

Proceedings of the 2004 National Forum on Contaminants in Fish

San Diego, California • January 25–28, 2004

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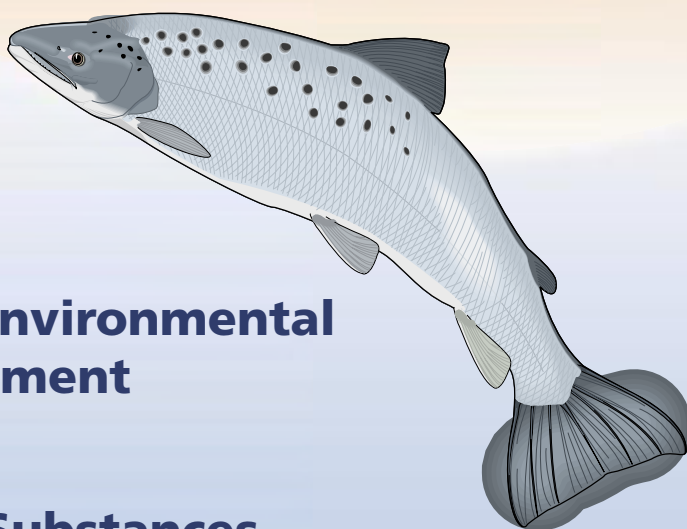
**U.S. Environmental
Protection Agency**



**California Office of Environmental
Health Hazard Assessment**



**Agency for Toxic Substances
and Disease Registry**



Proceedings of the 2004 National Forum on Contaminants in Fish

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Introduction

Representatives of 48 states, 2 U.S. territories, 12 tribes, 7 federal agencies, 3 Canadian provinces, and other interested organizations and individuals attended the 2004 National Forum on Contaminants in Fish. The forum was sponsored by the U.S. Environmental Protection Agency, the California Office of Environmental Health Hazard Assessment, and the Agency for Toxic Substances and Disease Registry and was held January 25–28, 2004, in San Diego, California.

The agenda, developed by a steering committee made up of representatives of state and federal agencies, presented a variety of perspectives and approaches to assessing and communicating public health risks related to fish contamination. Topics included monitoring contaminants in fish, approaches to melding commercial and noncommercial fish advisories, mercury issues (including the national mercury advisory), and risk management issues. The forum also included several regional workgroup meetings for state and tribal representatives to talk candidly about assessment approaches and needs. A poster session reception was also held to further the exchange of ideas.

This document presents the proceedings of the forum. It contains abstracts of presentations, copies of the slides used by presenters, transcriptions of questions and answers raised during the forum, and other information presented at the forum.

Summary of Conference Presentations

At the 2004 National Forum on Contaminants in Fish, 32 speakers presented technical information, perspectives on the national mercury advisory, and their experiences in developing and implementing advisory programs. Brief biographies of the speakers are included in Appendix C, and copies of the slides are presented in Appendix E.

The presentations were grouped into the following sessions over the course of 4 days:

- State and Tribal Regional Work Groups (breakout sessions and reporting back throughout the forum)
- Monitoring Strategies to Support Fish Advisories (held during Sunday workgroup session)
- Approaches to Melding Commercial and Noncommercial Fish Advisories (held during Sunday workgroup session)
- Mercury Issues
- Risk Management Issues
- Monitoring Contaminants in Fish
- Chemical Updates
- State/Tribal Reactions and Needs Assessment

The moderators of the panels, who were also members of the forum steering committee, offered additional comments and perspectives. Forum participants were encouraged to ask questions and provide comments, which were recorded on cassette tape and later transcribed.

I. Focus Group Testing

Pros and Cons of Focus Group Testing

Steve Bradbard, Consumer Studies, Food and Drug Administration

Focus groups have been around since World War II. Over 450,000 focus groups were conducted worldwide this past year. Focus groups are qualitative research tools that are rich in personal and in-depth information. The information derived is not suitable for statistical analysis; however, it does help to better understand underlying attitudes, feelings, and motivations that set the stage for how the participants look at a situation. What would you do to improve it? What do you think? How are we doing at communicating the idea or concept? The most important step is to develop a messaging strategy, similar to the current issues concerning the methylmercury fish advisory.

When working with focus groups, be sure not to overstep the data. A focus group involves a small number of people. It is not a random or national sample; it is not representative. When administering a focus group, you cannot talk about cause and effect because the audience is not random. At the same time, you cannot make broad generalizations. For instance, asking how many people are aware of a certain advisory is the wrong approach.

Focus groups are not an end in themselves. They are important tools for developing a research-based message and are used to refine the way we communicate. Focus groups allow you to test consumers' reactions to your message, concepts, and content. Lots of room exists for unintended meaning and behavior due to those misperceptions. Focus groups are an information evaluation tool but are only one step in the process.

When developing a message strategy, it is important to realize that focus groups account for just a piece of the process. Chemical and biological data, public relations, and media relations are only a few of the other components necessary to produce an effective fish advisory approach. When developing a messaging strategy, you must define the objective, select the target audiences, and develop message concepts to present. Once the concepts are formulated, you can test them in a focus group environment. Upon completion of the first focus group, you can refine your concepts and retest them on subsequent focus groups. After you have completed sufficient rounds of focus group testing, you can identify partners and intermediaries and then select the appropriate venues (e.g., Internet, broadcast) and opportunities for distribution and communication of the advisory.

It is important to remember that focus groups do not test awareness or knowledge. They concentrate on testing reactions, attitudes, motivations, and feelings of the participants in relation to the concepts and ideas being presented.

Focus groups are a great asset for redefining and fine-tuning the message and recommendations to be promoted in a fish advisory. Focus groups are useful for identifying message content that may be subject to multiple interpretations. They can help identify messages that will hurt the credibility of an agency or organization. Focus groups can also identify confusing language and the emotional "hot buttons" that can lead to change.

Most important, do not be fooled into thinking that you know how the "typical" consumer reacts to advisories and other information about fish consumption. On average, you probably know 99+% more than the "typical" consumer about this topic. Don't ever assume that the message is clear and understandable.

Focus groups do not need to be conducted at expensive, state-of-the-art research facilities. A great number of convenient samples exist around you, but remember that the rules for quantitative research do not apply here. Although it is not brain surgery, it is good (but not a necessity) to have a professional moderator.

In summary, the focus group approach has several pros and cons. On the positive side, focus groups are good reality checks; involve a convenient size sample; are in-depth and probing; and tap into the attitudes, feelings, and motivations that underlie behaviors. However, it is important to also remember that they are not representative, cannot generally be used in policy development, and do not measure awareness or knowledge.

Questions and Answers Following Presentation

Q: Randy Manning, Georgia Department of Natural Resources: We have tried to do a little bit of work with focus groups in our state on a shoestring budget. What are some of the biggest mistakes you see people make when they try to put these groups together like we did, basically using our own agency to control them?

A: Steve Bradbard: One of the biggest mistakes I've seen is where you actually go in with something in mind that you want to find, and as a result you tailor your discussion guide and all the discussions. You can lead a discussion in a particular direction to confirm your expectations. You really have to blow the balloon up and explore lots of different kinds of things if you are going to conduct focus groups. That's what they're good for.

Q: Randy Manning: What about the issue of the credibility of the person who is leading or putting on the focus group? In other words, if it is a state health department or a state environmental agency, they may actually have something invested in this message that they are trying to develop. Is credibility an issue, and who puts the focus group together and who runs it?

A: Steve Bradbard: I don't think credibility is an issue. I think it's more the actual moderator guide itself that you put together. It's good to have a couple of different people look over your guide. Maybe even get someone on the other side to look at it and get a read in terms of whether you are directing people toward particular topics. As far as the moderator, you just need to get somebody who is personable, who can keep the conversation going. I don't think that focus group respondents typically question the credibility of the moderator unless there is something that the moderator does that makes them feel like "You are not asking us what we want to tell you. You are telling us what you want us to tell you." Actually, I found that in a recent focus group. Somebody said, "Would you like us to share with you what we think, or do you want us to tell you what we think you would like to hear?" That is a pretty important thing to set out in the ground rules. There are no right or wrong answers, and everything is okay. You set up a permissive atmosphere for the respondents.

Q: Steve Blackwell, ATSDR: Although they aren't random and you can't get representative samples to make generalizations about people in general, you can obviously segment and stratify the focus groups you are trying to obtain some information from.

A: Steve Bradbard: That's a really good point. In fact, you will hear tomorrow afternoon that with methylmercury focus groups we did do segmentation by gender, so we had male groups and female groups. We also did segmentation by educational level. So you can get the right people in the room, and you can actually have some trends that seem pretty strong. You start to say, "Wow! It really seems like a lot of people look at it that way." But when it comes down to making a statement that you could then use in policy, you should never use focus group findings to set policy. You can use them as an ingredient with

other kinds of information for policy. Even if 80 out of 80 people say something, statistically it's still not something you can take to the bank.

II. Monitoring Strategies to Support Fish Advisories

EPA National Contaminant Study Design and Uses of Data

Leanne Stahl, U.S. Environmental Protection Agency, Office of Science and Technology

Fish study activities have been conducted through four phases starting in 1998. The team is working on completing Phase 3, sample collection and analysis. The final report is scheduled to be delivered toward the end of 2006.

Several accomplishments have been achieved during completion of phase activities outlined for the study. During the planning phase, the study design was developed, the statistical selection of lakes was performed, and the target list of chemicals was selected. During the mobilization phase, 10 orientation and training workshops were held, the QA and Field Sampling Plans were produced, and the 900 lakes were mapped for reconnaissance. Work completed during the fish sampling and analysis phase has included collection of fish from 500 lakes, chemical analysis of 749 fish samples, and development of the annual analytical QA report. The public outreach phase has included development of the fish study Web site (www.epa.gov/waterscience/fishstudy) and production of data CDs for release of the qualified information to the public.

Preliminary data has been summarized for predator composites from the first 3 years of the study. Mercury and PCBs were detected at some levels at all sites sampled during the first 3 years. Dioxins and furans were detected at 80% of these sites. Concentrations exceed human health risk standards for mercury at 40% of sites, for PCBs at 17% of sites, and for dioxins/furans at 11% of sites.

USEPA will begin analyzing fish study data once the full 4-year analytical dataset is available. Data analysis will consist of estimates of national means and percentiles and the cumulative frequency distribution plots for chemicals and composite types with sufficient data. Estimated cumulative frequency distributions for specific chemical types and specific fish types will be prepared to assist in the development of a national scope. In addition, national maps of chemicals by composite type for mercury, PCBs, and dioxins/furans will be produced. In addition, estimates of sampling variability based on replicate sampling data will be analyzed along with other sampling factors, including the number of fish in the composite, the size effects, and the species effects.

Future milestones over the short term (2004) include preparation of a Year 2 data CD for public release, analysis of Year 4 (2003) fish samples (~200 composites), production of a Year 4 analytical data QA report, distribution of Year 4 data to states and other partners, and an update to the fish study Web site. Longer-term milestones (2005–2006) include preparation of a Year 3 data CD for public release (2005), completion of the statistical analysis of the Year 4 fish tissue dataset (2005), submission of the draft final report of peer review (2005), production of the final fish study report (2006), and uploading of all data into USEPA's STORET system (2006).

Questions and Answers Following Presentation

Q: Tom Hornshaw, Illinois EPA: What are you going to do with the PBDE data since you are going to have only 1 year's worth of it? Why wasn't it included right from the beginning?

A: Leanne Stahl: We didn't have the resources to include it in the beginning. Our current division director, Denise Keehner, has identified resources that will allow us to do 1 year of analysis. We will be analyzing a statistical subset of the data, so we will be able to draw some conclusions with that one statistical subset. We won't be able to draw them with the same level of confidence as if we had 4 years. But the statisticians were very emphatic that if we did this, we had to use a statistical annual subset. So we've chosen the year 4 samples to do that on.

Q: Bill Kramer, USEPA: Would you like to say something about the frozen tissue samples that you retained for use?

A: Leanne Stahl: When we've had sufficient tissue available, we've been trying to archive at least 500 grams of tissue. We haven't had sufficient tissue to archive that amount of tissue in all cases. Having the archived tissue will allow us to do a full statistical subset of the PBDE analysis because not all of our year 4 samples were collected during the fourth year; some were collected in the earlier years. So, we will be using some of that archived tissue to complete the PBDE analysis.

Q: Bob Brodberg, California EPA: Outside of the report that comes out of this, do you know if EPA is planning to use the data generated in this in any of its other assessments, such as for dioxins or other chemicals?

A: Leanne Stahl: We've already had some of our programs request data, and they have received what data we have available to include in these assessments. Dioxins is one of the programs that has requested the data.

Q: Henry Anderson, Wisconsin Department of Health and Family Services: What kind of information did you gather specific to the lakes or the waterbodies that you sampled?

A: Leanne Stahl: The lakes were selected from a GIS [geographic information system] layer. They were selected based on a complex statistical design. We weren't trying to target any specific characteristics in selecting the lakes for the study.

Q: Henry Anderson: I understand the sampling frame, but what I'm suggesting is when people gathered the samples, did you get any characteristics of those?

A: Leanne Stahl: We have just the length and weight of the fish. We did get some pH measurements, but we did not get water chemistry or other characteristics that you could associate with the fish samples.

Q: Henry Anderson: Any water quality issues or sources nearby?

A: Leanne Stahl: We now have our final set of 500 lakes, and we are in the process of developing a data layer so we can overlay that with existing Agency data layers and try to determine where there are overlaps.

Q: John Cox, Confederated Tribes Umatilla Indian Reservation: I didn't see the mention of any radionuclides as chemicals being monitored. Did I miss it?

A: Leanne Stahl: No, we are not doing radionuclides. I guess when they were planning, the original target list of chemicals proposed included over 400 chemicals. It was strictly a resource issue in paring down to the current 268.

Q: Randy Manning, Georgia Department of Natural Resources: In looking at your graph that showed which chemicals were over EPA screening values with mercury and dioxin and PCBs, are screening values available for all of the chemicals—the 268 that you are monitoring in this study? And if they are not, do you know if anyone in EPA is working on trying to put something together for the data evaluation?

A: Leanne Stahl: Currently, we have been limiting ourselves to just the 25 screening values published in the fish advisory guidance. Right now, Jeff Bigler has some work under way to develop screening values for PBDEs, but that's the only active exercise I'm aware of that people are involved in to develop new screening values.

Model Application for Developing Fish Consumption Advisories

Stephen Wentz, U.S. Geological Survey

Methylmercury is a toxic chemical that has been shown to affect the health of humans and wildlife. Methylation of inorganic mercury and subsequent biomagnification of methylmercury through aquatic food webs is generally accepted as the primary pathway by which both humans and wildlife are adversely affected by mercury. Many federal, state, tribal, and local agencies monitor wild fish tissue mercury (fish-Hg) concentrations for the specific purposes of identifying spatial and temporal trends and preparing fish consumption advisories. However, fish-Hg concentrations vary with the samples' characteristics, such as kind of tissues sampled ("cut"), species, and fish size. Therefore, directly comparing samples with dissimilar sample characteristics for trend analysis or estimating unsampled fish-Hg concentrations for fish consumption advisories can be problematic. This problem greatly hampers the interpretation of fish-Hg datasets because obtaining wild fish samples with specific or consistent characteristics can be expensive or impossible. Several researchers have used regression methods to predict the mercury concentration of a standardized sample from samples of the same cut and species but of different lengths. These methods extend the range of samples that can be validly compared with samples of the same species and cut but different sized fish.

This study, by the U.S. Geological Survey (USGS) in cooperation the National Institute of Environmental Health, assesses a different approach based on statistical modeling (the covariance model) that encompasses not only fish of differing sizes, but also fish samples of different species and cuts. This covariance model was calibrated using a national dataset of fish-Hg analyses that contained 35,130 samples. Comparison of the covariance model with the current method (the size-class model) shows the covariance model produces more accurate fish-Hg predictions than the size-class model for the fish-Hg data currently being collected. The covariance model is useful for (1) standardizing fish-Hg concentrations to a common sample type for spatial and temporal analyses, and (2) estimating fish-Hg concentrations of un-sampled species, thereby enabling the development of more comprehensive fish consumption advisories. In addition, use of the covariance model will allow monitoring agencies to greatly reduce the number of analyses required to achieve the same prediction accuracy of fish-Hg concentration. This could substantially reduce the cost of a fish-Hg monitoring program. A Web site is being developed by the USGS to facilitate the dissemination of raw fish-Hg data and covariance model predictions, as well as mercury concentrations from other media (soil, sediment, and coal), on a national scale.

Questions and Answers Following Presentation

Q: Joe Sekerke, Florida Department of Health: Could you repeat what data were used to develop the model and then what data were used to test it?

A: Stephen Wente: The entire dataset was used to develop the model. Currently, about 7,500 observations have been randomly deleted one at a time from the dataset, and we are just doing a jackknife validation procedure to check the prediction accuracy. In other words, we are measuring how accurate a prediction would be for different kinds of observations, whether there were other observations from the same size class. If there weren't other observations from that same size class, how good is your prediction? If there were observations from the same size class, how good is your prediction? Does that help out? That's the way we are doing it. It's not that we've broken the dataset into two different datasets, and part of the reason for that is we are trying to compare against different models. If you took a size-class model, typically you would have two observations of data for each size class; and if you split that in half, you would have only one observation. So, it makes sense to do it the way that we're doing it. It is kind of complex, though, because you have to realize we are testing against these different models.

Q: Joe Sekerke: You use length. Have you done anything to look at age instead of length? We are using length as a surrogate for age, and age is really the important factor.

Stephen Wente: We made fish consumption advisories, so we used length with the intent of having something that the people would actually be able to relate to. I have used weight before, but I have never used age. We usually just don't have that many samples with age data available for them. If we did, that would be great to use. If you have a dataset like that, we would be happy to take it.

A: Bob Brodberg, California EPA: I have several questions that go to the complexity of the model. To input some data into the model, how much data does one need? Is your model a mixture of individual and composite samples, and therefore are you recommending putting in composite samples, individual samples—what is the n to put in to get something that fits your beta testing reliability for something coming out?

A: Stephen Wente: We would like it if people would actually identify how many fish are in there. We treat everything as a composite sample; an individual fish is a composite of one. But we would love to have it so it could be weighted so that we could trust something that has five fish in it more than something with just one fish in it. In other words, it would tend to come out closer to your predicted value. We would like to look at that. But when you look through the dataset, when you're trying to do something with a large dataset, you just have to take what's there, and a lot of the data in those datasets aren't identified as to how many fish are in the composite. A lot of them indicate that it's three to five fish; they don't give you an actual number, and sometimes they don't give you any number.

Q: Bob Brodberg: From some of the modeling I've seen done on some California data, it seems to work best if you have individual fish so that you really get your best measurement of variability based on the individual fish data. One other thing about the model: Can you comment on interpolation versus extrapolation from the data? I'm not sure what the size classes are in the mercury that you have for the curves that you show—if the curve is showing only the portion of the data for which you actually have something in the model or if it's actually going beyond, starting below and ending above. Tremblay, in some of his work and talking to us in California, said interpolation is okay within the data, but extrapolation outside the data gets you in trouble.

A: Stephen Wente: The ranges of fish length that we display there are actually the largest fish in the database for that species and the smallest fish for that species. So we don't go beyond it on the individual fish. But of course most of those lines were never collected at most of the sites, so in a way we are going well beyond the data all the time when we look at any particular site. Normally you wouldn't display 11 species like we did up here. You would usually pick out ones that you are actually concerned about at that particular site, and typically those would be the ones that you would collect the data for and then typically

those are the ones you would want to predict. It would be much more like a table as far as filling out the size classes.

Q: Steve Ellis, Tetra Tech: I have just a couple points of clarification. In your example you showed picking three species and then, if I understand right, the model [inaudible] best fit to those three species. Do you think your predictions would improve for a given location the more species you have?

A: Stephen Wente: Yes.

Q: Steve Ellis: The other thing that happens a lot is we are sampling and may be looking at human health when we want to look at fillets, but we know people eat other parts of the fish and we may want to extrapolate. Does the model predict concentrations in other tissue types based on, for example, fillets to whole bodies or fillets to organs?

A: Stephen Wente: Right now we have, I think, six tissue types allowed in the model—skin off, skin on, whole, and then viscera, eggs, and carcasses. There is a lot of liver data, and we'll probably be putting that in. The problem that you run into is that a lot of times people did not collect skin-off fillet, skin-on fillet, and whole fish at the same site. We do have some of that data in there. That helps out a great deal as far as getting those set up. But individual monitoring programs a lot of times will just stick to one type of sample. When they go out to a site, they always get livers, and you don't have any way of relating that back if there was never a skin-off fillet or a skin-on fillet or something else collected at that particular site. It's a question of being really careful with the model in stating what it does predict accurately and what it doesn't predict accurately.

Q: Randy Manning, Georgia Department of Natural Resources: Have you looked at the model and the curves or lines that were generated to see if there are differences if you just select different areas or regions of the country for the data that is being put into it? My thought is, particularly with mercury, you might be getting actually age class issues as much as size, but there might be differences, for example, in the lines generated for fish collected in the Southeast versus the Northeast.

A: Stephen Wente: I've broken down by states before, and all that I looked at was the idea of what's your prediction accuracy. I never looked at whether the lines would be subtly different between the different regions. I tend to believe that they are not that different, and I tend to think of this model as just giving you a general representation of these lines, but that would be something interesting to look at.

Roundtable Discussion on How Federal Agencies Can Assist State/Tribe Monitoring Programs

Q: Luanne Williams, North Carolina Department of Health and Human Services: I have a question about PCB risk assessments. There are dioxin-like PCBs listed in the guidance document for assessing the risk from exposure to PCBs in fish, but then how do you handle the nondioxin-like PCBs when you do a congener analysis? Most of the states I would say do Aroclor. A few of us are venturing out and tiptoeing into the area of doing congener analysis, and we want to do the congener analysis, but how do we assess the risk from exposure to the PCB congeners? I would like to have some assistance from either EPA or the states in assessing the risk from exposure to PCB congeners. Is that the way to go? Leanne Stahl, I have been told, looked at Aroclor analysis for a given fish and congener analysis for a given fish. Do they correlate? Are they similar? If they are similar, then maybe we should just do Aroclor analysis. I don't know. I just recently posted a huge reservoir for PCBs, our very first, and we've got a huge lake next to it. So I'm hoping that it's low, too. I had to wait 2 months longer to get my PCB congener analysis, and I couldn't wait any longer. I had to go ahead and issue an advisory based on my Aroclor analysis. That's the big question. We need some assistance. We need it all laid out. Tell us what we need to do to assess the risk.

A: Leanne Stahl, USEPA: I cannot answer the risk assessment question, but I can tell you that we were collecting both Aroclor data and PCB congener data for the fish study so we do have a national dataset that includes both if somebody had resources to investigate that issue further.

Q: Luanne Williams: Do they correlate?

A: Leanne Stahl: We haven't taken a look at that. That would require additional resources and commitment of additional resources, and no one has stepped forward to make that commitment yet.

C: Rick Greene, Delaware Department of Natural Resources and Environmental Control: Delaware has fairly extensive experience in the use of congener analysis in its fish tissue program. We have the benefit of having a fairly small state, so we can maybe do better work on fewer samples. We started off in the early 1990s with a short list of congeners, about 40 or so at that time, because there weren't analytical standards for the full suite of congeners that exist in the Aroclors. Every time we bootstrapped ourselves forward to the point now where we're looking at 160 congeners. Let me answer your first question, "How do you deal with the dioxin-like congeners versus those that are non-dioxin-like?" A gentleman from EPA headquarters prepared a document a few years ago that was a reassessment of those responses for PCBs. In the back of that document, there are some examples of what you do if you have good congener data, including congener data for the dioxin-like compounds. In a nutshell what you do is you first subtract the analytical concentration of your dioxin-like PCBs from your total and set that aside. The balance, we'll call that non-AH active PCBs, you can sum and then use your slope factor for regular PCBs (slope factor of 2, which is based on Aroclor-1260). For the dioxin-like compounds, the dioxin-like PCBs, what you would do is multiply each of those individual congeners by their respective TEF. You then get the TEQs from the PCBs. You also compute dioxins and furans. You sum those, and then you use the slope factor for 2,3,7,8-TCDD for that. I think that is the answer to how you mechanically do the calculation when you have good PCB congener data. The question is, are Aroclors the same thing as PCBs you see in fish tissue samples? I think the answer is unequivocally no. There's been quite a bit of work that shows that the congener pattern in fish is distorted relative to any standard Aroclor that you might choose to use as a standard. The question often becomes, what is the skill of your analyst to say that the pattern they are looking at looks like 1250 or 1260. So, Aroclors are not what is in fish unless you just happen to have a spill from a transformer and it's pretty fresh material from a recent event. But, by and large, Aroclors are not a good surrogate for what you have in fish.

C: Commented that she did have the assessment with her. She noted that on page 63 of the document, where there's been an analysis on the two different approaches, there are a couple of sentences: "This example, although perhaps extreme, shows how it is possible for a total PCB approach to underestimate the toxicity of a mixture when concentrations of a few dioxin-like or highly toxic congeners are enhanced through environmental and metabolic processes." So it actually shows you how the results should differ if you use a total PCB approach versus a congener-specific approach.

C: Rita Schoeny, USEPA Headquarters: If you can stick around until Wednesday, I am going to give a short presentation on the dioxin reassessment, which of course deals with the coplanar dioxin-like PCBs. It appears that you can perhaps get away with about four dioxin and dibenzofurans and one coplanar PCB and account for about 80% of the toxicity in "environmental samples." (That's your foodstuff.) And I can't tell you which one without looking at my notes.

C: Lon Kissinger, USEPA Region 10: I think this is a pretty controversial issue—how we look at the risk from Aroclors, how we look at the risks from the dioxin-like congeners, how they are summed, how they are treated in a risk management situation. I know EPA's new guidance for PCBs in soil is recommending that you might subtract the concentration of the dioxin-like congeners that you find in an Aroclor mixture.

For the Housatonic, that's been an approach that's been considered for fish tissue. Obviously, there are concerns about congener composition changing once you look at fish. It is kind of interesting, though. For example, for New Bedford Harbor, there is an article by Lake et al., and the congener patterns in sediment and lower trophic level fish were quite similar. That was surprising to me. So, I do think there really does need to be a bit more of an effort put into this. The actual risk assessment approach is not clear. And, of course, when you look at bioaccumulated congeners, they do tend to be more toxic than what you would find in Aroclors. It's not an easy situation to resolve.

C: John Cox, Confederated Tribe of the Umatilla Indian Reservation: I believe your question was how the federal agencies, states, and tribes could help. I guess my response would be by listening well. I'm just concerned about generalizations and average overall. I would like to be considered in a mix like that. I don't speak for all tribes, but I'll speak, as a member, for one. I don't like to be considered that way either. Coming down to a more final, fine tuning here regarding monitoring, which in my mind is sort of a technical word that means measurement of something, doing some analysis, sampling analysis, etc., I was under the impression that if you don't measure, you don't know. I see all these generalizations, and it sounds like we're doing a lot of tests across the nation. It's a very large nation with very diverse groups of people, very diverse landscapes, and very diverse ponds, streams, and so on from which people are extracting fish—an essential natural resource, food that is for their use. So I'm concerned that monitoring isn't doing enough in breadth and depth on the subject. If you measure over there, that's a result for over there. Many of us can identify with this through weather. You can go over the hill over there, and the weather is oftentimes different from that on this side of the hill. I know the weather is a lot different down on the Umatilla Indian Reservation versus 2 or 3 miles up on top of the mountains daily and in the summer and so forth. So that's one of my concerns about monitoring measurements.

Q: This is just a follow-up question to Rita Schoeny's comment that 80% of the toxicity is accounted for by those three groups of compounds. Are you referring to the cancer risk only or other types of toxicity as well, given all the emergent concerns about developmental disabilities in relation to PCBs?

A: Rita Schoeny: About the only good news about dioxin is that since there appears to be at least a common critical step in all the modes of action for the various toxic events, we can talk about cancer and noncancer effects in pretty much the same voice. In fact, as you pointed out, some of the concerns about developmental reproductive effects are quite serious. They are very likely to occur at the same sorts of levels of exposure as the cancer effects. So, again, this generalization that I made should be true for both.

C: I'm not aware that anybody has done dioxin-like compound congeners. If that's the case, if you take the dioxin-like congeners out, there may be no cancer slope factor for the remaining PCBs.

C: David Carpenter, SUNY, Department of Environmental Health and Toxicology: That's not the case. Nondioxin-like PCBs are also carcinogenic. They act through a totally different mechanism. I really don't agree with the comment Rita made in terms of a common mechanism of action. We have evidence for neurobehavioral effects of dioxin itself that it is not mediated through the AH receptor. I think that this is something that is a generality—that each of the congeners, including the dioxin-like congeners, has a unique profile of toxicity that operates through different mechanisms of action. To go back to the original question of Aroclor reporting, I think it's grossly inaccurate. First of all, it is an underestimate of the total PCB concentration because, as has been noted, the patterns change in fish, in humans, and in the environment as a result of dechlorination patterns. So, you're never getting the whole mixture. But I think it's a mistake to assume that all cancer is coming from dioxin-like congeners and that all the noncancer effects are not mediated by the dioxin-like congeners.

C: I don't know if there is any data out there. I haven't seen any, but unless you have tested the congeners without the dioxin-like, you don't know what their cancer activity is.

C: Rita Schoeny: I didn't mean to give the impression that the nondioxin-like PCB congeners are operating through this mode of action. We know there are neurotoxic effects of some of those PCB congeners that are not coplanar, are not mediated through an age receptor. My remarks were specifically and only referring to the coplanar PCBs for their dioxin-like activity.

III. Approaches to Melding Commercial and Noncommercial Fish Advisories

Minnesota Fish Consumption Advisory

Pat McCann, Minnesota Department of Health

Ms. McCann's discussion included a brief history of the commercial and local fish consumption advisory for the State of Minnesota, the basis for much of the advice, and the various revisions to the advisory that have been made over the past decade.

The State of Minnesota has been working to merge commercial and local fish consumption information since 1994. The Department of Health (DOH) felt that women of childbearing age needed to take into consideration all sources of mercury exposure in the fish types that they may eat. In support of these efforts, the DOH developed a brochure entitled "An Expectant Mother's Guide to Eating Minnesota Fish." Since the time of its publication, the brochure has been used by several states as a model for dissemination of fish advisory information. Advice on commercial fish has been based on mercury in fish consumed by pregnant women. The majority of the brochures and related information have been distributed mainly through health care providers directly to women.

In the past, the Minnesota brochure offered very conservative advice on local fish consumption. For example, the brochure stated that only 7 oz of local bluegill and sunfish should be eaten every month, depending on the local advisory. More recently, the advice from Minnesota is to limit consumption of these local fish types to no more than once a week.

For canned tuna, the brochure states that no more than 7 oz should be consumed per week. The brochure also states not to eat shark or swordfish at all and includes a general statement about other commercial fish, recommending that consumption of those varieties be limited to once a week.

In 2000, the Minnesota DOH revised the brochure based on input from test groups and updates in the form of new state and federal guidelines. Also with this revision, the format changed, the shape changed for ease of mailing, and more bullets were added to reduce the volume of text. Statewide fish consumption advice was included in the first bullets, followed by information on commercially caught fish. The 2000 brochure stated that it is very important to look at all fish types when choosing a fish to eat. The 2000 brochure also included a statement on the benefits of eating fish, including the nutritional aspect, benefit to the fetus and expectant mother, and the cardiovascular effects.

In 2001, the FDA released new information on mercury levels in fish. Again, the brochure was revised to be consistent with the new advice and to provide information on commercial fish similar to the information provided on local fisheries stocks. Again, the brochure recommended considering all fish types when making choices.

The Minnesota DOH worked closely with the State of Wisconsin to promote dissemination of the same advice for both fish types (commercial and local fish). Both states have been working hard to provide consistent information and advice.

In 2004, the Minnesota DOH is considering another revision to the brochure. The most recent draft revision includes concerns about consistency with other agencies (federal, state, American Heart Association, and others). Also, the new brochure will include the new FDA and USEPA advice when it is released. In Minnesota, the updated fish advisory is issued in the spring to coincide with the walleye season.

Other issues surrounding the 2004 revision include the classification of light versus albacore canned tuna; currently, they are included in the same category. In Minnesota, albacore tuna cannot be bought with Women, Infants, and Children (WIC) coupons, so the advice for both was combined to avoid confusing people. However, this may be inconsistent with the approach taken by other states and should be taken into consideration during any revisions to the brochure.

Other issues include consideration of other contaminants in commercial fish besides mercury. The Minnesota DOH does not give quantitative advice on dioxins, for example. Other concerns include information on farm-raised fish consumption, interpretation of the benefits of fish consumption, and inclusion of the new FDA mercury data.

After the newer FDA data is analyzed and associated with the established USEPA reference dose, consumption in Minnesota breaks down into three categories: unlimited, one meal per week, and one meal per month. The categories per fish and shellfish type break down as follows:

- Unlimited: Salmon, tilapia, flounder, oysters, clams, shrimp, scallops, sardines
- One Meal/Week: “light” canned tuna, cod, pollock, haddock, mahimahi, herring, catfish, crab
- One Meal/Month: “albacore” canned tuna, fresh tuna, halibut, orange roughy, lobster, grouper, red snapper

As outlined in the Great Lakes Protocol, states and agencies need to work on trying to be more consistent with data and information dissemination. From the perspective of risk assessment, agencies and states should consider addressing consistency issues concerning the reference dose used, contaminants examined (e.g., mercury, dioxin), and the statistical and data manipulation approach to use (e.g., mean, 95th percentile). In addition, there is a great deal of confusion concerning what constitutes a meal size. For example, USEPA guidelines state that 8 oz of fish equal one meal; however, FDA states that 12 oz should equal between two and three meals, while the American Heart Association (AHA) says that 12 oz equal three to four servings. Another concern includes interpretation of the appropriate use of significant figures representing exposure data.

Consistency in communication is another chief concern in properly updating fish advisory brochures. Highlights of communication issues are coordination between the various state, federal, and tribal agencies; determining how to present the canned tuna issue; and agreements on farm-raised fish. The age of children considered in the analysis must also be communicated; Minnesota recently switched from a child age of 6 to 15 to match the age used by the State of Wisconsin.

The Great Lakes Protocol of 1993 included a statement on the benefits of consuming fish. The statement read as follows:

“Fish are nutritious and good to eat. But some fish may take in contaminants from the water they live in and the food they eat. Some of these contaminants build up in the fish— and you—over time. These contaminants could harm the people who eat them so it is important to keep your exposure to these contaminants as low as possible. This advisory helps you plan what fish to keep as well as how often and how much

sport fish to eat. This advisory is not intended to discourage you from eating fish, but should be used as a guide to eating fish low in contaminants.”

Health Benefits

“When properly prepared, fish provide a diet high in protein and low in saturated fats. Many doctors suggest that eating a half-pound of fish each week is helpful in preventing heart disease. Almost any kind of fish may have real health benefits when it replaces a high-fat source of protein in the diet. You can get the health benefits of fish and reduce unwanted contaminants by following this advisory.”

In the new revised fish advisories, the health benefits of consuming fish should be tailored to provide advice specific to various types of consumers. A chart relating age, sex, and type of fish could be used to help individuals look up information specific to them.

The AHA has released information stating that the benefits and risks of eating fish vary depending on a person’s stage of life. Children, pregnant women, and nursing women usually have a low risk of cardiovascular disease, but may be at a higher risk of exposure to excessive mercury from fish. Therefore, avoiding potentially contaminated fish is a higher priority for these groups. For middle-aged and older men and for post-menopausal women, the benefits of eating fish far outweigh the risks within the established guidelines of the FDA and the USEPA.

The AHA recommends eating fish at least twice a week. However, some types of fish may contain high levels of mercury, PCBs, dioxins, and other environmental contaminants. Levels of these substances are generally highest in older, larger, predatory fish and marine mammals.

Fish and shellfish that provide enough omega-3 in two 8-oz servings per week include sardines, herring, salmon, albacore canned tuna, fresh tuna, rainbow trout, flounder, halibut, pollock, and oysters. Of these, salmon, flounder, oysters, and sardines are approved for consumption twice a week.

In conclusion, the 2004 revision to the fish advisory will provide meal advice based on mercury, as in the past; however, information on “light” and albacore tuna will be separated. Species that are low in mercury and high in omega-3s will be flagged (this needs to be done for the local fish species as well). The advisory should provide reasons to eat fish and address the variety of health benefits. The brochure should present simple methods and approaches; more information can then be provided on a Web site for those looking for further detail.

Maine Fish Consumption Advisory

Eric Frohberg, Toxicologist, Maine Bureau of Health

The discussion focused on how the State of Maine has been considering adding more information on commercial fish consumption to its existing consumption advisory and what overall revisions to prepare for the advisory in general. Maine’s current fish advisory brochure already includes some information on commercial fish consumption that is current with the advice given by the FDA. For these advisories, it is important to remain consistent with FDA’s advice, especially when relaying this information to the general public.

The current brochure focuses on recreational fish. Since most mercury exposure comes from commercially caught fish, the brochure will be updated to support a more global perspective. The current brochure tested well in rural parts of the state; however, it did not test well in urban parts of the state with

urban young mothers. The new brochure will be designed with a broader perspective and will be distributed to all OB-GYNs and through Women, Infants, and Children (WIC) services to address the issue of fish consumption and women of childbearing years.

Much of this change of thinking came about after close examination of contaminant issues relating to canned tuna. In 2000, the State of Maine used the nationwide Yess study (1993), which involved 220 samples and 12-can composite samples. Mercury in white tuna and albacore was significantly higher (three times) than in lighter. However, omega-3 fatty acid content was inversely correlated, white albacore having three times as much fatty acid content as light tuna.

The State of Maine used an integrative approach to fine-tune its brochure. This process included evaluation of mercury concentrations in other fish species, incorporation of the data on omega-3 fatty acids, comparison of other contaminants and how they related to other potential protein sources, focusing on composition rate data (fish that people actually eat), and cost considerations for replacement of protein sources.

The State of Maine then prepared a poster showing which commercial and locally caught fish to consume. The poster included information on (1) seafood that is best for you and your baby's health, (2) more great fish low in mercury, and (3) fish not to eat. Category 1 included canned and fresh salmon, Atlantic mackerel, shrimp, mussels, sardines, and smelt. Category 2 included flatfish, clams, light canned tuna, and scallops. Category 3 included swordfish, shark, smallmouth bass, and pickerel (local Maine stock). The first category included fish low in mercury and high in omega-3s. Low mercury levels were considered concentrations below 0.1 and a high omega-3 level was any concentration above 0.5.

The State of Maine is waiting to see what the FDA will decide, to ensure that the state's advice is similar. A new draft of the brochure is scheduled for release this spring. Several series of focus groups and revisions will be conducted until the brochure is fine-tuned; distribution of the final version is expected to occur at the end of summer.

In addition to mercury concerns, other contaminants, including dioxins and polychlorinated biphenyls (PCBs), are issues that affect fish in Maine waters. Data on PCB and dioxin contamination in salmon shows elevated levels in comparison with other protein sources. However, more information must be considered when deciding how to replace protein sources to deter contaminant intake while promoting the proven health benefits of fish consumption.

The State of Maine's decision to include salmon in its advisories was influenced by a press release from the NAP regarding the presence of dioxins and dioxin-like compounds in the food supply. The statement read: "Because of the health benefits associated with omega-3 fatty acids in fish, the committee did not recommend that people reduce their consumption of fatty fish below the currently recommended two servings per week."

North Carolina's New Advice on Eating Fish

Luanne Williams, North Carolina Department of Health and Human Services

Benefits and Risks of Eating Fish

Consumption of fish can be beneficial for both pregnant and breast-feeding women, and their developing children. The developing retina and nervous system of an unborn child may benefit from maternal consumption of fish during pregnancy.^{1,2} In addition, fish consumption has been associated with a decreased risk of heart attack and coronary artery disease in adults.²

However, methylmercury, an environmental pollutant, can accumulate to harmful concentrations in predatory fish.³ The developing human nervous system is particularly sensitive to methylmercury. Several studies have reported increasing effects on the developing nervous system of an unborn child with increasing maternal methylmercury exposure from routine fish and whale consumption.⁴ Neurological processes in the areas of language, attention, and memory were most affected. Studies conducted in New Zealand and the Faroe Islands concluded that the deficits observed can be considered predictive of problems in cognitive and academic performance associated with methylmercury exposure, or can affect the way the children may think, learn, and solve problems.⁴ These studies have shown the developing fetus to be at least three times more sensitive than adults.

Issuance of New State Advice

State and national fish tissue monitoring data have revealed high methylmercury concentrations (average level or median level > 0.5 parts per million) in predatory ocean fish and in certain North Carolina freshwater fish. The high-methylmercury ocean fish are shark, swordfish, king mackerel, and tilefish; the high-methylmercury freshwater fish are blackfish (bowfin), jack fish (chain pickerel), and largemouth bass caught in the eastern half of the state.⁵ Using a model generated by C.D. Carrington and M.P. Bolger with the Food and Drug Administration (FDA),⁶ 99% of women of childbearing age and children who avoid eating high-methylmercury fish and eat two 6-ounce meals a week of medium- to low-methylmercury fish are estimated to be below the USEPA recommended reference dose of 0.1 µg/kg-day. With this scenario, 1% of women of childbearing age and children are estimated to be at a methylmercury dose above the USEPA recommended reference dose with the maximum blood level estimated to be 14 µg/L. The risk for this small group of sensitive individuals would be less than 5% incremental risk above background of having abnormal neuropsychological test scores for the developing child (58 µg/L corresponds to a 5% incremental risk above background).⁷ Because of the health risks of consuming fish with high methylmercury levels and benefits of eating fish with medium to low levels, the North Carolina Department of Health and Human Services is recommending that women of childbearing age and children avoid eating the high-methylmercury fish and consume two meals a week of fish with medium to low levels, which is consistent with the recommendations of the FDA and USEPA.

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Florida Fish Consumption Advisory

George Henderson, Florida Department of Environmental Protection

This presentation briefly reviews the origins of Florida's two-tiered advisory. It presents information on freshwater and marine fish and mercury levels. The fish consumption advisory was completely revised in 2003 to clarify the message and better serve the public. The advisory is currently under review to further enhance its message.

Questions and Answers Following Presentations

Q: Patti Howard, Columbia River Inter-Tribal Fish Commission: As health professionals whose goal it is to reduce exposure to chemical contaminants through these fish advisories, do you feel you have a responsibility or can you play a role in the need to address source control and cleanup of the chemical contaminants in these fish advisories that you are currently issuing?

A: Luanne Williams: Indirectly, yes. In North Carolina when we issue advisories, that of course assists the North Carolina Department of Environment and Natural Resources in TMDLs for all the different sources, mercury sources, for a given waterbody. So for two-thirds of our state that is under an advisory that would give the water quality section in our state leverage to ensure that the mercury sources, air and water sources, in the area would collectively meet a given acceptable state standard. That standard, in our state, is way too high. We are in the process of lowering it. One of my jobs when I get back is to be on a working group and get that lowered. That is one thing that does assist in lowering the amount of mercury that is released into the air and water. Second, the publicity that these advisories generate in our state does prompt questions from the legislatures. We've done several television interviews and radio interviews, and we have a new bill in our state called the Clean Smokestacks Bill. We are putting pressure on our neighboring states to join us in requiring our major sources of mercury, such as our coal-fired power plants, to reduce NO_x, SO_x, and mercury at the same time by putting on scrubbers. It's like a snowball effect; it does make a difference indirectly. It may not be directly, but eventually it does make a difference. I would like to think so.

A: Eric Frohberg: Also, one of the things I really like about this new salmon study is it is large enough so that we now can really say, with some level of confidence, where these feed contamination issues are coming from. I think things can be done to improve the level of these lipophilic contaminants in farm-raised salmon.

A: Pat McCann: Yes. I would agree with what has been said, and I would add that fish advisories are, in general, used as the reason to reduce these contaminants in the environment. Also, we have heard today that we want to simplify getting out the message for fish advisories. So there is sometimes conflict about how big to make a brochure and how much information to put in there, how much information people want. There is kind of a give-and-take as far as how much information we can put in there on sources and where these contaminants come from. We try to do the best we can including that information, but sometimes it is difficult to do that.

A: Bob Gerlach: Up in Alaska it is a little bit different in the fact that most of the pollutants we are dealing with or monitoring up there are going to be from distant sources. We have very little industrial development there. It impacts our state a little bit differently, as we're finding when dealing with these problems.

Q: Arnold Kuzmack, USEPA: I would like to focus on the question that came up, directly or indirectly, on meal size. This is something we are going to have to face, particularly in the light of combining commercial and noncommercial fish advice. It's not just a matter of deciding whether it should be 6 oz or 8 oz. It's more complicated in that, in fact, 6 or 8 oz is fine as an average dinner portion, but canned tuna is eaten very differently and a typical serving size is 2 or 2½ oz. Just talking in terms of meals really doesn't reflect what the reality is, and I think that makes it a lot more complicated.

Q: Pat McCann: Do you have suggestions on how to deal with it?

A: Arnold Kuzmack: No.

A: Eric Frohberg: Folks don't think about whether their meal size is 0.4 lb or whatever; they are eating a meal. I was finally convinced to talk in our brochure just about a meal and not about the size of the meal. One of our rationales is that while our advisories are based on a half-pound serving raw, that's based on data and that is an upper estimate of how much folks are eating. I feel with some reasonable confidence that when folks sit down for a meal, they are eating less than half a pound at a sitting.

C: Luanne Williams: You will see in North Carolina's brochures, and on our Web site, that we have both. When you see the simple language, not the fine print, you will see meals. But the fine print has the oz for those who want to look a little deeper and are interested in knowing what a meal size is.

C: Diana Lee, California Department of Health Services: The continuing survey of food intake of individuals actually shows the average meal size of fish to be even less than 6 oz for adults. So, our general conception of meal size may even differ from the current estimates of meal sizes. Also, just a note that some cultures don't serve food in the way that a Western diet might serve it. So, in our practice, certainly working with different Asian populations, in particular, we have had to use different estimates and use common household or common reference sizes to determine portion sizes as opposed to a meal size. That might be something to keep in mind.

Q: Diana Lee: I also have another comment to add to the complexity of messaging. We have been working with different groups to try to see how we can capture fishery management issues as well in terms of sustainability. Minnesota (I believe it is Minnesota) has a guide that looks at fish management issues as well as the health issues in terms of fish contaminants and combines them for both commercial and recreational fish or sportfishing. Am I correct on that?

A: Pat McCann: I think you were thinking of an institute, not the state, but that was from Minnesota.

C: Diana Lee: I think it's an excellent guide to look at in terms of how we bring those issues together because we get a lot of questions from consumers about the fishery management issues. They see the seafood watch materials listed on different Web sites. Those are fishery management issues, not health-related issues, but I think there needs to be a joint message if we can at all craft that.

C: George Henderson, Florida Department of Environmental Protection: We have been accused many times of trying to do stealth management through the use of the health advisory with the marine fish. On the one hand, we've been accused of it but we haven't done it yet. On the other hand, in terms of fisheries management, many of these cases argue for eating smaller fish, therefore affecting the fisheries

management in a negative way. People suggest that if we only lower the minimum size of grouper or snapper, we can help obviate this problem of high mercury.

C: Joe Sekerke, Florida Department of Health: I have a comment and a question. I'll have to check on this because it's been 10 years since I've looked at it, but the Florida Institute for Farm and Agricultural Services has data that shows a 4-oz serving of fish is the same width, depth, and height of, I can't remember if it's half a piece of sandwich bread or a piece of sandwich bread, I'll get that and get it out to Jeb to get out to people. That's a good everyday thing that people can use for comparison.

Q: Joe Sekerke: You were talking about the dioxins being significantly higher in some of the food comparisons you did. I think the dioxin was 1.4 ppt and the other foods were lower. Was that statistically significant or biologically significant?

A: Eric Frohberg: No, it's eyeball significant.

Q: Joe Sekerke: The thing is, if you look at what you are changing the risk from, it can't change it more than one-half a log unit. You may have changed it from 1.0×10^{-5} to 1.3, but that's really not a significant change in the risk to the person who is consuming the dioxin. Was it that big a magnitude?

A: Eric Frohberg: No, it was not that big a magnitude. So the way we are thinking about it is really is this the area on which you want to focus your efforts in terms of reducing dioxin exposure.

Q: Joe Sekerke: What we are talking about, what people are panicking about, is the dioxins and PCBs in farm-raised salmon. The amount of their change in risk is really insignificant compared to eating other foods. They would not increase their risks from dioxins in particular.

A: Eric Frohberg: Yes. As a matter of fact, the graph I showed is, in terms of intake, looking at two meals per week. If you look at the actual intake of farm-raised salmon, it is going to be a lot less. Is that answering your question?

C: Joe Sekerke: The dioxin was higher in the salmon than it was in some of the other foods, but if you really look at the risks with the lower foods versus the risk with the farm-raised salmon, it really isn't that much different.

A: Eric Frohberg: I would agree with you.

Q: Susan Boehme, New York Academy of Sciences: I was wondering how you evaluate the success of your fish advisories. How do you know if the new ones are working any better than the old ones? What sort of method do you have to see if the message is reaching the public?

A: Eric Frohberg: We are actually doing a survey right now looking at women who have given birth in the past 3 months—whether they received our brochure, whether they are following the advisories, and their level of knowledge based on the brochure. And one of the things that is going to be really interesting about the survey is that we are asking for hair samples. We hope to be able to show a difference in hair mercury levels from our baseline data before we send out the brochures.

C: Luanne Williams: North Carolina is working with some Riverkeepers now. They usually get some grant money, and they can do surveys. If you are interested in evaluating the effectiveness of your fish advisory, you may want to consult with all your Riverkeepers to see if they would be willing to do surveys for you. I'm working with one of mine now. So we are in the process of doing that.

C: George Henderson: Florida hasn't done any formal analysis of it yet, but the anecdotal information based on putting stuff on the Web is that you get an exponential increase in the number of people who will call you and try to find out whether their particular lake or stream is safe. Based on that information, it is getting out to a wider audience than it was 10 years ago without signs.

C: Peter Flournoy, American Fishermen's Research Foundation: I think that both Eric Frohberg and George Henderson have started to put their fingers on some of the problems that I see and what you all are doing here without getting much advice on the different kinds of fish. Let's take tuna, for example. We see all these advisories about fresh and frozen tuna. What is tuna? Tuna can be North Pacific albacore or South Pacific albacore, yellowtail, skipjack, bluefin. There are a number of varieties, and nobody seems to make that distinction. Let's look at white meat versus light meat. The only kind of tuna, by law, that can be called white meat is albacore tuna, but albacore tuna comes from all over the world. It comes from places off our west coast; it comes in all different sizes and all different shapes. There is no one typical kind of albacore that necessarily goes into a can of white meat tuna. Everybody seems to agree on one thing, and that is that the bigger, older fish are likely to have accumulated more mercury so they are likely to have a higher mercury content, and that is fine. But, most recently you have heard all this about white meat tuna and albacore tuna. The Association that I represent will show that the tuna that we catch, which is albacore, is lowest probably in mercury than many other kinds of fish—certainly lower than the levels that EPA has found or FDA has found in albacore. Eric was a little concerned, it seems to me, about whether we just painted mackerel with one brush. You ought to be equally as concerned about painting albacore with just one brush—it's the same problem. It's just, I think, a lot more people eat albacore than mackerel, so maybe it's an even bigger problem than what you perceive in Maine. George, I think, really began to get to the problem when he indicated that grouper can be 10 different kinds of fish. So, I guess the plea that I am making is that if you are going to put out these health advisories and you are going to try to inform people, you actually should be informed yourselves, number one. Number two, you should try and do it in such a way that you are actually telling the public the biggest, most complete picture that you can. Now, why do I say that? Because I represent a lot of little guys who go out there and earn a living every day fishing. They are not the ones being sued and they're not the ones going to Washington to participate in EPA's or FDA's meetings because they don't have the money and they don't have the time because they are out fishing. So, you are playing with some very dangerous stuff here. We all remember the problem with the apples and what it almost did to the apple industry. You are getting very close to that kind of a situation.

Q: Eric Uram, Sierra Club: I just wanted to flag something here regarding the equivalency of a threefold increase in the omega-3s to the threefold increase in the mercury and wondering if there has been any sort of research done on whether there is a benefit to the omega-3s prior to pregnancy. Do they retain that benefit, whereas they retain the mercury and that buildup of body burden that is then transferred to the fetus?

A: Eric Frohberg: That is an interesting question. I don't know the answer for the omega-3s. I know there is separate advice. The U.K. did a workgroup looking at the essentiality of the omega-3s. They have advice for the general population for cardiac risk, but then they have advice for the pregnant and nursing women as well. It's higher. It's a good question about the body burden issue. You are always going to have a body burden; if you are consuming fish, you are going to have some level of mercury. That's one of the reasons why we state in our advisories that what we recommend is that if you are planning to get pregnant, you follow the advisories for women of childbearing age or planning to get pregnant. So, I guess that is sort of the way in which we are thinking about it.

Q: Rick George, Confederated Tribes of the Umatilla Indian Reservation, Oregon: I'm wondering to what degree you think the advisories and the recommendations that you each promulgated are protective of

tribal people in your states? And to what degree do you work with tribal health departments to develop and issue advisories?

A: Eric Frohberg: In Maine they are not designed to be protective of the tribes in the state. The tribes we treat separately; we have an agreement with them that we treat them separately. They issue their own advice to their own population. In addition, we don't mail our brochure to their tribal populations. We work very closely with them and do the best we can to make sure there isn't overlap in that area. In addition, in terms of working with them, we present ourselves as a technical resource, should they want our expertise or our data. We share data fairly frequently and talk with them a fair bit.

A: Pat McCann: We have a similar situation in Minnesota. Our advisory is not designed to protect subsistence fishers. Although we don't assume a consumption rate, we provide advice on meals per week or meals per month. There isn't a consumption assumed, but it's not designed for people who eat a lot of fish, necessarily. We also work with tribes within the state. We provide assistance. Some of them adopt our advisory, and some create their own.

A: Luanne Williams: We did work with our Indian Affairs when we released our new advice, and we shared our brochures with them. It was up to them to distribute them. We made ourselves available. We told them we were here if they needed us and would be happy to provide any assistance at all if they had any questions. We offered to come on the reservation and answer questions if they wanted us to do that. We did not get any requests to do that.

A: George Henderson: I am going to defer this to Joe Sekerke. I will say, however, that the advisory is not specifically aimed at subsistence fishermen and the state has made some efforts with the Muskogee and Seminole tribes to involve them. The stuff I'm more familiar with is to work with them to collect fish at the levels of where they are fishing and, second, to actually check the populations for elevated levels.

C: John Persell, Minnesota Chippewa Tribe Research Lab: I just wanted to comment on the earlier question regarding meal size. It is a little different for tribes, at least for Minnesota Chippewa Tribe, when talking about subsistence fishers, etc., regarding meals. We have used and will continue to use actual poundage in our guidance. When you talk about tribes, how they fish, bring fish and gather fish, and harvest fish, meals are done on a relatively large scale compared to what everyone is talking about here in ounces. You may eat pounds of fish over several weeks, day by day. It's a little bit different, so I just wanted to make that point.

IV. Formal Welcome and Introductions

Welcoming Remarks

Ben Grumbles, Acting Assistant Administrator for Water, U.S. Environmental Protection Agency (via video)

Hello, I'm Ben Grumbles. I'm the Acting Assistant Administrator for Water at the U.S. Environmental Protection Agency, and I'm coming to you from warm, sunny Washington, DC. Actually, it's not warm, and it's not sunny, which is part of the reason why I really regret not being able to be with you in San Diego at this important forum. But I just wanted to take a few minutes to convey a few things, appreciation, and the importance of your work during the forum. I personally come to EPA having spent a decade and a half in Congress working on legislation reauthorizing the Clean Water Act, establishing the Great Lakes Legacy Act, working on Clean Lakes legislation, and other water quality legislation, and the theme that has run through those efforts consistently has been to try to keep the fish happy and healthy and keep the ecosystem happy and healthy. The forum is so important. You are all aware of the tremendous challenges that we all face—persistent bioaccumulative toxics, persistent organic pollutants—a lot of challenges, long-term challenges. But there are a lot of short-term actions that we can all take involving risk assessment, communication, management, and concrete actions.

A couple of the things that I just really wanted to focus on are the two messages that are so important throughout the forum. The first is to make sure that the public knows that the benefits of eating fish are tremendous. Fish is a healthy part of a healthy diet. The second message is that the public should know the risks associated with eating contaminated fish. That is tremendously important and obviously a focal point of your efforts over the next several days. It is also so important to think not just locally and nationally, but also globally, about the various issues to reduce contamination and to communicate effectively on the benefits and risks associated with fish consumption. From the national standpoint, EPA and the states are continuing to work to reduce mercury emissions through Clean Air Act programs and authorities. In December, just this past month, EPA proposed significant rules, the Mercury Reduction Rule and the Interstate Air Quality Rule, which are key tools in the tool box to reduce contamination of fish through atmospheric deposition—mercury, NO_x and SO_x, sulfur dioxide. These are all important steps to take and that we will continue to take. There is also important legislation pending in Congress—the Clear Skies legislation—that this administration is pushing to help reduce atmospheric deposition of mercury, NO_x, and SO_x.

Globally, I think all of you are aware that mercury in particular is not just a national issue. It is a global environmental issue, and it is so important to be part of that effort, to join with the other 36 countries to reduce heavy metals and persistent organic pollutants. EPA is working vigorously with Congress to move forward on the POPs—the persistent organic pollutants—treaties. The other thing that I would like to focus in on is the critically important efforts of EPA, the Food and Drug Administration, and others to continue to improve and coordinate the communication of the benefits, and the risks, of fish consumption. We are very proud of the progress to date on mercury, and you will be hearing a lot about that. That is something that is still in the works and is very important. We are also very enthusiastic about following up with coordination and improvement on PCBs, whether they are in salmon or other fish. The partnership between EPA and FDA will continue to grow stronger.

The last thing I want to say is that over the next few days you will no doubt be hearing a lot of fish tales—some professional, others not so professional—in terms of good stories about catching fish. Of course, it's important to listen not only to your colleagues but also to the fish themselves. The tales and the stories that the fish have to tell are truly important. They tell us what we're doing to the air, the water, and the land. Sometimes they're good stories, and sometimes they're stories where we all know there needs to be improvement. The important thing is to listen to the fish, to listen to your colleagues, and to

work together. And I just want to thank you for taking the time to listen to this but, most important, for your commitment to this important issue. Thank you.

Welcoming Remarks

Val Siebel, Chief Deputy Director, California Office of Environmental Health Hazard Assessment

Good morning, everybody. For those of you not from California, on behalf of our new governor, Schwarzenegger, welcome to California. As the new governor, he's also appointed a new Secretary of the California Environmental Protection Agency, Terry Tamminen, who is from southern California and was with an environmental group before he became our Secretary. In a meeting we had with him last week, there were a couple of things that became evident to all of us. He actually quoted one of our fish advisories back to us, so he's very familiar with problems with some of the contaminants that we have in fish in California. He then asked us to put together a plan so that we could reduce the impact of mercury contaminants coming from California. So we're going to be doing some sort of plan that we will be bringing forward to him to see what we can do here in California to reduce mercury in the environment.

I was kind of interested to think about what kinds of temperatures some anglers are facing across the United States since so many of you are from other states as well. So I checked the newspaper this morning, and I found that anglers in Maine were facing a 5 degree temperature this morning. In Minnesota it was getting a little warmer, about 24. It was 25 in New Jersey, and here in San Diego it's going to be a great 62 degrees. So if I had my choice, I'd probably come here to San Diego. But then I didn't mention Florida, where it's going to be 80 today, if you can believe that.

So even though the anglers, I think, are facing different temperatures, one of the problems they face that's common, unfortunately, to all of them is some of the contaminants that they find in the fish that they're lucky enough to catch. And of course now we're finding that even farm-raised commercial fish can become contaminated from the feed that they receive. I'm told that even some of the fish stock that are planted in our lakes and streams suffer the same fate—that they're actually receiving some of the food that has been contaminated. When you're in the High Sierras fishing, you think you've got a fish that's probably fairly pristine, only to find out that the fish has PCBs or something of that nature in it already. It seems (to me anyway) that the public, as Denise was saying, is being barraged by a variety of news concerning different contaminants that are being found in all of our food supplies. We've recently found that acrylamides are formed in starchy foods. Here in California, of course, and in other places across the United States, we're finding perchlorate in our drinking water. It's a rocket fuel oxidizer, and now we hear that it's also being taken up by some of the vegetables being grown that are being watered by contaminated water. Mad cow disease was mentioned as well. And of course now fish. We're hearing more and more about mercury and the contamination that it presents and the decisions that have to be made by consumers regarding what they want to eat. I think that what comes along with these messages are the questions people have about why these contaminants aren't being prevented from reaching our food systems. I think part of the answer to that is that it's so expensive to reduce it, and sometimes we just don't have the answers yet. Those are the answers that we're going to be talking about and looking for at forums such as this. I know we recognize some of the legacy of some of those contaminants in the Great Lakes or in our eastern rivers. I know in Northern California from our gold and cinnabar mining we have a lot of mercury problems that have been passed along to the fish up in some of those lakes in the High Sierras.

As far as ocean fishing goes, as well as being overfished, of course, we have our marine fishing spots that have been contaminated as well. I think that will be the subject of part of the discussions at the forum here today. So it's critical, as Denise said, that we share our experiences here. As Bob mentioned, he's probably going to take a lot of new ideas back to the office. I hope we can fund some of them. But I think

they've actually been proven in your offices, and that's why we want to have these types of forums—to pass that information along and use what works.

I'm glad to see so many of you here today. I'm certain that this is going to be a productive meeting, and please enjoy your stay here in San Diego. Thank you.

V. Mercury Issues

Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii

Barbara Brooks, Hawaii Health Department, Hazard Evaluation and Emergency Response

In 2002 the Hazard Evaluation and Emergency Response Office, Hawaii Department of Health, measured total mercury concentrations in nine major fish species caught in the vicinity of the Hawaiian Islands. Twenty tissue samples per species were obtained from the United Fishing Agency, in Honolulu, Hawaii. In addition to total mercury, methylmercury was measured in 20% of the samples from each species. The weight ranges sampled were chosen to represent weights landed in Hawaii and were based on data provided by the National Marine Fisheries Service. The results showed that there were wide variations in mercury concentrations within and between species. Some fish species showed a correlation between weight and mercury concentration. Moonfish showed the highest average methylmercury concentration, with moderate levels measured in Pacific blue marlin, bigeye tuna, yellowfin tuna, albacore, and wahoo. Mercury concentrations in mahimahi, striped marlin, and skipjack tuna were relatively low. Methylmercury was the predominant form of mercury in all species except Pacific blue marlin, in which approximately 75% of the mercury was inorganic. The results of the study combined with data from other sources were used to prepare a pamphlet entitled *A Local Guide to Eating Fish Safely* for pregnant women, nursing mothers, and young children (<http://hawaii.gov/doh/>).

Mercury Concentrations in North Carolina's Top Five Commercially Sold and Recreationally Caught Marine Fish

Luanne Williams, North Carolina Department of Health and Human Services

On October 8, 2002, the North Carolina Mercury Fish Advisory Committee held its first meeting at the North Carolina Fisheries Association's office in New Bern, North Carolina. The committee members represent North Carolina Wildlife, Water Quality, Fisheries Association, Seafood, Aquaculture, Marine Fisheries, and Health. The committee recommended sampling and methylmercury analysis for the top five North Carolina commercial and recreational marine fish. The purpose of this sampling was to expand the list of fish that either should or should not be eaten by women of childbearing age and children. Fillet samples of spot, croaker, kingfish (sea mullet), bluefish, and speckled trout (spotted seatrout) were collected off the North Carolina coast by staff members of the NC Division of Marine Fisheries during October and November 2002. A total of 120 samples (mostly fillets) or 192 fish were submitted for analysis. Due to resource limitations at the DWQ lab, some of the bluefish, croaker, kingfish, and spot samples were composited to streamline the processing time. Composites contained four or fewer fish of similar size and of the same species. Results show that the median methylmercury levels for all species were below the NC level of concern of 0.4 mg/kg. The highest levels of methylmercury were detected in speckled trout (a maximum of 0.62 mg/kg) and the lowest levels were detected in spot (less than 0.01 mg/kg). Committee members recommended addition of spot, croaker, kingfish, and speckled trout to the list of fish that are safer to eat or that have lower methylmercury levels on the NC Department of Health and Human Services' Web site <http://www.epi.state.nc.us/>. Committee members agreed not to add bluefish to the list of fish that are safer to eat because the large bluefish were not included in the October–November sampling. The committee members recommended that 20 of the larger bluefish that are

commercially caught and sold and recreationally caught be sampled. The results of this sampling should be available by spring 2004.

Comparison of the October–November 2002 NC Methylmercury Marine Fish Tissue Sample Results to a 0.4 mg/kg Level of Concern (All fillets except where noted)

Species	Median (mg/kg)	Minimum (mg/kg)	Maximum (mg/kg)	Number of Fish
Spot	0.03 (fillets)	0.01	0.06	23
	0.02 (fillets)	0.01	0.03	2
Croaker	0.04 (fillets)	0.01	0.13	14
	0.065 (median for 10 composites containing 4 fish each)	0.03	0.16	40
Kingfish	0.07 (median for 10 composites containing 3 fish each)	0.04	0.14	30
Bluefish	0.08 (fillets)	0.07	0.12	5
	0.15 (fillets)	0.06	0.22	13
	0.16 (median for 17 composites with 12 composites containing 2 fish each and 5 composites containing 3 fish each)	0.04	0.4	39
Speckled trout	0.11 (fillets)	0.03	0.62	9
	0.05 (fillets)	0.05	0.07	3
	0.04 (fillets)	0.03	0.09	6
	0.09 (fillets)	0.04	0.24	8
				TOTAL 192 FISH SAMPLED

Options for a Gulf States Mercury Advisory for King Mackerel

Donald Axelrad, Florida Department of Environmental Protection

A Gulf of Mexico fish contaminants monitoring program conducted in 1995 revealed that king mackerel, a species of recreational and commercial importance, contained elevated levels of toxic methylmercury. On that basis, between 1996 and 1998 the five Gulf States—Texas, Louisiana, Mississippi, Alabama, and Florida—each issued a king mackerel consumption advisory to the public.

While there are differences among the five Gulf States’ king mackerel advisories, each recognizes that there is a relationship between fish size and fish mercury concentration, and advises “limited consumption” of king mackerel for size ranges where mercury concentrations warrant this. In contrast, in 2001 the Food and Drug Administration (FDA) issued advice that women of childbearing age should not eat king mackerel.

The FDA action prompted the Gulf States to reexamine their advisories to determine whether it was still appropriate to advise consumption of king mackerel and, if so, whether it was feasible to issue a single Gulf-wide advisory to replace the five existing advisories.

Advisories from the five Gulf States differ with respect to reference dose, age defined as a “child,” and advised rates of king mackerel consumption by fish size and mercury concentration categories. Discussions among representatives of the states resolved many of these differences, and issuance of a single Gulf-wide advisory hinged largely on whether a fish size-mercury concentration relationship applied for king mackerel from waters across the Gulf of Mexico.

Data analyses indicate that based on the similarity of the fish size-mercury concentration relationships across the Gulf of Mexico, there is scientific justification for a Gulf-wide advisory for king mackerel related to fish size.

However, Gulf king mackerel mercury concentrations are too high relative to the USEPA methylmercury reference dose to advocate consumption of this fish as a routine dietary component in a “heart-healthy diet.”

Representatives of the Gulf States will consider the new data and determine what advice to the public is warranted.

Recent Washington State Data on Mercury Concentrations in Tuna

Jim VanDerslice, Washington Department of Health

Currently, as environmental professionals, we are facing a similar problem: trying to let people make their own decisions concerning food consumption and dietary concerns. However, we have no idea if those decisions will ever be made.

In Washington State, the Departments of Health and Ecology have performed numerous studies concerning food intake and the consumer. This discussion centers on a study performed recently by the Department of Health to gather information on the consumption patterns and potential mercury levels of the canned tuna available in the state.

In Washington, the Lake Whatcom study was performed to study the mercury levels in bass within the lake. The lake itself is famous for smallmouth bass fishing. The study was a consumption survey used to compare the consumption of lake-caught fish versus both fish in general and canned tuna. The study compared lake bass results with results for other fish species and combined the consumption rates in the survey. The survey showed that both the consumption rate and associated mercury levels were higher for canned tuna than the corresponding levels of consumption and mercury for lake-caught fish.

As a result of this study, the Department of Health issued a consumption advisory for canned tuna in May 2001. The baseline value presented in the study was based on the value derived in the Yess study of 1993 (170 part per billion [ppb]). The advisory provided weight-specific consumption advice and targeted women of childbearing age and young children. Specific questions on tuna consumption were also added to the 2002 Behavioral Risk Factor Surveillance System (BRFSS) conducted by the Centers for Disease Control (CDC) in the state. One of the most important results of this effort was the determination that the majority of mercury tissue data available was quite old, and there was insufficient data comparing white versus light tunas.

Tuna Sampling Objectives

The Washington State Department of Health received a grant from the National Environmental Public Health Tracking Network to help address the key data gaps in fish tissue data and canned tuna identified during the previous study. The objective was to estimate mean mercury levels for various types of tuna. Specifically, this included comparing albacore (white) versus light tuna, solid versus chunk cuts of the fish, and whether it was packed in water or oil. The probability sampling was performed using 6-oz cans of tuna available for retail purchase from September through October 2003. The sampling excluded flavored tuna, tuna packed in oils other than vegetable oil, and low sodium preparations. The target sample size was 40 cans per type. Other factors, including how much money was available and how much each sample cost, were considered during development of the study. The results and mean values

for contaminants noted in various other studies were reviewed. This study attempted a minimum detectable difference of 85 ppb, which was half of what the mean level was in the Yess Study.

Initially, our study attempted to understand the process of where tuna comes from and how it makes its way into our homes. The more we researched the process of tuna production, the less we understood. Therefore, we took the point of view of the consumer and started examining consumption on the retail level. The initial data showed that many people thought that tuna wasn't always tuna and that where the fish was caught had a great deal to do with mercury levels. However, all this information is not available in the store—only the brand information and whether it is light or white, solid or chunk, or packed in oil or water.

To conduct our study, we performed probability sampling of what people were actually taking away from the stores. Lists were obtained from the state detailing all the places that sell food and their associated sales figures. We used these figures as a proxy for the sale of canned tuna. Although many stores were randomly selected, the probability of selection was proportional to the volume of total sales. Therefore, a store with a high volume of sales was more likely to be chosen. In terms of geographic distribution, the total package of retail stores included the more popular supermarket chains as well as mom-and-pop shops in rural areas.

For the purposes of this study, canned tuna was broken down into eight categories depending on species, cut, and packing medium. However, one of the eight categories, chunk albacore tuna packed in oil, is almost nonexistent and was removed from the sampling mix. Information on the remaining seven categories was then gathered. During our stratified sampling process, we went in the stores and selected the left-hand can on the top row, selected one can for each type and brand, sorted each by type, and then randomly selected one can from each type. We went to a total of 80 stores to collect the random samples.

Lab analysis of the canned tuna was conducted by the Washington State Department of Ecology, Manchester Environmental Laboratory. The samples were analyzed for total mercury using EPA method 245.5. Of the sampling results, the sampling targets were hit for all the categories except solid cut light tuna in oil; it was not found very often in the stores selected. The total number of stores where the type of canned tuna was found, the percent availability, and the average number of brands per store were also calculated. A total of 85% of the canned tuna sampled was one of three major brands (Star Kist, Bumble Bee, and Chicken of the Sea). Unfortunately, the results of this study compared the canned tuna on the basis of type, not brand. More money is needed to answer brand-specific mercury issues.

Results of the study showed that there is not much difference in mercury levels when comparing tuna packed in oil versus water or when looking at the cut of the tuna, chunk versus solid. However, the results did show the mean mercury levels in albacore (white) tuna were much higher than those in light tuna. After a statistical analysis of the results, it was determined that on average albacore (white) tuna is 151 ppb higher in mercury content than light tuna. The overall weighted means were 214.5 ppb for white and 57.1 ppb for light. It is important to note that not all albacore or light tunas are the same or caught in the same location. Also, the information is not likely stable over time since tuna consumption will vary throughout the season. However, the study clearly shows a real difference between mercury content in albacore (white) versus light tuna.

Canned Tuna Consumption

In 2002 the CDC planned and conducted the Behavioral Risk Factor Surveillance System (BRFSS), which was a nationwide probability-sample telephone survey of noninstitutionalized adults. The survey asked a series of questions, including “How often do you eat tuna?” and “When you eat canned tuna,

about how much of a standard 6-oz can do you eat in a sitting?”. The study randomly chose adults and any children in the household under the age of 5.

The Washington State 2002 BRFSS included 5,000 households and looked at a variety of information. The participants included 1,968 adult men, 2,919 adult women, 1,300 women between the ages of 18 and 44, 61 pregnant women, and 491 children between the ages of 1 and 5. Approximately 60% of women ages 18 to 44 and pregnant women stated that they ate less than one can of tuna per week. About 40% of children ate one can per week, and another 40% stated they did not eat tuna at all.

For those who identified some consumption of tuna, women 18 to 24 years old and pregnant women consumed approximately 3 oz of canned tuna per serving (half of a can), while children between 1 and 5 consumed 1.5 oz (or one-fourth of a can). On average, the consumption rate was 2 oz per sitting.

