Characterization of Potential Adverse Health Effects Associated with Consuming Fish from

Mountain Creek Lake

Dallas County, Texas

2016

Department of State Health Services
Division for Regulatory Services
Policy, Standards, and Quality Assurance Unit
Seafood and Aquatic Life Group
Austin, Texas

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LIST OF ACRONYMS

ARL	Acceptable Lifetime Risk Level
ATSDR	Agency for Toxic Substances and Disease Registry
BDL	Below Detection Limit
BMD	Benchmark Dose
BMDL	Benchmark Dose (Lower Confidence Limit)
ca	Cancer
CDC	Centers for Disease Control
CPF	Cancer Potency Factor
CSF	Cancer Slope Factor
DDD	Dichlorodiphenyldichloroethane
DDE	Dichlorodiphenyldichloroethylene
DDT	Dichlorodiphenyltrichloroethane
dL	Deciliter
DSHS	Department of State Health Services
g	Gram
GC	Gas Chromatograph
GERG	Geochemical and Environmental Research Group
GSMFC	Gulf States Marine Fisheries Commission
HAC	Health Assessment Comparison
HCH	Hexachlorocyclohexane
HI	Hazard Index
HQ	Hazard Quotient
in	Inches
IH	Interstate Highway
IRIS	Integrated Risk Information System
kg	Kilogram
lb	Pound
LOAEL	Lowest Observed Adverse Effects Level
MCL	Mountain Creek Lake
mcg	Microgram
mg	Milligram
mm	Millimeter
MRL	Minimal Risk Level
MS	Mass spectrometer
n	Sample Size
ND	Not Detected
NOAA	National Oceanic and Atmospheric Administration
NOAEL	No Observed Adverse Effects Level
nonca	Noncancer
p	Statistical Significance in a Hypothesis Test
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-p-Dioxin

LIST OF ACRONYMS CONT.

PCDF	Polychlorinated Dibenzofuran
pg	picogram
r	Correlation Coefficient
r^2	Coefficient of Determination
RfD	Reference Dose
RL	Reporting Limit
SALG	Seafood and Aquatic Life Group
SOP	Standard Operating Procedure
SSD	Seafood Safety Division
SVOC	Semivolatile Organic Compound
TCEQ	Texas Commission on Environmental Quality
TDH	Texas Department of Health
TEF	Toxicity Equivalence Factor
TEQ	Toxicity Equivalence
TL	Total Length
TMDL	Total Maximum Daily Load
TNRCC	Texas Natural Resources Conservation Commission
TPWD	Texas Parks and Wildlife Department
UL	Intake Level
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
$\bar{X}$	Mean

SUMMARY

Surveys of Mountain Creek Lake, Grand Prairie, Texas in 1995, 2001, 2002, 2003, and 2008 indicated that polychlorinated biphenyl (PCB) concentrations in fish exceeded Texas Department of State Health Service (DSHS) guidelines for protection of human health. From 1996–2010, the Texas Department of Health prohibited possession of fish from Mountain Creek Lake. Concentrations of PCBs decreased substantially from 1995 levels that led DSHS to prohibited possession of fish from Mountain Creek Lake. In 2010, DSHS rescinded the prohibited area and issued a fish consumption advisory. Since 2010, the DSHS has recommended that people do not eat fish from Mountain Creek Lake.

In 2015, the DSHS performed this study to investigate any potential change in fish tissue contamination in Mountain Creek Lake. The present study examined fish from Mountain Creek Lake for the presence and concentrations of environmental toxicants that, if eaten, potentially could negatively affect human health. The study also addresses the public health implications of consuming fish from Mountain Creek Lake and suggests actions to reduce potential adverse health outcomes.

Results of the 2015 survey indicate that PCB and dioxin concentrations in channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass continue to exceed DSHS guidelines for protection of human health. Confidence in the conclusions for many species of fish is limited by the small sample size. Sampling a small number of fish (i.e., individual species of fish or all fish species combined) decreases the confidence of mean contaminant concentrations for the fish population thus adding uncertainty to the conclusions.

Conclusions

- Regular or long-term consumption of channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass may result in adverse noncarcinogenic health effects. Therefore, consumption of these species of fish from Mountain Creek Lake **poses an apparent risk to human health**.

- Regular or long-term consumption of common carp, freshwater drum, and smallmouth buffalo may increase the likelihood of carcinogenic health risks. Therefore, consumption of these species of fish from Mountain Creek Lake **poses an apparent risk to human health**.

Recommendations

- People should not consume common carp, freshwater drum, and smallmouth buffalo from Mountain Creek Lake (Table 10).

- Women of childbearing age (Women and girls under 50) including pregnant women, women who may become pregnant, and women who are nursing infants and children less than 12 years of age, or who weigh less than 75 pounds should not consume channel catfish, common carp, freshwater drum, smallmouth buffalo, and white bass from Mountain Creek Lake.

- Women of childbearing age (Women and girls under 50) including pregnant women, women who may become pregnant, and women who are nursing infants and children less than 12 years of age, or who weigh less than 75 pounds may consume up to one four-ounce meal per month of flathead catfish **or** largemouth bass from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to one eight-ounce meal per month of channel catfish **or** white bass from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to two eight-ounce meals per month of flathead catfish from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to three eight-ounce meals per month of largemouth bass from Mountain Creek Lake.

- As resources become available, the DSHS should continue to monitor fish from Mountain Creek Lake for changes and establish trends in contaminants of concern or contaminant concentrations that would require a change in consumption advice.

INTRODUCTION

This document summarizes the results of a survey of Mountain Creek Lake conducted in 2015 by the Texas Department of State Health Services (DSHS) Seafood and Aquatic Life Group (SALG).[a] The SALG performed this study to investigate any potential change in fish tissue contamination in Mountain Creek Lake. The present study examined fish from Mountain Creek Lake for environmental toxicants to determine if adverse health effects are likely following fish consumption. The report also addresses the public health implications of consuming fish from Mountain Creek Lake and suggests actions to reduce potential adverse health outcomes.

History of the Mountain Creek Lake Fish Consumption Advisory

In 1994, the United States Geological Survey (USGS), contracted by the United States Navy (USN), conducted a study to determine if people regularly consume fish from Mountain Creek

[a] The terms DSHS and SALG may be used interchangeably throughout this document and mean the same agency.

Lake and to also determine that if fish were regularly consumed from Mountain Creek Lake what species did fishers consume. The results of the study showed that people regularly fish Mountain Creek Lake and that fishers were likely to consume channel catfish, common carp, and largemouth bass from the lake.[1] As part of the aforementioned study, the USGS examined several composite samples of fish from Mountain Creek Lake for selected contaminants. That preliminary examination revealed contaminants at concentrations of concern to the Texas Department of Health (TDH)[b], the Texas Natural Resources Conservation Commission (TNRCC)[c], and the United States Environmental Protection Agency (USEPA).

In July 1995, after consulting with TDH, TNRCC, USEPA, the USN, and other interested parties, the USGS conducted a comprehensive survey of contaminants in largemouth bass, common carp, and channel catfish from Mountain Creek Lake. This investigation showed widespread contamination of fish from Mountain Creek Lake due to polychlorinated biphenyls (PCBs) and organochlorine pesticides at concentrations exceeding TDH guidelines for protection of human health.[2]

On April 25, 1996, the Commissioner of Health for the State of Texas issued Aquatic Life Order Number 12 (AL-12) prohibiting possession of fish taken from Mountain Creek Lake in Dallas County, Texas.[3] The order did not prohibit catch-and-release fishing from the lake.

In August 2002, based upon two small datasets of fish from Mountain Creek Lake collected in 2001 and 2002, the TDH determined that a full-scale reevaluation of fish from this reservoir was necessary to determine whether consumption of fish from Mountain Creek Lake continues to pose a risk to public health.[4] Therefore, in 2003, the TDH funded by the USN, collected and evaluated 30 fish samples from Mountain Creek Lake to determine the likelihood that consumption of fish from this reservoir continue to pose a hazard to public health. The results of this investigation revealed that PCBs continue to pose an unacceptable health risk.[5] Based on these results, the TDH recommended to continue the possession ban issued in 1996.

In 2008, at the request of the TCEQ, as a part of its Total Maximum Daily Load (TMDL) 5-year follow-up program, the Texas Department of State Health Services (DSHS) Seafood and Aquatic Life Group (SALG) collected fish from the Mountain Creek Lake to reevaluate the extant Mountain Creek Lake prohibited area. The 2008 study was expanded to include additional study sites and to include an additional target analyte, polychlorinated dibenzofurans and/or dibenzo-p-dioxins (PCDFs/PCDDs), that the DSHS assessed in Mountain Creek Lake fish. The DSHS have not examined PCDFs/PCDDs in previous fish contaminant studies of Mountain Creek Lake. Currently, DSHS fish sampling procedures include PCDFs/PCDDs in its target analyte list or suite of contaminants that DSHS routinely analyzes in fish.

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[b] Now the Department of State Health Services (DSHS)
[c] Now the Texas Commission on Environmental Quality (TCEQ)

The 2008 survey of Mountain Creek Lake revealed the presence of PCBs at concentrations exceeding DSHS guidelines for protection of human health (0.047 mg/kg). Smallmouth buffalo PCDF/PCDD concentrations also exceeded DSHS guidelines for protection of human health (2.330 pg/g). [6] Regular or long-term consumption of fish from Mountain Creek Lake may result in adverse health effects. Concentrations of PCBs have decreased substantially from 1995 that led to the issuance of AL-12. Therefore, the DSHS risk assessors recommended the rescission of AL-12 for Mountain Creek and the issuance of a fish consumption advisory instead of prohibiting possession of fish from Mountain Creek Lake. The DSHS issued Fish and Shellfish Consumption Advisory 44 (ADV-44) [7] and AL-18[8] (to rescind AL-12) on October 1, 2010 advising people not to consume fish from Mountain Creek Lake.

The TMDL Program at the TCEQ and the Relationship between the TMDL Program and Consumption Advisories or Possession Bans Issued by the DSHS

The TCEQ enforces federal and state laws that promote judicious use of water bodies under state jurisdiction and protects state-controlled water bodies from pollution. Pursuant to the federal Clean Water Act, Section 303(d),[9] all states must establish a "total maximum daily load" (TMDL) for each pollutant contributing to the impairment of a water body for one or more designated uses. A TMDL is the maximum amount of a pollutant that a body of water can assimilate and still meet water quality standards.[10] TMDLs incorporate margins of safety to ensure the usability of the water body for all designated purposes. States, territories, and tribes define the uses for a specific water body (e.g., drinking water, contact recreation, aquatic life support) along with the scientific criteria designated to support each specified use.

Fish consumption is a recognized use for many waters. A water body is impaired if fish from the water body contain contaminants that make those fish unfit for human consumption or if consumption of those contaminants potentially could harm human health. Although a water body and its aquatic life may clear toxicants over time with removal of the source(s), it is often necessary to institute some type of remediation such as those implemented by the TCEQ. Thus, whenever the DSHS issues a fish consumption advisory or prohibits possession of environmentally contaminated fish, the TCEQ places the water body in its current *Texas Integrated Report of Surface Water Quality* formerly called the Texas Water Quality Inventory and 303(d) List.[11] The TCEQ is responsible for confirming the impairment and, if necessary, the TMDL program, then prepares a TMDL for each contaminant present that, if consumed, would be capable of negatively affecting human health. After approval of the TMDL, the stakeholders in the watershed prepare an Implementation Plan for each contaminant. These plans are designed to facilitate the rehabilitation of the water body over time. Successful remediation should result in return of the water body to conditions compatible with all stated uses, including consumption of fish from the water body. When the DSHS lifts a consumption advisory or possession ban, people may once again keep and consume fish from the water body. If fish in a water body are contaminated, one of the several items on an Implementation Plan for a water body on a state's 303(d) List consists of the periodic reassessment of contaminant levels in resident fish.

Description of Mountain Creek Lake

Mountain Creek Lake, a 2,493-acre reservoir, was constructed in 1937 by Dallas Power and Light (now Texas Utilities) to serve as a cooling pond for an electric generating power plant.[12, 13] The reservoir is located in Dallas County southeast of Grand Prairie, Texas on Mountain Creek, a tributary of the West Fork Trinity River. The Mountain Creek watershed is composed primarily of industrial and residential development. The northwest side of the reservoir is bordered by a decommissioned naval air station (NAS; the property is currently owned by the City of Dallas) and a naval weapons industrial reserve plant (NWIRP). Mountain Creek Lake is turbid and shallow, with an average depth of 8.5 feet and maximum depth of 26 feet.[12] The shoreline fishery habitat is primarily rip-rap and native emergent vegetation. Public access is limited to an undeveloped park and boat ramp on the east side of the reservoir and Mountain Creek Lake Park[14] operated by the City of Grand Prairie, Texas on the west side of the reservoir.

Population of Dallas County Surrounding Mountain Creek Lake

Dallas County is part of the Dallas-Fort Worth-Arlington metropolitan area, locally referred to as the "The Metroplex". The Metroplex is the largest metropolitan area in the state of Texas and the fourth largest in the United States. In 2014, according to the United States Census Bureau's (USCB) estimate, the 12 county Dallas-Fort Worth-Arlington metropolitan area has a population near 6,954,330.[15] The USCB also reported that the Dallas-Fort Worth-Arlington metropolitan area as the second fastest growing metropolitan area in the United States, which gained 528,120 residents from April 1, 2010 to July 1, 2014.[15] The Metroplex covers approximately 9,286 square miles; an area larger than the combined states of Connecticut and Rhode Island.

Subsistence Fishing at Mountain Creek Lake

The USEPA suggests that, along with ethnic characteristics and cultural practices of an area's population, the poverty rate could contribute to any determination of the rate of subsistence fishing in an area.[16] The USEPA and the DSHS find it is important to consider subsistence fishing to occur at any water body because subsistence fishers (as well as recreational anglers and certain tribal and ethnic groups) usually consume more locally caught fish than the general population. These groups sometimes harvest fish or shellfish from the same water body over many years to supplement caloric and protein intake. People, who routinely eat fish from chemically contaminated bodies of water or those who eat large quantities of fish from the same waters, could increase their risk of adverse health effects. The USEPA suggests that states assume that at least 10% of licensed fishers in any area are subsistence fishers. Subsistence fishing, while not explicitly documented by the DSHS, likely occurs in Texas. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.

METHODS

Fish Sampling, Preparation, and Analysis

The DSHS SALG collects edible fish from the state's public waters and evaluates the potential risks to the health of people consuming contaminated fish or shellfish. Fish tissue sampling follows standard operating procedures described in *Texas Fish Consumption Advisory Program Standard Operating Procedures Field Operations and Data Quality.*[17] The SALG bases its sampling and analysis protocols, in part, on procedures recommended by the USEPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1.*[18] Advice and direction are also received from the Fish Sampling Advisory Subcommittee of the legislatively mandated Texas Toxic Substances Coordinating Committee.[19] Samples usually represent species, trophic levels, and legal-sized specimens available for consumption from a water body. When practical, the DSHS collects samples from two or more sites within a water body to better characterize geographical distributions of contaminants.

Fish Sampling Methods and Description of the Mountain Creek Lake 2014 Sample Set

In November 2015, the SALG collected 80 fish samples from seven sample sites to provide spatial coverage of the study area (Figure 1): Site 1 Mountain Creek Lake (MCL) at the Cottonwood Cove; Site 2 MCL near Cottonwood Cove canal; Site 3 MCL near Cooperation Lane; Site 4 MCL near the dam; Site 5 MCL near the power plant intake; Site 6 MCL near the power plant outfall; and, Site 7 MCL near Mountain Creek. Species collected represent distinct ecological groups (i.e., predators and bottom-dwellers) that have some potential to bio-accumulate chemical contaminants, have a wide geographic distribution, are of local recreational fishing value, and/or that anglers and their families commonly consume. The 80 fish collected from Mountain Creek Lake represent all species targeted for collection from this water body (Table 1). The list below contains the number of each target species, listed in descending order collected for this study: channel catfish (20); largemouth bass (20); white crappie (10); freshwater drum (8); white bass (8); smallmouth buffalo (7); common carp (4); and, flathead catfish (3).

The survey team set gill nets at sample sites 1–7 in late afternoon (Figure 1); fished the sites overnight, and collected samples from the nets early the following morning. The gill nets were set at locations to maximize available cover and habitat at each sample site. During collection, to keep specimens from different sample sites separated, the team placed samples from each site into mesh bags labeled with the site number. The survey team immediately stored retrieved samples on wet ice in large coolers to ensure interim preservation. Survey team members returned to the reservoir any live fish culled from the catch and properly disposed of samples found dead in the gill nets.

