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Not Yet Glowing: Sacramento Delta Anglers and the Distant Hum of Risk

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Not Yet Glowing:
Sacramento Delta Anglers and the Distant Hum of Risk

By

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Abstract

The history of gold mining and industrial development around the waterways of Northern California have made the prominence of mercury contamination an increasing problem in the Sacramento-San Joaquin Delta (the Delta). Scientists strive to understand the relationship between mercury and aquatic environments, between mercury and fish, and between mercury and human health. Meanwhile, fishermen frequent the Delta for both sport and subsistence fishing and are often greeted with advisory signs urging them to limit their locally-caught fish consumption. Advisory signs, however, leave out the more complex historical and political processes that surround mercury's presence in the Delta waters, leaving fishermen with little information outside of the vague threat present on advisory signs. Advisory signs and similar education efforts make assumptions that the best way to mitigate the problem of mercury contamination is through public education, and that fishermen will share an expert-driven understanding of the risks associated with mercury contamination. This thesis addresses the many contexts in which knowledge about mercury is generated, and the many ways its risks are interpreted, framing the case of mercury contamination in four contexts: mercury in the environment, mercury in the body, mercury in the academy, and mercury in the community. Understanding mercury in the environment means placing it in a larger environmental context and understanding both its historic and present day significance. To look at the body means looking at both the toxicology of mercury and how scientists have assessed the risk of its consumption by people. Looking at mercury in the body is in part a reflection on scientific understandings of methylmercury (MeHg), and in part a look at how scientists and researchers impose perceptions of the problem on to affected communities. Academics frequently examine the case of mercury contamination. The methods they have used and recommendations they have made provide a springboard for my own fieldwork and analysis. Finally, I look to communities of fishermen to see how they understand the problem, how they understand their environments, and how they can be involved as the process to curb the problem of mercury contamination lumbers forward.

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All photographs by Aubrey White unless otherwise noted

Figure 1. Anglers fishing near advisory sign at Grizzly Island.

I. Introduction

The winding hillside roads of Suisun Bay lead to the marshy edge of the Sacramento- San Joaquin Delta and a small public fishing pier littered with remnants of fishing hooks, bait, and snagged lines. On any given night, a handful of fishermen populate this pier, lines cast into the slough that carries water from the Delta into the San Francisco Bay. Whether as a respite from the nearby suburban Fairfield or a search for the evening's dinner, men (and occasionally women) gather regularly at this point to converse into the evening and wait patiently for a bite at the end of the line. Just upstream of the pier, a drainage pipe approximately three feet in diameter dumps water into the slough. The water streaming from the pipe produces a slightly yellow froth that lingers around the shore and clings to the pier's wooden support beams. The pollutant

being dispelled into these waters is apparent, easy to see. But it is not the only contaminant present in this water.

At a nearby boat launch facility, advisory signs posted by the California Department of Public Health warn fishermen of the dangers of eating fish contaminated with mercury—a heavy metal present in the these waters as legacy of the state's gold rush and industrial development. Despite the signs of warning in proximity to the fishing pier, these fishers continue to gather and, as is often the case, continue to consume the fish they catch from these waters. This location is one of many throughout the Delta where fishers gather in the name of both sport and subsistence.

In brief, inorganic mercury (Hg) in the Delta watershed settles in stream and river-bottom sediments, in reservoirs behind dams, and along the bottom of relatively still waterways in the Delta. Under certain conditions (erosion, dredging, change in pH, reduced oxygen, increased organic carbon, increased temperature among others; Lakes Environmental, 2009; Wang, 2004), inorganic mercury becomes methylated and available to the food web. Through the process of bioaccumulation, methylmercury (MeHg) moves from sediment to phytoplankton to krill to fish and eventually to humans. By the time a fishermen eats a fish caught from the delta, that fish could have consumed methylmercury for many years. Warning signs specify which fish are considered most dangerous (striped bass and sturgeon) and discourage fishermen from consuming more than two meals per month of those species (women and children are limited to one meal per month).

Perhaps without realizing it, these fishermen are being observed from many different angles. The information fishermen may see at fishing locations or printed in the

fishing regulation manual is a single point in a long line of work and debate surrounding the problem of mercury contamination. And in many regards, fishermen are left to guess about all of the other factors involved in the problem. Floating around the issue are the U.S. Environmental Protection Agency (EPA), working to generate risk assessments that encourage less fish consumption amongst anglers; the California Department of Public Health (DPH), charged with disseminating the EPA's information about MeHg, notifying the public of its presence; and Community based organizations in the area, striving to ensure advisories are accessible to fishermen and pushing for more focus on cleaning up the polluted Delta waters. That clean up process takes the form of a *Total Maximum Daily Load Report* (TMDL), a document the California Environmental Protection Agency (CalEPA) is required to produce for any water body considered an 'impaired water body" by the US EPA. A TMDL is required for each individual toxin found in the delta waters, and each document accompanies a political process to establish a remediation plan and method for enforcement (Bigham, 2005). Throughout it all, academics sit somewhere in the mix, picking apart the situation and striving for improvement.

Most prevalent amongst academics are studies directly focused on the space where advisories and fishermen meet, generally asking how they respond to the risk of eating contaminated fish and their associated advisories. Literature stemming from various studies around the country (Connelly and Knuth 1998; Burger 2000, 2008; Burger and Gochfeld 1991; Burger, Pflugh, et al 1999; Velicer and Knuth 1994; Jakus, Downing, et al. 1997; May and Burger 1996; Beehler et al. 2001; Beehler et al. 2003; Westphal et al. 2008) assesses the effectiveness of agency-produced advisories, generally

concluding that they are somewhat ineffective. This literature asks how these specific education channels can be improved to further impress upon people the severity of mercury contamination. Many such studies work under the assumption that, if given the appropriate education, anglers will choose the less-toxic options in fish and fishing locations. While some of the literature encourages the inclusion of anglers in the education process (Burger, 1999; Westphal 2004), the literature does not extend to specific analysis of how anglers could be effectively involved in the process, nor does it offer a significant explanation as to why anglers may not be responding to advisories.

I began this study with a lens similar to that of existing studies, asking why anglers 'take the risk' and continue to eat self-caught fish that is contaminated with MeHg. And in many regards, I still seek to answer that question. But ultimately, the studies that currently exist are incredibly limited in their scope. Their narrow focus on the efficacy of advisory efforts and how to improve them leaves out some of the most important details of this story. Health advisories represent a single link in the chain of factors that contribute to the case of mercury contamination.

To tell a richer, more complete story of mercury contamination, I look at the ways historical, social, environmental, and political factors interact with one another, and how those interactions trickle down to affect the fishermen who line up along riverbanks and piers. In basing this study on a Political Ecology and Science and Technology Studies (STS) theoretical framework, the case of mercury contamination becomes less individualized and more a part of a larger system of interactions and social contexts. Political ecology "puts explanatory emphasis on political power and social organization in the shaping of the 'natural' environment, and encourages a historical examination of

the processes that produce geographies of environmental and social distress" (Pelling, 2003: 89). Mercury's presence in the California Delta stems from a long history of our abusive interactions with the environment. But when described to anglers, mercury's historical context is left out, implying by default that mercury's presence is natural.

When questioning only how to improve education efforts and change public behavior, agencies, scientists, and social scientists make assumptions as to what kinds of interactions with the environment are acceptable. The Delta becomes an industrial setting with uses that do not extend beyond that. Water becomes solely a resource; fish become recognized as little more than sport. Using a political ecology framework allows a more open understanding of the diversity of interactions that exist with the environment, and hopefully work towards allowing each of them to co-exist.

Robbins (2002) and Walker (2003) calls for the need to 'look up' when using a political ecology framework in the first world, "recognizing that informal politics are often inextricably interwoven with formal political institutions at multiple scales" (Walker, 2003: 19). Looking to the ways that the public understands the problem of mercury, how political institutions deal with it, and where the two parties meet (or fail to meet) reveal the dimensions of power that govern this case of environmental contamination.

When political ecology addresses third world environmental problems, its focus is generally on the direct interaction between indigenous communities and local political institutions. Studies 'radiate outward from individual 'resource users' to peasant communities and to regional, nation and global political and economic relations" (Walker, 2003: 9). In the case of mercury in the delta, our chain of explanation may be a

bit more circuitous. Because the public is generally greatly detached from the political processes surrounding mercury contamination, this project depends on a framework that recognizes these gaps in knowledge and information. Science and Technology Studies seek to understand the way that political influence and scientific information is felt and understood by the public. Stemming largely from how the public perceives the risks and benefits associated with technology and science, STS literature examine the "active forms of 'sense-making' involved in creating public attitudes and evaluations" (Irwin and Walker, 1999: 1311) of risks and environmental concerns. Authors ask us to understand risk perception as "unavoidably social" (Irwin, 1989: 20) and "necessarily founded upon deeper social models and assumptions" (Wynne, 1989: 33). Irwin states that "the technical analysis of hazard is placed at the core of the risk assessment process—with other factors such as social needs or the viewpoint of potential victims generally being treated in a much more informal and implicit fashion" (Irwin, 1989: 20). In looking at the social ramifications of risk assessment, we (academics, agencies, and others specifically involved in the process surrounding mercury contamination) can begin to formalize their place in the process.

Rather than asking simply how fishermen understand the problem of mercury contamination, this study opens to the question of how the problem of mercury contamination factors into fishermen's larger understandings of their environments. If the decision to eat potentially contaminated fish is a conscious decision, how is it weighted against the benefits of fishing and eating fish, and how is it weighted against other concerns? How does mercury fit into the concern over Delta waters and industrial landscapes? How do fishermen understand mercury as it fits into their own

environmental, health, and social contexts? What does mercury's treatment amongst scientists and policy makers tell us about our present and future relationships with our environments? What can these contexts tell us about the ways in which we can move forward productively with the problem of mercury contamination?

In examining the ways in which mercury is treated through research and policy work, I have found that little of the work moves beyond business-as-usual. That is, few researchers move beyond the assumed need for public education of mercury contamination, and few government agencies stretch past those education efforts. Mercury is still treated as a contaminant that exists in isolation and can be both understood and treated as such. And its presence is separated from the greater problem of the damage our society has done to our environments, and how, in light of this damage, the relationships forged with those environments are forced to change.

This paper asks the question, how is mercury contamination understood by those who study it and those who are affected by it, and how can those two understandings be used in tandem improve the situation as a whole? I frame the case of mercury contamination in four (tangled and blurry) contexts: mercury in the environment, mercury in the body, mercury in the academy, and mercury in the community. Understanding mercury in the environment means placing it in a larger environmental context and understanding both its historic and present day significance. Examining the geographical context of mercury contamination reveals that the current state of the Delta and the treatment of our local environment directly affect the severity of mercury's threat. To look at the body means looking at both the toxicology of MeHg and how scientists have assessed the risk of its consumption by people. Looking at mercury in the body is in part

a reflection on scientific understandings of MeHg, and in part a look at how scientists and researchers impose perceptions of the problem on to affected communities. Third, academics frequently examine the case of mercury contamination. The methods they have used and recommendations they have made provide a springboard for my own fieldwork and analysis. Finally, I look to communities of fishermen to see how they understand the problem, how they understand their environments, and how they can be involved as the process to curb the problem of mercury contamination lumbers forward.

This study is not a balanced look at all parties involved. My work began as community-based work and maintains that focus. My interest was in being out on the Delta and talking with fishermen. The necessary complement to that work was an examination of the information that exists about mercury and its dangers. My interest is in what information the public receives about the problem, and what is left out. I did not interview scientists, risk assessors, or policymakers in this study. Instead, I retrieved the information available about mercury and sifted through it, struggling to make sense of the problem. Interviewing risk assessors, policy makers, and others would have revealed their own struggles around the problem—which are no doubt abundant. And a future study would greatly benefit from this part of the story. But trying to understand mercury contamination through the documents that are available to the public reveals just how large the divide is between different understandings of the problem. Ultimately, the science and education efforts around MeHg must recognize their own uncertainties and welcome in the sometimes unexpected knowledge of fishermen in order to close the gaps of information and trust in this environmental conflict.

My own research process and involvement with fishermen is present throughout this study. And I make attempts at meaningful recommendations that can help guide future research efforts, while recognizing my own shortcomings and hurdles as a researcher. In some regard, the research I discuss and recommend was realized only in hindsight. Stirring over theories and field notes often generated more questions than answers, making me realize the questions I should have asked and the people I should have talked to. At the very least, my hindsight tells me that this research is worthy of continuation, of moving forward carrying a bit more knowledge about itself.

II. Research Background and Evolution

For the past year and a half, I have been traveling through the Delta in search of these fishermen as part of a three-year study in collaboration with Fraser Shilling and others[1], a UC Davis researcher who has been working on the issue for over five years. The survey aimed at uncovering information about the people fishing along the Delta, their fish consumption practices, and their knowledge of mercury contamination in the Delta and the accompanying advisories. The work consisted of a single, ten-minute survey and was meant to reach as many anglers as possible. In my year's work I talked to nearly one hundred anglers, while the study as a whole reached over three hundred. Throughout the study, community-based organizations (CBOs) helped conduct surveys for us, and our team served primarily as technical support during the formulation of the *Healthy Fish, Healthy Fishermen Coalition*—a young collaboration of organizations working to protect the right to fish in the San Francisco Bay and Sacramento Delta, and working to bring together the diverse populations that fish these waters. Throughout my work, I attended

[1] Luke Lippard, Mark Lubell, and various community based organizations have also been integral parts of that research process.

and spoke at two community-held workshops around mercury in the Delta, and have attended agency-held meetings that were part of the political process. I attended several coalition meetings and worked on planning efforts for the coalition's 'fish forum' that they hosted to engage agencies and have the community voice heard by policymakers.

The populations along the Delta represent many different ethnicities and interests and can hardly be classified as a 'community' in anything other than the abstract. The coalition works to bring individual ethnic and environmental justice groups together under the organizing umbrella of mercury contamination. For the Coalition, the presence of mercury in the Delta waters is an issue of environmental justice. The organizations involved predominantly represent ethnic and immigrant groups who frequently depend on Delta fish as a food source. The Coalition has pushed for its own inclusion in the political process surrounding contamination. They have, in the past two years, hosted community-driven forums that helped bring the attention of local agencies to the community-level needs surrounding this problem. The presence of the coalition or something like it is integral to the process surrounding mercury's presence. Community knowledge will not travel far without community organization. But the coalition has faced many hurdles in its development and currently sits idle. Stumbling blocks include lack of funding amongst individual organizations, racial tensions, academic/community tensions, and the difficulty of tackling mercury as a single issue amongst so many other pressing troubles.

In truth, the work I have conducted needs these community organizations to really count. As an academic, I lack the access to populations who are most affected by mercury contamination. Standing between us are not only language barriers, but also

barriers in trust. My position as an academic is often viewed no differently than any authority figure. So throughout this study is a constant tension between my work and the work of community organizations; a constant gap in information, access, and trust. Still, the conversations I did have with fishermen (including one focus group with a Cambodian group hosted by one of the Coalition's partnering organizations) proved rich and meaningful. Simply spending as many evenings on the Delta as I did meant for a string of engaging conversations that informed my work.

