April 22, 2008

Central Valley Regional Water Quality Control Board
Sacramento Main Office
11020 Sun Center Drive #200
Rancho Cordova, CA 95670-6114

RE: **Comments on the Proposed Methylmercury Basin Plan Amendment for the Sacramento-San Joaquin River Delta Estuary.**

Dear Board Members:

Thank-you for the opportunity to comment and provide input on the Methyl-Mercury TMDL for the Delta region and the proposed Basin Plan amendment. I will be referring to the Board staff's excellent report and the proposed TMDL with major comments. I will use my professional experience with mercury contamination, watershed processes, and subsistence fishing and fish consumption practices as the basis for these comments.

For the last decade, I have been involved in various projects that involve applied research into the area of abandoned mine contributions of mercury, distribution of risk factors associated with mercury bioaccumulation, fish consumption patterns in contaminated areas, and policy strategies for solving fish contamination. I am the lead author of the California Watershed Assessment Manual, as the result of a 3-year contract from CALFED. I have carried out special studies for the Delta Mercury Tributaries Council, the Sacramento Regional County Sanitation District (SRCSD), and the California Department of Public Health, Environmental Health Investigations Branch. My expertise is in geographic information systems modeling, aquatic ecology, water quality, watershed processes, and the intersection of policy and planning with scientific information. I have published over 3 dozen papers and reports in these and other areas. More recently, I have been coordinating an investigation of fish consumption patterns, fish advisory awareness, and health communication effectiveness in collaboration with two community organizations – People for Children's Health ad Environmental Justice and the Southeast Asian Assistance Center. This project has been funded by the SRCSD and the California Endowment and is the most comprehensive, extensive, and longest-running project of its kind in the Central Valley (Appendix A – interim report). I was also the lead for a Regional Board funded strategic plan development for the consideration and inclusion of people and impacted communities in TMDL and other pollution abatement decision-making (Appendix B – draft report). In this strategic plan, 30 key stakeholders representing impacted communities, local agencies, state and federal agencies, and academic scientists were interviewed. Based on these interviews recommended strategies were developed.

Major Comments:

1) Apparently implementation of the TMDL is proposed to start with an eight-year study period prior to requiring or carrying out significant abatement of mercury inputs, mercury methylation, and mercury bioaccumulation. In my experience over the last decade and based on stakeholder interviews, there is sufficient scientific information and there have been sufficient pilot management projects that an adaptive pollution abatement program is warranted rather than another eight years of study. Studies should accompany management and regulatory actions in order to ascertain effectiveness and an adaptive management loop established linking monitoring and evaluation findings with new policy and management decisions.

2) The target fish tissue methyl-mercury and waterway methyl-mercury concentrations are based on fish consumption rates that are too low and do not reflect our understanding of actual rates of fish consumption (TMDL Report Section 4.6). In addition, the report states on page 42 that "*A comprehensive survey of consumption of Delta fish has not been conducted. Thus, staff examined San Francisco Bay and national fish consumption studies, as well as several localized and pilot studies in the Delta, to develop Delta-specific consumption scenarios and ultimately recommend targets for human protection*." In fact such a study has been conducted over the last 2 ½ years and data analysis will be completed in June, 2008 ("Delta Consumption Study", Appendix A) . The report provides three main rates of consumption based on a combination of USEPA surveying for the US population (17.5 g/day to 142 g/day) and CDPH surveying of San Francisco Bay anglers (32 g/day). These rates are 95th percentile and higher rates for these populations. The rates are used to determine fish tissue targets to protect human health and are therefore important pieces of information. Scenarios A and C use a rate of 17.5 g/day and result in trophic level 4 (TL4) fish tissue Hg target concentrations of 0.29 to 0.40 mg/kg. Scenarios B and D use a rate of 32 g/day and result in target concentrations of 0.16 to 0.22 mg/kg. Scenario E uses a rate of 142 g/day and results in a target concentration of 0.05 mg/kg. A reasonable question is whether or not these fish consumption rates reflect actual consumption rates for anglers and their families in the Delta and are therefore useful in developing protective fish tissue targets and resulting discharge requirements. The bottom line from the Delta Consumption Study reported in Appendix A is that the 17.5 and 32 g/day rates are lower than mean rates for 21 of the 23 ethnicities eating fish caught in the Delta. They are lower than 90th and 95th percentile rates for all ethnicities. For anglers, the arithmetic mean total fish intake rate = 57 g/day ($\pm$ 11.8, 95% CI, n=375); range = 0 to 879 g/day; 90th percentile consumption rate = 123 g/day, 95th percentile = 199 g/day. In this respect the rates in the TMDL are not protective (in the linkage to fish tissue targets) of the average consumer of most ethnicities and the high consumers of all ethnicities. The scenario A – E rates are shown in comparison with the

Delta Consumption Study (Figure 1). The individual rates shown also reflect that rates of consumption vary seasonally, corresponding to peak in fishing activity.

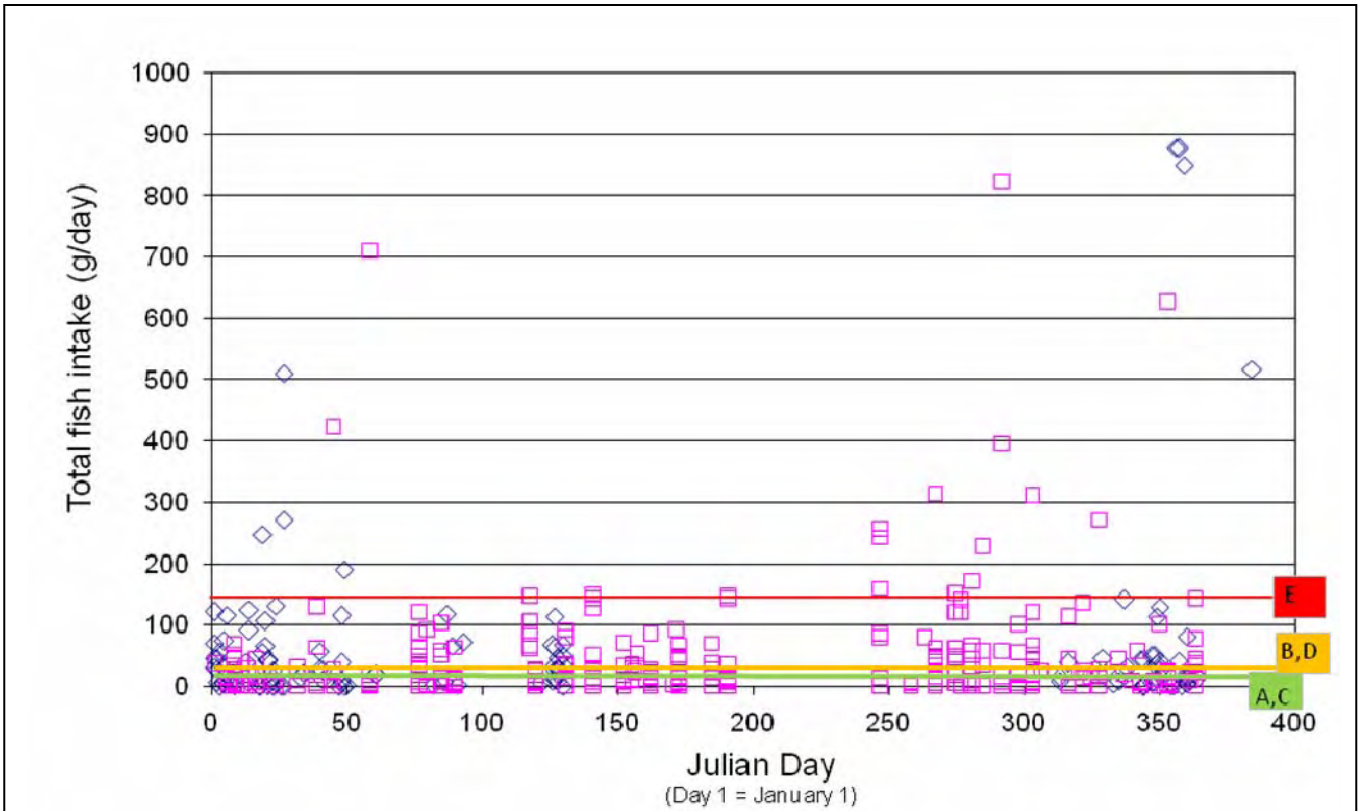

Figure 1 Rates of fish consumption per individual by calendar day compared to Scenarios A – E.

3) Mercury intake rates can be calculated based on fish species consumed, location the fish were caught, and rates of consumption. This is a critical step in evaluating actual risk and exposure for fish consumers in the Delta, but is missing from the TMDL report. The Delta Consumption Study made such calculations (Figure 2 and Appendix A). Most fish consumers interviewed have mercury intake rates greater than the EPA reference dose. About 5% have intake rates greater than 10 times the reference dose, which puts them in a range where health impacts are possible or likely. The highest intake rates are almost 70 times the reference dose.

The State Water Resources Control Board Resolution 2005-0060 directs the San Francisco Bay and Central Valley Regional Boards to “investigate ways, consistent with

their regulatory authority, to address public health impacts of mercury in San Francisco Bay/Delta fish, including **activities that reduce actual and potential exposure of and mitigate health impacts** to those people and communities most likely to be effected by mercury in San Francisco Bay-Delta caught fish, such as subsistence fishers and their families." An obvious question that is relevant here is what actual activities is the Regional Board going to take to immediately reduce actual and potential exposure among subsistence fishers, considering that the exposure and concomitant health impacts are being felt right now.

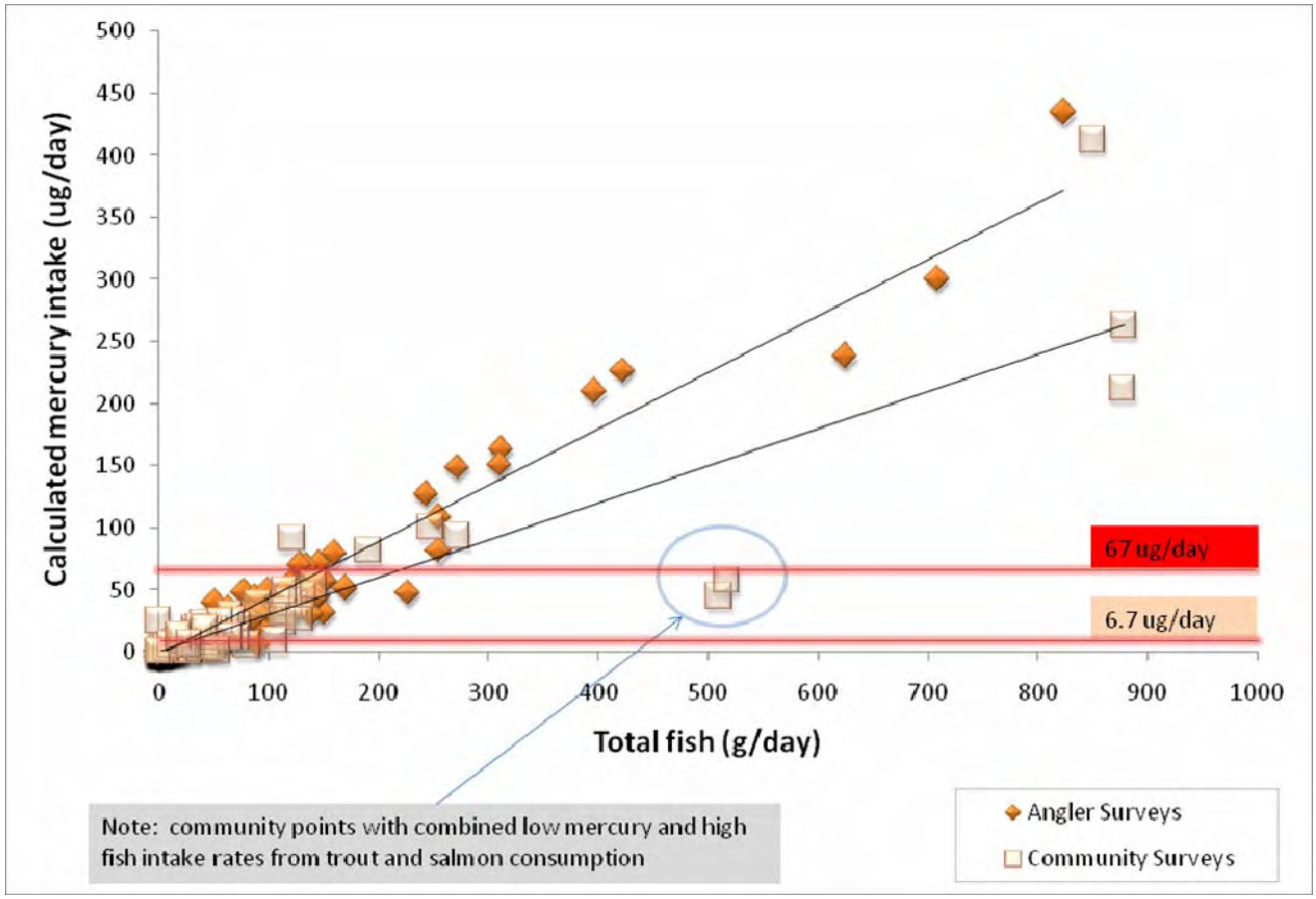

Figure 2 Calculated mercury intake rates and fish consumption rates compared to EPA reference dose and 10X reference dose for average human body weight.

4) It is questionable whether or not convincing people to eat less fish is a legitimate pollution control or pollution control impact activity under the Clean Water Act and this question deserves more investigation. What is clear is that the approaches taken so far are not as effective in changing fish consumption behavior as would be needed to count as risk or exposure management. If these activities are neither legal nor effective, it is worth asking why they are included in the TMDL at all. The Delta Consumption Study asked questions about risk management and reduction from a behavior and

communication point of view. Our findings suggest that, despite many years of warnings, most people are unaware of fish advisories and how to follow them and are consuming large amounts of mercury (Figure 3). Most people interviewed had little or no awareness of advisories about safe fish eating. Those who were most aware also had significantly higher fish consumption rates ($P<0.05$) than those who were unaware (Appendix A). This paradox may be explained by the likelihood that those fishing most often are going to be most aware of ALL fish-related information.

