57

METHYLMERCURY IN FISH FROM LAKE PILLSBURY (LAKE COUNTY): GUIDELINES FOR SPORT FISH CONSUMPTION

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24

METHYLMERCURY IN FISH FROM LAKE PILLSBURY (LAKE COUNTY): GUIDELINES FOR SPORT FISH CONSUMPTION

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

FOREWORD

This report provides recommended guidelines for consumption of fish from Lake Pillsbury (Lake County). These guidelines are provided to the public as a result of findings of high levels of mercury in fish tested from Lake Pillsbury. These recommendations are provided to protect against possible adverse health effects that may result from consumption of mercury-contaminated fish. The report provides background information and a description of the data and criteria used to develop the guidelines.

To protect public health in the interim period while this report was prepared for public comment, the County of Lake Health Services Department, Division of Environmental Health, issued a public health advisory for fish from Lake Pillsbury in consultation with the Office of Environmental Health Hazard Assessment. This advisory is included in Appendix I.

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INTRODUCTION

Mercury is a heavy metal that can be toxic to humans and other organisms. Mercury occurs naturally in the environment, and exists in various forms including elemental or metallic mercury, inorganic, and organic mercury (ATSDR, 1999; IARC, 1993). Cinnabar ores, naturally rich in mercury, are common in northern California. In fact, the California Coast Range contains one of the world's largest geologic deposits of mercury (SFEI, 1996). Extensive mining of this ore in the 1800's and early 1900's, largely to support gold mining operations, resulted in mobilized deposits of mercury in watersheds of the coastal mountains. Mercury continues to leach from scores of abandoned mines in the state. Thus, mercury contamination occurs as a result of both natural and anthropogenic sources. Mercury has also been commonly used in electrical equipment, medical supplies, dental amalgams, and as a fungicide in paints and on seeds and grains.

Once mercury is released into the environment, it cycles through land, air, and water. Many streams and other water bodies in northern California have sediments containing mercury at relatively high levels. The deposition of mercury in aquatic ecosystems is a concern for public and environmental health because inorganic mercury can be converted by microorganisms (bacteria and fungi) in the sediments into methylmercury, a particularly toxic form of mercury. The physical, chemical, and biological characteristics of water bodies affect the propensity for mercury to be converted to methylmercury. Methylmercury is taken up by organisms dwelling in the sediments and then subsequently by larger aquatic animals, including fish, that feed on the smaller organisms. In this way, 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. Concentrations of methylmercury in fish tissues can thus be orders of magnitude (*e.g.*, 10, 100, or 1000 times) greater than concentrations in water. High levels of methylmercury in fish pose a health concern to humans and other organisms that consume fish.

Consumption of fish is the principal route of exposure to methylmercury. Virtually all fish contain mercury at some level, and most of the mercury in fish is in the more toxic organic form, methylmercury. Whether consumption of fish is harmful depends on the concentrations of methylmercury in the fish and the amount of fish consumed.

The Office of Environmental Health Hazard Assessment (OEHHA) is the agency responsible for evaluating public health impacts from chemical contamination of sport fish, and issuing advisories, when needed, for the state of California. OEHHA's authorities to conduct these activities are based on mandates in the California Health and Safety Code, Section 205, to protect public health, and Section 207, to advise local health authorities. Fish advisories developed by OEHHA are published annually in the California Sport Fishing Regulations as mandated in Section 217.6 of the California Fish and Game Code.

BACKGROUND

Lake Pillsbury is a reservoir located in northwest Lake County in a relatively remote area (Figures 1 and 2). It is surrounded by Mendocino National Forest, and access is mainly via unpaved roads. The reservoir, operated by Pacific Gas and Electric Company (PG&E), is the result of the impoundment of water on the Eel River, and is used for water storage and to provide water flows downstream for fish. The construction of Scott Dam, which is located on the southwest shore of the reservoir, was completed in 1921 (L. McCloud, personal communication). The surface elevation and size of Lake Pillsbury fluctuate with water use and flow adjustments. At its maximum, the reservoir contains approximately 2000 surface acres of water. The reservoir is typically drawn down in late summer, particularly in dry years, and the deeper waters become less accessible as the shallow portions of the reservoir become dry, a portion of the

lakebed is exposed, and the boat launch no longer provides access to the water. As a result, the peak period of recreational use (including fishing) is likely to be in the late spring and summer (B. Gwynne, personal communication). Several campgrounds are situated around Lake Pillsbury, and a small residential community lives year-round near the lake. The largest population of recreational users consists of summer and/or weekend residents and visitors.

One of the principal game fish species in Lake Pillsbury is largemouth bass, *Micropterus salmoides*. This predatory species, which is one of the most sought after game fish in California by recreational fishers, lives up to 16 years but usually about 4 to 5 years in reservoirs (Moyle, 1976; McGinnis, 1984). Large bass in California reservoirs are typically 35 to 45 cm (approximately 14 to 18 inches) in total length and weigh up to about 2 kg (one pound). Largemouth bass are reported to be highly abundant in Lake Pillsbury, and have been measured at lengths and weights somewhat greater than those reported by Moyle (1976). The second most abundant species is the Sacramento pike minnow (*Ptychocheilus grandis,* formerly called the Sacramento squawfish). This species is also predatory and can reach large sizes up to one meter or more. This species was considered the top of the food chain, in habitats where it commonly occurred, before the introduction and distribution of largemouth bass in California. In years when largemouth bass populations decline in Lake Pillsbury, the pike minnow becomes the more predominant species. However, the pike minnow is not favored for consumption. Another species that occurs in Lake Pillsbury, and is prized for consumption, is rainbow trout (*Oncorhynchus mykiss*). However, this species is not as easily caught, and has not been sampled and analyzed for chemical contaminants at Lake Pillsbury. In addition, rainbow trout in Lake Pillsbury are stocked in the reservoir each year, and therefore, the "population" includes both hatchery-raised and wild fish. Larger trout (*e.g.*, 18 inches) that are reportedly caught by fishers could be either stocked fish that have over-wintered one or more years, or wild fish (J. Linn, personal communication).

