

HEALTH ADVISORY AND SAFE EATING GUIDELINES FOR FISH FROM DONNER LAKE (Nevada County, CA)

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and
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(Nevada County, CA)**

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FOREWORD

This report provides guidelines for consumption of various fish species taken from Donner Lake and its associated creeks, in Nevada County near Truckee, California. These guidelines were developed from evaluation of mercury and PCB concentrations in fish tested from these water bodies, and are provided to fish consumers to assist them in making choices about how frequently they can safely consume the types of fish in Donner Lake. Some fish tested from these water bodies showed moderate chemical contaminant levels and these guidelines are provided to protect against possible adverse health effects from consuming contaminated fish. Additionally, the guidelines provide information to aid consumers in selecting fish that are lower in contaminants. This report provides background information and a description of the data and criteria used to develop the guidelines.

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EXECUTIVE SUMMARY

Mercury, polychlorinated biphenyls (PCBs) and several other chemicals were analyzed in edible tissues of four fish species caught from Donner Lake, Nevada County, California. The contaminant data were evaluated by the Office of Environmental Health Hazard Assessment (OEHHA) to determine whether there may be potential adverse health effects associated with the consumption of certain sport fish from this lake. OEHHA determined that mercury and PCBs were the two chemicals of concern if fish caught in this lake and nearby creeks were eaten regularly.

Mercury is a trace metal that occurs naturally in the environment and is also redistributed as a result of human activities such as mining and the burning of fossil fuels. In aquatic systems, it undergoes chemical transformation to the more toxic organic form, methylmercury, which accumulates in fish and other organisms. Methylmercury can be toxic to humans, especially the developing fetuses and young children, because the critical target of toxicity is the nervous system. PCBs are man-made chemicals used mainly in electrical equipment and plastics. They were banned in the 1970s but do not break down easily in the environment and can accumulate in fish. PCBs may cause cancer or other health effects in humans. The risk associated with eating fish containing these chemicals depends on the toxicity of the chemicals and the exposure level. Based on this evaluation, OEHHA developed safe eating guidelines for these chemicals in fish caught from this lake and surrounding creeks, as described in this report.

Safe eating guidelines identify fish species with lower contaminant levels that are safe to eat frequently (once a week or more). Evaluating contaminants that may be found in fish is OEHHA's primary concern, but OEHHA's guidelines are also intended to reflect the general scientific consensus that eating fish at dietary levels that are easily achievable, but well above national average consumption rates, appears to promote significant health benefits, including decreased mortality. These benefits are thought to result from unique omega-3 fatty acids found in fish and include decreased rates of cardiovascular disease and stroke, decreased inflammation, and improvements in brain and visual function. Fish consumption during pregnancy has been associated with higher cognitive scores in young children. These safe eating guidelines provide consumer information to make healthy choices about fish consumption.

Based on the present evaluation, the following consumption advice is provided for brown trout, kokanee, lake trout, and rainbow trout at Donner Lake and associated creeks. The recommended consumption is no more than one serving (6-ounce cooked fish per serving) per week of brown trout or lake trout, or up to two servings per week of kokanee. This advice is based on the evaluation of PCBs and mercury levels in these fish.