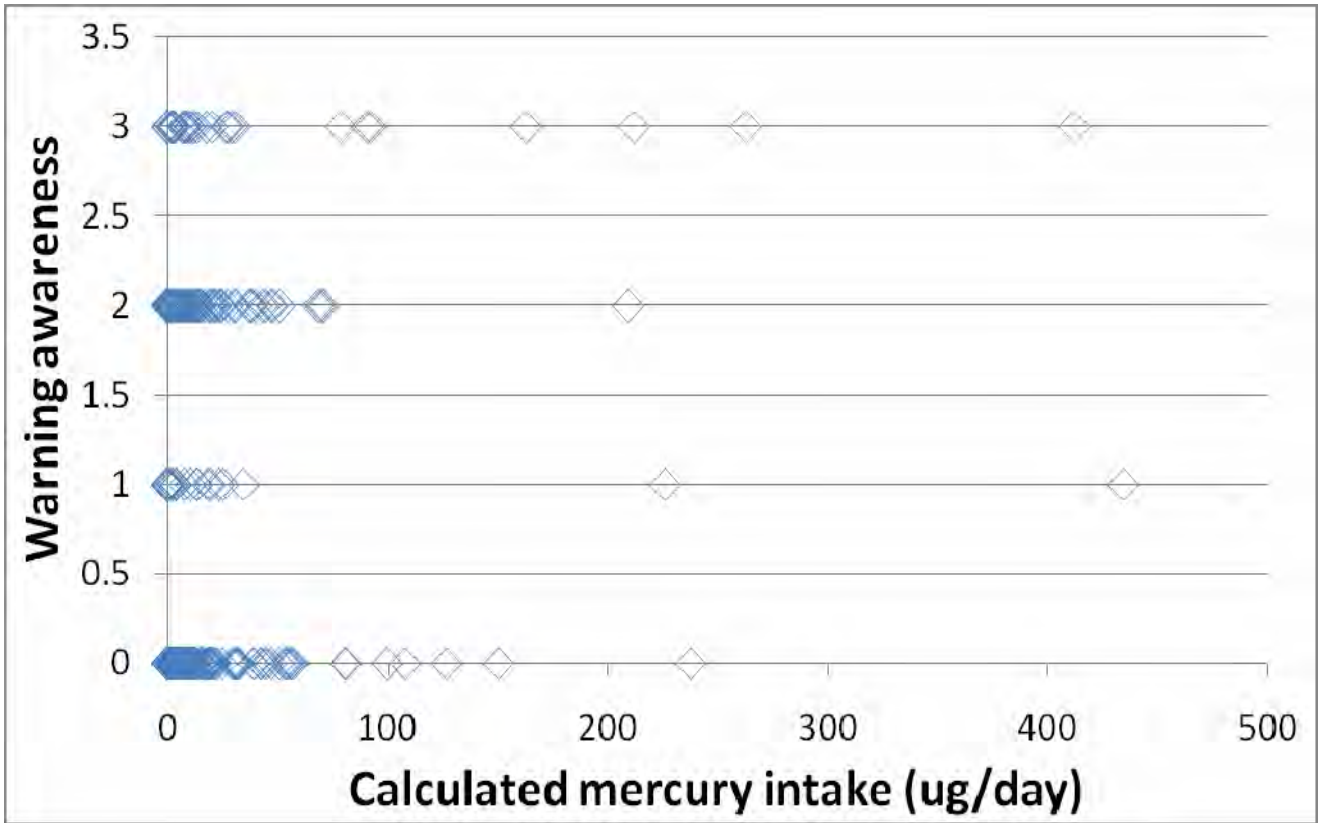

Figure 3 Awareness of warnings about fish consumption compared to mercury intake rate.

The obvious implication of this finding is that anglers and others eating locally-caught fish are not aware of warnings and advisories about fish-eating. This may be for a variety of possible reasons, some of which can be investigated. One that we looked at was the pathways that people eating fish use for receiving health information. We found that direct government sponsored pathways are not described as the ways people receive health information (Figure 4). The most common pathways are medical providers, mass media, and friends/community, with variation in preferences among ethnicities. This suggests that risk communication needs to occur through community-relevant pathways if the state (Regional Board, OEHHA) expects that actual communication will occur. In our collaboration that supports the Delta Consumption Study, the community organizations use technical information from partners (UC Davis)

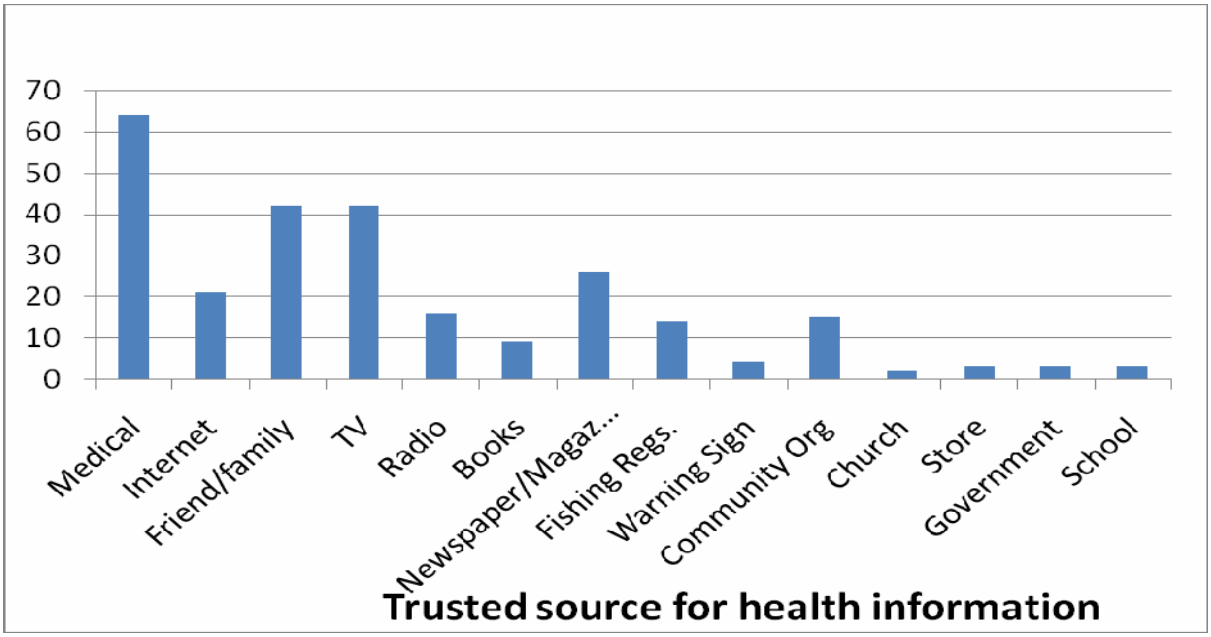

Figure 4 Trusted sources of health information among anglers and community members eating fish.

and the state in their own versions of communicating (ethnic radio, meetings). This has been effective because the organizations have taken ownership and speak with the cultural and linguistic voices of the community. This ultimately is the way to pursue communication with Delta and other anglers about risk – by supporting community service organizations who actually know their communities, not state agencies who have a steep and long learning curve.

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Appendix A

Contaminated Fish Consumption in California's Central Valley Delta

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Abstract

The Central Valley of California contains major rivers contaminated by mercury, a legacy of the gold mining era of the 1800s. The fish favored by anglers tend to be the ones with the highest tissue concentrations of mercury – catfish, striped bass, sturgeon, largemouth bass. This coincidence of contamination and angler focus has led to a policy conundrum: how can the social cost of advising subsistence anglers to eat less fish be balanced with the economic cost of reducing the mercury concentrations in fish? State agencies with regulatory and other jurisdiction have no consistent approach to this problem and are only now developing the database that could be used to inform policy alternatives. The present study focused on one region in the Central Valley (the Northern Delta) where mercury concentrations in fish and angling intensity are both high. Anglers and community members were surveyed for their fish preferences, rates of consumption, the ways that they receive health information, and basic demographic information. The rates of consumption of all fish and locally-caught fish for certain ethnicities were higher than the rates used by state agencies for planning. A broad range of ethnic groups were involved in catching and eating fish. The majority of anglers reported catching fish in order to eat and to feed to their families, including children and women of child-bearing age. There were varied preferences for receiving health information and no apparent correlation between knowledge of fish contamination and rates of consumption. Despite knowledge of fish contamination, calculated rates of mercury intake by subsistence anglers were well above the EPA reference dose. The findings here support a policy strategy of diverse community involvement in decision-making about mercury clean-up, an official recognition of a subsistence fishing population, and a combined strategy of environmental cleanup and long-term community involvement and education.

Introduction

Subsistence fishing is prevalent throughout the world, but tends not to be viewed as a behavior characteristic of urban communities. Urban California contains broad ethnic diversity, including many recently-arrived immigrants who appear to have retained the cultural and economic practice of subsistence fishing. The US Department of the Interior estimates that 10% of Californians engage in sport and subsistence-fishing (USDI et al., 2003). Subsistence fishing in areas with fish contamination creates immediate policy issues, both in terms of educating anglers about contamination and in speeding the rate of remediation of the contamination.

California's growth was based initially on a gold-mining boom. Mercury mined in the Coast Ranges was used in the Coast and interior ranges to amalgamate gold particles and improve their recovery (Alpers and Hunnerlach, 2000). The combined watersheds of the Central Valley contain thousands of legacy mercury and gold mining features, including tunnels, waste piles, and surface pits. These are estimated to provide about 25% of the mercury load leaving the Valley to the ocean (Stephen McCord, personal communication). The remaining mercury originates from natural geothermal activity, soil, atmospheric deposition, and industrial and domestic waste-water. This mercury enters the food chain primarily through bacteria-mediated mercury methylation (reviewed in Benoit et al., 2003) and bio-accumulates with higher and higher trophic

levels (Clarkson, 2002; Gilmour et al., 1998May et al., 2000). Predatory fish (e.g., striped bass) tend to have the highest tissue concentrations of mercury (Wiener et al., 2003).

California state agencies are responsible for a combination of advising the public about the health risks associated with eating contaminated fish, regulating activities that contribute to the problem, and actively restoring public trust values (e.g., clean waterways and edible fish). Currently the state does not have an explicit strategy for reducing mercury contamination of fish, or for communicating effectively with the fish-eating public. Part of the reason for this may lie in the lack of detailed information about who is eating what fish species, where they are doing this, how contaminated the fish are, and how to communicate with fish consumers. Another part of the reason may lie in the estimated social and financial cost of remediation of Central Valley waterways, which although only an informal calculation, has been given as being in the billions of dollars over many decades. The Central Valley Regional Water Quality Control Board has developed a draft total maximum daily load (TMDL) for mercury in the Delta because of impairment to fish consumed by humans and wildlife (Central Valley Regional Water Quality Control Board, 2007). Legally, the state must develop a plan to resolve this impairment, which by strict definition means reducing mercury concentrations in fish.

There is very high ethnic and language diversity in the Delta region of the Central Valley. Recently-arrived Hmong, Cambodian, Vietnamese, Russian, and Mexican populations are common in Central Valley urban areas. Many of these diverse communities relied on fishing as a cultural and economic practice in their countries of origin and have brought that practice with them. The social structure and accepted pathways of communication are quite different from the host culture. This can make effective communication for education and/or decision-making particularly challenging and is so far an existing gap in California state policy. There are also many California-born anglers and fish-consumers in the Delta region who are broadly distributed and generally do not congregate in a fixed set of locations.

The present study provides data to support decision-making for an initial statewide strategy to reduce fish contamination, involve diverse stakeholder communities, and to encourage safer fishing and eating patterns. A mean and range of fish consumptions is presented for the North Delta region of the Central Valley over 2 years, including information about individual fish species and ethnic communities. This information, combined with existing information about angling rates and fish tissue concentrations of mercury is used as the basis for a risk analysis. Finally, findings are presented showing the diverse mechanisms that anglers receive health related information.

Methods

Study Area

The study area comprised the North, South, and West Delta regions of the Central Valley, stretching from the cities of Sacramento and Stockton to the city of Vallejo (Figure 1). The waterways included the Sacramento River (the largest in California), the Port of Sacramento Shipping Channel, Montezuma Slough, and the San Joaquin River. Specific sites for surveying along the Sacramento River were: Garcia Bend City Park, Freeport, Clarksburg, and Port of

Sacramento shipping channel. Community members in Sacramento were also surveyed. These areas were chosen because they are popular angling locations and fish tissue contamination with mercury has been measured as high in the vicinity of the sites (within 10 river miles), or in the case of the community areas, are home to large numbers of anglers.

Survey Instrument, Sample, & Protocol

The survey instrument was designed to cover target fish species, fish consumption rates, health communication, and household demographics. It was designed in 2003 and 2004 in collaboration with the California Department of Public Health and is nearly identical to the instrument used in the recently-published study of women attending clinics in Stockton, CA (Silver et al., 2007). There were 17 questions and the questionnaire took about 10 minutes to administer. Answers were recorded on the questionnaire and coded and transferred to a computer spreadsheet. Fish filet models were used representing 3 different cooked weights of fish filet (1.5 oz., 4.5 oz., and 7.5 oz) in order to allow estimates of actual rates of fish consumption. Staff from the community service organization Southeast Asian Assistance Center (SAAC) were trained in the use of the survey instrument at 3 separate workshops over the 2 years of their active surveying.

Anglers were chosen for interviews as they were encountered along the river-bank. No bias was present in the selection. However, the interviews by UC Davis surveyors were only conducted in English, which resulted in a failure to interview about 5% of those approached. Surveys by staff of the Southeast Asian Assistance Center were in the native language of the respondent (Hmong, Lao, Mien, Russian). 500 anglers were interviewed approximately biweekly to monthly between September 2005 and June, 2008.

Community members were chosen for interviews based on knowledge that a family member fished, but without specific knowledge of how often they fished or ate fish. These interviews were conducted by SAAC staff in English, Russian, Hmong, Lao, Mien, and Spanish. Community members were interviewed between December, 2006 and June, 2008.

Subjects were told that the survey was of fishing activity along the river and was being conducted to better understand what kinds of fish people were catching and eating. They were asked if they could be interviewed and subsequently were questioned. They were not told in advance that the survey was related to concerns about fish contamination.

Spatial and Creel Survey Data

The fish contamination data were obtained from the California Central Valley Regional Water Quality Control Board (Regional Board, 2006), covering almost 30 years of measurements of mercury in various fish species, and from the San Francisco Estuary Institute (SFEI) for 2005 and 2006. Mean mercury concentrations (parts per million or micrograms/gram) were calculated for each target species using values for legal-sized or edible fish at or near the angler survey sites. In the case of striped bass, this corresponded to lengths >18 inches, for sturgeon this corresponded to lengths >48” and for all other fish species lengths >12”, except sunfish, bluegill, and crappie where lengths >6” were used.

Creel survey data covering 1999-2001 (the most recent and comprehensive available) were obtained from the California Department of Fish and Game in computer spreadsheets and in written reports to the US Fish and Wildlife Service. The survey covered fishing effort, types and numbers of fish caught, and location of fishing. The creel survey data were attributed to river mile points along the Sacramento River using ArcView 3.2. The river mile points were manually measured using ArcView 3.2 along the center-line of the river using geo-referenced digital photographs.

Survey Data Analysis

Fish consumption rates (g/day) were calculated for each individual based on 30-day recall of how much fish was eaten of individual types (e.g., catfish) and how often. Anglers were grouped by major race/ethnicity (e.g., Hispanic) according to Census Bureau classification. Minor ethnicity (e.g., Lao) was also recorded when the survey respondent provided sufficient information for the classification. Rates of mercury intake were calculated for individuals based on individual consumption rates for specific fish types and the regional mean mercury concentrations for those fish types. Data were organized in MS Excel and basic statistical analysis was done using this software. All statistical comparisons were done using the commercial statistical software package SPSS 16.0.

Results

Context: Fish Contamination and Creel Survey Angling Rates

Concentrations of mercury in commonly-eaten fish were calculated using a combination of the Regional Board and SFEI datasets (Table 1). Fish sizes ranged from >6" (bluegill) to >48" (sturgeon) and mean concentrations ranged from 0.052 ppm (shad) to 0.772 (largemouth bass).

Creel survey data indicate that the primary target fish species for anglers in the Northern region of the Central Valley Delta were striped bass, salmon, shad, and catfish. This is similar to the targeted species in the present study (Table 2). For all commonly-caught fish there were mercury concentration data available in the study region.

Rates of Fish Consumption

Consumption rates for locally-caught fish and commercially-acquired fish were calculated for all respondents (Figure 3 and Table 3). Rates found by SAAC staff and UC Davis researchers were not significantly different and were lumped. Consumption rates varied throughout the year, with peaks during the Fall when both striped bass and salmon are running (Figure 3), and fishing activity is this highest (Figure 2). The arithmetic mean of all rates of consumption of locally-caught fish (n=XXX) was 29.3 g/day, higher than the USEPA standard rate of 17.5 g/day. The arithmetic mean has been used before for fish consumption rate calculation (Sechena et al., 2003) and was used for most calculations because there was no obvious reason to use the geometric mean, which tends to under-estimate the "average". The geometric mean was also calculated in certain instances to allow comparisons with Silver et al. (2007). The rate of consumption of all

fish (locally-caught and commercial) was 42.7 g/day, higher than the combination of USEPA's rate for locally-caught fish (17.5 g/day) and the USDA's food intake rate for commercial fish (12.5 g/day). There was a significant relationship between the frequency that anglers fished and the amounts of locally-caught fish that they ate ($P<0.05$, Chi-square test). There was no significant relationship between day of the week when surveying occurred and ethnic group type, or fish consumption rate. Among the major ethnic groups, Hispanics ate the most locally-caught fish, followed by Asian, and African-American. However, there was no statistically significant difference in rates among the major ethnicities ($P>0.05$, Chi Square test). Of the ethnic sub-groups, the Lao respondents had the highest mean total fish consumption rate (67 grams/day) and locally-caught fish consumption rate (58 g/day), though the rates were not statistically different from the mean of all other groups (t-test, $p=0.17$ and $p=0.09$, respectively).

