GOLD COUNTRY ANGLER SURVEY

A Pilot Study to Assess Mercury Exposure
from Sport Fish Consumption in the Sierra Nevada

MAY 2011

THE SIERRA FUND

ABOUT THE SIERRA FUND

The Sierra Fund is the only nonprofit community foundation dedicated to the Sierra Nevada. Our mission is to increase and organize investment in the region's natural resources and communities. We pursue this mission three ways: through *Advocacy* to bring public funding to the region, *Philanthropy* to provide a vehicle for private funding, and *Strategic Campaigns* that pursue critically needed programs in the Sierra.

Since 2006, the **Reclaiming the Sierra Initiative** has been our primary strategic campaign. The goal of this Initiative is to assess and address mining's toxic legacy: the ongoing cultural, environmental and human health impacts of toxins left over from the Gold Rush.

In 2009, The Sierra Fund initiated two pilot studies to learn whether people who live, work, or recreate in the Sierra Nevada are being exposed to legacy mining toxins including mercury, arsenic, lead, asbestos and chromium. Results of the 2009-2010 *Gold Country Angler Survey* are presented here. The *2009 Recreational Trails and Abandoned Mines Assessment*, which looks at levels of contaminated mine waste on recreational trails near abandoned mines, was released in June 2010. Copies may be obtained online at *www.sierrafund.org* or by contacting The Sierra Fund directly.

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[*] *Created in 1992 as a private, independent foundation, TCWF's mission is to improve the health of the people of California by making grants for health promotion, wellness education, and disease prevention.*

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ABSTRACT

The purpose of the *Gold County Angler Survey* was to stimulate awareness, research, and policy reform to address the issue of mercury-contaminated fish in the Sierra Nevada. Potential mercury exposure and health hazard awareness of people fishing at mercury-contaminated water ways was determined based on their responses to a standard interview. The questionnaire used was based on one developed by the California Department of Public Health for a survey of anglers in the San Francisco Bay/Delta. The Gold Country Angler Survey was administered by trained volunteers at 12 fishing water ways in the Sierra in the summers of 2009 and 2010. A total of 69 interviews were completed during the 2009 season and 82 interviews were completed during the 2010 season, for a total of 151 interviews. The majority of the interviews were from Rollins Lake (n=33), Upper Scotts Flat (n=23), Camp Far West (n=21), Lake Englebright (n=17), Nimbus Dam (n=16), and Lake Wildwood (n=15).

The most popular fish eaten were bass (largemouth, smallmouth and striped) and trout (rainbow and brown). Bass and brown trout are predatory fish, that often have elevated mercury concentrations and are the subject of numerous fish consumption advisories in the Sierra. Survey respondents indicated that their most trusted sources of health information was their healthcare providers, however it is known that Sierra clinics do not routinely provide information about mercury exposure from eating locally caught fish. Posted fish consumption advisories were not observed at the vast majority of targeted water bodies.

Over 90% of respondents reported eating fish that were caught by themselves or by someone they know. Approximately half (47%) the anglers interviewed planned to eat the fish they caught that day, and the majority of those (73%) planned to feed the fish to their families. Significant numbers of anglers (50%) feed the fish they catch to children under the age of 18, women of child bearing age (54%) and, to a lesser extent, pregnant women in their household (6%). These groups are most at risk from the health impacts of eating mercury-contaminated fish.

Estimated mercury exposure indicates that some respondents eat more fish and are likely exposed to more mercury than amounts considered to be safe by OEHHA. When individuals' mercury exposure was calculated, 9% of anglers interviewed consumed more mercury than state guidelines recommend. The maximum mercury exposure level from sport fish consumption calculated from the survey responses was 90 micrograms (µg) of methylmercury (MeHg) per day, more than four times the recommended safe level of 21µg MeHg/day (based on a 70kg body weight). This person was a Caucasian man between the ages of 18 and 34 fishing at Nimbus Dam on the American River, who reported eating bass five times in the last month and also crappie one time in the last month. His typical serving size was two or three 7.5 oz portions each meal.

These results indicate that people are consuming locally-caught sport fish from mercury-contaminated water ways in amounts that exceed safe levels, and that in general there is limited understanding of the associated health hazards from eating mercury-contaminated fish. Collection of fish mercury data from local water ways, additional angler surveys, and immediate posting of existing fish consumption advisories are highly recommended.

INTRODUCTION

Exposure to mercury through sport fish consumption may be the single most significant route by which people are exposed to mining toxins in the Sierra Nevada Foothills, however little is known about the true extent of human exposure in the region. This study provides some insight into the extent of mercury exposure, and identifies an urgent need for a full characterization of mercury exposure to vulnerable populations.

The purpose of the Gold Country Angler Survey was to stimulate awareness, research, and policy reform to address the issue of mercury-contaminated fish in the Sierra Nevada. A survey of anglers in the Sierra Nevada Foothills, also known as the Gold Country, was conducted to provide an assessment of potential human exposure to mercury through sport fish consumption. Sport fish are fish that people catch rather than buy at a store or restaurant. The survey was performed during the late Spring through the Fall of 2009 and repeated in the Summer of 2010.

This report summarizes the Gold County Angler Survey methods, results, and recommendations for action, and provides lessons learned to encourage and improve future angler surveys.

Gold Mining and Mercury

The primary source of mercury in Sierra Nevada water ways was historic placer and hard rock gold mining activities during the 19th century. Mercury binds with gold to form an amalgam which enhances gold recovery. Mercury was used in sluice boxes to recover placer gold and also during stamp milling of hard rock ore. An estimated 26 million pounds of mercury were used in the Sierra Nevada during the California Gold Rush (Alpers, et al. 2005). Of these, an estimated 10 million pounds were lost to the environment in placer or hydraulic mining operations and another 3 million pounds were lost from hard rock mining (Churchill, 2000). Discharging both mercury-contaminated stamp mill sands and hydraulic mining debris into rivers and streams was common and thus, mercury entrained in mining waste was washed into streams and rivers.

Today, mercury remains in Sierra Nevada water ways. Elemental mercury can still be seen with the naked eye and mercury in fine sediment in these watersheds is at least 10 times higher than background levels. Mercury-laden sediment from historic mining has built up in the region's reservoirs. Other sources of mercury contamination include atmospheric deposition from coal burning and other industrial sources, and effluent released from waste water treatment facilities, but these sources pale compared to legacy mercury from historic gold mining in the Sierra Nevada.

Figure 1: Greenhorn Creek, a tributary to Rollins Reservoir - Photo taken in 2010 shows the creek channel still choked with hydraulic mining debris. (Photo: Nevada Irrigation District)

Methylmercury

Mercury was originally used at mine sites in elemental form or "quicksilver" but can exist in many different forms in the environment. Elemental mercury can be converted by microbial action to methylmercury, the form most readily incorporated into biological tissues. Methylmercury is what people who eat mercury-contaminated fish are exposed to, and it is toxic. Methylmercury bioaccumulates in living organisms, increasing in concentration in tissue at each trophic level from bacteria and algae to invertebrates, fish, and people who eat mercury-contaminated fish. Biomagnification of mercury results in exponentially higher levels of mercury each step up the food chain. This is illustrated by the example of a large predatory fish that in its lifetime has eaten many smaller fish. Consequently, larger predatory fish such as bass and brown trout, which are both highly sought after as sport fish, are of particular concern because they have much higher mercury levels than fish lower on the food chain.

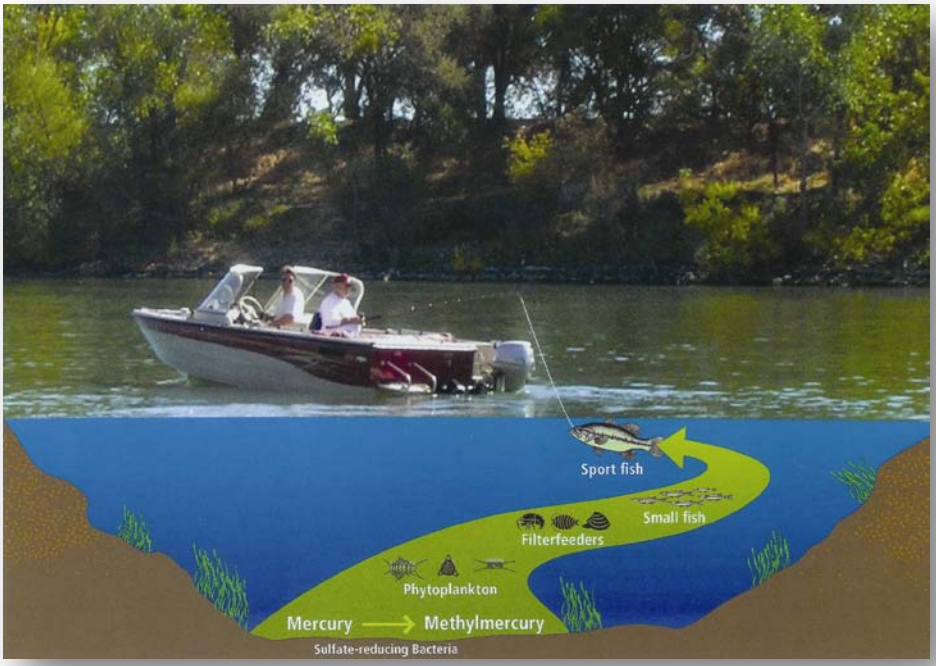


Figure 2: Methylmercury in the food chain

Health Effects of Mercury

Although fish should be part of a healthy diet, the negative health effects of eating mercury-contaminated fish are profound and may outweigh health benefits. Health effects of mercury include brain, nervous system, kidney, and immune system damage. Symptoms of mild mercury poisoning include tingling of the lips, fingers, and toes. More severe poisoning causes headaches, memory loss, vision and coordination difficulties, muscle spasms, pain and stiffness in joints, and heart disease.

The health effects of mercury on developing children and fetuses are of highest concern. High doses of mercury during pregnancy can cause birth defects and mental retardation in children. The effects of mercury exposure during childhood include slow development, language and memory impairment, delayed walking, and attention disorders. Children and fetuses are especially vulnerable to low levels of mercury exposure since their nervous systems are still developing and mercury easily passes through the placental barrier and the blood-brain barrier.

At-Risk Populations

Some demographic or ethnic groups such as Native Americans who traditionally eat sport fish may be disproportionately impacted by mercury contamination of the fish. The Native Peoples of the Sierra Nevada were decimated by the Gold Rush, and the presence of mercury in fish perpetuates the cultural devastation today. Additionally, low-income people may view fishing as an inexpensive way to feed

their families, and may not be aware of the potentially serious health effects. The California Department of Public Health (CDPH) has tried to educate communities about mercury and fish consumption by providing small grants to community groups that conduct educational activities that are culturally and linguistically appropriate for specific ethnic communities (Cambodian, Vietnamese, Latino, etc.). CDPH and county agencies have also posted signs in the Delta at fishing locations. CDPH has trained and distributed educational materials through food stamp education programs, WIC programs (Women, Infants, Children), and other organizations that serve lower income populations.

Previous Angler Survey Efforts

CDPH interviewed over 1,000 anglers in the San Francisco Bay Area in 1998-1999 (SFEI, 2001b). CDPH also completed a smaller Pilot Angler Survey in the San Joaquin River and Delta area in 2005 (CDPH, 2005). The Healthy Fish Coalition, which includes UC Davis researchers and students, performed angler surveys in 2005 through 2008 in the Sacramento River and Delta (Shilling, et al., 2010).

Despite the growing interest in mercury exposure from sport fish consumption in the California Bay/Delta, comparatively little attention has been paid to the upper watershed. The only survey conducted in the Sierra was a creel survey at Lake Englebright in 2003 and 2004 (Upper Yuba River Studies Program, 2006). The creel survey identified the number of species and size of fish that were caught and retained but did not collect data regarding fish consumption patterns, demographics or level of health hazard awareness. No other angler surveys or fish consumption surveys related to mercury have been conducted in the Sierra Nevada Foothills to date, therefore the effect that consumption of mercury-contaminated fish has had on the health of communities in this region is unknown. The Gold County Angler Survey is the first survey that focuses primarily on consumption of mercury-contaminated fish in the Sierra Nevada foothills.

Mercury Regulations: Fish Consumption Advisories and Water Quality

Mercury is highly regulated, both as a health concern and a water quality pollutant. The United States Food and Drug Administration (FDA) and Environmental Protection Agency (EPA) recommend that sensitive populations including young children, woman who are pregnant or could become pregnant, and nursing mothers limit their exposure to mercury. The FDA and EPA recommend that sensitive populations avoid certain high mercury species and limit consumption of commercial fish to no more than 12 ounces (uncooked weight, with smaller servings for children) a week, and for fish caught by family and friends, local advisories should be followed. If no local advisory is available, sensitive populations should limit consumption of locally caught fish to six ounces a week (FDA, 2004).

The California Office of Environmental Health Hazard Assessment (OEHHA) has issued fish consumption advisories for several northern Sierra water ways based on mercury levels in fish (OEHHA, 2009). In 2003, OEHHA issued an interim fish advisory for water bodies in the Sierra Nevada, and in 2009 OEHHA updated this advisory. In the advisory update process, the criteria for what constituted enough data for a fish advisory changed and more fish samples were required in order to issue a human health advisory (OEHHA, 2009). Because of limited fish samples from several Sierra Nevada locations, safe eating guidelines were eliminated. The OEHHA advisories that existed in 2003 but not in 2009 reflect the need for more data rather than an improved fishery. It should be noted that regardless of the status of the OEHHA advisory, the federal advisory is in place for all water bodies that do not have local (country or state) advice.

Under section 303(d) of the 1972 Federal Clean Water Act, States, Territories, and authorized Tribes are required to develop lists of impaired waters which do not meet water quality standards. The California EPA has issued 303(d) listings for mercury contamination of multiple water ways in the Sierra Foothills, Sacramento-San Joaquin Delta, and San Francisco Bay regions. Table 1 (below) indicates the status of 303(d) listing according to data from the Central Valley Regional Water Quality Control Board (CVRWQCB) and the 2003 and 2009 OEHHA fish advisories.

Table 1: Regulatory Status of Mercury-Impacted Water Ways in the Yuba and Bear Watersheds

Mercury-Impacted Water Way	303(d) Listed as impaired by mercury (CVRWQCB 2010)	Fish Consumption Advisory 2003 (OEHHA 2003)	Fish Consumption Advisory 2009 Update (OEHHA 2009)
Deer Creek	X*	X	**
Upper Scotts Flat Lake	X	X	**
Lower Scotts Flat Lake			
Lake Wildwood	X		
Bear River	X	X	**
Rollins Lake	X	X	X
Lake Combie	X	X	X
Camp Far West Reservoir	X	X	X
South Yuba River	X	X	**
North Yuba River	X		
Lake Englebright	X	X	X
Lower Yuba River (below Englebright)	X		
Lower American River (below Nimbus Dam)	X	X	X

* 303(d) listings have been issued for Little Deer Creek, a tributary to Deer Creek.
** Removed from the fish advisory during the 2009 update due to insufficient number of samples

SCOPE

The survey was conducted at twelve target reservoirs and rivers in the Gold Country. A map of all water ways included in the study can be found on page 10 and detailed descriptions of the major water ways are included in Appendix C. The interview locations were within the Yuba, Bear, American and Deer Creek watersheds in Nevada, Yuba and Placer Counties approximately one to two hours east of Sacramento, California.

These reservoirs and rivers were chosen because they were well known fishing areas, and contaminated by mercury from historic mining activities. They were also within a one-hour radius of the Grass Valley/Nevada City area, a feasible distance considering the resources of the study. The selected locations are listed as impaired for mercury by the Clean Water Act section 303(d) and some also have fish consumption advisories, the only exception being Lower Scotts Flat which is contiguous with Upper Scotts Flat Reservoir and Deer Creek.

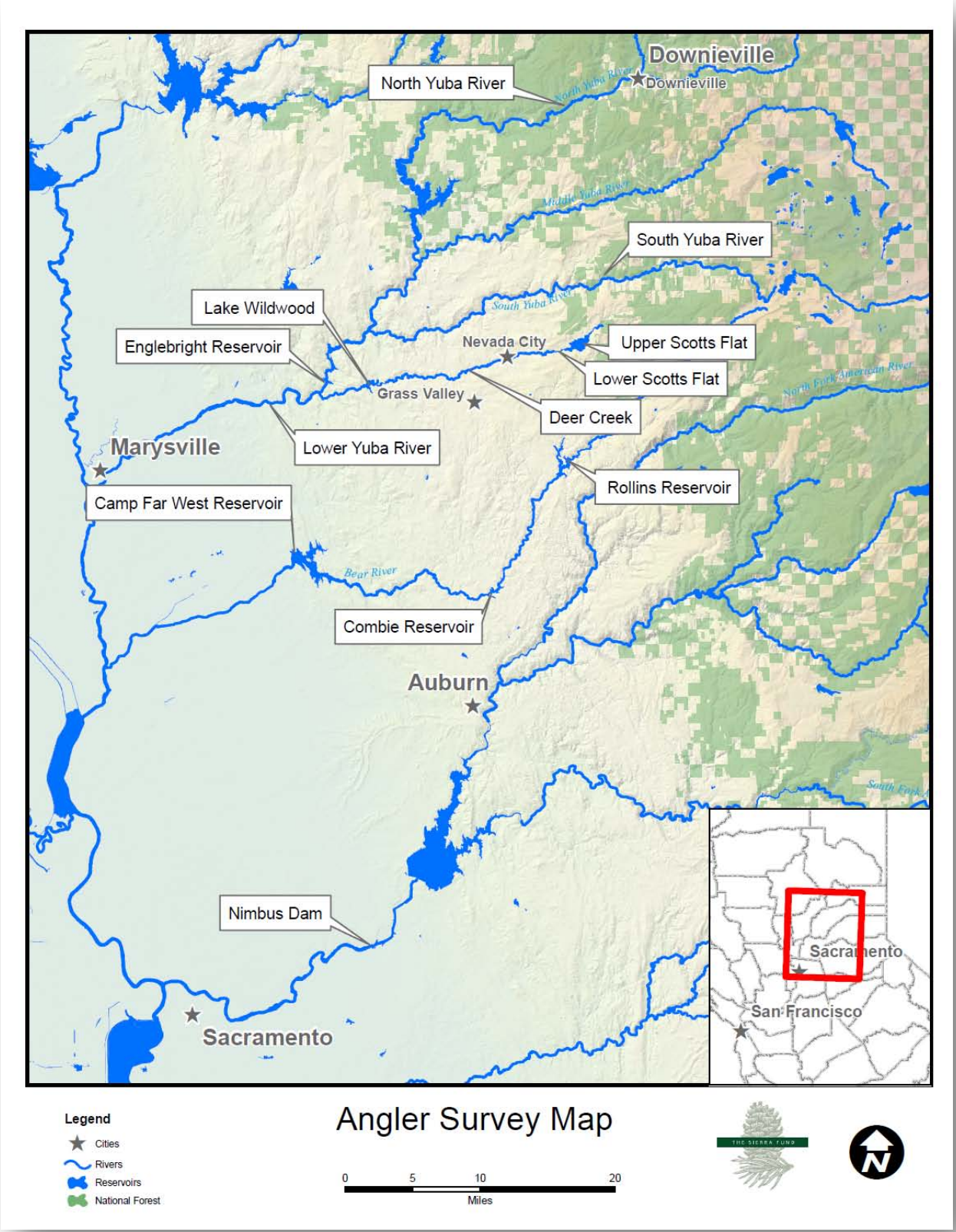


Figure 3: Map of Angler Survey Locations – Interviews were completed at water bodies known to be contaminated with mercury and within one to two hours of Nevada City, CA.

METHODOLOGY

The Gold Country Angler Survey was based on the Sacramento River Angler Survey that was conducted by the University of California (UC). Gold Country Angler Survey volunteers were trained by Healthy Fish Coalition collaborators, namely Dr. Fraser Shilling at UC Davis, to conduct the angler interview according to the protocol developed by UC Davis and CDPH. The format of the questionnaire and interview was kept the same as previous CDPH angler survey except for minor changes such as the names of locations and fish species. This was done to promote consistency between the surveys and facilitate cross-regional comparison of the survey results.

The survey was designed to collect information through face-to-face interviews with anglers encountered at fishing locations. Interviewing anglers at water bodies (rather than only residents) allowed the survey to include populations that may be consuming fish from Gold Country water bodies, but that do not necessarily live in the immediate area.

Questions were asked orally by a trained interviewer, who then recorded answers on a standard paper form. The entire interview was designed to take 10 minutes or less. A interviewer would record the date of the interview, their name, the start and end time of each interview, the location of the interview and the gender of the person interviewed. Then the interviewer would proceed to ask the standardized questions, in the established order.