The SALG utilized a boat-mounted electrofisher to collect fish. The SALG staff conducted electrofishing activities during daylight hours using pulsed direct current (Smith Root 7.5 GPP electrofishing system settings: 6.0-8.0 amps, 60 pulses per second [pps], low range, 500 volts, 40-50% duty cycle) to stun fish that crossed the electric field in the water in front of the boat. Staff used dip nets over the bow of the boat to retrieve stunned fish, netting only fish pre-selected as target samples. Staff immediately stored retrieved samples on wet ice in large coolers to enhance tissue preservation.

The SALG staff processed fish onsite at MCL. Staff weighed each sample to the nearest gram (g) on an electronic scale and measured total length (TL; tip of nose to tip of tail fin) to the nearest millimeter (mm; Table 1). All TL measurements were converted to inches for use in this report. After weighing and measuring a fish, staff used a cutting board covered with aluminum foil and a fillet knife to prepare two skin-off fillets from each fish. The foil was changed and knife cleaned with distilled water after each sample was processed. The SALG staff wrapped fillet(s) in two layers of fresh aluminum foil, placed in an unused, clean, pre-labeled plastic freezer bag, and stored on wet ice in an insulated chest until further processing. The SALG staff transported tissue samples on wet ice to their Austin, Texas headquarters, where the samples were stored temporarily at -5° Fahrenheit (-20° Celsius) in a locked freezer. The freezer key is accessible only to authorized SALG staff members to ensure chain of custody while samples are in the possession of agency staff. The SALG delivered the frozen fish tissue samples to the Geochemical and Environmental Research Group (GERG) Laboratory, Texas A&M University, College Station, Texas, for contaminant analysis.

Fish Age Estimation

The SALG staff removed sagittal otoliths from channel catfish, flathead catfish, largemouth bass, white bass, and white crappie samples for age estimation following otolith extraction procedures recommended by the Gulf States Marine Fisheries Commission (GSMFC) and Texas Parks and Wildlife Department (TPWD) unpublished procedures.[20, 21] Staff performed all otolith extractions on each fish sample after the preparation of the two skin-off fillets for chemical contaminant analysis. Following extraction, staff placed otoliths in an individually labeled coin envelope and then in a plastic freezer bag to transport to their Austin, Texas headquarters. Staff processed otoliths and estimated ages according to procedures recommended by the GSMFC and TPWD.[20, 21]

Analytical Laboratory Information

The GERG personnel documented receipt of the 80 Mountain Creek Lake samples and recorded the condition of each sample along with its DSHS identification number. Using established USEPA methods,[22] the GERG laboratory analyzed fish fillets from Mountain Creek Lake for inorganic and organic contaminants commonly identified in polluted environmental media. Analyses included seven metals (arsenic, cadmium, copper, lead, total mercury, selenium, and zinc), 123 semivolatile organic compounds (SVOCs), 70 volatile organic compounds (VOCs), 34 pesticides, 209 PCB congeners,[d, 23] and 17 polychlorinated dibenzo-*p*-dioxins and/or dibenzofurans (PCDDs/PCDFs) congeners.[24] The laboratory analyzed all 80 samples for mercury, PCBs and PCDDs/PCDFs. A subset of 16 of the original 80 samples was analyzed for the following contaminant groups: metals, pesticides, SVOCs, and VOCs. The SALG risk assessors selected the subset of samples based on target species and size class selection procedures outlined in SALG standard operating procedures (SOPs). In addition to SALG SOPs, if available, the SALG risk assessors use TPWD creel surveys to determine the species of fish most frequently harvested from the body of water and choose large specimens of the selected species of fish. The SALG risk assessors choose large fish to assess conservatively contaminant exposure when evaluating small sample sizes.

Details of Some Analyses with Explanatory Notes

Arsenic

The GERG laboratory analyzed five fish samples for total (inorganic arsenic + organic arsenic = total arsenic) arsenic. Although the proportions of each form of arsenic may differ among fish species, under different water conditions, and, perhaps, with other variables, the scientific literature suggests that well over 90% of arsenic in fish is likely organic arsenic – a form of arsenic that is virtually non-toxic to humans.[25] The DSHS, taking a conservative approach, estimated 10% of the total arsenic in any fish is inorganic arsenic and derived estimates of inorganic arsenic concentration in each fish by multiplying the reported total arsenic concentration in the sample by a factor of 0.1.

Mercury

Nearly all mercury[e] in upper trophic level fish three years or older is methylmercury.[26] Thus, the total mercury concentration in a fish of legal size for possession in Texas serves well as a surrogate for methylmercury concentration. Because methylmercury analyses are difficult to perform accurately and are more expensive than total mercury analyses, the USEPA recommends that states determine total mercury concentration in a fish and that – to protect human health – states conservatively assume all reported mercury in fish or shellfish is methylmercury. The GERG laboratory thus analyzed fish tissues for total mercury. In its risk characterizations, the DSHS compared mercury concentrations in tissues to a comparison value derived from the Agency for Toxic Substances and Disease Registry's (ATSDR) minimal risk level (MRL) for methylmercury.[27]

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[d] A PCB congener is any single, unique well-defined chemical compound in the PCB category. The name of a congener specifies the total number of chlorine substituents and the position of each chlorine (e.g., 4,4' dichlorobiphenyl is a congener comprising the biphenyl structure with two chlorine substituents, one on each of the number 4 carbons of the two rings). In 1980, a numbering system was developed, which assigned a sequential number to each of the 209 PCB congeners.

[e] DSHS interchangeably utilizes the terms "mercury," "methylmercury," or "organic mercury" to refer to methylmercury in fish.

Percent Lipids

The percent lipids content (wet weight basis) of a tissue sample is defined as the percent of material extracted from biological tissue with methylene chloride.[28] Tissue samples were extracted with methylene chloride in the presence of sodium sulfate and an aliquot of the extract was removed for lipid determination, filtered and concentrated to a known volume. A subsample is removed, the solvent is evaporated, the lipid residue weighed, and the percent lipid content is determined.

Polychlorinated Biphenyls (PCBs)

For PCBs, the USEPA suggests that each state measures congeners of PCBs in fish and shellfish rather than homologs[f] or Aroclors®[g] because the USEPA considers congener analysis the most sensitive technique for detecting PCBs in environmental media.[29, 20] Although only about 130 PCB congeners were routinely present in PCB mixtures manufactured and commonly used in the U.S. The GERG laboratory analyzes and reports the presence and concentrations of all 209 possible PCB congeners. From the congener analyses, the laboratory also computes and reports concentrations of PCB homologs and of Aroclor® mixtures. Despite the USEPA's suggestion that the states utilize PCB congeners rather than Aroclors® or homologs for toxicity estimates, the toxicity literature does not reflect state-of-the-art laboratory science. To accommodate this inconsistency, the DSHS utilizes recommendations from the National Oceanic and Atmospheric Administration (NOAA),[30] from McFarland and Clarke,[31] and from the USEPA's guidance documents for assessing contaminants in fish and shellfish.[18, 24] Based on evaluation of these recommendations, the DSHS selected 43 of 209 congeners to characterize "total" PCBs. The referenced authors chose to use congeners that were relatively abundant in the environment, were likely to occur in aquatic life, and likely to show toxic effects. SALG risk assessors summed the 43 congeners to derive "total" PCB concentration in each sample. SALG risk assessors then averaged the summed congeners within each group (e.g., fish species, sample site, or combination of species and site) to derive a mean PCB concentration for each group.

Using only a few PCB congeners to determine total PCB concentrations could underestimate PCB levels in fish tissue. Nonetheless, the method complies with expert recommendations on evaluation of PCBs in fish or shellfish. SALG risk assessors compare average PCB concentrations of the 43 congeners with health assessment comparison (HAC) values derived from information on PCB mixtures held in the USEPA's Integrated Risk Information System (IRIS) database.[32] IRIS

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[f] PCB homologs are subcategories of PCB congeners having equal numbers of chlorine substituents (e.g., the tetrachlorobiphenyls are all PCB congeners with exactly four chlorine substituents that may be in any arrangement).

[g] Aroclor is a PCB mixture produced from 1930 to 1979. It is one of the most commonly known trade names for PCB mixtures. There are many types of Aroclors and each has a distinguishing suffix number that indicates the degree of chlorination. The numbering standard is as follows: The first two digits refer to the number of carbon atoms in the phenyl rings and the third and fourth digits indicate the percentage of chlorine by mass in the mixture (e.g., Aroclor 1254 means that the mixture has 12 carbon atoms and contains 54% chlorine by weight).

currently contains noncarcinogenic toxicity information for three Aroclor® mixtures: Aroclors® 1016, 1248, and 1254. IRIS does not contain complete information for all mixtures. For instance, IRIS has derived reference doses (RfDs) for Aroclors 1016 and 1254. Aroclor 1016 was a commercial mixture produced in the latter years of commercial production of PCBs in the United States. Aroclor 1016 was a fraction of Aroclor 1254 that was supposedly devoid of dibenzofurans, in contrast to Aroclor 1254.[33] Noncarcinogenic toxicity estimates in the present document reflect comparisons derived from the USEPA's RfD for Aroclor 1254 because Aroclor 1254 contains many of the 43 congeners selected by McFarland and Clark and NOAA. As of yet, IRIS does not contain information on the systemic toxicity of individual PCB congeners.

For assessment of cancer risk from exposure to PCBs, the SALG uses the USEPA's slope factor of 2.0 milligram per kilogram per day (mg/kg/day) to calculate the probability of lifetime excess cancer risk from PCB ingestion. The SALG based its decision to use the most conservative slope factor available for PCBs on factors, such as food chain exposure; the presence of dioxin-like tumor-promoting or persistent congeners; and, the likelihood of early-life exposure.[32]

Calculation of Dioxin Toxicity Equivalence (TEQ)

PCDDs/PCDFs are families of aromatic chemicals containing one to eight chlorine atoms. The molecular structures differ not only with respect to the number of chlorines on the molecule, but also with the positions of those chlorines on the carbon atoms of the molecule. The number and positions of the chlorines on the dibenzofuran or dibenzo-*p*-dioxin nucleus directly affects the toxicity of the various congeners. Toxicity increases as the number of chlorines increases to four chlorines, then decreases with increasing numbers of chlorine atoms - up to a maximum of eight. With respect to the position of chlorines on the dibenzo-*p*-dioxin/dibenzofuran nucleus, it appears that those congeners with chlorine substitutions in the 2, 3, 7, and 8 positions are more toxic than congeners with chlorine substitutions in other positions. To illustrate, the most toxic form of PCDDs is 2,3,7,8–tetrachlorodibenzo-*p*-dioxin (2,3,7,8–TCDD), a 4-chlorine molecule having one chlorine substituted for hydrogen at each of the 2, 3, 7, and 8 carbon positions on the dibenzo-*p*-dioxin. To gain some measure of toxic equivalence, 2,3,7,8–TCDD – assigned a toxicity equivalency factor (TEF) of 1.0 – is the standard against which other congeners are measured. Other congeners are given weighting factors, or TEFs, of 1.0 or less based on experiments comparing the toxicity of the congener relative to that of 2,3,7,8-TCDD.[34, 35]

Using this technique, the DSHS converted PCDD or PCDF congeners in each tissue sample from the present survey to toxic equivalent concentrations (TEQs) by multiplying each congener's concentration by its TEF, producing a dose roughly equivalent in toxicity to that of the same dose of 2,3,7,8-TCDD. The total TEQ for any sample is the sum of the TEQs for each of the congeners in the sample, calculated according to the following formula.[36]

$$\text{Total TEQs} = \sum_{i=1}^{n}(\text{CI} \times \text{TEF})$$

CI = concentration of a given congener
TEF = toxicity equivalence factor for the given congener
n = # of congeners
i = initial congener
$\sum$ = sum

Derivation and Application of Health-Based Assessment Comparison Values for Systemic (Noncarcinogenic) Effects (HAC_{nonca}) of Consumed Chemical Contaminants

The effects of exposure to any hazardous substance depend, among other factors, on the dose, the route of exposure, the duration of exposure, the manner in which the exposure occurs, the genetic makeup, personal traits and habits of the exposed, or the presence of other chemicals.[37] People who regularly consume contaminated fish or shellfish conceivably suffer repeated low-dose exposures to contaminants in fish or shellfish over extended periods (episodic exposures to low doses). Such exposures are unlikely to result in acute toxicity but may increase risk of subtle, chronic, and/or delayed adverse health effects that may include: cancer, benign tumors; birth defects; infertility; blood disorders; brain damage; peripheral nerve damage; lung disease; and kidney disease.[37]

If diverse species of fish or shellfish are available, the SALG presumes that people eat a variety of species from a water body. Further, SALG risk assessors assume that most fish species are mobile. SALG risk assessors may combine data from different fish species and/or sample sites within a water body to evaluate mean contaminant concentrations of toxicants in all samples as a whole. This approach intuitively reflects consumers' likely exposure over time to contaminants in fish or shellfish from any water body but may not reflect the reality of exposure at a specific location within a water body or a single point in time. The DSHS reserves the right to project risks associated with ingestion of individual species of fish or shellfish from separate collection sites within a water body or at higher than average concentrations (e.g., the upper 95 percent confidence limit on the mean). The SALG evaluated contaminants in fish or shellfish by comparing the mean of a contaminant to its HAC value (e.g., in mg/kg) for non-cancer or cancer endpoints.

In deriving HAC values for noncarcinogenic (HAC_{nonca}) effects, the SALG assumes a standard adult weighs 70 kilograms (kg) and consumes 30 g of fish or shellfish per day (about one eight-ounce meal per week) and uses the USEPA's RfD[38] or the ATSDR's chronic oral MRLs.[39] When RfDs or MRLs are not available the SALG may use a Food and Nutrition Board, Institute of Medicine, National Academies tolerable upper intake level (UL) for nutrients.[h] The USEPA defines an RfD as

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[h] A tolerable upper intake level (UL) is the highest average daily nutrient intake level that is likely to pose no risk of adverse health effects to almost all individuals in the general population. As intake increases above the UL, the potential risk of adverse effects may increase. The UL represents total intake from food, water, and supplements.

An estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime.[40]

The USEPA also states that the RfD

> … *is derived from a BMDL* (benchmark dose lower confidence limit)*, a NOAEL* (no observed adverse effect level*), a LOAEL* (lowest observed adverse effect level)*, or another suitable point of departure, with uncertainty/variability factors applied to reflect limitations of the data used. [Durations include acute, short-term, subchronic, and chronic and are defined individually in this glossary]* and *RfDs are generally reserved for health effects thought to have a threshold or a low dose limit for producing effects.*[40]

The ATSDR uses a similar technique to derive its MRLs.[39] The DSHS divides the estimated daily dose derived from the measured concentration in fish tissue by the contaminant's RfD or MRL to derive a hazard quotient (HQ). The USEPA defines an HQ as

> *…the ratio of the estimated exposure dose of a contaminant (mg/kg/day) to the contaminant's RfD or MRL (mg/kg/day).*[41]

Note that, according to the USEPA, a linear increase in the HQ for a toxicant does not imply a linear increase in the likelihood or severity of systemic adverse effects. Thus, an HQ of 4.0 does not mean the concentration in the dose will be four times as toxic as that same substance would be if the HQ were equal to 1.0. An HQ of 4.0 also does not imply that adverse events will occur four times as often as if the HQ for the substance in question were 1.0. Rather, the USEPA suggests that an HQ or a hazard index (HI) – defined as the sum of HQs for contaminants to which an individual is exposed simultaneously – that computes to less than 1.0 should be interpreted as "no cause for concern" whereas, an HQ or HI greater than or equal to 1.0 "should indicate some cause for concern."

The SALG does not utilize HQs to determine the likelihood of occurrence of noncarcinogenic health effects. Instead, in a manner similar to the USEPA's decision process, the SALG computed HQs as a qualitative measurement. Qualitatively, HQs less than 1.0 are unlikely to be cause for concern while HQs greater than or equal to 1.0 might suggest the recommendation of a regulatory action to ensure protection of public health. Similarly, risk assessors at the DSHS may utilize an HQ to determine the need for further study of a water body's fauna. Notwithstanding the above discussion, the oral RfD derived by the USEPA represents chronic consumption. Thus, regularly eating fish containing a toxic chemical, the HQ of which is less than 1.0 is unlikely to cause adverse systemic health effects, whereas routine consumption of fish or shellfish in which the HQ equals or exceeds 1.0 represents a qualitatively unacceptable increase in the likelihood of systemic adverse health outcomes.

