Characterization of Potential Adverse Health Effects Associated with Consuming Fish from

Mountain Creek Lake

Dallas County, Texas

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

INTRODUCTION

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 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)[a], the Texas Natural Resources Conservation Commission (TNRCC)[b], 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. The Texas Commission on Environmental Quality (TCEQ) requested the present survey of Mountain Creek Lake as a five-year follow-up study under the Total Maximum Daily Load (TMDL) program for previously adopted TMDLs.

Description of Mountain Creek Lake

Mountain Creek Lake, a 2,710-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.[6,7] 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 eight feet and maximum depth of 26 feet.[6] The shoreline fishery habitat is primarily rip-rap and native emergent vegetation. Public access is limited to an

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

undeveloped park and boat ramp on the east side of the reservoir and Mountain Creek Lake Park[8] operated by the City of Grand Prairie, Texas on the west side of the reservoir.

Demographics of Dallas County Surrounding the Area of 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.[9] In 2008, according to the United States Census Bureau's (USCB) estimate, the 12 county Dallas-Fort Worth-Arlington metropolitan area has a population near 6,300,006.[9] The USCB also reported that the Dallas-Fort Worth-Arlington metropolitan area is the fastest growing metropolitan area in the United States, which gained 1,138,476 residents from April 1, 2000 to July 1, 2008.[9] The Metroplex covers approximately 9,286 square miles; an area larger than the combined states of Connecticut and Rhode Island.

Subsistence Fishing in 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 the rate of subsistence fishing in an area.[10] The Department of State Health Services (DSHS) finds, in concert with the USEPA, that 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 chemically contaminated fish or shellfish from a water body – or those who eat large quantities of fish from the same waters – could unknowingly increase their risk of adverse health effects from that consumption. 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 does occur. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.[10]

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),[11] all states must establish a TMDL for each pollutant contributing to the impairment of a water body for one or more designated uses. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources. TMDLs incorporate margins of safety to ensure the usability of the water body for all designated purposes and to account for seasonal variations in water quality. 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.[7]

Fish consumption is a recognized use for many waters. A water body is impaired if fish from that 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 devised by the TCEQ. Thus, whenever the DSHS issues a fish consumption advisory or prohibits possession of environmentally contaminated fish, the TCEQ automatically places the water body on its current draft 303(d) List.[7] The TCEQ is responsible for confirming the impairment and , if necessary, the TMDL program, then prepares a TMDL for each contaminant present at concentrations 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.

METHODS

Fish Sampling, Preparation, and Analysis

The DSHS Seafood and Aquatic Life Group (SALG) collects and analyzes edible fish from the state's public waters to evaluate potential risks to the health of people consuming contaminated fish or shellfish. Fish tissue sampling follows standard operating procedures from the DSHS *Seafood and Aquatic Life Group Survey Team Standard Operating Procedures and Quality Control/Assurance Manual.*[12] The SALG bases its sampling and analysis protocols, in part, on procedures recommended by the USEPA in that agency's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1.*[13] Advice and direction are also received from the legislatively mandated *State of Texas Toxic Substances Coordinating Committee (TSCC) Fish Sampling Advisory Subcommittee (FSAS).*[14] 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 Mountain Creek Lake 2008 Sample Set

In October 2008, SALG staff collected 80 fish samples from Mountain Creek Lake. Risk assessors used data from these fish to assess the potential for adverse human health outcomes from consuming fish from this reservoir.

Seven sites were selected to provide spatial coverage of the study area (see Figure 1 for approximate locations). Site 1 was located at Cottonwood Cove, Site 2 at Cottonwood Cove Canal, Site 3 near Cooperation Lane, Site 4 near the Dam, Site 5 near the Power Plant Intake, Site 6 at the Power Plant Discharge, and Site 7 near Mountain Creek mouth. Species collected represent distinct ecological groups (i.e. predators and bottom feeders) that have some potential to bioaccumulate 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 represented all species targeted for collection from this water body. Table 1 lists species sampled, the sample number of each species collected, and the length and weight (in metric units) of each sample from each collection site. Fish species for the 2008 Mountain Creek Lake project are listed in descending order by number of each species collected: channel catfish (20), largemouth bass (20), white bass (10), white crappie (10) common carp (7), freshwater drum (7), and smallmouth buffalo (6).

The SALG set gill nets in the late afternoon at each of the sample sites and fished those sites overnight. The gill nets were set in locations to maximize available cover and habitat. Staff retrieved captured fishes from the gill nets in the early morning hours, retaining only fish pre-selected as target samples. Staff immediately stored retrieved samples on wet ice in large coolers to ensure interim preservation, returning live fish culled from the catch to the water body.

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.

SALG staff processed fish onsite at Mountain Creek Lake**.** Staff weighed each sample to the nearest gram (g) on an electronic scale and measured total length (tip of nose to tip of tail fin) to the nearest millimeter (mm). 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 the knife cleaned with distilled water after each sample was processed. The team 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 the chain of custody remains intact while samples are in the possession of agency staff. The week following the collection trip, the SALG shipped frozen fish tissue samples by commercial carrier to the Geochemical and Environmental Research Group (GERG) Laboratory, Texas A&M University, College Station, Texas, for contaminant analysis.

Analytical Laboratory Information

Upon arrival of the samples at the laboratory, GERG personnel notified the SALG of 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, 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, and 17 polychlorinated dibenzofurans and/or dibenzo-*p*-dioxins (PCDFs/PCDDs) congeners. The laboratory analyzed all 80 samples for PCBs. A subset of 16 samples were selected for metals, pesticides, SVOCs, VOCs, and PCDFs/PCDDs analyses.[15]

Explanatory Details of Specific Analyses

Arsenic

The GERG laboratory analyzed each of 16 fish 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 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.[16] DSHS, taking a conservative approach, estimates 10% of the total arsenic in any fish is inorganic arsenic, deriving estimates of inorganic arsenic concentration in each fish by multiplying reported total arsenic concentration in the sample by a factor of 0.1.[16]

Mercury

Nearly all mercury in upper trophic level fish three years of age or older is methylmercury.[17] 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 that all reported mercury in fish or shellfish is methylmercury. The GERG laboratory thus analyzed fish tissues for total mercury. In its risk characterizations, DSHS compares 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 (in these risk characterizations, the DSHS may interchangeably utilize the terms "mercury," "methylmercury," or "organic mercury" to refer to methylmercury in fish).[18]

Polychlorinated Biphenyls (PCBs)

For PCBs, the USEPA suggests that each state measures congeners of PCBs in fish and shellfish rather than homologs or Aroclors® because the USEPA considers congener analysis the most sensitive technique for detecting PCBs in environmental media.[15] Although only about 130 PCB congeners were routinely present in PCB mixtures manufactured and commonly used in the United States (US), 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),[19] from McFarland and Clarke,[20] and from the

