HEALTH ADVISORY AND GUIDELINES FOR EATING FISH FROM NEW MELONES RESERVOIR

(Calaveras County and Tuolumne County)

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Office of Environmental Health Hazard Assessment
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LIST OF ACRONYMS AND ABBREVIATIONS

ATL	Advisory Tissue Level
CDFW	California Department of Fish and Wildlife
CERC	Columbia Environmental Research Center
DDTs	dichlorodiphenyltrichloroethane (DDT) and its metabolites dichlorodiphenyldichloroethane (DDD) and dichlorodiphenyldichloroethylene (DDE)
FMP	Fish Mercury Project
OEHHA	Office of Environmental Health Hazard Assessment
MDL	method detection limit
mm	millimeters
NLFTS	National Lakes Fish Tissue Study
PCBs	polychlorinated biphenyls
ppb	parts per billion
RL	reporting limit
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TSMP	Toxic Substances Monitoring Program
USBR	United States Department of the Interior, Bureau of Reclamation
US EPA	United States Environmental Protection Agency

PREFACE

The Office of Environmental Health Hazard Assessment (OEHHA), a department in the California Environmental Protection Agency, is responsible for evaluating potential public health risks from chemical contamination of sport fish. This task includes issuing fish consumption 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
  - Section 59011, to advise local health authorities
- California Water Code
  - Section 13177.5, to issue health advisories

The health advisories are published in the California Department of Fish and Wildlife Sport Fishing Regulations in the section on public health advisories.

This report presents guidelines for eating fish from New Melones Reservoir in Calaveras and Tuolumne Counties. The report provides background information and a description of how the guidelines were developed. The resulting advice is summarized in the illustration after the Table of Contents and List of Figures and Tables.

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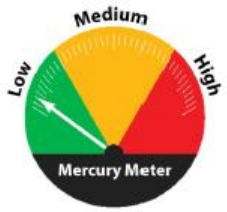

Catfish

Carp

Bass

2 servings a week	OR	1 serving a week	Do not eat

Women over 45 years and men can safely eat more fish

5 servings a week catfish	OR	2 servings a week carp	OR	1 serving a week bass

What is a serving?

For Adults For Children

The recommended serving is the size and thickness of your hand. Give children smaller servings.

Why eat fish?

Eating fish is good for your health.
Fish have Omega-3s that can reduce your risk for heart disease and improve how the brain develops in unborn babies and children.

What is the concern?

Some fish have high levels of mercury.
Mercury can harm the brain, especially in unborn babies and children.

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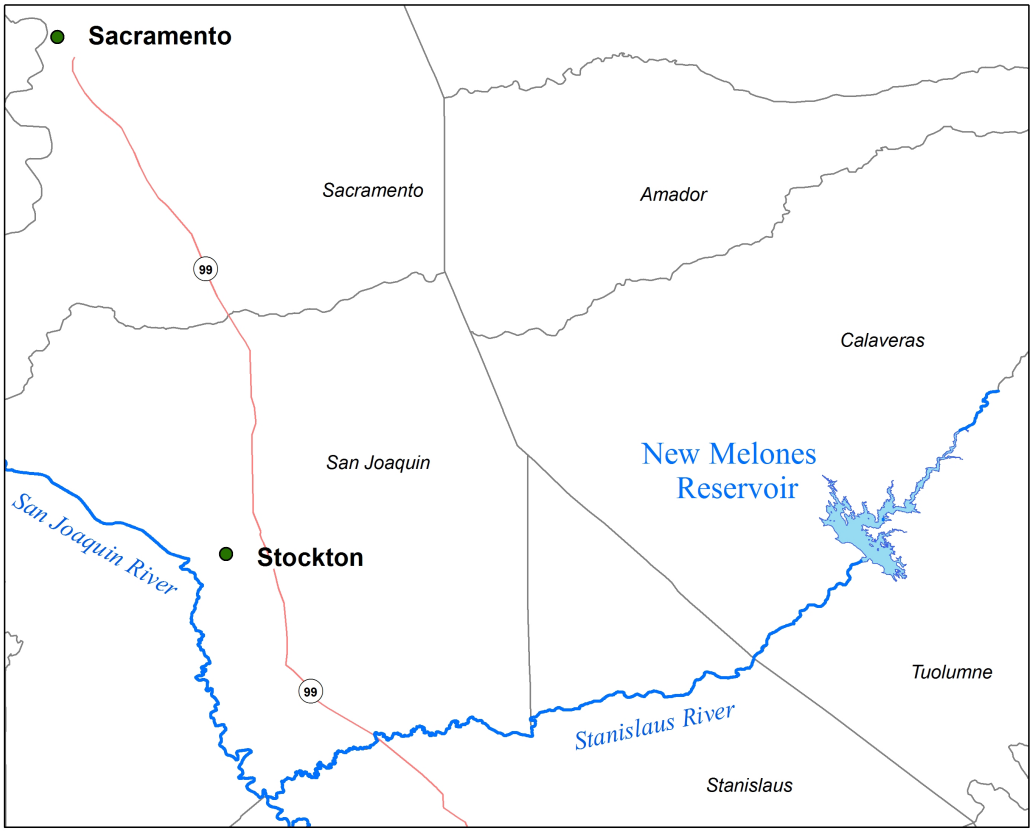
INTRODUCTION