Although the DSHS utilized chemical specific RfDs when possible, if an RfD is not available for a contaminant, the USEPA advises risk assessors to consider evaluating the contaminant by comparing it to the published RfD (or the MRL) of a contaminant of similar molecular structure or one with a similar mode or mechanism of action. For instance, Aroclor® 1260 has no RfD, so the DSHS uses the reference dose for Aroclor 1254 to assess the likelihood of systemic (noncarcinogenic) effects of Aroclor 1260.[39]

In developing oral RfDs and MRLs, federal scientists review the extant literature to devise NOAELs, LOAELs, or benchmark doses (BMDs) from experimental studies. Uncertainty factors are then utilized to minimize potential systemic adverse health effects in people who are exposed through consumption of contaminated materials by accounting for certain conditions that may be undetermined by the experimental data. These include extrapolation from animals to humans (interspecies variability), intra-human variability, and use of a subchronic study rather than a chronic study to determine the NOAEL, LOAEL, or BMD, and database insufficiencies.[38,40] Vulnerable groups such as women who are pregnant or lactating, women who may become pregnant, infants, children, people with chronic illnesses, those with compromised immune systems, the elderly, or those who consume exceptionally large servings are considered sensitive populations by risk assessors and USEPA. These sensitive groups also receive special consideration in calculation of an RfD.[40]

The primary method for assessing the toxicity of component-based mixtures of chemicals in environmental media is the HI. The USEPA recommends HI methodology for groups of toxicologically similar chemicals or chemicals that affect the same target organ. The HI for the toxic effects of a chemical mixture on a single target organ is actually a simulated HQ calculated as if the mixture were a single chemical. The default procedure for calculating the HI for the exposure mixture is to add the hazard quotients (the ratio of the external exposure dose to the RfD) for all the mixture's component chemicals that affect the same target organ (e.g., the liver). The toxicity of a particular mixture on the liver represented by the HI should approximate the toxicity that would have occurred were the observed effects caused by a higher dose of a single toxicant (additive effects). The components to be included in the HI calculation are any chemical components of the mixture that show the effect described by the HI, regardless of the critical effect from which the RfD came. Assessors should calculate a separate HI for each toxic effect.

Because the RfD is derived for the critical effect (the "toxic effect occurring at the lowest dose of a chemical"), an HI computed from HQs based on the RfDs for the separate chemicals may be overly conservative. That is, using RfDs to calculate HIs may overestimate health risks from consumption of specific mixtures for which no experimentally derived information is available.

The USEPA states that

> *the HI is a quantitative decision aid that requires toxicity values as well as exposure estimates. When each organ-specific HI for a mixture is less than one and all relevant effects have been considered in the assessment, the exposure*

being assessed for potential systemic toxicity should be interpreted as unlikely to result in significant toxicity.

And

When any effect-specific HI exceeds one, concern exists over potential toxicity. As more HIs for different effects exceed one, the potential for human toxicity also increases.

Thus,

Concern should increase as the number of effect-specific HI's exceeding one increases. As a larger number of effect-specific HIs exceed one, concern over potential toxicity should also increase. As with HQs, this potential for risk is not the same as probabilistic risk; a doubling of the HI does not necessarily indicate a doubling of toxic risk.

Derivation and Application of Health-Based Assessment Comparison Values for Application to the Carcinogenic Effects (HAC_{ca}) of Consumed Chemical Contaminants

The DSHS calculated cancer-risk comparison values (HAC_{ca}) from the USEPA's chemical-specific cancer potency factors (CPFs), also known as cancer slope factors (CSFs), derived through mathematical modeling from carcinogenicity studies. For carcinogenic outcomes, the DSHS calculated a theoretical lifetime excess risk of cancer for specific exposure scenarios for carcinogens, using a standard 70-kg body weight and assuming an adult consumes 30 grams of edible fish tissue per day. The SALG risk assessors incorporate two additional factors into determinations of theoretical lifetime excess cancer risk: (1) an acceptable lifetime risk level (ARL)[40] of one excess cancer case in 10,000 persons whose average daily exposure is equivalent; and, (2) daily exposure for 30 years, a modification of the 70-year lifetime exposure assumed by the USEPA. Comparison values used to assess the probability of cancer do not contain "uncertainty" factors. However, conclusions drawn from probability determinations infer substantial safety margins for all people by virtue of the models utilized to derive the slope factors (cancer potency factors) used in calculating the HAC_{ca}.

Because the calculated comparison values (HAC values) are conservative, exceeding a HAC value does not necessarily mean adverse health effects will occur. The perceived strict demarcation between acceptable and unacceptable exposures or risks is primarily a tool used by risk managers along with other information to make decisions about the degree of risk incurred by those who consume contaminated fish or shellfish. Moreover, comparison values for adverse health effects do not represent sharp dividing lines (obvious demarcations) between safe and unsafe exposures. For example, the DSHS considers it unacceptable when consumption of four or fewer meals per month of contaminated fish or shellfish would result in exposure to contaminant(s) in excess of a HAC value or other measure of risk. The DSHS also advises people who wish to minimize exposure to contaminants in fish or shellfish to eat a variety of fish and/or shellfish and to limit consumption of those species most likely to contain toxic contaminants. The DSHS aims to protect vulnerable subpopulations with its consumption advice, assuming that advice protective of vulnerable subgroups will also protect the general population from potential adverse health effects associated with consumption of contaminated fish or shellfish.

Children's Health Considerations

The DSHS recognizes that fetuses, infants, and children may be uniquely susceptible to the effects of toxic chemicals and suggests that exceptional susceptibilities demand special attention. [42, 43] Windows of special vulnerability (known as "critical developmental periods") exist during development. Critical periods occur particularly during early gestation (weeks 0 through 8), but can occur at any time during development (pregnancy, infancy, childhood, or adolescence) at times when toxicants can impair or alter the structure or function of susceptible systems.[44] Unique early sensitivities may exist after birth because organs and body systems are structurally or functionally immature at birth, continuing to develop throughout infancy, childhood, and adolescence. Developmental variables may influence the mechanisms or rates of absorption, metabolism, storage, or excretion of toxicants. Any of these factors could alter the concentration of biologically effective toxicant at the target organ(s) or could modulate target organ response to the toxicant. Children's exposures to toxicants may be more extensive than adults' exposures because children consume more food and liquids in proportion to their body weights than adults consume. Infants can ingest toxicants through breast milk, an exposure pathway that often goes unrecognized. Nonetheless, the advantages of breastfeeding outweigh the probability of significant exposure to infants through breast milk and women are encouraged to continue breastfeeding and to limit exposure of their infants by limiting intake of the contaminated foodstuff. Children may experience effects at a lower exposure dose than might adults because children's organs may be more sensitive to the effects of toxicants. Stated differently, children's systems could respond more extensively or with greater severity to a given dose than would an adult organ exposed to an equivalent dose of a toxicant. Children could be more prone to developing certain cancers from chemical exposures than are adults.[45] In any case, if a chemical or a class of chemicals is observed to be, or is thought to be, more toxic to fetuses, infants, or children, the constants (e.g., RfD, MRL, or CPF) are usually modified further to assure the immature systems' potentially greater susceptibilities are not perturbed.[38] Additionally, in accordance with the ATSDR's *Child Health Initiative*[46] and the USEPA's *National Agenda to Protect Children's Health from Environmental Threats,*[47] the DSHS further seeks to protect children from the possible negative effects of toxicants in fish by suggesting that this potentially sensitive subgroup consume smaller quantities of contaminated fish or shellfish than adults consume. Thus, the DSHS recommends that children weighing 35 kg or less and/or who are 11 years of age or younger limit exposure to contaminants in fish or shellfish by eating no more than four-ounces per meal of the contaminated species. The DSHS also recommends that consumers spread these meals over time. For instance, if the DSHS issues consumption advice that recommends consumption of no more than two meals per month of a contaminated species, those children should eat no more than 24 four ounce meals of the contaminated fish or shellfish per year and should not eat such fish or shellfish more than twice per month.

Data Analysis and Statistical Methods

The SALG risk assessors imported Excel© files into Systat® statistical software, version 13.1 installed on IBM-compatible microcomputers (Dell, Inc), to generate descriptive statistics (mean, 95% confidence limits of the arithmetic mean, standard deviation, minimum, and maximum concentrations) for reported chemical contaminants.[48] In computing descriptive statistics, SALG risk assessors utilized ½ the reporting limit (RL) for analytes designated as not detected (ND) or estimated (J-values).[i] The SALG risk assessors calculated PCDDs/PCDFs descriptive statistics using estimated concentrations (J-values) and assuming zero for PCDDs/PCDFs designated as ND.[j] The change in methodology for computing PCDDs/PCDFs descriptive statistics is due to the proximity of the reporting limits to the HAC value. Assuming ½ the RL for PCDDs/PCDFs designated as ND or J-values would unnecessarily overestimate the concentration of PCDDs/PCDFs in each fish tissue sample. The SALG used the descriptive statistics from the above calculations to produce the present report. The SALG employed Microsoft Excel® spreadsheets to create figures, to compute HAC_{nonca} and HAC_{ca} values for contaminants, and to calculate HQs, HIs, cancer risk probabilities, and meal consumption limits for fish from Mountain Creek Lake.[49] When lead concentrations in fish or shellfish are high, SALG risk assessors may utilize the USEPA's Interactive Environmental Uptake Bio-Kinetic (IEUBK) model to determine whether consumption of lead-contaminated fish could cause a child's blood lead (PbB) level to exceed the Centers for Disease Control and Prevention's (CDC) lead concentration of concern in children's blood (5 mcg/dL).[50, 51]

RESULTS

The GERG laboratory completed analyses and electronically transmitted the results of the Mountain Creek Lake samples collected November 2015 to the SALG in August 2016. The laboratory reported the analytical results for metals, pesticides, PCBs, PCDDs/PCDFs, SVOCs, and VOCs.

For reference, Table 1 contains a list of fish samples collected by sample site. Tables 2.1–2.9 present the results of metals analyses. Tables 3 and 4.1–4.3 contain summary results for pesticides and PCBs, respectively. Table 5.1–5.3 summarizes the PCDD/PCDF analyses. Table 6 depicts summary results for VOCs (i.e., trichlorofluoromethane). This report does not display

[i] "J-value" is standard laboratory nomenclature for analyte concentrations that are detected and reported below the reporting limit (<RL). The reported concentration is considered an estimate, quantitation of which may be suspect and may not be reproducible. The DSHS treats J-Values as "not detected" in its statistical analyses of a sample set.
[j] The SALG risk assessors' rationale for computing PCDDs/PCDFs descriptive statistics using the aforementioned method is based on the proximity of the laboratory reporting limits and the health assessment comparison value for PCDDs/PCDFs. Thus, applying the standard SALG method utilizing ½ the reporting limit for analytes designated as not detected (ND) or estimated (J) will likely overestimate the PCDDs/PCDFs fish tissue concentration.

SVOC data because these contaminants were not present at concentrations of concern in fish collected from Mountain Creek Lake during the described survey. Unless otherwise stated, table summaries present the number of samples with detected concentrations of contaminants, the number of samples tested, the mean concentration and standard deviation, and the minimum and the maximum concentrations. In the tables, results may be reported as ND, below detection limit (BDL) for estimated concentrations or "J-values", or as concentrations at or above the reporting limit (RL).

Inorganic Contaminants

<u>Arsenic, Cadmium, Copper, Lead, Selenium, and Zinc</u>

The GERG laboratory analyzed a subset of 16 fish tissue samples for six inorganic contaminants and 80 samples for mercury. All fish tissue samples from Mountain Creek Lake contained concentrations of selenium and zinc (Tables 2.1–2.9).

The SALG evaluated three toxic metalloids having no known human physiological function (arsenic, cadmium, and lead) in the samples collected from Mountain Creek Lake. Total arsenic concentrations ranged from BDL to 1.150 mg/kg with a mean of 0.133±0.275 mg/kg (Table 2.1). Sixteen of 16 fish analyzed contained estimated concentrations below the RL for cadmium and lead (Tables 2.2 and 2.4).

Three of the metalloids analyzed are essential trace elements: copper, selenium, and zinc.). All fish tissue samples contained estimated concentrations below the RL for copper (Table 2.3). Selenium concentrations ranged from 0.180 to 0.680 mg/kg with a mean of 0.341±0.119 mg/kg (Table 2.5). All samples also contained zinc. The mean zinc concentration in fish tissue samples from Mountain Creek Lake was 3.047±1.005 mg/kg (Table 2.6).

<u>Mercury</u>

Seventy-eight of 80 fish tissue samples evaluated from Mountain Creek Lake contained mercury (Table 2.7–2.10). Mercury concentrations ranged from ND to 0.465 mg/kg. The mean mercury concentration for the 80 fish tissue samples analyzed was 0.077±0.074 mg/kg.

Organic Contaminants

<u>Pesticides</u>

All samples examined contained concentrations of chlordane and 4,4'-dichlorodiphenyldichloroethylene (DDE). Chlordane concentrations ranged from 0.0005 to 0.0672 mg/kg with a mean of 0.0152±0.0171 mg/kg (Table 3). DDT (total) [2,4'-DDE + 4,4'-DDE + 2,4'-DDD + 4,4'-DDD + 2,4'-DDT + 4,4'-DDT] ranged from 0.0015 to 0.0590 mg/kg with a mean 0.0220±0.0199 mg/kg (Table 3). Dieldrin ranged from ND to 0.0036 mg/kg with a mean 0.0010±0.0011 mg/kg (Table 3). The mean endrin concentration in fish tissue samples from

Mountain Creek Lake was 0.0024±0.0042 (Table 3). Estimated to low concentrations greater than the reporting limit of endosulfan II, gamma HCH, hexachlorobenzene, heptachlor epoxide, mirex, and pentachlorobenzene were present in one or more fish samples (data not presented). Estimated concentrations were reported for alpha HCH, Delta HCH, pentachloroanisole, and tetrachlorobenzene (data not presented).

PCBs

All fish tissue samples evaluated from Mountain Creek Lake contained PCBs (Tables 4.1–4.4). Across all sample sites and species, PCB concentrations ranged from 0.006 (white crappie) to 1.740 mg/kg (freshwater drum). The mean PCB concentration for the 80 fish tissue samples evaluated was 0.141±0.283 mg/kg.

Channel catfish

Twenty channel catfish ranging from 16.6 to 28.1 inches TL ($\overline{X}$ – 21.5 inches TL) and from two to nine years of age were analyzed for PCBs (Table 1; Figure 4). One-hundred percent of the channel catfish samples examined were of legal size (≥ 12 inches TL).[52] PCB concentrations ranged from 0.019 to 0.305 mg/kg with a mean of 0.097±0.084 mg/kg (Tables 4.1–4.4).

Common carp

Four common carp ranging from 20.8 to 31.6 inches TL ($\overline{X}$ – 26.0 inches TL) were analyzed for PCBs (Table 1). Currently, there is no minimum length limit for common carp in Texas waters.[52] PCB concentrations ranged from 0.047 to 0.651 mg/kg with a mean of 0.204±0.298 mg/kg (Tables 4.1–4.4).

Flathead catfish

Three flathead catfish ranging from 22.3 to 29.5 inches TL ($\overline{X}$ – 25.0 inches TL) and from two to five years of age were analyzed for PCBs (Table 1; Figure 8). One-hundred percent of the flathead catfish samples examined were of legal size (≥ 18 inches TL).[52] PCB concentrations ranged from 0.017 to 0.100 mg/kg with a mean of 0.063±0.042 mg/kg (Tables 4.1–4.4).

Freshwater drum

Eight freshwater drum ranging from 17.5 to 22.9 inches TL ($\overline{X}$ – 19.9 inches TL) were analyzed for PCBs (Table 1). Currently, there is no minimum length limit for freshwater drum in Texas waters.[52] PCB concentrations ranged from 0.016 to 1.740 mg/kg with a mean of 0.326±0.582 mg/kg (Tables 4.1–4.4).

Largemouth bass

Twenty largemouth bass ranging from 14.7 to 21.9 inches TL ($\overline{X}$ – 17.8 inches TL) and from two to ten years of age were analyzed for PCBs (Table 1; Figure 9). One-hundred percent of the largemouth bass samples examined were of legal size (≥ 14 inches TL).[52] PCB concentrations ranged from 0.010 to 0.187 mg/kg with a mean of 0.047±0.051 mg/kg (Tables 4.1–4.4).