Throughout the year, I had many long conversations with anglers who were excited to talk to me once I completed the surveys. Some were interested in the issue of mercury contamination and learning specifics of advisory recommendations. Others were skeptical of my purpose and were eager to discuss my agenda. After completion of the survey, I often explained to people that I am working with community groups who have the explicit agenda of making sure the waters of the delta are cleaned and the anglers along it are accounted for in the process. Anglers I spoke with were also eager to tell tales of their biggest catch, or discuss the need for fish conservation in a time when finding fish is becoming increasingly difficult. I spent many evenings squatting along the shoreline, sitting on rocks, and leaning on piers, listening to anglers open up about their practices and their concerns.

It took months for me to realize that this was what we academics call data. I just thought it was conversation, unrelated to this very specific survey I was conducting. In some regard, I thought of these anglers as friends, and thought of taking notes on our conversations as disrespectful. But my interest in their stories and their questions increased, and spiraled into ideas around how to turn these conversations into an account

of fishing along the Delta. In talking with anglers about their practices, their ecological knowledge and their opinions about the environmental discussions surrounding this highly contested water body, I strive to better understand their role in this water system and how anglers are affected by its invisible toxins, its changes, and the political forces that guide them both.

This project has seen a lengthy evolutionary process that is important to highlight in order to properly frame what follows. I came to this project with an environmental justice intent. Having worked in the environmental and social justice realms in Los Angeles, I strove to extend my work into a local Central Valley context. My initial thoughts surrounding the existence of mercury in the Delta were of the need for remediation. When surveying along the Delta, I was hesitant to even describe the dangers of mercury consumption to anglers for fear that they would interpret it as pressure to not consume fish. Rather than seeing the information as generating choice for anglers, I viewed the message as increasing fears of contamination and thus limiting choice. My greatest concern was generating too much worry amongst anglers. In part, I was not even sure that mercury was a problem. I understood that mercury is a heavy metal; that it accumulates in fish and becomes available to consumers. But having never seen or heard of a case of mercury poisoning outside of early 'mad hatters' in the age of gold mining, I was skeptical of the validity of mercury as a pressing environmental concern.

In the quest for information on mercury, I found several historical cases of severe MeHg poisoning (in Iraq and Minamata, Japan) and much information on MeHg risk assessment, reference dose calculations, and toxicological effects. And while a fair

amount of the information I encountered was conclusive, there was also a massive amount of uncertainty in the science. The sensitivity of exposed populations affects their level of risk, affecting what can be considered an adequate reference dose. Samples of mercury levels in previously exposed people may be too small to be considered valid (National Research Council 2000). The methylation process in mercury is complicated by the diversity of waterways in the Delta, is be seasonally affected, may be magnified by wetlands and agricultural run off, but is still largely misunderstood in its totality (Panels from CALFED Science Conference, 2008). Scientists are unsure how mercury interacts with other toxins in the environment, and how that may affect human health (National Research Council 2000). While consumption advisories are based on MeHg as a neurotoxin, some research shows that its health effects could be significantly more diversified (NRC 2000).

Being unable to separate mercury from the context in which I was learning about it—that of the impaired water bodies of the delta and the people I encountered along its banks—these scientific uncertainties increased my concern over mercury. When I spoke with anglers along the Delta, their thoughts mirrored my own. Mercury does not exist in a vacuum, effectively separated from the rest of a fisherman's life. While I began this study to talk with fishermen about mercury, I recognized quickly that it wasn't a topic that many were particularly interested in discussing, and for a variety of reasons. In fact, I found that at times if I pressed on the issue of mercury contamination, it killed the conversation I was working to foster. But it made sense to not limit the conversation to mercury, and made sense to get a better understanding of how people understand the

contaminant in the greater picture of the Delta waters and environments they occupy in the rest of their lives.

The case of people fishing along the Delta for food is, today, an exceptional use of the water, a hiccup inside the greater functions of the Delta system. Its main intent is industrial—built for massive transport of water for urban and agricultural use. To find fishermen in this web of water and roads, you must know just what to look for.

III. Mercury in the Environment

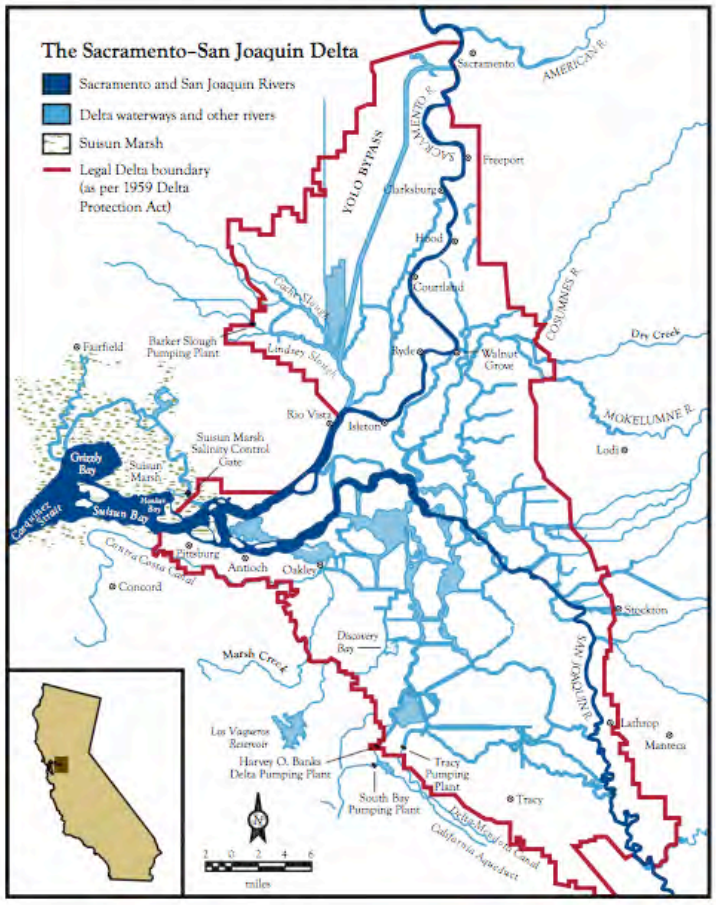

Figure 2. The Sacramento-San Joaquin Delta.
(Public Policy Institute of California, 2007)

Driving around an industrial park filled with semi-trucks and unmarked buildings, you would not imagine that this place existed. But there, at the end of the road that separates the industrial park from the port of Sacramento is a dead-end street that backs up to a fifty-foot levee. There is no indication of this being an access point to the Sacramento-San Joaquin Delta (the Delta), but there are several cars parked at the end of the road and a well-worn path leading to the top of the levee. When traveling the waterways of the delta, a car parked along the bank usually means there is a fishermen nearby, perhaps tucked around a corner or resting beneath a nearby tree.

The setting of this study is the banks along the Delta where fishermen commonly gather. The Delta is the confluence of the Sacramento and San Joaquin Rivers, once a place where the rivers dissolved into marshland and salt water intermingled with freshwater. The Delta today has since been constructed by feats of engineering—transforming an otherwise uninhabitable wetland into a series of islands and waterways specifically aimed at transporting water to the masses. As Kevin Starr writes, "this eco-region sustains within itself every positive and negative legacy of the way that Americans have re-structured the environment since seizing California from Mexico in 1846" (quoted in Wolff, 2003). The Delta is a messy place. So messy, in fact, that the first governance body created to 'manage' the Delta (CALFED) collapsed under its own stress (Shilling et. al, forthcoming). Most Californian's get their water from the Delta, as do many of the farmers of the Central Valley in need of irrigation. Literally millions of stakeholders depend on the future success of the Delta.

Understanding this complex body of water (or even really understanding its complexity) is nearly impossible. Because each factor is in some way co-dependent on

the one before it, privileging any single factor of the Delta's ecosystem is a difficult task. In John Muir's oft-quoted words, "When we try to pick out anything by itself, we find it hitched to everything else in the universe." And so I ask, how can we even begin to look at the Delta? What needs to be privileged in order to understand the ways in which competing factors overlap? In some ways, the entire story of the Delta exists in a single location—the hidden levee road that I stand on in search of anglers.

This small stretch of land, water, and wetlands in West Sacramento is a confluence of historical and present day

Figure 4. Anglers at Lisbon Slough.

Figure 3. Levee at Lisbon Slough.

Figure 5. View of FedEx Yard from Lisbon Slough.

complexities surrounding the Delta. In the pictures below we see a constructed wetlands, a constructed slough, a constructed deep-water shipping channel, a constructed levee, a port, smog, an industrial shipping facility, and an angler. These images look so different from one another. One site is a natural beauty—a wetlands filled with migratory birds and anglers seeking refuge from an urban existence. The other is an industrial expanse covered with miles of pavement, and the busy emptying of a cargo ship filled with anonymous goods en route from China. The wetlands seem calm, understandable, easy to read. The industry is unapproachable, kept out of view by high fences and heavy security. But in deconstructing these images, we find that they are perhaps not so different. The seemingly natural sites serve industrial purposes, and contain within them toxins that remind us of an industrial past that happened too quickly to predict its consequences. After all, these two sites are separated by nothing more than a levee—and we are familiar with the penetrability of these barriers.

Natural Setting

The wetlands that stretch between Davis and Sacramento may be deceiving. At first glance, the scene is wild, natural. And in some ways it is. Fish and birds populate the area, the place is unpaved and only minimally accessible. We may, in this image, see what Murray Bookchin refers to as 'free nature,' one untouched by human hands and left to its own ecological processes (Bookchin, 1989). But a closer examination of the image tells a more complex story. In the background is a large wetlands with meandering boundaries between plots of land, all of which come to an end at a clearly defined edge.

Figure 6. Yolo Basin, photographed from Lisbon Slough Levee.

This wetlands is called the Yolo Basin and has, in fact, been carefully constructed. It was specifically designed as a mechanism for flood control, wildlife management, agricultural use, and a site for recreation and education.

This site very much represents the history of the entire Delta as constructed wetlands. Land reclamation began in the Delta in the 1850s—at the very beginning of the western settlers' entry into the state. Settlers began to transform the extensive swamplands in the Central Valley into an extensive network of islands and water channels. Fertile soil, plenty of water, and a perimeter of mountains filled with gold made the Central Valley a choice site for settlement. But the Delta was a swamp, somewhere between water and land that was nearly impossible to in fact *settle on.* And so, engineers moved things around to serve the needs of this growing state—those of irrigation, mining, transportation infrastructure, and urban development. The era of land reclamation spanned nearly 80 years. During that time, 550,000 acres were reclaimed from their swampy existence (Mitchell, 1993; Lund et al., 2007; Kelley, R., 1998).

The Delta, once a "massive tidal marsh, with significant seasonal variations in flow and salinity, as well as large interannual variations caused by floods and droughts" (Lund, 2007: 42) has become, as Jane Wolff (2003) calls it, "a giant plumbing system," intricately engineered to maintain proper water levels, push back the salinity of the San Francisco Bay, and keep water flowing to diverse and distant constituencies for consumption. The management of the Delta has become one of the most important environmental challenges facing the state of California.

In many ways the Yolo Basin stretching between Davis and Sacramento represents a new wave of thinking about the Delta. Beyond a place of management, the wetlands are a successful attempt at multi-functionality. It provides a place for wildlife habitat, while simultaneously serving as flood protection, and as agricultural land used for economic activity (Yolo Basin Foundation, 2009). Much of the current discussion surrounding the Delta is one of regret (Wolff, 2003). The manipulation of the Delta throughout the past two centuries has left a legacy of much work to be done. The Yolo Basin, in many ways, represents an attempt at restoring damage done to this expanse of land. And on its own, it is a success. But these wetlands are the northernmost tip of the Delta. They are but a moment in a massive process. But this location also holds one of the highest concentrations of methylmercury in the Delta, and the benefits of creating a wetlands is countered by their ability to increase the methylation process (TMDL report, 2006).

Parallel to the Yolo Basin is a narrow, perfectly straight slough, generally referred to as the Lisbon Slough. If you follow the canal north, it splits off into three canals just north of Interstate 80, which in turn each split from each other, eventually meeting larger

streams, tributaries, or rivers. They are part of an intricate system whose specific origins are difficult to trace. But the path of the water is easier to follow. These small channels, each used to water the crops in this rich agricultural land, join together at the Lisbon Slough and follow a straight path through the Delta until they meet the San Francisco Bay. This slough is one of hundreds that cut through islands of agriculture and marshland, all reaching the same eventual fate.

Of significance here is the fact that the Lisbon Slough is purposefully separated from the wetlands next to it by a levee. And the Lisbon Slough is separated from the land behind it by another levee. The most prominent management tactic throughout the history of the Delta is the levee system. But as Sacramento has learned (or perhaps should learn) from our geographically similar New Orleans, the levee system does not really work. As Ari Kelman points out in his environmental history of New Orleans, "as the levee grew the river kept rising just enough to overtop its banks during flood stages." (Kelman, 2003: 168) Building taller levees, then, serves two functions. First, it serves to increase the severity of floods. And second, taller levees cut us off from our rivers, making their existence and potential danger that much easier to ignore. As Kelman tells us, it is not the existence of the levees, per se, that causes them to fail. Rather, it is the development that encompasses the river valley, the clearing of trees for agriculture, and the paving of grasslands that makes land impermeable and rivers more susceptible to flooding. And as these levees erode and crumble from neglect and urban development, the mercury methylation process increases, generating an even more obtuse danger.

Industrial Setting

In turning our backs on the Yolo Basin, we face an extraordinarily different site, but one intricately linked to the ecological situation of the Delta. Rows of Fed Ex trucks await being filled to carry cargo to destinations around the world. Further in the distance, tall cranes empty the cargo ships coming in from overseas, destined for trains and the beds of diesel trucks. Just as the water in the Lisbon Slough, this place is just a point in the process of goods movement. Above the buildings is a thick line of smog, a sure sign of massive transportation efforts and the bustle of an urban setting.

The Port of Sacramento shares the same essential story as the Yolo Basin and Lisbon Slough behind them. Agricultural desires to increase the stretch of its trade pushed the need for the creation of a deep-water shipping channel for cargo ships to travel the additional 76 miles from the Bay to Sacramento. The project was started in 1945 by the Army Corps of Engineers and involved the construction of a massive and perfectly straight channel stretching from the location of the port in West Sacramento to Suisun Bay, where the channel opens into a wide swath of water until it reaches the Bay (West Sacramento Historical Society, 2007). The deep water shipping channel, Lisbon Slough, and Yolo Basin all travel parallel to each other. They are confined to their respective areas through constructed levees, their water levels are controlled by water pumps, and further upstream, by dams along the Sacramento and San Joaquin Rivers.

Despite the physical barriers between them, these three bodies of water are part of the same larger system, leading to the same fate, and equally controlled by massive engineering. And this is, by and large, the point. What happens in the Delta affects both the Lisbon Slough and the Deep water shipping channel. Equally, what happens in the

Sierra Nevada or in the San Francisco Bay affects the Delta. And yet, it is our tendency to channelize and localize. We did it physically with the land of the Delta, and we do it today in our attempts to address individual environmental problems as though they existed in isolation.

This industrial image, then, shows us just what is at stake with the stability of the Delta—a massive system of transportation and a booming population. What is *not* shown in these photographs could add a series of layers to compound the situation even further. Beyond flooding, the Delta is faced with subsidence, the threat of salinity, and a massive loss of wildlife. There is one thing that is absolutely clear in the future of these waterways—the fate of the land and people dependent on the Delta also depends on the increased and perpetual *management* of the waters. We have grown ourselves into technological dependence and its presence seems to only increase. As technological intervention increased in the Delta, what qualified as "appropriate" use of the waters became political decisions (Robbins, 2004). Privilege fell upon those uses that forwarded California's rapid development.

