DRAFT

HEALTH ADVISORY

SAFE EATING GUIDELINES FOR FISH FROM THE LOWER FEATHER RIVER (BUTTE, YUBA, AND SUTTER COUNTIES)

August 2006

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FOREWORD

This health advisory provides safe eating guidelines for consumption of various fish species taken from the lower Feather River in Butte, Yuba, and Sutter counties. These guidelines were developed as a result of findings of high mercury levels in certain fish tested from this region and are provided to protect against possible adverse health effects from methylmercury as consumed from mercury-contaminated fish. Fish with low mercury levels considered safe to eat frequently are also noted in the guidelines. This report provides background information and a description of the data and criteria used to develop the guidelines. Once completed, the guidelines contained herein will become the final state advisory.

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EXECUTIVE SUMMARY

Mercury levels were evaluated in edible fish tissue from the lower Feather River in Butte, Yuba, and Sutter counties, areas possibly affected by historic gold mining. The lower Feather River includes portions of the river from the Fish Barrier Dam to the confluence with the Sacramento River. Mercury levels in fish were collected and analyzed through the Toxic Substances Monitoring Program (TSMP), the CALFED Mercury Project, and the Sacramento River Watershed Program (SRWP). A number of chlorinated hydrocarbon contaminants, including chlordane, DDTs, and PCBs, were also measured in fish and obtained through TSMP and SRWP. Data were evaluated by the Office of Environmental Health Hazard Assessment (OEHHA) in an effort to determine whether there may be potential adverse health effects associated with the consumption of sport fish from this water body.

Almost all fish contain detectible levels of mercury, more than 95 percent of which occurs as methylmercury, a highly toxic form of the element. Consumption of fish is the major route of exposure to methylmercury in the United States. The critical target of methylmercury toxicity is the nervous system, particularly in developing organisms such as the fetus and young children. Significant methylmercury toxicity can occur to the fetus during pregnancy even in the absence of symptoms in the mother. In 1985, the United States Environmental Protection Agency (U.S. EPA) set a reference dose (RfD, that is the daily exposure likely to be without significant risk of deleterious health effects during a lifetime) for methylmercury of $3x10^{-4}$ mg/kg-day, based on central nervous system effects (ataxia and paresthesias) in adults. In 1995, and confirmed in 2001, this RfD was lowered to $1x10^{-4}$ mg/kg-day, based on developmental neurologic abnormalities in infants exposed *in utero*, using the Iraqi and Faroe Island data, respectively. OEHHA finds convincing evidence that the fetus is more sensitive than adults to the neurotoxic effects of mercury, but also recognizes that fish can play an important role in a healthy diet, particularly when it replaces other, higher fat sources of protein. Numerous human and animal studies have shown that fish oils have beneficial cardiovascular and neurological effects. Because it is important to protect the most sensitive population without unduly restricting fish consumption in others, OEHHA chooses to use both the current and previous U.S. EPA reference doses for two distinct population groups. In these guidelines, the current RfD based on effects in infants will be used for women of childbearing age and children aged 17 and younger. The previous RfD, based on effects in adults, will be used for women beyond their childbearing years and men.

In order to provide safe eating guidelines for various fish species, contaminant concentrations in fish from a water body are compared to OEHHA guidance tissue levels for those chemicals, which are designed so that individuals consuming no more than a preset number of meals should not exceed the RfD or an accepted cancer risk level. Best professional judgment is used to determine the most appropriate data evaluation approach as well as the most suitable method to convert a complex data set into more simplified and unified consumption advice for risk communication purposes. Ultimately, safe eating guidelines identify those fish species with high contaminant levels whose consumption should be restricted (see the "Eat in Moderation" table) or avoided altogether (see the "Avoid" table), as well as those low-contaminant fish that may be consumed frequently as part of a healthy diet (see the "Eat Freely" table). A statistically representative sample size was available to provide safe eating guidelines for largemouth bass, white catfish, channel catfish, Sacramento pikeminnow, Sacramento sucker, redear sunfish, and carp. Supporting data (such as mercury concentration for a closely related species at a similar trophic level) were used to develop additional consumption guidelines for other black bass species, striped bass, and additional sunfish species from the lower Feather River.

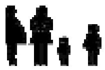
All individuals, especially women of childbearing age and children aged 17 and younger, are advised to follow the safe eating guidelines to ensure that methylmercury ingestion does not exceed the reference dose. To help sport fish consumers achieve this goal, OEHHA has developed guidelines for all fish species caught in the lower Feather River. Meal sizes should be adjusted to body weight as described in the safe eating guidelines table.

For general advice on how to limit your exposure to chemical contaminants in sport fish (e.g., eating smaller fish of legal size), as well as a fact sheet on methylmercury in sport fish, see the California Sport Fish Consumption Advisories (http://www.oehha.ca.gov/fish.html) and Appendices 1 and 2. Advice for other California water bodies can be found online at: http://www.oehha.ca.gov/fish/so_cal/index.html. It should be noted that, unlike the case for many chlorinated hydrocarbon contaminants, such as DDTs and PCBs, various cooking and cleaning techniques will not reduce the methylmercury content of fish.

SAFE EATING GUIDELINES

FISH CONSUMPTION FROM THE LOWER FEATHER RIVER

Fish are nutritious and should be part of a healthy, balanced diet. It is important, however, to choose your fish wisely. The American Heart Association recommends that healthy adults eat at least two meals of fish a week. OEHHA recommends that you choose fish to eat that are low in mercury such as those in the "Enjoy" category. Because some types of fish from the lower Feather River contain higher levels of mercury, OEHHA provides the recommendations below that you can follow to reduce the risks from exposure to mercury in fish.



Women of childbearing age, pregnant or breastfeeding women, and Children 17 years and younger

ENJOY **UP TO 2 MEALS A WEEK**	
Sunfish ***OR***	
EAT IN MODERATION **NO MORE THAN 1 MEAL A WEEK**	
Carp or Sacramento sucker	
AVOID **NO MORE THAN 1 MEAL A MONTH**	
DO NOT EAT	Striped bass or Sacramento pikeminnow
NO MORE THAN 1 MEAL A MONTH	Largemouth, smallmouth or spotted bass; or catfish

Women beyond childbearing age and men

ENJOY **UP TO 2 MEALS A WEEK**
Sunfish*, carp, Sacramento sucker, or channel catfish ***OR***
EAT IN MODERATION **NO MORE THAN 1 MEAL A WEEK**
Largemouth, smallmouth, or spotted bass; or white catfish
AVOID **NO MORE THAN 1 MEAL A MONTH**
Striped bass or Sacramento pikeminnow

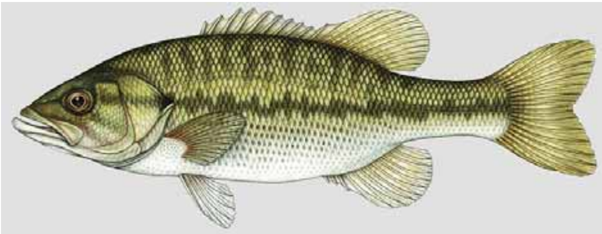
*Sunfish may be eaten up to 3 times per week by this population.

- **CONTACT WITH THE WATER IS SAFE.**
- **EAT SMALLER FISH OF LEGAL SIZE**. Fish build up mercury in their bodies as they grow.
- **MEAL SIZE DEPENDS ON BODY WEIGHT.** Meals are based on a 160 lb adult eating 8 ounces of fish (6 ounces after cooking)—about the size of two decks of cards. If you weigh less than 160 lbs, eat smaller portions of fish. Serve smaller meals to children.
- **DO NOT COMBINE FISH CONSUMPTION ADVICE**. Do not eat more than one of the listed fish species during the same time period unless you are eating from the Enjoy (green) category. If you eat fish from one place, following the advisory, avoid eating fish from other sources during the same time period.
- **CONSIDER THE FISH YOU BUY FROM STORES AND RESTAURANTS.** Women of childbearing age and children can safely eat up to 2 meals a week of most fish purchased in a store or restaurant, **OR** use this guide for eating fish caught from this water body. In a week when you eat 2 meals of fish purchased from stores or restaurants, avoid eating fish caught from a local water body. Commercial fish such as shrimp, king crab, scallops, farmed catfish, wild ocean salmon, oysters, tilapia, flounder, and sole generally contain some of the lowest levels of mercury. Women of childbearing age and children should not eat shark or swordfish, which contain the most mercury.
- **FISH FROM OTHER WATER BODIES MAY ALSO CONTAIN MERCURY**. Not all water bodies in California have been tested. With the exception of ocean or river-run salmon and steelhead, which generally contain low levels of contaminants, fish caught from places without safe eating guidelines should be eaten in limited amounts.

LOWER FEATHER RIVER SPORT FISH

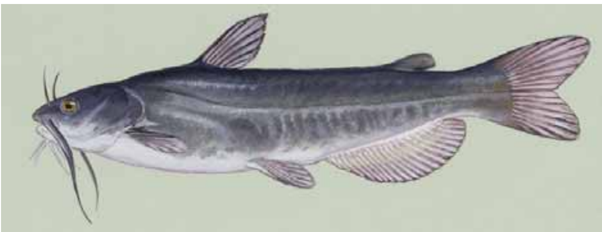
Largemouth Bass *Micropterus salmoides* D Raver USFWS

Smallmouth Bass *Micropterus dolomieu* D Raver USFWS



Spotted Bass *Micropterus punctulatus* Ohio DNR

Striped Bass *Morone saxatilis* D Raver USFWS



White Catfish *Amereiurus catus* D Raver USFWS

Channel Catfish *Ictaluru punctatus* D Raver USFWS

Sacramento Pikeminnow *Ptycheilus grandis* R Reyes USBR

Sacramento Sucker *Catostomus occidentalis* R. Reyes USBR

Common Carp *Cyprinus carpio* D Raver USFWS

Bluegill *Lepomis macrochirus* D Raver USFWS


Redear sunfish *Lepomis microlophus* D Raver USFWS

INTRODUCTION

Mercury contamination of fish is a national problem that has resulted in the issuance of fish consumption advisories in most states, including California (U.S. EPA, 2003). Mercury enters the environment from the breakdown of minerals in rocks and leaching from old mine sites. It is also emitted into air from mining deposits, the burning of fossil fuels, and other industrial sources, as well as from volcanic emissions. Mercury contamination thus occurs as a result of both natural and anthropogenic sources and processes. Once mercury is released into the environment, it cycles through land, air, and water. The deposition of mercury in aquatic ecosystems is a concern for public and environmental health because microorganisms (bacteria and fungi) in the sediments can convert inorganic mercury into organic methylmercury, a particularly toxic form of mercury. Once formed, methylmercury accumulates or "biomagnifies" in the aquatic food chain, reaching the highest levels in fish and other organisms at the top of the food web.