This report presents guidelines for eating fish from New Melones Reservoir in the central Sierra Nevada foothills, California (Figure 1). The reservoir was formed by the construction of New Melones Dam on the Stanislaus River. The river forms the border between Calaveras and Tuolumne Counties, and the reservoir extends into each county. New Melones Reservoir is located about 60 miles upstream from the confluence of the Stanislaus River with the San Joaquin River and 40 miles east of the city of Stockton.

FIGURE 1. LOCATION OF NEW MELONES RESERVOIR IN CALIFORNIA



New Melones Reservoir has a 2,400,000 acre·foot[1] capacity with a surface area of 12,500 acres. The shoreline is more than 100 miles when the reservoir is full. The dam was constructed by the U.S. Army Corps of Engineers and transferred for operation to the U.S. Bureau of Reclamation (USBR) in 1979 upon completion. The dam was first

[1] An acre-foot is the volume of one acre of surface area to a depth of one foot.

authorized by the Flood Control Act of December 1944 to replace Melones Dam[2], a smaller dam built in 1926. The Flood Control Act of October 1962 reauthorized and expanded the dam project as part of the "New Melones Unit" of the Central Valley Water Project. Construction of the new dam took many years due to controversy about environmental and cultural impacts and legal-proceeding delays. The dam is located in the Stanislaus River basin, which was occupied by the Central Sierra Miwok Indians prior to the gold rush in the 1840s.[3]

The primary function of New Melones Dam and Reservoir is flood control. The reservoir supplies water districts in the Central Valley. Downstream of the dam there is a hydroelectric power plant that supplies energy to about 72,000 households. Fishery enhancement, water quality improvement, and recreation were other stated goals of the New Melones Unit of the Central Valley Water Project[3]. The reservoir is reportedly home to rainbow and brown trout, black bass (largemouth and a few smallmouth, spotted and redeye bass), catfish, crappie, and kokanee[4].

OEHHA used the results from several monitoring programs described in this report to develop the advisory for fish caught in the New Melones Reservoir. The basic OEHHA process to develop consumption advice involves these steps:

1) Selection of the chemical data and fish species to be evaluated
2) Calculation of average chemical concentrations and other descriptive statistics as appropriate for the selected fish species
3) Comparison of the chemical concentrations with the OEHHA Advisory Tissue Levels (ATLs) for each chemical of concern

The ATLs (Appendix I) are acceptable exposure levels in fish tissue, based on chemical toxicity, for a range of consumption rates. Development of the ATLs also included consideration of health benefits associated with including fish in the diet (OEHHA, 2008).