When attempting to bring mercury into this conversation, its importance seems trumped by the fate of the state's water source and much of the country's food. But the problems are all intimately linked. As one problem worsens, others follow suit. And mercury, invisible as it may be, is an important consideration in each of the engineering and ecological challenges grappled with in these waters.

The collapse of the entire Delta system should worry the entire country. But the current state of the Delta is a result of years of misguided engineering that focused on productivity and use above natural functioning and longevity. And so, we have seen the

outcome of allowing historical errors to escalate into emergency situations. We can continue to allow those to pile up into the waters—mercury, PCBs, and agricultural run off until their presence reaches a new state of urgency. Or we can choose to acknowledge historical mistakes and work to remedy them before our next error.

Historical Context

The remnants of 47,000 gold mines sit abandoned throughout the Sierra Nevada mountains, hillsides blasted hollow by years of hydraulic mining and the quest for wealth. Along California's coastal region, several hundred mercury mines sit similarly abandoned. The mercury mined from these locations served as a magnet for gold. As water blasted earth away from the hills, mercury fused to the gold, allowing dirt to wash down into the streams below. Eventually, the mercury too was washed into the streams, this time latching tightly to the food web. The story of gold mining in California sits at the front of the long line of contamination that would follow and reveals to us how the designation of "appropriate use" of the region's resources prioritized progress over protection of many alternative uses.

These mine sites have been left abandoned and hollow by what Kevin Lynch describes as "our historic custom of moving on" (Lynch, 1990). Upon fulfilling their initial purpose, the mines were simply left behind. As the process of hydraulic mining became illegal and the mountains dried up of gold, miners were left to find new work—many of them, in fact, as fishermen (McEvoy, 1986). But it is misleading to look at the mines only as historical artifact. Rather, their influence continues today and has been escalated by the dramatic changes to the Delta that mining brought with it.

California as we know it today began with the mining industry. Beyond massive emigration to the state, the mining industry brought the beginnings of our industrial infrastructure. Unlike the east coast, which developed for several hundred years before industrialization began to take hold, California's late settling in the mid 1800s meant for rapid technological development (Wolff, 2003). The pace of gold mining's growth is staggering. What began as (and still holds the myth of being) a free-for-all for anyone with a pick quickly transformed into a systematized, low-wage industry.

Andrew Isenberg describes in depth the early stages of mining—a time he refers to as when tools became machines. Isenberg argues that the invention of hydraulic mining equipment was among the most significant catalysts for the manipulation and management of California's waters. The mining process involved water cannons blasting away hillsides to separate gold from rock, used mercury to amalgam the gold, and released huge amounts of sediment into the rivers and streams below. The mining process heavily intensified erosion and the risk of flood, prompting the construction of reservoirs and canals, both as a means of flood control and an attempt to "attract capital investment by imposing predictability on the rivers" (Isenberg, 2005: 28). But the increased capital investment, of course, meant growth in extraction, the necessity for expanded control of the water, and sent the mining industry at full speed into the treadmill of production (Schnaiberg, 1980). Isenberg's history details the scale of the industry's growth and our control over the waters. A few of his details are particularly poignant:

- By the 1860s, hydraulic mining consumed one million pounds of mercury annually. (39)
- From 1848 to 1874, California produced $950 million in gold. (24)

- California Hydraulic mining companies impounded 7.6 billion cubic feet of water in 1883—equal to 50% of the maximum capacity of the Hetch Hetchy Reservoir. (30)
- In 1883, 6,000 miles of ditches were constructed at the cost of $15 million. (30)
- Between the mid 1850s and 1885, 885 million cubic yards of debris were deposited in the rivers—a volume three and a half times greater than that excavated for the Panama Canal. (43)

As is often the case with industrial growth, the costs of production in mining were generally externalized. Hydraulic mining had significant impacts on agricultural practices and, by 1884, the grievances of farmers in the valleys below the Sierra mountains won a lawsuit outlawing hydraulic mining in California, in what Robert Kelley calls "one of the first successful attempts in modern American history to use the concept of general welfare to limit free capitalism" (Kelley, 1959, quoted in Wolff, 2003).[2]

The effect that hydraulic mining had on agriculture was a visible one—recognizable through increased flooding and the loss of arable lands. The sediment released from the mines also decimated fish and wildlife populations through rapid changes in environmental habitats that, with fish, disrupted their spawning grounds to the point that they would no longer successfully reproduce (McEvoy, 1986). Along with these recognizable changes brought on by mining was the less visible problem of contamination. Rebecca Solnit states that, in mining, "the gold was the point. The mercury was the secret" (Solnit, 2006). Mercury was a secret because it was mined from the earth and returned to the earth once it was used for gold extraction. Mercury can be

[2] It is incorrect to assume that agriculture did not also play a significant part in the mechanization of the Delta and similar waters. While Isenberg discusses the role of mining in this process, Don Mitchell's *The Lie of the Land* reveals the part that farmers played in this history. Robert Kelley's 1959 study *Gold vs. Grain: the hydraulic mining Controversy in California's Sacramento Valley* traces the conflict between farmers and miners.

easily left under the guise of being 'naturally occurring.' But the effect of mercury in the waters is significantly different that mercury in the mountains. Its intrusion into the Delta has been a lasting legacy of the Gold Rush that, in many ways, remains a secret today.

The Politics of Cleaning it all up

Exactly how does it all relate? What does the penetrability of a levee, the success of constructed wetlands, or the water supply troubles of the delta have to do with the case at hand? The answer is that as the delta crumbles under weight of a society's steps forward, mercury can more easily find its way into the cracks, into the wildlife, and into our bodies.

While mercury's most common historic use was for mining purposes, early photograph technologies, silvering of mirrors, and use in the hat-making process were of other early industrial uses (Bigham, 2005). Modern pathways into atmosphere and waters include combustion from coal-fired power plants, mercury-based pesticides and fungicides (which are now illegal in the U.S.), wastewater treatment, and paper and pulp factories (Bigham, 2005). Wang reports that mercury deposition flux today is 3-24 times higher than its pre-industrial rates (estimates differ according to location, with U.S. researchers estimated the highest increase in deposition) (Wang, 2004). Mercury located in soils can be agitated and introduced into the environment through tillage, logging, agricultural and urban runoff, and other activities that make soil prone to erosion (Wang, 2004: 325). Much of the mercury deposited into the delta from gold mining efforts sits in reservoirs, waiting to be moved into the delta system and become methylated and available for consumption.

How can a problem that is so broad in scope be dealt with regionally? Because of mercury's concentration in the Delta is so high, the waterway has been declared an 'impaired water body' by the EPA, requiring a political process and creation of a TMDL to determine potential remediation efforts. Following that report, the engineering consultants Tetra Tech created a *Regional Mercury Load Reduction Evaluation* that discusses extensive possibilities for remediation. Some of the potential efforts are relatively localized and simple. The many gold mines throughout the Sierras have been left mostly abandoned and uncovered, free to erode into the waterways and release mercury with the rest of the loose sediment. Remediation efforts, then, include simply (though perhaps not cheaply) stabilizing the hillsides of the mines. Properly grade the hills; plant new vegetation to disrupt erosion (Tetra Tech, 2008). The efforts are good practices that, in reality, should have been required years ago as the gold mining industry saw its last days.

Other suggestions require institutional enforcement, such as changes in farming practices that prevent unnecessary erosion. The political battle that this change would generate is not a part of this engineering assessment.

Other suggestions for remediation, however, leave Kelman's warnings ringing in my ears—that problems of engineering cannot likely be fixed by an increase in engineering. Tetra Tech's report makes recommendations to construct new levees and erosion and flood controls, stabilize streambeds, and install wing dams and check dams throughout delta waterways (Tetra Tech, 2008). In Tetra Tech's report, the peripheral canal, proposed to more readily transport water out of the delta, helps reduce mercury contamination by extracting sediment from the delta system. The Public Policy Institute

of California's 2007 assessment of possible futures for the delta included one future they called "fortress delta" (Lund, 2007). In the fortress, we concretize channels and thicken levee walls; we divert water around the delta to increase efficiency. But the construction will consistently need repair and improvement, perhaps eventually losing priority and left to crumble. While the engineering suggestions to remediate mercury contamination may seem realistic, they are temporary solutions that miss the fact that the mercury present is a part of a complex delta system that needs massive overhaul rather than piecemeal repair.

IV. Mercury in the Body: The Risk Assessment of Methylmercury

Uncertain Science

The dangers of elemental mercury from mining and industry-related activities have been known for hundreds of years. In 1878, British Parliament prohibited young workers from silvering mirrors with mercury. In 1898, the French passed a law to protect hat-makers from the dangers of mercury. The United States did not develop similar protection until 1941 (Bighman, 2004). Pesticides and fungicides containing mercury were not outlawed in the United States until the mid 1970s (Wang, 2004).

Methylmercury, however, was an unseen danger and not explored until the 1970s, when 30 years of mercury dumping in a bay near the fishing village of Minamata, Japan caused acute poisoning amongst much of the village's population. The symptoms in Minamata were widespread and severe. Children affected by the poisoning expressed mental retardation, primitive reflexes, cerebellar ataxia (muscle coordination difficulties), limb deformities, and other symptoms (National Research Council, 2000: 175). A similar

poisoning affected a population in Iraq that received grain treated with MeHg fungicide as aide in 1972. The grain, intended for planting, was used instead to make bread and killed several hundred people (Bigham 2004).

While elemental mercury can cause health problems from physical contact with the metal or inhalation of mercury fumes, methlymercury (mercury that has been methylated in low-oxygen and aquatic environments) is available for bio-accumulation in the food chain—first by phytoplankton, the by fish, and eventually by humans (Wang 2004). The accumulation of the toxin is slow and the effects can be greatly delayed after consumption of contaminated fish.

Research around methylmercury (MeHg) did not begin until the 1970s, and the existence of a worldwide mercury cycle was not known until the 1980s (Bigham, 2004). With such recent scholarship on the topic, "the ability to quantify the relationship between total mercury concentration in water and sediment and MeHg concentrations in fish continues to challenge researchers and regulators. Despite years of effort in developing numerical, mechanistic models, predictions of MeHg concentrations in fish remain highly uncertain" (Bigham, 2004: 30). Relationships between mercury concentrations in the environment and MeHg concentrations in fish remain similarly uncertain (Bigham, 2004).

California scientists are working to understand relationships between methylation and wetland restoration (CALFED Conference proceedings, 2008), the affect of MeHg on avian populations (CALFED conference proceedings, 2008), MeHg inputs and outputs in the Delta water system (Suchanek et al., 2009), and are consistently identifying new

lakes and other water bodies in the state with dangerously high mercury concentrations (Barlow, 2009; Zimmerman, 2009).

While scientists trudge through attempts to uncover the environmental existence of and processes affecting methylmercury, they are similarly uncertain about how to gauge the toxin's threat to humans. The risk assessments created by scientists drives fish consumption advisories present throughout the Delta waterways and is a heavily contested issue. Based on several cases of long-term, low-dose exposure to MeHg from fish consumption predominantly in the Faroe Islands, the EPA has created a reference dose for the amount of MeHg that can safely be consumed by people. That is, the EPA has decided through a modeling process and laboratory tests what level of exposure to MeHg is considered acceptable. The current EPA reference dose is .01µg/kg body weight per day (equal to .0001 ppm) and uses a ten-fold uncertainty factor to account for a number of significant uncertainties present in the risk assessment process (National Research Council, 2000). The shortcomings of risk assessment stem from factors throughout the assessment process—from the studies the reference dose is based upon, to how mercury reacts with the environment, to how the body reacts to methylmercury.

The Politics of Risk Assessment

First, the two cases of exposure used to determine acceptable risk yielded contradictory information around health effects from MeHg. The Faroe Islands study initially used blood from newborn's umbilical cord to establish MeHg-exposure level; the Seychelles study used maternal hair samples. Both studies focused attention on childhood development progress and MeHg's potential to cause neuro-developmental

disabilities. But the Faroe Islands tested its subjects periodically for seven years, whereas the Seychelles Islands study ceased testing at 5.5 years (National Research Council, 2000). The studies used different methods to test for health effects, different sample sizes, and scientists disagree as to which study generated more trustworthy results.

According to Jane Hightower's muckraking report *Diagnosis Mercury* (2009) tracing her hunt for accurate toxicology information on methylmercury, the controversy around the Faroe Islands and Seychelles Islands studies carries significantly more political baggage. Whereas funding for the Faroe Islands studies came from the U.S. national Institute of Environmental Health Sciences, the European Commission, the U.S. FDA and U.S. EPA, the Seychelles Islands study received significant private funding from parties with strong investment in the study's findings (Hightower, 2009: 196). The London-based food processing and marketing company Tropical Products Institute funded and initiated a pilot study on the islands and called for more research when they discovered elevated mercury levels amongst residents. The continued study saw funding from the Electric Power Research Institute (EPRI), a lobbying group for the power industry as well as from members of the fishing industry, and U.S. government funding (199). EPRI's investment in the study rested on their desire to protect coal-fired power plants, the world's largest source of mercury pollution. Meanwhile, the fishing industry fought to keep MeHg warning labels off of commercial fish, and to protect the corporate-managed tuna industry that comprised over 20 percent of the Seychelles gross domestic product and 50 percent of its foreign exchange earnings (202).

The Faroe Islands study discovered certain developmental disabilities that surfaced in children increasingly as they grew (with the greatest effects of mercury

contamination seen at seven years). The Seychelles study tested over seven hundred children and found no statistically significant abnormalities caused by MeHg exposure (National Research Council, 2000).

The National Research Council's report on the Toxicological Effects of Methylmercury, meant to inform the U.S. EPA how to update its MeHg reference dose (RfD) recommends the use of the Faroe Islands study as the central guide to a new RfD. The report does not cite political or funding dilemmas, but rather that the Seychelles islands' lack of results should eliminate it from risk assessment. Still, Hightower insists that industry interests will use the Seychelles Islands study as a counter-argument to any argument regarding the dangers of mercury.

The Faroe and Seychelles Island studies focused on the neuro-developmental damage brought on by MeHg exposure. But the potential harm done by MeHg exposure could extend far beyond just child development and is a major source of uncertainty amongst the scientific and risk assessment communities. While warnings for fish consumption focus on women and children, some studies show that men could potentially be affected as well. A study of 1,833 Finnish men found that men who consumed at 30g of fish per day had a 2.1-fold higher risk of heart attack (National Research Council, 2000: 171). Importantly, the mean fish consumption rate for our study was 40.6g/day, and 63.4g/day in surveys conducted by collaborating CBOs (Shilling et al., 2009: 13).

Second, while the Seychelles and Faroe Islands studies looked for developmental effects of MeHg, there is growing concern that the toxin could potentially affect immune and cardiovascular systems at low doses, and has potential effects on fertility rates (National Research Council, 2000).

Perhaps most concerning amongst this torrent of uncertainties is the question over how sensitive people are to MeHg exposure. The EPA reference dose refers strictly to the amount of MeHg that can be safely consumed, but does not specifically relate to the amount of fish a person can safely consume. Local creel studies (studies measuring MeHg concentration in fish tissues) are used to determine MeHg concentrations present in fish tissue (Shilling, White et al., 2009). But bodies can react very differently to MeHg concentrations. According to the National Research Council's report:

> Data from Iraq indicate that although some individuals were sensitive to low levels of exposure, some member of the cohort were not sensitive to extremely high levels of exposure. […] In any given population, there might be sensitive subpopulations whose sensitivity to MeHg is not adequately represented in the dose-response assessment. (National Research Council, 2000: 320).