USEPA's guidance documents for assessing contaminants in fish and shellfish[13, 15] to address PCB congeners in fish and shellfish samples, selecting the 43 congeners encompassed by the McFarland and Clark and the NOAA articles. The referenced authors chose to use congeners that were relatively abundant in the environment, were likely to occur in aquatic life, and were most likely – as projected from structure –activity relationships – to show assessable toxicity.[19, 20] SALG risk assessors summed the 43 congeners to derive "total" PCB concentration in each sample.[19,20] 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. Therefore, 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.[21] IRIS currently contains systemic toxicity information for five Aroclor® mixtures: Aroclors® 1016, 1242, 1248, 1254, and 1260. IRIS does not contain all information for all mixtures. For instance, only one other reference dose (RfD) occurs in IRIS – the one derived for Aroclor 1016, a commercial mixture produced in the latter years of commercial production of PCBs in the US. Aroclor 1016 was a fraction of Aroclor 1254 that was supposedly devoid of dibenzofurans, in contrast to Aroclor 1254.[22] Systemic 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, and because, 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 highest slope factor of 2.0 per (mg/kg/day) to calculate the probability of lifetime excess cancer risk from PCB ingestion. The SALG based its decision to use the most restrictive 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.[23]

Calculation of Toxicity Equivalent Quotients (TEQs) for Dioxins

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 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.[24, 25] Using this technique, risk assessors from the DSHS converted PCDF or PCDD congeners in each tissue sample from the present survey to 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.[26]

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

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

Derivation and Application of Health-Based Assessment Comparison Values for Systemic 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, habits of the exposed, or the presence of other chemicals.[27] 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.[27]

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, blue crab, and/or sampling 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 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 derives confidence intervals from Monte Carlo simulations using software developed by a DSHS medical epidemiologist.[28] The SALG evaluates contaminants in fish or shellfish by comparing the mean or the 95% upper confidence limit on the mean concentration of a contaminant to its HAC value (in mg/kg) for non-cancer or cancer endpoints.

In deriving HAC values for systemic (HAC_{nonca}) effects, the SALG assumes a standard adult weighs 70 kilograms (kg) and consumes 30 grams of fish or shellfish per day (about one 8-ounce meal per week) and uses the USEPA's RfD[29] or the ATSDR's chronic oral MRLs.[30] The USEPA defines an RfD as

> *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.*[31]

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.*[31]

The ATSDR uses a similar technique to derive its MRLs.[30] 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 a 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).*[32]

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, a 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. A 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 a 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 a HQ or HI greater than 1.0 "should indicate some cause for concern."

The SALG does not utilize HQs to determine the likelihood of occurrence of adverse systemic health effects. Instead, in a manner similar to the USEPA's decision process, the SALG may utilize computed HQs as a qualitative measurement. Qualitatively, HQs less than 1.0 are unlikely to be an issue while HQs greater than 1.0 might suggest a regulatory action to ensure protection of public health. Similarly, risk assessors at the DSHS may utilize a 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 exceeds 1.0 represents a qualitatively unacceptable increase in the likelihood of systemic adverse health outcomes.

Although the DSHS utilizes 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.[29]

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, use of a subchronic study rather than a chronic study to determine the NOAEL, LOAEL, or BMD, and database insufficiencies.[29,31] 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 and also receive special consideration in calculation of a RfD.[31, 33]

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"), a HI computed from HQs based on the RfDs for the separate chemicals may be overly conservative. That is, using RfDs to calculate HIs may exaggerate 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 HIs 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 calculates 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 calculates 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 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) [31] 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.[34, 35] 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) – times when toxicants can impair or alter the structure or function of susceptible systems.[36] 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.[37] 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.[29] Additionally, in accordance with the ATSDR's *Child Health Initiative*[38] and the USEPA's *National Agenda to Protect Children's Health from Environmental Threats,*[39] 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, 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 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 SPSS® statistical software, version 13.0 installed on IBM-compatible microcomputers (Dell, Inc) and used SPSS® to generate descriptive statistics (mean, standard deviation, median, minimum and maximum concentrations, and range) on measured compounds in each species from each sample site.[40] In computing descriptive statistics, SALG risk assessors utilized ½ the reporting limit (RL) for analytes designated as not detected (ND) or estimated (J-values)[c]. PCDFs/PCDDs descriptive statistics are calculated using estimated concentrations (J-values) and assuming zero for PCDFs/PCDDs designated as ND.[d] The change in methodology for computing PCDFs/PCDDS descriptive statistics is due to the proximity of the reporting limits to the HAC value. Assuming ½ the RL for PCDFs/PCDDs designated as ND or J-values would unnecessarily overestimate the concentration of PCDFs/PCDDs in each fish tissue sample. The SALG used the descriptive statistics from the above calculations to generate the present report. The SALG employed Microsoft Excel® spreadsheets to generate 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.[41] When lead concentrations in fish or shellfish are high, SALG risk assessors may utilize the EPA'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 (10 mcg/dL).[42,43]

RESULTS

The GERG laboratory completed analyses and electronically transmitted the results of the Mountain Creek Lake samples collected in October 2008 to the SALG on August 26, 2009. The laboratory reported the analytical results for metals, pesticides, PCBs, PCDFs/PCDDs, SVOCs, and VOCs.

For reference, Table 1 contains the total number of samples collected. Tables 2a through 2c present the results of metals analyses. Table 3 contains summary results of chlordane and 4,4′-DDE analyses, tables 4a through 4c summarize the PCB analyses, and table 5 summarizes PCDFs/PCDDs analyses. This paper does not display SVOC and VOC data because these contaminants were not present at concentrations of interest in fish collected from Mountain Creek Lake during the described survey. Unless otherwise stated, table summaries present the number of samples containing a specific toxicant/number tested, the mean concentration ± 1 standard deviation (68% of samples should fall within one standard deviation of the arithmetic mean in a sample from a normally-distributed population), and, in parentheses under the mean and standard deviation, the minimum and the maximum detected concentrations. Those who prefer to use the range may derive this statistic by subtracting the minimum concentration of a given toxicant from its maximum concentration. In the tables, results may be reported as ND (not detected), BDL (below detection limit), or as measured concentrations greater than or equal to the contaminant reporting limit (RL). According to the laboratory's quality control/quality assurance materials, results reported as "BDL" rely upon the laboratory's method detection limit (MDL) or its RL. The MDL is the minimum concentration of an analyte that be reported with 99% confidence that the analyte concentration is greater than zero, while the RL is the

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[c] *"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.*

[d] *The SALG risk assessors' rationale for computing PCDFs/PCDDs descriptive statistics using the aforementioned method is based on the proximity of the laboratory reporting limits and the health assessment comparison value for PCDFs/PCDDs. 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 PCDFs/PCDDs fish tissue concentration.*

concentration of an analyte reliably achieved within specified limits of precision and accuracy during routine analyses. Contaminant concentrations reported below the RL are qualified as "J-values" in the laboratory data report.[44]

Inorganic Contaminants

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

A subset of 16 samples was selected from the 80 samples collected from Mountain Creek Lake for metals analyses. The 16 samples comprised three of seven fish species collected from Mountain Creek Lake for this survey. All 16 fish tissue samples examined from Mountain Creek Lake contained some level of arsenic, copper, mercury, selenium, and zinc (Tables 2a- 2c).