Interview questions covered the following categories: fishing location and frequency, fish species sought or caught, and fish consumption patterns (e.g., how much locally caught fish is eaten, how much is store-, restaurant-, or cafeteria-bought, and who eats the fish). No personal identifiers such as name or address were collected, however the interview did include questions about the level of health hazard awareness, household demographics, ethnicity and age. To prompt accurate responses about serving sizes, interviewers presented plastic models of fish fillets (7.5 oz, 4.5 oz and 1.5 oz) and asked the angler to identify the size of their uncooked serving. A copy of the Gold Country Angler Survey questionnaire is included in Appendix D, and a summary of interview questions is provided in the box on the following page.

Interviewers followed a standard protocol (see Appendix B) in choosing and approaching anglers for an interview. All anglers encountered were approached to participate. Interviews were performed from shore or at boat ramps when anglers were putting in or taking out their boats. If a group of anglers was encountered, interviewers tried to interview as many as would cooperate, and attempted to interview individual anglers in private so that their answers did not influence other members of the group. Interviewers were to approach anglers in a calm, friendly manner to avoid alarming them. Interviewers were encouraged to memorize key interview questions so they could approach anglers in a casual manner and move quickly through the interview. Upon completion of the interview, anglers were offered laminated fish species identification cards, free tackle (spinners, hooks, worms and weights) and OEHHA fish advisories.

Interview locations were pre-determined based on popularity and the presence of known mercury contamination. Interview times of day and days of the week were flexible throughout the survey period. This allowed the survey to be adapted according to seasonal conditions and local fishing habits. The goal of this approach was to conduct approximately 30 interviews from each targeted location across a

range of times of day and days of the week so that a range of fishing activity was represented in the data collected.

Gold Country Angler Survey Questions

0) Would you mind participating in this short ten minute survey about fishing?
   a. If no then the reason for their decline is recorded.
1) Have you ever been interviewed before?
2) What are you trying to catch today?
3) Are you going to eat the fish you catch today?
   a. If yes, are you going to feed it to your family?
   b. If no, what are you going to do with the fish you catch?
   c. Do you ever eat fish that you or someone you know catches?
4) About how many times did you go fishing in the last 30 days?
5) a. Do you eat (catfish, largemouth bass, smallmouth bass, striped bass, sunfish, bluegill, crappie, rainbow trout, brown trout, kokanee salmon, other fish) that you or someone you know catches?
   b. How many times did you eat (species listed above) in the last 30 days?
   c. How much of the (species listed above) did you eat in one meal? (Used plastic models of uncooked fish fillets at sizes 1.5, 4.5 and 7.5 oz (provided by CDPH).)
   d. Where was the (species listed above) caught?
6) In the last 30 days, have you eaten fish that came from stores, markets, restaurants, or cafeterias?
7) If yes, in the last 30 days how many times did you eat commercially bought fish? How many times? How much? Where was it bought?
8) In the past year, have any children under 18 in your household eaten fish that you or someone you know catches?
9) In the past year, have any women between ages 18 and 49 in your household eaten fish that you or someone you know catches?
10) In the past year, have any women expecting a child or who have a baby in your household eaten fish that you or someone you know catches?
11) Have you ever heard or seen any health warnings about eating fish?
   a. If yes, do you remember what the warning said? (record exact response)
12) Do you remember where you saw or heard this warning?
13) Where do you get information about your health, about what is good or bad for you, that you trust?
14) If you don't mind, could you tell me how best to describe your race or ethnicity?
15) If you don't mind me asking, what is your age?
16) What zip code do you live in?
17) (Record gender)
18) If you don't mind me asking, what is your weight? (Or record weight category)

SURVEY RESULTS AND DISCUSSION

Completed Interviews and Effort Spent

The survey was conducted in 2009 and repeated in 2010. For the 2009 survey, volunteer interviewers were recruited in late winter and early spring. Two trainings were held in Spring 2009 prior to conducting the survey. A total of eleven volunteers were trained and participated in the 2009 Angler Survey. Dr. Fraser Shilling from UC Davis and the Healthy Fish Coalition trained four people who then trained the other seven volunteers. Several members of a local fly fishing organization, Gold Country Fly Fishers, participated as volunteers. Two summer interns from National University and California State University, Chico were trained for the summer of 2010 field season.

Figure 4: 2010 Angler Survey Interns
James Worthy and Alan Rhoades

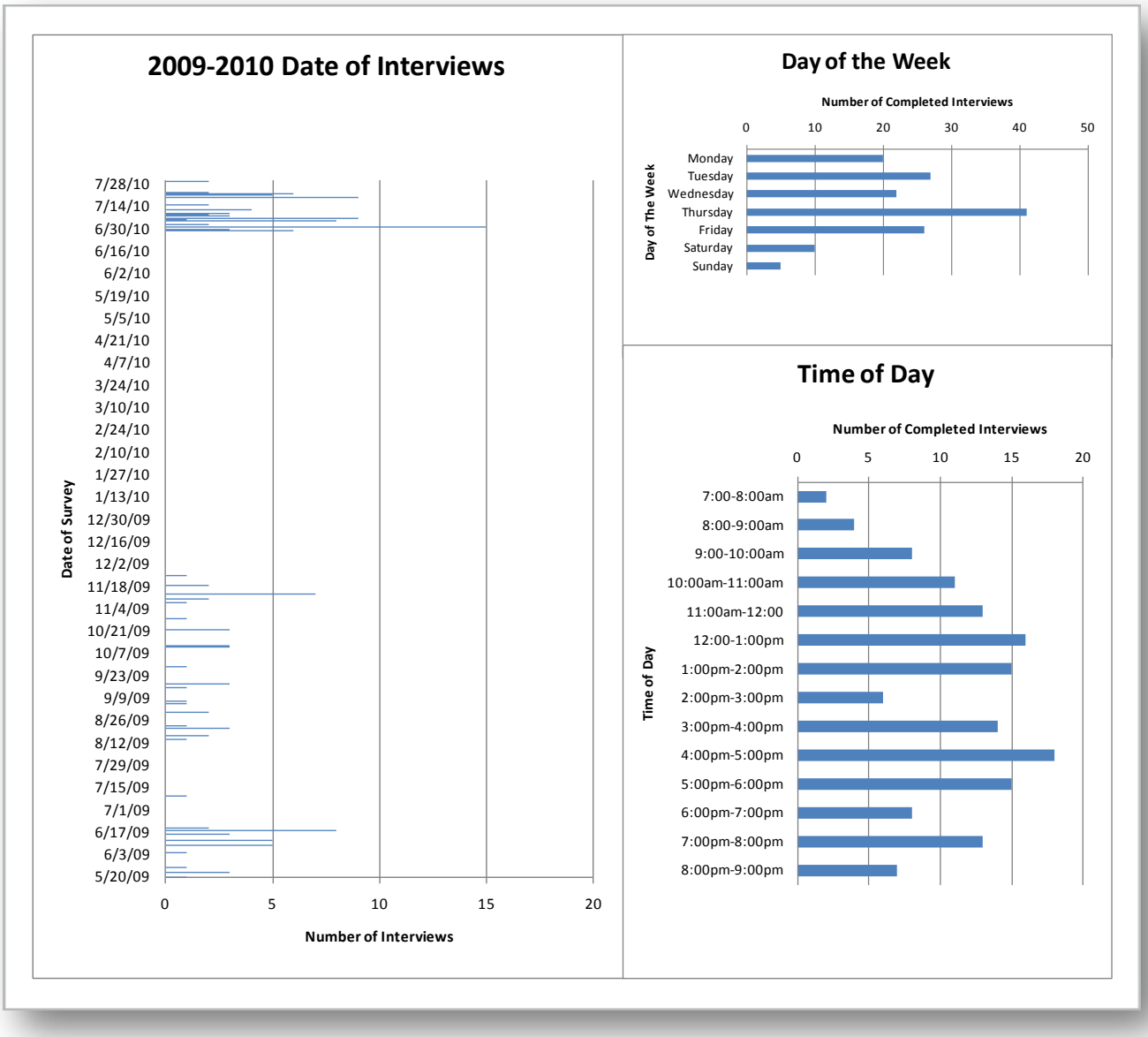
During the course of the survey, efforts were made to obtain an equal distribution of completed questionnaires from each of the target water ways. This was difficult during 2009 due to the nature of using volunteer interviewers who conducted interviews when they were either already in the field or went into the field when it was most convenient for them to do so. Due to difficulties locating anglers in the field, in 2009 a limited number of questionnaires were completed by interviewing anglers off of water ways. In these cases, anglers were asked to base their responses on their most recent fishing trip. However, in 2010 with two interns who were dedicated to conducting interviews it was possible to fill many gaps in the data set.

A total of 69 interviews were completed during the 2009 season. Volunteer interviewers visited 12 locations approximately 48 times (many of which were unproductive). Exactly how many visits were unsuccessful is difficult to calculate because volunteers did not log unsuccessful attempts, only time spent in the field. It was estimated that interviewers spent approximately 78 hours in the field searching for anglers on the shore and waiting for anglers at various boat ramps, and when they found them conducting the interviews. This translates to an average of less than two completed questionnaires per field visit and approximately 1.15 hours of field time spent per completed questionnaire.

In 2010 a total of 82 interviews were completed. The two interns worked to conduct interviews from areas and during times of day that were not covered during the 2009 season. Their efforts were focused on reservoirs for which there were less than 10 interviews completed in 2009, in particular, Rollins Reservoir, Camp Far West Reservoir, Lake Wildwood and Lake Englebright. Interviewers visited a single location until they had approximately 30 interviews from that site for the 2009 and 2010 season. In general it took three to six visits to a single site to accomplish this. Between 6 and 24 interviews were completed for each site in 2010. Visits took place at different times of the day that varied by site depending on the fishing conditions at each site. In general about two interviews per hour in the field (not including driving time) was typical.

Gold Country Angler Survey interviewers spent significantly more field time per completed questionnaire compared to similar surveys conducted in the Sacramento River, Delta and San Francisco Bay Areas. This is likely due to the broader geographic area covered by the survey, and because Sierra Foothills anglers seem to be more spread out at specific water ways making locating anglers in the field more difficult. It should be noted that it was difficult to find anglers at river or creek locations and thus, fewer questionnaires were completed from those locations.

In general, single and groups of two anglers were encountered during the survey. Most anglers were cooperative and interested in the survey. None said they had been interviewed before in the Gold Country or Delta region.



Figures 5: Interview Date, Time, and Day of Week – Interviews were conducted in May through November 2009 and again in July 2010. Interviews were completed at a variety of times of day. Interviews were completed on every day of the week, however more often on weekdays.

Location of Interviews

The majority of the completed questionnaires were obtained from the major reservoirs that are easily accessible from the Nevada City-Grass Valley area. Rollins Reservoir (22%), Upper Scotts Flat Reservoir (15%), Camp Far West Reservoir (14%), Lake Englebright (11%), the American River at Nimbus Dam (11%), and Lake Wildwood (10%) had the most completed interviews (Figure 6). A small number of interviews (1%) were conducted at other locations including Clear Creek in Butte County and Collins Reservoir in Yuba County. Native American anglers were interviewed at Indigenous Peoples Days in Nevada City in October 2009.

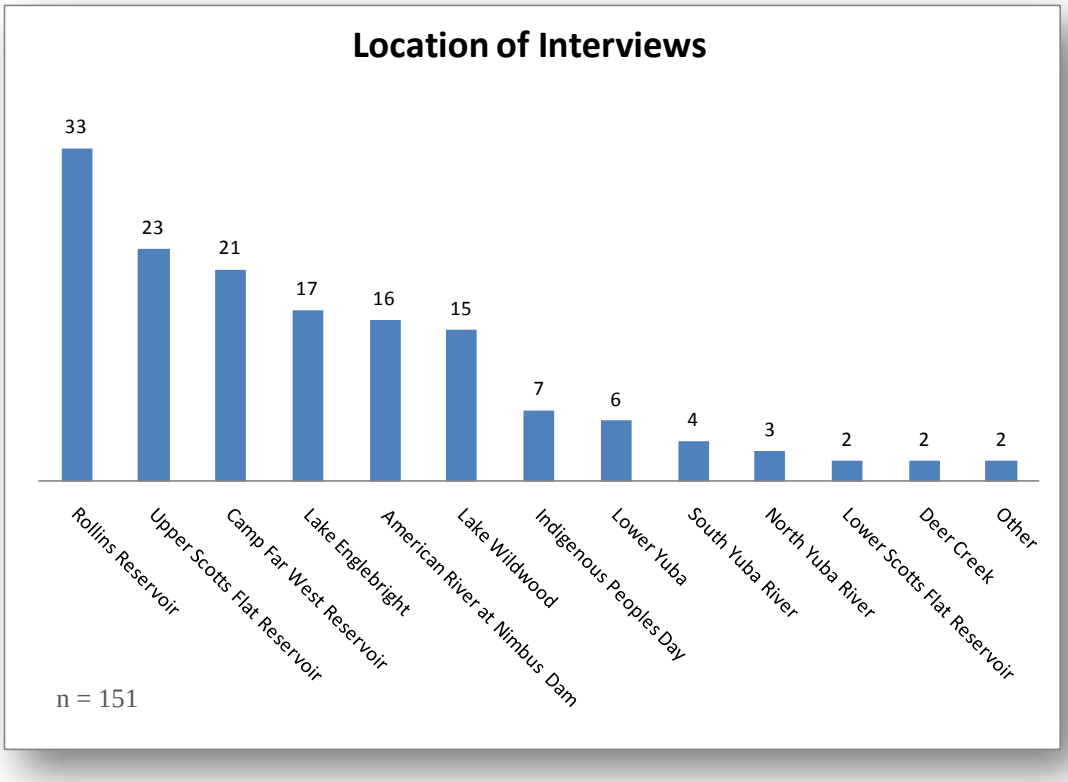


Figure 6: Locations where interviews were conducted - Rollins Reservoir (n=33), Upper Scotts Flat Reservoir (n=23), Camp Far West Reservoir (n=21), Lake Englebright (n=17), American River at Nimbus Dam (n=16), Lake Wildwood (n=15), Indigenous Peoples Day (n=7), Lower Yuba River (n=6), South Yuba River (n=4), North Yuba River (3), Lower Scotts Flat Reservoir (n=2), Deer Creek (n=2) and other locations (n=2) which included Clear Creek in Butte County and Collins Reservoir in Yuba County.

Interviews conducted along the Lower Yuba River, and to a lesser extent the South Yuba also took more effort per completed questionnaire, most likely because fishing activity was more sparse than on lakes and spread out over a larger area. No interviews were successfully completed from the Bear River or Lake Combie.

Survey Question Results

The following sections reflect individual survey questions and summary of the results for each question, as well as in some cases follow-up calculations that were made using survey response answers, in particular the methylmercury exposure calculation. Results are grouped under three general categories:

1. Demographics
2. Health Hazard Awareness
3. Fish Consumption

1. Demographics

Ethnicity of Anglers Surveyed

Anglers were asked their ethnicity or what ethnicity they identified most with (Figure 7). The majority of people surveyed (78%) considered themselves Caucasian, which is generally parallel with the population of Nevada and Placer Counties. The only other surveyed ethnic group of significant size was Native Americans (7%), who were specifically sought out at cultural events during the 2009 survey efforts. Consequently, the 10 Native Americans interviewed were not representative of anglers encountered in the field since these questionnaires were obtained at Indigenous Peoples Day events.

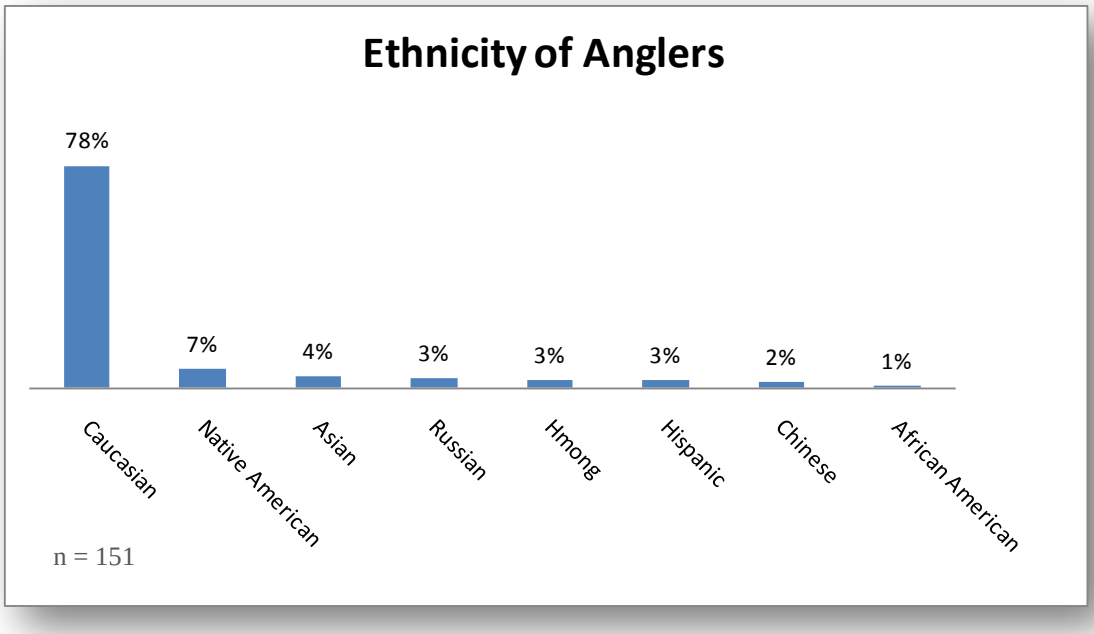


Figure 7: Ethnicity of anglers interviewed - Caucasian (n=118), Native American (n=10), Asian (n=6), Russian (n=5), Hmong (n=4), Hispanic (n=4), Chinese (n=3) and African American (n=1)

Based on anecdotal evidence, the study was expected to encounter more Latino and Asian anglers at Foothills reservoirs who reportedly travel up from Central Valley communities to fish, however during the 2009-2010 Survey, few individuals from non-Caucasian ethnic groups were interviewed. This may be in part due to language barriers. Future surveys should make efforts to target these populations because ethnic Southeast Asians from the Marysville and Central Valley areas may be the most at risk fishing populations due to their cultural practices, which include eating a large amount of wild caught

fish, and because they may have limited fluency in English and thus may not be aware of fish consumption advisories.

An interviewer did approach a group of five Hmong people fishing at the Lake Wildwood Dam but they spoke limited English and could not or would not participate in the survey. Capturing the practices of Hmong groups would be an important aspect of a follow up survey in the future and is clearly not captured in the current survey due to the limited number of individuals interviewed in this study, only four of which were Hmong.

Age Groups of Anglers

One of the survey questions targeted the age bracket of each survey participant. The interviewer would typically place the participant in the age group that seemed appropriate and would not ask directly, unless the interviewer felt there was significant uncertainty and a polite way of doing so. The largest age group was those between 18 and 34 years old (35%), followed by over 49 years (30%), and 35-49 years old (28%) (Figure 8).

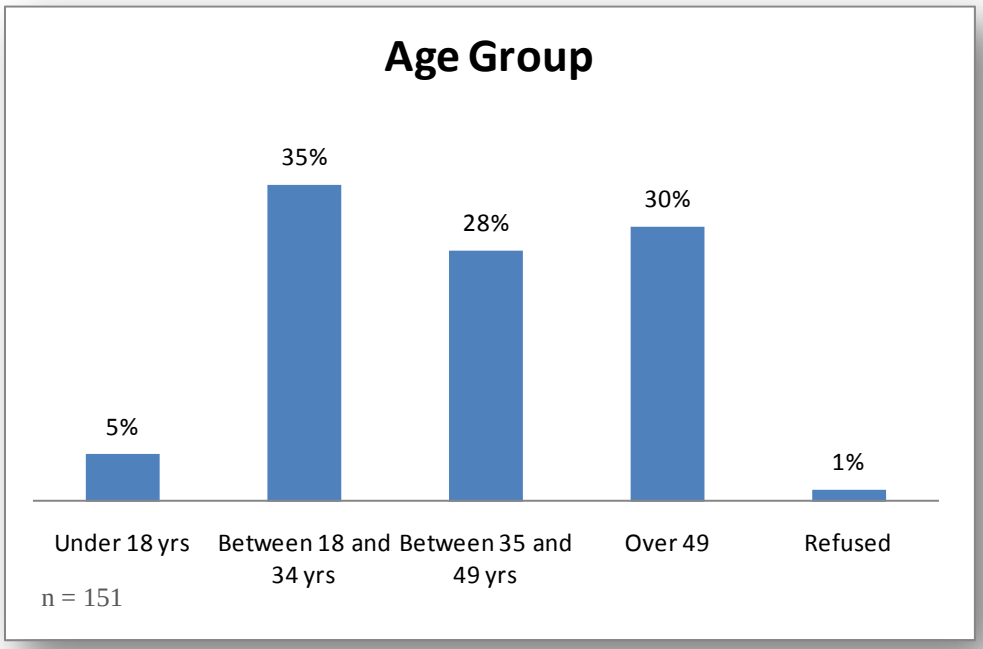


Figure 8: Apparent Age Group of interviewed anglers, Under 18 years old (n=8), between 18 and 34 years old (n=53), between 35 and 49 years old (n=42), and over 40 years old (n=46). Two questionnaires were left blank, meaning that the interviewer did not record the participant's age.