Predicted Mercury Doses

For a prediction of mercury doses (in micrograms per kilogram per day), the 95th sampling percentile was examined for comparison with the reference dosage (RfD). For white (albacore) tuna, the 95th percentile for women ages 18 to 44 was 0.095%; for pregnant women, the value was 0.07%, corresponding to 4.6% and 1.9% above the identified RfD, respectively. For children consuming white tuna, the 95% percentile represented 0.17 of the percent sampling of which 10.7% was above the RfD. In the case of light tuna, the 95th percentile for women ages 18 to 44 was 0.03; for pregnant women the value was 0.02%, corresponding to a 0.4% and 0.0% above the RfD. However, the sample population of pregnant women was very small compared with the overall sample population and the results cannot be interpreted as representative. For children eating light tuna, the 95th percentile was 0.05% with a corresponding 2.2% above the RfD.

Future Steps

As we move forward with this process, several questions are left unanswered. One main concern is the aspect of different consumption levels throughout the year. The next step is to examine the combined data and examine the differences between the various studies performed in the past. Then a second round of sampling will be conducted in Washington State pending appropriate funding. In addition, other state agencies will be consulted and reanalysis and revision of the current tuna consumption advisory will be considered. Additional questions will also be answered once the results of the 2004 BRFSS are received.

Acknowledgements

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Recent FDA Data on Mercury Concentrations in Fish

David Acheson, Food and Drug Administration

The FDA's data collection and analysis process over the past 12 months was divided into two assignments. Both assignments were completed in 2003.

The first assignment involved data on 12 different fish species. A total of 224 samples were collected for this assignment. Each of these was a composite sample made up of 12 individual fish samples. The

various species for this assignment were chosen primarily to fill identified data gaps for the FDA. Selection of these species had no correlation to the frequency of consumption or any other identified problems.

The fish samples collected under this assignment were from fresh, refrigerator-fresh, and frozen fish. Approximately one-third of the fish sampled were imported, and the remaining two-thirds were domestic. The geographic distribution of the fish sampled was nationwide. All fish samples were tested in the FDA laboratory for total mercury using standard methods.

The new data were compared with old composite data that goes back many years. Old data is identified as information previously published and currently available on the FDA Web site. Through this comparison, it was discovered that the old data was not species-specific and gave no indication of the location of sample collection, time of collection, and the like. The newly collected data includes all the necessary missing information, including details on the type of species, location of sampling, geographic coverage of the species, and so forth.

The second assignment involved the collection and analysis of samples of canned tuna. Samples were collected and managed as in the first assignment. A total of 170 white (albacore) and 119 light tuna samples were collected during July and August 2003. Each sample was a composite of 12 samples, and each was tested in the FDA laboratory for total mercury using standard methods.

The tuna samples were collected from products available in stores. Of the tuna sampled, 75% included major brands and the remaining 25% was composed of local or store brands. The tuna samples came in various volumes and packing media. The old and new data on tuna sampling were compared. Very little difference was noted between the old and new data for the light tuna. However, as in the previous assignment, the original species, size, and geographic location of the samples in the old sampling data are unknown at this time.

Panel Questions Regarding Mercury (Session 1)

Q: People were answering on the basis of a 6-oz can, but in reality a 6-oz can doesn't contain 6 oz. It contains only 5 oz, so that would scale the exposure levels down.

A: Thanks for that comment. I guess other people are duped by the labeling. That's a good point. We're glad to go back and revise our figures.

Q: Amy Kyle, University of California (UC), Berkeley: I have two questions, one to Dr. Acheson and one to the panel. When you use composites, I'm wondering what you think is the interpretation of the reporting of the range? You report the high and the low values, but they're of composite samples so it's a little hard to interpret what you think that range of the underlying data is. I'm wondering if you have any interpretation or thoughts on that. When you look on the Web site, it's presented as if it's a true range of what you'd expect to see. Yet, because it's a composite, it may not really represent the full range that you'd observe. The reason I ask about this is related to my second question to the panel, which is this: We're interested in the mean and median but also the upper end of the distribution when we're trying to target people of greatest concern. It seems like we're to move toward trying to give advice about what to eat and what not to eat and it seems like a lot of states are moving in that direction of trying to give the double message of the good fish and the bad fish. For someone who works with data, it seems like it might be time to address the question of how the data is reported by all the different parties who report it, because some people report means, some people report medians, some people report ranges, and we've seen some 95th percentile estimates. I'm wondering whether it might be time for you all to sort of agree to start doing it the same way so that the data could be more useful to each other in helping to sort out this

question of what's really low and what's really high. The other issue that I wanted to comment on along those lines is the issue of the species' names. It's very hard to tell when you look at the data from all over what species they are. So I'm wondering whether you all as a group could decide that maybe you could report, somewhere, the scientific name of all your species and then kind of agree together to report the median, the mean, the true range, the 95th percentile, and do it consistently. I don't think it would be that much harder for everyone to do, but it would make it much easier to see the larger picture when we're trying to see what's really low and what's really high so that we can give good public health advice. So, I'm asking the panel if they have any comments on that and then I have that specific question about what that range means in terms of composite samples, or if you have any comment on how to interpret that. Thank you.

A: David Acheson: You're absolutely right. You composite 12 fish. What does that mean? That's why I said it was a composite because obviously you need to understand the science behind the number. I think the explanation for that is that it comes down to a resource issue. Really, primarily, what we're interested in is what's the average. We want to know what the average is, and doing a composite is the best way to get us there. If resources were unlimited, then the nice thing to do would be to take individual samples of those 12 fish and take means of them, but you can't go there. The study isn't designed to set ranges. It's really looking at what's an average kind of level, but you know it would be nice to move in that direction if we could.

A: Luanne Williams: We generally use median levels. We want to know what that 50th percentile level is because your average is representative of all the levels. You could have a very high level and a very low level, and we want to know what that 50th percentile level is, what would be the level 50% of the time. We feel in North Carolina that that would give you a better idea of what the exposure is 50% of the time. As you can see from our data, our mean and median levels were similar, which is always good. I agree that we probably need to provide the scientific name so that we're all on the same page and that when we can, we need to do fillet samples. I was relying on another agency to do my analyses, and I was asking for fillets but some of them came back composites. There's not a whole lot I can do about that, but this was extra; they put it in with all the other samples and I got back some composites. That's why I broke out the data. I don't like merging fillet with composite data; I like to keep it separate because of what you just said. I want to know what's representative of what was caught. So I think that if you do composites or if you do fillets, you need to keep them separate. But I agree that we need to do fillets and we need to provide the scientific name, and I prefer using the median levels.

A: Unidentified panel member: It just seems like if you do different statistical analyses and use different parameters for different purposes, I think coming to more consistency when we're developing messages is important. But I don't think you'll get all the people to do their statistical analysis the same way. They're asking different questions in different ways.

C: Susan Boehme, New York Academy of Sciences: I just wanted to let you know, especially about the question about changes in mercury concentration over time, that there is a publication coming out by Dr. Burger. I believe it will be out next month in *Environmental Health Perspectives*. They looked at canned tuna over 5 years and tried to look at that question, and they did start to see evidence of differences from year to year. I'll try to get you a summary of that paper before the end of the meeting.

Q: John Wilson, Office of Water, USEPA: There's a lot of debate across the country about food labeling. I wonder what the panel would think about ideas for labeling fish. I think a lot of the debate is about country of origin right now in some of the other foods. If we were to proceed with additional labeling of fish, what would that include? What would be most useful? I think it gets to some of these other issues about what we call these different fish. I'm just interested in comments on that.

A: Luanne Williams: I would like to hear from FDA on that.

A: David Acheson: Somehow I thought you might. I think the issue of labeling is very complex. On the one hand, you want to provide maximum information. On the other hand, you don't want to confuse people. One of the reasons I stayed silent is that I was interested in hearing what people had to say about labeling. I think you're always left with how much space is on the can, how much you can get on there, and what's it going to mean. There's a lot of debate right now in terms of labeling and FDA in relation to obesity, for example, and how you improve the message to consumers over calories and percent daily intakes. So I think it's a complex area when the danger is that you put too much on the can and confuse everybody.

A: Luanne Williams: I know that when they use arsenic-treated wood, as of December 30, 2003, on the end caps they had the labels that arsenic was actually used on the pressure-treated wood and what the hazards were, and it was just a small label. Just an idea, but FDA may want to think about using some sort of label on the actual grocery stores and the markets stating which fish have been shown to contain high levels of mercury. We all know in this room what they are at this point in time. We know which fish. We know that there are other fish that may have high levels of mercury. But a lot of people beyond this room don't know. We have limited resources at the state level as to what we can do, and our budgets are being cut each year. But FDA has the power and more resources than we do at the state level in providing these signs. You could put just a small sign at fish markets. You may not be able to put it on the can. I know that there is limited space. But certainly at fish markets and grocery stores where the canned fish are sold, it could be done, and I'd like to see that done.

A: David Acheson: I think from FDA's perspective, whatever we can do to get the correct public health message out is where we want to go. Whether it's through labeling or through the press or consumer organizations, that's the goal.

Q: Tony Forti, New York State Health Department: I think that tilefish is something that's interesting, because those of us who have been in the sport fish consumption advisory business know we got the luxury of being able to say, "This fish is from this waterbody" and so forth. The tilefish example is kind of alarming because the difference in mercury levels between the old data and the new data is so big. And, I guess, there are also issues of species, geography, everything tied up in that. So I'm just wondering what the plans are, Dr. Acheson, to unravel the tilefish mystery here.

A: David Acheson: Exactly as you said: Figure out where they're coming from. So, the geography and the species. The answer must lie there. But you're right. If tilefish are geographically different, then the advice that the FDA and EPA are developing—essentially national advice—gets even more complicated if tilefish from one part of the country are "low" and in other parts of the country are "high." So again you have the difficulty of complexity. It's got to be based on the right science.

Update on Recent Epidemiologic Mercury Studies

Kate Mahaffey, U.S. Environmental Protection Agency

Recent reports from 2003 and 2004 provide additional insight into the epidemiological impacts of methylmercury. The reports used data generated during completion of the 1999 and 2000 National Health and Nutritional Examination Survey (NHANES) on organic blood mercury levels. Reanalysis of this data, in combination with interpretation of more recent findings, has provided further details concerning methylmercury levels as a result of fish consumption and the potential transmission of elevated methylmercury levels to the newborn populations of the United States. The various findings of these analyses are summarized below.

Ongoing data analysis has shown that there is a close association between the level of fish consumed and blood mercury levels in the examinees used for collection of the data in the 1999–2000 NHANES. It also confirms contradictory information concerning cord versus adult blood mercury levels and estimates that at least 300,000 newborns in the United States each year have *in utero* blood levels greater than USEPA's reference dose (RfD) of 5.8 microgram per liter ($\mu\text{g/L}$). Studies have also been conducted on mercury levels in a population in the Seychelles, on methylmercury-associated adult neuropsychological changes, and on the distribution of omega-3 fatty acids in fish versus identified mercury levels.

The data on blood organic mercury (methylmercury) levels collected during the 1999 and 2000 NHANES effort came from analyses of 1,709 women of childbearing age as a representation of the population of the United States. The data from NHANES was used to calculate total blood mercury levels and then the inorganic component. Organic levels were determined from a subset, and the remaining mercury present was determined to be organic (methylmercury).

To look at the consumption of fish in women of childbearing age, questionnaires and 24-hour recall diaries were used to determine frequency of fish consumption. Overall, 9% of women in the study consumed fish at least once per week. Fish consumption was much higher in women over the age of 30 and among Asian and Pacific Island ethnic populations. More detailed data discussing these results will be released in a publication in the next few months; some of the information is currently available from online publications.

As interpreted from the NHANES data, the derived associated ratio between dietary total mercury and blood organic mercury is between 0.5 and 0.6 (Mahaffey et al., 2003). This is a reasonable assumption considering the study uses fish consumption only from the past 30 days. Also, only 25% of mercury in the bloodstream can be associated with food consumed within the past 30 days due to mercury's long half-life.

It was shown that blood mercury concentrations were seven times higher among women who reported eating more than nine fish/shellfish meals within the past 30 days (which equates roughly to two or more times per week) compared to women who reported no fish/shellfish consumption in the past 30 days (Mahaffey et al., 2003). However, the study also shows that if fish with low mercury content is eaten, the results might not be the same according to the NHANES national dataset.

Plotting methylmercury as a percentage of total blood mercury versus the NHANES dataset for 1,709 adult women of childbearing age shows that when blood mercury levels become greater than $0.4 \mu\text{g/L}$, about 90% of what is present is methylmercury. The plot also shows that as the frequency of fish consumption increases, there is a greater occurrence of elevated mercury levels in the study's population. Plotting total mercury levels in women (ages 16 to 49) versus weekly fish consumption levels also shows that the percentage of women with elevated mercury levels changes with respect to the frequency of fish consumed during a certain time period. In this case, the plot interprets fish consumption greater than two times per week and less than two times per week.

The uncertainty factor for the RfD for methylmercury used during interpretation of this data was established by the National Academy of Sciences' (NAS) Committee on Mercury Toxicity. The Committee recommended an uncertainty factor of not less than 10. One of the reasons for this determination was the variability and uncertainty in estimating an ingested mercury dose from cord blood mercury concentrations. The original assumption was that the ratio between cord and blood mercury levels was roughly 1:1. Further examination of the adult women's blood collected during the NHANES and new findings from a Japanese study confirmed that cord blood mercury levels were higher in ratio

than 1:1. On average the ratio has been shown to be closer to 1:7 or 1:8; the Japanese study resulted in a ratio of 1:6 for cord mercury levels compared to blood mercury levels.

These newer ratios can be used to reanalyze the estimated number of newborns in the United States with *in utero* methylmercury exposures greater than the USEPA's RfD of 5.8 µg/L. The National Vital Statistics Report stated that the number of U.S. births in 2000 was 4,048,814. If using the original 1:1 ratio of cord versus maternal blood levels (5.8 µg/L cord to 5.8 µg/L maternal), approximately 7.8% of women have a total blood mercury level greater than or equal to 5.8 µg/L. This level would then be associated with approximately 300,000 newborns each year being born with levels greater than or equal to the 5.8 µg/L RfD (Mahaffey et al., 2003). If using the 1:7 ratio of cord to maternal blood mercury levels (5.8 µg/L in cord to ~3.5 µg/L in maternal blood, 15.7% of women had blood levels greater than or equal to the 3.5 µg/L level. This translates into 630,000 newborns each year with greater than or equal to 5.8 µg/L mercury *in utero*. Granted, variability and uncertainty pervade the NHANES data; however, based on information today, this is what the numbers tell us.

Several reports have been published over the past few years on neuropsychological evaluations of methylmercury toxicity. The Seychelles cohort update (released by Myer et al. in 2003) continued to observe no adverse effect of methylmercury exposure under the circumstances present on the Seychelles Islands. The Yokoo report (Yokoo et al., 2003) showed reduced function on tests for fine-motor skills among adult Amazonian villagers exposed to methylmercury. Also in 2003, Bueter and Edwards published a report on the Cree Indians. It noted that additional studies among adults in the tribes showed difficulty with accuracy and sharpness of visual fixation and pursuit in dynamic eye movement due to exposure to methylmercury.

Questions continue to emerge on the neurotoxic effects on adults from methylmercury exposures. The threshold proposed by the World Health Organization (WHO) for adult neurotoxicity is based on 5% prevalence of paresthesia at 50 ppm hair mercury. The data used to determine this threshold was generated in 1990. Currently, no physiological basis exists to assume that there are no effects at lower exposures. Also, paresthesia is not reversible with age; it continues to get worse with time. Therefore, the dose response at lower levels needs to be determined.

Recently, scientists and the public have been interested in the effects of omega-3 fatty acids on the body's health. Recent 2003 epidemiological data paid more interest in mercury as a cardiac toxin. Omega-3 fatty acids in fish are frequently cited as a health benefit of fish and shellfish intake. It has been determined that there is a substantial species-specific difference in the distribution of mercury and of omega-3 fatty acids. Species high in mercury are not necessarily high in omega-3s, and species high in omega-3s are not necessarily high in mercury.

The following table shows a comparison of mercury concentrations (parts per million) and omega-3 fatty acids (grams per 100 grams) in a select group of fish species.

High Mercury Species			High Omega-3 Species		
Species	Mercury (ppm)	Omega-3 (g/100g)	Species	Mercury (ppm)	Omega-3 (g/100g)
Tilefish	1.6	0.17	Mackerel	0.08	3.61
Shark	1.3	0.07	Salmon-sockeye	0.03	3.00
King mackerel	0.97	0.18	Herring	0.01	2.34
Swordfish	0.95	0.58	Tuna, albacore	0.26	2.33

Mercury concentrations range from less than 0.02 ppm mercury in shellfish such as abalone to several ppm of mercury in large predatory species. Omega-3 fatty acids (combined EPA and DHA values) range from less than 0.1 g/100g of fish (shark species) to greater than 3.5 g/100g of fish (mackerel species). Results of this exercise showed that there is a minimal association between the omega-3 fatty acid concentration in the fish species studied and the mercury concentration in the species.

These topics and more will be discussed in an upcoming meeting on medical issues related to mercury exposure. This meeting will be held in April 2004 and is sponsored by the USEPA and the U.S. Department of Health and Human Services in conjunction with multiple medical associations.

Update on the Current Mercury Reference Dose and the Implications for Revisions Based on Recent Data

Alan Stern, New Jersey Department of Environmental Protection, Division of Science, Research, and Technology

With the recent report released from the Seychelles cohort, there has been speculation on how that might affect the calculated reference dose (RfD). There have been expressions in literature and journals saying that the NRC committee did not have the newest data from the Seychelles and other important information on the appropriate RfD, and therefore our recommendations no longer are current. Unfortunately, the committee no longer exists; however, many of the original members have submitted commentaries to address these particular concerns.

The former members of the committee believe that the Seychelles study is high-quality data, yet it continues to address the same cohort from the previous study. Whatever issues were responsible for not finding an association between mercury and adverse health outcomes in the previous study is likely to be present in the new study with the same cohort. While the results are interesting and advance our knowledge concerning the possible effects of mercury on statistical and methodology perspectives on these studies, they don't change the outcome or assessment of those previous studies, and the derivation of the RfD. It is important to realize that the committee has performed not only an analysis of the Faroese data which was ultimately the critical study of RfD, but also meta-testing of the Faroese, Seychelles, and New Zealand studies together. The analysis showed that the results from the Seychelles study are not that much different than the Faroese alone. Not to discredit the Seychelles study, but our opinion is that the study does not change anything in terms of our recommendations for the appropriate RfD.

The remainder of this discussion will focus on two areas for update. The first is my assessment of the cardiovascular endpoint and the second is an update to the pharmacogenetic analysis or the reference dose reconstruction. Cardiovascular endpoint (CVE) is an attempt to address what is the most likely salient adult endpoint for methylmercury. In conjunction with USEPA, I have reviewed literature on CVE that involved three separate areas: (1) cardio infarctions (heart attacks), (2) blood pressure and heart rate effects, and (3) atherosclerosis.

For this study, when looking at the CVE, we examine the effects associated specifically with methylmercury. Some adverse health effects are currently associated only with inorganic mercury (e.g., cardiomyopathy). At present, it is not known to what extent inorganic and methylmercury share a common mode of action for cardiovascular effects.

Heart Disease

Various types of heart disease were considered during this study, including acute myocardial infarction (AMI), myocardial infarction (MI), coronary heart disease (CHD), and ischemic heart disease (basically heart attacks). The study that was the largest, most salient, and had the clearest information used to examine this topic was the Salonen study of 1995 (Salonen et al.).

The Salonen study involved 1,833 middle-aged Finnish men currently in the country's health registry. The study's participants' mean fish intake was 46.5 grams per day or roughly the 90th percentile of United States consumers. The participants' mean hair mercury concentration was 1.92 ppm, also in the 90th percentile for United States males. Although the Finnish cohort's fish consumption is slightly elevated compared with that in the United States, it is not unreasonably so. Currently, no good data is available for United States male mercury exposure.

Extrapolating on United States data from the 90th percentile, for hair mercury concentrations of 2 ppm or fish consumption greater than or equal to 30 grams of fish per day, the relative risk is approximately 1.7 for AMI and statistically significant. Also important was that hair mercury concentrations were found to be associated with immune complexes with oxidized low density lipids (LDL). Following this suggestion, we can examine other studies showing that mercury is associated with lipid peroxidation.

A similar study followed up on the same Finnish cohort in 2000 after an additional 4 years (Rissanen, 2000). The study focused on omega-3 (n-3) fatty acids relating to fish consumption and heart disease. As predicted from previous studies, the study found that when comparing the upper quintile to the lower quintile of n-3 fatty acids and hair mercury levels of less than 2 ppm, there was a 52% reduction in risk. However, when they looked at the same quintile and the stratified portion of the study that had more than 2 ppm mercury in hair, they then found the reduction in risk to be only 24%. In other words, the difference between hair mercury of more and less than 2 ppm reduces the protective effect of n-3s by 50%. This implies that a balance exists between the protective effects against acute heart disease of n-3 fatty acids and the adverse effects of methylmercury. This suggests a classic toxicological antagonistic effect.

Another study we reviewed was the 2002 European and Israeli Multi-center study (Guallar et al.). Essentially it was a case control study that looked at the potential for heart disease in men older than 70 while also examining omega-3 fatty acid intake. A drawback to this study was the mercury levels were determined using toenails instead of hair. Toenail mercury is a valid measure of exposure to methylmercury, but it is hard to compare it with data in other studies from hair or blood. In the study itself, after making a full model adjustment they looked at the odds ratio for heart attack and mercury's effect on heart attacks. The odds ratio for MI in the highest quintile was 2.2 times higher compared with the lowest quintile. This indicates that a monotonic positive dose-response relationship existed. It also implies that the toenail mercury is telling us that the relative exposure tends to relate to the risk of AMI. On the other hand, when it looked at the DHA surrogate, it was found that the dose-response relationship went down and gave a monotonic negative trend again consistent with the notion that mercury antagonizes the protective effects of n-3 fatty acids.

A third major study of acute heart disease involving United States health care professionals was conducted in 2002 (Yoshizawa et al.). The case study of coronary heart disease was conducted using middle-aged men and toenail mercury concentrations. Here the mean mercury concentrations were larger than the largest group in the previous study (Guallar et al.). The study did not find an association between toenail mercury concentrations and heart disease. However, the largest group in the study, approximately 60%, was composed of dentists. Mercury exposure in dentists was twice that of any other group.

An important question centered on whether there was a compounding exposure effect due to the occupational hazards of dentistry. Unfortunately, conclusions at this time are not clear. When the dentists group was taken out of the study population, the odds ratio went to between 1.3 and 1.7, depending on what type of adjustment was made. The highest odds ratio was found when the adjustment was also done for n-3 fatty acids. In other words, the protective effects of the n-3 fatty acids was taken into account. However, the results are no longer statistically significant when the dentists are removed from the sample group.

This brings up another question: does the putative association result from total mercury or methylmercury? The occupational exposure of the dentists would be a confounder here. Plus there was a potential exposure misclassification since the toenail samples were collected up to 5 years prior to the CHD event.

Minamata Disease

Another important study was performed on exposure to methylmercury in the city of Minamata, Japan. The Minamata study was a preliminary ecological study comparing causes of death in two heavily exposed districts of Minamata City (Tamashiro et al., 1988). The study found the diseases of the heart were not elevated; however, the focus on people diagnosed with Minamata disease did not necessarily correspond to medical conditions but related more to classifications from the standpoint of compensation. In addition, the period of analysis was approximately 20 years after the initial disease report, and methylmercury exposure in the control area was not documented.

A follow up case-control study was conducted in the Kumamoto prefecture. The study found no significant instances of heart disease identified on the death certificates of those with Minamata disease. However, causes of death were secondary to the presence of Minamata disease at the time. The information that was available noted that only ischemic heart disease was significantly associated with Minamata disease on any of the death certificates.

Atherosclerosis

Another interesting study was performed on atherosclerosis. The study was also conducted in Finland (Salonen et al., 2000) and measured the progression in men from eastern Finland. The study looked at carotid artery thickness through the use of ultrasound measurements. The thickness of the carotid artery is a measurement of how much material is deposited in the artery over time (progression of atherosclerosis). The hair mercury concentration of the upper quintile was elevated but not outrageously so (2.81 ppm). Looking at the data of the dependent variable as a progression of atherosclerosis, the exposure to methylmercury was highly significant and the beta (strength of the progression coefficient) for Hg was second only to systolic blood pressure which is not a risk factor of atherosclerosis. The study also found that there was a 7.3 % increase in the progression of thickening for each part per million of mercury in hair. Unfortunately it is the only study conducted along these lines.

Two studies were performed concerning blood pressure and heart rate after *in utero* exposure. Using the Faroese cohort, some evidence was found for the association of *in utero* methylmercury exposure (cord blood mercury) and blood pressure at 7 years. This was in consideration of both systolic and diastolic blood pressure. However, the dose response was found to plateau at low exposures (10 µg/L). It is hard to know how to interpret this information; however, similar types of dose relationships were found with lead and blood pressure. These results are inconsistent with findings in institutionalized patients with “fetal Minamata disease” (Oka et al., 2003). Animal studies also examined adolescents and adults; however, information from these is difficult to interpret because it involved extremely high doses. The study does tend to show that there is a relationship between high doses of mercury and frank neurological toxicity.

Summary of Cardiovascular Effects

Epidemiological studies suggest an association between heart disease (including AMI) and methylmercury. Causal mechanisms are suggested by the apparent antagonism between omega-3 fatty acids and methylmercury. It appears that the anti-oxidant properties of the omega-3 fatty acids are countered by the lipid peroxidation from the methylmercury. In fact, these results tell us that studies on cardiovascular disease and omega-3s (not even looking at the mercury aspect) have been somewhat inconsistent and may be explained by the fact that these cohorts each had different exposures to n-3 fatty acids as well as different exposures to mercury. If we wanted to perform a dose response/risk assessment for AMI based on methylmercury exposure, we have to take into consideration dose response from omega-3s.

The association between atherosclerosis and methylmercury is seen in only one study although the associated mechanics may be consistent with lipid peroxidation by methylmercury. Viewing the data from the risk assessment perspective, the Salonen and Guallar data seems appropriate for the risk assessment. However, we don't know where the toenail mercury data is on the spectrum of exposure, and this lack of information about the toenail mercury biomarker makes the Guallar study less useful. Salonen is the one to work with here.

Evidence of the effects of methylmercury on blood pressure at the current levels of exposure is weaker. It is unclear how to interpret the data and determine what the implications are for future risk. From the cardiovascular standpoint, there is reason to proceed with dose-response analysis to at least see where the reference dose will take us.

Reassessment of the Pharmacokinetic Model for Dose Reconstruction

Why should we consider this reassessment? We know what the benchmark dose is for cord blood but we do not know for maternal intake. We have to calculate back from a model. What is different about the model now from previous years is the cord blood versus maternal blood ratio. It is important to look at this from a probabilistic standpoint; if we look at only the central tendency estimate we are not going to be protective of the upper percentile of the populations because there is significant variability across the population for maternal dose and cord mercury concentrations.

Studies have shown that the pharmacokinetic variability in the pathway is relatively constant no matter who does the modeling; however, previous analysis did not agree on the central tendency. Also, none of those analyses looked at the relationship between cord and maternal mercury, which turns out to be a very important factor. That is justification for reanalyzing the model. Another point here is that in addition to including the maternal and cord work, my study has attempted to make this specific to the third trimester. This will help reflect pharmacokinetic factors that influence mercury concentration in cord blood.

Conclusions

On the basis of the preliminary analysis, the estimate of the mean maternal dose is about the same as USEPA's previous estimate. What we did find was that when you calculate the variability, the cord/maternal ratio increases significantly. Based on this analysis, USEPA initially assumed that was a factor of 3. In fact, when we redo the analysis and include the fact that the cord blood has a higher concentration of mercury than the corresponding maternal blood, it then looks like the 99th percentile and is a factor of 4 and not 3.

Thus, the estimate of the mean maternal dose is about the same as USEPA's previous estimate and the overall variability in the dose reconstruction is approximately 33% larger than USEPA's assumed value. It appears to be due largely to the variability in the cord/maternal ratio.

Bottom line, if an uncertainty factor approach is used to address pharmacokinetic variability, the preliminary analysis suggests that an uncertainty factor of approximately 4 may be justified (looking at 99th percentile of population variability). However, the third-trimester specificity of the analysis suggests that the 99th percentile estimate can be used directly in the RfD calculation. In that case an intake dose of 58 µg/L corresponds to 0.21 µg/kg/day. If an uncertainty factor (toxicodynamic factors, database insufficiency, etc.) of 3 is applied, the overall RfD could be 0.21 µg/kg/day/3 or 0.07 µg/kg/day.

Panel Questions Regarding Mercury (Session 2)

Q: Joe Sekerke: Dr. Stern, the slides that you were showing of the dose of mercury to the mother, in the last few slides, was that log dose?

A: Alan Stern: No, it's just a linear relationship: If the blood concentration is 58 µg/dL as the benchmark dose, what is the maternal dose that corresponds to that? Just a straight relationship. The relationship itself, as I showed you on the graph, is not entirely linear, although it does have a large linear portion. The part we're interested in is the nonlinear part. But that's just a point; it's just a ratio right now.

Q: Joe Sekerke: Were any of the doses log doses on the dose response curve?

A: Alan Stern: No.

Q: Dr. Mahaffey, I know this is a mercury session, but I was wondering, with respect to the adult findings, if there had been any further work looking at interactions between PCB and mercury or PBDEs and mercury.

A: Kate Mahaffey: I don't know the answer to that question.

Q: Eric Frohberg: On the NHANES data, for the folks who had elevated levels of mercury, is it possible to look at the consumption data reported and find out what species that elevated level came from?

A: Kate Mahaffey: Yes, there's a paper we submitted for publication on that.

Q: Eric Frohberg: Can you give us a hint?

A: Kate Mahaffey: Sure. There are five species that are most commonly consumed. We've separated the most commonly consumed species from the species highest in mercury. I would have to think too quickly to pull together an answer to your question reasonably, so let me not try to do that.

National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations

David Acheson, Food and Drug Administration

Denise Keehner, U.S. Environmental Protection Agency, Office of Science and Technology

The purpose of the Food Advisory Committee (FAC) meeting in December 2003 was to explain how FDA had responded to previous FAC recommendations in 2002 by developing a revised joint advisory with USEPA that addressed both locally and commercially caught fish.

The discussion includes the following:

1. A status report of how FDA has responded to the previous FAC recommendations (including a description of the process involved in developing a revised advisory based on the recommendations).
2. Review of exposure assessment as peer review.
3. Discussion of the focus group testing of the revised advisory.
4. Development of the final draft advisory after input from the focus groups.
5. FAC comments.

Status Report

The status report basically includes background on what was presented to the FAC and the FAC's response.

In 2001 the FDA and USEPA issued fish advisories, and in 2002 the FDA FAC was asked to evaluate that advisory. The 2001 FDA advisory stated three points: (1) avoid the list for the big four, (2) eat up to 12 oz of a variety of other fish (with reference to women of childbearing age), and (3) follow USEPA advice for recreationally caught fish.

In 2001 USEPA advised people to limit their consumption of freshwater fish caught by family and friends. In July 2002 the FAC needed to evaluate whether the advisory on methylmercury provided accurate protection for children and for women of childbearing age who might become pregnant.

The 2002 FAC meeting made six recommendations:

1. Better define what is meant by "eat a variety of fish."
2. Work with other federal and state agencies to bring commercial and recreational fish under the same umbrella.
3. Publish a quantitative exposure assessment used to develop the advisory.
4. Develop specific recommendations for canned tuna based on a detailed analysis of the contribution that canned tuna makes to overall methylmercury levels in women.
5. Address children more comprehensively in the advisory.
6. Increase monitoring of methylmercury in fish and the use of biomarkers.

Process to Address the Recommendations

In fall 2002 the USEPA Administrator and Secretary of HHS exchanged letters agreeing to collaborate and "bring commercial and recreational fish under the same umbrella advisory." A follow-up meeting took place between the Director of FDA's Center for Food Safety and Applied Nutrition and USEPA's Assistant Administrator for the Office of Water.

In 2002 and 2003 the FDA undertook the exposure assessment study. From April 2003 to the present, weekly meetings and joint work between FDA and USEPA have occurred:

1. Planned and completed independent external peer review of exposure assessment and revised exposure assessment.
2. Planned and held four stakeholder meetings.
3. Planned and produced draft joint advisory.
4. Planned and held eight focus groups in four different locations across the United States and revised the draft advisory based on focus group input.
5. Planned and prepared materials for the FAC.

A draft joint advisory was produced in December 2002. The advisory was revised in real time as responses were received from the focus groups and stakeholders. Also, the groups shared a tentative timeline and indicated that they would include the draft advisory and focus group testing and that we would have public meetings in fall of 2003. In July 2003 four stakeholder meetings were held with industry, consumers, health professionals, states, and tribes.

Key messages from stakeholder meetings early on included the following:

1. Need to continue research and bring new data and science into future revision, but it is still important to move forward.
2. Some concern about accuracy of tissue data in Bolger/Carrington model.
3. Concern about balanced message relating to fish and diets.
4. Concerns over timeline being too ambitious; noted that it was important to have focus groups and time for states to get on board.
5. Effective outreach and implementation to get the message out are critically important to achieving public health goals.

Between September and November 2003, the group worked together to develop the joint draft advisory that merged FDA's commercial fish advisory and USEPA's noncommercial fish advisory. In November 2003 focus group testing and real-time evaluations were conducted, including eight focus groups in four different locations. Testing of the advisory resulted in substantial revisions after the first focus group. That group did not understand the basic message and concluded that people might walk away from fish entirely. The comments were used to make significant revisions, increase clarity, and make the advisory straightforward.

In December 2003 the "final" draft advisory (post-focus groups) was presented.

Response to Recommendations

The following are the responses to the six recommendations from the 2002 FAC meeting.

1. *Better define what is meant by "eat a variety of fish."* FDA considered a number of ways to communicate: lists; expanded language; shorter, more explicit language, and so forth. Some of these ideas were tested in the focus groups. Lists did not work well in the focus groups so the result was a more truncated, explicit language on the variety of fish.
2. *Work with other federal and state agencies to bring commercial and recreational fish under the same umbrella.* In response, FDA and USEPA worked closely to develop a single, joint advisory concerning commercial and recreationally caught fish. In addition, they interacted with the states during this process through stakeholders meetings.

3. *Publish the quantitative exposure assessment used to develop the advisory.* The quantitative exposure assessment was developed in early 2003. It was presented publicly as a poster in March 2003. An external peer review was conducted, and a revised exposure assessment was developed in December 2003. The new assessment reflected two major changes: (1) it incorporated new data on mercury levels in fish, and (2) it integrated the comments from the various focus groups.
4. *Develop specific recommendations for canned tuna based on a detailed analysis of what contribution canned tuna makes to overall methylmercury levels in women.* Canned tuna is composed of two main types, albacore/white, and light. Canned tuna is one of the most consumed fish in the United States. Naming tuna specifically added a huge spotlight. The recommendation needed to be more specific. Exposure assessment scenarios were updated to address tuna more specifically. New data on levels of mercury in canned tuna were evaluated, and a specific statement regarding canned tuna was added to the advisory.
5. *Address children more comprehensively in the advisory.* FDA and USEPA determined that there was no scientific consensus to define specific age or weight in the revised advisory. More emphasis on young children was added to the text of the revised advisory, and children were not limited to the “Do Not Eat” list.
6. *Increase monitoring of methylmercury to include levels in fish and the use of human biomarkers.* As mentioned previously, two new assignments to measure mercury levels in fish were completed in 2003.

Questions to the FAC

Given the enormous interest in this issue and expectations from all perspectives, the one important point we all agree on is that we should move forward and begin our education program. As we learn more from scientific findings, population demographics, and NHANES and receive results from the education effort on consumer behavior, we might need to refine the approach. We believe that this activity should be conducted concurrently with an outreach and educational program that, in the interests of public health, should commence as soon as possible. The FAC therefore seeks the Committee’s concurrence.

National Mercury Advisory: Exposure Assessment and Peer Review

David Acheson, Food and Drug Administration

Rita Schoeny, U.S. Environmental Protection Agency, Office of Water

The 2002 FDA Food Advisory Committee provided several recommendations concerning the fish advice released in 2001. In response to these recommendations, a quantitative exposure assessment for development of the advisory was prepared and specific recommendations for canned tuna were developed based on detailed analysis of the contribution of canned tuna to overall methylmercury levels in women.

The exposure assessment was developed in two stages. The effort relied heavily on the data published in the National Health and Nutritional Examination Survey (NHANES) in 1999 and 2000. NHANES is a national survey based partly on national demographics. The data from the study can be illustrated graphically by comparing mercury blood level data on children and women of childbearing age versus both the equivalent blood mercury level of the USEPA reference dosage (RfD) and the benchmark dosage level (BMDL) from the Faroes study of the event level of various physiological tests. Graphically, it shows that there is a percentage of women below, at, and/or above the RfD (7.8%); however, no data points were above the effect level (~58%).

The first stage of exposure assessment development involved the design of a model that would closely mimic the NHANES data for blood mercury in women of childbearing age and small children between the ages of 2 and 5. The design reflected the assumption that the NHANES data showed no consumption restrictions or types of fish. One reason for this assumption was that the national survey presented unrestricted fish consumption and acted best as a baseline for comparison. The second stage involved taking the developed model and varying fish consumption, restricting it in several ways, and making predictions as to what would happen to this blood mercury level of women of childbearing age.

The exposure model could be illustrated in an exposure simulation and a biomarker simulation. The exposure simulation measures blood mercury intake from seafood consumption and looks at various fish species depending on the market share of those species in the United States. Short-term consumption data from 1989 to 1990 was used for both species and percentage of consumption. More recent data (1994 to 1996) used 2-day surveys instead of the 3-day surveys conducted in 1989 and 1990. Information was also gleaned from long-term purchase diaries (30 days). All three pieces of data were used to determine which fish species were being consumed relative to market data.

The biomarker simulation was designed to help estimate the blood or hair mercury levels predicted from various scenarios. Scenarios varied weekly levels of fish consumption one way or another, including no dietary exclusion (as outlined in the NHANES) and 12 oz per week of low-mercury fish. For the scenarios, fish were divided into high, medium, and low methylmercury levels. The high category comprised the big four: swordfish, shark, tilefish, and king mackerel. The low category included light tuna, catfish, shrimp, and salmon, among others. The medium category included albacore tuna, halibut, tuna steak, and American lobster, to name a few.

USEPA and FDA used the exposure assessment to consider scenarios and outcomes when formulating the basis for revised joint advice. The FDA/USEPA conclusions were discussed with stakeholders at a meeting in July 2003. During that meeting FDA/USEPA professed that the model closely predicts the NHANES data showing the population that exceeds the RfD and that they believe the model will be a useful tool in establishing the scientific background for the revised advisory. They also stated that the scenarios offered a way to provide information for risk management decisions. FDA and USEPA submitted the exposure assessment for peer review.

The review was performed on the poster presented in 2003 by Carrington and Bolger to the Society of Toxicology. The poster devised fish consumption scenarios and predicted blood and hair mercury for women of childbearing age and children between the ages of 2 and 5. The baseline scenario was expected to reflect the NHANES data.

The review performed was a “letter” review conducted through existing USEPA peer review contractors. USEPA and FDA described the required reviewers’ expertise and selected three reviewing contractors. USEPA approved the listed reviewers as having the requisite credentials, and the contractors were provided with all materials. Written comments were collected, and a peer review report was compiled.

USEPA/FDA asked the reviewers to address the following:

1. Was the document logical, clear, and concise? Are the arguments presented in an understandable manner?
2. Has the appropriate literature been cited? Are there publicly available, peer-reviewed papers that should be included?
3. Is the model clearly described? Are modifications supportable by existing data? Modifications include the following: expansion of fish categories from 24 to 28; filtered distributions in place of

analogues for some species; and the addition of 0.1 to 2 ppb of mercury to blood levels to account for sources other than fish.

4. Data from the Continuing Study of Food Intake by Individuals (CSFII) from 1989 to 1991 was the basis for distributions of fish consumption. This data was from 3 days of survey information versus 2 days for the later data (CSFII 1994–1996). What adjustments could be made to the compensation for the likely underreporting of fish consumption by the low-consumption portion of the population?
5. In the paper, women of childbearing age are defined as those between 18 and 45 years of age and children are defined as 2 to 5 years old. Are these the appropriate ranges?
6. Are the fish consumption scenarios logically described, clear, and supportable? Is the identification of 0.5 ppm of mercury or greater as “high mercury fish” appropriate?
7. For the purposes of the scenarios used in the exposure assessment, high, medium, and low mercury levels were set as follows: high—swordfish, shark, tilefish, and king mackerel; medium—greater than 0.13 ppm; and low—less than or equal to 0.13 ppm. Are these choices appropriate?

USEPA/FDA’s written response to the reviewers is available on the Web at (www.cfscan.fda.gov or www.epa.gov/ost/fish). This 37-page report describes the revisions to the assessment, differences of scientific opinion, reviews of comments considered outside the scope of the current analysis, and areas for future work.

Changes to the Model

The exposure assessment has been revised and expanded. In relation to mercury concentration attributes, the number of fish categories for which distributions were developed was expanded from 24 to 42, mercury concentrations were obtained for additional species, more data was collected on canned tuna, and a correction factor was applied to reflect water lost during food preparation.

In relation to consumption frequency, the model parameters used to extrapolate long-term frequency of consumption from short-term records were optimized to be consistent with the 30-day NHANES survey. The percentage of consumers was also changed from 70%–90% to 85%–95% to be consistent with NHANES. Changes in the model were also reflected in the species selected. The fraction of the annual seafood diets estimated from the individual dietary survey, instead of market share, was treated as an individual variable rather than as a population uncertainty. In addition, instead of using a range of 20%–80%, the range of individual repetitiveness was estimated using the NHANES survey.

The changes to the model resulted in the data’s more closely predicting what was illustrated in the NHANES report. The new advisory scenarios included (1) limiting total seafood consumption (6, 12, or 18 oz per week without regard to species); (2) restricting the species consumed (no limit on amount of fish consumed, and consumption should be limited to middle or low groups, or the low group only); (3) restricting both amounts and species. The baseline result of the model represented unrestricted consumption of fish. As the amount of fish consumed was restricted, the predicted blood mercury levels went down.

In summary, (1) many changes have been made to the exposure assessment; (2) for women of childbearing age, the model now generates slightly higher values than the NHANES survey, rather than slightly lower values; and (3) lowering seafood consumption by limiting the amount consumed and/or the species consumed can be expected to reduce higher levels of exposure to mercury from seafood encountered in the U.S. population.

Panel Questions Regarding Mercury (Session 3)

Q: Michael Bender, Mercury Policy Project: I have a comment and a question for Dr. David Acheson. Could you please summarize the reaction and recommendation of the Food Advisory Committee to the draft fish consumption advisory presented at the December 2003 meeting? And then my comment: I was at the meeting, and what I heard the pack say was that it was a good idea for FDA and USEPA to get together, but that you didn't get it quite right, especially for the albacore white tuna, and that there wasn't adequate information identifying low-mercury fish. Could you please elaborate?

A: David Acheson: Actually, that's the subject of a subsequent presentation that's going to happen this afternoon. If it's okay, I'd rather leave it until then where I'll be expanding on what we heard there.

Q: Michael Morrissey, Oregon State University: In the first two talks, Kate and Alan spoke very strongly about the interaction between omega-3 fatty acids as a mitigating effect for mercury. Rita, are you saying that that is not taken into consideration in terms of the mercury advisories?

A: Rita Schoeny: What we don't have at this point is any sort of a formal prediction as to a degree of risk or a diminution of risk or interaction between the omega-3s and the mercury. Apart from the fact that we're trying to design our advisory to ensure that people will continue to eat fish, we're not talking specifically about mercury versus omega-3s.

Q: Michael Morrissey: But you say that in the future as more information comes in, that can possibly be put into the model as well?

A: Rita Schoeny: I think that is a possibility.

A: Kate Mahaffey: Just as a clarifying point, I really didn't make that point at all. What I was saying is that different fish contain very different amounts of omega-3s as well as very different amounts of mercury. And I think that what Alan was saying is that there is an interaction between omega-3s and mercury in terms of coronary heart disease, not that omega-3s are protective against mercury.

Q: Johanna Congleton, Physicians for Social Responsibility, Los Angeles: I had a question about a comment that was made earlier regarding labeling cans of tuna—that one of the reasons for not putting a label on cans is that there's not enough room on the packaging. I'd just like to point out that a long time ago we decided to make room for nutritional information on all types of food products, some of which is specific to high-risk populations, such as saturated fat, sodium, that would be important for people at risk for heart complications. So what's the difference between warning women of childbearing age or vulnerable populations about mercury exposure and accommodating that on the packaging? Please share your thoughts on that.

A: David Acheson: I guess that's directed at me. I certainly don't want to give you the impression that we are bound by the space on the can. That wasn't what I wanted to leave you with. I think that what I want to leave you with is that our goal is to develop the most comprehensive public health message and find the most appropriate way to get that message over to the at-risk individual. If putting the label on the can is a way to do that as opposed to any other way, then certainly we'll take that into consideration. Again, what I was trying to allude to is that it's a complex issue of how one labels tuna for the presence of mercury. And, as we're beginning to hear, the issue of fish consumption is about more than just mercury. There is the positive side of fish consumption. There are potentially other contaminants in other types of fish. You'd have to just think this through very carefully in terms of where one drew the line and what exactly was said. But I think that the bottom line is that what we're really interested in doing is (and I

think I speak for both FDA and EPA) we want to get the right public health message out using whatever tools are at our disposal to do that. If that includes considering labeling a can, then we'd think about that.

Q: John Cox, Confederated Tribes of the Umatilla Reservation: I heard one of the panel members mention that she'd been involved in fish studies since 1993. I've been involved with the study of fish all my life and my mother also and her mother also, and her mother's mother, and all my ancestors. So we've been involved with fish for a long, long time. They're a part of who we are. When you teed up the recommendation, Mr. Acheson, one of your recommendations was to work with states and other federal agencies. Then Ms. Keehner later mentioned states, other federal agencies, and tribes. I'm wondering: Which is it? That's one question I have.

A: David Acheson: Well, what I had on the slide was a direct quote from what was taken from the recommendations of the Food Advisory Committee. It is our intent to work with all interested parties involved with developing advice on fish. That, absolutely, would include working with tribes.

A: Denise Keehner: And we did, in the stakeholder meetings, actually organize a conference with tribal representatives during that stage of the process. So we at EPA and those at FDA are interested in getting input from tribes as well as states.

Q: John Cox: For the audience's sake here, I know it's close to lunch, but there are over 550 federally recognized native tribes in North America, and there's something like, what, 50 states or so. So in terms of your consultation, I'd just like to ask from what percentage of coverage did you get input in doing that? That's one question. The other question is that you said that you broke up the country into quadrants, like you had four large meetings. How representative would that be of a whole nation in multiple groups like this?

A: Denise Keehner: Jeff, do you want to give the specifics on how we organized the tribal call for the stakeholders? Then we can talk about the focus group issue.

A: Jeff Bigler, USEPA: Yes, EPA works with a group of about 60 to 70 tribes from across the country on mercury issues. It's a group that's been developed over the past year and half or so. The invitation went out to between 60 and 70 tribes, and we had responses from 3, and 3 joined the call.

A: David Acheson: In relation to your question about breaking the country into quadrants, are you talking about in terms of the focus groups or in terms of the stakeholders?

Q: John Cox: Stakeholders is what I believe I'm referring to.

A: David Acheson: Okay, the stakeholders were not broken into quadrants. You're right. There were four groups, but they weren't really organized by geography. They were organized by interest. So we had an industry group, we had a consumer and health professional group, we had a state group, and tribes. It wasn't geographically based.

Q: John Cox: Once you get the mic, you shouldn't give it up. I know there's more room for comment, and that's why I'm here to engage. I'm concerned about, as I see the panel and the fixtures on it, we've got the Food and Drug Administration, people who are taking care of our food. We've got the Environmental Protection Agency, the people taking care of the environment. We've got various health organizations, the ones who are taking care of our health. I'm concerned that issuing a fish advisory, which is where it seems the meeting is gravitating, really doesn't fix the problem at all. So I see these organizations that are responsible for this, you know, and how are we going to get at fixing the problem? Just something to think about maybe. I don't expect an answer to that, but I expect something to be done.

Q: Joe Sekerke: I have a question about the ratio of maternal blood. Was it total mercury or organic mercury that was measured in both places?

A: Female panelist: They've looked at both. Alan may wish to comment specifically. There are studies that have measured total mercury and studies that have measured methylmercury.

A: Alan Stern: The analysis that Andy Smith and I did was based on published studies in the literature, some of which had methylmercury, some of which had total mercury. Greater than 80%, and generally greater than 90%, of the mercury in blood from people who don't have occupational exposures is methylmercury. Nonetheless, it was pointed out to us in review of the paper that the ratio was different for methylmercury-only studies versus total mercury studies. We recalculated and addressed that. I'm trying to remember which way the methylmercury-only studies went, but we addressed the fact that the methylmercury-only studies appeared to be different from the total mercury studies by a little bit, not by a lot. Overall, the values that we recommended and used in the dose reconstruction reflect both. It does make a lot of difference.

C: I believe the most recent Japanese study is based on organic, or methylmercury.

Q: Trina Mackie, UC Berkeley: Somebody earlier mentioned that there's been a need for some time for EPA and FDA to sort of come together and synchronize their recommendations.

A: David Acheson: It was the right thing to do.

Q: Henry Anderson: How does the model fit if you add in the sport fish consumption? Some of these surveys, even though there's a lot of licenses sold and a lot of people eat fish, it's still only about 20% of the women who eat fish, so they don't tend to appear in your national survey. And since we're interested in the sport fish side, and those who are successful may eat nothing but sport fish and a lot of it, are we going to be able to use this model and fit it together with our freshwater fish? As we saw, it varies considerably across the country, as does consumption.

A: Rita Schoeny: I think that the model structure and the data are certainly adaptable to more local situations. The way that it was run here is obviously reflective of market share, so obviously you don't get sport fish. It was also reflective of the 30-day purchase diary, so you do pick up some the sport fish there. And it was reflective of NHANES, so you pick up a little there as well. But again, it's not going to be reflective of the situation, specifically in the Gulf or in Minnesota or Wisconsin, for sportsfishers. In terms of being able to use the structure and do your own data inputs, it's usable.

Q: Kate Mahaffey: A question I have, which maybe Alan can answer better, is how do you think this model would work if you extrapolate to the higher exposures? Is there enough linearity in what we know of dose-response from the metabolic studies, most of which were done at high exposures anyway?

A: Alan Stern: Just so we don't get confused here, the model that Henry was just talking about was the exposure model, and you're talking about another model.

A: Kate Mahaffey: Yes, and it's an important distinction.

A: Alan Stern: Right.

C: Unnamed female panelist: ...maybe it's left alone at this point.

Q: Eric Uram, Sierra Club: Children's needs were one of the big questions raised regarding FDA's warnings, and knowing that children are not just small adults and that they have different aspects that need to be considered in the fact that their bodies are developing as they grow. EPA's reference dose is a weight-based reference dose, yet you decided that age and weight were not to be included in the language that you were putting out there. You felt that more general language would be appropriate to use. Could you elaborate a little further on why you decided to go against an age- or weight-based type of approach?

A: David Acheson: You're right. The reference dose is 0.1 mg/kg. My understanding is that the origin of the reference dose is based on defects in the fetus from maternal consumption. The difficulty we ran into was prescribing specific consumption amounts for children of different ages because the variable that we have is how much fish can you eat for a given age. But it's not just age; it's also weight. You may have a 5-year-old who's 40 lb, and you may have a 5-year-old who's 140 lb. That's a whole other problem that FDA is trying to address. But it's out there. Part of the difficulty is coming up with something that is consistent because it's not simply linear. We thought about that. We thought, can you take an average woman, 140 lb, 12 oz, and say, okay, for 70 lb you could make it 6 oz a week? And then for 35 lb, you could make it 3 oz per week? How does that play into age? A 70-lb individual may be 5 years old, may be 10 years old, may be 15 years old. How do you kind of work all of those variables in and yet retain a message that's understandable by the population as a whole? I'm not saying it's off the table. If we develop some science that will allow us to do that in some way, that retains the simplicity of the message and protects public health and is based on good science, then we're all ears. I would love to be able to do that because it's been raised over and over again. I'm not saying that we're not doing it because we won't do it. I'm saying that it's too difficult in the context of what we know and how to maintain the simplicity of the message. Hopefully, that gives you a little background as to why we're struggling with this. It's not off the table, that's for sure.

C: One comment about the reference dose. Since EPA's reference dose was used in the analyses, and so forth, it underlies some of our thinking about how to approach a fish advisory. The reference dose, as EPA constructed it, was based on a developmental exposure, a developmental endpoint. It is meant to protect the general population against any other kind of effect. When we have sufficient data, we can calculate a reference dose that would be specific for a particular age group or life stage. At the point where we did our reference dose, and taking advice from peer reviewers and from the NRC, we felt that there were not sufficient data to construct a specific reference dose for children. So in terms of the child issue, we're dealing with the adult reference dose, if you will, although based on a developmental effect. So the only question would be how much, on this milligram per kilogram basis, not trying to use a different reference dose that would try to account for any difference in susceptibility for children.

C: Just to follow this a little further, obviously neurological development for the very young does not cease at birth. The thing that is still under a lot of assessment is the period, say in the first year of life, and the effects of methylmercury during that period. I really can't even say a scenario is under active investigation because I frankly don't know the answer to that. It's certainly an area of active interest to people who assess risk. Having looked pretty closely at the NHANES data, I can tell you that given what we have of ages 1 through 6 within NHANES, and knowing based on the cord to maternal ratios, at birth we would think that, and reasonably anticipate, the infant's blood mercury is going to be substantially higher than that of the mother. By age 1, those blood and hair mercury levels are a lot lower than the mother's; in fact, they're about a quarter as high as those of the adult woman. We don't really know what accounts for this except reasonably the methylmercury exposure during that period of life has to be a lot lower than that which would keep up with the growth rate. So I think that what we're seeing is a lot of dilution through rapid growth. All of this is to say that we really don't know the impact of mercury exposure during this period. To second Dr. Acheson's point, scientifically at this stage we're not altogether clear on what to say.

A: Alan Stern: Just very briefly to back that up, from a risk assessment standpoint, there are no studies that specifically address the effects of methylmercury on development postnatally. And beyond that, we don't really understand what the mechanism is that's operating prenatally. If we knew what the mechanism was, we could then extrapolate it, or not, as appropriate to the postnatal period.

Q: Arnie Kuzmack, USEPA: Regarding this last discussion about the very small children, I was just wondering whether the NHANES dataset includes information as to whether the children were breast-fed. Could you try to do a correlation there? This presumes that breast-fed children were exposed to methylmercury and the formula-fed children were not for the most part in the first year.

A: I actually don't know. We can easily look it up.

Q: Henry Anderson: It seems to me that this model, the exposure assessment model, would be very helpful to states as well as to tribes. Is there any plan not only to make it available but also to provide perhaps some training? I know, for instance, that in Wisconsin, the Chippewa eat a lot of fish, but the fish they're eating are quite different from those of the Umatilla, who are eating a lot of fish as well. It would be helpful for these groups to be able to put in their fish values and their consumption rates and perhaps use this model to get an understanding of how they might vary their consumption, what impact various advice or selection of a type of species might have. So it would be very helpful, once you roll that out. This is a tool that we could use to get a sense of what our expectations are. It would be quite helpful. Thank you.

Mercury Focus Group Testing Results

Marjorie Davidson, Food and Drug Administration

The Methylmercury (MeHg) Consumer Advisory was targeted toward women who may become pregnant, nursing mothers, and young children. The USEPA/FDA used a total of eight focus groups to address the information placed in the new advisory.

Focus groups are a qualitative approach to research, and they were first used during World War II to survey troop morale. A focus group is a small discussion group of 5 to 10 people with certain common characteristics. The purpose of the group is to find out what the target audience thinks and feels about a particular issue, product, or service.

USEPA/FDA organized and held a total of eight focus groups in four locations of the country where consumption of different types of fish was prevalent. These areas were Calverton, Maryland; New Orleans, Louisiana; Seattle, Washington; and Minneapolis, Minnesota. The focus groups included a mixture of genders and education groups, and they included pregnant women, parents of young children, and women of childbearing age. All eight focus groups were held in November 2003. The focus groups were conducted through an iterative process. Changes were made incrementally to the advisory as the focus groups progressed throughout the month.

One of the goals of the focus groups was to examine the risk communication formats to see if USEPA and FDA were presenting the information in the best format possible. In addition, it was important to gauge consumer response to the advisory, paying particular attention to the incremental changes made to the advisory along the way. These included the enhanced attention to young children, the merging of commercial and noncommercial fish, and a more detailed discussion of canned tuna.

One of the most important aspects of the fish advisory was to balance the perceptions concerning minimizing the risks from methylmercury in fish while not jeopardizing the health benefits from eating fish.

The USEPA/FDA gleaned numerous findings from the focus group process. First, people wanted a simple message and they wanted to know exactly what harm would come to a child's development if he or she consumed high amounts of methylmercury and what should be done to avoid those high amounts. Some persons wanted more information. They were interested in knowing how methylmercury would affect the health of their baby or child, they wanted more data on particular types of fish species, and they wanted to know how methylmercury would affect other family members.

During completion of the focus group process, it was determined that information about the differences in methylmercury content in tuna steaks and albacore tuna versus light tunas was new to most participants. Most participants were not aware of the differences between types of tuna in general. Some people said they would begin to avoid tuna steaks and albacore tuna altogether.

Many participants had a similar perspective when it came to consumption of recreational fish. The advisory mentioned avoiding commercial fish when consuming recreational fish. To most participants, this was new information. Some participants thought of fish consumption as a whole and did not separate commercial and sport-caught fish.

Upon completion of the focus group process, almost all the participants reported that they will avoid species on the Do Not Eat list. Some of the participants stated they will eat less fish, while others said they will serve less fish to their children or choose to find other sources of protein. Most important, many participants noted that they would tell others about the risks of fish because if fish can be risky for pregnant women, it probably isn't good for other people.

In conclusion, the participant reaction noted was that, although there was no fear caused by the advisory, most women will not exceed the safe fish consumption level advised. The challenge will be to ensure that women, and the children they care for, continue to eat fish as an important protein and nutrient source in their diet.

National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory

Jim Pendergast, U.S. Environmental Protection Agency, Office of Science and Technology

National Mercury Advisory: December 2003 Committee Meeting to Address the Joint Advisory

David Acheson, Food and Drug Administration

USEPA and FDA are nearing completion of a joint federal advisory on the amount and types of fish that women of childbearing age and young children should avoid to keep methylmercury from reaching harmful levels. This revised advisory takes into account a series of recommendations made at an FDA Food Advisory Committee meeting in 2002. The draft joint advisory reconciles differences between the 2001 FDA advisory for commercial fish and the 2001 USEPA advisory for recreationally caught fish, thus providing consumers of fish with a unified and clear message on the amount of fish that they can safely eat, regardless of the source. It provides information on what types of fish women of childbearing age and young children should not eat, and on the types of fish they can eat, up to 12 oz (2 meals) per week. It also provides information about local fish advisories and tuna. The advisory, once final, should help result in a decrease in blood mercury levels in women of childbearing age.

Panel Questions Regarding Mercury (Session 4)

Q: Henry Anderson: I would simply say that 85% of advisories is how you get the word out. And we have not heard here, and so our opportunity is to provide input on how you implement this and how you get the word out. I didn't see anything on the slides here that fits on a refrigerator magnet, or a sippy cup, or any of the other kinds of tools that we've used. A campaign, if this is going to be a campaign, has not yet been delineated at least to us. So I think we can think about how we should do this. We're the ones with a lot of experience on this. How do we get that word out? When we get into the breakouts, they really would like some advice on that, as well as what the message is.

Q: Eric Uram, Sierra Club: A quick comment on the commercial versus recreational. You went to lakes and streams and figured that was all-encompassing, but you failed to acknowledge that marine areas are fished recreationally as well. You need to include other waters besides just lakes and streams, so it's not just inside the states that they're concerned with. My question is regarding what was brought up earlier today, which is the 12-composite aspect that FDA decided was the way that they were going to sample and analyze for the mercury content in fish. I feel that falls short. You really need to do something because there has to be a gray area there. A person cannot eat 12 meals of fish and actually average out all of those and still be safe. When you do the numbers in the comparison, with the amount of mercury that was tested in that 12-composite sampling, a person would not be able to eat all of those 12 meals and bring it down to the level of the composite sample. So what you need to do is go back and analyze for those areas where they wouldn't be able to do that. Go to a smaller number in a composite sample, or even to individual samples, and get a better assessment as to where those peaks and valleys are. Because certainly with a 12-composite sample you're knocking off a lot between the upper and lower bounds and putting it into the middle. We need to have a better idea of what's going on with that upper bound especially. Given that, can you comment on what FDA is going to do in the future regarding a 12-composite sample, or is there going to be any other directive to find out what is actually going on?

A: David Acheson: I addressed that this morning. There was a similar question earlier about the value of the composite samples and what the purpose of it was in terms of where we were trying to go with it. The current assignment will be conducted in the same way, with 12 composite samples. There is no immediate plan to change that. But your comment is valuable, and we'll take it into consideration as we move forward on that.

Q: Eric Frohberg: Regarding the list of low-mercury fish that you talked about developing, has there been any interest in looking into regional variation on how fish get distributed? I tried to look into that for Maine a bit, and the industry is very tight-lipped about what fish goes where. My interest was because we never see king mackerel up there. I'm wondering if there is a way that you can more effectively tailor the list of low-mercury fish to those regions where they're commonly consumed? We don't eat a lot of catfish, for example, in Maine. I presume folks down south eat a lot more catfish.

A: David Acheson: I can certainly offer you a response to that. I think that the difficulty is trying to develop a national advisory that relates to the nation as a whole. Part of where we're going with this, as I pointed out earlier, is that we saw these differences in tilefish. Obviously, you ask the questions: Why? What does that mean? Are tilefish from one area closer to the old data, and tilefish from another area closer to the new data? Obviously, if we knew that, it would be a good idea to communicate that to the public so they could determine what to do. I'm not saying that what you're suggesting isn't a great idea. But it's coming to the point where it would be so complicated if we started to have geographic distributions, and our focus groups have told us that complicated isn't good. That's not surprising. We're really trying to hit the common denominator across the country, and that's part of the dilemma.

Q: Eric Frohberg: Yes, I see your point. I can see a need for a national advisory but then pairing with states and regions to help the states to communicate the advisories. So, for example, we have a very active program in Maine distributing our local advisories as well as FDA's advice, but if we could get information that would help direct folks to low-mercury fish that are commonly marketed in New England, that would be valuable.

A: David Acheson: I don't dispute that for one minute. And certainly, again, to go with the tilefish example because there's something going on there, if we learned that the tilefish from a certain part of the country were low, it would make all kinds of sense to work with the states to communicate that locally. It wouldn't necessarily change the national advisory.

Q: When going forward with the advisory, you will have some tweaks. Will one of the tweaks be to reduce the advice from 12 oz a week of a variety of fish to 6 oz a week? The second question concerns the process of finalizing the advisory. I know that at the Food Advisory Committee one of the members was asked by the chair to put some specific recommendations in writing. I think that included a recommendation whether to include albacore on the Do Not Eat list and some other things. You alluded to the fact that there's a report coming. I wonder if you can shed any light on the timing of that and how that interacts with the focus testing that you're doing this week. What it sounded like you were hoping to do is finalize the advisory right after the focus testing. How does that all interact?

A: David Acheson: That's a whole bunch of questions. Let me try, and if I forget one, pick me up. First of all, we did not hear any specifics from the Food Advisory Committee to reduce from 12 to 6. That would be quite a tweak to do that. Certainly, the Committee is able to make those specific recommendations. If it does, we would certainly take that into consideration. The other point to make is that the FDA is not bound by what the Committee recommends. It's simply an advisory committee, and we're not bound to follow that, but obviously we pay close attention to it. Your second point was about the timing of it, in terms of when we expect to get comment on it. What's expected is that the minutes of the meeting will be signed off by the Chair. The Chair, Dr. Miller, raised the possibility that the transcript would be circulated to members of the Committee to come up with some recommendations or some consensus. I think he's still deciding whether he wants to do that or whether he's simply going to address the minutes himself. If the Committee comes up with recommendations that go beyond what we have taken as take-home messages and we feel that they're important, clearly we would have to incorporate that as we move forward. We're all very keen to keep this process moving as fast as we can. As I pointed out earlier, it's an ongoing process. Once we've got an advisory out there it's not done, finished; it will always be subject to change as new science and new information come along. So we're not anticipating anything radically different from the way we are going in terms of what the Committee is recommending. If it does, we'll clearly take that into account.

Q: Oh, right, the albacore recommendation. Do you expect something forthcoming from the Committee regarding putting albacore on a Do Not Eat list?

A: David Acheson: That's up to the Committee. We, FDA and EPA, as we were listening to the discussion, did not come away with a sense that it was going to specifically recommend that. You're right. There was a lot of discussion about that, and certainly some members of the Committee said that they felt it should be and I think others said no. What we heard at the end of the day was that they didn't question specifically that the avoid list should be changed or that the 12 oz should be changed. We'll see. They might, but my guess is that that won't happen.

Q: Tom Hornshaw, Illinois EPA: I have to take strong exception to the part of the message that tells pregnant women to see their doctor immediately if they think they've eaten high levels of mercury, or whatever it said, for several reasons. First of all, I think that the tone is way out of keeping with the rest of

the message. It sounds way too scary. I can even envision where women would go to a doctor and say, "Do I need an abortion right away?" Second, where it says "high levels" that's pretty unspecific. You have to give some education to the general population on what high levels of methylmercury might be. Third, sending them to a physician is probably the worst thing you can do because the physicians don't know anything about methylmercury risks. We have a program at Illinois EPA where doctors who are ending their residency come in and spend an hour with the IEPA toxicologist so that we can actually give them some discussion about environmental risks. We talk to them about lead-based paint, about mercury in fish, about Superfund sites, and things like that. From my experience, there's maybe 1 out of 20 or 25 of these residents who had any clue at all about methylmercury. If this an indication of what other medical schools are doing and they don't send their students to talk to environmental toxicologists, I expect that when a woman comes to them with questions about methylmercury, they're going to say, "I can't help you." The last part of it is, when they get there and they say, "I've been exposed to methylmercury from eating fish," the physician is going to say, "Well, then stop eating fish."

Q: Joe Sekerke, Florida Department of Health: Does anyone have any data that show that any of the shellfish have high levels of mercury? I haven't seen anything, and I'm just wondering if I'm just missing it or if it's out there or not. What about lobster? I haven't seen any real high levels of mercury in any of the shellfish. Has anyone seen anything different?

A: Lobster? Maybe we ought to change it from shellfish to lobster or get some more data to give a better idea because that's another that's going to have the omega-3, but it's a very popular source of seafood people eat. And I think that we ought to give them a little bit more specific information about what shellfish should be avoided or which ones can be eaten.

Q: Kathleen Schuler, Institute for Agriculture and Trade Policy: One of the key recommendations from the Food Advisory Committee, in its written report, was that FDA use the EPA reference dose in the fish advisory. My question is this: By advising women to eat 12 oz a week of a variety of fish, while I commend FDA for its intention of adding some low-mercury fish, that advice could put people at risk and could expose women unnecessarily to a dose over the reference dose because, say, they pick bluefish or tuna steak. Even if they ate that twice, they'd be over the recommendation. And even if the states start incorporating some of the commercial fish and are consistent with the EPA guidelines, there won't be an equality between what the states are saying and what the federal government is saying.

A: David Acheson: It's the way we view the reference dose because you're really sort of saying that we're basing this advice on the reference dose, and we are. But it's like how do we take the reference dose and use it to develop this advice? I think the answer to your question is that we don't regard the reference dose as a bright line, that 5.8 is okay and 5.9 is not, and 6 is not and 5.7 is okay. That's not the way we're approaching it. We regard the reference dose as a target that we're trying to move people toward. And we're doing it in such a way that we encourage people to continue to eat fish, that we continue to try to keep people safe. You're right. If you were to eat a serving of albacore tuna and a serving of orange roughy and if you take our average levels that we find from the data, yes, you'd be a little bit over the reference dose. We know that, and NHANES would support that. What the exposure assessment has told us is that if we could get people to follow the advice, we would be making some progress toward the reference dose. If you remember the slide that Rita Schoeny showed, yes, we wouldn't get everybody below it, but we would be making some progress toward it. I think the approach that we're trying to take here is to try to get a balanced message that doesn't come across as being so punitive that people are going to stop eating fish and to accept that the reference dose is not a bright line. Now everybody may not accept that that interpretation of the reference dose is correct, but that's how we are viewing the reference dose in the development of our advisory. It is a guide that we are trying to move people toward. We know that some will be a little over it, but we accept that. As time goes on and we

learn more about this and we gather more information about fish, maybe we can revise this to get people even further down. It's an ongoing process, and that's essentially the approach we've taken.

Q: Susan Boehme, New York Academy of Sciences: Yesterday we heard a presentation on focus groups and what you can use them for and what you can't use them for. Specifically, you cannot use them for awareness, and you cannot use them for knowledge. Yet it seems to me in your presentations that you definitely did use what you heard in those groups as knowledge. The issue of what is mercury, for instance. You heard that from one person, and you went and changed the advisory because of that. My comment is that if you're going to be doing more focus groups, be very careful about how you use what you hear from those focus groups, and apply it correctly because you have the expertise available to you to apply it correctly.

A: James Pendergast: Let me add something to that. You're very right. Dr. Bradbard yesterday talked about what you can and can't use focus groups for, and we recognize that. We also know that this is why we talked about additional information. Where people are starting to ask questions, and not just one but when more than one start asking questions, these are the same questions that some people are also going to ask when they read the advisory, if it was just the advisory. So we didn't have some way of being able to point people to where there's some additional information. There's a balance between pointing them to a Web site for all the information or starting to put some frequently asked questions in as an addendum and then off the Web site. What we were trying to balance from there is where to go for further information for those who wanted it.

A: Marjorie Davidson, FDA: Also, it isn't a case of knowledge. It's about developing a message so that they can understand the explanation of what mercury is.

Q: Bob Brodberg, California EPA: This is good—I'm following up on the focus group questions here. I wanted to check and see if a couple of things were understood in the focus groups, if you tested them or not. One is that the exposure assessment that you did is based on cooked size portions, and actually that's going to be different. A lot of the states start talking about the 8 oz instead of the 6 oz that you are. That's something that's going to show up as a little bit different in the messages right away. Did people in the focus groups understand that you're talking about cooked meals? It makes a certain amount of sense because that's what they're eating. The second thing was (and I can't repeat the language that you're using recently to talk about women of childbearing age), you go through a number of iterations to really talk about women of childbearing age. Someone actually said that at one point—you know, "women who are pregnant," "nursing mothers," and now "women who might become pregnant," which is a bit of a change, an improvement. So why not kind of go all the way to "women of childbearing age"? It is still nebulous. What are the ages? But did you look into that in the focus groups?

A: Marjorie Davidson: I am not quite sure I understand. Did you mean distinguishing between "women of childbearing age" and "women who might become pregnant"? Can you clarify the question?

Q: Bob Brodberg: I just wonder. Overall, isn't that a lot simpler language? And covers all of the groups that you've laid out there?

A: Marjorie Davidson: The "women of childbearing age" as opposed to the "women who might become pregnant"?

Q: Bob Brodberg: And the rest of them—women who are pregnant, women who might become pregnant, nursing mothers. I guess you didn't test that at all in the focus groups and that it didn't come up. So that's really what my question was. Then the second part is we can recommend that you consider that or not everybody may like it. But you didn't test it.

A: Marjorie Davidson: We've looked at both, but the trouble is that 50% of the women who don't plan on getting pregnant get pregnant, so we had to capture that group. But we also wanted to make sure that it's not a concern for people who just aren't remotely in that category. That's how we walked the fine line.

Q: Bob Brodberg: Even if you're not planning to become pregnant, you can still be of childbearing age. Did they understand that you were talking about cooked meals, or did you not test that?

A: Marjorie Davidson: We didn't really test it, but the conversation centered around cooked meals.

Q: Johanna Congleton, Physicians for Social Responsibility, Los Angeles: I have a question and a suggestion to follow up with a question. The question is how does the FDA plan on proactively, beyond just posting something on a Web site, communicate the advisory and the risk to the public, particularly health professionals? The reason I ask is that we conduct a statewide program with the California Department of Toxic Substances Control. It's a pollution prevention and health professional education program where we switch out mercury blood pressure gauges at community clinics and give the staff an hour-long educational workshop on risk communication and exposure prevention strategies so they can talk to their patients about this, particularly the staff that has the most interaction with the patients—nurses and health educators—really, if they have a vague understanding at best about the problem of mercury contamination in fish. There's also the issue that most low-income women or women who are uninsured get their prenatal care at these clinics. So it's very important. My suggestion is to target clinic associations. We have a number of them in California, and I'm sure other states are set up the same way. To kind of proactively disseminate this information so health providers are getting the message while they're administering prenatal care. If you could, let me know what other plans you have for educating that particular population.

