# Characterization of Potential Adverse Health Effects Associated with Consuming Fish from

## Lake Isabell

## Harris County, Texas

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**Division for Regulatory Services**
**Policy, Standards, and Quality Assurance Unit**
**Seafood and Aquatic Life Group**

# INTRODUCTION

## *Description of Lake Isabell*

Lake Isabell is a three-acre pond lying within the boundaries of Lake Houston Park (formerly Lake Houston State Park), a 5,000 acre park located 30 miles north of Houston in Montgomery and Harris counties near New Caney, Texas.[1,2] Officially opened in 1992, Lake Houston Park offers visitors access to a nature center and to activities that include camping, biking, hiking, kayaking, and horseback riding.[1,2] Lake Isabell has a fishing pier for access and offers opportunities to catch a variety of fish species, including sunfish, crappie, and largemouth bass.

## *Demographics of Montgomery and Harris Counties Surrounding the Area of Lake Isabell*

In 2007, the census bureau reported the population of Montgomery and Harris Counties to be 412,638 and 3,935,855 people respectively.[3,4] Located approximately 21 miles east of Conroe and 30 miles north of Houston, Lake Isabell is situated near the town of New Caney, Texas, within the confines of Lake Houston Park. Houston, the fourth largest city in the United States and the county seat of Harris County, Texas, had an estimated population in 2007 of 2,208,180.[4,5] Conroe, the county seat of Montgomery County, Texas is Montgomery County's largest city, having had an estimated population in 2007 of 52,516.[6]

## *Subsistence Fishing at Lake Isabell*

The United States Environmental Protection Agency (EPA) suggests that, along with ethnic characteristics and cultural practices of an area's population, poverty could contribute to the rate of subsistence fishing in the area.[7] The EPA and the Texas Department of State Health Services (DSHS) believe it important to consider subsistence fishing to occur at any water body because subsistence fishers (along with recreational anglers and certain tribal and ethnic groups) usually consume more locally caught fish than the general population. To supplement caloric and protein intake, subsistence fishers and other high-fish-consumption groups sometimes harvest fish or shellfish from the same water body over many years. Should local water bodies contain chemically contaminated fish or shellfish, people who routinely eat those fish or people who eat large quantities of fish from the same water body, could increase their risk of adverse health effects from consumption of contaminated seafood. The EPA 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 for Lake Isabell, likely does occur. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the EPA.[7]

## *History of the Tier 2 Mercury in East Texas Water Bodies Project*

Three Texas agencies, the DSHS, the Texas Commission on Environmental Quality (TCEQ), and the Texas Parks and Wildlife Department (TPWD), have critical interests in – and responsibilities for – contaminants in the waters of Texas, in the sediments, and in the fish and shellfish inhabiting those waters. The Seafood and Aquatic Life Group (SALG) at DSHS determines whether chemical contaminants in fish or shellfish pose a health risk to those who would consume those fish or shellfish and, if so, is responsible for preparing health advisories or bans on possession of contaminated fish or shellfish harvested by recreational and subsistence fishers from public water bodies in Texas.[8] The Commissioner of Health for the State of Texas issues those advisories or possession bans.[9]

Among its other duties, the TCEQ establishes and manages water quality standards for the state and addresses pollution of Texas' public waters. The TPWD manages state fish and wildlife resources, addresses pollution that may adversely affect these resources, and enforces closures or bans issued by DSHS. These, and several other state and federal agencies have, for many years, coordinated efforts to oversee contaminant monitoring of fish from Texas waters – and their flora and fauna – through the Toxic Substances Coordinating Committee (TSCC), a legislatively mandated interagency committee.[10]

The Tier 2 Mercury in East Texas Water Bodies Project is the second part of a two-stage project (Tiers 1 and 2) that accesses the expertise and resources of the TCEQ, the TPWD, and the DSHS.[11] The EPA financed this effort through a grant (ending December 31, 2008) to the TCEQ, which administered those funds. The agencies utilized most of the EPA funding for laboratory analysis of fish tissues for the presence and concentrations of chemical contaminants that, upon regular consumption in fish, could adversely influence an individual's health. The TPWD Inland Fisheries Division Contaminants Assessment Team[a] conducted Tier 1 studies as part of a three-year special study while the TCEQ conducted Tier 1 studies during routine field operations.

In 1999, the TPWD Contaminants Assessment Team began a three-year study of 60 reservoirs in 57 East Texas counties to delineate the geographical extent of mercury bioaccumulation and to study the interactions between the biotic and abiotic factors resulting in mercury bioaccumulation.[12] In addition to these objectives, the study identified water bodies in which mercury concentrations in fish tissues exceeded human health risk screening criteria. The TPWD selected East Texas as the study area because the Piney Woods and Oak Woodlands ecoregions have water, soil, and terrestrial plant communities that may correlate with accumulation of mercury in fish tissue.

The TPWD sampled fish from Lake Isabell in 2001 as a part of its special study, collecting three largemouth bass ranging in length from 11.9 to 12.4 inches. Comparison of the results of the TPWD Tier 1 mercury analysis showed that, at 0.949 mg/kg, mercury in Lake Isabell largemouth bass samples exceeded both the DSHS screening value and its health-based assessment comparison value ($HAC_{nonca}$). Based on this finding, the DSHS SALG – which conducts Tier 2 studies to characterize potential human health risks from consuming contaminated fish from Texas waters – selected Lake Isabell for a more intensive Tier 2 examination of the likelihood of adverse health outcomes from consumption of mercury-contaminated fish from this small Texas water body.

