-07	J	0.5	1E-07
Total TEQ =				3.4E-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 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.

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