A: Marjorie Davidson: Sure. I'd be happy to. What we plan on doing is distributing on a broad scale through all associations of health educators that deal with this particular audience, including WIC clinics. We also will be contacting physicians, as the gentleman said before, with also true knowledge that that isn't always the strongest place to go to get that information passed to these women. Because they are busy getting all kinds of other information in the short meetings that they have with their physicians. FDA has ready to go, as soon as this issue is resolved, an educational program targeted to pregnant women that's for use by educators, not to the physicians, but more to the nurse midwives and the nurses who are doing the training in the facilities. It has a video and a Web site as well as a curriculum, for those folks to use. We're also going to be using the media extensively. We've talked about this a great deal at FDA because the vast majority of women do get this kind of information through the media, through pregnancy magazines, through books on what you should do now that you're pregnant or that you're planning to become pregnant—those kinds of outlets. But I want to stress this: I know that so often the common belief is that we send it out there once and everybody gets it, but we have to repeat it over and over again, year after year, until it gets absorbed into the mind set. So we want to work very much with the states, because you're the folks on the ground who are getting the information out to people. It's one of the discussions that will be taking place in the near future.

A: James Pendergast: On top of that, at EPA we've had an agreement with ATSDR for many years on distributing information to primary care providers and we make use of that. As Marjorie was saying, it's multiple ways of getting information out and repetitive. You never can tell what's the best way because there is no best way. The best way is when someone actually has the information in front of them and starts paying attention to it.

Q: Johanna Congleton: Could I just also add that with this program we have an educational brochure translated into eight different languages, including five Pacific-Asian languages. So if anyone would like a copy, you can come talk to me or grab my card.

Q: Rob Riesch: A minor suggestion on communicating to the public the balanced message of minimizing risk and maximizing the benefits of eating fish. They are publicized as low-fat, high-protein, and omega-3 fatty acids, but I have never seen any message saying that fish is an excellent source of selenium. Selenium is an essential micronutrient, an antioxidant, and has plenty of evidence suggesting that it has protective effects against toxicity. The message needs to be made more loudly.

Q: What is known about selenium in different types of fish?

A: You don't want to have too much selenium. Selenium levels are typically not elevated. They are only elevated where it is concentrated in the food web, such as predator fish and shorebirds. Average levels of selenium in commercial and sport fish are pretty low.

C: Peter Fleur, American Fisherman's Research Foundation: Are there any here from the east coast old enough to remember the chant "Attica." I feel like I should chant "Alamon." But moving beyond that, I haven't heard anything today or yesterday to indicate that we have any information that the levels of methylmercury in tuna have increased over the past 40, 50, or 60 years. With better testing methods now, we can detect a smaller amount. However, the only evidence on this question indicates the opposite. Information from Hawaii shows no change in the level of methylmercury in tuna. I'm also unaware of an epidemic of Minamata flooding hospitals. It is puzzling that there are so many resources spent on this particular problem as opposed to PCBs, polyphenolchlorates, etc. Mercury seems to have really gotten people's attention. I am also aware that the consumption of tuna in the U.S. appears to be declining.

In this morning's presentations from Hawaii, our colleague showed high methylmercury levels in albacore. It is worth pointing out that it was all from 3-lb and larger fish. The kind of fish I've been talking about ranges from 8 to 12 lb. You'll see a poster presentation by Oregon State University that will demonstrate that and will add to your knowledge about this testing.

One more question on a comment in the new draft advisory: "May take over a year for levels to drop significantly." Again, this is with respect to methylmercury. The research that I'm aware of indicates that the methylmercury in your blood drops *significantly*, depending on what we mean by that, after 2, 3, and 6 months. That is a question I would like clarification on. What is the basis for that language in your advisory?

A: I'm not going to get into why we focused on mercury, which seems to be the topic of the day. I agree with you that there are other public health issues out there that we should pay attention to and that will have impacts on the resources we spend and how we divvy up our time to get the job done to protect public health. On the issue of how long it takes to get mercury levels down, that is based on the half-life of mercury, which is between 50 and 70 days. It is possible to argue on the term "significantly," but if you calculate that it takes about five to six half-lives to get something down to negligible levels, that would amount to a year. Arguably, three to four half-lives can be a significant decrease; however, the issue is not a drop but what it takes to get rid of it.

C: Jane Hightower indicated in a study that the amount of methylmercury in the blood of her patients dropped significantly after they stopped eating fish for as little as 2 months. I think there might be other people here from Physicians for Social Responsibility who might be able to add to that.

C: Well, if you say that the drop is half the amount, in the space of 60 days, that's all you are getting and that is the point.

Q: Michael Bender: A question for David Acheson. My recollection of the FAC discussion (pending final summary notes of the meeting) was that albacore tuna should end up either on the Do Not Consume list or

the limited consumption list. There were a variety of opinions. This is not a tweak. It is a major issue that was discussed not only in December but also in July 2002. Also to point out that there are now 12 states that warn about women and consumption of tuna, and a number of states are going to be saying something about the white versus light issue. We just conducted a distribution analysis of the FDA dataset that we got through FOIA (I have copies for people), where we combined our small dataset of 60 from the Mercury Policy Project with the FDA dataset. What we found was that the top 5% of cans had mercury levels over 0.64 ppm. Are you going to do any analysis on your recent dataset?

A: David Acheson: I didn't quite understand what you meant in your question. You are suggesting that we do some further analysis but in what specific way?

Q: Michael Bender: In terms of, for instance, what percent of people would be exposed at what level of mercury? We have 300 positive samples out there. Let's just work off that. Based on our analysis, the top 5% of cans have mercury levels over 0.64 ppm. When we combined it with our dataset we got an average higher than just the FDA dataset of 0.39 ppm. Another instance: the state of Washington did some kind of analysis where they estimated that 10% of children were going to be over the RfD. If you apply consumption rates to the data that you got, what percentage of people, say women and children, are going to be consuming what levels of mercury in fish in your canned tuna dataset? It looks like it is a robust dataset, though I did not hear till today that it was a composite of 12 fish. You are talking about 12 times 300, so that is a very significant dataset.

A: David Acheson: The presentation that Shirley did this morning did what you recommend. Those data from the new tuna, as well as the old data, were incorporated into the exposure assessment. The assessment doesn't integrate the data that you indicated, but it does integrate the data that I spoke about this morning. Basically it looks at the cross section of amount found in the fish and people's consumption. So I still don't understand what you are suggesting that goes beyond an exposure assessment.

Q: Michael Bender: I guess in terms of your overall recommendation, there was a question earlier about whether or not you are going to bring it down to 6 oz per week recommendation, which is what I saw the Bolger analysis basically say—that when you got the 12 oz of fish that is averaging what these canned tuna dataset, albacore is, you are going to be in exceedance of the EPA RfD, and in some cases, far exceed EPA's RfD. So I'm not sure why you are still not considering recommending less than 12 oz. I thought that was a lot of the discussion from the FAC.

A: David Acheson: We'll have to see where the FAC comes out. A lot of this discussion focuses on whether the albacore should be on either a Do Not Eat list or a limited-consumption list. Well, it already is. The recommendation for this average population is to eat 12 oz of a variety of fish and not to eat the same kind of fish twice a week. Now, most of our focus groups understood that to be you can eat a meal of one type of fish and then another meal of another kind of fish. So for salmon, shrimp, pollock, tuna, you essentially limit it to once a week, so it is already on a limited-consumption list, not on an "eat-as-much-as-you-want" list. I would raise the discussion in the breakout group so you can come up with some actual recommendations.

Q: Ira Palmer, DC Department of Health: I had a question for Jim. Why is there a distinction between recreationally caught fish and commercial fish? I noticed that almost twice the amount can be consumed on a recreational basis as opposed to if fish are commercially caught. Most people get their fish through commercial channels, and the fish are the same fish and could potentially present the situation that they are the same fish from the same waters.

A: David Acheson: There are different levels of mercury in fish. In terms of advisories for recreationally caught fish, states have been making fish advisories and recommendations on specific local bodies of water which are used for recreational fishing. EPA approached the bodies of water on which there are no state advisories and yet still support recreational fishing. The EPA recreational advisory is focused on those waters. Fresh water fish were considered around the United States for their median concentration, and the advice based on that. That concentration is higher than found in most commercial fish. Hence the difference between 6 oz on the recreational side, if state has not provided its own local advisories, versus 12 oz on the commercial side.

Q: Margy Gassel, California Office of Environmental Health Hazard Assessment: I understand that FDA is soliciting written comments on the draft advisory. How might we submit comments?

A: David Acheson: There is a docket number for comments, but if you have comments written between now and the end of this meeting we would love to hear them. You can give them to me. We will have feedback from the breakout rooms tomorrow morning, so we could use some hard-hitting, focused comments. The more comments that come as consensus, the more helpful for us, as opposed to hundreds of comments that we have to wade through and try to integrate.

Q: Don Axelrad, Florida Department of Environmental Protection: What is driving the EPA-FDA advisory? You seem to optimize the benefits (e.g., eat two meals of fish per week). However, from the risk angle, it's less clear what you are doing. Looking at some of the modeled scenarios—baseline, no high-mercury fish, etc.—you come up with percentage of women above reference dose. On the basis of Kate Mahaffey's data earlier today, estimate that 75,000 babies are overexposed to mercury for each percent of women above reference dose. Couldn't advice be driven by an acceptable percentage of women above reference dose, and then guidance on fish consumption be based on that? That would be a more quantitative way of doing things.

A: David Acheson: I guess the first question is who picks the "What is an acceptable level of women above reference dose?" The problem is I (and anyone else) would hate to have to pick that level. We do pick that number when we do a reference dose for mercury, of course. People have explained here that we doubled the 5% in the lower performing range so this is something that is done. But this is the business of government. Government has to make a policy decision as to what is acceptable.

Q: David Acheson: In your further guidance you point out that mercury comes from both natural sources and industrial discharges. I recommend you reverse the order of listing of those based on the fact that industrial discharges are responsible for double the amount from natural sources. Second, wouldn't it be nice to have a forum on how to reduce mercury in fish by reducing local source atmospheric emissions, for example.

Q: Pat McCann, Minnesota Department of Health: Dr. Davidson mentioned that materials were ready to go as soon as the advisory was complete. Are there plans to distribute them across states, and are we able to review the materials before they are distributed?

A: David Acheson: We will indeed work with the states on distribution.

Q: Will states have input?

A: David Acheson: What we developed on pregnant women has already had state input. As for the rest of the materials, we have not yet considered what we will be putting together. I presume it will follow a similar pattern.

Q: Jane Kay, San Francisco Chronicle: A question for Mr. Pendergast. FDA does not consider the reference dose a “bright line,” whereas EPA does consider it a “bright line.” In the press we are writing articles explaining to the public the risks of mercury in fish based on the reference dose. With a joint FDA-EPA advisory, alongside the well-known fact that a reference dose can easily be exceeded by, say, a child or a lightweight individual eating fish twice a week, is EPA going to go back on the reference dose advisory?

A: James Pendergast: We use the reference dose when we make risk decisions as when we talk about carcinogens at the 10^{-4} , 10^{-5} , 10^{-6} risk levels. We use that to guide calculations, but we don’t make management decisions using that as a “bright line.” Remember that when you do a risk assessment calculation and you come up with a risk management decision. Dr. Schoeny will add a couple of points to that. The quote about “we don’t consider the reference dose to be a bright line” is actually from the EPA. For health effects for which we think there may be a threshold, a reference dose is our attempt to calculate the population’s threshold. As scientists and risk assessors, we are moving away from old practices of reference dose where you take a no-effect level and divide it by a series of uncertainty factors to come up with a more probabilistic approach. That was done with the methylmercury reference dose. What we still don’t have as risk assessors is more of a risk calculation associated with a particular level of mercury exposure. The benchmark dose (magenta line on the graph I showed) was calculated to be a 5% effect level. Some reasonable statements may be made about that particular level. The statement that we made was that there is no such risk or there is a much decreased risk at the reference dose tenfold away from that line. However, we fall short of being able to make an assertion or prediction at this point is: If you double the reference dose, your risk is X, or if you are 50% over the reference dose, your risk is Y. The models are not there right now. We would like to move toward it, but we are not there yet.

C: Kate Mahaffey: I want to expand. Given the models we have for the benchmark dose, which we believe to be associated with fetal blood mercury or cord blood mercury in the high 50s, at that level you have doubled the prevalence of scores on the clinically subnormal range on the tests that we have used in setting this dose. That is considered an effect level. On the continuum between the reference dose that is calculated using an uncertainty factor of 10 between the benchmark dose and effect level, and the reference dose level that given what we know about mercury at this point and time that what we think is a safe dose—there’s this continuum in there that is sort of a gray zone. As you rise above the reference dose, the likelihood of effects increases. By the time you get to a benchmark dose, you’ve doubled the prevalence of these clinically subnormal scores. So in that continuum is where effect begins. Exactly where it begins, we don’t know, and this is a population-based risk, not an individual risk.

Q: Michael Callam, Nebraska Department of Environmental Quality: Following on the earlier question on the differences between the 6 oz versus 12 oz of the recreationally caught fish versus commercially caught fish. In the additional information you presented in your slides at the end of the advisory, you indicated that the concentrations in recreationally caught fish could be higher or lower vis-à-vis commercially caught fish. You also said that you looked at national averages of recreationally caught fish, and that those concentrations tended to be higher. The additional information slide contradicts that.

A: The national average is built upon different species in different locations. There are some species that have very low mercury and some that have higher. Local advisories recognize that in certain places, mercury levels can be low or they can be high; that is what we were trying to capture in that additional information statement. On the average, which is what the recreational advisory was based upon, the average of all species considered, that is how we came up with 6 oz.

Q: It seems that the advisory is recommending two fish meals a week. Is that correct?

A: Yes.

Q: We know from NHANES that 90% of women do not eat two fish meals a week. They eat less than that. Change in exposure assessment was if you were eating a lot, quit eating, or everybody quit eating the top fish, but continue to eat what you otherwise were eating. Then you would reduce the top end. The question is, have you run the model looking at all the women who ate two meals of fish (recommended), so that everybody would be increased? What proportion then would be over that, just by avoiding the top end? The reality is that the impact of this advisory, if women were to follow it, is to significantly increase the amount of fish that they eat, (a selected type of fish). The impact would be irrelevant because they are not eating that much. So I would be careful in recommending two meals, because if the whole population went to that, what would be the exceedances at that point, rather than assuming that 90% would ignore how much to eat but will pay attention to the do not eat and cut down there? That can be taken as a clerical statement. We are now going into break, and then following that are the breakout sessions.

VI. Comments on the National Mercury Advisory

Regional Recommendations on Mercury Issues

Question 1: How can noncommercial and commercial fish advisories be better merged?

Group 1: Northeast

- Wording is clear and pretty straightforward
- Have local and state advisories; the USEPA advice is a no-go
- Merging commercial and noncommercial advice at the state level
- Need for resources and coordination with the states—merging with local and national advice
- ATSDR might be used for this
- Can national advisory be presented in a modifiable format? Can it be modified for specific regions/geographic areas? Filled in electronically?
- Other contaminants are also a problem: need to have advice that includes other contaminants, not just mercury

Group 2: East

- Many of the comments that were made in group 1 are echoed in this group; want to go over in more detail
- Data gaps: Maryland and Virginia are coastal states, have a lot of species that are local and need to get information out about those species (i.e., spot, croaker, weakfish). Need to have information at the local level
- Kentucky: Have commercial catfish, have larger fish caught commercially and will have a lot more contaminants than those caught recreationally
- Educating retail outlet personnel: Maybe some sort of outreach, have simple fact sheets with the advisory, as well as providing training
- Have different contaminants other than mercury: Different states come up with different recommendations for different contaminants. Need consistency
- PCBs—Have overall message that includes mercury and PCBs
- Merging commercial and noncommercial advice: Look at monthly records and look at recreational and commercial fish

- o Monthly consumption as a whole and give guidance concerning both commercial and noncommercial too costly
- Joint advisory does not consider the full suite of contaminants

Group 3: South

- Like things simple—this was a big thing for the advisory
- Ways to meld the advisories—sense that advisories weren't melded together well, still the same two messages as in the past
- Would like for USEPA and FDA to come together with one recommendation, one meal recommendation, for fish
- While not unanimous, the consensus recommendation was that a national advisory that said people could have two meals of fish a week (taking into account the local elements of fish and contaminants) would provide a simple, consistent message without significantly increasing risk
- Encourage USEPA and FDA to look at that strongly

Group 4: Great Lakes

- Support the national advisory and encourage continuing efforts to improve advisory
- Would like more detail added to first paragraph that talks about benefits to developing fetus
- Differentiation of shellfish with associated advice
- Rewording of alarming statement to see doctor if consuming fish
- List species that are safe/OK to eat
- More explicit reference to state and tribal advice
- Encourage efforts to label fish products with species name and location of origin
- Provide advice in terms of meal frequency (e.g., 2 meals/wk) versus ounces

Group 5: Midwest/West

- Maybe the message that is being sent out is unclear, maybe too much information
- Like the South group, need a singular piece of advice that goes out
- Have USEPA/FDA advice and combine with state/local advice—way too much information, and needs to be simplified
- Need to come out with 1 number of how much to consume in a week/month
- Merging of species: might not be a complete understanding of what fish people are consuming—think that the list simplifies the choices that are available
- Look at commercial and noncommercial choices and use list to determine what is safe/unsafe
- Want a list that shows the high risk, low risk, and medium levels of commercial and noncommercial fish
- Four fish that are high risk are all marine fish—confusing listing of fish now present
- Left up to states to come up with list of noncommercial fish—there will be differences between regions and states as to what is safe and what isn't

Group 6: West

- One person observed that he wasn't sure everyone wanted a national advisory
- Looking toward dramatically changing this: keep it simple
- Fish to avoid, fish to eat: don't go with the numbers too much
- Last year, example from first nations in Canada with list of fish to eat; work to reduce exposure

- Implementation: Training other health care providers and practitioners, people in doctors' offices; nutritionists; nurses in perinatal clinics
- 1-800 consumer line for health care practitioners to get direct information about fish advisory and risk communication
- Format of national advice not applicable to everyone in the nation: not captured in the model or in national advice (Alaska, tribes, subsistence fishers, Hawaii, etc.)
- These high consuming populations not very well captured; have more resources to have them captured—separate model to use for these groups to have a better sense of how this plays out for them
- Resources put into solving problems of pollution

Question 2: How can communication be improved?

Group 1: Northeast

- Federal government has to commit to joint release at certain point in time, allow the states to review the material—have time to prepare
- Other ways to prepare and other advisories—communicating with local health professionals and other agencies
- Need to have review and consultation at the local level
- No duplication of efforts—coordination with the states and USEPA (mailing to physicians, etc.)
- Want coordination
- Details can be added in other communication efforts—posters or other education outreach, such as listing species lower in mercury: can get more information into materials once certain level of education is achieved
- Can say more about specific fish once everything is detailed
- Template materials need to be modified for local levels
- Some fish can be consumed unlimited?
- Special populations need to have customization at the state level

Group 2: East

- Internet—Types of media that are important to get information out to the public
- Use states as a conduit to get information out; have states and USEPA coordinate so that message is the same and coming out at the same time
- Need more than multimedia approach—go to the local level and tailor method to population to get information out to the people
- Recommendation for point of sale for fish
- Health care providers and provide training for the health care providers (internships, returned to Illinois program, etc.)
- More focused program on education for fish advisories specifically
- Fishing shows and cooking shows are already popular among many populations. Work the advisories in with the show to get the message out.
 - Play on the catch and release of large trophy fish that may be higher in contaminants, to advocate for catch and release of large fish
- Using Emeril to get the message out, highlighting the safe fish to eat and show how to prepare the fish
 - For example, focus on the fish that are safe for two meals per week

- Using celebrities: Get celebrities to look into advisories and get the message out
 - Do they support the move?
 - Is it publicly salient? Ride the wave.
- No best single way to communicate the advisory

Group 3: South

- Sense that the states will be left to deal with the follow-through (aftermath) once USEPA and FDA come out with the advisory
- Need to communicate well, early, and often in order for the states to be prepared once the advisories come out
- We should have a good fish list to balance out the bad fish list in the advisory
- This list need not be exhaustive
- States have the position to come up with more detailed lists according to their local and geographic locations—have hot links for the good fish and for the bad fish lists for each state
- This should be done by the states
- Gulf states need to rethink the mercury advice for king mackerel and have new revised list

Group 4: Great Lakes

- USEPA and FDA need to work with states and tribes to communicate message
- Primary role implementing communication, should be states and tribes
- Need support to continue and expand states and tribes' efforts to communicate advice
- Want state/tribal advisories integrated into the national advisory on a state or regional level
- Methods needed to evaluate the effectiveness of national advisory—communication methods need to reach general population, as well as specific groups and high risk—Evaluate behavior changes
- Expand efforts to identify new ways of communicating message involving market plan, health care, and other avenues
- Concerned about timing of communication between national and local levels: next spring, need to have time to coordinate everything, but content of national advice should not be delayed
- Need to develop an implementation and communication plan that coordinates national, state, and tribal roles

Group 5: Midwest/West

- Suggestion: Missouri has had success with media blitz; Nebraska has not done a good job of getting information out to the public
- Use the outlets of media and focus efforts on TV, newspapers, and radio spots, and have them link with information that the state/local agencies have available (Web sites, pamphlets, individual state agencies)
- Using fishing guides, informational pamphlets, etc., as well with media blitz
- Effort to trying to get information into health care providers
- Educate the health care providers to help get right information out

Group 6: West

- Didn't think that physicians' message was good: should be removed
- Proposition 65

- o California has unique form of communication: Attorney General's office should have feedback and coordination with federal agencies when the message is put out
 - o Proposition 65 signs: signs out in some grocery stores and markets; maybe put in restaurants
- Some of wording in communication: "contact local health departments" was confusing
- Many different agencies throughout the nation with different names: some really not a local health department, may have only very limited information
- Best way to deal with this: contact state advisory fish programs and put list of contacts in the advisory in order to get the right information out the right way
- Coordination and communication between federal, state, and local agencies: have a space for each state to add specific wording in order to link things together

Question 3: Is the message clear?

Group 1: Northeast

- Statement is clear and concise
- Preamble in front needs to have clarification: Statement for pregnant women
- Overcomplicated and things overstated
- Benefits and risk:
 - o Developmental above most literacy levels—also overstated
- Additional information on tuna:
 - o Final statement flip-flops—focus on light tuna and not have negative statement about white tuna
- Omega-3s: States are considering adding more benefits about eating fish in their advisories, but decided it was too complex at this time

Group 2: East

- Came up with possible alternative title: Eating Fish Safely: Advice for Women of Childbearing Age, Nursing Mothers, and Young Children
- Need to use language other than "immediately"—infers acute problem of emergency
- Fish and shellfish "should" (not can): need to use stronger and more proactive language
- Change the phrase "developmental problems" to "health problems in your child": Change of language
- Using proactive message for tuna, not a double-sided message
 - o Does not prevent confusing message regarding light and white tuna

Group 3: South

- Message is not clear
- Standardize one meal or two meals for fish
- Concerned that would lose audience if message is too complicated
- Standardize meal size and clarify if it is raw fish or cooked fish
- Maintain a short list of species nationally that are safe/bad to eat
- Language: Have specific recommendations (simplify language)
- "Mercury in fish can vary": This was considered obvious and not needed
- Recommend stating directly: "For purchased fish..." and "For recreationally caught fish..."

- General concerns
 - Canned tuna and light tuna: handled at state level
 - Moving in the right direction: feel strongly that we need simplicity in the message so that people can understand it and abide by it
 - Have USEPA and the states to coordinate and communicate
 - Gap for marine and caught fish: have one advisory for all fish (freshwater, marine, restaurant, and store-bought fish)

Group 4: Great Lakes

- USEPA and FDA need to develop an outline for future, continuing efforts to improve consumption advisory program involving state, tribes, and other parties
- FDA should consider more than just its data: need to consider other sources in order to develop best advice possible
- FDA needs to provide more information about its data, so that information can be used by consumers to understand and make decisions and used by states and tribes in developing advice
- Encourage more testing of fish
- USEPA and FDA need to use more effective methods to bring the tribes into national advisory process
- USEPA/FDA needs to work toward future improvements in advisory programs with the goal of developing the best, comprehensive public health message for diets, not just focus on mercury

Group 5: Midwest/West

- Title: too laborious and needed to be shortened
- Physicians statement was too alarmist and needed to be softened (little bit too overdone)

Group 6: West

- Message is not clear; many issues with the clarity of the advisory
- Tuna message needs to be clarified; too confusing; lost in additional information
- Joining commercial and noncommercial fish; if eat X of commercial; how much noncommercial is ok?
- And/or issue: Unclear as to what was advised and what was not
- Can purchase fish in many different places: some places commercial and noncommercial fish are the same
- Question about the sport portion of the advisory: old advice limited to freshwater fish
- New advisory is supposed to be for freshwater and marine fish—unclear in new advisory
- Advisory talks about mercury and methylmercury, then explains: not a good transition
- People questioned reality of fish data that had gone into model; a lot more of the fish need to be identified by species, not general common name
- The term “women who might become pregnant” needs to be changed to “women of childbearing age”
- Acknowledge that contamination is not acceptable and explain where it came from so that efforts can be directed to clean it up.

VII. Risk Management Issues

Results of Different Methods Used to Evaluate State Mercury Advisories

Henry Anderson, Wisconsin Department of Health and Family Services

Beginning in 1998 the Wisconsin Division of Public Health and the State of Maine Bureau of Health formed a consortium to assess the prevalence of fish consumption, understanding of mercury toxicity, and awareness of state sport-fish consumption advisories for mercury. Wisconsin and Maine also initiated new state advisory interventions to strengthen existing fish consumption advisory programs. At the 2002 Fish Forum we presented results of a 12-state random-digit dial telephone survey of 3,015 women of childbearing age (ages 18–45) focusing our analysis on advisory awareness. Awareness of state advisories was only 20%, ranging by state from 8% to 32%. Women who were older, had more than a high school education, and had a household member with a fishing license were the most informed about mercury and fish consumption advisories.

We present additional survey analyses focusing on the 9.5% of women who reported consuming two or more meals a week of fish (frequent consumers). Wisconsin state-specific evaluation methods will also be discussed.

Women consuming two or more fish meals a week were more likely to include sport fish in their diet than those consuming less fish (35% vs. 28%) but were not more aware of state advisories (22% vs. 20%). Frequent consumers had significantly higher incomes and were older (over the age of 30). Minorities were more likely to be frequent consumers (14% vs. 8%), but fewer were aware of advisories (13% vs. 22%). Frequent consumers were more knowledgeable about the toxicity of mercury and characteristics of fish associated with increased mercury levels.

In July 2003 we mailed questionnaires to the first 1,000 women who had given birth between June 1 and 7, 2003. The response rate was 74%. In the 12 months prior to the survey, 78% of respondents reported consuming canned tuna and 28% consumed sport fish. Forty-six percent of respondents were aware of Wisconsin's advisory. Only 2% said they knew a lot about the advisory and 28% said they knew "only a little." Advisory awareness was highest among those consuming two or more meals per month. Only 11% reported seeing one of two specific posters sent to physicians' offices and 13% reported seeing a brochure. In interviewing a sample of clinics, we found that between 20% (pediatrics) and 60% (obstetrics/gynecology) recalled receiving and using the educational materials.

Until source control and environmental remediation efforts can reduce the environmental burden of mercury below levels of concern, combined sport and commercial fish consumption advisories will remain the primary means of reducing human exposure to methylmercury. Ensuring and assessing the effectiveness of such advisories must be an ongoing activity.

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Questions and Answers Following Presentation

Q: Did you ask about fish oil supplements, or did you ask about breast-feeding?

A: Henry Anderson: We started out with 23 pages of a mail questionnaire and, again, talking to people in reality was you could have 8 questions and actually get the thing back. So, no we did not. We do have the ability to link the surveys with the information that comes on the birth certificate, so some of that

information—birth weight, number of children, maternal age, and all those data elements—we have, but we have not yet started analyzing that part of it.

Q: Aaron Mair, W. Haywood Burns Environmental Education Center: When you talk about the benefits of consuming fish, taking a positive approach, what is the impact of cutting away the fatty parts with respect to the omega-3 benefits?

A: Henry Anderson: That, of course, is a potential issue. What we feel is that there is sufficient fat left in the fish. I don't think anybody has actually looked at that, but we don't really encourage that. In our state, because of PCBs and DDT, our sport fish are quite high. Commercial fish, on the other hand, tend to come to the individual already skinned and filleted. There is very little trimming that's done on the commercial fish.

Q: Aaron Mair: What would you suggest or recommend to EPA and FDA regarding the message relative to the benefits?

A: Henry Anderson: My recommendation would be that there needs to be a holistic, integrated advisory. Obviously, skinning and removing the fat has nothing to do with mercury. At least in Wisconsin, we give that advice. We have heard that there is argument over how much PCB you can remove doing that, but I think everybody would admit that it does reduce some exposure. It is well accepted by all the communities that this is something they can do. And so we have found that of the advice we give, that is the most readily accepted. And the concern is that if you talk about mercury, do they believe they are reducing their exposure by continuing that? Certainly, holistically, it protects them or reduces some of the PCB contaminants.

Q: I work very heavily with WIC, and one of the things the state WIC program has told us is that now formulas specially fortified with omega-3s can be an option under the WIC program. This has come under discussion in terms of possibly being another deterrent to breast-feeding. I don't know if that has come up in your discussions with your WIC program in Wisconsin. This push for omega-3s for brain development, in particular, is now driving this whole other interest in omega-3s.

A: Henry Anderson: I would have to go back and look, but I don't believe that the WIC vouchers can be used to buy fish oil, for instance, supplements or anything like that. We are talking WIC because it is a nutrition program, and everybody comes to WIC to reach their target population with all sorts of messages and they tend to say, "We're too busy." We are still advocating strongly for breast-feeding. I don't think there is any talk about "Well, now because of the fish oil you don't need to breast-feed." There are so many other benefits to breast-feeding that that is our very simple, straightforward one-line message: "Breast-feed."

C: Luanne Williams, North Carolina Department of Health and Human Services: Because of this survey that was done in North Carolina, which is prior to 2002, we had a very low percentage of awareness. That just really pushed us even further into switching from a location-specific approach to a fish-specific approach so that we can really get that message out. We were not doing a very good job with the approach that we were using. I really appreciate EPA, Maine, and Wisconsin for helping us get that information.

Web-based Guidance on Risk Communication: An Update and Demonstration

Barbara Knuth, Cornell University, Department of Natural Resources

Volume 4 in the series of fish consumption health advisory program guidance documents, *Risk Communication*, was published in 1995. Since that time, tribes, states, and other agencies have made suggestions based on their use of the guidance, the evolution of fish consumption health advisory programs, and a growing understanding of the importance of building partnerships with the involved and affected communities. *Risk Communication* was the focus of a major national conference in 2001. Following the conference, USEPA charged a development team with revising the 1995 document. Based on comments from a variety of stakeholders, a goal was set to develop a Web-based risk communication guidance. The Web-based version is now available, at this meeting, for review and comment. The content of the document follows a risk communication model that includes problem analysis, community partner information needs assessment, risk communication strategy design, strategy implementation, and program evaluation. Tips on communication approaches, diagrams, case studies, health benefit information, and other features planned for the final document should improve the utility and navigability of the final guidance.

Questions and Answers Following Presentation

Q: Joe Sekerke, Florida Department of Health: I appreciate the idea that you are going to update the Web site on a periodic basis, but I know I've run into situations where I've gotten something off the Web site and then gone back later and it wasn't there the same way. Are you going to keep a history of when changes are made and what was changed so that if someone needs to go back because someone is questioning the information, I can go back and find the information? Will you keep a history like that?

A: Barbara Knuth: That is a really good point. To be honest, I don't know. I will talk with the Tetra Tech folks who are working on the technical details. That is a really useful point.

Risks and Benefits Revisited

Grace Egeland, McGill University

The Centre for Indigenous People's Nutrition and Environment (CINE), for which Dr. Egeland currently functions as the research chair, is a governing board composed of numerous Canadian organizations. These groups include the Assembly of First Nations, Council of Yukon First Nations, Dene Nation, Inuit Circumpolar Conference, Inuit Tapiriit Kanatami, Métis Nation (NWT), and the Mohawk Council of Kahnawake. These organizations represent sparsely populated native areas spreading from eastern Canada through the Yukon and Northwest Territories.

Traditional Food Versus New Food Consumption

When looking at the benefits and risk of fish consumption, the total days with or without traditional food (TF) consumption and the associated nutrient intake are examined. On days when TF is consumed in the identified population, a high amount of total energy is present in the form of protein. On days when TF is not consumed, there is a substantial reduction in the overall protein energy levels in the various groups studied (Yukon, Dene/Métis, and Inuit). Observations have shown that people are replacing traditional protein sources with other things. This is due, in part, to the expense of other forms of protein at the supermarket, especially considering that the majority of these goods will have been shipped to their retail locations. People are switching to carbohydrates as a percentage of their total energy intake, and consumption of fats is increasing (trans-fatty acids). Trans-fatty acids are formed when vegetable oils are exposed to high heats (as in baked goods). They are now considered by most professionals as even worse

than saturated fat. In the north, this has severe implications for food and fish food consumption advisories.

Fish Advisories and Food Consumption

Many ways exist to reduce the exposure and risks associated with methylmercury. Methylmercury is an established neurotoxin, and wanting to eliminate exposure even in the presence of conflicting evidence of low-level effects is understandable. It is important, however, to understand the potential benefits of fish consumption compared with the replacement of that food source with other market foods that have their own established concerns. In the future, there may be a move to zero tolerance.

Numerous issues must be considered when preparing an argument for fish advisories. First, what is the extent and nature of food security in the community? What is the local availability of market foods, especially the quality of food, diversity of products, and costs? What are the individual household income, household size, and food purchasing power? What alternative food choices are out there, and what is the usual composition of the daily meal (e.g., whether rice is consumed with fish)? And what other culturally acceptable food choices are out there for consumption? (Although tofu is a good source of protein, it will not likely be part of the northern tribal diets.)

Throughout the process, it is important to get to know the community. For example, it is important to understand what leading public health issues the population faces (e.g., diabetes). What other exposures are contributing to cognitive impairment in the community? What are the prevalence and severity of these factors? For example, many communities of the subject populations have a high incidence of iron deficiencies. In fact, up to 40% of pregnant women in these communities have iron deficiencies. Iron deficiencies can affect cognitive functioning. Additional questions that must be asked include what the impact on food security and the composition of the diet will be and whether the anticipated dietary composition changes would be beneficial in light of the public health challenges faced by the community.

Fish Studies and Omega-3 Fatty Acids

Other supportive studies have been conducted concerning fish consumption and associated omega-3 content. The USDA recommends consumption of 1 gram of long-chain fatty acids every day. Long-chain fatty acids, including eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are found in both freshwater and saltwater fish species. Ongoing studies have shown that 1 gram of long-chain fatty acids equates to consumption of 3.5 oz of rainbow trout. For U.S. men with cardiovascular concerns, studies recommend consumption of two fish meals a week. However, the origin of these studies must be questioned, especially in relation to their accuracy and applicability.

A study was performed recently in Singapore concerning breast cancer risk and fish intake. The Singapore Chinese Health Study included 35,298 women with breast cancer incidence. The participants were from 45 to 74 years old. They were studied from 1993 through 1998, and follow-ups were performed through 2000. It was determined that fish and shellfish protectiveness was reduced by 26% for the top three quartiles of intake relative to the lowest quartile. Among those in the lowest quartile of fish intake, high n-6 intake elevated risk relative to low n-6 intake. Fish and shellfish intakes by quartile equated to 24.5, 44.5, 58.3, and 80.5 grams intake per day.

Six cohort studies have been performed around the work concerning fish intake. In Norway, an inverse relationship was demonstrated when fish was poached (Vatten et al., 1990). In Japan, consumption of greater than five servings of dried fish per week was associated with a 50% lower risk compared with less than one serving per week (Key et al., 1999). However, in the United States, no significant findings were noted upon completion of four different studies (Stampfer et al., 1987; Toniolo et al., 1994; Gertig et al.,

1999; and Holmes et al., 1999). In reference to the United States' NHANES data, however, only 15% of the women studied consumed more than one serving of fish per week.

Endometrial Cancer and Fish Intake

Other studies have been performed to measure the impact of fish consumption in relation to other diseases and maladies in various human populations. Numerous studies have been performed on endometrial cancer and fish intake. A Swedish Case-Control Study of 1,055 cases and 4,216 controls was conducted where 75% to 80% of the group participated. Results of that study showed that fatty fish consumption inversely related with endometrial cancer. The highest quartile of the study compared fatty fish intake (median of 2 servings per week) versus the lowest quartile of intake (median of 0.2 serving per week). A significant 40% reduction was noted after adjusting for multiple risk factors.

Prostate Cancer and Fish Intake

Studies on prostate cancer and fish intake have also been performed. During completion of the Health Professionals' Follow-up Study, an inverse association was demonstrated between total fish intake and marine fish intake with metastatic prostate cancer. The study's result was derived by comparing consumption of greater than three servings per week to infrequent fish consumption.

Diabetes and Fish Consumption

The relationship of fish consumption advisories and diabetes has also been studied. For the purposes of Ms. Egeland's work, the perspectives from the northern indigenous communities on the perceived link between fish consumption advisories and diabetes is extremely important. Is there a direct or indirect link? Does any plausible mechanism for the effect on diabetes exist? For example, decreases in physical activity (subsistence fishing is very physical), increases in alternative food sources high in trans-fatty acids and saturated fat, and decreases in omega-3 fatty acids will all affect any correlation between diabetes and fish consumption.

Several studies have been performed on animals to help determine the relationship between fish intake and type 2 diabetes mellitus prevention. Results of these animal studies have shown saturated fat worsens insulin sensitivity. N-3 fatty acids in muscle cell membrane phospholipids strongly and positively correlate with insulin sensitivity. Also, n-3 fatty acids improve insulin action and counteract negative effects of saturated fat (Storlein, 1991). However, no evidence has indicated that those diagnosed with type 2 diabetes can alter their insulin sensitivity by adding foods high in fatty acids to their diets.

During a 4-year prospective trial held in the Netherlands, the cumulative incidence of abnormal glucose tolerance in 175 normoglycemic 64- to 87-year-olds was examined. It was determined that there was a 25% incidence in habitual fish consumers and a 45% incidence in non-fish consumers. Another 20-year prospective trial was performed in Europe. Men were studied in seven countries, including the Netherlands and Finland. The results of the study showed that baseline and recent fish consumption data was inversely related to the 2-hour glucose level. It showed that high intake of total fat and saturated fat increased the risk of NIDDM and glucose tolerance. Consumption of vitamin C-rich foods, legumes, vegetables, and potatoes also showed an inverse relationship to glucose levels.

Other studies performed to interpret fish intake and diabetes prevention include the Nurses' Health Study performed in the United States. For that study, 84,204 women were followed for 14 years. The results of the study showed the consumption of trans-fatty acids was associated with increased risk for diabetes. In this study, the highest fifth quintile of n-3 fatty acids intake was protective. The study also looked at 5,103 female nurses with type 2 diabetes mellitus but free of cardiovascular disease or cancer at the

baseline (1980 baseline). A follow-up was performed in 1996 (45,845 person-years of follow-up). Results showed that fish intake of greater than or equal to five servings per week provided a relative risk factor of 0.36; for study participants who consumed between two and four servings per week, the relative risk was 0.64; and for those who consumed fish one to three times per week, the relative risk was 0.60.

Diabetes, Fish Intake, and Pregnancy

The prevalence of diabetes in pregnant women has also been reviewed. Gestational diabetes (that is, diabetes in women prior to a pregnancy or during pregnancy) has not been studied extensively. However, risk factors have been determined to be similar to those with type 2 diabetes mellitus. Gestational diabetes has had a profound impact on indigenous communities. The background rate for gestational diabetes in the United States and Canadian populations is approximately 3% compared with greater than 18% for indigenous populations.

Offspring from women with diabetes have an increased risk for obesity at an early age and the potential for early onset of type 2 diabetes mellitus. Higher birth weight can disappear at around 1 to 2 years of age and reappear after age 5. Children born to a mother with gestational diabetes are 4 times more likely to be above the 90th percentile for weight dependent on age. By 8 years of age as great as 50% of offspring of diabetic mothers are above the 90th percentile.

Impairments in neurodevelopment can also occur in offspring of diabetic women. Greater impairments occur with poorer glycemic control. Strong and significant inverse correlations in motor and fine-motor control have been observed. Even diabetics with good glycemic control have noted neurological impairments. The developing brain may be sensitive to altered metabolism associated with diabetes. Mental development index (MDI) and psychomotor development index (PDI) scores were significantly lower in the diabetic group than in the controls.

Furthering the study of the impact on infants from diabetes, the method of infant feeding and the risk of glucose tolerance in adults aged 48 to 53 years have been studied. Bottle-fed subjects had a higher mean 2-hour plasma glucose concentration than those exclusively breast-fed. In addition, breast-fed infants had a higher percentage of DHA and total LCPUFAs in muscle phospholipids and lower plasma glucose levels compared with the formula-fed infants.

Fish, Mercury, and the Heart

The heart is one of the target organs for mercury. However, the true implications of heart disease as an endpoint are not understood. Mercury alters cardiac sodium handling, and there is evidence that mercury can modify response to viral infections. Overall, epidemiological evidence is inconsistent thus far.

Numerous studies have been conducted examining mercury's effects on the heart. In Sweden, two studies were conducted indicating no adverse effect on the risk of the first instance of heart disease. U.S. health professionals also performed a study that noted no overall adverse effects; however, there was a poorer power to observe the effect on non-dentists in the study. In a Finnish study, adverse effects were noted; however, many of the endpoints associated with low selenium were observed in previous studies from the same population. A more comprehensive study involving eight European countries and Israel noted several potential adverse effects.

Conclusions

Public health assessments and environmental assessments are being conducted to further expand our knowledge of these various topics. Better partnerships are needed to collect the necessary data and

provide useful and global perspectives. Better husbandry of our environment and sound health statements concerning our communities and the consumption of fish are needed. Overall, the burden of chronic disease is great, and the evidence is there that proves that fish consumption can play a vital role in future prevention strategies.

Questions and Answers Following Presentation

Q: There is some interesting work by Donna Mergler from the Amazon, which is in many areas remote populations also, where rather than comparing nonindigenous foods to what I believe you are calling noncountry food, they compared substituting one type of fish for another and found they could achieve substantial reductions in mercury exposure. Have you looked into those types of strategies rather than focusing on comparing store-bought food to country foods?

A: Grace Egeland: There are a lot of fish species available in the Amazon, an amazing variety of fish. When we go north, there are fewer species and it becomes more difficult. I think we are open to those issues, but there isn't the same amount of variability.

Q: Luanne Williams: How about fish oil supplements?

A: Grace Egeland: Let's talk about fish oil. It tastes bad. I would like to talk a little about this. Are you familiar with the beta carotene trial related to lung cancer? There is a lot of information about fruit and vegetables being protective for lung cancer, so why not give smokers beta carotene because this could reduce their risk? But when they did it, they found that there was actually an adverse effect related to the supplements, whereas eating fruits and vegetables showed beneficial effects. So we don't always know what's beneficial. When you take a supplement, you are still eating your diet, whatever that diet is, and so we have to be careful. I think in the coronary heart disease trial with the high-risk population, they do show that fish oil supplements are beneficial. But we can't estimate or assume that that is going to be the case across the board. What are we doing? Are these effects that we are observing in studies because they're eating lots of fish and not eating something else? Is that what's driving your associations, or is it something that is inherent in the fish? So I think we have to be a little bit careful with jumping from one to the next.

C: Just as a follow-up comment, the Food and Nutrition Board, which does the dietary recommendations for both the United States and Canada, has, on the National Academy of Science's Web site, a discussion of the omega-3 fatty acids, and the conclusions regarding the omega-3s are certainly complex. I would encourage people to look at that particular site for an overview because the results are not uniformly one way or the other. I think it is important to recognize that.

C: Eric Frohberg, Maine Department of Health: The other thing about fish oils is that I don't think there is any data in the United States. This is analogous to the whole farm-raised salmon thing. In England they looked at fish oil tablets and found lipophilic contaminant concentrations and actually pulled some of them off the market. I don't think there is any data in the United States on that.

Q: What were the contaminants, PCBs?

A: Eric Frohberg: I'm pretty sure they focused on dioxins and coplanar PCBs.

Fish Smart, Eat Safe! Risk Communication to Diverse Populations in an Urban Setting
*Lin Kaatz Chary, Great Lakes Center for Occupational and Environmental Safety and Health,
University of Illinois at Chicago, School of Public Health*

The PCB Risk Communication and Outreach Project was developed to address the goals of USEPA's program on persistent bioaccumulative toxics (PBT) efforts to reduce dietary exposure to PCBs and mercury from fish consumption. The goal was to contribute to the dissemination of information about the health risks to historically underserved target populations from eating PCB-contaminated fish caught in Lake Michigan, specifically recreational and subsistence fishermen (as distinct from traditional sportfishermen), and the women and children who eat their catch.

The project worked to develop a model for the USEPA PBT program for improving risk communication in hard-to-reach populations, particularly immigrant and low-income communities in urban settings, and to further inform USEPA's efforts in this area. In its first year, the project conducted a pilot survey of Chicago-area Lake Michigan fisherfolk to determine what knowledge existed among African American and non-English-speaking fishermen at two Chicago lakefront locations, and established a collaborative relationship with several community organizations in the Asian, Ethiopian, East European, and Hispanic communities in the Uptown neighborhood of Chicago.

In the second year, the project conducted outreach targeting fishermen at the same two lakefront fishing areas, and completed a shorter survey to extend the assessment of what fishermen knew about risks from PCBs and mercury. In the second year of this project, the scope of risk communication was expanded to include mercury risks, and work continued to develop a model that could be generalized to other similar communities.

Because Chicago has a large and diverse immigrant population, its Lake Michigan fishing piers regularly attract an extremely heterogeneous group of fishermen. Our survey identified individuals whose native languages included Spanish, Filipino (Tagalog), Vietnamese, Korean, Polish, Romanian, and Hindu. In addition, people come to the lakefront to fish not only from a wide range of Chicago neighborhoods, but also from across the greater Chicagoland area. This made traditional efforts focused through neighborhood organizations and single-language group communities impossible with our limited resource base, and it presented an outreach challenge that was not fully resolved. As a result, the project ended up working on three levels: at the citywide level, through efforts to approach the large non-English press; through the Women, Infants, and Children (WIC) program through the Chicago Department of Public Health; and through on-site outreach at the lakefront itself through various activities.

This project demonstrated that a significant gap exists between English speakers and non-English speakers on the Chicago lakefront with respect to knowledge of fish advisories, having heard of PCBs, and health risks from eating Lake Michigan fish contaminated with PCBs. In addition, substantive barriers to achieving the type of outreach desired by USEPA in a geographically large and diverse urban area such as Chicago were identified in the areas of policy, implementation, and funding.

Questions and Answers Following Presentation

Q: Susan Boehme, New York Academy of Sciences: You mentioned that it was impossible or difficult to get to the subsistence fisherman population with your approaches. Do you have any ideas about how to get to the subsistence fishermen?

A: Lin Kaatz Chary: I think that we did identify a lot of subsistence fishermen, but we defined them ultimately by our data as people who fished four or five times a week or every day. It was a surprising number of people who did that. I think that it is very difficult to identify [subsistence fishermen] because I

think people are very reluctant to admit that they rely on catching fish for their weekly market basket. So I don't have a better answer. I think you have to really refine your question to find out how often they fish and draw your conclusions from that. Of course, you can always ask income questions as well, which we did not do.

Q: Joe Sekerke, Florida Department of Health: We tried to identify subsistence fisher populations in the survey we did in Florida, a year-long survey in 1992–1993, and we could not identify what we would have called a subsistence fisher population. We specifically went to the food stamp distribution centers and counties that our food stamp people identified as where they thought it was most likely we would find subsistence fishermen. We were unable to identify anyone who came anywhere close to the 140 grams a day that EPA used to identify subsistence fishermen. We had some heavy fish eaters. We had one woman who reported eating 10 kilograms of catfish in one week. When you identified the population as non-English-speaking, was it that they didn't meet your requirement of having sufficient English to fill out the survey or that their first language was something other than English?

A: Lin Kaatz Chary: We didn't include the people who couldn't take the survey. That included people who took the survey in Spanish and Vietnamese and people whose native language was clearly other than English but who had enough English skills (crude at best).

Palos Verdes Shellfish Contamination Risk Communication

Sharon Lin, U.S. Environmental Protection Agency, Region 9

Gina Margillo, Impact Assessment, Inc.

The Fish Contamination Education Collaborative (FCEC) is a participatory outreach and education project and part of USEPA's overall program to address human health risks posed by the fish contamination related to the Palos Verdes Shelf Superfund site. USEPA Superfund committed approximately \$2 million for 2-year activities under FCEC. The cornerstone of the FCEC is the partnership among federal, state, and local government agencies, eight community-based organizations, and other local institutions. The key to the FCEC's success is the meaningful involvement of the public as a true partner.

The FCEC goals are to (1) reduce exposures of populations to contaminants in fish caught off the coast of Los Angeles and Orange counties; (2) conduct education with the most affected populations so they can make informed decisions about fish contamination issues; and (3) build local capacity to address fish contamination issues in the future. The FCEC program targets a culturally and ethnically diverse population. The target population includes anglers who fish off the Los Angeles and Orange County coasts, an ethnic population that buys white croakers in local ethnic markets, and ethnic and general populations, especially women of childbearing age and children. Pier and marina outreach, market outreach, media outreach, and general outreach programs were formed to address potential human exposure routes to fish contamination. Because of the high level of collaboration among all partners, scientific and regulatory agency experts and community members come together to discuss and craft outreach messages that are of importance and relevant to their respective communities. FCEC outreach is conducted in a culturally appropriate manner by the community members. The outreach materials are available in multiple languages, including Chinese, Chamorro, English, Ilocano, Khmer, Korean, Marshallese, Samoan, Spanish, Tagalog, Tongan, and Vietnamese.

For details about the FCEC program, please visit www.pvfish.org.

Questions and Answers Following Presentation

Time did not permit.

Mississippi Delta Case Study: Risk Communication

Linda Vaught, Mississippi Department of Environmental Quality, Information Center

In June 2001, the Mississippi Department of Environmental Quality (MDEQ) led the Mississippi Fish Advisory Task Force, comprising several Mississippi state agencies, in issuing a Mississippi Delta Fish Consumption Advisory. The advisory suggested limited consumption of certain types of fish with high concentrations of dichloro diphenyl trichloroethane (DDT) and toxaphene. The advisory was issued for almost every waterbody in the Mississippi Delta. In an intense 14-month campaign, MDEQ used various methods of outreach to convey the message to the fish-consuming public.

The campaign began with press conferences in Jackson and Stoneville, a city in the heart of the Mississippi Delta. The initial message was twofold: (1) MDEQ had conducted fish tissue sampling in all parts of the state. The data revealed that the majority of the fish in the state are safe to eat. (2) Certain fish from the Mississippi Delta contain high levels of DDT and toxaphene. We suggest that you limit your consumption to no more than two meals per month.

MDEQ continued with the following outreach:

- Booked appearances on urban talk radio programs and local television stations in the Delta for knowledgeable staff to discuss the advisory and answer questions.
- Developed fliers and posters in both English and Spanish.
- Established a toll-free telephone number to answer concerned citizens' questions.
- Involved 1,400 Delta pastors in getting the message out. Two separate letters were sent asking the pastors to read a message from the pulpit and to distribute fliers and hand out posters in their churches. A press conference was held on the steps of one Delta church with the pastor to draw attention to the message. The event was covered by print and broadcast media.
- Developed and posted signs at Delta lakes showing fish included in the advisory. A press release was sent out to all media.
- Placed fliers and posters in the Mississippi Department of Health's Delta health offices and in private health offices. A press conference was held at one Delta state health office. Press releases about the distribution were sent to the media.
- Used Boy Scout troops to place posters in libraries, schools, community centers, and places where fishermen congregate.
- Sent letters and information to commercial fishermen and fish markets.
- Placed a notice about the advisory in the annual fishing guide produced by the Mississippi Department of Wildlife, Fisheries, and Parks.
- Participated in Delta health fairs and fishing exhibitions.
- Developed, printed, and distributed a 16-page coloring book about the advisory to every third-grade student in the Delta.
- Created a song and jingle about the advisory that was aired on 78 radio stations.
- Placed advisory information on the MDEQ's Web site.

Questions and Answers Following Presentation

Time did not permit.

Risk Communication for Medical Practitioners

Steve Blackwell, Agency for Toxic Substances and Disease Registry

Several techniques and tools can be used to assist medical professionals in communicating fish advisory information to their patients. Information gained from visits with physicians can be one of the strongest forms of outreach when trying to reach your target population.

Today we come at this topic from varying views. We represent professionals in the fields of health, the environment, and academia. For all of us, one of the greatest resources for disseminating information is physicians; however, they are often the hardest to reach with health messages since they are continually bombarded with medical information. We at the Agency for Toxic Substances and Disease Registry (ATSDR), now a component of the Centers for Disease Control (CDC), believe that we can all be potential partners in outreach efforts to the public.

Various types of medical practitioners can provide insight to these outreach efforts: physicians, nurses, midwives, physician's assistants, nurse practitioners, and tribal clinicians and healers. In addition, dietary and nutritional professionals can also be an excellent resource for this type of advisory information. For physicians, the target groups include obstetrics/gynecology (OB/GYN), family practice, pediatrics, and internal medicine. Of all four groups, internal medicine professionals represent the largest number of professionals dealing overall with general medicine.

It is important to understand that many physicians work from a model; prevention doesn't complement their concerns as much as diagnosis and cure. In addition, physicians are extremely time-limited and hard to reach. For this topic in particular, medical school curricula may provide only one-half day, at most, of environmental and occupational medicine instruction. There are very few physicians certified in fields of environmental health.

In response, the USEPA and ATSDR cofounded and established a nationwide series of environmental health pediatric specialty units. A unit was established in each of the USEPA regions nationwide. These units are an excellent resource for environmental medicine information, and they are great advocates within the medical community. More information can be found by contacting the Association of Occupation and Environmental Clinics (www.aoec.org).

Various types of outreach to medical practitioners can be used. One of the most common is mass mailing. Unfortunately, mass mailings are very limited because you have no idea who sees the information, whether it will be passed on to the appropriate person, or whether it will be opened at all. Blast faxes are an older method to contact several people on an established list. However, they are most often used now only for emergency situations.

Grand rounds presentations may be one of the best ways to get information to physicians. The majority of physicians received their continued education credits from attending such presentations. Information presented through the grand rounds circuit can easily target the appropriate medical practitioners and foster outreach to the target community.

Other types of outreach to physicians include articles in medical journals, submitted as supplements or technical papers, as well as presentations at regional, state, and local conferences and meetings. It may even be practical to set up your own conference centered on a specific interest. Practitioners can also be targeted specifically and visited in person. In general, most physicians like to hear information from other physicians.

A variety of reference materials are available to outside professionals and the public. These include the CDC's Toxicological Profiles, which provide health and environmental information on specific chemicals. Case studies for environmental medicine, general environmental health, and pediatric health are also available from the CDC. Most of this information can be obtained on CD-ROM or from the Internet. The resource can also assist in raising the understanding of environmental medicine in the physician community. Education materials aimed directly at the patients are also greatly helpful. It is not only important to inform the physician community but it is also necessary to provide materials that the physicians can use to communicate that information to the public.

There are several benefits to training medical professionals to assist in the dissemination of information. It provides a better awareness of environmental hazards in general and can improve the quality of health care where hazardous substances in fish may threaten human health. The most important point is that messages are usually judged first by whether their sources are trusted. Trusted medical professionals are often the best source for the effective transfer of medical information.

Questions and Answers Following Presentation

Time did not permit.

VIII. Monitoring Contaminants in Fish

Contaminants in Farmed Salmon from Around the World

David Carpenter, State University of New York at Albany

We collected samples of over 700 salmon (about 2 metric tons) obtained from salmon farms in eight regions of the world, supermarket samples from 16 cities in North America and Europe, and wild Pacific salmon of the five major species, and we analyzed them for concentrations of 14 persistent organochlorine contaminants (polychlorinated biphenyls [PCBs], dioxins, and persistent pesticides) and 9 metals. On average the farmed and supermarket salmon had about 10 times the concentration of the organic contaminants that were found in the wild salmon, whereas the metals were not very different. We found that salmon from farms in Northern Europe (Scotland, Norway, Faroe Islands) were significantly more contaminated than those from North America (Maine, eastern Canada, British Columbia, and Washington State), whereas salmon farmed in Chile were least contaminated. However, even the least contaminated farmed salmon contained two to five times the contaminant concentrations found in the wild salmon. We applied USEPA's risk assessment methods for cancer on the basis of levels of PCBs, dieldrin, and toxaphene, the only ones of the 14 organics for which there is a clear USEPA guideline on carcinogenicity. Applying these guidelines, which are based on the amounts of fish that can be safely eaten without raising the risk of cancer above 1 in 100,000, most of the farmed fish trigger advisories that indicate that more than one fish meal per month increases the risk of cancer. The fish from Scotland and the Faroe Islands were the most contaminated and triggered advisories that more than one fish meal every 4 months would increase risk. The supermarket samples mirrored the levels found in the farmed salmon. The most contaminated samples came from Frankfurt, Germany, whereas the cleanest farmed salmon came from New Orleans, probably Chilean salmon. For the wild salmon, consumption advisories were much less restrictive, and in most cases up to eight meals per month did not cause elevated risk.

We also analyzed 14 samples of the food fed to farmed salmon, and we found the same pattern in terms of presence of contaminants and relative levels in different geographic regions as were found in the farmed fish. This food is concentrated from trash fish caught in local waters and appears to be the source of the contamination of the farmed salmon. The levels in the feed correlate roughly with the duration and density of industrialization in the different geographic regions, implying that we have sufficiently

contaminated the oceans of the world such that when one concentrates the oils and protein from small wild fish, one ends up with a product that contributes to hazards to human health.

Our risk estimates are clearly underestimations of the true risk. Almost all of the other organic contaminants studied are either proven (dioxins) or likely human carcinogens, but these have not been considered in this risk assessment. We also have not considered any of the noncancer endpoints, of which there are many for neurobehavioral decrements, endocrine disruption, and immune suppression. There are known benefits of ingestion of omega-3 fatty acids, which are relatively high in salmon, especially in the prevention of arrhythmias following a heart attack and possibly in promoting neurological and cognitive development. However, the presence of these contaminants at these high concentrations will counteract the beneficial effects. There are many available noncontaminated sources of omega-3 fatty acids, including wild salmon and other wild fish and seafood, canola and flaxseed oil, and some legumes. We conclude that farmed salmon constitute a significant source of elevated risk of cancer in people who consume it frequently.

Questions and Answers Following Presentation

Q: Rob Duff, Washington State Department of Health: I just want to comment that it is great that you shined the light on the fact that PCBs are in feed and they actually build up in farm salmon. My question deals with your risk assessment and the choice of the cancer endpoint because in our review of the literature, for PCBs especially, the weight of evidence clearly points to the neurodevelopmental health effects and that's the endpoint we have been using. If you look at that endpoint, if you use the RfD for Aroclor-1254 and plug it into your standard risk assessment equation, you get a somewhat lower risk in the range of 3 or 4 times 10^{-5} , which would allow you to eat more salmon than your calculation up there. One of the things I would like to point out is that cancer is not the only way to consider multiple-chemical exposure. There is a method called a hazard index where you select common endpoints from noncancer health effects and you can actually look at multiple-chemical exposure. We know that we have those endpoints with many of these contaminants. DDT, methylmercury, PCBs—all have neurodevelopmental endpoints. In fact, ATSDR has a draft guidance, an actual toxicological profile, to look at fish contaminants. It actually outlines how you can do this. So my question really is, what led you to choose cancer as the endpoint when in our review most of the weight of evidence really points toward the neurodevelopmental effects as what we should be basing our assessments on?

A: David Carpenter: I couldn't agree with you more that that's important. That is the kind of analysis we will be doing in subsequent publications. We chose cancer because of a formula that we didn't have to develop, albeit we did choose sort of at what level of risk. I think there are a whole host of things that we must have. We must have better ways of dealing with chemical mixtures, and we must also find ways to incorporate into risk assessment not just cancer, not just neurobehavioral effects, but also effects on the immune system and effects on other endocrine systems, and this is an enormous challenge. We are going to continue working with our data, but at this point we dealt only with cancer and only with cancer from three substances in this risk assessment.

Q: Steve Ellis, Tetra Tech: Often the net pen-raised salmon have higher lipid contents than the wild fish, and the data you presented wasn't lipid-normalized. Could you comment on how those trends of higher concentrations work on a lipid-normalized basis? Second, you mentioned that the arsenic was 100% organic, no inorganic arsenic, which is pretty rare. I think that all the samples we have worked with—a variety of fish—at least had some inorganic arsenic. I'm curious as to the method for arsenic.

A: David Carpenter: I'm not the best person to answer the methods for the metal determination. Those were farmed out to a commercial lab in British Columbia. Regarding the lipid adjustment, we have lipid

measurements that we will be dealing with in future publications, but as you correctly pointed out, this is not lipid-adjusted. There still is a significant excess concentration when these results are lipid-adjusted.

Q: Why did you leave the skin on?

A: David Carpenter: The reason we left the skin on is that's the way the fillets are sold. We did a survey, and have looked at other surveys, and almost everybody cooks fillets with the skin on. And a significant percentage of people eat the skin. It certainly is one of the unanswered questions: What degree of reduction in contaminant load would you get if you took the skin off? I should have said one other thing. The online materials listed in our science paper will give you a lot more information about the methods we used here. Obviously, as we go to full manuscripts we will present those in much greater detail.

Q: Arnold Kuzmack, USEPA: There has been a lot of discussion about omega-3 fatty acids in your paper and by other people here, and they tend to deal with it as one big thing. My understanding is that there are really quite different kinds and that the types in fish, EPA and DHA, are the ones most likely to have most of the benefits.

A: David Carpenter: No, I don't think that is true. The human body cannot insert a double bond at the three position, but we all can manufacture the longer-chain fatty acids from linolenic acid. There certainly is some debate. It's true that the EPA and the DHA are the major omega-3 fatty acids in fish, but in terms of health benefits there seems to be little difference between linolenic, which is what is in canola oil and I think in walnuts. There seems to be little difference in terms of health benefit whether it is a shorter-chain or a longer-chain omega-3 fatty acid.

Q: A couple of things. One is that I want to say we really like your doing this study. You've done a large enough sample size so it is clear what your source of contamination is, and that allows us to think about ways in which we can reduce this. It has been really unfortunate and very frustrating with the salmon industry sticking their head in the ground making specious complaints about all the other small studies rather than dealing with the situation. And it's really interesting to look at the difference in the way this played out. Granted, it's a different issue, but there are a lot of dissimilarities in the way this played out in the press compared with the dioxin contamination of catfish feed. The levels of dioxins aren't that different and it's played out very differently in the press because FDA dealt with the issue and the catfish industry. That said, we are very uncomfortable with the risk assessment part, in part because of the level of some of these contaminants in other foods, as we talked about the other day. That leads to my question: Do you and Barbara consider, based on how that recommendation was developed, the situation where this would apply? How does it differ from beef, cattle, or pork, where the problem is generalized contamination in the environment working its way up in the food stream?

A: David Carpenter: That's a good question. That is actually something I meant to cover and didn't. For those of you who haven't looked at it, I really recommend the Ireland report strongly. There are some very frightening things there that go to just what Eric said. One of the frightening statistics is that 7 billion pounds of waste animal fat is fed to animals. The *USA Today* newspaper delivered to my door this morning confirmed that all of the waste fat from cows is fed to pigs and chickens, and other animals. So the solution is the same for getting the dioxin-like compounds out of hamburger, chicken, and pork as it is out of salmon: Stop recycling carcinogen-containing animal products into animal food. Now, regarding the information on the levels in other foods, the FDA did a total diet survey in which it found that in general, the levels in our farm salmon were higher than those in other animal products. But, it's the same compound. It is quite correct, as Eric pointed out in his talk and others have pointed out, that on average Americans and Canadians eat a lot more beef than they do salmon. So from the point of view of our total body burden, we probably get more of it from other sources. That's not true for a lot of people, especially those health-conscious people who have gone to salmon in avoiding red meat. The problem is the same,

and we've got to get these contaminants out of all of our foodstuff. I think the solution is to not panic, eat a balanced diet, and be aware of the pluses and the minuses in different foodstuff. And we all need to work with our government officials to find ways of creating healthy food products in our supermarkets and increase the general knowledge in the public about the pluses and minuses.

Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet

Sandie O'Neill, Washington Department of Fish and Wildlife

In Washington State we are fortunate to have a fairly large, comprehensive, multiagency monitoring program to examine and assess the entire health of the Puget Sound environment. One of the most important components of this monitoring program is to look at the contaminants in fish, in this case PCB data.

Factors Affecting Contaminant Exposure Accumulation

Several factors can affect contaminant exposure in fishes, including the proximity to contaminant sources, the habitat, the trophic level (how high up the food chain the fish feeds), the gender and age of the fish, and the lipid content of the fish tissue. Which one of these factors is the most important depends. For example, fish that are higher on the trophic scale likely have higher levels of PCBs. However, select areas of higher contamination may exist where fish species lower on the food chain will have higher PCB levels than those higher on the trophic scale. That doesn't mean you have to analyze every fish, but it does mean you must look at those species with similar habitats, life histories, and exposures, and extrapolate from the data how PCB contamination may affect other fish.

In the Puget Sound, sediment PCB contamination varies among the different basins. The majority of contamination is located within the basins along the state's Interstate-5 corridor and includes the Cities of Seattle, Tacoma, and Everett. In Puget Sound, we sample fish species with different histories, diets, and from numerous locations in order to get a better understanding of how these contaminants accumulate in fishes.

Much of the data collected includes information on the English sole. The English sole is a bottom dweller, consumes benthic invertebrates, has a moderate home range (it doesn't move around a lot), and is ubiquitous in the Puget Sound and the west coast. We sampled these from up and down the Puget Sound and discovered that mean PCB values varied greatly in edible muscle tissue (we did not sample skin). The highest relative elevated concentrations were located in the central Puget Sound. Currently, we are looking at Aroclor data; however, we are moving toward congener data to be used in the future. It is very hard to compare PCB values from various studies unless you know the exact methods used.

When modeling the elevated PCB contamination with the other key factors (age, species, lipid content), we discover that the main driver for these benthic fishes and PCB contamination is sediment composition. By plotting the natural log of the PCBs in muscle tissue versus the mean composite age of the fish species and the in-sediment PCB concentrations, you can learn several things about the frequency of contamination. As sediment levels of PCB concentrations rise, the level of contaminants in fish increases greatly. On the other hand, the graph shows that age is less of a factor in part because we use composite samples and the age of the fish species doesn't vary much. Therefore age is not a driver. Basically, we can explain about 72% of the variations we see from the 41 different sample sites just based on the sediment chemistry.

English soles are by no means the worse case to look at in the Puget Sound. Sampling of rockfish in the same location demonstrated that English sole has approximately half the PCB contamination in the fish

muscle (62 µg/kg for sole versus 121 µg/kg for rockfish). Most has to do with the life history of the fish. Rockfish don't move around much; they are demersal, carnivorous (they eat higher trophically), very long-lived (80+ years).

Comparing PCB accumulation in male rockfish over time shows that male rockfish have increased PCBs concentrations with increased body burdens and age, but data for females fluctuates up and down with age. In general, we see this with many animals. Fishes like the rockfish are not fatty and have lipid contents of less than 1%. However, they produce quite fatty larvae and the females pass all their PCBs onto their offspring while the males will continue to accumulate theirs over time.

PCB Accumulation in Benthic and Demersal Fishes

In benthic and demersal fishes there will be more of a correlation with sediment concentrations. The highest correlation exists for fishes with small home ranges. Increases in trophic level (biomagnification) are also directly related and we possibly see bioaccumulation in long-lived fishes with variances usually seen between the male and female of the species.

This is very different with pelagic, anadromous, and wide-ranging fish species. These fish live predominantly farther up in the water column, have high fat and lipid content, are carnivorous, and have complex life histories. Salmon in general are anadromous, feed in marine water where most of their growth takes place, and are generally carnivorous. Salmon also have very complex life histories and each species is very different, implying that their unique contaminant exposure will also be different.

Data on local Puget Sound chinook and coho species has been collected since 1992. Concentrations were found to vary tremendously. Concentrations were higher in the individual and composite samples of chinook salmon since they are larger, much higher trophically, mostly carnivorous. Coho salmon have lower concentrations since they do eat some invertebrates. Pink and chum salmon have the lowest concentrations since they eat much lower trophically (jellyfish, etc.). With different fish species you get decreases and increases in concentrations (related to trophic status).

Where do PCBs come from? This is always a touchy question. Juvenile salmon entering salt water have a body burden of 1.4 µg of PCBs on average. As fish coming back to fresh water from the marine environment, they have an average body burden of 130 µg PCBs. Therefore, the contaminants they are picking up come mostly from marine waters. However, not all fish go to the same marine waters. Large variations in sizes can return at various ages.

Comparing saltwater age (age when the fish returns from salt water) also shows difference in trophic status. It was thought that we would see different concentrations of PCBs from these fish being in different parts of marine life, and also less of a concentration with the younger salmon because of different aspects of trophic life. The data is exactly the opposite. With increase in saltwater age, the PCB body burden decreases. The reasoning for this is that smaller fish stay closer to the coastline and don't venture into the open oceans, not like the older fish.

Does Oceanic Distribution Affect PCB Levels in Pacific Salmon Stocks in the Pacific Northwest?

This topic is very important from an environmental perspective, especially in considering whale species that feed on resident salmon populations. Will whale body burden be different as well? A study is planned to look at different chinook from several river systems up and down the west coast (from southeast Alaska to northern California).

PCB Accumulation in Pacific Salmon

The majority of the PCBs are accumulated in marine waters, including coastal areas and the open ocean. Adult chinook/sockeye accumulate higher PCB concentrations than pink and chum (higher on the trophic scale), and species- and stock-specific differences in life history traits, such as saltwater age and marine distribution, may influence PCB levels.

PCB Accumulation in Pelagic Fish

Pelagic fish integrate PCBs over broad areas. We need to know where the fish are from as well as where the prey on which they feed originated. Data has shown that trophic level affects PCB accumulation and the age and size may (or may not) affect PCB accumulation. Many variables affect the age association, including where the species feeds and on what trophic level they consume other fish or benthic species.

Most importantly, if you want to design a cost-effective monitoring program or communicate risk information, you must know your fish!! If not, you should at least know your local fish biologists.

Questions and Answers Following Presentations

Q: I have a question about the three-dimensional graph. What caught my eye is if you look at the highest sediment contamination and then look at PCB in muscle tissue versus age, you have a curve. So you are seeing a decline with older fish, but at intermediate sediment contaminant levels it looks like it keeps increasing with age. I was wondering about your interpretation of that.

A: Sandie O'Neill: I don't have a good one. These are all composite samples, so the age factor isn't as well modeled as the location factor is. And we may be seeing differences in maternal transfer of PCBs. I'm just not sure. Without having more detailed age data, it is hard to look at that.

Q: Joe Sekerke: Were the salmon that came back at younger ages sexually mature, or was it only the 4-year-old salmon?

A: Sandie O'Neill: They were ready to go. A lot of variation just naturally happens. The fish do come back at different ages.

C: Joe Sekerke: I want to reiterate that people doing risk assessments for fish consumption have to talk to fishery biologists. I had a situation where we were seeing dioxin levels in a paper and pulp mill where the bluegills were consistently higher than the largemouth bass. I kept saying, "This can't be right. There's something wrong with the data." Fortunately, there was another problem with the data so I didn't get in trouble, but it turned out the difference was that the bluegills stayed in the creek while the largemouth bass moved in and out of the creek.

Q: Bob Brodberg, California EPA: We looked a little bit at our Pacific salmon, and at least outside Sacramento before they come in, they are quite low in PCBs. I was wondering about the quillback rockfish and obviously if you focused on that one species for consistency and probably for comparison's sake. Did you look at some other rockfish? We have done some coastal sampling of rockfish, and there are a lot of different rockfish.

A: Sandie O'Neill: In Puget Sound the reason we focused on them is that there are three species. The main reason we focused on those particular fish species is that they are what is there. You can't extrapolate to all rockfish because not all rockfish are the same.

C: Bob Brodberg: That is the difficulty we find going from one species to another for miscellaneous contaminants.

Q: I was wondering if you considered the role of algae in the overall findings that you've seen because based upon what you see in the literature, that first step, the partitioning between water and the algae, is critical ultimately to what gets transferred up through the trophic food chain.

A: Sandie O'Neill: We participated in a PCB modeling workshop where we were trying to figure out where all the PCBs come from, how they get from the sediments up into the plant pelagic environment, and what types of biota are likely to be sinks for PCBs. We did come up with some ideas showing that we can get transfer from benthic areas from bottom sediments up the water column through reproductive products of the fish. If you have an English sole or a crab or a rockfish that's feeding in a contaminated area, it can internally transfer its PCBs to its pelagic eggs or larvae that become zooplankton eaten by other pelagic fishes. You can get a direct link that way, through the food web. One of the other things we looked at was plants as a potential way to fix PCBs. They have a fairly high lipid reservoir, and if you look at some of the literature values on PCBs in plants they are extremely low. But if you look at the biomass of plants in Puget Sound, you can have a heck of a lot of PCBs incorporated into that plant material. For a lot of the algae and things that die in the winter, does it get rereleased into the environment? So we happen to be doing some of that as a modeling exercise.