Women and men ate locally-caught and commercial fish at similar rates. Younger adults (18-34 y.o.) tended to eat at higher rates than middle-aged adults (35-49 y.o.), though the difference was not significant. Rates of consumption for locally-caught and commercial fish were similar for anglers from households with and without women of child-bearing age or children.

Balancing locally-caught and commercial sources of fish

Anglers and community members often consumed fish that they or someone they knew had caught as well as fish that they bought at markets or restaurants. For all ethnic groups and both genders combined, there was an inverse relationship between consumption rates of commercially-acquired fish and locally-caught fish (Figure 4).

Rates of Mercury Consumption

The combination of fish-type-specific consumption rates and fish-type-specific mercury concentrations were used to calculate the mercury intake rates of all surveyed anglers (Figure 5). Predictably, higher rates of mercury intake corresponded to higher rates of fish consumption because the types of fish consumed are similar across the range of consumption. Mean rates of mercury intake for individual ethnicities were compared to the USEPA standard (0.1 micrograms mercury/kg-bodyweight day^{-1}) and to the grand mean of all intake rates. Approximately 5% of anglers had a mercury intake rate at least 10 times higher than the USEPA standard-maximum advised rate. The mean total mercury intake rate for the whole sampled population is significantly greater than the USEPA standard ($P<0.05$, t-test). Similarly, the mean mercury intake rates for African-American, Asian, Southeast Asian, Vietnamese, Lao, and Hmong were all significantly higher than the USEPA standard ($P<0.05$). Asian Pacific Islanders were the only major ethnicity where the mean mercury intake rate was significantly less than the USEPA standard ($P<0.05$), though a few individual anglers had rates higher than the standard. Lao and Vietnamese ethnicities/nationalities had mean mercury intake rates that were significantly higher than the grand mean rate ($P<0.05$).

Awareness of Mercury Contamination

Respondents were asked about their awareness of warnings about fish contamination and their responses coded according to accuracy and completeness of the response (range = 0, no awareness, to 3, high awareness and accurate recall). Awareness was compared to fish consumption and various demographic parameters. Anglers that were more aware of warnings about fish contamination tended to eat more fish, with statistically higher rates of consumption for anglers with high awareness compared to those with low awareness $P<0.05$, t-test). Awareness was highest among White respondents (mean=1.5), followed by Native Americans (mean=1.3), and Asian Pacific Islanders (mean=1.0). Awareness was also highest in middle-aged respondents (compared to other age groups) and higher in men than women.

Pathways for Communication of Health Information

When sources of warnings about eating fish were compared among ethnicities, Asian, Southeast Asian, and White groups reported warnings from different sources than all other groups ($P<0.05$, Chi-square test). Similar results were found when trusted sources of health information were compared among groups. Asian, Southeast Asian, Hmong, and White groups reported trusting different sources for health information than all other groups ($P<0.05$, Chi-square test). There were no differences among age groups for trusted sources of health information, but people aged 35 to 49 y.o. recalled warnings from different sources than people aged 18 to 34 y.o.

Discussion

This study shows that anglers in the Sacramento/San Joaquin Rivers Delta may be exposed to mercury in amounts well above the EPA reference dose. This exposure is in part because the consumption rates of locally-caught fish (primarily) are relatively high (compared to the USEPA average value). In addition, the exposure is concentrated in non-white, primarily immigrant populations, though many ethnicities are affected. Because rates of fish consumption vary seasonally, based primarily on fish availability, affecting accuracy of calculated rates of mercury input with short-term studies.

Food Frequency Questionnaire

The present study relies on a food frequency questionnaire conducted by trained researchers. Survey respondents were asked for a 30-day recall of fish intake from local waters and commercial sources. One question might be whether or not the FFQ represents actual intake of fish (and therefore mercury). Although we did not employ in-home food diaries in this study, the vast majority of comparable studies using FFQs have reported accurate findings using this approach among a wide range of nationalities and ethnicities (Villegas et al., 2007; Quandt et al., 2007; Sullivan et al., 2006; Kuster et al., 2006; McNaughton et al., 2005).In cases where the FFQ is less accurate, it tended to under-estimate actual consumption (Hudson et al., 2006; Lee et al., 2002). In a study in nearby West-Sacramento, educators with the Food-Stamp Nutrition Education Program used food records to validate a FFQ-based approach for determining fish consumption rates (S. Jones, personal communication). For a few dozen women, they found no

significant differences between rates determined using the FFQ and rates from the food records. We feel that our application of the 30-day recall FFQ in conjunction with food models will tend to give a good estimation of actual fish intake rates and therefore mercury intake rates.

Consumption rates compared to other studies

The fish consumption rates in the present study vary to some degree by ethnicity. This has been found to be true for a comparable study in a nearby area (Silver et al., 2007) and other areas. Delta fish consumption rates are similar to the rates found for Asian American and Asian Pacific-Islanders in Washington (117.2 g/day; Sechena et al., 2003), for Yakama Nation members (58.7 g/day; CRITFC, 194), and New Jersey adults (50.2 g/day; Stern et al., 1996). The rates presented here are the first measured for local angling populations in the Delta.

The consumption rates observed for ethnic groups of Delta anglers (Table 3) are several times higher than the USEPA default consumption rate (17.5 g/day) based on USDA nation-wide consumption surveys (USEPA, 2001). This consumption rate was used by the USEPA to set the methylmercury concentration criterion for fish-tissue at 0.3 mg/kg fish tissue. The rates found here are also several times higher than the mean daily consumption rate (4.58 g/day) for the general US population (USEPA, 2002). These USEPA rates of consumption and the consumption rate calculated for San Francisco Bay anglers (mean = 32 g/day), are used by the Central Valley Regional Water Quality Control Board to set target fish tissue concentrations for the Delta through the TMDL process (Central Valley Regional Water Quality Control Board, 2007; described in more detail below). In all cases, these average rates are less than average local-fish consumption rates we found for Lao and Hispanic fish consumers and less than the average total-fish consumption rates we found for all ethnic groups examined (Table 3) except Hmong, Mien, and Chinese. The consumption rates of locally-caught fish that sometimes have multiple contaminants, especially near urban areas and near the San Francisco Bay, indicate that many fish-consumers in the Delta have exposure levels of immediate public health concern.

Mercury intake

Few studies have calculated mercury intake from subsistence fishing using local measurements of mercury concentrations in fish (Stern et al., 1996). Most studies have compared fish consumption rates with mercury body load (blood or hair; citations). Some studies have calculated potential mercury intake based on fish consumption rates using regional values for commercial fish (e.g., tuna) and compared these calculate intake rates to measured body loads. Our study provides the first accurate estimates of mercury intake for various populations eating locally-caught fish in California's Central Valley Delta, which can be compared in future studies to measured mercury body loads. These intake rates indicate that most fish-consumers may be taking in greater than the USEPA maximum of 0.1 micrograms/kg-body weight/day. About 5% of consumers are consuming >10 times the maximum recommended dose. Certain ethnic groups are on average consuming several times greater than the maximum. All of these findings pose complex, but straight-forward policy questions of who should be protected and to what degree.

Amounts vs. types of fish

Balancing fish consumption for health benefits with concerns about contamination requires consideration of type of fish, frequency of consumption and amount consumed. Researchers have found that rates of contaminant intake can depend as much on total fish intake as on the pattern of fish species consumption. However, by changing patterns of consumption, it is possible to retain the value of eating fish from a health point-of-view, while avoiding the neuorological harm from mercury intake (Oken et al., 2005). In this case, consuming fish with lower mercury concentrations (smaller, low trophic level) can result in net health benefits. Because it is unlikely that many anglers and communities will stop or reduce fish consumption in the region, patterns of consumption could be addressed. People could contribute to their exposure reduction by eating fish in the palette of preferred types that are low in contaminants, by catching them from places known to have lower contaminant concentrations, and by focusing more on smaller fish. Based upon our findings, the learning process for this behavioral change is unlikely to originate from state agencies, rather trusted community sources (organizations, peers, medical staff) and certain mass media are likely to be more effective. This suggests that community-based programs that develop and implement policies related to fish consumption behavior will be the most successful model.

Policy Issues

A. Mercury Intake Relative to EPA Reference Dose

The US EPA has determined that a dose of mercury of 0.1 microgram/kg body-weight/day is the maximum that children and women of child-bearing age should consume to protect fetal and child brain development (citation). This dose ("reference dose") is approximately one tenth the intake rate that has been found to result in measurable health effects. For a 67 kg (147 lb) person (average adult body-weight), the rate would be 6.7 micrograms of mercury/day or 201 micrograms mercury/month. Stern et al. (1996) calculated the mean rate of mercury intake for New Jersey adults, based on fish consumption rates (mean = 50.2 g/day), as 7.5 micrograms of mercury/day. The rates of mercury intake were calculated for all respondents (Figure 4) and are shown in Table 2 by ethnicity, gender, and age group. Only for the Mien ethnicity (N=8) and anglers <18 years old (N=2) were calculated mercury intake rates less than the reference dose. The Lao respondents had the highest mean mercury intake rate (26.7 micrograms/day), 4 times higher than the reference dose. The vast majority of this mercury intake was from locally-caught fish. Of the different ethnic groupings, Asian, Southeast Asian, Pacific-Islander, Hmong, and Lao all had mean mercury intake rates that were significantly higher than the reference dose (t-test, $p<0.05$). Five percent of respondents to the survey had intake rates $\geq$10 times the reference dose, putting them at risk of measurable health effects from mercury consumption.

B. State Response – Water Quality Regulation (Total Maximum Daily Load)

"*The most expeditious way to reduce the risks to humans of mercury toxicity is to implement an effective public outreach and education program that results in people changing their behavior to reduce mercury intake*." (from contract between Regional Water Quality Control Board and California Department of Public Health, 2007)

In their interpretation of the Clean Water Act, the state has developed a draft TMDL for mercury in edible fish (Central Valley Regional Water Quality Control Board, 2007). The implementation is intended to be a combination of reduction of methyl-mercury in sediments and water column through waste-load allocations and changes in fish-eating behavior in at-risk human populations. The first phase of implementation includes a determination of the feasibility of controlling methyl-mercury in fish, based on research and pilot control programs. The first phase also includes developing education and outreach programs directed at communities eating fish from the Delta. This is intended to be the short-term "risk-reduction" program paralleling mercury controls, in order to protect human health until fish tissue targets (for mercury) are achieved. One danger of this approach is that TMDL attainment for humans may be achieved through changing human behavior, as well as or rather than controlling mercury in the system. If in a future TMDL amendment, fish consumption rates have dropped because of effective communication by agencies, then fish tissue target concentrations could be raised higher than they would have to be now to protect high-end consumers. Because impairment is the legitimate target of TMDLs under the Clean Water Act, it remains to be seen whether or not risk-reduction can be defended as implementing a TMDL. Because state responsibility extends to protecting piscivorous birds and mammals, fish tissue targets may end up remaining relatively protective of high-ed human consumers as well.

A critical issue at the interface between state pollution policy and science is the method used to determine actionable risk. In this study and in most similar studies, the mean fish consumption rate is calculated to indicate the relative risk faced by consumers of contaminated fish. In many studies, the 90^{th} or 95^{th} percentile rates are also calculated as a way to track high-end consumers. In contrast, the TMDL acknowledges high-end consumers, but uses mean consumption rates to actually propose fish tissue targets for mercury concentrations. Arguably, the high-end consumers (subsistence anglers) should be the group used to set pollution control targets because they are at most risk of harm. The answer from the state to this issue is apparently to provide more "education and outreach" to reduce risk. Unfortunately, as found in this study, there may be no relationship between peoples' knowledge of fish contamination and their fishing and fish consumption behavior. Related to this is the choice of investigators to calculate arithmetic vs. geometric means. When data are distributed somewhat normally, with skew toward the upper end of consumption rates, there are no hard and fast rules to choosing the arithmetic or geometric means. However, there are consequences for policy development because the geometric mean for consumption rates is lower than the arithmetic mean. Target mercury concentrations in fish tissue based on geometric means will thus be proportionally higher than the targets set using arithmetic means. From a discharger and regulator point of view, it may be preferable to set higher targets, because they will be more attainable. From the point of view of protecting public and individual health, it may be preferable to be more conservative.

C. State Response – Water Quality/Fish Tissue Monitoring

Creel surveying in the Central Valley Delta waterways by the CDFG (data from 1999 & 2000) and then in the present study (Sacramento River only) points clearly to the following species being caught and eaten in the ratios indicated (proportions in parentheses: Striped Bass (40): Salmon (15): Shad (14): Any (7): Catfish (5): Sturgeon (2): Largemouth bass (0.2). In contrast,

the only state-funded monitoring program for mercury in these fish species (FMP, 2005 & 2006) shows that monitoring of fish in the vicinity of the study area is targeted in a quite different ratio (numbers of fish monitored): Sacramento Sucker (36): Catfish (31): Largemouth bass (28): Sacramento Pike Minnow (27): Carp (23): Salmon (17): Shad(15). Mercury in striped bass has recently been monitored, but the data are currently unavailable and cannot be included.

The monitoring program is designed to measure mercury concentrations in "sport" fish species that are commonly-eaten in the Delta sub-regions. In other systems scientific monitoring of fish contamination has focused on fish that regional anglers are catching and eating (Burger et al., 2006). Apparently this program must be significantly modified so that fish tissue monitoring for contaminants reflects the species targeted by frequent anglers and consumers. One solution would be for the monitoring to be conducted by the impacted angling communities, as opposed to researchers removed from the seasonally and ethnically-variable process of fish capture and consumption. Fish caught by anglers could be sampled directly in order to both measure potential exposure and fish species-specific mercury concentrations.

Community responses

In other areas where fish contamination has been approached from a public health perspective, the success of changing consumers' behavior has been variable. Different ethnicities are likely to maintain different pathways for communication of health information into the community and laterally among community members. A single cookie-cutter approach to communication of risk information may not be appropriate for the highly-diverse angling communities of California's Central Valley Delta region. An approach that is more likely to reflect the needs and communication pathways of these diverse communities is one originating from the communities themselves and possibly initiated by trusted community organizations.

Fish contamination is very much an environmental justice issue in the Central Valley because of disproportionate impacts to the ethnically diverse fish consumers and the lack of involvement of these impacted consumers in decision-making. Community organizations that the authors have collaborated with have expressed interest and have active involvement in decision-making around attainment of target concentrations of mercury in fish. As will probably be the case for effective communication and community education about fish contamination, an effective strategy for attainment of mercury standards would be one that originated from the knowledge and activities of groups representing the impacted communities.

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Figures

Figure 1. Angling intensity in study area. Data from the California Department of Fish & Game. Locations of fish tissue mercury monitoring sites in Regional Board database.