CHEMICALS OF POTENTIAL CONCERN

All fish samples from New Melones Reservoir were analyzed for mercury (as a measure of methylmercury). Mercury, a metal, is widely found in California in rock and soil. Its presence in the aquatic environment is the result of mining activities and releases into the environment from industrial sources, including the burning of fossil fuels and solid wastes. Mercury in the sediment is transformed by bacteria to the more toxic organic form, methylmercury. Methylmercury is then absorbed by fish when they eat small

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[2] The original dam is submerged below the New Melones Reservoir.

[3] http://www.usbr.gov/projects/Project.jsp?proj_Name=New+Melones+Unit+Project

[4] http://gloryholesports.com/new-melones-lake/

aquatic organisms. High levels of methylmercury can harm the brain, especially in fetuses and children as they grow.

Polychlorinated biphenyls (PCBs) and the persistent pesticides dieldrin, chlordane, and DDTs (dichlorodiphenyltrichloroethane and metabolites) were analyzed in one composite sample of five largemouth bass and one composite sample of ten carp.

PCBs are man-made chemicals previously used in electrical transformers, lubricating oils, and plastics, for example as flame retardants and electrical insulation. Depending on the exposure level, PCBs can cause cancer and other health effects in humans. Chlordane, DDTs, and dieldrin are pesticides that were banned from use many years ago but have persisted and accumulated in some fish from certain water bodies in California. These pesticides may cause cancer or adverse effects on the nervous system. Detailed discussion of the toxicity of these chemicals is presented in OEHHA (2008).

DATA SOURCES

The guidelines for eating fish from New Melones Reservoir were based on chemical analysis of fish samples by the studies described below. These projects had adequate documentation of sample collection, fish preparation, chemical analyses, and quality assurance, and detection limits were below levels of health concern.

SURFACE WATER AMBIENT MONITORING PROGRAM (SWAMP)

The SWAMP, operated by the State Water Resources Control Board (SWRCB), monitors water quality in California's surface waters. In 2007 and 2008, the program performed a statewide survey of inland lakes and reservoirs. The survey collected largemouth bass and carp from New Melones Reservoir in 2007 and analyzed them for mercury; one composite of carp was also analyzed for PCBs, chlordane, dieldrin, and DDTs.

TOXIC SUBSTANCE MONITORING PROGRAM (TSMP)

The SWRCB initiated the TSMP in 1976. The TSMP was organized to provide a statewide approach to detection and evaluation of toxic substances in fresh, estuarine, and marine waters through the analysis of fish and other aquatic life. After 25 years, TSMP was incorporated into the SWAMP. One composite sample of five carp was collected from New Melones Reservoir in 1987 and analyzed for mercury. Largemouth bass were also collected, but the fish were less than the minimum legal size of 12 inches (equivalent to 305 millimeters [mm]). Therefore, OEHHA did not use the results for the largemouth bass samples.

U.S. BUREAU OF RECLAMATION (USBR)

The USBR requested assistance from the U.S. Geological Survey, Columbia Environmental Research Center (CERC) with a study to measure mercury concentrations in selected sport fish species from New Melones Reservoir (May and Brumbaugh, 2005). The California Department of Fish and Wildlife (CDFW) and USBR collected the fish, and CERC analyzed the samples. The study was planned and implemented to address concerns for the accumulation of mercury in sport fish from the reservoir. Mercury was analyzed in multiple samples of catfish, bass, and kokanee, and one bluegill. The samples of kokanee were reported to be in poor condition. Therefore, OEHHA did not consider the analytical results reliable and did not include this species in the advisory.