Elevated levels of mercury associated with historic gold and mercury mining have been found in fish in numerous reservoirs and stream sites in northern California (see, e.g., May et al., 2000; Alpers et al., 2004). As a result, fish consumption advisories based on mercury contamination have been issued by the Office of Environmental Health Hazard Assessment (OEHHA) for various water bodies in Nevada, Placer, Yuba, Glenn, Tehama, Trinity, Marin, Lake, Yolo, Colusa, Napa, Sacramento, Solano, and Santa Clara Counties. In an effort to assess mercury and select chlorinated hydrocarbon (e.g., pesticides and PCBs) levels in fish from other northern California water bodies that may have been impacted by mining or other human activities, samples were collected from the lower Feather River (see Figure 1) by the Toxic Substances Monitoring Program (TSMP; which is now included under the Surface Water Ambient Monitoring Program [SWAMP] of the State Water Resources Control Board), the CALFED Mercury Project, and the Sacramento River Watershed Program (SRWP). Sufficient numbers of legal/edible-sized fish were available from this river to make an evaluation for carp, channel catfish, white catfish, largemouth bass, redear sunfish, Sacramento pikeminnow, and Sacramento sucker. The safe eating guidelines included herein are based on the potential exposure to methylmercury through consumption of certain fish from these areas and seek to minimize the associated potential health risks of such exposure (see the "Eat in Moderation" and "Avoid" tables). Although almost all sport and commercial fish contain measurable levels of mercury, unacceptable levels can accumulate in some species, particularly in areas where local mercury contamination is a problem. Safe eating guidelines also include information about fish with low levels of mercury considered safe to eat frequently (two or more times per week; see the "Enjoy" table).

OEHHA is the agency responsible for evaluating potential public health risks from chemical contamination of sport fish. This includes issuing advisories, when appropriate, for the State of California. OEHHA's authorities to conduct these activities are based on mandates in the California Health and Safety Code, Section 59009, to protect public health, and Section 59011, to advise local health authorities, and the California Water Code Section 13177.5, to issue health advisories. Fish advisories developed by OEHHA are published in the California Sport Fishing Regulations and California Sport Fish Consumption Advisories. OEHHA now emphasizes "safe eating guidelines" as part of health advisories in an effort to inform consumers of healthy choices in fish consumption as well as those that should be avoided or limited

In evaluating the TSMP, CALFED, and SRWP data, it was determined that some fish species in the lower Feather River had sufficient levels of mercury that could be a concern for sport fish consumers. Recent levels of chlorinated hydrocarbon pesticides and PCBs found in a limited number of fish samples were not of concern. Because fish consumption advice was not currently in place in this river, development of safe eating guidelines was deemed appropriate.

BACKGROUND

The Feather River is a tributary of the Sacramento River, the lower reaches of which run through Butte, Yuba, and Sutter counties. The lower river flows in a southerly direction approximately 65 miles from Oroville Dam to the confluence of the Sacramento River. This region was the site of the historic Oroville gold mining district, where placer and/or dredge mining operations took place from the gold rush until the early 1950s (Clark, 1998). Mercury was often used in these processes to aid in the recovery of gold (Hunerlach and Alpers, 2003) and, as a result, may have contaminated the river as well as nearby streams and creeks.

While known for its excellent shad, salmon, and striped bass fishing (Stienstra, 2004), many other species of fish can be caught in the river, including black bass, steelhead, catfish, carp, pikeminnow, sunfish, and sucker.

As noted above, mercury data used in this report originated from three different sources: TSMP[1], the CALFED Mercury Project[2] (Davis et al., 2003), and the SRWP[3]. Data were organized into a single electronic database in 2003 by the Central Valley Regional Water Quality Control Board (CVRWQCB); some corrections were made to originally published data at that time. Subsequently, OEHHA obtained the database from the CVRWQCB and made additional quality control revisions. The amended database was then used for preparation of these safe eating guidelines; data are referred to in the text and tables by their primary source (i.e., TSMP, CALFED, or SRWP). For legal and/or edible size fish (see criteria in footnotes of Table 1), a total of nine sport fish species were collected by electrofishing equipment or gill nets from 1978 to 2002 at five sites along the lower Feather River between the Fish Barrier Dam, just downstream from Oroville Dam, and the confluence with the Sacramento River. Species collected included bluegill, carp, channel catfish, white catfish, largemouth bass, redear sunfish, striped bass, Sacramento pikeminnow, and Sacramento sucker. Fish were measured and/or

[1] TSMP, a state water quality-monitoring program managed by the State Water Resources Control Board, was initiated in 1976 and continued until it was subsumed under SWAMP in 1997. The California Department of Fish and Game collects and analyzes the samples.
[2] The CALFED Mercury Project was funded by the CALFED Bay-Delta Program to investigate mercury cycling in the Bay-Delta System.
[3] The SRWP, formed in 1996, is comprised of a wide coalition of stakeholders including representatives from government agencies, academia, local organizations, and the public. The program, which includes monitoring of potentially toxic pollutants in surface waters of the Sacramento River watershed, is funded primarily by the federal government and is administered by U.S. EPA Region IX. The Sacramento Regional County Sanitation District, Sacramento District, Sacramento River Toxic Pollutant Control Program (SRTPCP), was instrumental in initiating the program and assists with funding. The San Francisco Estuary Institute (SFEI) coordinated fish monitoring.

weighed; boneless and skinless fillets were submitted as individuals or composites to the California Department of Fish and Game (CDFG) Water Pollution Control Laboratory (TSMP) or Moss Landing Marine Laboratories (TSMP and CALFED) or UC Davis. Mercury levels were determined by cold-vapor atomic absorption spectroscopy.

A number of chlorinated hydrocarbon contaminants, including chlordane, toxaphene, DDTs, and PCBs were also measured by TSMP or SRWP in a very limited number of samples of largemouth bass, white catfish, channel catfish, Sacramento pikeminnow, and Sacramento sucker collected from the lower Feather River (Davis et al., 2000). Homogenized tissue was analyzed by gas chromatography, using mass spectrometry (GC/MS) for chlorinated hydrocarbon determination. In most cases, mean values of these chemicals for each species (data not shown) did not exceed OEHHA screening values used to determine whether further evaluation or site-specific advice should be considered (Brodberg and Pollock, 1999). Additionally, most data were more than twenty years old. As concentrations of legacy chlorinated hydrocarbons are declining over time in the environment, additional data would be necessary to interpret current health risks from such exposure. Consequently, only mercury data were considered for these guidelines.

It is not possible to determine in advance how many samples of each fish species from each site will be necessary in order to statistically interpret contamination data for safe eating guidelines. However, U.S. EPA does recommend a minimum of three replicate composite samples of three fish per composite (nine total fish) in order to begin assessing the magnitude of contamination at a site. U.S. EPA also recommends that at least two fish species be sampled per site. Although composite analysis is generally the most cost-efficient method of estimating the average concentration of chemicals in a fish species, individual sampling provides a better measure of the range and variability of contaminant levels in a fish population (U.S. EPA, 2000a). Using these guidelines, OEHHA believes that a minimum of three replicates of three fish per composite or, preferably, nine individual fish samples of multiple species from each site should be analyzed for this type of pilot study. Fish samples should be collected from multiple (legal/edible-) size classes. Following this sampling protocol will allow estimation of the range and variation of contaminant concentrations at a particular site and derivation of a representative mean concentration for use in developing fish consumption guidelines. More samples will provide a better estimate of the mean contaminant level in various fish species and are especially important for large water bodies.

Of the samples collected from the lower Feather River, carp ($n = 11$), channel catfish ($n = 33$), largemouth bass ($n = 56$), redear sunfish ($n = 10$), Sacramento pikeminnow ($n = 33$), Sacramento sucker ($n = 28$), and white catfish ($n = 14$) had sufficient sample size (≥ 9 fish per species) of legal/edible size fish (see Table 1) to be considered representative of mercury levels in those species, thereby allowing adequate estimation of the health risks associated with their consumption. Interpretation of data for other fish when there is a limited sample size can be found in the guidelines for fish consumption section of this report.

METHYLMERCURY TOXICOLOGY

Mercury is a metal found naturally in rocks, soil, air, and water that can be concentrated to high levels in the aquatic food chain by a combination of natural processes and human activities (ATSDR, 1999). The toxicity of mercury to humans is greatly dependent on its chemical form (elemental, inorganic, or organic) and route of exposure (oral, dermal, or inhalation). Methylmercury (an organic form) is highly toxic and can pose a variety of human health risks (NAS/NRC, 2000). Of the total amount of mercury found in fish muscle tissue, methylmercury comprises more than 95 percent (ATSDR, 1999; Bloom, 1992). Because analysis of total mercury is less expensive than that for methylmercury, total mercury is usually analyzed for most fish studies. In this study, total mercury was measured and assumed to be 100 percent methylmercury for the purposes of risk assessment.

Fish consumption is the major route of exposure to methylmercury in the United States (ATSDR, 1999). As noted above, almost all fish contain detectable levels of methylmercury, which, when ingested, is almost completely absorbed from the gastrointestinal tract (Aberg et al., 1969; Myers et al., 2000). Once absorbed, methylmercury is distributed throughout the body, reaching the largest concentration in kidneys. Its ability to cross the placenta as well as the blood brain barrier allows methylmercury to accumulate in the brain and fetus, which are known to be especially sensitive to the toxic effects of this chemical (ATSDR, 1999). In the body, methylmercury is slowly converted to inorganic mercury and excreted predominantly by the fecal (biliary) pathway. Methylmercury is also excreted in breast milk (ATSDR, 1999). The biological half-life of methylmercury is approximately 44-74 days in humans (Aberg, 1969; Smith et al., 1994), meaning that it takes approximately 44-74 days for one-half of a single ingested dose of methylmercury to be eliminated from the body.