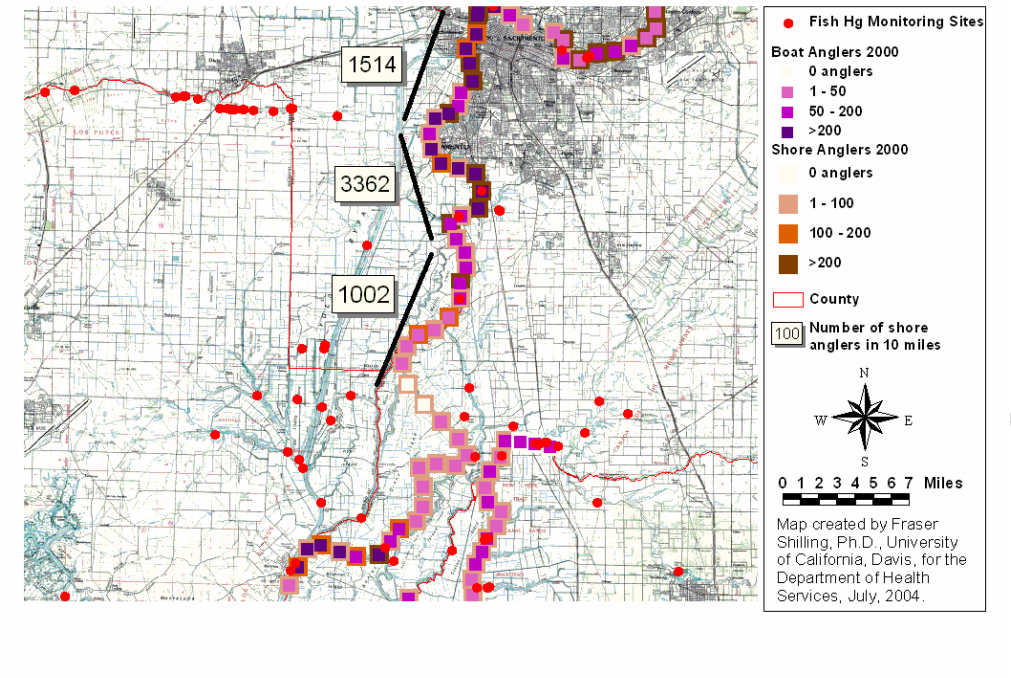


Figure 2. Fishing intensity varying by season and location on the Sacramento River. Data from the California Department of Fish & Game.

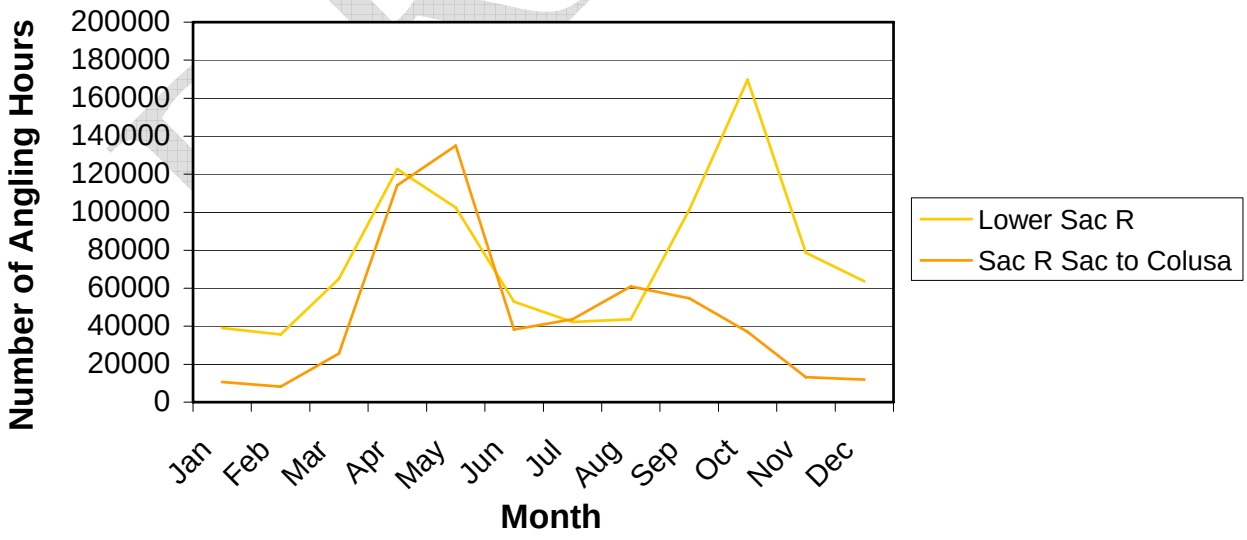


Figure 3. Total fish consumption rates over the year (Julian Day 1 = January 1st). Each symbol represents an individual interviewee. The lines at the bottom represent the scenarios for fish consumption used by the Central Valley Regional Water Quality Control Board's TMDL for methyl-mercury in the Delta. A,C = 17.5 g/day; B,D = 32 g/day; E = 142 g/day of fish consumed.

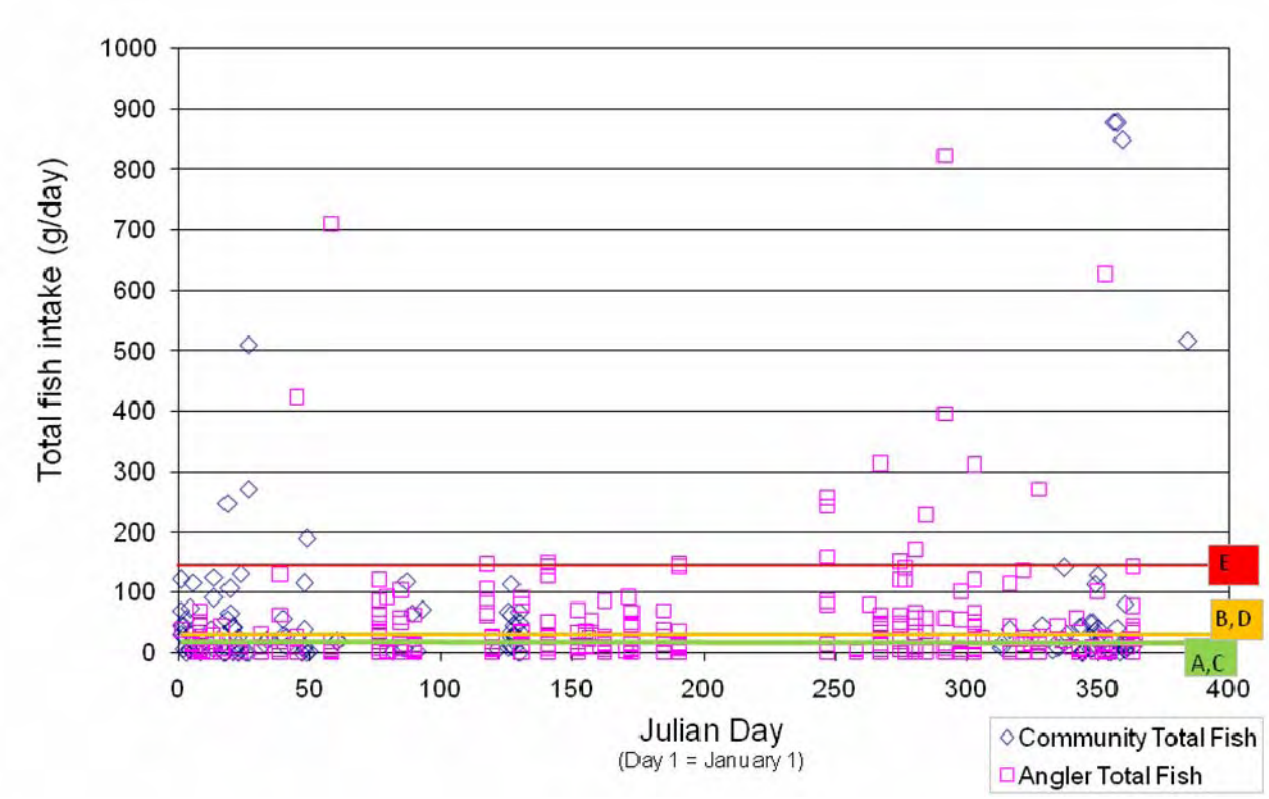


Figure 4. Relationship between consumption rates for locally-caught and commercially-acquired fish.

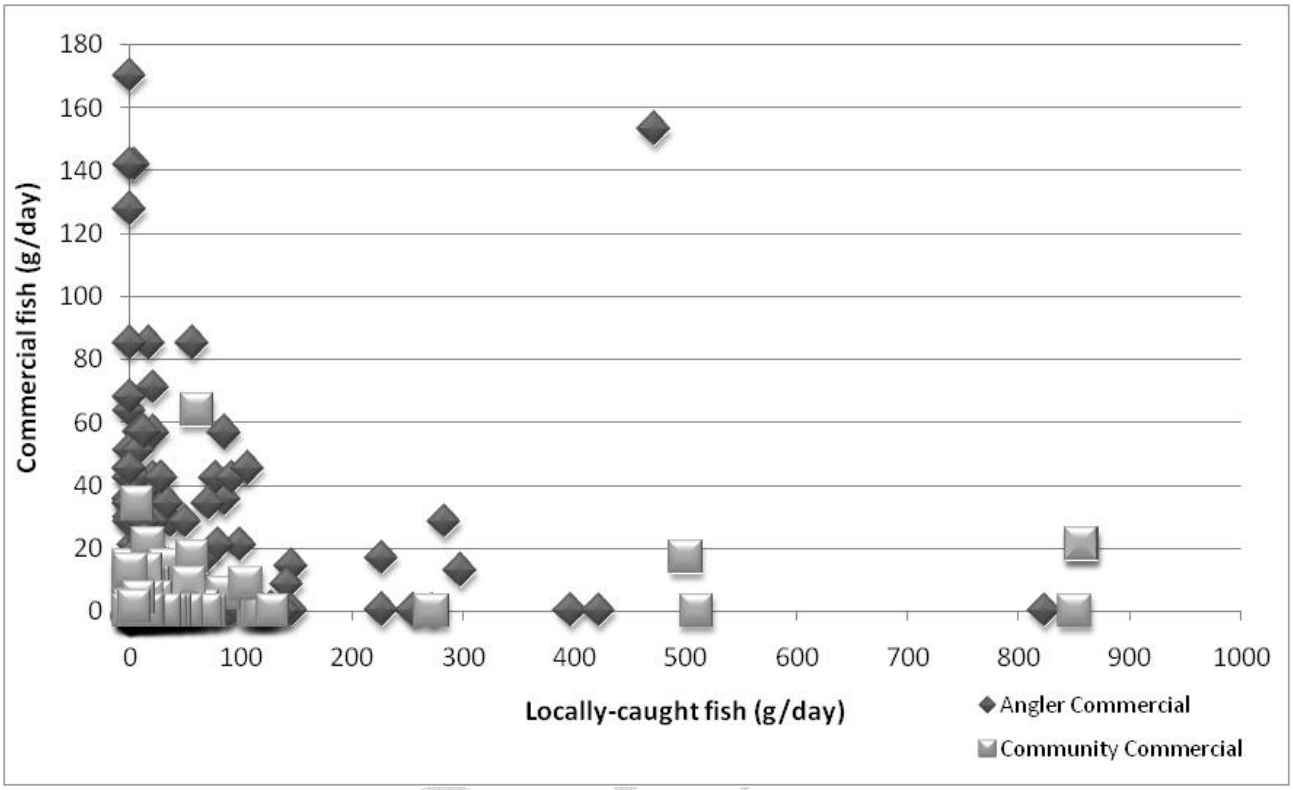
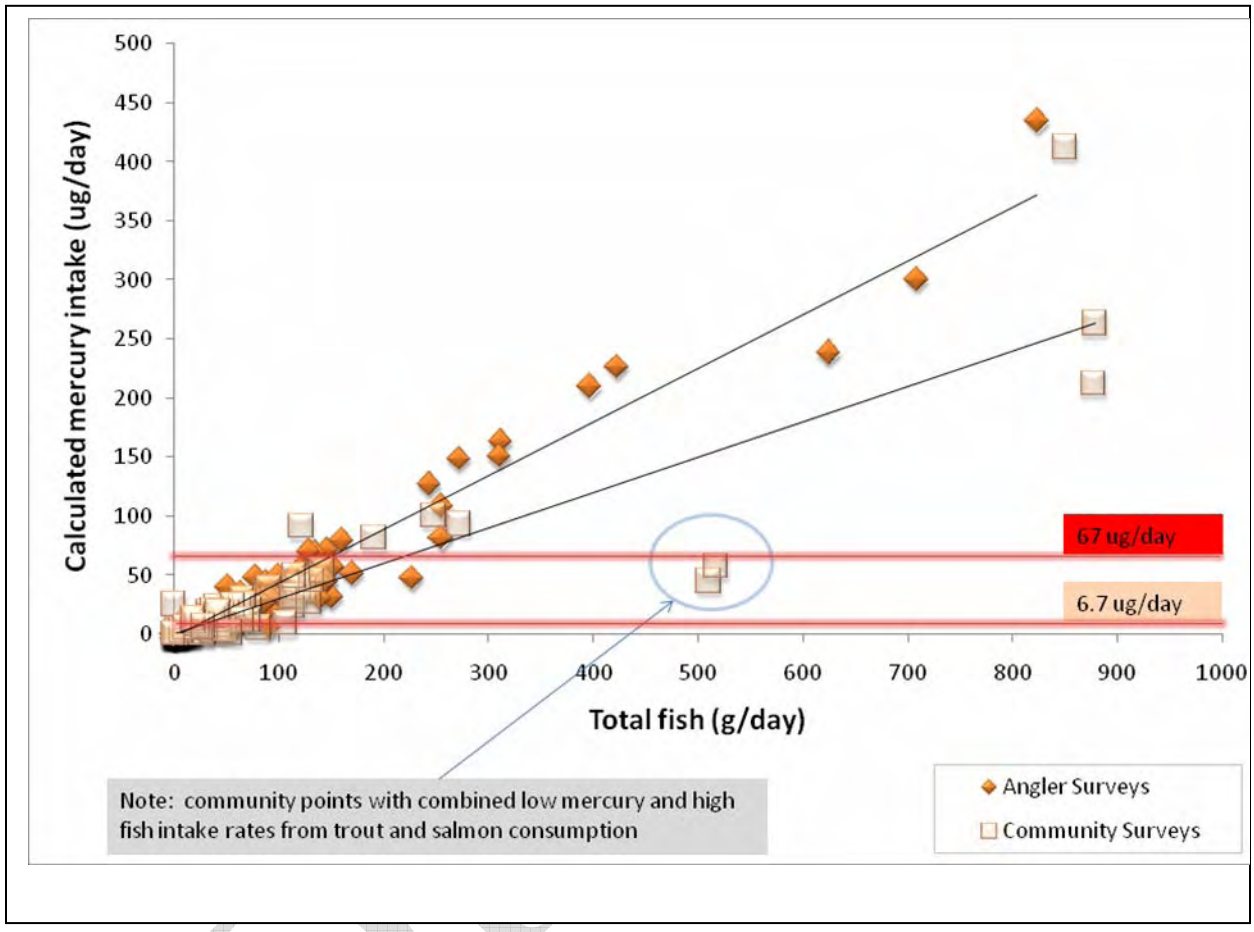


Figure 5. Calculated mercury intake rates per interviewee compared to total fish consumption rate. The lines corresponding to 6.7 micrograms Hg/day and 67 micrograms Hg/day are the USEPA reference dose for adults and ten times the dose, respectively.



Tables

Table 1. Mercury concentrations of commonly-eaten fish in the Northern Delta region. AR = American River, FR = Feather River, SR = Sacramento River. Data from the Regional Board database and San Francisco Estuary Institute reports online (http://www.sfei.org).