Sampling and analysis of fish from Lake Pillsbury for chemical contaminants were performed as part of the Toxic Substance Monitoring Program (TSMP). The TSMP was initiated in 1976 by the California State Water Resources Control Board (SWRCB). The program was developed to detect and evaluate the occurrence of toxic substances in water bodies throughout the state through the analysis of fish and other aquatic life that bioaccumulate chemical contaminants present in ambient water. The California Department of Fish and Game (DFG) collects and analyzes the samples for the SWRCB. The nine Regional Water Quality Control Boards primarily identify the sampling locations and species to be sampled in their respective regions in the state. Based on the amount of funding available each year, the regional boards determine how many and which locations to sample as well as which species and the number of samples to collect. Typically, broad geographic coverage of the state is achieved, but the number of samples at a given location is limited. Because the intent of the program is to evaluate water quality trends, the sampling design is not planned to provide data for human health evaluation. In some instances, however, there have been sufficient samples obtained from a selected water body to allow for an evaluation of human health risks from consumption of these fish.

Multiple samples of fish from Lake Pillsbury were collected and analyzed over a period of years. The North Coast Regional Water Quality Control Board (NCRWQCB) reviewed the results of testing of fish from Lake Pillsbury and requested that OEHHA consider these data and issue a health advisory for consumption of fish from this lake. In addition, in May 1998 the SWRCB listed Lake Pillsbury as an impaired waterbody under section 303(d) of the federal Clean Water Act due to high levels of mercury in fish tissues (Appendix II).

The Lake County Health Services Department, Division of Environmental Health, and Board of Supervisors were notified of the request to consider a health advisory for mercury in fish from Lake Pillsbury. They concurred that mercury levels in the fish were a cause for concern for public health, and offered support in obtaining information to better characterize mercury in fish in Lake Pillsbury and

informing the public of the potential impacts on public health. On June 14, 1999, the Lake County Health Services Department, Division of Environmental Health, in consultation with OEHHA, issued an advisory for Lake Pillsbury. This interim advisory was prepared to provide information to the public during the 1999 summer fishing season until this report and the guidelines contained herein could be made available for public comment and then finalized.

TOXICOLOGY OF METHYLMERCURY

Methylmercury is one of the few chemicals for which there is an extensive database on human exposure, and thus, knowledge of the toxicology of methylmercury can be based on data for humans (rather than, or in addition to, data derived from experimental animal studies). The health effects from exposure to methylmercury have been evaluated in several instances of human exposure that occurred under acute and/or high-dose conditions in the 1950's, 1960's, and early 1970's. In Japan, fish that were contaminated with very high levels of methylmercury following the discharge of mercury-containing factory waste were consumed in large quantities. In Iraq, poisoning occurred from the consumption of seed grain that had been treated with methylmercury. These incidents showed the nervous system to be the primary target organ for methylmercury and that the developing fetus is particularly vulnerable. Signs of toxicity experienced by adults included paresthesia (numbness and tingling); ataxia (loss of muscular coordination); visual, auditory, and other sensory disturbances; impairment of speech; and mental disturbances. In each of the poisoning episodes, many people experienced severe effects, and death occurred in adults and children. Subsequent studies documented abnormalities in the brain resulting from methylmercury poisoning. It was also noted that infants born from women who were exposed showed nervous system damage even when the mothers were only slightly affected or showed no signs of toxicity. Infants exposed during fetal development displayed cerebral palsy, altered muscle tone and deep tendon reflexes, and delayed developmental milestones (*e.g.*, walking and talking; IRIS, 1999). However, the amounts of mercury ingested in these episodes were much higher than levels commonly consumed in the U.S., and the more subtle effects from low-dose exposure to methylmercury have had to be extrapolated from the data from acute high-dose poisonings. OEHHA has listed methylmercury as a developmental toxicant under Proposition 65 since 1987.

Recently, two large epidemiological studies designed to address exposure to methylmercury at the low levels that typically occur from consumption of seafood have been conducted and reported. The results of these studies from the Seychelles and Faroe islands are currently being evaluated by OEHHA and by various national and international organizations.

Other Health Effects

In addition to neurologic effects, other health effects from exposure to methylmercury have been shown in studies on experimental animals. Kidney damage was reported in some species and several studies of mice exposed to methylmercury showed an increased incidence of tumors, as discussed below (IARC, 1993). However, health effects differ among species, and these effects resulted from exposure to high doses. It is generally thought that the nervous system is the most sensitive endpoint, particularly in the case of exposure to low doses of methylmercury.

Cancer Risks

The United States Environmental Protection Agency (U.S. EPA) evaluates a chemical's potential for causing cancer and classifies chemicals into one of five categories depending on the likelihood that it is a

human carcinogen. Group A designates those chemicals for which the evidence suggests it is a human carcinogen. Each subsequent group (*e.g.*, B, C) represents decreasing likelihood of carcinogenicity based on the supporting evidence (or lack thereof). U.S. EPA (IRIS, 1999) classified methylmercury as a possible human carcinogen (Group C) based on inadequate data in humans and limited evidence of carcinogenicity in animals.