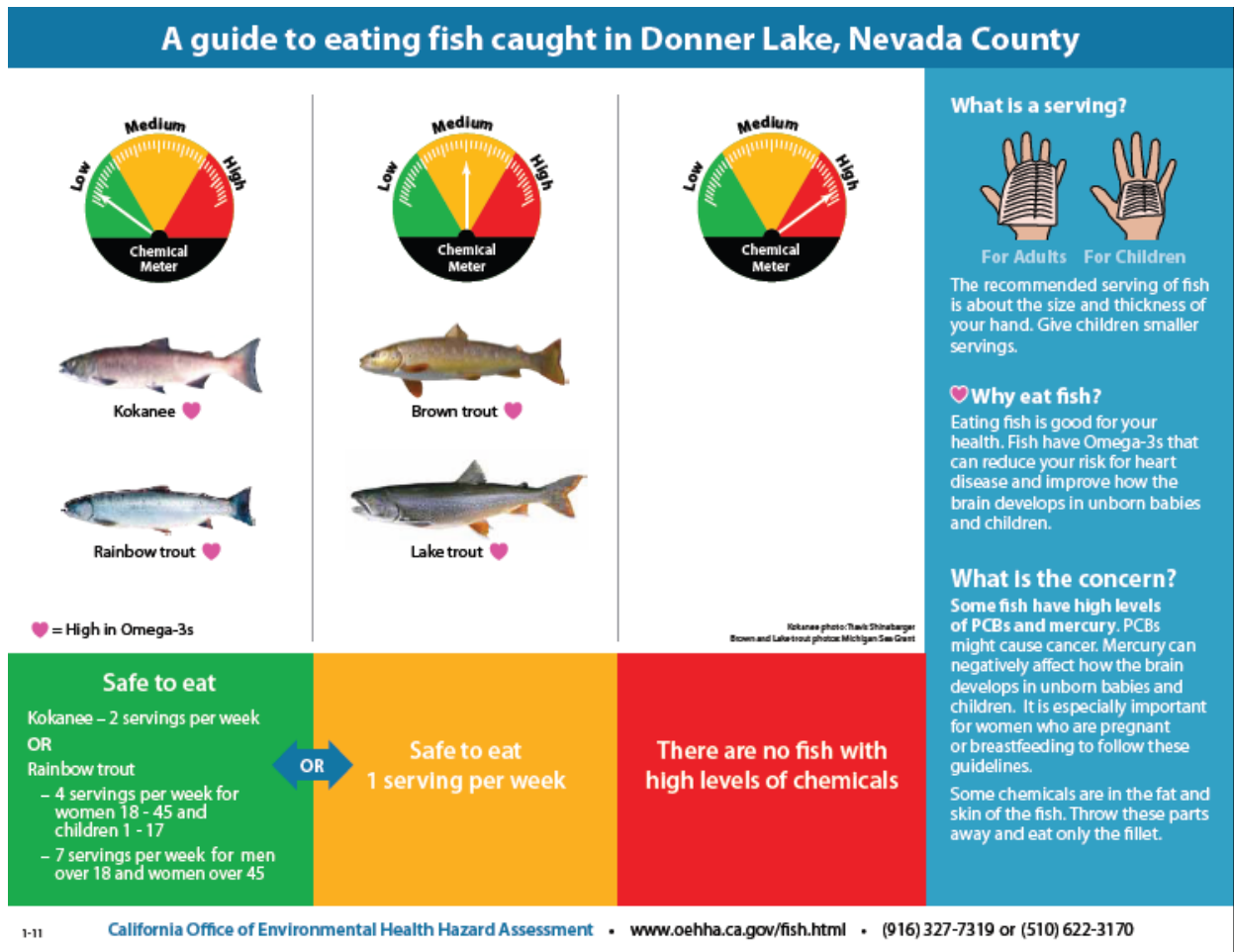
For rainbow trout, separate consumption advice has been developed for two populations because of mercury levels. Fetuses and children are more sensitive to the

toxic effects of methylmercury found in fish. The consumption recommendations are up to four servings per week for children 1 to 17 years and women 18 to 45 years old, and up to seven servings per week for women over 45 years and men.

The consumption advice should not be combined. For example, fishers can choose one fish from the “one-serving-per week” category to eat that week. Then they should not eat any other fish from any source until the next week.

For general advice on how to limit your exposure to chemical contaminants in sport fish (e.g., eating smaller fish of legal size), and a fact sheet on methylmercury and PCBs in sport fish, see the California Sports Fish Consumption Advisories available online at the OEHHA home page (<http://www.oehha.ca.gov/fish/chems/index.html>). Guidelines for other California water bodies are also posted online (http://www.oehha.ca.gov/fish/so_cal/index.html). Unlike the case for PCBs, various cooking and cleaning techniques will not reduce the methylmercury content of fish. Additionally, there are no known ways to prepare fish (such as soaking in milk) that will reduce the methylmercury content of fish.