Fish Species (Common Name)	N	Mercury Concentration		Length	Location
		(Mean ppm)	SD		
Shad	19	0.052	0.023	>15”	AR, Delta
Bluegill	10	0.208	0.125	>6”	SR, SRSC
Carp	30	0.309	0.197	>15”	SR
Catfish	44	0.424	0.251	>12”	SR, Delta
Crappie	5	0.309	0.104	>8”	SR, Delta
Chinook Salmon	25	0.09	0.03	>26”	AR, FR, SR
Largemouth Bass	63	0.774	0.324	>12”	AR, SR
Sacramento Pike Minnow	42	0.763	0.525	>12”	AR, SR
Split-tail	1	0.37		16”	SR
Sacramento Sucker	38	0.22	0.117	>12”	AR, SR
Rainbow Trout/Steelhead	12	0.061	0.014	>18”	AR, SR
Striped Bass	47	0.545	0.318	>18”	AR, Delta, SR
Sturgeon	11	0.271	0.241	>48”	SR
Sunfish	14	0.182	0.097	>8”	SR

Table 2. Ethnicity-specific targeting of fish species. Ranks determined from survey for all respondents. Any = any fish species, CF = catfish, KS = Chinook salmon, SB = striped bass, Stur = sturgeon.

Ethnicity		Target Fish		
		1st choice	2nd choice	3rd choice
African-American		Any	CF/SB	CF/SB
Asian		SB	CF/Shad	CF/Shad
	SE Asian	SB	CF	Shad
	Hmong	SB	CF/Shad	CF/Shad
Asian/Pacific Islander		KS	SB	Stur/Shad
Hispanic		SB	CF	KS
Native American		KS/Any/Stur		
White		SB	Stur	KS

Table 3. Mean fish and mercury intake rates and warning awareness levels for different groups.

		N	Local Fish		Commercial Fish		Total Fish	Warning Aware
			(g fish/day)	(micro-gram Hg/day)	(g fish/day)	(micro-gram Hg/day)	(g fish/day)	Mean, (0=none, 3 = high)
Ethnicity								
African-American		16	22.9	10.9	10.1	3.0	33.0	0.9
Asian		125	25.9		12.8		38.7	0.7
	Hmong	50	22.2	9	5.3	1.6	27.5	0.5
	Lao	21	57.9	24	9.1	2.7	67.0	0.4
	Mien	8	7.3	2.1	1.8	0.5	9.1	0
	Cambodian	6	28.1	15.4	14.2	4.3	42.3	0
	Vietnamese	21	22.4	9.8	32.8	9.8	59.2	1.1
	Chinese	16	21.5	4.2	10.2	6.4	31.7	1.2
Asian/Pacific Islander		24	15.8	4.3	25.7	8.0	41.5	1
Hispanic		20	40.0	18	18.2	5.7	58.2	0.7
Native American		3	10.9	3.8	61.4	18.4	72.3	1.3
White		32	22.4	9.6	15.1	4.6	37.5	1.5
Age	<18	2	7.8	3.4	8.5	2.6	16.3	0
	18-34	83	31.1	12.5	17.4	5.2	48.5	0.9
	35-49	82	18.5	8.3	14.9	4.5	33.4	1
	>49	54	26.6	10.2	13.6	4.1	40.2	0.6
Gender	F	23	22.1	9.5	16.2	4.9	38.3	0.6
	M	198	25.4	10.4	15.4	4.6	40.8	0.9
Household	Woman 18-49	142	854	350	417	126		0.9
	With Children	116	912	387	494	148		0.8
Awareness	0	136	584		404			
	1	8	1090		346			
	2	52	1102		659			
	3	25	842		429			

	1+2+3	85	1024		562			

Appendix B

Community-Based Strategies to Reduce Mercury Exposure in Delta Fishing Communities

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April 2008

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Cover photo credits: Striped bass ("Field Guide to Fishes", National Audubon Society); community meeting about fish contamination (Foua Ly); angler in Suisun Bay (Aubrey White).

Acknowledgments and Notes

Funding for development of these strategies was provided to the authors by the Central Valley Regional Water Quality Control Board, through the California Department of Public Health. Thanks to Janis Cooke (Regional Board) and Alyce Ujihara (California Department of Public Health) for their support, review, and suggested edits for this plan. We are grateful to the stakeholders who shared their perspectives and opinions (Appendix A), without which we would not have been able to conduct the project. We are especially grateful to Andria Ventura (Clean Water Fund) and Amy Vanderwarker for coordinating the meetings of community organizations, Bay and Delta stakeholders concerned about fish contamination.

Several community organizations involved in fish contamination issues provided input for this strategic plan. They reserve the right to pursue these ideas, potentially in collaboration with others, and expect that if state agencies and others want to pursue them, they plan to equally collaborate with and support the organizations. Because of the sensitivity of this issue, future relationships with communities and community organizations, with whom participation is desired, may hinge on respecting community desires to speak for and organize themselves.

"Forget about the education process… Create alternatives!…clean up certain areas so that people can safely fish in certain cleaned and maintained areas."
-- Debbie Davis, Environmental Justice Coalition for Water

Executive Summary

In recognition of the broad diversity of communities and geographies involved in fish contamination, the strategic plan describes a stakeholder decision-making model that is based in impacted communities, informed by science, and with support from state institutions. It is rooted in the tacit understanding of communities that agencies will pursue environmental cleanup.

Mercury is a common contaminant of fish eaten by residents of the San Francisco Bay and the Central Valley. A legacy of the Gold-Rush era as well as a component of industrial and municipal waste, mercury accumulates up the food chain until it is consumed by people as they eat fish. This plan describes ways that exposure and therefore health impacts from mercury can be reduced for communities and individuals that eat fish caught in the Sacramento/San Joaquin River Delta. Like any strategic plan, it starts out describing the nature of the problem, where we want to end up, and how we are going to get there.

California state agencies have been involved with the challenge of reducing exposure of subsistence anglers to legacy and contemporary pollutants. This has consisted of several pilot studies and plans to clean up legacy mercury and educate anglers about fish contamination. The knowledge base about mercury cycling and accumulation has been steadily increasing, improving the likely efficacy of programs to reduce total mercury entry into waterways, as well as methylation of mercury in the environment. Remediation of mercury in waterways consists of addressing both total and methyl-mercury entry from terrestrial sources as well as methylation conditions exacerbated or created by reservoir operation, agricultural discharge, and municipal waste water. Reducing exposure in the short-term (while clean-up operations get under way) is considered by certain state agencies (OEHHA and the Regional Board) to also involve reduced fish consumption by subsistence anglers and their families. Because this view is not shared among subsistence anglers, at least in practice, there is an unresolved tension between state goals and public goals and practices. Recent findings show that mercury concentrations can go up and down significantly from year-to-year, suggesting that our assumptions about mercury cleanup taking decades may be wrong.

This plan is intended to support the overall goal of reducing mercury exposure among members of the public consuming locally-caught fish. It is based on the assumption that cleanup and abatement activities will proceed through processes such as the TMDL and that while that is occurring, communities will decide how to respond to fish contamination. The plan was formulated based on the combined expertise of the UC Davis and Southeast Asian Assistance Center staff, as well as the interview responses from 30 stakeholders in the Delta region. These stakeholders were each asked 15 questions relating to their understanding of fish contamination by mercury, potential strategies and actions that could help solve fish contamination, and roles their organizations and others could play in helping reduce fish contamination with mercury.

The plan is organized into 5 parts, each dealing with a particular aspect of reducing mercury exposure and measuring our effectiveness as agencies and institutions in dealing with this

pollutant. It is intended to complement and overlap other discussions among engineers and scientists about the technical aspects of cleaning up mercury contamination in the environment and reducing new inputs of mercury from municipal and industrial waste and processes. The first part of this strategy covers monitoring fish tissue and fish consumption patterns as related processes. The second part deals with approaches for assessing mercury exposure in a culturally sensitive manner. The third part goes into detail about developing effective programs for educating and involving impacted community members. The fourth part talks about developing fish consumption advisories that are understandable to the diverse communities eating fish from regional waterways. The fifth and final part is the business plan for implementing the strategy, based on a decision-making model that necessarily places impacted communities at the center of deliberations about fish contamination and partners in implementing strategic solutions.

1) Monitoring fish and fish consumption

These two processes have been largely disconnected in the Bay-Delta, where fish contamination has been monitored by biologists and fish consumption has largely been monitored by social scientists and community health experts. Ideally, there would be close coordination between these activities, except for fish monitoring associated with bioaccumulation and similar studies. There are many ethnicities who consume locally-caught fish from the Delta region, so measuring consumption patterns is complicated by language, culture, and trust. Several of the interviewees are experts in this area. The plan describes how Universities, agencies, and community organizations can collectively and individually plan and implement monitoring of fish contamination and consumption.

Strategy Community organizations lead the design and implementation of fish tissue and fish consumption monitoring, aided by academic and agency scientists.

2) Assessing mercury exposure.

There have been few studies of either calculated exposure (based on frequency or amount of fish consumption) or actual exposure (based on blood-mercury concentrations). In California, a pilot study by CDPH revealed complicated results for the combination of fish consumption rates and blood-mercury concentrations (A. Ujihara, “Fish Forum” 2007). There are also cultural and community concerns about exposure monitoring, addressed by several of the stakeholder-interviewees. The plan addresses how agencies and others can collectively or individually calculate or directly address mercury exposure in diverse fish-consuming populations.

Strategy Community organizations, in partnership with agency and academic health professionals calculate or measure actual mercury exposure and community organizations lead communication of findings to communities and individuals.

3) Effective education and outreach.

Community organizations, the Department of Public Health, and UC Davis have all engaged anglers and community members in discussions about fish consumption, have developed educational programs and materials, and have collectively reached thousands of anglers and other fish consumers. Recent research has elucidated possible opportunities and barriers to effective communication with fish consumers. Several stakeholder interviewees are expert in this area. The plan describes how state agencies and others can individually and collectively organize and support education and outreach activities to both inform people about fish contamination and provide them with avenues to communicate with decision-makers about this problem.

Strategy Community organizations lead the design and implementation of education and outreach programs to communities and individuals eating large amounts of locally-caught fish, aided by academic and agency scientists.

4) Consumption advisories.

These are developed by the Office of Environmental Health Hazard Assessment (OEHHA) and federal agencies, with a variable level of collaboration with other agencies and academic scientists. The advisories are intended for communities with high linguistic, ethnic, and cultural diversity, so their development and implementation could take advantage of experts in this area of diversity in order to make the advisories effective. The plan describes how advisories can be developed by OEHHA in collaboration with others to provide science-based *and* diversity-based advisories.

Strategy Community organizations, in partnership with agency and academic health professionals and scientists, design fish-consumption guidelines that are accessible to the diverse cultures and communities in the Delta region.

5) Decision-making & implementation model

The current approach or model used for state decision-making vis-à-vis fish contamination features state agencies on the funding and funded sides of the equations, has state agencies as the primary or sole decision-makers, and has resulted in challenges to implementation of an exposure reduction strategy. Feedback from all Delta stakeholders suggest that a strategic decision-making model is needed to reduce mercury exposure in Delta fish-consumers. To improve effectiveness, this model features organizations from impacted communities at the center of decision-making and implementation, partnering with state institutions in support roles.

I. Essential Background

Fish contamination by mercury and other pollutants is common throughout the Delta region and San Francisco Bay. Mercury from legacy, waste-stream, atmospheric, and natural sources enters the food-chain and accumulates into fish that people and wildlife eat (Wood et al., 2008). Concentrations of mercury are high enough in fish commonly-caught in the Delta region (e.g., catfish in North Delta and striped bass everywhere) to pose health risks to people consuming fish more often than once per week. As cleanup and pollution abatement plans are developed and implemented, state agencies and community organizations have been interested in helping people to keep enjoying the health benefits of eating fish, while reducing their exposure to mercury.

In 2003, CALFED commissioned a "Mercury Strategy" from a panel of national experts (Wiener et al., 2003). They combed the literature, the knowledge of Californian experts and stakeholders, and the data available to support decision-making. They described the sources of mercury and conversion to methyl-mercury in the Delta and its watersheds. They described the primary challenge in the Delta as "*to avoid increasing – and to eventually decrease – biotic exposure to methylmercury"*. They recommended 6 linked core components to the overall strategy: (1) Quantification and evaluation of mercury and methylmercury sources, (2) remediation of mercury source areas, (3) quantification of effects of ecosystem restoration on methylmercury exposure, (4) monitoring of mercury in fish, health-risk assessment, and risk communication, (5) assessment of ecological risk, and (6) identification and testing of potential management approaches for reducing methylmercury contamination. Although this study and plan effectively covered the science of mercury "production", transport, methylation, and fate, it only superficially described the social and health implications of mercury or strategies that could be taken in relation to these considerations. The current strategy builds upon the "Mercury Strategy" and fleshes out core component #4, emphasizing community involvement and education in what has been primarily an agency-driven process.

Community groups, agencies, and other stakeholders have expressed a common desire to pursue clean-up of mercury and other pollutants in the Delta watershed. They also hold a common desire to inform communities about the problem of fish contamination in order to permit anglers of many ethnicities to enjoy the beneficial use of local fish consumption while protecting their health. This strategic plan is based on in-depth interviews with 30 stakeholders about how to implement these visions. It describes specific approaches and steps to understanding the problem of consumption of contaminated fish and education and involvement of very diverse communities in reducing mercury exposure. Based on broad stakeholder input for improving effectiveness, the plan includes a model for decision-making that places impacted communities at the center, while recognizing the important scientific and funding roles of state and federal agencies. This model is based on a potential arrangement that could occur between regulatory agencies and communities that in exchange for changing fish consumption, the agencies will pursue meaningful cleanup activities. The plan provides an environmental justice solution to an environmental justice problem.

II. Problem Setting

1) Geography

Waterways leading to the Delta carry mercury in various forms and oxidative states (Domagalski, 1998 & 2001). The Delta in turn delivers the bulk of the water to the San Francisco Bay. Anglers tend to live and fish in greater numbers nearer urban areas than in the rural parts of the Sierra Nevada, Coast Range, or Central Valley (Shilling, 2003, 2004). In other words, the problem of mercury contamination originates from throughout the Delta's and Bay's watershed, but is expressed in the more urbanized areas around the Delta and Bay Area.

In the Central valley, anglers are distributed diffusely along major rivers and streams, on and around certain reservoirs, and at certain concentrated locations when other access points are limited (Williams, Shilling, Leonelli, Shimoum, and White, personal observations). Unfortunately, through an accident in geography, anglers tend to co-occur with places where frequencies of fish contamination are among the highest in California – the major rivers and reservoirs feeding into the Delta and Bay, as well as the Delta and Bay themselves (Shilling, 2003, 2004).

The Central Valley Regional Water Quality Control Board, CALFED's Ecosystem Restoration Program, and others have funded years of extensive surveying of fish tissue mercury concentrations (e.g., Davis et al, 2003). Two major and relevant findings from this work are that there are many places where mercury concentrations in certain fish species are high (e.g., catfish in the Sacramento and San Joaquin Rivers). An equally significant finding is that there are also places and fish species where concentrations are relatively low (e.g., higher-elevation creeks and trout). Although these occurrences of low and high mercury concentrations in various fish and in various places is still being defined, the upshot is that there are so-called "cool spots" where catching and eating fish may not be harmful.

2) Cultural, policy, and management setting

Individual community organizations have long been aware of the importance of fishing and fish consumption among their clients (Williams, personal communication; Leonelli, personal observation; Norris, personal communication). Recently, there have been several studies that have revealed the ethnic variety of anglers throughout the Delta region (Shilling, 2004; Silver, 2007; Shilling et al., 2008). These observations and studies have led to the conclusions that many ethnicities are involved in frequent fishing and fish consumption in the North Bay and Delta and that there is a true subsistence fishing population that crosses ethnic boundaries. The importance of these observations and conclusions is that a single management or policy approach to exposure reduction may not be effective.

There are a variety of economic activities and legacy processes that impact who must remediate mercury contamination and how. State and federal agencies have statutory authority and responsibility to limit discharge of pollutants into waters of California and US. In the case of mercury and methyl-mercury, point sources of inorganic mercury, sources of methyl-mercury, and sites of methylation are reasonable targets for cleanup and abatement activities. The Clean Water Act requires the use of policy tools such as National Pollutant Discharge Elimination System (NPDES) permits and Total Maximum Daily Load (TMDL) determinations to reduce pollutant discharge to US waters. The Regional Board provides NPDES permits to dischargers and calculates TMDLs for individual pollutants for individual water-bodies. These are two possible tools that the Regional Board can use to reduce inorganic and organic mercury into waterways as well as to reduce pollutant discharge that contributes to methylation conditions. Dam and reservoir operations that are part of hydropower generation are regulated by the Federal Energy Commission. FERC has the power to require reservoir operators to limit environmental damage (including pollution discharge) from their facilities. Other state and federal regulatory powers exist to require polluters to abate (methyl)mercury inputs and remediate past inputs.

