# Health Consultation

AN EVALUATION OF CONTAMINANT CONCENTRATIONS IN FISH FROM GUNLOCK RESERVOIR FOR 2000 AND 2005

GUNLOCK RESERVOIR, WASHINGTON COUNTY, UTAH

AUGUST 26, 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

**Health Consultation: A Note of Explanation**

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.

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

# HEALTH CONSULTATION

# AN EVALUATION OF CONTAMINANT CONCENTRATIONS IN FISH FROM GUNLOCK RESERVOIR FOR 2000 AND 2005

## GUNLOCK RESERVOIR, WASHINGTON COUNTY, UTAH


Prepared by:

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

# Table of Contents

## 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. Gunlock Reservoir was one of the reservoirs selected for sampling as part of this national study.

In 2000, fish from Gunlock Reservoir were collected and analyzed for chemical contaminants that included heavy metals, volatiles, semivolatiles, PCBs, dioxins, and furans. The sampling site is shown in Figure 1. The data from 2000 indicated that largemouth bass may have mercury concentrations at levels that may have an adverse effect on human health. Sport fishers would be the population affected by consuming mercury contaminated fish from this reservoir. The EEP is not aware of people using this site for subsistence fishing. Additional fish sampling was conducted in July 2005 by UDEQ to further characterize the mercury concentrations in largemouth bass from Gunlock Reservoir. This health consultation is an evaluation of chemical contaminants in fish from Gunlock Reservoir covering the period 2000 and 2005.

## Results

Fish Analysis for 2000

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.

Three channel catfish caught from Gunlock Reservoir were homogenized and analyzed as a composite. Mercury, PCBs, pesticides, and seven dioxins/furans were detected (Table 1). Five largemouth bass were collected from Gunlock Reservoir, filleted, and analyzed as a composite. Mercury, 4,-4'-DDE, and PCBs were the only chemicals detected in largemouth bass (Table 2). Mercury levels were 0.28 mg/kg for channel catfish and 0.32 mg/kg for largemouth bass. Mercury was the only chemical detected at elevated levels.

Fish Analysis for 2005

Based on the results for mercury in largemouth bass in 2000, more fish were collected and analyzed for mercury. Eight largemouth bass and three bluegill were collected from Gunlock reservoir in June 2005 and analyzed for mercury levels (Tables 3 and 4). Fish from 2005 were analyzed individually and only the fillet portions were analyzed. Largemouth bass had a wet weight mercury range of 0.22 mg/kg to 0.95 mg/kg with an average value of 0.47 mg/kg. Bluegill samples ranged from 0.11 mg/kg to 0.26 mg/kg with an average of 0.20 mg/kg. Mercury levels were only detected at elevated levels in largemouth bass.

## Discussion

Adults and children that consume largemouth bass from Gunlock Reservoir are at risk of being exposed to mercury. 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) an exposed 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]. People consuming largemouth bass from Gunlock Reservoir is considered a completed exposure pathway since all five elements exist and exposure is occurring.

Non-Carcinogenic Effects

*Mercury*

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].

The amount of mercury in fish tissue tends to increase with the age and size of the fish. Fish-eating species of fish also accumulate higher concentrations of mercury than non-piscivorous fish [EPA 2000b]. The largemouth bass in this report are considered predatory fish and therefore may accumulate higher amounts of mercury than the bottom-dwelling channel catfish.

In fish tissue, the majority of mercury is methylmercury. Methylmercury is rapidly absorbed from the gastrointestinal tract. The body absorbs about 90 to 100 percent of ingested methylmercury. Methylmercury can be changed by your body to inorganic mercury. When this

happens in the brain, the mercury can remain there for a long time. When methylmercury does leave your body after you have been exposed, it leaves slowly over a period of several months, mostly as inorganic mercury in the feces. The biological half-life of methylmercury in humans is roughly 50 to 65 days. The half-life is a measure of rate for the time required to eliminate one half of a quantity of a chemical from the body. As with inorganic mercury, some of the methylmercury in a nursing woman's body will pass into her breast milk [ATSDR 1999].