[a] Formerly the TPWD Resource Protection Division

# METHODS

## *Fish Sampling, Preparation, and Analysis*

The DSHS 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.*[13] The SALG bases its sampling and analysis protocols, in part, on procedures recommended by the EPA in that agency's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1.*[14] Advice and direction are also received from the legislatively mandated *State of Texas Toxic Substances Coordinating Committee (TSCC) Fish Sampling Advisory Subcommittee (FSAS).*[15] 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 2007-2008 Lake Isabell Sample Set*

In June 2007, SALG staff collected five fish from Lake Isabell, returning in March 2008 to collect five additional samples. Because Lake Isabell (3 acres) is small, the SALG did not partition the lake into separate sites to provide spatial coverage of the study area; rather, the group utilized the entire lake as a single "site" (Figure 1). Species collected usually represent distinct ecological groups (e.g., 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 species that anglers and their families commonly consume. The 10 fish collected from Lake Isabell in June 2007 and March 2008 represented all species targeted for collection from this water body. Table 1 lists species sampled from Lake Isabell, the number of each species collected, and the length and weight (in metric units) of each sample. Species (# of samples) are as follows: black crappie (4), largemouth bass (4), and spotted gar (2).

The SALG utilized a boat-mounted electrofisher to collect fish. SALG staff conducted electrofishing activities during daylight hours, using pulsed direct current (Smith Root 5.0 GPP electrofishing system settings: 4.0-6.0 amps, 60 pulses per second [pps], high range 500-1000 volts, 80% to 100% duty cycle) to stun fish that crossed the electric field produced by the equipment 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 ensure interim preservation.

SALG staff processed fish onsite at Lake Isabell**.** Staff weighed each sample to the nearest gram on an electronic scale and measured total length (tip of nose to tip of tail fin) to the nearest millimeter. After weighing and measuring a fish, staff utilized a fillet knife and a cutting board covered with aluminum foil to prepare two skin-off fillets from each fish. The foil was changed and the filleting knife cleaned with distilled water between samples. The team wrapped each sample (consisting of two fillets) in two layers of fresh aluminum foil, placed each into an unused, clean, pre-labeled plastic freezer bag, and stored the sample on wet ice in an insulated chest until further processing. At the end of each sampling trip, SALG staff transported tissue samples on wet ice to headquarters in Austin, Texas, 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 collection, the team 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 10 Lake Isabell samples and recorded the condition of each sample along with its DSHS identification number.

Using established EPA methods, the GERG laboratory analyzed fish fillets from Lake Isabell for many 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, and 209 PCB congeners. The laboratory analyzed all 10 samples for mercury as well as a subset of 2 of the 10 samples for metals, pesticides, PCBs, SVOCs, and VOCs,[16]

### *Details and Explanatory Notes for Various Analytical Procedures*

#### ***<u>Arsenic</u>***

The GERG laboratory analyzed two fish for total (inorganic and organic) arsenic. Although the proportions of each form of arsenic may differ among 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.[17] DSHS, taking a conservative approach, estimates 10% of the total arsenic in any fish is inorganic arsenic, deriving estimates of inorganic arsenic concentrations by multiplying reported total arsenic concentration/fish by a factor of 0.1.[17]

#### ***<u>Mercury</u>***

Nearly all mercury in upper trophic level fish three years of age or older is methylmercury.[18] 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 EPA 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 ATSDR's minimal risk level for methylmercury.[19] (In these risk characterizations, the DSHS may interchangeably utilize the terms "mercury," "methylmercury," or "organic mercury" to refer to methylmercury in fish.)

***Polychlorinated Biphenyls (PCBs)***

For PCBs, the EPA suggests that each state measures congeners of PCBs in fish and shellfish rather than homologs or Aroclors® because the EPA considers congener analysis the most sensitive technique for detecting PCBs in environmental media.[16] 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 EPA'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),[20] from McFarland and Clarke,[21] and from the EPA's guidance documents for assessing contaminants in fish and shellfish[14, 16] to address PCB congeners in fish and shellfish samples. The preceding references recommend using 43 congeners for their likelihood of occurrence in fish, the likelihood of significant toxicity – based on structure-activity relationships – and for the relative environmental abundance of the congeners. [20, 21] SALG risk assessors sum the 43 suggested congeners to derive a "total" PCB concentration in each sample. Assessors then average the summed congeners within each group (e.g., species, site, or combination of site and species) to derive a mean PCB concentration for groups of interest.