Federal lands and certain state lands contain many of the abandoned mines that continue to contribute inorganic mercury to waterways that drain to the Central Valley, Delta, and Bay. Federal land managers have not obtained sufficient funds to begin cleanup and abatement activities in any meaningful way on these lands and they remain sources of mercury in the Delta watershed. Mine features are also present on private lands, but very little cleanup has been attempted there because of landowner concerns about liability. However, they remain a source of mercury, as significant a source as public lands. Agricultural lands contribute large amounts of organic carbon, sediment, and nutrients to Central Valley waterways. These contributions are likely to increase the number and activity of methylation environments in benthic sediments, slow-moving channels, and inundated lands (e.g., rice fields). Municipal discharge is a relatively minor contributor of mercury, but may exacerbate in-stream and down-stream mercury methylation conditions. Recent findings in Delta tributaries that fish tissue contamination can vary significantly (going up AND down) from month to month and year to year suggest that reducing mercury inputs and/or remediating methylation environments can provide short-term benefits as well as long-term benefits (Slotton, unpublished observations from Fish Mercury Project).

A critical feature of the context for this strategy is the current approach or model used for state decision-making vis-à-vis fish contamination. This approach features state agencies on the funding and funded sides of the equations, has state agencies as the primary or sole decision-makers, and has resulted in challenges to implementation of an exposure reduction strategy. This approach (shown in Figure 1) includes the Office of Environmental Health Hazard Assessment, the California Department of Public Health, and the Regional Board in decision-making roles. According to community organizations, they have a minor advisory role, compared to the core, funded team and receive a small percentage (<5%) of the total funding for the FMP for their work. Key stakeholders in this process and interviewed here expressed dissatisfaction with this model, with the strongest feelings being expressed by community organizations. Even state agency representatives have pointed to problems with implementing such an approach. This has primarily been because of the broad ethnic diversity disproportionately affected by fish contamination and the high barriers associated with state agencies leading outreach and

education efforts through official advisories and other modes of communication. Disaffected community organizations have become more common, obscuring the positive outcomes that have accompanied state agency involvement, such as funding, research, and policy formulation.

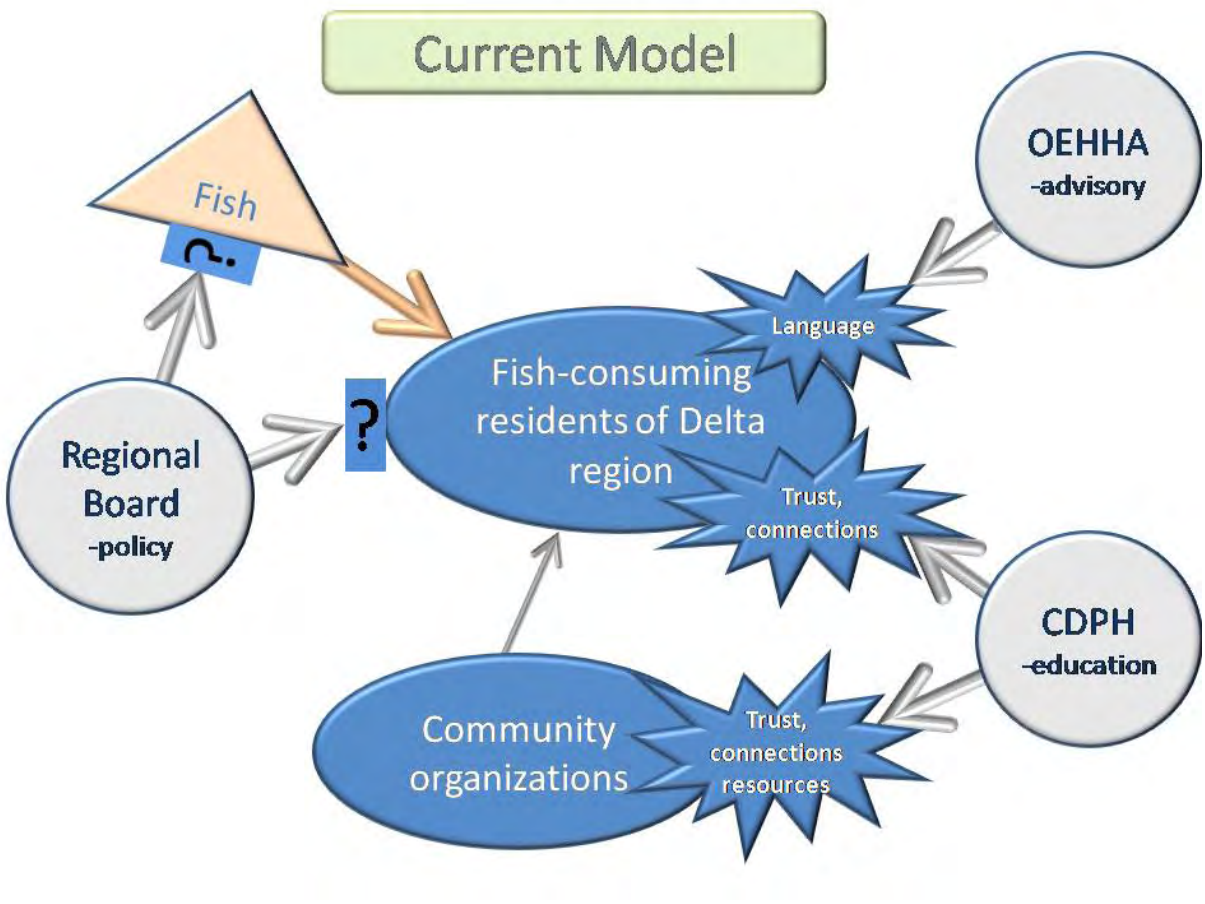

Figure 1 Decision-making and implementation model currently used in Delta fish contamination programs. Barriers are represented by the star shapes. Not all possible interactions and organizations are shown, only the primary ones. "Fish" refers to fish contamination, edible fish populations, and the activity of fish catching and eating.

"We cannot get people to stop eating fish. The best thing is to clean up the mercury. There should be state, federal, and private investment from people who did the polluting to fund clean up and to provide money to CBO's like us to do the community outreach and to educate."

-- David Shimoum, Southeast Asian Assistance Center

III. Core Strategies for Exposure Reduction

Development of Strategies

This plan describes strategies for reducing mercury exposure in fish-consumers developed using a stakeholder-based process. A combination of expert interviews, focal groups, and stakeholder meetings led to the implementable strategies described here. The strategies are based on 3 core values expressed by stakeholders – clean-up and reduce mercury and methyl-mercury inputs, educate fish-consumers to improve their choices, and provide alternatives to consuming contaminated fish.

1) Monitoring fish and fish consumption

These two processes have been largely disconnected in the Bay-Delta, where the majority of fish contamination has been monitored by biologists and fish consumption has largely been monitored by social scientists and community health experts. Ideally, there would be close coordination between these activities, except for fish monitoring associated exclusively with bioaccumulation and similar studies. There are many ethnicities who consume locally-caught fish from the Delta region, so measuring consumption patterns is complicated by language, culture, and trust. Several of the interviewees are experts in this area. The plan describes how Universities, agencies, and community organizations can collectively and individually plan and implement monitoring of fish contamination and consumption. A model for this approach has already been carried out by tribes, state agencies, and university researchers in the Great Lakes region (Dellinger, 2004).

A Model approaches

Since 2002, advocates for healthy fish consumption have canvassed and communicated with anglers about their fish consumption – People for Children's Health and Environmental Justice (PCHEJ) with African American and other ethnicities and California Indian Environmental Alliance with tribes. More recently, UC Davis scientists and community organizations (Southeast Asian Assistance Center & PCHEJ) have developed a unique collaborative project that was initially funded by the Sacramento Regional County Sanitation District and is currently funded by the California Endowment ($100,000 planning grant). This project is called "Community Capacity to Reduce Fish Contamination" (hereafter Community Collaborative).

The project includes surveying hundreds of anglers and community members about fish consumption patterns, holding community engagement meetings, developing education and outreach materials, and developing a community action plan for each of Sacramento and the

Vallejo-area. The Community Collaborative is advised by a technical advisory committee composed of equal numbers of agency and non-agency members. Proponents of the project point to the inexpensive development of a spatially and temporally diverse evaluation of consumption patterns, the inter-validation of UCD and community science results, the basis of the project in environmental justice principles, the control of the project by community organizations, and the support role of the state partner (UC Davis). The Community Collaborative is part of a regional coalition that has formed in the Delta and Bay, a "Healthy Fish Coalition" that has a well-developed capacity to take on mercury exposure reduction.

As part of a large three-year study of mercury in fish in the Delta region (the Fish Mercury Project, FMP), the San Francisco Estuary Institute measured mercury concentrations in fish that anglers were likely to eat and the California Department of Public Health (CDPH) surveyed hundreds of fish consumers about their consumption patterns. CDPH also developed education materials, held the two Fish Forums, gave out mini-grants to community organizations to help with community outreach and education, and was advised by a Local Stakeholder Advisory Group (LSAG). Proponents of the project point to its collaborative nature, the large amount of data collected about fish contamination, the mini-grant program, and the involvement of the LSAG. Critics of the program 1) described it as not supportive of environmental justice principles because community organizations had a traditional advisory role, but not decision-making power; 2) said that the mini-grants were not particularly helpful to the organizations themselves in terms of their increased capacity to be involved in the overall problem; and 3) said that the CDPH and other state agencies would be best positioned as support agencies in an effort led by community organizations. There are aspects of the FMP approach that could be wrapped into a collaboration with community organizations to strengthen the abilities of both.

Special Issue: Remediation, science, and exposure

Many stakeholders expressed strong opinions about state and federal agencies needing to more aggressively pursue mercury and methyl-mercury cleanup and reduction. Effective reduction in mercury exposure through remediation requires an understanding of the system to be treated. In recent studies, mercury concentrations in individual fish species have varied widely between years, within one watershed. This suggests that intentional management actions could have rapid effects on fish tissue concentrations at the scale of rivers tributary to the Delta. Control and management of both inputs of mercury (e.g., from legacy mines or oil refineries) and exacerbation of methylation environments (e.g., by agricultural and municipal discharge) may be possible. Many stakeholders felt that it was important to continue investigating the links between environmental mercury and human health, but they also felt that there was sufficient knowledge to proceed with remediation. There was tacit approval for moving forward to limit legacy and contemporary inputs, while conducting research about mercury sources, fates, transport, and cycling.

Recommended Strategies

1) To improve public trust, develop large "total removal" remediation projects to reduce regional and localized fish tissue mercury concentrations.
2) Pursue control of activities, through regulation, that could increase methylation environments.
2) Continue to study how mercury moves through the system and into edible fish.

B Fish Consumption Patterns

Fish consumption pattern investigation are critical to understanding who is fishing, where people are fishing, what kinds of fish people are eating, how much of each kind of fish is eaten, and what role fish plays in their overall diet and health choices. They are and should continue to be both the basis for water quality control planning and health communication planning.

Community organizations in the Community Collaborative, UC Davis, and the FMP-CDPH use essentially the same approaches for evaluating fish consumption patterns. One approach is the combination of a survey instrument with fish models, developed in collaboration between CDPH and UC Davis in early 2004, which both use for surveying large numbers of people who eat fish. CDPH's largest use of this tool was at a Women Infants & Children (WIC) clinic in Oct. 2004, where approximately 500 women were interviewed. WIC clinics provide dietary and health advice to poor communities otherwise unable to receive pre- and post-natal care while not all WIC recipients are eligible for the Comprehensive Perinatal Services Program [which provide perinatal care to low-income women in California] many of them are). The Community Collaborative has been using this approach for continuous surveying of anglers in the field and community members at home, with over 600 interviews since 2005 – the majority in 2007-2008. The survey instrument includes questions about fishing, fish consumption, knowledge of warnings about fish contamination, pathways for health communication, and demographics.

The FMP included a pilot investigation of fishing activity and fish consumption using boat-based surveying, in cooperation with the Department of Fish and Game (DFG). The DFG regularly surveys boat and shore anglers about their catch and provide a great resource because of their expertise about the location and activity of anglers. The DFG itself cautions about this approach, though, due to the formal nature of their physical presence and survey approach.

Both CDPH and the Community Collaborative have also used focal or expert group interviews to conduct a different type of information gathering. In both cases, investigators have conducted in-depth interviews of community experts to explore how people engage in fish consumption, make choices about fish, choose where to fish, and receive health-related information. Through this preliminary investigation, clear differences have become apparent about ethnic variation in fish consumption patterns and perception of health-related messages. Interviewed stakeholders felt that these approaches were important to compensate for possible inaccuracies (under-estimates) in consumption reporting in questionnaire-based approaches.

Two important findings of these fish consumption pattern investigations are that 1) almost all ethnicities catching fish in the Delta region are consuming those locally-caught fish at a mean rate much higher than thought by Regional and State Board staff (e.g., 32 g/day rate used in Delta methyl-mercury TMDL) and 2) community organizations and academic researchers find similar consumption patterns for the same communities. In the first case, one conclusion is that state agencies should make sure that the initial rates used in planning are accurate and periodic measurement of consumption patterns will be important for tracking pollution control and advisory program effectiveness. In the second case, a reasonable conclusion is that either community groups or academic researchers could conduct these investigations, but because of

both cost and linguistic diversity, community groups are well-positioned to determine consumption patterns for their own communities.

C Recommended Strategies

i) To inform cleanup and help people make choices, support fish tissue sampling by the organizations themselves or with the direct guidance from community organizations about what fish people are catching.
ii) Investigate fish consumption patterns from a combination of angler and community surveying methods and statistical tests.
iii) Carry out analyses in collaboration with community organizations and health providers so that interpretation of the results has broad understanding and buy-in.

> *"The public should know where the mercury hot spots are and we can do enough sampling to delineate the areas that have hot spots or seasonal hot spots. We need to warn them to not use those areas, especially the constant hot spots. We need to do this in addition to the standard fish consumption advisories."*
>
> -- Dave Lawler, USDI Bureau of Land Management

2) Assessing mercury exposure

Consuming fish contaminated with mercury leads to increased mercury concentrations in blood and other tissues. This increase is both the vehicle for effects to nervous systems and the indicator of potential impacts. By measuring individual body burdens of mercury and other pollutants in diverse communities eating fish, state agencies can improve understanding of the *potential* effects of fish contamination. People can also get the information they need to balance protecting their health by eating some fish, while not ingesting health-impacting levels of pollutants.

There have been few studies of either calculated exposure, based on frequency or amount of fish consumption (Stern et al., 1996), or actual exposure, based on blood-mercury concentrations (Gobeille et al., 2006; Schober et al., 2003). In California, a pilot study by CDPH revealed complicated results for the combination of estimated fish consumption rates and blood-mercury concentrations (A. Ujihara, presented at "Fish Forum" 2007). There are also cultural and community concerns about exposure monitoring, which were addressed by several of the interviewees.

Blood and hair mercury levels have been used to measure exposure of adults and potential or actual exposure of children (Budtz-Jorgensen, 2004; Dellinger, 2004). Hair monitoring tells us about long-term exposure to mercury in our diet, while blood mercury is more informative about

short-term exposure (months). Interpretation of these results are complicated by the possibility of individually-variable sensitivity to mercury and changing hair/blood ratios of mercury concentrations with age (Budtz-Jorgensen, 2004). However, this is often the best way to find out potential health impacts to *populations* from consuming fish.