Q: In New York we found that in freshwater systems lipid content is a real wildcard. As a matter of fact, in the same waterbody you could have carp and they are sky high, and in the smallmouth bass the trophic levels are relatively clean. We actually have a trout stream that had high levels of PCBs in the trout. When there was a drought, the lipid content went down and the PCB levels went down. When things cleared up, the trout got fat and the levels went up again. The question is, do you find these relationships hold up as well when you look at lipid-normalized data?

A: Sandie O'Neill: I don't lipid-normalize in terms of dividing it by the quotient method (i.e., where you divide by the percent lipids) because it's quite variable. Whenever we correct for lipid effect, we do it where you run a general linear model and put in a lipid as a covariant. If it tells you that lipid is a significant factor, you can correct for it. But in some fish species it isn't. For example, coho up and down the sound are the same age, and from one site to the next 48% of the variation in PCBs is explained by the lipids. However, when I look at the chinook that are also lipophilic, I don't see that and it is because the age or trophic differences are more important. But also it is a very dynamic time when we look at salmon. They are coming back to spawn. What is happening is that as they approach coastal streams, they are building up the lipid reserves in their body tissue. Once they get nearer the rivers, they are making eggs and they are starting to mobilize that fat from their lipid tissue into their eggs. Once you get a differential between lipids in the eggs versus the muscle tissue, you get a transfer. Some of the variation you are seeing probably has to do with what the trout are doing in terms of their reproductive status.

Model Application for Monitoring Contaminants in Fish

Stephen Wentz, U.S. Geological Survey

Methylmercury is a toxic chemical that has been shown to affect the health of humans and wildlife. Methylation of inorganic mercury and subsequent biomagnification of methylmercury through aquatic food webs is generally accepted as the primary pathway by which both humans and wildlife are adversely affected by mercury. Many federal, state, tribal, and local agencies monitor wild fish tissue mercury (fish-Hg) concentrations for the specific purposes of identifying spatial and temporal trends and preparing fish consumption advisories. However, fish-Hg concentrations vary with the samples' characteristics, such as

the kind of tissue sampled (“cut”), species, and fish size. Therefore, directly comparing samples with dissimilar sample characteristics for trend analysis or estimating unsampled fish-Hg concentrations for fish consumption advisories can be problematic. This problem greatly hampers the interpretation of fish-Hg datasets because obtaining wild fish samples with specific or consistent characteristics can be expensive or impossible. Several researchers have used regression methods to predict the mercury concentration of a standardized sample from samples of the same cut and species, but of different lengths. These methods extend the range of samples that can be validly compared with samples of the same species and cut but different sized fish.

This study, by the U.S. Geological Survey (USGS) in cooperation with the National Institute of Environmental Health, assesses a different approach based on statistical modeling (the covariance model) that encompasses not only fish of differing sizes, but also fish samples of different species and cuts. This covariance model was calibrated using a national dataset of fish-Hg analyses that contained 35,130 samples. Comparison of the covariance model with the current method (the size-class model) shows the covariance model produces more accurate fish-Hg predictions than the size-class model for the fish-Hg data currently being collected. The covariance model is useful for (1) standardizing fish-Hg concentrations to a common sample type for spatial and temporal analyses, and (2) estimating fish-Hg concentrations of unsampled species, thereby enabling the development of more comprehensive fish consumption advisories. In addition, use of the covariance model will allow monitoring agencies to greatly reduce the number of analyses required to achieve the same prediction accuracy of fish-Hg concentration. This could substantially reduce the cost of a fish-Hg monitoring program. The USGS is developing a Web site to facilitate the dissemination of both raw fish-Hg data and covariance model predictions, as well as mercury concentrations from other media (soil, sediment, and coal) on a national scale.

Questions and Answers Following Presentation

Q: I know I didn’t get a chance to do it well, but when I was trying to compare the raw data versus the model data in the west coast area, the ones I saw real quickly seemed that the model was consistently underestimating the raw data. Is there any bias that it underpredicts at low levels?

A: Stephen Wente: The colors are really messed up. You should have gotten the exact opposite. The raw data should have come out low on the north of San Francisco and then been transformed to very high values. As far as any kind of systematic bias on the model, we compare it to just taking the fish and putting them together in a size class versus using our model when we go through a validation method. The reason this kind of gets at what you are talking about is that we find less variability. In other words, if we have a systematic bias, we would miss that actual observation. If we had some kind of systematic bias (and I’m sure we do at some low level), but if we had a very large one, we would continuously come out with a very bad estimate.

Q: All models are better at some places than they are at others. I was just wondering if there was any consistency in the disagreement.

A: Stephen Wente: One thing that I can address is that the error does have a lognormal distribution. At very low concentrations, you have very narrow confidence limits; at high concentrations, you have much wider confidence limits.

IX. Chemical Updates

PBDEs—Rising Levels in Fish, Tox Review, and the California Ban

Tom McDonald, California Environmental Protection Agency, Office of Health Hazard Assessment/USEPA, OEHHA

Approximately 75 million pounds of polybrominated diphenyl ethers (PBDEs) are used each year in the United States as flame retardant additives for plastics in computers, televisions, appliances, and vehicle parts; and foams for furniture. PBDEs migrate out of these products and into the environment, where they bioaccumulate. PBDEs are now ubiquitous in the environment and are measured in indoor and outdoor air, house dust, remote Arctic regions, streams and lakes, terrestrial and aquatic biota, and human tissues. Concentrations of PBDEs measured in fish, marine mammals, and people from North America are among the highest in the world, and these levels appear to be increasing with each passing year. Initial data suggests that about 10% of Californians now have higher PBDE tissue concentrations than tissue concentrations of PCBs. Although not well understood, the primary sources of human exposure appear to stem from ingestion of foods, especially fish and breast milk, and possibly from direct exposure to PBDE-containing dusts in the home and office.

The State of California and the European Union have banned two of the three commercial mixtures of the PBDEs (Penta- and Octa-BDE), and firms in Japan have voluntarily stopped using PBDEs. The sole U.S. manufacturer announced that it would voluntarily cease production of the two banned products by the end of 2004.

The toxicological endpoints of greatest concern for environmental levels of PBDEs are thyroid- and estrogen-hormone disruption, and harm to the developing brain and reproductive organs. These concerns come from multiple studies in animals. The tissue levels of PBDEs in some people have reached the levels that caused developmental effects in animals. New research suggests that PBDEs and PCBs (which are also present in people) may work together to alter learning and behavior following exposures early in life.

Questions and Answers Following Presentation

Q: Can you comment a little further on the debromination and the deca issue?

A: Tom McDonald: Yes. There are other concerns with the deca. Its toxicity may not be as important or as strong as some of the more bioaccumulative congeners found in the penta and the octa, but there is a lot of research. At the dioxin meeting this year it was shown that when deca gets into the environment, it is debrominated by ultraviolet light and by the gut flora in fish. There may be some question as to what we find in our bodies—whether it comes directly from the use of the penta in foam or some of it comes from deca that has been weathered in the environment and has come back up to us through the food chain.

Q: Arnold Kuzmack, USEPA: Do you have any comments or insights on the substitution of PBDEs and what possible effects they might have?

A: Tom McDonald: Yes, there are quite a number of groups that are looking at alternatives. For example, many companies do not use PBDEs in their plastic products. IBM, NEC, and Hewlett-Packard have already moved to other solutions in their computer products. Many use different technologies, such as separating the electronic components from the housing either by barrier or by redesigning the product. Others have gone to plastics that are inherently less flammable. Companies such as IKEA have stopped using PBDEs in their furniture. I think they use a melamine barrier over nontreated foam, which means

when it burns it chars and creates an impervious layer. Other companies are also trying to develop other chemical additives that would replace these.

Q: Arnold Kuzmack: How many of the effects have been repeated and found to agree with the original data?

A: Tom McDonald: With respect to the mice, the laboratory has repeated these studies a dozen times using a tetra-2-penta and a hexa and a deca congener and have all seen those effects. The Italian lab used the penta mixture and found the effects in mice.

Q: Arnold Kuzmack: Is that the only one that has been done two different times?

A: Tom McDonald: Those are the only two groups that have looked at behavioral effects in mice. We have a limited toxicity set because the issue wasn't brought to our attention until the past 5 years.

Dioxin

Rita Schoeny, U.S. Environmental Protection Agency, Office of Water

The information summarized in this presentation was mostly prepared by Mr. William H. Farland, PhD. Ms. Schoeny presented this information on his behalf.

Recent History

Development and revision of the dioxin assessment have been ongoing since 1988. The assessment has been reviewed multiple times by multiple federal and state bodies, as well as by peer experts, and it continues to remain controversial. Ongoing revisions and additions to the assessment will likely continue to be controversial. USEPA and the other parties involved are still discussing potential changes and revisions. More and more related data continues to be released from various sources in the United States.

After revisions to the 2000 draft assessment document, both the Science Advisory Board (SAB) and the Interagency Working Group (IWG) performed subsequent reviews of the draft. IWG requested a review of the document by the National Academy of Sciences (NAS) to help ensure that the risk estimates contained in the draft reassessment (2003 version) are scientifically robust and that there is a clear delineation of all associated uncertainties (October 29, 2003). USEPA has sent the three volumes of the external draft to NAS; however, the initial planning meetings for the review have not been conducted to date. Because a public review component is involved, the information for the external draft will be available to the public. Currently the three volumes are classified as a "do not cite or quote" draft. However, the report has a wealth of knowledge to allow others to formulate conclusions, even though concrete conclusions by USEPA are not currently part of the document.

The SAB report released in May 2001 made several recommendations and suggestions related to the revised 2000 version of USEPA's dioxin assessment. SAB first complimented USEPA on the comprehensiveness of the assessment and the careful, thorough review of the literature involved in preparing the report. SAB also had several suggestions for improvements, including more focus on noncancer effects, an increased emphasis on the mode of action, and more clarification of the uncertainties involved in the estimates.

The SAB identified a lack of consensus on several key issues, including whether the cancer characterization of dioxins, dibenzofurans, and PCBs should be carcinogenic or likely carcinogenic; whether the margin of exposure and/or the reference dose should be used, and what the appropriate upper

bound limit used to estimate the cancer risk was. However, the SAB did recommend that USEPA should take a stand, finish the assessment, and get it out the door, even though the information included might be viewed by many as controversial.

Major Issues Identified in the SAB and Public Comments Addressed

Comments by the SAB and the public identified several issues that required addressing, including the following major issues:

1. The scarcity of data for national means for potential sources and pathways.
2. More information on dioxin-like PCBs in the exposure document.
3. More information on the state of the exposure model's validation.
4. Better and more information on trends in environmental levels and body burdens.
5. More explanation on the use of Toxicity Equivalency Factors (TEFs) and Toxicity Equivalency Quotients (TEQs).
6. Human versus animal data impact on hazard and risk characterization.
7. The significance of enzyme induction and other biochemical effects.
8. Most important, what are the relative roles of data, scientific inference, and science policy in the development of the assessment? For USEPA, it is important to follow the body of scientific policy on how data is interpreted and how conclusions are drawn. It is necessary to distinguish between what USEPA thinks and how the scientists are charged for peer review of the assessment.

USEPA worked with other federal agencies to reach conclusions illustrated in the assessment document. Although the topic has been extremely controversial, USEPA has not faced its responsibilities alone. General information, review, and scientific coordination were provided by professionals at the National Institute of Environmental Health Sciences (NIEHS), the National Institute of Occupational Safety and Health (NIOSH), the Department of Defense (DOD), the Department of Health and Human Services (DHHS), the United States Department of Agriculture (USDA), and the Food and Drug Administration (FDA).

Key Findings of the Reassessment: Exposure Document

The following are several of the findings gathered during reassessment of the exposure document:

1. Environmental levels of dioxin have declined since the 1970s.
2. Current U.S. regulatory efforts have addressed most of the known large industrial sources (pulp and paper mills, etc.). There was an 80% reduction between 1987 and 1995; further reductions are expected.
3. Currently, open burning of household wastes is the biggest unaddressed contemporary source identified.
4. Other potentially uncharacterized sources remain, including general burning activities, ceramics, forest fires, secondary steel and mining facilities, and reservoir sources.
5. Exposure to the general population has declined but currently averages 1 picogram per kilogram per day (pg/kg/day) or approximately 56 to 70 pg/person/day.
6. General population exposure is from animal fats in the commercial food supply. Local sources make little contribution to most people's exposure (unless you consider large-scale consumption from a local source, e.g., recreational fish). Environmental levels in meat and dairy products are the major contributors.
7. Air deposition onto plants consumed by domestic meat and dairy animals is the principal route for contamination of the commercial food supply.

8. Reservoir sources are a significant component of current exposure and may dominate future exposure. They currently account for most coplanar PCB exposure, and the current contribution of dibenzofurans from this source is unknown.
9. Special populations may be more exposed, but prevalence is not well substantiated.

Further information is available in *Dioxins and Dioxin-like Compounds in the Food Supply: Strategies to Decrease Exposure*, Institute of Medicine (IOM) and National Academy of Sciences, July 2003.

Key Findings of the Reassessment: Health Document

Review of the health document produced additional comments and suggestions for data presentation and interpretation. Highlights of these include the following:

1. A variety of noncancer effects in both human and animals should be identified and used as references. These effects include developmental toxicity, immunotoxicity, endocrine effects, chloracne (for several exposures), cardiovascular disease, oxidative stresses, and thyroid effects.
2. TEQs provide the best means for evaluating equivalent mixtures using WHO₉₈ TEFs and including coplanar PCBs.
3. Body burden is the best dosage meter for estimating overall risk.
4. Environmental mixtures of dioxin-like compounds are likely to be carcinogenic to humans, in line with the DHHS; 2,3,7,8-TCDD is carcinogenic to humans.

Comparisons have been made between U.S. and international organizations with respect to body burden, effect, safety, and guidance factors. Each of these analyses has developed a “safety assessment” for the amount consumed on a daily basis. For example, the World Health Organization (WHO) in 1997 stated that the total daily intake should not exceed between 1 and 4 pg/kg/day, and the Agency for Toxic Substance and Disease Registry (ATSDR) in 1999 said that the daily intake should not exceed 1 pg/kg/day. The Joint Expert Committee on Food Additives (JECFA) in 2001 stated that based on a total mean intake of 70 pg/kg, the daily intake should not exceed 2.3 pg/kg/day.

Comparison of USEPA Results

Numerous similarities and differences were identified between USEPA’s reassessment and the information provided by other associated agencies.

The following are some of the similarities:

1. Each of the studies focused on the lowest adverse effects.
2. Each study used body burden as the dosage meter (except ATSDR).
3. Each suggested that additional decrease of intake is necessary.

Some of the differences between these studies were as follows:

1. The assumption that cancer will be insignificant at guidance.
2. The use of a safety/uncertainty factor (between 3.2 and 90) for lowest observed adverse effect level, pharmacodynamics, and human variability.
3. The development of a safety assessment version a “margin-of-exposure” (MOE)/quantitative risk assessment.

Key Findings of the Reassessment: Risk Characterization

The findings of the reassessment of the risk characterization include the following:

1. Cancer slope factor is based primarily on recently published analyses of human data and has been revised upward by a factor of ~6 from the 1985 values (based on the 1978 rat study).
2. Cancer risk to the general population from background (dietary) exposure may exceed 10^{-3} (1 in 1,000) and will likely be less and even zero for some individuals.
3. Noncancer effects have been observed in animals and humans at levels within 10 times background levels.
4. It is likely that part of the general population is at or near exposure levels where adverse effects can be expected.

Summary

1. Dioxin science has evolved rapidly, and more data will continue to lead to better understanding of dioxin's effects and will continue to raise more questions.
2. Expanded human data on cancer reinforces our previous concern for the potential for human health impacts.
3. Identification of noncancer effects in animals and humans is sufficient to generate a similar level of concern.
4. Environmental levels and human exposure are declining but are still at a level of concern. Current source characterization is complex, with uncontrolled burning and reservoir sources potentially playing a significant role.

Further questions should be directed to:

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Questions and Answers Following Presentation

Q: Does the Agency have any rational advice to the states on how we can approach fish advisories for dioxin and furans?

A: Rita Schoeny: That's an easy question. I think what we have is a good assessment with bad news. In that sense it's not dissimilar to mercury. The best we can do, given the persistent nature of these compounds, is to continue to issue advice either limiting or banning the consumption of highly contaminated fish. No, it's not going to be the major component of the diet. The people who are eating the non-fatty fish, in this particular instance, are going to incur lower burdens, particularly if that takes up a greater proportion of their diet. One of the conclusions that we came to is, those eating a diet high in fat and high in animal protein, not fish, are likely to be getting a substantial exposure. If you're on Atkins, you are probably best off eating a low-fat fish. This is not a problem that's going to have simple solutions.

Updating USEPA's Ambient Water Quality Criteria for Arsenic: Toxicity and Bioaccumulation

Charles O. Abernathy and Tala Henr, U.S. Environmental Protection Agency, Office of Science and Technology; Health and Ecological Criteria Division; Tyler Linton, William Clement, and Dennis McIntyre, Great Lakes Environmental Center

The Clean Water Act requires USEPA to develop, publish, and periodically revise the ambient water quality criteria (AWQC). The human health AWQC are numeric values for concentrations of chemicals in ambient waters that are considered to be protective of human health. In 2000 the Agency updated the methodology for deriving AWQC to reflect advances in key areas such as risk assessment, exposure assessment, and bioaccumulation. It published partial updates to the AWQC, incorporating new information on toxicity and fish consumption for 83 chemicals in 2000 and proposed updates on 15 chemicals in 2002. Arsenic (As), for which reassessments of health endpoints and the bioaccumulation factor are ongoing, was not included in the 2000 or 2002 updates. Key components of the As criteria reassessment are the toxicology and bioaccumulation inputs. At present, in the Integrated Risk Information System, the toxicological basis for the existing As criteria is skin cancer. USEPA has considered recent information on target tissues and dose-response relationships for As toxicity and concluded that the cancer potency factor should be based on bladder and lung cancers. Accordingly, USEPA is revising the cancer slope factor. To assess the bioaccumulation potential of As, a literature review was conducted to identify data on the relative amounts of inorganic and organic As in aquatic organisms and surface waters. The literature search results have been reviewed for applicability in deriving trophic-level specific bioaccumulation factors, in accordance with the 2000 human health methodology. At the present time, the database is insufficient to derive bioaccumulation factors for any As species other than total As. The proportion of total As in freshwater fish that is inorganic appears to be considerably higher than that previously reported for marine fish and shellfish, and it indicates that As speciation data from marine species should not be used for freshwater species. (The opinions expressed in this abstract are those of the authors and do not necessarily reflect the views or policies of USEPA.)

Questions and Answers Following Presentation

Q: Bob Brodberg, California EPA: To do a meaningful risk assessment on arsenic, do you really need all the speciation results? Are there toxicity criteria numbers for monomethylarsonic acid (MMA) and dimethylarsenic acid (DMA)? It seems like those are the ones where we would want to focus a risk assessment.

A: Charles Abernathy: Let me make one clarification. Risk assessment for drinking water is a completely separate issue because we're starting with inorganic and not various species. (What you are exposed to in that case is inorganic arsenic and its metabolites.) When it comes to the national BAF, we're dealing with a vast array of different products, from both what one is exposed to and the toxicities of those.

Q: Bob Brodberg: So that hasn't really been resolved. In fish, we would probably look at those speciated. It seems like a more expensive analysis, and I'm just trying to determine if it is really worth doing. We actually have a lot of other chemicals that are going to drive the risk in a sense.

A: Charles Abernathy: That becomes a priority. We are working on it and talking to some of the people who have done the work to see if we can get a little bit better outline of their data and how to use it. I don't know how EPA is going to prioritize it at this time. We are working on it, but with the Safe Drinking Water Act reanalysis of arsenic in drinking water coming up, it certainly won't have the priority that that does. That's all I can say at this time.

Q: Lon Kissinger: It seems that there are a lot of issues associated with the measurements of the different arsenic species—sample handling issues, extraction issues, and chromatographic issues. And in summarizing the data or trying to get a sense of what's happening, overall it would seem that defining all those parameters would be really important. Is there any effort going to be put out to do a better job of defining all those concerns?

A: Charles Abernathy: As you say, this is a problem. For example, it was only roughly 3 years ago that DMA(+3) and MMA(+3) were found in human urine. Why was that? Preservation of the urine and being able to separate the species at +5 and +3. We were fortunate to have people like Bill Cullen and Chris Lee in Canada who can do this. They worked with people like Sam Cohen and Dave Thomas and his group. Bill Cullen actually made the MMA(+3) and the DMA(+3), synthesizing it chemically. So that is a problem, and we are discussing whether we should put out guidance. It's extremely expensive to do this. The people who generally do this are research labs with a grant.

C: Lon Kissinger: There's really a crying need for it. For example, in Puget Sound we're left with the aftermath of an ASARCO smelter. People are concerned with the health risk of inorganic arsenic in fish tissue, and it may not be significant. The background concentrations may be similar regardless of the environmental source.

Q: John Cox: With arsenic being in the same family as phosphorus, I wonder about the extent of knowledge where arsenic replaces phosphorus and may therefore disrupt some of these phosphorylation processes and some of these Krebs cycles.

A: Charles Abernathy: This was worked on in the 1950s by Lipman at Harvard and Orenius in Sweden in the same time period, and there is a process called arsenolysis. When you form ATP, if you put in arsenate, it's a competitive inhibitor. What you get is an ADP arsenate form. This is unstable n-lysis, and the process is called arsenolysis. It can interfere but does not appear to be a major mechanism of toxicity. We haven't been able to find anything that this actually directly affects. Most of it, for example arsenite +3, has been reported to inhibit 200 to 300 different enzymes. It inhibits DNA repair enzymes, and it has also been reported to cause DNA nicking. However, a later report from RTP showed that the nicking was the result of reactive oxygen species formation. If you block the reactive oxygen species formation, you block the DNA nicking, so that seems to be indirect. We haven't had any such effects reported for the arsenate and the phosphate interaction.

Q: For those groups that actually measure total arsenic but have the responsibility of assessing and doing the risk assessment, what would be your recommendation on the fraction of that total that should be taken as or assumed to be inorganic for purposes of risk assessment?

A: Charles Abernathy: In saltwater fish, a vast majority is organic. If you use 10 percent across the board, you are being overly protective in seafood (what comes from the ocean). In freshwater fish, I'm not sure we can do that yet. And the reason is, if you look at the laboratory studies, they show that in some of the freshwater fish the majority of the arsenic is inorganic. So we're not exactly sure what to do with that yet. That's why we need more data. At the present time we can't make a recommendation.

X. Regional Needs Assessment

The participants at the forum were divided into six regional workgroups based on geographic location—Northeast, East, South, Great Lakes, Midwest and West. Each regional workgroup met independently to discuss and react to the presentations made during the Tuesday sessions on risk management issues and monitoring contaminants in fish, as well as the roundtable discussions held on Sunday to discuss how federal agencies can assist state/tribe monitoring programs. Groups were asked to identify top regional concerns and identify needs to address those concerns. Following is a summary of the needs assessment conducted by each workgroup. The level of priority for each need is listed as low, medium, or high. Three of the six regional groups (Great Lakes, Midwest and West) have not yet provided rankings for their needs.

East

Presented by Joseph Beaman, Maryland Department of the Environment

The East region was defined as the geographical area including the states of Delaware, Kentucky, Maryland, Tennessee, Virginia, and West Virginia, and Washington, DC. Representatives from all six states and the District of Columbia participated in the forum group discussions. No representatives from Native American tribes participated in this discussion group.

Top Regional Priorities, Issues, and Concerns for Fish Contaminant Programs

Federal Agency (USEPA/FDA) Assistance

- Several states in the East Work Group are facing reduced budgets for administering their fish contaminant advisory programs. The monies allocated to state fish advisory programs are normally considered nondiscretionary because the advisory programs are nonregulatory in scope. Reducing nondiscretionary expenditures is frequently among the first steps states are taking to balance their budgets. Thus, states could greatly benefit from some additional federal funding to support their existing fish contaminant advisory programs and to cover the collection of new data to fill existing data gaps. **Priority Ranking: High**
- Funding support and staff are needed to support state risk communication efforts following the release of advisories, especially large advisories like the national mercury advisory. These risk communication efforts are very time-consuming and expensive, and the states just do not have the resources to do a good job. **Priority Ranking: High**
- A regional point of contact (in Region 3) is needed to consult with on fish tissue issues. Regional coordination is important, especially for large advisories or shared waters. **Priority Ranking: Medium**

National Mercury Advisory

Needs Assessment

- Regarding the National Mercury Advisory, the advisory needs to be simple and very easily understood by the target audience. We think that the advisory should consider, in some way, other contaminants, especially contaminants that drive advisories in a number of states, like PCBs. Are

mercury and PCBs mutually exclusive, or are we dealing with levels of both such that they needed to be looked at additively (i.e., neurotoxicity in fetus)? **Priority Ranking: High**

- There is a need to deal with consumption of sport fish and store-bought fish on a holistic level. **Priority Ranking: Medium**
- A national communication strategy is needed. USEPA needs to provide a national 1-800 number for these advisories, as well as training and resources at the regional level. **Priority Ranking: High.**

Melding Commercial and Noncommercial Advisories

Needs Assessment

- Data gaps must be filled in for local species that may be important as both sport fish and commercial species. This might be accomplished by conducting a survey of national FT program managers as to the top three to five locally important sport/commercial fish. For example, in Maryland white perch are an important local commercial species—recreational advisories for white perch vary from four to five meals per year to unlimited consumption, depending on the part of the Bay that you are in. **Priority Ranking: High**

Monitoring Contaminants in Fish

Needs Assessment

- Federal support is needed for the monitoring of emergent contaminants, such as PBDEs and PFOs. Maryland has recently begun monitoring PBDEs in areas where it thinks PBDEs might be found at elevated concentrations in some of its fish. Federal support to increase monitoring efforts for emergent contaminants or to help compile existing data would be helpful. **Priority Ranking: Medium/High**
- States need guidance on how to deal with dioxins and furans in advisories. If we are going to monitor, we need guidance on where to monitor because the analysis costs are very expensive. Delaware made a recommendation to assess dioxin based on a comparative risk index—overall dietary risk versus the contribution from fish alone. If fish consumption increased background risk (all food exposure sources) above some threshold (e.g., > 10%), then consider for advisory. **Priority Ranking: Low/Medium**
- Consistency is needed in monitoring strategies. Many states do not have a monitoring strategy, and they monitor based on priorities at hand. How do we get a consistent monitoring strategy together? **Priority Ranking: Low/Medium**

Risk Management Issues

Needs Assessment

- It is recommended that USEPA provide support for regional issues when we have large shared waterbodies. Support could include things such as facilitating meetings and providing support to work out solutions where state agencies are having difficulties agreeing on management approaches. **Priority Ranking: Low/Medium**

- Provide modeling support for total maximum daily loads (TMDLs) related to fish consumption advisories such as mercury and PCBs. TMDLs for banned compounds often have legacy issues and require complex models. States do not have adequate resources to do TMDLs and no money for TMDL implementation or cleanup in the case of PCBs. **Priority Ranking: High**

South

Presented by Joe Sekerke, Florida Department of Health

The South region was defined as the geographical area including the states of Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, and Texas. Representatives from all eight states participated in the forum group discussions. No representatives for Native American tribes participated in this discussion group.

Top Regional Priorities/Issues/Concerns for Fish Contaminant Programs National Mercury Advisory

Consistency of Advisories from EPA/FDA

- The advisory about tuna steaks/albacore tuna was not clear enough and we would ask that USEPA try to provide a clearer explanation of what the problem is and how people should handle it. The Gulf group is trying to get a harmonious advisory for king mackerel. **Priority Ranking: High**
- Three out of the eight states in the group have had at least anecdotal data about adult mercury poisoning related to consuming fish. We are curious whether any other states have had similar situations and whether they would be willing to share such information. We are not sure whether the issue is being dealt with properly and whether mercury poisoning is turning up in other states (i.e., not isolated to just Texas, Florida, and Louisiana). The USEPA and FDA are going have to address the issue because it involves commercial fisheries. **Priority Ranking: Medium**

Monitoring Contaminants in Fish

Main Priorities/Issues/Concerns

- Funding: laboratories are starting to run into major problems in capacity for testing for the different contaminants, particularly the dioxins and PCBs. Request that USEPA consider issuing grants to the states to help them with this issue. **Priority Ranking: High**
- States could benefit from recommendations/guidance from USEPA on qualified laboratories to conduct chemical analyses for different contaminants. **Priority Ranking: High**
- What statistical methods should be used on PCB analysis? Is there any guidance from USEPA on design and how many samples you have to take? **Priority Ranking: Low**
- We are in the transition period between analyzing for Aroclors and PCB congeners. USEPA needs to provide guidance on which congeners should be analyzed for, what concentrations will be used for making decisions, and which laboratories are capable of conducting the analyses and meeting quality assurance requirements. I think that the USEPA has developed guidelines for congeners in fish. Will the same congeners be used for soil, sediment, and other media? If not,

then we need guidance on which PCB congeners need to be analyzed for in other media. **Priority Ranking: Medium**

Risk Management Issues

Needs Assessment

- Risk communication: We would like some guidance from USEPA and FDA or other agencies about where we can get funding to help promote state communication programs. **Priority Ranking: Low**

Northeast

Presented by Eric Frohberg, Maine Bureau of Health

The Northeast region was defined as the geographical area including the states of Connecticut, Maine, Massachusetts, New Jersey, New Hampshire, Rhode Island, and Vermont. Representatives from five states (Connecticut, Maine, Massachusetts, New Jersey, Rhode Island) and one Native American tribe (Aroostook Band of Micmacs) participated in the forum group discussions.

Top Regional Priorities/Issues/Concerns for Fish Contaminant Programs

Federal Agency (USEPA/FDA) Assistance

- A USEPA regional coordinator is needed to help us coordinate fish contaminant program actions within the Northeast and other geographical regions. For example, New York is in several different geographic regions, the Great Lakes as well as the East Coast. The USEPA regional coordinator could act as a point of contact to help coordinate between the different regions in the appropriate states. Some of the things this person could do are (1) helping to identify sources of funding and (2) identifying and promoting coordinated activities. In particular we are thinking about data and data collection as well as data sharing (i.e., regional outreach). **Priority Ranking: Medium**
- Would like to see additional items on USEPA's Web site. For instance, direction on funding (ideas for sources), projects funded by USEPA and how to get the results from the funded projects. **Priority Ranking: Low**

Melding Commercial and Noncommercial Advisories

Needs Assessment

- Because of the success with the national approach to the mercury advisory, it would be helpful to move on to other contaminants of concern like PCBs and dioxins. In particular, if you take USEPA's recreational fishing guidance and calculate a PCB concentration, you get approximately 11 ppb. The FDA's number is approximately 2 ppm. Although the group doesn't think these numbers should be identical, because they are derived from different situations, I don't think anyone uses 11 ppb to issue advisories, or would be comfortable using 2 ppm. Having this great disparity between the numbers recommended by USEPA and FDA makes it more difficult for states to implement their fish contaminant programs and communicate the potential risks to the public.

- We recommend that USEPA develop a new guidance document that provides a review of the literature that addresses the benefits of omega-3 fatty acids. We see this as being valuable in several ways. It would bring together all the current information, including the data on Omega-3 fatty acids in different species of fish, but it would also act as a road map to research, identifying the data gaps. It would be helpful to get some research to identify age-specific benefits regarding consumption of Omega-3 fatty acids. **Priority Ranking: High**

Monitoring Contaminants in Fish

Needs Assessment

- We are very interested in receiving toxicity information on additional chemicals that have not been addressed in IRIS (PDBEs, endocrine disruptors, etc.). **Priority Ranking: Medium**

Great Lakes

Presented by Henry Anderson, Wisconsin Department of Health and Family Services

Top Regional Priorities/Issues/Concerns for Fish Contaminant Programs

The Great Lakes region was defined as the geographical area including the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin. Representatives from all eight states participated in the forum group discussions. In addition, representatives from four Native American tribes or organizations (Chippewa Resource Authority, Minnesota Chippewa Tribe Research Laboratory, Great Lakes Indian Fish and Wildlife Commission, and Michigan Inter-Tribal Council) also participated.

National Mercury Advisory: Needs Assessment

Issue of Risk Communication as It Relates to the National Mercury Advisory

- We want to remind USEPA and FDA that states have a limited staff resource and anytime something like the national mercury advisory comes out that requires additional effort on the part of our staff, it will, for better or worse, impact our staff, who at this time of the year are preparing for our own initiatives and advisories. So when you get ready to issue your advisory plan, it really would be helpful if the agencies (1) coordinate with the states and (2) consider funding or providing resources to states to compensate them for their role in this advisory. States will have an important role, because as soon as the advisory is issued we will immediately be contacted by the press as to what we think about it, etc. All of these efforts require staff resources. It is very important that the timing of when the national mercury advisory is issued be coordinated with the states so that USEPA is aware of how the states will respond and the states can prepare to handle the additional demands of risk communication efforts. **Priority Ranking: High**
- We need a mechanism to capture and disseminate reports of poisoning associated with fish consumption. **Priority Ranking: High**

Monitoring Contaminants in Fish

Needs Assessment

- Members of our group feel very fortunate to have our own USEPA monitoring program (the Great Lakes Program Office). However, we observe that the Great Lakes Program Office is struggling due to lack of sufficient funding. It is important, not just to the Great Lakes states, but to all of us, that adequate support be maintained for the Great Lakes Program Office to ensure that data and information continue to be tracked and processed, especially for emerging contaminants. The tracking of what is occurring in the region is very important. For example, if each state is using its meager funds to analyze five samples of PBDE in fish and we don't coordinate efforts, we could end up with states sampling the same species in the same waterbody and deriving less information than if we had coordinated regional sampling efforts. It is important, and we believe USEPA would be a good resource to facilitate exchanging information. It is important to identify the gaps as we put together this monitoring strategy. We are supportive of USEPA's methodologies and would like to see the same sophisticated models used for other contaminants (not just mercury). It is important to have standardized methodologies. Laboratory training is important. We need an RfD for toxicological data. **Priority Ranking: High**
- We really need a coordinated strategy for monitoring streams in the vicinity of point sources for the emerging contaminants. **Priority Ranking: Medium**
- We suggest looking at the other brominated compounds; a continuation of the fish contaminant program is critical. **Priority Ranking: High**
- While Great Lakes States have quite similar mercury advisories, our states need to get together to come up with a uniform protocol for our mercury advisories. **Priority Ranking: High**
- Great Lakes States are going to review our protocol developing PCB advisories. **Priority Ranking: Medium**
- We need to develop a format or protocol to query new data submittals to catch duplication among the datasets submitted by states and tribes. **Priority Ranking: Medium**
- We need new rapid analysis equipment that would allow live tissue extraction. USEPA could assist by providing guidance on this technology. **Priority Ranking: Medium**
- Developing datasets for assessing temporal and spatial trends and incorporating trend analysis into our monitoring programs should be a priority. We do have some trend data in the Great Lakes States. Trend data can provide important feedback on whether management actions are working. A baseline for assessing PBDE is important to evaluate what effect the ban will have on tissue residues. **Priority Ranking: High**

Midwest

Presented by Mike Callam, Nebraska Department of Environmental Quality

The Midwest region was defined as the geographical area including the states of Arkansas, Colorado, Iowa, Kansas, Missouri, Nebraska, New Mexico, North Dakota, Oklahoma, South Dakota, and Wyoming. Representatives from all these states, except Kansas and South Dakota, and a representative from the Cheyenne River Sioux Tribe participated in the forum group discussions.

Top Regional Priorities/Issues/Concerns for Fish Contaminant Programs

Federal Agency (USEPA/FDA) Assistance

- We need funding. It is felt that not much is being done from monitoring through risk communication in Midwest states. The regional comparability of information that we are giving out is not cohesive, especially with shared waters, and that is something that was a concern among the group's states. **Priority Ranking: High**

Monitoring Contaminants in Fish

Main Priorities/Issues/Concerns

- The group would like to see a more organized process developed for sharing information on fish contaminants and advisory information—something similar to what the Great Lakes States have done. A need for our group would be for USEPA to support such a process. Because our monitoring and assessment vary widely within our region, there's a need for greater cohesiveness. **Priority Ranking: Medium/High**
- The monitoring is also rather scattered among the states. The actual waterbodies that are being visited are different. There are discrepancies and maybe confusion as to what the real risk levels are within each state. The types of fish species are also different. There is also a general lack of understanding as to what the people of the Midwest are actually consuming. The group identified a need for a fish consumption survey to be conducted to identify what fish are being consumed and in what amounts. We also need to obtain information on the consumption of different food sources such as clams. **Priority Ranking: Medium/High**
- A better list of contaminants that we are trying to identify in the fish samples is needed. Something that could help in that regard is the USEPA's national fish tissue study. **Priority Ranking: Low**

West

Presented by Robert Brodberg, Cal/EPA, Office of Environmental Health Hazard Assessment

The West region was defined as the geographical area including the states of Alaska, Arizona, California, Hawaii, Idaho, Montana, Nevada, Oregon, Utah, and Washington. Representatives from all of these states except Nevada participated in the Forum group discussions. In addition, representatives from seven Native American Tribes or organizations (Columbia Inter-Tribal Fish Commission, Lytton Rancheria, McGrath Native Village Council, Nez Perce Tribe, Snoqualmie Tribe, Yakama Nation, and Yellowhawk Tribe) also participated.

Top Regional Priorities/Issues/Concerns for Fish Contaminant Programs Monitoring Contaminants in Fish

Main Priorities/Issues/Concerns

- Monitoring is very important, and continued monitoring resources are extremely important to all of us. We need to know what's out there. Guam is monitoring near hotspots— places where they know there are problems. They would like funding to look at areas that they don't know about.
- Guidance on how states might develop and use a stratified random sampling design, like the one used in the National Study of Chemical Residues in Lake Fish Tissue, for their own water quality indicator studies. This sampling might serve as a basis for statewide advisories, and it could also be useful to help identify clean spots within states, or sites of unexpected contaminants. **Priority Ranking: High**
- Continued work on guidance for selecting new bioaccumulative chemicals in the environment, such as inert ingredients in pesticide formulations that should be monitored. **Priority Ranking: High**
- Research on correlating PCB levels measured as Aroclors with PCBs measured as congeners. Because a number of different methods are used for PCB analysis, we need to know the biases of the different methods so that we can determine whether the concentrations of PCBs in the environment are increasing, decreasing, or remaining stable. Additional guidelines on options and selection of analytical methods would be helpful to the states because we all have resource constraints. For example, would an Aroclor method be adequate for measuring PCBs at some level? At what concentration does it become critical to run a congener method? Is it really necessary to run more costly analyses for dioxin-like PCBs in all samples? **Priority Ranking: High**
- Compare the current suite of recommended monitoring chemicals in fish with the suite of chemicals that are looked at in other environmental or biological monitoring programs (e.g., the NHANES biological monitoring through CDC) to ensure that we are looking at chemicals of exposure. **Priority Ranking: Medium**
- There were some suggestions to validate our current suite of recommended monitoring chemicals by looking at unknown GC/MS peaks. This could be done as part of the National Study of Chemical Residues in Lake Fish Tissue study. Analysis and identification of the peaks will help us determine whether chemicals are accumulating in fish to which we previously have not paid attention. **Priority Ranking: Medium**
- The Group recommends that the tissue samples collected during the National Study of Chemical Residues in Lake Fish Tissue study be archived to serve as a baseline for future trends analysis. A national tissue bank for archiving samples would allow reexamination of historical samples to see if previously unidentified chemicals were present. **Priority Ranking: Low**
- States would like to see more efforts to harmonize some of the development of TMDLs and fish advisories. (In most places they are not one in the same.) It was also suggested that efforts be made to harmonize environmental tracking programs with TMDLs and fish advisories. **Priority Ranking: Low**

- There should be additional studies to understand the relationship between “fish condition” (effects of nutritional status) and contaminant level in fish. **Priority Ranking: Low**

Risk Assessment Issues

Main Priorities/Issues/Concerns

- Risk assessment. People don’t seem to be entirely aware of the Coglianò method for PCB congeners and how to evaluate these chemicals for assessing potential cancer risk. The group thought that the method needed to be formalized and better explained to facilitate use by the states. In addition, some kind of guidance for assessing noncancer effects of PCBs should be developed and provided. **Priority Ranking: High**
- We’re looking forward to the development of toxicity criteria for PFOS chemicals and PBDEs. There was a suggestion that USEPA continuing looking at tools for synergistic and additive effects of chemicals. **Priority Ranking: High**

Risk Management Issues

Main Priorities/Issues/Concerns

- Continued information on risk versus benefits from fish consumption. There was interest in this sort of information in general and also in terms of substitution foods (e.g., what to do when there is a lack of options). **Priority Ranking: High**
- The states would like more information about the benefits and sources (specific fish species and plant sources) of omega-3 and omega-6 fatty acids. Also, the states would like more information on incorporating this information into their advisories. **Priority Ranking: High**
- It would be a good idea to get some core questions on a nationwide basis on the risk factor surveys. For example, the state of Washington put questions about fish consumption on the state portion of the survey. Questions of the national level would be useful for the national program and could also be broken out and used at the state level in a consistent way. This seemed like it would be useful to all of us. **Priority Ranking: Medium**
- When putting out advisories, including the national advisories, people thought it was important to include some sort of link with an explanation of the pollutant sources that the advisory is based on (Why is this chemical here?) because that motivates people to work on cleaning up such sources. We suggest more efforts to make this linkage. **Priority Ranking: Medium**

There was a suggestion to revisit EPA’s guidance on the effects of cooking and cleaning on reduction of contaminants. EPA guidance documents provide a review, but maybe it is something that could be looked at again, or at least revised to incorporate new data. **Priority Ranking: Low**

XI. Closing Remarks

Bob Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

On behalf of all the cosponsoring agencies—ATSDR, USEPA, and California EPA's Office of Environmental Health Hazard Assessment—I want to thank you all for being here. It's been great to see you all. I didn't have a chance to talk to nearly enough people. I hope you enjoyed your stay and it was sunny enough for you here in San Diego. We look forward to seeing you again at the next Fish Forum. In addition, on behalf of all participants, I want to thank ATSDR, Steve Blackwell, and USEPA, Jeff Bigler, for cosponsoring the forum. I also want to thank all members of the steering committee for the work that they did in planning the sessions. They were really good sessions, and there was a lot of good discussion, and I hope you leave with good ideas. I also want to thank Steve Ellis and his coworkers, who have held this together behind the scenes (Steve, Melissa DeSantis, Clair Meehan, and Ashley Moats). I really think that we owe them a big hand at this time. Thanks very much, and it sounds like we're still depending on you to get out that proceedings document.

It's been another great forum for me, and we really need to have these again. This is a great opportunity for the states to talk to each other and share ideas. We don't necessarily agree on everything, but this is a good place to discuss differences and get questions answered. There's been a lot of good information put out there as a result of these forums and through USEPA. All of the guidance documents are getting updated, and there is even more information in them. They're a great resource. There's a lot of agreement. We're seeing FDA and USEPA reach some agreement on something that we've asked them to talk about for a long time. I think that is excellent, and we should all continue to work toward that. The more that we agree between states, the simpler this is all going to be. We've made great progress, and I think we will continue to do that at the next forum. On behalf of the Office of Environmental Health Hazard Assessment, thanks once again for being here.

Appendices

Appendix A: Forum Agenda

Appendix B: Steering Committee Members

Appendix C: Biographies of Speakers and Moderators

Appendix D: List of Forum Attendees

Appendix E: Slide Presentations

Appendix F: Poster Abstracts

Appendix A: Forum Agenda

Appendix A: Forum Agenda

Sunday, January 25, 2004

- 9:00 – 5:00 **Registration**
- 11:00 – 1:00 **State and Tribal Regional Work Groups**
Topics of Interest to Group Members
- 1:00 – 2:00 LUNCH (on your own)
- 2:00 – 2:15 **Forum Organization and Objectives**
Jeffrey Bigler, U.S. Environmental Protection Agency, Office of Science and Technology
Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment
Steve Ellis, Tetra Tech, Inc.
- 2:15 – 2:35 **Pros and Cons of Focus Group Testing**
Steve Bradbard, Consumer Studies, Food and Drug Administration
- Monitoring Strategies to Support Fish Advisories**
Moderator: Randy Manning, Georgia Department of Natural Resources
- 2:35 - 2:55 **EPA National Contaminant Study Design and Uses of Data**
Leanne Stahl, U.S. Environmental Protection Agency, Office of Science and Technology
- 2:55 – 3:15 **Model Application for Developing Fish Consumption Advisories**
Stephen Wentz, U.S. Geological Survey
- 3:15 – 3:30 **Round Table Discussion on How Federal Agencies Can Assist State/Tribe Monitoring Programs**
- 3:30 – 3:45 BREAK
- Approaches to Melding Commercial and Noncommercial Fish Advisories**
Moderator: Bob Gerlach, Alaska Department of Environmental Conservation
- 3:45 – 4:00 **Minnesota Fish Consumption Advisory**
Pat McCann, Minnesota Department of Health
- 4:00 – 4:15 **Maine Fish Consumption Advisory**
Eric Frohmberg, Maine Bureau of Health
- 4:15 – 4:30 **North Carolina's New Advice on Eating Fish**
Luanne Williams, North Carolina Department of Health and Human Services
- 4:30 – 4:45 **Florida Fish Consumption Advisory**
George Henderson, Florida Department of Environmental Protection
- 4:45 – 5:15 **Round Table Discussion**

Monday, January 26, 2004

8:00 – 8:20 Formal Welcome and Introductions

General Forum Moderators:

*Jeffrey Bigler, U.S. Environmental Protection Agency, Office of Science and Technology
Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health
Hazard Assessment*

Welcoming Remarks:

*Benjamin Grumbles, Acting Assistant Administrator, Office of Water, U.S. Environmental Protection
Agency
Val Siebal, Chief Deputy Director, California Office of Environmental Health Hazard Assessment*

Mercury Issues

Moderator: Henry Folmar, Mississippi Department of Environmental Quality

8:20 – 8:35 Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii

Barbara Brooks, Hawaii Health Department, Hazard Evaluation and Emergency Response

8:35 – 8:45 Mercury Concentrations in North Carolina's Top Five Commercially Sold and Recreationally Caught Marine Fish

Luanne Williams, North Carolina Department Health and Human Services

8:45 – 9:00 Options for a Gulf States' Mercury Advisory for King Mackerel

Donald Axelrad, Florida Department of Environmental Protection

9:00 – 9:15 Recent Washington State Data on Mercury Concentrations in Tuna

Jim VanDerslice, Washington Department of Health

9:15 – 9:30 Recent FDA Data on Mercury Concentrations in Fish

David Acheson, Food and Drug Administration

9:30 – 9:45 Panel Questions for Clarification

9:45 – 10:00 BREAK

10:00 – 10:10 Forum Organization and Objectives

Steve Ellis, Tetra Tech, Inc.

Mercury Issues, Continued

Moderator: Henry Anderson, Wisconsin Department of Health and Family Services

10:10 – 10:35 Update on Recent Epidemiologic Mercury Studies

Kate Mahaffey, U.S. Environmental Protection Agency

10:35 – 10:55 Update on the Current Mercury RfD and the Implications for Revisions Based on Recent Data

*Alan Stern, New Jersey Department of Environmental Protection, Division of Science, Research,
and Technology*

10:55 – 11:05 Panel Questions for Clarification

11:05 – 11:35 National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations

David Acheson, Food and Drug Administration

Denise Keehner, U.S. Environmental Protection Agency, Office of Science and Technology

11:35 – 12:05 **National Mercury Advisory: Exposure Assessment and Peer Review**
David Acheson, Food and Drug Administration
Rita Schoeny, U.S. Environmental Protection Agency, Office of Water

12:05 – 12:15 **Panel Questions for Clarification**

12:15 – 1:45 LUNCH (on your own)

Mercury Issues, Continued

Moderator: Henry Anderson, Wisconsin Department of Health and Family Services

1:45 – 2:00 **Mercury Focus Group Testing Results**
Marjorie Davidson, Food and Drug Administration

2:00 – 2:20 **National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory**
Jim Pendergast, U.S. Environmental Protection Agency, Office of Science and Technology

2:20 – 2:35 **National Mercury Advisory: December 2003 Committee Meeting to Address the Joint Advisory**
David Acheson, Food and Drug Administration

2:35 – 2:50 **Panel Questions for Clarification**

2:50 – 3:15 **National Mercury Advisory: Communication/Implementation Strategy**
Open Forum

3:15 – 3:30 BREAK

3:30 – 5:00 **Regional Breakout Sessions**
Mercury Issues: State/Tribe Reactions and Needs Assessment

6:00 – 8:00 **Reception and Poster Displays**

Tuesday, January 27, 2004

8:00 – 8:15 **Welcome and Introductions**
General Forum Moderators:
Jeffrey Bigler, U.S. Environmental Protection Agency, Office of Science and Technology
Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

8:15 – 9:25 **Regional Group Reports: National Mercury Advisory Comments and Reactions**

9:25 – 9:40 BREAK

Risk Management Issues

Moderator: Luanne Williams, North Carolina Department of Health and Human Services

9:40 – 10:00 **Results of Different Methods Used to Evaluate State Mercury Advisories**
Henry Anderson, Wisconsin Department Health and Family Services

10:00 – 10:20 **Web-based Guidance on Risk Communication: An Update and Demonstration**
Barbara Knuth, Cornell University, Department of Natural Resources

10:20 – 10:50 **Risks and Benefits Revisited**
Grace Egeland, McGill University

- 10:50 – 11:10 **Fish Smart, Eat Safe! Risk Communication to Diverse Populations in an Urban Setting**
Lin Kaatz Chary, Great Lakes Center for Occupational and Environmental Safety and Health, University of Illinois at Chicago, School of Public Health
- 11:10 – 11:35 **Palos Verdes Shelf Fish Contamination Risk Communication**
Sharon Lin, U.S. Environmental Protection Agency, Region 9
Gina Margillo, Impact Assessment, Inc.
- 11:35 – 11:55 **Mississippi Delta Case Study: Risk Communication**
Linda Vaught, Mississippi Department of Environmental Quality, Information Center
- 11:55 – 12:15 **Risk Communication for Medical Practitioners**
Steve Blackwell, Agency for Toxic Substances and Disease Registry
- 12:15 – 1:30 LUNCH (on your own)

Monitoring Contaminants in Fish

Moderator: Brian Toal, Connecticut Department of Public Health

- 1:30 – 2:00 **Contaminants in Farmed Salmon from Around the World**
David Carpenter, University at Albany, SUNY
- 2:00 – 2:20 **Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet**
Sandie O'Neill, Washington Department Fish and Wildlife
- 2:20 – 2:40 **Model Application for Monitoring Contaminants in Fish**
Stephen Wentz, U.S. Geological Survey
- 2:40 – 2:55 **Panel Questions for Clarification**
- 2:55 – 3:15 BREAK
- 3:15 – 5:00 **Regional Breakout Sessions**
 Monitoring and Risk Management: State/Tribe Reactions and Needs Assessment

Wednesday, January 28, 2004

- 8:00 – 8:15 **Welcome and Introductions**
General Forum Moderators:
Jeffrey Bigler, U.S. Environmental Protection Agency, Office of Science and Technology
Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

Chemical Updates

Moderator: Joseph Beaman, Maryland Department of Environment

- 8:15 – 8:40 **PBDEs - Rising Levels in Fish, Tox Review, and the California Ban**
Tom McDonald, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment
- 8:40 – 9:00 **Dioxin**
Rita Schoeny, U.S. Environmental Protection Agency, Office of Water
- 9:00 – 9:20 **Arsenic: Speciation and Hazard**
Charles Abernathy, U.S. Environmental Protection Agency, Office of Science and Technology
- 9:20 – 9:35 BREAK

Forum State/Tribe Reactions and Needs Assessment: Regional Presentations and Discussion

Moderator: Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

9:35 – 11:20 **Regional Presentations**

11:20 – 11:50 **Questions and Comments**

11:50 – 12:00 **Closing Remarks**

General Forum Moderators:

Jeffrey Bigler, U.S. Environmental Protection Agency, Office of Science and Technology

Robert Brodberg, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment

Appendix B: Steering Committee Members

Appendix B: Steering Committee Members

Jeff Bigler, co-chair

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Appendix C: Biographies of Speakers and Moderators

Appendix C: Biographies of Speakers and Moderators

Charles O. Abernathy, Ph.D.

Dr. Abernathy is a toxicologist in USEPA's Office of Water in Washington, DC. He received his A.B. from Asbury College, his M.S. from the University of Kentucky, and his Ph.D. from North Carolina State University. Dr. Abernathy is the author or coauthor of over 80 scientific articles in professional journals and books. He has also coedited six books.

David William Kennedy Acheson, M.D.

Dr. Acheson received his M.D. from the University of London and, following training in internal medicine and infectious diseases in the United Kingdom, moved to New England Medical Center and Tufts University in Boston in 1987. As an associate professor at Tufts University, he undertook basic molecular pathogenesis research on food-borne pathogens, especially Shiga toxin-producing *E. coli*, from 1987 until 2001. In 2001 Dr. Acheson moved his laboratory to the University of Maryland Medical School in Baltimore to continue research on food-borne pathogens. In September 2002 he took a position as Chief Medical Officer at the Food and Drug Administration's Center for Food Safety and Applied Nutrition.

Dr. Acheson is internationally recognized for both his public health expertise in food safety and his research in infectious diseases. He is a fellow of the Royal College of Physicians (London) and the Infectious Disease Society of America.

Henry A. Anderson, M.D.

Dr. Anderson is the Chief Medical Officer and State Environmental and Occupational Disease Epidemiologist with the Wisconsin Department of Health and Family Services. He has held these positions since 1980.

Dr. Anderson has published over 150 scientific articles. He has been involved in the study of human exposure to PCBs for more than 20 years and led the effort for a Great Lakes Basin-wide uniform sport fish advisory protocol. He also leads a USEPA- and ATSDR-funded consortium of five state health departments that studies the reproductive and endocrine function of frequent Great Lakes sport fish consumers. The consortium also assesses advisory awareness and understanding in the Great Lakes Basin. Dr. Anderson, with the state of Maine, is assessing women's awareness of mercury toxicity and state fish consumption advisories in 12 states.

Donald M. Axelrad, Ph.D.

Dr. Axelrad is an environmental administrator in the Mercury Program of the Florida Department of Environmental Protection (FDEP) in Tallahassee.

Dr. Axelrad worked for the Department of Conservation, Victoria, Australia, for 17 years before joining FDEP. For the past 7 years, he has been involved in managing research on mercury sources,

biogeochemistry, bioaccumulation, toxicity, and model development, specifically to identify options for reducing mercury concentrations in Everglades fish and wildlife.

Joseph Beaman

Mr. Beaman is head of the Ecotoxicology and Standards Section in the Technical and Regulatory Services Administration of the Maryland Department of the Environment.

Mr. Beaman received his B.S. in Forest Biology from the College of Environmental Science and Forestry at Syracuse University and his M.S. in Environmental Science from Hood College. He worked as a military scientist in the Army, performing research on arboviruses for 7 years at the U.S. Army Research Institute for Infectious Diseases at Fort Detrick. He then transitioned to work for the Army as a civilian contractor performing aquatic toxicology research for 8 years at the U.S. Army Center for Environmental Health Research at Fort Detrick. For the past 3 years Mr. Beaman has been a toxicologist at the Maryland Department of the Environment. His main duties include serving as technical lead for the state's water quality standards program and programmatic lead for monitoring, risk assessment, and risk communication related to fish consumption advisories.

CDR Stephen Blackwell, R.S., M.P.H.

CDR Blackwell is an Environmental Health Officer in the U.S. Public Health Service, stationed in Atlanta with the Agency for Toxic Substances and Disease Registry.

CDR Blackwell received his B.S. in Environmental Health from East Carolina University in Greenville and his M.P.H. from the Florida International University in Miami. He has worked on risk communication and medical outreach issues involving national fish advisories for 6 years under an interagency agreement with USEPA. He has also served in various duty stations throughout his 19 years with the Public Health Service, including the Centers for Disease Control and Prevention, the Indian Health Service, and the U.S. Coast Guard.

Steve Bradbard, Ph.D.

Dr. Bradbard earned his Ph.D. in Psychology from the University of Maryland in 1978. After practicing as a clinical psychologist for 15 years, he took a job as Vice President of Research and Social Marketing for a Washington, DC, firm specializing in risk communication. Over the next 8 years, he developed research-based national health and safety campaigns for federal clients, including the USEPA, National Institutes of Health, and Department of Transportation.

Dr. Bradbard has worked at the Food and Drug Administration for the past 2½ years. He is the supervisor of the Consumer Studies research team in the Center for Food Safety and Applied Nutrition, where he oversees consumer surveys, experimental studies, and focus groups.

Robert K. Brodberg, Ph.D.

Dr. Brodberg is a senior toxicologist in the Office of Environmental Health Hazard Assessment, which is part of the California Environmental Protection Agency.

Dr. Brodberg received his B.S. in Biology from Heidelberg College and his M.S. and Ph.D. in Biology from Bowling Green State University. He has worked as a risk assessor for the state of California since 1989. Dr. Brodberg has worked on human health assessments for pesticides, sediment quality objectives, and water quality issues. He is currently Chief of the Fish and Water Quality Evaluation Unit, which is responsible for assessing the potential human health risks of eating chemically contaminated sport fish and seafood, as well as issuing sport fish consumption advisories for California.

Barbara A. Brooks, Ph.D.

Dr. Brooks is the State Toxicologist for the Hawaii Department of Health in Honolulu.

Dr. Brooks received her B.S. in Nutritional Science from the University of Arizona and received her M.S. in Food Science and her Ph.D. in Toxicology from Cornell University. After obtaining her Ph.D., she was a Postdoctoral Research Associate in molecular genetics at St. Mary's Medical School in London and later at the University of California at Los Angeles. For the past 12 years, Dr. Brooks has been the State Toxicologist for the Hawaii Department of Health. She is involved in all aspects of human health risk assessment for the state and is interested in biomonitoring for hazardous environmental substances.

David O. Carpenter, M.D.

Dr. Carpenter is Director of the Institute for Health and the Environment, University at Albany, State University of New York, and Professor in the Department of Environmental Health and Toxicology, School of Public Health, University at Albany.

Dr. Carpenter received his B.S. from Harvard College and his M.D. from Harvard Medical School. He chose a career of research, teaching, and public health, with specific research interests in neuroscience, toxicology, and radiobiology. Dr. Carpenter is very active in fundamental research related to understanding the function of the human nervous system in health and disease. His recent research has focused on the study of stroke; how neurons respond to a lack of oxygen and glucose; how nerve cells die in diseases, such as Alzheimer's disease; and particularly how environmental contaminants, such as lead, mercury, and PCBs, cause decrements of intelligence when children are exposed. Dr. Carpenter headed a major interdisciplinary research effort to study the effects of PCBs and related compounds in humans and animals at the Mohawk Nation at Akwesasne. He has become a national spokesperson on issues relating to the responsibilities and ethics of how research scientists should work with communities, as well as on issues of environmental justice.

Marjorie Davidson, Ph.D.

Dr. Davidson is responsible for public education on food safety and food terrorism at the Food and Drug Administration. She develops risk communication and educational programs for food handlers along the food safety continuum from farmers in the fields to consumers in the home. Prior to joining the FDA, Dr. Davidson worked at the U.S. Department of Agriculture, where she was responsible for health promotion activities, including school-based programs. She has extensive experience in media relations from her previous work in the White House and on Capitol Hill.

Grace Egeland, Ph.D.

Dr. Egeland joined McGill University in 2002 as a recipient of a 5-year Canada Research Chair Award in Nutrition, Environment, and Health. She is a faculty member of the Center for Indigenous Peoples' Nutrition and Environment, which has an all-Aboriginal Governing Board and affiliation with McGill University.

Dr. Egeland earned her Ph.D. in Chronic Disease Epidemiology from the University of Pittsburgh and has since worked at the U.S. Centers for Disease Control, the Alaska Department of Health and Social Services, and the University of Bergen. She has worked in diverse research arenas from occupational and environmental science to reproductive and chronic disease epidemiology— experiences that have given her a broad public health perspective useful in speaking to the diversity of issues pertinent to evaluating risks and benefits of traditional food. Dr. Egeland has published in a number of leading journals, including the publication of a policy forum article in *Science* on mercury risks and benefits of fish consumption. Indigenous Peoples recognizes the importance of traditional food toward promoting their health and well-being and requests that environmental risks be assessed within a framework of an appreciation for cultural and health benefits.

Steven Ellis, Ph.D.

Dr. Ellis is the Director of Northwest Water Services in Tetra Tech's Seattle office. He received his B.S. in Biology from Lawrence University and his M.S. and Ph.D. in Biological Oceanography from Oregon State University. Dr. Ellis has more than 20 years of experience in managing and conducting environmental studies in freshwater and coastal marine ecosystems. He has assisted USEPA in the development of several of the national guidance documents for assessing chemical contaminants for use in fish advisories and has conducted numerous fish contaminant studies for USEPA, state agencies, Australia, and the Dominican Republic to assess potential risks to human consumers.

Dr. Ellis has participated in several of the previous National Fish Contaminant Forums by conducting risk assessment and monitoring training workshops, facilitating discussion sessions, providing plenary presentations, and preparing Forum Proceedings documents.

Henry Folmar

Mr. Folmar is the Lab Director for the Mississippi Department of Environmental Quality Laboratory in Pearl. He earned B.S. and M.S. degrees in Fisheries Biology from Auburn University. Mr. Folmar has worked on monitoring contaminants in fish tissue since 1979. He has chaired the Mississippi Fish Advisory Task Force since 1990, and he is a charter member of the Southern States Mercury Task Force.

Eric J. Frohberg

Mr. Frohberg is a toxicologist with the Maine Bureau of Health. He has been involved in the development of the fish consumption advisories program, as well as the Bureau's risk communication program. This has included development of the new brochures, testing efforts with low-literacy focus groups, and an evaluation of the risk communication program through a survey of recent mothers.

Mr. Frohberg has been involved in other projects, including well water safety and the decommissioning of the local nuclear power plant. Prior to working for the state of Maine, he worked with the Western

Shoshone and Southern Paiute to evaluate risk from consuming traditional foodstuffs affected by aboveground nuclear weapons testing.

Robert F. Gerlach, V.M.D.

Dr. Gerlach is the State Veterinarian for Alaska. The Office of the State Veterinarian coordinates Alaska's Fish Monitoring Program.

Dr. Gerlach received his B.S. in Veterinary Science at the Pennsylvania State University and his V.M.D. from the University of Pennsylvania. He did a postdoctoral fellowship at Lovelace Inhalation Toxicology Research Institute in Albuquerque, studying the effects of aging on pulmonary function in beagle dogs. For 16 years Dr. Gerlach resided in Alaska and worked as a private practitioner until starting work for the Department of Environmental Conservation coordinating the Fish Safety Monitoring Program. In the spring of 2003, he accepted the position of State Veterinarian.

Benjamin H. Grumbles

Mr. Grumbles was appointed Acting Assistant Administrator for USEPA's Office of Water on December 29, 2003. He began his service in the Office of Water as Deputy Assistant Administrator in February 2002. He also served as Acting Associate Administrator for the Office of Congressional and Intergovernmental Relations from September 2 through December 29, 2003.

Before joining USEPA, Mr. Grumbles was Deputy Chief of Staff and Environmental Counsel for the House Science Committee. From May 1985 through January 2001, he served in various capacities on the House Transportation and Infrastructure Committee staff, including Senior Counsel for the Water Resources and Environment Subcommittee. During his 15 years of service on the Committee, he focused on programs and activities of USEPA, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration.

Since the early 1990s, Mr. Grumbles has been an adjunct professor of law at the George Washington University Law School, teaching a course on the Clean Water Act, Safe Drinking Water Act, Ocean Dumping Act, and Oil Pollution Act.

His degrees include a B.A. from Wake Forest University, a J.D. from Emory University, and an LL.M. in Environmental Law from the George Washington University Law School.

George Henderson

Mr. Henderson is a senior research scientist with the Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute. He received his B.A. in Natural Sciences from the University of Pennsylvania and his M.S. in Zoology from the University of Massachusetts.

Mr. Henderson has 30 years of experience researching toxins and contaminants in Florida marine ecosystems. He serves as State Scientific Support Coordinator for oil spill response. Since 1989 Mr. Henderson has coordinated the marine fish/mercury program in Florida.

Lin Kaatz Chary, Ph.D.

Dr. Chary is the former project coordinator and co-principal investigator of the PCB Risk Communication and Outreach Project's "Fish Smart! Eat Safe!" campaign.

Dr. Chary received her B.A. in English and Theatre from the University of Michigan in Ann Arbor, and her M.P.H. and Ph.D. in Public Health from the University of Illinois at Chicago, School of Public Health. She has worked on Great Lakes contaminant issues for 18 years, first as Executive Director of the Grand Calumet Task Force in Northwest Indiana, later as a consultant to nongovernmental organizations on environmental and labor issues, and most recently at the Great Lakes Center for Occupational and Environmental Safety and Health at the University of Illinois at Chicago, School of Public Health, where she worked on a study of the health effects of PCBs in an occupational cohort and on other projects related to PCBs and environmental health policy. She has also worked in the international arena with the International POPs Elimination Network and continues to work on Great Lakes contaminant issues, such as brominated fire retardants.

The "Fish Smart! Eat Safe!" campaign, which was completed in October 2003, was a USEPA-funded project that focused on gathering information about Lake Michigan fisheaters and conducting outreach in an urban setting.

Barbara A. Knuth, Ph.D.

Dr. Knuth is a professor and chair of the Department of Natural Resources at Cornell University and co-leader of the Human Dimensions Research Unit.

Dr. Knuth received two bachelor's degrees (Zoology and Interdisciplinary Studies) and her M.S. in Environmental Science from Miami University (Ohio). She received her Ph.D. in Fisheries and Wildlife Sciences from Virginia Tech. Her research interests focus on risk perception, communication, and management associated with chemical contaminants in fish and with other wildlife and natural resources issues. She has served on National Academy of Sciences and Institute of Medicine committees and most recently focused on implications of reducing dioxins in the food supply. She serves as President-elect of the American Fisheries Society (AFS) and received the AFS Distinguished Services Award in 1999. She has received several teaching awards, including recognition from the U.S. Department of Agriculture and the National Association of Colleges and Teachers of Agriculture. She has served as associate editor of *Society and Natural Resources* and *North American Journal of Fisheries Management*. She has served on numerous scientific panels and advisory boards, including the Board of Technical Experts of the Great Lakes Fishery Commission and the Great Lakes Science Advisory Board of the International Joint Commission.

Sharon Lin, P.E.

Ms. Lin is a project manager for the Palos Verdes Shelf Superfund Site with the USEPA Region 9 office in San Francisco. She is responsible for the overall implementation of the USEPA's Palos Verdes Shelf Superfund Institutional Controls program, which consists of public outreach and education, monitoring, and enforcement components.

Ms. Lin received her B.S. in Chemistry and her M.S. in Civil and Environmental Engineering. She is a registered civil engineer. After graduate school, she worked as a project engineer for an environmental consulting firm on USEPA Superfund-related projects. From 1996 to 2000, Ms. Lin worked at USEPA

headquarters in Washington, DC, on USEPA's national water program, focusing on sediment and Total Maximum Daily Load (TMDL) issues. Prior to becoming a Superfund project manager, Ms. Lin spent 2 years with the TMDL program in USEPA Region 9, primarily focusing on TMDL development in the Los Angeles area.

Kathryn R. Mahaffey, Ph.D.

Dr. Mahaffey's professional career is in exposure assessment and toxicology of metals. She has worked extensively in the area of food safety. Following graduate training in nutritional biochemistry and physiology at Rutgers University, she completed postdoctoral training in neuro-endocrinology at the University of North Carolina School of Medicine. Her research has been on susceptibility to lead toxicity with greatest focus on age and nutritional factors, resulting in more than 100 publications in this area. During her long career with the U.S. government, she has been influential in lowering lead exposures for the U.S. population through actions to remove lead from foods and beverages and from gasoline additives during the 1970s and 1980s.

In the past decade, Dr. Mahaffey has been actively involved in risk assessments for mercury and assessments of human exposure to methylmercury. She was the author of the NIH *Report to Congress on Mercury* and a primary author of USEPA's *Mercury Study Report to Congress*. Dr. Mahaffey was one of the primary developers of USEPA's *Mercury Research Strategy*, which was released in late 2000. Along with other team members, she was responsible for the 2001 USEPA/FDA national advisory on fish consumption. Dr. Mahaffey was one of a group of three USEPA health scientists who revised the basis for the Agency's reference dose for methylmercury, which was used in developing the Methylmercury Water Quality Human Health Criterion. In 2002 she received USEPA's Science Achievement Award in Health Sciences for this work. This is USEPA's highest health sciences award and is presented in conjunction with the Society of Toxicology. Most recently she has been evaluating and publishing national estimates of exposures to methylmercury in the U.S. population as shown in the 1999–2000 National Health and Nutrition Examination Survey.

Dr. Mahaffey is the Director of the Division of Exposure Assessment Coordination and Policy within the Office of Science Coordination and Policy of USEPA's Office of Prevention, Pesticides, and Toxic Substances. This division runs USEPA's Endocrine Disruptor Screening and Validation Program. Dr. Mahaffey remains active in research and developing USEPA's policies on methylmercury.

Randall O. Manning, Ph.D.

Dr. Manning is the Coordinator of the Environmental Toxicology Program in the Georgia Department of Natural Resources, Environmental Protection Division.

Dr. Manning received his Ph.D. from the University of Georgia and was a Postdoctoral Research Associate and an Assistant Research Scientist in the Department of Pharmacology and Toxicology at the University of Georgia from 1986 to 1990. His interest in fish consumption advisories began in 1991 when he coordinated the development of guidelines for a fish monitoring strategy and risk-based advisories. Continuing interests include uncertainties regarding fish consumption rates and patterns, and potential benefits from fish consumption as they relate to risk communication. Dr. Manning is a member of the Society of Toxicology, a diplomate of the American Board of Toxicology, and an Adjunct Assistant Professor in the Departments of Pharmaceutical and Biomedical Sciences, College of Pharmacy, University of Georgia, and in the Department of Environmental and Occupational Health, Rollins School of Public Health, Emory University.

Gina Margillo

Ms. Margillo has 14 years of experience in public health program planning, implementation, and evaluation. Her expertise lies in creating participatory processes that encourage community and government collaboration. This includes research, education, decision-making, and needs assessment. Since 1994 Ms. Margillo has worked as a contractor to the Environmental Health Investigations Branch of the California Department of Health Services. She worked with a team of scientists to assess exposures to communities living around Superfund sites across the state of California. With an emphasis on building community capacity, Ms. Margillo designed health education campaigns, conducted risk communication training, developed public outreach materials, and facilitated public forums.

In her current role as the project manager for the Fish Contamination Education Collaborative, a project funded by the USEPA, Ms. Margillo designed and is implementing an extensive participatory environmental justice education project that aims to prevent exposures of at-risk populations to contaminated fish in the area of the Palos Verdes Shelf Superfund site. She manages four public outreach programs and a multidisciplinary collaborative of over 30 state, federal, and local agencies, public institutions, and organizations representing eight linguistically and ethnically diverse communities.

Pat McCann

Ms. McCann is program manager of the Minnesota Fish Consumption Advisory Program at the Minnesota Department of Health. She received her B.S. in Chemical Engineering from the University of Minnesota Institute of Technology and her M.S. in Environmental Health from the University of Minnesota School of Public Health. As Program Manager for the Fish Consumption Advisory Program, her responsibilities include researching the toxicological characteristics of contaminants in Minnesota fish and wildlife, evaluating environmental and exposure data, and developing fish and wildlife consumption guidelines and communicating them to the public.

Thomas A. McDonald, Ph.D.

Dr. McDonald is a staff toxicologist (specialist) with California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment in Oakland. His primary activities include development of children's cancer guidelines, hazard identification and dose-response assessment of carcinogens, peer review, and technical support to the state's science advisory boards and Attorney General's office.

Dr. McDonald received his B.S. in Molecular Biology and his M.P.H. from the University of California at Berkeley, and his Ph.D. in Environmental Health Sciences (Toxicology) from the University of North Carolina (UNC) at Chapel Hill. Before taking a position with Cal/EPA, he worked as a chemist for Chevron and as a postdoctoral fellow at UNC-Chapel Hill. Dr. McDonald has recently served on national peer-review panels and is the current president of the Genetic and Environmental Toxicology Association of Northern California.

Sandie O'Neill

Ms. O'Neill is a research scientist with the Washington Department of Fish and Wildlife in Olympia. She received her B.S. in Zoology from Memorial University of Newfoundland and her M.S. in Zoology from the University of British Columbia.

For the past 15 years, Ms. O'Neill has led the Puget Sound Ambient Monitoring Program's assessment of contaminant exposure in Puget Sound salmon and marine fishes. Her main research interests are understanding the influence of fish life history on contaminant accumulation and mapping the flow of contaminants through the aquatic food webs.

James F. Pendergast

Mr. Pendergast is Chief of the Health Protection and Modeling Branch in the Office of Water, where he manages USEPA's fish and beach advisory programs and provides technical support for water quality modeling and sediment contamination assessments. He has 27 years of professional experience in environmental engineering, water quality modeling, and regulatory controls. Since moving to EPA headquarters in 1990, Mr. Pendergast worked on the 2000 revision to the TMDL rule and the reauthorization of the Clean Water Act, and was a Section and Branch Chief and later Acting Director of the NPDES Permits Division. He was a principal in leading the Water Protection Task Force, where he helped manage USEPA's work to support efforts by drinking water and wastewater treatment utilities to understand vulnerable points and to mitigate the threat from terrorist attacks as quickly as possible. He worked for 6 years in USEPA Region 6 in the NPDES permits and Superfund programs. Prior to joining USEPA in 1984, he was a project manager at Limno-Tech, Inc., where he developed models of water quality impacts from nonpoint and point sources on rivers, lakes, and estuaries.