The World Health Organizations' International Agency for Research on Cancer (IARC) Working Group on the Evaluation of Carcinogenic Risks to Humans (1993) concluded that there is inadequate evidence in humans for the carcinogenicity of mercury and mercury compounds. The IARC determined, however, that there is sufficient evidence in experimental animals (based on mouse studies) for the carcinogenicity of methylmercury chloride. The IARC (1993) thus listed methylmercury compounds as possibly carcinogenic to humans (Group 2B classification). OEHHA added methylmercury compounds to the Proposition 65 list of carcinogens in 1996, based on the IARC classification. OEHHA is further evaluating this issue; however, numerical values for the cancer potency of methylmercury have not been developed at this time. The potential for carcinogenic effects from exposure to methylmercury should be noted, but current understanding of the toxicology of methylmercury supports consideration of neurotoxicity as the principal and appropriate endpoint of concern.

Toxicokinetics of Methylmercury

Methylmercury in seafood is readily and almost completely absorbed from the gastrointestinal tract and distributed to most tissues. Methylmercury can pass across the placenta to the fetus and to nursing children in breast milk. Excretion of methylmercury compounds is mainly in the bile, but also in feces and urine as well as breast milk. In humans, methylmercury compounds have a biological half-life of approximately two months (IARC, 1993).

MERCURY LEVELS IN FISH FROM LAKE PILLSBURY

TSMP Data

Fish were sampled and tested from Lake Pillsbury principally in the years 1991 to 1995. Unless otherwise stated, all samples were "fillets" (edible muscle tissue). A few samples were obtained in earlier years. One composite sample was obtained in 1981 of green sunfish, *Lepomis cyanellus*. This species is not known to be abundant in Lake Pillsbury or sought by fishers. Two composite samples of Sacramento pike minnow were also collected, one in 1988 and one in 1989. The sample collected in 1988 had an average fish length of 63 mm (2 ½ inches) and thus did not provide relevant information because the fish were too small for consumption. The sample collected in 1989 was considered in this analysis. In addition to the 1989 sample, five composite samples of Sacramento pike minnow (from 1992, 1993, and three from 1995) were considered in this analysis. However, it should be noted that many of these samples were comprised of small fish and thus the data set for Sacramento pike minnow would not be sufficient in itself to support issuing an advisory. The results of analysis of these samples were compared to the results for legal-sized largemouth bass (fillet) samples.

The majority of the fish tested from Lake Pillsbury were largemouth bass. Both individual fish and composite samples were obtained. Composite samples include tissues obtained from more than one fish of a given species. The number of fish used to make a composite sample may vary by species but should be consistent within each species sampled. Composite samples are generally used to maximize the amount of information gained without incurring higher analytical costs from additional individual

samples. Composite samples provide an estimate of the "average" chemical concentration in a group of fish collected. This method precludes measuring the range (upper and lower limits) of chemical concentrations, and masks some of the variability in chemical concentrations, but does generally provide a good representation of average concentrations. The accuracy of the results is aided by including fish of similar size in a composite sample. Furthermore, because individual fish were also sampled and analyzed from Lake Pillsbury, a comparison of individual and composite results was possible. Similar concentrations of mercury were found across individual and composite samples.

In the years 1991 to 1993, six composite samples of largemouth bass were obtained, as well as two composite liver samples. The number of bass in each composite varied by sample and ranged from two to 24. The average size of the fish tested in composite samples ranged from 120 mm (considerably less than the legal size requirement of approximately 305 mm) to 508 mm in total length (TL). In years 1993 to 1995, 12 individual largemouth bass were sampled and analyzed. Two of these fish were less than legal size and one (303 mm) was just under the legal size limit. The rest of the individual largemouth bass tested ranged from 363 mm to 520 mm (TL). For the purposes of evaluating human health risks and issuing advisories, only legal-sized fish and tissues commonly consumed (fillets) were included. Data from small fish and liver samples were considered for informational purposes only. The data considered in developing consumption guidelines included three composite samples and nine individual samples of legal-sized largemouth bass (fillets).

The samples were obtained principally from the Eel River Arm of Lake Pillsbury, with a few samples collected in other locations (Figure 3). Because these fish species tend to move around over time, particularly in small reservoirs such as Lake Pillsbury, a fisher could conceivably catch the same fish at different locations in the reservoir. Therefore, fish collected from the various sampling locations around Lake Pillsbury are not treated independently (as discrete populations of fish), and Lake Pillsbury is considered as a uniform water body with respect to fish. The analytical results, which show similarity in mercury levels across locations, support this premise. Consumption advice for Lake Pillsbury thus pertains to fish caught at any location.

The TSMP data files provide a complete report on the chemicals and other parameters measured in the samples, and can be accessed through the SWRCB's web site on the Internet at http://www.swrcb.ca.gov, under "Programs." The analytical results for mercury in legal-sized largemouth bass fillet samples are provided in Table 1. These data were considered suitable for use in developing a health advisory.

Although the laboratory analyzed for total mercury, the conservative assumption that 100 percent of the mercury in fish is methylmercury was made. This assumption is commonly applied because most (99 percent) of the mercury in muscle tissue in fish is methylmercury (Bloom, 1992). Largemouth bass showed mercury levels ranging from 0.57 to 1.8 ppm (parts per million, wet weight). The average (mean) concentration of the samples presented in Table 1 is 1.08 ppm. Mercury concentrations tend to increase with increasing fish size (and age), with larger older fish showing higher levels of mercury. This relationship generally holds for the fish tested from Lake Pillsbury but the relationship is not absolute. In other words, some smaller fish also showed high levels of mercury in the tissues.