US EPA NATIONAL FISH TISSUE STUDY (NLFTS)

US EPA conducted a national survey of chemical residues in fish tissue from lakes and reservoirs in the lower 48 states (US EPA, 2009). Samples were collected from 2000 through 2003. The survey was a screening-level study based on a random selection of lakes. US EPA used the results to estimate the percentage of lakes in the U.S. with chemical concentrations in fish above levels of potential concern for humans or fish-eating wildlife. One composite sample of five largemouth bass collected from New Melones Reservoir in 2003 was analyzed for a suite of chemicals including mercury, PCBs, and the pesticides DDTs, chlordane, and dieldrin.

Table 1 shows the type and number of fish sampled from New Melones Reservoir, the project under which they were collected, and the year sampled.

TABLE 1. FISH COLLECTED FROM NEW MELONES RESERVOIR

Common Name	Scientific Name	Number of Samples	Total Number of Fish	Year Sampled	Data Source
Bass, largemouth	*Micropterus salmoides*	5	5	2003	NLFTS
		10	10	2004	USBR
		22	22[a]	2007	SWAMP
Bass, spotted	*Micropterus punctulatus*	5	5	2004	USBR
Bluegill	*Lepomis macrochirus*	1	1	2004	USBR
Carp	*Cyprinis carpio*	1	5	1987	TSMP
		2	10	2007	SWAMP
Catfish, channel	*Ictalurus puntatus*	15	15	2004	USBR
Catfish, white	*Ameiurus catus*	2	2	2004	USBR
Kokanee salmon[b]	*Oncorhynchus nerka*	11	11	2004	USBR

[a] Four of these largemouth bass were less than legal size (12 inches, or 305 mm).
[b] OEHHA did not include kokanee in the advisory for New Melones Reservoir.
NLFTS = National Fish Tissue Study, USBR = U.S. Bureau of Reclamation, SWAMP = Surface Water Ambient Monitoring Program, TSMP = Toxic Substances Monitoring Program

CHEMICAL CONCENTRATIONS

Fish samples were prepared as skinless fillets and analyzed for total mercury as individual fish or composite samples. Composite samples are prepared from equal amounts of tissues from several individual fish, all of the same species. Composite sampling is usually done to reduce the cost of analyses. The analytical result from a composite sample represents an average concentration.

In the TSMP, mercury was analyzed by cold vapor atomic absorption spectrometry. Samples from SWAMP were combusted and analyzed by DMA (direct mercury analyzer), a combination of thermal decomposition and atomic absorption. The NLFTS analyzed total mercury by oxidation, purge and trap, and cold vapor atomic fluorescence spectrometry. Results are reported in parts per billion (ppb) wet weight. Total mercury analyzed was assumed to be 100% methylmercury because almost all mercury present in fish is the more toxic form methylmercury (Bloom, 1992).

For analysis of legacy pesticides and PCBs (as congeners[5]), largemouth bass and carp were analyzed as composite samples. Pesticides and PCBs in SWAMP samples were analyzed by gas chromatography. Samples in the NLFTS were analyzed for PCBs by high resolution gas chromatography/mass spectrometry and for organochlorine pesticides by gas chromatography/halide specific detector. The method detection limits (MDL) and reporting limits (RL)[6] for all chemicals analyzed are shown in Appendix II.

OEHHA used the arithmetic mean (average) of the chemical concentrations for each fish species to represent average human exposure. The mean concentrations were weighted by taking into account the number of fish in composite samples. The samples used to calculate mean chemical concentrations either met CDFW's legal size requirements for largemouth bass (CDFW, 2014-2015) or OEHHA's criteria for minimum "edible" size based on species size at maturity and professional judgment (OEHHA, 2005). Table 2 shows the mean mercury concentrations and total lengths[7] for each species.

[5] Congeners are related compounds with similar chemical forms. Of the 209 possible PCB congeners, SWAMP reported 52 and NLFTS analyzed all 209.

[6] The MDL is the point at which the chemical can be identified (but not quantified). The RL is the lowest concentration of a chemical that can be accurately quantified in a sample.

[7] Total length is the maximum length of the fish, with the mouth closed and the tail fin pinched together.

