Proceedings of the National Forum on Contaminants in Fish, May 6 and 9, 2001

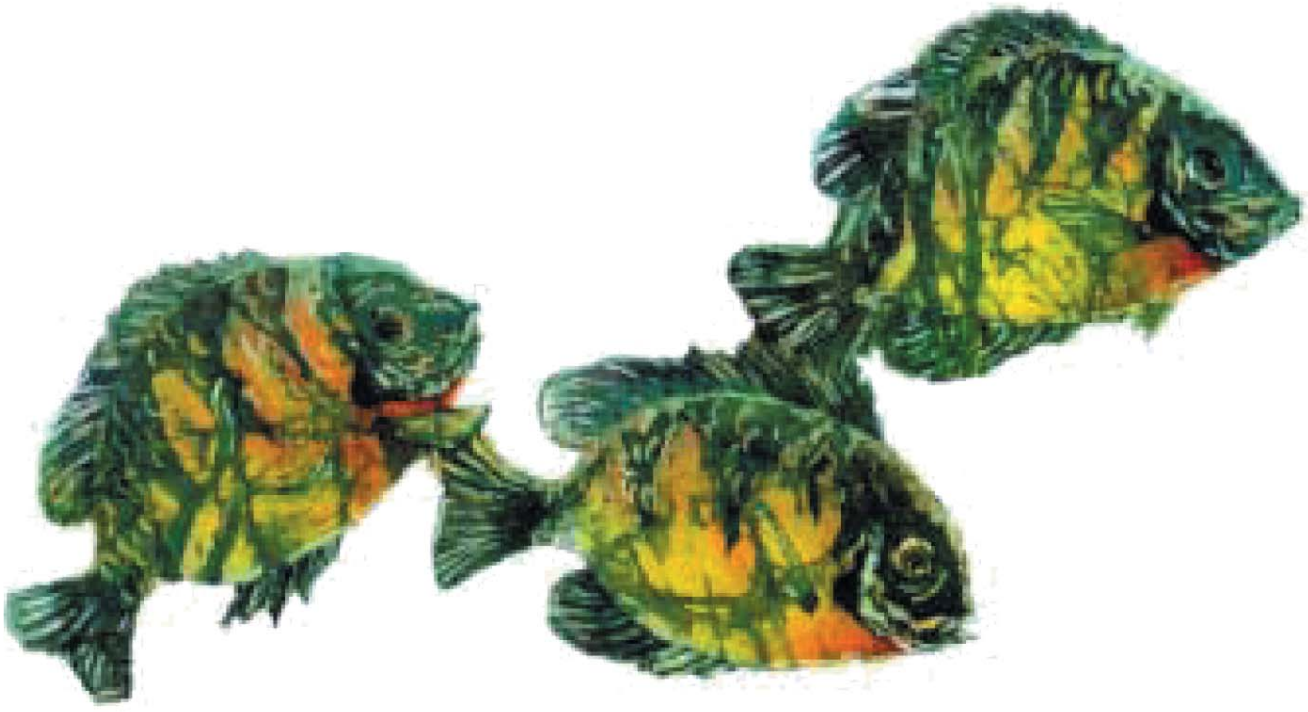
Sponsored by

U.S. Environmental Protection Agency
(under Cooperative Agreement No. X-82825101-0)
Minnesota Department of Health

Prepared by

Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC 27709

August 2001



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Acknowledgments

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The following steering committee members and other individuals contributed their time and expertise to develop the 2001 Fish Forum program, select priorities, and facilitate forum discussions:

- Thomas Armitage, EPA Office of Water
- Jeffrey Bigler, EPA Office of Water, co-chair
- Susan Gilbertson, EPA Office of Water
- Richard Greene, Delaware Department of Natural Resources and Environmental Control
- Michael Haire, EPA Office of Water
- Evelyn MacKnight, EPA Region 3
- Randall Manning, Georgia Department of Natural Resources
- Patricia McCann, Minnesota Department of Health, co-chair
- William Morrow, EPA Office of Water
- Elizabeth Southerland, EPA Office of Science and Technology.

In addition, the following individuals served as regional session leads for the Sunday breakout sessions of state fish advisory program contacts:

- Henry Anderson, Wisconsin Division of Public Health
- Robert Brodberg, California Environmental Protection Agency
- Patricia Cochran, Alaska Native Science Commission
- Thomas Fikslin, Delaware River Commission
- Tracy Shelley, South Carolina Department of Health and Environment
- Brian Toal, Connecticut Department of Public Health.

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Summary of National Forum on Contaminants in Fish May 6 and 9, 2001

Part I
Summary of National Forum on Contaminants in Fish
May 6 and 9, 2001

The 2001 Forum on Contaminants in Fish was held in Chicago, Illinois, on Sunday, May 6, and Wednesday, May 9, 2001. This forum, which was sponsored by the Minnesota Department of Health in partnership with the U.S. Environmental Protection Agency (EPA), was held in conjunction with the 2-day National Risk Communication Conference. The Forum and the Conference were attended by 356 representatives of 49 states and 52 Native American tribal organizations as well as EPA Regions, federal agencies, and universities and private organizations. During the 2-day forum, attendees listened to presentations from speakers and participated in regional breakout sessions to discuss state and tribal fish consumption advisory programs; consistency of these programs with each other and with EPA guidance, particularly with respect to mercury; and regional issues and concerns to be communicated to EPA's Office of Water. Presenters at the 2001 Forum spoke on a range of topics within two broad categories: chemical updates and linkages between the Fish Advisory and Water Quality Standards programs.

Attendees met most of Sunday in informal regional sessions to discuss their fish advisory initiatives and share information on their fish advisory program issues and needs or attended a Water Quality Program breakout session held concurrently with the regional sessions. Attendees convened in full session to hear Steven Ellis present results from a study of *Polychlorinated Biphenyls in Four Freshwater Fish Species from the Willamette River, Oregon: Analysis of 209 PCB Congeners and Aroclor Mixtures* (see Part III). Following his presentation, regional session leads presented summaries of their discussions to all participants.

Regional Breakout Session Summaries

The Northeast Region reported that all states in the region have mercury fish consumption advisories (FCAs) in place and most states use adult RfDs for them. State representatives expressed concern about how EPA will communicate the nationwide mercury advisory in states with different mercury advisory information and identified a need for regional discussion on variability in PCB FCAs. Participants noted the variability among states in this region including:

- Child age in FCAs (Maine uses 8 years; Massachusetts uses 12 years)

- How FCAs are communicated to women (e.g., are you pregnant or do you plan to become pregnant)

- Accounting for commercial fish in state FCAs for locally caught fish (are commercial and noncommercial species overlapping or mutually exclusive?)

- Setting FCAs based on statewide mean mercury (or other contaminant) residue levels vs. upper percentile values

The Chesapeake/Delaware Region cited a need for better coordination of advisories. They discussed the need to determine the best form for communicating advisories, the need for national vs. regional focus groups, the need to include public outreach/communication specialists on advisory teams, and the need for balance in the level of detail—that is, generic vs. species-specific information. Only Delaware has multiple contaminant advisories. Individual states are developing protocols, but there is a need for a common protocol and for flexibility. Emerging issues for this group include

- PCBs–analysis of congeners vs. Aroclors

- Arsenic- What conversion factor—4% vs. 10%—do you use to convert total arsenic residue values to the percentage that is the toxic inorganic arsenic form

- Monitoring BDE (brominated diphenyl ethers) and modern pesticides and measuring methylmercury.

States in the South are all issuing advisories and most aim to address multiple contaminants. There has been a shift in "drivers" from PCBs to mercury. Most states use a tiered approach (e.g., advice for sensitive population groups vs. advice for the general population or recreational fishers). These states are using more protective methodologies for determining risk and are collaborating with neighboring states (e.g., Southern State Mercury Task Force). These states recognize the need for better outreach (and evaluation), but lack funding.

The Great Lakes regional group expressed the need for advisory programs to develop simple, easy-to-understand, common exposure reduction messages. Many programs focus too much on very detailed exposure reduction strategies in their fish advisories, such as fish size and waterbody-specific advice. These states think it is important not to push people toward a less healthful diet. There is no consensus on a Great Lakes Mercury Protocol because of different geochemistry and different geopolitics. These states are working to ensure adequate support for communication efforts (e.g., Great Lakes Consortia effort). This group also cited a need for uniform methodology in laboratories and in round robin testing and protocols.

The Western regional session discussed monitoring of emerging contaminants (pharmaceuticals), monitoring at mining and military sites, particularly in Alaska, and communicating to populations with limited options with respect to consumption. How does one define subsistence/high-end consumers? Do upper percentiles for subsistence fishers work? How does one include cultural practice in FCAs? On the subject of risk assessment, these states felt that there were risk-benefit tradeoffs. They would like to see more research on expressing this as

some cumulative risk-benefit function. This could include multimedia and multichemical exposures. They want more community perspective and involvement in the management process and community-based involvement and partnerships. Cultural benefits accrue with a balanced approach to health benefits—cultural, spiritual, and nutritional. More funding is needed for environmental justice and flexible pollution prevention grants as well as for tribes/states for sampling and analysis.

Chemical Updates

Introduction

The morning session on Wednesday, May 9, began with an introduction by Elizabeth Southerland, Office of Science and Technology, which included a summary of the results of the state and tribal fish advisory contacts regional meetings that took place on Sunday and a brief overview of the states' responses to a questionnaire discussed in the groups on Sunday. Dr. Southerland provided an update on the National Fish and Wildlife Contamination Program and outlined EPA's 4-year National Lake Study, which is collecting fish tissue residue data on more than 100 chemical contaminants in fish from lakes throughout the United States. She also discussed plans to develop new national guidance for assessing the effectiveness of state and tribal advisory programs. Dr. Southerland gave a brief update on the EPA/ATSDR (Agency for Toxic Substances and Disease Registry) Healthcare Outreach Project. EPA, in cooperation with ATSDR, will send the brochures *Should I Eat the Fish I Catch?* to pediatricians, family physicians, OBGYNs, and women's health clinics. EPA will also distribute to these same medical organizations the new EPA/FDA mercury advisory. Dr. Southerland also discussed plans to update the national risk communication guidance (Volume 4) based on the results of the National Conference on Risk Communication (held in conjunction with this forum). EPA will also develop and maintain risk communication information on the EPA website and has already added a newsletter feature to the National Listing of Fish and Wildlife Advisories (NLFWA) website.

Speakers Alan Stern, Kathryn Mahaffey, Rita Schoeny, Alan Levy, Deborah Rice, and Dwain Winters provided updates on chemicals that are of particular concern because of their bioaccumulation in fish, shellfish, and other wildlife tissues and subsequent health effects to humans.

Summary of NRC Committee Findings

Alan Stern of the New Jersey Department of Environmental Protection summarized findings of the National Research Council (NRC) report that reviewed toxicological and epidemiologic data to determine if the EPA reference dose (RfD) was appropriate. He also described the background of the study and the NRC Committee's charge and approach to its charge. Three major studies were originally reviewed to evaluate the RfD for mercury, including the Faroe Islands study (Grandjean et al.), the New Zealand study (Kjellstrom et al.), and the Seychelles Island study (Clarkson et al.). The NRC Committee concluded that

- The EPA RfD (0.1 µg/kg-d) is a scientifically appropriate level that adequately protects public health.
- The Iraqi study should no longer be used as scientific basis of the RfD.
- The RfD should be based on neurodevelopmental effects.
- The Faroe Islands study was the most appropriate study on which to base the RfD.
- The most sensitive and reliable endpoint from the Faroe Islands study is the Boston Naming Test.

The committee also cited database insufficiencies and their possible connection to sequelae and latent effects, immunotoxicity, and cardiovascular effects. Based on the database insufficiencies and toxicokinetic variability, the committee supported an overall uncertainty factor of at least 10. Dr. Stern also discussed current developments, including the results of the most recent National Health and Nutrition Examination Survey (NHANES) mercury biomonitoring effort, which found that greater than 10 percent of women of child-bearing age in the United States exceed the 1.0-ppm level of mercury in hair, roughly corresponding to exposure at the reference dose. The NRC Committee did not quantitatively consider nondevelopmental effects in their evaluation of the RfD for mercury, the uncertainty factor includes consideration of nondevelopmental effect (paraesthesia); therefore, 0.1 g/kg-d might be considered necessary for the protection of the general population. The overall uncertainty factor adjustment of 10 recommended by the NRC Committee address nondevelopmental health endpoints (cardiovascular and immunotoxicity). Thus, the recommendation of 0.1 µg/kg-d by the NRC committee may be construed as providing protection for adult as well as developmental health effects and may thus be applicable to the entire population.

Methylmercury: Developing the 2001 Reference Dose

Kathryn Mahaffey of EPA's National Center for Environmental Assessment provided an update of the U.S. EPA reference dose for methylmercury, including the NRC Committee on Toxicology recommendations for the methylmercury reference dose. Dr. Mahaffey discussed the neurodevelopmental delays and deficits currently considered to be the critical effect, the three cohort studies evaluated, and the decision that the reference dose should be based on the Faroe Islands study. The NRC-preferred benchmark dose level (BMDL) was based on 58 µg/L cord blood and an estimated 11 ppm mercury in maternal hair and corresponds to approximately 1 µg/kg of body weight per day of dietary intake of methylmercury. EPA's current RfD for methylmercury, 0.1 µg/kg-d, is based on a BMDL from a linear model using an uncertainty factor of no less than 10. Dr. Mahaffey also described the time line in setting the revised RfD. The EPA RfD for methylmercury is based on several scores from the Faroe cohort's measurements (developmental neuropsychological impairment in children), supporting scores from a New Zealand study, and an integrated analysis of the Faroe, New Zealand, and Seychelles studies from the National Academy of Sciences Report. The RfD represents a statistically significant association between maternal hair mercury levels and test scores at less than 10 ppm mercury in hair, while the BMDL reflects maternal hair mercury levels of 11 ppm. This RfD was reviewed

by a committee from the National Academy of Sciences (NAS) to help EPA evaluate the level at which adverse effects of methylmercury occur. Their findings support the EPA RfD value.

Methylmercury, EPA RfD Issues and Use

Rita Schoeny of EPA's Office of Water presented information on the EPA 2001 RfD for methylmercury, including issues and use of the RfD. The RfD was based on a BMDL of 1.0 µg/kg-d developed from neuropsychological effects in Faeroe children exposed in utero through maternal seafood consumption. However, EPA believes the RfD 2001 is applicable to lifetime daily exposure for all populations, including sensitive subgroups, and is not restricted to pregnancy or the developmental period. Dr. Schoeny also presented a summary of historic and recent effects of methylmercury in adults. The EPA 2001 RfD was used to develop the mercury criterion published in January 2001 and will now become the basis for fish advisories. Risk-based fish consumption limits are intended to protect public health and provide guidance on the maximum number of meals of fish that may be consumed over a specified time. Recommended equations were reviewed for calculating the maximum allowable daily fish consumption rate using a value of 65 kg for female body weight. Recommended meals per months based on 8 oz (0.227 kg/meal) were also reviewed. The EPA National Freshwater Fish Advisory, which was developed concurrently with the Food and Drug Administration (FDA) advisory on mercury in commercial marine fish, targeted pregnant women, those who could become pregnant, nursing women, and those feeding young children. The national recommendation to limit consumption of locally caught freshwater fish applies where the state or local health departments have not developed advisory programs and have not issued any advisory for mercury. However, the national advisory is superceded where states have monitored fish tissue mercury levels and have issued their own advisories for mercury.

FDA Methylmercury Consumer Advisory

Alan Levy of the FDA Office of Consumer Affairs described FDA efforts to develop the National Mercury Advice to Consumers for commercial marine species and gave background on the focus groups that were used to test possible messages about the hazards of mercury contamination in fish. Focus groups revealed that the general population is not aware of the mercury hazard in eating fish; however, once the hazard is known, consumers want to know which fish are safe to eat. The focus group study found that it was easy to make consumers aware of the mercury hazard and to identify specific fish they should avoid. It was difficult, however, to give them quantitative advice about how much fish to eat because their understanding of such advice depended on the amount and type of fish they typically consumed. Consumers were easily confused by or misinterpreted quantitative advice to limit consumption. The recommendations from the focus groups were to emphasize the message to avoid fish high in mercury and to downplay quantitative advice. The FDA methylmercury consumer advisory is for women who are pregnant or who may become pregnant. A NAS/NRC report prompted development and issuance of the advisory, which is conservative, recommending that women minimize the mercury burden on their bodies. The advisory recommends that women who are pregnant or who may become pregnant not eat fish with high methylmercury levels, such as shark, swordfish, king mackerel, and tilefish, but recommends that such women eat up to 12 ounces of other fish per week on a regular basis. The FDA goal is for at-risk consumers to

reduce the risks from methylmercury by limiting consumption of a few kinds of fish that contain high levels of mercury and still eat a balanced diet of seafood.

Noncancer Risk Assessment for PCBs

Deborah Rice of the U.S. EPA National Center for Environmental Assessment, Office of Research and Development, provided an update on noncancer risk assessment for PCBs. She identified general goals for the assessment, including

- Identifying the most sensitive organ system, endpoints, and studies
- Drawing any conclusions possible concerning the relative toxicity of different congener classes
- Providing guidance relevant to specific situations (site-specific or food advisories) based on the above information.

The major health effects obtained from human (epidemiological) and animal studies included reproductive, immunotoxicity, neurotoxicity, and thyroid effects. Hazard characterization was based on epidemiological data for relevant studies and on blood or other tissue levels.