Human toxicity of methylmercury has been well studied following several epidemics of human poisoning resulting from consumption of highly contaminated fish (Japan) or seed grain (Iraq, Guatemala, and Pakistan) (Elhassani, 1982-83). The first recorded mass methylmercury poisoning occurred in the 1950s and 1960s in Minamata, Japan, following the consumption of fish contaminated by industrial pollution (Marsh, 1987). The resulting illness was manifested largely by neurological signs and symptoms such as loss of sensation in the hands and feet, loss of gait coordination, slurred speech, sensory deficits including blindness, and mental disturbances (Bakir et al., 1973; Marsh, 1987). This syndrome was subsequently named Minamata Disease. A second outbreak of methylmercury poisoning occurred in Niigata, Japan, in the mid-1960s. In that case, contaminated fish were also the source of illness (Marsh, 1987). In all, more than 2,000 cases of methylmercury poisoning were reported in Japan, including more than 900 deaths (Mishima, 1992).

The largest outbreak of methylmercury poisoning occurred in Iraq in 1971-1972 and resulted from consumption of bread made from seed grain treated with a methylmercury fungicide (Bakir et al., 1973). This epidemic occurred over a relatively short term (several months) compared to the Japanese outbreak. The mean methylmercury concentration of wheat flour samples was found to be 9.1 micrograms per gram (μg/g). Over 6,500 people were hospitalized, with 459 fatalities. Signs and symptoms of methylmercury toxicity were similar to those reported in the Japanese epidemic.

Review of data collected during and subsequent to the Japan and Iraq outbreaks identified the critical target of methylmercury as the nervous system and the most sensitive subpopulation as the developing organism (U.S. EPA, 1997). During critical periods of prenatal and postnatal structural and functional development, the fetus and children are especially susceptible to the toxic effects of methylmercury (ATSDR, 1999; IRIS, 1995). When maternal methylmercury consumption is very high, as happened in Japan and Iraq, significant methylmercury toxicity can occur to the fetus during pregnancy, with only very mild or even in the absence of symptoms in the mother. In those cases, symptoms in children are often not recognized until development of cerebral palsy and/or mental retardation many months after birth (Harada, 1978; Marsh et al., 1980; Marsh et al., 1987; Matsumoto et al., 1964; Snyder, 1971).

The International Agency for Research on Cancer (IARC) has listed methylmercury compounds as possible human carcinogens, based on inadequate data in humans and limited evidence in experimental animals (increased incidence of tumors in mice exposed to methylmercury chloride) (IARC, 1993). Based on IARC's evaluation, OEHHA has administratively listed methylmercury compounds on the Proposition 65 list of chemicals known to the State of California to cause cancer. No estimate of the increased cancer risk from lifetime exposure has been developed for methylmercury.

DERIVATION OF REFERENCE DOSES FOR METHYLMERCURY

A reference dose (RfD) is an estimate of daily human exposure to a chemical that is likely to be without significant risk of adverse effects during a lifetime (including to sensitive population subgroups), expressed in units of mg/kg-day (IRIS, 1995). This estimate includes a safety factor to account for data uncertainty. The underlying assumption of a reference dose is that, unlike carcinogenic effects, there is a threshold dose below which certain toxic effects will not occur. The reference dose for a particular chemical is derived from review of relevant toxicological and epidemiological studies in animals and/or humans. These studies are used to determine a No-Observed-Adverse-Effect-Level (NOAEL; the highest dose at which no adverse effect is seen), a Lowest-Observed-Adverse-Effect-Level (LOAEL; the lowest dose at which any adverse effect is seen), or a benchmark dose level (BMDL; a statistical lower confidence limit of a dose that produces a certain percent change in the risk of an adverse effect) (IRIS, 1995). Based on these values and the application of uncertainty factors to account for incomplete data and sensitive subgroups of the population, a reference dose is then generated. Exposure to a level above the RfD does not mean that adverse effects will occur, only that the possibility of adverse effects occurring has increased (IRIS, 1993).

The first U.S. EPA RfD for methylmercury was developed in 1985 and set at $3x10^{-4}$ mg/kg-day (U.S. EPA, 1997). This RfD was based, in part, on a World Health Organization (WHO) report summarizing data obtained from several early epidemiological studies on the Iraqi and Japanese methylmercury poisoning outbreaks (WHO, 1976). WHO found that the earliest symptoms of methylmercury intoxication (paresthesias) were reported at blood and hair concentrations ranging from 200-500 µg/L and 50-125 µg/g, respectively, in adults. In cases where ingested mercury dose could be estimated (based, for example, mercury concentration in contaminated bread and number of loaves consumed daily), an empirical correlation between blood and/or hair mercury concentrations and onset of symptoms was obtained. From these studies, WHO determined that methylmercury exposure equivalent to long-term daily intake of 3-7 μg/kg body weight in adults was associated with an approximately 5 percent prevalence of paresthesias (WHO, 1976). U.S. EPA further cited a study by Clarkson et al. (1976) to support the range of blood mercury concentrations at which paresthesias were first observed in sensitive members of the adult population. This study found that a small percentage of Iraqi adults exposed to methylmercury-treated seed grain developed paresthesias at blood levels ranging from 240 to 480 μg/L. The low end of this range was considered to be a LOAEL and was estimated to be equivalent to a dosage of 3 μg/kg-day. U.S. EPA applied a 10-fold uncertainty factor to the LOAEL to reach what was expected to be the NOAEL. Because the LOAEL was observed in sensitive individuals in the population after chronic exposure, additional uncertainty factors were not considered necessary for exposed adults (U.S. EPA, 1997).

Although this RfD was derived based on effects in adults, even at that time researchers were aware that the fetus might be more sensitive to methylmercury (WHO, 1976). It was not until 1995, however, that U.S. EPA had sufficient data from Marsh et al. (1987) and Seafood Safety (1991) to develop an oral RfD based on methylmercury exposures during the prenatal stage of development (IRIS, 1995). Marsh et al. (1987) collected and summarized data from 81 mother and child pairs where the child had been exposed to methylmercury *in utero* during the Iraqi epidemic. Maximum mercury concentrations in maternal hair during gestation were correlated with clinical signs in the offspring such as cerebral palsy, altered muscle tone and deep tendon reflexes, and delayed developmental milestones that were observed over a period of several years after the poisoning. Clinical effects incidence tables included in the critique of the risk assessment for methylmercury conducted by U.S. FDA (Seafood Safety, 1991) provided dose-response data for a benchmark dose approach to the RfD, rather than the previously used NOAEL/LOAEL method. The BMDL was based on a maternal hair mercury concentration of 11 parts per million (ppm). From that, an average blood mercury concentration of 44 μg/L was estimated based on a hair: blood concentration ratio of 250:1. Blood mercury concentration was, in turn, used to calculate a daily oral dose of 1.1 μg/kg-day, using an equation that assumed steady-state conditions and first-order kinetics for mercury. An uncertainty factor of 10 was applied to this dose to account for variability in the biological half-life of methylmercury, the lack of a two-generation reproductive study and insufficient data on the effects of exposure duration on developmental neurotoxicity and adult paresthesias. The oral RfD was then calculated to be $1x10^{-4}$ mg/kg-day, to protect against developmental neurological abnormalities in infants (IRIS, 1995). This fetal RfD was deemed protective of infants and sensitive adults.

The two previous RfDs for methylmercury were developed using data from high-dose poisoning events. Recently, the National Academy of Sciences was directed to provide scientific guidance to U.S. EPA on the development of a new RfD for methylmercury (NAS/NRC, 2000). Three large prospective epidemiological studies were evaluated in an attempt to provide more precise dose-response estimates for methylmercury at chronic low-dose exposures, such as might be expected to occur in the United States. The three studies were conducted in the Seychelles Islands (Davidson et al., 1995, 1998), the Faroe Islands (Grandjean et al., 1997, 1998, 1999), and New Zealand (Kjellstrom et al., 1986, 1989). The residents of these areas were selected for study because their diets rely heavily on consumption of fish and marine mammals, which provide a continual source of methylmercury exposure (NAS/NRC, 2000).

Although estimated prenatal methylmercury exposures were similar among the three studies, subtle neurobehavioral effects in children were found to be associated with maternal methylmercury dose in the Faroe Islands and New Zealand studies, but not in the Seychelle Islands study. The reasons for this discrepancy were unclear; however, it may have resulted from differences in sources of exposure (marine mammals and/or fish), differences in exposure pattern, differences in neurobehavioral tests administered and age at testing, the effects of confounding variables, or issues of statistical analysis (NRC/NAS, 2000). The National Academy of Sciences report supported the current U.S. EPA RfD of $1x10^{-4}$ mg/kg-day for fetuses, but suggested that it should be based on the Faroe Islands study rather than Iraqi data.

U.S. EPA has published an updated RfD document that arrives at the same numerical RfD as the previous fetal RfD, using data from all three recent epidemiological studies while placing emphasis on the Faroe Island data (IRIS, 2001). In order to develop an RfD, U.S. EPA used several test scores from the Faroes data, rather than a single measure for the critical endpoint as is customary (IRIS, 2001). U.S. EPA developed BMDLs utilizing test scores for several different neuropsychological effects with cord blood as the preferred biomarker. The BMDLs for different neuropsychological effects in the Faroes study ranged from 46-79 µg mercury/liter blood. U.S. EPA then chose a one-compartment model for conversion of cord blood to ingested maternal dose, which resulted in estimated maternal mercury exposures of 0.857-1.472 µg/kg-day (IRIS, 2001). An uncertainty factor of ten was applied to the oral doses corresponding to the range of BMDLs to account for interindividual toxicokinetic variability in ingested dose estimation from cord-blood mercury levels and pharmacodynamic variability and uncertainty, leading to an RfD of $1x10^{-4}$ mg/kg-day (IRIS, 2001). In support of this RfD, U.S. EPA found that benchmark dose analysis of several neuropsychological endpoints from the Faroe Island and New Zealand studies, as well as an integrative analysis of all three epidemiological studies, converged on an RfD of 0.1 µg/kg-day (IRIS, 2001). U.S. EPA (IRIS, 2001) now considers this RfD to be protective for all populations. However, in their joint Federal Advisory for Mercury in Fish, U.S. EPA and U.S. FDA only apply this RfD to women who are pregnant or might become pregnant, nursing mothers, and young children (U.S. EPA, 2004) (see Guidelines for Fish Consumption section for further details).