Three of the metalloids analyzed are essential trace elements: copper, selenium, and zinc. All 16 fish tissue samples contained copper (Table 2b). The mean copper concentration in fish sampled from Mountain Creek Lake was 0.132±0.063 mg/kg. Smallmouth buffalo had the highest average concentration of copper (0.137±0.088 mg/kg). All fish tissue samples assayed contained selenium. The average selenium concentration in fish from Mountain Creek Lake was 0.363 mg/kg with a standard deviation of ±0.141 mg/kg (Table 2c). Selenium in fish from Mountain Creek Lake ranged from 0.186 to 0.631 mg/kg. All samples examined also contained zinc (Table 2c). The mean zinc concentration in fish tissue samples from Mountain Creek Lake was 2.931±1.438 mg/kg.

The SALG evaluated four toxic metalloids having no known human physiological function (arsenic, cadmium, lead, and mercury) in the samples collected from Mountain Creek Lake. All 16 fish assayed contained arsenic ranging from 0.056-0.285 mg/kg (Table 2a). One fish, a largemouth bass, contained cadmium at a concentration exceeding the laboratory's RL (Table 2b). The three species assayed (channel catfish, largemouth bass, and smallmouth buffalo) contained lead at low concentrations greater than the RL (Table 2b). The average lead concentration in all fish combined was 0.188±0.200 mg/kg (Table 2b).

All 16 fish samples analyzed contained mercury (Table 2b). Channel catfish contained the lowest average mercury concentration (0.090±0.061 mg/kg). A largemouth bass – weighing 7.2 pounds and measuring 23.6 inches – contained the highest mercury concentration of all samples (0.704 mg/kg), a value greater than three standard deviations above the mean for combined species (0.142±0.164 mg/kg).Other species mercury concentrations varied from estimated concentrations to 0.185 mg/kg (Table 2b).

Organic Contaminants

<u>Pesticides</u>

The GERG laboratory analyzed 16 fish for 34 pesticides. All samples examined contained concentrations of chlordane and 4,4′-DDE (Table 3). Chlordane concentrations ranged from BDL-0.086 mg/kg in fish (Table 3). Smallmouth buffalo contained the highest concentration of 4,4′-DDE (0.186 mg/kg; Table 3). The mean 4,4′-DDE concentration in fish was 0.036±0.047

mg/kg. Two of 16 samples assayed contained low concentrations of hexachlorobenzene (data not presented).

PCBs

The present study marks the first instance in which the SALG required analysis of fish tissue samples from Mountain Creek Lake for PCB congeners rather than Aroclors®. Thus, it is important that readers do not attempt to make direct comparisons between PCB concentrations in this report and Aroclor® concentrations from previous studies of Mountain Creek Lake.

All 80 fish tissue samples assayed contained concentrations of one or more PCB congeners (Tables 4a through 4c). No fish sample contained all PCB congeners (data not shown). Across all sites and species, PCB concentrations in fish ranged from 0.009 mg/kg (white crappie) to 0.949 mg/kg (freshwater drum; Table 4c). Six of seven fish species evaluated had mean PCB congener concentrations that exceeded the DSHS HAC_{nonca} for PCBs (0.047 mg/kg; Table 4c). Smallmouth buffalo contained the highest mean concentration of PCBs (0.463±0.227 mg/kg), followed by freshwater drum (0.291±0.314 mg/kg), followed by channel catfish (0.153±0.159 mg/kg), followed by common carp (0.113±0.116 mg/kg), followed by white bass (0.106±0.066 mg/kg), and then by largemouth bass (0.058±0.062 mg/kg). White crappie contained the lowest mean concentration of PCBs (0.012 mg/kg; Table 4c). The mean PCB concentration in all 80 fish tissue samples assayed was 0.138±0.182 mg/kg (Table 4c).

The DSHS SALG evaluated the PCB data using univariate analysis of variance (ANOVA) to determine if there were differences in fish tissue PCB concentrations between the seven Mountain Creek Lake sample sites. The ANOVA revealed that there were no differences in fish tissue PCB concentrations between sample sites ($F(6, 73) = 1.066$, $p = 0.391$). Because PCB concentrations did not statistically differ between sample sites, SALG risk assessors used data combined from all sample sites to assess health risks associated with consuming PCB-contaminated fish from Mountain Creek Lake.

PCDFs/PCDDs

The GERG laboratory analyzed 16 fish tissue samples for 17 of the 210 possible PCDF/PCDD (135 PCDFs + 75 PCDDs) congeners from Mountain Creek Lake. The congeners examined consist of 10 PCDFs and 7 PCDDs that contain chlorine substitutions in, at a minimum, the 2, 3, 7, and 8 positions on the dibenzofuran or dibenzo-*p*-dioxin nucleus and are the only congeners reported to pose dioxin-like adverse human health effects.[45] Although 12 of the 209 PCB congeners – those often referred to as "coplanar PCBs," meaning the molecule can assume a flat configuration with both phenyl rings in the same plane – may also have dioxin-like toxicity, the SALG does not assess PCBs for dioxin-like qualities because the dioxin-like behavior has been less extensively evaluated. Table 5 contains species-specific summary statistics for PCDFs/PCDDs in fish collected from Mountain Creek Lake. Before generating summary statistics for PCDFs/PCCDs, the SALG risk assessors converted the reported concentration of each PCDF or PCDD congener reported present in a tissue sample to a concentration equivalent in toxicity to that of 2,3,7,8-TCDD (a TEQ concentration - expressed as pg/g). All fish tissue samples contained at least one of the 17 congeners assayed (minimum – to – maximum concentration after conversion: 0.001-6.622 pg/g; Table 5). No samples contained all 17 congeners (data not shown). Smallmouth buffalo contained the highest mean TEQ concentration (2.548±2.323 pg/g), followed by channel catfish (0.526±1.076 pg/g).

SVOCs

A subset of 16 samples was selected from the 80 samples collected from Mountain Creek Lake for SVOCs analyses. The laboratory detected no SVOCs in fish from Mountain Creek Lake.