The results from other analyses of fish from Lake Pillsbury are summarized in Table 2, which includes a small data set for Sacramento pike minnow and samples from small (less than legal size) largemouth bass as well as liver samples from largemouth bass. The data in Table 2 were not considered suitable for issuing an advisory but were compared to the data in Table 1, and were considered to provide supporting evidence that mercury accumulates at levels of concern even in small fish and in liver samples. Six composite samples of Sacramento pike minnow were collected and analyzed. There is no legal size limit for this species; however, many of the samples were comprised of small young fish. The concentrations of mercury in Sacramento pike minnow also corresponded to fish size, with the composite of the largest

fish having the highest concentration. The two composite samples of large Sacramento pike minnow showed mercury levels comparable to those in legal-sized largemouth bass.

HEALTH ASSESSMENT

OEHHA generally uses a risk-based approach to characterize and evaluate risks from exposure to chemicals. The risk-based approach compares the levels of chemical contaminants in fish tissues to reference doses that have been established for chemicals with potential noncarcinogenic effects. A reference dose (RfD) as defined by U.S. EPA is an estimate, with uncertainty spanning perhaps an order of magnitude, of the daily exposure of the human population, including sensitive subgroups, to a potentially hazardous material that is likely to be without risk of deleterious effects during a lifetime. The RfD for methylmercury is currently under review by OEHHA and other agencies as a result of the newer studies mentioned above. Therefore, a quantitative health risk evaluation is not feasible until this review is completed.

The U.S. Food and Drug Administration (FDA) has an established action level of 1 ppm for mercury in fish and shellfish moving in interstate commerce. This value was based on assumptions about national fish consumption habits and contamination in commercial seafood products. U.S. EPA does not support application of the federal standard to sport fish since the risks may be greater to fishers who consume large amounts of fish from local water bodies. U.S. EPA encourages states and tribes, whose responsibility is to assess and manage risks from contaminated sport fish, to use a risk-based approach to evaluating human health risks and issuing advisories.

OEHHA has issued advisories based on findings of less than 1 ppm mercury in fish using the U.S. EPA RfD and a risk-based approach. OEHHA is currently reevaluating recent epidemiological studies to determine an appropriate toxicity reference value for methylmercury. However, in the present case regarding Lake Pillsbury, the observation that many of the fish tested from the lake exceeded the FDA action level for mercury is in itself a sufficient indication of the need for consumption guidance. In addition to using the risk-based approach for evaluating the potential risks from exposure to chemicals of concern in sport fish, OEHHA supports using an approach that is consistent with, and does not exceed, standards (*i.e.*, FDA Action Levels) for commercial fish. Therefore, OEHHA does not support regular consumption of fish that exceed the FDA action level of 1 ppm for mercury.

The results from testing of fish from Lake Pillsbury showed that most fish exceeded 1 ppm for mercury. In addition, the overall average concentration of legal-sized largemouth bass from Lake Pillsbury (1.08 ppm) exceeded this level. Fewer samples of Sacramento pike minnow were tested from Lake Pillsbury, and the samples were, for the most part, relatively small. Nevertheless, the two samples of pike minnow that were large enough to be consumable showed tissue levels for mercury that were comparable to levels in largemouth bass.

The level of mercury in water from Lake Pillsbury does not exceed any standards and is not a health concern. As mentioned previously, inorganic mercury is methylated in the aquatic environment to become methylmercury, which is the chemical form in fish responsible for the toxicity found in humans following ingestion of excessive amounts of the chemical. In water, the chemical is found as mercury, which has different toxic properties than methylmercury, and has a drinking water standard for public health protection. Mercury has been detected at relatively high levels in fish in Lake Pillsbury. However, mercury has not been detected in water samples taken from Lake Pillsbury. Therefore, the water that flows out of Lake Pillsbury is not known to pose a health threat due to mercury.

Pregnant or Lactating Women

The developing fetus is most susceptible to the toxic effects of methylmercury. Pregnant women also appear to be somewhat more sensitive than the non-pregnant adult is (Fan and Chang, 1991). In addition, methylmercury can be excreted in breast milk. Therefore, the subpopulations for which the most health-protective actions are appropriate include pregnant women, women who may become pregnant soon or who plan a pregnancy within a year, and nursing mothers. These subpopulations should carefully follow the recommended guidance provided below. Furthermore, reducing exposure to mercury one year in advance of a pregnancy would allow for the elimination of most of the methylmercury that may have accumulated in the tissues of women who have regularly consumed fish contaminated with high levels of methylmercury.

Children

The central nervous system continues to develop after birth and thus it is believed that the developing brain in young children is also more susceptible to exposure to methylmercury. The data on methylmercury health effects do not indicate the point at which young children become similar to adults in their sensitivity or susceptibility to methylmercury. It would be prudent to assume that until brain growth has stabilized at age six, children should follow the guidelines for the developing fetus and pregnant women. Children age six and older should follow the guidelines provided below for the general adult, adjusting for differences in body weight (*i.e.*, reducing meal size according to body weight as described in Table 3).

General Adults

The adult is not as sensitive or susceptible to the effects of methylmercury as is the developing child, and therefore, would not need to limit intake of fish containing mercury to the same extent as would the identified subpopulations (pregnant women, women who plan a pregnancy within a year, and nursing mothers).

FISH CONSUMPTION GUIDELINES

To protect the public from potential adverse health effects related to consumption of methylmercury in fish, the following guidance was developed for each subset of the population that may consume fish from Lake Pillsbury. The guidelines are based principally on analyses of largemouth bass obtained from Lake Pillsbury. The advice is also appropriate for Sacramento pike minnow from Lake Pillsbury, although it is believed that this species is not as widely consumed. The levels of mercury in rainbow trout and other species from Lake Pillsbury (*e.g.*, blue gill) have not been tested, and thus are not known. In order to provide consumption guidelines that are appropriate for other species, samples would need to be collected and analyzed.[1] It should be noted that rainbow trout are stocked in Lake Pillsbury and thus the younger, smaller trout may not have accumulated high levels of mercury. Larger trout, however, may have accumulated higher levels of mercury, and should be tested in the future to confirm or refute whether it is

[1] Similarly, fish in the rivers and creeks upstream and downstream of Lake Pillsbury have not been adequately tested for determining levels of chemical contamination, and thus it is not possible to evaluate whether they pose health risks if consumed.

appropriate to include this species in the advisory recommendations. In the interim, as a prudent health action, this advisory can be applied to all fish from Lake Pillsbury.