OEHHA finds that there is convincing evidence that the fetus is more sensitive than adults to the neurotoxic and subtle neuropsychological effects of methylmercury. As noted previously, during the Japanese and Iraqi methylmercury poisoning outbreaks, significant neurological toxicity occurred to the fetus even in the absence of symptoms in the mother. In later epidemiological studies at lower exposure levels (e.g., in the Faroe Islands), these differences in maternal and fetal susceptibility to methylmercury toxicity were also observed. Recent evidence has shown that the nervous system continues to develop through adolescence (see, for example, Giedd et al., 1999; Paus et al., 1999; Rice and Barone, 2000). As such, it is likely that exposure to a neurotoxic agent during this time may damage neural structure and function (Adams et al., 2000), which may not become evident for many years (Rice and Barone, 2000). Thus, OEHHA considers the RfD based on subtle neuropsychological effects following fetal exposure to be the best estimate of a protective daily exposure level for pregnant or nursing women and children aged 17 years and younger.

OEHHA also recognizes that fish can play an important role in a healthy diet, particularly when it replaces other higher fat sources of protein. Numerous human and animal studies have shown that fish oils have beneficial cardiovascular and neurological effects (see, for example, Harris and Isley, 2001; Iso et al., 2001; Cheruka et al., 2002; Mori and Beilin et al., 2001; Daviglus et al., 1997; von Schacky et al., 1999; Valagussa et al., 1999; Moriguchi et al., 2000; Lim and Suzuki, 2000). Nonetheless, the hazards of methylmercury that may be present in fish, particularly to developing fetuses and children, cannot be overlooked. When contaminants are present in a specific food that can be differentially avoided, it is not necessary to treat all populations in the most conservative manner to protect the most sensitive population. Sport fish consumption advisories are such a case. Exposure advice can be tailored to specific risks and benefits for populations with different susceptibilities so that each population is protected without undue burden to the other. Fish consumption guidelines utilize the best scientific data available to provide the most relevant advice and protection for all potential consumers.

In an effort to address the risks of methylmercury contamination in different populations as well as the cardiovascular and neurological benefits of fish consumption, two separate RfDs will be used to assess risk for different population groups. OEHHA has formerly used separate methylmercury RfDs for adults and pregnant women to formulate advisories for methylmercury contamination of sport fish (Stratton et al., 1987). Additionally, the majority of states issue separate consumption advice for sensitive (e.g., children) and general population groups**.** OEHHA chooses to use both the current and previous U.S. EPA references doses for two distinct population groups. For these safe eating guidelines, the current RfD of $1x10^{-4}$ mg/kg-day, based on effects in infants, will be used for women of childbearing age and children aged 17 and younger. The previous RfD of $3x10^{-4}$ mg/kg-day, based on effects in adults, will be used for women beyond their childbearing years and men.

MERCURY LEVELS IN FISH FROM THE LOWER FEATHER RIVER

In general, mercury concentrations in fish and other biota are dependent on the mercury level of the environment in which they reside. However, there are many factors that affect the accumulation of mercury in fish tissue. Fish species and age (as inferred from length) are known to be important determinants of tissue mercury concentration (WHO, 1989; 1990). Fish at the highest trophic levels (i.e., top predatory fish) generally have the highest levels of mercury. Additionally, because the biological half-life of methylmercury in fish is much longer (approximately 2 years) than it is in mammals, tissue concentrations increase with increased duration of exposure (Krehl, 1972; Stopford and Goldwater, 1975; Tollefson and Cordle, 1986). Thus, within a given species, tissue methylmercury concentrations are expected to increase with increasing age and length. The accumulation of mercury in fish is also dependent on environmental pH, redox potential, temperature, alkalinity, buffering capacity, suspended sediment load, and geomorphology in individual water bodies (Andren and Nriagu, 1979; Berlin, 1986; WHO, 1989).

For legal/edible sized fish, the mean mercury concentration, length, and sample size for each species collected and analyzed from the lower Feather River are presented in Table 1. Complete descriptive statistics for these fish can be found in Appendix 3. Individual mercury concentrations and lengths of legal/edible size fish from which species means were generated can be found in Appendix 4. Individual mercury concentrations and lengths for fish below legal/edible size fish are presented in Appendix 5, although these fish were not used for development of the safe eating guidelines.

Mercury concentrations in legal/edible size fish of all species from the lower Feather River ranged from 0.10 ppm in a redear sunfish to 3.5 ppm in a striped bass. For those species collected with sufficient sample size to adequately represent mercury levels ($n \geq 9$ fish), the following mercury concentrations and fish lengths were reported for edible/legal-sized fish: mean mercury concentration for Sacramento pikeminnow was 0.97 ppm, with a range of 0.13 to 2.26 ppm; lengths ranged from 256 to 500 mm, with a mean of 354 mm in this species. Mercury levels in largemouth bass averaged 0.72 ppm, with a range of 0.18 to 2.35 ppm. Largemouth bass ranged in length from 305 to 495 mm, with a mean of 337 mm. Mercury concentrations in white catfish ranged from 0.39 to 1.25 ppm, with a mean of 0.61 ppm; lengths in this species ranged from 205-670 mm, with a mean of 360 mm. Channel catfish had a mean mercury concentration of 0.36 ppm (range: 0.17 to 0.73 ppm) and a mean length of 509 mm. Carp and Sacramento sucker had similar mean mercury concentrations at 0.29 ppm (range: 0.12 to 0.50 ppm) and 0.28 ppm (range: 0.21 to 0.41 ppm), respectively. Carp mean length was 504 mm while sucker mean length was 458 mm. Redear sunfish contained an average mercury concentration of 0.16 ppm (range: 0.10 to 0.22 ppm) and an average length of 157 mm (range: 154 to 159 mm).

GUIDELINES FOR FISH CONSUMPTION

Guidance tissue levels have been developed that relate the number and size of recommended fish meals to methylmercury concentrations found in fish (Table 2). OEHHA has developed guidance levels for mercury or methylmercury (Brodberg and Klasing, 2003) similar to risk-based consumption limits recommended by U.S. EPA (U.S. EPA, 2000b). These guidance values were designed so that individuals consuming no more than a preset number of meals should not exceed the RfD for methylmercury. Meal sizes are based on a standard 8-ounce (227 g) portion of uncooked fish (approximately 6 ounces after cooking) for adults who weigh approximately 70 kg (equivalent to 154 lbs), and the assumption that meal size corresponds to body weight. Consumers can adjust their meal size to stay within the advisory guidelines by adding or subtracting one ounce of fish, respectively, for each 20-pound difference in body weight. (see Appendix 1 for general fish consumption advice). OEHHA generally issues site-specific consumption advice beginning at a consumption frequency of 12 meals per month (three times a week). Fish that can be eaten at this frequency represent fish with lower levels of mercury. OEHHA encourages greater consumption of fish in this category, designated as "Enjoy," in order for consumers to continue eating fish while minimizing the risk. OEHHA typically also uses other consumption frequencies of eight meals a month, four meals a month, one meal a month, and no consumption. Guidance tissue levels for women beyond their childbearing years and men are approximately three times higher than for sensitive populations because of the three-fold higher RfD level used for this population group. This sensitive population is defined as women of childbearing age (including women who are pregnant or breastfeeding) and children aged 17 years and younger.

Mean mercury concentrations for all fish species with a minimum of nine fish per sample were compared to the guidance tissue levels to develop consumption guidelines. As noted above, for the lower Feather River, sample size was sufficient to issue fish consumption guidelines for carp, channel catfish, white catfish, largemouth bass, redear sunfish, Sacramento pikeminnow, and Sacramento sucker. When sample size for a particular species from a water body is too small to assure a statistically representative sample, other information may be useful to help develop consumption recommendations for that species. When there are less than nine individual or three composite samples at a site for a given species, advice for that species may be extrapolated from data for other, similar species at that site or from the same species at a similar site. This method is acceptable when evaluation of the entire data set shows clear trends that justify the issuance of prudent, protective health advice even in the absence of a statistically representative sample. For example, it may be reasonable to provide consumption advice for a particular species with few or no data (e.g., smallmouth bass) when adequate data are available for another, related fish species at that site (e.g., largemouth bass).

For the lower Feather River, supporting data were examined to determine whether they could be used to assist in the development of fish consumption advice. Because different species of black bass often contain similar levels of the same contaminant in the same water body, it is recommended that consumers follow the advice for largemouth bass for other black bass species (smallmouth and spotted bass) caught in this river. Only six legal-sized striped bass were collected from the lower Feather River; however, mercury concentrations in this species averaged 1.27 ppm and ranged up to 3.5 ppm. Additionally, a below legal-sized striped bass caught from the river contained 1.65 ppm mercury. Given the very high average mercury concentration in this species and the generally high level of mercury in other predatory fish from this river, it was considered prudent to provide consumption advice for striped bass even without nine samples, using the available mean. Bluegill were also not collected in sufficient numbers from the lower Feather River to provide a statistically valid sample. OEHHA recommends that fishers follow the redear sunfish advice for bluegill or other sunfish species from this river.

Safe Eating Guidelines for the Lower Feather River:

Based on the evaluation of all data from the lower Feather River, it is recommended that **women of childbearing age and children aged 17 and younger** do not consume any striped bass or Sacramento pikeminnow from this water body. Additionally, this population should limit consumption of largemouth, smallmouth, or spotted bass (black bass species) or white catfish or channel catfish to no more than one meal a month. Alternatively, this population may eat carp or Sacramento sucker up to one meal a week or sunfish species (bluegill, redear or green sunfish) up to two meals per week.