TABLE 2. MERCURY CONCENTRATIONS IN FISH FROM NEW MELONES RESERVOIR

Fish Species (Common Name)	Number of Samples	Total Number of Fish	Mean Total Length (mm)	Mercury (ppb)	
				Mean	Range
Bass, largemouth	29	33	384	788	270-1480
Bass, spotted	5	5	401	404[a]	240-530
Bass, combined	34	38	387	738	240-1480
Bluegill	1	1	164	180	NA
Carp	3	15	576	292	201-420
Catfish, channel	15	15	620	131	50-280
Catfish, white	2	2	407	40	30-50
Catfish, combined	17	17	595	120	30-280

[a] All spotted bass were sampled and analyzed by USBR; largemouth bass sampled by USBR were lower in mercury than largemouth bass sampled under SWAMP.

For PCBs, chlordanes, and DDTs, each of the concentrations presented was the sum of the detected parent compound, congeners, and metabolites, where applicable. Since the MDLs or RLs were relatively low, ≤ 5 ppb, individual congeners or metabolites with concentrations reported as non-detects were assumed to have no residue. This is a standard method of handling non-detect samples for PCBs and other chemicals with multiple congeners or metabolites when detection levels are adequate (US EPA, 2000a).

The mean concentrations of PCBs, DDTs, chlordanes, and dieldrin are shown in Table 3. The concentrations of PCBs and pesticides were lower than the ATL threshold values for daily consumption (OEHHA, 2008). Therefore, PCBs and pesticides were not considered further for developing consumption advice. The guidelines for eating fish from New Melones Reservoir are based solely on mercury concentrations.

TABLE 3. PCBS AND PESTICIDES IN FISH FROM NEW MELONES RESERVOIR

Fish Species (Common Name)	Number of Samples	Total Number of Fish	Mean Total Length (mm)	Concentration (ppb)			
				PCBs	DDTs	Chlordanes	Dieldrin
Bass, largemouth	1[a]	5	337	3.4	1.5	0	0
Carp	1	10	566	0.4	0	0.4	0

[a] The results are the average of the sample and a duplicate sample. It was not possible to determine with certainty, from the documentation of the data, whether the same fish were used to form the duplicate sample.

DEVELOPMENT OF GUIDELINES FOR EATING FISH FROM NEW MELONES RESERVOIR

GENERAL INFORMATION

The OEHHA advisory process considers the health benefits of fish consumption as well as the risk from exposure to chemical contaminants that may be found in fish. Benefits are included in the advisory process because there is considerable evidence and scientific consensus that fish should be part of a healthy, well-balanced diet. Fish contain many nutrients that are important for general health and, in particular, help promote optimal growth and development of babies and young children and may reduce the incidence of heart disease in adults (FDA/US EPA, 2014; American Heart Association, 2014; OEHHA, 2008; Institute of Medicine, 2007; Kris-Etherton et al., 2002). Fish is a significant source of the specific omega-3 fatty acids, docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), thought to be associated with many of these beneficial effects (USDA/USDHHS, 2010; Weaver et al., 2008).

The 2010 U.S. Dietary Guidelines recommend that consumers eat at least eight ounces of cooked seafood[8] per week ("young children need less depending on age and calorie needs") and that "women who are pregnant or breastfeeding consume eight to twelve ounces of seafood per week from a variety of seafood types" (USDA/USDHHS, 2010). However, the particular fish that people eat is an important factor in determining the net beneficial effects of fish consumption. For example, studies have shown that children of mothers who ate low-mercury fish during pregnancy scored better on cognitive tests compared to children of mothers who did not eat fish or ate high-mercury fish (Oken et al., 2005, 2008). Accordingly, because of the high mercury content of these fish species, the Dietary Guidelines recommend that women who are pregnant or breastfeeding do not consume shark, swordfish, tilefish, or king mackerel, and limit consumption of albacore tuna to six ounces per week (USDA/USDHHS, 2010).