Fig 1. A guide to eating fish caught in Donner Lake



INTRODUCTION

Fish consumption advisories have been issued in all 50 states in the U.S. and they cover about 40% of the country's total lake acreage and river miles (U.S. Environmental Protection Agency, U.S. EPA, 2009). Mercury contamination of fish, in particular, is a national problem: 80% of advisories in effect in 2008 were at least partially the result of mercury contamination. The presence of polychlorinated biphenyls (PCBs) has resulted in the second greatest number of fish consumption advisories nationwide (U.S. EPA, 2009). Mercury is a trace metal that occurs naturally in the environment and is also redistributed as a result of human activities such as mining and the burning of fossil fuels. In aquatic systems, it undergoes chemical transformation to the more toxic organic form, methylmercury, which is accumulated in fish and other organisms. Methylmercury can be toxic to humans, especially the developing fetuses and young children, because the critical target of toxicity is the nervous system.

PCBs are man-made chemicals used mainly in electrical equipment and plastics. They were banned in the 1970s but do not break down easily in the environment and can accumulate in fish. PCBs may cause cancer or other health effects in humans. The risk associated with eating fish containing these chemicals depends on the toxicity of the chemicals and the exposure level. Fish consumption advisories based on mercury contamination have been issued by the Office of Environmental Health Hazard Assessment (OEHHA) for various water bodies in at least 30 California counties, including some coastal areas. Advisories based on PCBs have been issued for the San Francisco Bay, several reservoirs in the San Francisco Bay area and coastal regions of Ventura, Los Angeles and Orange counties.

Donner Lake, with a surface area of 960 acres, is located in Nevada County; its watershed includes portions of Placer and Nevada Counties. Summit Creek is the largest tributary of Donner Lake. Donner Creek flows out of the lake to the Truckee River. The lake is managed as a reservoir and provides domestic water to surrounding development and for the Reno, Nevada area. Land use in the watershed includes residential and commercial development, Donner Memorial State Park, Interstate 80, and a railroad. The lake supports a recreational fishery. Fish samples collected in the 1990s showed the presence of priority organics, which resulted in this placement of the lake on the Clean Water Act 303(d) list of impaired water bodies needing remedial programs called Total Maximum Daily Loads (TMDLs) (State Water Resources Control Board, 2010).

The source of contaminants in fish at Donner Lake is unknown. Potential sources of mercury, PCBs, chlordane, and other contaminants may include, but not be limited to, spills from the major highway (i.e., Interstate 80) or railroad (i.e., Union Pacific) corridors which parallel the lake, atmospheric deposition, and exposure of planted fish during early development in hatcheries. PCBs may also come from power transformers and/or stormwater runoff containing improperly disposed waste oils. Chlordane and other

pesticides may reach the lake via stormwater runoff from development around the lake, and/or from improperly disposed pesticide products. While local sources may contribute a significant amount, or even the majority, of detected contaminants at Donner Lake, atmospheric deposition is also a known contributor of contaminants to lakes of the Sierra Nevada (Datta et al., 1998; Heyvaert et al., 2000a and b; Ohyama et al., 2004; Drevnick et al., 2009; Bradford et al., 2010). In the study by Ohyama et al. (2004), detectable levels of PCBs (Aroclor 1254 and 1260), DDTs and chlordanes were measured in kokanee and rainbow trout from Donner Lake.

DATA COLLECTION

Data used for this evaluation were obtained from the Surface Water Ambient Monitoring Program (SWAMP) database, with samples from three studies: Toxic Substance Monitoring Program (TSMP) Study (2002, one sample), Regional Water Quality Control Board Region 6 (RWQCB6) Focused Donner Lake Study (2005-2006, 49 samples), and SWAMP Lakes Fish Contaminant Study (2007, two samples). OEHHA and the Lahontan Regional Water Quality Control Board collaborated on the sampling plan for 2005-2006 as part of the SWAMP program.