The relatively high number of anglers in the 18-35 year old group and the over 49 age group may indicate that younger and perhaps less employed and/or older or retired people have more time to fish, especially during business hours when the majority of the interviews were conducted. Comparatively few anglers were under 18 years of age. Interviewers were trained to not question people under 18 years of age. Those who were interviewed appeared at least 18 and their exact age was only learned at the end

of the interview. These individuals were included in the results due to the limited sample size and because information from young anglers is important because they are a sensitive population for mercury exposure. The majority of anglers encountered were men. Out of 151 individuals interviewed only 16 were of women, or 11%.

2. Health Hazard Awareness

Accuracy of Health Hazard Awareness Response

Anglers were asked if they had heard or seen any health warnings about eating fish. Interviewers were trained not to prompt the respondent at any time during the interview, especially when asking about awareness. Responses were recorded word for word and the level of health hazard awareness was later evaluated by reviewing responses to determine how many specific health issues were recalled. In analysis of answers, three specific health issues considered representative of accurate health hazard awareness were considered: species of fish for which warnings had been issued, demographic groups most at risk from mercury, and the recommended maximum number of meals of mercury-impacted fish species which can be safely eaten per month.

Results of this type are always difficult to interpret because respondents may not have told the interviewer everything they know. These results were analyzed in the same way that the Healthy Fish Coalition analyzed the responses to this question. A single scientist reviewed all questionnaires and coded them according to the accuracy of the response to the three aspects of health issue: species of fish, sensitive populations, and frequency of meals. For example, a response was given one point if their answer included some indication of pollution awareness, in the water, from mercury, or of the fish. A second point was given if a response included something related to children or pregnant women (eg. sensitive population). A third point was given if the response included some indication of how much should be eaten, such as two meals a month, or even “not very often.” Most respondents’ replies included one of these three issues, but very few included information on all three issues. If a response did not relate to any of these three issues or was inaccurate then it was included as “not accurate.”

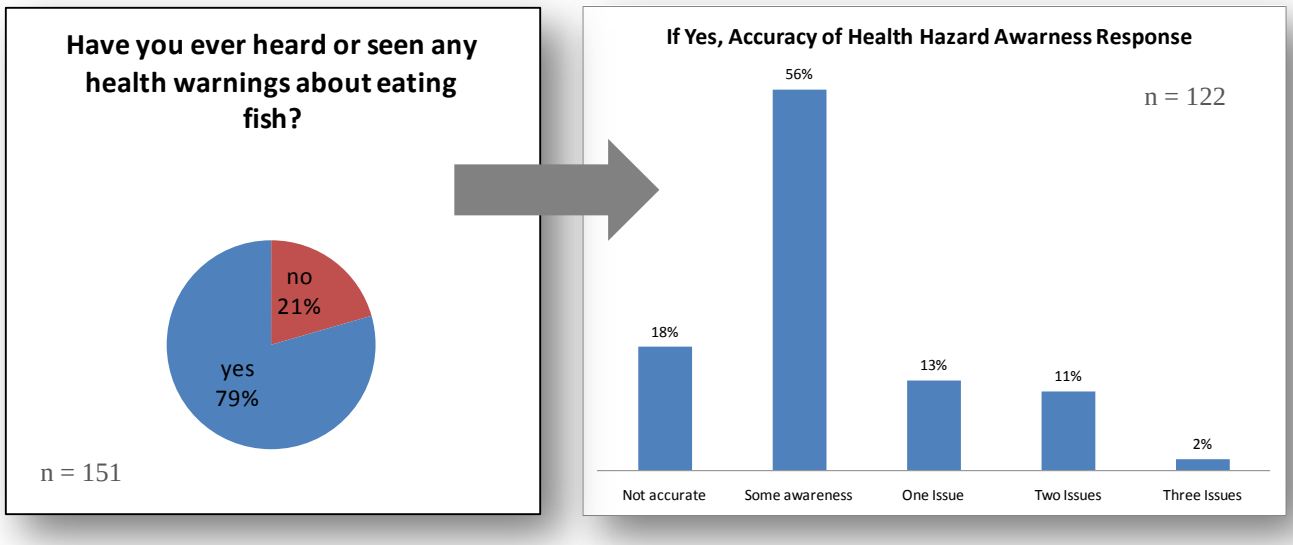


Figure 9: Level of Awareness of Health Warnings Regarding Sport Fish Consumption - Of all survey respondents (n=151) ,21% reported that they had never heard of seen any health warning about eating fish (n=31). When asked to provide details about the health warning, only 2% of respondents could correctly recall three aspects of the health warning (n=2). 18% could not accurately recall any aspect of the health warning (n=22), 56% had some level of awareness (n=68), 13% could correctly recall one aspect of the health warning (n=16), and 11% could correctly recall two aspects of the health warning (n=14).

Most people surveyed (79%) reported that they had heard or seen some type of health related warnings concerning fish consumption (Figure 9). Compared to other studies, 79% general awareness is relatively high. It was only 61% in the San Francisco Bay study, and 63% in the 2005 Delta pilot survey.

Figure 10: Fish Consumption Advisory at Lake Wildwood – This sign, erected by property owners, is posted near the dam at Lake Wildwood, the only public fishing access. It is one of only two fish consumption postings observed at targeted water bodies.

When asked to specify their knowledge, 56% of the respondents had some level of health hazard awareness such as awareness of mercury contamination, but did not identify any of the three specific issues looked for. Thirteen percent identified awareness of one of the three issues correctly. Twelve percent reported two issues correctly and only two percent reported three issues correctly. Eighteen percent of the responses were completely inaccurate.

Survey results regarding the level of accuracy of health hazard awareness indicate most respondents had some level of awareness of potential health hazards from fish consumption. However, the more detailed the level of awareness looked for, the fewer correct responses were provided. This indicates that Sierra anglers lack the specific information needed to make informed decisions to balance the benefits of eating fish with the risks of eating too much contaminated fish.

Trusted Health Information Sources

Survey respondents were asked where they get trusted information about health and what is good and bad for them. The most trusted source of information was health care providers, reported by 57% of respondents. In a 2006 survey of Sierra health clinics (and follow up interviews in 2011), The Sierra Fund found that none of the clinics surveyed used environmental health history forms or typically discussed fish mercury issues with patients, including maternal health patients (TSF, 2006). This may be because health care providers tend to be overworked or overwhelmed by other issues or have not been trained on this issue. After health providers, trusted sources included friends and family members, posted signs, fishing regulation handbooks, and to a lesser extent internet and television.

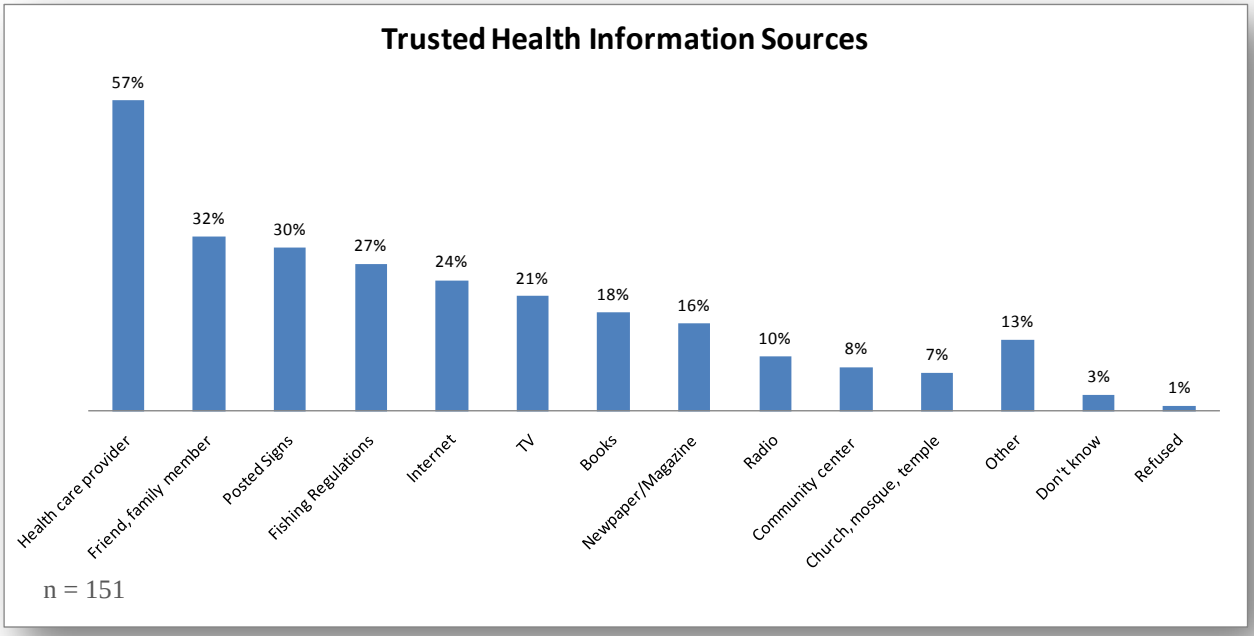


Figure 11: Sources of trusted health information - Out of the 151 survey participants, 86 trusted health care providers, 48 trusted friends and family, 46 posted signs, 41 fishing regulations, 36 trusted the internet, 32 trusted the TV, 27 books, 24 newspapers and magazines, 15 trusted the radio, 12 community centers, 11 church/mosque/temple, 20 said other sources than these, 4 said they did not know, and 2 refused to answer the question.

3. Fish Consumption

Consumption of Sport Fish

Nearly half (47%) of the people surveyed reported that they intended to eat the fish they caught that day. Of those who intended to eat the fish, 73% said they would also feed the fish to their families (Figure 12). Catch-and-release fisherman accounted for 51% of the survey respondents.

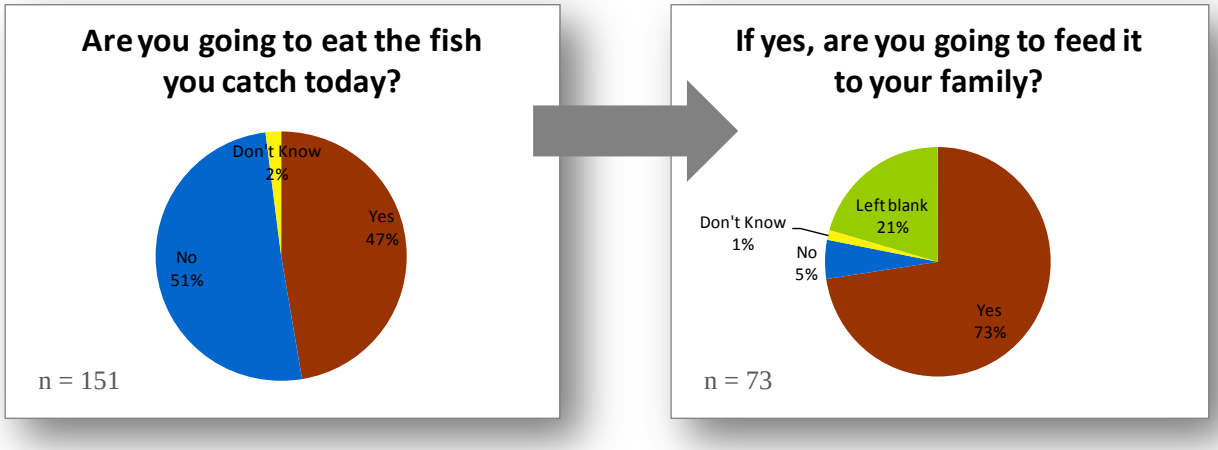


Figure 12: Fish Consumption vs. Catch and Release - Yes (n=71), No (n=76), three said they did not know, and one questionnaire was left blank. The follow up question "Are you going to feed it to your family?" was answered by 73 individuals: Yes (n=53), No (n=4), don't know (n=1), and blank (n=15).

The percentage of anglers who intended to eat the fish they caught (47% of those surveyed) was only slightly less than that found by other angler surveys conducted in the state. This may be because more catch and release anglers (51% of those surveyed) fish the Gold Country water ways. These results may also show some sample bias since many of the volunteers conducting the survey in 2009 were members of a fly fishing group and may have preferentially interviewed at locations where they (and other catch and release anglers) like to fish.

Of the 76 people who reported that they were not going to eat the fish they caught that day, 56 answered yes to the question: "Do you ever eat fish that you or someone you know catches?" The total number of people who reported ever eating sport fish was 132 out of 144 (seven questionnaires were left blank) or 92% of the people responding (Figure 13). This percentage includes sport fish caught in the Sierra as well as those caught elsewhere.

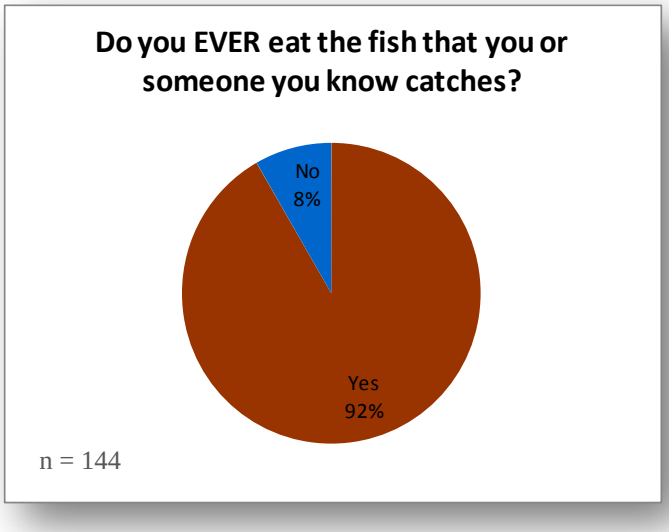


Figure 13: Sport Fish Consumption - All anglers, even those who were not going to eat the fish they caught that day, were asked if they ever ate sport fish that they caught or that was caught by others. Of the people who answered this question (n=144, because 7 surveys were left blank) 132 said yes (n=132, or 92%) and 12 said no (n=12, or 8%).

Fish Consumption by Species

Anglers who reported eating sport fish that either they or someone they know caught (total of 132 respondents or 92%) were asked to identify the species of sport fish they ate. Anglers were shown a color printed card to assist in accurately identifying fish species and could select more than one species.

The most popular reported species of fish eaten from Sierra Foothills water ways was trout (77% of respondents) and the second most popular was some species of bass (65%). The category "any species of bass" was added during the 2010 survey effort for people who did not know or distinguish which kind of bass they caught and was also selected for all anglers who mentioned eating one or more of the species of bass listed. Both bass and brown trout have relatively high mercury concentrations and are the subject of many fish consumption advisories. Other popular species included catfish (39%), kokanee salmon (39%), and crappie (28%). Percentages are out of 132, the number of survey respondents who answered yes to eating sport fish that either they or someone they knew caught (Figure 14).

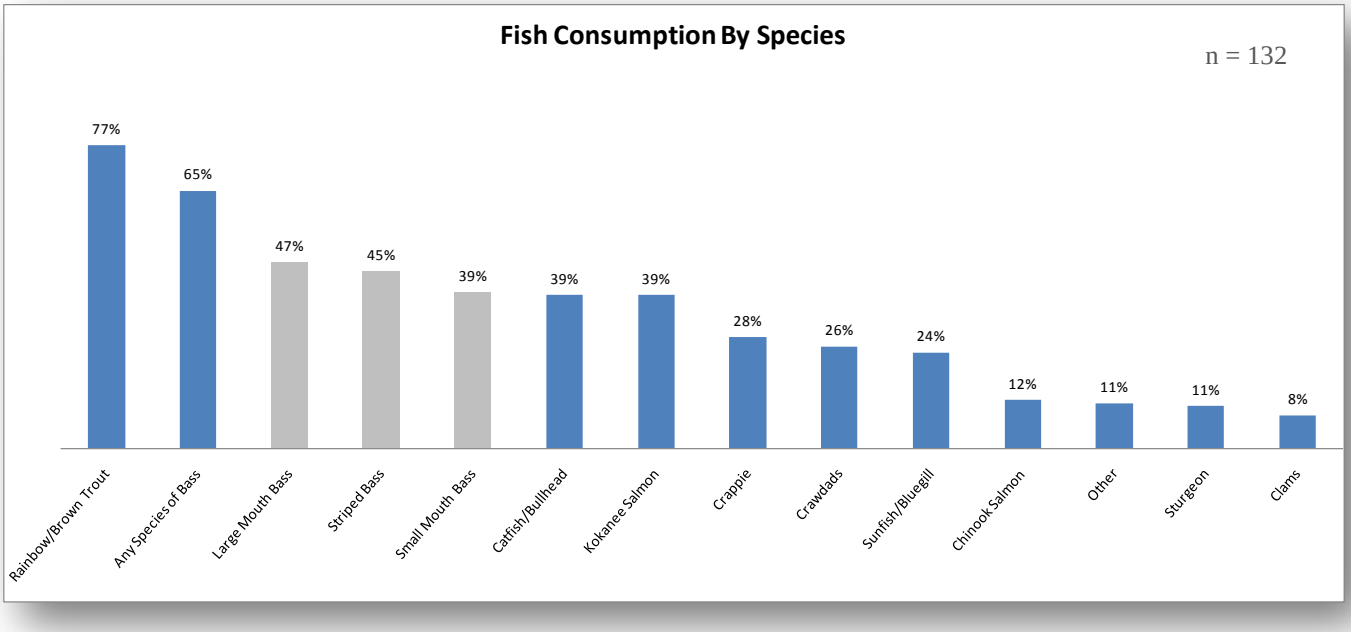


Figure 14: Fish Consumption by Species - Rainbow/brown trout (n=101), any species of bass (n=86), largemouth bass (n=62), striped bass (n=59), smallmouth bass (n=52), catfish (n=51), kokanee salmon (n=51), crappie (n=37), crawdads (n=34), sunfish/bluegill (n=32), chinook salmon (n=16), other (n=15), sturgeon (n=14), and clams (n=11). Percentages are out of 132, the number of respondents who said they ate fish that either they or someone they know caught.

For the 2010 survey effort the distinction between rainbow trout and brown trout was introduced and 52 of the 78 surveys collected in 2010 reported eating brown trout, for an estimated 67% of anglers. This is significant because unlike rainbow trout, brown trout are predatory and therefore typically have higher levels of mercury than rainbow trout.

For each type of fish that an angler reported eating, follow up questions were asked about the amount of fish consumed, and where that fish was caught. This allowed the survey to consider the angler's mercury exposure, and whether that exposure was from eating fish caught in the Gold Country.

Portion Sizes and Amount of Sport Fish Consumed Per Person

Anglers were asked how much fish they ate per meal and how many meals they ate in the last 30 days. Thirty days was considered the time range that most people could accurately remember what they had eaten and was commonly used in other angler surveys. OEHHA fish consumption guidelines are calculated based on an 8 oz (uncooked) serving size. To determine typical serving sizes, interviewers showed anglers plastic models of uncooked fish fillets and asked participants to identify their typical serving size of uncooked fish. The plastic models were provided by CDPH and were made from the same molds used in their 2005 study. The models represented uncooked fish in 1.5 oz, 4.5 oz and 7.5 oz serving sizes.

Some anglers reported eating large portion sizes, as much as 15 to 22.5 oz at one meal, which is two or three 7.5 oz fish portions, but the average reported meal size of all anglers was 6.9 ounces, within the OEHHA guidelines of six to eight ounces. High consumption anglers were identified by the survey as those who ate considerably more meals per month than are consistent with OEHHA guidelines and thus may be exposed to greater amounts of mercury than is considered safe (Figure 15).