Mr. Pendergast received both his B.S. in Environmental Engineering and his M.S. in Water Resources Engineering from the University of Michigan. He is a Registered Professional Engineer. Mr. Pendergast is a member of the Water Environment Federation, the American Society of Civil Engineers, and the Society of Environmental Toxicology and Chemistry. He has published several papers on water quality modeling in engineering journals and conference proceedings.

Rita Schoeny, Ph. D.

Dr. Schoeny is Senior Science Advisor for USEPA's Office of Water. She received her B.S. in Biology at the University of Dayton and her Ph.D. in Microbiology from the School of Medicine of the University of Cincinnati. She was appointed Assistant Professor in the Department of Environmental Health in the University of Connecticut Medical School after completing a postdoctoral fellowship in the Kettering Laboratory. Dr. Schoeny has held adjunct appointments and regularly lectures at colleges and universities on risk assessment.

Dr. Schoeny joined the USEPA in 1986. Prior to her current position she was Associate Director of the Health and Ecological Criteria Division of the Office of Science and Technology. Dr. Schoeny was the manager for major assessments and programs in support of the Safe Drinking Water Act, including scientific support for rules on disinfectant by-products, arsenic, microbial contaminants, and the first set of regulatory determinations from the Contaminant Candidate List. She has held various positions in the Office of Research and Development, including Chief of the Methods Evaluation and Development Staff,

Environmental Criteria and Assessment Office, Cincinnati; Associate Director NCEA-Cin; and chair of the Agency-wide workgroup on cancer risk assessment.

Dr. Schoeny has published in the areas of metabolism and mutagenicity of PCBs and polycyclic aromatic hydrocarbons, assessment of complex environmental mixtures, health and ecological effects of mercury, drinking water contaminants, and principles of human health risk assessment. She is a national expert in mercury and its health effects; she was a lead and coauthor of the *Mercury Study Report to Congress*, a multi-volume work on exposure, health, and environmental effects of mercury emissions from anthropogenic U.S. sources. She was a principal scientist and manager for Ambient Water Quality Criterion for Methylmercury (which won the USEPA's 2002 Science Achievement Award for Health Sciences) and contributed to development of the USEPA and FDA advice on mercury in fish.

Dr. Schoeny is the recipient of several awards, including USEPA Gold, Silver, and Bronze Medals, USEPA Science Achievement Award for Health Sciences, the Greater Cincinnati Area Federal Employee of the Year Award, the University of Cincinnati Distinguished Alumnae Award, and Staff Choice Award for Management Excellence.

Val F. Siebal

Mr. Siebal is the Chief Deputy Director of the Office of Environmental Health Hazard Assessment. Prior to this assignment, he was an Ombudsman for the Department of Toxic Substances Control and served as a Regional Administrator, managing an office that dealt with permitting, enforcement, and site mitigation of hazardous waste sites in Northern California.

Mr. Siebal is a Registered Medical Laboratory Technologist. He has a degree in Biological Science and Chemistry.

Leanne Stahl

Ms. Stahl is an environmental scientist in USEPA's Office of Science and Technology in the Office of Water. She received her B.S. in Biological Oceanography from the University of Washington in Seattle and completed graduate courses in fisheries. For 6 years she worked on fisheries research projects at the University of Washington before joining the federal service.

Ms. Stahl began her federal career at the National Oceanic and Atmospheric Administration managing coastal monitoring programs before moving to USEPA in 1990. Since 1999, she has served as the Program Manager of the National Study of Chemical Residues in Lake Fish Tissue.

Alan Stern, Ph.D.

Dr. Stern received his Ph.D. in Public Health from the Columbia University School of Public Health. He is Chief of the Bureau for Risk Analysis in the Division of Science and Research of the New Jersey Department of Environmental Protection, where he specializes in human health risk and exposure assessment. Dr. Stern is board certified in toxicology, and an adjunct associate professor in the School of Public Health and the Department of Environmental and Community Medicine of the University of Medicine and Dentistry of New Jersey. He served as a member of the National Research Council/National Academy of Sciences Committee on the Toxicological Effects of Methylmercury.

His current scientific and research interests include assessment of exposure and risk from methylmercury and other heavy metals, biomonitoring, exposure assessment, interindividual variability in dose-response, and probabilistic approaches to risk assessment.

Brian Toal

Mr. Toal is the director of the Toxic Hazards Assessment Program at the Connecticut Department of Public Health (DPH). He has been in the Toxic Hazards Assessment Program for 19 years and has served in numerous roles during that time. He oversees hazardous waste site assessment activities under a grant from the Agency for Toxic Substances and Disease Registry. He also oversees the DPH's response to all toxic hazard-related questions from Connecticut's public on topics, such as indoor air quality, fish advisories, ground water contamination, and pesticides. In the past, he helped initiate DPH's programs for radon, asbestos, and occupational health.

Mr. Toal received his B.S. in Biology from the University of Connecticut and his M.S. in Public Health from the University of Washington.

Jim VanDerslice, Ph.D.

Dr. VanDerslice is the Senior Epidemiologist in the Office of Environmental Health Assessments for the Washington State Department of Health.

He has an M.S. and a Ph.D. in Environmental Engineering from the University of North Carolina at Chapel Hill. Dr. VanDerslice has worked for the past 4 years as an environmental epidemiologist with the Department of Health on issues including fish consumption, infants' exposure to nitrate in drinking water, use of geographic information systems, and pesticide illness surveillance. Prior to that, he taught at the University of Texas, School of Public Health, focusing on water quality and ambient air quality epidemiology studies.

Linda Vaught

Ms. Vaught is the Communications Director for the Mississippi Department of Environmental Quality in Jackson.

Ms. Vaught has her B.S. from Arkansas Tech University and her M.S. from Mississippi State University. She has worked for the Mississippi Department of Environmental Quality since 1980 in various public relations areas. For over 2 years, Ms. Vaught has guided the agency in communication areas, including working with the media, developing outreach campaigns and outreach materials, revamping the agency's Web site, and developing information for the Web.

Stephen P. Wentz, Ph.D.

Dr. Wentz is an aquatic biologist with the Minnesota state district office of the U.S. Geological Survey. He received B.S. degrees in Wildlife Biology and Natural Resource Management, his M.S. in Biology from Ball State University, and his Ph.D. in Environmental Quality Assessment from Purdue University.

Dr. Wenthe has worked on issues related to the biological assessment of water quality for 4 years in Indiana's Department of Environmental Management and 2 years in the USGS Minnesota District Office. The fish mercury model he will be presenting was originally developed as part of his doctoral research and is central to his current research at the USGS.

Luanne Williams, M.D.

Dr. Williams is a state toxicologist for North Carolina and is a full member of the Society of Toxicology.

Dr. Williams's primary responsibilities as a state toxicologist include developing state environmental standards for North Carolina and health risk assessments for contaminated soil, air, water, and fish. She is also the coeditor and a contributing author of the published book *Environmental Health Secrets*.

Dr. Williams received a Doctor of Pharmacy degree at Campbell University School of Pharmacy in North Carolina. She also participated in a residency program at the University of North Carolina Hospital in Chapel Hill and completed undergraduate courses at the University of Tennessee in Knoxville.

Appendix D: List of Forum Attendees

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Appendix E: Slide Presentations

Pros and Cons of Focus Group Testing – Steve Bradbard

Pros and Cons of Focus Group Testing

Steven L. Bradbard, Ph.D.
FDA Center for Food Safety
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The Basics

- Qualitative research tool
- Helps you better understand consumers' underlying attitudes, feelings, and motivations.
- An important step in developing a messaging strategy

Don't overstep the data

- Remember:
 1. You are dealing with a small N, and
 2. Its not a random sample
- So:
 1. You can't talk about cause-and-effect, and
 2. You can't make generalizations

Not an end unto itself

- Focus groups are an important tool when developing a research-based messaging strategy.
- They allow you to test consumers' reactions to your message concepts and content.
- But remember, they are only a step in the process.

Messaging Strategy

- Define the objectives
- Select the target audiences
- Develop message concepts
- Test the concepts
- Refine and retest the concepts
- Identify partners and intermediaries
- Select the venues and opportunities

What are you testing?

- Awareness? – No
- Knowledge? - No
- Reactions? - Yes
- Attitudes? – Yes
- Motivations? – Yes
- Feelings? – Yes

Pros and Cons of Focus Group Testing – Steve Bradbard

Unintended Meanings

- “Remember, you can’t put too much water in a nuclear reactor.”
- Focus groups are useful for identifying message content that may be subject to multiple interpretations.

Unreasonable Requests

- “You want me to wash my car on my lawn?”
- Focus groups can help identify messages that will hurt your overall credibility

Keep it simple, stupid!

- “What in hell is an aquatic organism?”
- Focus groups can help identify confusing language.

I never thought about that !!!

- “Give me a good reason why I should wear a seatbelt?”
- Focus groups help to identify the emotional “hot buttons” that lead to change.

But everyone knows this

- Don’t fool yourself into thinking you know how the “typical” consumer reacts to advisories and other information about fish consumption.
- Like it or not, you know 99+% more than the “typical” consumer about this topic.
- So don’t assume that your message is clear and understandable.

Money doesn’t grow on trees

- Focus groups do not need to be conducted at expensive, state-of-the-art research facilities.
- There are lots of convenience samples around you – remember, the rules for quantitative research do not apply.
- Its not brain surgery. A professional moderator is good to have, but not a necessity.

Pros and Cons of Focus Group Testing – Steve Bradbard

Pros and Cons

- Good reality check
- Convenience samples
- In-depth probing
- Taps into attitudes, feelings, and motivations that underlie behaviors
- Not representative
- Can't generalize for use in policy
- Don't measure awareness or knowledge

EPA National Contaminant Study Design and Uses of Data – Leanne Stahl

EPA's National Fish Tissue Study: A Unique Partnership

2004 National Forum on Contaminants in Fish

January 25, 2004

Leanne Stahl
Program Manager
Office of Science &
Technology



1

Presentation Overview

Background
Study Design
Accomplishments
Preliminary Results
Final Data Analysis
Future Milestones

2

A Unique Study

- ◆ First national study of contaminant levels in freshwater fish based on a statistical design
- ◆ Largest set of chemicals ever studied in fish
- ◆ Largest project being conducted under EPA's Persistent, Bioaccumulative, and Toxic (PBT) Pollutants Program



3

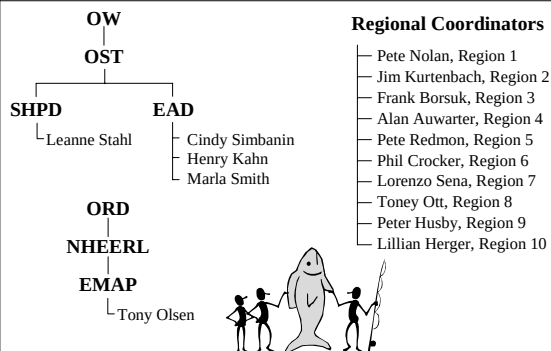
Objective

- ◆ *The objective of the National Fish Tissue Study is to estimate the national distribution of the mean levels of selected persistent, bioaccumulative, and toxic chemical residues in fish tissue from lakes and reservoirs in the contiguous United States.*
- ◆ Study results will
 - ◆ Provide a national baseline for assessing progress of pollution control activities
 - ◆ Identify areas that require further investigation



4

EPA Fish Study Team



5

Study Partners

- ◆ Extensive national network of partners supporting the National Fish Tissue Study, including:
 - ◆ 47 States
 - ◆ 3 Tribes
 - ◆ 2 Other Federal Agencies
 - National Park Service
 - Tennessee Valley Authority
- ◆ Partners participate in the following activities:
 - ◆ Lake reconnaissance
 - ◆ Fish collection
 - ◆ Annual data review



6

EPA National Contaminant Study Design and Uses of Data – Leanne Stahl

Sampling Design

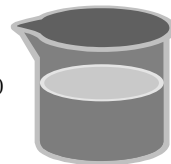
- ◆ Sample 500 lakes and reservoirs in the lower 48 states that were selected according to a statistical sampling design
- ◆ Categorize lakes and reservoirs into 6 size ranges
- ◆ Collect two 5-fish composites (predator and bottom dweller) from each site
- ◆ Apply consistent methods nationwide for sample collection and analysis
- ◆ Re-sample 10% of the lakes to evaluate sampling variability



7

Target Chemicals

- ◆ EPA is analyzing the fish tissue for 268 chemicals, including PCB congeners and breakdown products
 - ◆ 2 metals (Hg and As [5 forms])
 - ◆ 17 dioxins/furans
 - ◆ 159 PCB congener measurements
 - ◆ 46 pesticides
 - ◆ 40 semi-volatile organics (e.g., PAHs)
- ◆ EPA recently added analysis of PBDEs for Year 4 samples only



8

Fish Sampling QA/QC

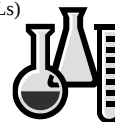
- ◆ Consistency in fish collection, handling, and shipping through:
 - ◆ Orientation/training of study participants
 - ◆ Implementation of detailed SOPs
 - ◆ Distribution of identical field sampling materials to all sampling teams
 - ◆ Preparation of fish samples in a controlled laboratory environment



9

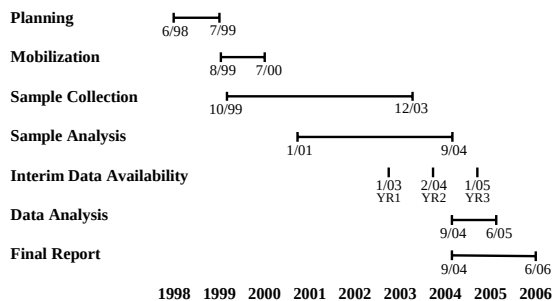
Tissue Analysis QA/QC

- ◆ Consistency and comparability of fish tissue analysis maintained throughout the study by using:
 - ◆ Same standard analytical method for each chemical
 - ◆ Same laboratory for each type of analysis
 - ◆ Consistent method detection limits (MDLs) and QC acceptance criteria standards
 - ◆ Standard data reporting formats and standard process for data quality assessment



10

Key Fish Study Activities



11

Accomplishments

Planning	• Study design development • Statistical selection of lakes • Target chemical selection
Mobilization	• 10 orientation/training workshops • Production of QA Plans and Field Sampling Plan • Mapping and reconnaissance of 900 lakes

12

EPA National Contaminant Study Design and Uses of Data – Leanne Stahl

Accomplishments

Fish Sampling & Analysis

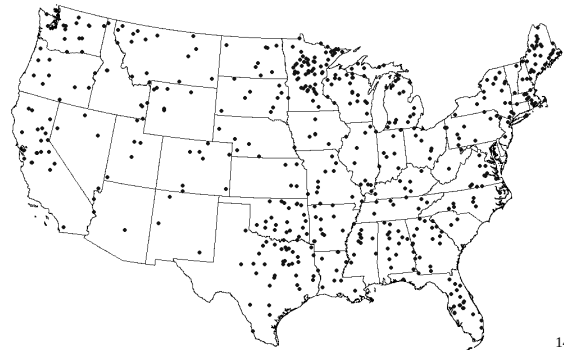
- Fish collection at 500 lakes
- Chemical analysis of 749 fish samples
- Development of annual analytical QA report

Public Outreach

- Development of fish study website (www.epa.gov/waterscience/fishstudy)
- Production of data CDs for public release

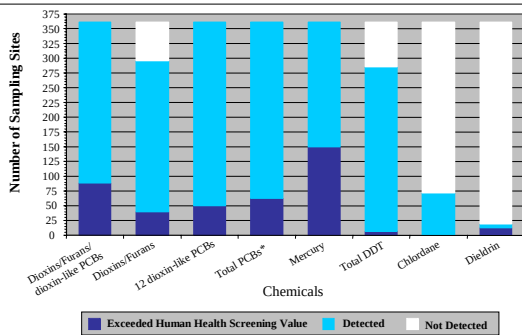
13

500 Sampling Locations



14

Preliminary Data Summary for Predators (Fillet Analysis: Years 1-3)



*Zero for non-detected analytes; sum of congeners for PCBs

15

Data Analysis

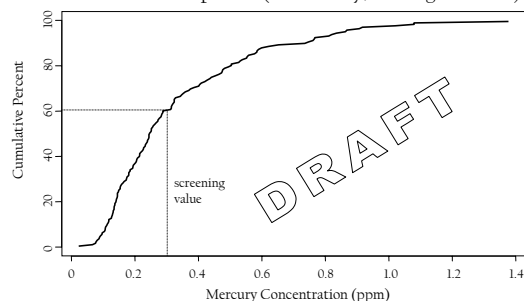
- ◆ EPA will begin analyzing fish study data once the full 4-year analytical data set is available.
- ◆ Data analysis will consist of the following core components:
 - ◆ Estimates of national means and percentiles
 - ◆ Cumulative frequency distribution plots for chemicals and composite types with sufficient data



16

Preliminary National Distribution

Example of Cumulative Frequency Distribution of Mercury in 137 Predator Composites (Preliminary, Unweighted Data)



17

Data Analysis (cont.)

- ◆ National maps of chemicals by composite type for mercury, PCBs, and dioxins/furans
- ◆ Estimate of sampling variability based on replicate sample data
- ◆ Analysis of various sample factors, including:
 - Number of fish in the composite
 - Size effects
 - Species effects



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EPA National Contaminant Study Design and Uses of Data – Leanne Stahl

Future Milestones	
Short-term (2004)	Long-term (2005-2006)
• Prepare Year 2 data CD for public release • Analyze Year 4 (2003) fish samples (~200 composites) • Produce Year 4 Analytical Data QA Report • Distribute Year 4 data to states/other partners • Update fish study website	• Prepare Year 3 data CD for public release (2005) • Complete statistical analysis of 4-year fish tissue data set (2005) • Submit draft final report for peer review (2005) • Produce final fish study report (2006) • Upload data into EPA's STORET (2006)

19



Model Application for Developing Fish Consumption Advisories – Stephen Wente

Model Application for Developing Fish Consumption Advisories:

Mercury Pilot Project

Paul Hearn Stephen Wente John Aguinaldo David Donato

Susan Price Seth Tanner Ovidio Rivero-Bartolomei



1

Problem – Cost vs. Information

Species	Size Class 1	Size Class 2	Size Class 3
A	?	Sampled	Sampled
B	?	Sampled	?
C	Sampled	?	?
D	?	?	Sampled
E	?	?	?



2

Fish Hg Model Details

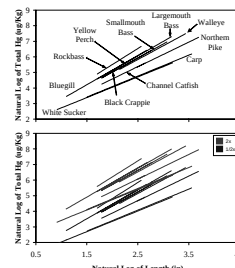
- Regression method (Covariance model)
- Accounts for:
 - Less than detection limit values
 - Differences between samples
 - Species (Hg increases with trophic position)
 - Tissues sampled (skin-off fillet > skin-on > whole)
 - Fish length (larger fish are higher in Hg)
- Calibrated to national dataset



3

Fish Hg Model (log space)

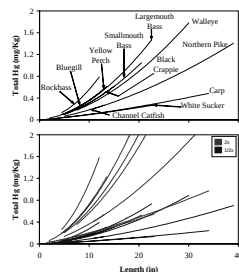
- Slopes – describe potential Hg accumulation rate for each sample type
- Intercepts – describe levels of bio-available Hg “before” each sampling event



4

Fish Hg Model (arithmetic space)

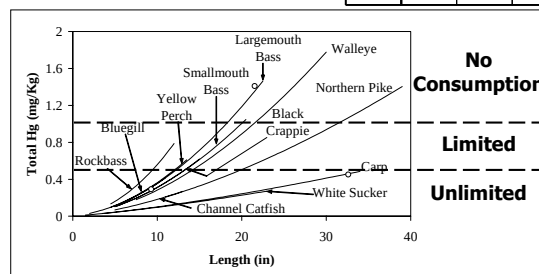
- Slopes – become exponents describing curvature
- Intercepts – become multiplication factors
- Error – has a log-normal distribution



5

Consumption Advisory

Species	Size 1	Size 2	Size 3
A	?	Sampled	Sampled
B	?	Sampled	?
C	Sampled	?	?
D	?	?	Sampled
E	?	?	?

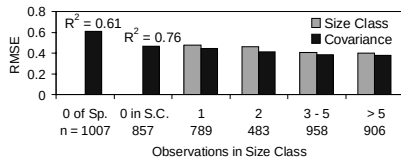


6

Model Application for Developing Fish Consumption Advisories – Stephen Wente

Accuracy Assessment

- Calibrated to NLFWA data (n = 31,813)
- 5000 random jackknife predictions

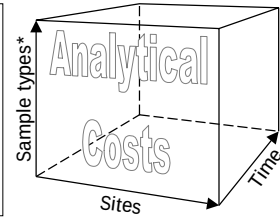


Information quality & quantity is better

Monitoring Program Economics

- Costs:
 - Sampling
 - Travel
 - Labor
 - Analytical
- Benefits:
 - Information Quality
 - Information Quantity

Program efficiency:
Information per unit cost

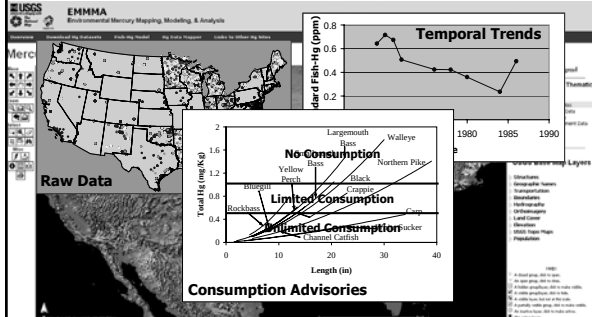


*Sample types is number of species × size classes × tissue types

Analytical Cost Reduction

Size classes	3
Species	5
Sites	50
Years	5
Replicates per size class/event	4
Cost/Sample	\$100
Size class model (3000 parameters)	\$1,500,000
Covariance Model (250 parameters)	\$100,000

Project Website



"Continuously updated" data & analysis

How Can I Evaluate this Model?

- You voluntarily provide data
- ~~You apply model~~ We apply model and provide results on website
- You evaluate prediction quality (Do predictions make sense?)
- You decide if, and how much, results are used

Questions/Comments

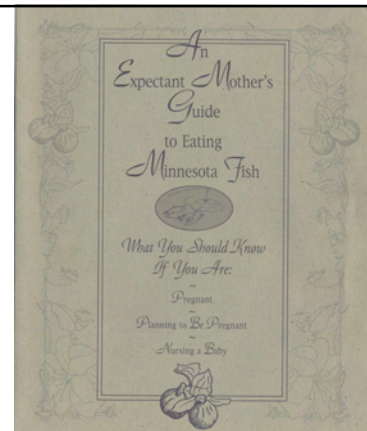
Additional information:

- Website demonstration in poster area (sign-up to receive website address)
- Presentation: Tuesday @8:55 AM, "Model Application for Monitoring Hg in Fish"
- Peer-reviewed publication in preparation
- Request presentation (via telephone) to your group (spwente@usgs.gov)

Minnesota Fish Consumption Advisory – Pat McCann

Fish Consumption Advice for Kids and Moms in Minnesota

Pat McCann
Minnesota Dept of Health



What About Store-Bought Fish?

The fish or shellfish you buy from your grocery store or fish market can also contain contaminants. Although there are laws to limit these contaminants, not all commercial fish are tested.

Pregnant or nursing women should not eat swordfish or shark. Canned tuna have mercury levels comparable to many Minnesota-caught fish. It is safe for a pregnant woman to eat up to 7 ounces of tuna each week — if it is the only source of mercury-contaminated fish, including sport-caught fish, eaten that week.

Most commercial ocean fish, such as shellfish, flounder, pollack, and cod, are low in PCBs. A pregnant or nursing woman can safely eat these once a week.

Remember to consider ALL sources of fish you eat when making your choices.

An Expectant Mother's Guide to Eating Minnesota Fish



What you should know if you are pregnant, planning to be pregnant or breastfeeding

MINNESOTA
MDH
DEPARTMENT OF HEALTH

What kinds and how much fish should I eat?

This following guidelines are for women of childbearing age and children under 15 years of age.

Follow these guidelines when eating fish:

For fish caught in Minnesota lakes and rivers:

Amount of each type of fish caught in Minnesota		
• Freshwater bass • Crappie • Pike • Walleye	• Walleye: 10-15 lbs • Crappie: 10-15 lbs • Pike: 10-15 lbs • Walleye: 10-15 lbs	• Walleye: 10-15 lbs • Crappie: 10-15 lbs • Pike: 10-15 lbs • Walleye: 10-15 lbs
1 pound a week	1 pound a week	Do not eat

For commercial fish (bought in a store or eaten in a restaurant):

- Freshwater fish are low in contaminants and safe to eat.
- Freshwater fish are low in contaminants and safe to eat.
- Freshwater fish are low in contaminants and safe to eat.
- Do not eat swordfish, shark, or bluefish.

Include all sources of fish you eat when making choices.

Example: If you eat 10 pounds of walleye from a store and 10 pounds of walleye from a restaurant, you have eaten 20 pounds of walleye. Do not eat more than 10 pounds of walleye in a week.

Which fish are more likely to contain higher amounts of contaminants?

- larger fish
- older fish
- fish that feed on other fish (walleye, northern pike, bass)
- fatty fish

Fish are an excellent low-fat food. Eat a variety of fish as part of your balanced food choices.

There are many reasons to enjoy a variety of fish often:

- Fish are a great source of protein, vitamins and minerals.
- The oils found in fish are important for unborn and breast-fed babies.
- Eating fish may play a role in the prevention of heart disease in adults.

Minnesota Fish Consumption Advisory – Pat McCann

Food and Drug Administration
Center for Food Safety and Applied Nutrition
Office of Seafood
2001

Mercury Levels in Seafood Species

The following tables provide the mean and range of mercury levels in a variety of fish and shellfish

Table 1
Fish With Highest Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Tilapia	1.45	0.65-3.73	60
*Gambusia	1.00	0.10-3.82	598
King Mackerel	0.73	0.30-1.67	213
*Shark	0.96	0.05-4.54	324

Table 2
Fish and Shellfish With Much Lower Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Groupers (Heterostichus)	0.43	0.05-1.35	64
Tuna (tuna or blue)	0.32	MD-1.30	191

What kinds and how much fish should I eat?

The following guidelines are for women of child-bearing age and children under 15 years of age.

Follow these guidelines when eating fish:

For fish caught in Minnesota lakes and rivers:

Amount of each type of fish caught in Minnesota	Do not eat
• Bluefish (smaller than 20 lb) • Perch • Rock Bass • Smallmouth Bass (smaller than 10 lb) • All species of other species	• Walleye (smaller than 20 lb) • Yellow Perch (smaller than 20 lb) • Rock Bass (smaller than 10 lb) • All species of other species

1 meal a week 1 meal a month Do not eat

For commercial fish (bought in a store or eaten in a restaurant):

Amount of each type of fish	Do not eat
• Fresh salmon • Canned salmon • Shellfish	• Cod • Pollock • Haddock • Clam • Crab • Shrimp • Tuna • Other fish

2-3 meals a week 1 meal a month Do not eat

Include all sources of fish you eat when making choices.

For example, if you eat 6 ounces of canned tuna, eat only once a week before eating another meal of any type of fish. Or, if you eat one meal from the above tables, do not eat any other meal of fish for one month.

Which fish are more likely to contain higher amounts of contaminants?

- larger fish
- older fish
- fish that feed on other fish (walleye, northern pike, bass)
- fatty fish

Most ocean fish are low in contaminants. However, some fish contain higher amounts of mercury.

The following guidelines for some popular species can be followed to allow you to enjoy commercial fish and at the same time reduce your risk to mercury:

Ocean Species	Women of child-bearing age and children under 15	Women beyond child-bearing age and men
Salmon, canned salmon, and shellfish	2-3 meals per week	Unlimited Consumption
Cod, pollock, haddock, canned tuna (not oil)	1 meal per week	Unlimited Consumption
Tuna steaks, halibut, orange roughy	1 meal per month	1 meal per week
Shark, swordfish, king mackerel, tilefish	Do Not Eat	1 meal per month

- ## 2004 Revision? (many issues)
- Consistency with other agencies
 - Joint EPA/FDA advice?
 - Separate advice for "light" vs. albacore canned tuna
 - Contaminants in addition to mercury
 - Dioxins (IOM recommendations)
 - Farm raised fish
 - Benefits
 - New FDA mercury in fish data

Consumption Advice – FDA data EPA RfD

Meal Advice	Species
Unlimited	Salmon, tilapia, flounder oysters, clams, shrimp, scallop, sardines
One Meal/Week	"light" canned tuna, cod, pollock, haddock, mahi mahi, herring, catfish, crab
One Meal/Month	"albacore" canned tuna, fresh tuna, halibut, orange roughy, lobster, grouper, red snapper

- ## Consistency
- Risk assessment
 - RfD
 - Contaminant(s)
 - Mercury
 - Others ?
 - Data
 - Sources of data
 - Statistic – mean?
 - Meal size
 - EPA guidelines 8oz = 1 meal
 - FDA advisory 12oz = 2 to 3 meals
 - AHA statement 12oz = 3 to 4 servings
 - Significant Figures
- Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory
- 

Minnesota Fish Consumption Advisory – Pat McCann

Meal Advice Categories – Mercury Women and Children

Unlimited consumption	< 0.06 ppm Hg
1 meal / week	> 0.06 - 0.2 ppm Hg
1 meal / month	> 0.2 - 1.0 ppm Hg
Do not eat	> 1.0 ppm Hg

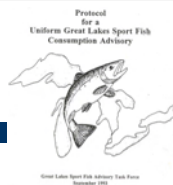
4. RISK-BASED CONSUMPTION LIMIT TABLES

Table 4-3. Monthly Fish Consumption Limits for Noncarcinogenic Health Endpoint - Methylmercury

Risk Based Consumption Limit*	Noncancer Health Endpoints ^b
Fish Meals/Month	Fish Tissue Concentrations (ppm, wet weight)
Unrestricted (>16)	0 - 0.029
16	>0.029 - 0.059
12	>0.059 - 0.078
8	>0.078 - 0.12
4	>0.12 - 0.23
3	>0.23 - 0.31
2	>0.31 - 0.47
1	>0.47 - 0.94
0.5	>0.94 - 1.9
None (<0.5)	>1.9

Consistency (cont.)

- Communication
 - With other agencies/organizations
 - EPA, FDA, AHA, States, Tribes
 - Canned tuna
 - Farm raised
 - Age of Child
 - “And” vs. “Or” (between meal advice categories)
 - Benefits



A Guide to Your Health

Fish are nutritious and good to eat. But some fish may take in contaminants from the water they live in and the food they eat. Some of these contaminants build up in the fish - and you - over time. These contaminants could harm the people who eat them, so it is important to keep your exposure to these contaminants as low as possible. This advisory helps you plan what fish to keep as well as how often and how much sport fish to eat. This advisory is not intended to discourage you from eating fish, but should be used as a guide to eating fish low in contaminants.

Health Benefits

When properly prepared, fish provide a diet high in protein and low in saturated fats. Many doctors suggest that eating a half-pound of fish each week is helpful in preventing heart disease. Almost any kind of fish may have real health benefits when it replaces a high-fat source of protein in the diet. You can get the health benefits of fish and reduce unwanted contaminants by following this advisory.

Benefits – Tailor advice for person?

- Fetal development - cell membranes of retina, brain & central nervous system
- CVD
- Nutritional comparison to other food choices - low fat, high quality protein
- Cultural

Benefits and risks of eating fish vary depending on a person's stage of life

- Children, pregnant and nursing women usually have low CVD risk but may be at higher risk of exposure to excessive mercury from fish. Avoiding potentially contaminated fish is a higher priority for these groups.
- For middle-aged and older men, and women after menopause, the benefits of eating fish far outweigh the risks within the established guidelines of the FDA and Environmental Protection Agency.

AHA "Fish, Levels of Mercury and Omega-3 Fatty Acids"

Minnesota Fish Consumption Advisory – Pat McCann

“2 meals per week” Recommendation

- The American Heart Association recommends eating fish at least twice a week. However, some types of fish may contain high levels of mercury, PCBs (polychlorinated biphenyls), dioxins and other environmental contaminants. Levels of these substances are generally highest in older, larger, predatory fish and marine mammals.

Which fish have enough omega-3 in 2 - 8oz meals per week?

Sardines, herring, salmon, albacore canned tuna, fresh tuna, rainbow trout, flounder, halibut, pollock, oyster, (mackerel?)

Which can be eaten 2X/wk?

- Salmon, flounder, oysters, sardines

2004 Revision

- Provide meal advice based on mercury as in past
 - Separate advice for “light” and albacore tuna
- Flag species both low in mercury and high in omega-3’s (need to do the same for local species)
- Provide reasons to eat fish which address variety of benefits

Maine Fish Consumption Advisory – Eric Frohberg

Consumer Advisory for Commercial Fish

Maine Department of Human Services
Bureau of Health



Maine Bureau of Health • Environmental Toxicology Program

Consumer Advisory for Commercial Fish

Ocean Fish and Shellfish

♦ Striped bass and bluefish Limit: For everyone, 2 meals per month

♦ Swordfish, shark, tilefish, and king mackerel Limit: For pregnant and nursing women, women who may get pregnant, and children under 8, NO meals
For all others, 2 meals per month

♦ Canned tuna (the 6-ounce size) Limit: For pregnant and nursing women, women who may get pregnant, and children under 8, 1 can of "white" or 2 cans of "light" tuna per week
No limits for all others as part of a balanced diet

♦ All other ocean fish and shellfish, including canned fish and shellfish Limit: For pregnant and nursing women, women who may get pregnant, and children under 8, 2 meals per week
No limits for all others as part of a balanced diet

FDA Advice ☐ ☐

No FDA Advice? ☐ ☐

"White" vs "Light" ☐ ☐

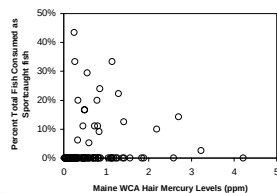
FDA Advice ☐ ☐

Maine Bureau of Health • Environmental Toxicology Program

Brochure Redesign



- Recreational Fishing "feel to brochure"
- Most meHg exposure from commercial fish
- Brochure tested well in rural parts of state
- Did not test well among urban young mothers



Maine Bureau of Health • Environmental Toxicology Program

Focus on Hg in Canned Tuna

Data from Yess 1993. Nationwide, 220 samples, 12 can composites

Type	# of comps	Avg meHg ppm
Chunk Light	106	0.1
Chunk White	19	0.31
Solid White	71	0.26

3x Difference
In Hg Content

Type	Grams EPA+DHA per 100 grams
Light Tuna	0.27
White Tuna	0.86

3x Difference
In Omega-3
Content

Maine Bureau of Health • Environmental Toxicology Program

Integrative Approach

- Evaluate Hg Concentrations
- Include data on Omega-3 fatty Acids
- Look at other contaminants and how they relate to other protein sources
- Consumption Rate data – focus on fish that folks eat
- Cost – don't tell Mainers to eat expensive fish

Maine Bureau of Health • Environmental Toxicology Program

Choose Fish Low in MERCURY

Fish You Buy

Fish You Catch

Seafood Best for you and your Babies Health
All very low in mercury and high in Omega-3 fish oils

More Great Fish Low in mercury But not as high in Omega-3 fish oils.

DON'T EAT THESE FISH!
They have too much mercury

Canned Salmon
Fresh Salmon
Atlantic Mackerel
Shrimp

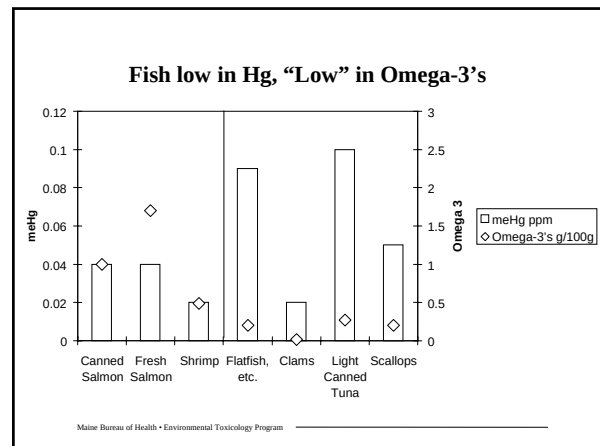
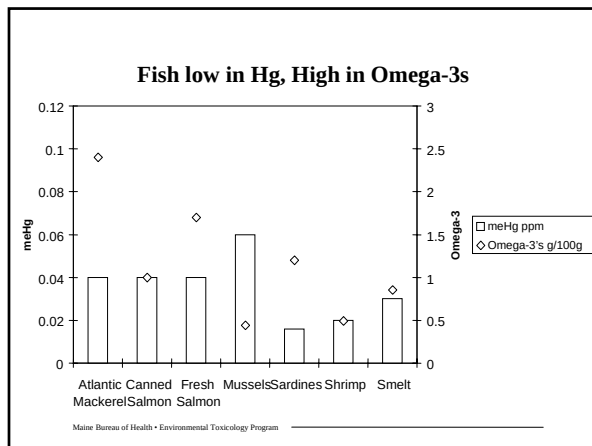
Mussels
Sardines
Smelt

Flatfish, etc.
Clams
Light Canned Tuna
Scallops

Swordfish
Shark
Smallmouth Bass
Pickering

Maine Bureau of Health • Environmental Toxicology Program

Maine Fish Consumption Advisory – Eric Frohberg



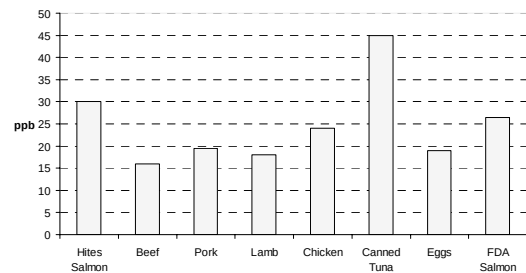
Next Steps

- Wait and see what FDA’s Advice looks like
- Draft this spring
- Focus Group Test rural and urban lower literacy individuals
- Revise, focus group test, ad infinitum
- Distribute by end of summer

Maine Bureau of Health • Environmental Toxicology Program

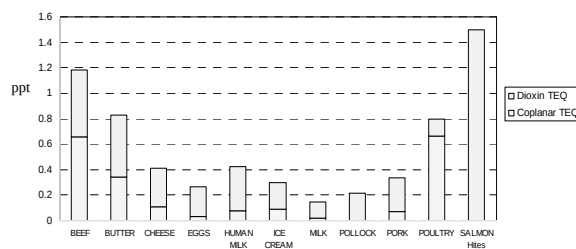
Farm Raised Salmon – Total PCBs

Comparison to other Dietary Sources



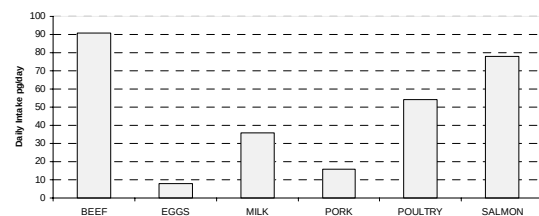
Farm Raised Salmon – Dioxins

Comparison to other Dietary Sources



Farm Raised Salmon

Conversion to Dietary Dioxin and Coplanar Intake Assuming 2 meals/week Farm Raised Salmon



Maine Fish Consumption Advisory – Eric Frohmberg

Decision to Include Salmon in Advisories

“Because of the health benefits associated with omega-3 fatty acids in fish ... the committee did not recommend that people reduce their consumption of fatty fish below the currently recommended two servings per week.”

Press Release from NAP regarding release of Dioxins and Dioxin-Like Compounds in the Food Supply: Strategies to Decrease Exposure

Maine Bureau of Health • Environmental Toxicology Program

North Carolina's New Advice on Eating Fish – Luanne Williams

North Carolina's New Advice on Eating Fish



Luanne K. Williams, Pharm.D.
Toxicologist
NC Department of Health and Human
Services

Former Approach

- Action level issuing advice due to methylmercury 1 mg/kg
- 11 freshwater rivers and lakes
- 1 ocean fish king mackerel



Reasons for Change in NC Fish Advice

- Complex in 2001 with US EPA, FDA and NC giving three sets of advice
- 2001 USEPA 1 ml/wk freshwater
- 2001 FDA stores and restaurants 2 meals a week and do not eat shark, swordfish, king mackerel and tilefish

Reasons for Change in NC Fish Advice

- NC location specific advisories and king mackerel advisory
- Needed simple, understandable, and concise message
- Needed more stringent methylmercury action level
- Get information to women of childbearing age and children

All This Advice is Giving Me a Headache!

- 2 meals a week from restaurants
- 1 meal a week from fresh waters
- Do not eat fish from 11 NC fresh waters
- Do not eat shark, swordfish, king mackerel, & tilefish



North Carolina's New Advice on Eating Fish – Luanne Williams

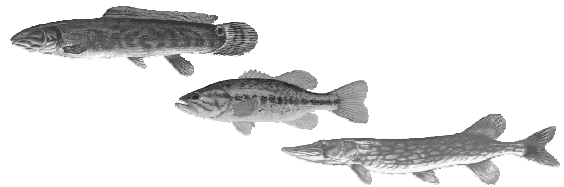
New Action Level 0.4 mg/kg

- WCB and children 1/2 meal a week at US EPA dose 0.1 ug/kg-d
- 5 meals/wk at 0.4 mg/kg 5 % risk of fetus abnormal neuropsychological effects



90 - 99 Freshwater Fish Data

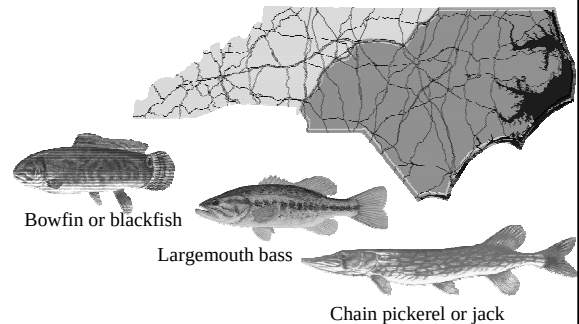
- 3 freshwater fish median and mean levels at action level across NC
- bowfin (blackfish), largemouth bass and chain pickerel (jack)



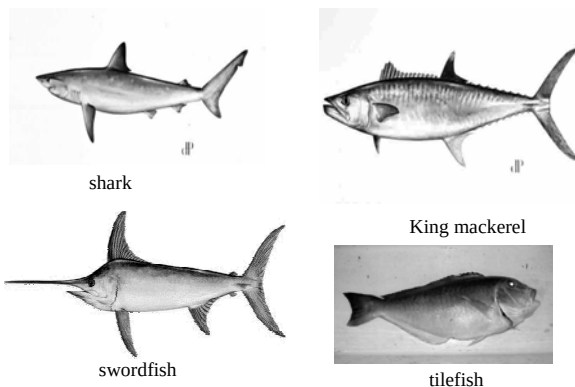
Statistics

	N	Mean ppm	Median ppm	Max ppm
Bowfin	475	0.9	0.7	5.7
Chain Pickerel	103	0.7	0.6	2.0
Large-mouth Bass	820	0.7	0.5	3.6

NC Freshwater Fish High in Methylmercury South and East of I-85



Ocean Fish High in Methylmercury



Issuance of New NC Fish Advice

- NC recommends WCB and Children avoid consumption of 7 high methylmercury fish
- Shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin, and chain pickerel
- Recommends consumption of low methylmercury fish because of health benefits

North Carolina's New Advice on Eating Fish – Luanne Williams

NC Advice

WCB 15-44 yrs and Children < 15

0 meals/week high mercury fish
2 meals a week of low mercury fish (list provided on web)

General public

1 meal a week high mercury fish
4 meals a week of low mercury fish

Estimated Risks With New Advice

- According to FDA Model by Carrington and Bolger in *Risk Analysis* Volume 22 No. 4 2002
- 99% of people who eat two 6 oz meals a week of fish with avg. < 0.5 mg/kg below EPA recommended dose 0.1 ug/kg-d

Estimated Risks With New Advice

- 1 % estimated to be above US EPA recommended dose
- Maximum blood level estimated to be 14 ug/L
- Risk to developing child would be less than 5% incremental risk above background of having abnormal neuropsychological test scores
- Very low risk for very small number of people

Risk Communication

- Newsletters, fliers, and emails
- OBGYNS, pediatricians, family physicians, NC Medical Society, nurse midwives, health departments, NC Cooperative Extension, March of Dimes, and Indian Affairs
- Spanish and English materials available
<http://www.epi.state.nc.us/epi/fish>



Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii – Barbara Brooks

Mercury Levels in Hawaiian Commercial Fish

Barbara Brooks, Ph.D.
Hazard Evaluation and Emergency
Response, Hawaii Department of
Health



Team Members

- Hawaii Department of Health
 - Clarence Callahan, Ph.D.
 - Grace Takebayashi
 - Mark Sutterfield
- United Fishing Agency
 - Brooks Takenaka



Fish in Hawaii

- Fishing is a major industry
- 25 million pounds sold at auction annually
- Top fish sold are tuna and billfish



Study Design

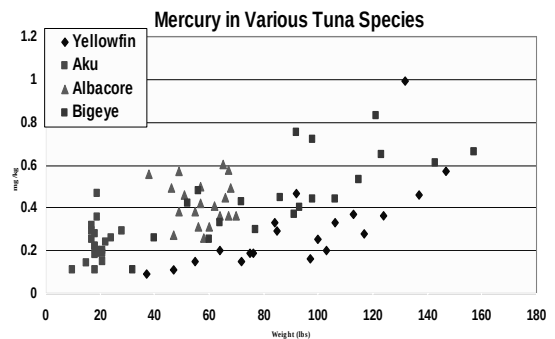
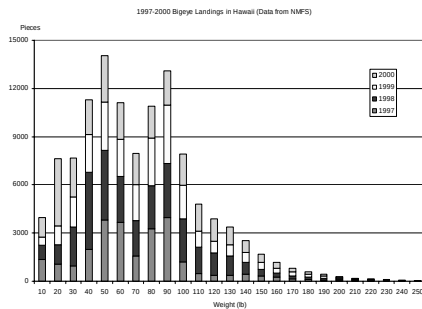
- Fish obtained at the auction
- Weight of fish recorded
- Muscle sample obtained near tail portion
- Total mercury-EPA 6000/7000 Series Method
- 20% from each species-Methylmercury 1630, total mercury 1631



Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii – Barbara Brooks

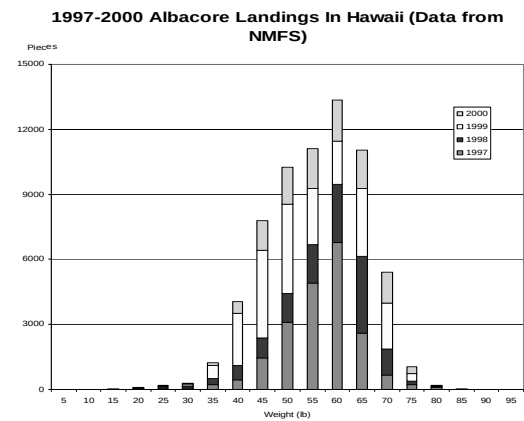
Fish Species Sampled

- Albacore (Tombo)
- Yellowfin Ahi
- Bigeye Ahi
- Skipjack (Aku)
- Dolphinfin (Mahimahi)
- Pacific Blue Marlin (Kajiki)
- Striped Marlin (Nairagi)
- Moonfish (Opah)
- Wahoo (Ono)

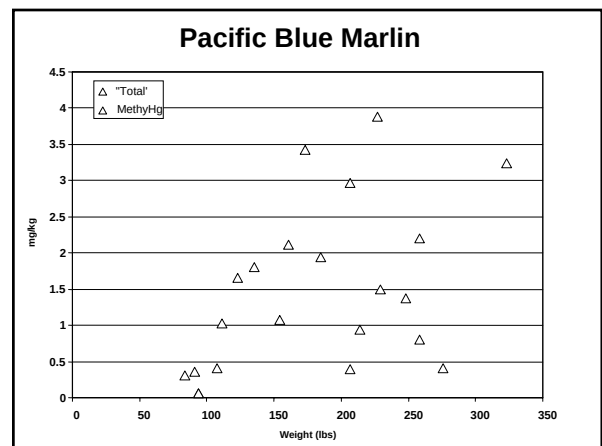
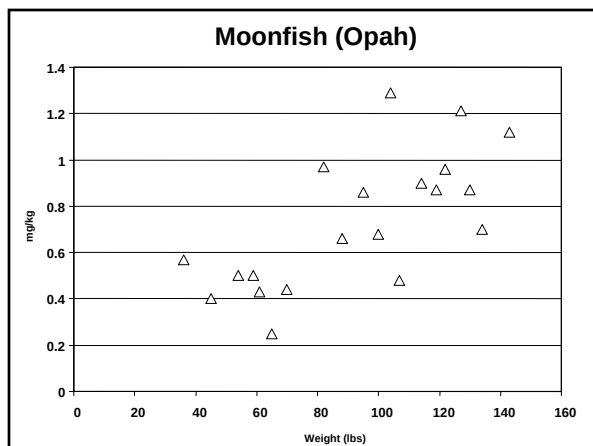
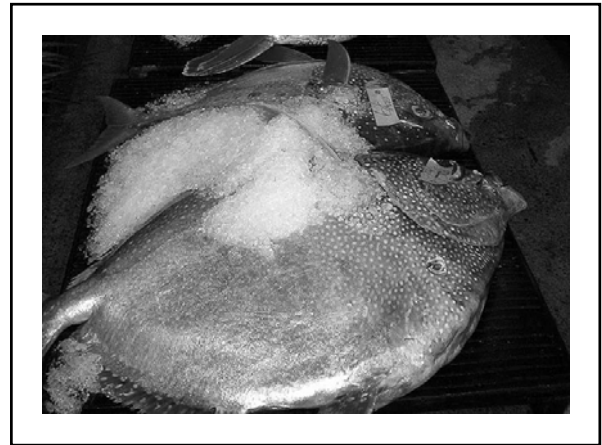
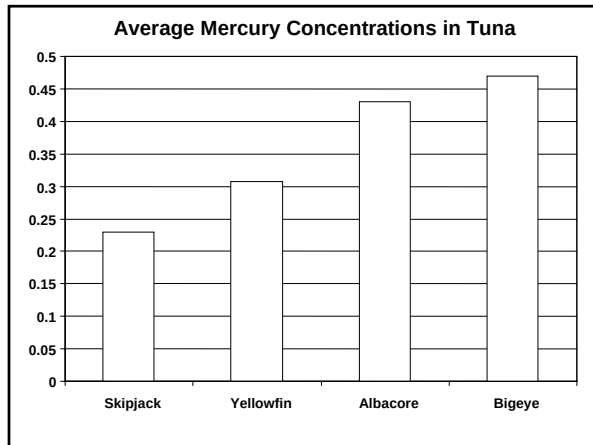
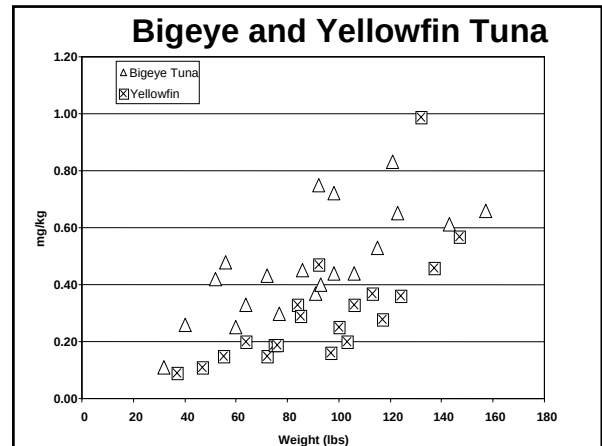
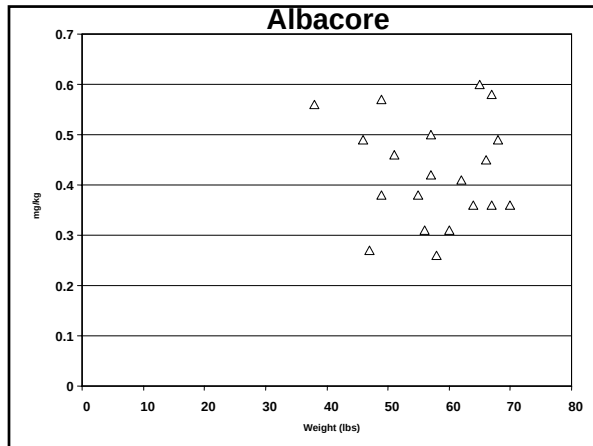


Mercury/weight correlations

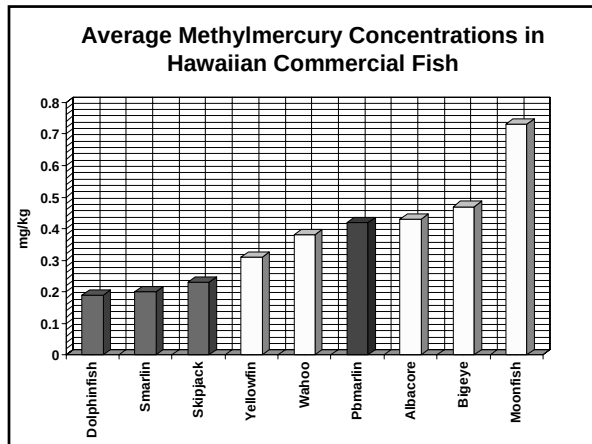
- Positive correlation between weight and mercury concentration in bigeye and yellowfin tuna
- No apparent correlation in skipjack or albacore in the size ranges sampled



Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii – Barbara Brooks



Mercury Levels in Tuna and Other Major Commercial Fish Species in Hawaii – Barbara Brooks



Summary: Pregnant Women, Nursing Mothers and Young children

- Do not eat-Pacific blue marlin
- Once every two weeks-Bigeye, yellowfin, albacore, wahoo, moonfish
- Once a week-Skipjack, dolphinfish, striped marlin



Future Studies

- Retail study of commonly consumed fish
- Study of exposure in Hawaii
 - Fish consumption surveys
 - Hair samples in fish eaters
 - Blood samples in population
- Impact of the volcano on mercury levels in the environment



Mercury Concentrations in North Carolina's Top Five Commercially Sold and Recreationally Caught Marine Fish – Luanne Williams

Methylmercury Concentrations in NC's Top Five Marine Fish



Luanne K. Williams, Pharm.D.
Toxicologist
NC Department of Health and Human Services

NC Mercury Fish Advisory Committee Members

- NC Wildlife Resources Commission
- NC Water Quality
- NC Fisheries Association
- NC Dept. of Agriculture Aquaculture
- NC Marine Fisheries
- NC Department of Health and Human Services

NC Mercury Fish Advisory Committee

- Formed after changed advisory approach from location-specific to fish-specific in 2002
- Ample freshwater data but lacked methylmercury data on NC's top marine fish
- Risk communication strategies
- Inform committee of risks to developing child

New NC Fish Advice WCB and Children

- WCB and Children avoid consumption of 7 high methylmercury fish ≥ 0.4 ppm
- Shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin, and chain pickerel
- Recommend two meals a week of low methylmercury fish because of health benefits

New NC Fish Advice General Public

- General public eat one meal a week of 7 high methylmercury fish ≥ 0.4 ppm
- Shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin, and chain pickerel
- Recommend four meals a week of low methylmercury fish because of health benefits

Estimated Risks With New Advice

- According to FDA Model by Carrington and Bolger in *Risk Analysis* Volume 22 No. 4 2002
- 99% of people who eat two 6 oz meals a week of fish with avg. < 0.5 mg/kg below EPA recommended dose 0.1 ug/kg-d

Mercury Concentrations in North Carolina's Top Five Commercially Sold and Recreationally Caught Marine Fish – Luanne Williams

Purpose of Sampling Top 5 Marine Fish

- Expand list of high methylmercury fish that should not be eaten by women of childbearing age and children
- Expand list of low methylmercury fish that should be eaten by women of childbearing age and children

NC's Top 5 Marine Fish

Expected Low Levels

- spot
- croaker
- kingfish or sea mullet

Expected High Levels

- bluefish
- speckled trout or spotted seatrout

NC's Top Five Marine Fish



spot

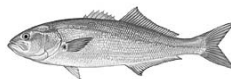


croaker



kingfish or sea mullet

NC's Top Five Marine Fish



bluefish



speckled trout or
spotted seatrout

Collection of Ocean Fish

- NC Division of Marine Fisheries
- Commercial and recreational fisheries
- Weighed, measured in length, filleted, skinned, wrapped in aluminum foil, frozen
- Analyzed

Spot

- 25 fish (fillets)
- Mean length 9 inches
- Mean sample weight 0.5 lbs > mean weight 0.4 lbs spot caught recreationally in NC
- Mean methylmercury level 0.02 ppm
- Median methylmercury level 0.03 ppm

Mercury Concentrations in North Carolina's Top Five Commercially Sold and Recreationally Caught Marine Fish – Luanne Williams

Croaker

- 54 fish (14 fillets + 10 composites 4 fish/composite)
- Mean length 10 inches
- Mean sample weight 0.5 lbs slightly < mean weight 0.6 lbs croaker caught recreationally in NC
- Mean methylmercury level 0.06 ppm fillets and 0.07 ppm composites
- Median methylmercury level 0.04 ppm fillets and 0.07 ppm composites

Southern Kingfish or Sea Mullet

- 30 fish (10 composites 3 fish / comp)
- Mean length 11 inches
- Mean sample weight 0.5 lbs equal to mean weight 0.5 lbs Kingfish caught recreationally in NC
- Mean methylmercury level 0.08 ppm
- Median methylmercury level 0.07 ppm

Speckled Trout or Spotted Seatrout

- 26 fish (fillets)
- Mean length 17 inches
- Mean sample weight 2 lbs > mean weight 1.4 lbs Speckled Trout caught recreationally in NC
- Mean methylmercury level 0.11 ppm
- Median methylmercury level 0.08 ppm

Bluefish

- 57 fish (18 fillets + 17 composites 2-3 fish /comp)
- Mean length 14 inches
- Mean sample weight 1.7 lbs > mean weight 0.94 lbs Bluefish caught recreationally in NC
- Mean methylmercury level 0.12 ppm fillets and 0.17 composites
- Median methylmercury level 0.12 ppm fillets and 0.16 composites
- Largest 26 inches mean 0.4 ppm

NC Mercury Fish Advisory Committee Recommendations

- Add spot, croaker, kingfish, and speckled trout to list of fish that are safer to eat for women of childbearing age and children
- Not to add bluefish to list of fish that are safer to eat at this time
- Sample 20 bluefish 26 inches and larger



Options for a Gulf States' Mercury Advisory for King Mackerel – Donald Axelrad

Options for a Gulf States' Mercury Advisory for King Mackerel

Donald M. Axelrad¹, Curtis D. Pollman²,
George E. Henderson³, and Frederick Kopfler⁴

¹Florida Department of Environmental Protection

²Tetra Tech Inc.

³Florida Fish and Wildlife Conservation Commission

⁴USEPA Region 4 Gulf of Mexico Program Office



King Mackerel – *Scomberomorus cavalla*

2



Family Scombridae – Mackerels and Tunas

Geographical Distribution: Western Atlantic from Massachusetts to Rio de Janeiro, Brazil.

Interest to Fisheries: King mackerel is an important species for recreational and commercial fisheries throughout its range.

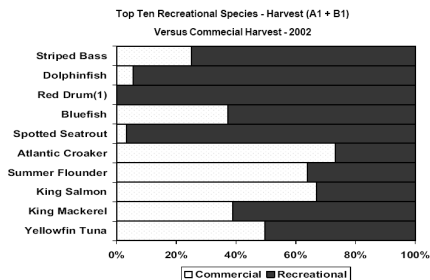
Size: Maximum size is 173 cm fork length and 45 kg weight.

Food: Food consists primarily of fishes with smaller quantities of penaeid shrimps and squids.

3



Top ten marine fish species in descending order of US recreational catch by weight, and comparison of recreational vs. commercial catch (NMFS)



5

2002 U.S. Recreational Landings (NMFS)

King Mackerel

- 6,769,000 pounds
- (3,043,000 pounds from the Gulf)
- 690,000 fish

Options for a Gulf States' Mercury Advisory for King Mackerel – Donald Axelrad

2002 U.S. Commercial Landings (NMFS)

King Mackerel

- 4,471,000 pounds
(2,179,000 pounds from the Gulf)
- \$6,291,000 in value

U. S. Food and Drug Administration
May 2001

Mercury Levels in Seafood Species

Table 1
Fish With Highest Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Tilefish	1.45	0.65-3.73	60
Swordfish	1.00	0.10-3.22	598
King Mackerel	0.73	0.30-1.67	213
Shark	0.96	0.05-4.54	324

U. S. Food and Drug Administration
May 2001

Mercury Levels in Seafood Species

Table 2
Fish and Shellfish With Much Lower Mercury Levels

SPECIES	MEAN (PPM)	RANGE (PPM)	NO. OF SAMPLES
Grouper (Mycteroperca)	0.43	0.05-1.35	64
Tuna (fresh or frozen)	0.32	ND-1.30	191
*Lobster Northern (American)	0.31	0.05-1.31	88
Grouper (Epinephelus)	0.27	0.19-0.33	48
*Halibut	0.23	0.02-0.63	29
*Sablefish	0.22	ND-0.70	102
*Pollock	0.20	ND-0.78	107
*Tuna (canned)	0.17	ND-0.75	248



AN IMPORTANT MESSAGE FOR PREGNANT WOMEN AND WOMEN OF CHILDBEARING AGE WHO MAY BECOME PREGNANT ABOUT THE RISKS OF MERCURY IN FISH

You can protect your unborn child by not eating these large fish that can contain high levels of methylmercury:

Shark
Swordfish
King mackerel
Tilefish

10



For Immediate Release

June 4, 1996

HEALTH ADVISORY FOR KING MACKEREL

TALLAHASSEE – The Florida Department of Health and Rehabilitative Services and the Department of Environmental Protection today jointly announced a health advisory urging limitations on consumption of King Mackerel caught from the Gulf of Mexico. Mercury in King Mackerel increased with size and age of fish. Based on this relationship the advisory is as follows:

Fish Size	Mercury Level	Advisory
Less than 33"	< 0.5 ppm	Safe for unrestricted consumption
33 to 39 inches	0.5 to 1.5 ppm	Adults: one 8-oz. meal/week. Women of childbearing age and children: one 8-oz. meal/month
More than 39"	> 1.5 ppm	Should not be consumed

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FLORIDA DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

March 3, 1989

TO: Charles S. Mahan, M.D., State Health Officer
FROM: Richard W. Freeman, Ph.D., Director, Toxicology
SUBJECT: Exposure Guidelines for Mercury in Fish

"The WHO RID (0.43 µg MeHg/kg-body weight/day), ..., is, I think, the best estimate of risk from exposure to MeHg (methylmercury) in fish flesh.

"For the 0.5 to 1.5 ppm range of mercury values, adults should restrict intake to one meal per week unless the person is pregnant, a lactating female, a female intending to become pregnant or a child less than 15 years of age. In this latter case, intake should be restricted to one meal per month."

0.43 µg/kg-body weight/day / 4.3 weeks per month = 0.1 µg/kg body weight/day
or, for women of childbearing age and children, Florida's MeHg RID since 1989 has been equivalent to USEPA's current MeHg RID.

12

Options for a Gulf States' Mercury Advisory for King Mackerel – Donald Axelrad

Comparison of Gulf of Mexico States' Consumption Advisories for King Mackerel re Mercury

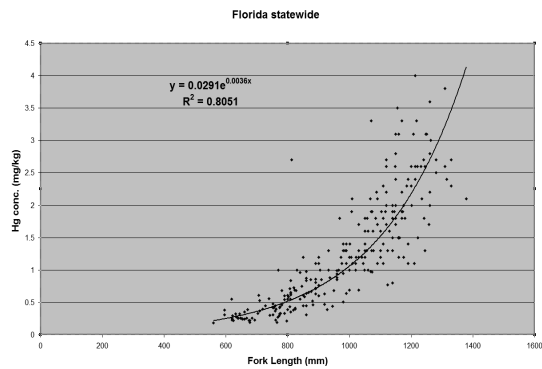
State	No Consumption	Adults – Limited Consumption	Women of Childbearing Age – Limited Consumption	Children – Limited Consumption
Florida	> 39" fork length	33" to 39" one meal per week	One meal per month	< 11 years old, one meal per month
Alabama	> 39"	< 39" one meal per month	No consumption	< 15, no consumption
Mississippi	> 39"	33" to 39" one meal every two weeks	One meal every two months	< 7, one meal every two months
Louisiana	> 39" total length	< 39" four meals per month	One meal per month	< 7 years, one meal per month
Texas	> 43" total length	39" to 43" one meal per week	One meal per month	No defined age – one meal per month

13

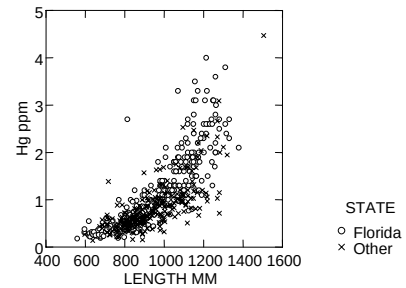
Differences in King Mackerel advisories among the five Gulf of Mexico States:

- RfD
- Age defined as a child
- Advised rates of fish consumption by fish size and Hg concentration categories
- Fish size ranges for categories of fish consumption limitation
- Gulf-wide advisory based on fish size? Requires a consistent mercury concentration - fish size relationship

Florida Gulf and Atlantic King Mackerel, Fish Size vs. Mercury

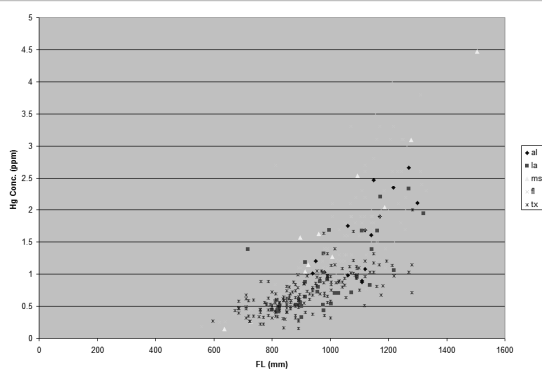


King Mackerel Size vs. Hg, Florida Data¹ and Other Gulf States Data

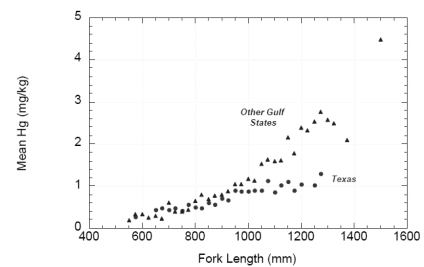


¹Includes Atlantic sites

King Mackerel Size vs. Hg Concentration for All Gulf of Mexico States



King Mackerel Hg as a Function of Fork Length Class.

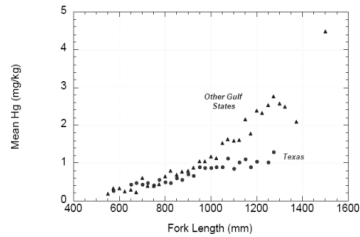


Data pairs represent mean mercury concentration for King Mackerel for 25mm fork length size classes.

Options for a Gulf States' Mercury Advisory for King Mackerel – Donald Axelrad

*Below ca. 1000 mm, the fork length - mercury concentration relationship appears identical for fish from Texas and the other Gulf States.

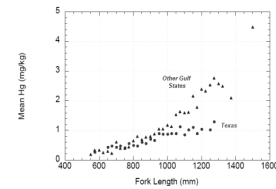
* Above ca. 1000 mm, for Texas King Mackerel the slope of the fork length - mercury concentration relationship diverges from that for fish from the other Gulf States.



Results of a paired t-test indicate:

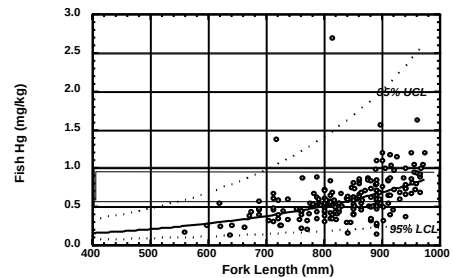
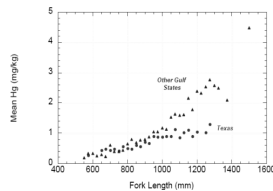
*For size classes < 950 mm (i.e., fish 950 – 974 mm in fork length), the mean mercury concentration difference between fish from Texas and those from other Gulf States is statistically insignificant: -0.041 mg/kg , $p = 0.3067$

*For size classes > 950 mm, the mean mercury concentration difference between fish from Texas and those from other Gulf States is statistically significant: -0.730 mg/kg , $p = 0.0002$



*Note that for the fish size class at which the King Mackerel fork length – mercury concentration relationship diverges between Texas and the other Gulf States, the mercury concentration is ca. 1 mg/kg, and above the concentration for which fish consumption would be recommended.

*As such, there is scope for a Gulf-wide King Mackerel consumption advisory for fish < 975 mm (38.4 inches) in fork length and < 1 mg/kg in mercury concentration.



Plot of mercury concentrations vs. fork length for King Mackerel collected in the Gulf of Mexico by the five Gulf States, for all fish with fork length less than 975 mm. Blue dotted lines show the upper and lower 95% confidence limits.

Monthly Fish Consumption Limits for Methylmercury (USEPA)

Fish meals/month	for Fish Hg ppm	Hg in King Mackerel
16	> 0.03–0.06	
12	> 0.06–0.08	
8	> 0.08–0.12	
4	> 0.12–0.24	Gulf range 0.2–4.5 ppm
3	> 0.24–0.32	
2	> 0.32–0.48	
1	> 0.48–0.97	FDA mean 0.73 ppm
0.5	> 0.97–1.9	
None (<0.5)	> 1.9	

*Adult body weight = 70 kg

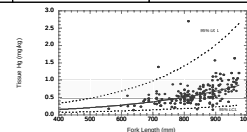
*Average fish meal size = 8 oz. fresh weight

*USEPA's RID for MeHg, 0.1 microgram/kg-body weight per day

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Calculated King Mackerel fork lengths for specified meal frequencies and corresponding fish mercury concentration ranges

Fish meals/month	Fish Tissue Hg (ppm)	Fork Length (inches) – best fit model	Fork Length (inches) – 97.5% CL
1 meal/month	> 0.48–0.97	30.7 – 40.1	19.7 – 27.4
2 meals/month	> 0.32–0.48	25.4 – 30.7	15.3 – 19.7
3 meals/month	> 0.24–0.32	21.6 – 25.4	12.1 – 15.3
4 meals/month	> 0.12–0.24	12.4 – 21.6	4.5 – 12.1



Options for a Gulf States' Mercury Advisory for King Mackerel – Donald Axelrad

American Heart Association Scientific Statement

Fish Consumption, Fish Oil, Omega-3 Fatty Acids, and Cardiovascular Disease.

Penny M. Kris-Etherton, PhD, RD; William S. Harris, PhD; Lawrence J. Appel, MD, MPH; for the Nutrition Committee.

SUMMARY

Omega-3 fatty acids have been shown in epidemiological...trials to reduce the incidence of CVD.... Evidence...suggests that EPA+DHA supplementation ranging from 0.5 to 1.8 g/d significantly reduces...cardiac... mortality....

Collectively, these data are supportive of the recommendation made by the AHA Dietary Guidelines to include at least two servings of fish per week (particularly fatty fish)....

The fish recommendation must be balanced with concerns about environmental pollutants, in particular PCB and methylmercury....

Advisory options

Calculated King Mackerel fork lengths for specified fish mercury levels

Fish meals/month	Fish Tissue Hg (ppm)	Fork Length (inches) – Best fit model	Fork Length (inches) – Model 97.5% CL
1 meal/month	> 0.48–0.97	30.7 – 40.1	19.7 – 27.4
2 meals/month	> 0.32–0.48	25.4 – 30.7	15.3 – 19.7
3 meals/month	> 0.24–0.32	21.6 – 25.4	12.1 – 15.3
4 meals/month	> 0.12–0.24	12.4 – 21.6	4.5 – 12.1

24 inches is legal minimum King Mackerel size



12/11/2003

Advice For Women Who Are Pregnant, Or Who Might Become Pregnant, and Nursing Mothers, About Avoiding Harm To Your Baby Or Young Child From Mercury in Fish and Shellfish.

To protect your baby follow these 3 rules:

1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury
2. Levels of mercury in other fish can vary. You can safely eat up to 12 ounces (2 to 3 meals) of other purchased fish and shellfish a week. Mix up the types of fish and shellfish you eat and do not eat the same type of fish and shellfish more than once a week.
3. Check local advisories about the safety of fish caught by family and friends in your local rivers and streams. If no advice is available, you can safely eat up to 6 ounces (one meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

Based on the similarity of the fish size – mercury concentration relationships across the Gulf of Mexico, there is scope for a Gulf-wide advisory for King Mackerel that is tied to fish size.

However, Gulf of Mexico King Mackerel mercury concentrations are too high relative to the MeHg reference dose to advocate its use as a routine dietary component in a “heart-healthy diet”.

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QUESTIONS?

Options for a Gulf States' Mercury Advisory for King Mackerel

Donald M. Axelrad¹, Curtis D. Pollman²,
George E. Henderson³ and Frederick Kopfler⁴

¹Florida Department of Environmental Protection, Tel. 850-245-8306

²Tetra Tech Inc.