The report adds that factors affecting dose-response may include gender, genetics, health status, nutritional influences, and co-exposure to other neurotoxicants.

But our uncertainties exist beyond just the study of MeHg exposure, and extend more broadly into the unknowns of environmental contaminant exposure. Brown et al. (2000) cite *synergistic effects* and *etiological uncertainty* as factors beyond the dose-response relationship that concerns MeHg scientists. "It is almost impossible to document conclusively that a specific disease is caused by exposure to specific environmental effluents. There is difficulty in understanding the relationships between toxins in the biosphere and morbidity and mortality" (Brown et al., 2000: 10). Beyond just considering what other toxins a person may be exposed to, it is important to consider how those exposures may interact with one another. A fisherman exposed to MeHg may also have been exposed to pesticides, air pollution, asbestos, or any other potential threat.

And without knowing the specifics of exposure and the possibilities for their interaction, our knowledge of the dangers falls short.

Pairing this with the management history and debacle of the Delta itself and we are left with a landscape of risks seemingly impossible to navigate. Brown (2000) highlights the irony that the "more culturally mediated the environment, the more volatile and mysterious it becomes. Enlightenment thinkers, of course, promised just the opposite. Human knowledge and interventions would tame nature, harness it to social ends. Environments do increasingly serve social ends, but they appear anything but tame" (Brown, 2000: 16). In this environment of competing interests, incomplete knowledges, and invisible dangers, the attempts to reveal the mystery of mercury

Figure 7. Delta advisory signs created by the California Office of Environmental Health and Hazards Assessment (OEHHA).

contamination and tame its dangers appears in the form of advisory signs dotting fishing piers throughout the Delta and similarly contaminated water bodies. Behind the curtains of research, the case of mercury contamination is complex and misunderstood. But the dominant form of mitigation to the problem is this single sign in a specific location, veiling the levels of assumptions that go into assessing risk.

With advisories about eating fish currently present in 40 states, academics have latched on to them as an important research topic. Once all of the information from risk assessment is boiled down to a single sign or simple set of advisories, does it do any good? Or are the protective measures taken by risk assessors based on a false assumption that public education about risks are the best ways to prevent them?

What follows is an analysis of some of the studies completed about fish consumption advisories throughout the country. In question is how effective advisory signs are, but also how we as researchers can improve our own work to strive for more than mitigation by education.

V. Mercury in the Academy

Sacramento Delta Survey and questions of efficacy

In my initial involvement with this project, I was given a clipboard and backpack full of fishing lures (used as incentives and thank you's to fishermen) and tasked with asking fishermen a set of 17 questions. The survey was designed to better understand the demographics of people fishing along the Delta and glimpse the patterns of fish consumption in the region as well as the varying levels of awareness about mercury health advisories. After asking the same questions to nearly 100 anglers, I began to

reconsider the effectiveness of some of the questions I was asking. Many of the questions were strictly quantitative:

- Do you eat fish that you or someone you know catches? How many times did you eat that fish in the last 30 days?
- In the last 30 days have you eaten fish that came from stores, markets, restaurants, or cafeterias?
- About how many times did you go fishing in the last 30 days?

Those questions sought to characterize the population of fishermen who are consuming above the EPA reference dose. Other questions held a more qualitative quality, but were treated in a mostly quantitative manner in the survey:

- Have you ever heard or seen any health warning about eating fish? If so, do you remember what the warning said?
- Where do you get information about your health, about what is good or bad for you, that you can trust, that you really believe?

In the case of the first question, I recorded answers in a small three-line box on the right side of the page. While some respondents were unaware of advisories and the box was left blank, others provided long answers, far exceeding the limits of this small box and causing me to write in the margins of the page or, worse yet, only write down a limited amount of the information I was given. For some fishermen, this question brought up concerns over water quality, environmental health, and drought. They were able to draw out some of their major concerns with the Delta waterways with this single question. But knowing the answers would be scored on a 0-3 scale according to mercury awareness, I often failed to write down what was said outside of answers specifically related to mercury. In other instances, fishermen began to ask questions about health

concerns, or express a fear that I would be telling them not to eat fish. I walked away from multiple interviews feeling as though this survey was insufficient for the rich information that its questions generated.

Accompanying the question of awareness were questions of where people heard the information they knew, and who they trusted to give them information about their health. This question proved the most difficult to ask, and often the most difficult to answer. Reactions to the question were usually knee-jerk. "My doctor," "my family," "myself" are common responses. Few people take time to think through who it is they may actually trust. The question is at once too specific, generating a quick response, and too vast, asking anglers to assess all the channels through which they get information. But in some ways the response is telling—particularly when it is "myself" or "nobody." So much conflicting information is promulgated in our daily lives. Fish alone carry the weight of being extraordinarily healthy, dangerously toxic, a political battlefield for water usage, and a strong indicator of the health of our bio-environments.

The survey format makes this level of analysis difficult. This survey worked to generate extensive coverage of the area to better understand the workings of the larger fishing population. Yet it was designed to ask questions that required deep contemplation and a trust in the intentions of the interviewer that takes longer than ten minutes along the water to develop. And the results of the survey reflected these troubles.

Community versus University Researchers

While the survey generated important information as to demographics of people fishing along the Delta and types of fish these anglers commonly seek, one result

increased my questioning of the survey's effectiveness, and of the effectiveness of surveying in general. Many fishermen are monolingual in one of a number of Asian languages and are therefore inaccessible to me along the river. Several community organizations our UC Davis team has been working with on the project conducted surveys of community members in their mother tongues. What we found was that the community surveys showed a significantly higher level of fish consumption and lower level of awareness than the surveys we conducted (Shilling et al., 2009). My concerns arose that perhaps we, as university researchers, were not so capable of accurately surveying, that we were not being given accurate information—whether based on a matter of trust or a matter of language barriers and/or for another reason.

Macnaghten and Urry (1998) criticize the use of surveys to generate information about environmental knowledge and opinion. They critique surveys for the presumptions they make about their respondents and the results they perhaps cannot deliver. Surveying assumes that:

- People act as discrete independent beings whose actions are largely isolated from the turbulent, complex and often contradictory practices and discourses which criss-cross contemporary societies (88), and
- People's innermost values and beliefs can be revealed from their instantaneous responses to sets of questions formulated in advance by the investigator (88).

If I am to ask an angler who he trusts for information about his health, his one word response does not reveal to me his socially- and culturally-embedded attitudes towards particular sources of information, nor does it reveal his own personal experience with doctors, media, family members, or fishing authorities. Further, if an angler understands authorities to be discouraging fish consumption, then his response to his level of fish

consumption may be downplayed if a university researcher is assumed to be an authoritative figure.

Still, the survey method serves to generate much needed information on the subject of fish consumption and continues to be used. In hopes of gleaning some insight into how our survey could be improved, I looked to angler surveys created throughout the country in recent years. Upon searching for other angler surveys, I discovered that our survey is in very good company. Dozens of accounts of angler surveying across the country and abroad—New Jersey, New York Mississippi, Puerto Rico, Canada, amongst others—ask questions about the effectiveness of contamination advisories and patterns of fish consumption amongst anglers (Connelly and Knuth 1998; Burger 2000, 2008; Burger and Gochfeld 1991; Burger, Pflugh, et al 1999; Velicer and Knuth 1994; Jakus, Downing, et al. 1997; May and Burger 1996; Beehler et al. 2001; Beehler et al. 2003; Westphal et al. 2008). Each survey asks how fishermen understand advisories and what affects their consumption habits. Some look specifically at risk perception difference according to ethnicity (Beehler 2001, 2003; Burger 1999), others assess the responses to differing formats of consumption advisories (Connelly and Knuth, 1998). I was, quite frankly, overwhelmed by the number of studies that already exist on the topic. Meanwhile, the attention paid to California anglers and mercury contamination is just now on the rise. One reason for this may be the obscure nature of California's contamination. Whereas existing studies focus on locations where heavy industrial pollution is the source of contamination (and in the case of Puerto Rico, a declared superfund site), California's mercury contamination stems from the long-forgotten mercury mines of the gold rush.

I approached the literature on past angler studies with three general themes. First, assessing the methodologies of previous studies informed my own fieldwork and generated potential changes to the quantitative survey we had been using. Second, I investigated the findings and patterns in these studies to understand what kinds of information could be generalized and translated to my current work. Finally, I looked to the information largely left out of existing studies to inform my own line of questioning and theoretical approach. Below is what I gleaned from existing surveys.

Methodologies of Previous Studies

Joanna Burger is perhaps the most prolific of academics focusing on the issue of fish consumption amongst anglers. Her work has focused on New York, New Jersey, and Puerto Rico, and, like my work, strives to understand the relationship between anglers and state-created health advisories. Her angler-related studies span nearly twenty years and her work provides a strong framework for my own.

Burger's studies are conducted at specific fishing locations with individuals and groups in the process of fishing. In the study of anglers at a superfund site in Puerto Rico, Burger discusses her specific methodology for gaining entry into each interview:

> Prior to each interview, we introduced ourselves, exchanged pleasantries, admired the catch or techniques, and explained that we were not government representatives. In each group, we identified a spokesperson, usually the oldest and/or most talkative person (Burger and Gochfeld, 1991: 271).

Admiring an angler's daily catch is almost a guaranteed way to start a conversation. And distancing oneself from the government has been, in my experience, essential. For a

fisherman, the act of fishing is often a time for relaxation and (for some) escape, and an interruption is frequently unwelcome.

Other studies in search of angler opinion and knowledge have used by-mail and telephone survey methods (Velicer and Knuth, 1994; Jakus and Downing, 1997, respectively). Velicer and Knuth's study used a combination of mail and interview methods, with interviews focusing specifically on migrant workers and low-income residents, but not specifically on migrant and low-income *anglers*. The study did not directly target anglers, but based its quantitative data on mail surveys with health care experts, fishery experts, and 'opinion leaders' from sport fishing organizations. The mail surveys conducted asked what advisory dissemination methods would be most successful, while the interviews with migrant workers focused on whether this target audience had been reached with existing advisory channels. Migrant workers were not included in quantitative analysis, effectively excluding them from the advisory process. The methodology applied here suggests that anglers are strictly targets for advisories, while 'experts' and 'opinion leaders' are the decision makers in advisory dissemination.

A line of questioning commonly asked in angler surveys is that of anglers' opinions of health advisories and perceived risks of fish consumption. Burger et al. (1999) asked these questions in survey form amongst urban fishermen in New Jersey. Questions included "whether fishermen considered fish or crabs safe to eat, […] whether they thought that eating their catch would increase the risk of cancer or cause problems for an unborn or developing child, […] and whether they believed the warnings and whether they would modify their behavior if they heard warnings" (Burger et al., 1999: 219). Importantly, Burger does not mention in her methodology description how

interviewers introduced themselves, and whether they told fishermen that they were not government representatives. Burger specifically addressed this in a prior study (1991), and the presence of an effective introduction may weigh heavily on the information fishermen are willing to give at an interview.

Burger's questioning is significant and could be an important element to add to our existing survey. Our survey asks about fish consumption and knowledge of consumption advisories, but leaves out the explicit connection between the two and the very important question of, "Does it matter to you?" Still, despite the importance of the question, the shortcomings of the survey format may interfere with the answers given by anglers by assuming that answers are more candid and thought-out than they may in fact be.

Another set of studies on fishing practices and risk perception utilizes focus group methods, participant observation, and unstructured interviews to elicit information (Beehler et al., 2001; Beehler et al., 2003; Westphal et al., 2008). Westphal's interviewers fished alongside fishermen and asked questions without taking extensive notes on site or filling out a survey. Westphal asserts that, "the informal, non-hierarchical approaches of participant observation and unstructured interviewing builds trust between researcher and study participants, which can help elicit more information from participants and increase the likelihood that they will reveal sensitive information that one is generally less likely to share with a stranger such as incidents of trespassing or reliance on fishing for subsistence (Bernar 1994)" (Westphal, 2008: 49). These more in-depth methods allow the authors to better analyze the environmental perceptions of anglers in terms of how their opinions and knowledge are affected by their broader social

and cultural contexts. What is missing from the intensive approach is the extensive information on the populations of people fishing and amount of fish commonly consumed by anglers. The two methods combined, then, provide a more holistic picture of the quantitative data that helps guide advisories and agencies, while also addressing the more socially-guided inquiry of how people are actually affected by the presence of consumption advisories.

Relevant Findings of Previous Studies

A key finding in Velicer and Knuth's study is an assessment of which advisory dissemination methods are most effective. Opinion leaders, fishery experts, and health care experts rated (1) "letters mailed to licensed anglers" and (2) "[New York State] Fishing, Small Game Hunting, and Trapping Regulations Guide" as most effective. Rated as least effective across the board was "information from friend/fellow angler" (Velicer and Knuth, 1994: 839). The authors go on to recognize that the 'expert' opinion on advisory dissemination may not be correct, asserting that "migrant farm workers, however, generally did not have access to mass media or to locations where the regulations guide was available. Further, even if they did have access to mass media or the Guide, it was unlikely that they would understand it due to English literacy barriers" (840). Still, the authors recommend that education efforts come from health care workers and social service tutors, entirely ignoring the factor of trust in education efforts.

Other authors on the topic, however, suggest that communication amongst anglers may be more significant than Velicer and Knuth give credit. In multiple studies

conducted by Burger and colleagues, she found that anglers frequently turn to each other for information. When looking at New Jersey anglers, Burger found that "most of the sample (64 percent) obtained their fish and fishing information from other anglers or from bait and tackle shops" (Burger, Pflugh, et. al., 1999: 221). In Puerto Rico, 67% of crabbers and 58% of fishermen obtained information on mercury contamination from friends—higher than any other source of information (Burger and Gochfeld, 1991: 273). While anglers are likely to get their information from a diverse number of sources, these studies show a clear pattern in anglers obtaining information from each other.

The general goal of each of these studies is to increase the effectiveness of mercury advisories and to ensure a well-informed public. Studies consistently recommend improved state-generated education methods in order to remedy these gaps. And many of the recommendations for increased education are creative and could prove somewhat effective.

Burger (2008) recommends advisory mechanisms model the Community Fisheries Management programs that are in place for commercial fisheries. She does not, however, discuss specific ways that such a program could be created. Westphal (2008) suggests a 'Master Angler program modeled after Cooperative Extension's 'Master Gardener' program. "The great advantage of such a program is that it provides a mechanism for disseminating information along the proven and trusted informal social networks that already exist in recreational fishing" (Westphal, 2008: 60). Westphal's suggestion is aligned with the understanding that anglers commonly trust friends and fellow anglers for both advisory and regulation information (Burger et al., 1999; Pflugh et al., 1999). Other studies suggest educational intervention that incorporates culturally-

specific techniques, local languages, and respects varying lifestyles (Beehler et al., 2001; Beehler et al., 2003; Burger et al., 1999).

Fundamental Flaws

Despite the creative approaches to educational efforts, each of these studies holds within them several fundamental flaws that limit their potential to affect change. First, several of the studies note anglers are not necessarily prone to changing their consumption behaviors because of advisory knowledge. May and Burger (1996) found that 65% of interviewees thought fish was safe to eat despite warnings, and 70% continued to eat their catch despite warnings. Our survey found that no correlation existed between angler advisory awareness and fish consumption—meaning anglers who were more aware of warnings were not less likely to consume locally-caught fish (Shilling, White et al., 2009).