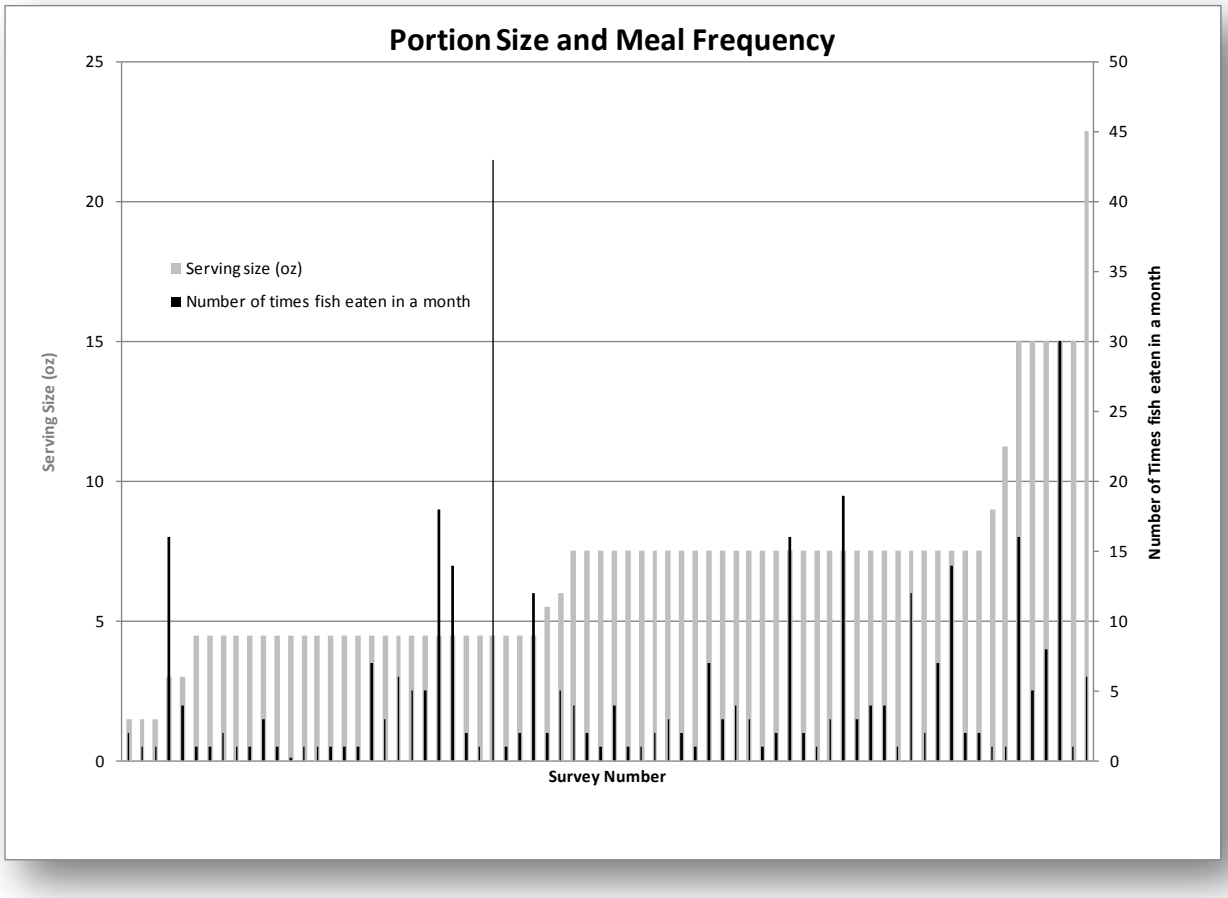


Figure 15: Portion Size and Meal Frequency - Gray bars represent serving size of fish portions (oz) of each surveyed individual. The largest reported serving size was 22.5 oz. Thin black bars represent number of meals the participant reported eating during the previous month. The greatest number of meals was 40 in a month.

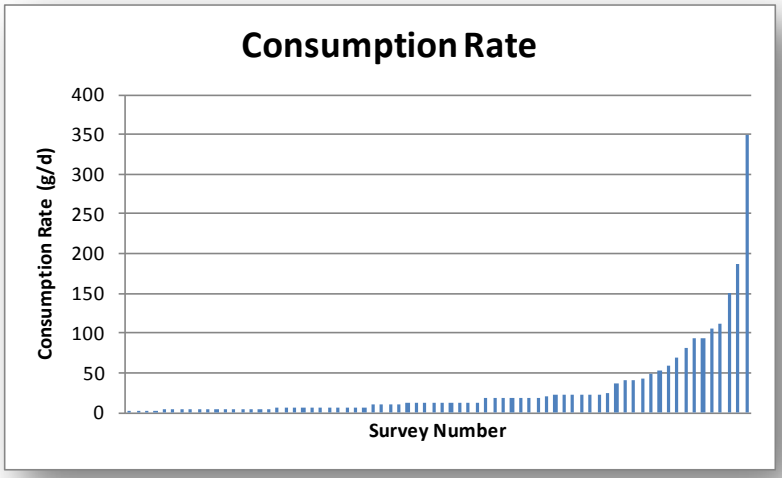


Figure 16: Consumption Rates (g/day) - Consumption rate is the combination of meal size (g of fish/meal) and meal frequency (meals/month) into a more commonly used metric of grams/day. The highest consumption rate was 350 g/day (15 oz/day). The average consumption rate was 30g/day.

The number of meals per month varied greatly among anglers. One angler ate 40 sport fish meals in a month, but the majority ate fish one to two times a week or four to eight times a month. The combination of these two variables is captured in Figure 16, Consumption Rate in grams per day, a more common measurement for public health professionals. The average consumption rate was 30 g/day, and the maximum was 390 g/day, an individual who reported eating 15 ounces in a day, every day over the course of a month.

Household Consumption Information

Anglers who answered yes to eating sport fish that they or someone they knew caught were asked a series of questions regarding which demographic groups in their household had also eaten fish they or someone they know had caught in the past year. Survey results indicate a relatively large percentage (50%) of anglers who eat the fish they catch also feed the fish to children in their household under the age of 18. A slightly larger percentage (54%) feed the fish they caught to women of childbearing age in their household. Just six percent had fed the fish they catch to pregnant or nursing mothers in the past year (Figure 17). This may reflect a greater awareness about the dangers of fish consumption for pregnant and nursing mothers.

These results are of concern since these three groups have the greatest health risk from mercury exposure. The results suggest there is a low level of awareness of the dangers associated with eating mercury-contaminated fish especially for children and women of child bearing age.

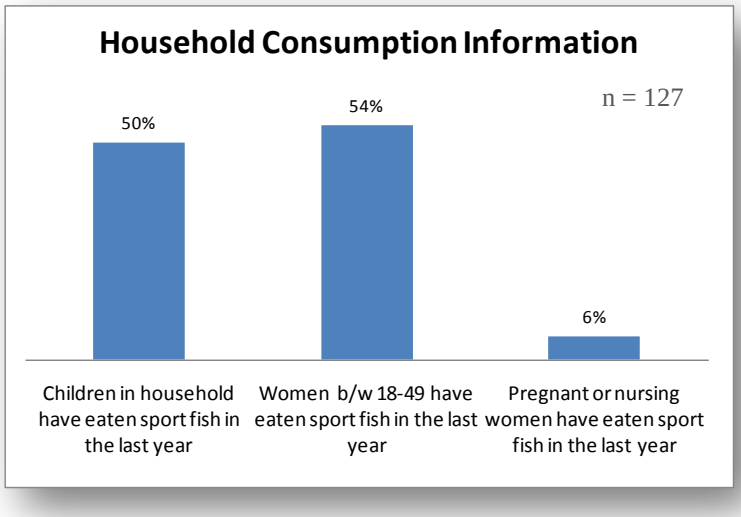


Figure 17: Household Demographics and Sport Fish Consumption - From anglers who eat the fish they or someone they know catches (n=127), the number who reported children in their household that also eat sport fish is 50% (n=64), women between the ages of 18-49 is 52% (n=69), and pregnant or nursing women is 6% (n=7).

Methylmercury Exposure from Sport Fish

In order to learn if anglers were eating fish within safe exposure guidelines an estimated amount of methylmercury in each species of fish was compiled, and used to calculate the approximate exposure of each survey participant based on answers to questions about fish consumption in the past 30 days.

To complete this analysis, the following three steps were followed:

1. Determine methylmercury levels in each species of sport fish
2. Calculate exposure of each survey participant
3. Compare results to OEHHA safe levels

1. Determine Methylmercury Levels in Sport Fish

Fish contamination data provided by the Central Valley Regional Water Quality Control Board (CVRWQCB) current database was used to estimate the level of methylmercury in Gold Country sport fish (Table 2). The database was populated with fish mercury data from the State Water Board's Surface Water Ambient Monitoring Program (SWAMP), FERC relicensing projects, and other projects. These data were also used in the 2008-2010 303(d) listing process.

Table 2: CVRWQCB 2010 Average Fish Mercury Concentrations for Gold Country Angler Survey Water bodies

Fish Species	**n**	**Mean** (ppm)	**SD**	**Length** (inches)	**Location of fish samples (**CFW=Camp Far West; LWW=Lake Wildwood; Yuba= Lower Yuba, North Fork, and/or South Fork)
Bluegill	12	0.19	0.09	> 6	Folsom, CFW, Combie, Rollins, Scotts Flat
Brown Trout[1]	146	0.22	0.18	>6	American, Bear, Deer Creek, Yuba, and Feather Watersheds
Catfish	31	0.75	0.28	> 6	Folsom, CFW, Rollins
Chinook Salmon	11	0.59	0.27	>6	Folsom
Crappie[2]	5	0.31	0.10	>8	Delta, Lower Sacramento River
Largemouth Bass	95	0.64	0.20	>6	Folsom, CFW, Combie, Rollins, Scotts Flat, LWW, Englebright
Rainbow Trout	76	0.14	0.09	>6	Folsom, Combie, Deer Creek, Scotts Flat, Englebright, Yuba
Smallmouth Bass	33	0.65	0.15	>6	Folsom, CFW, Rollins, Englebright, Yuba
Spotted Bass	53	0.73	0.18	>6	Folsom, CFW, Rollins, Englebright, Yuba
Striped Bass[3]	18	0.89	0.49	>6	American River below Nimbus, Lower Feather
Sturgeon[4]	11	0.27	0.24	>48	Lower Sacramento River
Sunfish	4	0.17	0.13	>6	Folsom, Scotts Flat, Englebright

[1] Because of limited brown trout data for targeted water bodies, the average value in Table 2 is taken from data covering a much larger region in the Sierra Nevada.
[2] The only crappie data from the targeted water bodies was a single fish from Rollins Reservoir which has a value of 0.31ppm, therefore the value used was from Shilling et al. 2010.
[3] Although striped bass are uncommon in the targeted Gold Country water bodies, anglers reported eating it. This value is taken from CVRWQCB data in the lower American and Feather River watersheds.
[4] There were no data for sturgeon in the targeted water bodies. The value in Table 2 was used from Shilling et al. 2010.

Table 2 includes data compiled by CVRWQCB from almost 30 years of measurements of mercury in various fish species up to 2010. To construct this table, CVRWQCB calculated average total mercury concentrations (parts per million or micrograms/gram) for each target species. Of the total amount of mercury found in fish muscle tissue, methylmercury comprises more than 95 percent (ATSDR, 1999; Bloom, 1992). For the purpose of this exposure analysis it was assumed that 100 percent of the mercury in fish tissue is in the form of methylmercury.

Best professional judgment was used to select the most appropriate fish mercury concentration for use in this exposure analysis since there is a relatively limited data set for surveyed water bodies, and to a lesser extent the Sierra Nevada region. For brown trout, no data were provided from target water bodies, so the mercury value was an average of brown trout data provided by the CVRWQCB for the greater Sierra Nevada region. This included data from the American, Bear, Deer Creek, Yuba and Feather River watersheds for a total of 146 samples. For crappie and sturgeon, values were used for fish caught in the Delta and Lower Sacramento River, since data from the Sierra Nevada region was not available.

In an effort to promote regional comparisons and relate findings of this study to other research efforts, fish mercury averages from targeted Gold Country water bodies were also compared to the fish mercury levels used in the similar angler survey effort in the San Francisco Bay/Delta, published by Shilling et al. 2010. Table 3 compares the two sets of data. With the exception of bluegill and largemouth bass, Gold Country averages were higher than those from Bay/Delta water bodies.

Table 3: Fish Mercury Data from Targeted Water Bodies Compared to the Bay/Delta

Fish Species	**Gold Country Fish Mercury Data** (CVRWQCB)				**Bay/Delta Fish Mercury Data** (Shilling et al., 2010)			
	n	**Mean** (ppm)	**SD**	**Length** (inches)	**n**	**Mean** (ppm)	**SD**	**Length** (inches)
Bluegill	12	0.19	0.09	> 6	10	.208	.125	>6
Brown Trout	146	0.22	0.18	>6				
Catfish	31	0.75	0.28	> 6	44	.424	.251	>12
Chinook Salmon	11	0.59	0.27	>6	25	.09	.03	>26
Crappie	5	0.31	0.10	>8	5	0.309	0.104	>8
Largemouth Bass	95	0.64	0.20	>6	63	.774	.324	>12
Rainbow Trout	76	0.14	0.09	>6	12	.061	.014	>18
Smallmouth Bass	33	0.65	0.15	>6				
Spotted Bass	53	0.73	0.18	>6				
Striped Bass	18	0.89	0.49	>6	47	.545	.318	>18
Sturgeon	11	0.27	0.24	>48	11	.271	.241	>48
Sunfish	4	0.17	0.13	>6	14	.182	.097	>8

The small sample size and high range of variability in fish mercury levels, even among the water bodies targeted by this survey, indicate that more fish data are needed from Gold Country water bodies to accurately calculate the methylmercury exposure from sport fish consumption. This high variability could be the result of site history (mining intensity) of the water bodies and/or due to different life history patterns of fish. For example, resident salmon in Folsom Reservoir have an average mercury concentration of 0.78 ppm, whereas anadromous salmon below Nimbus Dam would likely have an

average mercury concentration similar to Delta salmon, or 0.09 ppm. Additionally the average value for largemouth bass in Lake Combie was 0.907 ppm whereas Lake Englebright had an average of 0.35 ppm.

2. Calculate Exposure of Gold Country Angler Survey Participants

The Gold Country Angler Survey included the following questions in order to determine the methylmercury exposure of individual survey respondents:

- How much sport fish he or she consumed in the last 30 days
- Which species of sport fish were consumed
- Where the fish had been caught[5]
- Typical serving sizes

The 2010 survey also included the following questions:

- How much of what kinds of commercially bought fish he or she consumed in the last 30 days
- Participant's body weight

To calculate the methylmercury exposure from sport fish, the number of times the survey participant reported eating a particular species of sport fish in the last 30 days was multiplied by reported portion sizes and the average mercury concentration determined for that species (as indicated in Table 2). This calculation was performed for each species of fish the participant reported eating in the last 30 days. Resulting values were added to achieve a cumulative total. The result was the approximate amount of mercury consumed by the individual, measured in micrograms per day.

An example calculation for an individual who reported eating two 7.5 oz meals of rainbow trout and one 7.5 oz meal of largemouth bass in the last 30 days:

TROUT: 7.5 oz/meal * 2 meals / 30 days * 28.35 g/oz * 0.14 µg Hg/g = 1.98 µg Hg /day
BASS: 7.5 oz/meal * 1 meal / 30 days * 28.35 g/oz * 0.64 µg Hg/g = 4.54 µg Hg /day

TOTAL: 1.98 µg Hg /day of trout + 4.54 µg Hg /day of bass = **6.52 µg Hg /day**

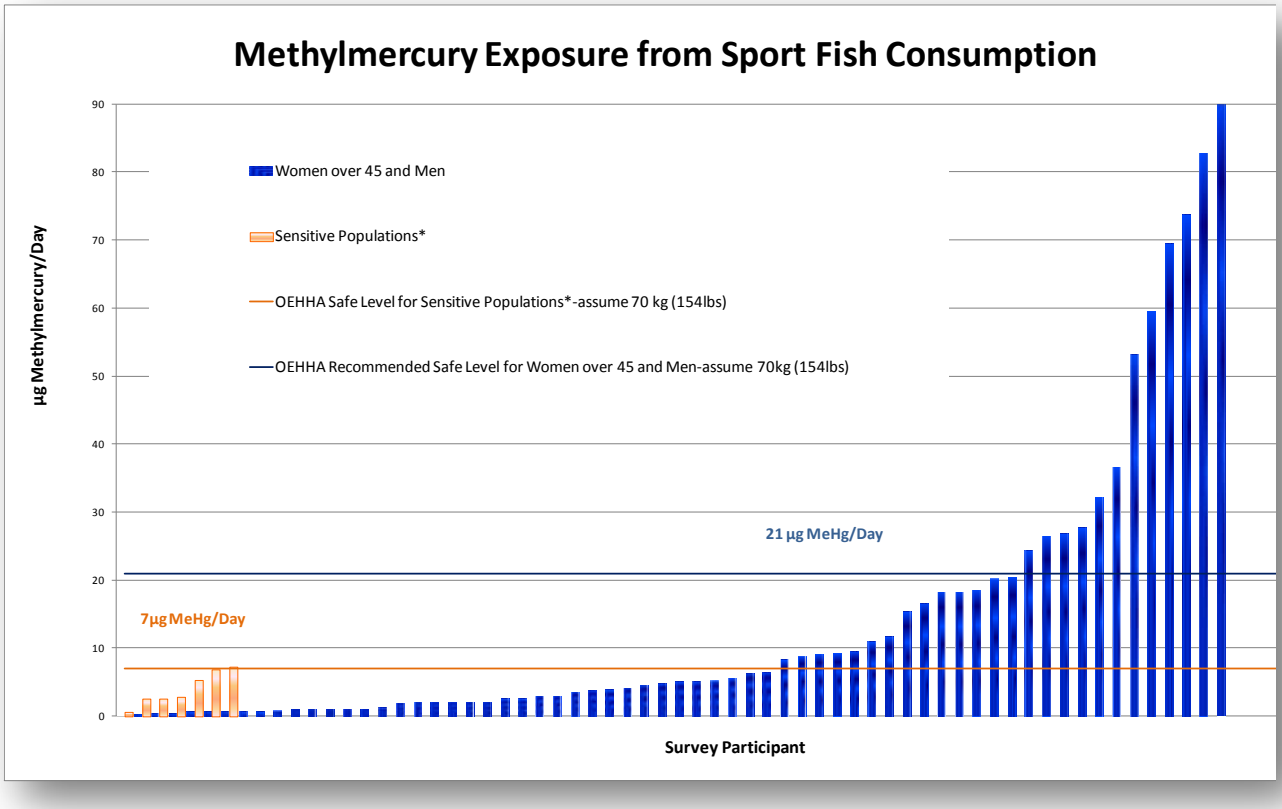
3. Compare Participants' Exposure to OEHHA Safe Consumption Levels

According a 2008 OEHHA report on the development of sport fish advisories, the OEHHA recommended safe levels of methylmercury exposure are 0.1 µg of mercury/kg of body weight per day for women aged 18 to 45 years and children under 17 years, and 0.3 µg of mercury/kg of body weight per day for women over 45 years and men (OEHHA, 2008). The safe level of exposure depends on each individual's body weight.

[5] Although anglers were asked where the fish were caught, this information was not used in the calculation of methylmercury exposure because of the limited site-specific data.

In order to compare calculated levels of methylmercury exposure from this survey to OEHHA standards, a standard body weight was assigned of 70 kg (154 lbs) for all adults, and children were assigned half that weight or 35 kg (77 lbs). OEHHA fish advisories are based on these weights. There are separate safe exposure levels for men as compared to women of child bearing age and children because developing fetuses and children are more sensitive to the harmful effects of methylmercury than adults.

Adult weight was used for mercury exposure calculations for all participants. Therefore, the safe exposure level assuming a body weight of 70 kg (or 154 lbs) is 21 µg of mercury/day for women over 45 years or men, and 7 µg of mercury/day for women under the age of 45. A child's safe exposure level must be calculated using the standard weight of 35 kg (or 77lbs) and only 0.1 µg of mercury per kg of body weight, resulting in a limit of 3.5 µg of mercury/day for children. This level is not shown in Figure 18, because children were not surveyed.



* Sensitive Populations are considered by OEHHA to be women aged 18 to 45 and children under 17.

Figure 18: Methylmercury exposure from Sport Fish - This graph displays the calculated methylmercury exposure for all anglers who reported eating sport fish in the previous 30 days. The majority of the anglers were within the safe eating limits, while thirteen anglers were above safe eating limits, and one person was more than four times the recommended safe exposure level. One member of the sensitive populations (orange bars) was above the recommended safe exposure level.

In Figure 18, each bar represents the calculated exposure level of a single survey respondent. Men and women over 45 who were surveyed are represented in dark blue bars. Women younger than 45 or all individuals under the age of 18 (of which there was one) are represented in light orange bars. The

OEHHA recommended safe level of exposure for men is the dark blue line at 21 µg Hg/day. The OEHHA recommended safe level for women under 45 is the orange line at 7 µg Hg/day.

Results of this evaluation suggest that the majority of the Gold Country Angler Survey respondents are not exposed to dangerous levels of methylmercury through eating sport fish, however the exposure potential remains high. Calculations show that 9% of the surveyed anglers (n=151) consumed more mercury than state and federal guidelines recommend. Although the sample size is small, these results clearly point to the need for more surveys, especially from sensitive populations, and more outreach to the fishing population.

The highest calculated exposure to methylmercury from sport fish consumption was 90 µg methylmercury/day, more than four times higher than the recommended exposure level, the next highest was 83 µg methylmercury/day, also four times higher than the recommended level. The highest level of mercury exposure was from a man interviewed at Nimbus Dam on the American River in July 2010. He was a Caucasian who ate bass five times in the last month and also crappie one time in the last month. His typical serving size was two or three 7.5oz portions each meal. The second highest level of mercury exposure was from a Native American man interviewed at the South Yuba River in 2009. He had eaten chinook salmon eight times in the last month and rainbow trout eight times in the last month. His typical serving size was two 7.5 oz portions.