³Florida Fish and Wildlife Conservation Commission

⁴USEPA Region 4 Gulf of Mexico Program Office

Recent Washington State Data on Mercury Concentrations in Tuna – Jim VanDerslice

Canned Tuna Mercury Levels and Consumption Patterns in Washington State

Jim VanDerslice, Helen Murphy,
Glen Patrick, David McBride
Washington State Department of Health

Stuart Magoon, Department of Ecology

National Forum on Contaminants in Fish
January 26, 2004

Background

Lake Whatcom study

- Compared lake bass to other fish species
- Combined with consumption rates from survey
- Hg intake from canned tuna much higher

Issued consumption advisory for tuna May, 2001

- Based on values by Yess, 1993 (170 ppb)
- Provided weight specific consumption advice
- Targeted women of child-bearing age, young kids

Tuna consumption on 2002 BRFS

Hg tissue data old, insufficient data on white vs. light

Tuna Sampling Objective

Estimate mean Hg levels for each 'type'

- Species: Albacore (white) vs. light
- Cut: Solid vs. chunk
- Packing: Water vs. oil

Probability sample of 6 oz. cans of tuna available for retail purchase during September-October 2003

- Excluded flavored tuna, tuna packed in oils other than vegetable oil, low sodium preparations, etc...

Target: 40 cans / type (min detectable diff = 85 ppb)

Selecting Stores

Primary Sampling Unit: Retail Outlets

Obtained listing of all food outlets

- Amount of food sales (\$)
- Used as proxy for sales of canned tuna

Randomly selected stores

- Probability of selection proportional to sales

Store Locations



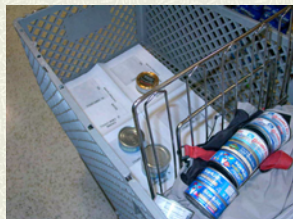
Types of Canned Tuna

Species	Cut	Packing	Type
White (albacore)	Chunk	Oil	WCO
		Water	WCW
	Solid	Oil	WSO
		Water	WSW
Light	Chunk	Oil	LCO
		Water	LCW
	Solid	Oil	LSO
		Water	LSW

Recent Washington State Data on Mercury Concentrations in Tuna – Jim VanDerslice

Stratified Sample by Type

- # Choose left-hand can on top row
- # Select one for each type and brand
- # Sort by type
- # Randomly select one can from each type



Lab Analysis

- # Conducted by WA Department of Ecology Manchester Environmental Lab
- # Analyzed for total Hg, using EPA method 245.5

Sampling Results

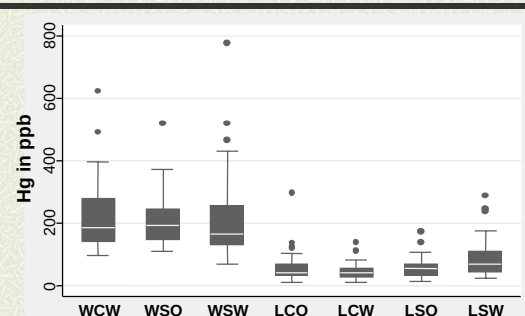
Type	N	# stores	Availability	Ave # brands
WCW	44	57	77%	2.2
WSO	42	83	51%	1.2
WSW	44	46	96%	3.4
LCO	45	55	82%	2.2
LCW	44	46	96%	3.9
LSO	28	83	34%	1.2
LSW	42	83	51%	1.0

Total of 289 cans sampled

Tuna Brands

Brand	#	%
Star Kist	123	43%
Bumble Bee	99	34%
Chicken of the Sea	26	9%
All other brands	41	14%

Hg Concentrations, by Type



Linear Regression Results

Factor	Parameter Estimate	Std. Err.	t	P> t
White	151.3	11.3	13.3	<0.001
Solid	15.8	12.7	1.2	0.22
Water	-5.2	9.3	-0.6	0.58
constant	56.8	8	7.1	<0.001

Hg levels in white tuna was, on average, 151 ppb higher than light.

Other factors were not associated with Hg levels.

Recent Washington State Data on Mercury Concentrations in Tuna – Jim VanDerslice

Canned Tuna Hg Concentrations



	Mean* (ppb)	95% CI
White	214.5	191.3 - 237.8
Light	57.1	50.9 - 63.3

* - Weighted means

Canned Tuna Consumption



BRFSS 2002

- Nationwide probability-sample telephone survey

Questions:

- "How often do you eat canned tuna?"
- "When you eat canned tuna, about how much of a standard 6 oz. can do you eat at a sitting?"

Randomly-chosen adult

Randomly-chosen child under 5

WA BRFSS 2002 Sample

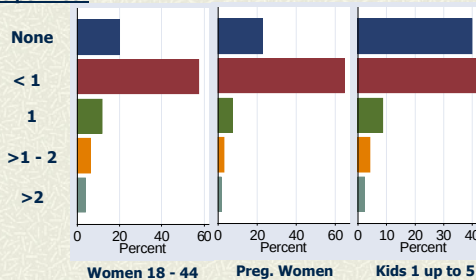


# Adult men	1,968
# Adult women	2,919
# Women 18 to 44	1,300
# Pregnant women	61
# Kids 1 up to 5	491

"How often do you eat canned tuna?"



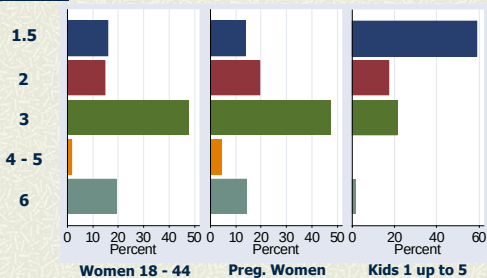
Times per week



"How much ... tuna do you eat at a sitting?"



Oz. per meal



Predicted Hg Dose ($\mu\text{g}/\text{Kg day}$)



Tuna	Dose	Women 18 - 44	Pregnant women	Kids 1 up to 5
White	95th %-tile	0.095	0.07	0.17
	% > RfD	4.6%	1.9%	10.7%
Light	95th %-tile	0.03	0.02	0.05
	% > RfD	0.4%	0.0%	2.2%

Next Steps



- # Combine data and examine differences between studies
- # Conduct 2nd round of sampling in WA (pending funding)
- # Consult with other states and consider revising current tuna consumption advisory
- # 2004 BRFSS consumption questions

Acknowledgements



- # The 2002 BRFSS data collection was funded by WA DOH
- # The Canned Tuna Hg Study was funded through the Washington Environmental Public Health Tracking Network grant from the National Centers for Environmental Health, CDC (U50/CCU022438-01)

Recent FDA Data on Mercury Concentrations in Fish – David Acheson

Mercury Levels in Fish – Recent FDA Data

David W K Acheson



Recent FDA Assignments to Measure Mercury in Fish

- Two new assignments to measure mercury in fish in United States commerce completed in 2003
 - 12 different species of fish – total of 224 samples
 - Canned tuna
 - 170 samples of albacore/white
 - 119 samples of light



12 Different Species of Fish

- Grouper (i.e., Grouper black, Gag, Gulf, Grouper yellowfin, Yellowmouth, Tiger, Scamp)
- Red Snapper
- Orange Roughy
- Seabass Black
- Trout, saltwater (common names Seatrout Spotted, Seatrout Sand, Weakfish)
- Croaker, Atlantic
- Tilefish, Golden
- Trout, freshwater (Lake and/or Rainbow Trout)
- Bluefish
- Whitefish
- Sardines (Pacific, Spanish)
- Crawfish (Crayfish)



Mercury Assignment on 12 species

- Fresh, refrigerated, frozen
- Approximately one third domestic imports
 - Baltimore, Chicago, Florida, Los Angeles, New York, San Francisco, Seattle, South West
- Approximately two thirds domestic samples
 - Atlanta, Florida, Los Angeles, New Orleans, New England, New York, San Francisco



Mercury Assignment

- Each sample tested was a composite of 12 individual samples.
- Tested in FDA laboratories
- Used standard methods to measure total mercury



Mercury data in fish and shellfish

	OLD DATA			NEW DATA		
	MEAN	RANGE	n	MEAN	RANGE	n
Bluefish	0.30	0.20-0.40	2	0.318	0.139-0.479	21
Croaker*	0.28	0.18-0.41	15	0.054	0.013-0.096	21
Grouper*	0.27	0.19-0.33	48	0.569	0.072-1.205	20
Crawfish/crayfish	NA	NA	NA	0.028	0.014-0.047	20
Trout Freshwater	0.42	1.22 (max)	NA	NA	NA	NA
Farm Raised Trout	NA	NA	NA	0.033	0.015-0.110	15
Orange Roughy	0.58	0.42-0.76	9	0.485	0.013-0.762	20
Red Snapper	0.60	0.07-1.46	10	0.154	0.077-0.395	12
Trout Seawater	0.27	ND-1.19	4	0.328	0.022-0.744	20
Tilefish*	1.45	0.65-3.73	60	NA	NA	NA
Golden Tilefish	NA	NA	NA	0.208	0.055-1.123	20
Whitefish*	0.16	ND-0.31	2	0.068	0.027-0.137	14
Black Sea Bass	NA	NA	NA	0.127	0.058-0.352	20
Sardine	NA	NA	NA	0.016	0.004 - 0.035	21

*Unknown Species

Recent FDA Data on Mercury Concentrations in Fish – David Acheson

Tuna Mercury Assignment

- 75% major brands
- 25% store, local, and other brands
- Representative of the volume and type of major and local brands and packing medium (e.g. spring water, broth, and oil) available in the area.
- Los Angeles, San Francisco, Seattle, Chicago, Dallas, New England, New York, Florida.



Mercury data in canned tuna

	OLD DATA			NEW DATA		
	MEAN	RANGE	n	MEAN	RANGE	n
Canned tuna	0.17	0.000-0.75	248	NA	NA	NA
White tuna	0.29	ND-0.49	17	0.358	0.03-.85	170
Light tuna	0.12	ND-0.75	225	0.123	0.00-0.53	119



Future Assignments

- FDA will continue to monitor mercury levels in tuna and a variety of other fish species during FY04.



Methylmercury: Epidemiology Update

Kathryn R. Mahaffey, Ph.D.
U.S. Environmental Protection Agency
Washington D.C.

Fish Forum – San Diego - 2004

Reports in 2003/2004 . . .

- 1999-2000 NHANES organic blood Hg
- *Close association with fish intake in 1999-2000 NHANES examinees.*
- Confirmation of cord blood [Hg] : adult blood [Hg] in Japanese.
- *Estimate at least 300,000 newborns in US each year with in utero blood [Hg] greater than 5.8 µ/L.*

Reports in 2003/2004 (*continued*)

- Seychelles cohort update.
- *Methylmercury-associated adult neuro-psychological changes at hair [Hg] < 50 ppm.*
- Distribution of omega-3 fatty acids (EPA and DHA) in fish and shellfish vs. [Hg] in fish and shellfish.

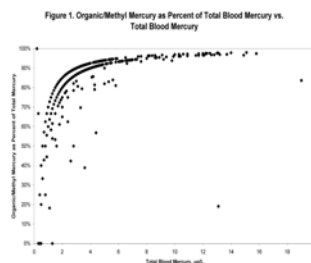
1999-2000 NHANES Blood Mercury

- Blood organic mercury (i.e., methylmercury) among 1709 women of childbearing age representative of US population.
- *Overall, 9% of women consumed fish at least once a week. Fish consumption higher among women over age 30 and among Asians and people of "Island" ethnicity.*

1999-2000 NHANES Blood Mercury

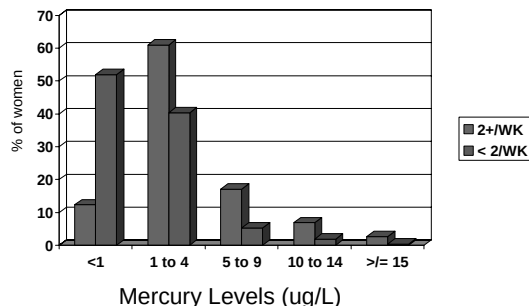
- Association: $R = 0.5$ to 0.6 between dietary total mercury and blood organic mercury (Mahaffey et al., 2003).
- Blood mercury concentrations were 7 X higher among women who reported eating 9+ fish/shellfish meals within past 30 days (i.e., 2 or more times per week) compared with women who reported no fish/shellfish consumption in the past 30 days (Mahaffey et al., 2003).

Methylmercury as a Percent of Total Blood Mercury: 1999-2000 NHANES Adult Women of Childbearing Age



Update on Recent Epidemiologic Mercury Studies – Kate Mahaffey

**Total Mercury Levels in Women,
Aged 16-49
by Weekly Fish Consumption Levels**



Basis for Uncertainty Factor of 10 in the Reference Dose for Methylmercury

Three-fold for toxicokinetics:

■ Basis for the UF of 10:

Variability and uncertainty in estimating an ingested mercury dose from cord blood mercury concentration.

Cord:maternal ratio for blood [Hg] ranges from > 3 to less than 1. Average ~ 1.7 to 1.8. New Japanese data indicate ratio of 1.6 for cord : maternal pairs.

Three-fold for toxicodynamics and uncertainty.

Estimated Number of Newborns with In Utero Methylmercury Exposures >= RfD

- Number of US births in 2000: 4,058,814 (*National Vital Statistics Reports*).
- 1 : 1 ratio of cord to maternal blood [Hg], i.e., 5.8 cord to 5.8 maternal, 7.8% of women had total blood [Hg] >= 5.8, ~ 300,000 newborns each year > 5.8 ug/L (Mahaffey et al., 2003).
- 1.7 : 1 ratio of cord to maternal blood [Hg], i.e. 5.8 cord to ~ 3.5 maternal, 15.7% of women had total blood [Hg] >= 3.5 ug/L, ~ 630,000 newborns each years >= 5.8 ug/L cord blood.

[Note: this estimate is preliminary in nature, and is based on recently available information about mercury in umbilical cord blood versus maternal blood. This new information was presented as part of an ongoing scientific dialogue on how best to understand mercury exposures. EPA is still reviewing these new studies and their potential implications. This recalculation does not impact or change the established Reference Dose (RfD); rather this work focuses solely on an exposure estimate.]

2003/2004 Reports on Neuropsychological Evaluations of Methylmercury Toxicity

- **Myers et al. 2003.** Seychelles cohort update (Lancet). Continued to observe no adverse effects of methylmercury exposure under the circumstances present in the Seychelles Islands.
- **Yokoo et al. 2003.** *Reduced function on tests of fine motor speed and dexterity and on tests of verbal memory among adult Amazonian villagers exposed to methylmercury.*
- **Beuter and Edwards, 2003.** Cree Indians. Additional studies among adults showed difficulty with accuracy and sharpness of visual fixation and pursuit in dynamic eye movements.

Emerging Question on Adult Neurotoxic Effects of Methylmercury Exposures

WHO proposed threshold for adult neurotoxicity based on 5% prevalence of paresthesias at 50 ppm hair mercury (1990).

No physiological basis to assume there are no effects at lower exposures

Dose-response at lower levels needs to be determined.

Mercury and Omega-3 Fatty Acids

- In 2003 additional epidemiology data raised more interest in mercury as a cardiac toxin.
- **Omega-3 fatty acids in fish frequently cited as a health benefit of fish and shellfish intake.**
- Key piece of information is that there are substantial species-specific differences in the distribution of mercury and of the omega-3 fatty acids.
- **Species high in mercury are not necessarily high in omega-3s and species high in omega-3s are not necessarily higher in mercury.**

Update on Recent Epidemiologic Mercury Studies – Kate Mahaffey

Comparison of Mercury (ppm) and Omega-3 Fatty Acid (g/100g) in Fish Species

■ High Mercury Species

Tilefish: 1.6 Hg, 0.17 O-3s

Shark: 1.3 Hg, 0.07 O-3s

King Mackerel: 0.97Hg,
0.18 O-3s

Swordfish: 0.95 Hg, 0.58
O-3s

■ High Omega-3 Species

Mackerel: 0.08 Hg, 3.61 O-
3s

Salmon-sockeye: 0.03 Hg,
3.00 O-3s

Herring: 0.01 Hg, 2.34 O-
3s

Tuna, albacore: 0.26 Hg,
2.33 O-3s

Variation in Mercury and Omega-3 Fatty Acids in Fish and Shellfish

- Mercury concentrations range from < 0.02 ppm Hg in shellfish such as abalone to several ppm Hg in large predatory fish.
- *Omega-3 fatty acids (combined EPA and DHA) range from < 0.1 gram/100 grams of fish (e.g., shark species) to > 3.5 grams/100 grams of fish (mackerel species).*
- There is minimal association between the omega-3 fatty acid concentration in the fish species and the mercury concentration in the species.

Upcoming Meeting

- Meeting on medical issues related to mercury exposure.
- Orlando, Florida
- April – 2004
- Sponsored by US EPA and US HHS in conjunction with multiple medical associations.

Update on the Current Mercury RfD and the Implications for Revisions Based on Recent Data – Alan Stern

Update on the Current Mercury RfD & the Implications for Revisions Based on Recent Data

Alan H. Stern, Dr. P.H., DABT
Division of Science, Research and
Technology
New Jersey Dept. Environmental
Protection

Cardiovascular Endpoint

- Effects associated specifically with MeHg
 - some health effects currently associated only with inorganic Hg
 - e.g., cardiomyopathy
 - not known to what extent inorg. and MeHg share common mode of action for cardiovascular effects

• Heart Disease

- including AMI, MI, CHD, ischemic heart disease
- Salonen et al. (1995)
 - Finland – 1833 middle-aged men in health registry
 - mean fish intake = 46.5 g/day
 - **90th percentile of U.S. consumers**
 - mean Hg hair = 1.92 ppm
 - **~ 90th percentile of U.S. males**
 - hair Hg = 2 ppm, or ≥ 30 g fish/day
 - **RR = 1.7 for AMI, ($p = 0.038$)**
 - **Hair Hg assoc. with immune complexes with oxidized LDL**

- Follow up of Finnish cohort additional 4 years (Rissanen, 2000)
 - prospective measurement of fish n-3 fatty acids
 - **upper quintile of n-3 fatty acids AND hair Hg < 2 ppm → 52% reduction in risk**
 - **upper quintile n-3 fatty acids AND Hg > 2 ppm → 24% reduction in risk**
 - Hg > 2 ppm reduced protective effect of n-3's by ~ 50 %
 - implies balance between protection of n-3's and adverse effects of MeHg

- Multi-center study (Europe and Israel) (Guallar et al. 2002)
 - men ≤ 70 yrs.
 - case control - first AMI
 - DHA (n-3 fatty acid)
 - toenail Hg
 - interpretation of exposure?
 - with full model adjustment, (including n-3's) OR for AMI in highest quintile Hg was 2.2 times OR in lowest quintile
 - monotonic positive dose-response
 - dose response modeling for DHA gave monotonic negative trend
 - Consistent with Hg antagonism of n-3 protection

- U.S. health care professionals study (Yoshizawa et al. (2002)
 - case-control study of coronary heart disease
 - middle-aged men
 - toenail Hg
 - Hg conc. larger than largest group in Guallar et al.
 - n-3 fatty acids
 - dentists were largest group
 - 63% of controls
 - Hg exposure > twice that of other groups
 - occupational exposure to Hg⁰?

Update on the Current Mercury RfD and the Implications for Revisions Based on Recent Data – Alan Stern

- toenail Hg not associated with risk of CHD
 - for total cases
 - with dentists excluded OR = 1.3-1.7
 - higher OR with adjustment for n-3's
 - not significant – small n
- does putative association result from total Hg or MeHg?
 - if MeHg, then inclusion of dentists is a confounder
- potential exposure misclassification
 - toenail samples collected up to 5 yrs. prior to CHD event

- Minamata
 - preliminary ecological study comparing causes of death in two heavily exposed districts of Minamata to Minamata City as a whole (Tamashiro et al., 1988)
 - diseases of the heart were not elevated
 - period of analysis was approx 20 years after initial disease report
 - peak period for heart disease may not have been included
 - MeHg exposure in control area not documented
 - case-control study in Kumamoto prefecture
 - causes of death secondary to Minamata disease analyzed

- OR not significant for any cause
 - ischemic heart disease - OR = 1.3 males 0.65 females
 - other heart disease - OR = 1.3 males 2.0 females
 - only ischemic heart disease sig. associated with Minamata disease on death certificates

- Atherosclerosis
 - Salonen et al. (2000) measured progression in men from E. Finland
 - ultrasound measurement of thickness of carotid artery
 - two measurements 4 yrs. apart
 - hair Hg
 - upper quintile = 2.81 ppm
 - multivariate regression model
 - Hg highly significant
 - beta for Hg second only to systolic BP
 - 7.3% increase in progressive thickening for each ppm Hg in hair

- **Blood pressure and heart rate – *in utero* exposure**
 - Some evidence for association of *in utero* MeHg exposure (cord blood Hg) and BP at 7 yrs. (Faroes cohort, Sørensen et al., 1999)
 - systolic and diastolic
 - dose response plateaus at low exposures (10 ug/l)
 - Also decrease in heart rate *variability*
- Inconsistent with findings in institutionalized patients with “fetal Minamata disease” (Oka et al., 2003)
- Animal studies examined adolescents and adults
 - some associations, but generally high dose effects with frank neurological toxicity

Summary of Cardiovascular Effects

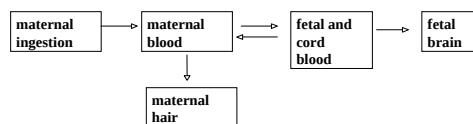
- Epidemiological studies suggest an association between heart disease (including but not limited to AMI) and MeHg
- Causal mechanism suggested by apparent antagonism between n-3 fatty acids and MeHg
 - anti-oxidant properties of n-3's and lipid peroxidation stress from MeHg?
 - different levels of n-3's and MeHg by species may explain differences among studies of potential cardiovascular benefits of fish consumption
 - risks from MeHg may not be straightforward, but would be expected to be mediated by n-3 exposure

Update on the Current Mercury RfD and the Implications for Revisions Based on Recent Data – Alan Stern

- association between atherosclerosis and MeHg seen only in single study
 - mechanism may be consistent with lipid peroxidation by MeHg
- Salonen et al., 1995, and Guallar et al. (2002) may lend themselves to dose-response modeling
 - lack of information about toenail Hg as a biomarker makes Guallar study less useful
- Evidence for effects of MeHg on BP at current levels of exposure is weaker
 - no epi. studies in adults
 - animal data difficult to interpret given multiple toxicities
 - *in utero* BP effects are unclear with respect to persistence and long-term implications
 - of concern

Reassessment of the pharmacokinetic model for dose reconstruction

Pharmacokinetic Pathway for Fetal Exposure to MeHg

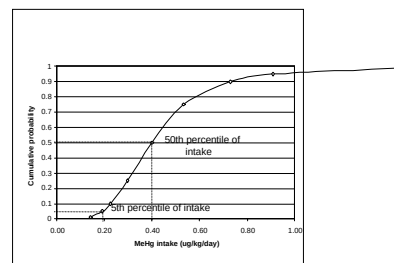


One Compartment Pharmacokinetic Model (for blood)

$$D = \frac{C_c \times R \times b \times V}{(A \times F) \times W}$$

Pharmacokinetic Variability in Pathway

based on one-compartment model
(Stern, 1997)



- Previous analyses have produced consistent estimates of population variability in the dose reconstruction

Estimate of Pharmacokinetic Variability Dose-Blood from 3 studies

	50 th percentile/ 5 th percentile (95% of var.)	50 th percentile/ 1 st percentile (99% of var.)
Stern (1997)	mean = 1.8	mean = 2.4
Swartout and Rice (2000)	2.1	2.8
Clewell et al. (1999)	1.4	1.7

- However, previous analyses were inconsistent in absolute values predicted for the dose
 - this was largely a function of differences in central tendency estimates
 - selection of appropriate data sets and central tendency estimates was uncertain
 - analyses differed with respect to the specificity of the parameter values to pregnancy and stage of pregnancy
- Also, previous analysis implicitly assumed that $Hg_{\text{cord}}/Hg_{\text{maternal}} = 1.0$

Update on the Current Mercury RfD and the Implications for Revisions Based on Recent Data – Alan Stern

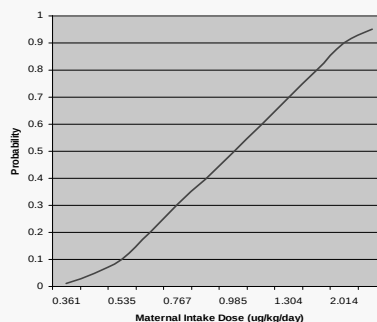
- Current re-analysis is largely third-trimester-specific
 - reflecting pharmacokinetic factors which influence Hg conc. in cord blood
- Current re-analysis incorporates the $Hg_{\text{cord}}/Hg_{\text{maternal}}$ ratio

- W – data on maternal weight at delivery
 - correlated with V
- V – data on third-trimester total blood volume
- b – data on elimination rate ($T_{1/2}$) from pregnant women in Iraqi poisoning
- F – not pregnancy specific
 - however, may not significantly change during pregnancy
 - uncertain parameter
- A – not pregnancy specific
 - unlikely to vary much with pregnancy
- R – delivery-specific
 - well documented

Preliminary results of revised dose reconstruction Maternal dose (ug/kg/day) corresponding to 58 ug/l in cord blood

		<u>current EPA value</u>
mean	1.03	1.08
s.d.	0.73	
1 st percentile	0.21	
5 th percentile	0.31	
10 th percentile	0.39	
50 th percentile	0.84	
50 th percentile/5 th percentile	2.7	
50 th percentile/1 st percentile	4.0	3 (assumed)

**Probability of Maternal Intake Dose
Corresponding to 58 ug/l in Cord Blood**



- Thus, on the basis of the preliminary analysis:
 - the estimate of the mean maternal dose is about the same as EPA's previous estimate
 - the overall variability in the dose reconstruction is approximately 33% larger than the EPA assumed value
 - appears to be due largely to the variability in the cord/maternal ratio

- If a UF approach is used to address pharmacokinetic variability, the preliminary analysis suggests that a UF of approx. 4 may be justified
 - 99% of population variability
- However, the third-trimester specificity of the analysis suggests that 99th percentile estimate can be used directly in the RfD calculation
 - 58 ug/l $\approx$ 0.21 ug/kg/day
- If a UF (toxicodynamic factors, database insufficiency etc.) of 3 is then applied, overall RfD could be
 - 0.21 ug/kg/day/3 = 0.07 ug/kg/day

National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations – David Acheson, Denise Keehner

FDA and EPA Development of a Joint Advisory for Methylmercury-containing fish and shellfish for Women of Childbearing age and Children.

David W K Acheson
Denise Keehner



Purpose of the FAC meeting

The purpose of the FAC meeting was to provide a report of how FDA has responded to the FAC recommendations in developing a revised joint advisory with EPA that addresses both commercial and locally caught fish.



Structure of the presentations

1. Status report of how FDA has responded to the previous FAC recommendations.
 - Description of the process involved in developing a revised advisory based on the recommendations.
2. Review of the exposure assessment
3. Discussion of focus group testing of the revised advisory.
4. The final draft advisory – post focus groups
5. FAC comments



Status Report



Outline

- Background of relevant recent history in relation to the current advisory
- Process involved in responding to the six primary recommendations from the 2002 Food Advisory Committee meeting
- Response to the recommendations
- Question to the 2003 Food Advisory Committee



Background

- 2001 FDA and EPA issued advisories on fish consumption.
- 2002 FDA Food Advisory Committee asked to evaluate the advisory.



National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations – David Acheson, Denise Keehner

2001 - FDA Advisory

- Avoid Shark, Swordfish, King Mackerel, Tilefish
 - Aimed at women of childbearing age and young children.
- Eat up to 12oz/week of a variety of other fish
 - Aimed at women of childbearing age
- Follow EPA advice for recreationally caught fish



2001- EPA Advisory

- Limit consumption of freshwater fish caught by family and friends to one meal/week
 - Adult -- 6 ounces cooked, 8 ounces uncooked
 - Child --2 ounces cooked, 3 ounces uncooked
- Applies to areas where states have not provided advice about untested waters
- Check with state or local health department for advice on waters where friends /family fish
- Target -- women who are of child-bearing age and children
- Follow FDA advice for ocean, commercial fish



FAC 2002 - Charge

The Committee was asked to evaluate whether the FDA's consumer public health advisory on methylmercury provides adequate protection for pregnant women and women of childbearing age who may become pregnant



FAC 2002 - Recommendations

1. Better define what is meant by “eat a variety of fish” ,
2. Work with other federal and state agencies to bring commercial and recreational fish under the same umbrella,
3. Publish a quantitative exposure assessment used to develop the advisory,



FAC 2002 - Recommendations

4. Develop specific recommendations for canned tuna, based on a detailed analysis of what contribution canned tuna makes to overall methyl mercury levels in women,
5. Address children more comprehensively in the advisory,
6. Increase monitoring of methyl mercury to include levels in fish and the use of human biomarkers.



Process to address the recommendations



National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations – David Acheson, Denise Keehner

Key Process Milestones

- Fall 2002: EPA Administrator and Secretary of HHS exchange letters agreeing to collaborate and “bring commercial and recreational fish under the same umbrella advisory”.
 - Follow-up meeting held between Director of FDA’s Center for Food Safety and Applied Nutrition and EPA’s Assistant Administrator for the Office of Water
- Feb 2003: Set up joint working and leadership group from FDA/EPA
 - Staff and managers from FDA/EPA



Key Process Milestones (con)

- 2002-03: FDA undertakes exposure assessment
- April 2003 to present: Weekly meetings and joint work between FDA and EPA
 - Planned and completed independent external peer review of exposure assessment and revised exposure assessment,
 - Planned and held 4 stakeholder meetings,
 - Planned and produced draft joint advisory,
 - Planned and held 8 Focus Groups in 4 different locations across the U.S. and revised draft advisory on basis of Focus Group input,
 - Planned and prepared materials for this FAC



Key Process Milestones (con)

- July 2003: Stakeholder meetings
 - EPA/FDA met with industry, consumers and health professionals, States and Tribes and reported on progress in responding to FAC recommendations of July 2002
 - Shared with Stakeholders a tentative timeline that included Focus Group testing of a draft advisory in November and a public meeting in Fall of 2003



Key Process Milestones (con)

- July 2003: Stakeholder meetings (con)
 - Key messages from Stakeholder meetings included:
 - Need to continue research, bring new data and science into future revisions; but, important to move forward now
 - Some concern about accuracy of tissue data in model
 - Concern about balanced message vis-à-vis fish in diet
 - Proposed timeline seems ambitious; important to have Focus Groups and time for States to be on board
 - Effective outreach and implementation to get the message out are critically important to achieving public health goals



Key Process Milestones (con)

- September/October 2003: Developed draft joint advisory
 - Initial draft advisory was 2 and ½ pages in length
- November 2003: Focus Group testing and real time revisions
 - 8 Focus Groups in 4 different locations
 - Testing of advisory resulted in substantial revisions after first Focus Group in Calverton, Maryland: message not received
 - Lesser refinements occurred after subsequent Focus Groups



Key Process Milestones (con)

- December 2003: Public meeting/presentation at FDA FAC
 - Presenting “final” draft advisory (post Focus Groups)
 - Looking for concurrence on readiness to move forward



National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations – David Acheson, Denise Keehner

Response to Recommendations



Response to recommendations

1. Better define what is meant by “eat a variety of fish”

- Consider a variety of methods
 - Lists of fish
 - Expanded language
 - Shorter explicit language
- Tested some of these in focus groups



Response to recommendations

2. Work with other federal and state agencies to bring commercial and recreational fish under the same umbrella,

- Close collaboration between FDA and EPA to develop a single joint advisory concerning commercial and recreationally caught fish,
- Interacted with States during this process through Stakeholder meetings.



Response to recommendations

3. Publish a quantitative exposure assessment used to develop the advisory

- Quantitative exposure assessment developed in early 2003.
- Presented publicly as a poster in March 2003
- External peer review in August 2003
- Revised exposure assessment December 2003
 - New data on mercury levels in fish
 - Comments from the peer review



Response to recommendations

4. Develop specific recommendations for canned tuna, based on a detailed analysis of what contribution canned tuna makes to overall methyl mercury levels in women

- Canned tuna comprised of two main types.
 - Albacore/white
 - Light
- Canned tuna is one of the most frequently consumed fish in the United States
- Exposure assessment scenarios address tuna specifically
- New data on levels of mercury in canned tuna
- Specific statement regarding canned tuna added to the advisory



Response to recommendations

5. Address children more comprehensively in the advisory

- FDA and EPA determined that there was no scientific consensus to define a specific age or weight in the revised advisory.
- More emphasis on young children in the revised advisory
 - In the title
 - In the text
 - Not limited to the “Do Not Eat” list
- Statement added indicating children should eat less than the 12oz because they are smaller.



National Mercury Advisory: Description of Existing Advisory and August 2003 FDA FAC Recommendations – David Acheson, Denise Keehner

Response to recommendations

6. Increase monitoring of methyl mercury to include levels in fish and the use of human biomarkers.

- Two new assignments to measure mercury in fish in United States commerce completed in 2003
 - 12 different species of fish – total of 224 samples
 - Canned tuna
 - 170 samples of albacore/white
 - 119 samples of light



Question to the FAC

- Given the enormous interest and expectations from all perspectives on this issue, the one important point we believe all agree on, is that we move forward and begin our education program.
- As we learn more from scientific findings, population demographics, NHANES and receive results from the education effort on consumer behavior, we may need to refine the approach.
- We believe that this activity is best conducted concurrently with an outreach and educational program that in the interests of public health should commence as soon as possible. We therefore seek the Committee's concurrence.



National Mercury Advisory: Exposure Assessment and Peer Review – David Acheson, Rita Schoeny

Exposure Assessment: Peer Review and Revisions

Rita Schoeny, EPA
David W K Acheson, FDA

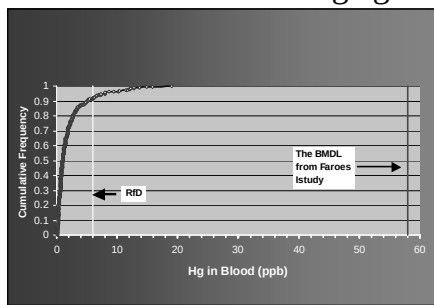


Why was the exposure assessment done?

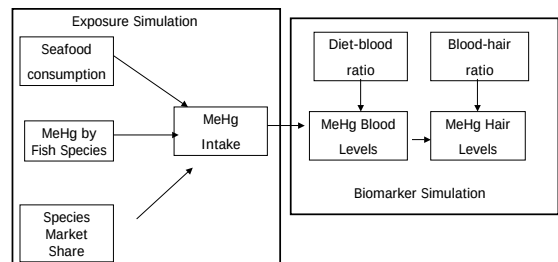
- Response to 2002 – FDA Food Advisory recommendation on the 2001 fish advice
 - Publish a quantitative exposure assessment used to develop the advisory
 - Develop specific recommendations for canned tuna, based on a detailed analysis of what contribution canned tuna makes to overall methyl mercury levels in women



NHANES – blood mercury levels in women of childbearing age



MeHg Exposure Model Overview



Exposure simulation

- Short term consumption (3 day) – CSFII '89-90
- Long-term purchase diaries (30 day)
- Market share data
 - Shrimp 19.6%
 - Tuna (light) 15.7%
 - Salmon 11.1%
 - Pollock 10.3%
 - Catfish 7.6%
 - Tuna (albacore) 6.5%
 - 70.8%**



Estimation of blood or hair Hg predicated on Scenarios

- Scenarios – weekly levels of fish consumption
 - e.g. No dietary exclusions at all or
 - 12 oz /wk of low mercury fish
- For the scenarios fish were divided into high, medium and low MeHg
 - High: Swordfish, Shark, Tilefish, King Mackerel
 - Medium: e.g. Albacore Tuna, Halibut, Tuna steaks, Rockfish, Haddock, American Lobsters
 - Low: e.g. Light Tuna, Cod, Pollock, Catfish, Shrimp, Salmon, Flatfish, Scallops, Clams, Sardines, Oysters



National Mercury Advisory: Exposure Assessment and Peer Review – David Acheson, Rita Schoeny

EPA and FDA use of an exposure assessment

- Considered scenarios and outcomes in formulating bases for revised joint advice
- Discussed FDA / EPA conclusions with Stakeholders at July meetings:
 - The model closely predicts the NHANES data showing population exceeding RfD
 - FDA and EPA believe this will therefore be a useful tool in establishing the scientific background for an advisory
 - FDA and EPA believe the scenarios offer a way to inform the risk management decisions
 - FDA and EPA are submitting this exposure assessment for peer review



What was reviewed?

- Poster presentation by CD Carrington and PM Bolger, presented at 2003 meeting of the Society of Toxicology (abstract published in *The Toxicologist*)
 - Devised fish consumption scenarios and predicted blood and hair mercury for women of child-bearing age and children
 - Baseline scenario expected to reflect NHANES data



How was review done?

- “Letter” review done through existing EPA peer review contract (Contract No. 68-C-02-091, Versar)
 - EPA /FDA described required reviewer expertise
 - Contractor selected 3 reviewers
 - EPA approved listed reviewers as having the requisite credentials
 - Contractor provided all materials to reviewers, collected written comments from reviewers, compiled peer review report



EPA /FDA wrote the charge to the reviewers -- 1

1. Is the document logical, clear and concise? Are the arguments presented in an understandable manner?
2. Has the appropriate literature been cited? Are there publically available, peer-reviewed papers that should be included? Please provide copies of any papers or reports for consideration.
3. Is the model clearly described? Are modifications supportable by existing data? Modifications include these: expansion of fish categories from 24 to 28; fitted distributions in place of analogues for some species; addition of 0.1 to 2 ppb mercury to blood levels to account for sources other than fish.



EPA /FDA wrote the charge to the reviewers -- 2

4. Data from the Continuing Study of Food Intake by Individuals (CSFII) from 1989-1991 were the basis for distributions of fish consumption. These data were from three days of survey information vs. two days for the later data (CSFII 94-96). Comment on this choice. Comment on the adjustments made to compensate for likely under-reporting of fish consumption by the low consumption portion of the population.
5. In this paper women of child-bearing age are defined as those between 18 and 45 years of age; children are defined as of 2 to 5 years old. Are these the appropriate ranges?



EPA /FDA wrote the charge to the reviewers -- 3

6. Are the fish consumption scenarios logically described, clear and supportable? Comment on the identification of 0.5 ppm mercury or greater as “high mercury fish.”
7. For purposes of applying the scenarios in the exposure assessment, the following boundaries were set for High, Medium and Low mercury contamination of fish species: High, swordfish, shark, tilefish, king mackerel; medium greater than 0.13 ppm; low less than or equal to 0.13 ppm. Comment on these choices. Note and comment on the following: 0.12 ppm is a level of mercury contamination that would permit 12 oz. fish/week without exceeding the RfD.



National Mercury Advisory: Exposure Assessment and Peer Review – David Acheson, Rita Schoeny

Response to reviewers

- Written response by EPA / FDA available on Web. (www.cfsan.fda.gov, www.epa.gov/ost/fish)
- This describes
 - Revisions to assessment,
 - Differences of scientific opinion,
 - Review comments considered outside the scope of the current analyses,
 - Areas for future work



The exposure assessment has been revised and expanded

Some changes in response to review

- More categories of fish added; new data on [Hg]
- Correction for water lost from food preparation
- Parameters in consumption frequency chosen to reflect NHANES
- Slight increase in number of consumers
- Variation in consumer fish choice (changed to individual variable from population variable)
- Scenarios changed to reflect limit on amount of fish consumed, type of fish consumed and limits on both
- Body weight scaling changed



Model Changes: Mercury Concentration

- The number of fish categories for which distributions were developed was expanded from 24 to 42.
- Mercury concentration data was obtained for additional species.
- More data collected on canned tuna
- A correction factor was applied to reflect water loss during food preparation.



Model Changes: Consumption Frequency

- The model parameters used to extrapolate long-term frequency of consumption from short-term records were optimized to be consistent with the 30 day NHANES survey.
- The percentage of consumers was also changed from 70-90% to 85 to 95% in order to be consistent with the NHANES survey.



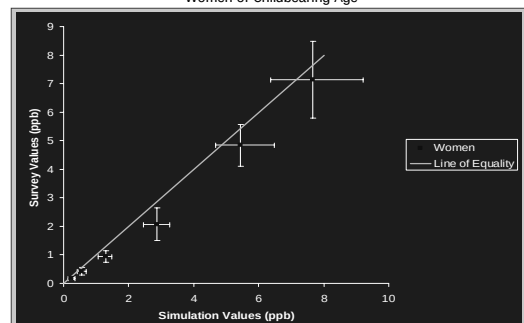
Model Changes: Species Selection

- The fraction of the annual seafood diet estimated from the individual dietary survey, as opposed to market share, was treated as an individual variable rather than as a population uncertainty.
- Instead of using a range of 20 to 80%, the range of individual repetitiveness was estimated using the NHANES survey.



Blood MeHg: Simulation vs. NHANES

Women of Childbearing Age



National Mercury Advisory: Exposure Assessment and Peer Review – David Acheson, Rita Schoeny

Hg Concentration Groups

High	Medium		Low	
Swordfish	Grouper	Sablefish	Blue crabs	Catfish
Shark	Orange Roughy	Halibut	Snow crab	Whitefish
King Mackerel	Tuna, Albacore	Rockfish	Cod	Croaker
	Trout, Saltwater	Haddock	Tuna, Light	Scallops
	Tuna, Steaks	Snapper	Sea Bass	Flatfish
	Spiny Lobster	Bluefish	Trout, freshw.	Crawfish
	Dungeness Crab	Lobster	Perch, freshw.	Salmon
			King Crab	Shrimp
			Blue Crab	Clams
			Ocean Perch	Tilapia
			Oysters	Sardines

Advisory Scenarios

- Limit Total Seafood Consumption
 - 6, 12, or 18 oz per week without regard to species.
- Restrict Species Consumed
 - No limit on amount of fish consumed.
 - Consumption limited to either middle or low groups (No High), or low group (Low Only).
 - Where seafood from the restricted group(s) is specified, the serving is replaced by a random selection from a market-share distribution of low mercury species.
- Restrict Both Amount and Species



Advisory Scenario Simulations: Total Consumption Limits

	Baseline	18 oz/week	12 oz/week	6 oz/week
Average	2.3 (2.1, 2.6)	2.2 (2.0, 2.5)	2.1 (1.9, 2.3)	1.7 (1.5, 1.8)
Median	1.3 (1.1, 1.5)	1.3 (1.1, 1.5)	1.3 (1.1, 1.5)	1.2 (1.0, 1.4)
90th Percentile	5.5 (4.7, 6.5)	5.4 (4.6, 6.4)	5.1 (4.4, 5.7)	3.5 (3.3, 3.8)
95th Percentile	7.7 (6.4, 9.2)	7.4 (6.2, 8.9)	6.5 (5.7, 7.2)	4.2 (3.9, 4.5)
99th Percentile	13.6 (10.8, 20.2)	11.7 (10.2, 14.4)	9.5 (8.4, 11.3)	6.2 (5.3, 8.2)
99.5th Percentile	16.4 (13.1, 25.9)	13.7 (11.4, 17.1)	11.5 (9.4, 14.8)	7.9 (6.4, 10.6)
99.9th Percentile	26.3 (17.5, 52.0)	20.7 (14.1, 35.4)	18.8 (12.8, 24.9)	12.2 (8.5, 15.1)
% > RfD	8.8 (6.4, 12.0)	8.5 (6.3, 11.4)	7.1 (4.8, 9.4)	1.3 (0.8, 2.2)



All units are ppb, with confidence limits in parentheses

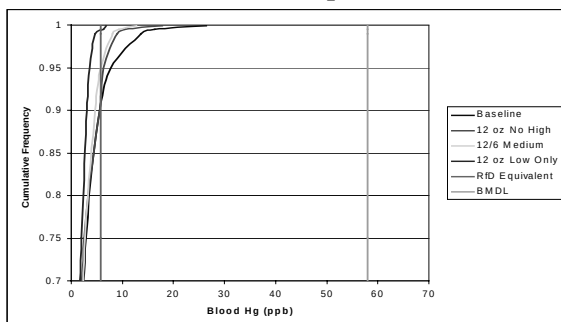
Advisory Scenario Simulations: Species Consumption Limits

	Baseline	No High	Low Only
Average	2.3 (2.1, 2.6)	2.3 (2.0, 2.5)	1.7 (1.5, 1.9)
Median	1.3 (1.1, 1.5)	1.3 (1.1, 1.5)	1.0 (0.8, 1.2)
90th Percentile	5.5 (4.7, 6.5)	5.3 (4.6, 6.2)	3.8 (3.3, 4.4)
95th Percentile	7.7 (6.4, 9.2)	7.4 (6.3, 9.4)	5.4 (4.4, 6.7)
99th Percentile	13.6 (10.8, 20.2)	13.1 (10.5, 20.3)	8.8 (7.0, 14.3)
99.5th Percentile	16.4 (13.1, 25.9)	16.1 (11.8, 27.1)	10.4 (8.0, 16.7)
99.9th Percentile	26.3 (17.5, 52.0)	26.6 (17.9, 49.6)	14.4 (10.1, 24.7)
% > RfD	8.8 (6.4, 12.0)	8.5 (6.3, 11.4)	4.2 (2.3, 6.5)



All units are ppb, with confidence limits in parentheses

Scenario Comparison



Summary

- Many revisions have been made to the exposure assessment
- For women of childbearing age the model now generates slightly higher values than the NHANES survey, rather than slightly lower values
- Lowering seafood consumption by either limiting the amount consumed and/or the species consumed can be expected to reduce higher levels of exposure to mercury from seafood encountered in the U.S. population



National Mercury Advisory: Exposure Assessment and Peer Review – David Acheson, Rita Schoeny

Advisory Scenarios: Limit Combinations

Scenario	High	Middle	Low	Total
12 oz No High	None	12 oz/wk	12 oz/wk	12 oz/wk
12 oz Variety	None	6 oz/wk	12 oz/wk	12 oz/wk
12/6 Albacore	None	6 oz/wk	12 oz/wk	12 – Albacore oz/wk
12/6 Medium	None	6 oz/wk	12 oz/wk	12 – Medium oz/wk
12 oz Low Only	None	None	12 oz/wk	12 oz/wk



Advisory Scenario Simulations: Limit Combinations

	Baseline	12 oz No High	12 oz Variety	12/ 6 Albacore	12/ 6 Medium	12 oz Low Only
Average	2.3 (2.1, 2.6)	2.0 (1.8, 2.2)	2.0 (1.8, 2.2)	2.0 (1.8, 2.2)	1.9 (1.7, 2.1)	1.5 (1.3, 1.7)
Median	1.3 (1.1, 1.5)	1.3 (1.1, 1.5)	1.3 (1.0, 1.5)	1.2 (1.1, 1.5)	1.3 (1.1, 1.5)	0.5 (0.4, 0.6)
90th Percentile	5.5 (4.7, 6.5)	4.9 (4.4, 5.5)	4.9 (4.3, 5.6)	4.8 (4.3, 5.4)	4.7 (4.2, 5.2)	2.0 (1.8, 2.3)
95th Percentile	7.7 (6.4, 9.2)	6.3 (5.7, 7.0)	6.2 (5.5, 6.9)	6.0 (5.5, 6.7)	5.7 (5.1, 6.5)	3.6 (3.1, 4.0)
99th Percentile	13.6 (10.8, 20.2)	9.0 (8.0, 11.2)	9.1 (8.0, 10.7)	8.8 (7.4, 11.3)	8.0 (6.9, 9.4)	4.6 (4.0, 5.3)
99.5th Percentile	16.4 (13.1, 25.9)	10.6 (9.1, 13.7)	10.7 (9.1, 12.8)	10.6 (8.4, 14.1)	9.3 (7.7, 11.3)	6.3 (5.4, 8.2)
99.9th Percentile	26.3 (17.5, 52.0)	17.8 (12.4, 25.7)	15.3 (12.0, 18.1)	17.8 (12.0, 23.9)	12.7 (9.7, 15.2)	6.9 (5.8, 8.8)
% > RfD	8.8 (6.4, 12.0)	6.7 (4.8, 8.8)	6.2 (4.2, 9.0)	5.9 (3.9, 8.2)	4.8 (3.0, 7.4)	1.9 (0.5, 3.7)

all units are ppb, with confidence limits in parentheses

Mercury Focus Group Testing Results – Marjorie Davidson

Overview of Focus Groups

Consumer Advisory on
Methylmercury

Marjorie L. Davidson, PhD



Methylmercury (MeHg) Consumer Advisory

- Message for:
 - Pregnant women
 - Women who may become pregnant
 - Nursing mothers
 - Young children



What are focus groups?

- Qualitative research with beginnings in WWII
- Small group discussions of 5-10 people with certain common characteristics
- Purpose is to find out what the target audience thinks and feels about an issue, product, or service

8 Focus Groups

- Calverton, Maryland; New Orleans, Louisiana; Seattle, Washington; and Minneapolis, Minnesota
- Mixed gender and education groups; pregnant women; parents of young children; women of childbearing age
- Held November, 2003
- Iterative Process



Focus Groups' Goals

- Examine risk communication formats
- Gauge consumer response to advice
 - Enhanced attention to young children
 - Merging commercial and noncommercial fish
 - Discussing tuna



Balance

- Minimize the risks from methylmercury in fish
- Not jeopardize the health benefits from eating fish



Mercury Focus Group Testing Results – Marjorie Davidson

FINDINGS: Most people want a simple message

- Methylmercury may harm a child's development if consumed in high amounts
- What should be done to avoid high amounts



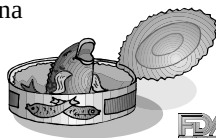
FINDINGS: Some people want more information

- Want to know how methylmercury will affect the health of their baby or child
- Want to know data about particular species of fish
- Want to know how methylmercury will affect others



What about tuna?

- Information about the difference in methylmercury content in tuna steaks and albacore tuna versus light tuna was new to some participants
- Some participants said they would avoid tuna steaks and albacore tuna



What about Recreational Fish?

- Avoiding commercial fish when consuming recreational fish was new information
- Some participants think of fish consumption as a whole; don't separate commercial and sport caught fish



What will participants do?

- Almost all participants reported that they will avoid species identified as DO NOT EAT
- Some participants will eat less fish
- Some participants will serve less fish to their children



What will participants do? Cont'd

- Spillover effect – Many participants will tell others about the risks of fish because if fish can be risky for pregnant women, it probably isn't good for other people.



Mercury Focus Group Testing Results – Marjorie Davidson

CONCLUSION

- Women will not exceed the safe fish consumption advice
- The challenge will be to ensure that women, and the children they care for, continue to eat fish as an important protein and nutrient source in their diet



National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory – Jim Pendergast

Revised Joint FDA and EPA Advisory

James Pendergast, EPA
David W K Acheson, FDA



Title of Draft Joint Advisory:

*ADVICE FOR WOMEN WHO ARE PREGNANT, OR
WHO MIGHT BECOME PREGNANT, AND NURSING
MOTHERS, ABOUT AVOIDING HARM TO YOUR
BABY OR YOUNG CHILD
FROM MERCURY IN FISH AND SHELLFISH.*



Draft Joint Advisory has three main elements

Risk Message
Consumer Advice
Additional Information



Risk Message

Who is at risk

*WOMEN WHO ARE PREGNANT, OR
WHO MIGHT BECOME PREGNANT,
NURSING MOTHERS, AND YOUNG
CHILDREN*



Risk Message (continued)

Why they are at risk

Fish and shellfish can be an important part of a balanced diet. It is a good source of high quality protein and other nutrients and is low in fat. The FDA and EPA are advising pregnant women and nursing mothers to eat the types and amounts of fish and shellfish that are safe to prevent harm to the development of their baby or young child.



Consumer advice

Benefits and risk

*If you follow advice given by
FDA and EPA you will gain the
positive benefits of eating fish
but avoid any developmental
problems from mercury in fish.*



National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory – Jim Pendergast

Consumer advice

How much fish?

To protect your baby follow these 3 rules:

1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury



Consumer advice

(continued)

How much fish?



To protect your baby follow these 3 rules (cont'd):

2. Levels of mercury in other fish can vary. You can safely eat up to 12 ounces (2 to 3 meals) of other purchased fish and shellfish a week. Mix up the types of fish and shellfish you eat and do not eat the same type of fish and shellfish more than once a week.

Consumer advice

(continued)

How much fish?

To protect your baby follow these 3 rules (cont'd):

3. Check local advisories about the safety of fish caught by family and friends in your local rivers and streams. If no advice is available, you can safely eat up to 6 ounces (one meal) per week of fish you catch from local waters, but don't consume any other fish during that week.



Consumer advice

(continued)

How much fish?

Follow these same rules when feeding fish and shellfish to your young child, but the serving sizes should be smaller.



Additional Information

1. But I thought fish was good for me when I am pregnant?
It is, fish and other seafood long have been considered to be good sources of protein with the added advantage of being low in saturated fat and high in healthy omega-3 fatty acids. However, scientists have learned that shark, swordfish, king mackerel and tilefish contain levels of mercury in them that may harm your unborn child. This is why FDA and EPA are advising you to avoid these fish. By eating other types of fish in moderation you will get the health benefits of fish.

Additional Information

2. What about tuna?



Tuna is one of the most frequently consumed fish in the United States. Mercury levels in tuna vary. Tuna steaks and canned albacore tuna generally contain higher levels of mercury than canned light tuna. You can safely include tuna as part of your weekly fish consumption.

National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory – Jim Pendergast

Additional Information

3. Is there methylmercury in all fish?

Nearly all fish contain traces of methylmercury. However, larger fish that have lived longer have the highest levels of methylmercury because they've had more time to accumulate it. These large fish (swordfish, shark, king mackerel and tilefish) pose the greatest risk to pregnant women. Other types of fish are safe to eat in the amounts recommended by FDA and EPA. If you want more information about the levels in various types of fish see the FDA food safety web site. www.cfsan.fda.gov or the EPA website at www.epa.gov/ost/fish.



Additional Information

4. I'm not pregnant - so why should I be concerned about methylmercury?

If you regularly eat types of fish that are high in methylmercury, it can accumulate in your blood stream over time. Methylmercury is removed from the body naturally, but it may take over a year for the levels to drop significantly. Thus, it may be present in a woman even before she becomes pregnant. This is one of the reasons why women who are trying to become pregnant should also avoid eating certain types of fish. **Note:** If you have questions or think you've been exposed to large amounts of methylmercury, see your doctor or health care provider immediately.



Additional Information

5. Why do I need to get local advice for locally caught fish?

Some kinds of fish and shellfish caught in your local waters may have higher or much lower than average levels of mercury. This depends on the levels of mercury in the water in which the fish are caught. Those fish with lower levels may be safely eaten more frequently and in larger amounts.



Additional Information

6. How can learn about local advisories?

Before you go fishing, check your Fishing Regulations Booklet for information about local advisories. You can also contact your local health department for information about local advisories. See below for state and tribal contact information.

Note: If you have questions or think you've been exposed to large amounts of methylmercury, see your doctor or health care provider immediately.



Additional Information

7. What is mercury?

Mercury occurs naturally in the environment and can also be released into the air through industrial pollution. It falls from the air and can accumulate in streams and oceans and is turned into methylmercury in the water. It is this type of mercury that is harmful to your baby. Fish absorb the methylmercury as they feed in these waters and so it may build up in the fish. It builds up more in some types of fish than others, depending on what the fish eat, which is why the levels in the fish vary.



Additional Information

- For further information about the risks of mercury in fish and shellfish call the U.S. Food and Drug Administration's food information line toll-free at 1-888-SAFEFOOD or visit FDA's Food Safety Website www.cfsan.fda.gov
- For further information about the safety of locally caught fish and shellfish, visit the Environmental Protection Agency's Fish Advisory website www.epa.gov/ost/fish or contact your State or Local Health Department. A list of state or local health department contacts is available at www.epa.gov/ost/fish. Click on Federal, State, and Tribal Contacts.



National Mercury Advisory: Overview of the New Joint Agency National Mercury Advisory – Jim Pendergast

FDA Food Advisory Committee Comments

Comments from December 2003 FAC

- The FAC has not yet made formal recommendations.
- There were a number of comments made by the committee:
 - Format issues
 - Multiple advisories
 - Research needs

FAC Comments

1. Format issues:
 - Make the message positive
 - Say something about list of fish that are safe to eat (low group)
 - Make portion size consistent between variety and local
 - Consider adding body weights vs. amounts for children
 - Improve the clarity of the tuna message

FAC Comments

2. Possible need for multiple advisories
 - Current priority is to get the advisory we have out with "tweaks"
 - Consider a separate advisory for children
 - Consider a separate advisory for specific high risk populations
 - Consider a separate advisory for the general public

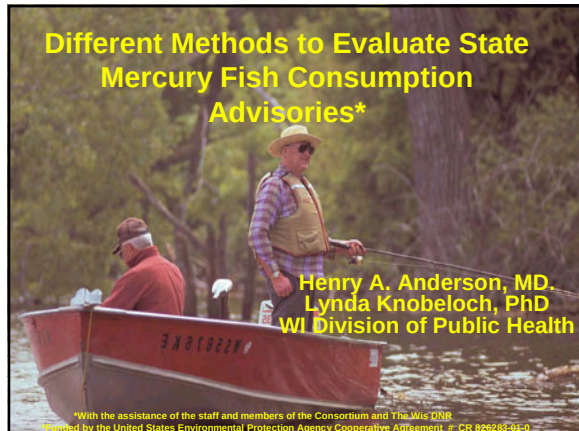
FAC Comments

3. Research issues
 - Need more fish data on species, sub species, geography
 - Work with industry to get industry data
 - Study the impact of the advisory on consumer behavior
 - Gather more information about the 8% above the RfD

Milestones and Timeline

Tasks	Dates
Meetings with Stakeholder Groups and Federal Agencies	July 30, 2003
Conduct Focus Groups	November 2003
Meet With Food Advisory Committee	December 2003
Hold National Forum on Contaminants in Fish	January 2004
Targeted Release of Advisory	Spring 2004
Implement Advisory	Throughout 2004

Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson



Consortium for Improving the Effectiveness of Mercury Fish Consumption Advisories

States

Maine, Wisconsin

Universities

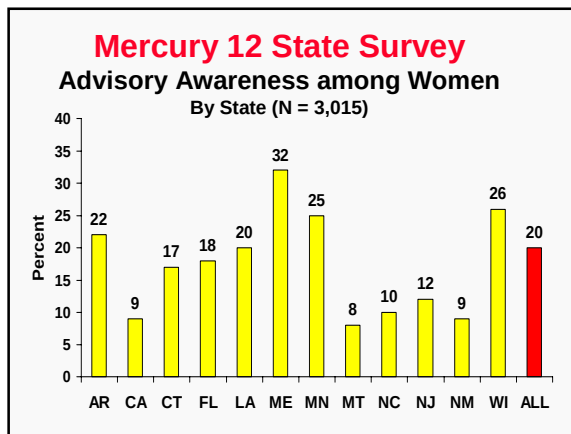
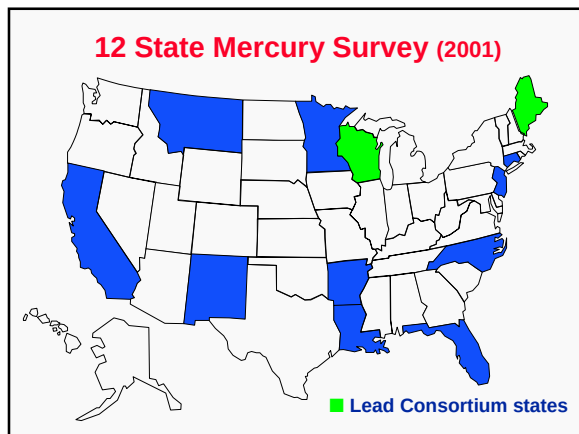
University of Wisconsin - Madison, Marquette University, Milwaukee, WI

Federal Government

United States Environmental Protection Agency, Office of Research and Development, Cincinnati, OH

United States Environmental Protection Agency, Office of Water, Washington, DC

National Center for Environmental Health, CDC, Atlanta, GA



Recognition of Mercury Toxicity by Advisory Awareness

	Aware of Advisory	Not Aware of Advisory
Harms developing child	87%*	67%
Harms ability of muscles	52%*	37%
Body can eliminate mercury	19%	18%

*Significantly higher than among those unaware of state advisories (P<0.01)

Recognition of Mercury Distribution in Fish by Advisory Awareness

	Aware of Advisory	Not Aware of Advisory
Mercury not reduced by cooking	76%*	47%
Higher in older fish	56%*	43%
Higher in larger fish	38%*	29%
Higher in fish that eat others	23%*	18%
Highest in muscle/meat	8%	6%

*Significantly higher than among those unaware of state advisories (P<0.01)

Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson

Fish Consumption and Advisory Awareness by Demographics

	Income		Education	
	<\$25,000	>\$25,000	up thru HS	College
Aware of Mercury Advisory	11%	23%*	16%	23%*
Ate Sport Fish in past 12 months	24%	31%*	27%	30%
Ate 2 or more fish meals/week	7%	10%*	6%	11%*
Fishing License Household	27%	39%*	38%*	33%

* Significantly higher $p < 0.01$

Fish Consumption and Advisory Awareness by Demographics

	Race		Age	
	Other	White	<30 yrs	>30 yrs
Aware of Mercury Advisory	13%*	22%*	10%	24%*
Ate Sport Fish in past 12 months	27%	30%	24%	31%*
Ate 2 or more fish meals/week	14%*	8%	7%	11%*
Fishing License Household	17%	39%*	32%	36%

*American Indians (31%) Hispanic ethnicity 12%, Blacks 11%, and Asian or Pacific Islanders 7%.

* Significantly higher $p < 0.01$

Distribution of Sport Fish Information by Consumption Frequency

	< 2 meals/week (N=2692)	2 or more meals/week (N=282)
Aware of Mercury Advisory	20%	22%
Ate Sport Fish in past 12 months	28%	35%*
Fishing License Household	35%	35%

*Significantly higher than among frequent fish consumers ($P < 0.01$)

Recognition of Mercury Toxicity by Consumption Frequency

	< 2 meals / week	2 or more meals / week
Harms developing child	66%	77%*
Harms ability of muscles	39%	50%*

*Significantly higher than among frequent fish consumers ($P < 0.01$)

Recognition of Mercury Distribution in Fish by Consumption Frequency

	< 2 meals/week	2 or more meals/week
Higher in larger fish	30%	37%*
Higher in fish that eat others	18%	26%*
Higher in older fish	45%	48%
Highest levels in muscle/meat	6%	8%
Body can eliminate mercury	18%	21%*
Mercury not reduced by cooking	47%	59%*

*Significantly higher than among frequent fish consumers ($P < 0.01$)

Mercury Advisory Pilot Interventions Maine and Wisconsin

- **Wisconsin (2001 - 2004)**
 - Posters, brochures, Magnets, Sippy Cups, Growth Charts, Bandage dispensers, Notepads, Fact cards
 - WIC clinics
 - Local health departments
 - Physician Offices - Family Practice, Pediatrics, Ob/Gyn



Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson

Survey of 1,000 Women Who Gave Birth June 1-7, 2003



Evaluation Tool #1

Purpose of Survey



- To assess:
 - fish consumption during pregnancy
 - awareness of the fish consumption advisory
 - familiarity with selected outreach materials

Results

Questionnaires mailed in July to all 1,000 live normal births during June 1-7, 2003

\$2.00 Incentive

2 mailings, one reminder postcard

Total cost \$12,000.

Response rate of 74%

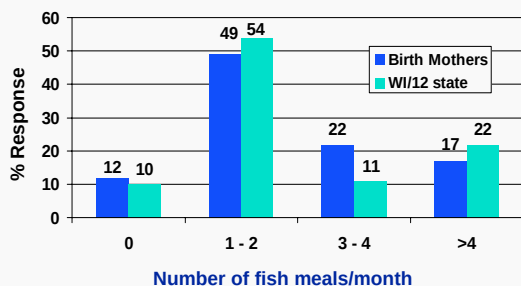
740/1000

5% consumed fish 2 or more times a week

In the past 12 months, have you eaten any of the following?

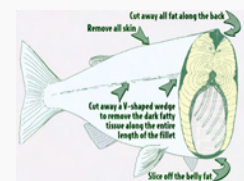
Type of fish	% Yes
Canned Tuna	73%
Shellfish	53%
Frozen Filets	60%
Sport-caught fish	28%
Other	14%
No fish	12%

Over the past 12 months, how many meals of fish did you eat per month?



Is there more mercury in the fat, the organs, the meat, or does it not matter?

Fat	14%
Organs	7%
Meat	8%
Doesn't matter	10%
Don't know	60%
Left blank	1%



PCB Advice

Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson



How much do you know about the guidelines for eating sport fish?

	Birth	WI-12 State
Aware of Advisory	46%	26%
Unaware	53%	73%



How much do you know about the guidelines for eating sport fish?

A lot	2%
Some	16%
Only a little	28%
Nothing	53%
Left blank	1%





How much do you know about the guidelines for eating sport fish?

	<2 meals/mo	2 or more meals/mo
A lot	2%	2%
Some	10%	21%
Only a little	25%	31%
Nothing	62%	45%
Left blank	1%	1%

After learning about mercury, did you change your diet?



I didn't know about the issue	35%
Ate SAME amount of fish	27%
Ate LESS fish	15%
Ate different TYPES of fish	11%
Never ate fish	11%
Ate MORE fish	<1%

Outreach Materials Evaluation

“Hook into Healthy Fish”

“What Women of Childbearing Age should know about Eating Fish”

“A Women and Child Guide..”






Multi-Language Posters for Doctor's Offices

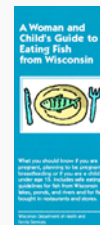
Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson

Have you seen either poster?

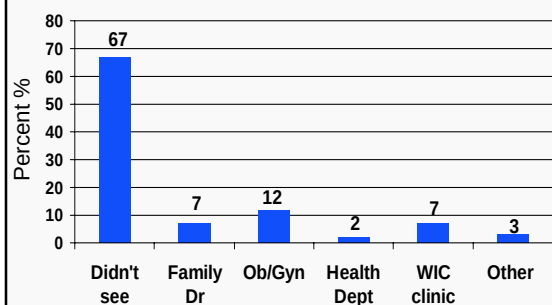
Hook Into Healthy Fish (1999-2001)	2 %
What Women of Childbearing Age Should Know (2002-2003)	11%
Both posters	3%
Don't recall seeing either poster	83%

Have you ever seen our pamphlet entitled A Woman and Child's Guide to Eating Fish from Wisconsin?

Yes	13%
No	85%
Left blank	2%



Where did you see these materials?



Evaluation 2

Materials were mailed to targeted clinical facilities - Did they receive, use?

- Random telephone interviews of 5%
 - 101 surveys of 2,020 sites mailed materials
 - 5 Clinical facility types
 - Family Practice
 - Pediatrics
 - Ob/Gyn
 - WIC clinics
 - Health Departments

Results

Documented that 59 (60%) out of 101 facilities remembered receiving/using the information

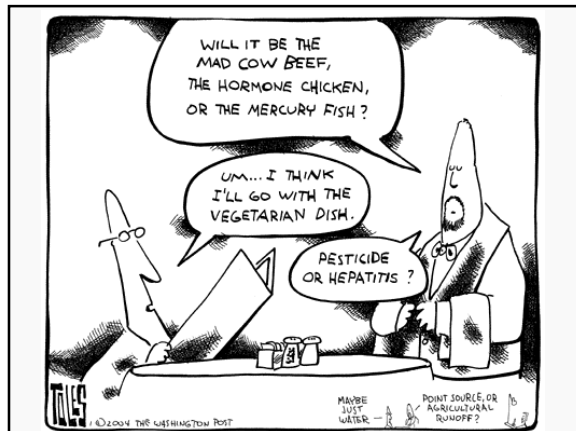
Family Practice 12/30 or ~ 40%
 Ob/Gyn 6/10 or ~ 60%
 Pediatrics 2/10 or ~ 20%
 Health Departments 16/26 or ~ 62%
 WIC Clinic 23/25 or ~ 92%

2004 Assessment Plans

- Behavioral Risk Factor Survey
 - 4,000 adults
- Hair Hg testing will be offered
- Incentive may be offered to encourage participation

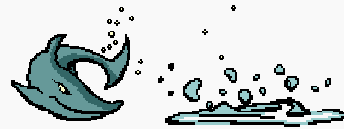


Results of Different Methods Used to Evaluate State Mercury Advisories – Henry Anderson



Different Methods to Evaluate State Mercury Fish Consumption Advisories

Any Questions?



Web-based Guidance on Risk Communication: An Update and Demonstration – Barbara Knuth

Web-based Guidance on Risk Communication: An Update and Demonstration

Barbara Knuth
Cornell University

Guidance History

Volume 4
EPA 823-R-95-001
March 1995



2001



The Development Team

- Technical contractor: Tetra Tech, Inc.
- Consultants:
John Hesse, MI Judy Sheeshka, Ont.
Barbara Knuth, NY Patrick West, WI
- Stakeholders:
Workgroup General

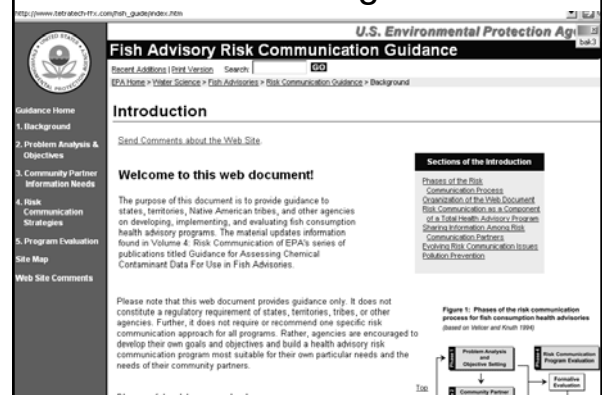
Approach for Revised Guidance

- Acknowledge contamination is not “acceptable.”
- Encourage community involvement.
- Link to other phases of the risk analysis process.

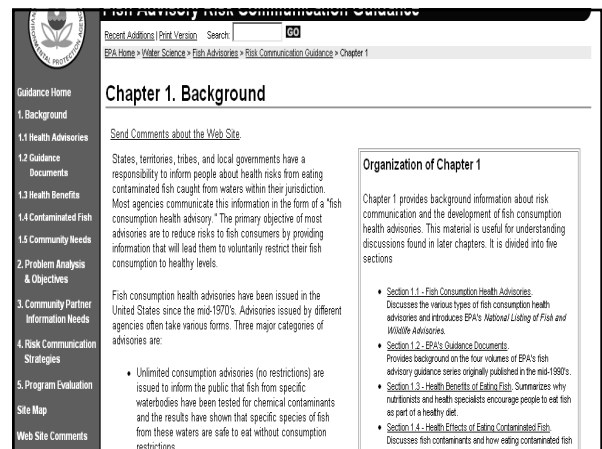
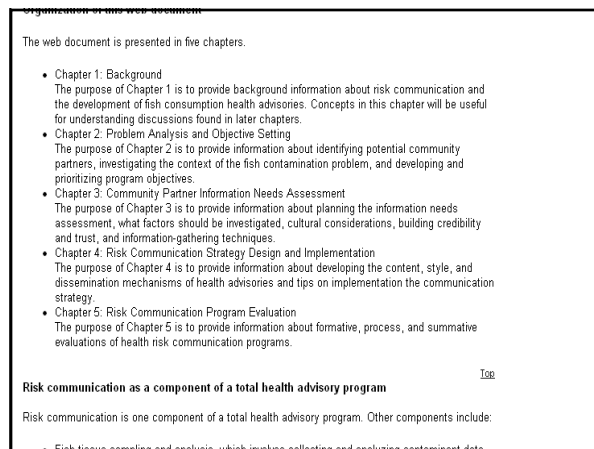
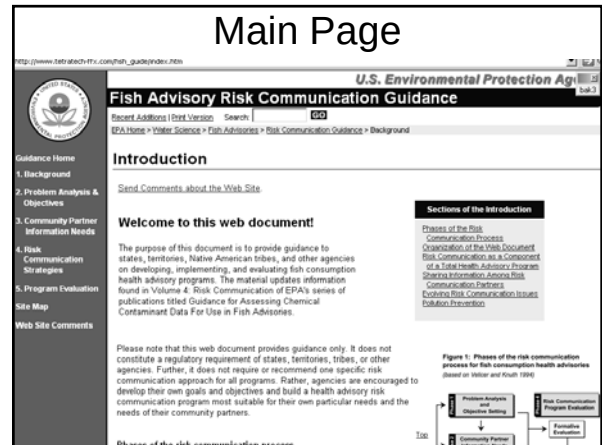
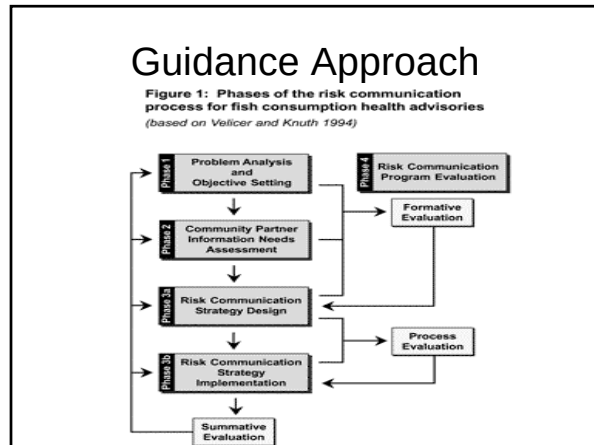
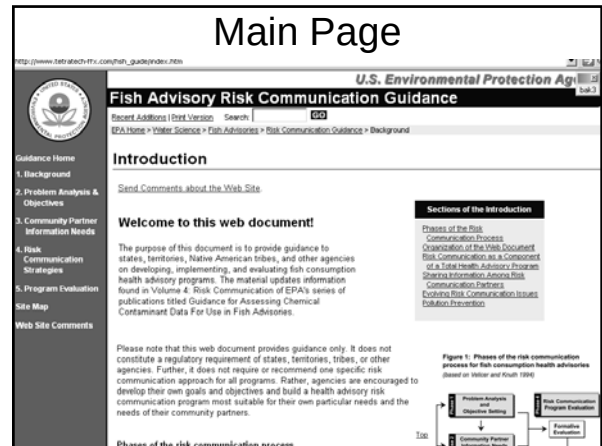
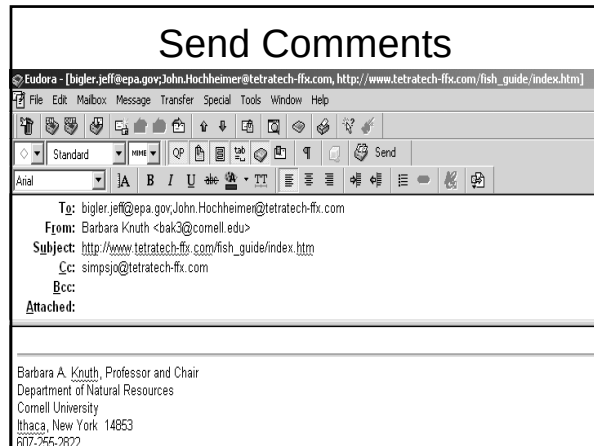
Approach for Revised Guidance

- Enhance outreach materials of the National Fish and Wildlife Contamination Program.
- Web-based to encourage “tailored” use of guidance to meet community and user needs.