OEHHA also recommends that **women of childbearing age and children aged 17 and younger** follow the Joint Federal Advisory for Mercury in Fish for commercial fish. This advisory recommends that these individuals do not eat shark, swordfish, king mackerel, or tilefish because of their high levels of mercury. It also recommends that these individuals can safely eat up to an average of 12 ounces (two average meals) per week of a variety of other cooked fish such as shrimp, canned light tuna, salmon, pollock, or (farm-raised) catfish. Albacore (“white”) tuna is known to contain more mercury than canned light tuna; it is therefore recommended that no more than 6 ounces of albacore tuna be consumed per week. If 12 ounces of cooked fish from a store or restaurant are eaten in a given week, then OEHHA recommends that sport fish caught from the lower Feather River or other California water bodies should not be consumed in the same week.

For the lower Feather River, OEHHA recommends that **women beyond their childbearing years and men** limit consumption of striped bass or Sacramento pikeminnow to one meal per month. Alternatively, this population may eat up to one meal per week of largemouth, smallmouth, or spotted bass or white catfish or they may eat sucker or carp or channel catfish up to two times per week or sunfish up to three times per week.

Additionally, OEHHA recommends that women beyond their childbearing years and men take into account the commercial fish that they eat, especially high-mercury fish such as shark, swordfish, king mackerel, or tilefish. If they consume these species, they should reduce consumption of sport fish caught in the lower Feather River, or other California water bodies, accordingly.

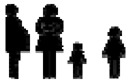
It is very important to note that if an individual consumes multiple species or catches fish from more than one site, the recommended guidelines for different species and locations should not be combined. For example, if a person eats a meal of fish from the one meal per month category, he or she should not eat any other fish for at least one month. For fish in the one meal per week category, an individual can eat one species of fish one week, and the same or a different species from the meal per week category the next week. Fish species in the two and three meals per week category can be combined in the same week.

For general advice on how to limit your exposure to chemical contaminants in sport fish (e.g., eating smaller fish of legal size), see Appendix 2. It should be noted that, unlike the case for many fat-soluble organic contaminants (e.g., DDTs and PCBs), various cooking and cleaning techniques will not reduce the methylmercury content of fish. Meal sizes should be adjusted to body weight as described in the advisory table.

SAFE EATING GUIDELINES

FISH CONSUMPTION FROM THE LOWER FEATHER RIVER

Fish are nutritious and should be part of a healthy, balanced diet. It is important, however, to choose your fish wisely. The American Heart Association recommends that healthy adults eat at least two meals of fish a week. OEHHA recommends that you choose fish to eat that are low in mercury such as those in the "Enjoy" category. Because some types of fish from the lower Feather River contain higher levels of mercury, OEHHA provides the recommendations below that you can follow to reduce the risks from exposure to methylmercury in fish.



Women of childbearing age, pregnant or breastfeeding women, And children 17 years and younger

ENJOY **UP TO 2 MEALS A WEEK**	
Sunfish ***OR***	
EAT IN MODERATION **NO MORE THAN 1 MEAL A WEEK**	
Carp or Sacramento sucker	
AVOID **NO MORE THAN 1 MEAL A MONTH**	
DO NOT EAT	Striped bass or Sacramento pikeminnow
NO MORE THAN 1 MEAL A MONTH	Largemouth, smallmouth or spotted bass; or catfish

Women beyond childbearing age and men

ENJOY **UP TO 2 MEALS A WEEK**
Sunfish*, carp, Sacramento sucker, or channel catfish ***OR***
EAT IN MODERATION **NO MORE THAN 1 MEAL A WEEK**
Largemouth, smallmouth, or spotted bass; or white catfish
AVOID **NO MORE THAN 1 MEAL A MONTH**
Striped bass or Sacramento pikeminnow

*Sunfish may be eaten up to 3 times per week by this population.

- **CONTACT WITH THE WATER IS SAFE.**
- **EAT SMALLER FISH OF LEGAL SIZE**. Fish build up mercury in their bodies as they grow.
- **MEAL SIZE DEPENDS ON BODY WEIGHT.** Meals are based on a 160 lb adult eating 8 ounces of fish (6 ounces after cooking)—about the size of two decks of cards. If you weigh less than 160 lbs, eat smaller portions of fish. Serve smaller meals to children.
- **DO NOT COMBINE FISH CONSUMPTION ADVICE**. Do not eat more than one of the listed fish species during the same time period unless you are eating from the Enjoy (green) category. If you eat fish from one place, following the advisory, avoid eating fish from other sources during the same time period.
- **CONSIDER THE FISH YOU BUY FROM STORES AND RESTAURANTS.** Women of childbearing age and children can safely eat up to 2 meals a week of most fish purchased in a store or restaurant, **OR** use this guide for eating fish caught from this water body. In a week when you eat 2 meals of fish purchased from stores or restaurants, avoid eating fish caught from a local water body. Commercial fish such as shrimp, king crab, scallops, farmed catfish, wild ocean salmon, oysters, tilapia, flounder, and sole generally contain some of the lowest levels of mercury. Women of childbearing age and children should not eat shark or swordfish, which contain the most mercury.
- **FISH FROM OTHER WATER BODIES MAY ALSO CONTAIN MERCURY**. Not all water bodies in California have been tested. With the exception of ocean or river-run salmon and steelhead, which generally contain low levels of contaminants, fish caught from places without safe eating guidelines should be eaten in limited amounts.

RECOMMENDATIONS FOR FURTHER SAMPLING

To more clearly elucidate contamination problems in the lower Feather River, it is recommended that further fish sampling be done. In particular, emphasis should be placed on collecting data for popular fish species such as striped bass, trout, crappie, and other sunfish, if available, that were not previously sampled or had low sample size. Sampling at least nine fish of one or more of these or other local species would provide data necessary for development of fish consumption advice specific for these species. Anadromous species such as shad, salmon and steelhead are typically low in mercury. However, because the lower Feather River has a large population of these species and is a popular fishing site, OEHHA recommends sampling of these species in the lower Feather River to obtain a more comprehensive understanding of their contaminant levels. Collection of additional data for the lower Feather River will provide anglers with more information on their potential risks from consumption of high mercury fish as well as options for choosing lower mercury fish in this water body.

FIGURE 1.
LOWER FEATHER RIVER SAMPLING SITES

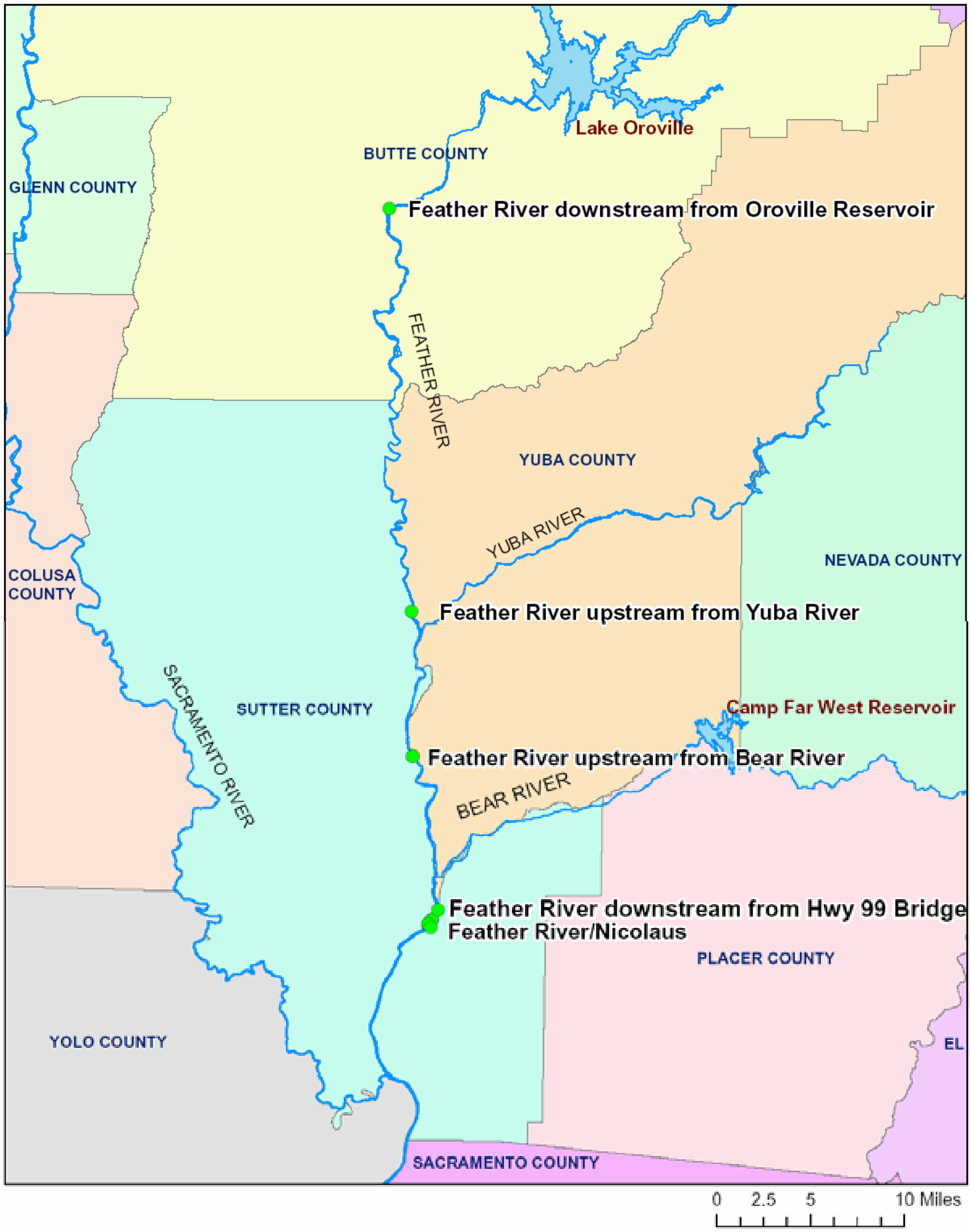


Table 1. Overall Mean Mercury (Hg) Concentrations (ppm, wet weight) and Lengths (mm) of Fish from the Lower Feather River[1]			
	Hg (ppm)	Total Length (mm)[2]	Number of Fish
Bluegill	0.12	184	5
Carp	0.29	504	11
Channel Catfish	0.36	509	33
Largemouth Bass	0.72	337	56
Redear Sunfish	0.16	157	10
Sacramento Pikeminnow	0.97	354	33
Sacramento Sucker	0.28	458	28
Striped Bass	1.27	652	6
White Catfish	0.61	360	14

[1]Excludes fish below the following legal or edible size limits:

- Bluegill or sunfish: 100 mm
- Carp: 200 mm
- Largemouth and smallmouth bass: 305 mm
- Sacramento pikeminnow: 250 mm
- Sacramento sucker: 200 mm
- Striped bass: 457 mm
- White catfish: 200 mm

[2]Length is presented as total length (the longest length from the tip of the tail fin to the tip of nose/mouth).