Dr. Rice offered several conclusions involving congener-specific toxicity: (1) for immunotoxicity, reproductive effects, and physical development of offspring, the TEQ approach for Ah receptor activation will probably provide protection for all PCBs; (2) for developmental neurotoxicity, both dioxin- and non-dioxin-like congeners are active, and the TEQ approach is inappropriate; (3) for thyroid effects, both congener classes are active; and (4) for all endpoints, available evidence does not suggest differential toxicity for lightly vs. highly chlorinated congeners. With regard to cleanup or health advisories, both dioxin- and non-dioxin-like PCBs have health effects. TEQs cannot be used to make decisions for all human health endpoints, and developmental neurotoxicity is a critical effect. In addition, both lightly and highly chlorinated PCBs have health effects, and there is no evidence that one is more toxic than another for noncancer effects. With respect to analysis of PCB levels in fish, the Aroclor pattern does not match that in fish tissue; congener- specific analysis is expensive but accurate, but information on individual congeners may not be needed. It was recommended that some form of total PCB analysis be used.

U.S. EPA Reassessment of Dioxin and Related Compounds

Dwain Winters of the U.S. EPA Office of Water provided an update of EPA's reassessment of dioxin and related compounds. Dioxin-like compounds include 7 dioxin congeners, 11 furans, and 3 PCB congeners. Dioxin-like compounds are high-potency or likely human carcinogens based on unequivocal animal carcinogens, limited human information (epidemiological), and mechanistic plausibility. Dioxin-like compounds are also receptor-mediated noncancer toxicants in both animals and humans that have developmental toxicity to immune, nervous, and reproductive systems; immunotoxicity; endocrine effects; chloracne; and other effects. Environmental exposures to dioxin are around 1 pg TEQ/kg-d

(PCDDs/PCDFs/PCBs). Populations with possibly higher intakes include nursing infants, individuals consuming fatty diets, and some subsistence fishers and farmers in proximity to contamination. Of the dioxin-like compounds, five make up about 80 percent of the total TEQ in human tissues: 2,3,7,8-TCDD; 1,2,3,7,8-PCDD; 1,2,3,6,7,8-HXCDD; 2,3,4,7,8-PCDF; and PCB 126. The risk to the general population from exposure includes an upper bound cancer risk of 1 x 10^{-3} and adverse noncancer effects observed within 10 times background level.

Dr. Winters also described the primary pathways and sources of human exposure. Freshwater fish and shellfish represent 19 percent of the total background exposure to dioxin-like compounds, with marine fish and shellfish, dairy, beef, and milk representing 7, 21, 14, and 16 percent, respectively. Based on sediment data, dioxin exposure levels appear to have peaked in the late 1960s to early 1970s and to have declined since. Declines have also been supported by emissions inventory data, which show an 80 percent decrease between 1987 and 1995. Human tissue data also suggest that current levels are about 50 percent of those reported in 1980 (25–55 pg TEQ/g lipid) and steady-state PK modeling of current intake levels projects tissue levels of about 11 pg TEQ/g lipid.

Arsenic Assessments for Water

Rita Schoeny of the EPA Office of Water presented an update on arsenic assessments for water and the arsenic problem as it relates to bioaccumulation in fish and shellfish. Dr. Schoeny described the health effects of inorganic arsenic, including acute and chronic effects, and the mode of action. Based on recommendations by the National Academy of Science (1999) and the Science Advisory Board (2000), which recommended a "downward revision as promptly as possible," the Agency is in the process of revising the old arsenic standard set in 1942. Two international organizations, the World Health Organization and the European Union, have set a standard of 10 ppb for arsenic. The final arsenic rule establishes a standard of 10 ppb where benefits justify the costs (at the upper end of target risk range of 10^{-6} to 10^{-4}). EPA evaluated a variety of best available technologies and small systems technologies for arsenic removal from drinking water. In addition, risk estimates for health effects were revised to adjust for differences between the U.S. and Taiwanese populations, and the cost of compliance was evaluated. The timetable for the arsenic rule was also reviewed. Inorganic species of arsenic (+3) and (+5) are the prevalent valence states of arsenic in water; however, seafood primarily contains organic arsenic compounds, such as arsenobetaine and arsenocholine, which are not considered toxic. When the relative source contributions were compared, U.S. food provided up to 10 to 12 µg/d of inorganic arsenic for adults, while Taiwanese food provided a mean of 50 µg/d inorganic arsenic for adults (range of 15 to 211 µg/d inorganic arsenic for adults). Total arsenic concentrations vary greatly in marine fish and shellfish between and within species. Most arsenic in marine fish is in the form of arsenobetaine and arsenocholine, which are excreted unchanged. Less is known about the organic arsenicals in freshwater fish. The chemical components in these freshwater organic arsenicals differ from components in the marine forms, but the freshwater forms are also likely to be excreted unchanged. The main human health risks appear to involve inorganic arsenic forms associated with ingestion from domestic water wells or small public or transient water supply systems in areas showing naturally elevated levels of arsenic compounds in groundwater.

Luncheon Talk

Dr. Stuart Harris, of the Confederated Tribes of the Umatilla Indian Reservation, gave a personal account of the impacts on Native American culture resulting from fish contaminants and fish advisories. For his Columbia River Basin tribe, nearly 99 percent of the fish in the river are gone, and every remaining fish is contaminated to a greater or lesser extent. Dr. Harris described how his culture depends on exercising all the practices, activities, and life styles developed from a partnership with the ecology of the river system. He compares the impact on his culture of this loss of fishing and fish consumption with the loss of reading in the mainstream American culture. How would American lives change if people were asked to give up reading, and how would their lives changes if a core attribute of mainstream culture were affected? Such is the loss for those Native American peoples whose culture has evolved in close association with the fish. While fish advisories may be needed, they are only useful as an interim short-term measure. EPA needs to set goals and take action in developing multimedia and watershed approaches to permitting. Losing fish means losing more than the health benefits of eating fish; it also means losing ceremonies, identity, and religion for Native American tribal peoples. Dr. Harris's full presentation is provided in Part III, Presentation Materials.

Linking Fish Advisory and Water Quality Standards Programs

Elizabeth Southerland, U.S. EPA, Standards and Applied Science Division (SASD), Office of Science and Technology, Office of Water, moderated this panel discussion. The panel, made up of a group of experts from EPA headquarters and representatives from two state agencies that issue fish consumption advisories, provided overviews on the similarities and differences between the water quality programs based on the Clean Water Act and public health-based fish consumption advisory programs. Six speakers provided various perspectives on the linkage between fish advisory and water quality standards programs.

Introduction

In her introductory remarks, Elizabeth Southerland described how water quality-based programs at both the federal and state levels seek not only to advise people on ways to minimize public health risks, but also to implement management measures to reduce the pollution problems so that measures like fish consumption advisories can be rescinded. No one wants advisories in place any longer than necessary. The ultimate challenge is to link the fish consumption advisory efforts back to the regulatory, cleanup, and pollution prevention programs under the Clean Water Act (and under the Clean Air Act or the Superfund Program, if needed) and cut back on the pollution sources.

U.S. EPA Fish and Wildlife Contamination Program

Thomas Armitage, EPA Office of Water, discussed EPA's efforts over the past decade to promote consistent risk-based approaches to interpret chemical residue levels in fish tissues as a foundation for developing consumption advisories for both noncarcinogenic and carcinogenic effects. Preferred technical approaches are described in a multivolume guidance document under the series title *National Guidance for Assessing Chemical Contaminant Data for Use in Fish*

Advisories. In this document guidance series, *Volume 1 – Fish Sampling and Analysis***,** covers sampling methods, chemical analysis procedures, statistical design, monitoring strategies, and quality assurance/quality control aspects and provides methodology for developing risk-based screening values. *Volume 2 – Risk Assessment and Fish Consumption Limits* provides guidance for developing risk-based fish consumption limits and provides toxicological profiles for 25 bioaccumulative chemicals. These documents are updated periodically. EPA supports approaches that ground a state's fish advisory process on concepts reflected in the most current EPA water quality criteria for human health protection. Fish advisory programs use measured concentrations of a contaminant in fish tissue a the starting point, while the Water Quality Standards Program uses concentrations that are expected to be present based on assumed consumption rates. There are similarities in these approaches, and EPA feels that linkages can be strengthened among these programs.

The Clean Water Act: Water Quality Standards

Susan Gilbertson, EPA Office of Water, outlined the components of state water quality standards, which consist primarily of designated uses applied to individual waterbodies along with appropriate criteria that ensure the protection of the uses. Typical designated uses can include public water supplies; propagation of fish, shellfish, and wildlife; agricultural uses and industrial uses; and navigation. The Clean Water Act goal for water quality adequate to support fishable conditions wherever possible includes both a goal to protect the ecological integrity of the fish communities and a human health goal that fish and shellfish should be safe for humans to catch and eat. Many of the EPA criteria for toxics developed for the Section 304(a) priority pollutants figure prominently in fish consumption advisories. While fish consumption advisories are not ordinarily issued by states under Clean Water Act programs, the presence of conditions leading to these advisories often reflects the nonattainment of water quality standards designated uses. Designated use nonattainment can then trigger a variety of regulatory responses, such as listing under the Clean Water Act's provisions for developing TMDLs contained in Section 303(d).

Methodology for Deriving Ambient Water Quality Criteria (AWQC) for the Protection of Human Health (2000)

Denis Borum described major features in EPA's recent revisions to the 1980 Ambient Water Quality Criteria National Guidelines. These updates appear in *Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health* (EPA-822-B-00-004, October, 2000), which will be used by states and tribes to refine the human health criteria in their water quality standards. These revisions incorporate significant scientific advances in key areas, such as cancer and noncancer risk assessments, exposure assessments, and bioaccumulation in fish. Available documents include the Federal Register Notice with background information and summaries of public comments with responses, the methodology document, a risk assessment technical support document, and a fact sheet. Companion technical support documents on exposure assessment and bioaccumulation in fish are being developed. These materials may be accessed at http://www.epa.gov/ost/humanhealth. In implementing the new methodology, EPA encourages states and tribes to use local studies on fish consumption that better reflect local intake patterns and choices. However, EPA has recommended default fish consumption values for the general population, recreational fishers, and subsistence fishers. EPA

has also recommended a method to account for other sources of exposure, such as food and air, when deriving ambient water quality criteria for noncarcinogens and nonlinear carcinogens. For bioaccumulation, the methodology focuses on the use of bioaccumulation factors (BAFs) instead of bioconcentration factors (BCFs) for estimating potential human exposure to contaminants via the consumption of contaminated fish and shellfish. The revised methodology will provide more flexibility for decision making at the state, tribal, and EPA regional levels.

EPA Human Health Criterion

Rita Schoeny, EPA Office of Water, highlighted key features in EPA's recently released criterion for methylmercury. This criterion document is different from most human health criteria, which are usually developed for ambient water. The situation with mercury is complicated. For most waterbodies, there are few point discharges remaining. The majority of mercury inputs to waterbodies come from atmospheric deposition. In addition to direct inputs to surface water, the atmospheric deposition hits land surfaces and is carried into waterbodies with runoff. Mercury can be encountered in the environment as elemental mercury, ionic mercury, or divalent mercury. Bacteria can then transform the inorganic forms into methylmercury. Methylmercury is the form of primary concern for fish consumption advisories because this is the form in which the mercury is bioconcentrated and bioaccumulated into organisms. In the new criterion document, EPA focused on levels and exposure issues for methylmercury in the fish tissues. Key risk-based features in the new criterion guidance include the following:

- RfD for methylmercury is 0.1 µg/kgbw-d.
- RSC is 0.027 µg/kgbw-d exposure through fish consumption of 17.5 g/d.
- No "default" BAF (bioaccumulation factors) values are recommended—criterion is in µg/kg of fish tissue.
- The tissue-based criterion is 0.3 mg methylmercury/kg of fish.

EPA has a website with a wide range of useful information on mercury (www.epa.gov/mercury).

Water Quality Standards and Fish Advisories ("Apples and Oranges or One Kettle of Fish?")

Richard Greene of the Delaware Department of Natural Resources and Environmental Control provided a state perspective on the linkage between water quality standards and fish advisories. He highlighted major similarities and differences between two programs, noting that the major similarity is protecting public health from the consumption of contaminated fish, while the major difference is that standards are highly regulatory and advisories are largely nonregulatory. He further noted that the fundamental linkage between the two programs is the process of bioaccumulation. Building on this linkage, he emphasized the need for EPA to develop guidance on field-derived bioaccumulation factors (BAFs). Greene then went on to discuss how Delaware has linked water quality standards and fish advisories within the context of the Clean Water Act's TMDL listing requirements. Delaware's current listing rationale is that the issuance of a "no consumption" or "limited consumption" fish advisory constitutes a

violation of state water quality standards and warrants a TMDL listing. The TMDL process provides a framework for linking pollutant sources, mass loadings, fate and transport, bioaccumulation, and water quality standards; but this can be a complex and expensive process for PBTs. Greene concluded by recommending that state WQS program participants need to acquaint themselves with their fish advisory program counterparts and start a serious dialogue. They also need to establish common goals; improving water quality and lifting advisories can result from agency cooperation.

Water Quality Standards and Fish Advisories: Apples and Oranges, Most Definitely

Randall Manning of the Georgia Department of Natural Resources added to Richard Greene's presentation by outlining his state's perspective on what works and what is not working well enough in building linkages between WQS programs and fish advisory programs. Progress has been made over the past decade in establishing institutionalized dialogues between the two groups. There is still inconsistency between the way the WQS program makes "lists"—for TMDLs, for example—and the listing process used in most fish advisory programs. In Georgia and in other states, advisories are being forced to do work they were never intended to do. In some cases, this may lead to cutbacks in waterbody-specific tissue sampling and an overreliance on statewide advisories. Consistent national guidance needs to be developed with input from the states, and a more evenhanded way to interpret data is needed to ensure consistent applications across regions. There are tremendous differences between stringency of state fish consumption advisory programs and how that information is used by state WQS programs to list impaired waters. In Georgia, and in other states, advisories are being used in ways that were never intended. This unintended use of fish consumption advisories may have adverse impacts on existing advisory programs.

Part II

Fish Forum Agenda

National Forum on Contaminants in Fish

Events scheduled for May 5 - 9, 2001

Agenda

Saturday, May 5 Early arrival

Early arrival Chicago and Holiday Inn Chicago Mart Plaza
State and Tribal programs set-up for Risk Communication Displays/Posters

Sunday, May 6 National Forum on Contaminants in Fish

8:00 a.m. - 6:00 p.m.

Registration Check-In

State and Tribal programs set-up for Risk Communication Displays/Posters continues

10:00 a.m. -12:00 p.m.

Special Fish Advisory Program Regional Meetings

Breakout groups will be organized by geographic areas:

Great Lakes	*American Room*
Northeast	*Merchants Room North*
Chesapeake Bay/Delaware Estuary	*Merchants Room South*
South	*Mansion Room*
West	*Steamboat Room North and South*

Special Water Quality Standards Meeting *Shakespeare Room*

12:00 p.m. - 1:00 p.m.

Lunch - On your own

1:00 p.m. - 2:30 p.m.

Special Fish Advisory Program Regional Meetings

Breakout groups will be organized by geographic areas:

Great Lakes	*American Room*
Northeast	*Merchants Room North*
Chesapeake Bay/Delaware Estuary	*Merchants Room South*
South	*Mansion Room*
West	*Steamboat Room North and South*

1:00 p.m. - 4:00 pm.

Special Water Quality Standards Meeting *Shakespeare Room*

2:30 p.m. - 4:00 p.m. *Western Stagehouse Room*
Special Fish Advisory Program Regional Meeting - Summary Reports

4:00 p.m. - 6:00 p.m. *Sauganash Ballroom East*
Risk Communication Display Session - refreshments

6:00 p.m.
Dinner - On your own

Monday, May 7 National Risk Communication Conference

8:00 a.m. - 6:30 p.m. *Sauganash Ballroom West*

Tuesday, May 8 National Risk Communication Conference

8:00 a.m. - 5:00 p.m. *Sauganash Ballroom West*

Wednesday, May 9 National Forum on Contaminants in Fish

8:00 a.m. – 8:30 a.m. *Sauganash Ballroom East*
EPA Introduction/Welcome - Elizabeth Southerland, USEPA
Recap of Summary Reports from Sunday Fish Advisory Program Regional Sessions
Update on EPA Fish Contamination Program Activities

8:30 a.m. – 8:40 a.m.
Questions and Answers Session
Elizabeth Southerland, USEPA

8:40 a.m. – 10:00 a.m.
Mercury Update - Alan Stern, New Jersey Department of Environmental Protection, Kathryn Mahaffey, USEPA, Rita Schoeny, USEPA, Alan Levy, Food and Drug Administration,
Provide update on recent mercury policy and toxicological issues
NAS Report Update
EPA response to NAS report
FDA Mercury Advisory for Women and Children

10:00 a.m. – 10:20 a.m.
Questions and Answers Session on Mercury
Rita Schoeny, USEPA, Kate Mahaffey, USEPA, Alan Stern, New Jersey Department of Environmental Protection, Alan Levy, Food and Drug Administration

10:20 a.m. – 10:40 a.m.
Break

10:40 a.m. – 11:05 a.m.
PCBs Update - Deborah Rice, USEPA
Provide update on recent PCB policy and toxicological issues

11:05 a.m. – 11:30 a.m.
Dioxin Update - Dwain Winters, USEPA
Provide update on recent dioxin policy and toxicological issues
Update on dioxin reassessment

11:30 a.m. – 11:45 a.m.
Questions and Answers Session on PCBs and Dioxin
Deborah Rice, USEPA, Dwain Winters, USEPA

11:45 a.m. – 1:00 p.m.
Lunch

12:00 - 12:45 p.m. - **Luncheon speaker, Stuart Harris, Natural/Cultural Resources Coordinator Confederated Tribes of the Umatilla Indian Reservation - Impacts of fish contaminants on Native American culture**

1:00 p.m. – 1:15 p.m.
Arsenic Update - Rita Schoeny, USEPA
Provide update on recent arsenic policy and toxicological issues

1:15 p.m. - 1:20 p.m.
Linking Water Quality Standards and Fish Advisories -
Elizabeth Southerland, USEPA
Introduction

1:20 p.m. - 1:40 p.m.
Federal Overview of Fish Advisories and Water Quality Standards -
Thomas Armitage, USEPA, Susan Gilbertson, USEPA

1:40 p.m. - 2:10 p.m.
EPA's 2000 Methodology for Deriving Ambient Human Health Water Quality Criteria
Denis Borum, USEPA

2:10 p.m. - 2:20 p.m.
EPA's Section 304(a) Water Quality Criterion for the Protection of Human Health: Methylmercury -
Rita Schoeny, USEPA

2:20 p.m. - 2:50 p.m.