Results of the 2000 mercury concentrations in fish from Gunlock Reservoir were compared to the SV. The SV for mercury is 0.3 milligrams mercury per kilogram fresh fish weight (mg/kg) [EPA 2000a]. Largemouth bass from Gunlock Reservoir were the only fish samples that exceeded the SV for mercury.

Five out of the eight largemouth bass collected in June 2005 exceeded the SV for mercury of 0.3 mg/kg. All three bluegill samples analyzed were below the 0.3 mg/kg mercury SV value.

The nervous system is very sensitive to all forms of mercury. In poisoning incidents that occurred in other countries, some people who ate fish contaminated with large amounts of methylmercury or seed grains treated with methylmercury or other organic mercury compounds developed permanent damage to the brain and kidneys. Animals exposed orally to long-term, high levels of methylmercury or phenylmercury in laboratory studies experienced damage to the kidneys, stomach, and large intestine; changes in blood pressure and heart rate; adverse effects on the developing fetus, sperm, and male reproductive organs; and increases in abortions and stillbirths [ATSDR 1999].

The Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA) are advising women who may become pregnant, pregnant women, nursing mothers, and young children to avoid some types of fish and to only eat fish and shellfish that are lower in mercury [EPA 2004b]. The types of fish to avoid include shark, swordfish, king mackerel or tilefish because they contain high levels of mercury. Up to 12 ounces (2 average meals) a week of a variety of fish and shellfish can be eaten that are lower in mercury. The most commonly eaten fish that are low in mercury are shrimp, canned light tuna, salmon, pollock and catfish. Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. Up to 6 ounces (one average meal) of albacore tune can be eaten per week. The state of Utah currently has no fish advisories for mercury.

Consumption Limits

When SVs are exceeded, consumption limits can be estimated to determine how many meals of fish can be safely consumed each month [EPA 2000b]. Calculations are based on an adult body weight of 70 kg with a meal size of 227 g fish and a child body weight of 16 kg with a meal size of 113 g of fish (Appendix A).

Based on an average mercury concentration of 0.47 mg/kg in largemouth bass, adults can safely eat 2 eight ounce meals per month; and women who may become pregnant, pregnant women, nursing mothers, and young children can eat 1 four ounce meal per month of largemouth bass from Gunlock Reservoir.

Samples of channel catfish did not exceed the non-carcinogenic or the carcinogenic screening values for any of the contaminants detected. Consumption limits were therefore not calculated for channel catfish.

Samples of bluegill did not exceed the non-carcinogenic screening value for mercury. Consumption limits were therefore not calculated for bluegill.

## 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 may sustain permanent damage if toxic exposures occur during critical growth stages. Children's health was considered as a part of this health consultation.

Very young children may be more sensitive to mercury than adults. Mercury in the mother's body passes to the fetus and may accumulate there. It can also pass to a nursing infant through breast milk. However, the benefits of breast-feeding may be greater than the possible adverse effects of mercury in breast milk. Mercury's harmful effects that may be passed from the mother to the fetus include brain damage, mental retardation, incoordination, blindness, seizures, and inability to speak. Children poisoned by mercury may develop problems of their nervous and digestive systems, and kidney damage [ATSDR 1999].

Due to the possible health effects from chemical contaminants on the fetus, pregnant women should follow the consumption limits assigned to children.

## Conclusions

Largemouth bass collected from Gunlock Reservoir have levels of mercury that may result in a risk of adverse health effects. Based on higher fish consumption rates, the potential for adverse health effects is higher for those consuming fish at a subsistence level. The EEP is not aware of people using this site for subsistence fishing. Based on the nature of the contaminant, it is highly likely that exposure has occurred, continues to occur, and will exist in the future for those people that catch and consume largemouth bass from the site. The route of exposure is through ingestion of contaminated fish. Consumption of largemouth bass from Gunlock Reservoir above the consumption advisory limit is considered a public health hazard based on concentrations of mercury in this species of fish.

Fish consumption of largemouth bass from Gunlock Reservoir should be limited to 2 eight ounce meals per month for adults and 1 four ounce meal per month for women who may become pregnant, pregnant women, nursing mothers, and young children.