There are several factors that must be considered when measuring exposure: 1) the role of low and moderate individual mercury concentrations in the context of the overall body burden of toxic chemicals; 2) the response of different ethnicities to different possible ways of sampling for mercury exposure – blood vs. hair; and 3) communicating the findings back to the individuals and communities sampled. In both cases, community health organizations can provide a doorway for regional and state organizations to gain access to and serve individuals and communities.

Cultural/ethnic responses to mercury exposure testing

According to community organization staff, certain ethnicities, including most Asian ethnic groups, may have a deep resistance to blood tests and sampling, and the perceived need for this testing and guaranteed benefit would have to be well established by parties well-known and trusted by the individual ethnicities. According to one interviewee, the person taking the blood sample would need to be from the same tribe to be trusted in this way. Hair monitoring would be less invasive, but many people have never heard of this method and its effectiveness would have to be explained. Native Americans in particular would find this method of sampling invasive and would be concerned about the process. Most people are not aware of the effects of mercury on the body, and the connection between mercury and their health should be explained and documented. Usually this requires citing proof in the form of published testing, both human bodies and fish. Once people are aware and convinced of the health impacts of mercury, and convinced that mercury is present in the fish they eat, they are willing to take preventive or corrective measures. This information is especially effective in communicating with women, who as mothers and preparers of family meals, can choose what their families consume.

Communicating findings to tested individuals and communities

People say that their own doctors are trusted sources of health information. Most people would want to receive their own individual health information – the products of mercury testing – in the privacy of a regular doctor's appointment. Otherwise, a trusted health or service provider would be a reasonable choice for conveying individual testing results. In general, stakeholders suggest, any mercury testing information must be part of an overall chemical-burden analysis to give it context. Other professionals, such as a college professor or public official (e.g., public health officer) are also credible sources of health information. If these credible sources are interviewed or heard on the ethnic language radio (e.g., PSAs) then this would be an effective message delivery strategy for the community. It is often assumed that limited-English-speakers are literate in their own languages, which is not always the case. Communities of a certain size have their own ethnic media, usually radio broadcasts which are very popular. Often community organizations either sponsor a radio program, or use radio to communicate all kinds of program, health, or other information.

A Recommended Strategies

i) Regional Board should fund, or support funding, community organizations/health providers to provide guidance and play the lead role in recruiting individuals for blood testing in clinical settings to examine exposure to mercury and other fish and environment contaminant.

ii) Community organizations/health providers collaboratively play the lead role in interpreting and communicating calculated or actual mercury exposure results for tested individuals and communities-of-origin of the tested individuals, in the context of overall chemical body burdens.

iii) Community organizations, in collaboration with scientists provide alternative strategies for fish consumption (e.g., fishing in areas that are not as contaminated).

3) Effective education and outreach

The Department of Public Health and Community Collaborative have both engaged anglers and community members in discussions about fish consumption, have developed educational programs and materials, and have collectively reached many hundreds of fish consumers. Recent research has elucidated possible opportunities and barriers to effective communication with fish consumers (Shilling et al., 2008). Several interviewees are expert in this area and provided feedback on appropriate strategies

All stakeholders interviewed for this plan felt that it was critical to inform people of risks from fish contamination. There was concern that the information not scare people away from eating fish, that the process be culturally-appropriate, and messaging occur via trusted communicators. There are several key components to a successful strategy of engaging with communities: a) involve community groups and members in decision-making about remediation and fish consumption advisories, b) identify who is to be engaged and thus how, c) identify the mechanisms likely to be effective in involving community leaders and the community at large, and d) collaboratively develop messages with community groups and representatives.

Special Issue: Changing consumption patterns

Stakeholders reported that there are more and more indications of state agencies pursuing a strategy of encouraging people to eat less fish as an efficient and cheaper way to deal with mercury pollution. This is evident in Regional Board TMDL documentation and comments from an interviewed stakeholder in this study. However, this strategy does not explicitly recognize the cultural, spiritual, economic, dietary, and recreational value of fishing and fish consumption to a wide variety of ethnicities and communities in the Delta region. Stakeholders interviewed were concerned about this approach by the state, while recognizing the importance of telling people about some of the risks of eating certain fish caught from certain places.

Recommended Strategies

1) Temper any attempts to change fish consumption patterns by describing how the state is also vigorously pursuing cleanup.
2) Build trust with fish-consumers by showing performance of cleanup activities.

A Involve community in decision-making

Many of the communities involved in eating large amounts of locally-caught fish have not traditionally been represented in decision-making about how to best communicate with them. Organizations and other representatives of communities have the expertise to provide guidance about effective education and outreach on fish contamination. Many of the groups below have been involved in one way or another in this issue for several years.

Group/organization	Community	Previous role with pollution issues
Southeast Asian Assistance Center	Southeast Asian and Russian immigrants	Angler and community surveying, health communication, exposure reduction strategy, Community Collaborative
People for Children's Health and Environmental Justice	African-American, Hispanic	Angler and community surveying, health communication, exposure reduction strategy, environmental justice policy, Community Collaborative
United Cambodian Families	Cambodian immigrants	Health communication about fish contamination
Lao Family Community of Stockton	Laotian immigrants and others	Health communication about fish contamination
Todos Unidos	Hispanic	Health communication about fish contamination
West County Toxics Coalition	African-American	Advocacy, health strategies
Lao Khmu Association	Laotian immigrants	Health communication about fish contamination

Surveying by the CDPH and the Community Collaborative provides preliminary guidance for which organizations and communication avenues may provide the most connection with the diverse fishing communities about health effects of fish contamination. For example, Hispanic anglers and fish consumers prefer medical providers, friends & family, or TV; African-American anglers prefer medical providers, friends & family, and the newspaper; and Southeast Asians prefer medical providers, friends & family, radio spots, and community groups (Williams, Leonelli, Shimoum, personal observations; Shilling et al., 2008). Other ethnicities also report trusting these and other mechanisms for receiving health-related information. There are over 20 ethnicities catching and eating fish in the Delta region (Shilling et al., 2008). In order to communicate effectively with all of them, a very diverse communication strategy will have to be pursued. Most stakeholder-interviewees felt that this was best done by community organizations which already had the trust of these communities.

B Recommended Strategies

i) Support regional meetings on fish contamination coordinated and facilitated by a neutral facilitator (several stakeholders recommended Deb Marois, debmarois@sbcglobal.net).

ii) Support regional organizers, funded by state funds and working for and with communities to provide trainings on fish contamination – remediation and exposure reduction – and to build capacity of CBOs where needed.

iii) Health professionals (ideally from the same ethnicity) and/or academics work with community organizations to develop accurate, effective messages about health effects of mercury, where it is encountered, and how to avoid it.

ii) Because community stakeholders and others interviewed feel that the current model of outreach and education is ineffective, community groups should lead dissemination of the messages to key persons/leaders in each community, and in every contact with clients/community members. The message should be linked to every service provided. This could be through in-language information cards (eg, those prepared by CDPH) handed to clients, in-language radio announcements for programs or events, posters on the office/church/community center walls, and reminders in any type of regular communication (newsletter, flyer). In every case, messaging should be accompanied by in-person conveyance of information by experts trusted by the community.

"These communities have been approached by numerous agencies to just don't eat fish or with complicated rules. For women who are pregnant and subsistence fishers… they won't stop and education campaigns don't take this into account. They can't afford to stop and it's often a cultural thing too. Agency efforts to educate have already created distrust, education is not a feasible solution."

-- Debbie Davis, Environmental Justice Coalition for Water

4) Consumption advisories

These are developed by the Office of Environmental Health Hazard Assessment (OEHHA) and federal agencies, with a variable level of collaboration with other agencies and academic scientists. The advisories are intended for communities with high linguistic, ethnic, and cultural diversity, so their development and implementation could take advantage of experts in this area of diversity in order to make the advisories effective. Currently, most ethnicities do not report signs and other printed materials as effective ways of communicating with them about fish contamination. Most stakeholders interviewed for this plan said that current approaches to sharing advisory information are ineffective and not sufficiently extensive through communities to even be potentially effective.

OEHHA has already tried the model of developing advisories with *post-hoc* input from target communities. Because there is little opportunity to adjust the advisory after this process, another model worth considering is the development of advisories in complete collaboration with community organizations.

Figure 2 Multi-lingual fish advisory sign

OEHHA begins this process with the collection of information about which fish species have measured mercury concentrations above certain thresholds. The collaboration at this step could involve community groups helping to decide which fish are most important to consider, based on regional and ethnic preferences. In the event of insufficient information about fish species that are popular, or that with a small number of samples appear to be a problem, additional data could be collected. The next step involves determining risks associated with eating these particular fish at specific consumption rates. The collaboration at this step could involve community groups determining appropriate consumption rates to use and any considerations of seasonality, amounts consumed per fish species, and preferred sizes of fish. The third step, currently not part of the process, could involve community groups determining alternative messages that could accompany the advisory, such as which fish species may be safe to eat instead of the target fish, as well as which areas may be safer than others. The final step in the process is to craft the message into (usually) written advice in sign, brochure, or DFG manual form. Recently, the messages have also been translated and posted as signs and posters at fishing locations and other places anglers may see them. The collaboration at this step could consist of community organizations determining appropriate mechanisms for communicating with specific ethnicities (e.g., print vs. visual media), which ethnicities may need the most involvement based on specific fish consumption rates, and ways to evaluate how effective the advisory is in communicating risk and alternatives.

"The most effective messages come from people within the community …. The most direct strategy is to support community organizations and leaders as the primary messengers."

-- Holly Brown-Williams, UC Berkeley School of Public Health

A Recommended Strategies

i) Develop advisories collaboratively between community organizations and OEHHA to actually get the message to fishing communities in the Bay Delta. This will require the knowledge and input from communities directly as to the best and culturally specific ways to get the info out. This will also preferably be targeted to women, as there is

suggestion of a large proportion of subsistence fishers are men, not women. As a result of interviewee responses, it was indicated that women would heed warnings more than men.

ii) In collaboration with community groups, test effectiveness of advisories with community follow-up.

IV. Implementation

1) Decision-Making and Implementation Model

Feedback from Delta stakeholders suggest that a strategic decision-making model is needed to reduce mercury exposure in Delta fish-consumers (Figure 3). This model builds on the research and work conducted by the FMP, the Community Collaborative, and other work of individual agencies and organizations. This model is a strategic response to an emerging problem – the disconnect between the growing knowledge about fish consumption as a threat to public health and the fish-consuming public themselves.

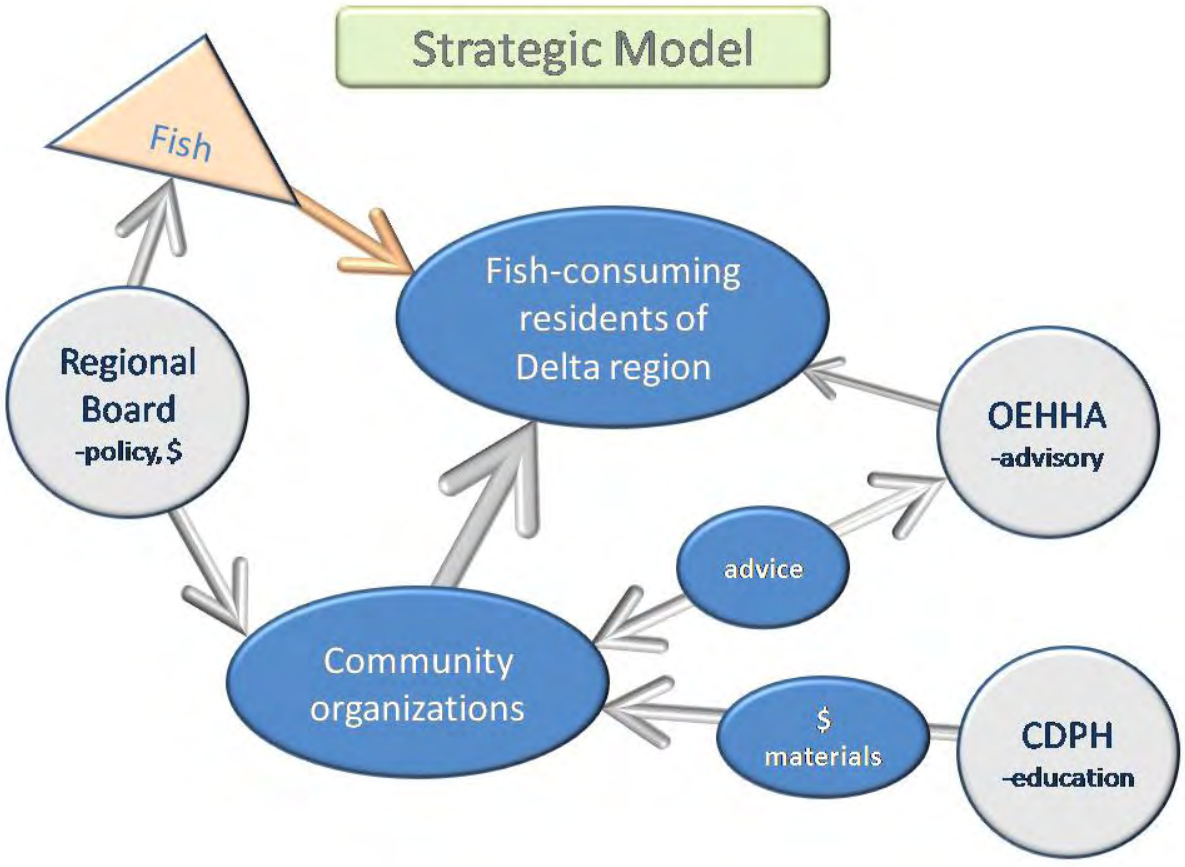

Figure 3 Strategic decision-making model for fish contamination and mercury exposure reduction. To simplify the model, not all possible interactions are included, or all possible agencies and organizations. “Fish” refers to fish contamination, edible fish, and the activity of eating fish.

One way that a reconnection between state and community can be supported is through the identification and creation of community advisory boards who will be composed of members in the community that have interest in developing a sustainable relationship built on trust, where the community member is respected for their knowledge just as much as the scientist for their unique contribution that they bring to the development of effective strategies of developing and social marketing advisories.

The implementation model relies on several important factors: 1) recognition and development of the community organizations' capacity to take on this role, 2) recognition by state agencies that their statutory roles can be filled with the aid of community organizations, and 3) the movement of state agencies to a support role in education, science, and funding.

A Community capacity

Individually, dozens of community organizations in the Delta region have tackled major public health, safety, and economic problems on behalf of their client communities (e.g., lead contamination, gang violence, poverty). Individually, they have used tens to hundreds of thousands annually of private and public dollars through contracts, grants, and donations to take on these problems. Collectively, these organizations have spent millions of dollars dealing with some of the most intransigent of social and public-health problems. In doing so, these organizations have worked at the individual, neighborhood, and community level to effect change at multiple scales to an extent that few if any individual public agencies could hope to achieve. Collectively, community organizations in the Delta have the capacity to accept the funding, collaboratively make decisions, and make changes at the community level.

Community agencies have developed years of expertise in identifying individual and collective social problems, and working to solve these problems. Because of the nature of most funding mechanisms, the problem solving is considered the "outcome" and an end in itself. Learning how to prevent problems, by advocating policy and systems changes, would take this experience and skill to the next level. Community organizations would need meaningful and sustained connection to State agencies and policy makers, through funded projects, meetings, conferences and formation of local advisory groups, to develop this capacity to become the most effective and valuable partners.

"Scientists can describe the problem and help with education. But they don't know community; I know community. Both of us are learning and it is a two-way street."