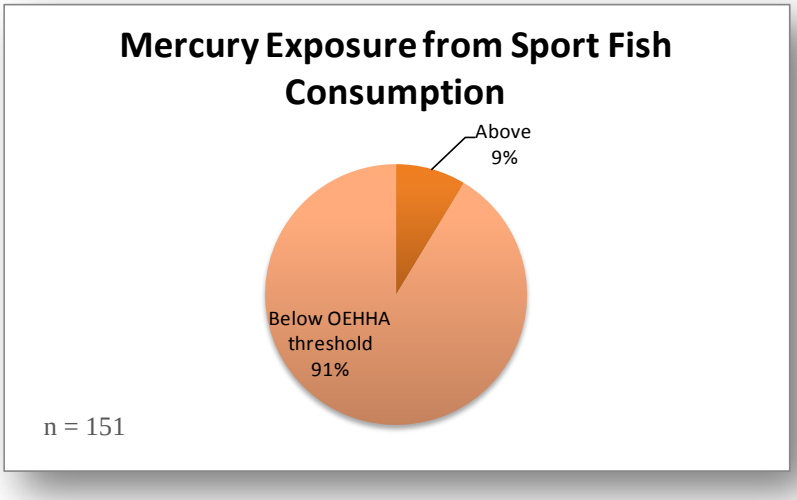


Figure 19: Mercury Exposure from Sport Fish Consumption
Results of all surveyed anglers (n=151) indicated that 9% (n=13) were exposed to methylmercury from sport fish consumption at levels that were above OEHHA safe eating guidelines of 21µg/day (women over 45 and men) or 7µg/day (sensitive population s including women younger than 45 and men younger than 18).

The next four highest exposure levels from sport fish consumption (74, 70, 60, and 53 µg MeHg/day), between two and four times the recommended levels, were from individuals interviewed at Nimbus Dam on the American River. They were all males 170-200 lbs, three were Caucasian and one was Hmong. They all ate bass, and one ate sunfish/bluegill and crappie every day and another ate 15 oz of rainbow trout every day.

Almost as high (37 µg methylmercury/day) was a single fisherman at Scotts Flat Reservoir who reported eating bass, sunfish/bluegill and trout more than six times a month and ate a single 7.5 oz as a typical serving.

The highest level of exposure calculated from the 2009 survey responses was 21.94 micrograms of methylmercury per day, just over the recommended safe level. This person was a Hmong man between

the ages of 39 and 45 fishing at Lake Wildwood, who reported eating largemouth bass at least four times a month. He was observed fishing with a group of five Hmong men and women who had caught a stringer of large-sized largemouth bass which they indicated they planned to eat.

Additional Calculation: Methylmercury Exposure from Commercial Fish

Exposure to methylmercury through the consumption of commercial fish was not considered in the above analysis, therefore participants' actual methylmercury exposure may be higher still. In an effort to learn whether participants' total mercury exposure was within safe levels, the 2010 survey effort added questions to quantify commercial fish consumption. Of the 72 interviews conducted in 2010, 34 answered yes to eating commercially bought fish, almost 50%.

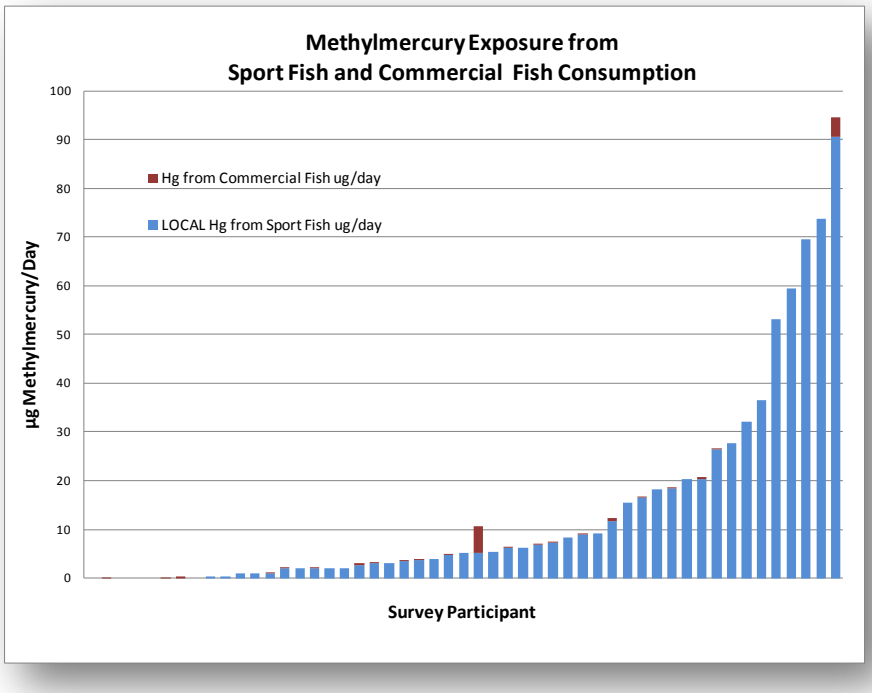


Figure 20: Mercury exposure from sport fish and commercially bought fish – This graph shows mercury exposure of individuals surveyed in 2010 field season only, and only the top 50 exposure levels from 2010 are displayed here.

The responses from 2010 survey participants show that the commercial fish most commonly eaten among those surveyed were albacore and canned tuna, salmon, fish sticks (cod), and halibut. The mercury levels in these fish (Table 4) were obtained from the GotMercury.org online mercury calculator (http://www.gotmercury.org). It should be noted that chunk light tuna typically has less mercury (0.118 ppm) compared to canned albacore (0.353 ppm). Results of calculations of participants' mercury exposure considering both commercial and sport fish (Figure 20) show that the majority of exposure was from sport fish, but commercial fish consumption is an important factor in determining whether individuals who eat sport fish are exposed to dangerous levels of mercury.

Table 4: Average Mercury Concentrations in Commercial Fish (GotMercury.org)

Commercial Fish	Hg (ppm)
Albacore	0.357
Canned Tuna	0.353
Salmon	0.014
Sticks	0.095
Halibut	0.252

Additional Calculation: Mercury Exposure Based on Weight

Calculating an individual's mercury exposure based on a default weight is problematic in some cases, particularly for women. If adults were less than 154 lbs then they may be exposed to methylmercury above recommended levels, because OEHHA uses this default weight for their calculations. The reported weight of anglers was recorded during 2010 survey efforts in order to determine if this was a potential issue.

In the 2010 survey effort, respondents were asked their body weight and it was recorded as an exact weight rather than a category. Using this information, the OEHHA safe exposure level was calculated for each individual. This calculation used OEHHA recommended safe levels of methylmercury exposure of 0.1 µg of mercury/kg of body weight per day for women aged 18 to 45 years and children under 17 years, and 0.3 µg of mercury/kg of body weight per day for women over 45 years and men (OEHHA, 2008).

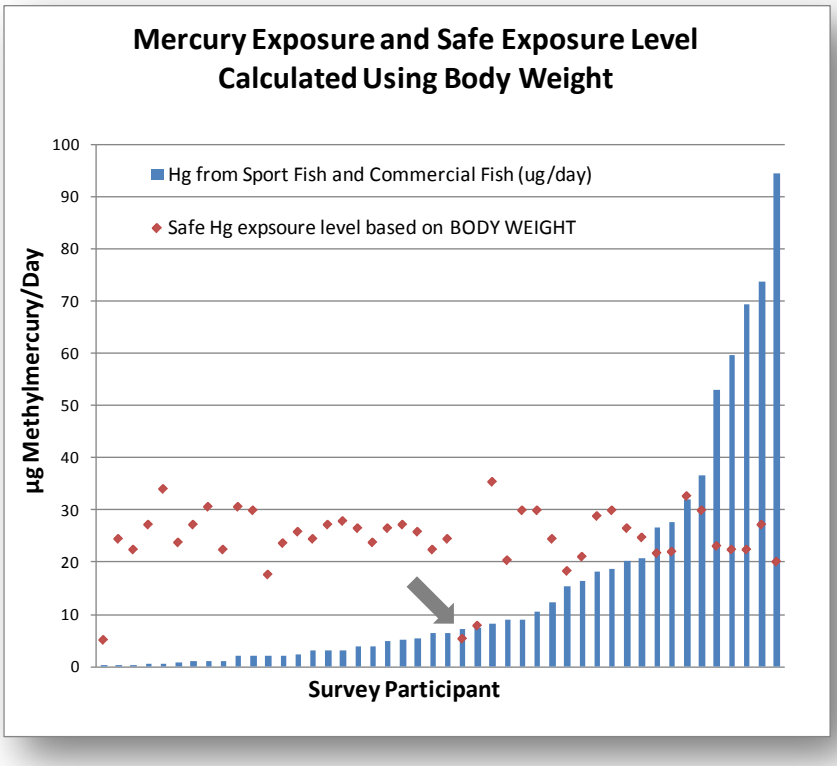


Figure 21: Mercury Exposure and Safe exposure level calculated using body weight - Mercury exposure from fish consumption compared to safe consumption guidelines calculated using participants' bodyweight. Results are presented for the top 50 exposure levels from 2010 survey respondents.

These calculations show that fish consumption advisories based on the default weight of 70 kg are for the most part protective of public health. One exception (indicated by the arrow) was a young woman who weighed 120 lbs. Her safe exposure level using her body weight was 5.4ug/day, less than the default safe exposure level of 7 µg/day, while her mercury exposure from fish consumption was 7.9 µg/day.

SUMMARY AND RECOMENDATIONS

The *Gold Country Angler Survey* was a project of The Sierra Fund's Reclaiming the Sierra Initiative. Its purpose was to stimulate awareness, research and policy reform to address the issue of mercury-contaminated fish in the Sierra Nevada. Interviews were conducted to learn whether people who eat sport fish caught in Sierra Nevada waters are being exposed to mercury from historic mining activities. Survey results indicate that a significant percentage (92%) of Sierra anglers are consuming the fish they catch, and some (9%) are consuming methylmercury at levels above the OEHHA safe eating guidelines. Collection of additional local fish mercury levels and angler survey data is warranted in order to more accurately quantify methylmercury exposure from sport fish consumption.

Results Summary

Anglers were encountered and interviewed at all targeted water ways with the exception of the Bear River and Lake Combie. Between 15 and 33 interviews were conducted at Rollins Lake, Scotts Flat Reservoir, Camp Far West Reservoir, Lake Englebright, the American River below Nimbus Dam, and Lake Wildwood. Completion of interviews in the Sierra Nevada was time intensive compared with more populous areas since anglers were often spread out and seldom fish in groups. With a total of 151 interviews this study should not be considered a comprehensive overview of anglers in the Gold County, but is more accurately considered a pilot study. Because the participant cohort was small, it is difficult to make regional conclusions, especially in regards to sensitive populations.

The results of the survey questions can be summarized into three categories:

- Angler Demographics
- Advisory Awareness
- Fish consumption

Demographics Results Summary

The ethnicity of the anglers surveyed was predominantly Caucasian and nearly equally split among age groups 18-34, 35-49, and 49 and over. Notable exceptions were the groups of Hmong anglers fishing at Lake Wildwood and Nimbus Dam, and Native Americans who were interviewed at the Indigenous Peoples Day event in Nevada City.

Advisory Awareness Results Summary

Although most respondents had some level of awareness of health hazards associated with sport fish consumption and mercury exposure, reported knowledge of specific factors tended to be vague or inaccurate. These results suggest a lack of awareness of the specific information needed to make informed health decisions to balance the benefits of eating fish with the risks of eating too much mercury-contaminated fish.

Posted fish consumption advisories were not observed at most of the water ways where consumption advisories were in effect and interviews were conducted. The two postings observed (at Lake Wildwood and Lake Englebright) were either difficult to understand, lacking in specific information, or were relatively small and inconspicuous.

The most commonly reported trusted sources of health hazard information were health care providers, followed by friends and family and posted signs. Recent research suggests that health care providers in the Sierra Nevada region do not typically disseminate information regarding the health risks from consuming sport fish contaminated with mercury and generally do not ask their patients about their fish consumption habits (TSF, 2006). Survey results point to health care providers as the most trusted way to increase health hazard awareness among people who eat locally caught fish.

Fish Consumption Results Summary

Over 90% of the anglers surveyed reported eating the fish they catch. Of those who were planning to eat the fish they caught that day, nearly three quarters (73%) of those intended to feed the fish to their families: approximately half said they feed the fish they catch to children under the age of 18 (50%), and/or to women of child bearing age (54%). These groups are most at risk from the health impacts of eating mercury-contaminated fish. One of the most popular fish eaten was bass, which tends to have elevated mercury concentrations and is the subject of numerous fish consumption advisories. People reported eating fish from all the water ways where interviews were conducted, particularly from the larger reservoirs such as Rollins Reservoir, Camp Far West, Upper Scotts Flat Reservoir, and Lake Englebright.

Fish portion sizes reportedly eaten by survey respondents were generally consistent with portion sizes used by OEHHA to develop fish consumption advisories (average 6.9 oz). However, certain anglers reported eating significantly larger portions, as much as 15 to 22 ounces in a single meal, and certain anglers reported eating more meals per month (up to 40 per month) than the advisories recommend.

Results of calculations performed to estimate the amounts of mercury consumption by specific survey respondents show that 9% of anglers exceeded state guidelines for mercury intake, and some anglers were exposed to four times safe levels. Results of this evaluation suggest that the majority of the Gold Country Angler Survey respondents are not exposed to dangerous levels of methylmercury through eating sport fish, however the exposure potential remains high.

Recommendations

Based on the results of the Gold Country Angler Survey, The Sierra Fund has developed five recommendations for action that will help protect the public and reduce consumption of contaminated fish:

1. Post signs at fishing locations
2. Collect fish mercury data
3. Conduct additional angler surveys
4. Increase funding for outreach to better inform the public about risks
5. Reduce mercury in aquatic ecosystems by remediating abandoned mines

1: Post Signs at Fishing Locations

Post existing fish consumption advisories. Fish consumption advisories need to be posted as signs at all popular fishing locations on water ways where OEHHA advisories are in effect. Posting efforts should include partnerships with property owners, fishing groups and state and local government agencies and should be sensitive to all concerned parties. Signs should be clear and understandable, and presented in English as well as other languages if non-English speakers are known to fish at that location.

Clarify jurisdiction for posting fish consumption advisories. Although posting existing fish consumption advisories is a simple, relatively inexpensive and extremely important task, it has not been done because it is currently unclear which entity, agency or department is responsible for posting fish advisories in the field. A policy mandate and budget is needed for either a state or local agency to implement posting of existing advisories.

Provide information in areas where advisories do not yet exist. Information also needs to be present in areas where fish consumption advisories have not yet been established, due to insufficient fish data. A general fish consumption guideline based on existing knowledge could be developed for the Sierra region, where the presence of mercury from historic mining is widespread, and generally the same species of fish are found. This general advisory should be posted at any and all Sierra water bodies were anglers are present in order to improve awareness. Landowners should be encouraged to post through education and incentives.

2: Collect Fish Mercury Data

Collect fish data to complete fish consumption advisories. More fish need to be tested from Sierra Nevada water ways so that fish advisories can be issued for all relevant species of fish. Fish sampling should be conducted in all the water bodies where fish are caught and eaten. Enough fish samples should be taken of each species and from each location to learn whether OEHHA fish advisories are warranted.

Use water body-specific fish data to calculate human exposure. Additional fish data from Sierra water bodies will improve estimates of mercury exposure for Sierra anglers, since fish from these water bodies may have different mercury levels than those from other areas of the state or region. This information is important for human health research, as well as providing a basis for remediation projects, and mercury regulations including TMDLs.

3: Additional Angler Surveys

Collect more surveys. Additional angler surveys are needed from the Sierra Nevada region to substantiate these results. A larger number of survey participants (200-300) would enable a more accurate assessment of fish consumption patterns at specific locations and estimates of methylmercury exposure. Lessons learned from this process (see Appendix A) should be considered in planning other survey efforts. Future surveys should focus on the following locations and populations:

- **Target reservoirs.** Survey results suggest that reservoirs have the highest concentrations of anglers and the most anglers likely to be eating the fish they catch. Future survey efforts should concentrate on reservoirs to increase their efficiency. In particular, more effort should be spent in the American River watershed since some of the highest consumers of mercury found by this study were fishing below Nimbus Dam. Conducting more surveys early in the spring, in the early morning hours, and from boats would provide more representative data from reservoirs.

- **Expand geographical scope.** Additional angler surveys should be conducted in other areas of the Sierra Nevada in order to determine if the impacts identified in the Northern Sierra region are present in other areas where similar historic mining activities and demographic conditions exist. Locations for future surveys should include water ways downstream of historic hydraulic mining that therefore have the potential for mercury contamination. Other areas where historic mining impacts are known but where fish advisories have not yet been developed (possibly due to insufficient data) should be considered, including the upper American, Cosumnes and Mokelumne River watersheds in El Dorado, Amador and Calaveras Counties.

- **Target sensitive populations.** Not enough individuals from sensitive populations were contacted by this study to draw conclusions about their mercury exposure from sport fish. A different approach may be needed to gauge exposure of sensitive populations since findings show that there are relatively few women present at fishing locations. Additionally, to gauge exposure of children, specific questions would need to be directed to parents. This population could be targeted through an interview conducted door-to-door or at health clinics that asked most of the same questions.

- **Target ethnic groups.** During future surveys, more effort should be made to identify fishing activities by non-Caucasian ethnic groups. Interviewers should be recruited who are bilingual in Spanish, Hmong or other languages. During future surveys it would be advisable to request help from the Southeast Asian Assistance Center in contacting at risk groups and translating the questionnaire.

Calculate mercury exposure with water body-specific values for Sierra fish. Water body-specific fish mercury data would improve the accuracy of future exposure calculations for anglers. Average fish mercury levels created using small data sets from multiple water ways do not accurately represent exposure because of significant regional variability. This variability warrants water body-specific exposure calculation, rather than region-wide averages. More fish data are needed from local water ways to complete the data set for Sierra fish.

Coordinate with other research efforts. Expanded and future surveys should coordinate with ongoing or proposed research in associated areas including:

- Development of Total Maximum Daily Loads (TMDLs)
- Assessments of mercury concentrations in specific fish species from individual water ways
- Assessments of mercury levels in humans

Information from these and other sources as well as improved survey techniques, such as increasing survey participation (greater number of completed interviews), a consistent design for covering

locations, times of day and days of the week, and structural/content improvements to the questionnaire as described in the lessons learned (Appendix A), will allow better estimates of actual mercury exposure from a statistically representative population, and document a critical pathway in the fate and transport of mercury from the environment to human exposure.

4: Increase funding for outreach to better inform the public about risks

Increase overall public awareness. In order to address the general lack of health hazard awareness identified in this survey, additional public outreach should be performed to increase awareness of the health risks associated with eating fish high in mercury. Health care providers should be informed and assisted in providing accurate information. An education program in local schools and Public Service Announcements for television, radio and internet may improve public awareness in the long term. Region-specific educational programs should be coordinated with additional survey efforts.

Increase awareness of policymakers. Local, state and tribal leaders need to know about the problems existing from historic gold mining, particularly the dangers of eating mercury-contaminated fish and the fact that a large population of people are eating these fish. Policymakers need to take action to encourage cleanup of water ways, public education efforts, and additional data collection.

Advocate for funding. Funding is critically needed for the outreach programs described above. Funding is needed for posting of existing advisories, fish data collection for development of comprehensive advisories, and public education and posting efforts.

5: Reduce Mercury in Aquatic Ecosystems by Remediating Abandoned Mines

The sources of most of the mercury in Sierra Nevada waters are abandoned mine lands that in most cases were abandoned more than 100 years ago. Cleaning up these sources of mercury could have a significant impact on reducing mercury contamination in area fish. Increased collaboration among local, state and federal agencies is essential in order to assess and address legacy mining issues in ways that will have a positive impact on water quality and supply, and human health.