Smallmouth buffalo

Seven smallmouth buffalo ranging from 24.2 to 30.7 inches TL ($\overline{X}$ – 27.1 inches TL) were analyzed for PCBs (Table 1). Currently, there is no minimum length limit for smallmouth buffalo in Texas waters.[52] PCB concentrations ranged from 0.193 to 1.647 mg/kg with a mean of 0.542±0.518 mg/kg (Tables 4.1–4.4).

White bass

Eight white bass ranging from 10.6 to 15.2 inches TL ($\overline{X}$ – 14.2 inches TL) and from two to five years of age were analyzed for PCBs (Table 1). One-hundred percent of the white bass samples examined were of legal size (≥ 10 inches TL).[52] PCB concentrations ranged from 0.032 to 0.296 mg/kg with a mean of 0.107±0.082 mg/kg (Tables 4.1–4.4).

White crappie

Ten white crappie ranging from 10.1 to 14.0 inches TL ($\overline{X}$ – 11.7 inches TL) and from one to five years of age were analyzed for PCBs (Table 1; Figure 7). One-hundred percent of the white crappie samples examined were of legal size (≥ 10 inches TL).[52] PCB concentrations ranged from 0.006 to 0.037 mg/kg with a mean of 0.014±0.009 mg/kg (Tables 4.1–4.4).

PCDDs/PCDFs

Sixty-nine of 80 fish tissue samples contained at least one of the 17 PCDD/PCDF congeners ranging from ND–5.782 TEQ pg/g with a mean of 1.061±1.426 TEQ pg/g (Table 5.1–5.4). No samples contained all 17 congeners (data not shown). Smallmouth buffalo contained the highest mean PCDD/PCDF TEQ concentration (3.751±1.378 pg/g; Table 5.4).

SVOCs

The GERG laboratory analyzed a subset of 16 Mountain Creek Lake fish tissue samples for SVOCs. Quantifiable concentrations greater than the reporting limit were reported for Diethyl phthalate in five fish samples (data not presented). Estimated concentrations of phenol, phenanthrene, diethyl phthalate, bis (2-ethylhexyl) phthalate, and nitrobenzene were present in one or more fish samples analyzed (data not presented). The laboratory detected no other SVOCs in fish from Mountain Creek Lake.

VOCs

The Seafood and Aquatic Life Group Survey Team Standard Operating Procedures and Quality Control/Assurance Manual contain a complete list of the 70 VOCs selected for analysis. A subset of 16 fish tissue samples were selected for analysis from Mountain Creek Lake. Trichlorofluoromethane concentrations ranged from 0.001–0.415 mg/kg with a mean of 0.107±0.116 mg/kg (Table 6). Quantifiable concentrations greater than the reporting limit were reported for acetone, carbon disulfide, methylene chloride, trichloroethene, and naphthalene in one or more fish samples (data not presented in tables). Estimated quantities of benzene, toluene, chlorobenzene, ethylbenzene, m+p-xylene, o-xylene, and 1,2,3-trichlorobenzene were also present in one or more fish tissue samples analyzed from Mountain Creek Lake (data not presented).

Acetone, methylene chloride, and naphthalene were also identified in one or more of the procedural blanks, suggesting that that these compounds were introduced during sample preparation. VOC concentrations less than the reporting limit are difficult to interpret due to their uncertainty and may represent a false positive. The presence of many VOCs at concentrations less than the reporting limit may be the result of incomplete removal of the calibration standard from the adsorbent trap, so they are observed in the blank. VOC analytical methodology requires that the VOCs be thermally released from the adsorbent trap, transferred to the gas chromatograph (GC), and into the mass spectrometer (MS) for quantification.

DISCUSSION

Risk Characterization

Because variability and uncertainty are inherent to quantitative assessment of risk, the calculated risks of adverse health outcomes from exposure to toxicants can be orders of magnitude above or below actual risks. Variability in calculated and in actual risk may depend upon factors such as the use of animal instead of human studies, use of subchronic rather than chronic studies, interspecies variability, intra-species variability, and database insufficiency. Because most factors used to calculate comparison values result from experimental studies conducted in the laboratory on nonhuman subjects, variability and uncertainty might arise from the study chosen as the "critical" one, the species/strain of animal used in the critical study, the target organ selected as the "critical organ," exposure periods, exposure route, doses, or uncontrolled variations in other conditions.[38] Despite such limitations, risk assessors must calculate parameters to represent potential toxicity to humans who consume contaminants in fish and other environmental media. The DSHS calculated risk parameters for noncarcinogenic and carcinogenic endpoints in those who would consume fish from the Mountain Creek Lake. Conclusions and recommendations predicated upon the stated goal of the DSHS to protect human health follow the discussion of the relevance of findings to risk.

Characterization of Noncarcinogenic Health Effects from Consumption of Fish from Mountain Creek Lake

Inorganic Contaminants

None of the species of fish evaluated contained arsenic, cadmium, copper, lead, mercury, selenium, or zinc at concentrations at or above DSHS guidelines for protection of human health.

Organic Contaminants

PCBs and PCDDs/PCDFs were observed in fish from Mountain Creek Lake at concentrations at or above respective HAC_{nonca} (0.047 mg/kg; 2.330 pg/g; Tables 4.1–4.4, 5.1–5.4, and 8.1–8.2). None of the species of fish evaluated contained any other organic contaminants at concentrations at or above DSHS guidelines for protection of human.

PCBs

All fish tissue samples (*n* = 80) evaluated contained PCBs. Fifty-three percent of all samples analyzed contained PCB concentrations exceeding the HAC_{nonca} for PCBs (0.047 mg/kg; Tables 4.1–4.4). Seven (channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass) of the eight species of fish evaluated had mean PCB concentrations exceeding the HAC_{nonca} for PCBs or an HQ of 1.0 (Tables 4.1–4.4 and 8.1–8.2). The all fish combined mean PCB concentration (0.141 mg/kg) exceeded the HAC_{nonca} for PCBs or an HQ of 1.0.

Meal consumption calculations are useful for risk managers to make fish consumption recommendations and/or take regulatory action. The SALG risk assessors calculated the number of eight-ounce meals of fish from Mountain Creek Lake that healthy adults could consume without significant risk of PCB-related adverse noncarcinogenic effects (Tables 8.1–8.2). Meal consumption rates were based on the overall mean PCB concentration by species. The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week for these species of fish: 0.4 meals per week of channel catfish; 0.2 meals per week of common carp; 0.7 meals per week of flathead catfish; 0.1 meals per week of freshwater drum; 0.9 meals per week of largemouth bass; 0.1 meals per week of smallmouth buffalo; or, 0.4 meals per week of white bass. The SALG risk assessors suggest that fish from Mountain Creek Lake contain PCBs at concentrations that may pose potential noncarcinogenic health risks and that people should not consume common carp, freshwater drum, and smallmouth buffalo and limit their consumption of channel catfish, flathead catfish, largemouth bass, and white bass from Mountain Creek Lake. Because the developing nervous system of the human fetus and young children may be especially susceptible to adverse noncarcinogenic health effects associated with consuming PCB-contaminated fish, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation.

PCDDs/PCDFs

Sixty-nine of 80 fish tissue samples assayed contained PCDDs/PCDFs. Thirteen percent of all samples analyzed contained PCDD/PCDF concentrations exceeding the HAC_{nonca} for PCDDs/PCDFs (2.330 pg/g; Tables 5.1–5.4 and 8.1–8.2). One (smallmouth buffalo) of eight species of fish evaluated had mean PCDD/PCDF concentrations exceeding the HAC_{nonca} for PCDDs/PCDFs or an HQ of 1.0 (Tables 5.1–5.4 and 8.1–8.2). The all fish combined mean PCDD/PCDF concentration did not exceed the HAC_{nonca} for PCDDs/PCDFs or an HQ of 1.0. The consumption of smallmouth buffalo from Mountain Creek Lake may pose potential noncarcinogenic health risks.

Meal consumption calculations are useful for risk managers to make fish consumption recommendations and/or take regulatory action. The SALG risk assessors calculated the number of eight-ounce meals of fish from Mountain Creek Lake that healthy adults could consume without significant risk of PCDD/PCDF -related adverse systemic effects (Tables 8.1–8.2). Meal consumption rates were based on the overall mean PCDD/PCDF concentration by species. The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week of smallmouth buffalo. The SALG risk assessors estimated that people should not consume more than 0.6 meals per week. The SALG risk assessors suggest that smallmouth buffalo from Mountain Creek Lake contain PCDDs/PCDFs at concentrations that may pose potential noncarcinogenic health risks and that people should limit their consumption of smallmouth buffalo from Mountain Creek Lake. Because the developing nervous system of the human fetus and young children may be especially susceptible to adverse systemic health effects associated with consuming PCDD/PCDF-contaminated fish, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation.

Characterization of Theoretical Lifetime Excess Cancer Risk from Consumption of Fish from Mountain Creek Lake

The USEPA classifies arsenic, most chlorinated pesticides, PCBs, and PCDDs/PCDFs as human carcinogens. Arsenic, chlordane, dieldrin, and DDT (total) were present in fish samples analyzed from Mountain Creek Lake, but none of these contaminants evaluated singly by species or all species combined had mean contaminant concentrations that would be likely to increase the risk of cancer to exceed the DSHS guideline for protection of human health of one excess cancer in 10,000 equally exposed individuals.

PCBs

The mean PCB concentrations observed in freshwater drum and smallmouth buffalo exceed the DSHS guideline for protection of human health of one excess cancer in 10,000 equally exposed individuals and the HAC_{ca} for PCBs (0.272 mg/kg; Tables 4.1–4.4 and 9.1–9.3). PCB concentrations at or above the HAC_{ca} for PCBs were observed in one or more samples of channel catfish, common carp, freshwater drum, smallmouth buffalo, and white bass. The all fish combined mean PCB concentration did not exceed the HAC_{ca} for PCBs.

The SALG risk assessors calculated the number of eight-ounce meals of freshwater drum or smallmouth buffalo from Mountain Creek Lake that healthy adults could consume without significantly increasing their lifetime excess cancer risk (Table 9.1–9.3). The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week of freshwater drum (0.8 meals per week) or smallmouth buffalo (0.5 meals per week). Because children may experience effects at a lower exposure dose than adults, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation. The SALG risk assessors suggest that consumption of freshwater drum and smallmouth buffalo from Mountain Creek Lake would be likely to increase the risk of cancer to exceed the DSHS guideline for protection of human health from PCB exposure.

PCDDs/PCDFs

The mean PCDD/PCDF concentrations observed in smallmouth buffalo exceed the DSHS guideline for protection of human health of one excess cancer in 10,000 equally exposed individuals or the HAC_{ca} for PCDDs/PCDFs (3.490 pg/g; Tables 5.1–5.4 and 9.1–9.3). The all fish combined mean PCDD/PCDF concentration did not exceed the HAC_{ca} for PCDDs/PCDFs. The consumption of smallmouth buffalo from Mountain Creek Lake would be likely to increase the risk of cancer to exceed the DSHS guideline for protection of human health.

The SALG risk assessors calculated the number of eight-ounce meals of smallmouth buffalo from Mountain Creek Lake that healthy adults could consume without significantly increasing their lifetime excess cancer risk (Tables 9.1–9.3). The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week of smallmouth buffalo (0.9 meals per week). Because children may experience effects at a lower exposure dose than might adults because children's systems may be more sensitive to the effects of toxicants, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation. The SALG risk assessors suggest that consumption of smallmouth buffalo from Mountain Creek Lake would be likely to increase the risk of cancer to exceed the DSHS guideline for protection of human health from PCDD/PCDF exposure.

Characterization of Calculated Cumulative Noncarcinogenic Health Effects and of Cumulative Excess Lifetime Cancer Risk from Consumption of Fish from Mountain Creek Lake

Cumulative Noncarcinogenic Health Effects

Cumulative noncarcinogenic effects of toxicants may occur if more than one contaminant acts upon the same target organ or acts by the same mode or mechanism of action. PCBs and PCDDs/PCDFs in fish from Mountain Creek Lake could have these properties, especially with respect to effects on the immune system. Multiple organic contaminants in Mountain Creek Lake fish increased the likelihood of noncarcinogenic adverse health outcomes for all species of fish evaluated (Tables 8.1–8.2). The combined toxicity of PCBs and PCDDs/PCDFs in channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass exceeded an HI of 1.0.

Meal consumption calculations are useful for risk managers to make fish consumption recommendations and/or take regulatory action. The SALG risk assessors calculated the number of eight-ounce meals of fish from Mountain Creek Lake that healthy adults could consume without significant risk of PCB and/or PCDD/PCDF -related adverse systemic effects (Tables 8.1–8.2). Meal consumption rates were based on cumulative toxicity from exposure to PCBs and PCDDs/PCDFs by species. The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week of channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, or white bass (Tables 8.1–8.2). The SALG risk assessors suggest that channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass from Mountain Creek Lake contain PCBs and PCDDs/PCDFs at concentrations that may pose potential noncarcinogenic health risks and that people should limit their consumption of fish from Mountain Creek Lake. Because the developing nervous system of the human fetus and young children may be especially susceptible, the SALG risk assessors recommend more conservative consumption guidance for these sensitive subpopulations.

Cumulative Carcinogenic Health Effects

The SALG also queried the probability of increasing lifetime excess cancer risk from consuming fish containing multiple inorganic and organic contaminants. In most assessments of cancer risk from environmental exposures to chemical mixtures, researchers have considered any increase in cancerous or benign growths in one or more organs as cumulative, no matter the mode or mechanism of action of the contaminant. In this assessment, risk assessors added the calculated carcinogenic effect of arsenic, chlorinated pesticides, PCBs, and PCDFs/PCDDs (Tables 9.1–9.3). In each instance, addition of the cancer risk for these chemicals increased the theoretical lifetime excess cancer risk. The cancer risk increase did elevate lifetime excess cancer risk to a level greater than the DSHS guideline for protection of human health of one excess cancer in 10,000 persons equivalently exposed for common carp, freshwater drum, and smallmouth buffalo.

The consumption of common carp, freshwater drum, and smallmouth buffalo from Mountain Creek Lake likely increases the risk of cancer to exceed the DSHS guideline for protection of human health. The SALG risk assessors estimated that healthy adults could consume less than one eight-ounce meal per week for these species of fish: 0.8 meals per week of common carp; 0.5 meals per week of or freshwater drum; or, 0.3 meals per week of smallmouth buffalo (Tables 9.1–9.3). Because children may experience effects at a lower exposure dose than adults, the SALG risk assessors recommend more conservative consumption guidance for this sensitive subpopulation. The SALG risk assessors suggest that consumption of channel catfish, common carp, and hybrid striped bass from Mountain Creek Lake would be likely to increase the risk of cancer to exceed the DSHS guideline for protection of human health from multiple contaminant exposures.

CONCLUSIONS

The SALG risk assessors prepare risk characterizations to determine public health hazards from consumption of fish and shellfish harvested from Texas water bodies by recreational or subsistence fishers. If necessary, the SALG risk assessors may suggest strategies for reducing risk to the health of those who may eat contaminated fish or seafood to risk managers at the DSHS, including the Texas Commissioner of Health.

This study addressed the public health implications of consuming fish from Mountain Creek Lake, located in Dallas County, Texas. Confidence in the conclusions for many species of fish is limited by the small sample size. Sampling a small number of fish (i.e., individual species of fish or all fish species combined) decreases the confidence of mean contaminant concentrations for the fish population thus adding uncertainty to the conclusions. Risk assessors from the SALG conclude from the present characterization of potential adverse health effects from consuming fish from Mountain Creek Lake that:

1. Channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, white bass, and white crappie mean concentrations of arsenic, cadmium, copper, lead, mercury, selenium, zinc, pesticides, SVOCs, or VOCs; either singly or in combination do not exceed the DSHS guidelines for protection of human health. Therefore, consumption of these species of fish containing the above-listed contaminants **poses no apparent risk to human health**.

2. White crappie mean PCB concentrations do not exceed the DSHS guidelines for protection of human health. Therefore, consumption of white crappie containing only PCBs **poses no apparent risk to human health**.

3. Channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, white bass, and white crappie mean PCDD/PCDF TEQ concentrations do not exceed the DSHS guidelines for protection of human health. Therefore, consumption of these species of fish containing only PCDDs/PCDFs **poses no apparent risk to human health**.

4. Channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass mean PCB concentrations exceed the DSHS guidelines for protection of human health. Regular or long-term consumption of these species of fish may result in adverse noncarcinogenic health effects and/or increase the likelihood of carcinogenic health risks. Therefore, consumption of these species of fish from Mountain Creek Lake **poses an apparent risk to human health**.

5. Smallmouth buffalo mean PCDD/PCDF TEQ concentrations exceed the DSHS guidelines for protection of human health. Regular or long-term consumption of smallmouth

buffalo may result in adverse noncarcinogenic health effects and/or increase the likelihood of carcinogenic health risks. Therefore, consumption of smallmouth buffalo from Mountain Creek Lake **poses an apparent risk to human health**.

6. Consumption of multiple organic contaminants (i.e., PCDDs/PCDFs and PCBs) in channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass increases the likelihood of noncarcinogenic health risks. Regular or long-term consumption of these species of fish may result in adverse noncarcinogenic health effects. Therefore, consumption of these species of fish from Mountain Creek Lake **poses an apparent risk to human health**.

7. Consumption of multiple inorganic and/or organic contaminants observed in common carp, freshwater drum, and smallmouth buffalo increases the likelihood of carcinogenic health risks. Therefore, consumption of these species of fish containing multiple contaminants **poses an apparent risk to human health**.

RECOMMENDATIONS

Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the USEPA.[18, 24, 53] Risk managers at the DSHS may decide to take action to protect public health if a risk characterization confirms that people can eat four or fewer meals per month (women past childbearing age [women 50 and older] and males 12 and older: eight-ounces per meal; women of childbearing age [women and girls under 50] and children less than 12: four-ounces per meal) of fish or shellfish from a water body under investigation. Risk management recommendations may be in the form of consumption advice or a ban on possession of fish from the affected water body. Fish or shellfish possession bans are enforceable under subchapter D of the Texas Health and Safety Code, part 436.061(a).[54] Declarations of prohibited harvesting areas are enforceable under the Texas Health and Safety Code, Subchapter D, parts 436.091 and 436.101.[54] The DSHS consumption advice carries no penalty for noncompliance. Consumption advisories, instead, inform the public of potential health hazards associated with consuming contaminated fish or shellfish from Texas waters. With this information, people can make informed decisions about whether and/or how much, contaminated fish or shellfish, they wish to consume. The SALG concludes from this risk characterization that consuming channel catfish, common carp, flathead catfish, freshwater drum, largemouth bass, smallmouth buffalo, and white bass from Mountain Creek Lake **poses an apparent hazard to public health.** Therefore, SALG risk assessors recommend that:

- People should not consume common carp, freshwater drum, and smallmouth buffalo from Mountain Creek Lake (Table 10).

- Women of childbearing age (Women and girls under 50) including pregnant women, women who may become pregnant, and women who are nursing infants and children less than 12 years of age, or who weigh less than 75 pounds should not consume channel catfish, common carp, freshwater drum, smallmouth buffalo, and white bass from Mountain Creek Lake.

- Women of childbearing age (Women and girls under 50) including pregnant women, women who may become pregnant, and women who are nursing infants and children less than 12 years of age, or who weigh less than 75 pounds may consume up to one four-ounce meal per month of flathead catfish or largemouth bass from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to one eight-ounce meal per month of channel catfish or white bass from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to two eight-ounce meals per month of flathead catfish from Mountain Creek Lake.

- Women past childbearing age (Women 50 and older) and males 12 and older may consume up to three eight-ounce meals per month of largemouth bass from Mountain Creek Lake.

- As resources become available, the DSHS should continue to monitor fish from Mountain Creek Lake for changes and establish trends in contaminants of concern or contaminant concentrations that would require a change in consumption advice.

PUBLIC HEALTH ACTION PLAN

Communication to the public of new and continuing possession bans or consumption advisories, or the removal of either, is essential to effective management of risk from consuming contaminated fish. In fulfillment of the responsibility for communication, the DSHS takes several steps.

- The agency publishes fish consumption advisories and bans in a booklet available to the public through the SALG. To receive the booklet and/or the data, please contact the SALG at 512-834-6757.[55]
- The SALG also posts the most current information about advisories, bans, and the removal of either on the internet at http://www.dshs.texas.gov/seafood.[56] The SALG regularly updates this Web site.
- The DSHS also provides the USEPA (https://www.epa.gov/fish-tech), the TCEQ (http://www.tceq.texas.gov), and the TPWD (http://www.tpwd.texas.gov) with information on all consumption advisories and possession bans. Each year, the TPWD informs the public of consumption advisories and fishing bans on its Web site and in an official downloadable PDF file containing general hunting and fishing regulations

available at http://tpwd.texas.gov/regulations/outdoor-annual/. A booklet containing this information is available at all establishments selling Texas fishing licenses.[52]

Communication to the public of scientific information related to this risk characterization and information for environmental contaminants found in fish is essential to effective risk management. To achieve this responsibility for communication, the DSHS provides contact information to ask specific questions and/or resources to obtain more information about environmental contaminants in fish.

- Readers may direct questions about the scientific information or recommendations in this risk characterization to the SALG at 512-834-6757 or may find the information at the SALG's Web site (http://www.dshs.texas.gov/seafood). Secondarily, one may address inquiries to the Environmental and Injury Epidemiology and Toxicology Unit of DSHS (800-588-1248).
- The USEPA's IRIS Web site (http://www.epa.gov/iris/) contains information on environmental contaminants found in food and environmental media.
- The ATSDR, Division of Toxicology (888-42-ATSDR or 888-422-8737 or the ATSDR's Web site (http://www.atsdr.cdc.gov) supplies brief information via ToxFAQs.™ ToxFAQs™ are available on the ATSDR Web site in either English or Spanish (http://www.atsdr.cdc.gov/toxfaqs/index.asp). The ATSDR also publishes more in-depth reviews of many toxic substances in its *Toxicological Profiles* (ToxProfiles™) http://www.atsdr.cdc.gov/toxprofiles/index.asp. To request a copy of the ToxProfiles™ CD-ROM, PHS, or ToxFAQs™ call 1-800-CDC-INFO (800-232-4636) or email a request to cdcinfo@cdc.gov.

Figure 1. Mountain Creek Lake Map

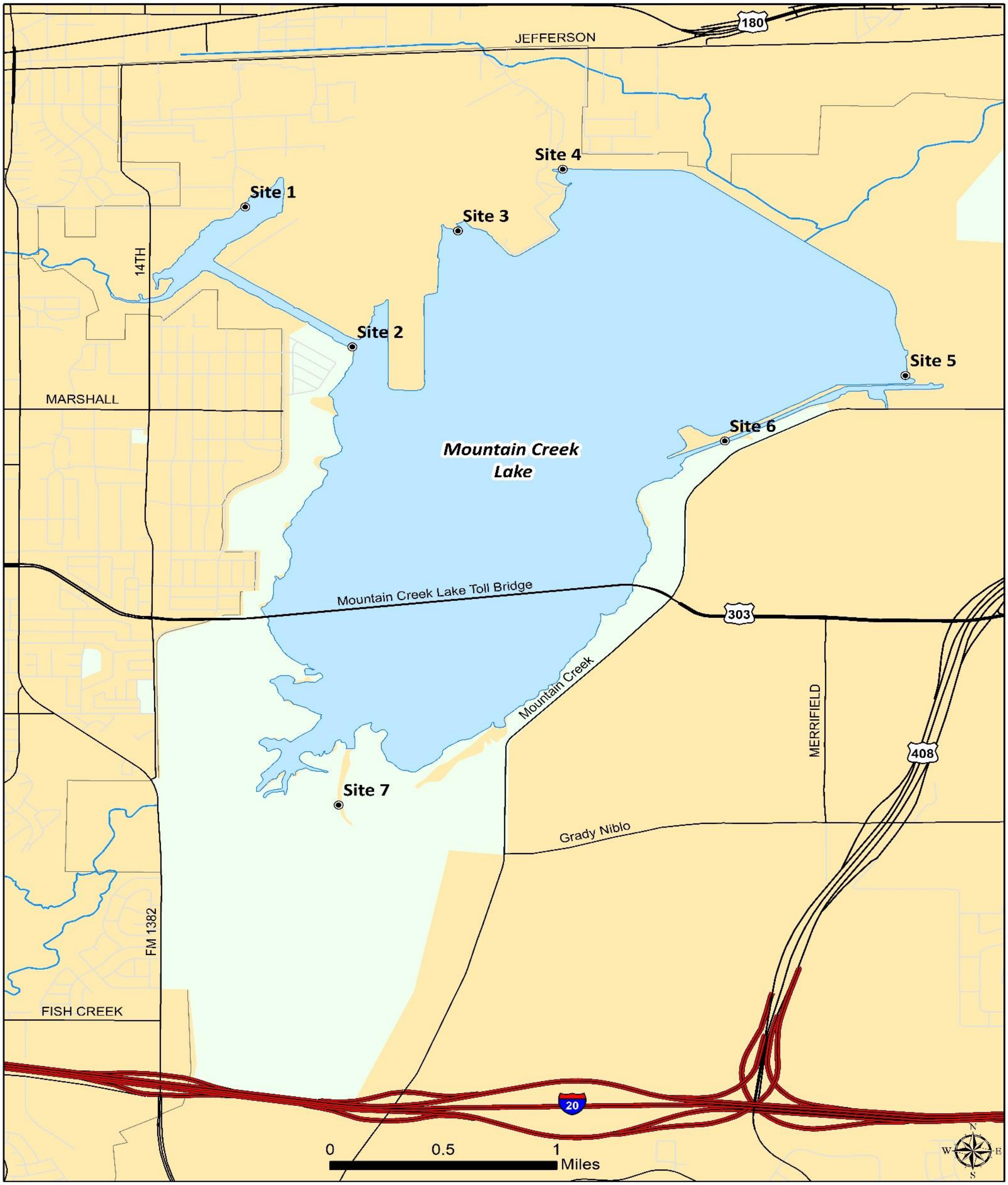


Figure 2. Length at age for channel catfish collected from Mountain Creek Lake, Texas, 2015.

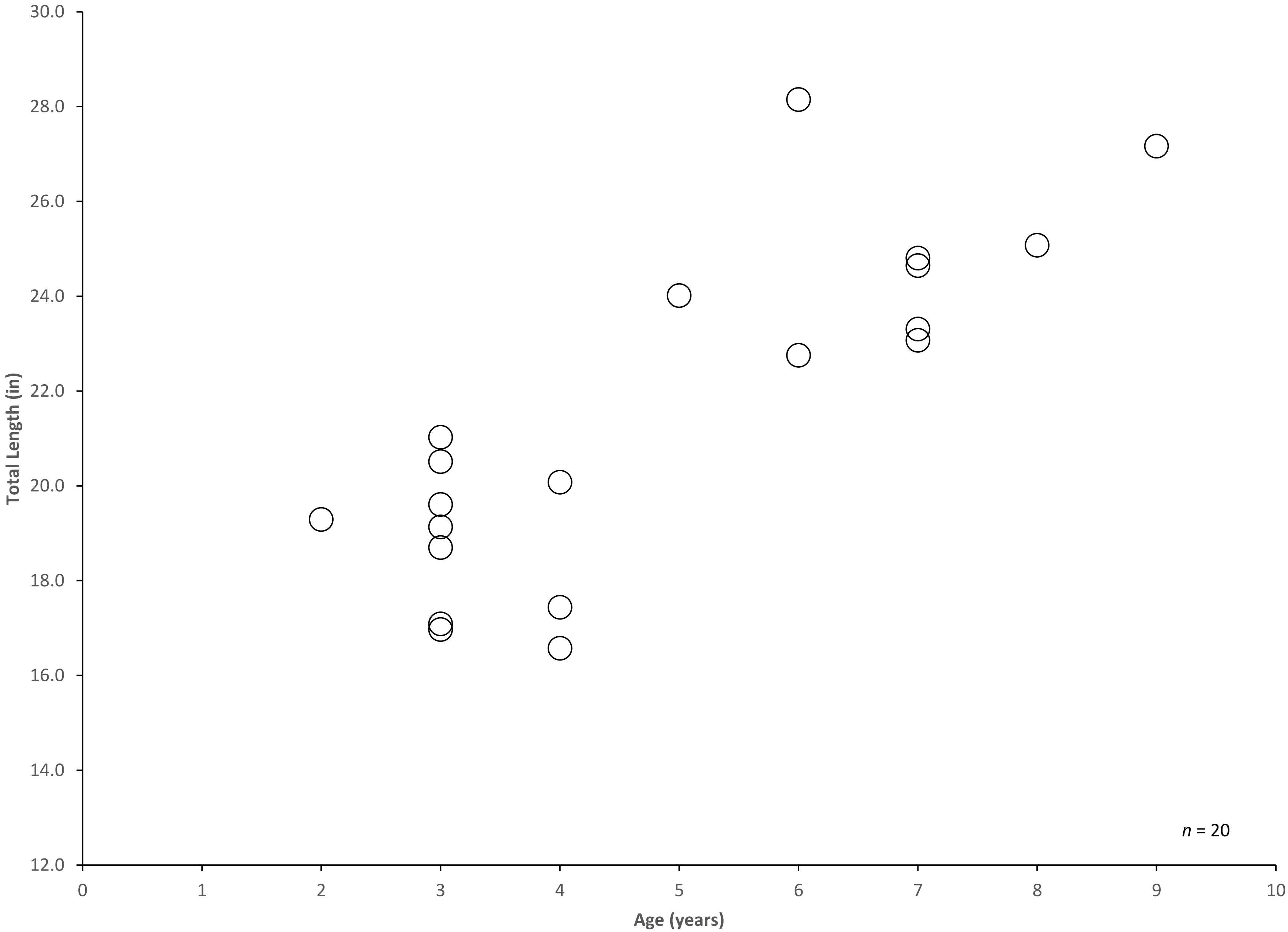


Figure 3. Length at age for flathead catfish collected from Mountain Creek Lake, Texas, 2015.

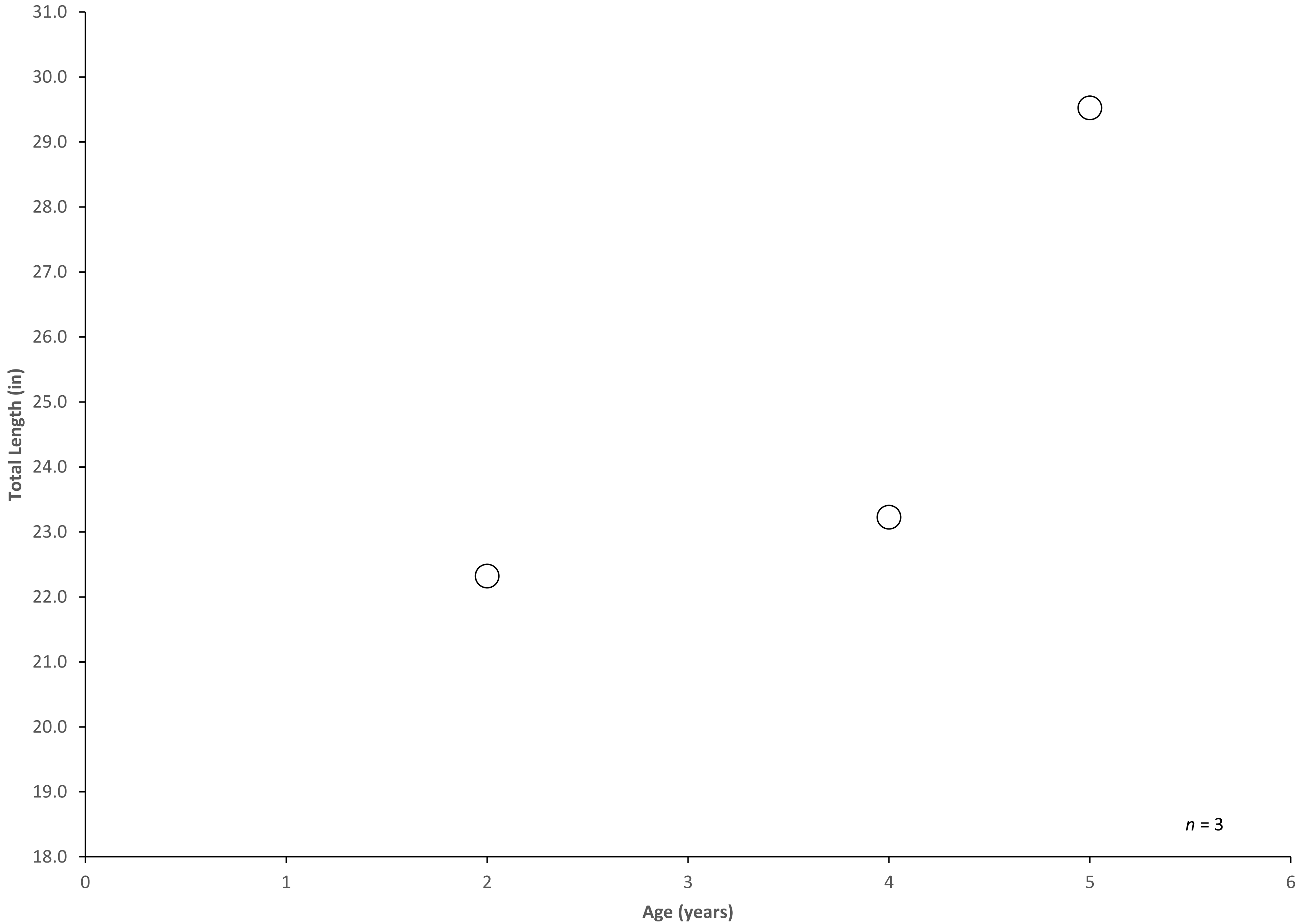


Figure 4. Length at age for largemouth bass collected from Mountain Creek Lake, Texas, 2015.