As indicated above, separate guidelines are provided for subsets of the population. This approach is intended to emphasize the additional risk to the developing fetus and young children, and to encourage women and young children to follow advice that provides the extra protection appropriate for them.

Pregnant or Lactating Women

It is recommended that pregnant and nursing women, and women who may become pregnant within a year, not eat fish from Lake Pillsbury.

Children

It is recommended that children under age six do not eat fish from Lake Pillsbury. Children age six and older should follow the guidelines provided for the general adult, adjusting for differences in body weight (*i.e.*, reducing meal size according to body weight as described in Table 3).

General Adults

The general adult can consume fish from Lake Pillsbury on an occasional, but not regular, basis. This recommendation also applies to children age six and older. Meal size should be adjusted for differences in body weight using the guidelines provided in Table 3.

HEATH ADVISORY FOR LAKE PILLSBURY

The guidelines described above were used to develop the following health advisory for Lake Pillsbury:

Because of elevated levels of mercury, pregnant and nursing women, women who may become pregnant within a year, and children under age six should not eat fish from Lake Pillsbury. Adults and children age six and older may eat fish from Lake Pillsbury on an occasional, but not regular, basis. Meal size should be adjusted to body weight using the information in the accompanying table (Table 3).

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GLOSSARY

acute short term exposure to a chemical, *i.e.*, one dose or multiple doses occurring for a limited duration (24 hours/14 days or less), or the effects from such an exposure

anthropogenic deriving from a human source

bioaccumulation net accumulation of a chemical by an organism as a result of uptake from all routes of exposure (*e.g.*, water, food)

biomagnification accumulation of a chemical to higher concentrations at higher levels in the food web through dietary accumulation

carcinogen an agent capable of inducing a cancer response

chronic multiple exposures occurring over an extended period of time, or a significant fraction of the organism's life-time, or effects from such an exposure

developmental toxicity adverse effects on the developing organism (including death, structural abnormality, altered growth, or functional deficiency) that may result from exposure prior to conception (in either parent), during prenatal development, or postnatally up to the time of sexual maturation, and which may be detected at any point in the life span of the organism

dose-response the relationship between the amount or magnitude of exposure (dose) and the extent of biological response or toxic injury produced by the chemical

endpoint an observable or measurable biological or chemical event used as an index of the effect of a chemical on a cell, tissue, organ, or organism

epidemiology the study of the distribution and determinants of disease and injuries in human populations

half-life the period required for a chemical to decrease in concentration to one-half of the original concentration

neurotoxicity adverse effects in the nervous system caused by chemicals, pathogens, or trauma

noncarcinogen a chemical or substance that causes noncancer health effects

reference dose (RfD) an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime

sensitivity the condition whereby adverse health effects that occur from exposure to a chemical contaminant are determined by "quantitative" differences; a chemical can produce the same effects in infants, children, or adults, but the magnitude of effect differs

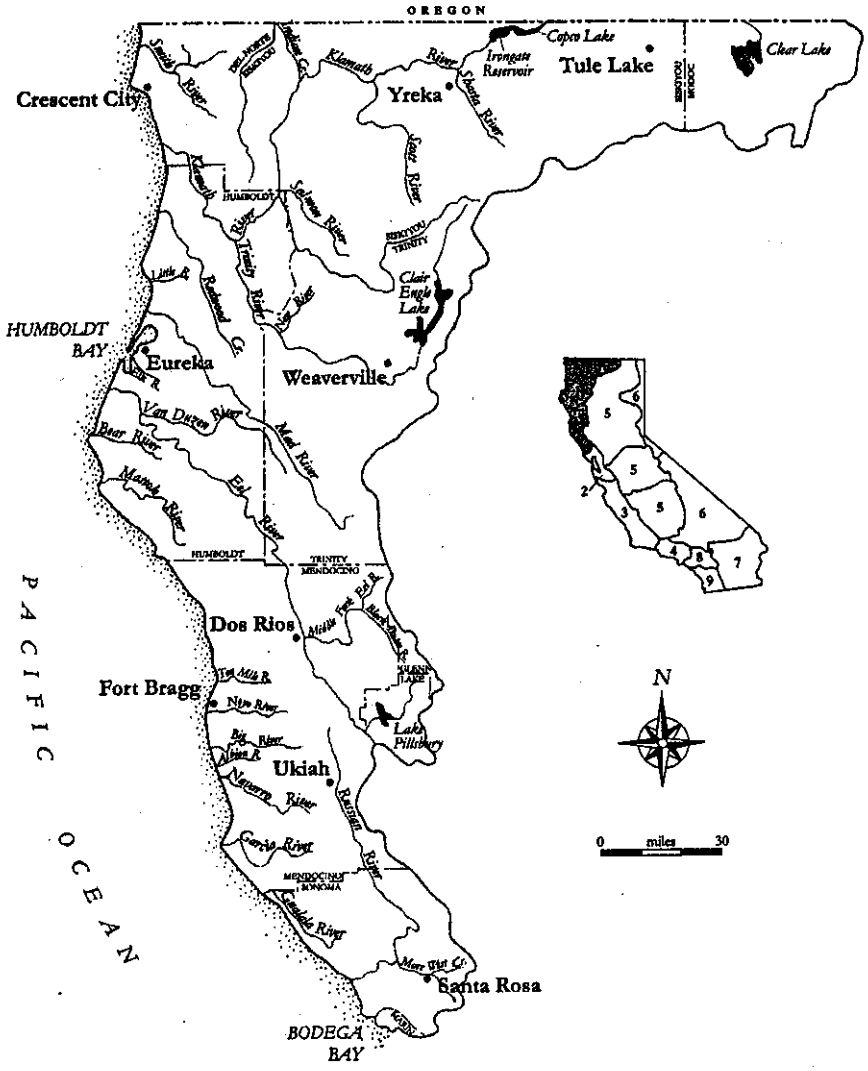
subchronic multiple or continuous exposure to a substance usually occurring over three months/spanning approximately 10 percent of the lifetime of an organism, or the effects from such an exposure