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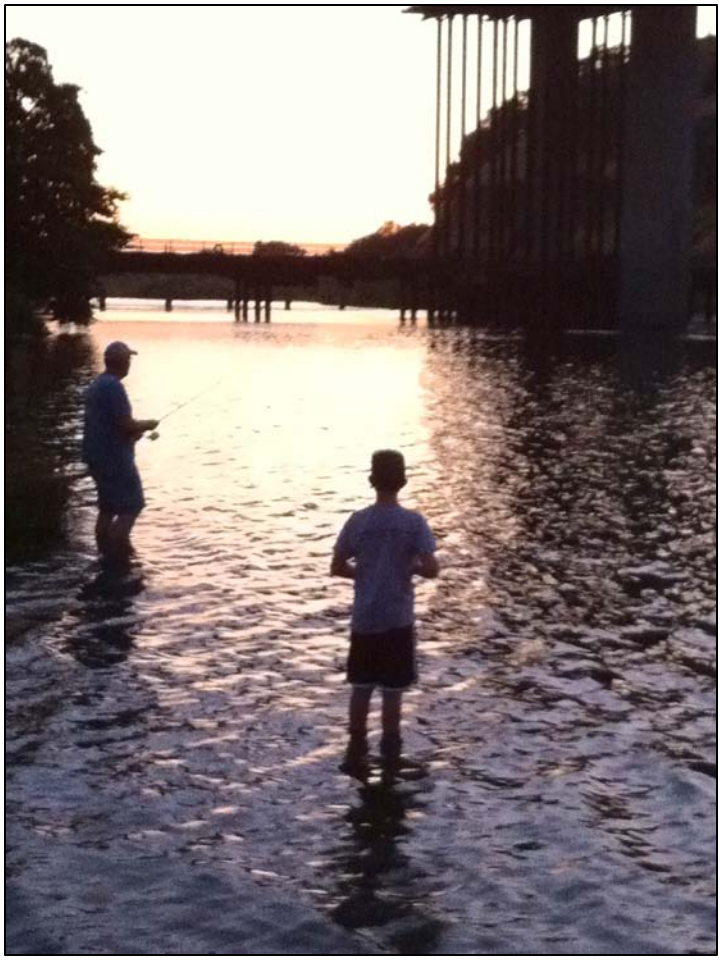
APPENDICES



Appendix A: Angler Survey Lessons Learned

Appendix B: Angler Survey Protocol

Appendix C: Gold Country Angler Survey Target Water Bodies

Appendix D: Gold Country Angler Survey Questionnaire

Appendix E: Sierra Nevada Sport Fish Species

Appendix F: Fish Portion Model

Appendix G: OEHHA 2003 Health Advisory for Northern Sierra Nevada Foothills

Appendix H: OEHHA 2009 Update of California Sport Fish Advisories

APPENDIX A

Lessons Learned

The following paragraphs present some of the lessons learned which should inform future angler survey efforts in the Sierra Nevada region. The lessons learned are grouped into two categories: suggestions for improving survey implementation and suggestions for improving the questionnaire itself.

Survey Implementation

Focus study design and scope. A focused plan for conducting interviews at a limited number of targeted locations should be completed before interview efforts begin, in order to ensure a statistically representative population in the survey results. This could be accomplished by first characterizing fishing activities such as angling intensity, catch per unit effort, and fishing preferences. The study design should include times of day that interviewers will visit each location, and how often the location should be visited.

Use dedicated, coordinated interviewers. Interviewer availability and the nature of the volunteer effort during the 2009 season limited the number of completed interviews and limited the selection of fishing times and locations. The 2009 volunteer interviewers reported that they generally attempted to conduct interviews as their time permitted and during times when in their opinion most fishing was likely to occur. The single most important improvement during the 2010 survey season was obtaining more interviews that better represented the population of anglers. The reason for this improvement is attributed to working with just two dedicated volunteer interns who took a coordinated approach to interview completion efforts. They would repeatedly visit a single location until the designated numbers of interviews were completed.

Talk to anglers informally after the interview. In 2010, interns made an effort to talk to anglers after the questionnaire was completed to learn about other potential locations to conduct interviews, and the best time of day to catch anglers. Through these efforts, unique "spots" at targeted locations were found, specifically areas low-income anglers frequented because they did not require entrance fees.

Include educational materials as part of survey. After completing the survey questionnaire, some interviewees were given a printed OEHHA fish mercury advisory brochure. This practice should be part of all surveys administered, and interviewers could be better trained to inform anglers and provide more specific information to fishermen.

Provide "thank you" tokens. In 2010, interviewers assembled a tackle box of common fishing gear (hooks, worms, spinners, weights) and would offer a few pieces to anglers after completion of the interview. Anglers were very appreciative of this gesture. This proved an inexpensive and effective way of building trust and general good will with anglers.

Track refusal rate. The number and location of people who were encountered in the field, but declined to participate in the survey should be recorded, and when appropriate the reason for their refusal.

Review questionnaires daily. Completed questionnaires should be reviewed by other team members the day that interviews were conducted to check for completeness and to ensure that the interviewer understands the importance of obtaining accurate, detailed information for all categories so that exposure calculations can be made and no sections are left blank.

Calculate exposure based on water body-specific fish mercury levels. Mercury concentrations in fish vary by species and by water way. For this effort, fish mercury levels in the exposure calculations were in some cases based on fish data from across the Sierra Nevada, or from Sacramento Delta and San Francisco Bay locations. Analysis of future surveys should include fish mercury values based entirely on fish from target water bodies in order to more accurately calculate specific exposure levels.

Questionnaire Improvements/Revisions

Reposition household demographic questions. The structure of the angler survey questionnaire used in 2009 (based on the Sacramento River angler survey) placed the questions regarding household demographics after questions regarding health hazard awareness. This could create a bias if interviewees became embarrassed to admit feeding mercury-contaminated fish to their families. In some cases interviewers reported that interviewees seemed reluctant or refused to answer these questions. Future surveys may be more accurate if household demographic questions are asked before health hazard awareness questions.

Include spotted bass. Spotted bass are the subject of multiple consumption advisories in the Gold Country, and should be specifically listed in the survey questionnaire.

Reposition age question. A few interviews of minors were inadvertently completed because the question about age category was at the end of the interview. This question should be among the first asked to avoid this problem.

Make age categories consistent with OEHHA guidelines. OEHHA age categories for fish consumption guidelines consist of different guidelines for women over 45, while survey age categories grouped individuals as over or under 49. Future surveys should determine age categories as above or below age 45, in order to be consistent with fish advisories for women.

APPENDIX B

Angler Survey Protocol 2009

This appendix includes the body of a protocol document developed for The Sierra Fund's Gold Country Angler Survey. This document was produced by Friends of Deer Creek in January 2009.

The survey protocol document was intended for use by watershed groups or other organizations to assist in conducting angler surveys in their areas. Contact The Sierra Fund for a full copy of the protocol, which includes background information about mercury and mining activities, and appendices with fish species data, portion models, and health information.

It should be noted that three minor changes were made to the survey questionnaire for the 2010 field season. These changes had no effect on the protocol for conducting the interview.

- *A series of questions were added (after original question 6) to characterize and quantify commercial fish consumption.*
- *The Health Warnings Section was moved after the Household Demographics Section.*
- *The angler's weight was asked or estimated as the final question of the interview.*

Survey Protocol: How to Plan and Conduct the Angler Survey

The following sections outline the approach to planning and conducting the survey:

1. Identify Survey Area
2. Research Fishing Activities
3. Identify at Risk Fishing Populations
4. Identify Timing of Target Fishing Activities
5. Survey Questions and Approach
6. Recruit and Train Survey Interviewers
7. Conduct Survey

Identify Survey Area

Each participating organization will define their survey area based on their available human and financial resources and the extent of the potential mercury exposure problem in their area. For example if the goal is to understand the fish consumption at a single water body, then the survey need only be conducted at that location. If the goal of the survey is to address fish consumption throughout a watershed or on more than one watershed, then the survey should be conducted wherever fishing activity is known to occur in the watershed. Ideally, the survey area would be based on an area local to the organization which is logistically manageable (within one hour drive of the organization office) and where mercury impacted fishing waters are present.

Within the general survey area specific target waterways should be determined based on existing information such as the presence of mercury impacted waterways, either those defined by regulatory agencies (303d listings) or suspected based on historic activities. This would include historic mining activities which released mercury within or upstream of the target waterway. All waterways which have been 303d listed for mercury impacts by the California Regional Water Quality Control Boards should be considered priority locations for surveys. Using historical books, illustrations and maps, identify all possible sources of mercury including hydraulic mining, hard rock gold mining where stamp mills used mercury or waste water treatment plants which release effluent to waterways

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Prioritize your identified waterways by magnitude of potential impact, regulatory listings, likely amount of fishing activity and accessibility. Identify a list of specific target waterways likely to have significant mercury impacts and fishing activity. You may want to identify more potential waterways initially and focus on the highest priority locations first depending on resource availability.

Research Fishing Activities in Target Waterways

Once you have identified a list of target waterways for your survey, begin researching fishing activities in these areas. The following list of suggested activities will help you to find popular fishing spots, learn what types of fish are typically caught in these locations and decide where to conduct your survey.

1) Start with an internet search such as “fishing”, “(name of target waterway)”. Many fishing web sites provide useful information for your survey. Google Earth and web based mapping services will help identify access and use patterns. List specific information which will help in conducting the survey such as specific fishing locations, types of fish caught, bait shop locations and guide services (a valuable source of fishing information).

2) Visit the waterways; look for fishermen, note accessible fishing locations, evidence of fishing, boat ramps, bait shops.

3) Talk to local fishermen if you see them or anyone who might know about fishing. Ask people background questions about fishing in that location such as: How is the fishing here? What fish do you catch? How big do they get? When is the best time to fish? Are they good to eat? Do a lot of people fish here? Who fishes here? Do they eat the fish? etc.

4) Research whether any angler surveys have been done for this waterway (mercury or not) such as creel surveys by the Department of Fish and Game.

5) Interviews: Make phone calls to guide services, bait shops and the Department of Fish and Game (DFG). The local DFG game warden is likely the most knowledgeable person regarding all aspects of fishing activities in your area.

Once you have completed the above steps, you should have enough information to determine where and when to conduct your angler survey.

Identify At Risk Fishing Populations

While you conduct your background research, keep in mind the question; which groups are most likely eating the fish caught in local waterways? Develop a general idea of where you can get the most information from these groups. Indentify and contact local Tribes and Tribal Governments to ask for their input and assistance in conducting your survey. Talk with Government Agencies or other groups about fishing and awareness of mercury health issues associated with eating fish such as County Health Departments, California Department of Public Health (CDPH), Department of Fish and Game (DFG) and community service organizations. Record the names and contact information of helpful people in each organization. Tell them about your angler survey project. Ask for their advice and if they are interested, offer to share your survey findings once you have completed the study. In this way you will build a group of technical advisors and community stakeholders who will be helpful to your organization during the survey and in the future.

Based on your background research and general inquiries, identify all populations who may be at risk of eating mercury impacted fish. Anecdotal evidence suggests that individuals who rely on fishing for a part of their diet may not obtain fishing licenses and therefore may not be aware of fish advisories. It may be challenging to get these people to participate in your survey and may require creative strategies. The CDPH Needs Assessment, (conducted mainly in the Central Valley region) identified Southeast Asians, Latin Americans, African Americans and Russians as ethnic groups who eat locally caught fish. Native American Tribes in the Sierra Nevada region also eat locally caught fish as a traditional part of their diet. If you suspect any of these groups area fishing in your area make every effort to include them in your survey.

Previous studies have suggested that shore fishermen and bait fishermen are more likely to be eating the fish they catch and may be less aware of health advisories than fly fishermen and boat fishermen. While all fishermen should be part of the survey, at risk fishing groups should be the main target of your survey, especially if resources are limited. Be aware of the different ethnic groups and potential language barriers. For example Southeast Asians traditionally rely on fish as a major part of their diet. Recent immigrants may speak little English and may have no way of knowing of mercury hazards. Special considerations may be required to survey these fishermen. Your survey will be most effective if you can recruit translators, cooperative bilingual fishermen and ethnic community service groups such as the South East Asian Assistance Organization to assist in bridging the language barriers. In home surveys for different ethnic groups conducted by an interviewer in the native language may be easier to conduct and more comprehensive.

Identify the Best Time to Conduct the Survey

Levels of fishing activity in the Sierra Foothills region vary considerably based on time of year, weather, water level, water temperature, insect hatch, fish planting etc. Research or ask knowledgeable people (guide services, game warden, etc.) when the best time of year, time of day and weather for fishing are. Each waterway may be different depending on elevation, fish species, fish planting and other local conditions. Check local newspapers sports pages for fishing columns or articles about fishing conditions in your area. Review published Department of Fish and Game (DFG) regulations regarding fishing seasons.

Based on initial inquiries, find out when the most common fishing season is (often spring or summer) and what time of day the most fishermen are out. If they fish from boats, when do they typically go out and return? Do shore fishermen fish at different times than boat fishers or fly fishermen? Before you start the survey, figure out when you have the best chance of meeting fishermen who will participate in your survey.

Survey Questions

This protocol document includes a template survey provided as Appendix A. The template is based on a Sacramento River and Delta survey conducted by Healthy Fish Coalition in 2005 and has been modified by Friends of Deer Creek for use in the Bear River, Deer Creek and South Yuba River watersheds. To adopt the survey for your area, modify the place names of target waterways (page 1) and fish species (questions 5a and 5d). The survey is intended to be used along with previous surveys in the Sacramento San Joaquin River Delta and proposed surveys in the Sierra Nevada Region in order to be able to evaluate fish mercury exposure over a broad geographical area. Consistency in data collection is critical to this effort.

The following guidelines and suggestions on how to give the survey effectively are referenced to specific questions on the attached Gold Country Survey template (Appendix A). Use these suggestions to train the people who will be giving the survey.

General: Approach fishermen in a friendly conversational manner. Be prepared to ask the first few questions (at least questions A, 2, 3a) before you pull out paperwork or a clip board. At this point, ask if the person is willing to participate in a survey that will take about 10 minutes. If they say yes, then you can pull out the clipboard, briefly jot down the initial responses and continue with the survey. Be sure to move through the questions relatively quickly. Fishermen will likely be anxious to start fishing or get back to fishing.

Date, Interviewer Name, Time, Location: This information is important in case questions come up during data compilation and evaluation so that the Survey interviewers can be contacted and to refresh his or her memory.

Question A: (Have you ever been interviewed) If the person answers yes and they have been interviewed by a person in your organization for the current survey, thank them and do not continue the survey. This will avoid duplicate data collection. If they say no or that they participated in a different survey, continue with the interview if they are willing.

Q2. (What fish are you catching) Take a brief answer, Question 5 asks more specific details on the species of fish they may be catching and eating.

Q3a. (Are you going to eat the fish) This question may prompt the interviewee to ask "why do you ask?" If they do, defer the question until the end of the interview. This will avoid biasing their responses. Offer to give them a brochure and answer their questions at the end of the survey. Say "I'd be happy to answer all your questions at the end of the interview, but we would like to get your responses before we give you our information." In this way you will reduce the risk of biasing their answers and your data.

Q4. (How often do you fish?) If they are not sure, ask for an estimated number of fishing days in the past month.

Q5a-5d. (Fish species and amounts eaten) These questions will be easier to get accurate answers if you have props including color pictures of fish species and scale models or pictures of fish filet portions.

Q5a. Show the interviewee a printed card showing names and pictures of fish species. People may not know the names of fish or use different names for the fish. Record the name they give you and if different, what you think the species listed on the survey is.

Q5c. (Size of portions) The Healthy Fish Coalition survey used scale models of portion sizes to show survey participants. Models are provided to assist in giving surveys. Use the models to show people for a visual approximation of how much they typically eat. If models are not available for your survey, show the interviewees the scaled fish filet portion. This picture shows the large (12 oz) size portion. Be sure to tell them this is an uncooked filet. Marks on the picture indicate the approximate, medium (8 oz) and small (4 oz) portion sizes. Be sure not to modify the scale when copying this picture.

Q5d. (Where fish caught) Modify your survey question to include your target waterways. Note code numbers for each location which will be used during data evaluation.

Q6a,b. (Amount of commercial fish consumption) This question is important to help identify the total amount of fish people are eating. Commercial fish (particularly ocean fish) also contain varying amounts of mercury depending on species and size.

Q7a.-9. (Health warning awareness) Have a fish mercury health warning pamphlet to give the interviewee but do not give it to them until the interview is complete. Do not push a pamphlet on them if they seem uninterested.

Q9. (Information sources) Ask this question without reading response categories. We are only interested in their clear recollections as opposed to sparking vague recollections.

Q10.-13. (Household and demographic info) Be sensitive when asking personal questions. Although these questions are very important to knowing who is eating the fish, do not push people who seem unwilling to answer personal questions.

Q13a. (Ethnicity) This is also important but it may be a sensitive question. If they don't readily answer this question, go to Q 13c. and record an apparent ethnicity. Determining the ethnicity of people who eat fish will help target communities and languages for health risk warnings.

Q14. 15. 16. (Age zip code, gender) The answers to these questions will be useful to determine demographics of "at risk" groups.

Special Questions. These questions are optional and can be given to willing participants who show interest in mercury contamination in the fish they catch. Give them a brochure when you

ask these questions and be willing to discuss their concerns. For example, be able to quote or show them the OEHHA fish consumption advisories for the particular waterway you are on and the fish they may be catching.

Recruit and Train Survey interviewers

A major factor in the effectiveness of your survey will be to having enough trained and enthusiastic survey interviewers to cover the specific waterways and target populations you determine. You may need to narrow down the number of target waterways and survey locations, so that you have enough Survey questioners to adequately cover each location. A recruitment effort could include emails or flyers to members and volunteers of your organization. If a University or Community College is located in your area, motivated students could be volunteer survey interviewers. Contact a science department faculty member or student advisor to help you recruit volunteers. Some schools may give credit to students who participate in conducting the angler survey.

Organizational meetings:

Once you have a group of interested people, hold a meeting to discuss the project, distribute copies of the survey, protocol document and pamphlet. Request input to encourage "ownership" If you need more people, encourage attendees to recruit their friends.

Training: Once you have a survey team, make sure they are familiar with survey protocol, memorize key survey questions so they can approach fishermen in a casual manner. Discuss time commitments, safety issues, assign teams and coverage areas. Identify language barriers early in the process. If possible, find bilingual survey interviewers to match with fishermen language groups. Strategize on access points, times to give surveys, how to approach people to encourage participation. For example, if attempting to interview fishermen who may not have licenses, survey interviewers could bring a fishing pole and fish themselves to gain trust and ask as many questions as possible from memory.

Have survey interviewers practice on each other before they go out, so that the survey can be done without heavy reliance on the paperwork. The survey will be more effective if the initial questions can be given and the fisherman is comfortable with participating before paperwork is pulled out. Ask if the fisherman is willing to complete the survey before digging in to the more detailed questions.

Conducting the Survey

The angler survey can be conducted over as wide a geographical area as is feasible for the participating organization. All data can potentially be valuable in identifying at risk fishing groups and developing strategies for directing information and advisories which are protective of human health. Especially in the case of smaller surveys, the goal of the survey may not be so much to provide detailed quantitative statistical analysis, as to identify specific at risk fishing groups, where they fish, what they catch and how much fish they eat. This information will be used to better inform policy makers at risk groups and to inform and promote mercury cleanup efforts.

Teams of two people should go out together for safety, support and fun. Have survey interviewers split up to give surveys in a broader area. Have each survey questionnaire stapled or bound together and the props handy so the survey can be given efficiently. Approach fishermen in a calm friendly manner so that you do not disturb their fishing experience. Any adult with a fishing pole is a potential candidate to be interviewed. If you encounter a group of fishermen, try to interview as many fishermen as will cooperate, but try and get them to move away from the group for the interviews so that their answers do not influence later interviewees.

Consider giving thank you gifts such as lures or color fish ID cards to survey participants. The Healthy Fish Coalition offered a choice of lures from a tackle box to fishermen after they had completed a survey. Other surveys have handed out fish carabineers to survey participants. This is a nice gesture of appreciation and leaves everyone with a good feeling about the survey experience.

Identify a target number of questionnaires to complete for your survey. The more survey questionnaires that are completed, the more accurate the statistical analyses will be and the less statistical variability will be inherent in the data. Set a specific time period over which your angler survey will be given (such as 2 months) so data collection and evaluation can be efficient and doesn't drag on. You could have a pilot survey period with later surveys such as at a different seasons or split up the survey by location if you have limited resources or if timing of high fishing activities varies by waterway.

Different populations may fish at different times. Some studies have suggested that the majority of fishing activities happen before 9am and after 6pm. Schedule times of day and days of the week that your surveys are conducted so that all fishing activity is represented in your data.

Set achievable targets for your survey interviewers in advance including, number of surveys per day, number of days in the field and hours per day. Talk with your survey interviewers frequently and ask for feedback and accounts of their experiences. This way survey interviewers feel useful but not overused and you avoid burnout. Schedule survey times in advance and have a responsible staff person from your organization on call during survey periods to provide support and deal with any problems or questions that arise. A staff person should also be designated to collect completed surveys within a reasonable time frame.

APPENDIX C

Gold Country Angler Survey Target Waterbodies

This appendix provides detailed information on several of the waterbodies targeted by the study. A map showing all waterways included in the survey can be found on page 10.

Deer Creek

Deer Creek, a southern tributary of the Yuba River, is approximately 30 miles long and runs from its headwaters at 5,000 feet elevation through Upper Scotts Flat and Lower Scotts Flat Lakes, Nevada City, Lake Wildwood and into the Lower Yuba River below Lake Englebright. During the latter half of the 19th century until the middle of the 20th century, mining activities in the watershed deposited vast quantities of hydraulic mining debris and stamp mill tailings in Deer Creek and its tributary drainage courses. Hydraulic mining debris (gravel, sand, and fine particles) were washed down from hydraulic mines, angular waste rock was deposited on the creek banks from hard rock mining tunnels, and mercury-contaminated mill sands were discharged into the creek from stamp mills. Mining in the Deer Creek watershed produced approximately 25 million cubic meters (33 million cubic yards) of mine waste, which is equivalent to the removal of approximately 13 centimeters (five inches) of material across the entire watershed area (Allan, 2009).