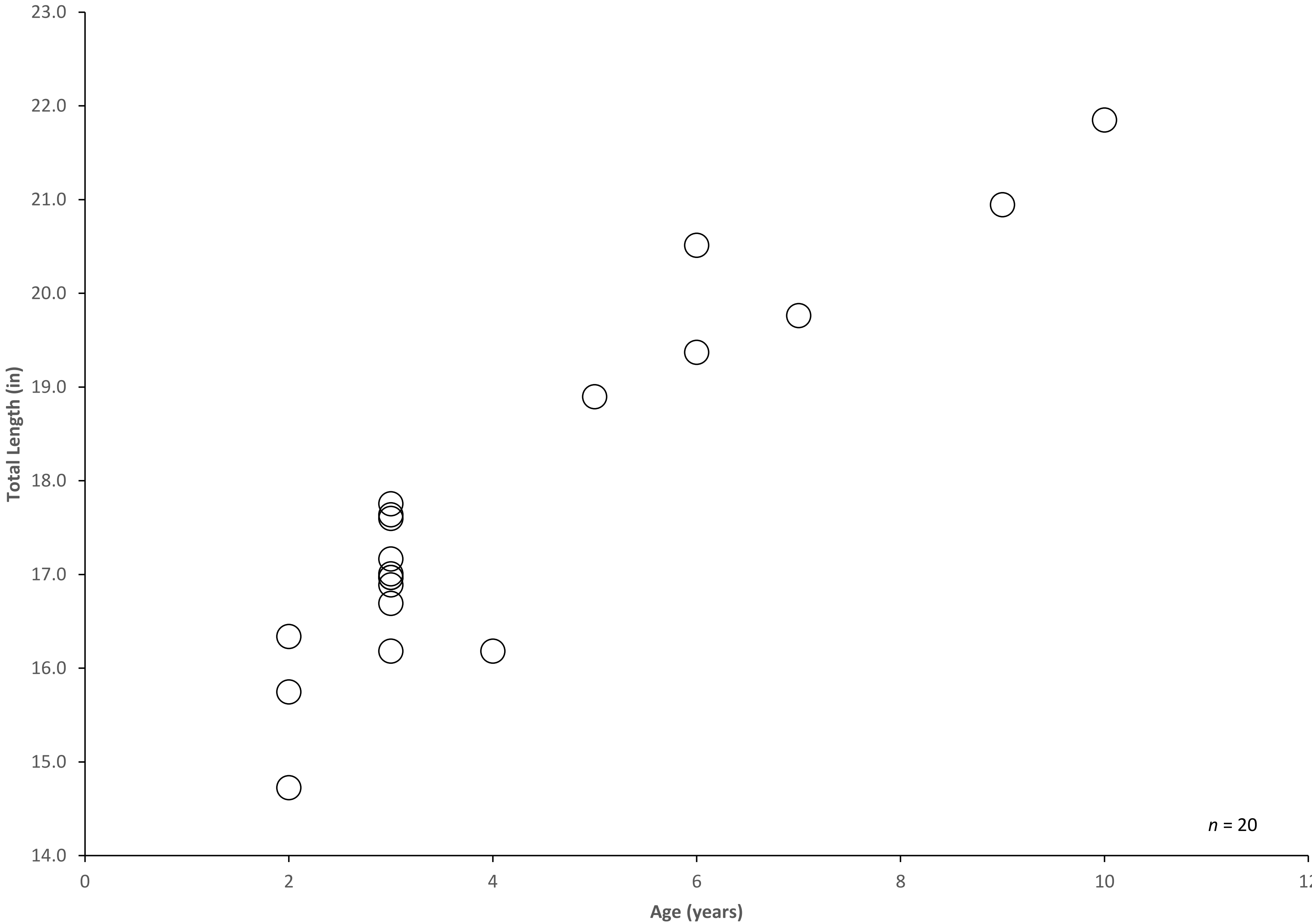


Figure 5. Length at age for white bass collected from Mountain Creek Lake, Texas, 2015.

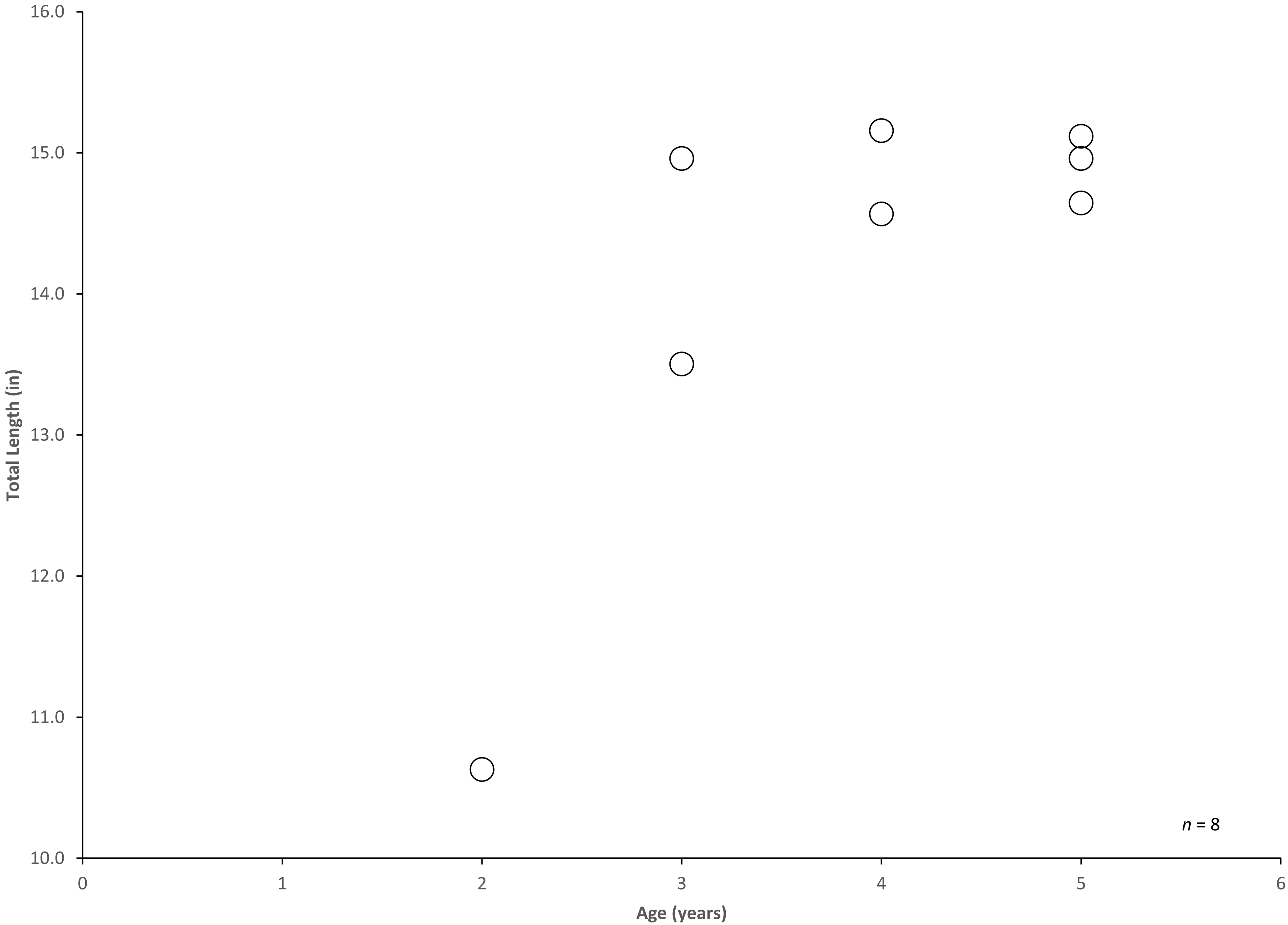
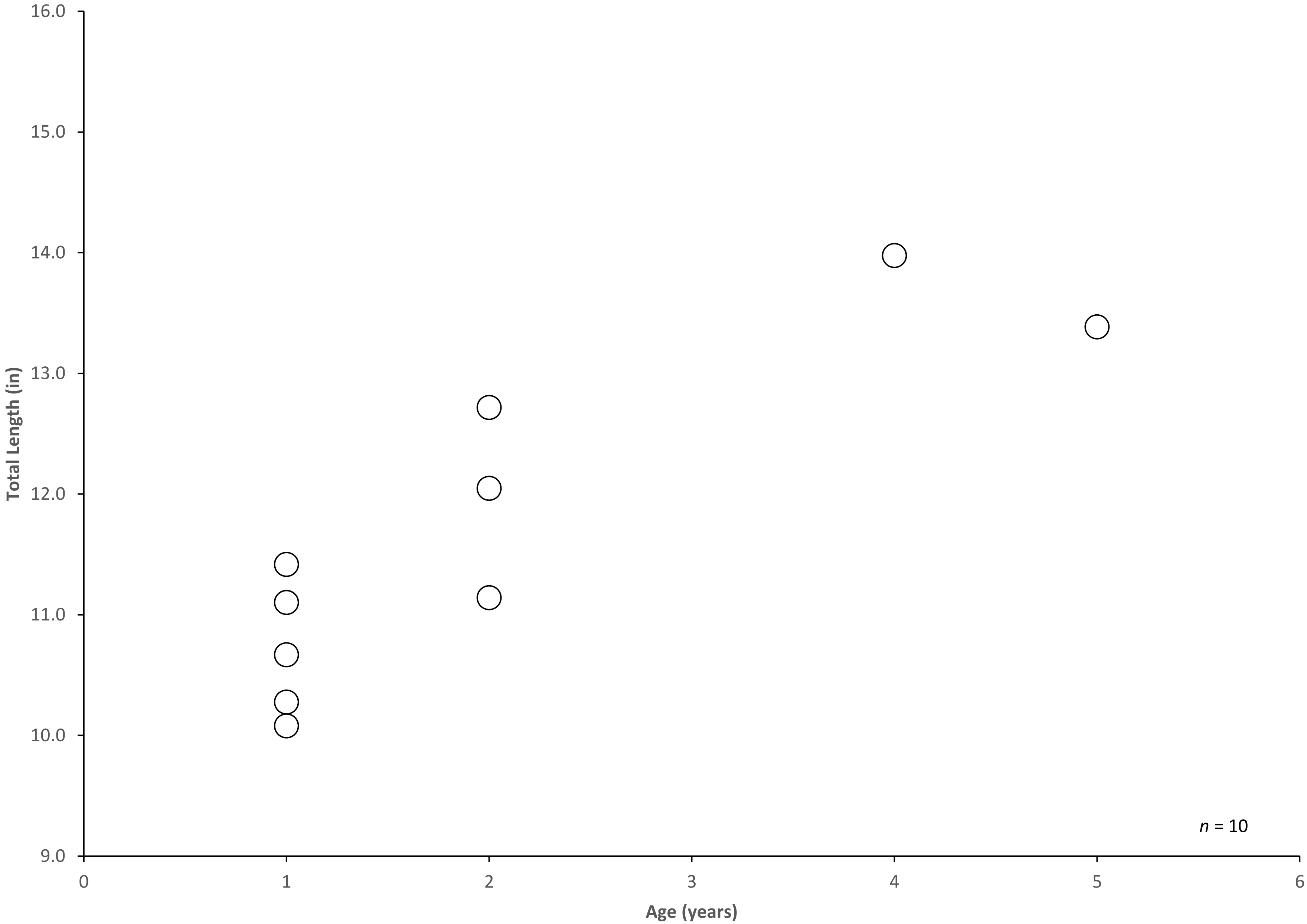


Figure 6. Length at age for white crappie collected from Mountain Creek Lake, Texas, 2015.



TABLES

Table 1. Fish samples collected from Mountain Creek Lake 2015. Sample number, species, total length, and weight recorded for each sample.					
Sample Number	Species	Total Length		Weight	
		Millimeters (mm)	Inches (in)	Grams (g)	Pounds (lb)
Site 1 Mountain Creek Lake at Cottonwood Cove					
MCL1	Common carp	613	24.1	3066	6.8
MCL3	Smallmouth buffalo	615	24.2	4765	10.5
MCL4	Channel catfish	630	24.8	2143	4.7
MCL5	Channel catfish	490	19.3	967	2.1
MCL43	Channel catfish	521	20.5	1359	3.0
MCL44	Largemouth bass	492	19.4	1958	4.3
MCL45	Largemouth bass	502	19.8	2150	4.7
MCL46	Largemouth bass	480	18.9	1729	3.8
MCL47	Largemouth bass	555	21.9	2777	6.1
MCL48	Largemouth bass	532	20.9	2379	5.2
MCL51	White crappie	355	14.0	716	1.6
MCL45	Largemouth bass	502	19.8	2150	4.7
Site 2 Mountain Creek Lake at Cottonwood Cove Canal					
MCL6	Smallmouth buffalo	780	30.7	15000	33.1
MCL7	Channel catfish	586	23.1	2031	4.5
MCL8	Channel catfish	690	27.2	3283	7.2
MCL53	Freshwater drum	444	17.5	1227	2.7
MCL55	Freshwater drum	503	19.8	2305	5.1
MCL56	Freshwater drum	479	18.9	1634	3.6
MCL58	Largemouth bass	374	14.7	793	1.7
MCL59	Largemouth bass	521	20.5	2077	4.6
MCL60	White crappie	261	10.3	250	0.6
MCL61	White crappie	306	12.0	418	0.9

Table 1. cont. Fish samples collected from Mountain Creek Lake 2015. Sample number, species, total length, and weight recorded for each sample.					
Sample Number	**Species**	**Total Length**		**Weight**	
		Millimeters (mm)	**Inches (in)**	**Grams (g)**	**Pounds (lb)**
Site 3 Mountain Creek Lake near Cooperation Lane					
MCL9	Smallmouth buffalo	656	25.8	6634	14.6
MCL10	Common carp	528	20.8	1866	4.1
MCL11	Freshwater drum	541	21.3	2664	5.9
MCL62	White bass	380	15.0	688	1.5
MCL63	White bass	343	13.5	535	1.2
MCL64	White bass	384	15.1	618	1.4
MCL65	White bass	380	15.0	672	1.5
MCL66	White bass	370	14.6	587	1.3
MCL67	White bass	372	14.6	624	1.4
MCL68	Largemouth bass	431	17.0	1436	3.2
MCL69	Largemouth bass	415	16.3	1096	2.4
MCL70	Largemouth bass	431	17.0	1261	2.8
MCL71	Channel catfish	510	20.1	1199	2.6
MCL72	Channel catfish	486	19.1	985	2.2
MCL73	Channel catfish	475	18.7	878	1.9
MCL74	Channel catfish	434	17.1	733	1.6
MCL75	Channel catfish	431	17.0	660	1.5
MCL76	White crappie	282	11.1	352	0.8
MCL77	White crappie	271	10.7	309	0.7
Site 4 Mountain Creek Lake at Dam					
MCL12	Smallmouth buffalo	703	27.7	7568	16.7
MCL13	Freshwater drum	566	22.3	2636	5.8
MCL14	Freshwater drum	581	22.9	2727	6.0
MCL15	Flathead catfish	750	29.5	5558	12.3
MCL81	White bass	270	10.6	330	0.7
MCL92	Largemouth bass	447	17.6	1595	3.5
MCL93	Largemouth bass	448	17.6	1578	3.5
MCL94	Largemouth bass	424	16.7	1394	3.1