susceptibility the condition whereby adverse health effects from exposure to a chemical contaminant are due to "qualitative" differences; that is, unique processes of growth and development in the exposed organism, particularly in young, not fully matured individuals

toxicology the study of the nature and mechanism of adverse effects of substances on living organisms and other biologic systems

toxicokinetics referring to the time course and variations in absorption, distribution, metabolism, and elimination of a chemical which causes toxicity

Figure 1: Location of Lake Pillsbury in Northern California



7163

Figure 2: Location of Lake Pillsbury in Lake County, California

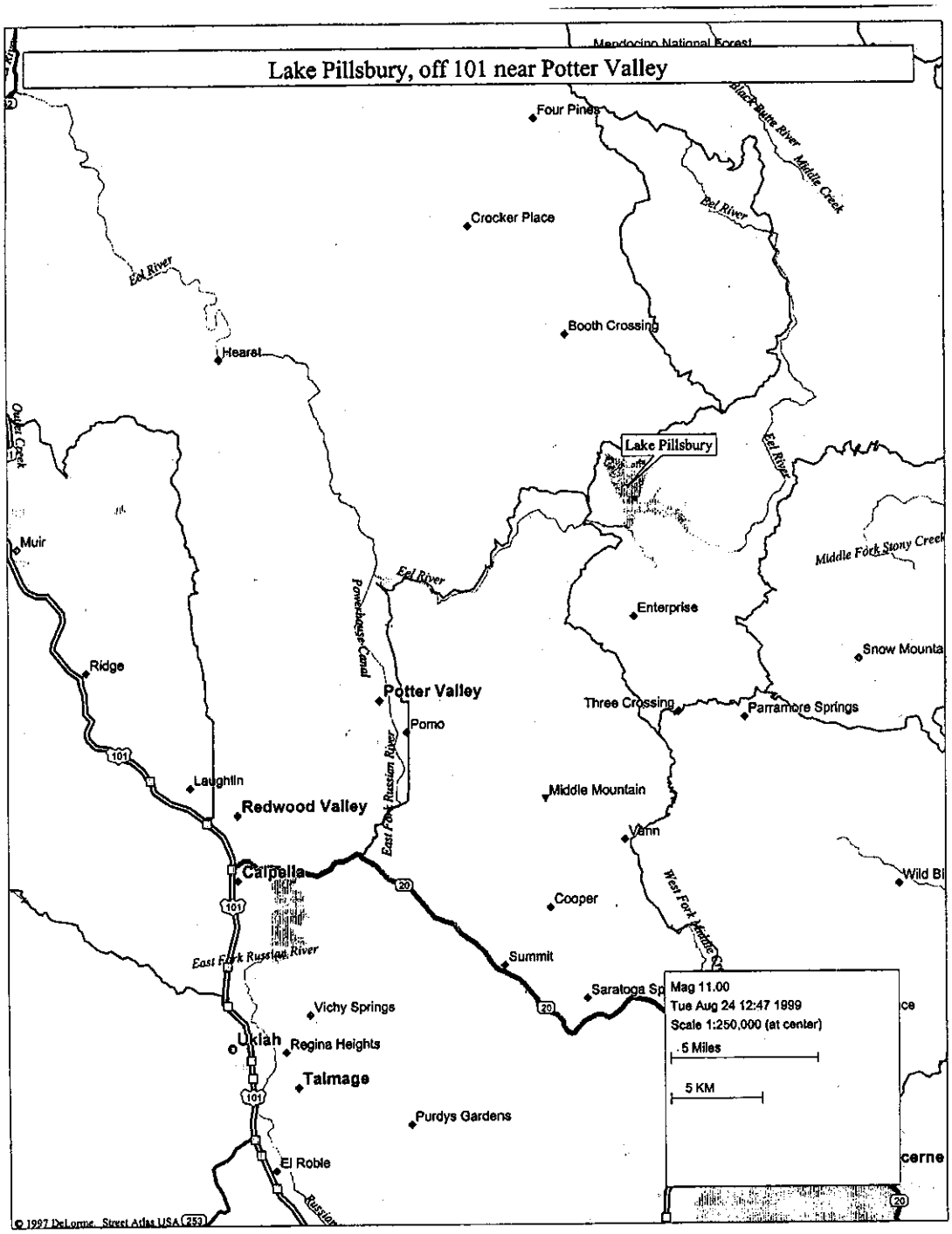


Figure 3: Fish Sampling Locations at Lake Pillsbury

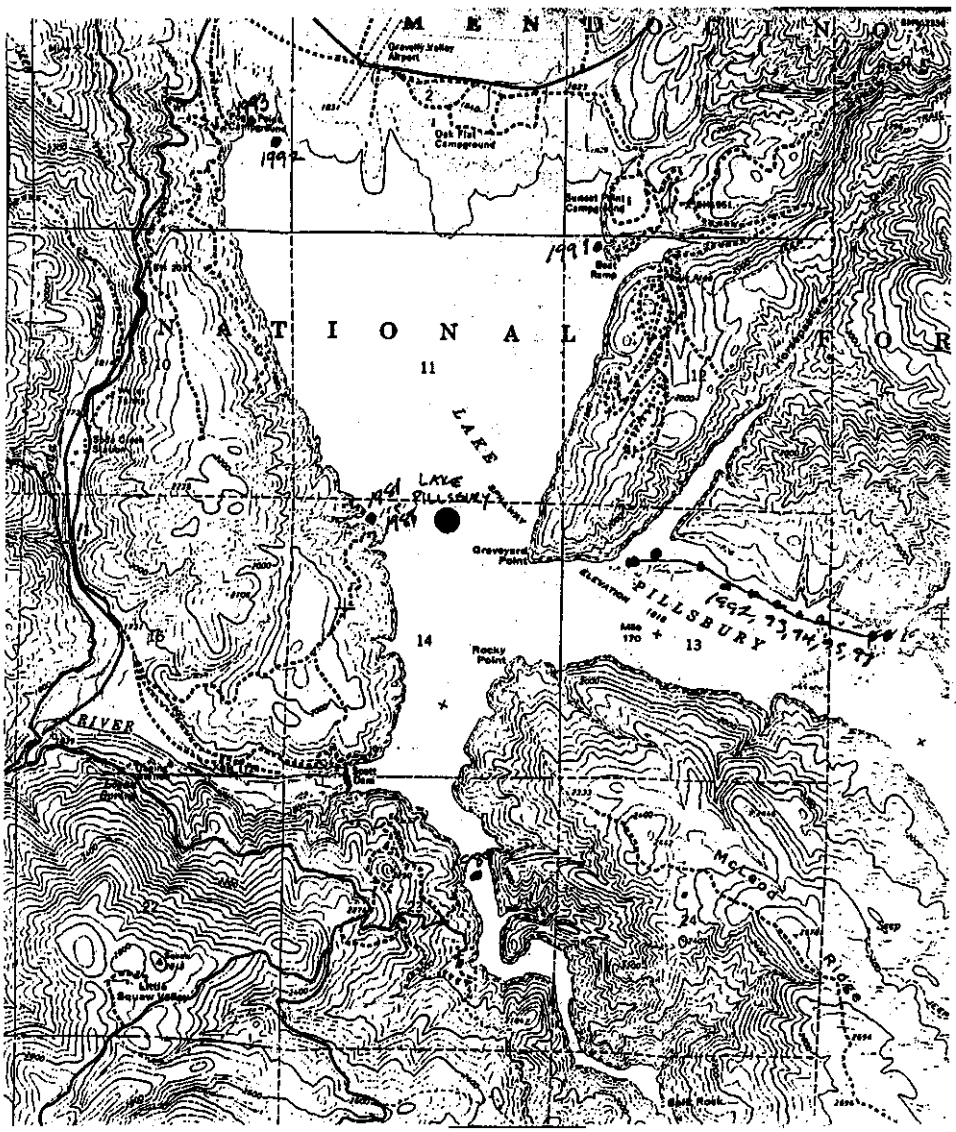


Table 1: Toxic Substances Monitoring Program (TSMP) Data on Mercury in Fish From Lake Pillsbury Used to Develop Advisory