Using only a few PCB congeners to determine total PCB concentrations could conceivably 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 HAC values derived from information on PCB mixtures held in the EPA's Integrated Risk Information System (IRIS) database.[22] IRIS currently contains systemic toxicity information for five Aroclor® mixtures: Aroclors® 1016, 1242, 1248, 1254, and 1260 (not all information is available for all mixtures; for instance, only one other reference dose (RfD) occurs in IRIS – that of Aroclor 1016, a commercial mixture devoid of dibenzofurans).[23] Systemic toxicity estimates in the present document reflect comparisons derived from the EPA's RfD for Aroclor 1254. 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 EPA'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.[24]

## *Derivation and Application of Health-Based Assessment Comparison Values (HACnonca) for Systemic (noncarcinogenic) Effects 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, and the presence of other chemicals.[25] 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 include cancer, benign tumors, birth defects, infertility, blood disorders, brain damage, peripheral nerve damage, lung disease, and kidney disease.[25] If diverse species of fish or shellfish are present, the SALG presumes that people eat a variety of species from a water body. Further, SALG risk assessors at DSHS 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 Richard Beauchamp, MD, a DSHS medical epidemiologist.[26] The SALG evaluates contaminants in fish or shellfish by comparing the mean or the 95% upper confidence limit on the average 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 and consumes 30 grams of fish or shellfish per day (about one 8-ounce meal per week) and uses the EPA's oral RfD[27] or the Agency for Toxic Substances and Disease Registry's (ATSDR) chronic oral minimal risk levels (MRLs).[28] The EPA 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.*[29]

The EPA 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.*[29]

The ATSDR uses a similar technique to derive its MRLs.[28] The DSHS divides the estimated daily dose (calculated in mg/kg/day) derived from the measured concentration in fish tissue by the contaminant's RfD or MRL to derive a hazard quotient (HQ).

A HQ, defined by the EPA, *is*

> *…the ratio of the estimated exposure dose of a contaminant (mg/kg/day) to the contaminant's RfD or MRL (mg/kg/day).*[30]

Note that, according to the EPA, 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. 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 EPA suggests that an HQ or a hazard index (HI) that computes to less than 1.0 should be interpreted as "no cause for concern" whereas an HQ or HI greater than 1.0 "should indicate some cause for concern." Therefore, the SALG does not utilize HQ's to determine the likelihood of occurrence of adverse systemic health effects. Instead, in a manner similar to the EPA's decision process, the SALG may utilize computed HQs as a point of departure for management decisions – assuming, for instance, that hazard quotients less than 1.0 are unlikely to be an issue while HQs greater than 1.0 might suggest that a regulatory action could be taken 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 EPA represents chronic consumption. Thus, regularly eating fish containing a toxic chemical, the HQ of which is less than 1 is unlikely to cause adverse systemic health effects, whereas routine consumption of fish or shellfish in which the HQ exceeds 1 represents a qualitatively unacceptable increase in the likelihood of systemic adverse health outcomes.

Although, as advised by the EPA, the DSHS preferentially utilizes the RfD calculated by federal scientists for a specifically named contaminant, should no RfD be available for a contaminant, the EPA advises risk assessors to consider using an RfD (or an MRL) for a contaminant of similar molecular structure, or one of similar mode or mechanism of action. For instance, no published RfD is available for Aroclor® 1260, so the DSHS uses the reference dose for Aroclor 1254 to assess the likelihood of systemic or noncarcinogenic effects of Aroclor® 1260.[28]

In developing oral RfDs and MRLs, federal scientists review the extant literature to devise NOAELs, LOAELs, or 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: 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.[27,29] 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 – all groups that risk assessors and the EPA consider sensitive groups – also receive special consideration in calculation of an RfD.[29, 31]

The primary method for assessing the toxicity of component-based mixtures of chemicals in environmental media is the hazard index (HI). The EPA recommends HI methodology for groups of toxicologically similar chemicals. Although knowing the mode or mechanism of action of chemicals of interest to risk assessors, the lack of this information however boils down to using the "similarity of target organs" as the definition of "toxicological similarity." The default procedure for calculating the HI for the exposure mixture chemicals is to add the hazard quotients (the ratio of the external exposure dose to the RfD) for all component chemicals affecting the same target organ or organ system.

Summing HQ's approximates the value the mixture's "hazard quotient" likely would have taken if all chemicals in the mixture could have been simultaneously tested (as a single chemical). For example, the HI for liver toxicity should approximate the degree of liver toxicity that would have been present if effects of the whole mixture were due to a single chemical. Target organs addressed by the HI's should be decided for each particular mixture assessment and a separate HI calculated for each toxic effect of concern. The mixture components to be included in the HI calculation are any chemical components showing the effect described by the HI, regardless of the critical effect upon which the RfD comes.

A note of caution: 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 derived from RfDs may be overly conservative, thereby resulting in an exaggeration of health risk from consumption of the mixture of chemicals.

The EPA 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 1 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 1, concern exists over potential toxicity. As more HI's for different effects exceed 1, the potential for human toxicity also increases.*

Thus,

> *Concern should increase as the number of effect-specific HI's exceeding 1 increases. As a larger number of effect-specific HI's exceed 1, 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 ($HAC_{ca}$) for Application to the Carcinogenic Effects of Consumed Chemical Contaminants***