VOCs

The GERG laboratory reported the 16 fish tissue samples selected for analysis from Mountain Creek Lake to contain quantifiable concentrations >RL of one or more VOCs: acetone, carbon disulfide, methylene chloride, trichlorofluoromethane, and toluene (data not presented). Trace quantities[e] of most VOCs were also present in one or more fish tissue samples assayed from Mountain Creek Lake (data not presented). The *Seafood and Aquatic Life Group Survey Team Standard Operating Procedures and Quality Control/Assurance Manual* contains a complete list of the 70 VOCs selected for analysis.[12] All VOCs, excluding chloromethane, vinyl chloride, bromomethane, chloroethane, and dichlorodifluoromethane, were also identified in one or more of the procedural blanks, indicating the possibility that these compounds were introduced during sample preparation. VOC concentrations <RL are difficult to interpret due to their uncertainty and may represent a false positive. The presence of many VOCs at concentrations <RL may be the result of incomplete removal of the calibration standard from the adsorbent trap, so they are observed in the blank. VOCs analytical methodology requires that VOCs are thermally released from the adsorbent trap, transferred to the gas chromatograph (GC), and into the GC/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. Since 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.[29] Despite such limitations, risk assessors must calculate parameters to represent potential toxicity to humans who consume contaminants in fish and other environmental media.

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[e] *Trace: in analytical chemistry, a trace is an extremely small amount of a chemical compound, one present in a sample at a concentration below a standard limit. Trace quantities may be designated with the "less than" (<) sign or may also be represented by the alpha character "J" – called a "J-value" defining the concentration of a substance as near zero or one that is detected at a low level but that is not guaranteed quantitatively replicable*

The DSHS calculated risk parameters for systemic and cancerous endpoints in those who would consume fish from 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. Meal consumption calculations are integral to the SALG's risk characterizations and are used by DSHS risk managers to determine whether consumption advice or regulatory actions might be necessary to protect human health from adverse effects of consuming toxicants in fish from Texas waters.

Characterization of Systemic (Noncancerous) Health Effects from Consumption of Fish from Mountain Creek Lake

PCBs and PCDFs/PCDDs were observed in fish from Mountain Creek Lake that equaled or exceeded their respective HAC_{nonca} (Tables 4a through 5). No species of fish collected from Mountain Creek Lake contained any other inorganic or organic contaminants at concentrations that equaled or exceeded the DSHS guidelines for protection of human health or would likely cause systemic risk to human health from consumption of fish from Mountain Creek Lake (Tables 4a-5). Potential systemic health risks related to the consumption of fish from Mountain Creek Lake containing inorganic and organic contaminants (other than PCBs and PCDFs/PCDDs) are not of public health concern. Consequently, this risk characterization concentrates on assessing the likelihood of adverse health outcomes that could occur from consumption of Mountain Creek Lake PCB and PCDFs/PCDDs-contaminated fish. Tables 6 through 7 provide hazard quotients for mercury, PCBs, and PCDFs/PCDDs in each species of fish collected from Mountain Creek Lake and the recommended weekly consumption rate for each species.

<u>PCBs</u>

All fish collected from Mountain Creek Lake in 2008 contained PCBs (Tables 4a through 4c). Sixty one percent of all samples (N = 80) analyzed contained PCB concentrations that equaled or exceeded the HAC_{nonca} for PCBs (0.047 mg/kg). Mean PCB concentrations for channel catfish, common carp, freshwater drum, largemouth bass, smallmouth buffalo, and white bass assayed exceeded the HAC_{nonca} for PCBs or a HQ of 1.0 (Tables 4c and 7), and the *All Species* mean PCB concentration (0.138 mg/kg) exceeded the HAC_{nonca} for PCBs or a HQ of 1.0 (Tables 4c and 7), representing a potential systemic health risk related to the consumption of fish from Mountain Creek Lake. White crappie, a lower trophic level fish, was the only species assayed that did not contain PCB concentrations exceeding the HAC_{nonca} for PCBs or a HQ of 1.0 (Tables 4c and 7).

Meal consumption calculations may be useful for decisions about consumption advice or regulatory actions. The SALG risk assessors calculated the number of 8-ounce meals of fish from Mountain Creek Lake that healthy adults could consume without significant risk of adverse systemic effects (Table 7). The SALG estimated this group could consume 0.3 (8-ounce) meals per week of fish containing PCBs (Table 7), suggesting that fish from Mountain Creek Lake contain PCBs at concentrations that could result in adverse effects on human health and that adults limit their consumption of fish from Mountain Creek Lake. The developing nervous system of the human fetus may be especially susceptible to these effects.

PCDFs/PCDDs

All fish collected from Mountain Creek Lake in 2008 contained PCDFs/PCDDs (Table 5). Nineteen percent of all samples (N = 16) analyzed contained PCDFs/PCDDs concentrations that equaled or exceeded the HAC_{nonca} for PCDFs/PCDDs (2.33 pg/g). The mean PCDFs/PCDDs concentration for smallmouth buffalo assayed exceeded the HAC_{nonca} for PCDFs/PCDDs or a HQ of 1.0 (Tables 5 and 7) representing a potential systemic health risk related to the consumption of smallmouth buffalo from Mountain Creek Lake. The *All Species* mean PCDFs/PCDDs concentration (1.190 pg/g) did not exceed the HAC_{nonca} for PCDFs/PCDDs (Tables 5). PCDFs/PCDDs concentrations observed in fish excluding smallmouth buffalo do not exceed the DSHS guidelines for protection of human health or are not likely to cause systemic risk to human health from consumption of fish (Tables 5 and 7).

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

The USEPA classifies arsenic, 4,4′-DDE, chlordane, PCBs, and PCDFs/PCDDs as carcinogens. Although arsenic, PCDFs/PCDDs, and chlorinated pesticides were present in samples from Mountain Creek Lake, none were observed at concentrations that would be likely to substantially increase the risk of cancer to exceed the DSHS guideline for protection of human health of 1 excess cancer in 10,000 equally exposed individuals (Table 8). PCBs contribute the majority of the calculated increase in the theoretical probability of cancer associated with consumption of fish from Mountain Creek Lake.

PCBs

The mean concentration of PCBs in freshwater drum and smallmouth buffalo exceeded the HAC_{ca} for PCBs (Table 4c). The excess cancer risk for those consuming PCB-contaminated freshwater drum or smallmouth buffalo was approximately 1 in 9,355 equally exposed individuals and 1 in 5,880, respectively (Table 8). Based on these cancer risk estimates, the SALG risk assessors calculated that healthy adults could consume 0.9 (8-ounce) meals per week of freshwater drum or 0.5 (8-ounce) meals per week of smallmouth buffalo containing PCBs (Table 8) suggesting that people should limit consumption of these species of fish from Mountain Creek Lake. PCB concentrations observed in freshwater drum and smallmouth buffalo might cause or contribute to cancer in people who regularly consume these species from Mountain Creek Lake. The mean concentration of PCBs ($\bar{x}$ = 0.138 mg/kg) in fish did not exceed the HAC_{ca} for PCBs or the DSHS guideline of 1 excess cancer in 10,000 equally exposed individuals who consume fish from Mountain Creek Lake (Table 4c and 8).