Table 2. Guidance Tissue Levels (ppm total mercury or methylmercury* wet weight) for Two Population Groups		
Population Group:	**Women of childbearing age and children aged 17 years and younger**	**Women beyond childbearing age and men**
Reference Dose (RfD):	**1×10^{-4} mg/kg-day**	**3×10^{-4} mg/kg-day**
Meals per Month	**Tissue Concentration (ppm)**	
30 (224 g/day)	≤0.03	≤0.09
12 (90 g/day)	>0.03 – 0.08	>0.09 – 0.23
8 (60 g/day)	>0.08 – 0.12	>0.23 – 0.35
7 (52 g/day)	>0.12 – 0.13	>0.35 – 0.40
6 (45 g/day)	>0.13 – 0.16	>0.40 – 0.47
5 (37 g/day)	>0.16 – 0.19	>0.47 – 0.56
4 (30 g/day)	>0.19 – 0.23	>0.56 – 0.70
3 (22 g/day)	>0.23 – 0.31	>0.70 – 0.94
2 (15 g/day)	>0.31 – 0.47	>0.94 – 1.40
1 (7.5 g/day)	>0.47 – 0.94	>1.40 – 2.81
0	>0.94	>2.81

*The values in this table are based on the assumption that 100% of total mercury measure in fish is methylmercury. This may not be true for shellfish, so methylmercury needs to be measured directly in these species for use in this table.

The following general equation can be used to calculate the fish tissue concentration (in mg/kg) at which the consumption exposure from a chemical with a non-carcinogenic effects is equal to the reference level for that chemical at any consumption level:

$$\text{Tissue Concentration} = \frac{(\text{RfD mg/kg-day})(\text{kg BW})(\text{RSC})}{\text{CR kg/day}}$$

where,

RfD = Chemical specific reference dose or other reference level
BW = Body weight of consumer
RSC = Relative source contribution of fish to total exposure
CR = Consumption rate as the daily amount of fish consumed

For example: $$\frac{(1 \times 10^{-4}\text{ mg/kg-day})(70\text{ kg body weight})(1)}{.030\text{ kg/day}} = 0.23\text{ mg/kg tissue}$$

This equation was applied above to determine tissue concentrations of methylmercury (assuming 100% of measured total mercury is methylmercury in fish) in sport fish that would be below or equivalent to the chemical's reference level when eating different amounts of fish.

Meal sizes used in this table: Although people eat different meal sizes, their typical portion size is related to their individual body weight in a fairly consistent manner. The standard portion size eaten by an average adult (body weight 70 kg or 154 pounds) is eight ounces (227 g) (U.S. EPA, 1994). A standard portion of one fish meal a month is equivalent to 7.5 g/day, one meal per week is equivalent to 30 g/day, two meals per week is equivalent to 60 g/day, and three meals per week is equivalent to 90 g/day. In some cases, fish tissue concentrations corresponding to intermediate meal frequencies were incorporated into the standard meal categories used for providing "safe eating guidelines" such that the hazard quotient (the ratio of exposure to the reference dose) did not exceed unity (1), including rounding.

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APPENDIX 1: METHYLMERCURY IN SPORT FISH: INFORMATION FOR FISH CONSUMERS

Methylmercury is a form of mercury that is found in most freshwater and saltwater fish. In some lakes, rivers, and coastal waters in California, methylmercury has been found in some types of fish at concentrations that may be harmful to human health. The Office of Environmental Health Hazard Assessment (OEHHA) has issued health advisories to fishers and their families giving recommendations on how much of the affected fish in these areas can be safely eaten. In these advisories, women of childbearing age and children are encouraged to be especially careful about following the advice because of the greater sensitivity of fetuses and children to methylmercury.

Fish are nutritious and should be a part of a healthy, balanced diet. As with many other kinds of food, however, it is prudent to consume fish in moderation. OEHHA provides advice to the public so that people can continue to eat fish without putting their health at risk.

WHERE DOES METHYLMERCURY IN FISH COME FROM?

Methylmercury in fish comes from mercury in the aquatic environment. Mercury, a metal, is widely found in nature in rock and soil, and is washed into surface waters during storms. Mercury evaporates from rock, soil, and water into the air, and then falls back to the earth in rain, often far from where it started. Human activities redistribute mercury and can increase its concentration in the aquatic environment. The coastal mountains in northern California are naturally rich in mercury in the form of cinnabar ore, which was processed to produce quicksilver, a liquid form of inorganic mercury. This mercury was taken to the Sierra Nevada, Klamath mountains, and other regions, where it was used in gold mining. Historic mining operations and the remaining tailings from abandoned mercury and gold mines have contributed to the release of large amounts of mercury into California's surface waters. Mercury can also be released into the environment from industrial sources, including the burning of fossil fuels and solid wastes, and disposal of mercury-containing products.

Once mercury gets into water, much of it settles to the bottom where bacteria in the mud or sand convert it to the organic form of methylmercury. Fish absorb methylmercury when they eat smaller aquatic organisms. Larger and older fish absorb more methylmercury as they eat other fish. In this way, the amount of methylmercury builds up as it passes through the food chain. Fish eliminate methylmercury slowly, and so it builds up in fish in much greater concentrations than in the surrounding water. Methylmercury generally reaches the highest levels in predatory fish at the top of the aquatic food chain.

HOW MIGHT I BE EXPOSED TO METHYLMERCURY?

Eating fish is the main way that people are exposed to methylmercury. Each person's exposure depends on the amount of methylmercury in the fish that they eat and how much and how often they eat fish.

Women can pass methylmercury to their babies during pregnancy, and this includes methylmercury that has built up in the mother's body even before pregnancy. For this reason, women of childbearing age are encouraged to be especially careful to follow consumption advice, even if they are not pregnant. In addition, nursing mothers can pass methylmercury to their child through breast milk.

You may be exposed to inorganic forms of mercury through dental amalgams (fillings) or accidental spills, such as from a broken thermometer. For most people, these sources of exposure to mercury are minor and of less concern than exposure to methylmercury in fish.

AT WHAT LOCATIONS IN CALIFORNIA HAVE ELEVATED LEVELS OF MERCURY BEEN FOUND IN FISH?

Methylmercury is found in most fish, but some fish and some locations have higher amounts than others. Methylmercury is one of the chemicals in fish that most often creates a health concern. Consumption advisories due to high levels of methylmercury in fish have been issued in about 40 states. In California, methylmercury advisories have been issued for San Francisco Bay and the Delta; Tomales Bay in Marin County; and at the following inland lakes: Lake Nacimiento in San Luis Obispo County; Lake Pillsbury and Clear Lake in Lake County; Lake Berryessa in Napa County; Guadalupe Reservoir and associated reservoirs in Santa Clara County; Lake Herman in Solano County; San Pablo Reservoir in Contra Costa County; Black Butte Reservoir in Glenn and Tehama Counties; Lake Natoma and the lower American River in Sacramento County; Trinity Lake in Trinity County; and certain lakes and river stretches in the Sierra Nevada foothills in Nevada, Placer, and Yuba counties. Other locations may be added in the future as more fish and additional water bodies are tested.

HOW DOES METHYLMERCURY AFFECT HEALTH?

Much of what we know about methylmercury toxicity in humans stems from several mass poisoning events that occurred in Japan during the 1950s and 1960s, and Iraq during the 1970s. In Japan, a chemical factory discharged vast quantities of mercury into several bays near fishing villages. Many people who consumed large amounts of fish from these bays became seriously ill or died over a period of several years. In Iraq, thousands of people were poisoned by eating contaminated bread that was mistakenly made from seed grain treated with methylmercury.

From studying these cases, researchers have determined that the main target of methylmercury toxicity is the central nervous system. At the highest exposure levels experienced in these poisonings, methylmercury toxicity symptoms included such nervous system effects as loss of coordination, blurred vision or blindness, and hearing and speech impairment. Scientists also discovered that the developing nervous systems of fetuses are particularly sensitive to the toxic effects of methylmercury. In the Japanese outbreak, for example, some fetuses developed methylmercury toxicity during pregnancy even when their mothers did not. Symptoms reported in the Japan and Iraq epidemics resulted from methylmercury levels that were much higher than what fish consumers in the U.S. would experience.

Individual cases of adverse health effects from heavy consumption of commercial fish containing moderate to high levels of methylmercury have been reported only rarely. Nervous system symptoms reported in these instances included headaches, fatigue, blurred vision, tremor, and/or some loss of concentration, coordination, or memory. However, because there was no clear link between the severity of symptoms and the amount of mercury to which the person was exposed, it is not possible to say with certainly that these effects were a consequence of methylmercury exposure and not the result of other health problems. The most subtle symptoms in adults known to be clearly associated with methylmercury toxicity are numbness or tingling in the hands and feet or around the mouth; however, these symptoms are also associated with other medical conditions not related to methylmercury exposure.

In recent studies of high fish-eating populations in different parts of the world, researchers have been able to detect more subtle effects of methylmercury toxicity in children whose mothers frequently ate seafood containing low to moderate mercury concentrations during their pregnancy. Several studies found slight decreases in learning ability, language skills, attention and/or memory in some of these children. These effects were not obvious without using very specialized and sensitive tests. Children may have increased susceptibility to the effects of methylmercury through adolescence, as the nervous system continues to develop during this time.

Methylmercury builds up in the body if exposure continues to occur over time. Exposure to relatively high doses of methylmercury for a long period of time may also cause problems in other organs such as the kidneys and heart.

CAN MERCURY POISONING OCCUR FROM EATING SPORT FISH IN CALIFORNIA?