Yet, angler surveys continue to operate with the assumption that there exists a golden-ticket of advisory methods, that the exact approach will eventually be discovered to protect most anglers against the threats of environmental contamination. Several studies suggest that trust of government agencies is a major barrier to changing consumption behaviors in the face of warnings. Burger and May (1996) suggest that "agencies issuing advisories must improve their credibility in the public eye, and involving independent parties in sampling, testing, and reporting may help the process of rebuilding trust in government agencies" (Burger and May, 1996: 470). Beyond simply changing advisories, agencies have to change the way they are perceived by the public—a change that requires significantly more effort than altering the location and language of

advisory signs. Changing the public's perception of agencies in fact requires a change in the way that agencies understand the public and seek to involve them in agency-driven processes.

The flaws present in these angler surveys extend beyond their recommendations on education efforts. While many of them address the differing ways that fishermen come to understand their environments, few take the step to address ways that differing social and cultural values can affect our steps forward, and perhaps move beyond business-as-usual into an entirely new approach to this rift in communication. Beehler (2003) begins to make this step forward suggesting that "for risk communication to appropriately address the issue of risk education in minority groups, it is essential for [agencies] to understand the perspectives of these groups" (113).

Even beyond the premise of education stands the acceptance of contamination, the resignation that our relations with the environment are permanently degraded by contaminants and our only solution is to make sure that everyone knows. None of these studies suggested the possibility of clean up, nor did they suggest to anglers they spoke with that they have a right to clean waters. This oversight speaks to our present emphasis on environmental mitigation. Harm done in one place is allowable so long as mitigation for it exists in another. At stake is the continued degradation of the way we view our involvement with nature and our environments.

Turning our attention to understandings of risk as socially-constructed will generate a more in depth insight into ways that fishermen understand contamination and help us formalize their perspectives.

Social Theories of Risk

I entered this study with the quest to understand risk perception amongst Delta fishermen. The previously discussed angler surveys frequently use the term and ideas surrounding *risk perception*. The phrase is most commonly attributed to Paul Slovic (1992) for his *psychometric paradigm* of risk perception. Slovic defines the paradigm as:

> a theoretical framework that assumes that risk is subjectively defined by individuals who may be influenced by a wide array of psychological, social, institutional, and cultural factors. The paradigm assumes that, with appropriate design of survey instruments, many of these factors and their interrelationships can be quantified and modeled in order to illuminate the responses of individuals and their societies to the hazards that confront them (1992: 120).

Existing angler surveys largely work based on this paradigm, assuming that talking with enough anglers will reveal the patterns of their risk perception and decision-making framework.

In some instances, the framework is helpful, but proponents of social theories of risk warn of the paradigm's shortcomings. Otway (1992) says quantifying risks falsely assumes that if distant risks were "'put into perspective' through comparison with familiar risks we could better judge their social acceptability" (Otway, 1992: 216). Like MacNaghten and Urry's (1998) criticism of surveying methods, Otway considers the weighing of risks and benefits as 'fragile values' stripped of meaning when quantified.

Otway and others criticize the term *risk perception* specifically, stating that people do not, in fact, perceive risks *per se*, but rather the "totality of whatever activity causes the risk" (1992: 224). MeHg as a food and environmental contaminant cannot be seen, cannot be perceived by our senses, and so an understanding of the greater context is necessary to see its potential as a threat. The information circulated about mercury fails

to contextualize and historicize its presence, making it increasingly difficult for us to see the "totality of whatever causes the risk." While I agree with Otway's analysis that people judge risks on a more universal than specific basis, the scarcity of information about mercury's reason for being forces people to perceive the risk only as it is publicly presented.

To discuss the concept of *perceived risk* broadens the conversation to one of risk society (Beck, 1992). Beck defines risk as "a systematic way of dealing with hazards and insecurities induced and introduced by modernization itself. Risks, as opposed to older dangers, are consequences which relate to the threatening force of modernization and to its globalization of doubt" (21). As we generate wealth through technology and development, we open ourselves to the dangers that travel downstream from our desired progress. Risks, then, are not the actual hazards, but the way in which the threats brought on by progress can be understood. Central to Beck's thesis is that risks differ from known dangers because of their invisibility. The general public cannot detect risks brought on by technological advancements; the nature of their threat requires modeling and prediction.

> [Risks] induce systematic and often *irreversible* harm, generally remain *invisible,* are based on *causal interpretations*, and thus initially only exist in terms of the (scientific or anti-scientific) *knowledge* about them. They can thus be changed, magnified, dramatized, or minimized within knowledge, and to that extent they are particularly *open to social definition and construction*. Hence the mass media and the scientific and legal professions in charge of defining risks become key social and political positions (Beck, 1992: 23; italics in original).

Beck's polemic responds generally to the threat of radioactivity as the most invisible and perhaps most seemingly dangerous risk brought on by modernization, but extends to toxins like mercury and pesticides that are equally undetectable. To think about risk in

terms of public perceptions, then, generally fails. Risks cannot be directly perceived and instead require outside, expert knowledge and the circulation of information in order to be understood. The issues of trust and the social relationships that envelop this process cannot be ignored.

Here, STS scholars and Beck may begin to disagree. Beck proposes that because risks are invisible, they require expert knowledge for the public to understand. While Beck recognizes a loss in public trust for authorities and experts during the modernization process, his institutional focus ignores the interactions (social, cultural, political) that shape grassroots perceptions of risk (Wynne, 1996). Whereas Beck neglects the knowledge that the public may carry about risks based on experience, STS scholars seek out this knowledge, recognizing that the perceptions of risk that the public may hold are generated through a combination of 'expert' information, socially generated interpretations of the information, and personal experience.

Wynne's example of personal experience of risks revolves around the case of Cumbrian sheep farmers' contaminated fields following the Chernobyl disaster (Wynne, 1996). Though scientists working on the project assumed the field contamination came from Chernobyl, the farmers attached the contamination to the closer source of the area's nuclear power plant and questioned expert-driven conclusions. When scientists attempted to carry out a series of tests to determine the source and level of contamination, the farmers' local experience (of the land, sheep behavior, etc.) effectively slashed the validity of scientific tests. The farmers' local knowledge was essential for determining not only the source of contamination, but for even generating the tests to measure the reach of risk.

In contrast, Beck proposes the opposite—that our judgments are based on "general knowledge devoid of personal experience" (1992, 72), that our experiences are so distant from risks that he considers our consciousness of them "second-hand non-experience" (72).

Defining 'experience' presents a challenge. Cumbrian sheep farmers may not have seen first-hand how their sheep were affected by contamination. But they were intimately linked with the nearby nuclear power plant (some worked there part time). Still, their knowledge of nuclear energy as posing a potential threat depended on external information, not experience. The difference, though seemingly semantic, ultimately rests on different views of what is recognized and accepted as knowledge.

Beck highlights the distrust amongst the public of so-called expert information, and effectively widens the gap between the two, making the public both dependent on and distrustful of expert knowledge. Slovic's *psychometric paradigm* theory of risk perception does the same in its attempts to quantify how public perceptions of risk differ from those of experts (Slovic, 1992). STS scholars focus instead on dismantling the divide between expert and local knowledge (Argawal, 1995), bringing in to question the effectiveness of expert-imposed risk communication and seeking pathways for productive relationships between expert and local knowledge (Irwin and Walker, 1999). The search for truth must allow for "multiple rationalities" (Irwin and Michael, 2003).

STS establishes a framework for understanding risk perception as "unavoidably social" (Irwin, 1989: 20) and "necessarily founded upon deeper social models and assumptions" (Wynne, 1989: 33). The field seeks to describe "the exploration of contemporary public responses to risk and environmental concerns" and considers "the

more active forms of 'sense making' involved in creating public attitudes and evaluations" (Irwin and Walker, 1999: 1311).

Irwin and Walker stress the need for empirically-based understandings of risk perception. "Risk concerns may form only one—and not necessarily a unique or separable—part of the conditions within which everyday life is constructed and within which people actively make sense of the social worlds in which they live" (Irwin and Walker, 1999: 1312). They stress the need to remain open in the face of local studies, accepting the fact that, as a researcher, the risks that appear relevant in a setting may not be considered a risk at all, and that the knowledge and perception of risks may be deeply embedded in an undetectable set of social values and exchanges.

And so, how can the case of mercury contamination be understood in light of these theories? In many ways, the case rests between Beck's and STS's concepts. MeHg is an invisible toxin—undetectable by sight, smell, or taste, and long-term exposure MeHg poisoning largely goes undetected because its symptoms are so vague[3]. So in some sense, the case of mercury is aligned with Beck's proposal—that MeHg's invisibility makes us dependent on authoritative information, and ultimately more vulnerable to the heavy metal's dangers.

I cannot help but feel defeated at such a conclusion. It may be the case that knowledge of mercury depends on understanding an advisory sign. In that case, it works to focus studies on how well people understand posted signs and increase awareness of mercury's threat. But to acknowledge the problem from the perspective of STS allows us to look at the social relations that surround understandings of the problem. For Beck the

[3] Symptoms are more obvious with the case of acute MeHg poisoning, which some believe goes under-diagnosed in the medical field (Hightower, 2008; Groth, 2009).

ways to understand an environmental risk may be limited to whether or not the public trusts the experts giving information. But to broaden our focus, the information about mercury threatens the very identities of fishermen along these banks, and the way fishermen understand the risks is often intimately linked with the preservation of that identity.

Similarly, the understandings that fishermen have with mercury are linked with their own social values, their understandings of their environments, their health, their relationships to authorities, and so on. One of the many angler surveys that exists suggest that:

> Educating and protecting at-risk communities require more than increasing the perception of risk, because risk perception alone does not guarantee behavior change (Kottak, 1999). Rather, a culturally competent approach would supply anglers with essential risk reduction information and also explicate how it connects directly to their own local knowledge, attitudes, and practices (Beehler, 2003: 113).

While Beehler's suggestion surpasses many of the other studies' recommendations to simply improve signage, social science theorists may argue that he has it backward. Risk communicators do not need to inform anglers of how risks connect with their knowledge, attitudes, and practices. Anglers are already well aware of these connections and actively incorporate them into their thinking. "We might picture the artisan-craftsmen not as passive recipients of bourgeois wisdom, but as active makers of their own intellectual worlds, their own really useful knowledge" (Desmond, 1987 quoted in Wynne, 1989: 50). To begin to recognize the usefulness of such knowledge, we must first recognize it as knowledge *per se*. We must recognize what Habermas terms 'emancipatory interest,' in which people will critically "reflect on the processes in which they are engaged" in order to forward their own knowledge and judgment of such social processes (Boud, 1995:

134). What follows is an attempt to better understand and acknowledge the greater universe in which mercury exists.

VI. Mercury in the Community

Demographics of Fishing Community

To begin with, we do not know a lot about the fishing communities present on the delta. We know that as of 2001 there were approximately 1.2 million licensed anglers in California, 191,000 of which lived in 5 counties encompassing the Delta—Sacramento, San Joaquin, Solano, Yolo, and Contra Costa (data from the CDFG License Bureau; Shilling, White, et al., 2009: 12). And we know that this region of California contains broad ethnic diversity, including many recently-arrived Hmong, Cambodian, Vietnamese, Russian, and Mexican immigrants. Whereas subsistence fishing practices are commonly thought of as relegated to developing countries, many of these recent immigrants have likely retained the cultural and economic practice of subsistence fishing (Shilling, White, et al., 2009). Along the Delta are also many California-born fishermen, some of who fish for sport and others for food. Fishermen are spread throughout the delta waterways and come from diverse locations both locally and abroad. To call this a community means little more than a group of people who engage in the same activity.

But we do know a bit about their consumption practices, and know that they are commonly eating the fish from these waters. According to our survey findings, the arithmetic mean consumption rate of locally caught fish for the 373 anglers we surveyed was 27.4 g/day for all anglers—higher than the USEPA standard fish

consumption rate of 17.5 g/day (the number used to establish the consumption limits in advisories). The rate of consumption for both locally caught and commercial fish was 40.6 g/day. For surveys conducted by community groups, the mean consumption rate was 55.2 g/day for locally caught fish, and 63.4 g/day for locally caught and commercial fish combined (Shilling, White, et al., 2009: 14). Keep in mind the study that indicated 2-fold increased risk for heart attack in persons who consumed more than 30g/day of fish (National Research Council, 2000: 171. Approximately 5% of the anglers we surveyed had a MeHg intake rate at least 10 times higher than the USEPA reference dose (Shilling, White, et al., 2009: 16). The numbers are telling, but most of the story must be listened to in depth.

Approach

Fishing is an anecdotal practice. Familiar stories amongst fishermen are tales of quests and catches. Like the quest for Moby Dick in the deep blue, river fishermen share the pursuit of a fish that consistently evades the end of their lines. The fish goes by many names—The Monster, The Beast, Big Mo—to name a few. In one story The Monster drags a fishermen half way down the Sacramento River before finally snapping the hook lodged in its jaw. In another, a seven-foot sturgeon, wrestled out of the water for nearly an hour, is released after being momentarily admired by its captor. In many ways, I think the stories carry fishermen forward, sharing the common goal of the greatest catch in the water.

Fishing as an anecdotal practice, however, extends beyond sporting fantasies and shared consolation over the fish that got away. Fishermen sit for hours, sometimes days,

patiently watching their thin clear line cast into the water. In that time, fishermen cultivate relationships with one another about their practices, their favorite locations, their tricks and tips, their knowledge of the area.

In my work, I have tried to get in on the fish stories. I have sought to understand the practices, opinions, and knowledge of fishermen as they pertain to this environment of storied pursuit. What began as a quest to understand fishermen's knowledge and opinion of mercury contamination, became much more open as my conversations with fishermen began. Primarily, mercury seemed to be less of a topic of interest and knowledge than I originally anticipated. As my conversations progressed, I recognized that the topic of mercury did not exist in a vaccum, but was part of the greater concerns and knowledge of the fishermen with whom I was talking. Irwin and Walker (1999) faced the same reality in their work in a small industrial town, and encourage researchers to truly listen to the concerns of community members, and strive to write work that is representative of those concerns.

Methods

My method of interviewing mirrored that of surveying. With a notebook in tow, I walked along the banks of Delta channels and sloughs that are frequent fishing sites. I talked with each person along the bank in search of those who are both English speakers and open to talking. They are few and far between—sometimes as low as one in twenty fishermen along the banks meet these criteria. Each conversation began with the same question. "Any bites?" The question is common amongst fishermen, and quickly told me whether or not to keep walking. Because many fishermen along the delta are non-

English speakers (and often those who consume the most fish), I hosted a group interview with members of a Cambodian community, assisted by a translator from their representing community group.

While I approached each interview with a specific set of questions, I worked to let my interviewees guide the conversations as much as possible. Similarly, my questions evolved throughout my interview process, and so questions I asked at the end of my time of the river were somewhat different from those I asked in the beginning.

In many ways, the sample is a sample of convenience. Rather than targeting a specific group of fishermen, I spoke with whoever seemed willing. While I wanted to talk with fishermen who ate fish frequently, the most talkative folks were sometimes those who never ate their catch. While I initially saw these conversations as irrelevant, I realized they could just as easily inform my research. Additionally, I relied on field notes from the year's worth of surveying I did. Because those conversations would casually follow the survey I conducted, they were often rich with information and an important source of data. Between November, 2008 and April, 2009 I conducted interviews with 21 fishermen, some in groups and some as individuals. I spoke with close to 100 fishermen during my year of surveying, a number of which turned into conversations following the survey.