The DSHS calculates cancer-risk comparison values ($HAC_{ca}$) from the EPA's chemical-specific cancer potency factors (CPFs) – also known as slope factors (SFs) – 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) [29] of one excess cancer case in 10,000 persons whose average daily exposure is equivalent and (2) daily exposure for 30 years. Comparison values used to assess the probability of cancer do not contain "uncertainty" factors as such. 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 (bright-line divisions) 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.[32, 33] 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 pregnancy, infancy, childhood, or adolescence – indeed, at any time during development – times when toxicants can impair or alter the structure or function of susceptible systems.[34] Unique early sensitivities may exist because organs and body systems are structurally or functionally immature – even 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 which 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, in proportion to their body weights, children consume more food and liquids than adults do, another factor that might alter the concentration of toxicant at the target. 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.[35] In any case, if a chemical – or a class of chemicals –is observed to be – or is thought to be – more toxic to the fetus, infants, or children than to adults, the constants (e.g., RfD, MRL, or CPF) are usually further modified to assure protection of the immature system's potentially greater susceptibility.[27] Additionally, in accordance with the ATSDR's *Child Health Initiative*[36] and the EPA's *National Agenda to Protect Children's Health from Environmental Threats,*[37] 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 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, ideally, 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 Lake Isabell.[38] In computing descriptive statistics, SALG risk assessors utilized ½ the detection limit for analytes designated as not detected (ND) or estimated (J)[b]. The SALG used the descriptive statistics from the above calculations to generate the present report. SALG protocols do not require hypothesis testing. Nevertheless, when data are of sufficient quantity and quality, and, should it be necessary, the SALG can utilize SPSS® software to determine significant differences among contaminant concentrations in species and/or at collection sites as needed. The SALG employed Microsoft Excel® spreadsheets to generate figures, to compute ($HAC_{nonca}$ and $HAC_{ca}$) for contaminants, and to calculate HQ, HI, cancer risk probabilities, and meal consumption limits for fish or shellfish from Lake Isabell.[39] 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).[40, 41]

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[b] *"J-value" is standard laboratory nomenclature for analyte concentrations that are detected and reported below the detection 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.*

# RESULTS

The GERG laboratory completed analyses and electronically transmitted the results to the SALG at the DSHS in 2008. The laboratory reported the analytical results for mercury (10 samples), metals, pesticides, PCBs, semivolatile organic compounds (SVOCs), and volatile organic compounds (VOCs: 2 samples).

For reference, Table 1 contains the total number of samples collected from Lake Isabell in June 2007 and March 2008. Table 2a through 2c contains summary results of metals in fish collected in June 2007 and March 2008 from Lake Isabell. The paper does not display pesticide, PCB, SVOC and VOC data. 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 see 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, BDL (below detection limit), or as measured concentrations. 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 reporting limit (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 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 GERG data report.[42]

### *Inorganic Contaminants*

#### ***Arsenic, Cadmium, Copper, Lead, Mercury, Selenium and Zinc***

Arsenic and cadmium were detected in only one of the two largemouth bass samples analyzed at concentrations of no risk to human health (Tables 2a-2b). Inorganic contaminants/constituents such as copper, lead, selenium, and zinc were reported present in the two largemouth bass analyzed at concentrations of no risk to human health (Table 2b). The laboratory reported that all largemouth bass analyzed contained lead; however, the mean concentration was reported below the laboratory’s reporting limit (Table 2b). The mean concentrations of copper, selenium, and zinc in all largemouth bass analyzed from Lake Isabell were 0.273±0.154 mg/kg, 0.931±0.434 mg/kg, and 6.190±3.106 mg/kg respectively (Table 2b).

Mercury, was present in all fish tissue samples examined (Table 2c). The mean mercury concentration in all fish tissue samples from Lake Isabell was 0.634±0.268 mg/kg (Table 2c). The median concentration of mercury in all fish tissue samples was 0.643 mg/kg. A largemouth bass weighing 3.94 pounds (1788 g) and measuring 19.88 inches (505 mm) contained the maximum concentration of mercury (1.177 mg/kg). The lower and upper 95% confidence limit on the mean mercury concentration across all fish tissue samples was 0.442 mg/kg and 0.826 mg/kg, respectively.

## *Organic Contaminants*

### ***Pesticides***

The GERG laboratory analyzed a subset of 2 of the 10 samples for 34 pesticides from Lake Isabell. Trace[c] quantities of chlordane, mirex, 4,4'-DDE, 2,4'-DDD, endosulfan II, endosulfan sulfate, malathion, and methoxychlor were present in at least one of two fish samples analyzed (data not presented). One fish sample collected (ISB 6) contained a measurable concentration of 4,4'-DDE at 0.0006 mg/kg. No other pesticides were reported present in fish tissue analyzed from Lake Isabell.

### ***PCBs***

The GERG laboratory analyzed the same subset of 2 of the 10 samples for PCBs as it did for metals and pesticides from Lake Isabell. The laboratory detected trace quantities of PCBs representing one or more of those congeners between PCB 1 and PCB 202 (International Union of Pure and Applied Chemists [IUPAC] assigned numbers) in the two samples analyzed for PCBs. The traces of PCBs were reported as estimated concentrations (J-values) (data not presented). One fish sample collected (ISB 6) contained a measurable concentration of only one congener (PCB 132/153/168) at 0.0006 mg/kg.

### ***SVOCs***

The GERG laboratory analyzed the same subset of 2 of the 10 samples for SVOCs as it did for metals, pesticides, and PCBs from Lake Isabell. Trace quantities of bis (2-ethylhexyl) phthalate were present in both fish samples analyzed (data not presented). No other SVOCs were reported present in fish tissue analyzed from Lake Isabell.