-- David Shimoum, Southeast Asian Assistance Center

B State agency statutory role

The Office of Environmental Health Hazard Assessment (OEHHA) has a critical role in solving mercury exposure through its development of fish consumption advisories. The effectiveness of these advisories relies entirely on the ability of anglers to understand the advisories and to use them to make decisions. OEHHA must develop the advisories based on the best available science, but there is no requirement that they must be developed with only minimal stakeholder feedback. Community organizations are ideally placed to play a consulting role in describing how advisories should be developed, who they should be targeted toward, and how they should be communicated. OEHHA can fulfill its statutory requirements while basing certain of its decisions on this consultation

The Regional Water Quality Control Board (RB) has a critical role in encouraging and requiring clean-up of California's waterways. It functions as the main agency arbiter (besides the USEPA) of solutions to reducing mercury exposure through fish consumption. The development of solutions depends on a combination of public constituencies impacted by impairment of beneficial uses and regulatory devices to encourage or require reduction of impairment. The RB can and should recognize the key role of impacted communities as decision-makers about potential solutions as a part of effective water quality management. Interviewed stakeholders felt that the most critical roles for the Regional Board were in developing effective TMDLs for mercury and providing support to community organizations.

The California Department of Public Health (CDPH) has played a combined leadership and an assistance role so far in developing health educational materials for CDPH and community organization outreach programs. CDPH has also investigated fish consumption patterns and health communication. These roles are critical feature of the implementation of mercury exposure reduction strategies. With funded consultation with community organizations, CDPH could develop materials that suit the particular communities, are produced professionally, and are in appropriate languages.

The California Department of Fish and Game (CDFG) daily communicates with anglers through print media and in-person. The Fishing Regulations handbook has been described by many anglers as their source of information about fish contamination in certain areas. CDFG staff regularly conduct creel surveys in various parts of the Delta watershed. These advisories and surveying functions provide a two-way stream of information to and from anglers. With consultation with community organizations, the flow of information could be improved, both in terms of survey accuracy and methods for presenting advisory information.

C State institution support role for community organizations

Community organizations are the most likely to be effective at conducting education and outreach activities with diverse communities and functioning as intermediaries between the impacted public and state agencies. In their lead role, community organizations can ensure that development and implementation of strategies involving diverse communities are linguistically

and culturally appropriate. They can be involved at the level of decision-making and at the level of implementation.

State institutions (e.g., University of California) have an important role in this process – as providers of technical and funding resources. This provision of assistance will vary with state agency, geography, and community involved. Three kinds of basic scenarios can be foreseen and anticipated:

1) Regulation-related research support: State agencies (the Regional Board) can require that impacted communities be involved by dischargers and others seeking permits to release mercury and others that could require permits (e.g., public lands management agencies). Scientists could help community organizations with recommending additional research needed to implement the TMDL. This would improve the abilities of communities to become involved in the regulatory processes affecting their lives.

2) Technical support: Universities and state agencies have varying capacity to provide technical information to community organizations depending on their need. Community groups and others have expressed the opinion that state universities are most ideally placed in this role. They should also receive technical information from these organizations to improve their effectiveness with specific communities. For example, fish advisories are best developed with the cooperation of those familiar with the workings of the communities intended to receive or benefit from the advisories.

3) Funding support: state and federal institutions have access to funding unavailable to community organizations and fee mechanisms to develop funding resources. Because community organizations can play a critical role in reducing mercury exposure, they should be supported by general funds, bonds, impact fee-based programs, and research programs through direct contracting from agencies or grant programs. The conventional approach is to support other agencies and familiar private consultants in reducing impacts to beneficial uses. This approach is ineffective when used over large geographic areas with dozens of ethnicities.

2) Implementation of Mercury Exposure Reduction

Using a community-based model for decision-making and implementation is likely to be the most effective use of limited resources and result in the most sense of ownership and investment by fishing communities and fish consumers. A critical question is whether or not community organizations have this capacity. Given that the organizations interested in dealing with fish contamination have demonstrated this capacity incidentally with other public health issues and in direct relation, this is a non-issue. In addition, community organizations collectively have access to single contractors (e.g., UC Davis) that can receive large grants and disburse them to member groups in a coalition.

All stakeholders interviewed expressed support for the role that community organizations can play. Many of these same organizations have stressed the importance of respecting their intellectual property rights when it comes to sharing their ideas with certain state agencies and non-governmental organizations involved in the issue of fish contamination. Stakeholders and other CBOs express cautious optimism that programs from the past (e.g., FMP) will not be exactly repeated and that instead new collaborations will be sought where community

organizations will play a role in decision-making and receive funding on par with state institutions.

Collaborative project development was supported by all interviewed stakeholders, where each party plays a role consistent with their expertise and policy role. Broadly, this consisted of state and federal agencies playing a support technical and research role to understanding and implementing mercury cleanup, mercury cycling and mercury bioaccumulation; state agencies and dischargers providing fee and other funding mechanisms for community organizations to conduct large-scale projects; community organizations making decisions about remediation, research, and communication; and community organizations implementing various education and outreach projects.

The table below shows various activities consistent with the recommended strategies described above. It describes potential costs, estimated based on stakeholder input and the experience of the strategic plan authors. It also shows who should conduct these activities, the desired outcomes, and links to the TMDL as one policy nexus.

Recommended activity	Potential cost (Staff time, materials, stipends)	Responsible party	Desired outcomes	Link to TMDL
Strategic decision-making model process	$200,000/year for 10 CBOs in coalition	State-funded, one or two coalition leads	Improved collaboration between state and community, improved information sharing	Coordinated approach to decision-making, action development, and implementation
Fish consumption pattern surveying (community and anglers)	$90/surveyed individual (Community Collaborative) $250/individual (FMP/CDPH)	Community groups in collaboration with academic and/or agency scientists	Patterns of fish consumption, knowledge of fish contamination, trust	Direct measure of fish consumption behavior. Indirect measure of exposure.
Fishing and fish consumption practices (focal groups, key informants)	$100/surveyed individual, $250/focus group (Community Collaborative)	Community groups	Fishing and fish consumption patterns; mechanisms for receiving and using fish-related advice	Direct way of developing ethnicity-specific involvement in reducing mercury exposure
Fish monitoring	$50/sample for field sampling $100/tissue sample	Community groups collaborating with academic and/or agency scientists	Patterns of contamination in fish eaten by local populations	Direct measure of fish contamination for species eaten regionally

Mercury exposure	$75/sample for clinic sampling $100/blood sample and/or calculated exposure	Community health organizations in collaboration with academic and/or agency scientists	Patterns of exposure in fish-eating populations	Direct measure of human exposure
Education	$2,000/1,000 people (publication) $30,000/1,000 people (development)	Community groups and health organizations	Vast majority of fish-consumers aware of contamination	Indirect approach to changing behavior in response to risk
Outreach/In-reach	$20,000/1,000 people or 10 organizations	Community groups in collaboration with agencies	Improved communication between state agencies and communities	Improved decision-making by state agencies for mercury reduction
Consumption advisory	$50,000/regional advisory	Community groups in collaboration with academic and/or agency scientists	Advisories that resonate with the communities for which they are intended and reflect their consumption practices	Indirect approach to changing behavior in response to risk

V. Conclusions

Fish contamination has become a critical issue in the San Francisco Bay, Delta, and influent rivers because of concerns about overall health risk and disproportionate impacts to subsistence fishers, many of whom are ethnic minorities and/or poor. Stakeholders interviewed as part of this strategy plan development had the following suggested strategies and actions:

1) Include community organizations in all stages of research, education, outreach, and remediation.
2) Focus on both cleanup of contamination (legacy and contemporary) and informing people eating locally-caught fish about potential health impacts and alternatives.
3) Characterize impacts to affected populations to inform Clean Water Act related work.
4) Study the effects and effectiveness of both remediation and education and outreach approaches.

Many community organizations are already involved or aware of fish contamination as an issue for their client communities. What has been lacking to date has been the resources for them to become substantially involved in the planning, research, and education/outreach components of reducing mercury exposure from fish consumption. As these resources become available, more and more organizations will be able to become involved in planning and research, a critical part of the process of solving what is in large part an environmental justice problem.

State and federal agencies, tribes, and others are investigating ways to clean up legacy pollutants in the Delta and its watershed. This involves both reducing inputs from known sources (e.g., abandoned mines) as well as reducing the environments for mercury methylation due to degraded water quality because of agriculture, waste discharge, or water storage. In parallel, agencies and others are focusing on education and outreach to anglers to inform them of risks from eating "too much" contaminated fish. Because of the number of anglers in the Delta region and the dispersed and diverse nature of anglers, this is a challenging task. However, because of excellent connections within communities, place and ethnic-based organizations are increasingly being asked to conduct this work.

Over the last 3 years, 2 major studies have been conducted to understand fish consumption patterns. In both cases, over 500 anglers and/or community members were asked about their fishing and fish consumption behavior. Even with these large numbers of surveyed individuals, it remains to be seen if studies of this size are sufficient given the geographic and ethnic diversity of anglers and fish consumption. In parallel and prior to these studies, agencies have measured concentrations of mercury in target fish species (for consumption). The combination of fish contamination and consumption patterns helps determine risk to subsistence fishing populations.

Finally, as we collectively engage in monitoring and implementation, the need to evaluate our effectiveness becomes more apparent – for remediation and education/outreach. Effectiveness will be a product of fish consumers awareness of fish contamination (increasing), mercury and methyl-mercury cleanup (increasing), environmental methyl-mercury (decreasing), edible fish tissue concentrations (decreasing), fish consumption patterns (changing to less toxic fish), and community investment (increasing).

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Appendix A: Stakeholders interviewed and workshop participants during the development of the strategic plan

Community organizations and non-governmental organizations

Debbie Davis	(Environmental Justice Coalition for Water, Oakland)
David Shimoum	(Southeast Asian Assistance Center, Sacramento)
Lim Leang	(United Cambodian Families, Stockton)
Sophat Sorn	(Seventh Day Adventist Church, Stockton)
Chan Chanthasack	(Lao Khmu Association, Stockton)
Seng Her	(Sacramento Lao Family Community)
Lawrence Lo	(Stockton Lao Family Community)
Tham Le	(Vietnamese Voluntary Foundation, Stockton)
Houa Lee	(UC Extension, Stockton)
Izzy Martin	(Sierra Fund, Grass Valley)
Andria Ventura	(Clean Water Fund)
Sherri Norris	(California Indian Environmental Alliance)

Local agencies

Julie Campbell, Chris Husing, Elizabeth Vigio, Sheri Rulon, Janet Talksy, Amelia Schendel, Patricia To, & Teri Duarte	(Woman Infant Child Clinics – WIC, Sacramento)
Glennah Trochet	(Sacramento County Medical Officer)
Cathy Carmichael	(Sacramento Native American Health Clinic)
Jennifer Choy	(Kaiser Permanente, Sacramento)
Vicki Fry	(Sacramento Regional County Sanitation District)

State and federal agencies and universities

Robert Titus	(California Department of Fish and Game)
Robert Brodberg	(Office of Environmental Health Hazard Assessment)
Holly Brown-Williams	(UC Berkeley, School of Public Health)
Tess Shiner	(FSNEP, UC Cooperative Extension)
David Lawler	(USDI Bureau of Land Management)
Brian Bergamaschi	(US Geological Survey)

Workshop participants (Nov. 13, 2007 & Feb. 22, 2008)

Christine Cordero (Center for Environmental Health), David Shimoum & Laura Leonelli (Southeast Asian Assistance Center), Barbara Parrila-Barrigan (Restore the Delta), Savong Lam (United Cambodian Families), Michael Kent (Contra Costa County Dept. Public Health), Christina Medina (Ma'at Academy), Carlos Torres (Todos Unidos), Whitney Dotson, Benny Lee (Environmental Justice Coalition for Water), Angela Berry & Sherri Norris (California Indian Environmental Alliance), Andria Ventura & Jennifer Clary (Clean Water Fund), Amy Vanderwarker (formerly of Environmental Justice Coalition for Water), and Fraser Shilling (UC Davis)

Appendix B Questionnaire used to interview stakeholders

Structured Interview (Community-oriented) Questionnaire for Regional Delta TMDL Strategy

"*Appropriate topics for the strategy include: guidance for fish monitoring; assessment of quantities and species of fish consumed; assessment of exposure to mercury; development of educational materials; development of consumption advisories; and effective public outreach tactics. The strategy should describe the most effective and appropriate actions for the SWRCB and the Regional Board, other state and local agencies and private entities (e.g., community-based organizations and health care providers), and estimate costs.*" (DPH-Regional Board Task 2 Description)

[Thank-you for agreeing to be interviewed for this project. We are developing a holistic strategy for dealing with mercury exposure in the Delta. The strategy is tied to the Delta Total Maximum Daily Load – TMDL for mercury, currently under development by the Central Valley Regional Water Quality Control Board. The TMDL is the policy used to regulate water quality and the Regional Board is the state agency responsible for regulating water quality. We would like your help in identifying ways that mercury exposure can be assessed and reduced and ways that people can become more engaged and educated about mercury exposure.]

1) How would you categorize your particular knowledge, interest, or expertise in relation to mercury contamination and exposure? OR Do you have background or knowledge on any of these topics?

- ☐ Legacy mercury in the environment
- ☐ New inputs of mercury into the environment
- ☐ Mercury methylation in the environment
- ☐ Mercury in fish
- ☐ Public exposure to mercury
- ☐ Public health issues with fish contamination
- ☐ Public education about fish contamination
- ☐ Policy development for mercury clean-up
- ☐ People's fishing or fish consumption activity
- ☐ Public health issues

How did you learn of these issues?

2) Do you think there is sufficient knowledge about where mercury is coming from (sources), how it is being moved through the environment (transport) and where it is ending up (fates)? What else do you think we need to do to improve our knowledge of mercury cycling in the Delta?

Monitoring
Research

3) Eating fish contributes to health and may be culturally and economically important. However, mercury can cause a variety of brain and nervous system dysfunctions.

a) If people are consuming a lot of fish in the Delta region, do you think they should be informed of these dysfunctions?

b) Who should be responsible for sharing this information with them?

c) Who do you think they will trust and believe?

d) What are some barriers to members of (your) community receiving and understanding information about fish contamination? What health-education programs have been successful?

4) How would efforts to reduce consumption of locally-caught fish financially and culturally impact certain communities and populations?

5) Some of organizations have surveyed anglers and community members about their consumption of fish. Do you think this is a good way to find out how much fish people are eating? What are the advantages and draw-backs of this approach?

6) There are advisories from the state government for how much fish people should eat. Are you aware of these and how they are developed? Do you think they are effective? If so, what makes them effective and if not, what makes them ineffective?

7) Exposure to mercury can be measured in an individual's blood or hair. What do you think are some limitations or advantages to doing this, with each of these methods? How should the information about mercury be share with the person giving the hair or blood sample?

8) The TMDL for mercury will focus on a combination of scientific studies, pilot mercury remediation projects, and public education and outreach programs. What kinds of public outreach and education programs do you think are most effective and how much will they cost?

9) Recently, alternative strategies have been considered to give fish consumers other fish choices and alternative locations to fish. What alternative strategies do ou think are feasible and should be considered?

10) What do you think is an appropriate role and appropriate types of actions for your organization and organizations like yours in dealing with fish contamination?

11) What do you think is an appropriate role and appropriate types of actions for state government (the Central Valley Regional Board) in dealing with fish contamination?

12) How do you see your organization working within a collaborative framework involving other organizations, stakeholders or individuals to create and implement strategies or plans for mercury reduction?

13) Are you already collaborating with other organizations to incorporate diverse concerns, ideas and resources into a mercury reduction strategy?

14) How could collaboration increase the effectiveness and reduce the timeframe of a mercury reduction strategy?

15) How could scientific and non-scientific agencies and organizations work better together? [probe for specific ideas, like agency liaisons]

16) There are limited public funds available to deal with issues like environmental clean-up. Do you think the state government should invest the funds required to cleanup mercury in the environment so that people can safely eat fish? [probing for the conditions on “yes” or “no”]

17) What do you think are the trade-offs or issues between reducing mercury in the environment and in fish and trying to get people to reduce the amount of fish they eat?