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

Cumulative systemic 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 PCDFs/PCDDs in Mountain Creek Lake fish could have these properties, especially with respect to effects on the immune system. Multiple inorganic or organic contaminants in the Mountain Creek Lake samples did not increase the likelihood of systemic adverse health outcomes from consuming any species of fish from Mountain Creek Lake above that of the potential health risks associated with consuming PCB-contaminated fish (Table 2a-7). The SALG also queried the probability of increasing lifetime excess cancer risk from consuming fish containing multiple inorganic and organic contaminants. Consumption of multiple contaminants in fish from Mountain Creek Lake did not increase the calculated lifetime excess cancer risk to a risk significantly larger than that of PCBs alone in these fish (all data not shown; Table 8).

CONCLUSIONS

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, SALG may suggest strategies for reducing risk to the health of those who may eat contaminated fish or seafood to risk managers at 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. Risk assessors from the SALG conclude from the present characterization of potential adverse health effects from consuming fish from Mountain Creek Lake

1. That white crappie do not contain PCB concentrations exceeding the HAC_{nonca} for PCBs. Therefore, consumption of white crappie **poses no apparent risk to human health**.

2. That fish excluding white crappie from Mountain Creek Lake contained PCBs at concentrations exceeding DSHS guidelines for protection of human health. Regular or long-term consumption of fish from Mountain Creek Lake may result in adverse health effects. Therefore, consumption of fish from Mountain Creek Lake **poses an apparent risk to human health**.

3. That smallmouth buffalo contain PCDFs/PCDDs at concentrations exceeding DSHS guidelines for protection of human health. Regular or long-term consumption of smallmouth buffalo from Mountain Creek Lake may result in adverse health effects. Therefore, consumption of smallmouth buffalo **poses an apparent risk to human health**.

4. That consumption of multiple inorganic or organic contaminants in fish does not significantly increase the likelihood of systemic or carcinogenic health risks above that of PCBs observed in fish from Mountain Creek Lake. Therefore, SALG risk assessors conclude that consuming fish containing multiple contaminants at concentrations near those observed in fish in addition to PCBs do not significantly increase the risk of adverse health effects.

RECOMMENDATIONS

Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the USEPA.[13, 15, 46] Risk managers at the DSHS may decide to take some action to protect public health if a risk characterization confirms that people can eat four, or fewer meals per month (adults: eight ounces per meal; children: 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).[47] Declarations of prohibited harvesting areas are enforceable under the Texas Health and Safety Code, Subchapter D, parts 436.091 and 436.101.[47] 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, members of the public 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 fish from Mountain Creek Lake **poses an apparent hazard to public health.** Therefore, SALG risk assessors recommend

1. That pregnant women, women who may become pregnant, women who are nursing, infants, and children less than 12 years of age or who weigh less than 75 pounds should not consume any species of fish from Mountain Creek Lake.

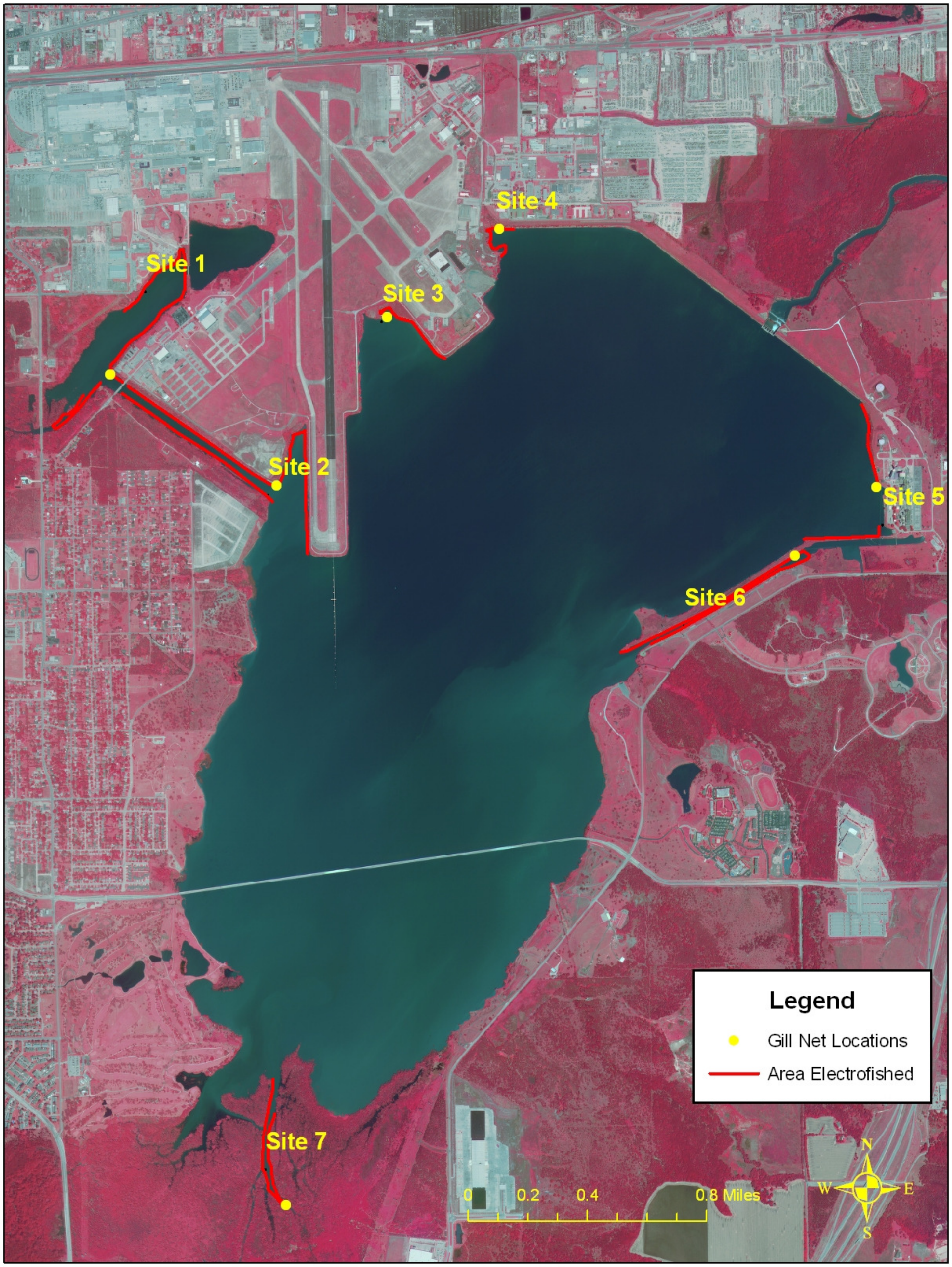
2. That adult men and women past childbearing age should not consume any species of fish from Mountain Creek Lake.