### ***VOCs***

The GERG laboratory analyzed the same subset of 2 of the 10 samples for VOCs as it did for metals, pesticides, PCBs, and SVOCs from Lake Isabell. At least one sample contained trace[c] quantities of carbon disulfide, toluene, cis-1,2-dichloroethene, dibromomethane, benzene, cis-1,3-dichloropropene, trans-1,3-dichloropropene, bromodichloromethane, dibromochloromethane, bromoform, toluene, chlorobenzene, ethylbenzene, m+p-xylene, o-xylene, styrene, isopropylbenzene, bromobenzene, 1,1,2,2-tetrachloroethane, 2-chlorotoluene, 4-chlorotoluene, 1,3,5-trimethylbenzene, 1,2,4-trimethyl benzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2-dichlorobenzene, n-propylbenzene, 4-isopropyl toluene, tert-butylbenzene, sec-butylbenzene, n-butylbenzene, 1,2-dibromo-3-chlorpropane, 1,2,3-trichlorobenzene, and hexachlorobutadiene (data not presented). The procedural blanks also contained most of these contaminants, indicating the possibility of post collection contamination. One or both samples contained measurable concentrations of carbon disulfide, methylene chloride, trichlorofluromethane,

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[c] *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.*

methyl methacrylate, 1,2-dibromomethane, toluene, tetrachloroethene, 2-hexanone, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and/or naphthalene (data not presented). Quality control data were within acceptable limits.

# DISCUSSION

### *Risk Characterization*

Variability and uncertainty are inherent to quantitative assessment of risk. Thus, calculations that model risks of adverse health outcomes from exposure to toxicants can be orders of magnitude above or below “actual” risks. Variability between calculated and 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. Many factors used to calculate comparison values come from experiments conducted in the laboratory on nonhuman subjects. Variability and uncertainty in the estimates of toxicity might therefore arise from judgment calls by investigators or reviewers, e.g., the study chosen as the "critical" investigation, the species/strain of animal used in the critical study, the target organ observed to be the "critical organ," exposure periods, exposure route, or doses. Uncontrolled (confounding) variables or variations in other conditions could occur. Some contaminants are overtly toxic, while others have only subtle effects. Finally, available information varies by contaminant. The literature is replete with information on some toxicants while others have hardly any data.[27] Risk assessors often must calculate parameters to represent potential toxicity to humans who consume contaminants in fish and other environmental media despite these limitations. For those contaminants appearing in Lake Isabell fish for which enough information is given, the DSHS calculated risk parameters for systemic toxicity and for carcinogenicity in those who would consume fish from the lake. The SALG utilizes risk parameters in meal consumption calculations – integral to the SALG's risk characterizations as consumption limits are among the variables DSHS risk managers utilize to determine departmental actions to protect human health from adverse effects of consuming toxicants in fish from Texas waters. Conclusions and recommendations predicated upon the stated goal of the DSHS to protect human health follow the discussion of the relevance of the Lake Isabell results to risk of human health effects.

### *Characterization of Systemic (Noncancerous) Health Effects from Consumption of Fish from Lake Isabell*

The SALG analyzed four largemouth bass, four black crappie, and two spotted gar from Lake Isabell for mercury. The SALG also screened two of the four largemouth bass for organic contaminants and metals other than mercury because largemouth bass have proved a sentinel species for chemical contamination in fresh-water fish from Texas water bodies. Should the result of such a screening procedure suggest that more-widespread contamination exists in fish from a Texas water body, the SALG endeavors to re-sample the water body to determine whether such contamination is indeed present. In the present study, the two largemouth bass did not suggest the presence of high concentrations of contaminants other than mercury.

***Inorganic Contaminants***

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

The two largemouth bass from Lake Isabell contained copper, selenium, and zinc. These trace minerals are essential to human health and to the health of other animals but may be toxic at high concentrations. Toxicity occurs most often with acute ingestion of high doses but also can occasionally occur with long-term, low level consumption.[43] In the two largemouth bass samples, copper, selenium, and zinc occurred at concentrations far lower than these elements' respective $HAC_{nonca}$ values (Table 2b). SALG risk assessors conclude, therefore, that eating fish from Lake Isabell that contain copper, selenium, and/or zinc at concentrations similar to those observed in tested samples should not result in deleterious effects on individuals' health.

In contrast to copper, selenium, and zinc, neither arsenic nor cadmium nor lead nor mercury has a known function in mammalian physiology. All are toxic to terrestrial mammals.

Most of the arsenic in fish, including arsenobetaine, also called "fish arsenic" – is an organic form of arsenic that is virtually nontoxic to humans, in part because the human kidney easily eliminates "fish arsenic" from the body.[44] Inorganic arsenic, on the other hand, may be toxic to humans. One of the two largemouth bass samples analyzed contained arsenic (Table 2a). To assess the likelihood of toxicity from consuming inorganic arsenic in fish from Lake Isabell, SALG risk assessors first calculated the inorganic portion of the total concentrations of arsenic in the fish (using a factor of 0.1 as outlined in the methods section of this report). SALG risk assessors then compared the calculated inorganic fraction to the $HAC_{nonca}$ for inorganic arsenic. Although one of the largemouth bass from Lake Isabell contained measurable arsenic, the concentration did not exceed the $HAC_{nonca}$ for inorganic arsenic. The mean arsenic concentration was also below the $HAC_{nonca}$. The calculated inorganic arsenic fraction neither exceeded nor approached the $HAC_{nonca}$ for arsenic. Further, the HQ for inorganic arsenic in the two samples did not approach 1.0. Based on these observations, the DSHS concludes that consuming fish from Lake Isabell that contain inorganic arsenic would be unlikely to affect human health negatively.