The interviews were largely open-ended conversations that I let change according to each person or groups' engagement. But each contained questions that fit into the following categories (interview questions attached in appendix A):

- Cultural understandings of fishing in the face of contamination
- Angler interpretation of and response to advisories

- Angler community knowledge
- Angler knowledge of and response to cumulative impacts
- Angler relationship to conservation and regulations

While I initially intended to record the interviews, most fishermen where uncomfortable with being recorded. Instead I depended on a speedy note-taking hand, writing down important quotes verbatim to later help generate a narrative. I used a grounded theory (Glaser and Strauss, 1967) approach to the interviews, reviewing my notes for themes though never explicitly coding.

The result is an incredibly diverse set of responses, some of which hardly seem comparable. But the sample is representative in its diversity. It represents a wide array of cultures that exist along the Delta, each of which mold and sculpt fishermen's understanding of and interaction with their environments. To overlook the diversity of knowledge and opinions would negate my purpose out on the Delta—to help open a space for fishermen's experiences in the conversations around the state of the environments with which they are so closely linked.

What follows are a number of profiles. Fish stories, if you will. The profiles highlight some of the conversations I had on the Delta that I view as the most informative to my line of questioning. In part, I present them as individual profiles to highlight the diversity of knowledge and opinion amongst fishermen and maintain the distinctiveness of each conversation. But beyond that, within each conversation exist the social and cultural backbones that may be the basis for how many other fishermen understand this problem. I present these cases individually because this is a story about communication and narration. These stories are not intended to represent a meta-narrative of how

fishermen view the environment and case of mercury contamination. Rather, they reveal how varied those understandings may be and how difficult it is to synthesize the knowledge of such a diverse population. There are, however, some similarities that connect the profiles and the conversations I had throughout the past year, which I will return to and explore how these small conversations can fit into the larger picture of risk perception, ecological knowledge, and interactions with our environments.

Fish Stories: Soapy Waters

To a fisherman, the river's shore is a site of relaxation, a site of retreat, of sport, and of food. The threats that may exist within these water bodies are invisible, quiet. A hum of danger subtly surrounds fishing in this area, but for many it is just outside of earshot.

Figure 8. Soapy Waters at Knight's Landing.

Introducing the threat of mercury exposure to fishermen I speak with is often like discussing a non-issue. Fishermen frequently come across as unconcerned, aloof even. The motivation behind this de-amplification of present threats (Burger, 1999) seems at times to be a refusal to spoil a seemingly pristine place. But at times, these waters show their threats more visibly. Unlike mercury contamination, there are times when pollution

in the waters is easy to see. I encountered such an instance during my research, and it makes for a fruitful, and somewhat perplexing, place to start.

In early November of 2008 I drove north of the Delta to Knight's Landing in search of salmon fishermen. This location is surrounded by agricultural lands, and boasts a popular fishing spot and boat launch. For the past year, salmon had been off-limits to fishermen due to record low salmon returns and serious concern over the future of the salmon population throughout California and Oregon. For two months starting in November 2008, the salmon season opened from Knight's Landing and north along the Sacramento River. With such a short window for fishing, I knew I would likely find a number of fishermen trying their luck with the limited number of fish in the waters.

This site is similarly popular for sturgeon fishermen who camp out for sometimes weeks at a time to fish through the night. And just off the river is a small agricultural slough that empties into the Sacramento River and hosts a small fishing site popular amongst crappie fishermen (that's the type of fish, not the level of skill). Salmon are incredibly low in MeHg due to their short life cycles, and so my targets were not necessarily salmon fishermen. Rather, I headed to this northern spot knowing that the fishermen out were likely those who paid close attention to fishing news and were knowledgeable about fishing regulations and fish populations.

Upon crossing the bridge over the Sacramento River, I saw a site that pulled my attention away from mercury altogether. Billowing out of the dam at the end of the agricultural slough was a thick white foam, glistening in the early morning sun. The foam piled up against the bank, enveloped the bases of boats, and headed south down the Sacramento, visible for likely a quarter-mile down the river.

Still, fishermen cast their lines into the frothing water—at least twenty fishermen populated the banks. For those I talked to, the incident was natural, expected. According to one fisherman, "this is the only time of year you see the foam. It's around for a month or so. 'Old Timers' say that the foam is from the salmon. You know the fish are around if the foam is around." The reasoning is somewhat logical. The foam comes once a year, and always in late fall, when the fall salmon run begins. If you were in search of environmental clues for the start of the salmon season, this could easily serve as one. But knowing that salmon travel through these waters twice a year (once in the fall and once in the spring), I felt the need for further inquiry.

Stopping a man on the Knight's Landing pier, my father (whom I was traveling with that day) asked simply, "what do you think?"

"Fish are taking a bath," he said. Like the fishermen before him, this man pointed out that the foam comes out from the dam every year. He noted, however, that nearby cornfields is the foam's source. Not far from him, two California Fish and Game workers sat parked in their truck with the radio on. According to these men, the foam is a fungicide from the rice fields, happening in the fall when they flood the fields to break down the organic matter. I asked if they thought the fishermen knew this. "They probably don't know what it is; probably don't care as long as the fish are biting."

Though I considered their response somewhat patronizing, I couldn't help but similarly question the actions and intentions of the fishermen I had spoken with. Bea and her husband Ike[4] both consume fish from the Delta and Sacramento River. They discussed selecting their fishing sites according to the physical signs of a site's health.

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[4] All interviewee names have been changed to protect confidentiality.

Yet their concern for the soap filling up along the sides of the river was negligent in my eyes. In fact, it was described as positively indicating the presence of salmon.

Somewhat baffled, I walked down to a small beach to talk with a few more fishermen. An elderly woman told me that the foam was natural and not harmful. Her granddaughter, Sophia, who was likely no older than ten, pulled her Blackberry from her pocket and Googled the words "foamy water river." She opened a document from the University of Maine, stating that foam running through rivers is naturally occurring, just as her grandmother had stated. They smiled at me, satisfied. The website Sophia found (which I later searched for again) provided a three-line explanation of foam found in rivers, with little discussion about its variety of potential causes (Schmitt, 2005). I questioned its validity, but these fishermen did not. Rather, it reinforced their intuition that the foam is natural, and served to protect their fishing practice.

Wynne (1989) describes a similar instance of a community's perception of a local coal company. In the face of the company's effluence draining into a local creek, the community rationalized its presence and understated its level of threat. My conversations here on the river today mirror much of Wynne's explanations of this community's risk de-amplification:

> A coal company and its management of a dam might be seen as a relatively transparent set of 'effective causes' of risks, with immediately identifiable lines of control and responsibility. […] Yet the pervasive and increasingly close importance of these systems requires that people construct some working rationalizations of their troubling and confusing experiences of them, even when they do not unleash dramatic interventions into their lives (Wynne, 1989: 53).

One of the women fishing at this site said to me, "if there were a natural disaster, my family would be alright because we can fish." With her feeling of resilience and

security tied up in the act of fishing, recognizing an environmental pollutant potentially causing interference with her practice becomes a threat to her identity and sense of self-reliance. And rather than acknowledging the potential danger of soap-filled waters, these fishermen construct the narrative that the soap is a sign of good fishing, turning the soap into a positive sign rather than a threat. The Fish and Game workers resting in their truck were, to an extent, correct. So long as the fish were biting, the soap was of little concern. But this response may not have been generated out of ambivalence, as these men suggested, but rather out of a strong sense of self-preservation. To recognize fishing as potentially dangerous could pose a threat to the very identity that fishing generates—one of self-reliance and distance from the systems that may pose threats to life away from the river.

Fish Stories: Glowing Green

Ike and Bea were among those fishermen hoping to catch their one-salmon-per-person limit on that day in November. Bea works for a health insurance company and Ike is a welder who recently inherited his father's farm. Both are hunters as well as fishermen and eat self-caught fish, though infrequently. Like so many of the fishermen out here, they have been fishing since their youth, acquiring their fishing skills and knowledge from their families and fellow fishermen. At one point in the conversation, Bea left to discuss with another fishermen the law on fishing with two rods simultaneously. They complain of disrespect for fishing sites amongst other fishermen, release small fish (younger fish means breeding fish), express concern for water shortages in the region, and agree with the necessity for a closed salmon season this year.

Their wish, however, is that their fishing licenses had been discounted as a result. In their years of fishing, they have noticed fewer fish in the waters and fewer points of access for fishing, but no break for the cost of a license.

Bea reads the regulation guide each year and knows of mercury contamination because of it. She has seen signs, heard of mercury on the news, and has known of mercury as a prominent problem in the area for years. Her response to the problem is, "I think it's a bunch of hooey. Unless you're constantly eating fish every day, then it's not a concern." Ike chimed in a moment later exclaiming, "I eat fish five or six days a week, and I'm not glowing green." Ike was referring to eating canned tuna almost everyday. Tuna, while not a locally caught fish and thus not represented in the area's advisories, has some of the highest levels of mercury amongst commercially caught fish. But both disbelieve the existing warnings.

Ike's response is one I've heard from several fishermen in my time on the Delta. In some cases, it is a statement about the present, as in this case. In others, the statement references the future. "In twenty years, you'll be glowing green," and "someday, you'll be glowing."

In mentioning the green glow, Ike references back to a cold war fear of nuclear weapons, and fears of nuclear power and the tragedy of Chernobyl. The phrase seems nearly commonplace, almost lacking in meaning. But whether consciously or not, he referenced major historical shifts in the way that Americans view their environments and its affect on their health. While I didn't ask for his age, Ike appears to be in his 50s, making him the prime age to have been engulfed in the words of Rachel Carson and brewing fears of DDT and an environment headed towards collapse (Carson, 1962).

But the reference is presented as a joke, as an unrealistic concern. Mercury may as well be kryptonite. There is a wide and sweeping distance between the threats of mercury contamination and its long off consequences. And with the current worries that plague some (if not all) of these fishermen, the threat of MeHg exposure is obtuse and distant. Like the threat of nuclear disaster, mercury contamination and poisoning as something that may or may not happen, not as something that in fact *is* happening (Flyvbjerg, 1993). Many explanations of methylmercury-related health risks are as vague as "Neurobehavioral developmental difficulties." In the case of advisory materials, the threat of exposure is made apparent without any explanation of the potential harm, leaving anglers to determine their own conclusions as to the cause of the danger. A fall back to the fear of fall out, then, seems rather understandable.

But as a product of the Silent Spring era, Ike and Bea's knowledge of pesticides in the water is more attuned. Also, Ike was raised in a farming household and is in the process of becoming a farmer himself. Bea notes that refuse dumped in the ocean some 50 or 60 years ago may just now be appearing as a problem in our water supply.

> Bea: "There have been times we've been out here and haven't fished because the water's too nasty and warm.
>
> Ike: "Have you been to clear lake? It smells, it gets algae in the summer. I don't know how it ever got the name Clear Lake."

These two refuse to fish from sloughs because of their proximity to farms and concentrated levels of chemicals. They do not eat crawdads because of the waters in which they are found—according to Ike, waters too close to crops.

Their concern over pollution resides close to their lifestyle, close to a hazard that is detectable directly in their lives. The line of socially-produced understandings of the environment extends from Irwin's investigations of the industrial town in Northeast England.

> What made the state of the river a focus of attention was not the pollution itself but its relevance to him as a boat owner. His knowledge was acquired and maintained not simply in the context of Jarrow, but in the context of the social practice of sailing, just as the earlier observations about the effects of pollution on the fish and other aquatic life were made in the context of the social practice of fishing (Irwin et al. 1999, 1320).

The threats that Ike and Bea see as most prevalent are those that directly affect their fishing practice—the accessibility of fishing sites, the cost of licenses, the dangers of pesticides in the water. And so, they act to protect themselves in response to the hazards they can readily recognize. And the rest becomes far off and untouchable.

Fish Stories: A Lesson in Mercury

The day I spoke with Samuel and Darren proved to be one of my most difficult as a researcher. I have frequented Freeport for the past year and half conducting surveys. The one street town of Freeport, an unincorporated part of Sacramento, houses three bait and tackle shops and backs up to a small marina. To the north of the marina, a well-worn path stretches down the shores of the Sacramento for a mile or so. The path runs through thickets of waist-high grasses, over boulders covered in fishing bait debris, and under pipes dumping treated wastewater into the river. The shore is frequently filled with fishermen, each having staked out a small beach or rock along the path. At times of the year when the water is high, some pockets of beach are particularly difficult to reach.

Access to these spots requires ever so carefully walking across swaths of loose rock, placed here to fortify the levee, testing each rock for its stability before placing any weight on it. With my backpack on and arms outstretched, I slowly cross these rocks, sometimes watched by fishermen as I approach their camps. I am always slightly embarrassed as I wrestle with this terrain. Fishermen seem to glide along these rocks with gear in hand.

Trash is generally strewn about at the beaches—empty bags of sunflower seeds, beer cans, fishing lines, and once even a shopping cart, half buried in the mud. The wastewater pumping into the water is from the Sacramento Regional County Sanitation District, and is one of many throughout the delta that increase the pollution in delta waterways (Cal EPA Regional Water Quality Control Board, 2009).

Ammonia still present in the wastewater after treatment has recently been under scrutiny for the threats it poses to human health (Weiser, 2009). The wastewater not only dumps mercury into the Sacramento River, but also increases the potential for the methylation of mercury by stirring up sediment, making this part of the river particularly toxic. Despite the site's popularity amongst fishermen in search mainly of striped bass and sturgeon, no advisory signs have been posted along the shore.

I have frequently had much success talking with fishermen at this site. Today, however, presented more of a challenge. I approached at least ten fishermen or groups of fishermen as I clumsily made my way along the rocky path. "Any bites?" I ask each fisherman. On this day, responses were mostly sullen "no's" with little to follow. Some fishermen show a clear sign of not wanting to talk by ignoring my question altogether, or answering quietly without looking away from the river. I generally keep walking at such

responses. Today, nearly all of them seemed to be so unfriendly. An elderly fishermen I once spoke with told me, "we're fishermen, can't you tell we're trying not to exist." His words rang true with each of the people I passed who averted their eyes or ignored my question.

Finally, after a discouraging number of rejections, I met Samuel and Darren, two African American men who proved to be talkative and playful. Samuel chuckled that I might be spending my free time looking for fishermen to talk to. Well yes, I do. They seemed willing to talk predominately for entertainment purposes. Samuel fishes frequently—sometimes several times each week, but never eats fish. Darren fishes less frequently, and eats fish only on occasion.

Samuel refuses to eat fish, and always has. His reasons for not eating fish balance between conservation and distrust of fish meat, but are more intuitive than anything else.

"If they're breeders, throw 'em back. And if it's older the meat is tainted, the meat is not that good." Samuel says he discourages his friends from eating fish regularly. Any more than an occasional fish fry is too often. Fish that smell fishy shouldn't be consumed. Fish that are too old will be no good to eat. For being a long time fishermen, Samuel was adamantly opposed to consuming fish. But when I asked him if he'd seen any advisories about eating fish, he said no. Undercooked fish and raw shellfish are common causes of food-borne illnesses (food poisoning and parasites; Center for Disease Control, 2009), so perhaps Samuel holds this tacit knowledge in his mind. But his distrust in fish may extend beyond that knowledge.