State Experiences Integrating Water Quality Standards and Fish Advisories -

Rick Greene, Delaware Department of Natural Resources and Environmental Control
Randy Manning, Georgia Department of Natural Resources

2:50 p.m. - 3:00 p.m.

Break

3:00 p.m. - 5:00 p.m.

Questions and Answers with the Federal/State Panel -

Elizabeth Southerland, USEPA - moderator
Tom Armitage, USEPA, Susan Gilbertson, USEPA, Denis Borum, USEPA, Rita Schoeny, USEPA, Mike Haire, USEPA, Randy Manning, Georgia Department of Natural Resources
Rick Greene, Delaware Department of Natural Resources and Environmental Control

Closing Remarks

Betsy Southerland, USEPA

Part III

Presentation Materials

USEPA's
National Fish and Wildlife Contamination Program

Office of Science and Technology
United States Environmental Protection Agency

USEPA's Fish and Wildlife Contamination Program

- **Provides technical assistance to State, Tribal and Federal agencies on matters related to health risks associated with exposure to chemical contaminants in fish and wildlife**

- **Current Activities include:**
  - **National Guidance Documents**
    - **Volumes 1 and 2, Third Editions: Published November 2000.**
  - **National Surveys and Databases**
    - **2000 Update of NLFWA**
    - **2000 Survey of State Advisory Programs: Complete by Summer 2001**

USEPA's Fish and Wildlife Contamination Program

- Current Activities (cont'd):
  - National Conferences and Workshops
    - Proceedings Document from 1999 AFS/EPA Forum (online at: www.fisheries.org)
    - National Risk Communication Conference/2001 Forum:
      - Proceedings by Fall 2001
  - Grants for Sampling and Analysis
    - Four 25-35K State Grants Issued in FY00/01: WY, MS, AZ, WV
  - Conduct Special Studies
    - Comparative Dietary Risk
  - National Mercury Advisory

USEPA's Fish and Wildlife Contamination Program

- Proposed FY02 Activities:
  - National Conferences and Workshops
    - 2002 Forum
  - Grants for Sampling and Analysis
    - Hope to provide limited number small grants in FY02
  - Special studies
    - Pursue research needs with EPA/ORD on Comparative Risk Project
  - Continue with National Outreach to Medical Community
  - New National Guidance
    - Second Edition to Volume 4: Risk Communication
    - New National Guidance on Assessing Effectiveness of Advisory Programs
  - New Website Features (www.epa.gov/ost/fish
    - Current News and Events
    - Outreach Materials From Risk Communication Conference
  - USEPA National Lake Study Program
    - Update

THE NATIONAL RESEARCH COUNCIL'S REPORT ON

TOXICOLOGICAL EFFECTS OF METHYLMERCURY

Alan Stern

Committee on Toxicological Effects of Methyl Mercury

- **Robert A. Goyer (Chair)**, University of Western Ontario
- **H. Vasken Aposhian**, University of Arizona
- **Lenore Arab**, University of North Carolina
- **David C. Bellinger**, Harvard Medical School
- **Thomas M. Burbacher**, University of Washington
- **Thomas A. Burke**, The Johns Hopkins University
- **Joseph L. Jacobson**, Wayne State University
- **Lynda M. Knobeloch**, State of Wisconsin Bureau of Environmental Health
- **Louise M. Ryan**, Harvard School of Public Health and Dana-Farber Cancer Institute
- **Alan H. Stem**, New Jersey Department of Environmental Protection

Sponsor of Study

U.S. Environmental Protection Agency (EPA)
(requested by U.S. Congress)

Background to Study

- **Hg is widespread and persistent in the environment**
- **EPA identified fossil-fuel power plants (coal-fired utility boilers) greatest source of Hg emissions**
- **MeHg can accumulate up food chain in aquatic systems**
- **Consumption of contaminated fish major source of MeHg exposure in U.S.**
- **Well-documented population poisonings, high-level occupational exposures, and world wide chronic low-level environmental exposures**
- **Because of data gaps, Congress directed EPA to request NAS to perform an independent study**

Committee's Charge

- **Evaluate evidence that led to EPA's RfD for MeHg determine if critical study, end point of toxicity and uncertainty factors (UFs) are appropriate**
- **Evaluate new data not considered in 1997 Mercury Study Report to Congress**
- **Consider exposures in environment that support evaluation of likely human exposures (especially subpopulations and consumption of fish)**
- **Identify data gaps and make recommendations for future research**

Committee's Approach To Its Charge

- **Evaluated body of scientific basis for risk assessments conducted by EPA and other agencies**
- **Evaluated new findings since EPA developed RfD**
- **Met with investigators of major ongoing epidemiological studies**
- **NOT charged to calculate RfD, but provided scientific guidance to EPA**

Committee's Approach To Its Charge

- Reviewed effects of MeHg to determine target organ, critical study, end point of toxicity, and dose for RfD
- Evaluated appropriateness of biomarkers for estimating dose
- Evaluated sources of uncertainty for RfD
- Statistically analyzed available dose-response data
- Performed margin of exposure analysis to assess public-health implications of MeHg

Current RfD

- Based on neurodevelopmental effects seen following poisoning in Iraq (Marsh et al. 1987)
- Calculated a benchmark dose of 11 ppm Hg in hair (corresponds to intake dose of 1 μg/kg-d)
- Composite UF of 10:
  - 3 for variability in human population (half-life and hair-to-blood ratio)
  - 3 for lack of two-generation reproductive study and data on effect of exposure duration on sequelae of developmental neurotoxicity and adult paresthesia
- RfD of 0. 1 μg/kg-d

Health Effects

- Neurodevelopmental effects in animals similar to those seen in humans
- Also evidence in humans and animals for:
  - adverse effects on developing and adult cardiovascular system *some evidence shows effects at or below levels for neurodevelopmental effects*
  - immunotoxicity
- Committee concludes neurodevelopmental deficits most sensitive, well documented effects, and currently most appropriate for derivation of RfD

Health Effects, *continued*

- Extensive data on effects of MeHg on development of brain
- Most severe effects in humans following high-dose poisoning episodes (Japan and Iraq):
  Mental retardation, cerebral palsy, deafness, and blindness in individuals exposed *in utero*
- Chronic, low-dose prenatal MeHg (maternal consumption of fish) associated with subtle end points of neurotoxicity in children:
  Tests of attention, fine-motor function, language, visual-spatial abilities, and verbal memory

Health Effects, *continued*

- Two studies found associations between MeHg exposure:
  New Zealand (Kjellstrom et al.)
  Faroe Islands (Grandjean et al.)
- One study did not find associations:
  Seychelles Islands (Clarkson et al.) All 3 studies well designed and carefully conducted, examining exposures within range of general U.S. population exposures

Choice of Critical Study

- Large body of evidence showing adverse neurodevelopmental effects, RfD should not be derived from a study that did not observe associations (i.e., Seychelles Islands study)
- Advantages of Faroe Islands study over New Zealand study include larger study population, the use of two measures of exposure, and more extensive peer review in epidemiological literature, in 1998 NIEHS workshop, and in response to committee's questions
- Given strengths of Faroe Islands study, it is most appropriate study for deriving RfD

Dose-Response Assessment

- Because data from Faroe Islands study is measured on continuous scale, no widely accepted procedure for determining a dose with no adverse effect. Therefore, statistical approach should be used to determine point of departure - i.e., calculation of benchmark dose
- Benchmark dose is the lowest dose, estimated from the modeled data, that is expected to be associated with a small (5%) increase in the incidence of adverse outcome

Dose-Response Assessment, *continued*

- Dose response data based on Hg concentrations in cord blood should be modeled using K-power model (K>1)
- Most sensitive reliable endpoint from that study is the Boston Naming Test
- Based on single endpoint, Faroe Island study
  BMDL = 58 ppb Hg in cord blood (12 ppm in hair)
- Integrative analysis using data from all 3 studies is consistent (but not recommended as sole basis of RfD because of exploratory nature)

Dose Estimation

- Exposure to MeHg can be estimated from dietary records or by measuring concentration of Hg in blood or hair
- Use of two or more measurement methods increases likelihood of uncovering true dose-response relationships
- Use of umbilical-cord-blood or maternal-hair Hg concentrations as biomarkers of exposure is adequate for estimating dose
- Differences between toxicokinetics in individuals creates uncertainty:
  An uncertainty of 2-3 would account for individual differences in the estimation of dose in 95% to 99% of the general population

Committee's Recommendations

- Value of EPA's current RfD (0.1 µg/kg-d) is a scientifically appropriate level that adequately protects public health
- Iraqi study should no longer be used as scientific basis of RfD
- RfD should be based on neurodevelopmental effects
- Faroe Island study should be used as critical study for derivation of RfD
- Most sensitive reliable endpoint from that study is the Boston Naming Test

Committee's Recommendations, *continued*

- **Dose response data based on Hg concentrations in cord blood should be modeled using K-power model (K≥1)**
- **Yields a BMDL of 58 ppb Hg in cord blood: Corresponds to a BMDL of 12 ppm of Hg in hair as a point of departure for derivation of RfD**

Committee's Recommendations, *continued*

- BMDL should be divided by uncertainty factors to account for toxicokinetic variability
- Factor of 2-3 would account for toxicokinetic variability in 95% to 99% of the general population
- Database insufficiencies: include possible sequelae and latent effects, immunotoxicity, and cardiovascular effects
- Considering the toxicokinetic variability and what is known about database insufficiencies, the committee supports an overall composite uncertainty factor of at least 10

Annual Number of Newborns at High Exposure Risk

US population of women aged 15 to 44 years[1]	60,208,000
Percent reporting fish consumption[2]	30.5%
Female fish consumers aged 15 to 44 years	18,363,440
Highest 5 percent – consuming 100 g/day	918,172
Birth rate for women aged 15 to 44 years [3]	65.6 per 1,000
Annual number of newborns at high exposure risk	60,232

1 Population Estimates Program, U.S. Census Bureau, POPULATION@CENSUS.GOV December 23, 1999
2 Continuing Surveys of Food Intake by Individuals, 1989/1990
3 National Center for Health Statistics, National Vital Statistics Report, Vol. 48, No. 3, March 2000

Current Developments, Questions and Issues

- **NHANES Hg biomonitoring**
- **RfD equivalent to ~1.0 ppm in maternal hair**
- **>10% of women of childbearing age in the U.S. exceed 1.0 ppm in hair**
- **consistent with estimates in report (NJ, and EPA)**
- **consistent with MOE estimates (based on BMDL) of <10 for 95th percentile**

Current Developments, Questions and Issues, *continued*

- **PCBs**
- **Associated with adverse neuro-developmental performance**
- **Significant exposure**
- **Cord tissue PCB measure difficult to assess**
- **Little or no apparent change in Hg effect for BNT (or others due to PCB exposure**

Current Developments, Questions and Issues, *continued*

- **Maternal blood/cord blood mercury ratio**
  - **BMD is based on cord blood**
  - **UF for biomarker dose conversion based on pharmacokinetic modeling to maternal blood**
  - **Report cited data suggesting maternal cord ratio = 1.0**
  - **More detailed review suggests mean ration of 1.3 or greater**
  - **Suggests that UF for variability in biomarker-dose conversion may be insufficient**

Current Developments, Questions and Issues, *continued*

- Implication of large short-term exposures for fish consumption advisories
  - **Data are reported as average over 3-9 months**
  - **Precludes quantifying dose-response for shorter exposure periods**
  - **Most consumption advisories based on averaging intake over a month** *(i.e., one month's intake of 180 µg for 60 kg woman can be consumed in one day)*
  - **What is the RfD based on one-day exposure?**
  - **Need dose-response data based on continuous strand hair analysis**

Current Developments, Questions and Issues, *continued*

- Should there be a separate RfD for the "general population"?
  - **"Old" RfD for "general population" based on non-developmental effect (paraesthesia)**
  - **Report UF includes consideration of non-developmental (adult) effects (cardiovascular, immunotoxic)**
  - **Therefore 0.1 µg/kg/day might be considered necessary for the protection of the "general population"**
  - **However, NRC committee did not quantitatively consider non-developmental effects**
  - **Appropriate to address adult endpoints directly (cardiovascular studies, Amazon studies)**

Methylmercury: Developing the 2001 Reference Dose

Kathryn R. Mahaffey, Ph.D.
U.S. Environmental Protection Agency, Washington, D.C.

NRC Committee on Toxicology Recommendations for the RfD

- Neurodevelopmental delays and deficits are currently considered to be the critical effect.
- *Cohort studies from three geographic areas were considered: the Seychelles Islands, New Zealand, and the Faroe Islands.*
- The Reference Dose should be set based on Faroe Islands' cohort data.

NRC Preferred BMDL

- 58 ug/L cord blood.
- *Estimated 11 ppm [Hg] in maternal hair.*
- Corresponds to ~ 1 ug/kgbw/day dietary intake of methylmercury.

Determining the RfD from the "Benchmark Dose" Level

- The recommended model is essentially a linear model.
- An uncertainty factor (UF) should not be less than 10.

US EPA's Time Line in Setting the Revised RfD - 2001

- Report published by NRC Committee on Toxicology of Methylmercury – July 2000.
- *Background Review Document for RfD completed October 15, 2000 – Rita Schoeny, Deborah Rice & Kate Mahaffey.*
- Peer Review Panel Meeting on 11/15/00. *Peer reviewers:* Kim Dietrich, Bruce Fowler, Gary Ginsberg, Martha Keating, Chris Newland, Pam Shubat, and Andy Smith.
- *Peer Review Comments Incorporated.*
- Human Health Criterion for Methylmercury published in Federal Register January 15, 2001.

Estimating a Benchmark Dose

- A statistical procedure called *"benchmark dose"* should be used.
- The *"benchmark dose level"* (BMDL) is the lowest dose, estimated from the modelled data, that is expected to be associated with an increase in the incidence of adverse outcomes.

EPA's RfD for Methylmercury is based on:

- Several scores from the Faroese cohort's measurements: Continuous Performance Test (CPT), Boston Naming Test (BNT), California Verbal Learning Test (CVLT).
- *Supporting scores from the New Zealand study, McCarthy Perceived Performance (MCCPP) and McCarthy Motor Test (MCMT).*
- Integrated analysis of Faroese, New Zealand, and Seychelles – from NAS Mercury Report.

EPA's RfD for Methylmercury

- BMDL's are not a NOAEL equivalent.
- *Within the Faroese cohort data, statistically significant associations between maternal hair [Hg] and test scores remain at [Hg] < 10 ppm.*
- BMDL reflects maternal hair [Hg] of 11 ppm.

EPA's RfD for Methylmercury is based on:

- *An increase in the prevalence of clinically subnormal scores from 5% to 10%.*
- All endpoints converge on an RfD of 0.1 ug/kgbw/day. With and without adjustment for PCB exposures within the Faroese cohort.

EPA's RfD for Methylmercury

- Basis for the UF of 10:

  Three-fold for toxicokinetics:

  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.

  Three-fold for toxicodynamics.

EPA's RfD for Methylmercury

- Not included in the UF:

  Cardiovascular Effects

  Reproductive Effects

  Persistent and Delayed Neurotoxicity.

EPA's RfD for Methylmercury is based on:

- Neuropsychological tests that indicate neuropsychological processes involved with a *child's ability to learn and process information.*
- ***Doubling*** the risk of scores in a range considered *clinically subnormal.*

EPA's RfD for Methylmercury

Critical Effect	*Experimental Doses*	*UF*	*MF*	*RfD*
Developmental neuropsychological Impairment Human epidemiological Studies (Grandjean et al., 1997; Budtz-Jorgensen et al., 1999).	BMDDL range 32-79 ug/L Maternal blood for neuropsychological effects in offspring at 7 years of age. Maternal daily intakes between 0.596 and 1.472 ug/kgbw/day	10	1	1E-4 mg/kg/day (0.0001 mg/kg/day)

NHANES IV-99 Blood Mercury
Women Ages 16 – 49 Years

Blood Hg Ug/L	*Number of Subjects*	*50th Percentile*	*90th Percentile*
Women	679	1.2 (0.8 – 1.6)	6.2 (4.7 – 7.9)

Methylmercury: Dose Response

Blood Mercury	*Response*
< 5 ug/L	Without measurable adverse effect - RfD
~ 5 to ~58 ug/L	Following *in utero* exposure increasing probability of subnormal scores on neuro-developmental tests as blood levels increase from 5 to 58 ug/L. At BMDL of 58 ug/L doubling of the prevalence of test scores (i.e., from 5% to 10%) in the clinically subnormal range.
~ 58 to 200 ug/L	Increased likelihood of subnormal scores on neurodevelopmental tests following *in utero* exposures. Adults experience visual and motor problems. At 200 ug/L ~ 5% of adults experience paresthesias.

Blood and Hair Mercury Levels in the US

- Local data on blood mercury levels from Wisconsin and Arkansas.
- Hair mercury data from 12 states.
- Additional states data cited in US EPA's *Mercury Study Report to Congress* released in 1997.

Next Steps in Assessing Occurrence of Elevated Blood and Hair Mercury Levels in the United States

Considering a workshop on reports of cases and patients with elevated levels.

Contact: 'e' mail for Kate Mahaffey

<mahaffey.kate@epa.gov>

Methylmercury

Rita Schoeny

EPA RfD -- Issues and Use

NAS Report, Public Health

- " The population at highest risk is the children of women who consumed large amounts of fish and seafood during pregnancy. ... the risk to that population is likely to be sufficient to result in an increase in the number of children who have to struggle to keep up in school and who might require remedial classes or special education."