Catching and eating sport fish (i.e., fish and shellfish that people catch for themselves, friends or family) can be an important and economical way for consumers to meet the seafood consumption recommendations of the Dietary Guidelines. However, the mercury (and other contaminant) content of sport fish can vary widely by species and location. In order to address the potential health concerns associated with consuming contaminants in sport fish, OEHHA has established ATLs (Advisory Tissue Levels, i.e.,

[8] "Seafood is a large category of marine animals that live in the sea and in freshwater lakes and rivers. Seafood includes **fish,** such as salmon, tuna, trout, and tilapia, and **shellfish,** such as shrimp, crab, and oysters" (USDA/USDHHS, 2010).

acceptable exposure levels) for chemicals that are known to accumulate in the edible tissues of fish. ATLs consider both the toxicity of the chemical and potential benefits of eating fish. OEHHA uses the ATLs to determine the maximum number of servings per week that consumers can eat, for each species and at each location, to limit their exposure to these contaminants. Consumers can use OEHHA's guidance when choosing which fish and how much to eat as part of an overall healthy diet.

There are two sets of ATLs for methylmercury in fish because of the age-related toxicity of this chemical (OEHHA, 2008). The fetus and children are more sensitive to the toxic effects of methylmercury. Thus, the ATLs for women who might become pregnant (typically 18 to 45 years of age) and children (the sensitive population) are lower than for women over 45 years and men. The lower ATL values for the sensitive population provide protection to allow for normal growth and development of the brain and nervous system of unborn babies and children. Detailed discussion about the toxicity of common fish contaminants and health benefits of fish consumption, as well as derivation of the ATLs, are available in OEHHA, 2008. A list of ATLs used in this report is presented in Appendix I.

Data for fish species may be combined as a single group based on their taxonomy (i.e., they are in the same taxonomical Family and/or genus) and other considerations when specified in the following discussion of the water-body specific advice. For each fish species or group of related species in this advisory[9], OEHHA compared the average concentration of each chemical detected in fish fillet to the ATL for that chemical in order to establish the maximum number of servings per week that could be consumed. When there is more than one chemical of concern, OEHHA provides advice based on the chemical that leads to the most restrictive consumption advice (i.e., the lowest number of servings per week). In addition, because mercury and PCBs cause similar adverse effects in the sensitive population (developmental neurotoxicity), OEHHA uses multiple chemical exposure methodology (US EPA, 1989 and 2000b) to minimize potential additive effects of these chemicals. Thus, consumption advice may be more restrictive for the sensitive population when both chemicals are present in the same fish than it would be for either chemical alone.

OEHHA recommends that individuals strive to meet the U.S. Dietary Guidelines seafood consumption recommendations, while also adhering to federal and OEHHA recommendations to limit the consumption of high-contaminant fish. The advice discussed in the following section represents the maximum recommended number of servings per week for different fish from this water body. People should eat no more than the recommended number of servings for each fish species or species group.

[9] A species group includes related species. Fish species within the same genus are most closely related, and Family is the next level of relationship.

Consumption advice should not be combined. That is, if a person chooses to eat a fish from the “one-serving-a-week’’ category, then they should not eat any other fish from any source until the next week. If a person chooses to eat a fish from the “two-servings-per-week” category, they can combine fish species from that category for a total of two servings in that week. Then they should not eat any other fish from any source until the next week.

Sample Evaluation

OEHHA requires a minimum of nine fish per species to represent that species in a small water body. Related species were considered together, and doing so increased the sample size for bass and catfish. OEHHA compared the mean mercury concentrations of species or related species groups with sufficient data to the ATLs. Only one bluegill was collected and analyzed; therefore, OEHHA could not include it in the advisory.

Bass

Largemouth bass and spotted bass are members of the same genus. Based on the average mercury level in largemouth bass and spotted bass of 738 ppb, OEHHA recommends no consumption for the sensitive population and one serving a week for women over 45 years and men.