Main Page



Web-based Guidance on Risk Communication: An Update and Demonstration – Barbara Knuth



Web-based Guidance on Risk Communication: An Update and Demonstration – Barbara Knuth

This screenshot shows the EPA's Fish Advisory Risk Communication Guidance website, specifically Section 1.3: Health Benefits of Eating Fish. The page features a navigation menu on the left with links to Background, Health Advisories, Guidance Documents, Health Benefits, Contaminated Fish, Community Needs, Problem Analysis & Objectives, Community Partner Information Needs, Risk Communication Strategies, Program Evaluation, Site Map, and Web Site Comments. The main content area includes a search bar, a 'Send Comments about the Web Site' link, and a 'Topics' button. The text explains that fish are an important part of a healthy diet and that fish consumption health advisories are designed to reduce risks to fish consumers by providing information that will lead them to voluntarily restrict their fish consumption to healthy levels. It also lists various vitamins and minerals found in fish, such as Vitamin A, Vitamin B6, Vitamin B12, Vitamin D, Calcium, Iron, Zinc, and Selenium.

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Web-based Guidance on Risk Communication: An Update and Demonstration – Barbara Knuth



The reason for identifying subpopulations and assigning them specific and more strict consumption limits is because they generally possess a greater risk of adverse effects from contaminants. The most common examples of identified subpopulations are women who are pregnant or may become pregnant, nursing mothers, and young children.

Waterbody Conditions

Fish consumption recommendations can apply to specific waterbodies, specific types of waterbodies, and waterbodies within specific geographic regions. In general, waterbody-specific fish consumption recommendations are issued when waterbody-specific risk assessment information is available. When it is impossible to monitor all or most waterbodies for a contaminant, some states issue a general statewide advisory (e.g., Connecticut, Florida, Indiana, Michigan, Maine, New Hampshire, New York, Ohio, and Vermont).

Fish Species and Size

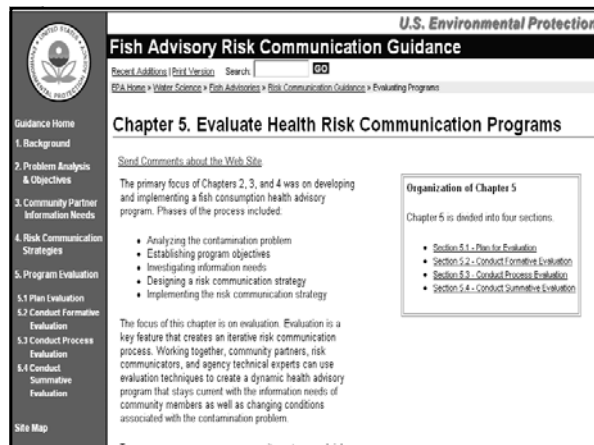
Physiological and ecological differences among fish species causes variation in the rate that contaminants bioaccumulate and biomagnify within body tissue. Consequently, risk management goals and supporting risk assessment analysis may allow agencies to issue specific consumption recommendations based on fish species and fish size. In general these recommendations are based on one or more of the following concepts:

Tip

The EPA website includes access to fact sheets about each of the primary contaminants responsible for fish consumption advisories nationwide. These fact sheets are great sources of more detailed information about sources of chemicals of concern in fish tissue, fate and transport, other potential sources of exposure, and health concerns.

More Information

For more information on EPA's Fish and Wildlife...



Advantages to Web Approach

- Guidance is more accessible to a wide range of fish consumption advisory programs and groups issuing or learning about consumption advisories.
- Guidance is less daunting – web pages to negotiate rather than a large book to read.

Advantages to Web Approach

- A living document modified and updated easily.
- More choices of examples, tools, methods, and current information related to fish consumption advisories and specific partners.

Advantages to Web Approach

- Responsive to stakeholders who indicated a web-based approach has the potential to be more useful.
- Allows the format to become personalized, based on the path a user takes.

Web-based Guidance on Risk Communication: An Update and Demonstration – Barbara Knuth

Possible Disadvantages of Web-based Approach

- The web-based guidance is accessible only to those with web access.
- To be a living document, will need a process to be able to be updated continually.

Next Steps

- View and comment: See computer in poster session room.
- Enhance text (e.g., update mercury information).
- Add navigation aids.
- Add illustrations, tables, case studies.
- Review by tribes and states.
- Target: August, 2004

Thanks to the Stakeholder Workgroup!

Janice Adair, AK
Rosetta Alcantra, AK
Robert Brodberg, CA
Mike Callam, NE
Josee Cung, MN
Henry Folmer, MS
Eric Frohmberg, ME

Jim Labelle, AK
Randall Manning, GA
Maria Maybee, NY
Dave McBride, WA
Pat McCann, MN
Ora Rawls, MS
Brian Toal, CT
Luanne Williams, NC

Don't forget to view
the website in the
poster room!

Risks and Benefits Revisited – Grace Egeland

Benefits and Risks Revisited

G.M. Egeland, Ph.D.
Canada Research Chair
Centre for Indigenous Peoples' Nutrition
and Environment (CINE)
School of Dietetics and Human Nutrition
McGill University



Centre for Indigenous
Peoples' Nutrition and
Environment

Founding director –Dr. Harriet Kuhnlein

CINE Governing Board Members

-  Assembly of First Nations
-  Council of Yukon First Nations
-  Dene Nation
-  Inuit Circumpolar Conference
-  Inuit Tapiriit Kanatami
-  Métis Nation (NWT)
-  Mohawk Council of Kahnawake

Yukon, Dene/Métis and Inuit Research Communities



Nutrient Intake on Days With or Without Traditional Food (TF) (least square means $\pm$ SEM)

		With TF	N	Without TF	N
Total energy (Kcal)	Yukon	2052 $\pm$ 45 *	413	1947 $\pm$ 52	389
	Dene/Métis	2261 $\pm$ 39 *	662	2085 $\pm$ 55	350
	Inuit	2170 $\pm$ 35 *	1092	1857 $\pm$ 41	783
As % Energy Carbohydrate	Yukon	37 $\pm$ 0.6		42 $\pm$ 0.7 *	
	Dene/Métis	36 $\pm$ 1		42 $\pm$ 1 *	
	Inuit	37 $\pm$ 0.5		49 $\pm$ 0.6 *	
Protein	Yukon	32 $\pm$ 0.5 *		19 $\pm$ 0.5	
	Dene/Métis	31 $\pm$ 0.4 *		20 $\pm$ 0.6	
	Inuit	33 $\pm$ 0.4 *		17 $\pm$ 0.5	
Fat	Yukon	30 $\pm$ 0.6		40 $\pm$ 0.5 *	
	Dene/Métis	31 $\pm$ 1		37 $\pm$ 1 *	
	Inuit	32 $\pm$ 0.5		38 $\pm$ 0.6 *	

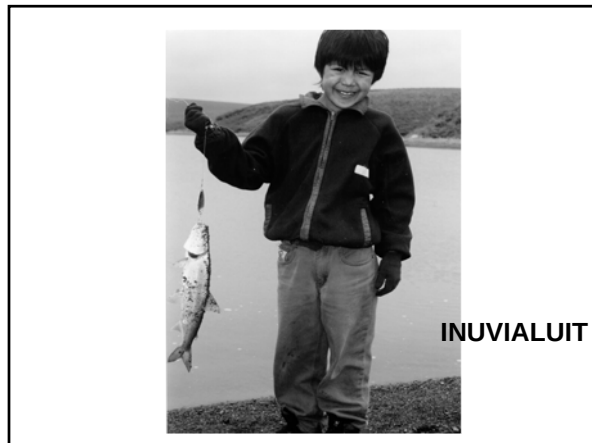
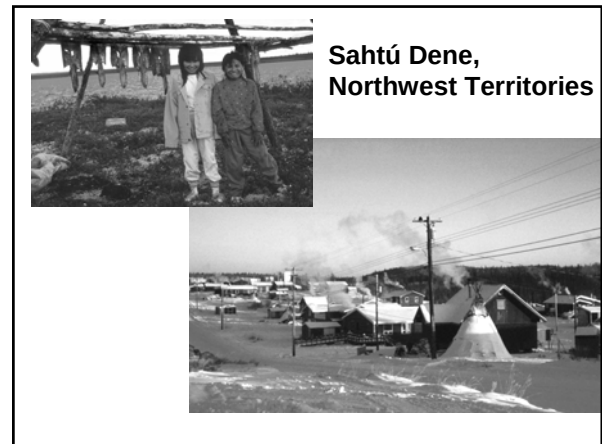
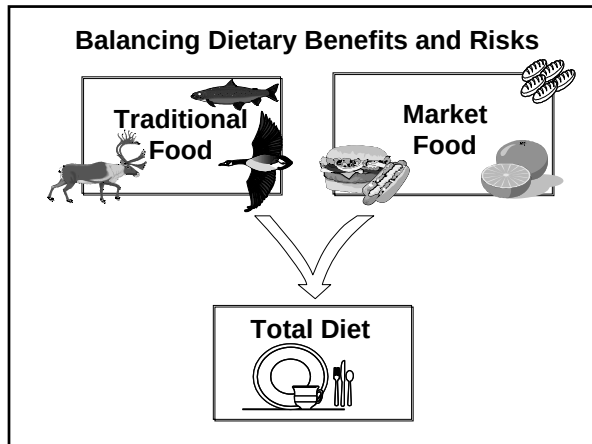
* significant $p < 0.05$ (adjusted for season, site, gender, age)

Dietary Nutrients in Days With or Without Traditional Food (TF) (least square means $\pm$ SEM)

		With TF	Without TF
Protein, % energy	Yukon	32 $\pm$ 0.6*	18 $\pm$ 0.3
	Dene/Métis	30 $\pm$ 1*	19 $\pm$ 1
	Inuit	32 $\pm$ 0.4*	16 $\pm$ 0.5
Iron, mg	Yukon	25 $\pm$ 1*	13 $\pm$ 1
	Dene/Métis	25 $\pm$ 1*	15 $\pm$ 2
	Inuit	36 $\pm$ 2*	11 $\pm$ 2
Zinc, mg	Yukon	28 $\pm$ 1*	12 $\pm$ 1
	Dene/Métis	25 $\pm$ 1*	15 $\pm$ 1
	Inuit	22 $\pm$ 0.7*	9 $\pm$ 0.7
Vit. A, RE	Yukon	500 (430, 582)	462 (395, 540)
	Dene/Métis	304 (258, 358)	321 (254, 405)
	Inuit	438 (378, 507)*	301 (262, 346)

* significantly greater at $p \leq 0.05$

Risks and Benefits Revisited – Grace Egeland



Benefits of Fish Consumption Advisories:

- Reduction in MeHg exposures and risks associated with MeHg;
- MeHg is an established neurotoxin;
- To want to eliminate exposures even in the presence of conflicting evidence of low-level effects is understandable;
- Is there a move toward zero tolerance in the future?

Could a fish consumption advisory be contraindicated by community factors?

1. What is the extent and nature of food security in the community?
 - Local Availability of Market Food; Quality, Diversity, Costs
 - Household income, household size, and food purchasing power;
 - Alternative food choices and meal composition;
 - Culturally acceptable food choices.

Risks and Benefits Revisited – Grace Egeland

Could a fish consumption advisory be contraindicated by community factors?

2. What are the leading public health issues they face?
3. What other exposures are contributing to cognitive impairment in the community? What is the prevalence and severity of these factors?

Guidelines for Evaluating Benefits and Risks of Fish Consumption Advisories

4. What will be the impact on food security and composition of the diet?
5. Would the anticipated dietary composition changes be beneficial in light of the public health challenges faced by the community?

Fish and Omega-3 Content (Source: USDA)

Fish Species	EPA + DHA g/3 oz.	Oz. for 1 g of EPA/DHA*
Herring -Pacific	1.8	1.5
Salmon		
Atlantic Farmed	1.1-1.8	1.5 - 2.5
Atlantic Wild	0.9-1.6	2.0 - 3.5
Chinook	1.5	2.0
Rainbow Trout -Wild	0.8	3.5
Farmed	1.0	3.0
Tuna –White canned	0.7	4.0
Light canned	0.3	12.0
Fresh	0.2 – 1.3	2.5 – 12.0
Cod -Atlantic	0.2	12.5

*long-chain n-3 fatty acids
EPA = eicosapentaenoic acid, DHA=docosahexaenoic acid

Current status on Fish Intake and ...

- Cancer
- Diabetes
- Heart Disease

Breast Cancer and Fish Intake

- Singapore Chinese Health Study
 - Prospective Study of 35,298 women and breast cancer incidence;
 - 45-74 yrs and enrolled 1993-1998 (followed through 2000);
 - Fish and shellfish protective; 26% reduction for top 3 quartiles of intake relative to lowest quartile;
 - Among those in the lowest quartile of fish intake, high n-6 intake elevated risk relative to low n-6 intake (RR =1.87, 95% CI 1.06-3.27).
 - Fish/shellfish intake by quartiles: 24.5, 44.2, 58.3, 80.5 g/day.

Gago-Dominquez et al. *British Journal of Cancer* 2004; 89: 1686-1692.

Fish Intake and Breast Cancer

- 6 Cohort Studies on fish intake;
 - Norway –NS inverse relationship poached meals (Vatten et al, 1990);
 - Japan –≥ 5 servings of dried fish associated with a 50% lower risk compared to ≤1 serving, p < .05. (Key et al, 1999)
 - US –No significant findings (Stampfer et al, 1987; Toniolo et al 1994; Gertig et al, 1999; Holmes et al, 1999);
 - Only 15% of US women consume > 1 fish serving/week – NHANES I (Gillum et al, 1996).

Risks and Benefits Revisited – Grace Egeland

Endometrial Cancer and Fish Intake

- Swedish Case-Control Study of 1,055 Cases and 4216 Controls; of which 75% and 80% participated;
- Fatty fish consumption inversely related with endometrial cancer;
- Highest quartile of fatty fish intake (median of 2 servings/week) vs. lowest quartile of intake (median 0.2 servings/week) –OR =0.6 (95% CI=0.5-0.8);
- A 40% reduction after adjusting for multiple risk factors.

Terry et. al., *Cancer Epidemiology, Biomarkers and Prevention* 2002;11:143-145.

Prostate Cancer and Fish Intake

- Health Professionals' Follow-up Study;
- Inverse association of total fish intake and marine fish intake with metastatic prostate cancer;
- > 3 servings/week compared with infrequent fish consumption, OR=0.5 (0.3 – 0.8);

Augustsson et al, *Am J Epidemiology* 2001;153:S31 (abstract).

Diabetes and Fish Consumption Advisories

Northern Perspectives from Indigenous Communities:

- Community folks --perceive a link between fish consumption advisories and diabetes;
- Direct or indirect link?
- Any plausible mechanism for an effect on diabetes?
 - decreases in physical activity;
 - increase in alternative food sources high in *trans*-fatty acids, saturated fat;
 - decreases in omega-3 fatty acids and high protein diet;
 - weight gain.

Fish Intake and Type 2 Diabetes Mellitus Prevention

Animal Studies:

- Saturated fat worsens insulin sensitivity;
- *n*-3 fatty acids in muscle cell membrane phospholipids strongly and positively correlated with insulin sensitivity;
- *n*-3 fatty acids improve insulin action and counteracts negative effects of saturated fat (Storlein 1991).

Fish Intake and Diabetes Prevention

Four - Year Prospective Trial:

- Cumulative incidence of abnormal glucose tolerance in 175 elderly normoglycemic 64-87 year olds;
- 25% incidence in habitual fish consumers;
- 45% incidence in non-fish consumers;

Feskens et al, *Diabetes Care* 1991; 14:935-941

Fish Intake and Diabetes Prevention

20-year prospective trial:

- Finnish and Dutch Cohorts of the Seven Countries Study – men only;
- Baseline and recent fish consumption were inversely related to 2-hour glucose level ($p < .05$);
- High intake of total fat and saturated fat increased risk of NIDDM and glucose tolerance;
- Vitamin C, legumes, vegetables and potatoes also inversely related.

Feskens et al., *Diabetes Care* 1995; 18:1104-1110.

Risks and Benefits Revisited – Grace Egeland

Fish Intake and Diabetes Prevention

- Nurses Health Study -US
 - 84,204 women;
 - 14-year follow-up
 - *Trans* fatty acids associated with increased risk;
 - Highest 5th quintile of *n-3* intake protective, RR= 0.8 (95% CI=0.67-0.95);

Salmeron et al, *Am J Clin Nutr* 2001;73:1019-26.

Fish Intake and Coronary Heart Disease Mortality Among Diabetics

Nurses' Health Study

- 5,103 female nurses with type 2 diabetes mellitus but free of cardiovascular disease or cancer at baseline (1980 baseline);
- Follow-up in 1996 (45,845 person-years of follow-up);
- Fish Intake
 - ≥ 5 times/week RR =0.36 (95% CI=0.2-0.66)
 - 2-4 times/week RR =0.64 (95% CI=0.42-0.99)
 - 1-3 times/week RR =0.60 (95% CI=0.42-0.85)

Hu et. al. Circulation 2003;107:1852-1857.

Diabetes and Pregnancy

- Gestational Diabetes -Risk factors –not as extensively studied;
- Risk factors similar to type 2 DM;
- Profound impact on many indigenous communities;
- Background Rate for U.S. and Canadian Populations = 3%;
- $\geq 18\%$ in many indigenous communities.

Pregnancy, Diabetes, and Offspring's Risks

- Increased risk for obesity at an early age and early onset type 2 diabetes mellitus;
- 4 times more likely to be above 90th percentile for weight for age;
- Higher birth weight –can disappear around 1-2 years of age and reappears after age 5;
- By 8 years as great as 50% of offspring of diabetic pregnancies are above the 90th percentile.

Pregnancy, Diabetes, and Offspring's Risks

- Impairments in Neurodevelopment:
 - Greater impairments with poorer glycemic control;
 - HbA_{1c} (n=19) strong and significant inverse correlations with Bender ($r = -0.5$), Bruininks general motor ($r = -0.4$) and fine motor ($r = -0.4$).
 - White's classification of glycemic control (n=53) significant and strong inverse correlations with MFP sensory ($r = -0.3$), LTS sensory ($r = -0.29$).
- Ornoy et al, 1998;

Pregnancy, Diabetes, and Offspring's Risks

- Diabetes with good glycemic control:
 - Neurological impairments now noted;
 - Developing Brain may be sensitive to altered metabolism associated with diabetes;
 - MDI score and PDI score significantly lower in the diabetic group than in the controls (91.04 vs. 98.15 and 85.15 vs. 95.54)
 - MDI=mental development index, psychomotor development index. Hod et al, *J Pediatric Endocrinology & Metabolism* 1999; 12:867-872.

Risks and Benefits Revisited – Grace Egeland

Diabetes: Early Infant Feeding

Method of infant feeding – and risk of glucose tolerance in adults aged 48-53 years (Ravelli et al, 2000):

- Bottle-fed subjects had a higher mean 2-hour plasma glucose concentration than those exclusively breast-fed;
- Breast-fed infants have a higher % of DHA and total LCPUFAs in muscle phospholipids and lower plasma glucose levels compared with the formula-fed infants.

Fish, Hg and the Heart

- Heart is one of the target organs for Hg;
- Implications heart disease endpoint not understood;
- Hg alters cardiac sodium handling;
- Evidence that Hg can modify response to viral infections;
- Epidemiological Evidence is inconsistent thus far.

Fish, Hg and the Heart

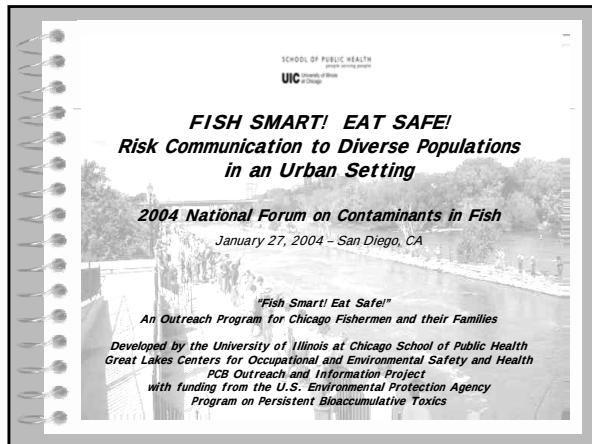
- Sweden –two studies -- no adverse effect on risk of first MI;
- US Health Professionals –no overall adverse effects –poor power to observe effect in non-dentists;
- Finland –adverse effects noted; many of the same endpoints associated with low Se in previous studies in same population;
- EURAMIC –8 European Countries and Israel – toenail Hg and non-fatal MI –adverse effects noted –DHA protective;
- Minimata—no elevated rate of death from CHD and no elevated risk of arteriosclerosis with high hair Hg levels.

■ Public Health Assessment and Environmental Assessments

■ Better Partnerships Are Needed

- Burden of Chronic Disease is Great – Evidence that fish consumption can play a role in prevention strategies.

Fish Smart, Eat Safe! Risk Communication to Diverse Populations in an Urban Setting –Lin Kaatz Chary



Purpose

Urban, ethnic fishers may not be reached by fish advisories, particularly if they do not routinely obtain fishing licenses. If Lake Michigan fish are a significant portion of their diet for any reason, they may be disproportionately exposed to PCBs.

Project Components – 2002 - 2003

- Outreach letters and phone calls
- Meetings with health advocates from community groups
- Surveys at fishing piers
- Community events
- Outreach hand-outs
- Chicago Department of Public Health
- Newspaper Articles to Chicagoland
- African-American and Non-English Press

Survey - 2002

- 2 Locations on Chicago Lake Michigan lakefront
- Non-Random selection of ethnic respondents
- Screened: All eat or share the fish caught
- Surveys in English, Spanish and Vietnamese
- 57 Completed Surveys

Ethnicity of Respondents

Ethnicity	Percentage
Asian	37%
African-American	28%
Hispanic	26%
East European	9%

Survey - 2003

- 2 Locations on Chicago Lake Michigan lakefront
- All willing fishermen interviewed
- Screened: All eat or share the fish caught
- Surveys in English and Spanish
- 160 Completed surveys

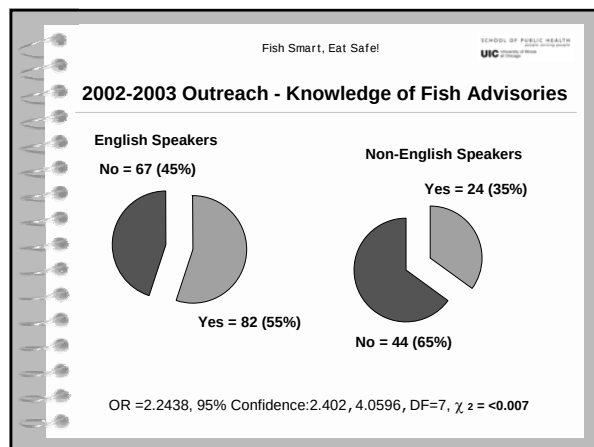
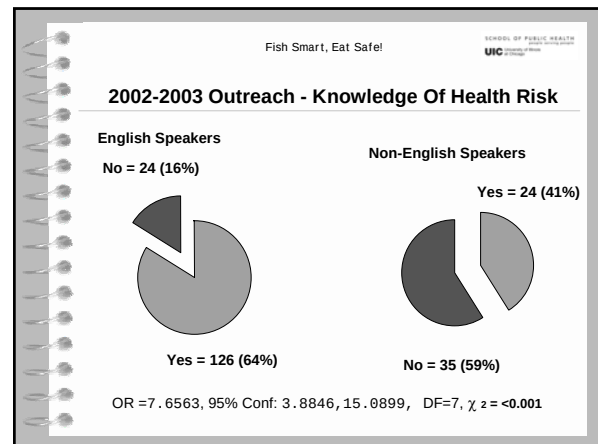
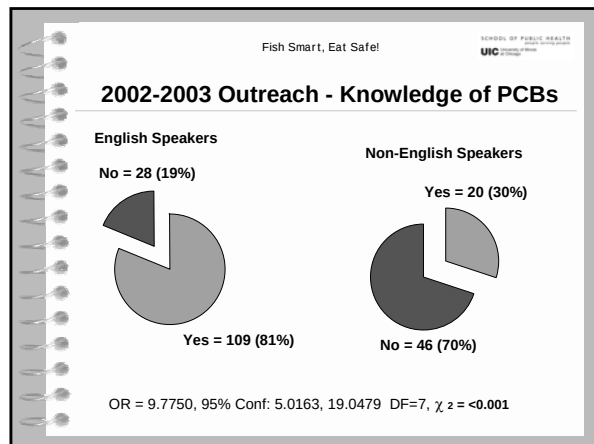
Native Language of Respondents

Native Language	Count	Percentage
English	156	68%
Non-English Speakers	73	32%

English and Non-English Speakers 2002-2003

Language	Count	Percentage
English Speakers	156	68%
Non-English Speakers	73	32%

Fish Smart, Eat Safe! Risk Communication to Diverse Populations in an Urban Setting –Lin Kaatz Chary



- Fish Smart, Eat Safe! SCHOOL OF PUBLIC HEALTH
UIC University of Illinois at Chicago
- ## Additional Findings . . .
- Median age of fishermen was 40-49 years
 - 86% were men
 - 82% of fishermen share their catch with family and friends
 - 14% of non-Native English speakers and 8% of English speakers identified carp or catfish as one of the two fish eaten most frequently
 - The mode value for consumption of catch frequency was "more than one time per week"
 - Almost all fishers [2002] obtained fishing licenses (91%)
 - Family physician identified as most trustworthy source of information about fish contamination; the media (tv, newspaper, radio) the most common source of information about contaminants in fish
 - Fishermen came to Lake Michigan from multiple neighborhoods and communities in the Chicagoland area

- Fish Smart, Eat Safe! SCHOOL OF PUBLIC HEALTH
UIC University of Illinois at Chicago
- ## Conclusions . . .
- In urban communities struggling with multiple social challenges, fish consumption issues are frequently underestimated or unrecognized as relevant. Subsistence fishing often occurs "below the radar."
 - In populations which are heterogeneous, culturally and language-diverse, risk communication requires additional resources and new strategies for reaching target fishermen.
 - Access to information about the risks of PCB contamination in Lake Michigan fish and risk of mercury contamination in other waterways remains a significant environmental justice issue; knowledge is not accessible uniformly, and significant disparities remain in non-English speaking communities about these risks.

- Fish Smart, Eat Safe! SCHOOL OF PUBLIC HEALTH
UIC University of Illinois at Chicago
- ## Conclusions (continued) . . .
- Fish advisory information is not easily accessible to key populations such as pregnant women, and many health providers at the community level do not have the information or tools to address the issue even if they are interested.
 - Existing fish advisories are difficult to find, difficult to follow, and pay inadequate attention to cultural preferences and practices
 - Fish consumption advice is conflicting and inconsistent

Fish Smart, Eat Safe! Risk Communication to Diverse Populations in an Urban Setting –Lin Kaatz Chary

Fish Smart, Eat Safe! SCHOOL OF PUBLIC HEALTH
UIC University of Illinois at Chicago

Recommendations:

- 1) **Develop ongoing media campaigns and risk communication materials which:**
 - recognize the heterogeneity of targeted communities in urban settings,
 - are designed in consultation with community representatives,
 - are culturally sensitive and appropriate,
 - are widely translated into multiple languages to assure accessibility to the broad diversity of target communities; e.g., regular dissemination of information to foreign-language radio stations and print media
- ✓ **Consistency between agency guidelines**

Fish Smart, Eat Safe! SCHOOL OF PUBLIC HEALTH
UIC University of Illinois at Chicago

Recommendations (continued):

- 2) **Focus on primary health care providers, obstetricians, and pediatricians as key messengers of fish consumption information in target communities**
- 3) **Develop an outreach program for EPA regions, where needed, which includes:**
 - 1) an outreach campaign to community groups and health care personnel,
 - 2) dedication of at least one individual trained to do outreach presentations and act as a local resource person,
 - 3) a widely-disseminated toll-free phone number which connects to a live person who can answer questions about advisories specific to relevant areas in the region, and is available for outreach presentations to interested groups and organizations.

**PCB Risk Communication and Outreach Project
2002-2003
“Fish Smart, Eat Safe!”**

The University of Illinois at Chicago School of Public Health
Great Lakes Centers for Occupational and Environmental Safety and Health
U. S. Environmental Protection Agency Program on Persistent Bioaccumulative Toxics

Lin Kaatz Chary, PhD, MPH
Babette J. Neuberger, JD, MPH

Student Outreach Personnel:

2002	2003
Estella Hernandez	Rita Gondocs
Jacek Louis Ubaka	Nida Khan
	Joy Schnackenberg

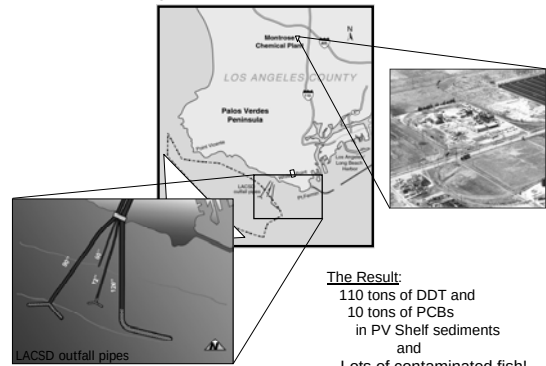
Vietnamese Association of Illinois
Kimphuong Van
Mr. Qua

Palos Verdes Shell Fish Contamination Risk Communication – Sharon Lin

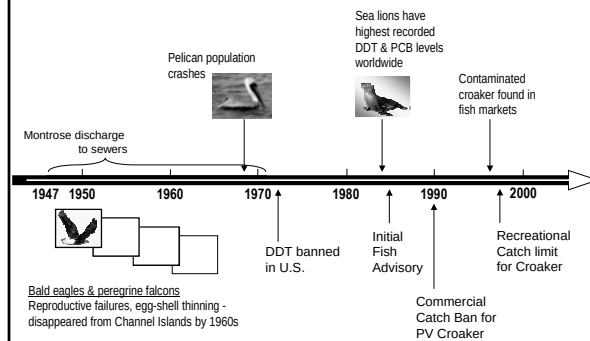
EPA Palos Verdes Shelf Fish Contamination Program

Sharon Lin, USEPA Region 9
Gina Margillo, Impact Assessment Inc.
January 27, 2004

Why is there a Problem?



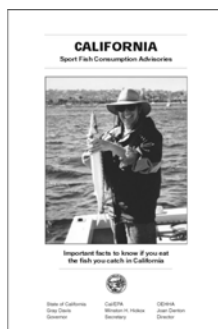
Historic Timeline – Injury



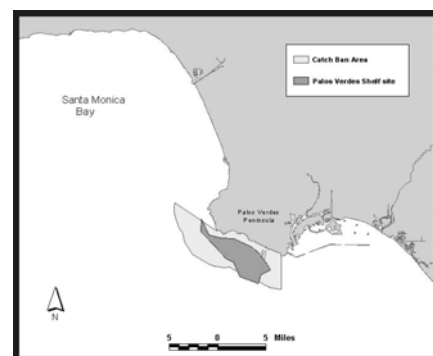
Current conditions

- Commercial fishing: White croaker commercial catch ban off of PVS
- Sport (recreational) fishing: White croaker daily bag limit from Point Dume to Dana Point
- State fish advisory from Point Dume to Dana Point

Current Advisory

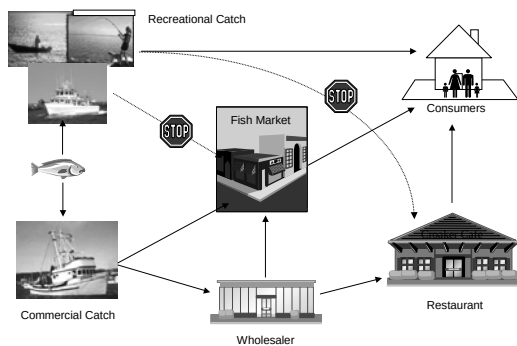


White Croaker Commercial Catch Ban



Palos Verdes Shell Fish Contamination Risk Communication – Sharon Lin

Potential Human Risk Exposure Routes



EPA's Program

1. Public Outreach & Education
2. Monitoring (markets & ocean)



3. Enforcement of White Croaker fishing ban & catch limit

History of EPA's PVS Program

- 1999 EPA initiates pilot outreach & education project (contract with California Department of Health Services)
- 2002 EPA initiates fish in ocean monitoring
- 2003 EPA initiates full-scale public outreach and education program implementation (contract with Impact Assessment Inc.)



Risk Communication - Target Audience

- Anglers who fish off of the coast
- Ethnic-specific public who buy white croakers in local markets – many with limited English speaking ability
- Ethnic-specific population at large, especially women of childbearing age and children
- General population at large

Fish Contamination Education Collaborative (FCEC) Goals and Objectives

- 1) To reduce exposures of populations who regularly eat fish caught off the LA and OC coasts
- 2) To conduct education with the most affected populations so that they can make informed health choices
- 3) To strengthen local capacity to address fish contamination issues now and in the future

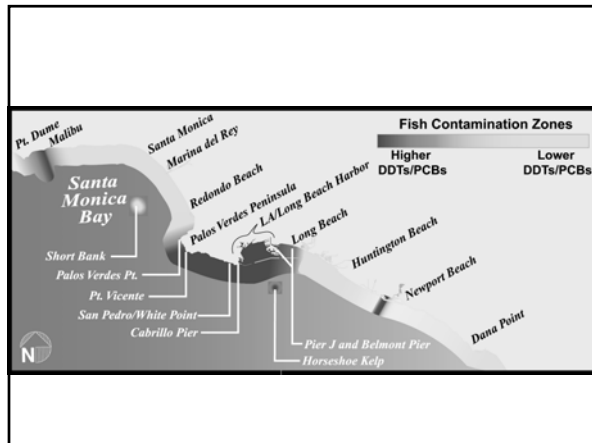
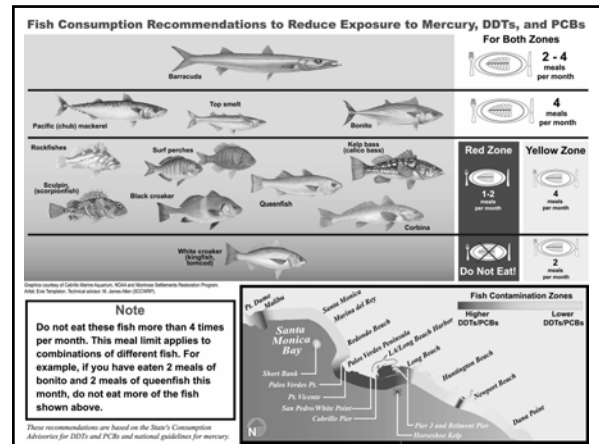
FCEC Strengths

- Collaborative of over 30 partners: MOUs
- Focus is on capacity building: Funds to CBOs, training and technical assistance
- High level of government and community partnering
- Ethnically/culturally diverse:
 - 8 communities, 14 languages

Palos Verdes Shell Fish Contamination Risk Communication – Sharon Lin

Four Programs

- General Outreach
- Pier Outreach
- Market Outreach
- Media Outreach



Summary Messages

- Fish is good for you but some fish you catch from the coast may have more harmful chemicals to your health than other fish.
- Do not eat white croaker from the red zone on the map. In general, fish caught in this area are more contaminated

Summary Messages

- Fish caught in the yellow zone on this map are safer than fish caught in the red zone.
- Before fishing in the red or yellow zones, call 213-240-7785 (Los Angeles County Department of Health Services) to check the local advisories. Information about fish contamination will be updated in the very near future.

Summary Messages

- Do not eat the fatty parts (skin, guts, egg) of the fish you catch from the Los Angeles and Orange County coasts because they contain more chemicals.
- Because chemicals affect development, children through adolescence and women of child-bearing age are more sensitive to the harmful chemicals and should be especially careful.

Palos Verdes Shell Fish Contamination Risk Communication – Sharon Lin

Slogan

- Know your fish, reduce the risks

General Outreach

- Project provides curriculum, training workshops, in-language materials, technical assistance.
- Partners design and implement in-language education campaigns in their communities.
- Focus is on building capacity of CBOs to conduct education

General Outreach Training



Diana Lee, scientist with California Dept of Health Services discusses contamination issues with CBOs.

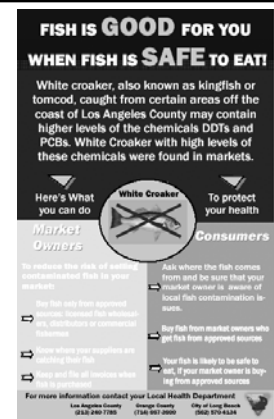
Education/Outreach Materials

- Curriculum
 - FAQ fact sheet
 - Web site
 - Angler brochure
 - Project description brochure
 - Market poster and flyer
 - Interactive display
-
- Various materials developed by CBOs

Market Outreach

- CBOs receive training, education and materials.
- CBOs choose local markets for outreach
- CBOs work with market owners to promote purchase of fish from approved sources
- Market education as opposed to regulation. Promotes accountability

Market Poster



Palos Verdes Shell Fish Contamination Risk Communication – Sharon Lin

Market Outreach Training



FCEC Partners learn how to identify a white croaker.

Pier Outreach

- Outreach conducted in eight languages with anglers on piers and shore sites seven days a week.
- Members of affected communities are recruited, hired and trained to become outreach workers.
- Aquarium docent program, kiosk, new signage.

Media Outreach

- Media campaign using radio, TV, and print in 8 languages
- Media advocacy training for CBOs
- Two successful press conferences targeted multi-ethnic media

Media Outreach Launch



Wayne Nastri, US-EPA Region 9 Administrator speaks at the FCEC Launch at the Aquarium of the Pacific.

On the horizon

- Revised angler brochure
- Consumer brochure (non-angler/women)

Summary

- Government agencies and communities must partner at all stages (from risk assessment to risk reduction) to effectively mitigate exposures to contaminants.

For More Information/Materials

WWW.PVSFISH.ORG

Mississippi Delta Case Study: Risk Communication – Linda Vaught

Mississippi Delta Fish Consumption Advisory

OUTREACH

Linda Vaught, Communications Director
Mississippi Department of Environmental Quality



MDEQ

1

Fish Advisory Issued

- June 2001
- Mississippi Advisory Task Force
 - Department of Environmental Quality
 - Department of Health
 - Department of Wildlife, Fisheries, and Parks
 - Department of Agriculture and Commerce
 - Department of Marine Resources



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2

Fish Advisory Issued

- DDT
- Toxaphene
- Fish: buffalo, carp, gar, catfish (>22")
- Best numbers ever
 - Safe level changed
 - Began using EPA's guidance

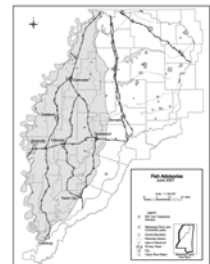


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3

Fish Advisory Issues

- Fish: main food source
- Large geographical area
- Reading
- Don't panic
- It's an ADVISORY



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4

Kick-off

- June 21, 2001
- Press conferences
 - Jackson
 - Stoneville
- Press advisory
- Press release
- Media carried statewide



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5

Kick-off



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Mississippi Delta Case Study: Risk Communication – Linda Vaught

Kick-off



7

Kick-off



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8

14 Months

- Outreach
 - Media
 - Partners
 - Task Force
 - Churches
 - Health care providers
 - Boy Scouts
 - Libraries
 - Schools

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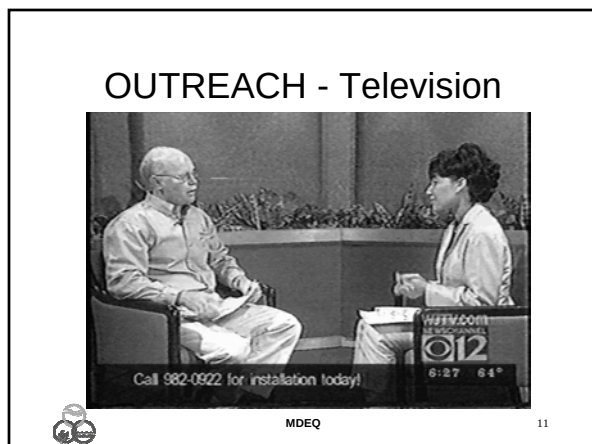
OUTREACH - Television

- Television
 - Talk shows
 - *Mississippi Outdoors* program

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OUTREACH - Television



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OUTREACH - Radio

- Radio
 - Urban talk radio
 - Heart of Mississippi Delta
 - Gospel and blues
 - Listen to the Eagle
 - Statewide radio program
 - PSA & song on 78 radio stations

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Mississippi Delta Case Study: Risk Communication – Linda Vaught

Newspaper article

Media Field Trip

- Media field trip
 - Sampling techniques
 - Analyzing samples
- Much publicity
- Used video again



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Newspaper article

Media Field Trip



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Newspaper article

Media Field Trip



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Contact Us

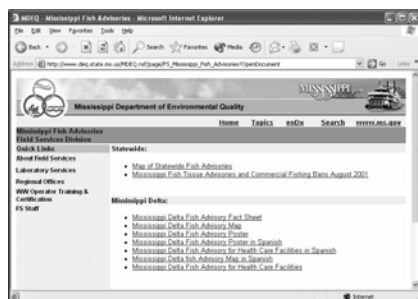
- Established Toll-Free Phone Number
- Created Web Pages

Questions?
1-888-786-0661



MDEQ

Contact Us

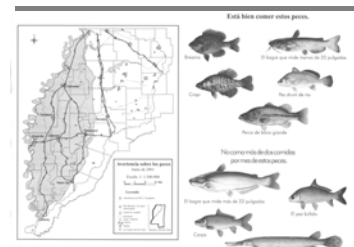


MDEQ

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Printed Materials

- Created and printer fliers
 - English
 - Spanish



[illegible][illegible]

Printed Materials

**What You
Should Know About
Eating Mississippi Delta Fish**

Some fish from the Mississippi Delta lakes and streams contain levels of certain pesticides that pose health risks when eaten over a long period of time.

Individuals should limit the amount of lakefish, strip, cat, and bluegill caught (and/or greater than 22 inches in length). But they need to eat more than four meals a month.

The warning applies to ALL waters in the Mississippi portion of Delta but not the Arkansas-Mississippi River border or the west and the Gulf of Mexico to the east.

The state warning applies to freshwater fish, but not OCEANIC fish caught by you (shellfish is not safe). www.dnr.ms.gov for more.

The amount of fish you'll consume is in fish in the area. Don't eat freshwater fish in the Mississippi watershed and eating those fish that are safe to eat.

Eating fish with high levels of DDT and heptachlor over an extended period of time may increase the risk of cancer.

Many important fish are including bass, brown, largemouth bass, and smallmouth bass. But they're not safe to eat.

Consumption of fish is not safe.



MISSISSIPPI DEPARTMENT OF
ENVIRONMENTAL QUALITY

FOR INFORMATION OF
ENVIRONMENTAL CLARITY

For Information Call
1-888-786-0061



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Printed Materials

- Created and printer posters
 - English
 - Spanish



DELTA FISH ADVISORY

DO NOT EAT ANY BUFFALO FISH FROM ROEBUCK LAKE

DO NOT EAT MORE THAN TWO MEALS PER MONTH OF THESE FISH

NO LIMIT ON THESE FISH

MISSISSIPPI DEPARTMENT OF ENVIRONMENTAL QUALITY

For more information call toll free - 1-888-785-0661

Printed Materials

- Created and printer posters
 - English
 - Spanish



RECOMENDACIONES PARA LOS PECES DEL DELTA
(Ver la lista de peces con sus correspondientes nombres que se ven más arriba.)

No como ningún pez búfalo del Lago Reubuck.

No como más de dos comidos por mes de los peces cuyos alifonnes se ven más arriba.

Está bien comer estos peces. Se pueden comer sin límite.

El Departamento de Calidad Ambiental del Estado de Misipi
Si necesita más información, puede llamar al cargo al 1-800-795-0061

Churches

- 1,400 Delta Churches
- Mailed Letters
 - Announcement from pulpit
 - Need assistance
 - Poster
 - Flier



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Mississippi Delta Case Study: Risk Communication – Linda Vaught

Churches

July 17, 2001

Dear Pastor:

The Mississippi Department of Environmental Quality (MDEQ) has recently issued a **fish consumption advisory** for several species of fish in most of the Mississippi Delta. We know that you are a vital link to the citizens of your area, and **we ask for your assistance in getting out** important information that may help protect the health of your congregation.



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Churches

Pastor: Please read the following information to your congregation:

The Mississippi Department of Environmental Quality (MDEQ) has issued a fish consumption advisory for several species of fish in most of the Mississippi Delta.



MDEQ

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Another Reminder

- Another press release- August 2001

MDEQ CONTINUES OUTREACH ABOUT DELTA FISH CONSUMPTION ADVISORY

JACKSON, MS., August 8, 2001 – The Mississippi Department of Environmental Quality (MDEQ) continues to try to reach the fishing public about the fish advisory for fish caught in all Mississippi Delta waters from the Mississippi River levee on the west to the bluff hills on the east. After announcing this advisory on July 26, 2001, the Department has been doing a number of things to reach the entire fishing public with the advisory information.



More Letters

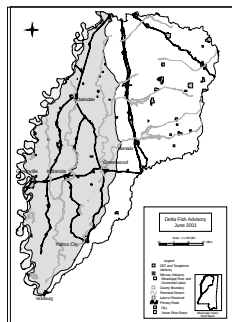
- 600 Commercial Fishermen
 - Map
 - Letter



MDEQ

More Letters

- 600 Commercial Fishermen
 - Map
 - Letter



MDEQ

More Letters

October 4, 2001

Dear Mississippi Commercial Fishing License Holder:

I am writing to inform you about an issue that is important to us at the Department of Environmental Quality (DEQ), and to ask your help in passing this information on to your customers.



MDEQ

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Mississippi Delta Case Study: Risk Communication – Linda Vaught

And More Letters

- 400 Fish Markets
 - Letter
 - Map
 - MS Dept. of Agriculture and Commerce



MDEQ

And More Letters

February 7, 2002

Dear Delta Area Fish/Seafood Market Manager:

I am writing to discuss with you a matter that is of special concern to us at the Mississippi Department of Environmental Quality (MDEQ) regarding the protection of our fellow citizens and their environment. We need and ask your help in passing this information on to your customers.



MDEQ

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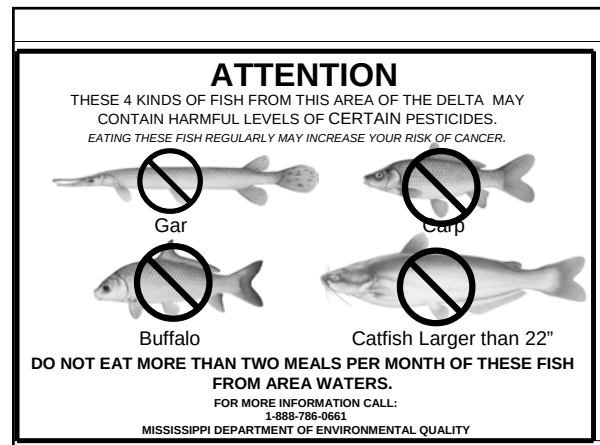
Signs Posted at Delta Lakes

- MDEQ developed and printed signs
- Media interested in signage



MDEQ

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MDEQ

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Signs Posted at Delta Lakes

- MDWFP placed signs
 - Boat ramps
 - Fishing areas



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Mississippi Delta Case Study: Risk Communication – Linda Vaught

Signs Posted at Delta Lakes

- MDWFP placed signs
 - Boat ramps
 - Fishing areas



MDEQ

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Tell Them Again

- Another press release- March 2002

MDEQ REMINDS DELTA ABOUT FISH CONSUMPTION ADVISORY

JACKSON, MS., March 28, 2002 – With spring in the air and fishing on the minds of many Delta residents, the Mississippi Department of Environmental Quality (MDEQ) is reminding Delta residents that the Delta fish-consumption advisory issued in June 2001 is still in effect.



MDEQ

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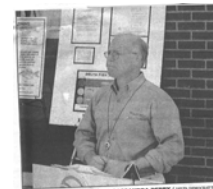
Church Press Conference

- Press Conference
 - St. Peter's Baptist Church
 - Leland, MS
- 2nd Letter - Churches
- Present
 - Task Force
 - Pastor
 - Media



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KASSANDRA PERIN / Delta News Service
Phil Ross, of Mississippi Department of Environmental Quality, speaks to the media about the Delta Fish Advisory.

FISH: Fishing at Deer Creek

FROM A1
...stated Delta fish...
...was fishing on Deer Creek...
...I hadn't heard anything this year...
...Floyd Moore of Greenville, who was fishing on Deer Creek...
...Cassandra Perin can be reached at (601) 477-1111 or at cperin@delta.com.

Deltans reminded about fish advisory

BY KASSANDRA PERIN
The Mississippi Department of Environmental Quality, with spring in the air and fishing on the minds of many Delta residents, the Mississippi Department of Environmental Quality (MDEQ) is reminding Delta residents that the Delta fish-consumption advisory issued in June 2001 is still in effect.



MDEQ

Delta Heath Care

- Wrote letters to Delta health care providers
- Provided for distribution
 - Fliers
 - Posters



MDEQ

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Delta Heath Care

July 12, 2002

Dear Delta County Health Professional,

We at the Mississippi Department of Environmental Quality (MDEQ) and the Mississippi Department of Health (MSDH) are asking your help in informing your customers and clients about an important health issue in your area. Last summer, MDEQ along with MSDH issued a regional fish advisory for the Delta.



MDEQ

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Mississippi Delta Case Study: Risk Communication – Linda Vaught

Delta Health Care

- Press conference - Delta health office
- Announced health care distribution
 - Fliers
 - Posters
- Announced Spanish version
- Announced coloring book

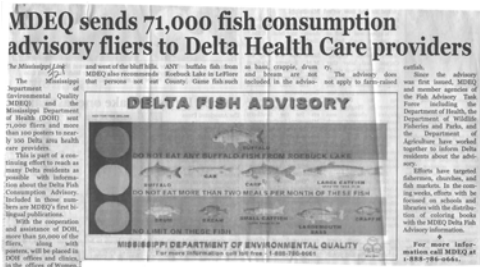


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Wildlife Expositions

- Attended wildlife expositions



MDEQ

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Wildlife Expositions

- Attended wildlife expositions



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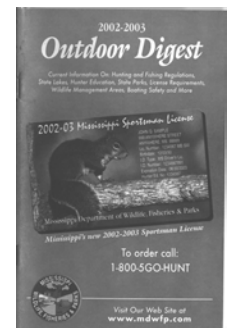
47

Outdoor Digest

- MDWFP
 - Outdoor Digest



MDEQ



Mississippi Delta Case Study: Risk Communication – Linda Vaught

Outdoor Digest

- MDWFP
– Outdoor Digest



additional guidance and Trout/Bass Fishing rules can be found in the Delta Fishing Digest, which is available at all Delta fishing sites.

Fish Time Advisory & Commercial Fishing Rules

Fish Species	Season	Time	Limit	Notes
Striped Bass	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
White Bass	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Crappie	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Bluegill	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Yellow Perch	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Channel Catfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Flathead Catfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Walleye	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Rock Bass	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Shiner	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Golden Shiner	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
White Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Blue Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Red Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Green Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Black Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
White Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Blue Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Red Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Green Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat
Black Crayfish	April - May	6:00 AM - 6:00 PM	10 per angler	10 per boat

MDEQ

Delta Health Fairs

- Participated in two Delta health fairs



MDEQ

50

Coloring Book

- Distributed 17,000 Copies in Mississippi Delta
- Schools -3rd Grade
- Libraries
- Health Offices



MDEQ

51

An MDEQ Guide to Safe Fishing in the Mississippi Delta

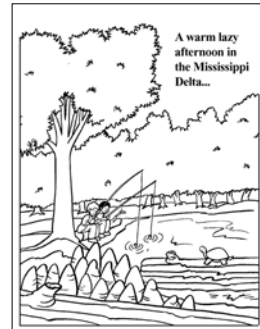


Whyee
The MDEQ Fishing Answer Worm



MDEQ

52



53

Coloring Book

- Good Media Coverage

Coloring books at local library warn Delta kids about toxic fish

The staff of Mississippi is warning youngsters of the danger of some pesticide-treated fish in Delta waters with the distribution of new coloring books in schools and libraries.

In August, the state expanded a program to warn anglers about the fish in more than 71,000 Delta fishing sites. The consumption advisory program began last year with the posting of signs at boat ramps and fishing locations in the Delta.

The consumption advisory states that bottom-feeding fish, such as catfish, carp and gar, as well as any catfish more than 22 inches long, should not be eaten more than twice a month. If caught in Delta lakes, it also suggests that no one eat any catfish from the Delta Lake in Leavelle County.

Pesticides DOT and Toxaphene have both been found in Delta waters. They still persist in sediments and lake bottom in the heavily agricultural Delta.

According to Phil Bass, director of Department of Environmental Quality's Office of Pollution Control, the Fish in the Delta coloring book will go out this week to more than 45 libraries and 80 schools throughout the Delta.

Bass said the coloring book was created to teach children about which fish are and are not included in the advisory, how pollution affects fish, pollution control and fishing.

Coloring books warn Delta kids about toxic fish

JACKSON, Miss. — The state of Mississippi is warning youngsters of the danger of some pesticide-treated fish in Delta waters with the distribution of new coloring books in schools and libraries.

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For More Information

- Linda Vaught
- Communications Director
- Miss. Dept. of Environmental Quality
- 601.961.5053
- Linda_Vaught@deq.state.ms.us
- www.deq.state.ms.us



MDEQ

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Risk Communication for Medical Practitioners – Steve Blackwell

Risk Communication for Medical Practitioners

*Stephen Blackwell, RS, MPH
Commander USPHS
Agency for Toxic Substances
and Disease Registry*

ATSDR



ATSDR



ATSDR

Medical Practitioners

- Physicians
- Nurses
- Midwives
- Physicians Assistances
- Nurse Practitioners
- Tribal Clinicians and Healers

ATSDR

Physicians

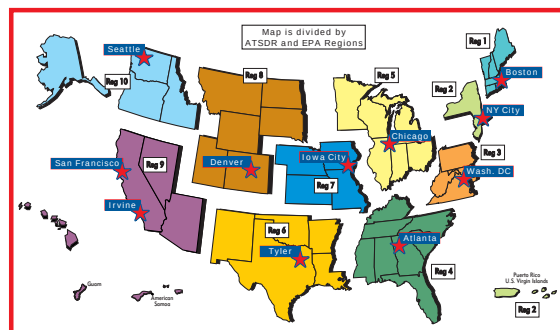
- OB/GYN
- Family Practice
- Pediatric
- Internal Medicine

ATSDR

Risk Communication for Medical Practitioners – Steve Blackwell



ATSDR



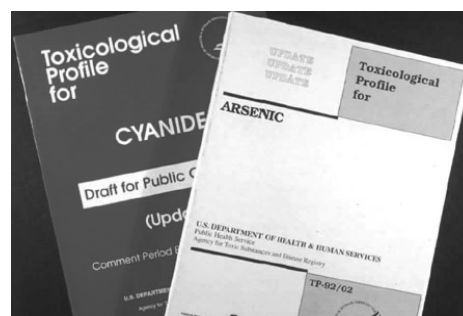
ATSDR

Types of Outreach to Medical Practitioners

- **Mass mailings**
- **Blast Faxes**
- **Grand rounds presentations**
- **Articles in medical journals**
- **Presentations and displays at conferences and meetings**
- **Targeting specific practitioners and visiting them in person**

ATSDR

Training Reference Materials



ATSDR

Case Studies in Environmental Medicine

[illegible]

ATSDR

Patient Education Materials



ATSDR

Patient Education Materials



ATSDR

Training Benefits

- Improve awareness of environmental hazards in general
- Improve quality of health care where hazardous substances in fish may threaten human health

ATSDR

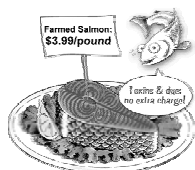
Thank You For Your Attention

Any Questions?

ATSDR

Contaminants in Farmed Salmon from Around the World – David Carpenter

CONTAMINANTS IN FARMED SALMON FROM AROUND THE WORLD



David O. Carpenter, MD
Institute for Health and the Environment
University at Albany
Rensselaer, NY 12144

Supported by the Environmental Division of the Pew Charitable Trust

SALMON



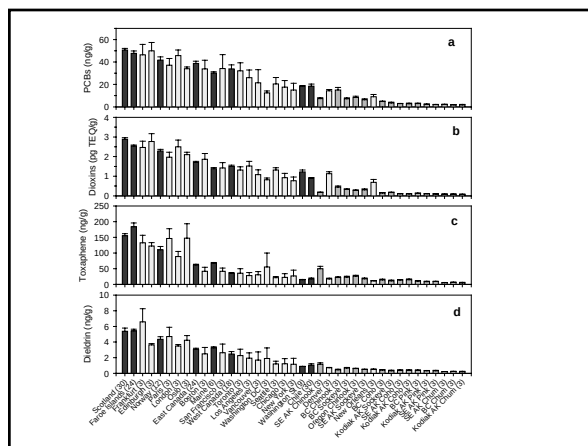
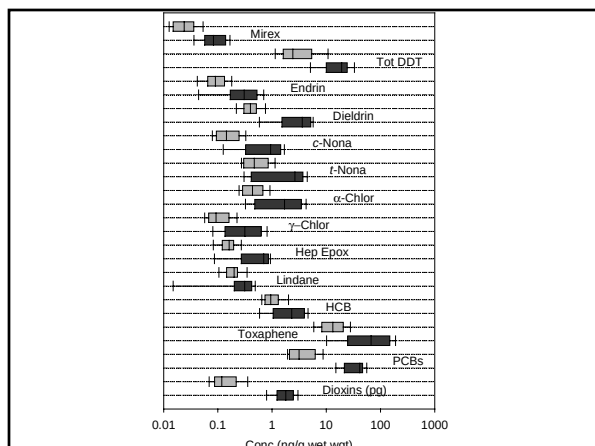
A very popular fish with high levels of omega-3 fatty acids, known to be beneficial in preventing sudden cardiac death. Farming of salmon has grown very rapidly, now at levels of over 1 million tons per year. Farmed salmon are relatively cheap and are available throughout the year.

Purpose of Our Study

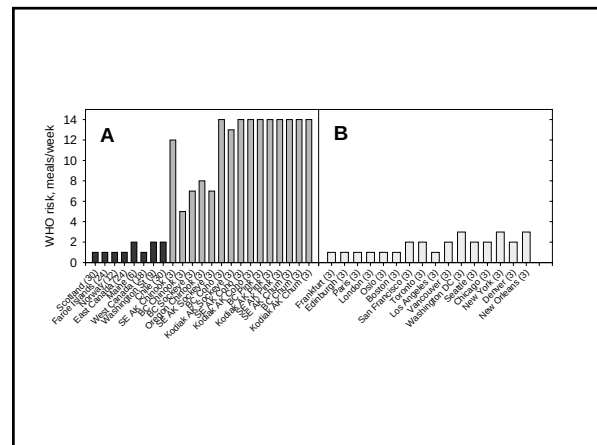
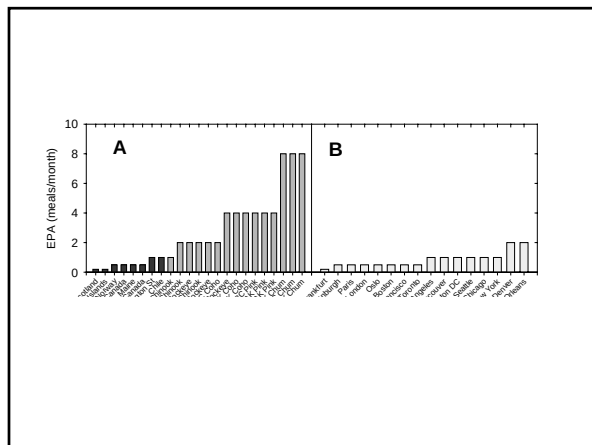
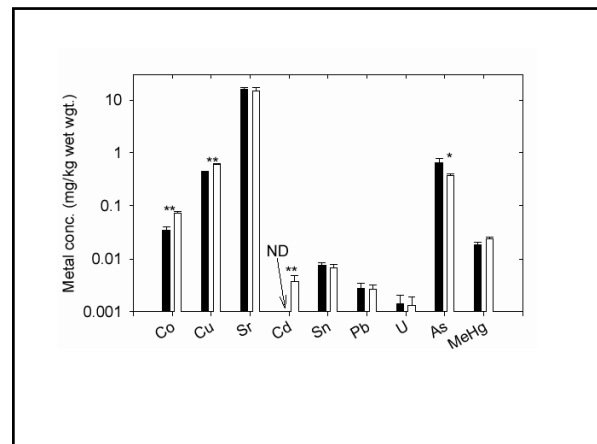
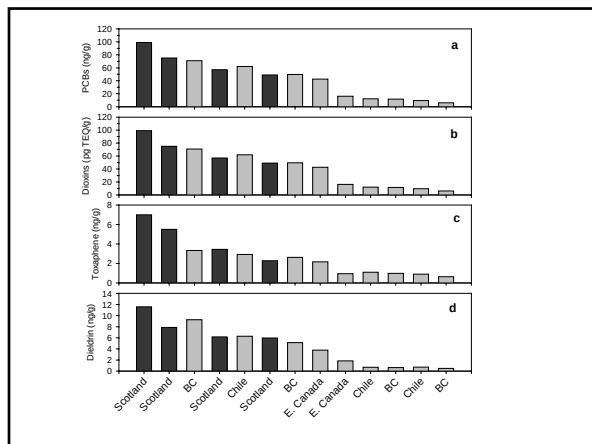
To analyze Atlantic salmon from farms in eight salmon-farming regions, Atlantic salmon fillets from supermarkets in 16 cities and wild Pacific salmon of five species for the presence of environmental organic and metal contaminants.



- We purchased 459 whole farmed salmon from 51 farms in eight farming regions in six countries (Scotland, Norway, Faroe Islands, Eastern Canada, Maine, Western Canada, Washington State, Chile).
- We purchased 135 wild Alaskan salmon, including chum, coho, chinook, pink and sockeye, from suppliers in Alaska and Western Canada.
- We purchased salmon fillets in supermarkets in 16 North American and European cities (Vancouver, Seattle, Los Angeles, San Francisco, Denver, Chicago, Toronto, New Orleans, Washington, D.C., New York, Boston, London, Edinburgh, Paris, Frankfurt, Oslo).
- Composites of three fish or three fillets (for a total of 246 samples) were analyzed for 14 organic contaminants, and nine metals.
- We purchased nine samples of farmed salmon feed from different parts of the world for analysis.



Contaminants in Farmed Salmon from Around the World – David Carpenter



The presence of contaminants may counteract the beneficial effects of omega-3 fatty acids:

- Omega-3 fatty acids are well documented to prevent cardiac arrhythmias, especially in persons who have had one heart attack. They do not protect against cancer. However, PCBs and dioxins cause an elevation of serum lipids, which is the greatest risk factor for a heart attack.
- Although less well established, there is some evidence that intake of omega-3 fatty acids during gestation increase cognitive function in children. But PCBs and dioxins are very well documented to cause deficits in IQ.
- Therefore, while eating uncontaminated salmon is healthy, eating contaminated salmon or any other fish is going to counteract the beneficial effects.

CONCLUSIONS

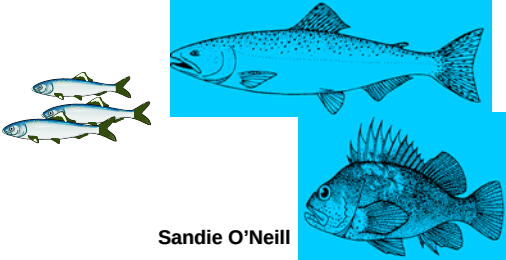
Farmed salmon have significantly greater levels of organochlorine compounds than do wild salmon, and the source appears to be the fish food. Farmed salmon from Northern Europe have significantly higher levels than those from Chile and Washington State.

Salmon are known to have relatively high amounts of omega-3 fatty acids, but the beneficial effects of omega-3 fatty acids on sudden cardiac death must be balanced against the increased risk of cancer from the contaminants.

Using EPA cancer risk assessment methods for PCBs, dieldrin and toxaphene and WHO dioxin TEQ methods for cancer risk assessment, farmed salmon from all regions studied elicited highly restrictive fish consumption advisories, while those for wild salmon are much less stringent. However, even this advisory does not consider other carcinogenic substances found to present, nor does it consider all non-cancer endpoints. Some of the non-cancer endpoints may be of greater importance from a public health perspectives.

Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet – Sandie O'Neill

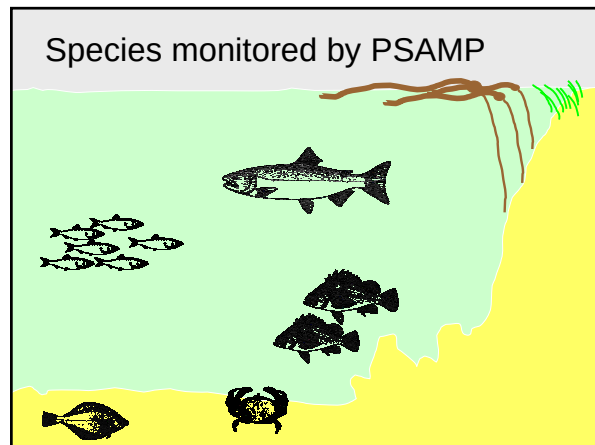
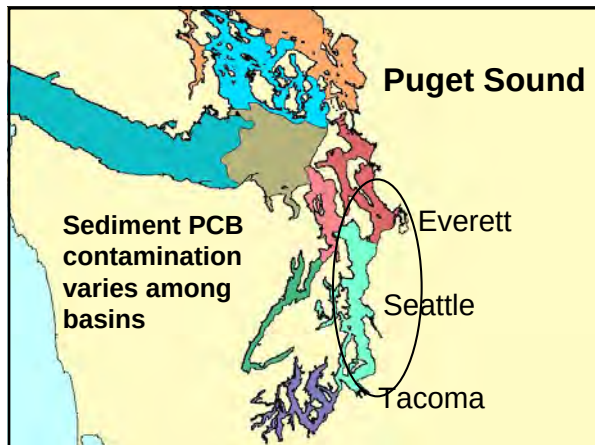
Factors Affecting Contaminants in Fishes
Habitat, Life History and Diet



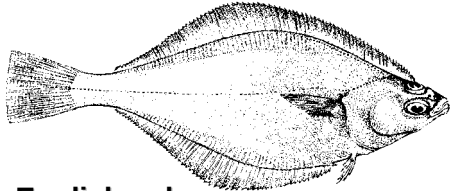
Sandie O'Neill
Washington Department of Fish & Wildlife
Puget Sound Ambient Monitoring Program

Factors Affecting Contaminant Exposure and Accumulation

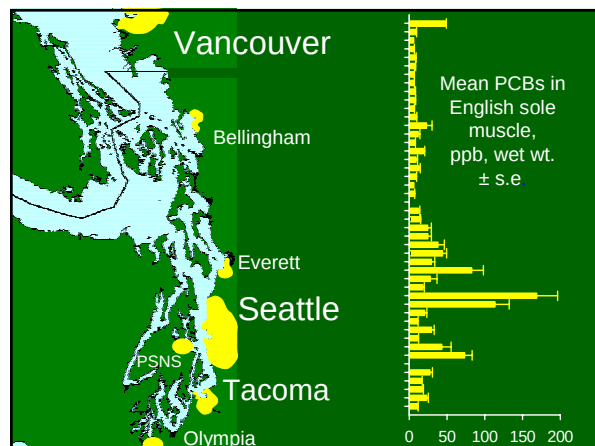
- proximity to contaminant sources
- habitat
- trophic level
- gender and age of fish
- lipid content of tissues



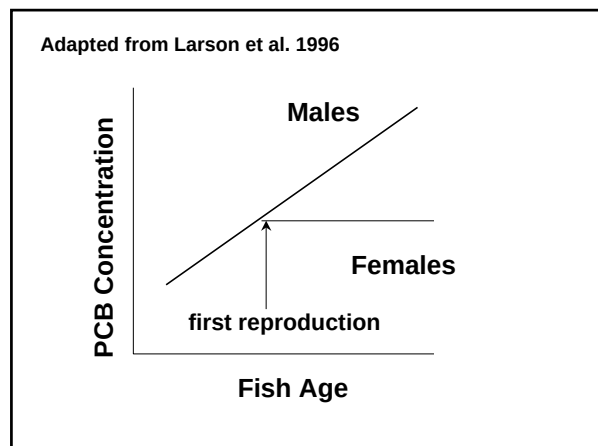
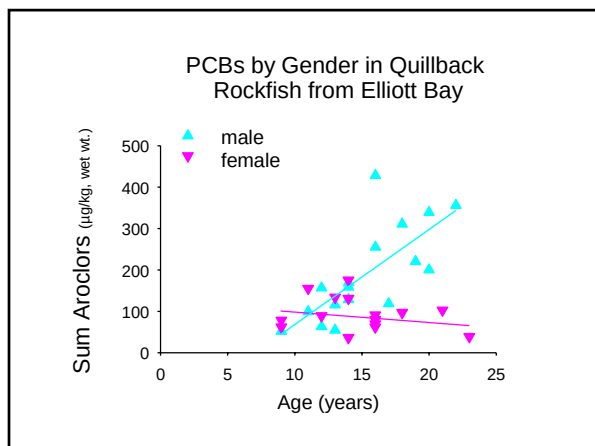
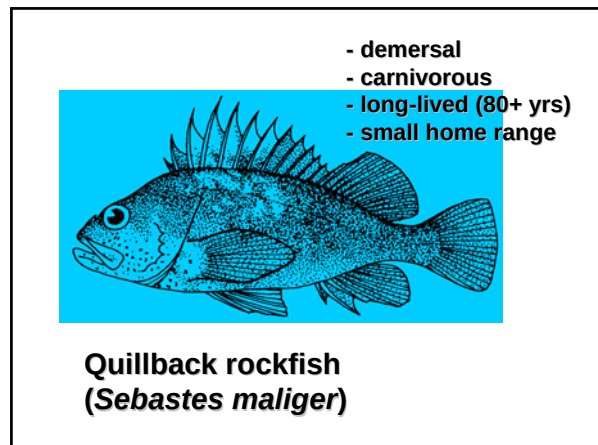
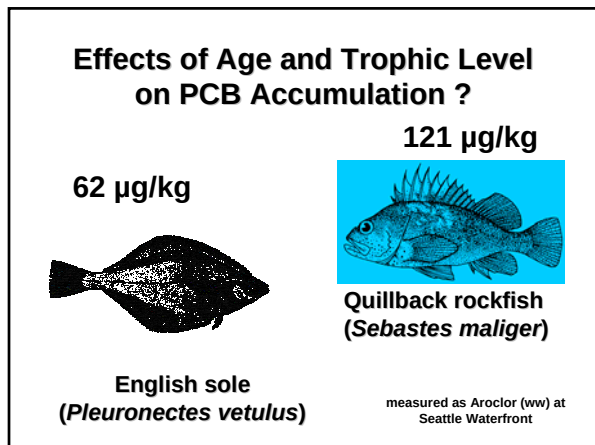
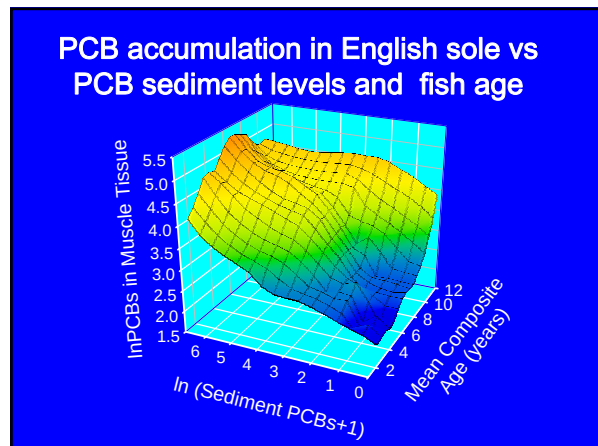
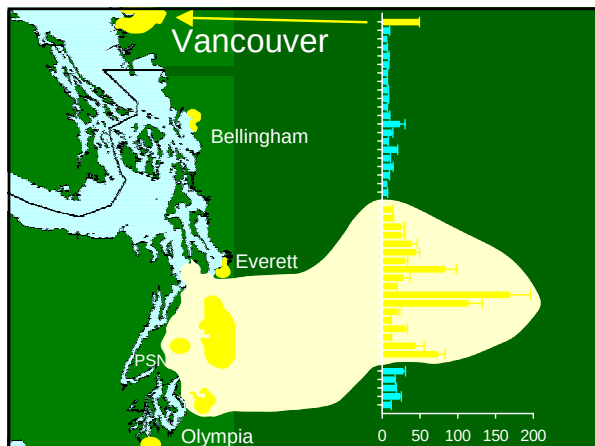
- bottom dwelling
- consumes benthic infauna
- moderate home range
- ubiquitous in Puget Sound (and west coast)



English sole
(Pleuronectes vetulus)



Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet – Sandie O'Neill

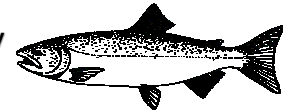


Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet – Sandie O'Neill

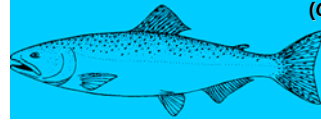
PCB Accumulation in Benthic and Demersal Fishes

- Correlated with sediment concentrations
 - highest correlation in fish with small home range
- Increase with trophic level (biomagnification)
- Bioaccumulation in long lived fish
 - possible male/female differences

- anadromous, wide-ranging, pelagic
- carnivorous
- high fat content
- complex life history

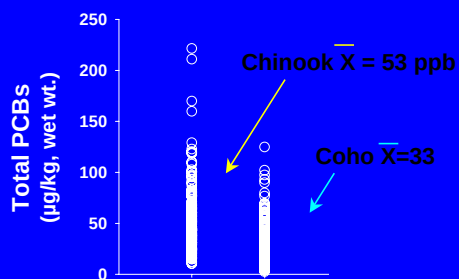


Coho salmon
(*Oncorhynchus kisutch*)



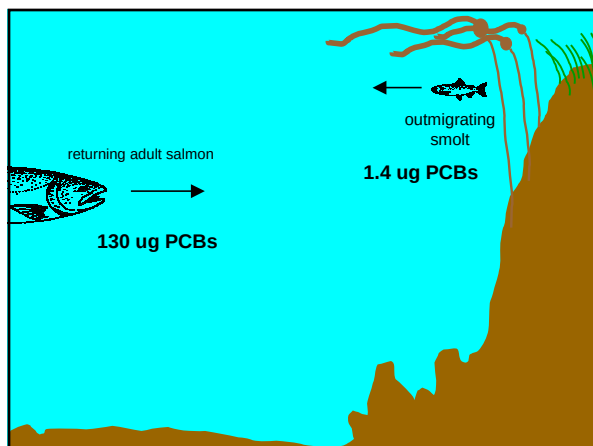
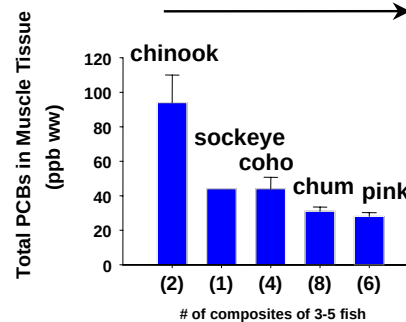
Chinook salmon
(*Oncorhynchus tshawytscha*)

PCBs in muscle of adult salmon returning to Puget Sound



PCBs in Pacific salmon from Alaska

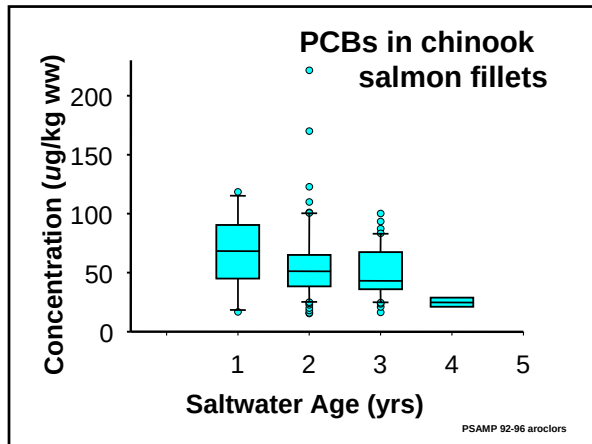
Decreasing Trophic Level
→



Mature male chinook salmon



Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet – Sandie O'Neill



**Does oceanic distribution affect
PCB levels in Pacific salmon
stocks in the Pacific Northwest?**

Contaminant analysis planned to assess geographic variation in PCB levels in Pacific salmon

Location	Species				
	Chinook	Sockeye	Pink	Chum	Coho
SE Alaska (mixed stocks)	★	★	★		★
N. BC coast (Skeena)	★			★	
C. BC coast (Kimsquit)	★	★			
Georgia Basin (Fraser)	★				
Puget Sound (mixed stocks)					★
Puget Sound (Skagit)			★		
Puget Sound (Nook/ Nisq)	★			★	
WA/OR coast (Columbia)	★				
CA coast (Sacramento)	★				

6-8 fish per composite

PCB Accumulation in Pacific Salmon

- Majority of PCBs are accumulated in marine waters including coastal areas & open ocean.
- Adult chinook /sockeye accumulate higher PCB concentrations than pink and chum.
- Species and stock-specific differences in life history traits such as saltwater age and marine distribution may influence PCB levels.