3. That as resources become available, the DSHS should continue to monitor fish from Mountain Creek Lake for changes or trends in contaminants or contaminant concentrations that would necessitate 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 Texas Department of State Health Services (DSHS) takes several steps. The agency publishes fish consumption advisories and bans in a booklet available to the public through the Seafood and Aquatic Life Group (SALG). To receive the booklet and/or the data, please contact the SALG at 512-834-6757.[48] The SALG also posts the most current information about advisories, bans, and the removal of either on the internet at http://www.dshs.state.tx.us/seafood. The SALG regularly updates this Web site. The DSHS also provides USEPA (http://epa.gov/waterscience/fish/advisories/), the TCEQ (http://www.tceq.state.tx.us), and the Texas Parks and Wildlife Department (TPWD) (http://www.tpwd.state.tx.us) with information on all consumption advisories and possession bans. Each year, the TPWD informs the fishing and hunting public of consumption advisories and fishing bans on it's Web site and in an official hunting and fishing regulations booklet available at many state parks and at all establishments selling Texas fishing licenses.[49] 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.state.tx.us/seafood). Secondarily, one may address inquiries to the Environmental and Injury Epidemiology and Toxicology Branch of the Department of State Health Services (512-458-7269). The USEPA's IRIS Web site (http://www.epa.gov/iris/) contains information on environmental contaminants found in food and environmental media. The Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology (888-42-ATSDR or 888-422-8737) or the ATSDR's Web site (http://www.atsdr.cde.gov) supplies brief information via ToxFAQs.™ ToxFAQs™ are available on the ATSDR Web site in either English (http://www.atsdr.cdc.gov/toxfaq.html) or Spanish (http://www.atsdr.cdc.gov/es/toxfaqs/es _toxfaqs.html). The ATSDR also publishes more in-depth reviews of many toxic substances in its *Toxicological Profiles* (ToxProfiles™). 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 Sample Sites



TABLES

Table 1. Fish samples collected from Mountain Creek Lake on October 27, 2008 through October 30, 2008. Sample number, species, length, and weight were recorded for each sample.

Sample Number	Species	Length (mm)	Weight (g)
Site 1 Mountain Creek Lake at Cottonwood Cove			
MCL1	Channel catfish	480	1088
MCL2	Common carp	621	3389
MCL3	Largemouth bass	375	795
MCL4	Smallmouth buffalo	545	3661
MCL75	Largemouth bass	493	2101
MCL76	Largemouth bass	527	2550
MCL77	Largemouth bass	430	1357
MCL78	Largemouth bass	416	1271
MCL79	Channel catfish	500	961
MCL80	Channel catfish	555	1623
Site 2 Mountain Creek Lake at Cottonwood Cove Canal			
MCL5	Smallmouth buffalo	720	9231
MCL6	Common carp	517	1702
MCL7	Channel catfish	520	1199
MCL8	Channel catfish	565	1869
MCL9	White crappie	322	523
MCL12	White crappie	294	371
MCL16	White crappie	342	600
MCL81	Freshwater drum	618	3610
MCL82	Freshwater drum	505	2741
MCL83	Largemouth bass	465	1810
MCL86	Largemouth bass	516	2247
MCL87	Channel catfish	520	1287
MCL88	Channel catfish	513	1253
MCL89	White bass	395	837
Site 3 Mountain Creek Lake at Cooperation Lane			
MCL17	Smallmouth buffalo	644	6034
MCL18	Common carp	563	2710
MCL19	Largemouth bass	515	2433
MCL52	Largemouth bass	558	2978
MCL53	Largemouth bass	450	1634
MCL55	White bass	369	667
MCL56	White bass	417	909
MCL57	White bass	380	680
MCL58	White bass	380	717
MCL60	White crappie	327	615

Table 1. Fish samples collected from Mountain Creek Lake on October 27, 2008 through October 30, 2008. Sample number, species, length, and weight were recorded for each sample.			
Sample Number	**Species**	**Length (mm)**	**Weight (g)**
Site 3 Mountain Creek Lake at Cooperation Lane (continued)			
MCL62	Channel catfish	496	1137
MCL63	Channel catfish	550	1417
MCL64	Channel catfish	560	1155
Site 4 Mountain Creek Lake at the Dam			
MCL39	Smallmouth buffalo	591	4660
MCL40	Common carp	532	2182
MCL41	Channel catfish	532	2144
MCL42	White crappie	289	403
MCL90	Freshwater drum	575	3640
MCL91	Freshwater drum	523	2608
MCL92	Largemouth bass	510	2147
MCL93	Largemouth bass	370	755
MCL94	Largemouth bass	370	793
MCL97	White bass	333	498
MCL98	White bass	370	700
MCL99	White bass	400	839
MCL100	Channel catfish	550	1789
Site 5 Mountain Creek Lake at Power Plant Intake			
MCL31	Channel catfish	520	969
MCL33	Channel catfish	685	3692
MCL34	Common carp	534	2118
MCL35	Freshwater drum	559	3137
MCL36	White crappie	319	578
MCL65	Largemouth bass	382	847
MCL68	Largemouth bass	467	1633
MCL70	Smallmouth buffalo	642	5964
MCL71	White crappie	257	271
MCL72	Freshwater drum	530	2473
MCL73	Freshwater drum	663	6649
MCL74	Channel catfish	617	2690
Site 6 Mountain Creek Lake at Power Plant Discharge			
MCL43	Smallmouth buffalo	728	11113
MCL44	Channel catfish	625	2579
MCL45	Channel catfish	615	2052
MCL46	Channel catfish	595	2013
MCL47	Channel catfish	579	2206
MCL48	White bass	365	686
MCL50	White crappie	279	308

Table 1. Fish samples collected from Mountain Creek Lake on October 27, 2008 through October 30, 2008. Sample number, species, length, and weight were recorded for each sample.			
Sample Number	**Species**	**Length (mm)**	**Weight (g)**
Site 6 Mountain Creek Lake at Power Plant Discharge (continued)			
MCL104	White crappie	357	761
MCL108	Largemouth bass	405	1169
MCL109	Largemouth bass	417	1357
MCL110	Common carp	480	1408
MCL111	White bass	375	685
Site 7 Mountain Creek Lake at the Mouth of Mountain Creek			
MCL21	Channel catfish	475	885
MCL22	Common carp	460	1187
MCL24	Largemouth bass	465	1991
MCL25	Largemouth bass	591	3271
MCL26	Largemouth bass	534	2851
MCL27	White crappie	298	458

Table 2a. Arsenic (mg/kg) in fish collected from Mountain Creek Lake, 2008.					
Species	**# Detected/ # Sampled**	**Total Arsenic Mean Concentration ± S.D. (Min-Max)**	**Inorganic Arsenic Mean Concentration[f]**	**Health Assessment Comparison Value (mg/kg)[g]**	**Basis for Comparison Value**
Channel catfish	5/5	0.072±0.014 (0.056-0.094)	0.007	0.7 0.362	EPA chronic oral RfD for Inorganic arsenic: 0.0003 mg/kg–day EPA oral slope factor for inorganic arsenic: 1.5 per mg/kg–day
Largemouth bass	5/5	0.173±0.019 (0.147-0.192)	0.017		
Smallmouth buffalo	6/6	0.226±0.064 (0.131-0.285)	0.023		
All fish combined	16/16	0.161±0.077 (0.056-0.285)	0.016		