NAS Report --

- "...the risk of adverse effects from the current MeHg exposures in the majority of the population is low. However, individuals with high MeHg exposures from frequent fish consumption might have little or no margin of safety (i.e. , exposures of high-end consumers are close to those with observable effects)."

RfD 2001

- RfD = 0.1 μg/kg/day
- Based on NRC and external scientific input
- BMDL of 1.0 μg/kg/day -- from neuropsychological effects in Faroese children exposed *in utero* through maternal seafood consumption
- No data to support separate RfD for children
- Applicable to lifetime daily exposure for all populations including sensitive subgroups; not restricted to pregnancy or developmental periods

Are adults at risk from methylmercury?

- Definition
- Uncertainty analysis
- Documented effects in adults

RfD Definition

- An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious health effect during a lifetime.

Uncertainty analyses MSRC 1997

- Monte Carlo approach to measure uncertainty and variability in endpoints
  - Iraqi adults – paresthesia
  - Iraqi children – all neurodevelopmental effects
- Overlapped
  - Both rather gross effects

Effects in adults

- Fish-eating populations in the Amazon
  - Lebel et al. (1996) – decreased manual dexterity ♀, reduced color discrimination, near visual contrast sensitivity, peripheral vision ♂ ♀
  - Lebel et al. (1998) manual dexterity, alternating hand coordination, muscular fatigue, visual effects
  - Dolbec et. al. (2000) – neurobehavioral changes; median mercury 9 ppm.

Effects in adults -- 2

- Cardiovascular effects
  - Salonen et al. (1995)
  - 1833 Finnish men
  - Over 7-year period men with hair Hg of 2 ppm or higher had 2-fold greater risk of acute myocardial infarction

Effects in adults -- 3

- Minamata population
  - Kinjo et al. (1993) – high prevalence of sensory disturbance and deficits in "acts of daily living"; prevalence relatively greater in Minamata group compared with appropriate age control group
  - Fuluda et al. (1999) – increased symptoms in Hg area adults (not MD patients)
    - Heart palpitation, dysthesia, staggering, hand tremors, dizziness, tinnitus, pain in legs and hands

Support from animal studies

- Newland & Rasmussen (2000) postpartum exposure in rats led to decline in motor performance task
- Rice et al. (3 studies) – accelerated aging of sensory system function in monkeys exposed developmentally.

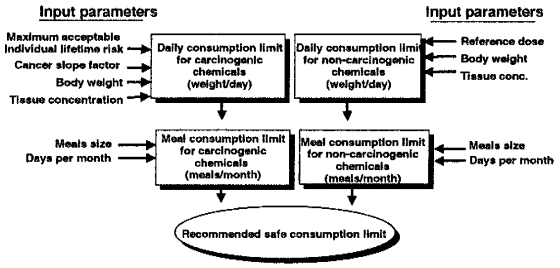
Uses of RfD

- Criterion development – published 1/01
- Other EPA regulatory or risk management activities
- Basis for fish advisories

Risk-Based Fish Consumption Limits

- Limits are intended to protect human health by limiting exposure to chemical contaminants in fish tissue
- Provide guidance on the maximum number of meals of fish from a defined area that can be eaten, over a specified time period, by defined groups of consumers.

Calculation of Safe Consumption Limits



Recommended Fish Meals per Month
Based on Methyl Mercury Fish Tissue Levels
based on *USEPA* Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories

$$CR_{lim}\ (kg/day) = \frac{RfD \times BW}{C_m} \quad \text{(Eq. 3-3)}$$

- CR_{lim} = Maximum allowable daily fish consumption rate (kg/day)
- RfD = Reference dose (.0001 mg/kg-day)
- BW = Consumer body weight (65 kg)
- C_m = Measured concentration of chemical contaminant "m" in a given species of fish (mg/kg)

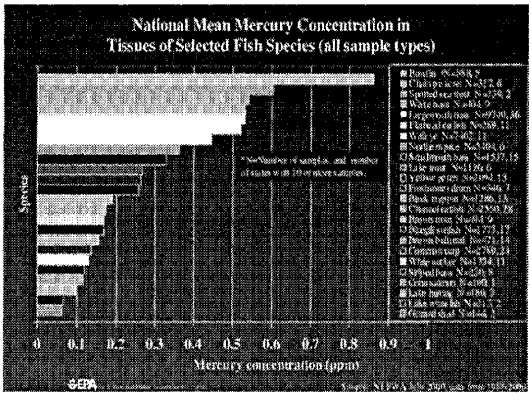
Recommended Fish Meals per Month
Based on Methylmercury Fish Tissue Levels
based on *USEPA* Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories

$$CR_{mm}\ (meals/month) = \frac{CR_{lim} \times T_{ap}}{MS} \quad \text{(Eq. 3-2)}$$

- CR_{mm} = Maximum allowable fish consumption rate (meals/month)
- CR_{lim} = Maximum allowable daily fish consumption rate (kg/day)
- T_{ap} = Time averaging period (365.25 days/12 months = 30.44 days/month)
- MS = Meal size (0.227 kg fish/meal)

Recommended Fish Meals per Month
Based on Methymercury Fish Tissue Levels
based on *USEPA* Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories

MeHg Fish tissue levels (mg/kg)	Meals (8 oz) per Month
.1	9
.2	4.5
.3	3.0
.4	2.3
.5	1.8
.6	1.5
.7	1.3
.8	1.1
.9	1



National Freshwater Fish Advice -- 1

- Developed in concert with FDA
  - Released 12/00; revised 3/01
- Target -- women who are
  - Pregnant
  - Could become pregnant
  - Nursing
  - Feeding a young child

National Freshwater Fish Advice -- 2

- Limit consumption of freshwater fish caught by family and friends
  - One meal /week
  - Meal
    - **Adult -- 6 ounces cooked, 8 ounces uncooked**
    - **Child --2 ounces cooked, 3 ounces uncooked**
- Check with state or local health department for advice on waters where friends /family fish
- Follow FDA advice for ocean, commercial

Methyl Mercury

Consumer Advisory

FDA Consumer Advisory is not a State or Local Fish Advisory

- Directed mainly at fish consumers, not fishermen.
- Talks about the hazard of mercury, not other contaminants
- Focuses mainly on commercial fish, not sport-caught fish.
- Framed as a food safety problem more than as an environmental problem.

Purpose of Focus Groups

- Determine the communication environment for effective messages.
  - Comprehensible
  - Distinctive
  - Relevant
  - Credible

Information Objectives

- Who is the perceived target audience?
- What do consumers already know?
- What do they readily understand?
- What are they likely to misunderstand?
- What do they perceive to be the relevant information they need to know, but don't.

Communication Environment for Methylmercury Fish Advisories

- General population is not very aware of a mercury hazard in fish.
  - People who fish, who are heavier fish eaters, are more familiar with hazard, probably because they have seen consumer advisories.
  - Casual fish eaters are surprised and impressed when they hear about hazard.
- If it is a problem for pregnant women, it's a problem for everyone.

Communication Environment for Methylmercury Fish Advisories

- Once hazard is known, the first question is "What fish are OK to eat?"
  - Consumers want to avoid fish high in mercury and eat fish low in mercury.
  - Messages about limiting consumption are seen as "do not eat" messages.
  - Many consumers, particularly pregnant women, see fish as a dispensable part of the diet.

Communication Environment for Methylmercury Fish Advisories

- Consumers, particularly non-fisherman, have weak knowledge of the similarities and differences between fish.
  - They know what they eat by name, but most don't eat many kinds of fish.
  - They don't know which fish are large or small, bottom feeders or predators.
  - They don't even reliably know which fish are freshwater or marine.

Communication Environment for Methylmercury Fish Advisories

- Quantitative dietary advice about how much fish to eat does not seem practically relevant to many consumers.
  - They don't think its relevant because they don't eat that much fish.
  - They don't think its relevant because the advice doesn't say it covers fish they typically eat.

Communication Environment for Methylmercury Fish Advisories

- Consumers want to know more about
  - how mercury gets into fish
  - how to tell whether certain fish are high in mercury
  - the health effects of mercury
- General principles and rules of thumb.

Conclusions from focus group

- Easy to make consumers aware of MeHg hazard.
- Easy to identify specific fish they should avoid.

Conclusions from focus group

- Hard to get them to see distinctions between different kinds of fish.
- Hard to give them quantitative advice because their understanding of it depends importantly on the amount and type of fish they already eat.

Methyl Mercury (MeHg) Consumer Advisory

- Message for Women Who:
  - Are Pregnant; or
  - May Become Pregnant

Rationale

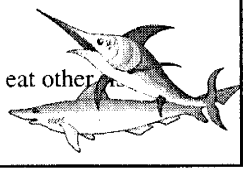
- Prompted by NAS/NRC Report
- Conservative:
  - Minimize/Prevent Body Burden Increase

Balance

- Minimize MeHg Risks
- Mindful of Seafood's Health Benefits
- Easy solution is to avoid high mercury fish.

Avoiding Harmful Levels
that Could Harm an Unborn Child

- Don't eat fish that have high MeHg levels such as
  - Shark
  - Swordfish
  - King Mackerel
  - Tilefish
- Large long-lived fish that eat other fish



As a matter of prudence

- Nursing Mothers,
- Young Children Should also Avoid these fish.

Quantitative Advice

- You can eat 12 ounces per week, on average, of other species as long as you eat a variety of species.
- Chronic consumption level, not isolated splurging, is the issue.

Fresh Water Fish/Sport Caught Fish

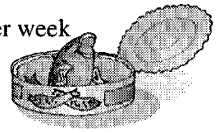
- Treated as a separate issue, under the jurisdiction of
- EPA
- State or Local Health Authorities

High Mercury Fish Designation

- Based on species average MeHg levels, not on action levels.
- Revised advisory added:
  - King Mackerel
  - Tilefish

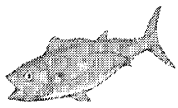
Why Not Canned Tuna?

- Most frequently consumed commercial species BUT
- Average MeHg levels are not that high.
- Consumption data shows lower than anecdotal indications
- 99th percentile = 7 oz. Per week



What About Fresh Tuna?

- MeHg Levels closer to canned tuna than shark and swordfish
- Consumption not high



Advisory's Goal

- Balanced Diet of Seafood Consumption
- Keep MeHg Levels Low

"Safe" Fish: Considerations

- MeHg Levels
  - Most species: trace to 0.5 ppm
- U.S. Consumption Patterns
  - Canned Tuna
  - Shrimp
  - Catfish

"Safe" Fish Amounts
for At-Risk Populations

- Include 12 ounces per week cooked
- Consistent with American Heart Association recommendations

Outreach and Education

- General and specialized media
- Physicians, nurses, health departments
- Membership organizations
- "Grass roots" education to high fish eating populations

Evaluation: FDA Consumer Survey

Measures consumer trends on food safety knowledge, attitudes, and behaviors

Conclusion

- FDA's Advisory
  - Simple and Direct Message
  - Targeted to At-Risk Group – Pregnant Women
  - Based on Best Available Data

Noncancer Risk Assessment for PCBs

Deborah C. Rice
National Center for Environmental Assessment
Office of Research and Development
U.S. Environmental Protection Agency
Washington, D.C.

Current Regulatory Levels

EPA—IRIS 1996

Aroclor 1254

Tryphonas *et al.*, 1989, 1991	LOAEL = 5 ug/kg/day
Immune effects	UF = 300
	RfD = 0.02 ug/kg/day

Aroclor 1016

Barsotti & Van Miller, 1987	LOAEL = 28 ug/kg/day
Schantz *et al.*, 1989, 1991	NOAEL = 7 ug/kg/day
Behavioral effects	UF = 100
Decreased birth weight	RfD = 0.07 ug/kg/day

Current Regulatory Levels

ATSDR—Tox Profile 2001

Chronic

Tryphonas *et al.*, 1989, 1991	LOAEL = 5 ug/kg/day
Aroclor 1254	UF = 300
Immune effects	MRL = 0.02 ug/kg/day

Intermediate

Rice & colleagues	LOAEL = 7.5 ug/kg/day
Breast milk mixture	UF = 300
Behavioral effects	MRL = 0.03 ug/kg/day

General Goals/Strategy for Assessment

1. Identify the most sensitive organ systems, endpoints, and studies
2. Draw any conclusions possible concerning the relative toxicity of different congener classes (i.e., dioxin- vs. non-dioxin-like, lightly vs. highly chlorinated)
3. Provide guidance relevant to specific situations (site-specific, food advisories) based on above information

Expert Committee for Hazard Identification EPA 2001

Area	Chapter author/EPA manager
congener patterns in media and tissue	David Cleverly
metabolism	Jim Olson/Jerry Blancato
hepatic	Larry Hansen/Gary Foureman
immuno	Alan Silverstone/Ralph Smialowicz
endocrine – animal	Larry Hansen/Amy Mucha
endocrine – human	Vicky Persky/Amy Mucha
repro-developmental	Dick Peterson/Gary Kimmel
neuro	Sue Schantz/Deborah Rice

Major Health Effects

Reproductive	***human (epidemiological)***, animal
Immune deficiency	***human (epidemiological)***, animal
Neurotoxicity	***human (epidemiological)***, animal
Thyroid effects	***human (epidemiological)***, animal
Physical development	animal, human at high doses
Effects on metabolism	humans, animals

Strategy for Hazard Characterization

- Based on epidemiological data for relevant studies
  - quantitative analysis
- Based on blood or other tissue levels
  - requires dose conversion

TEQ Approach

- Ah receptor activation (CYP1A1, EROD induction, *in vivo* effects)
  - planar and mono-ortho PCBs
  - Suitable for immunotoxicity, reproductive effects, physical development
- Ryanodine receptor activation
  - different potency than for Ah receptor activation
  - di- and tri-ortho PCBs
  - involved in calcium regulation in many organs
  - found in high concentrations in brain
  - not correlated very well with behavioral effects

Some Conclusions Regarding Congener-Specific Toxicity

- For immunotoxicity, TEQ approach will probably provide protection for all PCBs
- For reproductive effects and physical development of offspring, TEQ approach will probably provide protection for all PCBs
- For developmental neurotoxicity, both dioxin- and non-dioxin-like congeners are active, TEQ approach is inappropriate
- For thyroid effects, both congener classes are active
- For all endpoints, available evidence does not suggest differential toxicity for lightly vs. highly chlorinated congeners

Conclusions for Cleanup/Health Advisories

- Both dioxin- and non-dioxin-like PCBs have health effects
  - can't use TEQ to make decisions
  - developmental neurotoxicity is a critical effect
- Both lightly and highly chlorinated PCBs have health effects
  - no evidence that one is more toxic than the other for noncancer effects

Comparison of Some PCB Congeners in Aroclor, Fish and Humans

Persistent PCB Congeners	Aroclor 1260	Lake Ontario Salmon	American Breast Milk	Blood Lake Ontario Fish Consumers
	%	%	%	ppb lipid
28	0.04	<3	8.80	n/a
101	2.50	1.9	0.97	n/a
118	0.49	9.4	6.50	26.5
138	6.50	8.6	10.00	102
149	7.40	4.5	nd	n/a
153	9.60	5.4	12.00	126
170	6.80	2.4	5.30	44.7
180	9.10	3.2	5.30	97.5
183	2.30	<3	1.40	n/a
202	1.20	<3	0.37	n/a

Analysis of PCB Levels in Fish

- Aroclor pattern does not match that in fish tissue — 1260 or 1254:1260 better than 1254
- Congener-specific — expensive and accurate
  - not need information on individual congeners
- Can we choose a few congeners to analyze?
  - choice restricted by methodology (packed column GC)
  - co-elution, ratios may vary for different sites
- Use PGC and total all congeners
  - other contaminants
- Convert all PCBs to decachlorobiphenyl and use PGC to quantitate (EPA Method 508A)
  - chlorinates biphenyl

DIOXIN

U. S. Environmental Protection Agency's Reassessment of Dioxin and Related Compounds

Dwain Winters
Director Dioxin Policy Project
Office of Pollution Prevention and Toxics
202 260 8558
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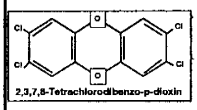
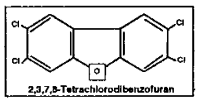
Dioxin-Like Compounds
Similar Structures -- Similar Toxic Properties



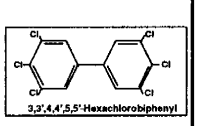
Dioxins
75 congeners

2,3,7,8-TCDD
1,2,3,7,8-PeCDD
1,2,3,4,7,8-HxCDD
1,2,3,6,7,8-HxCDD
1,2,3,7,8,9-HxCDD
1,2,3,4,6,7,8-HpCDD
1,2,3,4,6,7,8,9-OCDD



Furans
135 congeners

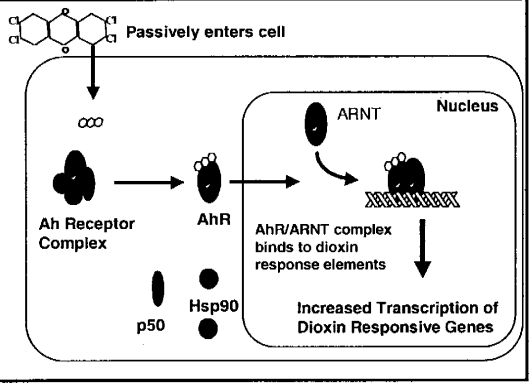
2,3,7,8-TCDF
1,2,3,7,8-PeCDF
2,3,4,7,8-PeCDF
1,2,3,4,7,8-HxCDF
1,2,3,6,7,8-HxCDF
1,2,3,7,8,9-HxCDF
2,3,4,6,7,8-HxCDF
1,2,3,4,6,7,8-HpCDF
1,2,3,4,7,8,9-HpCDF
1,2,3,4,6,7,8,9-OCDF



PCBs
209 congeners

3,3',4,4'-TeCB
3,3',4,4',5-PeCB
3,3',4,4',5,5'-HxCB

Mechanism of Action of Dioxin



Dioxin-like Compounds are High Potency *Human* or *Likely* Human Carcinogens

TCDD ➔ Characterized as a human carcinogen
Others ➔ Likely to be carcinogenic

Based on:

- Unequivocal animal carcinogen
- Limited human information (epidemiologic/other)
- Mechanistic plausibility

Cancer potency increasing with focus on human studies

Note: **In February 1997, the International Agency for Research on Cancer (IARC) classified 2,3,7,8-TCDD as a Category 1, "Known" human carcinogen; HHS/ROC proposed the same in 1999**

Dioxin-like Compounds are Receptor-Mediated Noncancer Toxicants in Animals and Humans

- ➔ Developmental Toxicity
  - ***Targets:***
    - ➢ Developing Immune System
    - ➢ Developing Nervous System
    - ➢ Developing Reproductive System
- ➔ Immunotoxicity
- ➔ Endocrine Effects
- ➔ Chloracne
- ➔ Others

Current Dioxin Exposure/Body Burdens

➔ *Environmental Exposure*

- **~ 1 PG TEQ/Kg/Day (PCDDs/PCDFs/PCBs)**
- **Possible Higher Intake Populations**
  - **Nursing infants**
  - **Fatty Diet**
  - **Some subsistence fishermen and farmers in proximity to contamination**

Four of 17 toxic CDD/CDF congeners and one of the 11 toxic PCBs account for most of the toxicity in human tissue concentrations

2,3,7,8-TCDD
1,2,3,7,8-PCDD,
1,2,3,6,7,8-HxCDD
2,3,4,7,8-PCDF
PCB 126.