STATION NAME	COLLECTION DATE	SPECIES COMMON NAME	NO. FISH[1]	FISH AGE (YRS)	TISSUE TYPE[2]	FISH LENGTH (MM)	MERCURY (PPM WET WT)
Lake Pillsbury	10-Sep-91	Largemouth Bass	5	3-6	F	415	0.79
LP/Eel River Arm	06-Oct-92	Largemouth Bass	4	7-9	F	508	1.1
Lake Pillsbury	06-Oct-92	Largemouth Bass	4	4-8	F	452	1
LP/Eel River Arm	10-Sep-93	Largemouth Bass	1	6	F	455	1.5
LP/Eel River Arm	11-May-94	Largemouth Bass	1	9	F	520	1.5
LP/Eel River Arm	11-May-94	Largemouth Bass	1	6	F	460	1.8
LP/Eel River Arm	11-May-94	Largemouth Bass	1	5	F	424	1.6
LP/Eel River Arm	11-May-94	Largemouth Bass	1	4	F	363	1.1
LP/Eel River Arm	12-Jul-95	Largemouth Bass	1	5	F	424	1.8
LP/Eel River Arm	12-Jul-95	Largemouth Bass	1	4	F	388	0.57
LP/Eel River Arm	12-Jul-95	Largemouth Bass	1	4	F	375	0.61
Lake Pillsbury	23-Sep-95	Largemouth Bass	1	6	F	457	1

[1] More than one fish indicates a composite sample

[2] F indicates Fillet; L indicates Liver

Table 2: Other Toxic Substances Monitoring Program (TSMP) Data on Mercury in Fish From Lake Pillsbury Used to Support Development of Advisory