[f] *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.*
[g] *Derived from the MRL or RfD for noncarcinogens or the USEPA 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 2b. Inorganic contaminants (mg/kg) in fish collected from Mountain Creek Lake, 2008.				
Species	**# Detected/ # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)**	**Basis for Comparison Value**
Cadmium				
Channel catfish	0/5	ND[h]	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg–day
Largemouth bass	1/5	0.012±0.005 (ND-0.021)		
Smallmouth buffalo	0/6	ND		
All fish combined	1/16	0.013±0.004 (ND-0.021)		
Copper				
Channel catfish	5/5	0.161±0.027 (0.122-0.193)	333	National Academy of Science Upper Limit: 0.143 mg/kg–day
Largemouth bass	5/5	0.096±0.040 (BDL[i]-0.275)		
Smallmouth buffalo	6/6	0.137±0.088 (BDL-0.275)		
All fish combined	16/16	0.132±0.063 (BDL-0.275)		
Lead				
Channel catfish	4/5	0.090±0.075 (ND-0.200)	NA	EPA IEUBKwin32 Version 1.1 Build 9
Largemouth bass	4/5	0.210±0.314 (ND-**0.768**[j])		
Smallmouth buffalo	6/6	0.251±0.147 (BDL-0.398)		
All fish combined	14/16	0.188±0.200 (ND-0.768)		
Mercury				
Channel catfish	5/5	0.090±0.061 (BDL-0.185)	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg–day
Largemouth bass	5/5	0.254±0.265 (BDL-**0.704**)		
Smallmouth buffalo	6/6	0.091±0.052 (BDL-0.160)		
All fish combined	16/16	0.142±0.164 (BDL-**0.704**)		

[h] *ND: "Not Detected" was used to indicate that a compound was not present in a sample at a level greater than the reporting limit.*

[i] *BDL: "Below Detection Limit" – Concentrations were reported as less than the laboratory's reporting limit ("J" values). In some instances, a "J" value was used to denote the discernable presence in a sample of a contaminant at concentrations estimated as different from the sample blank.*

[j] **Emboldened numbers** indicate the concentration of a contaminant exceeded a DSHS HAC Value.

Table 2c. Inorganic contaminants (mg/kg) in fish collected from Mountain Creek Lake, 2008.				
Species	**# Detected/ # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)**	**Basis for Comparison Value**
Selenium				
Channel catfish	5/5	0.201±0.017 (0.186-0.223)	6	EPA chronic oral RfD: 0 .005 mg/kg–day ATSDR chronic oral MRL: 0.005 mg/kg–day NAS 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) to account for other sources of selenium in the diet
Largemouth bass	5/5	0.378±0.046 (0.311-0.431)		
Smallmouth buffalo	6/6	0.484±0.118 (0.348-0.631)		
All fish combined	16/16	0.363±0.141 (0.186-0.631)		
Zinc				
Channel catfish	5/5	3.801±0.840 (3.329-5.288)	700	EPA chronic oral RfD: 0.3 mg/kg–day
Largemouth bass	5/5	3.301±1.780 (1.582-6.297)		
Smallmouth buffalo	6/6	1.897±0.962 (1.000-3.982)		
All fish combined	16/16	2.931±1.438 (1.000-6.297)		

Table 3. Pesticides (mg/kg) in fish collected from Mountain Creek Lake, 2008				
Species	**# Detected / # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)**	**Basis for Comparison Value**
Chlordane				
Channel catfish	5/5	0.010±0.007 (BDL-0.020)	1.167 1.553	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor 0.35 per mg/kg-day
Largemouth bass	5/5	0.004±0.003 (BDL-0.008)		
Smallmouth buffalo	6/6	0.042±0.024 (0.023-0.086)		
All fish combined	16/16	0.020±0.023 (BDL-0.086)		
4,4′-DDE				
Channel catfish	5/5	0.018±0.015 (0.001-0.041)	1.167 1.599	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.34 per mg/kg-day
Largemouth bass	5/5	0.006±0.003 (0.003-0.010)		
Smallmouth buffalo	6/6	0.075±0.059 (0.020-0.186)		
All fish combined	16/16	0.036±0.047 (0.001-0.186)		

Table 4a. PCBs (mg/kg) in fish collected from Mountain Creek Lake, 2008.

Species	# Detected / # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)	Basis for Comparison Value
Site 1 at Cottonwood Cove				
Channel catfish	3/3	**0.161**[k]±0.121 (**0.047**-**0.287**)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	**0.290**		
Largemouth bass	5/5	**0.095**±0.098 (0.010-**0.256**)		
Smallmouth buffalo	1/1	**0.706**		
All fish combined	10/10	**0.196**±0.208 (0.010-**0.706**)		
Site 2 at Cottonwood Cove Canal				
Channel catfish	4/4	**0.084**±0.060 (0.023-**0.145**)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	0.025		
Freshwater drum	2/2	**0.089**±0.009 (**0.082**-**0.095**)		
Largemouth bass	2/2	0.044±0.027 (0.026-**0.063**)		
Smallmouth buffalo	1/1	**0.252**		
White bass	1/1	**0.110**		
White crappie	3/3	0.014±0.006 (0.011-0.021)		
All fish combined	14/14	**0.074**±0.068 (0.011-**0.252**)		
Site 3 near Cooperation Lane				
Channel catfish	3/3	**0.088**±0.052 (0.033-**0.136**)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	**0.267**		
Largemouth bass	3/3	**0.102**±0.068 (0.028-**0.160**)		
Smallmouth buffalo	1/1	**0.794**		
White bass	4/4	**0.122**±0.045 (**0.061**-**0.166**)		
White crappie	1/1	0.011		
All fish combined	13/13	**0.164**±0.202 (0.011-**0.794**)		

[k] **Emboldened numbers** indicate the concentration of a contaminant exceeded a DSHS HAC Value.

Table 4b. PCBs (mg/kg) in fish collected from Mountain Creek Lake, 2008.