Fish were collected by Department of Fish and Game staff along Summit Creek and Donner Creek, and bank or open water areas of Donner Lake, using gill nets, fishing rods, or backpack electrofisher. Species collected included brown trout, kokanee, lake trout, and rainbow trout. All fish met the total fish length for legal and/or edible size with the exception of one 330 mm lake trout in a composite sample. Total fish length is the longest length from the tip of the tailfin to the tip of the nose/mouth. The minimum lengths are 200 mm for brown trout, kokanee, and rainbow trout, and 350 mm for lake trout (Gassel and Brodberg, 2005). Sufficient samples of kokanee and lake trout were collected to develop the consumption guidelines for these species. They were at least nine individuals or three composite samples with three individuals each as specified under the OEHHA sampling guidelines (Gassel and Brodberg, 2005). While fewer than nine samples of brown trout and rainbow trout were collected (Table 1), results for these species were evaluated because they are in the same family as the other species in Donner Lake and showed similar or lower accumulation of mercury and organic chemicals (OEHHA, 2009).

Collected fish were skinned/scaled, filleted and homogenized. Some samples were analyzed as individuals while others were composited (three to five fish/composite). Ideally, the difference in the minimum and maximum lengths of fish in a composite should not exceed 75% (Gassel and Brodberg, 2005). For this data set, the composite met this criterion with two exceptions: one brown trout and one kokanee. Since these two samples were close to 75%, their results were included in this evaluation.

Samples were analyzed by the California Department of Fish and Game Water Pollution Control Laboratory (Rancho Cordova, CA). All data used in this evaluation were validated by the SWAMP Data Management Team using SWAMP Data Quality

Objectives (precision, accuracy, recovery, completeness, and sensitivity). Total mercury was detected using a Direct Mercury Analyzer according to EPA method 7374. The reporting limit was 0.02 µg/g (20 ppb). All fish samples collected from Donner Lake showed detectable mercury at ≥35 ppb. Total mercury analyzed in the fish was assumed to be 100% methylmercury because almost all mercury present in fish is methylmercury (Wiener et al., 2007).

The organochlorines were detected by gas chromatography equipped with an electron capture detector according to EPA method 8081AM. Dichlorodiphenyltrichloroethane and its metabolites (DDTs) analyzed included DDT (o,p'; p,p'), DDD (o,p'; p,p') and DDE (o,p'; p,p') and their method detection limits (MDLs) ranged from 0.34 to 1.24 ppb. Total chlordanes consisted of cis-chlordane, trans-chlordane, cis-nonachlor, trans-nonachlor, and oxychlordane, and the MDLs ranged from 0.18 to 0.44 ppb. Two MDLs were listed for dieldrin; they were 0.21 ppb or 0.421 ppb. PCBs were also detected by gas chromatography, using EPA method 8082M. A total of 54 PCB congeners were reported. Their MDLs ranged from 0.033 ppb (PCB 151 and 198) to 0.227 ppb (PCB 101), with an average MDL of 0.05 ppb.

For the chlorinated compounds, total concentration for each compound (parent and congeners, or metabolites, if applicable) was the sum of detected concentrations. Since the MDLs were relatively low, in particular for PCBs, samples with concentrations reported as non-detects were assumed to have no residue, one of the approaches for non-detect samples (U.S. EPA, 2008). If one-half of the MDL were used instead of the zero value, it would have added ≤2 ppb to the total mean concentrations of the chlorinated compounds and would not have changed the recommended guidelines.

Mean contaminant concentrations, fish lengths, number of samples (including composites) analyzed, and number of fish per composites are presented for each species in Table 1. Chemical concentrations are reported in wet weights. Arithmetic means, rather than geometric means, were used to represent the central tendency (average) for each species in this report. In general, arithmetic means for environmental chemical exposures are more health-protective than geometric means, and are commonly used in human health risk assessments. Grand means for each chemical were calculated as the weighted average of composite and individual means.