No case of mercury poisoning has been reported from eating California sport fish. The levels of mercury in California fish are much lower than those that occurred during the Japanese outbreak. Therefore, overt poisoning resulting from sport fish consumption in California would not be expected. At the levels of mercury found in California fish, symptoms associated with methylmercury are unlikely unless someone eats much more than what is recommended or is particularly sensitive. The fish consumption guidelines are designed to protect against subtle effects that would be difficult to detect but could still occur FOLLOWING unrestricted consumption of California sport fish. This is especially true in the case of fetuses and children.

IS THERE A WAY TO REDUCE METHYLMERCURY IN FISH TO MAKE THEM SAFER TO EAT?

There is no specific method of cleaning or cooking fish that will significantly reduce the amount of methylmercury in the fish. However, fish should be cleaned and gutted before cooking because some mercury may be present in the liver and other organs of the fish. These organs should not be eaten.

In the case of methylmercury, fish size is important because large fish that prey upon smaller fish can accumulate more of the chemical in their bodies. It is better to eat the smaller fish within the same species, provided that they are legal size.

IS THERE A MEDICAL TEST TO DETERMINE EXPOSURE TO METHYLMERCURY?

Mercury in blood and hair can be measured to assess methylmercury exposure. However, this is not routinely done. Special techniques in sample collection, preparation, and analysis are required for these tests to be accurate. Although tests using hair are less invasive, they are also less accurate. It is important to consult with a physician before undertaking medical testing because these tests alone cannot determine the cause of personal symptoms.

HOW CAN I REDUCE THE AMOUNT OF METHYLMERCURY IN MY BODY?

Methylmercury is eliminated from the body over time provided that the amount of mercury taken in is reduced. Therefore, following the OEHHA consumption advice and eating less of the fish that have higher levels of mercury can reduce your exposure and help to decrease the levels of methylmercury already in your body if you have not followed these recommendations in the past.

WHAT IF I EAT FISH FROM OTHER SOURCES SUCH AS RESTAURANTS, STORES, OR OTHER WATER BODIES THAT MAY NOT HAVE AN ADVISORY?

Most commercial fish have relatively low amounts of methylmercury and can be eaten safely in moderate amounts. However, several types of fish such as large, predatory, long-lived fish have high levels of methylmercury, and could cause overly high exposure to methylmercury if eaten often. The U.S. Food and Drug Administration (FDA) is responsible for the safety of commercial seafood. In 2004, FDA and the U.S. Environmental Protection Agency (U.S. EPA) issued a Joint Federal Advisory for Mercury in Fish advising women who are pregnant or could become pregnant, nursing mothers, and young children not to eat shark, swordfish, king mackerel, or tilefish. The federal advisory also recommends that these individuals can safely eat up to an average of 12 ounces (two average meals) per week of a variety of other cooked fish purchased in stores or restaurants, such as shrimp, canned light tuna, salmon, pollock, or (farm-raised) catfish. Albacore ("white") tuna is known to contain more mercury than canned light tuna; it is therefore recommended that no more than six ounces of albacore tuna be consumed per week. In addition, the federal advisory recommends that women who are pregnant or may become pregnant, nursing mothers, and young children consume no more than one meal per week of locally caught fish, when no other advice is available, and eat no other fish that week. The federal advisory can be found at http://www.cfsan.fda.gov/~dms/admehg.html or http://www.epa.gov/ost/fishadvice/advice.html.

In addition, OEHHA offers the following general advice that can be followed to reduce exposure to methylmercury in fish. Chemical levels can vary from place to place. Therefore, your overall exposure to chemicals is likely to be lower if you fish at a variety of places, rather than at one location that might have high contamination levels. Furthermore, some fish species have higher chemical levels than others in the same location. If possible, eat smaller amounts of several different types of fish rather than a large amount of one type that may be high in contaminants. Smaller fish of a species will usually have lower chemical levels than larger fish in the same location because some of the chemicals may become more concentrated in larger, older fish. It is advisable to eat smaller fish (of legal size) more often than larger fish. Cleaning and cooking fish in a manner that removes fat and organs is an effective way to reduce other contaminants that may be present in fish.

WHERE CAN I GET MORE INFORMATION?

The health advisories for sport fish are printed in the California Sport Fishing Regulations booklet, which is available wherever fishing licenses are sold. OEHHA also offers a booklet containing the advisories, and additional materials such as this fact sheet on related topics. Additional information and documents related to fish advisories are available on the OEHHA Web Site at http://www.oehha.ca.gov/fish.html. County departments of environmental health may have more information on specific fishing areas.

APPENDIX 2. GENERAL ADVICE FOR SPORT FISH CONSUMERS

You can reduce your exposure to chemical contaminants in sport fish by following the recommendations below. Follow as many of them as you can to increase your health protection. This general advice is not meant to take the place of advisories for specific areas, but should be followed in addition to them. Sport fish in most water bodies in the state have not been evaluated for their safety for human consumption. This is why we strongly recommend following the general advice given below.

Fishing Practices

Chemical levels can vary from place to place. Your overall exposure to chemicals is likely to be lower if you eat fish from a variety of places rather than from one usual spot that might have high contamination levels.

Be aware that OEHHA may issue new advisories or revise existing ones. Consult the Department of Fish and Game regulations booklet or check with OEHHA on a regular basis to see if there are any changes that could affect you.

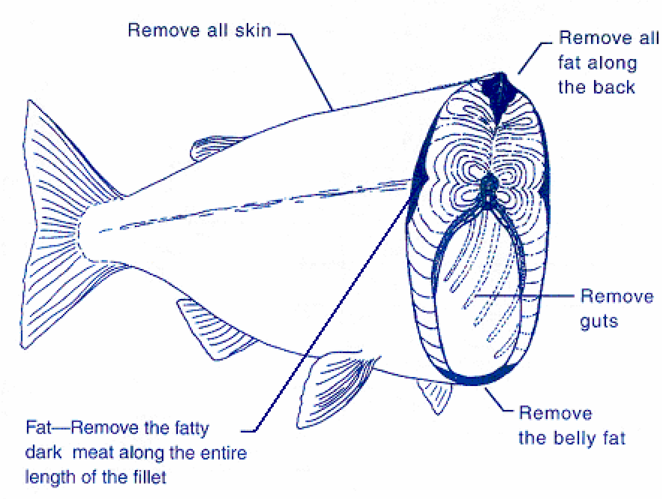
Consumption Guidelines

Fish Species: Some fish species have higher chemical levels than others in the same location. If possible, eat smaller amounts of several different types of fish rather than a large amount of one type that may be high in contaminants.

Fish Size: Smaller fish of a species will usually have lower chemical levels than larger fish in the same location because some of the chemicals may accumulate as the fish grows. It is advisable to eat smaller fish (of legal size).

Fish Preparation and Consumption

- Eat only the fillet portions. Do not eat the guts and liver because chemicals usually concentrate in those parts. Also, avoid frequent consumption of any reproductive parts such as eggs or roe.
- Many chemicals are stored in the fat. To reduce the levels of these chemicals, skin the fish when possible and trim any visible fat.
- Use a cooking method such as baking, broiling, grilling, or steaming that allows the juices to drain away from the fish. The juices will contain chemicals in the fat and should be thrown away. Preparing and cooking fish in this way can remove 30 to 50 percent of the chemicals stored in fat. If you make stews or chowders, use fillet parts.
- Raw fish may be infested by parasites. Cook fish thoroughly to destroy the parasites.



Advice for Pregnant Women, Women of Childbearing Age, and Children

Children and fetuses are more sensitive to the toxic effects of methylmercury, the form of mercury of health concern in fish. For this reason, OEHHA's advisories that are based on mercury provide special advice for women of childbearing age and children. Women should follow this advice throughout their childbearing years.

The U.S. Food and Drug Administration (FDA) is responsible for commercial seafood safety. FDA has issued the following advice about the risks of mercury in fish to pregnant women and women of childbearing age who may become pregnant. FDA advises these women not to eat shark, swordfish, king mackerel, or tilefish. FDA also advises that it is prudent for nursing mothers and young children not to eat these fish as well.

The U.S. Environmental Protection Agency has also issued national advice to protect women who are pregnant or may become pregnant, nursing mothers, and young children against consuming excessive mercury in fish. They recommend that these individuals eat no more than one meal per week of non-commercial freshwater fish caught by family and friends.

National advice for women and children on mercury in fish is available from the U.S. Environmental Protection Agency at *www.epa.gov/waterscience/fishadvice/advice.html* and the U.S. Food and Drug Administration at *www.cfsan.fda.gov/~dms/admehg.html*

APPENDIX 3. DESCRIPTIVE STATISTICS FOR MERCURY CONCENTRATION (PPM, WET WEIGHT) AND LENGTH (MM) FROM LOWER FEATHER RIVER SITES

Descriptive Statistics[1] for Mercury Concentration (ppm, wet weight) and Length (mm) From Trinity

	Mercury ppm						Total Length mm [2]						# Fish per Composite						Total # Fish
Species	Mean	Median	SD[3]	Min	Max	CI[4]	Mean	Median	SD[3]	Min	Max	CI[4]	n=1	n=2	n=3	n=4	n=5	n=6	
Bluegill	.12	.12	[3]	.12	.12	[3]	184	184	[3]	184	184	[3]	0	0	0	0	1	0	5
Carp	.29	.12	.20	.12	.50	.16-.42	504	452	59	452	566	464-544	0	0	0	0	1	1	11
Channel Catfish	.36	.29	.20	.17	.73	.29-.43	509	522	63	414	590	487-531	6	1	0	2	1	2	33
Largemouth Bass	.72	.61	.44	.18	2.35	.60-.84	337	327	37	305	495	327-347	30	0	0	0	4	1	56
Redear Sunfish	.16	.16	.06	.10	.22	.11-.21	157	157	2.7	154	159	155-159	0	0	0	0	2	0	10
Sacramento Pikeminnow	.97	.88	.50	.13	2.26	.79-1.15	354	357	57	256	500	334-374	18	0	0	0	3	0	33
Sacramento Sucker	.28	.27	.05	.21	.41	.26-.30	458	451	32	419	543	445-470	5	0	1	0	4	0	28
Striped Bass	1.27	1.03	1.16	.32	3.50	.05-2.50	652	636	108	533	817	539-766	6	0	0	0	0	0	6
White Catfish	.61	.50	.30	.39	1.25	.44-.79	360	271	146	205	670	276-444	9	0	0	0	1	0	14

[1] Data weighted by number of individuals per sample.