PCB Accumulation in Pelagic Fish

- Pelagic fish integrate PCBs over broad areas.
 - Need to know where fish (and their prey) feed
- Trophic level affects PCB accumulation
- Age/size may (or may not!) affect PCB accumulation
 - Depends if age/size classes feed in different areas
 - Depends if age/size classes eat at different trophic levels

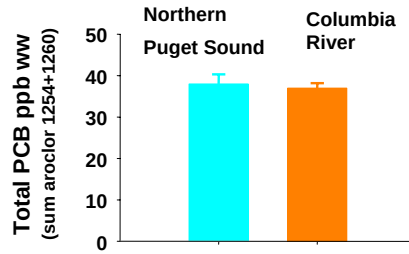
If you want to
 - design cost effective monitoring programs
 - communicate risk information



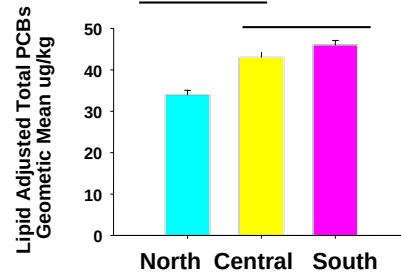
**Know your fish!
(or your local
fish biologist)**

Factors Affecting Contaminant Exposure in Fishes: Habitat, Life History, and Diet – Sandie O'Neill

**Geographic Variation in PCB Levels
in chinook salmon returning to spawn**



**Lipid Adjusted PCB for Chinook Salmon
Returning to Puget Sound Rivers**



Model Application for Monitoring Contaminants in Fish – Stephen Wenté

Model Application for Monitoring Contaminants in Fish: Mercury Pilot Project

Paul Hearn Stephen Wenté John Aguinaldo David Donato

Susan Price Seth Tanner Ovidio Rivero-Bartolomei



1

Samples Difficult to Compare

Species	Sampling Events						
	1	2	3	4	5	6	7
A	X	X		X			X
B		X	X		X		X
C	X		X	X		X	
D		X		X		X	
E	X		X			X	



2

Fish Hg Model Details

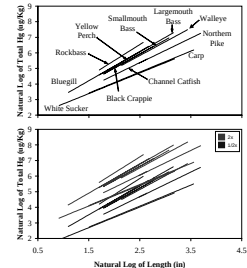
- Regression method (Covariance model)
- Accounts for:
 - Less than detection limit values
 - Differences between samples
 - Species (Hg increases with trophic position)
 - Tissues sampled (skin-off fillet > skin-on > whole)
 - Fish length (larger fish are higher in Hg)
- Calibrated to national dataset (35,130)



3

Fish Hg Model (log-log space)

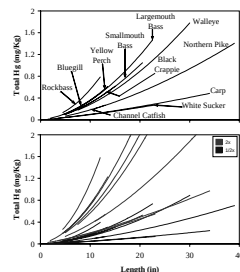
- Slopes – describe potential Hg accumulation rate for each sample type
- Intercepts – describe levels of bio-available Hg “before” each sampling event



4

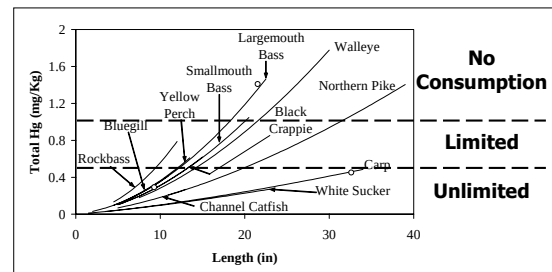
Fish Hg Model (arithmetic space)

- Slopes – become exponents describing curvature
- Intercepts – become multiplication factors
- Error – has a log-normal distribution



5

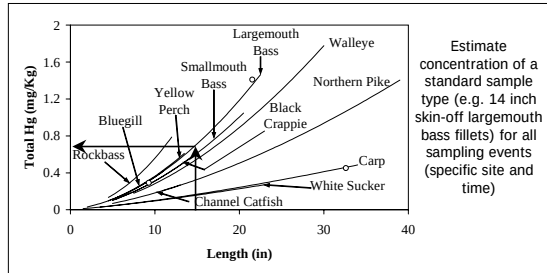
Consumption Advisory



6

Model Application for Monitoring Contaminants in Fish – Stephen Went

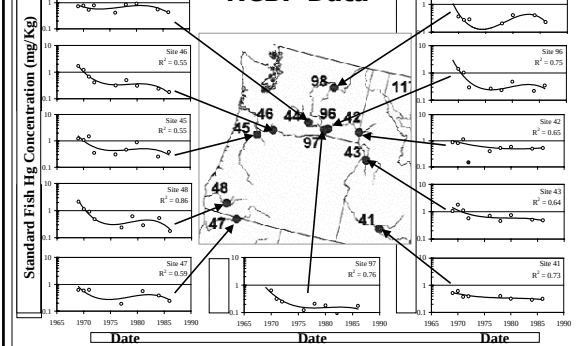
Standardize Sample Type



USGS NIEHS

7

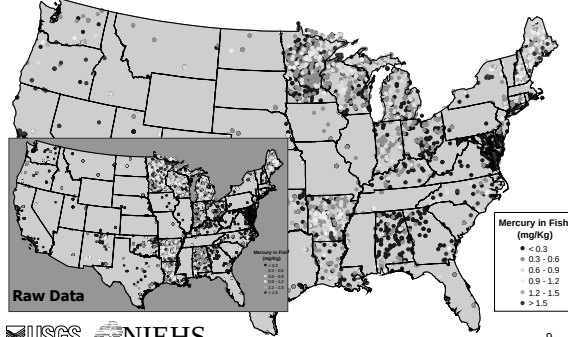
Northwestern US Fish Hg Trends: NCBP Data



USGS NIEHS

8

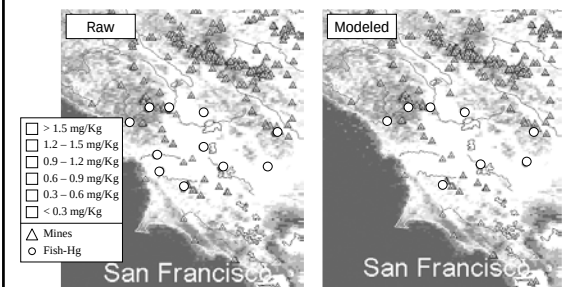
Modeled Spatial Variation (14 inch Largemouth Bass Skin-off Fillets)



USGS NIEHS

9

Modeled Data Can Show Spatial Trends Not Reflected in Raw Data

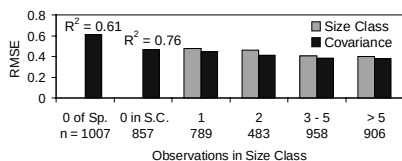


USGS NIEHS

10

Accuracy Assessment

- Calibrated to NLFWA data (n = 31,813)
- 5000 random jackknife predictions



Information quality & quantity is better

USGS NIEHS

11

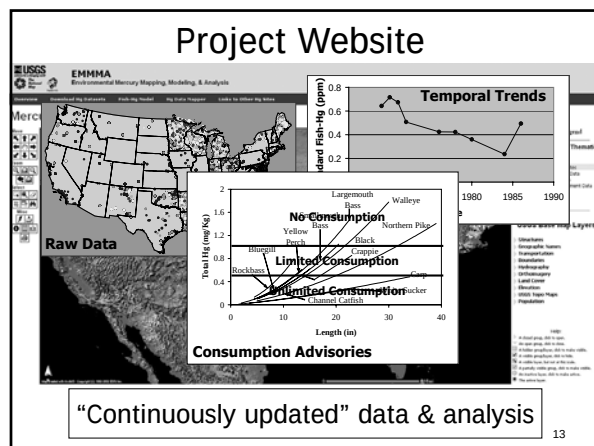
Analytical Cost Reduction

Species	5	
Size classes	3	
Sites	50	
Times	5	
Replicates	4	
Cost/Sample	\$100	
Size classes	\$1,500,000	*Sample types is number of species × size classes × tissue types
Covariance	\$100,000	

USGS NIEHS

12

Model Application for Monitoring Contaminants in Fish – Stephen Wente



How Can I Evaluate this Model?

- You voluntarily provide data
- ~~You apply model~~ We apply model and provide results on website
- You evaluate prediction quality (Do predictions make sense?)
- You decide if, and how much, results are used

Questions/Comments

Additional information:

- Website demonstration in poster area (sign-up to receive website address)
- Peer-reviewed publication in preparation
- Request presentation (via telephone) to your group (spwente@usgs.gov)

PBDEs – Rising Levels in Fish, Tox Review, and the California Ban – Tom McDonald

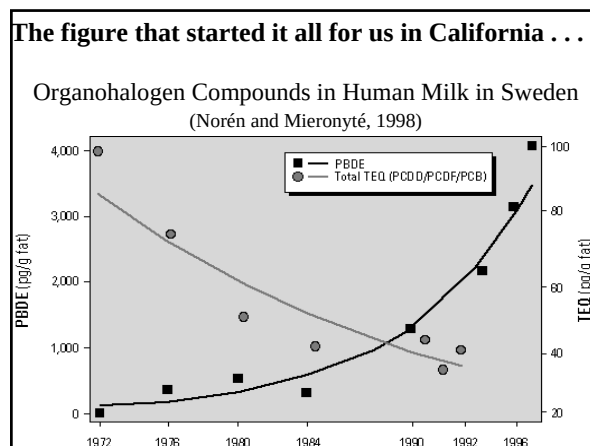
PBDEs – Rising Levels in Fish, Tox Review and the California Ban

U.S. EPA National Forum on Contaminants in Fish
San Diego, California
January 28, 2004

Tom A. McDonald, M.P.H., Ph.D.
OEHHA, California EPA
tmcdonal@oehha.ca.gov

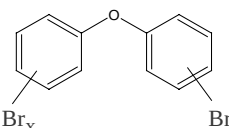


Office of Environmental Health Hazard Assessment



Introduction

The polybrominated dipenylethers (PBDEs)



- Added to many consumer products
- Flame retardant
- Saves lives



Office of Environmental Health Hazard Assessment

PBDE Use in the Americas

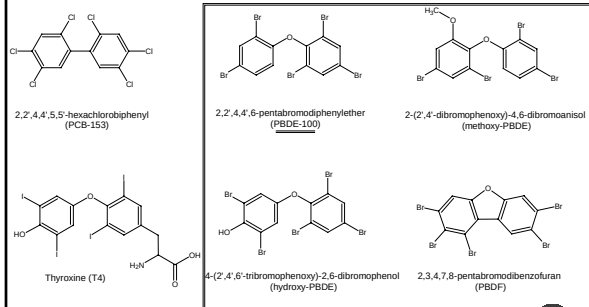
PBDE Technical Mixture	Million lbs/yr (2001)	% of World's Use	Product Uses
Penta-BDE†	15.7	95	Furniture (foam cushions)
Octa-BDE	3.3	40	Electronics (ABS plastic, cable)
Deca-BDE	54.0	44	Electronics (HIPS plastic) and textiles

† Highly bioaccumulative

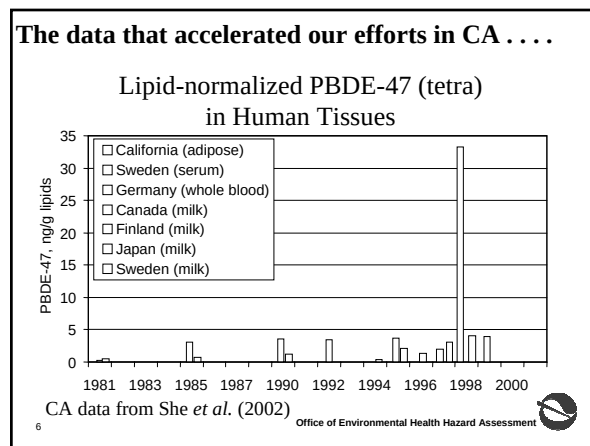
BSEF, 2003

Office of Environmental Health Hazard Assessment

Structural Similarity of PBDEs, Their Metabolites and Environmental Derivatives to T4 and PCBs



Office of Environmental Health Hazard Assessment



PBDEs Relate to Several Important Topics of the Day

- Children's Health
- Endocrine Disruption
- Persistent Organic Pollutants (POP)/ Persistent Bioaccumulative Toxicants (PBT)
- Emerging Environmental Challenge
- High Production Volume (HPV) Chemical

7

Office of Environmental Health Hazard Assessment



PBDEs Have Become Ubiquitous Environment Contaminants

PBDEs are measured in

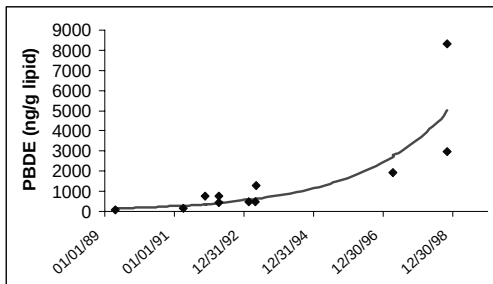
- Indoor and outdoor air
- Remote Arctic regions (i.e., long-range transport)
- House and office dust
- Rivers and lakes and sediments
- Sewage sludge
- Foods
- Biota (terrestrial and marine mammals, fish, humans)

8

Office of Environmental Health Hazard Assessment



Time-trend: PBDEs in Blubber of California Seals (She *et al.*, 2002)



N=11

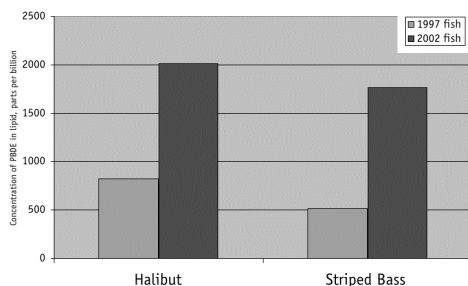
9

Office of Environmental Health Hazard Assessment



Fish from San Francisco Bay

PBDE levels in striped bass and halibut 1997 and 2002

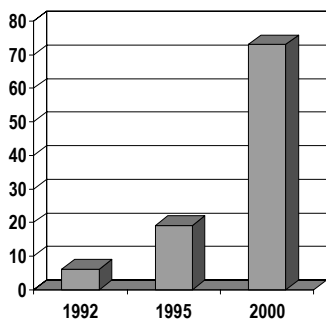


10 EWG (2003)

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PBDEs in Columbia River Whitefish



From Genelle, British Columbia

Sum PBDE (ng/g fresh weight)

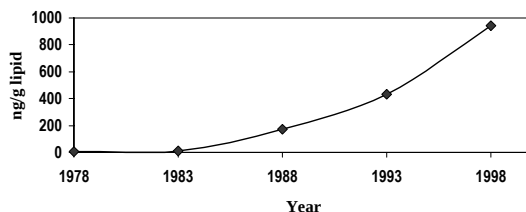
11

Rayne *et al.* (2003) Environ Sci Technol 37(13):2847-54.

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PBDEs in Lake Ontario Trout (1978 - 1998)

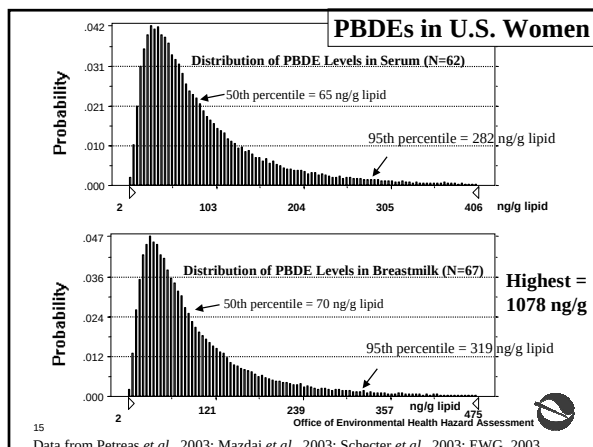
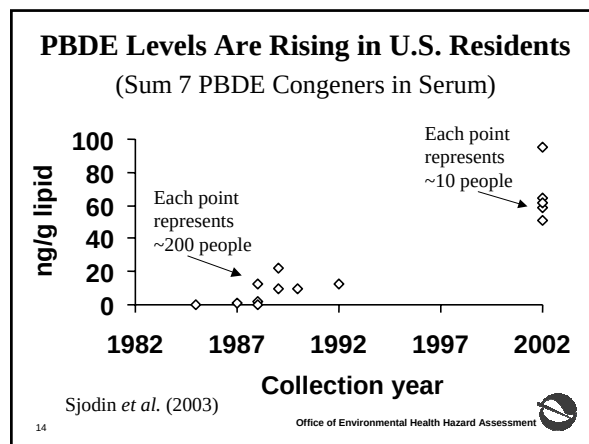
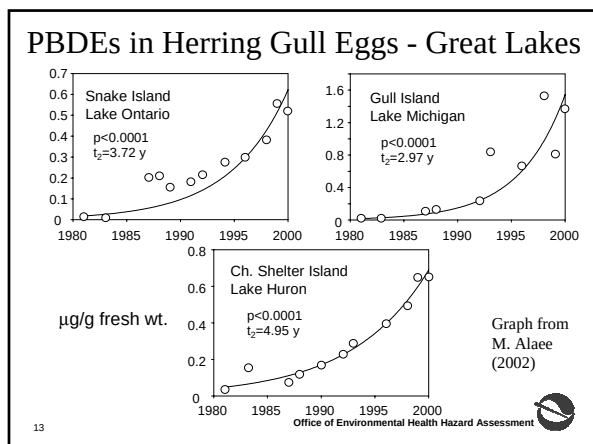


Luross *et al.* (2000)

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High-end Human Exposures

- 5% of people likely have lipid-normalized PBDE levels greater than 300 ng/g
 - That's about 15 million people in the U.S.
- **WHY?**
 - Fish intake?
 - Indoor exposures, house dust?
 - Differences in pharmacokinetics (i.e., inter-individual variability in uptake, metabolism or excretion)?
 - Look for future research to address this question

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For Many Individuals, PBDE Tissue Levels Have Now Surpassed PCB Levels

- Initial data from our agency indicate that among 57 California women :

7% had higher tissue concentrations of total PBDEs than total PCBs

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Toxicity Concerns for the PBDEs

- Endocrine disruption
 - Thyroid and estrogenic effects
- Developmental effects
 - Brain and reproductive organs
- Possibly cancer
 - NTP initiating long-term studies of Penta
 - Environmental conversion to dioxins/furans
 - Brominated dioxins/furans measured in people

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Thyroid Hormone Disruption

- Good evidence in rats and mice
- Some evidence in humans
- Relative potencies
penta-BDE > octa-BDE >>> deca-BDE
- Effects additive with co-exposures to PCBs
- Possible mechanisms
 - Hormone mimicry (transthyretin binding)
 - UDGP enzyme induction ($\uparrow$ T4 excretion)

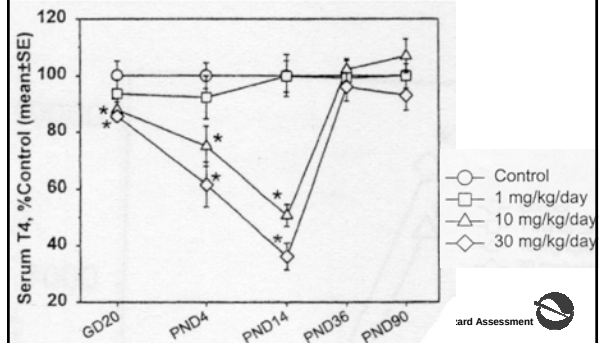
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Example: Thyroid Hormone Disruption

•Zhou et al. (2002): Penta-BDE (tech.) given to pregnant rats 0, 1, 10, 30 mg/kg-d from gestational day 6 through postnatal day 21



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Estrogenic Effects

- Postnatal exposure of rats to PBDE-99 altered expression of estrogen-regulated genes (Lichtensteiger *et al.*, 2003)
 - Prostate: androgen receptor, estrogen receptor ER- α and ER- β , insulin-like growth factor (IGF-I)
 - Brain: Progesterone receptor, ER- α
- *In vivo* estrogenic activity was not predicted from *in vitro* assays.
 - PBDE-99 low estrogenic activity in MCF-7 cells.

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Developmental Toxicity

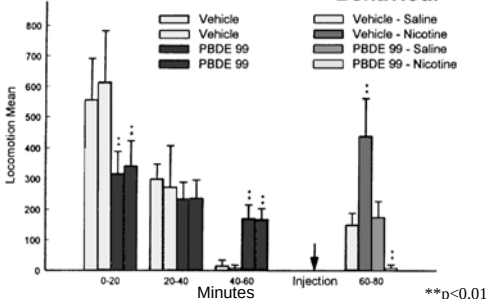
- Neurological system (3 independent laboratories)
 - Altered behavior, learning and memory in mice
 - Hearing loss in rats
 - Effects permanent, i.e., measured in adulthood
 - Effects additive with co-exposure of PBDE and PCB
- Male reproductive system (2 labs):
 - Delayed puberty
 - Increased ventral prostate and seminal vesicle weights
- Female reproductive system (3 labs):
 - Delayed puberty
 - Alterations to ovary cell structure

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Spontaneous Behaviour Nicotine Induced Behaviour



Effects, measured in adulthood, worsen with age. Same pattern seen with many neurotoxic PCBs. Viberg *et al.*, 2000

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Risk:

Compare High-end Human Levels to Tissue Levels in PBDE-treated Rodents

- Estimates of rodent body burdens of PBDE resulting from doses that caused these effects are equivalent to total PBDE levels attained in humans.

– If humans are as sensitive as animals, then there is:

“No margin of safety.”

Science News (2003) 164:266-8.

– Better data are needed to compare tissue concentrations between rodents and humans.

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Risk (continued)

- **An even greater concern: PBDEs and PCBs may be working together.**
 - PCB levels are usually higher than PBDEs
 - Same effects on some mechanistic endpoints
 - Co-administration of PCB and PBDE caused additive effects with respect to:
 - **behavior alterations in mice**
 - **thyroid hormone disruption**
 - PBDEs/PCB co-exposures further increases the likelihood that exposure will result in health effects.

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Penta- and Octa-BDE are Now Banned Chemicals



- **Banned in California starting 2008**
 - AB302 (Chan et al.), signed into law in August.
- **U.S. manufacturer announced it will voluntarily cease production by end of 2004**
- **Banned by the European Union starting 2005**
- **Already voluntarily phased out in Japan**



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Text of California Ban (AB302)

“On and after January 1, 2008, a person may not manufacture, process, or distribute in commerce a product, or a flame-retarded part of a product, containing more than one-tenth of 1 percent of pentaBDE or octaBDE, by mass.”

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Summary

- **PBDEs in consumer products are escaping into the environment – now everywhere**
- **PBDE levels rising rapidly in fish, other wildlife and people in North America**
- **Some folks have much higher levels than most for reasons unknown.**
 - Levels similar to levels associated with health effects
- **Penta- and Octa-PBDE banned in CA and the EU; not used in Japan.**
 - Renewed concern over Deca (new data on debromination by UV and biota)

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Dioxin – Rita Schoeny

Dioxin: EPA Update

Rita Schoeny
Office of Water
January 2004

Recent History

- ☑ Science Advisory Board (SAB) review; May 1995
- ☑ Report received from the SAB; Fall 1995
- ☑ Major SAB comments -- revision and re-review of Chapter 8: Dose-Response(D/R)Modeling and Risk Characterization; add TEF Chapter
- ☑ Internal, Inter-Agency, and External Review of D/R and TEF Chapter and revised Integrated Summary and Risk Characterization
- ☑ SAB re-review of revised D/R and TEF Chapter and Integrated Summary and Risk Characterization -- November 1 and 2, 2000
- ☑ SAB/Executive Committee review of Nov. meeting draft report and letter to Administrator -- May 31, 2001

Very Recent History

- ☑ Revisions to 2000 Draft and Inter-Agency (IWG) Review (2002/2003)
- ☑ IWG requests a review by the NAS to help ensure that the risk estimates contained in the draft reassessment (2003 version) are scientifically robust and that there is a clear delineation of all associated uncertainties (Oct. 29, 2003)

➔ Response to NAS, Finalization and Publication

SAB Report: May 31, 2001

- Compliments on careful and thorough review of the literature
- Suggested improvements
 - More focus on non-cancer effects
 - Increased emphasis on mode of action
 - More clarification of uncertainty

SAB Report: May 31, 2001 -- 2

- Lack of SAB consensus on several key issues
 - Cancer characterization – Carcinogen vs. Likely Carcinogen
 - Margin of Exposure and/or Reference Dose
 - Upper bound estimate of cancer risk
- Recommended Agency expeditiously move toward finalization of EPA's Dioxin Reassessment
- (www.epa.gov/science1/fiscal01.htm)

Major Issues Identified in SAB/Public Comments Addressed

- Sparse data for national means for sources/ pathways
- More info on dioxin-like PCBs in exposure document
- State of exposure model validation
- Trends in environmental levels/ body burdens
- TEFs/ TEQs
- Human data impact on hazard and risk characterization
- Significance of enzyme induction and other biochemical effects
- Relative roles of data, scientific inference, science policy

Dioxin – Rita Schoeny

EPA worked with other Federal agencies to reach conclusions

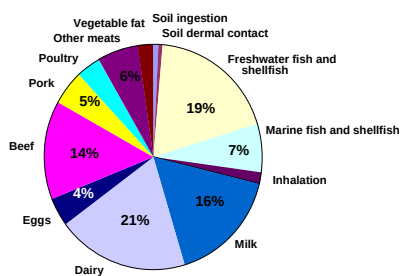
- NIEHS authors Chapter 8, "Dose / Response"
- NIEHS, NIOSH, DOD contributing authors (plus EPA and non-Federal scientists)
- NIOSH scientist published key cancer dose/ response analysis (2001)
- DHHS *Report on Carcinogens 2001*, TCDD listed as "Human Carcinogen"
- USDA, FDA collaborate on food survey design and data collection

Key Findings of the Reassessment Exposure Document -- 1

- Environmental levels have declined since the '70s
- Current US regulatory efforts have addressed most of the known large industrial sources
 - ~80% reduction between '87 and '95; further reductions anticipated)
- Open burning of household wastes is the biggest unaddressed contemporary source identified so far.
- There remain many uncharacterized sources that could be significant
 - e.g., burning, ceramics, forest fires, secondary steel, reservoir sources
- Exposure to general population has declined but currently averages ~1pg/kg/day

Adult Average Daily Intake of CDDs/CDFs/dioxin-like PCBs

2000 Draft Estimate: ~ 65 pg TEQ_{DFF}-WHO₉₈/day



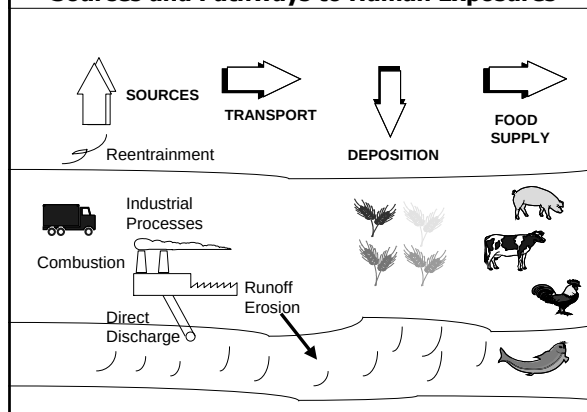
Key Findings of the Reassessment Exposure Document -- 2

- General Population Exposure is from animal fats in the commercial food supply
 - Local sources make little contribution to most peoples' exposure
 - Environmental levels in meat & dairy production are major contributor
- Air deposition onto plants consumed by domestic meat and dairy animals is the principal route for contamination of commercial food supply

Key Findings of the Reassessment Exposure Document -- 3

- Reservoir sources are a significant component of current exposure and may dominate future exposure
 - accounts for most coplanar PCB exposure
 - unknown contribution for Dibenzofurans
- Special populations may be more exposed but prevalence is not well substantiated
- See *Dioxins and Dioxin-like Compounds in the Food Supply: Strategies to Decrease Exposure*, IOM/NAS, July 2003

Sources and Pathways to Human Exposures



Dioxin – Rita Schoeny

Key Findings of the Reassessment *Health Document -- 1*

- Variety of noncancer effects in animals & humans
 - Developmental Toxicity
 - Immunotoxicity
 - Endocrine Effects
 - Chloracne
 - Others
- Toxic equivalents (TEQ) provide the best means for evaluating mixtures
 - Use WHO₉₈ TEFs
 - Include coplanar PCBs

Key Findings of the Reassessment *Health Document -- 2*

- Body burden is the best dose metric for estimating risk
- Environmental mixtures of dioxin-like compounds are likely to be carcinogenic to humans; 2,3,7,8-TCDD is carcinogenic to humans.

US, International Comparisons

	Body Burden L/NOAEL	Effect	Safety/ Unc. Factor	Guid.	Daily Intake (pg/kg/d)
WHO 1997	10-40 ng/kg	Several	10	TDI	1-4
ATSDR 1999	32* ng/kg	Neuro-Devel.	90	MRL	1
JECFA 2001	13/25 ng/kg	Devel.	3.2/9.6	TMI	2.3**

*Body burden from original publication; ATSDR used intake of 0.12 ng/kg/day

** Based on TMI = 70 pg/kg

Comparison with EPA

- Similarities
 - Focus on lowest adverse effects
 - Use body burden as dose metric (expect ATSDR)
 - Suggest additional decrease in intake is necessary
- Differences
 - Assume cancer will be insignificant at guidance
 - Use safety/ uncertainty factor (between 3.2 to 90) for LOAEL, pharmacodynamics, human variability
 - Safety assessment vs. a MOE / quantitative risk assessment

Key Findings of the Reassessment *Risk Characterization -- 1*

- Cancer slope factor
 - Based primarily on recently published analyses of human data
 - Revised upward by factor ~ 6 from 1985 value (based on 1978 rat study)
- Cancer risk to general population from background (dietary) exposure
 - May exceed 10-3 (1 in 1000)
 - Likely to be less and even zero for some individuals

Key Findings of the Reassessment *Risk Characterization -- 2*

- Non-cancer effects observed in animals and humans at levels within 10X background
- Likely that part of the general population is at or near exposure levels where adverse effects can be anticipated.

Dioxin – Rita Schoeny

Summary

- Dioxin science has evolved rapidly; more data lead to better understanding ... and more questions
- Expanded human data on cancer reinforce our previous concern for the potential for human health impacts.
- Identification of non-cancer effects in animals and human are sufficient to generate a similar level of concern
- Environmental levels and human exposure are declining but are still at a level of concern
- Current source characterization is complex with uncontrolled burning and reservoir sources potentially playing a significant role.

Further Questions?

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Arsenic: Speciation and Hazard – Charles Abernathy

Bioaccumulation of Arsenic (As) in Fish & Toxicity of As Species

Charles O. Abernathy
HECD/OST
US EPA
Washington, DC

Topics

- Methodology
- As Levels in Aquatic Organisms
- Available Data on Freshwater Species
- Uncertainties
 - As Speciation
 - Toxicities
- Summary

Methodology for Deriving AWQC

- 1980
 - BCF (water exposure only) used to estimate bioaccumulation
- 2000*
 - For inorganics & organometallics that do not biomagnify – use Procedure 5
 - Field BAFs & Laboratory BCFs are considered equally
 - $BAF = C_t / C_w$

*see Methodology for Deriving AWQC for the Protection of Human Health (2000) for details on BAF framework

Does As Bioaccumulate in Fish?

- Yes, but BAFs are small relative to many other organic & organometallic PBTs (e.g., PCBs, methyl-Hg)
- BAFs for tissues of upper trophic level freshwater & marine organisms range from ~ 5 to 5000 L/kg
- As does not appear to biomagnify (increasing concentration with increasing trophic level); BAFs for $TL2 \geq TL3 \geq TL4$

As BAF Measurements in Freshwater Organisms

Trophic Level	Species Mean BAFs - Range (n)	
	Lentic	Lotic
2	10 to 19,000 (43)	7 to 3,800 (7)
3	4 to 95 (18)	2 to 1,000 (20)
4	45 to 46 (1)	6 to 270 (2)

Chemical Species of As

- Inorganic
 - Arsenite (+3)
 - Arsenate (+5)
- Organic
 - Arsenobetaine
 - Monomethyl Arsinic Acid (MMA, MSMA)
 - Dimethylarsonic Acid (DMA, Cacodylic Acid)
 - Arsenocholine
 - Arsenosugars
 - Arsenolipids

Arsenic: Speciation and Hazard – Charles Abernathy

As Speciation Data for TL3 & 4 Fish

Species	Exposure Type	Inorganic	As (+3)	As (+5)	Organic
Minnow	Field	NM	-	-	0.97
Sweet Fish	Field	NM	-	-	0.88
Salmon	Field	NM	-	-	0.99

As Speciation Data for TL3 & TL4 Fish

Species	Exposure Type	Fraction of Total Arsenic			
		Inorganic	As (+3)	As (+5)	Organic
	Lab-Water				
Tilapia	(+3)	0.39	0.25	0.14	0.50
	(+5)	0.72	0.36	0.36	0.25
	MMA	0.71	0.40	0.31	0.27
	DMA	-	-	-	0.94
	Lab-Diet				
Tilapia	(+3)	0.97	0.41	0.56	0.023
	(+3)	0.85	0.41	0.44	0.037
Medaka	(+3)	1.00	0.26	0.74	0.0
Guppy	(+3)	0.15	-	-	0.84

Uncertainties

- Most speciation data for marine organisms
- As speciation:
 - 85 to $\geq$ 90% organic As in marine organisms
 - As species reported in freshwater organisms varies widely
 - Toxicity of As species varies greatly

Acute Toxicity of As Species

<u>Species</u>	<u>LD₅₀ (mg/kg)</u>
• <u>Inorganic</u>	
Arsenite (+3)	15 to 42*
Arsenate (+5)	20 to 200
• <u>Organic</u>	
MMA	700 to 1800
MMA (+3; i.p.)	~30
DMA	1,200 to 2,600
Arsenocholine	6,500
Arsenobetaine	$\geq$ 10,000

Additional Toxicological Considerations

- Toxic Moieties
 - Inorganic As (+3 & +5)
 - MMA & DMA (+3 & +5)
 - +5 reduced to +3 (more toxic form)
- However, As Species and Valence States are not usually determined

Additional Toxicological Considerations

- Arsenobetaine
 - Metabolically inert (99% excreted as parent)
 - Not cytotoxic
 - No mutagenic activity
- Arsenocholine
 - Mostly metabolized to Arsenobetaine
- Arsenicals do not concentrate in human milk
- Seafood ingestion does not increase Inorganic As exposure

Arsenic: Speciation and Hazard – Charles Abernathy

Summary - Bioaccumulation

- As bioaccumulates in aquatic organisms, but BAFs are generally small relative to other Persistent, Bioaccumulative Toxicants (e.g., PCBs, methylmercury)
- As does not appear to biomagnify (BAFs TL2 $\geq$ TL3 $\geq$ TL4)

Summary - Speciation

- Limited data indicate that both inorganic and organic As are present in freshwater organisms
- Chemical Speciation Data in Freshwater Fish is Variable
 - Lab data indicate higher % of inorganic As
 - Field data indicate higher % of organic As

Summary - Toxicity

- Valence State (+3 vs. +5) greatly affects toxicity of As
- Arsenobetaine & Arsenocholine have relatively low toxicity

Data Needs

- Data to Derive Freshwater BAFs
 - Total [As] in Water
 - Total [As] in freshwater organism tissues
 - [As Species] in freshwater organism tissues
- Are there real differences in the inorganic/organic As ratios following field vs. laboratory exposures?
- EPA would appreciate receiving any/all data you may have

Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms
(EPA-822-R-03-032)
December 2003

- www.epa.gov/waterscience/criteria/arsenic/tech-sum-bioacc.pdf
- Compilation of data available in the literature (and calculated Species Mean BAFs) for consideration in developing or revising Water Quality Standards
 - Use aquatic species BAFs appropriate for Regional, State or Tribal consumption patterns.
- Does not provide National BAFs

- Dr. Tala Henry
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- Dr. Charles Abernathy
Phone: 202-566-1084
Email: abernathy.charles@epa.gov

- EPA's *Technical Summary of Information Available on the Bioaccumulation of Arsenic in Aquatic Organisms* (EPA-822-R-03-032)
www.epa.gov/waterscience/criteria/arsenic/tech-sum-bioacc.pdf

Appendix F: Poster Abstracts

Appendix F: Poster Abstracts

An Interactive Database of Mercury in the Fishery Resources of the Gulf of Mexico

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Mercury finds its way into aquatic ecosystems in a variety of ways. Atmospheric deposition is one major pathway. Not only does mercury in the atmosphere cross political and jurisdictional boundaries, but migratory pelagic predator fish also do. After a preliminary assessment indicated that mercury was a widespread contaminant in edible tissue of fish taken from the Gulf, the Gulf of Mexico Program Management Committee directed the Program Office to conduct an analysis of the occurrence of mercury in the fishery resources of the Gulf of Mexico. A steering committee consisting of persons with knowledge of environmental mercury analysis from state health and environmental agencies of the five states surrounding the Gulf of Mexico, USEPA, U.S. Food and Drug Administration (FDA), and the National Oceanic and Atmospheric Administration (NOAA) was formed to oversee the project. Emphasis was placed on data collected during and after 1990 as the steering committee concluded that analytical methods had been improved and standardized sufficiently that the results from the various laboratories were comparable. Tissue monitoring data sets from Florida, Alabama, Mississippi, Louisiana, and Texas state monitoring programs; the USEPA's EMAP; NOAA's Mussel Watch Program; and the National Marine Fisheries Service's GulfChem Study were acquired. These data sets were aggregated into a regional database, which is available over the Internet with data mapper software that allows the user to query the database, produce maps of the query results, and zoom in on specific estuaries. The database was updated in September 2003 and contains almost 27,000 records. The database can also be downloaded in its entirety for use on a local computer.

California Water Quality and Fish Contamination Project

Maura Mack

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Environmental Health Investigations Branch

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The poster illustrates the California Water Quality and Fish Contamination Project, a statewide strategic planning initiative to protect natural resources and public health. Given California's numerous and dispersed waterbodies, its large and diverse population, and the complexity of its fish contamination problems, a coordinated, multiagency, multidisciplinary approach that actively engages stakeholders representing impacted communities is essential to protect the state's water resources and public health. The California Policy Research Center of the University of California, the Environmental Health Investigations Branch of the California Department Health Services, and the Office of Environmental Health Hazard Assessment of the California Environmental Protection Agency initiated the project in 2003. The project involves coordination of relevant federal, tribal, state, and local agencies with key private sector, advocacy, community-based, and scientific organizations to achieve the following goals: (1) protect waterbodies in California from contamination, particularly where fish are caught for human

consumption, and (2) promote and protect the health of populations consuming contaminated fish and other aquatic life. Specific project outcomes include identifying project mandates and authorities as well as gaps, building upon existing abilities and authorities to establish a system for tracking and investigating fish contamination problems, implementing community-based pollution prevention interventions, and increasing public awareness about health benefits and risks from consuming fish, as well as ways to reduce exposure to contaminants in fish. Stakeholder participation will be incorporated into all decision-making processes.

Communicating Information on Methylmercury in Fish to Women of Childbearing Age via Perinatal Healthcare Providers

Margy Gassel, Robert Brodberg, and Sue Roberts

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The Office of Environmental Health Hazard Assessment (OEHHA) is the agency in California responsible for developing and issuing fish consumption advisories for chemically contaminated sport fish. OEHHA also incorporates the U.S. Food and Drug Administration's advice for commercial seafood as part of education, outreach, and communication to fish consumers. OEHHA's Fish Advisory Program staff recognized the need to expand outreach efforts, especially to females of childbearing age, about methylmercury in fish. A profusion of recent news stories on the dangers of methylmercury and other contaminants in fish, at the same time that fish is being promoted as a healthy food, has heightened the need to provide accurate information about the risks versus benefits of eating fish.

The Women, Infants, and Children (WIC) program is a federal program that supports nutrition and health for pregnant women, new mothers, and young children. Similarly, many counties in California operate perinatal councils to provide healthcare services to new mothers and their children. Public health nurses and nutritionists, dietitians, and maternal and child health specialists, among others, staff these programs. OEHHA previously distributed advisory brochures to WIC agencies and California county health and environmental departments. Several programs in California requested staff training from OEHHA after receiving conflicting messages from agencies, doctors, and the media. In addition, WIC program administrators were concerned because they distribute canned tuna to breastfeeding mothers. In response, OEHHA has offered training that covers the sources and accumulation of methylmercury in fish, toxicokinetics and human health effects, risks and benefits of fish consumption, and determination of "safe" levels of exposure. The presentations focus on women and children, and they present and clarify current advice and recommendations for sport and commercial fish consumption. Training of WIC and perinatal program staff provides an excellent opportunity to reach the at-risk population through the practitioners who interact with them. The effectiveness of the training was evaluated using brief questionnaires before and after the presentation. Responses showed increased knowledge and confidence on the subject, less confusion, and changes in opinions and beliefs as a result of the presentation. Direct feedback from training participants indicated that they had benefited from OEHHA's training.

A Community-Led Survey of Fish Consumption Behaviors of Anglers at the Richmond Harbor and San Pablo Reservoir

Sharon Fuller and Kelly Speth

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A community-led, community-designed research study was conducted in Richmond, California, to assess the fishing habits, fish consumption patterns, demographics, and general awareness of health advisories related to fish consumption. High school student interns with the Ma'at Youth Academy conducted short interviews with shore-based anglers fishing at the Richmond Harbor and the San Pablo Reservoir. In a multiple-response question, 73 percent (n=77) of the 105 anglers surveyed eat some or all of the fish they catch and 70 percent (n=74) catch bass. Anglers were found predominantly to be residents of Richmond (79 percent) and live in households of 1 to 4 people (71 percent); 40 percent of all anglers surveyed live in households with at least one child aged 5 years or younger. The survey found that 64 percent of anglers surveyed speak English and 26 percent speak Spanish as a primary language; other languages spoken in the home by those surveyed included Laotian, Chinese, Filipino, Japanese, German, and Farsi. As many as 65 percent of those surveyed did not know or think that local waters are contaminated. We conclude that efforts at informing this population have been inadequate; continuing efforts to educate the community, including a second survey, are currently under way.

Contaminated Subsistence Fish: A Yakama Nation Response

Chris Walsh, Carol Craig, and William Lambert

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Pollution from agriculture, pulp and paper mills, aluminum smelters, mining, and nuclear weapons production is present in the Columbia River watershed. The contaminants include pesticides, PCBs, chlorinated dioxins and furans, aroclors, and metals. In addition to ecological risk, this contamination may pose a risk for humans. Tribal people who follow traditional diets eat large amounts of fish, and there is concern that they may be at elevated risk for organ damage and diseases such as cancer. Our project has three major objectives: (1) *To inform and educate the community about health risks related to the contamination of subsistence fish.* The stakeholders include the general tribal membership, elected leaders, program managers and administrators, and health care providers. Further, there are vulnerable segments of the population, including women of childbearing age, fetuses, infants and children, and elders. (2) *To foster joint problem solving in the tribal community.* We seek to create an environment in which the various stakeholders can work together to evaluate alternatives for reducing health risks. (3) *As culturally appropriate, to promote personal behavior change and protective action, and raise the awareness of health care providers and improve the recognition and treatment of disease.* We present our model of community engagement and shared decision-making. Focus groups with tribal leaders, health care providers, and susceptible groups have defined risk messages that are culturally appropriate, and in turn are delivered by video programs and oral presentations. Clinicians are counseling patients on diet and nutrition, and making improvements in screening for cancer. The Tribal Council is engaged in planning recommendations for personal behavior change and is using the video programs to advocate more stringent environmental protection at the federal and state levels. (This research is supported by the NIEHS under Cooperative Agreement #7 R25 ES011074.)

Cooperative Effort by West Virginia University, USGS Cooperative Fish and Wildlife Research Unit, Division of Natural Resources (DNR), Department of Health and Human Resources (DHHR), Department of Environmental Protection (DEP) for West Virginia Statewide Fish Tissue Analysis

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Objective/Background

The objective of this study is to determine the extent to which fish in the watersheds of West Virginia are contaminated with polychlorinated biphenyls (PCBs) and mercury and the concentrations of those contaminants.

The West Virginia Fish Consumption Advisory Technical Committee (FCATC) is represented by the state's Division of Natural Resources (DNR), Department of Health and Human Resources (DHHR), and Department of Environmental Protection (DEP). The FCATC's efforts to assess contaminants in fish have been inhibited by the lack of current, statewide data and permanent funding for tissue collection and analysis. In 2001 the DEP secured a grant for \$35,000 from the USEPA for statewide monitoring of fish samples for PCBs and mercury in lakes and streams. These chemicals were selected based on a review of the available historic fish tissue data within the state that indicated these chemicals are the most prevalent pollutants of concern.

The FCATC targeted 53 lakes and streams for sampling. Sites were selected in an effort to maximize the geographic coverage for fish tissue data. Sample collection was performed by DNR. The West Virginia University (WVU)/United States Geological Survey's Cooperative Fish and Wildlife Research Unit were contracted to perform tissue analysis. West Virginia's fish tissue consumption guidelines were adopted by FCATC in 2002. This consumption guide, which is based on USEPA's fish advisory protocols, assesses the toxicity of a variety of contaminants and offers guidance for developing consumption advisories for children and adults who consume sport-caught fish. These guidelines allowed West Virginia to issue risk-based advisories, rather than following U.S. Food and Drug Administration action levels. The consumption guide provides meal limitations for the general public and for sensitive life stages (children and pregnant women) and uses five categories of consumption: unlimited consumption, one meal per week, one meal per month, six meals per year, and "do not eat."

Fish Collection/Analysis

A total of 53 rivers and lakes were sampled during the 2-year collection phase. Samples were collected from 65 different locations and resulted in a total of 306 composite samples. The total number of fish collected was 1,409. The objective was to collect predators and "bottom feeders" (benthic fishes) from each site. Three size composites were collected for each group (small, medium, and large) and a composite consisted of three to six fish. The selection of species for this study was based on species distribution and desirability as a game fish. Each individual fish was filleted and skinned. Fillets were combined with other fillets in composites and homogenized according to USEPA's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories*.

Results/Preliminary Findings

Samples for PCB analysis are being analyzed. Mercury results for samples collected in 2002 are summarized below. Mercury data for 2003 are not available at this time.

Data from the 2002 samples revealed that mercury levels were highest in bass and walleye. Suckers, channel catfish, and trout had the lowest mercury values. For largemouth bass there were no differences in concentrations of mercury related to size of fish (small, medium, and large). When compared with the West Virginia fish consumption guidelines, none of the composites fell into the “do not eat” category. The results for the remaining categories were six meals per year, 9 composites; one meal per month, 106 composites; one meal per week, 38 composites; and unlimited consumption, 32 composites.

Evaluation of Maine's Risk Communication Program

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Maine has an ongoing risk communication program that distributes easy-to-read Safe Eating Guidelines for fish consumption directly to pregnant women through OB/GYNs, FPs who deliver babies, and the WIC program. The success of Maine's risk communication program will be evaluated based on a random survey of women who have given birth to a child within the last 3 months. The sample will be drawn from the birth certificate registry and will evaluate receipt of the state's easy-to-read brochure, effectiveness of distribution methods, and any change in fish consumption behavior. USEPA funding via the Consortium for Improving the Effectiveness of Fish Consumption Advisories for Mercury-Contaminated Sport Fish has provided a Maine-specific baseline estimate of knowledge of the fish consumption advisories from which to measure any increase in knowledge. The sample size (n=500) is expected to provide 90 percent statistical power to detect an increase in general awareness of the mercury advisories from the baseline of 40 percent to 50 percent or higher. In addition, participants are asked to provide a hair sample, which will be analyzed for mercury to compare with baseline state and national data and to identify real vs. perceived changes in the reporting of fish consumption rates.

Evaluation of the Management of Water Quality and Fish Contamination in California's Sacramento-San Joaquin Watershed: Lessons for Developing a More Integrated Model

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Current management of water quality and fish contamination in California involves multiple federal, state, and local agencies. Their efforts span a wide array of different work that includes ecosystem restoration, pollution remediation, public health tracking, water and fish tissue monitoring, and public outreach. With so many involved at such different levels, there are opportunities for projects to overlap and parallel each other. Identifying these commonalities can aid agencies in meeting their goals of public health and environmental protection. This evaluation will identify opportunities for collaboration on water quality and fish contamination management in the Sacramento-San Joaquin watershed. Collaboration may entail sharing data, combining goals and resources to conduct a single study, cowriting a grant proposal,

or coordinating on public outreach and education activities. Given its size and diversity, the Sacramento and San Joaquin Rivers watershed embodies some of the biggest challenges facing efficient management of water quality and fish contamination problems in California and reflects many of the issues that are relevant to the state as a whole. The approach and methods used in this evaluation will provide recommendations that are appropriate for the Sacramento-San Joaquin watershed and will produce a model that is applicable to other areas of the state that face similar challenges with water quality and fish contamination management.

Fish Consumption Mini-Grants

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The Portland Harbor Superfund site is a 6-mile stretch of the Willamette River in the city of Portland, Oregon. Although the primary exposure pathway to river contaminants has been determined to be fish consumption, not enough information exists about the anglers from specific ethnic and racial groups who catch and consume fish from the harbor. It is known, however, that different fishing communities prefer various species, fishing locations, and meal preparation techniques. A mini-grant opportunity was developed in an attempt to focus outreach efforts to these communities. The desired outcome from these grants is the development and implementation of culturally appropriate health education materials and outreach activities. These community-based grants engage youth and community groups that serve populations consuming fish from the Portland Harbor who would not otherwise be reached in health education activities. Award amounts range from \$1,500 to \$2,000, with the intent of preventing and reducing adverse health effects from fish consumption. This may provide a low-cost option for implementing health education objectives for hard-to-reach populations in other communities.

Fish Contamination: A Tribal Perspective, Issues and Solutions

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Fish are an important food source for people throughout the world. In addition, fish are an essential cultural element of the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) and many other tribes in the Pacific Northwest and North America. To these indigenous people fish contamination is not just about fish, it is a powerful unnatural force, anthropogenic in origin, that is disproportionately undermining, eroding, and jeopardizing their culture, health, and well-being compared with U.S. norms. The accelerated deculturalization caused by fish contamination as a matter of perspective is analogous to the loss of the buffalo to the Plains Indians of North America in the mid-19th century. Studies to date have shown that fish contamination is widespread throughout the world, affecting species that inhabit the Columbia River Basin watershed, including the aboriginal lands of the CTUIR. Although lacking in depth and breadth, results from these studies have provided the precursory information needed to perform risk assessments for tribal communities using tribal based risk scenarios. Such analyses have shown that a traditional tribal life style in which fish are an important food source subjects the individual to acute and chronic health risks 10 to 100 times the U.S. norm. Two important issues for tribes are (1) how to handle and communicate this elevated risk to tribal members, and (2) how to protect this Treaty resource.

Solutions should be knowledge-based and cooperative among state-holds, which will require further monitoring and investigation of scientific, technical, jurisdictional, and legal issues. The poster presentation is a distillation of the tribal perspective and information on fish contamination, the issues and solutions.

Induction of Cytochrome P450 Enzymes in Tilapia (*Oreochromis niloticus*) by Florfenicol

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There are only two antimicrobial agents currently in use in aquaculture in the United States, Romet-30 and Terramycin for Fish. However, they are not approved for all species currently produced in aquaculture. With the fish farming industry growing as quickly as it is (10 billion pounds of imported and domestic fish each year) and the continuous evolution of antimicrobial resistant bacteria, there is a pressing need for a spectrum of approved drugs to combat bacterial diseases in aquaculture facilities. Part of the approval process involves determining the time it takes for the antibiotics to clear from the fish's system because residual antibiotics in the fish can affect the health of the consumer. Currently, antimicrobials are evaluated on an individual species basis, which slows the approval process and increases the cost of drug evaluations. If a single test species could be used to model or predict antibiotic clearance in related species, the approval process could be expedited with consumers feeling safe that the fish they are purchasing are devoid of any antimicrobial agents in their tissue. The specific purpose of this study is to evaluate the effect that florfenicol has on the expression of hepatic P450 oxygenases of several fish species after repeat intraperitoneal injection. CYP450s are known indicators of drug metabolism, and therefore may provide a valid biomarker of antibiotic use in commercially relevant aquaculture species. The initial study will examine the impact of Aquaflorâ (florfenicol as marketed by Schering-Plough, Union, NJ) on the hepatic P450 system of a freshwater tilapia species (*Oreochromis niloticus*). This will be accomplished using standard immunological techniques where the presence of hepatic P450s of the tilapia will be detected with cross-reacting antibodies raised against known P450 isoforms (rat CYP1A1 and human CYP3A4). Once a baseline response has been established using tilapia, species-to-species variation will be explored using channel catfish (*Ictalurus punctatus*) and marine species hybrid striped bass (*Morone saxatilis* male x *Morone chrysops* female) as test subjects. Information gathered in these investigations will be used to determine whether P450 induction can be used as a reliable indicator of antibiotic use and clearance across species lines, to streamline the approval process for antibiotics needed to support the aquaculture industry. This also provides additional methods for testing illegal doses of unapproved antibiotics in the worldwide aquaculture industry. This study is funded by the National Research Support Project No. 7 (NRSP-7), the Minor Use Animal Drug Program of the Cooperative State Research, Education, and Extension Service of the USDA (CREES/USDA).

Keeping Our Traditions and Our Families Alive: Micmac Fish Consumption Survey

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No abstract provided.

Long-term Studies of Dieldrin in Fish Below Two Midwestern Reservoirs

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Results from 25 years of monitoring class III common carp (*Cyprinus carpio*) fish fillets and whole fish tissue for dieldrin residues below two Midwestern flood reservoirs will be presented. (For example, dieldrin in carp fillets averaged 65 parts per billion (ppb) in 1977, decreasing to 3.3 ppb in 2002 below Red Rock Reservoir in south-central Iowa.) Data from 2003 will be available by conference time. Data from other parameters (alachlor, chlordane, chlorpyrifos, and trifluralin) will also be presented. The project, Des Moines River Water Quality Network (<http://www.cce.iastate.edu/research/lutz/dmrwqn/dmrwqn.html>), is conducted by Iowa State University, Department of Civil, Construction, and Environmental Engineering, and is sponsored by the Rock Island District Corps of Engineers.

Managing Risks from Contaminated Fish in the Columbia Basin: A Tribal Perspective

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Using USEPA's 2002 Columbia River Basin Fish Contaminant Survey and the Columbia River Inter-Tribal Fish Commission's Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin as starting points, we analyzed the results of the chemical analyses and risk assessments to put them into perspective for a tribal client. Our report discussed the survey methods, the chemicals of concern, and the risks and benefits of fish consumption. A key aspect of the project was communicating the implications and applicability of formal risk assessment methodologies to subsistence tribal populations in terms of consumption rates and harvest locations. We also researched approaches to managing risks from contaminated fish around the United States to provide context and policy options for tribal risk managers. In addition to our report, we created informational brochures for tribal members and area residents to help them make better choices about eating locally caught fish. Our poster presents a summary of our findings, a comparison of benchmarks for fish advisories, and lessons learned for communicating risks to tribal populations.

Mercury Content in West Coast Troll-Caught Albacore Tuna (*Thunnus alalunga*)

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Ninety-one albacore tuna (*Thunnus alalunga*) captured during the 2003 commercial fishing season were tested for mercury content in the fish muscle. Additional information, such as location, weight, length, lipid, and moisture content, was also collected. The fish were harvested between 29.25 degrees north (off Southern California) and 48.30 degrees north (off the coast of British Columbia, Canada) from July to November. Fish weight ranged from 3.14 to 11.62 kg, and length was in the range of 50.8 to 86.4 cm.

Mercury content was found to range from a low of 0.027 microgram per gram ($\mu\text{g/g}$) (ppm) to a high of 0.26 $\mu\text{g/g}$ in the samples tested. The average mercury content was 0.14 $\mu\text{g/g}$, which is well below both U.S. FDA and Canadian standards (1.0 $\mu\text{g/g}$ and 0.50 $\mu\text{g/g}$, respectively). There was a positive correlation between length and weight of albacore with mercury content. There was no correlation with date of capture. Results indicate that West Coast troll-caught albacore have low levels of mercury in the edible flesh and meet international standards for mercury levels in fish.

Mercury in Marine Life

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Mercury levels in fish and wildlife have long been a concern of the USEPA. Federal regulatory actions have limited mercury emissions to air and direct discharges to waterbodies. Most of the data supporting these actions relate to mercury concentrations in freshwater fish. The Mercury in Marine Life project is an attempt to assess the extent of mercury monitoring and the level of mercury contamination in the estuarine and marine environment nationwide. Data sets from federal, regional, and state monitoring programs covering the estuarine and coastal waters of 24 states, the District of Columbia, and Puerto Rico were reviewed and aggregated into one database. The completed database contains over 15,000 mercury tissue concentration records for marine fish and shellfish taken over the past 10 years (roughly 1990–2001).

Monitoring Mercury and Organic Contaminants in Freshwater Fish from Washington State

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Various historical monitoring efforts throughout Washington State have detected toxic contaminants in fish tissue, surface water, and sediment. In many cases, levels of contaminants in fish tissue have been high enough to threaten the health of humans and wildlife. Increased awareness of potential health effects on humans and wildlife, such as reproductive abnormalities, neurological problems, and behavioral changes, has generated a need for more information about the extent of fish tissue contamination in Washington. The Washington State Department of Ecology has responded to these concerns with a statewide Persistent-Bioaccumulative-Toxic (PBT) Initiative. Two monitoring efforts were developed to assess the extent of freshwater fish tissue contamination: a statewide mercury survey and a longer-term effort for additional contaminants such as pesticides, PCBs, PBDEs, and TCDDs/TCDFs. The statewide mercury survey was conducted to support the goals of the Washington State Mercury Chemical Action Plan. Total mercury concentrations were measured in 185 bass collected from 18 lakes and 2 rivers throughout Washington to assess the extent of mercury contamination of this popular game fish. Up to 10 individual fish were collected at each site and were analyzed to evaluate relationships between tissue mercury levels and other characteristics such as fish age, length, weight, sex, and lipids. These data would also aid in designing a long-term trend monitoring program. Water and sediment samples were also collected to examine other factors that could affect mercury uptake in fish. Mercury concentrations in tissue were found to vary widely among waterbodies and among individual fish from the same waterbody. Tissue mercury levels were strongly correlated with fish age, length, and weight. Twenty-three percent of the fish had mercury levels exceeding USEPA's Fish Tissue Residual Criterion for methylmercury of 300

micrograms per kilogram ($\mu\text{g/kg}$) wet weight. Fifty-one percent of the fish had tissue concentrations at or above a Washington State Department of Health Interim Fish Tissue Screening Criterion of $150 \mu\text{g/kg}$ wet weight. The longer-term effort, the Washington State Toxics Monitoring Program, began in 2001. Its goal is to monitor freshwater fish and surface water for a range of contaminants in areas where data are old or lacking. Results from this program are being used to assess the potential for adverse health effects on humans and wildlife. The information generated is also being used by resource managers and other groups to help educate the public on the extent of toxic contamination in Washington State. Since 2001 fish have been collected from approximately 30 sites (10 per year). Results from 2001 are available on the Internet at <http://www.ecy.wa.gov/programs/eap/toxics/index.html>, along with a description of the program.

Palos Verdes Shelf Fish Contamination Education Collaborative

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USEPA's Fish Contamination Education Collaborative is a participatory public outreach and education project that is part of EPA Region 9's overall program to address human health risks posed by fish contamination related to the Palos Verdes Shelf Superfund Site in Southern California. The goals of the Collaborative are (1) to reduce exposure of populations to site-related chemicals in fish caught off the coast of Los Angeles and Orange Counties, and (2) to conduct education with the most affected populations so they can make informed decisions about fish contamination issues. Outreach on fishing piers, in fish markets, through workshops with target populations, and through use of the media is being conducted in Cantonese, Cebuano, Chamorro, English, Ilocano, Khmer, Korean, Mandarin, Marshallese, Samoan, Spanish, Tagalog, Tongan, and Vietnamese.

PCDDs/PCDFs, PCBs, and PBDEs in Wild and Farm-Raised Fish

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This poster presents results for concentrations of PCDDs, PCDFs, PCBs, and PBDEs (polybrominated diphenylethers, a class of flame retardants) in wild and farm-raised fish. The toxicity of PCDDs/PCDFs and PCBs is widely documented, but little is known about the effects of PBDE exposure. Recent studies indicate that it may be similar to PCB exposure. This study will include both freshwater and saltwater fish and as many of the same species of farm-raised fish.

Possible Ramifications of Higher Mercury Concentrations in Fillet Tissue of Skinnier Fish

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Mercury concentrations were found to be statistically higher in the fillet tissue of the skinnier individuals of a fish species (striped bass) experiencing starvation when collected from Lake Mead, on the Arizona-Nevada border. This is considered a consequence of a faster loss of the body's fillet tissue (by metabolism) than the loss of methylmercury from the body. Because such a response could be a common phenomenon and one having relevance to consumer guidance, it is offered for consideration during the Forum's special session on the development of a Joint National Mercury Advisory. Although this work was reviewed by USEPA and approved for publication, it may not necessarily reflect official Agency policy.

Research, Outreach, and Education on Fish Contamination in the Sacramento-San Joaquin Delta Watershed (Delta Watershed Fish Project)

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Mercury, a potent neurotoxin, bioaccumulates in fish in California's Sacramento-San Joaquin Delta watershed at levels that may pose health risks to people who consume the fish. Mercury is prevalent in the Delta watershed because of human activities, such as past mercury mining in the Coastal range and gold mining in the Sierra Nevada, and naturally occurring deposits. Pregnant and nursing women, infants, and young children need to be especially careful about limiting their exposure to mercury. Excessive exposure to mercury can harm the nervous system of developing babies and children, leading to subtle decreases in learning ability, language skills, attention, and memory.

The poster focuses on activities under way by the Delta Watershed Fish Project to reduce exposure to mercury and other chemicals among populations that consume fish caught in the Delta watershed. The Environmental Health Investigations Branch (EHIB) of the California Department of Health Services, working in collaboration with other state and local agencies, tribes, and community-based organizations, is undertaking a number of activities to address this concern. During August 2002–September 2003, EHIB conducted a needs assessment in five Delta counties to identify specific populations that consume fish caught in the Delta watershed and their awareness, concerns, and information needs. Based on the results of the needs assessment, a local stakeholder advisory group was created to involve community members in identifying appropriate outreach, education, and training activities, and developing, translating, and distributing materials. The advisory group will focus on raising awareness of fish consumption advisories and the health risks of exposure to mercury in fish to the populations they serve, particularly women of childbearing age and pregnant and breastfeeding women. Populations that fish for subsistence in the Delta watershed, such as Latino, Southeast Asian, African American, and Russian communities, are also at risk. The project will provide training and information to social service and health care providers who serve the target populations and will seek their assistance in disseminating information. Additional needs assessments in two other counties are under way, and options for

conducting fish consumption studies are being explored to learn more about the populations that are consuming fish caught in the Delta watershed.

Vibrio vulnificus Education

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Illnesses and deaths associated with the consumption of raw molluscan shellfish containing *Vibrio vulnificus* continue to be a significant challenge for public health officials and the shellfish industry. In 2001 the Interstate Shellfish Sanitation Conference (ISSC) expanded the scope of the National Shellfish Sanitation Program (NSSP) to include measures to reduce the number of illnesses associated with *V. vulnificus* through the adoption of a national *Vibrio vulnificus* Risk Management Plan.

The ISSC's *Vibrio vulnificus* Illness Risk Management Plan includes a disease reduction goal for decreasing the rate of etiologically confirmed shellfish-borne *V. vulnificus* septicemia illnesses from the consumption of commercially harvested raw or undercooked oysters by 40 percent within 5 years and by 60 percent within 7 years. The plan includes three primary components: (1) education of the at-risk population, (2) development and promotion of a post-harvest treatment process that eliminates *V. vulnificus*, and (3) harvest controls. The education component focuses on the education of high-risk consumers, health professionals, and a targeted, broader consumer audience. Each state's involvement in this collective illness reduction program would focus on these cumulative illness reduction goals. The initial years of the plan focus on education and post-harvest treatment; however, should the goals not be met, the states would identify and prepare for implementation of specific harvest, labeling, or other controls that would provide equivalent illness reduction.

Vibrio vulnificus is a gram-negative bacterium and is considered the most lethal of the vibrios inhabiting brackish and salt water. This bacterium is not the result of bacteriological or chemical pollution of marine waters but occurs naturally in warm, coastal areas, such as the Gulf of Mexico. *V. vulnificus* is found in higher concentrations from April through October, when coastal waters are warm.

Most healthy individuals are not at risk for *Vibrio vulnificus* infection. Persons at high risk include those with liver disorders, such as hepatitis, cirrhosis, and liver cancer; hemochromatosis; diabetes mellitus; and immunocompromising conditions such as HIV/AIDS or cancer, or undergoing treatments for them. Individuals who take prescribed medication to decrease stomach acid levels or who have had gastric surgery are also at risk.

Filter-feeding shellfish, such as oysters and clams, concentrate *Vibrio vulnificus* in their tissues. When a person eats these shellfish raw or undercooked, the bacteria enter the digestive tract and multiply rapidly. In addition to ingestion, high-risk individuals can become infected when cuts, burns, or sores are exposed to sea water containing *Vibrio vulnificus*.

The ISSC is a national, nonprofit organization formed in 1982 to foster and promote shellfish sanitation through the cooperation of state and federal control agencies, the shellfish industry, and the academic community. The ISSC adopts uniform procedures, which are incorporated into the National Shellfish Sanitation Program and implemented by all shellfish control agencies.

Water Quality Standards Database

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USEPA is developing the Water Quality Standards Database (WQSDB) to improve public access to information on how the waters they care about are being protected for fish consumption, and how actions in their watershed can help or harm those waters. The first phase of developing this online database consists of a compilation of “designated uses,” which describe the functions each waterbody is intended to support—fishing, swimming, drinking water source, or some other use. The second phase will add numeric “water quality criteria,” which represent the quality of water that supports particular uses. When completed, the WQSDB will allow access to maps and tables for all of the approximately 2.7 million surface waterbodies across the nation. WQS regulations for all 79 states, tribes, and territories and tables and maps of the 28 jurisdictions currently on the database can be viewed at www.epa.gov/wqsdatabase.

Mapping, Modeling and Analysis of Environmental Contaminants: Mercury Pilot Project

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Understanding the causes and consequences of mercury contamination in the environment is a problem of enormous geographic scope and scientific complexity. Effectively addressing this task requires the integration of data and expertise from many scientific disciplines. This Web site was created to support environmental and health researchers, as well as land and resource managers, by providing the following:

1. Easy access to key environmental mercury datasets, including atmospheric mercury emissions, NADP monitoring sites, and mercury concentrations in fish tissue, soils, stream sediments, and coal. All data are downloadable in shapefile format with included .dbf files.
2. An online descriptive model for mercury in fish tissue that factors out variations in mercury due to differences in species, length, and sample type. Application of this model to a comprehensive national compilation of fish tissue data will allow the detection of spatial and temporal trends in mercury concentrations that would otherwise be obscured. The model will also help state and local agencies reduce the costs of their sampling efforts for estimating fish-tissue mercury concentrations without loss of effectiveness.
3. Online mapping tools, USGS maps, imagery, and other thematic data that allow the display and analysis of mercury data and printing of maps. Data from The National Map include digital versions of more than 50,000 topographic quadrangles, nationwide coverage of 1-meter aerial photography, Landsat satellite imagery, land cover, elevation, hydrology, transportation, and geographic names.