These five compounds make up about 80% of the total TEQ in human tissue

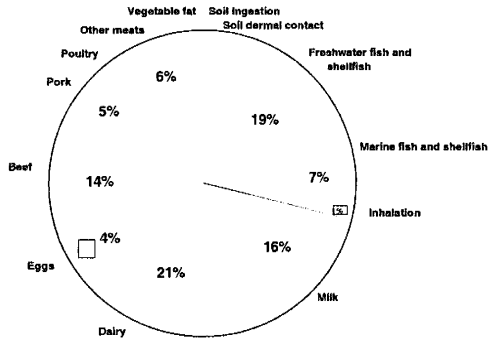
Risks To General Population From Exposure to Dioxins

- Upper Bound Cancer Risk From Mean General Population Exposure --- $1x10^{-3}$
- Adverse Non-cancer Effects Observed Within 10X of Background

Pathways and Sources of Human Exposures

- **Pathways:**
  - → **Ingestion of soil, meats, dairy products, fish**
  - → **Inhalation of vapors and particulates**
  - → **Dermal contact with soil**
- **Sources:**
  - → **Combustion**
  - → **Metal Smelting, Refining, Processing**
  - → **Chemical manufacturing**
  - → **Biological and Photochemical Processes**
  - → **Reservoir sources**

BACKGROUND EXPOSURE DIOXIN-LIKE COMPOUNDS



Estimated Dioxin/Furan Mean Background Exposure

Media	Conc. (TEQ$_{DF}$-WHO$_{97}$)	Intake Rate	Daily Intake (mg/kg-day)	Daily Intake (pg/kg-day)	% of Total
Soil ingestion	0.3 ppt[a]	50 mg/day	8.6×10^{-12}	8.6×10^{-3}	1.1
Soil dermal contact	0.3 ppt	12 mg/day	1.5×10^{-12}	1.5×10^{-3}	0.3
Freshwater fish and shellfish ingestion	1.0 ppt	5.9 g/day	8.4×10^{-12}	8.4×10^{-3}	13.9
Marine fish and shellfish ingestion	0.26 ppt	9.6 g/day	3.6×10^{-12}	3.6×10^{-3}	5.9
Inhalation	0.12 pg/m^3	19.3 m^3/day	2.3×10^{-12}	2.3×10^{-3}	3.7
Water ingestion	0.00056 ppq	1.4 L/day	1.1×10^{-14}	1.1×10^{-5}	<0.01
Milk ingestion	0.015 ppt	175 g/day	4.5×10^{-11}	4.5×10^{-2}	7.4
Dairy ingestion	0.12 ppt	55 g/day	9.4×10^{-11}	9.4×10^{-2}	15.5
Eggs ingestion	0.081 ppt	0.24 g/kg/day	1.9×10^{-11}	1.9×10^{-2}	3.2
Beef ingestion	0.18 ppt	0.71 g/kg/day	1.3×10^{-10}	1.3×10^{-1}	21.0
Pork ingestion	0.26 ppt	0.22 g/kg/day	6.2×10^{-11}	6.2×10^{-2}	10.1
Poultry ingestion	0.065 ppt	0.50 g/kg/day	3.4×10^{-11}	3.4×10^{-2}	5.6
Other meat ingestion	0.16 ppt[b]	0.35 g/kg/day[c]	6.2×10^{-11}	6.2×10^{-2}	10.1
Vegetable fat ingestion	0.054 ppt[c]	17 g/day	1.4×10^{-11}	1.4×10^{-2}	2.2
		Total	6.1×10^{-10}	6.1×10^{-1} [e]	100.0

Estimated Dioxin-Like PCB Mean Background Exposure

Media	Conc. (WHO$_{98}$ TEQ$_{DF}$)	Intake Rate	Daily Intake (mg/kg-day)	Daily Intake (pg/kg-day)	% of Total
Soil ingestion	2.3 ppt[a]	50 mg/day	1.6×10^{-11}	1.6×10^{-2}	0.5
Soil dermal contact	2.3 ppt	12 mg/day[d]	3.9×10^{-11}	3.9×10^{-2}	0.1
Freshwater fish and shellfish	1.2 ppt	5.9 g/day	1.0×10^{-11}	1.0×10^{-2}	34.9
Marine fish and shellfish ingestion	0.28 ppt	9.6 g/day	3.4×10^{-11}	3.4×10^{-2}	14.8
Inhalation	–	–	–	–	–
Water ingestion	–	–	–	–	–
Milk ingestion	0.0088 ppt	175 g/day	2.2×10^{-11}	2.2×10^{-2}	5.7
Dairy ingestion	0.020 ppt	55 g/day	4.8×10^{-11}	4.8×10^{-2}	13.9
Eggs ingestion	0.10 ppt	0.24 g/kg/day	2.4×10^{-11}	2.4×10^{-2}	7.3
Beef ingestion	0.084 ppt	0.71 g/kg/day	6.0×10^{-11}	6.0×10^{-2}	18.2
Pork ingestion	0.012 ppt	0.22 g/kg/day	2.6×10^{-12}	2.6×10^{-3}	0.8
Poultry ingestion	0.026 ppt	0.50 g/kg/day	1.3×10^{-11}	1.3×10^{-2}	4.0
Other meat ingestion	0.041[b]	0.35 g/kg/day[c]	1.4×10^{-11}	1.4×10^{-2}	4.3
Vegetable fat ingestion	0.027 ppt	17 g/day	8.0×10^{-12}	8.0×10^{-3}	2.7
		Total	3.3×10^{-10}	3.3×10^{-1} [e]	100.0

Background CDD/CDF TEQs in Fish and Shellfish, Consumption Rates, and Intakes

Fish Class	Species	Consumption Rate (g/day)	N	CDD/CDF TEQ Conc. (Pg/g fresh wt.)	CDD/CDF TEQ Intake (pg/day)
Estuaries Fish	Flounder (e/f)	0.08	7	1.9	1.0
	Rockfish/Striped Bass (d)	0.043	28	1.2	0.052
	Salmon (d)	0.042	39	0.57	0.024
	Mullet (e)	0.024	2	0.068	0.0023
	Other				
	Flatfish	0.39	0		
	Perch	0.18	0		
	Porgy	0.12	0		
	Herring	0.12	0		
	Anchovy	0.042	0		
	Smelts	0.0074	0		
	Eel	0.0038	0		
	Sturgeon	0.00017	0		
	Total Other*	0.83	0	1.3	1.1
Freshwater Finfish	Catfish-farmed (b,d,h)	0.90	30	2.0	1.8
	Trout-farmed (e,h)	0.41	6	1.9	0.78
	Perch (e) (walleye)	0.17	2	1.2	0.20
	Carp (e)	0.14	4	1.2	0.17
	Pike (e) (pickerel)	0.035	3	0.48	0.017
	Salmon (d)	0.00083	39	0.57	0.00047
	Other				
	Whitefish	0.012	0		
	Carp	0.0012	0		
	Smelts	0.00095	0		
	Rainbow	0.00017	0		
	Sturgeon	0.014	0		
	Total Other*		0	1.3	0.015
Total Freshwater/Est. Finfish		3.3	118	1.8	5.3
Freshwater/Estuarine Shellfish	Shrimp (b,c)	2.0	19	0.080	0.16
	Crab Average (i)	0.30	33	0.37	0.11
	Oyster Average (i)	0.15	18	0.47	0.070
	Scallop (d)	0.0011	11	0.16	0.00015
	Crayfish (i)	0.0090	25	0.30	0.0027
	Other				
	Clam	0.014	0		
	Snails	0.0017	0		
	Total Other**	0.0157	0	0.43	0.0068
Total Freshwater/Est. Shellfish		2.5	108	0.14	0.35
Unknown Freshwater/Est. Species	Fish***	0.14	9	1.3	0.18
Total Fresh./Est. Fish		5.9	223	1.0	5.8

Background CDD/CDF TEQs in Fish and Shellfish, Consumption Rates, and Intakes

Fish Class	Species	Consumption Rate (g/day)	N	CDD/CDF TEQ Conc. (Pg/g fresh wt.)	CDD/CDF TEQ Intake (pg/day)
Marine Finfish	Tuna (c)	3.1	16	0.060	0.19
	Cod (c)	1.4	13	0.15	0.21
	Salmon (d)	1.2	36	0.07	0.74
	Pollack (d)	0.25	19	0.22	0.055
	Mackerel (d)	0.11	1	0.95	0.10
	Other				
	Perch	0.36	0		
	Haddock	0.25	0		
	Whiting	0.25	0		
	Squid	0.17	0		
	Perch	0.13	0		
	Sardine	0.12	0		
	Sea Bass	0.10	0		
	Swordfish	0.098	0		
	Pompano	0.054	0		
	Octopus	0.032	0		
	Flatfish	0.028	0		
	Redfish	0.028	0		
	Snapper	0.028	0		
	Whitefish	0.012	0		
	Striped	0.0086	0		
	Shark	0.0048	0		
	Ray	0.0041	0		
	Total Other****	1.8	0	0.39	0.72
Total Marine Finfish		8.6	93	0.26	2.9
Marine Shellfish	Scallop (d)	0.19	11	0.13	0.030
	Lobster (d)	0.13	16	0.25	0.049
	Crab (d)	0.19	39	0.39	0.054
	Other				
	Clams	0.75	0		
	Mussels	0.070	0		
	Conch	0.0021	0		
	Snails	0.0017	0		
	Total Other****	0.77	0	0.25	0.20
Total Marine Shellfish		1.3	66	0.29	0.34
Unknown Marine Species	Seafood (g)***	0.000	0	0.39	0.031
	Fish***	0.220	0	0.39	0.09
Total Marine Fish		9.8	158	0.26	2.5
TOTAL FISH		15.6	2220	0.53	8.3

Inventory of Sources of Dioxin in the United States - Sept. 2000 draft

	1987 Emissions (g TEQ/yr, Whittaker)	1995 Emissions (g TEQ/yr, Whittaker)	% Total
Municipal Solid Waste Incineration, air	6677.0	1250.0	30%
Backyard Barrel Burning, air	604.0	629.0	15%
Medical Waste Incineration, air	2590.0	468.0	11%
Secondary Copper Smelting, air	940.0	271.0	6%
Cement Kilns (haz waste), air	117.8	156.1	3%
Sewage Sludge/land applied, land	76.6	76.6	2%
Residential Wood Burning, air	59.9	62.8	2%
Coal-fired Utilities, air	50.8	50.1	2%
Diesel Trucks, air	27.8	33.5	1%
Secondary Aluminum Smelting, air	16.3	29.1	1%
2,4-D, land	33.4	25.9	1%
Iron Ore Sintering, air	32.7	28.0	1%
Industrial Wood Burning, air	26.4	27.6	1%
Bleached Pulp and Paper Mills, water	356.0	19.5	1%
Cement Kilns (non-haz waste), air	13.7	17.8	1%
Sewage Sludge Incineration, air	6.1	14.8	0%
EDC/Vinyl chloride, air	NA	11.2	0%
Oil-fired Utilities, air	17.8	10.7	0%
Crematoria, air	5.5	9.1	0%
Unleaded Gasoline, air	2.6	5.9	0%
Hazardous Waste Incineration, air	5.0	5.8	0%
Lightweight ag kilns, haz waste,air	2.4	3.3	0%
Kraft Black Liquor Boilers, air	2.0	2.3	0%
Petrol Reflex Catalyst Reg., air	2.2	2.2	0%
Leaded Gasoline, air	37.5	2.0	0%
Secondary Lead Smelting, air	1.2	1.7	0%
Paper Mill Sludge, land	14.1	1.4	0%
Cigarette Smoke, air	1.0	0.8	0%
EDC/Vinyl chloride, land	NA	0.7	0%
Primary Copper, air	0.5	0.5	0%
EDC/Vinyl chloride, water	NA	0.4	0%
Boilers/industrial furnaces, air	0.6	0.4	0%
Tire Combustion, air	0.1	0.1	0%
Drum Reclamation, air	0.1	0.1	0%
TOTAL	11,246	3,227	77%
Percent Reduction from 1987		77%	

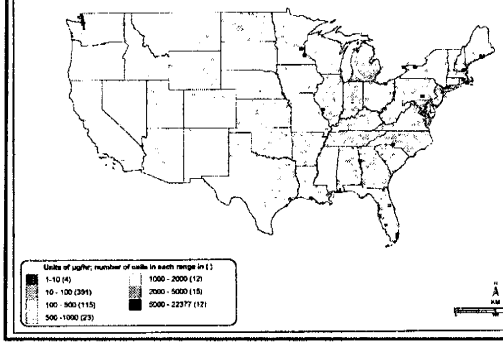
Inventory of Sources of Dioxin in the United States-May, 2000

	1987 Emissions (g TEQ/yr, Whittaker)	1995 Emissions (g TEQ/yr, Whittaker)	2002-4 Estimates (g TEQ/yr, Whittaker)
Municipal Solid Waste Incineration, air	6677.0	1250.0	12.0
Backyard Barrel Burning, air	604.0	629.0	629.0
Medical Waste Incineration, air	2590.0	468.0	7.0
Secondary Copper Smelting, air	940.0	271.0	5.0
Cement Kilns (haz waste), air	117.8	156.1	7.7
Sewage Sludge/land applied, land	76.6	76.6	76.6
Residential Wood Burning, air	59.9	62.8	62.8
Coal-fired Utilities, air	50.8	50.1	50.1
Diesel Trucks, air	27.8	33.5	33.5
Secondary Aluminum Smelting, air	16.3	29.1	29.1
2,4-D, land	33.4	25.9	25.9
Iron Ore Sintering, air	32.7	28.0	28.0
Industrial Wood Burning, air	26.4	27.6	27.6
Bleached Pulp and Paper Mills, water	356.0	19.5	12.0
Cement Kilns (non-haz waste), air	13.7	17.8	17.8
Sewage Sludge Incineration, air	6.1	14.8	14.8
EDC/Vinyl chloride, air	NA	11.2	11.2
Oil-fired Utilities, air	17.8	10.7	10.7
Crematoria, air	5.5	9.1	9.1
Unleaded Gasoline, air	2.6	5.9	5.9
Hazardous Waste Incineration, air	5.0	5.8	3.5
Lightweight ag kilns, haz waste,air	2.4	3.3	3.4
Kraft Black Liquor Boilers, air	2.0	2.3	2.3
Petrol Reflex Catalyst Reg., air	2.2	2.2	2.2
Leaded Gasoline, air	37.5	2.0	2.0
Secondary Lead Smelting, air	1.2	1.7	1.7
Paper Mill Sludge, land	14.1	1.4	1.4
Cigarette Smoke, air	1.0	0.8	0.8
EDC/Vinyl chloride, land	NA	0.7	0.7
EDC/Vinyl chloride, water	NA	0.4	0.4
Boilers/industrial furnaces, air	0.6	0.4	0.4
Tire Combustion, air	0.1	0.1	0.1
Drum Reclamation, air	0.1	0.1	0.1
TOTAL	11,246	3,227	1,762
Percent Reduction from 1987		77%	92%

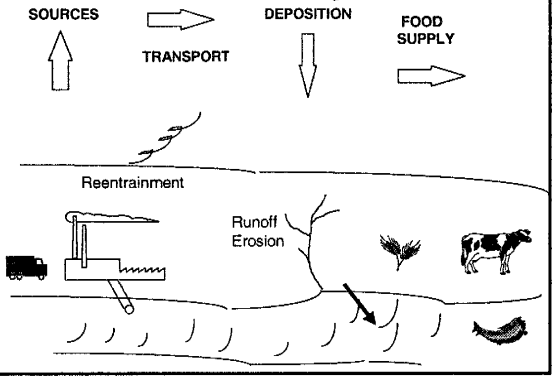
Inventory of Sources of Dioxin in the United States-May, 2000