## Recommendations

The Environmental Epidemiology Program recommends a fish advisory for Gunlock Reservoir because of the levels of mercury detected in largemouth bass. Fish consumption of largemouth bass from Gunlock Reservoir should be limited to 2 eight ounce meals per month for adults and 1 four ounce meal per month for women who may become pregnant, pregnant women, nursing mothers, and young children.

The EEP recommends that concentrations of mercury, PCBs, pesticides and other chemicals continue to be monitored in game fish from Gunlock Reservoir.

## 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 Southwest Utah Public Health Department to notify the public of the findings of this health consultation. A press release and fact sheet will be prepared to inform the public of the fish consumption advisory. A copy of this health consultation and the fish advisory will be posted on the EEP 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 Southwest Utah Public Health Department to monitor fishing at Gunlock Reservoir to identify potential subsistence fisher populations affected by mercury in fish from Gunlock Reservoir.

## Authors

**Report Prepared By:**

D. Jason Scholl, Ph.D., Toxicologist
Environmental Epidemiology Program
Office of Epidemiology
Utah Department of Health

**Designated Reviewer:**

R. Wayne Ball, Ph.D., DABT, Toxicologist
Environmental Epidemiology Program Manager
Office of Epidemiology
Utah Department of Health

## Certification

This Health Consultation, An Evaluation of Contaminant Concentrations in Fish from Gunlock Reservoir for 2000 and 2005, 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 cooperative agreement partner.

Charisse Walcott
Technical Project Officer
Division of Health Assessment and Consultation
ATSDR

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

Alan Yarbrough
Cooperative Agreement Team Leader
Division of Health Assessment and Consultation
ATSDR

## References

Agency for Toxic Substances and Disease Registry (ATSDR). 1999. Toxicological profile for mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Public Health Assessment Guidance Manual (Update). January 2005.

Environmental Protection Agency. 2000a. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis; 3rd ed. Washington. Publication No. EPA 823-B-00-007.

Environmental Protection Agency. 2000b. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits; 3rd ed. Washington. Publication No. EPA 823-B-00-008.

Environmental Protection Agency. 2004a. Fact Sheet: 2004 Update. The National Study of Chemical Residues in Lake Fish Tissue. Publication No. EPA-823-F-04-021. www.epa.gov/waterscience/fishstudy/

Environmental Protection Agency. 2004b. What You Need to Know about Mercury in Fish and Shellfish. Publication No. EPA-823-F-04-009. Accessed from the internet from: http://www.epa.gov/waterscience/fishadvice/advice.html