Hydraulic and hard rock mining debris in Deer Creek – Photo of the Champion Mine and Home Mine, upstream of Lake Wildwood, viewed from the east at the Providence Mine, two miles west of Nevada City. (Photo: Friends of Deer Creek)

Posted fish advisories were neither observed, nor anticipated at popular fishing locations on Deer Creek. Deer Creek was 303(d) listed as impaired for mercury in November 2010. Deer Creek had a fish consumption advisory in 2003 for all trout, which recommended no more than two meals per month for women of childbearing age and children age 17 and younger. However, in 2009 OEHHA determined that there was not enough data to support a fish advisory for Deer Creek (OEHHA, 2009). Little Deer Creek, a tributary that converges with Deer Creek in Nevada City, is also 303(d) listed as impaired for mercury due to USGS samples taken in 1999 by May et al. (CVRWQCB, 2006).

Upper and Lower Scotts Flat Lakes

Upper Scotts Flat Lake is a reservoir located in the upper Deer Creek watershed at an elevation of approximately 3,000 feet. Lower Scotts Flat Lake, just downstream, is much smaller. Together they have combined water storage of 5,555 acre-feet (Nevada Irrigation District, 2001). Upper Scotts Flat offers a wide variety of fish, including German brown and rainbow trout,

kokanee salmon, largemouth bass, smallmouth bass, bluegill, bullhead catfish and channel catfish. Lower Scotts Flat has rainbow trout, brown trout and a self-sustaining population of kokanee salmon. Upper Scotts Flat offers a barrier-free fishing pier and launch ramp facilities, a full service marina and abundant camping facilities. Lower Scotts Flat is a quiet, lightly-fished reservoir where "the bank fisherman and float tuber is king." The Department of Fish and Game stocks 5,000 pounds of catchable rainbows in the upper lake and 1,000 pounds in the lower lake each year, according to the American River Fish Hatchery. The DFG also stocks 50,000 kokanee salmon fingerlings annually in the upper lake.

Posted fish advisories were not observed at Upper Scotts Flat Lake or Lower Scotts Flat Lake. Upper Scotts Flat Lake is listed as impaired for mercury by the Clean Water Act section 303(d) (CVRWQCB, 2010). Upper Scotts Flat Lake also had a fish advisory in 2003 recommending no more than one meal per month of bass and no more than two meals per month of catfish for women of childbearing age and children age 17 and younger. However, in the 2009 update due to more stringent data requirements, it was determined that there was insufficient data to issue a fish consumption advisory on Upper Scotts Flat Lake (OEHHA, 2009). The Nevada Irrigation District has expressed interest in posting this reservoir with general fish consumption and mercury advisory information at the boat launch area and at the fish washing area.

Lake Wildwood

Lake Wildwood is a relatively shallow reservoir located in the lower Deer Creek watershed. The reservoir is located downstream of large hydraulic and hard rock gold mine sites and receives sediment and water contaminated with mercury. The lake is privately owned by the Lake Wildwood Association and is surrounded by residential development. The only public access other than homeowners and guests is from the dam area along Pleasant Valley Road. People fish from the dam and from the shore at this location, especially during the spring and early summer. As the lake warms during the summer, fishing activity at the dam decreases significantly. The water level in Lake Wildwood is lowered most years by over ten feet in the fall (around early October) to allow for dredging of accumulated sediment. Lake Wildwood is located within a 30 minutes' drive of Marysville and other low-income Central Valley communities.

Fish advisory signs posted at Lake Wildwood
(Photo: James Worthy)

A posted fishing advisory sign is located on the dam at Lake Wildwood. The sign reads:

> *Warning: The California Office of Environmental Health Hazard Assessment has issued a health advisory urging limited consumption of largemouth bass caught in Scotts Flat Reservoir in the Deer Creek watershed (which is upstream from Lake*

Wildwood). Because of a pattern of mercury contamination in fish sampled throughout the Sierra Lakes Region, which includes Lake Wildwood, women of childbearing age and children under 18 should eat bass no more than once a month. Others should eat bass no more than twice a month. For information on advisories in this area call OEHHA at 916-323-4763.

A "Catch and Release Largemouth Bass" sign was also recently erected at the dam fishing location. Both of these signs are in English. Lake Wildwood was recently listed as impaired for mercury under the Clean Water Act but it does not currently have a fish consumption advisory issued by OEHHA.

Rollins Lake

Rollins Lake is a reservoir in the upper Bear River watershed at an elevation of approximately 2,200 feet with a surface area of 900 acres and 26 miles of shoreline. Rollins has a storage capacity of 65,988 acre-feet. It is located on the border of Nevada County and Placer County. Rollins Lake is 303(d) listed for mercury and is located downstream of Greenhorn Creek, Steephollow Creek, and the upper Bear River, all of which remain choked with mercury-contaminated historic hydraulic mining debris. In addition, the reservoir catchment basin contains both large and small abandoned hydraulic mine pits which discharge mercury-contaminated sediment and water.

Greenhorn Creek, a tributary to Rollins Reservoir – Photo taken in 2010 shows the creek channel still choked with hydraulic mining debris. (Photo: Nevada Irrigation District)

Rollins Lake is accessible from Interstate 80 near the town of Colfax off Rollins Lake Road and from Highway 174 off Orchard Springs Road and Greenhorn Road. Boat ramps are located to the north of the dam and southeast of the dam. Private campgrounds are located on a northern arm of the lake off Greenhorn Road and on the east side of the lake off You Bet Road. According to a fishing web site, brown trout fishing is best in winter and fall, rainbow trout in spring and summer, smallmouth bass in spring, summer and fall, channel catfish in summer and fall, and bluegill and crappie in summer and fall.

Posted fish advisories were not observed at any of the three Rollins Lake boat ramps that were visited.

Rollins was 303(d) listed as impaired for mercury in 2010, and it does have a current fish consumption advisory for catfish, of which no more than one meal per month is recommended for women of childbearing age and children age 17 and younger (OEHHA, 2009). Other fish species such as bluegill, brown trout, crappie and largemouth bass may be impacted by mercury, however OEHHA did not have sufficient sample data from which to develop a fish consumption advisory for these species at Rollins Lake. The Nevada Irrigation District has expressed interest in posting this

reservoir with general fish consumption and mercury advisory information at the boat launch areas.

Camp Far West Reservoir

Camp Far West Reservoir is in the lower Bear River watershed at an elevation of 300 feet. The lake is approximately 2,200 acres in size with 30 miles of shoreline when full. The lake is mostly in Yuba County with the western shore in Nevada County and the southern shore in Placer County. It is a 303(d) listed waterway for mercury contamination resulting from mine waste from upstream in the Bear River. Recent USGS studies have identified some of the highest mercury levels in fish in the Sierra region in this reservoir. It is located within one hour's drive of Sacramento and 15 to 30 minutes of the towns of Lincoln, Wheatland and Marysville, providing easy access to low-income fishermen as well as sport fishermen. Fishing is mainly from boats and occasionally from the shore. Boat ramps are located at the North Recreation Area, accessible from Camp Far West Road and the South Recreation Area accessible from Karchner Road. According to a fishing web site, largemouth (black) bass are the most popular sport fish along with spotted bass and smallmouth bass. Night fishing is reportedly "great in the summer." Other fish include channel catfish, crappie, bluegill and bullheads.

No posted fishing advisories were observed at either of the two entry gates, boat ramps or camping areas at Camp Far West Reservoir. Camp Far West is listed as impaired for mercury by the Clean Water Act section 303(d) and it has a 'Do Not Eat' fish consumption advisory for catfish and largemouth, smallmouth and spotted bass, and recommends one serving per week of bluegill and crappie for women of childbearing age and children age 17 and younger (CVRWQCB, 2010; OEHHA, 2009).

Lake Englebright

Lake Englebright is a long, narrow, and deep reservoir in the lower Yuba River watershed at an elevation of 527 feet. The lake is 850 acres in size and has 24 miles of shoreline. Englebright Dam was constructed as a debris dam to contain hydraulic mining debris from the three forks of the Yuba River. It is a listed by the Clean Water Act section 303(d) as impaired for mercury. It is accessed from Mooney Flat Road off State Highway 20, approximately 30 minutes' drive from Marysville and 20 minutes from Grass Valley. The main fish species include rainbow and brown trout, kokanee salmon, smallmouth and largemouth bass, and catfish. Most fishing was observed to be from boats. Limited shore fishing is accessible from the dam area and the boat ramp area on the south side of the lake or from Rice's Crossing Road near the upper end of the lake.

One posted fishing advisory was observed at the Joe Miller Recreation Area boat ramp at Lake Englebright. The posting was on a letter-sized printed black and white sheet on a bulletin board with several other fliers and could easily be overlooked by many anglers. Lake Englebright has a "Do Not Eat" fish consumption advisory for largemouth, smallmouth and spotted bass, and recommends no more than one meal per week of bluegill and sunfish, and two meals per week of rainbow trout for women of childbearing age and children age 17 and younger (OEHHA, 2009).

APPENDIX D

Gold Country Angler Survey

Date: _____ **Interviewer name:** _____ **Time start:** _____:_____ **am** **pm**
end: _____:_____ **am** **pm**

Location of Interview:

- ☐ Lake Wildwood
- ☐ Upper Scotts Flat Lake
- ☐ Lower Scotts Flat Lake
- ☐ Deer Creek- location:_____
- ☐ Lake Englebright
- ☐ South Yuba River- location:_____
- ☐ Camp Far West Reservoir
- ☐ Lake Combie
- ☐ Rollins Lake
- ☐ Bear River- location:_____
- ☐ Other:_____

A. Have you ever been interviewed before about fishing or eating fish

- ☐ Y (fishing ___eating fish ___) Who?
- ☐ N (proceed)

1b. [IF INDIVIDUAL DOES NOT WANT TO BE SURVEYED] Please note any known reason that they declined:

- ☐ No time
- ☐ Language barrier
- ☐ Appeared threatened/uncooperative
- ☐ Other:_____
- ☐ Unknown

1c. [IF NO] Record observed gender and ethnicity:

- ☐ Male ☐ Female
- ☐ White ☐ Asian/Pacific Islander
- ☐ Black ☐ Native American
- ☐ Hispanic ☐ DON'T KNOW
- ☐ Other _____

2. What are you trying to catch today?_____

3a. Are you going to eat the fish you catch today?

- ☐ Yes
- ☐ No
- ☐ Don't know/Not Sure
- ☐ Refused

[If yes] Are you going to feed it to your family? ☐ Yes ☐ No

3b. [IF NO] What are you going to do with the fish you catch?

- ☐ Give it to others to eat
- ☐ Catch and release it
- ☐ Other: _____
- ☐ Refused

3c. [IF NO] Do you ever eat fish that you or someone you know catches?

- ☐ Yes
- ☐ No [IF NO, SKIP TO **Q6a**]
- ☐ Don't know/Not Sure [SKIP TO **Q6a**]
- ☐ Refused [SKIP TO **Q6a**]

4. About how many times did you go fishing in the last 30 days?

_____**[ENTER NUMBER] per**

- ☐ week
- ☐ month
- ☐ other_____
- ☐ Don't know
- ☐ Refused

5a. Do you eat [*NAME OF FISH]* that you or someone you know catches? *Ask about specific fish listed below, as well as any others that are not named.* *Do this question first down the column, then come back and do fish by fish for b-d.*	**5b. How many times did you eat *[NAME OF FISH]* in the LAST 30 DAYS?** *If zero, skip to next row.*	**5c. How much *[NAME OF FISH]* did you eat in one meal?** *SHOW PICTURE OF FISH PIECES. Circle letter and write number of UNCOOKED models per meal.* *Only ask for types eaten in the **last 30 days.*** **A – Small** **C – Medium** **E – Large**	**5d. Where was the *[NAME OF FISH]* caught?** *Only ask for types eaten in the **last 30 days.*** *WRITE RESPONSE AND ENTER CODE* 1= Lake Wildwood 2= Upper Scotts Flat Lake 3= Lower Scotts Flat Lake 4= Deer Creek 5= Englebright Lake 6= South Yuba River 7= Camp Far West Reservoir 8= Lake Combie 9= Rollins Lake 10= Bear River 11= Other Location of survey(write response below)
☐ Catfish/Bullhead		A C E (Circle) ____ # of portion models/meal	
☐ Bass (don't know which species)		A C E (Circle) ____ # of portion models/meal	
☐ Large Mouth Bass		A C E (Circle) ____ # of portion models/ meal	
☐ Small Mouth Bass/ Black Bass		A C E (Circle) ____ # of portion models/ meal	
☐ Stripped Bass		A C E (Circle) ____ # of portion models/ meal	
☐ Sunfish		A C E (Circle) ____ # of portion models/ meal	
☐ Bluegill		A C E (Circle) ____ # of portion models/ meal	
☐ Crappie		A C E (Circle) ____ # of portion models/ meal	
☐ Rainbow Trout		A C E (Circle) ____ # of portion models/ meal	
☐ Brown trout		A C E (Circle) ____ # of portion models/ meal	
☐ Kokanee Salmon		A C E (Circle) ____ # of portion models/ meal	
☐ Other_____		A C E (Circle) ____ # of portion models/ meal	
Do you eat [*NAME OF SHELLFISH]* that you or someone you know catches?			
☐ Clams		____ # of clams/meal	
☐ Crawdads/ crayfish		____ # of crayfish/meal	

6. In the last 30 days, have you eaten fish that came from stores, markets, restaurants, or cafeterias? (examples, tuna, fish sticks)

☐ Yes

☐ No

☐ Don't know/ Not Sure

☐ Refused

7a. Do you eat [*NAME OF FISH]* from stores, markets, restaurants, or cafeterias? *Ask about specific fish listed below, as well as any others that are not named.* *Do this question first down the column, then come back and do fish by fish for b-d.*	**7b. How many times did you eat *[NAME OF FISH]* in the LAST 30 DAYS?** *If zero, skip to next row.*	**7c. How much *[NAME OF FISH]* did you eat in one meal?** *SHOW PICTURE OF FISH PIECES or models. Circle letter and write number of UNCOOKED models per meal.* *Only ask for types eaten in the **last 30 days.*** **A – Small** **C – Medium** **E – Large**	**7d. Where was the *[NAME OF FISH]* bought?** *Only ask for types eaten in the **last 30 days.*** *WRITE RESPONSE AND ENTER CODE* 1= grocery store 2= restaurant 3= cafeteria 4= Other
☐ Shark		A C E (Circle) ____ # of portion models/meal	
☐ Bass		A C E (Circle) ____ # of portion models/ meal	
☐ Swordfish		A C E (Circle) ____ # of portion models/ meal	
☐ Tile fish		A C E (Circle) ____ # of portion models/ meal	
☐ King Mackerel		A C E (Circle) ____ # of portion models/ meal	
☐ Albacore Tuna		A C E (Circle) ____ # of portion models/ meal	
☐ Canned Tuna		A C E (Circle) ____ # of portion models/ meal	
☐ Salmon		A C E (Circle) ____ # of portion models/ meal	
☐ Fish sticks		A C E (Circle) ____ # of portion models/ meal	
☐ Halibut		A C E (Circle) ____ # of portion models/ meal	

☐ Other_____		A C E (Circle) ____ # of portion models/ meal	
Do you eat [*NAME OF SHELLFISH]* that you or someone you know catches?			
☐ Clams		____ # of clams/meal	
☐ Calamari		____ # of calamari/meal	
☐ Shrimp		____ # of shrimp/meal	

HOUSEHOLD & DEMOGRAPHIC INFORMATION

8. In the past year, have any children under 18 in your household eaten fish that you or someone you know catches?

☐ Yes
☐ No
☐ Don't know/ Not Sure
☐ Refused

9. In the past year, have any women between ages 18 and 49 in your household eaten fish that you or someone you know catches?

☐ Yes
☐ No
☐ Don't know/ Not Sure
☐ Refused

10. In the past year, have any women expecting a child or who have a baby in your household eaten fish that you or someone you know catches?

☐ Yes
☐ No
☐ Don't know/ Not Sure
☐ Refused

HEALTH WARNINGS

11a. Have you ever heard or seen any health warnings about eating fish?

☐ Yes →

☐ No

☐ Don't know/Not sure [GO TO Q9]

☐ Refused

11b. [IF YES] Do you remember what the warning said?

☐ Yes

☐ No

☐ Don't know/Not sure

☐ Refused

[IF YES, RECORD EXACT RESPONSE]

_____

_____

_____

12. Do you remember where you saw or heard this warning?

1 ☐ Television 2 ☐ Radio 3 ☐ Sign at fishing location 4 ☐ Friend 5 ☐ Brochure
6 ☐ Market or store 7 ☐ Clinic 8 ☐ Other: _____
9 ☐ Don't Know/Not Sure 10 ☐ Refused

13. Where do you get information about your health, about what is good or bad for you, that you <u>trust, that you really believe</u>?
[DO NOT READ RESPONSE CATEGORIES. CHECK UP TO 3 THAT APPLY.]

1 ☐ Health care provider, clinic or hospital
2 ☐ Internet
3 ☐ Friend, family member
4 ☐ TV
5 ☐ Radio
6 ☐ Books
7 ☐ Newspaper/Magazine
8 ☐ Fishing Regulation Manual
9 ☐ Posted signs
10 ☐ Community center or organization
11 ☐ Church, mosque, or temple
12 ☐ Other (specify): _____
13 ☐ Don't know/Not sure
14 ☐ Refused

14a. If you don't mind, could you tell me how best to describe your race or ethnicity. [SHOW list. CHECK ALL THAT APPLY]

☐ **White**
- ☐ Russian
- ☐ Ukrainian
- ☐ Other _____

☐ **Black/African American**

☐ **Black/Caribean**

☐ **Native American**

☐ **Hispanic/Latino**
- ☐ Mexican
- ☐ Guatemalan
- ☐ El Salvadorian
- ☐ Nicaraguan
- ☐ Honduran
- ☐ Caribean (Dominican, Puerto Rican, Cuban, etc.)
- ☐ Other: _____

☐ **Other:** _____

☐ **Unknown**

☐ **Refused**

☐ **Asian**
- ☐ Cambodian
- ☐ Chinese
- ☐ Hmong
- ☐ Filipino
- ☐ Japanese
- ☐ Khmu
- ☐ Korean
- ☐ Lao
- ☐ lu-Mien
- ☐ Vietnamese
- ☐ Other:_____

☐ **Pacific Islander**
- ☐ Fijian
- ☐ Hawaiian
- ☐ Samoan
- ☐ Tahitian
- ☐ Tongan
- ☐ Other:_____

14b. [IF MORE THAN ONE BOX SELECTED] Which race do you most identify with: _____

14c. [IF REFUSED, RECORD OBSERVED ETHNICITY]: _____

15. If you don't mind me asking, what is your age: [READ CHOICES. CHECK APPROPRIATE BOX.]

1 ☐ Under 18

2 ☐ between 18 and 34

3 ☐ between 35 and 45

4 ☐ over 45

5 ☐ Refused

16. What zip code do you live in? _____

17. [RECORD GENDER]

☐ male

☐ female

18. [RECORD APPROXIMATE WEIGHT]

☐ under 70 pounds

☐ over 150 pounds

☐ estimate_____

Special Questions We are doing this surveying because there is mercury in the fish in the lake/river that people like you are eating. We know where a lot of the mercury is coming from, how it is getting into fish, and that people like to eat the fish.

We would like to know what you think should be done about this?

Do you think the government should clean up the mercury so it does not get into the fish?

Do you think people like you should eat less fish because there is mercury in the fish?