[2] Average total lengths of fish are presented. TSMP samples reported fork length only. Average fork lengths for the TSMP samples were 411 mm for carp (one sample only), 463 mm for channel catfish, 295 mm for largemouth bass (one sample only), and 431 for Sacramento sucker. The conversion factor for carp and Sacramento sucker was 1.1 (fork length times 1.1 = total length), for channel catfish 1.15 (fork length times 1.15 = total length), and for largemouth bass 1.05 (fork length times 1.05 = total length).

[3] Confidence Interval and Standard Deviation are omitted because Hg ppm and Length mm are constant.

[4] 95 percent Confidence Interval.

APPENDIX 4: MERCURY VALUES OF INDIVIDUAL FISH TISSUE SAMPLES OF LEGAL/EDIBLE SIZE FROM THE LOWER FEATHER RIVER

All Samples Meet OEHHA Size Criteria

Common Name	Data Source	Year	Site	#	Total Length (mm)	Fork Length (mm)	Total Weight (g)	Mercury ppm Wet Wt
Bluegill	CALFED	1999	Feather River/Nicolaus	5	184	184	104	.121
Carp	TSMP	1988	Feather River/d/s Highway 99 Bridge	6	452	411	1347	.120
Carp	CALFED	2000	Feather River upstream Bear River	5	566	566	.	.497
Channel Catfish	TSMP	1991	Feather River/d/s Highway 99 Bridge	1	414	360	639	.180
Channel Catfish	TSMP	1978	Feather River/d/s Highway 99 Bridge	4	441	383	863	.290
Channel Catfish	TSMP	1991	Feather River/d/s Highway 99 Bridge	1	520	452	1444	.380
Channel Catfish	TSMP	1988	Feather River/d/s Highway 99 Bridge	6	522	454	1271	.170
Channel Catfish	TSMP	1991	Feather River/d/s Highway 99 Bridge	1	564	490	1536	.240
Channel Catfish	TSMP	1982	Feather River/d/s Highway 99 Bridge	2	572	497	1733	.310
Channel Catfish	TSMP	1991	Feather River/d/s Highway 99 Bridge	1	581	505	1631	.340
Channel Catfish	TSMP	1991	Feather River/d/s Highway 99 Bridge	1	587	510	2025	.270
Channel Catfish	TSMP	1993	Feather River/d/s Highway 99 Bridge	6	590	513	1856	.230
Channel Catfish	CALFED	1999	Feather River/Nicolaus	1	473	473	986	.721
Channel Catfish	SRWP	2000	Feather River/Nicolaus	5	479	479	.	.729
Channel Catfish	CALFED	2000	Feather River upstream Bear River	4	423	423	.	.499
Largemouth Bass	SRWP	2002	Feather River/Nicolaus	5	327	327	410	.450
Largemouth Bass	SRWP	2002	Feather River/Nicolaus	5	338	338	442	.410
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	305	305	392	.649
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	310	310	358	.667
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	310	310	392	.555
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	314	314	.	.633
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	321	321	468	.667
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	322	322	363	.787
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	339	339	524	2.08
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	350	350	565	1.03
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	361	361	653	1.52
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	456	456	1446	1.51
Largemouth Bass	CALFED	1999	Feather River/Nicolaus	1	495	495	1699	2.35
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	305	305	.	.628
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	305	305	.	.397
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	305	305	.	.469
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	306	306	.	.536
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	311	311	.	.699
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	311	311	.	.818
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	321	321	.	.417
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	334	334	.	.789
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	334	334	.	.547
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	339	339	.	.562
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	355	355	.	.860
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	362	362	.	.998
Largemouth Bass	SRWP	1998	Feather River/Nicolaus	5	382	382	827	1.15
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	6	313	313	.	.607
Largemouth Bass	CALFED	2000	Feather River upstream Bear River	1	343	343	.	.760
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	306	306	.	.534
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	330	330	.	.727
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	335	335	.	1.08
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	355	355	.	.273
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	383	383	.	.545
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	395	395	.	1.59
Largemouth Bass	TSMP	2001	Feather River upstream Yuba River	5	309	295	527	.178

Common Name	Data Source	Year	Site	#	Total Length (mm)	Fork Length (mm)	Total Weight (g)	Mercury ppm Wet Wt
Redear Sunfish	SRWP	2000	Feather River/Nicolaus	5	154	154	.	.220
Redear Sunfish	SRWP	2001	Feather River upstream Bear River	5	159	159	.	.100
Sacramento Pikeminnow	SRWP	2002	Feather River/Nicolaus	5	335	335	244	.880
Sacramento Pikeminnow	SRWP	2002	Feather River/Nicolaus	5	357	357	312	1.38
Sacramento Pikeminnow	CALFED	2000	Feather River/Nicolaus	1	256	256	.	.298
Sacramento Pikeminnow	CALFED	2000	Feather River/Nicolaus	1	280	280	.	.233
Sacramento Pikeminnow	CALFED	1999	Feather River/Nicolaus	5	287	287	152	1.20
Sacramento Pikeminnow	CALFED	2000	Feather River/Nicolaus	1	319	319	.	1.21
Sacramento Pikeminnow	CALFED	2000	Feather River/Nicolaus	1	320	320	.	.686
Sacramento Pikeminnow	CALFED	2000	Feather River/Nicolaus	1	329	329	.	.346
Sacramento Pikeminnow	SRWP	2001	Feather River/Nicolaus	1	500	500	.	.640
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Bear River	1	394	394	.	2.26
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Bear River	1	466	466	.	2.14
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	350	350	.	.362
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	357	357	.	.732
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	359	359	.	.125
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	371	371	.	1.01
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	376	376	.	.646
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	385	385	.	.416
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	396	396	.	.297
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	421	421	.	.872
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	447	447	.	1.46
Sacramento Pikeminnow	CALFED	2000	Feather River upstream Yuba River	1	455	455	.	1.08
Sacramento Sucker	TSMP	1991	Feather River/d/s Oroville Reservoir	1	431	392	784	.210
Sacramento Sucker	TSMP	1991	Feather River/d/s Oroville Reservoir	1	457	415	961	.410
Sacramento Sucker	TSMP	1991	Feather River/d/s Oroville Reservoir	1	462	420	972	.350
Sacramento Sucker	TSMP	1991	Feather River/d/s Oroville Reservoir	1	479	435	991	.310
Sacramento Sucker	TSMP	1991	Feather River/d/s Oroville Reservoir	1	543	494	1486	.340
Sacramento Sucker	CALFED	2000	Feather River/Nicolaus	3	430	430	.	.342
Sacramento Sucker	SRWP	2001	Feather River/Nicolaus	5	469	469	.	.280
Sacramento Sucker	CALFED	2000	Feather River upstream Bear River	5	446	446	.	.206
Sacramento Sucker	SRWP	2001	Feather River upstream Bear River	5	497	497	.	.270
Sacramento Sucker	CALFED	2000	Feather River upstream Yuba River	5	419	419	.	.269
Striped Bass	CALFED	1999	Feather River/Nicolaus	1	626	626	.	1.28
Striped Bass	CALFED	1999	Feather River/Nicolaus	1	645	645	.	.320

Common Name	Data Source	Year	Site	#	Total Length (mm)	Fork Length (mm)	Total Weight (g)	Mercury ppm Wet Wt
Striped Bass	CALFED	1999	Feather River/Nicolaus	1	817	817	.	3.50
Striped Bass	SRWP	2000	Feather River/Nicolaus	1	556	556	.	1.22
Striped Bass	CALFED	2000	Feather River upstream Bear River	1	533	533	.	.435
Striped Bass	CALFED	2000	Feather River upstream Bear River	1	736	736	.	.845
White Catfish	CALFED	1999	Feather River/Nicolaus	1	491	491	1190	.620
White Catfish	CALFED	1999	Feather River/Nicolaus	1	497	497	.	.745
White Catfish	SRWP	2000	Feather River/Nicolaus	1	205	205	.	.455
White Catfish	SRWP	2000	Feather River/Nicolaus	1	269	269	.	.846
White Catfish	SRWP	2000	Feather River/Nicolaus	1	272	272	.	.392
White Catfish	SRWP	2000	Feather River/Nicolaus	1	278	278	.	1.21
White Catfish	SRWP	2000	Feather River/Nicolaus	1	492	492	.	.548
White Catfish	SRWP	2000	Feather River/Nicolaus	1	545	545	.	.554
White Catfish	SRWP	2000	Feather River/Nicolaus	1	670	670	.	1.25
White Catfish	SRWP	1997	Feather River/Nicolaus	5	264	264	.	.391

APPENDIX 5: MERCURY VALUES OF INDIVIDUAL FISH TISSUE SAMPLES BELOW LEGAL/EDIBLE SIZE FROM THE LOWER FEATHER RIVER

All Samples below OEHHA Size Criteria

Common Name	Data Source	Year	Site	#	Total Length (mm)	Fork Length (mm)	Total Weight (g)	Mercury (ppm) Wet Wt
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	233	233	.	.265
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	236	236	.	.213
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	255	255	.	.459
Largemouth Bass	SRWP	2000	Feather River/Nicolaus	1	302	302	.	.672
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	215	215	.	.292
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	249	249	.	.109
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	255	255	.	.770
Largemouth Bass	CALFED	2000	Feather River upstream Yuba River	1	298	298	.	.133
Smallmouth Bass	TSMP	1979	Feather River/d/s Highway 99 Bridge	4	253	240	212	.220
Smallmouth Bass	TSMP	1987	Feather River/d/s Highway 99 Bridge	6	262	249	243	.550
Smallmouth Bass	TSMP	1980	Feather River/d/s Highway 99 Bridge	5	271	257	305	.640
Spotted Bass	TSMP	1984	Feather River/d/s Highway 99 Bridge	5	259	244	229	.570
Spotted Bass	TSMP	1981	Feather River/d/s Highway 99 Bridge	5	269	254	282	.340
Spotted Bass	TSMP	1983	Feather River/d/s Highway 99 Bridge	5	272	257	286	.780
Striped Bass	SRWP	2000	Feather River/Nicolaus	1	441	441	.	1.653