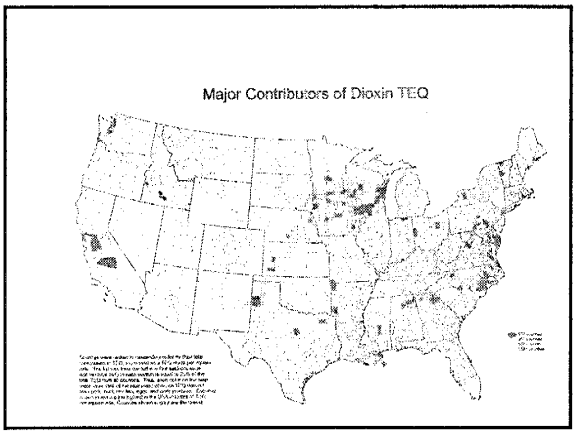
	1987 Emissions (g TEQ/yr, Whittaker)	1995 Emissions (g TEQ/yr, Whittaker)	2002-4 Estimates (g TEQ/yr, Whittaker)
Backyard Barrel Burning, air	604.0	629.0	629.0
Sewage Sludge/land applied, land	76.6	76.6	76.6
Residential Wood Burning, air	59.9	62.8	62.8
Coal-fired Utilities, air	50.8	50.1	50.1
Diesel Trucks, air	27.8	33.5	33.5
Secondary Aluminum Smelting, air	16.3	29.1	29.1
2,4-D, land	33.4	25.9	25.9
Iron Ore Sintering, air	32.7	28.0	28.0
Industrial Wood Burning, air	26.4	27.6	27.6
Cement Kilns (non-haz waste), air	13.7	17.8	17.8
Sewage Sludge Incineration, air	6.1	14.8	14.8
Municipal Solid Waste Incineration, air	6677.0	1250.0	12.0
Bleached Pulp and Paper Mills, water	356.0	19.5	12.0
EDC/Vinyl chloride, air	NA	11.2	11.2
Oil-fired Utilities, air	17.8	10.7	10.7
Crematoria, air	5.5	9.1	9.1
Medical Waste Incineration, air	2590.0	468.0	7.0
Unleaded Gasoline, air	2.6	5.9	5.9
Secondary Copper Smelting, air	940.0	271.0	5.0
Hazardous Waste Incineration, air	5.0	5.8	3.5
Kraft Black Liquor Boilers, air	2.0	2.3	2.3
Petrol Reflex Catalyst Reg., air	2.2	2.2	2.2
Leaded Gasoline, air	37.5	2.0	2.0
Secondary Lead Smelting, air	1.2	1.7	1.7
Paper Mill Sludge, land	14.1	1.4	1.4
Cigarette Smoke, air	1.0	0.8	0.8
EDC/Vinyl chloride, land	NA	0.7	0.7
EDC/Vinyl chloride, water	NA	0.4	0.4
Lightweight ag kilns, haz waste,air	2.4	3.3	0.4
Boilers/industrial furnaces, air	0.6	0.4	0.4
Tire Combustion, air	0.1	0.1	0.1
Drum Reclamation, air	0.1	0.1	0.1
TOTAL	11,246	3,227	1,762
Percent Reduction from 1987		77%	92%

Top 80-percent Emitting Sources, Dioxin/Furan TEQ Emissions



Sources and Pathways to Human

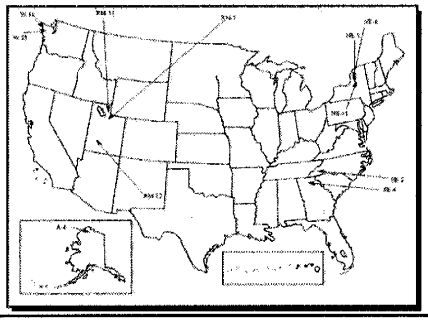


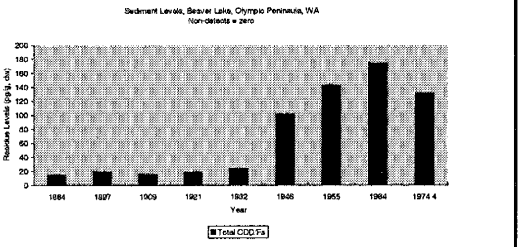


Dioxin Exposure Trends

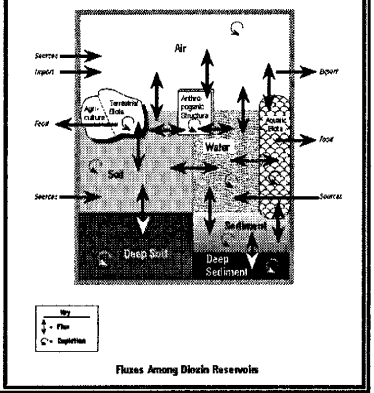
- → **Environmental levels:**
  - Peaked in late 60s/early 70s; declined since based on sediment data
  - Decline also supported by Emissions Inventory which shows significant decrease from 1987 to 1995 (~80%)
- → **Human tissue data suggest current levels are about half of 1980 levels (55 to 25 pg TEQ_{DFP}/g lipid)**
- → **Steady state PK modeling of current intake levels project tissue levels of about 11 pg TEQ_{DFP}/g lipid.**

Location of Lakes for Sediment Core Sampling





Fluxes among dioxin reservoirs



Arsenic – Assessments for Water

Rita Schoeny

Fish Forum
May 9, 2001

Health Effects of As

- **Acutely toxic**
  - Uncouples oxidative phosphorylation
- **Chronic effects:**
  - Skin, bladder, lung, kidney and liver cancer.
  - Vascular disease, obstructive lung disease, diabetes, skin lesions.
  - Animal studies on reproduction and development inconclusive.

Mode of Action

- Inorganic As not directly mutagenic
  - **Comutagenic**
  - **Chromosome anomalies, breakage**
  - **Effects on DNA repair**
- NRC & EPA Panels concluded that the dose-response associated with effects would be sublinear or threshold in shape
- [An organic metabolite is DNA reactive and affects gene expression (new studies)]

Why a New Arsenic Standard?

- **Old standard of 50 ppb: Set in 1942.**
- **1986 Safe Drinking Water Act (SDWA): Required EPA to set new standard by 1989 -- deadline not met.**
- **1996 SDWA: Proposal by 1/00 and final by 1/01; proposal deadline not met.**
- **NAS (1999) and SAB (2000) – recommended a "downward revision as promptly as possible;"**
- **International standards (based on skin cancer):**
  - ***World Health Organization (WHO)* set 10 ppb standard in 1981.**
  - ***European Union (EU)* set a 10 ppb in 1998 based on WHO standard.**

EPA's New Standard for Arsenic

- **MCLG = 0; linear dose-response, Taiwan data**
- **Feasible level = 3 ppb (based on treatment technologies and analytical methods).**
- **Analyzed the relative risk to human health at various levels (3 - 20 ppb) and the associated costs and benefits.**
- **Determined that the benefits do *not* justify the costs at 3 ppb; proposed a standard of 5 ppb (discretionary SDWA authority to set above feasible level).**
- **Final rule sets a standard of 10 ppb – where benefits justify the costs (upper end of target risk range of 10^{-6} to 10^{-4}).**

Occurrence Breakdown by System Size

	CWSs		NTNCs	
System size	# >10 ppb	Total # CWSs	# > 10 ppb	Total #NTNCs
25-500	1,570	32,177	897	17,259
501-3,300	581	14,043	144	2,856
3301-10,000	145	4,303	3	85
10,000	92	3,591	1	20
Totals	2,388	54,164	1,046	20,985
	5.7 million people		1.1 million people	

What Treatment Technologies Did EPA Consider?

- Best Available Technologies
  - Ion Exchange (where sulfate < 50 mg/L)
  - Activated Alumina
  - Modified Coagulation/Filtration
  - Modified Lime Softening (pH>10.5)
  - Oxidation/Filtration (where high iron)
  - *Electrodialysis Reversal (listed but not recommended)*
  - *Reverse Osmosis (listed but not recommended)*
- Small System Technologies (above + following)
  - POU Reverse Osmosis and POU Activated Alumina

Changes in the Rule As a Result of Public Comments

- **Health effects**: revised risk estimates to adjust for more differences between U.S. and Taiwan populations.
- **Benefits**: reduced estimated benefits as a result of revised risk estimates and performed sensitivity analysis for latency and other factors
- **Cost of compliance**: Revised technologies to ensure least cost technologies; did sensitivity analysis
- **Time to comply**: extended to 5 years for all systems
- **MCL choice**: promulgated 10 ppb

As Rule 2001

- Standard published 1/22/01
- Announced plans to review standard 3/20/01
  - Extended effective date for 60 days 3/23/01
- FR Notice 4/23 proposes to extend effective date 9 months (to 2/22/02) for reviews
  - Compliance dates (2006) unaffected
  - NRC to review health assessment ~ 8/01
  - NDWAC to review cost estimates ~ 8/01

Arsenic Species

- Inorganic
  - Arsenite As III, arsenate As V generally in water
- Organic arsenicals in foods
  - Monomethylarsonic acid (MMA)
  - Dimethylarsinic acid (DMA)
  - Arsenosugars
  - Arsenobetaine $Me_3AsCH_2CO_2$
  - Arsenocholine $Me_2AsCH_2CH_2OH$

Exposure

- Inorganic species As(III), As(IV) dominant in water, many forms of arsenic in environment
  - 5% of ground water systems and <0.1% surface water systems > 10 µg/L
- As methylated by microorganisms, plants and animals
- Food: ~90% Organic/10% Inorganic
  - Fish and seafood largely arsenobetaine, not absorbed. Algal sugars convert to DMA.

Organic As Is Rare in Water

- Inorganic forms more prevalent than organic (monomethylarsonic acid (MMA) and dimethylarsonic acid (DMA)).
- Taiwanese ground water wells < 1 µg/L me-As.
- No DMA or MMA in West Bengal, India.
- 2 of 14 California samples >1 µg/L DMA/MMA.

Relative Source Contribution

- U.S. food provides up to 10-12 µg inorganic arsenic a day for adults (NRC pg. 49).
- Taiwanese food may provide 50 µg a day from yams and rice (NRC, pg. 51), or between 15-211 µg a day.
- A drinking water standard of 10 µg/L would have higher contribution from water vs food.

Exposure to As though Fish Donohue and Abernathy –1

- Literature and unpublished data on As species in fish, shellfish
- Distributions plotted
- Mean, median, 95th percentile combined with fish, shellfish intakes (CSFII 89-91)
- Reference diet = 90% marine fish

Inorganic As from Fish

Consumer	As ppb	Fish g/day	As µg/day
Hi fish, Hi As	120	461	55
Hi fish, $\bar{x}$ As	26	461	12
Hi fish, med As	12	461	6
$\bar{x}$ fish, hi As	120	42	5
$\bar{x}$ fish, $\bar{x}$ As	26	42	1
$\bar{x}$ fish, med As	12	42	0.5

Organic As in Fish

Species	**Concentration**	**Median**	n
Arsenobetaine	9.3 – 100%	81%	38
Arsenocholine	ND – 15%	ND	16
Arsenophospholipids	0.17 – 15%	1.1%	10
Arsenosugars	18%		2
MMA	<0.0006 – 6.7%	<0.0008%	9
DMA	ND – 12.9%	1.9%	15
Unidentified	41 –85%	73%	10

Exposure to As though Fish (Donohue and Abernathy) - 2

- Much variation in total As in marine fish and shellfish
  - Variation between and within species
- Most As in marine fish is arsenobetaine, smaller amounts of arsenocholine
  - Accumulate more As than do freshwater fish
  - AsB and AsCh excreted unchanged
- Less known about organic arsenicals in freshwater fish
  - May contain [high] of unidentified organo As

As CWA Criteria

- Human health criterion published 1980
  - Based on skin cancer assessment
  - Listed in National Toxics Rule
  - 0.018 µg/L (water and organisms), 0.14 µg/L (organisms only)
  - Inorganic As only
  - Will revise post drinking water rule
- Aquatic life criteria 2.2 and 4.3 µg/L 1995

Luncheon talk at the Annual National Forum on Contaminants in Fish
Sponsored by EPA, MN Dept of Health, SRA
Chicago; Holiday Inn Mart Plaza, May 9, 2001

IMPACTS OF FISH CONTAMINATION ON NATIVE AMERICAN CULTURE

Stuart Harris, Natural/Cultural Resources Coordinator, SSRP Program, Confederated Tribes of the Umatilla Indian Reservation, PO Box 638, Pendleton OR 97801;
stuartharris@ctuir.com. **541/966-2408.**

Good afternoon, I'd like to begin by thanking the Conference organizers and the EPA for bringing us all together today. It's customary where I'm from, to also wish you a safe journey home and that you find your home in the same condition that you left it in.

How many of you have a 401K or a retirement account? Raise your hands. How are your accounts doing? Well, my fish are my retirement account, and they are not doing very well. Your accounts may be down 50% but are recovering. My account is down 99% and seems to be at risk of disappearing altogether.

I am here to speak to you about cultural impacts derived from fish contaminants and fish advisories. The task of informing a population about what is in their fish, and how much, what type, or what part, of a fish they can consume is no small thing. Information from many different places has to be integrated. When an advisory impacts a Sovereign Nation such as a Treaty Tribe, ALL of the factors associated with the Advisory and how it may impact that Sovereign Nation have to be taken into account.

I am a staff scientist for the Confederated Tribes of the Umatilla Indian Reservation, or CTUIR. My job is to analyze the risks to our people and our culture from pollution impacts. I have to protect my people's treaty rights, resources, culture, and reservation. I have to educate my people about any hazards stemming from pollution. I also get opportunities to educate regulators and academia about what pollution impacts mean to my culture and the health and future of my children and all the children to come.

The CTUIR is a sovereign government that has a legal interest in the natural resources upon which the CTUIR's treaty rights are based. The federal government, when it entered into this treaty, affirmed that it has both a moral and legal fiduciary obligation to protect the natural resources upon which our treaty is based. The United State government made a legally binding promise when it signed our treaty, and this obligation extends to all parts of the federal government. This obligation does not fade with time and it extends far into the future. The United States Constitution refers to all treaties as "the supreme law of the land." Therefore, upholding our Treaty is a constitutional duty that extends to all federal agencies. Tribes have at least the status of states, and many tribal governments were established by Treaties long before the states where they are now located came into being.

The CTUIR or Umatilla Indian Reservation, is located in northeastern Oregon near Pendleton, Oregon, and is occupied by the descendants of three Columbia Plateau Tribes – the Cayuse, the Walla Walla, and the Umatilla Tribes. My family and relatives have lived within the Columbia River watershed for thousands and thousands of years. The river and all of the inter-dependent resources have sustained us both physically and spiritually for that whole time.

Our elders tell us about the creation of the world. First, the Creator made the world and the oceans. The Fish and the food they eat were the first people. Then the Creator made the deer, the coyote, other animals, and their foods. He made the roots and berries and medicines. Everything was as it should be, but after a little while Itsiyaya (Coyote) said "Everything is good, but something is missing." So the Creator created humanoids. They came without instructions and had to be trained, just like any coyote pup. The Creator, through the itsiyaya, taught the humanoids about how to be human-beings (these are the real people like the fish people) and to respect the other people and their things in this world, and told humans how to work with them and to use them properly.

We, the Tetokin or Indian People, celebrate our origins at every meal through the telling of these stories and through the placement of the food of our plate. The foods are placed in the order of their creation in a counterclockwise circle on our plates at home and at our ceremonies, the same direction as the solar system turns. Our people know and have known since these stories originated that the Earth spins into the sunrise, and travels counterclockwise around the sun, which in turn travels counterclockwise around the galaxy. We even have ancient symbols and stories that describe the spiral galaxy turning counterclockwise.

My people have many other oral histories or stories. These are not "mythology" or superstitions of an unobservant people, but portray the natural world very accurately. We have stories about early eruptions and their effects, of Mount St. Helens and Mount Mazama or Crater Lake, and about ancestors of modern animals. Our word for elephant, which has been around since those times. We have stories about our people getting caught up in the Missoula Floods, which occurred approximately 16,000 years ago and created the present course of the Columbia River and other landforms. Our oral history story tells about this event, but modern science only "discovered" this within the last 50 years. Our oral histories are the distillation of wisdom about the ecology refined over innumerable generations, not something that needs to be improved by mechanical measurements which are not as sensitive as our own eyes.

Under the Treaty of 1855 [12 Stat. 945], the Tribes ceded lands to the United States yet retained rights to perform cultural activities on those lands, including but not limited to fishing, hunting, gathering roots and berries, and pasturing livestock. Many legal cases have upheld the Treaties and confirmed that the tribes have legal rights to at least half the fish in the Columbia River. The problem today is that 99% of the fish are gone, and every single remaining fish is contaminated to a greater or lesser extent. Plus, the water they live in is contaminated and over-committed to conflicting interests such as hydropower and irrigation.

I do, and will continue, to exercise my Treaty reserved rights to the fullest extent possible. It is important for you to understand that my great-grandparents paid for these rights with their blood. There are thousands of martyrs just like my great-grandparents in the histories of the Native Sovereign Nations throughout these United States. You must work with their descendants

who are still dealing on a daily basis with the memories and consequences. These people, like my relatives, insisted – even when they were held at gunpoint and executed for resisting - that they, their children, and their children's children, must have the resources needed to carry our cultures into the future.

My culture is dependent on, and springs forth from, exercising all the practices, activities, and lifestyles we have developed from a partnership with the ecology, thousands of years ago. I insist that I must be allowed to effectively exercise my treaty rights. I insist that I have the freedom to go about my business without interruption. I insist that I be able to practice my religion just like any of you in this room. And I demand the freedom to consume any and all parts of all the foods that my elders have taught me are the center of our cultural and spiritual lives without fearing for my life or the lives of my children.

I and my family have committed to uphold a spiritual and cultural duty brought down to us young people from our elders. That duty includes the responsibility, for as long as anybody can remember, to cherish and partake of the gifts that are freely given to us. When I was young and full of pride for giving to some charity, one of my elders explained to me that the giving of tithes is a good thing. He then asked me if I would go so far as to offer up one of my limbs for another's dinner. I was shocked as a youngster, at this notion of cutting off my leg for someone's dinner. He continued on, "You think you are so generous, but compared to the tsuyem (the fish) your gift is but a token. They willingly offer up their lives and flesh for us." Yet today, their worth is valued in kilowatt-hours, acre-feet of irrigation water, and parts per billion of pollutants.