Species	# Detected / # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)	Basis for Comparison Value
Site 4 near Dam				
Channel catfish	2/2	**0.192**±0.042 (**0.163-0.222**)		
Common carp	1/1	**0.082**		
Freshwater drum	2/2	**0.345**±0.065 (**0.299-0.391**)		
Largemouth bass	3/3	0.030±0.023 (0.013-**0.056**)	0.047	EPA chronic oral RfD: 0.00002 mg/kg–day
Smallmouth buffalo	1/1	**0.330**	0.272	EPA slope factor: 2.0 per mg/kg–day
White bass	3/3	**0.049**±0.016 (0.036-**0.067**)		
White crappie	1/1	0.010		
All fish combined	13/13	**0.133**±0.134 (0.010-**0.391**)		
Site 5 near Power Plant intake				
Channel catfish	3/3	**0.189**±0.031 (**0.154-0.214**)		
Common carp	1/1	0.035		
Freshwater drum	3/3	**0.389**±0.486 (0.090-**0.949**)	0.047	EPA chronic oral RfD: 0.00002 mg/kg–day
Largemouth bass	2/2	0.031±0.023 (0.015-**0.047**)	0.272	EPA slope factor: 2.0 per mg/kg–day
Smallmouth buffalo	1/1	**0.328**		
White crappie	2/2	0.011±0.002 (0.009-0.012)		
All fish combined	12/12	**0.182**±0.261 (0.009-**0.949**)		

Table 4c. PCBs (mg/kg) in fish collected from Mountain Creek Lake, 2008.				
Species	**# Detected / # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)**	**Basis for Comparison Value**
Site 6 at Power Plant discharge				
Channel catfish	4/4	**0.249**±0.336 (**0.048-0.750**)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	**0.080**		
Largemouth bass	2/2	0.033±0.029 (0.013-**0.053**)		
Smallmouth buffalo	1/1	**0.370**		
White bass	2/2	**0.160**±0.125 (**0.072**-**0.248**)		
White crappie	2/2	0.013±0.003 (0.011+0.016)		
All fish combined	12/12	**0.155**±0.216 (0.011-**0.750**)		
Site 7 at the mouth of Mountain Creek				
Channel catfish	1/1	0.019	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	0.014		
Largemouth bass	3/3	0.024±0.015 (0.012-0.041)		
White crappie	1/1	0.009		
All fish combined	6/6	0.019±0.011 (0.009-0.041)		
All Sampling Sites				
Channel catfish	20/20	**0.153**±0.159 (0.019-**0.750**)	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	7/7	**0.113**±0.116 (0.014-**0.290**)		
Freshwater drum	7/7	**0.291**±0.314 (**0.082-0.949**)		
Largemouth bass	20/20	**0.058**±0.062 (0.010-**0.256**)		
Smallmouth buffalo	6/6	**0.463**±0.227 (**0.252-0.794**)		
White bass	10/10	**0.106**±0.066 (0.036-**0.248**)		
White crappie	10/10	0.012±0.004 (0.009-0.021)		
All fish combined	80/80	**0.138**±0.182 (0.009-**0.949**)		

Table 5. PCDFs/PCDDs toxicity equivalent concentrations (TEQ; pg/g) in fish collected from the Mountain Creek Lake, 2008.				
Species	**# Detected / # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (pg/g)**	**Basis for Comparison Value**
PCDFs/PCDDs				
Channel catfish	5/5	0.526±1.076 (0.001-**2.447**[l])	2.33	ATSDR chronic oral MRL: 1.0 x 10^{-9} mg/kg/day
Largemouth bass	5/5	0.223±0.282 (0.006-0.591)		
Smallmouth buffalo	6/6	**2.548**±2.323 (0.678-**6.622**)	3.49	EPA slope factor: 1.56 x 10^5 per mg/kg/day
All fish combined	16/16	1.190±1.823 (0.001-**6.622**)		

Table 6. Hazard quotients (HQ) for mercury in fish collected from Mountain Creek Lake in 2008. Table 6 also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[m]		
Species	**Hazard Quotient**	**Meals per Week**
Channel catfish	0.1	7.2
Largemouth bass	0.2	5.7
Smallmouth buffalo	0.1	7.1
All fish combined	0.2	5.7

[l] **Emboldened numbers** indicate the concentration of a contaminant exceeded a DSHS HAC Value.
[m] *DSHS assumes that children under the age of 12 years and/or those who weigh less than 35 kg eat 4-ounce meals*

Table 7. Hazard quotients (HQs) and hazard indices (HIs) for PCBs and PCDFs/PCDDs in fish species collected in 2008 from Mountain Creek Lake. Table 7 also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.[n]

Species/Contaminant	Number (N)	Hazard Quotient	Meals per Week
Channel catfish			
PCBs	20	**3.3**[o]	**0.3**[p]
PCDDs/PCDFs	5	0.2	4.1
Hazard Index (meals per week)		**3.5 (0.3)**	
Common carp			
PCBs	7	**2.4**	**0.4**
Freshwater drum			
PCBs	7	**6.2**	**0.1**
Largemouth bass			
PCBs	20	**1.2**	**0.7**
PCDDs/PCDFs	5	0.1	9.7
Hazard Index (meals per week)		**1.3 (0.7)**	
Smallmouth buffalo			
PCBs	6	**9.9**	**0.1**
PCDDs/PCDFs	6	**1.1**	**0.8**
Hazard Index (meals per week)		**11.0 (0.1)**	
White bass			
PCBs	10	**2.3**	**0.4**
White crappie			
PCBs	10	0.3	3.6
All fish combined			
PCBs	80	**3.0**	**0.3**
PCDDs/PCDFs	16	0.5	1.8
Hazard Index (meals per week)		**3.5 (0.3)**	

[n] *DSHS assumes that children under the age of 12 years and/or those who weigh less than 35 kg eat 4-ounce meals.*
[o] **Emboldened numbers** denote the HQ for PCBs exceeds 1.0
[p] **Emboldened numbers** denote the calculated allowable meal consumption rate for an adult is less than one/week

Table 8. Calculated theoretical lifetime excess cumulative cancer risk from consuming fish containing PCBs and PCDFs/PCDDs collected in 2008 from Mountain Creek Lake and suggested consumption (8-ounce meals/week) for 70 kg adults who regularly eat fish from Mountain Creek Lake over a 30-year period.[n]				
Species/Contaminant	**Number (N)**	**Theoretical Lifetime Excess Cancer Risk**		**Meals per Week**
		Risk	**1 excess cancer per number of people exposed**	
Channel catfish				
PCBs	20	5.6E-05	17,792	1.6
PCDDs/PCDFs	5	1.5E-05	66,350	6.1
Cumulative Cancer Risk		7.1E-05	14,030	1.3
Common carp				
PCBs	7	4.2E-05	24,090	2.2
Freshwater drum				
PCBs	7	**1.1E-04**[q]	**9,355**	**0.9**[r]
Largemouth bass				
PCBs	20	2.1E-05	46,935	4.3
PCDDs/PCDFs	5	6.4E-06	156,504	14.5
Cumulative Cancer Risk		2.8E-05	36,107	3.3
Smallmouth buffalo				
PCBs	6	**1.7E-04**	**5,880**	**0.5**
PCDDs/PCDFs	6	7.3E-05	13,697	1.3
Cumulative Cancer Risk		**2.4E-04**	**4,114**	**0.4**
White bass				
PCBs	10	3.9E-05	25,681	2.4
White crappie				
PCBs	10	4.4E-06	226,852	21.0
All fish combined				
PCBs	80	5.1E-05	19,726	1.8
PCDDs/PCDFs	16	3.4E-05	29,328	2.7
Cumulative Cancer Risk		8.5E-05	11,794	1.1

[q] **Emboldened numbers** denote calculated excess lifetime cancer risk after 30 years exposure is greater than 1 X 10^{-4}
[r] **Emboldened numbers** denote the calculated meal consumption rate for adults is less than one per week

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