DATA EVALUATION

As a first step in interpreting contaminant levels in fish, OEHHA has developed advisory tissue levels (ATLs) for PCBs, methylmercury, and other contaminants found in fish (Klasing and Brodberg, 2008) similar to risk-based consumption limits recommended by the U.S. EPA (U.S. EPA, 2000). ATLs relate the number and size of recommended fish meals to chemical contaminant concentrations found in fish (Table 2). These values were designed so that individuals consuming no more than a preset number of meals should not exceed the reference dose (RfD) for non-cancer hazards on average for chronic exposure; or a risk level of 1×10^{-4} for cancer (no more than one additional case

of cancer for every 10,000 people) for the contaminant of concern. ATLS for methylmercury for women over 45 years and men are approximately three times higher than for sensitive populations because of the three-fold higher RfD used for this population group. The sensitive population is defined as women of childbearing age (18 to 45 years), including women who are pregnant or breastfeeding, and children 1 to 17 years of age. Meal sizes were based on a standard eight-ounce (227 grams) portion of uncooked fish, which is approximately six ounces after cooking, for adults who weigh about 70 kilograms (equivalent to 154 pounds). OEHHA recommends that people who weigh less than 70 kilograms eat smaller portions of fish and, in particular, children up to age 12 eat about half as much. A description of the process of developing ATLS, including toxicological information on PCBs, methylmercury, and other potential contaminants, can be found in Klasing and Brodberg (2008).

Brown Trout:

All brown trout were caught along the bank or the creeks in November 2005. Only one composite sample (three fish) of brown trout was analyzed for the chlorinated compounds. The average total fish length was 512 mm. The difference in fish lengths in the composite was 71.4% (minimum of 432 mm and maximum of 605 mm), slightly lower than the 75% criteria (Gassel and Brodberg, 2005). The mean concentrations were: 55 ppb (PCBs), 7 ppb (DDTs), 4 ppb (chlordanes), and 0.2 ppb (dieldrin).

Four fish (one fish per sample) were analyzed for mercury. The average total fish length was 440 mm, and the average mercury concentration was 172 ppb. The average total PCBs of 55 ppb and mercury of 172 ppb were the highest among the species analyzed. While there may be uncertainty associated with the PCB value since it was from a single composite sample, these levels were similar to those detected in kokanee and lake trout. The relatively low levels of DDTs, chlordanes and dieldrin were consistent with those detected in other species from this lake.

Based on the total PCBs and mercury concentrations in the brown trout, in comparison with the respective ATLS (Table 2), OEHHA advises that women 18 to 45 years and children 1 to 17 years of age should eat no more than one serving of brown trout per week. The one serving per week advice is also applicable for women over the age of 45 years and men because of the total PCBs concentration.

Kokanee:

A total of 18 kokanee were collected from either the creeks or the open water of Donner Lake on November 2005 or May 2006. Six composite samples (three fish per composite) with an average total fish length of 399 mm, were analyzed for chlorinated compounds. The average concentrations were: 32 ppb (PCBs), 7 ppb (DDTs), 10 ppb (chlordanes), and 0.7 ppb (dieldrin). For mercury analysis, a total of 25 fish were in 21 samples (two as three-fish composites, and 19 individual fish). The average total fish length was 396 mm, and the average mercury concentration was 73 ppb. One kokanee composite sample analyzed for all contaminants had a difference in fish lengths of

70.51% (minimum of 275 mm and maximum of 390 mm), close to the 75% criteria. The contaminant concentrations associated with this sample were within the range of concentrations reported for other kokanee samples.

Based on the ATLS, OEHHA advises that consumers can eat up to two servings of kokanee per week for all populations. This frequency was based on PCB and mercury concentrations for women 18 to 45 years and children 1 to 17 years of age, and PCB concentration for women over the age of 45 years and men.