The salmon return year after year to the remnants of their homes. Every last one of them fulfills their part of a compact that both our peoples made in the beginning. The development of the modern infrastructure has made it very hard for the fish. Nevertheless the fish willingly die trying to come home because they promised to come and nourish us. We honor them each year when they return, and at every meal, and we try to take care of their home while they are gone to the ocean. We tell our children to be like the fish because they, just like my human elders, selflessly give of themselves for the benefit of the people. We don't club and throw away our fish, just like we don't throw away our elders.

I would hope that you begin to understand that for my children to live full and beautiful lives the health of those natural resources which we subsist on, must be held at the highest level by all. I cannot emphasize enough that the federal government has a fiduciary responsibility to protect our Treaty resources. The states must also recognize that these treaties have been upheld numerous times in court and are the supreme law of the land, and should be treated as ARARs.

I am a Cayuse-Nimipoo. Our traditional environmental knowledge-based culture, which has co-evolved with nature through thousands years of ecological education, has provided my family and relatives with the knowledge that their unique and valid system of holistic environmental management is the truth. That truth being, that our traditional methodologies are the best way to manage a watershed given the limited space, water, and resources, as evidenced by thousands of years of implementation. It is also understood that throughout the year, when my relatives participate in activities such as fishing, hunting and gathering for foods, medicines, ceremonies, and subsistence, the associated activities are as important as the end product. In the Judeo-Christian tradition, an analogy would be "kosher" dietary practices. All of the foods and

implements gathered and manufactured by my traditional brothers and sisters are interconnected in at least one, but more often in many ways. I have met many people who follow cultural teachings or lessons brought down through history from the elders. Our individual and collective well-being is derived from membership in a healthy community. We are trained how to properly access the ancestral lands and gather traditional resources in a continuously sustainable manner. With training, young tribal members such as myself gain the ability to satisfy their personal responsibility to participate in traditional community activities and to help maintain the spiritual quality of our resources.

In preparing to come here today, I asked many people about their culture. I am assuming that all of you have a culture. Is there anybody here who doesn't have a culture? Everyone does; it's those things that you have carried around for generations. Maybe it seems they only come out on holidays. But some cultural attributes are so pervasive throughout a society that most people couldn't recognize them if their life depended on it. Take reading for example. Reading is a cultural attribute. It's been around for 8000 years or so on the Indo-European continent.

Think about today's topic, cultural impacts of fish advisories. What if you were asked to give up reading (obtaining and sharing information through written words and numbers)? How would your life be changed if this fundamental, cultural core attribute, were impacted? If it were taken away from you completely, it would be a disaster. Why else do we fight illiteracy at every turn? And even if you were only allowed some percentage during each day, it would probably still be a disaster. What would you choose to read? Would you choose to read your email or an Agatha Christie novel? Would you choose to use your word quota on tracking your retirement account status? Or would you waste your cultural word quota by reading the credits at the end of the show? Civilization as we know it today would be forever changed.

You may be thinking, "Choose something else besides reading. Reading is too ubiquitous in my life, too integral to our society and it's not realistic to think we could give up reading. If I gave up reading, I wouldn't be me. My profession communicates with written words and numbers, and my promotions and tenure are likely to be based on how much I publish. Without my profession, what would I be? How would our laws be taught? How would our ideals be expressed?"

Your reaction to this concept is exactly the same reaction I got when I asked my elders what if we were forced to give up eating our fish. Many of the reactions I got started with a shocked look, and then they demanded proof – who says these fish or those words can harm me? Why do I have to throw away this fish or burn these books? That is an example of a cultural impact of a fish advisory. Of course, it's "for the good of the people." But before you know it, people will be reading the comics and novels and going back their traditional ways of eating one or two pounds of fish per day. There's nothing like curling up in a chair on a rainy afternoon and eating smoked salmon with a good novel.

I have been told that there may be people in regulatory positions who think that people who don't comply with advisories are dumb, or uneducated, or deserve to get sick if there is a way to avoid the fish. I know that I will be blamed for not complying with an advisory. Some of you here today may think that people like me need to "get real" because this is a modern

chemical progressive world, and I'm trying to stand in the way of progress, and so I should hurry up and get assimilated into the good old American melting pot.

I need to explain that our fish and all of the supporting activities have been formulated for real reasons, survival reasons, a long time ago. I have been taught that I am part of an ancient oral tradition of cultural norms. The material or fabric of this tradition is unique, and is woven into a single tapestry that extends from far in the past, and long into the future. A risk from pollution that potentially affects one person of my community may have lasting impacts throughout all of the community, forever. In other words, a wave of risk can ripple outwards, affecting all of the individuals in our culture, just like a wave generated and propagated in a tapestry. You must remember, that if a culture dies, the only remnants are the material artifacts. In the event of the unthinkable happening, a continuously sustainable, natural resource based, material culture, such as the one my people and many other indigenous Tribal Nations embody, would rapidly disperse into the natural environment leaving no trace of our living cultures.

I recognize that the regulatory framework is fragmented by an accident of history. A problem was recognized a piece at a time and legislation was written to fix each piece as it was identified. But I cannot accept such a piecemeal approach. I and many like me are not going to change, not because we're being stubborn, uncooperative, or unreasonable, but because our ancestors have withstood a holocaust, termination policies, and religious persecution and I will not let them down.

I feel that advisories may be useful, but only as an unfortunate interim necessity. Responding to fish contamination is not just a communication problem. It is not a problem of communicating risk across a cultural divide. It is not just a matter of balancing risks and benefits. The problem is, we need to see EPA setting goals, taking action and standing firm to make things safe again. We need to see action in developing multi-media and watershed approaches to permitting. Trust responsibility is not a question of wall street profits verses children's health; it is a legal obligation.

The situation in the Columbia River at present is; that if a Tribal member fully exercised his or her treaty rights for long enough, given the amount of contamination in our fish now, it would probably be lethal. I don't want to have to scare people away from fish or their culture, but I must protect women and children and elders. Ultimately, we need to clean up the fish and the river, and we need to do it before any more cultural knowledge is lost.

To illustrate my point, here is an illustration I want to show you. [Figure 1; "Risk-Benefits or Loss-Harm"]. This slide depicts, on the left, the risk-benefit paradigm that most of you are familiar with. It assumes a 17.5 grams per day, a suburban fish ingestion rate. It assumes that people have the choice to eat more fish or no fish. In this case a person can balance the benefits to the heart from eating fish with the risks from the chemicals. For a suburban situation this method works. However, there are members of my family that traditionally eat 1000 grams per day (two and one half pounds per day). They and many of my people have done this for thousands and thousands of years. Today, this level of fish ingestion is generally precluded either through the loss of fisheries or through the high levels of contamination, so most of the fish benefits have already been lost. We have already lost most of the heart-protective benefits, and now have chemical risk. We have already lost the diabetes protection and the

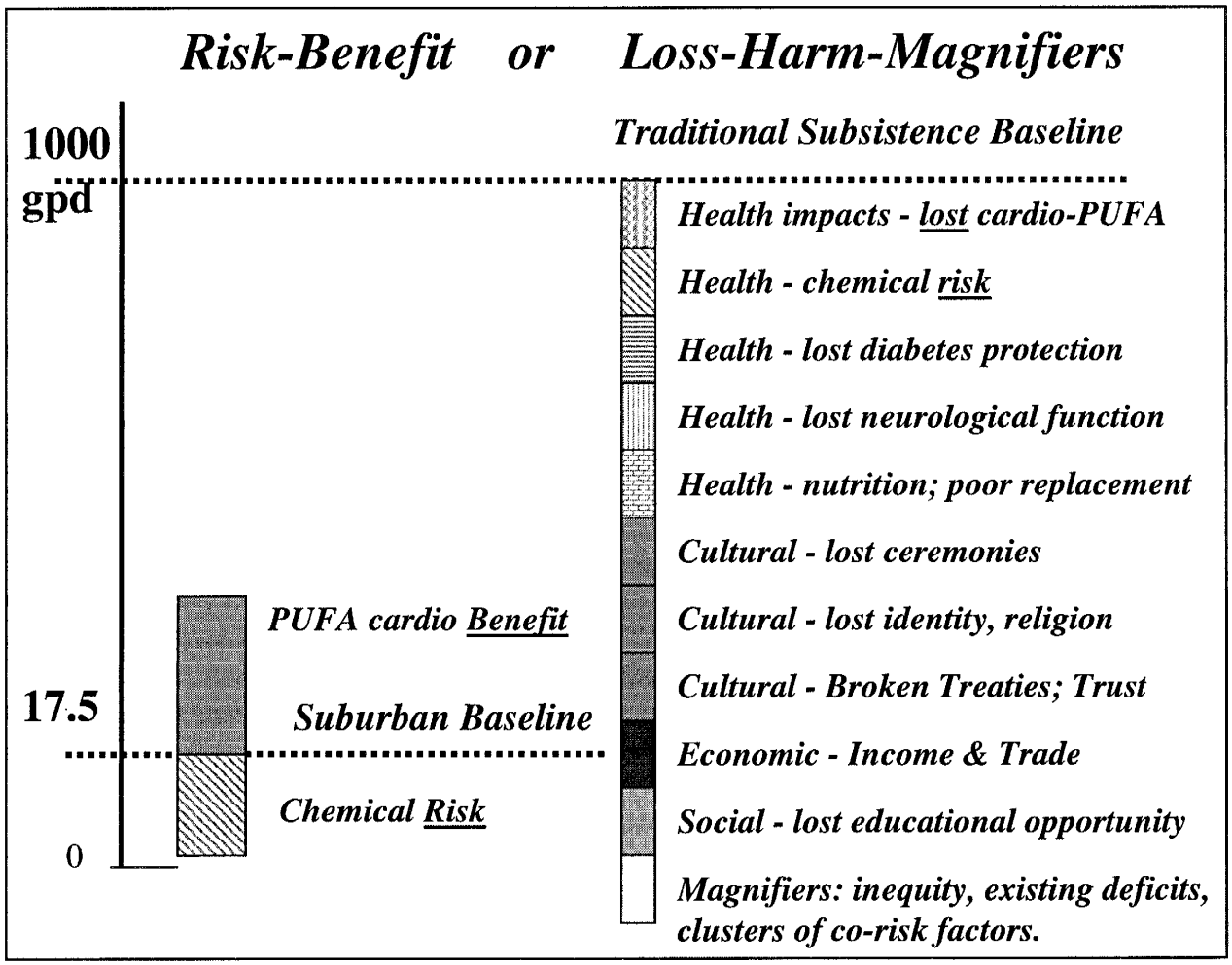


Figure 1. Comparison of risk benefit and loss-harm-magnifiers for traditional fish consumption.

neurological protection, both of which are well-documented benefits of eating fish. We have lost the nutrition, which is compounded by poor quality substitutes. Losing fish also means that we lose some of our ceremonies, our identity, and our religion. Our treaties have been broken once again. Also gone are commercial income from fishing and the fish used in trade networks. We are losing opportunities to educate our children and transfer the precious knowledge from one generation to the next. And finally there may be magnifiers of increased sensitivities, clusters of co-risk factors within tribal populations, disproportional impacts, and existing cultural deficits. This is why I think the conventional risk benefit paradigm is inappropriate for tribal situations and I would like to encourage the EPA to work with the Tribes on a Tribal method.

You must remember that we, the Tetokin, have been impacted through the encroachment of your society. Our tribal population has been affected by biological warfare, ecological warfare, economic warfare, and downright attempts at genocide. Yet, we have survived, with our culture intact even though we have been forced to endure this 600-year holocaust. The real history of our people is not being taught to you in school. Our struggle is not over. With each successive generation we are forced to react to numerous environmental, cultural, health, and

education impacts from members from your society who still perceive us a characters in a Hollywood movie.

My people have to deal with this complex set of problems, complete with numerous entrenched interests such as agribusiness, mining, and government, infrastructure development, and competing value sets vying for ever-decreasing resources. We use a logical process that includes education, law, analysis, research, and planning. Each of these processes is filtered and translated through our culture. Please note that the current EPA guidance for environmental justice fails to capture tribal concerns and does not deal fairly with the science of traditional environmental management. It does not adequately describe how to evaluate the distribution of risk between population groups such as tribes compared to suburbia. It completely omits evaluation of differences in impacts between the American society and my culture, and between different Tribal cultures and the resources on which those cultures depend. For example, I know that traditional tribal members with subsistence lifestyles will receive at least 2 to 100 times more exposure to a contaminant than a suburban resident might receive at identical environmental concentrations. I also know that my fellow tribal members typically have a larger burden of co-risk factors such as poor nutritional status, loss of natural diet, poorer access to health care, differences in metabolism, and so on. This means that tribal members might hypothetically not only receive more exposure, but might also be more sensitive, and have more obstacles to overcome in order to be healthy. Therefore, the cumulative impacts could be greatly magnified for tribal populations versus suburban populations.

Fish advisories are based on the best available science, and communicated to the public with the best socio-demographic profiling available. No stone is left unturned in attempts to enlighten us about making wise choices. Yet when you communicate your recommendations to Native Sovereign Nations such as mine, please remember that we too have logical, repeatable, verifiable, processes that I feel need to be taken into consideration up front, early in the decision making process.

To illustrate my point, I want to review the conventional scientific method because my tribal religion is based on an observational and applied science that has proved its worth over thousands of years through survival of my people. I want to briefly review the process for moving from observation, to hypothesis, to theory, to law. Tribal science has followed this path also.

Science is the observation, identification, description, experimental investigation, and theoretical explanation of phenomena. The scientific method is a general term for the lines of reasoning that scientists follow in attempting to explain natural phenomena. It typically includes observation, analysis, synthesis, classification, and inductive inference, in order to arrive at a hypothesis that seems to explain the phenomenon or solve the problem.

Remember that a hypothesis becomes theory if it withstands repeated testing and application. A hypothesis is a conception that is tentatively assumed, and then tested for validity by comparison with observed facts and by experimentation. A theory is a hypothesis that is supported to some extent by experimentation or factual evidence but that has not been so conclusively proven as to be generally accepted as law. Scientific law, such as the laws of physics, are so conclusively confirmed as to be inarguable.

Science is a product of the society that develops it, and the way that the theories and laws are expressed serve the needs of that society. American Indians have been observing natural phenomena, describing them, experimentally investigating them, and explaining natural phenomena and the natural resources for thousands of years. This tribal environmental knowledge forms the basis of traditional environmental management.

The reasoning that led to the determination of how to behave in the environment, based on what the environment consists of, is transferred to members of the tribe. Therefore, when a tribal member is gathering cultural materials, whether it is food or something else, he or she does it in a manner that reflects the principles of the science of traditional environmental management. This is the application of science, traditional tribal science, distilled into daily practice for the survival of a people.

The principles of traditional environmental management have been codified into law. There are some things you can do out in the environment and other things that you cannot do. The results of an action affect many things. The entropy of complex ecosystems is difficult to determine using "western" science, but the results of the most probable reactions have been observed by our elders and is related to us younger people through oral histories. Attention to the knowledge passed down means immediate survival and continuation of our people. Disregarding the knowledge can result in eating a poison, starvation or poor health. For countless generations our elders have told us about environmental conditions, and that our behavior is a product of rigorous and proven methodology that has guaranteed our survival through all types of natural cycles. Our lifestyle is resilient and has persisted through floods, droughts, cataclysms, upheavals, and warfare. We carry the unique and individual genes specifically adapted to and modified by our homelands.

Therefore, when I am asked, "What is cultural risk?" my answer is:

> "Because our people, the Tetokin, have been genetically modified by the ecology for thousands upon thousands of years, and have had their behavior modified as a result of responding to the flux of the ecology of our land for thousands upon thousands of years, and have produced a viable holistic environmental management system designed for continuously sustainable enhancement of our culture, and because the fabric of our very existence, including our sounds, medicine, science, art, music, and lifestyle is a reflection of thousands upon thousands of years of site-specific environmental shaping, any impact to those resources of which we are an inseparable part, is a risk to my culture."

I was asked by an educated man once, "How can a culture be irradiated?" He thought that only tangible things can be irradiated and therefore only tangible things can be at risk. He could not accept the notion of cultural risk. My answer is: "If my people are kept from a sacred site because that piece of mother earth has been contaminated, then I cannot transmit traditional teaching to future generations about the life significance of that site and therefore a significant part of my culture will be irreversibly altered."

How can you put a price on a sacred song that is derived from a landscape feature and is significant to the survival to my people and therefore my gene pool? Impacts to the ecology

directly impact the health of my people and put my culture at risk. Through time, my genetic characteristics may be adversely affected, thus destroying a multi-thousand year long fabric of blood. When an organism interacts and specializes within a finite set of environmental factors for thousands and thousands of years, that organism becomes the ecology. Within an ecological system all parts are important and all parts interact. Eventually the parts become mutually dependent, and neither part can be removed without harming or killing the whole.

When I asked the elders, they said to me, its true we have become the salmon and they have become us. We have lived and died for so long within the cycle of salmon that our flesh is one within the salmon people. We have lived here for more than ten thousand years eating salmon, deer, roots, and berries. The very molecules in our bodies have been passed back and forth between earth, plants, animals, and human beings. We have lived so long with our brothers and sisters that we have become one of them. We honor them every time we eat, setting our table just so. We pray for forgiveness from the Creator so the soul of the departed goes quietly into the land of light. We ask that their bodies nourish us and to make us strong. We cannot be separated from who we are. And we cannot forget the people who gave their lives for our children. Our lives, our voices, our thoughts, our bodies, are derived from these foods and water. No one can tell us anything different, because we know who we are, and where we came from. Our way of life and our culture are from our foods and the ancient knowledge of how they come to be with us, within us. When we contaminate the fish we contaminate ourselves and our children.