Figures and Tables

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

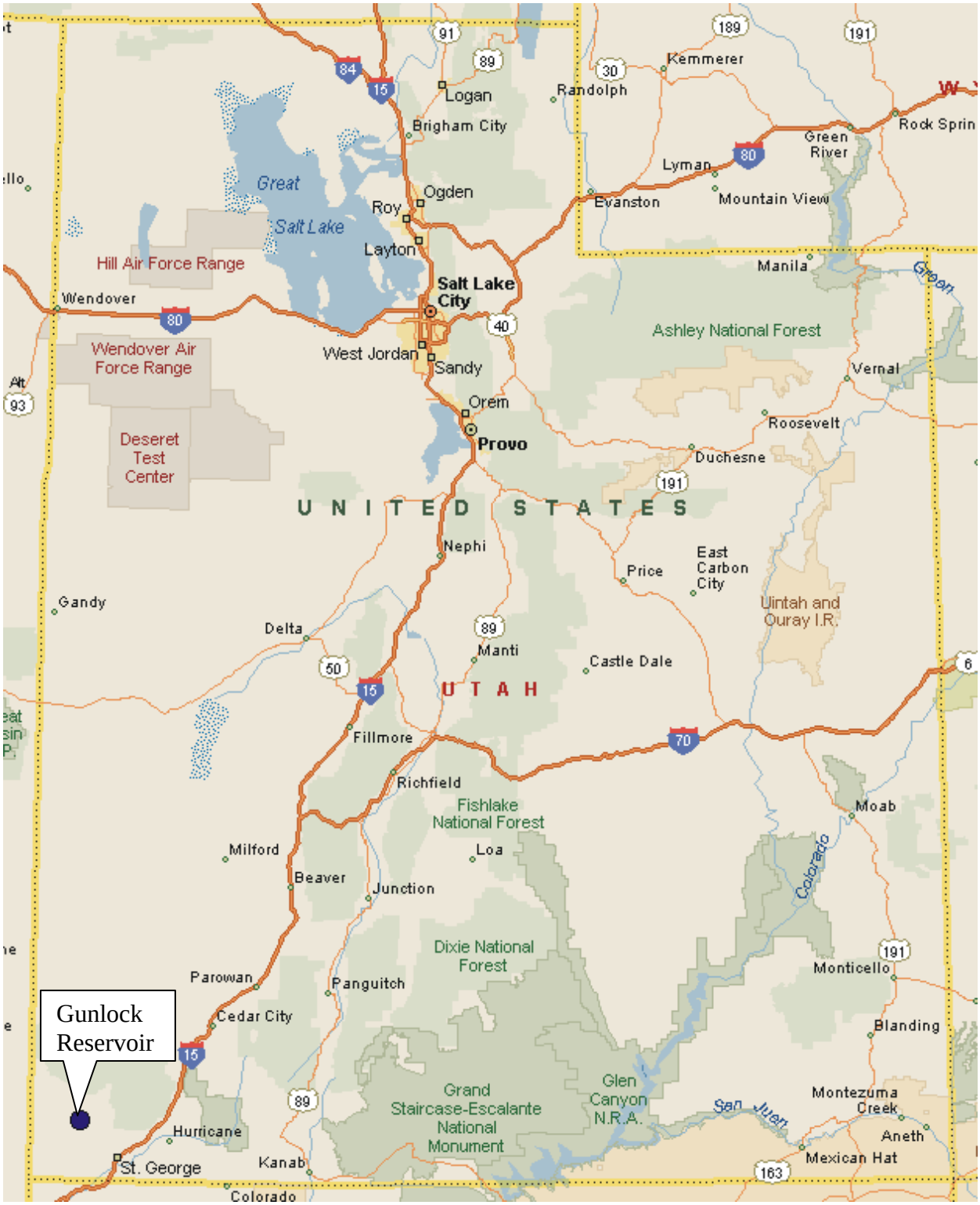

**Table 1. Sampling data for chemicals detected in channel catfish whole fish composite samples from Gunlock Reservoir, Utah (2000).**

| Analyte | Concentration (mg/kg)* | Non-Cancer Screening Value (mg/kg) | Cancer Screening Value (mg/kg) | SCC Code† |
|---|---|---|---|---|
| 4,-4'-DDE | 0.012 | 2.0 | 0.117 | NA |
| Mercury | 0.28 | 0.3 | NA | NA |
| Total PCBs | 0.0072 | 0.08 | 0.02 | B, J |
| trans-Nonachlor | 0.0020 | 2.0 | 0.114 | J |
| Trifluralin | 0.0058 | 30 | 5.2 | J |
| | | | | |
| 1,2,3,4,7,8-HXCDF | 5E-08 (5E-09 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 1,2,3,6,7,8-HXCDD | 1E-07 (1E-08 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 1,2,3,7,8-PECDD | 1E-07 (1E-07 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 1,2,3,7,8-PECDF | 7E-08 (4E-09 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 2,3,4,7,8-PECDF | 1E-07 (4E-09 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 2,3,7,8-TCDD | 5E-08 (5E-08 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | J |
| 2,3,7,8-TCDF | 1E-07 (1E-08 TEQ) | 4E-06 TEQ | 2.56E-07 TEQ | NA |
| Total TEQ‡ | 2E-07 | 4E-06 TEQ | 2.56E-07 TEQ | NA |

Fish samples collected by Utah Department of Environmental Quality.
* Wet weight concentrations of contaminants from composite analysis.
† B = Blank contamination; J = Estimated value.
‡ TEF = toxicity equivalency factor; TEQ = toxic equivalency concentration; See Table 7 for explanation of dioxin and dioxin-like compound toxicities.