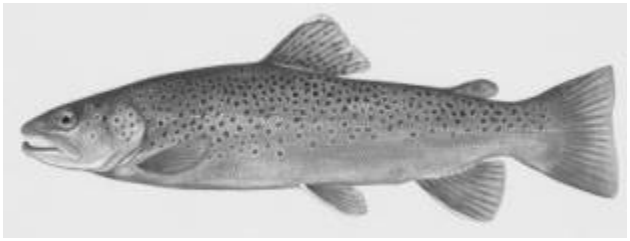
APPENDIX E

Sierra Nevada Sport Fish Species

Black Crappie (*Pomoxis nigromaculatus*)

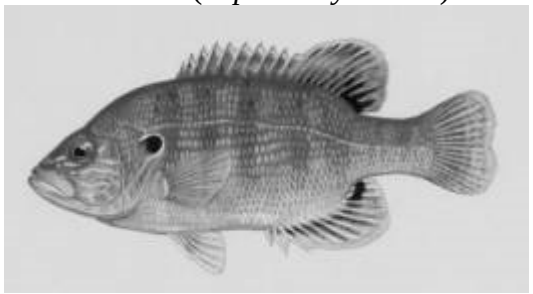
Bluegill (*Lepomis macrochirus*)

Brown Trout (*Salmo trutta*)



Channel Catfish (*Ictalurus punctalus*)

Green Sunfish (*Lepomis cyanellus*)

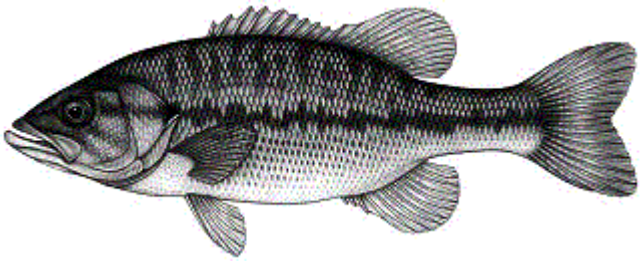


Largemouth Bass (*Micropterus salmoides*)

Rainbow Trout (*Oncorhynchus mykiss*)

Smallmouth Bass (*Micropterus dolomieu*)

Spotted Bass (*Micropterus punctulatus*)



APPENDIX F

Fish Portion Model

APPENDIX G

Health Advisory for Selected Water Bodies in the Northern Sierra Nevada Foothills (Nevada, Placer, and Yuba Counties)

California Office of Environmental Health Hazard Assessment (OEHHA)
December 12, 2003

Based on evaluation of data from this Sierra region OEHHA recommends that females of childbearing age and children aged 17 and younger should eat no bass from Camp Far West Reservoir. Additionally, they should eat no more than two meals per month of channel catfish from that site. At Lake Combie, Lake Englebright, Rollins Reservoir, and Scotts Flat Reservoir, consumption of bass and channel catfish should be restricted for this group to no more than one or two meals per month for these species, respectively. No more than two meals per month of any trout species should be consumed from Deer Creek or no more than four meals per month of any trout species from mining areas of the Bear and South Yuba Rivers. For other fish in reservoirs or streams in this region and throughout California, it is recommended that females of childbearing age and children aged 17 and younger follow the recent U.S. EPA national freshwater sport fish consumption advice for pregnant or nursing women and young children of no more than four meals per month of fresh water fish (U.S. EPA, 2001).

OEHHA also recommends that females of childbearing age and children aged 17 and younger follow the FDA advice for pregnant women, women of childbearing age who may become pregnant, nursing mothers, and young children on commercial fish consumption. FDA advises these individuals not to eat shark, swordfish, king mackerel, or tilefish because of their high levels of mercury. FDA also recommends that these women can safely eat up to an average of 12 ounces per week of other cooked fish from a store or restaurant such as shellfish, canned fish, smaller ocean fish or farm-raised fish. Children should limit consumption to less than 12 ounces of cooked fish per week. Also, if 12 ounces of cooked fish from a store or restaurant are eaten in a given week, then sport fish caught in the Sierra Lakes region should not be eaten in the same week.

For the females beyond their childbearing years and adult males, OEHHA recommends that bass from Camp Far West Reservoir be consumed no more than two times per month. Additionally, consumption of channel catfish from this reservoir should be limited to no more than four meals per month. Consumption of all bass and channel catfish from Lake Combie, Rollins Reservoir, and Scotts Flat Reservoir should be restricted to no more than two or four meals per month for these species, respectively. Consumption of all bass and channel catfish from Lake Englebright should be limited to no more than four meals per month. Additionally, no more than four meals per month of any trout species should be consumed from Deer Creek or no more than twelve meals per month of any trout species from mining areas of the Bear and South Yuba Rivers. Because of the general pattern of mercury contamination in all fish sampled from the Sierra Lakes region, OEHHA advises that consumption of all other fish for which no site specific

advice is given above be restricted to no more than 12 meals per month for females beyond their childbearing years and adult males from any of the above sites. Additionally, OEHHA recommends that females beyond their childbearing years and adult males take into account the commercial fish they eat, especially high-mercury fish such as shark, swordfish, king mackerel, or tilefish. If they consume these species, they should reduce consumption of sport fish caught in this Sierra region accordingly.

Fish Consumption Guidelines for Females of Childbearing Age and Children Aged 17 and Younger	
Location and Fish Species	Do Not Eat More Than*
	Meals per Month
Camp Far West Reservoir	
All Bass	Do Not Eat
Channel Catfish	2
Lake Combie, Lake Englebright, Rollins Reservoir, and Scotts Flat Reservoir	
All Bass	1
Channel Catfish	2
Bear River below Highway 20, South Yuba River	
Below Lake Spalding	
All Trout	4
Deer Creek	
All Trout	2
All of the Above Sites**	
Other sport fish species	4
* Consumption limits for each species assume that no other contaminated fish are being eaten. If you eat multiple fish species or fish at multiple sites, limit your total consumption to the amount recommended for the fish with the fewest recommended meals. If you also eat fish from a store or restaurant, reduce your consumption of sport fish from the Sierra Lakes region accordingly. **All fish species were not evaluated at all sites. If available, use consumption advice for the most similar species at the same site or the same species at a nearby site, whichever recommends the fewest meals. If consumption advice is not available for that species at any site, follow U.S. EPA national guidance for pregnant or nursing women and young children recommending consumption of no more than one meal per week of freshwater sport fish.	

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

Fish Consumption Guidelines for Females Beyond Their Childbearing Years and Adult Males	
Location and Fish Species	DO Not Eat More Than*
	Meals Per Month
Camp Far West Reservoir	
All Bass	2
Channel Catfish	4
Lake Combie, Rollins Reservoir, and Scotts Flat Reservoir	
All Bass	2
Channel Catfish	4
Lake Englebright	
All Bass	4
Channel Catfish	4
Bear River below Highway 20, South Yuba River	
Below Lake Spalding	
All Trout	12
Deer Creek	
All Trout	8
All of the Above Sites **	
Other sport fish species	12
* Consumption limits for each species assume that no other contaminated fish are being eaten. If you eat multiple fish species or fish at multiple sites, limit your total consumption to the amount recommended for the fish with the fewest recommended meals. If you also eat fish from a store or restaurant, reduce your consumption of sport fish from the Sierra Lakes region accordingly. **All fish species were not evaluated at all sites. If available, use consumption advice for the most similar species at the same site or the same species at a nearby site, whichever recommends the fewest meals. For fish species caught from the listed water bodies but not included in the guidelines, OEHHA recommends consumption of no more than 12 meals per month of any fresh water sport fish from the Sierra Lakes region.	

If you have questions, please contact :
California Environmental Protection Agency
Office of Environmental Health Hazard Assessment
Pesticide and Environmental Toxicology Section
P.O. Box 4010
Sacramento, California 95812-4010
Phone: (916) 323-4763
Fax: (916) 327-7320

APPENDIX H

Office of Environmental Health Hazard Assessment (OEHHA) 2009 Update of California Sport Fish Advisories March 2009

(Excerpts: Protocols and Sierra Nevada Water Bodies)

Excerpt 1: Protocols

OEHHA's Protocol for Updating Fish Advisories

The purpose of this report is to describe the process the Office of Environmental Health Hazard Assessment (OEHHA) used to update existing sport fish advisories. Two factors prompted the update procedure: 1) the development of advisory tissue levels, or ATLs, and 2) new chemical data for fish from California water bodies with advisories. OEHHA included the updated advisories in the California Department of Fish and Game 2009 Sport Fishing Regulations booklets, published in spring 2009. Not all advisories were updated at this time. Updated advisories are also posted on OEHHA's Web site (http://www.oehha.ca.gov/fish/so_cal/index.html).

Advisory Tissue Levels (ATLs)

OEHHA's fish advisories are also called "safe eating guidelines." They provide information to sport fish consumers in California to assist them in choosing to eat fish low in contaminants and high in beneficial fats. OEHHA developed ATLs for evaluating fish tissue data and developing advisories. ATLs were determined after several steps.

Safe Exposure Thresholds

First, OEHHA established limits for exposure to common chemicals in fish based on a review of the toxicity of these chemicals. OEHHA used these safe exposure thresholds to develop the ATLs. OEHHA applies ATLs to measured levels of chemicals in sport fish to determine how much fish can be safely eaten.

Benefits of Eating Fish

Second, OEHHA reviewed studies that showed regular fish consumption—such as twice a week—provides many types of health benefits. ATLs were thus designed to achieve two outcomes that support public health: 1. Discourage eating sport fish that cannot be eaten often because of chemical contamination 2. Encourage consumption of sport fish that can be safely eaten in amounts likely to confer health benefits

Improving Communication

Third, OEHHA took into account principles of good communication when developing the ATLs. For example, ATLs simplify advice by limiting the number of possible recommendations. The ATLs identify the contaminant threshold for fish that can safely be eaten at least once a week. OEHHA uses the ATLs to organize fish with different chemical levels into high, medium, and low level groups. OEHHA also worked with the California Department of Public Health to simplify advisories and improve their design. For further information on ATLs and the toxicology of common chemicals in fish, see the June 2008 OEHHA report[1] by Klasing and Brodberg at: http://www.oehha.ca.gov/fish/gtlsv/crnr062708.html.

New Data for Fish from California Water Bodies

OEHHA obtained new data on mercury and other chemicals in fish from several sources.

(1) The California Surface Water Ambient Monitoring Program (SWAMP) This program collected mainly largemouth bass, but also several other fish species, from lakes throughout California in 2007. In addition to mercury, SWAMP analyzed some samples for selenium and chlorinated hydrocarbon contaminants.

(2) The Fish Mercury Project (FMP) The California Bay-Delta Authority funded researchers from several organizations to study mercury in the Central Valley. Fish samples were collected for three years, 2005 – 2007. (See http://www.sfei.org/cmr/fishmercury/ for more information on this project.)

(3) The United States Geological Survey (USGS) USGS provided fish data to OEHHA from studies of mercury at several water bodies.

(4) The City of Benicia The City of Benicia sampled fish from a local water body in 1998 and tested them for mercury.

OEHHA combined new data with data staff previously used to develop safe eating guidelines. OEHHA then evaluated the combined dataset—using the ATLs—to update the existing safe eating guidelines.

Internal Guidelines for Consistency

A major goal in updating the advisories was to ensure that current and future advisories are based on consistent guidelines. OEHHA developed and used the following guidelines for that purpose.

Sample Size

OEHHA issues advice for fish or shellfish species only when there are enough samples to evaluate.

- ☐ OEHHA requires at least nine individual fish from a species at a water body to issue advice for that species.
- ☐ An exception can apply to a few fish species commonly known to build up high levels of mercury.
    - Examples include largemouth bass and Sacramento pikeminnow.
    - When at least five individuals, but less than nine, of one of these species have been sampled at a water body, OEHHA will consider giving advice for that species.
    - OEHHA will compare mercury levels in that species and others from the same water body that build up mercury. OEHHA will consider giving the same advice for both species.

Related Species

Closely related species can be hard to tell apart, and often have similar levels of contamination.

OEHHA used these guidelines to simplify advice for related species.

- ☐ Closely related species are evaluated together as a group.
- ☐ Examples of closely related species are:
    - Black bass—largemouth, smallmouth, and spotted bass
    - Sunfish—bluegill, redear, and green sunfish
- ☐ The species group must contain at least nine individual fish of two or more of the related species.
- ☐ An average chemical concentration of all fish in the species group is used for the group. The average is weighted by the number of individual fish per species.
    - For example, the average chemical level measured in a composite of ten fish from one species would count ten times more than the level in one fish sampled from a second species.

Balancing Risks and Benefits

OEHHA recommends eating fish species known to have high levels of beneficial fats—omega-3 fatty acids—that can provide health benefits to consumers. OEHHA will consider the omega-3 content of fish species when its chemical level is close to the border between two consumption recommendations.

- ☐ If the species has high levels of omega-3 fatty acids, OEHHA will consider recommending the greater amount of consumption.
- ☐ When omega-3 levels are low, or unknown, OEHHA will consider giving the more restrictive recommendation.

Keeping Communication Simple

Safe eating guidelines are matched to a familiar color code scheme as follows:

- ☐ Fish with high mercury levels are shown in a red category
- ☐ Fish with medium mercury levels are shown in a yellow category
- ☐ Fish with low mercury levels are shown in a green category

When the advice differs for species within the same category, OEHHA may make minor changes for some species to keep the safe eating guidelines simple and easier to follow. For example, OEHHA may choose the most restrictive advice, the most common, or an average of possible recommendations within the category. In these cases, OEHHA considers specific factors for each situation.

The process OEHHA used to update the safe eating guidelines presented in this report can also serve for developing consistent advisories in the future. By using the ATLs to evaluate all fish data and following the internal guidelines described above, OEHHA can provide more uniform advice for eating fish.

Excerpt 2: Sierra Nevada Water Bodies

9. Northern Sierra Nevada Foothills (Nevada, Placer, and Yuba Counties)

OEHHA previously issued an advisory for a combination of several reservoirs, rivers, and creeks in the Sierra foothills. In the advisory update process, only fish species with sufficient sample sizes were given safe eating guidelines. Because sample sizes were not adequate for any fish species from the following water bodies, safe eating guidelines ***are no longer provided***. It was not possible to determine whether fish from these water bodies are safe to eat based on the limited data.

- ☐ Bear River below Highway 20
- ☐ Deer Creek
- ☐ South Yuba River
- ☐ Scotts Flat Reservoir

Other considerations:

Seven largemouth bass were sampled from Scotts Flat Reservoir, and bass are a known accumulator of mercury. However, the average mercury level in bass from Scotts Flat Reservoir (0.38 ppm) was lower than mercury levels in bass from the other reservoirs in the Sierra foothills region. This lower level also corresponds to safe consumption. Because no other fish species

were analyzed from Scotts Flat Reservoir, OEHHA was not able to evaluate whether consumption of bass (or other fish species) from Scotts Flat Reservoir could be recommended.

The remaining water bodies in the Sierra foothills advisory—Lake Englebright, Rollins Reservoir, Camp Far West Reservoir, and Lake Combie—were updated. Separate safe eating guidelines were issued for each water body, as explained below.

10. Lake Englebright (Yuba and Nevada Counties)

The updated safe eating guidelines for Lake Englebright included new data combined with prior data. More information about this updated advisory is given below.

New data:

OEHHA received fish data collected and analyzed for mercury at Lake Englebright by University of California at Davis researchers (in cooperation with the U.S. Geological Survey—USGS) as part of the 2002 Upper Yuba River Studies Program[6]. The dataset included:

- ☐ 29 bluegill
- ☐ 3 largemouth bass
- ☐ 11 smallmouth bass
- ☐ 25 spotted bass
- ☐ 49 rainbow trout

Related species:

OEHHA grouped the following related species:

- ☐ Bass: largemouth, smallmouth, and spotted bass
- ☐ Sunfish: bluegill and green sunfish

Table 6 shows a summary of data used in the updated advisory for Lake Englebright.

Common Name	Number of Fish	Mean Mercury (ppm)	Mean Total Length (mm)
Sunfish	31	0.30	161
Bass	56	0.45	338
Rainbow trout	49	0.08	290

11. Rollins Reservoir (Nevada and Placer Counties)

No new data were available for Rollins Reservoir. The updated safe eating guidelines were based on prior data and the ATLs. Only channel catfish had an adequate sample size for inclusion in the updated advisory. OEHHA omitted the following fish species because sample sizes were too small:

- ☐ Three bluegill
- ☐ Four brown trout
- ☐ One crappie
- ☐ Two largemouth bass

12. Camp Far West Reservoir (Yuba, Nevada, and Placer Counties)

The updated safe eating guidelines for Camp Far West Reservoir included new data. More information about this updated advisory is given below.

New data:

OEHHA combined previous data with new data for Camp Far West Reservoir from two sources to update the safe eating guidelines:

- ☐ SWAMP sampled 13 legal-size spotted bass from Camp Far West Reservoir in 2007 and analyzed them for mercury. They also sampled ten channel catfish and analyzed them for mercury, selenium, and organics.
  - Selenium and organics concentrations were below levels of health concern.
  - OEHHA combined the results for mercury levels with prior data to update the advisory.
- ☐ In addition to sampling in 2000, which provided data for the previous advisory, USGS collected additional samples in 2002 from Camp Far West Reservoir[7]. The samples were analyzed for mercury and included:
  - 16 bluegill
  - 10 spotted bass

Related species:

OEHHA grouped the following related species:

- ☐ Bass: largemouth bass and spotted bass

Beneficial fats:

The mean mercury level for catfish from Camp Far West Reservoir was close to the limit for "no consumption" for the sensitive population, women aged 18 – 45 and children 1 – 17 years. Because catfish are not known to have high omega-3 levels, OEHHA changed the recommendation for the sensitive population from one serving a week to "no consumption." Table 7 shows a summary of average mercury concentrations in the fish samples from Camp Far West Reservoir.

Table 7. Average Mercury and Size in Fish from Camp Far West Reservoir

Common Name	Number of Fish	Mean Mercury (ppm)	Mean Total Length (mm)
Bluegill	19	0.19	140
Channel catfish	13	0.44	443
Largemouth and spotted bass	38	0.85	357

13. Lake Combie (Placer and Nevada Counties)

The updated safe eating guidelines for Lake Combie included new data combined with prior data. More information about this updated advisory is given below. **New data:** In 2007, SWAMP sampled two fish species from Lake Combie. Ten legal-size largemouth bass were analyzed for mercury. One composite sample of five suckers was analyzed for mercury, selenium, and organics. A second composite sample of five suckers was also analyzed for mercury.

- ☐ The concentrations of organics and selenium were below levels of health concern.
- ☐ Average mercury levels in the largemouth bass and two composite samples of sucker were included in the updated advice.

Sample size:

Fish species with insufficient sample sizes (less than a minimum of nine individuals) were not included in the safe eating guidelines:

- ☐ Two bluegill
- ☐ Two rainbow trout

Table 8 shows average mercury concentrations in the combined fish data for the updated safe eating guidelines for Lake Combie.

Common Name	Number of Fish	Mean Mercury (ppm)	Mean Total Length (mm)
Largemouth bass	19	0.90	393
Sucker	10	0.53	444

14. Lower Feather River (Butte, Yuba and Sutter Counties) OEHHA updated the safe eating guidelines for the Lower Feather River using new data combined with prior data and the ATLs.

New data:

Fish from several locations on the Lower Feather River were sampled and analyzed for mercury under the FMP in 2005 and 2006. FMP samples included:

- ☐ 10 American shad

- ☐ 5 bluegill
- ☐ 10 redear sunfish
- ☐ 5 carp
- ☐ 5 crappie
- ☐ 14 largemouth bass
- ☐ 23 pikeminnow
- ☐ 30 sucker

Sample size:

Crappie was the one fish species with insufficient sample size (less than a minimum of nine individuals) to include in the safe eating guidelines. Bluegill data were combined with those for redear sunfish, and carp samples were combined with prior data for carp. In addition, five river-run Chinook salmon and six river-run steelhead trout were collected at the Feather River Hatchery. Although samples sizes were too small for evaluating these fish specifically, OEHHA issued general safe eating guidelines in 2009 for river-run salmon as follows.

River-run salmon from rivers in northern California are generally low in contaminants. Unless otherwise noted, prohibited, or restricted, they can be eaten 2 to 3 servings a week by women ages 18 – 45 and children ages 1 – 17 years; and 7 servings a week by men over 17 years and women over 45 years old.

Known accumulator species:

Striped bass are known to accumulate high levels of mercury. OEHHA provided advice for six striped bass based on the advice for largemouth bass and pikeminnow, species also high in mercury in the Lower Feather River. Table 9 shows a summary of mercury data for fish in the updated safe eating guidelines for the Lower Feather River.

Table 9. Average Mercury and Size in Fish from the Lower Feather River

Common Name	Number of Fish	Mean Mercury (ppm)	Mean Total Length (mm)
American Shad	10	0.05	436
Bluegill and redear sunfish	30	0.18	172
Carp	16	0.24	504
Channel and White Catfish	47	0.43	465
Largemouth Bass	61	0.71	337
Sacramento Pikeminnow	38	0.87	345
Sacramento Sucker	38	0.25	424
Striped Bass	6	1.27	652

THE SIERRA FUND

Reclaiming the Sierra Initiative

RESOURCES

As a part of the **Reclaiming the Sierra Initiative,** The Sierra Fund is building a toolbox to help Sierra Nevada community members and leaders learn about and address the issue of legacy mining toxins. The following documents are available online at *www.sierrafund.org:*

Mining's Toxic Legacy: An Initiative to Address Legacy Mining Toxins in the Sierra Nevada

This 85-page report is the first-ever comprehensive look at the ongoing environmental, cultural and human health impacts of the Gold Rush. Also available: 8-page Executive Summary.

Protecting Public Health and the Environment from Legacy Mining Toxins: A Primer for Nonprofit Organizations in the Sierra Nevada

This document summarizes the key issues that confront land trusts and land and water conservation organizations working in the Sierra Nevada.

Protecting Public and Environmental Health from Legacy Mining Toxins: A Primer for Local Government Officials in the Sierra Nevada

This document summarizes the key issues that confront local government officials with legacy mining in their jurisdiction.

Building a Mining Toxins Working Group: A Blueprint for California

This working document is meant to guide collaboration among and encourage community involvement in the many efforts to address legacy mining contamination in the Sierra Nevada.

Recreational Trails and Abandoned Mines Assessment

Released in June 2010, the purpose of this study was to learn whether recreationists may be exposed to mine waste or naturally occurring hazardous substances on public lands in the Sierra Nevada.

THE SIERRA FUND

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