A largemouth bass from Lake Isabell also contained cadmium at a level less than one-tenth the $HAC_{nonca}$ for this element. The average cadmium concentration did not exceed the $HAC_{nonca}$ either, suggesting that eating fish from Lake Isabell that contain cadmium would be unlikely to cause adverse health effects in humans.

The two largemouth bass samples contained lead at levels reported as below the detection limit for this metalloid. The toxic effects of lead are primarily those of abnormal nervous system development and/or function, with fetuses and children the sensitive population.[25] Although lead reportedly does not penetrate the mucus barrier or the scales of fish and apparently does not bioconcentrate in fish so that it does not pose a human health risk,[45] researchers have not found a threshold for the neurotoxic effects and trends suggest that no such threshold exists.[46] Thus, any lead ingested in fish might have adverse effects in sensitive individuals. The SALG usually subjects lead in fish to the EPA's IEUBK model. However, because lead in the largemouth bass from Lake Isabell occurred at trace levels, these data were not analyzed in the IEUBK because children's blood lead levels would likely be unaffected by consumption of lead at levels below the detection limit (0.271 mg/kg) in fish from Lake Isabell.

All fish collected from Lake Isabell contained mercury (Table 2c). At an average concentration of 0.54 mg/kg, mercury in black crappie (n=4) and spotted gar (n=2) was lower than the $HAC_{nonca}$ for methylmercury. Mercury in largemouth bass (0.778±0.326 mg/kg; n=4) exceeded the $HAC_{nonca}$ (0.7 mg/kg). The mean concentration of mercury in all samples (0.634±0.268 mg/kg; n=10) did not exceed, the methylmercury $HAC_{nonca}$. The DSHS concludes from these data that mercury in largemouth bass poses a risk to the health of sensitive groups who may consume this species from Lake Isabe

***Organic Contaminants***

***<u>Pesticides</u>***

The laboratory reported the presence of trace to low concentrations of one or more pesticides in the two largemouth bass from Lake Isabell (data not shown). No pesticide occurred at a concentration that exceeded its $HAC_{nonca}$ value. No pesticide generated a HQ greater than 1.0; therefore, consumption of any species of fish from Lake Isabell containing pesticides would not increase the likelihood of systemic adverse events.

***<u>SVOCs</u>***

The laboratory reported the presence of trace to low concentrations of one or more SVOCs in the two largemouth bass from Lake Isabell (data not shown). No SVOC occurred at a concentration that exceeded its $HAC_{nonca}$ value. No SVOC generated a HQ greater than 1.0, suggesting that consumption of any species from Lake Isabell that contained SVOCs would not increase the likelihood of systemic adverse events.

***<u>VOCs</u>***

The two largemouth bass collected from Lake Isabell contained traces of numerous VOCs (data not shown). No VOC occurred at a concentration that exceeded its $HAC_{nonca}$ value. No VOC generated a HQ greater than 1.0. These data suggest that consumption of any VOC in any fish species from Lake Isabell would not increase the likelihood of systemic adverse events.

***<u>PCBs</u>***

One or more PCB congeners were present in the two largemouth bass analyzed for these contaminants. The total concentrations of PCBs in each of the largemouth bass did not exceed the $HAC_{nonca}$ for Aroclor 1254 (data not shown). No PCB congener occurred at a concentration that exceeded the $HAC_{nonca}$ value for these organic contaminants. Nor did the average total PCB concentration exceed the $HAC_{nonca}$. No PCB congener generated a HQ greater than 1.0 nor did total PCBs generate a HQ greater than 1.0. These data suggest that consumption of PCBs in any species of fish from Lake Isabell is unlikely to result in systemic adverse health effects at numbers greater than the background levels of those events.

***Characterization of Theoretical Lifetime Excess Cancer Risk from Consumption of Fish from Lake Isabell***

The SALG found no increase in the calculated theoretical lifetime excess risk of cancer for any contaminant identified in fish tissue from Lake Isabell.

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

***Cumulative Systemic Effects***

The SALG found no evidence to suggest that those who consume fish from Lake Isabell are more likely to suffer systemic adverse health effects than those who do not consume fish from this water body.

***Cumulative Carcinogenicity***

The SALG did not observe an increase in the calculated lifetime excess risk of cancer from simultaneous exposure to multiple carcinogens in those people who eat fish from Lake Isabell than in those who do not consume fish from this water body.

## 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, the SALG may suggest strategies for reducing risk to the health of those who 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 Lake Isabell. Risk assessors from the SALG conclude from the present characterization of adverse health effects potentially associated with consuming fish from Lake Isabell

1. That consumption of largemouth bass from Lake Isabell containing mercury **poses an apparent hazard to public health**.

2. That mercury in black crappie and spotted gar did not exceed the $HAC_{nonca}$ for mercury in fish. Consumption of black crappie and/or spotted gar from Lake Isabell **poses no apparent hazard to human health**.

3. That other contaminants observed in fish from Lake Isabell, including inorganic or organic metalloids and organic components consisting of chlorinated pesticides, PCBs, VOCs, and SVOCs did not exceed their respective $HAC_{nonca}$ or $HAC_{ca}$ and therefore **pose no apparent hazard to human health** either singly or in combination.