**Table 2. Sampling data for chemicals detected in largemouth bass fillet composite samples from Gunlock Reservoir, Utah (2000).**

| Analyte | Concentration (mg/kg)* | Non-Cancer Screening Value (mg/kg) | Cancer Screening Value (mg/kg) | SCC Code† |
|---|---|---|---|---|
| 4,-4'-DDE | 0.00087 | 2.0 | 0.117 | J |
| Mercury | **0.32** | 0.3 | NA | NA |
| Total PCBs | 0.00053 | 0.08 | 0.02 | B, J |

Fish samples collected by Utah Department of Environmental Quality.
Values that exceed the SV are shown in bold.
* Wet weight concentrations of contaminants from composite analysis.
† B = Blank contamination; J = Estimated value.

**Table 3. Mercury results for individual largemouth bass fillet samples from Gunlock Reservoir, Utah (June 2005).**

| Sample | Mercury concentration (mg/kg)* | ACZ Code |
|---|---|---|
| LB-01 | **0.85** | NA |
| LB-02 | **0.38** | NA |
| LB-03 | **0.39** | NA |
| LB-04 | **0.32** | NA |
| LB-05 | **0.95** | NA |
| LB-06 | 0.22 | NA |
| LB-07 | 0.27 | NA |
| LB-08 | **0.41** | NA |
| Average = | **0.47** | |

Fish samples collected by Utah Department of Environmental Quality.
Values that exceed the SV are shown in bold.
* Wet weight concentration.

**Table 4. Mercury results for individual bluegill fillet samples from Gunlock Reservoir, Utah (June 2005).**

| Sample | Mercury concentration (mg/kg)* | ACZ Code† |
|---|---|---|
| BG-01 | 0.26 | NA |
| BG-02 | 0.11 | B |
| BG-03 | 0.22 | NA |
| Average = | 0.20 | |

Fish samples collected by Utah Department of Environmental Quality.
* Wet weight concentration.
† B = Analyte concentration detected at a value between the MDL and PQL.

**Table 5. 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 |
| 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
SVs based on body weights and fish consumption rates as described in Appendix A.
* 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 6. Carcinogen screening value calculations for chemicals detected.**

| Analyte | Oral Slope Factor $(mg/kg/day)^{-1}$ | Screening Value (mg/kg) |
|---|---|---|
| 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 A.
There are no EPA Oral Slope Factor values for the following detected chemicals: mercury and TEQs.
* EPA considers chlordane the sum of chlordane, oxychlordane, and trans-nonachlor [EPA 2000b].

**Table 7. Dioxin and dioxin-like compound toxicities.**

| **Channel catfish** | | | |
|---|---|---|---|
| Analyte | Concentration (mg/kg) | TEF | TEQ (mg/kg) |
| 1,2,3,4,7,8-HXCDF | 5E-08 | 0.1 | 5E-09 |
| 1,2,3,6,7,8-HXCDD | 1E-07 | 0.1 | 1E-08 |
| 1,2,3,7,8-PECDD | 1E-07 | 1 | 1E-07 |
| 1,2,3,7,8-PECDF | 7E-08 | 0.05 | 4E-09 |
| 2,3,4,7,8-PECDF | 1E-07 | 0.5 | 4E-09 |
| 2,3,7,8-TCDD | 5E-08 | 1 | 5E-08 |
| 2,3,7,8-TCDF | 1E-07 | 0.1 | 1E-08 |
| | | Total TEQ = | 2E-07 |

**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

## 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:

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

| **Largemouth bass** | RfD | BW | $C_m$ | $CR_{lim}$ |
|---|---|---|---|---|
| Adult | 0.0001 | 70 | 0.47 | 0.0149 |
| Child | 0.0001 | 16 | 0.47 | 0.0034 |

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)

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

| **Largemouth bass** | $CR_{lim}$ | $T_{ap}$ | MS | $CR_{mm}$ |
|---|---|---|---|---|
| Adult | 0.0149 | 30.44 | 0.227 | 2.0 |
| Child | 0.0034 | 30.44 | 0.113 | 0.9 |

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.