Lake Trout:

Seventeen lake trout were collected, primarily at the west end of the lake, in the five composite samples (four as three-fish composites from August 2005, and one as five-fish composite from October 2002 collected for TSMP). The average total fish length was 414 mm. The average concentrations were: 43 ppb (PCBs), 9 ppb (DDTs), 11 ppb (chlordanes), and 0.3 ppb (dieldrin). For mercury, a total of 13 individual fish samples were analyzed. The average total fish length was 427 mm, and the average mercury concentration was 155 ppb.

For lake trout, OEHHA advises that women 18 to 45 years and children 1 to 17 years of age should eat no more than one serving of lake trout per week because of the PCBs and mercury concentrations found in these fish. The one serving per week advice is also applicable for women over the age of 45 years and men because of the total PCBs.

Rainbow Trout:

Only a single sample (five-fish composite) of rainbow trout was collected in September 2007 as part of the SWAMP study for the analysis of chlorinated chemicals (Davis et al., 2010). The average total fish length was 364 mm. The concentrations were: 2 ppb (PCBs), 3 ppb (DDTs), 0.2 ppb (chlordanes), and not detectable (dieldrin, MDL of 0.421 ppb). For mercury, three samples were analyzed: the same composite used for chlorinated chemical analysis, another five-fish composite also collected for the SWAMP study, and a single fish collected in August 2005. While the average total fish length for all samples was 404 mm, the fish from the two SWAMP samples were much smaller (average of 364 mm), compared to 485 mm for the single fish 2005 sample. The weighted average mercury concentration was 49 ppb, but the range was wide with 167 ppb found in the 2005 fish, and 35 ppb and 40 ppb in the 2007 composites. The lower concentration and smaller size of the 2007 samples suggested that they might be hatchery transplants from previous years. California Department of Fish and Game records showed release of hatchery rainbow trout (about 200-gram fish) to this lake in 2006 and 2007 (CDFG, 2010). Younger fish, and especially those recently transplanted from hatcheries, are expected to have lower concentrations of mercury.

Based on the average mercury concentration, OEHHA advises that consumers can eat up to four servings of rainbow trout per week for women 18 to 45 years and children 1 to 17 years of age. Women over the age of 45 years and men can eat up to seven servings a week of this species because of the relatively low PCBs and mercury concentrations.

GUIDELINES FOR EATING FISH CAUGHT FROM DONNER LAKE

OEHHA generally issues consumption advice beginning at a consumption frequency of one serving per week. A serving is defined as one eight-ounce portion of uncooked, or a six-ounce portion of cooked fish per meal. It is approximately equivalent to the two, 3.5-ounce servings (cooked) weekly fish consumption rate currently recommended by the American Heart Association (AHA, 2010). If, based on very low contaminant concentrations, fish can be consumed even more frequently than a total of six ounces of cooked fish per week, advice for consumption for two or more meals per week, as appropriate, may also be provided. OEHHA recommends that consumers avoid regular consumption of fish that cannot safely be eaten at a minimum of six ounces of cooked fish a week. While Table 2 does not show ATLs for all possible serving size categories, ATLs for four, five, six, and seven servings per week can be calculated, as in Klasing and Brodberg (2008), using consumption rates of 128, 160, 192, and 224 grams/day (g/day), respectively. In addition, because of the potential beneficial effects from regular fish consumption, thought to stem largely from unique omega-3 fatty acids in fish, OEHHA encourages people of all ages, especially women 18 to 45 years of age and children, to eat fish that are low in mercury or other contaminants and high in omega-3 fatty acids. Trout and salmon are good sources of omega-3 fatty acids (Kris-Etherton et al., 2002).

In all cases, **consumption advice should not be combined**. Fishers can choose one fish from the “one serving-per-week” category to eat that week. Then they should not eat any other fish from any source until the next week. If they choose fish that can be eaten two servings a week, for example, they can combine fish species from that group for a total of two servings in that week. Then they should not eat any other fish from any source until the next week.