# RECOMMENDATIONS

Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the EPA.[14, 16, 47] Risk managers at the DSHS may decide to take some action to protect public health if a risk characterization confirms that people can safely eat four, or fewer than four, 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).[48] Declarations of prohibited harvesting areas are enforceable under the Texas Health and Safety Code, Subchapter D, parts 436.091 and 436.101.[48] 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 how much – contaminated fish or shellfish they wish to consume. The SALG of DSHS concludes from this risk characterization that consuming largemouth bass from Lake Isabell that contain mercury poses **an apparent hazard to public health.** Therefore, the SALG recommends

1. That women who are pregnant, women who may become pregnant, and women who are nursing an infant eat no largemouth bass from Lake Isabell because consuming mercury through consumption of this species could result in adverse effects on the developing nervous system.

2. That men and women beyond childbearing limit consumption of largemouth bass from Lake Isabell to two eight ounce meals per month (preferably no more than one meal every two weeks) because largemouth bass from this small lake contain mercury at concentrations greater than the $HAC_{nonca}$ for this contaminant.

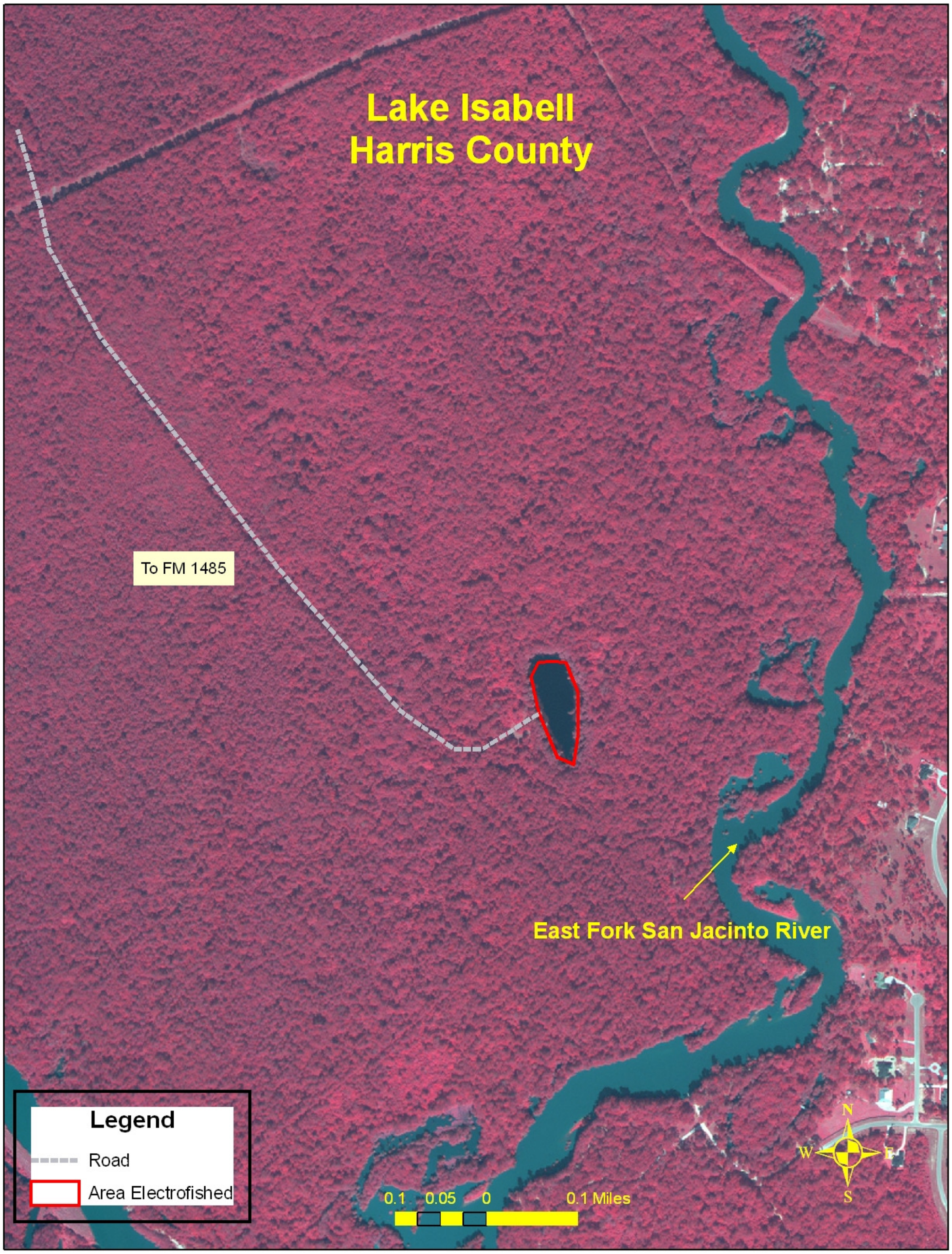
3. That small children (those $\leq$12 years of age or who weigh less than 75 pounds) limit consumption of largemouth bass from Lake Isabell to two four ounce meals per month (preferably no more than one meal every two weeks) because largemouth bass from this lake contain mercury at concentrations greater than the $HAC_{nonca}$ for this contaminant.