Table 1. cont. Fish samples collected from Mountain Creek Lake 2015. Sample number, species, total length, and weight recorded for each sample.					
Sample Number	Species	Total Length		Weight	
		Millimeters (mm)	Inches (in)	Grams (g)	Pounds (lb)
Site 5 Mountain Creek Lake at Power Plant Intake					
MCL16	White crappie	256	10.1	268	0.6
MCL17	Smallmouth buffalo	697	27.4	8415	18.6
MCL18	Flathead catfish	590	23.2	2537	5.6
MCL19	Channel catfish	592	23.3	2314	5.1
MCL20	Channel catfish	637	25.1	3200	7.1
MCL83	Flathead catfish	567	22.3	1892	4.2
MCL84	Freshwater drum	491	19.3	1519	3.3
MCL85	White bass	385	15.2	813	1.8
MCL86	White crappie	323	12.7	542	1.2
MCL87	White crappie	290	11.4	340	0.7
MCL89	Largemouth bass	432	17.0	1386	3.1
MCL90	Largemouth bass	411	16.2	1132	2.5
MCL91	Largemouth bass	411	16.2	1183	2.6
Site 6 Mountain Creek Lake at Power Plant Outfall					
MCL21	Common carp	802	31.6	6619	14.6
MCL22	Smallmouth buffalo	690	27.2	6942	15.3
MCL23	Channel catfish	421	16.6	648	1.4
MCL24	Channel catfish	498	19.6	1232	2.7
MCL25	Channel catfish	715	28.1	4336	9.6
MCL26	Largemouth bass	400	15.7	904	2.0
MCL27	Largemouth bass	436	17.2	1548	3.4
MCL28	Largemouth bass	451	17.8	1553	3.4
Site 7 Mountain Creek Lake at Mountain Creek					
MCL29	Smallmouth buffalo	685	27.0	6353	14.0
MCL30	Common carp	701	27.6	4083	9.0
MCL31	Freshwater drum	448	17.6	1172	2.6
MCL32	Channel catfish	443	17.4	716	1.6
MCL33	Channel catfish	578	22.8	1737	3.8
MCL34	Channel catfish	610	24.0	1740	3.8
MCL35	Channel catfish	626	24.6	2685	5.9
MCL38	White crappie	283	11.1	306	0.7
MCL39	White crappie	340	13.4	602	1.3
MCL40	Largemouth bass	429	16.9	1100	2.4
MCL41	Channel catfish	534	21.0	1381	3.0

Table 2.1. Arsenic (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.					
Species	**Number Detected/ Number Tested**	**Total Arsenic Mean ± S.D. (Min-Max)**	**Inorganic Arsenic Mean[k]**	**HAC Value (nonca) and HAC Value (ca; mg/kg)[l]**	**Basis for Comparison Value**
Channel catfish	5/5	0.062±0.027 (BDL-0.110)	0.006	0.700	EPA Chronic Oral RfD for Inorganic Arsenic — 0.0003 mg/kg–day
Largemouth bass	5/5	BDL	BDL		
Smallmouth buffalo	6/6	0.262±0.440 (BDL-1.150)	0.026	0.363	EPA Oral Slope Factor for Inorganic Arsenic — 1.5 per mg/kg–day
All fish combined	16/16	0.133±0.275 (BDL-1.150)	0.013		

Table 2.2. Cadmium (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	5/5	BDL	0.233	ATSDR Chronic Oral MRL— 0.0001 mg/kg–day
Largemouth bass	5/5	BDL		
Smallmouth buffalo	6/6	BDL		
All fish combined	16/16	BDL		

[k] Most arsenic in fish and shellfish occurs as organic arsenic, considered virtually nontoxic. For risk assessment calculations, DSHS assumes that total arsenic is composed of 10% inorganic arsenic in fish and shellfish tissues.

[l] Derived from the MRL or RfD for noncarcinogens or the EPA slope factor for carcinogens; assumes a body weight of 70 kg, and a consumption rate of 30 grams per day, and assumes a 30-year exposure period for carcinogens and an excess lifetime cancer risk of $1x10^{-4}$.

Table 2.3. Copper (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	5/5	BDL	334	Based on the Tolerable Upper Intake Level (UL) — 0.143 mg/kg–day[m]
Largemouth bass	5/5	BDL		
Smallmouth buffalo	6/6	BDL		
All fish combined	16/16	BDL		

Table 2.4. Lead (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	5/5	BDL	N/A	N/A
Largemouth bass	5/5	BDL		
Smallmouth buffalo	6/6	BDL		
All fish combined	16/16	BDL		

[m] The Food and Nutrition Board, Institute of Medicine, National Academies UL for copper is 10 mg/day.

Table 2.5. Selenium (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	5/5	0.246±0.052 (0.180-0.310)	6	EPA Chronic Oral RfD — 0.005 mg/kg–day ATSDR Chronic Oral MRL — 0.005 mg/kg–day UL: 0.400 mg/day (0.005 mg/kg–day) RfD or MRL/2 — (0.005 mg/kg –day/2= 0.0025 mg/kg–day)[n, 57]
Largemouth bass	5/5	0.378±0.048 (0.310-0.440)		
Smallmouth buffalo	6/6	0.388±0.159 (0.270-0.680)		
All fish combined	16/16	0.341±0.119 (0.180-0.680)		

Table 2.6. Zinc (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	5/5	3.526±0.289 (3.220-3.980)	700	EPA Chronic Oral RfD — 0.3 mg/kg–day
Largemouth bass	5/5	3.192±0.790 (2.630-4.540)		
Smallmouth buffalo	6/6	2.528±1.375 (1.210-5.140)		
All fish combined	16/16	3.047±1.005 (1.210-5.140)		

[n] The DSHS applied relative source contribution methodology (RSC) developed by EPA to derive a HAC value for selenium. DSHS risk assessor's assumed that 50% of the daily selenium intake is from other foods or supplements (≈ 200 µg/day for a 70 kg adult or one-half the RfD) and subtracted an amount equal to 50% of the RfD from the RfD to account for other sources of exposure to selenium. The remainder of the RfD, 0.0025 mg/kg/day, was utilized to calculate the HAC value for selenium.

Table 2.7. Mercury (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 1 Mountain Creek Lake at Cottonwood Cove				
Channel catfish	3/3	0.039±0.028 (0.016-0.070)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Common carp	1/1	0.052		
Largemouth bass	4/5	0.189±0.120 (ND-0.317)		
Smallmouth buffalo	1/1	0.022		
White crappie	1/1	0.049		
All fish combined	10/11	0.108±0.110 (ND-0.317)		
Site 2 Mountain Creek Lake at Cottonwood Cove Canal				
Channel catfish	2/2	0.084±0.072 (0.033-0.135)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Freshwater drum	3/3	0.095±0.041 (0.061-0.141)		
Largemouth bass	2/2	0.262±0.287 (0.059-0.465)		
Smallmouth buffalo	1/1	0.057		
White crappie	2/2	0.026±0.005 (0.023-0.030)		
All fish combined	10/10	0.109±0.132 (0.023-0.465)		
Site 3 Mountain Creek Lake at Cooperation Lane				
Channel catfish	5/5	0.024±0.007 (0.018-0.035)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Common carp	1/1	0.038		
Freshwater drum	1/1	0.164		
Largemouth bass	3/3	0.063±0.012 (0.049-0.070)		
Smallmouth buffalo	1/1	0.027		
White bass	6/6	0.112±0.049 (0.056-0.173)		
White crappie	2/2	0.026±0.010 (0.019-0.033)		
All fish combined	19/19	0.066±0.052 (0.018-0.173)		

Table 2.8. Mercury (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 4 Mountain Creek Lake at Dam				
Flathead catfish	1/1	0.039	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Freshwater drum	2/2	0.170±0.105 (0.096-0.244)		
Largemouth bass	3/3	0.056±0.001 (0.056-0.057)		
Smallmouth buffalo	1/1	0.031		
White bass	1/1	0.050		
All fish combined	8/8	0.079±0.069 (0.031-0.244)		
Site 5 Mountain Creek Lake at Power Plant Intake				
Channel catfish	2/2	0.067±0.001 (0.066-0.068)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Flathead catfish	2/2	0.037±0.012 (0.029-0.046)		
Freshwater drum	1/1	0.146		
Largemouth bass	3/3	0.064±0.013 (0.052-0.078)		
Smallmouth buffalo	1/1	0.021		
White bass	1/1	0.069		
White crappie	3/3	0.030±0.009 (0.020-0.038)		
All fish combined	13/13	0.056±0.033 (0.020-0.146)		
Site 6 Mountain Creek Lake at Power Plant Outfall				
Channel catfish	3/3	0.043±0.029 (0.021-0.076)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Common carp	1/1	0.055		
Largemouth bass	3/3	0.062±0.010 (0.051-0.069)		
Smallmouth buffalo	1/1	0.039		
All fish combined	8/8	0.051±0.019 (0.021-0.076)		

Table 2.9. Mercury (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 7 Mountain Creek Lake at Mountain Creek				
Channel catfish	5/5	0.067±0.040 (0.040-0.136)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Common carp	1/1	0.059		
Freshwater drum	1/1	0.115		
Largemouth bass	0/1	ND		
Smallmouth buffalo	1/1	0.085		
White crappie	2/2	0.123±0.071 (0.073-0.173)		
All fish combined	10/11	0.076±0.049 (ND-0.173)		

Table 2.10. Mercury (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	20/20	0.050±0.035 (0.016-0.136)	0.7	ATSDR Chronic Oral MRL for Methylmercury — 0.0003 mg/kg–day
Common carp	4/4	0.051±0.009 (0.038-0.059)		
Flathead catfish	3/3	0.038±0.009 (0.029-0.046)		
Freshwater drum	8/8	0.131±0.057 (0.061-0.244)		
Largemouth bass	18/20	0.110±0.117 (ND-0.465)		
Smallmouth buffalo	7/7	0.040±0.023 (0.021-0.085)		
White bass	8/8	0.099±0.049 (0.050-0.173)		
White crappie	10/10	0.049±0.046 (0.019-0.173)		
All fish combined	78/80	0.077±0.074 (ND-0.465)		

Table 3. Pesticides (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca) and HAC Value (ca; mg/kg)**	**Basis for Comparison Value**
Chlordane (sum)				
Channel catfish	5/5	0.0145±0.0144 (0.0005-0.0380)	1.167 1.556	EPA Chronic Oral RfD — 0.0005 mg/kg–day EPA Oral Slope Factor — 0.35 per mg/kg–day
Largemouth bass	5/5	0.0030±0.0014 (0.0011-0.0045)		
Smallmouth buffalo	6/6	0.0258±0.0207 (0.0131-0.0672)		
All fish combined	16/16	0.0152±0.0171 (0.0005-0.0672)		
Dieldrin				
Channel catfish	3/5	0.0012±0.0014 (ND-0.0036)	0.117 0.034	EPA Chronic Oral RfD — 0.00005 mg/kg–day EPA Oral Slope Factor — 16 per (mg/kg)/day
Largemouth bass	5/5	0.0009±0.0011 (BDL-0.0028)		
Smallmouth buffalo	3/6	0.0010±0.0010 (ND-0.0023)		
All fish combined	11/16	0.0010±0.0011 (ND-0.0036)		
Endrin				
Channel catfish	3/5	0.0021±0.0029 (ND-0.0070)	0.700	EPA Chronic Oral RfD — 3.0E-4 (mg/kg)/day
Largemouth bass	4/5	0.0007±0.0005 (ND-0.0013)		
Smallmouth buffalo	3/6	0.0040±0.0063 (ND-0.0163)		
All fish combined	10/16	0.0024±0.0042 (ND-0.0163)		
Total DDT				
Channel catfish	5/5	0.0235±0.0235 (0.0015-0.0574)	1.167 1.601	EPA Chronic Oral RfD — 5.0E-4 mg/kg–day EPA Oral Slope Factor — 3.4E-1 per (mg/kg)/day
Largemouth bass	5/5	0.0052±0.0028 (0.0026-0.0091)		
Smallmouth buffalo	6/6	0.0348±0.0159 (0.0201-0.0590)		
All fish combined	16/16	0.0220±0.0199 (0.0015-0.0590)		

Table 4.1. PCBs (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 1 Mountain Creek Lake at Cottonwood Cove				
Channel catfish	3/3	**0.170**[o]±0.131 (0.044-**0.305**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Common carp	1/1	**0.057**		
Largemouth bass	5/5	**0.124**±0.044 (**0.077**-**0.187**)		
Smallmouth buffalo	1/1	**0.642**		
White crappie	1/1	0.021		
All fish combined	11/11	**0.168**±0.176 (0.021-**0.642**)		
Site 2 Mountain Creek Lake at Cottonwood Cove Canal				
Channel catfish	2/2	**0.087**±0.046 (**0.055**-**0.120**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Freshwater drum	3/3	**0.228**±0.120 (**0.098**-**0.335**)		
Largemouth bass	2/2	0.020±0.009 (0.013-0.026)		
Smallmouth buffalo	1/1	**0.552**		
White crappie	2/2	0.013±0.001 (0.012-0.013)		
All fish combined	10/10	**0.147**±0.180 (0.012-**0.552**)		

[o] Emboldened numbers denote that PCB concentrations equal and/or exceed the DSHS HAC value for PCBs.

Table 4.2. PCBs (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 3 Mountain Creek Lake near Cooperation Lane				
Channel catfish	5/5	**0.091**[p]±0.117 (0.024-**0.299**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Common carp	1/1	**0.651**		
Freshwater drum	7/7	**1.740**		
Largemouth bass	3/3	0.022±0.005 (0.016-0.026)		
Smallmouth buffalo	1/1	**0.247**		
White bass	6/6	**0.128**±0.084 (**0.067**-**0.296**)		
White crappie	2/2	0.025±0.018 (0.012-0.037)		
All fish combined	19/19	**0.209**±0.402 (0.012-**1.740**)		
Site 4 Mountain Creek Lake at Dam				
Flathead catfish	1/1	**0.100**	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Freshwater drum	2/2	**0.051**±0.049 (0.016-**0.086**)		
Largemouth bass	3/3	0.033±0.011 (0.023-**0.044**)		
Smallmouth buffalo	1/1	**0.193**		
White bass	1/1	0.032		
All fish combined	8/8	**0.066**±0.060 (0.016-**0.193**)		

[p] Emboldened numbers denote that PCB concentrations equal and/or exceed the DSHS HAC value for PCBs.

Table 4.3. PCBs (mg/kg) in fish collected from Mountain Creek Lake by sample site, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 5 Mountain Creek Lake at Power Plant Intake				
Channel catfish	2/2	**0.151**[q]±0.103 (0.078-**0.224**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Flathead catfish	2/2	0.045±0.040 (0.017-**0.073**)		
Freshwater drum	1/1	**0.063**		
Largemouth bass	3/3	0.022±0.010 (0.010-0.030)		
Smallmouth buffalo	1/1	**1.647**		
White bass	1/1	**0.052**		
White crappie	2/2	0.008±0.003 (0.006-0.011)		
All fish combined	13/13	**0.173**±0.447 (0.006-**1.647**)		
Site 6 Mountain Creek Lake at Power Plant Outfall				
Channel catfish	3/3	0.044±0.038 (0.019-**0.088**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Common carp	1/1	**0.061**		
Largemouth bass	3/3	0.014±0.004 (0.011-0.019)		
Smallmouth buffalo	1/1	**0.307**		
All fish combined	8/8	**0.068**±0.100 (0.011-**0.307**)		
Site 7 Mountain Creek Lake at Mountain Creek				
Channel catfish	5/5	**0.074**±0.068 (0.029-**0.186**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Common carp	1/1	**0.047**		
Freshwater drum	1/1	0.022		
Largemouth bass	1/1	0.010		
Smallmouth buffalo	1/1	**0.206**		
White crappie	2/2	0.009±0.002 (0.007-0.010)		
All fish combined	11/11	**0.061**±0.071 (0.007-**0.206**)		

[q] Emboldened numbers denote that PCB concentrations equal and/or exceed the DSHS HAC value for PCBs.