I asked him about regulations, about Fish and Game workers who frequent the sites. He quickly referred to them as "fucking dickheads," saying they used to visit this

site and only question people "from the hood." His distrust for authority is clear, and perhaps explains why he does not read the regulation manual. Even if he never personally encountered Fish and Game representatives on the water, his knowledge of others' encounters and perhaps threatening encounters with authority figures elsewhere follows Samuel out to the river. His distrust cannot be contextually detached. Westphal's (2003) study encountered similar distrust from African American anglers in Chicago's Calumet region.

Turning to Darren, I asked if he had seen any health advisories. His immediate response was, "if a 220 pound man eats eight ounces of fish he gets sick from the mercury." His response prompted a dialogue between the two, in which Darren explained the case of mercury to Samuel.

Samuel: "Mercury? In the water?"

Darren: "In all the waters."

Despite Samuel being unaware of the mercury problem at first, his memory seemed jogged by the conversation. The two of them discussed the different waters in the region that are affected by the mercury. But Darren's knowledge does not stem from official advisories or the regulation manual. In fact, he specifically said he has never seen signs at fishing location and sees it as a problem. Rather, his knowledge is from high school science class. He professed his love for his high school science class. It is almost as though the two men hold the same tacit knowledge. For Darren, his knowledge of mercury is deeply embedded in his mind and keeps him from consuming fish on a regular basis. For Samuel, his knowledge is partially instinctual, but likely arises from information he's heard throughout his time as a fishermen. The source of the information

is generally irrelevant. It is his own intuition about the safety of fish that keeps him from eating it at all.

Towards the end of their exchange about mercury, Samuel proclaimed that this is why he doesn't eat fish. His proclamation sounded like the validation of knowledge he had held for a long time, as though saying, "I knew it all along!"

The conversation between Samuel and Darren highlights one of the fundamental problems of risk communication—that its top-down tactic will serve to alienate more than educate, and can deter people from even paying attention. Many of the angler surveys across the country cite 'fellow anglers' as a common and trusted source of information (Beehler, 2003; Westphal, 2008). Fishermen turn to each other for information about regulations, fishing locations and tactics and in this case, contamination. What happened here may open the door for a long line of communication between Samuel and Darren, may trickle outwards to the friends that Samuel consistently warns about eating fish. As Otway and Wynne point out, "The main product of risk communication is not information, but the quality of the social relationships it supports. Risk communication is not an end in itself; it is an enabling agent to facilitate the continual evolution of relationships" (Otway and Wynne, 1998: 227). If risk communicators want to deter fish consumption, this is more the way to do it.

Fish Stories: When Everything has a Warning

One of the great complications of searching for fishermen on the banks of the delta is the language barrier. At least a dozen languages are represented on these waters, and many fishermen are monolingual. Southeast Asians comprise a large percentage of

the fishermen in the region, and their fish consumption practices rate the highest amongst any ethnicity (Shilling, White, et al., 2009).

Stockton houses a large community of Cambodian immigrants, many of whom are refugees of the Khmer Rouge regime. They are familiar with genocide, refugee camps, and likely a number of negative encounters with government officials (Miller, 2007). To talk with this population requires trustworthy access and translation. A Cambodian community group whom we have been working with throughout this project offered to facilitate and translate a group interview with a few willing Cambodians. Much to my surprise, on the day of the interview, 12 Cambodians arrived to listen and take part.

The experience was telling for two reasons. First, in talking with a large group of fishermen, I was able to see their shared understandings of fishing and contamination. Though only a few members of the group were vocal throughout the interview, all of them listened attentively and expressed their agreement with many of the statements expressed by a few.

Second, the experience showed the barriers that stand between me as a researcher and the work that I am pursuing. During the interview, several of the fishermen pressed one another not to share sensitive information with me. At one point, my translator paused the interview to explain that I am interested in their opinions about the subject; that I am working with her organization to help make fishing safe. I realized that I had not explained my intentions very clearly at the beginning of the interview. I introduced myself as a student who was working on issues that fishermen are facing, and that I was interested in talking with them about their fishing knowledge and opinions about issues

such as water pollution. I was trying to keep my introduction vague. In part, I want to know how much they know about mercury and contamination, so it is somewhat unhelpful to tell them at the outset that I am here to talk about mercury. But without explaining that my intentions were to protect their right to fish, I was seen as a distant authority, one who perhaps should not be talked with freely. That experience in and of itself reveals answers to my research questions. The skepticism towards authority and outsider distrust plays itself out in the understandings these Cambodians have of health advisories toward fish and of water contamination in the area.

Despite this outsider hurdle, the interview proved incredibly informative. The twelve fishermen gathered around the small living room (which also served as a bedroom) in one family's home. The house was in a low income neighborhood in south Stockton, the hub of the areas' Cambodian population. They all began talking with one another right away and I had to struggle a bit to begin the interview. To start with, I asked simply if they had been out fishing that morning. They had not been out that morning because the fish were not biting. Typically, the earliest bird of the fishermen heads for the water in the morning, and calls fellow fishermen with a full report. If the fish are biting, groups of fishermen head out together, and often cook what they catch right on the banks of the water. If there are no fish, the group is saved a trip to the Delta.

When asked why they fish, the immediate response is leisure, entertainment, and exercise. "Cambodians like fish," they say. Lanh, the most talkative member of the group, expressed that fishing is part of Cambodian culture; that they have to fish. All of these fishermen emigrated from Cambodia, and they all fished in their homeland. But

unlike the sport-like method of a reel and a line, they fished in Cambodia with nets and cages. In Cambodia, the objective was clearly to catch fish for food.

And they all eat fish frequently. They feed their families with the fish they catch and share it with their friends. Some even sell the fish they catch at a local park in Stockton[5]. Only later in the conversation was an economic dependence on fish even hinted at. Casually and slightly out of context, one woman remarked, "if you don't want us to eat the fish, why don't you give us money to go buy some fish at the store." It was at this point that my translator helped to clarify my intentions. While some of the angler surveys mention that economic dependence on subsistence fishing is uncommon amongst their subjects (OEHHA, 1995; Beehler, 2001), none recognize that perhaps that information is too sensitive to freely admit in a survey or short interview context.

When I asked if they knew of health warnings about eating fish, nearly everyone in the room shook their heads 'no.' Lak, who sat by the front window wearing a large sun hat, said her doctor encourages her to eat fish, that fish is good for her. Several others nodded in agreement. But they have all seen the advisory signs. The signs are posted where the Delta canals run through downtown Stockton, and where houses back up to the water. In response to these signs, these Cambodian fishermen avoid those locations. They simply fish elsewhere, where there are no advisory signs. At first, their response may be labeled as a misunderstanding of advisory signs. But Irwin and Michael (2003) shed a different light on the response, claiming that:

> …understanding is a highly complex concept, which, from the perspective of ethnographic public understanding of science, incorporates: the use of ignorance; local or situated knowledges; the appropriation and production of expert

[5] This was not revealed to me in this interview. My translator informed me of this practice, and a journalist who recently wrote about the community discussed the fish sales. But the practice is illegal, and so the information is not easily offered up.

> knowledge; relations of trust with experts and expert bodies; the mutual embedding of knowledge and social identity (65).

The group did not recognize specifics about the advisory signs seen at fishing locations, but recalled details when the warnings came from a closer source. One fisherman had received an advisory pamphlet at church, likely passed out by the Cambodian community group, and remembered that the warnings said to avoid certain types of fish, and to only eat a certain amount. Several people in the room named Striped Bass as the fish to avoid, a fish commonly eaten amongst this group.

Initially, the validity of these signs is not in question. They see the signs and so fish elsewhere. Similarly, they don't fish sites where the water is stagnant, where there is oil on the surface, or sites were the water smells bad. Their assertion that pollution and fish contamination should be visible supports other angler surveys (Westphal, 2008; Burger, 2000), and mirrors many of the conversations I have had.

As a researcher, one of the decisions I am consistently faced with is whether or not to discuss the health warnings associated with mercury. In some instances, the opportunity to discuss the health effects seems beneficially educational. In others, spouting off the potential health effects puts me in the position of the authority figure, seemingly trying to discourage fish consumption. But here, the discussion seemed appropriate. I explained that the warnings they had seen referred to mercury contamination and that, despite the fact that mercury could not be seen, it existed throughout the area and, if consumed too frequently, could cause sickness over time. One woman in the background mumbled "cancer." Others nodded that they knew it could make you sick, but that there are warnings that everything can make you sick.

But at this point, the tone of the conversation shifted slightly. I asked if the group was aware of other pollutants. "Sure, we are aware of other pollutants," Lanh responded, "everything has a warning on it. Beef has a warning, pork has a warning, fish has a warning. Sometimes I try to follow the warnings, and then when I don't I think that I am healthier than the people who follow all the warnings." Here, the group became a bit restless, chattering to one another. The group was dissuading Lanh's response, telling him not to be so candid with me. My translator interrupted to try to regain the trust of the group.

When I pressed on the matter, the conversation turned to prescription medicines. Oot said the doctor gives her 5 different medications and some of them make her sick and so she doesn't take all of them, then the doctors tell her that she is not getting any better because she isn't following the instructions on her medications. She says the only medication she takes regularly is her insulin. Several other fishermen chimed in and started a conversation about medicines. There is a medicine for everything and not all of them work together, but they get prescribed together. They continued to discuss how they selectively listened to their doctors.

Understanding health for these Cambodians has become mediated by western medicine; by the way we correlate 'environment' and 'health.' Though I did not press on the issue of Cambodian understandings of health (they were skeptical enough of my intentions without asking about their personal ailments), another story may relate. *The Spirit Catches You and You Fall Down* (Fadiman, 1997) is an ethnographic account of a Hmong child with a severe case of epilepsy and her family's battle with western doctors. The story frustratingly describes the repeated miscommunication between the family and

the girl's doctor. The misunderstandings extended far beyond the obvious language barrier into the much more complex realm of the way Hmong culture understands and treats illness.

One of the themes Fadiman discusses in her book is the relationship the Hmong forge between their traditional medicine and western medicine practices. Generally, Hmong depend on their own medicinal practices expect in instances of emergency, or when a problem can be easily remedied with the use of antibiotics. An analysis of Cambodian culturally-based health decisions parallels that of the Hmong. In Frye's (1991) work, Cambodians will travel upwards of 80 miles to find culturally-appropriate medical care (39). Only in instances of emergency will they use nearby western medical facilities. Frye's study assumes that Cambodian's "cling to traditional treatment as it provides a sense of comfort" (41) and assures readers that Cambodians are working to assimilate to American culture. Fadiman's study stands more evenly between the two medical practices, asserting that, "if you stand at the point of tangency, you can see both sides better than if you were in the middle of either one" (Fadiman, 1997: viii).[6]

What does this tell us about the Cambodians I spoke with? In question is not so much whether these fishermen understand the risks of eating contaminated fish, but whether they even share an understanding of 'risk' at all. Wynne (1992) warns of assuming a 'natural' meaning of risk aligned with technical definitions and physical measurements. Experts, he claims, tend not to "recognize that the indigenous meaning that people give to risk may include many other objective dimensions, such as whether valued social relationships and identities are threatened, or dependency on what may be

[6] My discussion of Hmong and Cambodian medical understanding is not meant to aggregate these cultures, but is meant to point out that they may share some narrative elements.

inscrutable and distant social actors or institutions" (282). The process of weighing risks and benefits, created by western scholars, may not extend to this Cambodian community, relatively new to and isolated from this risk society.

Some community organizations in the region recommend better-informing doctors about mercury contamination and allowing them to communicate health advisories. But the strong divide in medical understandings may mean for no more success than advisory signs posted at fishing locations. Besides which, this group is acutely aware of the political background of this story. When I asked what their main concerns were, several said they wanted environmental groups to clean the waters. That, combined with the comment that "if you don't want us to eat the fish, why don't you give us money to go buy some fish at the store," suggests that engaging this group politically may be significantly more beneficial than working to decrease their fish consumption. But instead they are seen as some of the most 'hard to reach' fishermen, isolated and fraught with cultural and communication barriers.

Fish Stories: Sifting Through a Life of Knowledge

Rita grew up in Copperopolis, California amongst a legacy of gold mines and recreational gold miners. She has known about mercury since her youth, and has fished for just as long. She describes her love for fish and her love for fishing. "I get so hungry for it because I was raised on it" she said to me, a hint of longing in her voice. Fishing for Rita is more than a sport. To fish gives Rita the opportunity "to talk to god, pray to the sun, be spiritual." Despite being raised on fish and the spiritual connection Rita feels

with the practice of fishing, she limits her fish consumption to no more than once a month.

After a lifetime of consuming fish regularly (Rita is in her later sixties), she experienced a bout of illness that she attributes to methylmercury. After catching and eating a bucket full of self-caught clams, Rita's legs developed large and painful sores that lasted for nearly three months. Following that sickness, Rita greatly reduced the amount of fish she eats. There have been incidences of acute mercury poisoning reported by a few scholars (Hightower, 2009; Groth, 2009). But the symptoms are unlike those Rita described. Memory loss, hair loss, blurred vision, and tremors are all common symptoms, open sores are not.

Similarly, Rita describes purging the fish and clams she eats in vinegar or beer to "watch the mercury float to the top." I have been able to find no information about the success of purging contaminants from fish. While some toxins (PCBs for example) are stored in the fats of fish and can be removed by removing fatty tissue, methylmercury can be neither detected in nor removed from fish tissue (though potentially from the liver and other organs) (OEHHA, 2009).

In their assessment of fishermen's perceptions of risk at a superfund site in Puerto Rico, Burger and Gochfeld (1991) found that fishermen were relatively unconcerned with the potential threat of mercury in the waters they fished. They assumed the mercury contamination to be isolated to the abandoned town upstream from where they fished, and their only knowledge of the problem came from the conflicting media stories. Burger and Gochfeld's analysis concludes with the finding that the risk presented by the superfund site was in fact relatively low, claiming that the fishermen "arrived at the right

conclusion for the wrong reason" (276). Left out by the authors is the possibility that fishermen's ambivalence to contamination warnings may have been correct; that they were reasonably distrustful or disinterested. Instead, these fishermen are treated as stumbling upon their own safety.

I have battled with my assessment of Rita's situation. She is incredibly aware of mercury contamination, as she is with pesticides in the water and urban runoff, referring to the Sacramento River as a "flushing system; a toilet." Does it matter then that her diagnosis of mercury contamination may be inaccurate, or that her fish-purging process may not be effective? Otway declares that, "ordinary people (i.e., the lay public) are pretty good at acting in accordance with their own beliefs and values to attain their own goals. Or, as Fiorino (1989, 294) put it, 'the lay public are not fools'" (218). Rita has sifted through years of information about mercury and similar contaminants present in the waters she is so intimately linked with. And throughout, she has held on to what seems most useful. And because of it, she is protecting herself against illness. She may be constructing a 'folk narrative' to understand a distant problem (Beehler, 2003), or she may be only holding on to the information she finds more pertinent to her life (Burger and Gochfeld, 1991), but she is making sense of it. And sometimes, I feel that is as much as can be asked.