4. That state agencies consider retesting fish from Lake Isabell for mercury contamination within five years.

# 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 1-512-834-6757.[49] 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 the USEPA (http://epa.gov/waterscience/fish/advisories/), the TCEQ (http://www.tceq.state.tx.us), and the 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 its Web site and in an official downloadable PDF file containing general hunting and fishing regulations booklet available at http://www.tpwd.state.tx.us/publications/nonpwdpubs/media/outdoor_annual_2008_2009.pdf. [50] A booklet containing this information is available at all establishments selling Texas fishing licenses.[51] 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 (EIETB) of the DSHS (512-458-7269). The EPA'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 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.* 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. Lake Isabell


Lake Isabell
Harris County
To FM 1485
East Fork San Jacinto River
Legend
Road
Area Electrofished
0.1 0.05 0 0.1 Miles
N
W
E
S

# TABLES

**Table 1. Fish samples collected from Lake Isabell in June 2007 and March 2008. Sample number, species, length, and weight were recorded for each sample collected.**

| Sample Number | Species | Length (mm) | Weight (g) |
|---|---|---|---|
| ISB1 | Largemouth bass | 505 | 1788 |
| ISB2 | Largemouth bass | 360 | 596 |
| ISB3 | Black crappie | 274 | 330 |
| ISB4 | Spotted gar | 523 | 520 |
| ISB5 | Spotted gar | 654 | 1060 |
| ISB6 | Largemouth bass | 353 | 549 |
| ISB7 | Largemouth bass | 350 | 540 |
| ISB8 | Black crappie | 290 | 389 |
| ISB9 | Black crappie | 285 | 336 |
| ISB10 | Black crappie | 272 | 329 |

Table 2a. Arsenic (mg/kg) in largemouth bass collected from Lake Isabell, 2007-2008.

| Species | # Detected/ # Sampled | Total Arsenic Mean Concentration ± S.D. (Min-Max) | Inorganic Arsenic Mean Concentration[d] | Health Assessment Comparison Value (mg/kg)[e] | Basis for Comparison Value |
|---|---|---|---|---|---|
| Largemouth bass | 1/2 | 0.167±0.187 (ND-0.299) | **0.017** | 0.7<br>0.362 | EPA chronic oral RfD for Inorganic arsenic: 0.0003 mg/kg–day<br>EPA oral slope factor for inorganic arsenic: 1.5 per mg/kg–day |

[d] *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.*
[e] *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 2b. Inorganic contaminants (mg/kg) in largemouth bass collected from Lake Isabell, 2007-2008.**

| Species | # Detected/ # Sampled | Mean Concentration ± S.D. (Min-Max) | Health Assessment Comparison Value (mg/kg) | Basis for Comparison Value |
|---|---|---|---|---|
| **Cadmium** | | | | |
| Largemouth bass | 1/2 | 0.030±0.006 (ND-0.034) | 0.47 | ATSDR chronic oral MRL: 0.0002 mg/kg–day |
| **Copper** | | | | |
| Largemouth bass | 2/2 | 0.273±0.154 (0.164-0.382) | 333 | National Academy of Science Upper Limit: 0.143 mg/kg–day |
| **Lead** | | | | |
| Largemouth bass | 2/2 | BDL[f] | 0.6 | EPA IEUBKwin |
| **Selenium** | | | | |
| Largemouth bass | 2/2 | 0.931±0.434 (0.624-1.238) | 6 | EPA chronic oral RfD: 0 .005 mg/kg–day<br>ATSDR chronic oral MRL: 0.005 mg/kg–day<br>NAS UL: 0.400 mg/day (0.005 mg/kg–day)<br><br>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 |
| **Zinc** | | | | |
| Largemouth bass | 2/2 | 6.190±3.106 (3.994-8.386) | 700 | EPA chronic oral RfD: 0.3 mg/kg–day |

**Table 2c. Mercury (mg/kg) in fish collected from Lake Isabell, 2007-2008.**

| Species | # Detected/ # Sampled | Mean Concentration ± S.D. (Min-Max) | Health Assessment Comparison Value (mg/kg) | Basis for Comparison Value |
|---|---|---|---|---|
| **Mercury** | | | | |
| Black crappie | 4/4 | 0.538±0.176 (0.382-**0.776**) | 0.7 | ATSDR chronic oral MRL: 0.0003 mg/kg–day |
| Largemouth bass | 4/4 | **0.778**±0.326 (0.384-**1.177**) | | |
| Spotted gar | 2/2 | 0.539±0.309 (0.320-**0.757**) | | |
| All fish combined | 10/10 | 0.634±0.268 (0.320-**1.177**) | | |

[f] *BDL: "Below Detection Limit" – Concentrations were reported as less than the laboratory's method detection 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*

**Table 3. Hazard quotients (HQ) for mercury in fish collected from Lake Isabell in 2007-2008. This table also provides suggested weekly eight-ounce meal consumption rates for 70-kg adults.**[g]

| Species | Hazard Quotient | Meals per Week |
|---|---|---|
| Black crappie | 0.8 | 1.2 |
| Largemouth bass | **1.1** | **0.8** |
| Spotted gar | 0.8 | 1.2 |
| All fish combined | 0.9 | 1.0 |

[g] *DSHS assumes that children under the age of 12 years and/or those who weigh less than 35 kg eat 4-ounce meals.*

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