Table 4.4. PCBs (mg/kg) in fish collected from Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	20/20	**0.097**[r]±0.091 (0.019-**0.305**)	0.047 0.272	EPA Chronic Oral RfD for Aroclor 1254 — 0.00002 mg/kg–day EPA Slope Factor — 2.0 per mg/kg–day
Common carp	4/4	**0.204**±0.298 (**0.047**-**0.651**)		
Flathead catfish	3/3	**0.063**±0.042 (0.017-**0.100**)		
Freshwater drum	8/8	**0.326**±0.582 (0.016-**1.740**)		
Largemouth bass	20/20	**0.047**±0.051 (0.010-**0.187**)		
Smallmouth buffalo	7/7	**0.542**±0.518 (**0.193**-**1.647**)		
White bass	8/8	**0.107**±0.082 (0.032-**0.296**)		
White crappie	10/10	0.014±0.009 (0.006-0.037)		
All fish combined	80/80	**0.141**±0.283 (0.006-**1.740**)		

[r] Emboldened numbers denote that PCB concentrations equal and/or exceed the DSHS HAC value for PCBs.

Table 5.1. PCDDs/PCDFs toxicity equivalent (TEQ) concentrations (pg/g) in fish collected from the Mountain Creek Lake by sample site, 2015.

Species	Number Detected/ Number Tested	Mean ± S.D. (Min-Max)	HAC Value (nonca; mg/kg)	Basis for Comparison Value
Site 1 Mountain Creek Lake at Cottonwood Cove				
Channel catfish	3/3	1.272±0.712 (0.546-1.969)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Common carp	1/1	1.358		
Largemouth bass	5/5	0.865±0.386 (0.317-1.355)		
Smallmouth buffalo	1/1	**4.635**[s]		
White crappie	0/1	ND		
All fish combined	10/11	1.285±1.240 (ND-**4.635**)		
Site 2 Mountain Creek Lake at Cottonwood Cove Canal				
Channel catfish	2/2	0.996±0.579 (0.587-1.406)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Freshwater drum	3/3	**2.457**±2.882 (0.667-**5.782**)		
Largemouth bass	2/2	0.220±0.066 (0.173-0.266)		
Smallmouth buffalo	1/1	**4.583**		
White crappie	2/2	0.110±0.045 (0.079-0.142)		
All fish combined	10/10	1.461±2.023 (0.079-**5.782**)		

[s] Emboldened numbers denote that PCDD/PCDF TEQ concentrations equal and/or exceed the DSHS HAC value for PCDDs/PCDFs.

Table 5.2. PCDDs/PCDFs toxicity equivalent (TEQ) concentrations (pg/g) in fish collected from the Mountain Creek Lake by sample site, 2015.

Species	Number Detected/ Number Tested	Mean ± S.D. (Min-Max)	HAC Value (nonca; mg/kg)	Basis for Comparison Value
Site 3 Mountain Creek Lake near Cooperation Lane				
Channel catfish	4/5	0.341±0.238 (ND-0.631)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Common carp	1/1	**3.667**[t]		
Freshwater drum	7/7	**5.686**		
Largemouth bass	2/3	0.036±0.033 (ND-0.063)		
Smallmouth buffalo	1/1	2.125		
White bass	6/6	1.484±1.034 (0.563-**3.285**)		
White crappie	0/2	ND		
All fish combined	15/19	1.168±1.559 (ND-**5.686**)		
Site 4 Mountain Creek Lake at Dam				
Flathead catfish	1/1	1.284	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Freshwater drum	2/2	0.707±0.572 (0.302-1.111)		
Largemouth bass	3/3	0.295±0.121 (0.188-0.427)		
Smallmouth buffalo	1/1	**5.590**		
White bass	1/1	0.293		
All fish combined	8/8	1.183±1.828 (0.188-**5.590**)		

[t] Emboldened numbers denote that PCDD/PCDF TEQ concentrations equal and/or exceed the DSHS HAC value for PCDDs/PCDFs.

Table 5.3. PCDDs/PCDFs toxicity equivalent (TEQ) concentrations (pg/g) in fish collected from the Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Site 5 Mountain Creek Lake at Power Plant Intake				
Channel catfish	2/2	1.258±0.788 (0.701-1.815)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Flathead catfish	2/2	0.284±0.115 (0.203-0.365)		
Freshwater drum	0/1	ND		
Largemouth bass	2/3	0.232±0.243 (ND-0.485)		
Smallmouth buffalo	1/1	**4.103**[u]		
White bass	1/1	0.859		
White crappie	0/3	ND		
All fish combined	9/13	0.673±1.152 (ND-**4.103**)		
Site 6 Mountain Creek Lake at Power Plant Outfall				
Channel catfish	3/3	0.508±0.441 (0.235-1.017)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Common carp	1/1	0.708		
Largemouth bass	3/3	0.183±0.070 (0.129-0.262)		
Smallmouth buffalo	1/1	**3.371**		
All fish combined	8/8	0.769±1.096 (0.129-**3.371**)		
Site 7 Mountain Creek Lake at Mountain Creek				
Channel catfish	5/5	1.303±1.343 (0.183-**3.526**)	2.33 3.49	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day EPA Slope Factor — 1.56 x 105 per mg/kg–day
Common carp	1/1	0.717		
Freshwater drum	1/1	0.293		
Largemouth bass	1/1	0.084		
Smallmouth buffalo	1/1	1.849		
White crappie	1/2	0.063±0.089 (ND-0.126)		
All fish combined	10/11	0.871±1.068 (ND-**3.526**)		

[u] Emboldened numbers denote that PCDD/PCDF TEQ concentrations equal and/or exceed the DSHS HAC value for PCDDs/PCDFs.

Table 5.4. PCDDs/PCDFs toxicity equivalent (TEQ) concentrations (pg/g) in fish collected from the Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Channel catfish	19/20	0.903±0.838 (ND-**3.526**[v])		
Common carp	4/4	1.613±1.403 (0.708-**3.667**)		
Flathead catfish	3/3	0.617±0.583 (0.203-1.284)		
Freshwater drum	7/8	1.846±2.427 (ND-**5.782**)	2.33	ATSDR Chronic Oral MRL for 2,3,7,8 – TCDD —1.0 x 10-9 mg/kg–day
Largemouth bass	18/20	0.355±0.371 (ND-1.355)	3.49	EPA Slope Factor — 1.56 x 105 per mg/kg–day
Smallmouth buffalo	7/7	**3.751**±1.378 (1.849-**5.590**)		
White bass	8/8	1.257±0.982 (0.293-**3.285**)		
White crappie	3/10	0.035±0.058 (ND-0.142)		
All fish combined	69/80	1.061±1.426 (ND-**5.782**)		

[v] Emboldened numbers denote that PCDD/PCDF TEQ concentrations equal and/or exceed the DSHS HAC value for PCDDs/PCDFs.

Table 6. Volatile organic compounds (mg/kg) in fish collected from the Mountain Creek Lake by species, 2015.				
Species	**Number Detected/ Number Tested**	**Mean ± S.D. (Min-Max)**	**HAC Value (nonca; mg/kg)**	**Basis for Comparison Value**
Trichlorofluoromethane				
Channel catfish	5/5	0.040±0.032 (0.010-0.076)	700	EPA Chronic Oral RfD — 3.0E-1 (mg/kg)/day
Largemouth bass	5/5	0.099±0.128 (0.027-0.326)		
Smallmouth buffalo	6/6	0.170±0.131 (0.032-0.415)		
All fish combined	16/16	0.107±0.116 (0.010 -0.415)		

Table 7. Hazard quotients (HQs) for mercury in fish collected from Mountain Creek Lake in 2015. Table 7 also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[w]			
Species	**Number of Samples**	**Hazard Quotient**	**Meals per Week**
Channel catfish	20	0.07	13.0
Common carp	4	0.07	12.7
Flathead catfish	3	0.05	unrestricted[x]
Freshwater drum	8	0.19	4.9
Largemouth bass	20	0.16	5.9
Smallmouth buffalo	7	0.04	unrestricted
White bass	8	0.14	6.5
White crappie	10	0.07	13.2
All fish combined	80	0.11	8.4

[w] DSHS assumes that children under 12 years of age and/or those that weigh less than 35 kg eat four-ounce meals.

[x] Denotes that the allowable eight-ounce meals per week are > 16.0.

Table 8.1. Hazard quotients (HQs) and hazard indices (HIs) for PCBs and/or PCDDs/PCDFs in fish collected from Mountain Creek Lake in 2015. Table 8.1 also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[y]			
Contaminant/Species	**Number of Samples**	**Hazard Quotient**	**Meals per Week**
Channel catfish			
PCBs	20	**2.08**[z]	**0.4**[aa]
PCDDs/PCDFs		0.39	2.4
Hazard Index (meals per week)		**2.47**	**0.4**
Common carp			
PCBs	4	**4.37**	**0.2**
PCDDs/PCDFs		0.69	1.3
Hazard Index (meals per week)		**5.06**	**0.2**
Flathead catfish			
PCBs	3	**1.35**	**0.7**
PCDDs/PCDFs		0.26	3.5
Hazard Index (meals per week)		**1.61**	**0.6**
Freshwater drum			
PCBs	8	**6.99**	**0.1**
PCDDs/PCDFs		0.79	1.2
Hazard Index (meals per week)		**7.78**	**0.1**
Largemouth bass			
PCBs	20	**1.01**	**0.9**
PCDDs/PCDFs		0.15	6.1
Hazard Index (meals per week)		**1.16**	**0.8**

[y] DSHS assumes that children under 12 years of age and/or those that weigh less than 35 kg eat four-ounce meals.
[z] Emboldened numbers denote that the HQ or HI is ≥ 1.0.
[aa] Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.

Table 8.2. Hazard quotients (HQs) and hazard indices (HIs) for PCBs and/or PCDDs/PCDFs in fish collected from Mountain Creek Lake in 2014. Table 8.2 also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[bb]			
Contaminant/Species	**Number of Samples**	**Hazard Quotient**	**Meals per Week**
Smallmouth buffalo			
PCBs	7	**11.61**[cc]	**0.1**[dd]
PCDDs/PCDFs		**1.61**	**0.6**
Hazard Index (meals per week)		**13.22**	**0.1**
White bass			
PCBs	8	**2.29**	**0.4**
PCDDs/PCDFs		0.54	1.7
Hazard Index (meals per week)		**2.83**	**0.3**
White crappie			
PCBs	10	0.30	3.1
PCDDs/PCDFs		0.02	unrestricted[ee]
Hazard Index (meals per week)		0.32	2.9
All fish combined			
PCBs	80	**3.02**	**0.3**
PCDDs/PCDFs		0.45	2.0
Hazard Index (meals per week)		**3.48**	**0.3**

[bb] DSHS assumes that children under 12 years of age and/or those that weigh less than 35 kg eat four-ounce meals.
[cc] Emboldened numbers denote that the HQ or HI is ≥ 1.0.
[dd] Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.
[ee] Denotes that the allowable eight-ounce meals per week are > 16.0.

Table 9.1. Calculated theoretical lifetime excess cumulative cancer risk from consuming fish collected in 2015 from Mountain Creek Lake containing carcinogens and suggested consumption rate (eight-ounce meals/week) for 70 kg adults who regularly eat fish from Mountain Creek Lake over a 30-year period.[ff]

Species/Contaminant	Number of Samples	Theoretical Lifetime Excess Cancer Risk		Meals per Week
		Risk	Population Size that Would Result in One Excess Cancer	
Channel catfish				
Arsenic	5	1.7E-06	604,938	unrestricted[gg]
Chlordane		9.64E-07	1,037,037	unrestricted
Dieldrin		2.9E-06	340,278	unrestricted
Total DDT		1.5E-06	667,211	unrestricted
PCBs	20	3.6E-05	28,064	2.6
PCDDs/PCDFs		2.6E-05	38,649	3.6
Cumulative Cancer Risk		6.6E-05	15,239	1.5
Common carp				
PCBs	4	7.5E-05	13,344	1.2
PCDDs/PCDFs		4.6E-05	21,637	2.0
Cumulative Cancer Risk		**1.2E-04**[hh]	**8,254**	**0.8**[ii]
Flathead catfish				
PCBs	3	2.3E-05	43,210	4.0
PCDDs/PCDFs		1.8E-05	56,564	5.2
Cumulative Cancer Risk		4.1E-05	24,497	2.3

[ff] DSHS assumes that children under 12 years of age and/or those who weigh less than 35 kg eat 4-ounce meals.
[gg] Denotes that the allowable eight-ounce meals per week are > 16.0.
[hh] Emboldened numbers denote calculated excess lifetime cancer risk after 30 years exposure is greater than 1.0E-04.
[ii] Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.

Table 9.2. Calculated theoretical lifetime excess cumulative cancer risk from consuming fish collected in 2015 from Mountain Creek Lake containing carcinogens and suggested consumption rate (eight-ounce meals/week) for 70 kg adults who regularly eat fish from Mountain Creek Lake over a 30-year period.[jj]				
Species/Contaminant	**Number of Samples**	**Theoretical Lifetime Excess Cancer Risk**		**Meals per Week**
		Risk	**Population Size that Would Result in One Excess Cancer**	
Freshwater drum				
PCBs	8	**1.2E-04**[kk]	**8,350**	**0.8**[ll]
PCDDs/PCDFs		5.3E-05	18,906	1.7
Cumulative Cancer Risk		**1.7E-04**	**5,792**	**0.5**
Largemouth bass				
Chlordane	5	1.67E-07	5,982,906	unrestricted[mm]
Dieldrin		2.9E-06	340,278	unrestricted
Total DDT		3.1E-07	3,202,614	unrestricted
PCBs	20	1.7E-05	57,920	5.4
PCDDs/PCDFs		1.1E-05	98,311	9.1
Cumulative Cancer Risk		2.8E-05	35,821	3.3
Smallmouth buffalo				
Arsenic	6	7.2E-06	139,601	12.9
Chlordane		1.7E-06	598,291	unrestricted
Dieldrin		2.9E-06	340,278	unrestricted
Total DDT		2.2E-06	457,516	unrestricted
PCBs	7	**2.0E-04**	**5,023**	**0.5**
PCDDs/PCDFs		**1.1E-04**	**9,304**	**0.9**
Cumulative Cancer Risk		**3.1E-04**	**3,262**	**0.3**

[jj] DSHS assumes that children under 12 years of age and/or those who weigh less than 35 kg eat 4-ounce meals.
[kk] Emboldened numbers denote calculated excess lifetime cancer risk after 30 years exposure is greater than 1.0E-04.
[ll] Emboldened numbers denote that the calculated allowable meals for an adult are ≤ one meal per week.
[mm] Denotes that the allowable eight-ounce meals per week are > 16.0.

Table 9.3. Calculated theoretical lifetime excess cumulative cancer risk from consuming fish collected in 2015 from Mountain Creek Lake containing carcinogens and suggested consumption rate (eight-ounce meals/week) for 70 kg adults who regularly eat fish from Mountain Creek Lake over a 30-year period.[nn]

Species/Contaminant	Number of Samples	Theoretical Lifetime Excess Cancer Risk		Meals per Week
		Risk	Population Size that Would Result in One Excess Cancer	
White bass				
PCBs	8	3.9E-05	25,441	2.4
PCDDs/PCDFs		3.6E-05	27,765	2.6
Cumulative Cancer Risk		7.5E-05	13,276	1.2
White crappie				
PCBs	10	5.1E-06	194,444	unrestricted[oo]
PCDDs/PCDFs		1.0E-06	997,151	unrestricted
Cumulative Cancer Risk		6.1E-06	162,715	15.0
All fish combined				
Arsenic	16	3.6E-06	279,202	unrestricted
Chlordane		9.6E-07	1,037,037	unrestricted
Dieldrin		2.9E-06	340,278	unrestricted
Total DDT		1.4E-06	727,867	unrestricted
PCBs	80	5.2E-05	19,307	1.8
PCDDs/PCDFs		3.0E-05	32,894	3.0
Cumulative Cancer Risk		8.8E-05	11,349	1.0

[nn] DSHS assumes that children under 12 years of age and/or those who weigh less than 35 kg eat 4-ounce meals.
[oo] Denotes that the allowable eight-ounce meals per week are > 16.0.

Table 10. SALG recommended fish consumption advice for Mountain Creek Lake, 2015.			
Contaminants of Concern	**Species**	**Women of childbearing age and children < 12**	**Women past childbearing age and males 12 and older**
Dioxins and PCBs	Channel catfish	**DO NOT EAT**	1 meal/month
	Common carp	**DO NOT EAT**	**DO NOT EAT**
	Flathead catfish	1 meal/month	2 meals/month
	Freshwater drum	**DO NOT EAT**	**DO NOT EAT**
	Largemouth bass	1 meal/month	3 meals/month
	Smallmouth buffalo	**DO NOT EAT**	**DO NOT EAT**
	White bass	**DO NOT EAT**	1 meal/month

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