STATION NAME	COLLECTION DATE	SPECIES COMMON NAME	NO. FISH[1]	FISH AGE (YRS)	TISSUE TYPE[2]	FISH LENGTH (MM)	MERCURY (PPM WET WT.)
LP/Eel River Arm	06-Oct-92	Largemouth Bass	4	7-9	L	508	1.7
Lake Pillsbury	06-Oct-92	Largemouth Bass	4	4-8	L	452	1
LP/Eel River Arm	06-Oct-92	Largemouth Bass	24	1	F	128	0.37
Lake Pillsbury	10-Sep-93	Largemouth Bass	2	2	F	234	0.51
Lake Pillsbury	10-Sep-93	Largemouth Bass	18	1	F	120	0.37
LP/Eel River Arm	11-May-94	Largemouth Bass	1	2	F	280	0.67
LP/Eel River Arm	11-May-94	Largemouth Bass	1	2	F	275	0.92
LP/Eel River Arm	12-Jul-95	Largemouth Bass	1	3	F	303	0.43
Lake Pillsbury	15-Nov-89	Sacramento Pike Minnow	6	5+	F	358	0.8
Lake Pillsbury	06-Oct-92	Sacramento Pike Minnow	25	1-5	F	195	0.59
Lake Pillsbury/ Eel River Arm	10-Sep-93	Sacramento Pike Minnow	6	5-6	F	425	1.6
Lake Pillsbury/ Eel River Arm	23-Sep-95	Sacramento Pike Minnow	8	2-3	F	221	0.46
Lake Pillsbury	23-Sep-95	Sacramento Pike Minnow	6	2-3	F	221	0.33
Lake Pillsbury/ Eel River Arm	23-Sep-95	Sacramento Pike Minnow	13	1-2	F	149	0.25

[1] More than one fish indicates a composite sample

[2] F indicates Fillet; L indicates Liver

7167

Table 3: Adjusting Fish Meal Size for Body Weight

IF YOU WEIGH...		YOUR MEAL SIZE SHOULD NOT EXCEED...	
Pounds	***or kilograms***	**Ounces[1]**	***or grams***
19	*9*	**1**	*28*
39	*18*	**2**	*57*
58	*26*	**3**	*85*
77	*35*	**4**	*113*
96	*44*	**5**	*142*
116	*53*	**6**	*170*
135	*61*	**7**	*199*
154	*70*	**8**	*227*
173	*79*	**9**	*255*
193	*88*	**10**	*284*
212	*96*	**11**	*312*
231	*105*	**12**	*340*
250	*113*	**13**	*369*
270	*123*	**14**	*397*
289	*131*	**15**	*425*
308	*140*	**16**	*454*

[1] Sixteen ounces is equal to one pound

7168

APPENDIX I

COUNTY OF LAKE
HEALTH SERVICES DEPARTMENT
Division of Environmental Health
922 Bevins Court
LAKEPORT, CALIFORNIA 95453-9739
Telephone 707/ 263-2222
South Shore Civic Center
Telephone 707/ 994-2257

Robert Erickson, LCSW, MPA
Health Services Director

Martin A. Winston, R.E.H.S., M.P.H.
Environmental Health Director

PUBLIC HEALTH ADVISORY

June 14, 1999, Lakeport, California

The Lake County Department of Health Services, Division of Environmental Health, has been notified by the California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, of the presence of mercury in two species of fish in Lake Pillsbury. Other species have not yet been sampled.

Based upon this information we are issuing the following fish consumption advisory for Large Mouth Bass, the Sacramento Pike Minnow, and other fish caught from Lake Pillsbury:

Because of the mercury levels in these fish, women who are pregnant or who may soon become pregnant, nursing mothers, and children under age 6 should not eat these fish from Lake Pillsbury. Data on other species of fish are not available; however, it is recommended that this advice should apply to all species, until further notice.

Adults and children 6 –15 years of age should only eat fish caught in Pillsbury occasionally. Regular consumption would be unsafe due to the mercury levels.

If you have any questions, please feel free to contact Manuel Ramirez, REHS, Hazardous Materials Specialist or Martin A. Winston, REHS, MPH, Director of Environmental Health at (707) 263-2222.

Our mission is to promote and protect the health of the people of Lake County through education and the enforcement of public health laws.

1998 CALIFORNIA 303(d) LIST AND TMDL PRIORITY SCHEDULE

Approved by USEPA: 12-May-99

REGION	TYPE	NAME	HYDRO UNIT	POLLUTANT/STRESSOR*	SOURCE	PRIORITY	SIZE AFFECTED	UNIT	START DATE	END DATE
1	E	EEL RIVER DELTA	111.110							
				Sedimentation/Siltation		Low	6350	Acres	0204	1206
					Range Land					
					Silviculture					
					Nonpoint Source					
				Temperature		Low	6350	Acres	0204	1206
					Nonpoint Source					
1	E	ESTERO AMERICANO	115.300							
				Nutrients		Medium	692	Acres	0497	0206
				Water Quality Attainment strategy is attempting to increase voluntary measures for attainment of standards and objectives, as was done in the Estero de San Antonio / Stemple Creek TMDL Water Quality Attainment Strategy, adopted by the North Coast Regional Water Quality Control Board at the December 11, 1997 meeting.						
					Pasture Land					
					Manure Lagoons					
				Sedimentation/Siltation		Medium	692	Acres	0497	0206
				Water Quality Attainment strategy is attempting to increase voluntary measures for attainment of standards and objectives, as was done in the Estero de San Antonio / Stemple Creek TMDL Water Quality Attainment Strategy, adopted by the North Coast Regional Water Quality Control Board at the December 11, 1997 meeting.						
					Riparian Grazing					
					Hydromodification					
					Removal of Riparian Vegetation					
					Streambank Modification/Destabilization					
					Erosion/Siltation					
					Nonpoint Source					
1	E	ESTERO DE SAN ANTONIO	115.400							
				Nutrients		Low	319	Acres	0496	0498
				This water body/pollutant was relisted by USEPA.						
					Pasture Land					
					Manure Lagoons					
1	E	NAVARRO RIVER DELTA	113.500							
				Sedimentation/Siltation		Medium	20	Acres	0298	1200
					Erosion/Siltation					
1	L	LAKE PILLSBURY	111.630							
				Mercury		Low	2280	Acres	1209	1211
					Natural Sources					