Recommendations for women 18 to 45 years, including pregnant and breastfeeding women, and children 1 to 17 years of age for eating fish from Donner Lake:

- Eat no more than one serving a week of brown trout or lake trout.
- Eat up to two servings a week of kokanee.
- Eat up to four servings a week of rainbow trout.
- Serving size for women is six ounces of cooked fish (equal to eight ounces before cooking). Serving size can be adjusted to add one ounce of fish for every 20 pounds of body weight above, or subtract one ounce of fish for every 20 pounds of body weight below, the average weight of 160 pounds. Serving size for children up to age 12 is about half as much as adults (three ounces of cooked fish).
- Eat only the fillet portion. Skin and trim all visible fat. Thoroughly cook before eating, preferably using a method that allows the fish juice to drain away.

Recommendations for women over the age of 45 years and men for eating fish from Donner Lake:

- Eat no more than one serving a week of brown trout or lake trout.
- Eat up to two servings a week of kokanee.
- Eat up to seven servings a week of rainbow trout.
- Serving size is six ounces of cooked fish (equal to eight ounces before cooking). Serving size can be adjusted to add one ounce of fish for every 20 pounds of body weight above, or subtract one ounce of fish for every 20 pounds of body weight below, the average weight of 160 pounds.
- Eat only the fillet portion. Skin and trim all visible fat. Thoroughly cook before eating, preferably using a method that allows the fish juice to drain away.

Figure 2. Map of Donner Lake, Nevada County, CA



Donner Lake



Nevada County, CA

Table 1. Mean Mercury and PCB Concentrations and Lengths of Fish from Donner Lake				
	Brown Trout	Kokanee	Lake Trout	Rainbow Trout
Chlorinated Compounds¹				
Number of Samples ²	1	6	5	1
Total Number of Fish	3	18	17	5
Mean Total Fish Length ³ (mm)	512	399	414	364
Mean Total Chlordanes (ppb)	4	10	11	0.2
Mean Total DDTs (ppb)	7	7	9	3
Mean Dieldrin (ppb)	0.2	0.7	0.3	0
Mean Total PCBs (ppb)	55	32	43	2
Mercury				
Number of Samples ²	4	21	13	3
Total Number of Fish	4	25	13	11
Mean Total Fish Length ³ (mm)	440	396	427	404
Mean Mercury (ppb)	172	73	155	49

¹ Total concentration was sum of congeners or metabolites, if applicable. Non-detected values were not included in the sum.

² Each sample may be an individual fish or composite of at least three fish per composite. Mean of composites and individuals combined; means were weighted by number of individuals per composite.

³ Length is presented as total length (the longest length from the tip of the tail fin to the tip of the nose/mouth). All fish were of legal and/or edible size with the exception of one 330 mm lake trout (Gassel and Brodberg, 2005).

Table 2. Advisory Tissue Levels (ATLs) for Selected Fish Contaminants Based on Cancer or Non-Cancer Risk Using an 8-Ounce Serving Size

Contaminant	Consumption Frequency Categories ¹ and ATLs ² (in ppb)			
	Three 8-ounce Servings per Week	Two 8-ounce Servings per Week	One 8-ounce 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

¹Serving 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 (for example, individuals weighing 80 pounds should eat one four-ounce serving a week when the table recommends eating one eight-ounce serving per week).

²For each chemical, ATLs were calculated separately for cancer and non-cancer risk, if appropriate, for consumption frequency categories of from one, two, and three eight-ounce servings per week (Klasing and Brodberg, 2008). The most health-protective ATLs, selected from either cancer or non-cancer based risk, are used in the guidelines. ATL values are rounded based on laboratory reporting of three significant digits in results, where the third reported digit is uncertain (estimated). They are rounded to the second digit, which is certain. When residue data are compared to this table they should also first be rounded to the second significant digit as in this table.

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