Carp

The mean mercury level in carp was 292 ppb. Based on the data, OEHHA recommends one serving a week for the sensitive population and two servings a week for women over 45 years and men.

Catfish

Channel catfish and white catfish are members of the same Family, Ictaluridae. Based on the combined average of 120 ppb mercury, OEHHA recommends two servings a week for the sensitive population and five servings a week for women over 45 years and men.

Maximum Recommended Number of Servings

The maximum recommended numbers of servings per week for fish from New Melones Reservoir are shown in Table 4.

TABLE 4. RECOMMENDED MAXIMUM NUMBER OF SERVINGS PER WEEK FOR FISH FROM NEW MELONES RESERVOIR

Fish Species	Women 18–45 years and Children 1–17 years	Women over 45 years and Men
Bass, largemouth and spotted	0	1
Carp	1	2
Catfish, channel and white	2	5

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APPENDIX I. ADVISORY TISSUE LEVELS

Advisory Tissue Levels (ATLs) guide the development of advice for people eating sport fish. ATLs show maximum numbers of recommended fish servings that correspond to the chemical levels found in fish. OEHHA uses ATLs to provide advice to prevent consumers from being exposed to:

- more than the average daily reference dose[10] for chemicals not known to cause cancer, such as methylmercury, or
- for cancer-causing chemicals, a risk level greater than one additional cancer case in a population of 10,000 people consuming fish at the given consumption rate over a lifetime. This cancer endpoint is the maximum acceptable risk level recommended by the US EPA (2000b) for fish advisories.

For each chemical, ATLs were determined for both cancer and non-cancer risk, if appropriate, for one to seven eight-ounce servings per week. The most health-protective ATLs for each chemical, selected from either cancer or non-cancer based risk, are shown in the table below for zero to three servings per week. Exposure to chemicals in fish from New Melones Reservoir would be at or below the average daily reference dose or the cancer risk probability of one in ten thousand if the guidelines for eating fish from New Melones Reservoir are followed.

Advisory Tissue Levels (ATLs)
Based on Cancer or Non-Cancer Risk Using an 8-Ounce Serving Size

Chemical	**Consumption Frequency Categories[a] and ATLs[b] (in ppb)**			
	Three Servings per Week	Two Servings per Week	One Serving per Week	No consumption
Chlordanes	>140-190	>190-280	>280-560	>560
DDTs	>390-520	>520-1,000	>1,000-2,100	>2,100
Dieldrin	>11-15	>15-23	>23-46	>46
Methylmercury (Women 18 to 45 years and children 1 to 17 years of age)	>55-70	>70-150	>150-440	>440
Methylmercury (Women over age 45 years and men)	>160-220	>220-440	>440-1,310	>1,310
PCBs	>15-21	>21-42	>42-120	>120

[a] Serving sizes (prior to cooking, wet weight) are based on an average 160 pound person. Individuals weighing less than 160 pounds should eat proportionately smaller amounts.

[b] When residue data are compared to this table, they should also first be rounded to the second significant digit.

[10] The reference dose is an estimate of the maximum daily exposure to a chemical likely to be without significant risk of harmful health effects during a lifetime

APPENDIX II. METHOD DETECTION LIMITS AND REPORTING LIMITS

Concentrations are in ppb wet weight

Analyte	NLFTS		SWAMP	
	MDL	RL[11]	MDL	RL
Hg	0.521	2.0	0.012	0.012
PCBs	0.0002-0.0052	0.0005-0.020	0.2 or 0.3	0.6 or 0.9
DDTs	0.38-2.2	2.0-4.0	0.093-0.21	0.97-4.85
Chlordanes	0.488-1.95	2.0-4.0	0.188-0.46	0.97
Dieldrin	0.44	1.0	0.419	0.49

NLFTS = National Lakes Fish Tissue Study, SWAMP = Surface Water Ambient Monitoring Program, MDL = method detection limit, RL = reporting limit

[11] NLFTS uses the term ML (minimum level or quantitation limit) instead of RL.