VII. Discussion: Bringing it Back Together

What do these stories tell us when they are placed together? What do they not tell us? First, these stories do not reveal how a particular ethnicity or a particular cultural

background perceives the risks of mercury and other water contaminants. Other studies of this kind seek a decisive answer to the question of how specific communities understand the risks they face on these waters, and how they choose to respond to or ignore these risks. These studies frequently conclude by arguing that the rift in communication stems from the advisories themselves. And to a certain extent, they are right. But what these studies and the agencies creating advisories seem to miss is the character of the population at hand. Fishermen, I would argue, are in a class all their own—one attached heavily to a sense of self-reliance and wary of authority. In striving to understand how advisories are ineffective, it is essentially to recognize them as threatening the identities fishermen are struggling to protect.

For many I spoke with, the identity is as basic as seeking respite at a fishing location. I heard from fishermen that fishing is relaxing, provides good exercise, is a chance to 'get away from it all.' For some, that removal from work life, home life, or city life was even more apparent. Last Valentine's day I encountered three men at the Grizzly Bay slough near the city of Suisun. One man smoked a joint while we spoke, another admitted calling in sick to work in order to come fishing, and the third avoided phone calls with his girlfriend about their Valentine's plans. These men were clearly here to not be bothered. The fishing pier was considered a safe space—out of sight from bosses, authority, and shaky relationships. Others I encountered were more up front about this independence. Like the woman who fished into soapy waters and told me, "if there were a natural disaster, my family would be alright because we can fish." Or the fisherman who refused an interview with me proclaiming that, "we're fishermen. Can't you tell we're trying not to exist?" While this fisherman was the only person I

encountered who so explicitly stated this quest for invisibility, many others I encountered seemed to share the sentiment in their refusal to talk with me.

Still others expressed blatant distrust. One young Mien fisherman recognized my role as an academic. As I approached him for an interview, he told me, "research. Research is the reason we can't fish for salmon anymore." Whether research created the systems that ultimately decimated the salmon population, or whether research detected the decreased fish populations, 'research' clearly had a role in the closure of the salmon season, which this fisherman viewed with distrust. Others expressed their distrust by questioning whether my intention was to get them to stop eating fish. In some instances the distrust was less directed, and reflected more of a loss of faith in expert advice, like those fishermen who answered the question "when it comes to information about your health, who do you really trust?" with answers like "nobody" or "myself." Person after person I spoke with expressed this sort of disillusionment.

In discussing the case of Cumbrian sheep farmers, Wynne describes the risks presented to farmers as:

> in essence threats to basic social identities—threats brought about by the alien and inadequate models of human nature and human relations tacitly embodied in the objectivist expert discourses. They are threats because they come not as mere assumptions or hypotheses to be tested—and perhaps revised—in practice, but as prescriptions or forms of social control (Wynne, 1996: 53).

From here, it is possible to look at advisory signs themselves as forms of social control, providing little information from distant authorities yet expecting changes in behavior amongst fishermen. But the mounting distrust amongst these fishermen extends beyond just the presence of advisory signs.

One of the places where fishermen can find advisory information is in the Fresh Water Fishing Regulation Guide (popularly, 'The Reg') available at all bait shops in the area. The Reg is 62 pages long this year, with an additional supplement released in May. Several pages are dedicated to the advisory, while the rest are filled with the rules of fishing in the region by which all fishermen are expected to abide. The lists are long, change frequently, and vary for different water bodies. Regulations include what size fish an angler can keep, what sex fish an angler can keep, what size hook and line are allowable, time of day fish can be caught, and season openings and closures (California Department of Fish and Game, 2009). Regulations are designed with conservation efforts in mind and meant to preserve the sporting nature of fishing. And most fishermen I have spoken with seem to respect the rules, and are aware of many of them. But also present is the feeling that every move made by fishermen is regulated and monitored for its legality. Samuel, who I spoke with at Freeport, expressed his concern over being caught by the Department of Fish and Game for breaking a rule he was not even aware of. On top of regulations, some fishermen have complained of their licenses increasing in price as allowable fishing sites become more and more scarce and regulations become tighter. And if a fisherman is not fluent in English, the rules are altogether inaccessible. The Cambodian fishermen I spoke with told me they learn the rules each year when they buy a license and the vendor explains to them the major regulations.

An air of illegality and uncertainty, then, consistently surrounds the act of fishing. In terms of advisories, this uncertainty means they come across as one more rule to follow, one more barrier between an angler and his or her catch. In terms of risk communication and research, this presents a barrier that agencies and academics studying

risk perception have left out altogether. When academics go searching for information, their presence may be immediately seen as a threat, as seeking out those fishermen who are breaking the rules. For risk assessors and agencies, the distance between them and fishermen may be too large to bridge by simply improving signage efforts.

Similarly, advisories fail to provide choices to fishermen because they ultimately leave fishermen in the dark. The anglers I spoke with were generally aware of contaminants in the Delta waters. Their knowledge was rarely based on the advisory signs and official forms of agency-driven communication. In part, this seems a function of ethnicity. The people most in need of the fish they catch (frequently Southeast Asian fishermen) are impacted the most by contaminated waters, and most negatively affected by a push to eat less fish. But in sticking to the question of communication that has been present throughout this study, advisory signs and similar warnings allow for only a narrow swath of understanding to those who have the greatest access to information and an understanding of risk that coincides with formal, scientific mode of understanding. Looked at in that regard, this deficit in communication becomes more than a function of ethnicity—it opens into a hierarchy of acceptable knowledge. Agency-driven advisories provide the bare minimum amount of information to the public, assuming perhaps that the public does not need to know more and that they have complete trust in this official knowledge.

Ultimately, I argue that what the entire problem of mercury contamination is missing is *involvement*. Political Ecology studies generally look at the intersections between environmental problems, public practices, and a government's connection to each of them (Robbins, 2004). But in this case, the linkage between those three factors is

distant and diffuse. Mercury is a legacy problem—one that was generated long ago and is just now beginning to be dealt with. But because of its age, mercury takes a back seat to some of the area's most pressing ecological dilemmas. Scientific understanding of the problem is fraught with holes, but that uncertainty is kept quiet, as is the way in which our modern environmental practices may be the culprit in worsening the mercury problem.

With the process surrounding mercury as invisible as the contaminant itself, the possibility is eliminated for mercury to become a social learning process. The risk of mercury contamination is socially constructed by experts and fishermen alike. But without these two processes working in tandem, barriers will always exist between them. Otway and Wynne (1989) "A social learning process would deepen and expand the definitions of risk, without eliminating conflict, ambiguity, or indeterminacy" (283). As it stands now, the design of the process avoids conflict and hides ambiguity.

As they exist now, advisories serve to educate fishermen away from their fishing practices. They strive to ensure that fishermen on these waters consume less than a prescribed amount of fish. What happens if we shift our thinking to treat fish consumption advisories as satisfying a right-to-know and a right-to-choose.

Californians have long demanded a right-to-know about hazardous materials present in their communities (Superfund Amendments and Reauthorization Act of 1986 Title III). But the information given in advisory signs and similar education efforts provides only a small parcel of knowledge relating to this complex issue. Advisories ignore the social nature of the problem. Mercury contamination is conveyed as a *natural*

threat, one without a source or a history, one that simply is the way it is. The threat sits empty, nothing but a green glow in the distance.

If advisories revealed the causes of mercury contamination, they would better succeed at fulfilling the right-to-know. Its relation to industry, our uncertainty of its dangers, and the potential for the toxin's remediation are important pieces of information that better serve the public. Perhaps if it were better understood that mercury could be remedied, that efforts could be made to protect people from these dangers, the attitudes of fishermen may change. The sense of distance and inevitability that surrounds mercury contamination for many will suddenly be seen in a political and social light.

To change this process requires significantly more than changing the language on advisory signs and including more information in the fishing regulations manual. Shining light on the political process surrounding mercury requires actually opening that process to the public, and actively involving them in its steps forward. That means making the language of political documents easier to understand. That means representing both the known health risks of methylmercury and those scientists are uncertain of. But mostly, it means taking the matter of risk assessment and clean up out of abstract models and into the community.

Jason Corburn (2002) recommends "community-based cumulative exposure assessment," which bases assessment not on risk but on what a community is actually exposed to. So rather than simply assessing the risk of mercury contamination, a cumulative exposure assessment would involve community groups in investigating the many risks and health threats that community members may face, which may be the most threatening, and which have the most potential for remediation. With community

members involved along the way, their own knowledge and experience can help generate a better understanding of which risks communities are willing and able to personally avoid, and which require intervention and remediation.

But it is important to not romanticize such a vision, and to remember the barriers standing between the current situation and steps forward. From this study I have gleaned some of the routes fishermen do seem to follow for information and in search of openings in the barriers. The information the Cambodian fishermen were able to recall most readily came from advisories passed out at church by a local community organization. Anglers frequently cite fellow anglers as some of their most trusted sources of information. And many depend on their local experience to drive their fishing practices. All of these suggest that fishermen are most likely to absorb information given by their inner circles, by those people (and environments) to which they feel closest.

The coalition discussed early on in this thesis can play an integral role. Community organizations, environmental justice groups, and UC Davis academics established the Healthy Fish, Healthy Fishermen Coalition as a means of finding their way into the political process surrounding the case of mercury contamination. The coalition encountered a number of problems that essentially caused its dissolution. One problem was simply a lack of funding to work on such a specific issue. Many of the organizations involved tackle the major problems in their communities that include poverty, immigration issues, and domestic violence, to name a few. Standing alone, the problem of mercury barely fits into the mission statement of some organizations, and they often cannot afford to have an employee tackle the work. Expanding the issue into the greater problem of community hazard exposures would enable these groups to find a

place for mercury on their already full plates. To do so requires both external funding sources and the organization of a coalition to expose mercury as affecting multiple communities and as part and parcel of a greater set of problems.

A second cause for the coalition's collapse was a strained relationship between the academy and community organizations and a struggle over the roles that each play. The case resembled much of what has occurred throughout the political process surrounding mercury. At the forefront was the question of who held ownership over the coalition, and who was present to provide needed support. And often the community organizations felt that the ownership tilted towards academics. The coalition struggled both internally to generate momentum and externally to gain legitimacy amongst agencies. From my own involvement with the coalition, I saw a struggle over just how such a group could become actively involved in the process. But the coalition should play an integral role in the process surrounding mercury. Agencies must recognize the coalition's importance and turn to it to bridge the gap between agencies and fishermen. Internally, the coalition can work to become the vehicle for community organizing, and help push the agenda of community-based exposure assessment (or something similar) and inclusion in mercury's political process. The coalition could take on efforts such as Westphal's (2008) suggestion cited earlier to begin a 'master angler' program. Community organizations are eager to find their way into this process, but the entry way is not obvious. In opening the process, in creating concrete ways for affected people to be involved, we may find fewer holes in our knowledge and more ways to generate trust amongst one another.

VIII. Conclusion

Where does this leave us? In this thesis, I have strived to understand some of the major players involved in this seemingly small case of contamination and environmental conflict, asking how each of those players frame the problem and how we changing the relationships between the players can allow all of them to move forward together. In some regards, I am left again with John Muir's words, "when we try to pick out anything by itself, we find it hitched to everything else in the universe." Mercury contamination is only a small fraction of the environmental degradation present in the Delta. Mercury both contributes to and is worsened by the Delta's demise, and cleaning up the contaminant seems to require nothing short of a re-visioning of our relationship with this fragile water body. The magnitude of mercury's threat is still greatly misunderstood, and may always be. Risk assessors lack specific information about exposed populations. Environmental contaminants may be far too widespread and their effects too synergistic to ever understand in isolation.

While that work moves along slowly, education efforts dominate the quest for mitigation by focusing on risk reduction. But despite the uncertainties that envelop the scientists, engineers, and agencies involved in research, education efforts communicate only a sliver of information, leaving out the context of mercury's presence that may in fact help anglers better understand the problem.

This question of understanding is one challenged by science and technology studies (STS) and academics studying risk perception amongst anglers. This study has reinforced many of the theories generated by STS. When looking at the ways anglers understand the risks of mercury contamination, most apparent is how the social and

cultural contexts that each angler is embedded in affect their understanding of the problem. How this study pushes forward the field of STS is in the complex character of this case. Anglers are aware of contaminants and hold knowledge of their environments that could play a valuable role in the political process around mercury. But because of mercury's invisibility, anglers are still dependent on expert knowledge in order to understand the nature of the problem. Whereas STS studies may conclude that expert-driven knowledge should work to include the knowledge of affected communities, this case instead concludes that expert knowledge must change its tune altogether to make apparent its own uncertainties and knowledge-generating process.

Still, fishermen are an exceptional group—one that often intentionally distances itself from authority and the voices of experts, instead emphasizing self-reliance and independence. It is unproductive to assume that simply opening the doors of information will bring about change.

My critique of previous studies of anglers' risk perceptions largely criticizes the conclusions that education efforts can continue so long as they become more culturally relevant. And I am equally the subject of my critique that an accurate assessment of risk perceptions can never be carried out by outsiders with clipboards. I am in agreement with fellow academics that education efforts around mercury should be improved. But rather than simply edited to increase cultural sensitivity, education efforts should be overhauled to alert anglers to the more complex story. And to see change in the case of mercury contamination requires those closer to fishermen to shorten the distance between each of the parties involved in this complex case. Community coalitions can act as translators of language and information, can better understand the concerns of fishing

communities and work to expand the case outside of the narrow focus of a single contaminant.

Still, this is a story of communication. And a story of day-lighting the part that fishermen can and do play in the case of mercury contamination and the Delta environments. And despite all of the cultural, social and language barriers that separate me from the anglers with whom I spoke, many have opened up to tell me about their knowledge and concerns. It seems to me that, above all, the anglers I spoke with are in search of balance. Many are interested in and willing to discuss toxins in the environment. And most of them make efforts to protect themselves from the dangers they know and understand. But the benefits of fishing are plentiful—from food to sport to community amongst fellow fishermen. And so, the worry over contaminants that seem so distant can only go so far. Fishermen are asked to pay their fee, to abide by a set of regulations and protect the delicate fish populations in the Delta. And in return, they should be granted the continued beneficial use of these waters without fear of the green glow off in the distance.

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Appendix

Guiding Interview Questions

1) *Cultural understandings of fishing in the face of contamination*
Why do you fish?
Do you eat the fish you catch? If so, why?
What kinds of decisions do you make about the food you eat?
Do you see yourself as part of a fishing community?
How does your community (fishing and non-fishing alike) influence your consumption choices?
In what ways do you view fishing as a cultural activity?
Do you know of any health risks associated with eating fish?
Do those affect your consumption choices?

2) *Angler interpretation of and response to advisories*
Are you aware of any fish advisories?
Do the advisories affect your fishing behavior? In what ways?
Do you know who creates the advisories?
Do you believe them?
What do you understand the message of the advisories to be?
How do fishers talk to each other about advisories?
Do these conversations affect your fishing behavior? In what ways?

3) *Angler Community Knowledge*
What kinds of information do you learn from your fellow fishers about fishing practices, fishing locations, etc.? Why do you fish this spot?
Do you choose a location solely because of the fish available there, or do you also factor in accessibility, community, etc.?

4) *Cumulative Impacts*
What other toxics/contaminants are you aware of both in fishing and in the rest of your life?
Do you think about those when you make choices about your food?
Under what circumstances would you change your fish consumption?
Do you eat any fish you catch, or are you selective?
What are your criteria for selecting an edible fish?

5) *Angler relationship to conservation and regulations*
What do you think about fishing regulations?
What do you see as their role in conservation?
Do you think the regulations are just?
What do you think the role of the individual is in fish conservation?