I want to close by asking you to remember that, no matter how narrowly your job description may be written, that water and fish are part of life. I challenge you to find ways to utilize your culture for the benefit of all our cultures. For when we've negotiated the best protective levels and developed fish-friendly infrastructure, all of our children, yours and mine, will thank us because what we do today lives on in history. Thank you

U.S. Environmental Protection Agency Fish and Wildlife Contamination Program

Tom Armitage

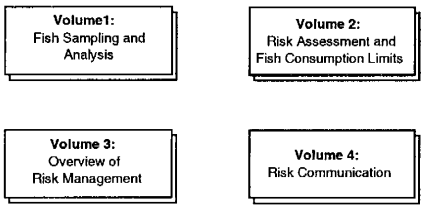
National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories

1. Fish sampling and analysis

2: Risk assessment and fish consumption limits

EPA

National Guidance Documents Published by EPA



EPA

EPA Guidance on Fish Sampling and Analysis

- EPA guidance on assessing chemical contaminants in fish and shellfish covers:
  - Sampling methods
  - Chemical analysis
  - Statistical design
  - Monitoring strategy
  - Quality assurance/quality control
- Provides methodology for developing risk-based screening values

EPA

Risk-based Screening Values

- Screening values (SV) are called "risk-based" because they provide a direct link between fish consumption rate and risk levels.
- General equation for screening value:

Screening value =

(Dose response variable x body weight) / consumption rate

- Screening values are derived separately for chemicals with noncarcinogenic and carcinogenic effects

EPA

EPA Guidance on Risk Assessment and Fish Consumption Limits

- Provides guidance on the development of risk-based fish consumption limits.
- Describes EPA's four-step risk assessment process for consumption of fish and shellfish.
- Provides toxicological profiles for 25 chemicals of concern

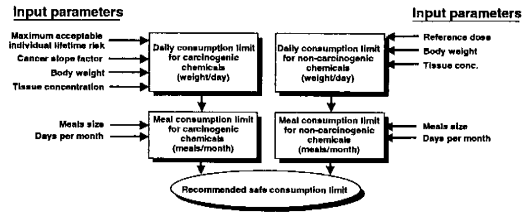
EPA

Risk-Based Fish Consumption Limits

- Definition:
  - Risk-based fish consumption limits can be used to identify the maximum number of meals of fish from a defined area that can be eaten, over a specified time period, by defined groups of consumers
  - These limits are intended to protect human health by limiting exposure to chemical contaminants in fish tissue

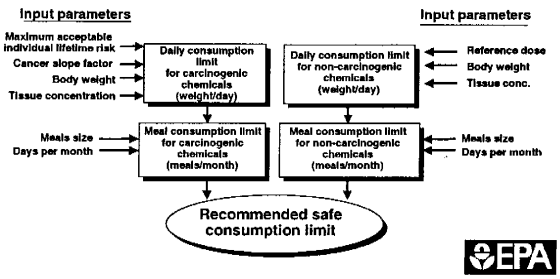
EPA

Calculation of Safe Consumption Limits



EPA

Calculation of Safe Consumption Limits



EPA

Daily Consumption Limits for Carcinogens

$$CR_{lim}\ (kg/day) = (ARL \times BW) / (q_1^* \times C_m) \quad \text{(Eq. 3-1)}$$

- CR_{lim} = Maximum allowable daily fish consumption rate (kg/day)
- ARL = Maximum acceptable individual lifetime risk level (unitless)
- BW = Consumer body weight (kg)
- q_1^* = Cancer slope factor $(mg/kg\text{-}day)^{-1}$
- C_m = Measured concentration of chemical contaminant "m" in a given species of fish (mg/kg)

EPA

Daily Consumption limits for NonCarcinogens

$$CR_{lim}\ (kg/day) = \frac{RfD \times BW}{C_m} \quad \text{(Eq. 3-3)}$$

- CR_{lim} = Maximum allowable daily fish consumption rate (kg/day
- RfD = Reference dose (mg/kg-day)
- BW = Consumer body weight (kg)
- C_m = Measured concentration of chemical contaminant "m" in a given species of fish (mg/kg)

EPA

Meal Consumption Limits

$$CR_{mm}\ (meals/month) = \frac{CR_{lim} \times T_{ap}}{MS} \quad \text{(Eq. 3-2)}$$

- CR_{mm} = Maximum allowable fish consumption rate (meals/month)
- CR_{lim} = Maximum allowable daily fish consumption rate (kg/day)
- T_{ap} = Time averaging period (365.25 days/12 months = 30.44 days/month)
- MS = Meal size (kg fish/meal)

EPA

The Clean Water Act: Water Quality Standards

Clean Water Act

National Goal:

"water quality which provides for the protection and propagation of fish, shellfish and wildlife and **** recreation in and on the water" wherever attainable

CWA Section 101(a)

Water Quality Standards

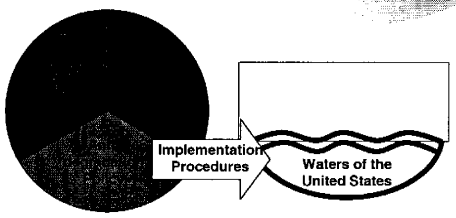
Water Quality Standards must:

- Protect the public health and welfare
- Enhance and maintain the quality of water
- Serve the purposes of the Act

- Beneficial Uses to be considered:
  - Public water water supplies, propagation of fish shellfish and wildlife, agricultural uses, industrial uses and navigation.

CWA Section 303(c)

Water Quality Standards



Designated Uses

- CWA Section 101(a):
  - Wherever attainable provide water quality for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water.

- CWA Section 303(c):
  - Take into consideration waters use and value for public water supplies, propagation of fish and wildlife, recreation, and navigation.

Water Quality Criteria

Water Quality Criteria must:

-- protect the designated uses
-- contain sufficient parameters/constituents
-- be based on sound scientific rationale
-- support the most sensitive use

Water Quality Criteria

Numeric Criteria:

- -- EPA's section 304(a) criteria
- -- site specific modifications of EPA's section 304(a) criteria
- -- other scientifically defensible methods

Narrative Criteria:

- -- qualitative waterbody description
- -- procedures for deriving quantified numeric interpretation

Antidegradation Policy

Governs decisions on changes in water quality:

- -- existing uses must be maintained and protected
- -- show lower water quality is necessary to accommodate important social and economic development before degrading "high quality waters"
- -- provide for maintaining and protecting water quality of Outstanding National Resources

Regulatory Baselines for Standards Review and Approval

- Uses must include fishing and swimming wherever attainable
- Criteria must include sufficient parameters to protect uses
- Criteria must be based on sound scientific rationale
- Criteria must protect downstream uses
- Existing uses must be protected
- High quality waters must not be degraded unless necessary for important social and economic development

Human Health Chemical Criteria

Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)

Major revisions:

- -- cancer risk assessment
- -- non-cancer risk assessment
- -- exposure assessment
- -- bioaccumulation in fish

www.epa.gov/ost/humanhealth

Pathogen Criteria

Goal: Reduce/Prevent Risks of Microbial Infection Due to Contaminated Waters

- -- new criteria and indicators
- -- analytical methods
- -- monitoring protocols

www.epa.gov/ost/standards/bacteria/

METHODOLOGY FOR DERIVING AMBIENT WATER QUALITY CRITERIA (AWQC) FOR THE PROTECTION OF HUMAN HEALTH (2000)

Denis Borum
National Forum on Contaminants in Fish
Chicago, Illinois
May 9, 2001

BACKGROUND ON AWQC HUMAN HEALTH METHODOLOGY REVISIONS

- Required by Clean Water Act [Section 304(a)] to revise criteria for water quality to accurately reflect latest scientific knowledge. Science and policy guidance have substantially evolved since the original methodology (first revision since 1980).
- Primarily serves as guidance to States/Tribes in adopting enforceable numerical criteria into Water Quality Standards; EPA must also promulgate replacement standards for States/Tribes.

BACKGROUND ON AWQC HUMAN HEALTH METHODOLOGY REVISIONS, *continued*

- Four major revision areas:
  1) Cancer (consistent with revisions to new Agency cancer guidelines)
  2) Noncancer (new approaches such as benchmark dose/RfD range)
  3) Exposure Assessment (fish consumption rates, body weights, and relative source contribution)
  4) Bioaccumulation factors (instead of BCFs)

FINAL AWQC METHODOLOGY REVISIONS

November 2000 Publications

- Federal Register Notice
  - Notice of Availability/Summary
  - Background Information (Q&A format)
  - Implementation Issues (Q&A format)
  - Summary of Comments and Responses
- Final National AWQC Methodology Revisions
- Risk Assessment Technical Support Document
- Peer Review Response Document

SUPPLEMENTAL METHODOLOGY DOCUMENTS

- Technical Support Document (TSD) volumes are being developed for the following subject areas:
  - Exposure Assessment TSD
  - Bioaccumulation TSD
- Development of a companion BAF Field Guidance Document is anticipated to begin in fiscal year 2002.

GENERALIZED EQUATIONS FOR DERIVING AWQC

- Noncancer Effects $$AWQC = RfD \cdot RSC \cdot \left(\frac{BW}{DI + (FI \cdot BAF)}\right)$$
- Nonlinear Cancer Effects $$AWQC = \frac{POD}{UF} \cdot RSC \cdot \left(\frac{BW}{DI + (FI \cdot BAF)}\right)$$
- Linear Cancer Effects $$AWQC = RSD \cdot \left(\frac{BW}{DI + (FI \cdot BAF)}\right)$$

where:
AWQC = Ambient Water Quality Criterion (mg/L)
POD = Point of departure (mg/kg-day)
RSD = Risk-specific dose (mg/kg-day)
BW = Human body weight (kg)
FI = Fish intake (kg/day)
RfD = Reference dose (mg/kg-day)
UF = Uncertainty Factor (unitless)
RSC = Relative source contribution account of nonwater sources of exposure
DI = Drinking water intake (L/day)
BAF = Bioaccumulation factor (L/kg)

CANCER RISK ASSESSMENTS

- Cancer Risk Assessment
  - Final methodology applies the principles of the July 1999 revised draft Guidelines consistent with 1986 Guidelines
  - Recommends use of all biological information to assess agent's mode of action
  - Incorporates use of either linear or nonlinear approaches based on data
- New/revised 304(a) criteria for carcinogens will be at a 10^{-6} risk level.
  - Recommends State/Tribal criteria based on either a 10^{-5} or 10^{-6} risk level
  - Indicates States/Tribes should generally ensure that most highly exposed population does not exceed 10^{-4} risk level
  - Indicates that approval of statewide 10^{-4} risk level is unlikely

NONCANCER RISK ASSESSMENTS

- Noncancer assessments incorporate published Agency Guidelines. Also recommending newer, more quantitative risk assessment approaches (i.e., benchmark dose, categorical regression) when data support their use.
- Reference Dose (RfD) value in deriving criteria.
  - Clarified issue of uncertainty associated with RfD value
  - National 304(a) criteria will be based on Agency IRIS values
  - State/Tribal flexibility discussed in the Risk Assessment TSD
  - State/Tribal use of flexibility will require Agency review for scientific adequacy.

EXPOSURE ASSESSMENTS

- Fish consumption data preferences:
  1) Local data
  2) Data of similar geography/populations
  3) National survey data
  4) EPA default intakes

EXPOSURE ASSESSMENTS, *continued*

- EPA default fish consumption intakes
  - Based on the USDA/CSFII 1994-96 data
  - Based on uncooked weight values
  - Species designations based on life history
  - General population default rate is 90th percentile (CSFII) value
  - Sport/subsistence defaults =estimates of avg based on surveys
- Final default fish intake rates:
  - General popln (90th percentile) and sport fisher (avg) = 17.5 g/day
  - Subsistence fisher (average) = 142.4 g/day
  - Women of childbearing age (90th percentile) = 235.5 g/day*
  - Children (90th percentile) = 156.3 g/day*.

**for use with RfDs based on acute/subchronic effects*

EXPOSURE ASSESSMENTS, *continued*

- **Relative Source Contribution (RSC) policy adopted into final Methodology**
  - RSC is a method for considering multiple sources of exposure when calculating AWQC.
  - Applies to noncarcinogens and nonlinear carcinogens only.
- **Body weights and drinking water intake rates provided for**
  1) Adults (genders combined) in the general population
  2) Women of childbearing age
  3) Children.

EXPOSURE ASSESSMENTS, *continued*

- **Fish intake rates provided for:**
  - Adults (genders combined) in the general population
  - Sport anglers
  - Subsistence fishers
  - Women of childbearing age
  - Children
- **Incidental water ingestion will not be factored into chemical default criteria.**
  - Guidance will be presented in Exposure Assessment TSD for States/Tribes
  - EPA may consider this route of exposure for microbial criteria

BIOACCUMULATION ASSESSMENT

- Uses BAF to quantify bioaccumulation
- Scale of BAF Application:
  - Generally use national default BAF for setting national criteria
  - Encourage States/Tribes to modify national default BAF using local/regional data
- Use of predicted BAFs:
  - Measured BAFs are still preferred
  - Predicted BAFs will not be used when data indicate substantial metabolism by target biota (e.g., PAHs in fish)
  - When metabolism data are inadequate, assume no metabolism

BIOACCUMULATION ASSESSMENT, continued

- Use of Biota-Sediment Accumulation Factors (BSAF):
  - Continue to use BSAF method for deriving BAFs (particularly useful for poorly measured pollutants such as dioxins)
  - Restrictions placed on its use (e.g., nonionics with moderate-high hydrophobicity)

BIOACCUMULATION ASSESSMENT, continued

- Recent validation of BAFs predicted using BSAFs and model-derived BAFs:
  - Very good agreement between predicted BSAFs and measured BAFs (most data for PCBs, some chlorinated pesticides, chlorinated benzenes)
  - Good agreement for 3 of 4 evaluated locations on model-derived BAFs; generally not as good as BSAF
- National Default Parameters Updated to Reflect New Data (organic carbon, partition coefficients, lipid content)

RELATIVE CHANGES IN CRITERIA

RfD	+/- 3X (more or less stringent)
Cancer Slope	+/- 2-5X (more or less stringent)
Fish Consumption Rate	3-13X more stringent
BAF	0-100X more stringent
RSC	20-80% lower RfD

Other Exposure Factors - no change (providing additional defaults)

IMPLEMENTATION GUIDANCE State/Tribal Flexibility in Implementation

- Encouraging a greater role for States/Tribes in developing criteria.
  - Making risk assessment decisions (e.g., factoring in uncertainty and variability in decisions)
  - Adapting criteria to local conditions, especially with exposure and bioaccumulation assumptions.
  - Encouraging them to conduct peer review on criteria to enhance scientific defensibility.

IMPLEMENTATION GUIDANCE, *continued*

- States and Tribes will be expected to adopt new or revised AWQC consistent with the final Methodology as part of their next triennial review cycle. After EPA develops or revises a 304(a) criterion, we expect States/Tribes to:
  - Establish numerical values based on our most recent 304(a) criteria
  - Modify 304(a) criteria to reflect site-specific conditions
  - Establish values based on other scientifically defensible methods
  - Establish narrative criteria where numeric criteria cannot be determined

Methylmercury

Rita Schoeny

EPA Human Health Criterion

Criterion Equation*

$$AWQC = RfD \times RSC \times \left(\frac{BW}{DI + \sum_{i=2}^{4} (FI_i \times BAF_i)} \right)$$

* generalized equation for a noncarcinogen

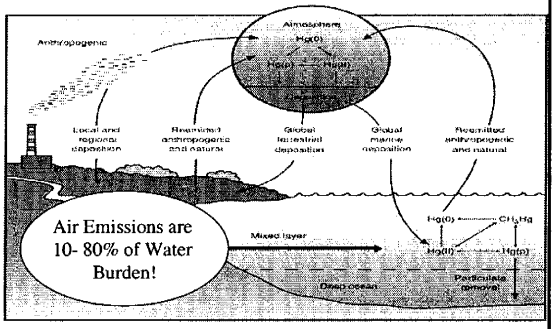
2001 304(a) Methylmercury Criterion at a glance

- RfD = 0.1 µg/kg bw/day; RfD is based on developmental effect but for all populations
- RSC = 0.027 µg/kg bw/day (exposure is through consumption of fish; RSC deals with marine)
- Fish consumption =17.5 g/day
- BAF = No BAF; criterion is in terms of fish tissue
- Criterion = 0.3 mg methylmercury/kg fish tissue, wet wt. (could translate to a total Hg water concentration of ~1-10 ng/L)

RfD 2001

- RfD = 0.1 µg/kg/day
- Based on NRC and external scientific input
- BMDL of 1.0 µg/kg/day -- from neuropsychological effects in Faroese children exposed *in utero* through maternal seafood consumption
- No data to support separate RfD for children
- Applicable to lifetime daily exposure for all populations including sensitive subgroups; not restricted to pregnancy or developmental periods

Geochemical Cycle of Mercury



Adapted from US Dept. of Interior's Report on Hg in the Florida Everglades

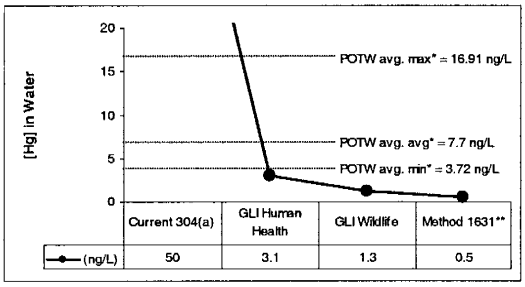
Bioaccumulation Issues

- EPA developed draft national BAF for freshwater
  - Insufficient data for estuarine BAF
- Vary 2 orders of magnitude
  - 50,000 to 10,000,000
- Peer review did not support national BAFs due to current data/science limitations
- We did not use a BAF for the criterion
- We suggest use site-specific BAF, waterbody-specific, or a model

How Do We Deal with a Fish Tissue Residue-based Criterion ?

- Tissue criterion = 0.3 mg methylmercury/kg fish
- Federal Register Notice discusses "*tissue-to-water translator recommendations*"
  - develop site-specific BAFs, if cannot do this then
  - use a bioaccumulation model
  - or use EPA's empirically derived BAFs
- May need an empirical MeHg-to-Hg conversion factor for water
- Resulting water value ~ 4-7 ng/L total Hg

Mercury Benchmarks



*based on AMSA mercury effluent characterization project
**detection limit = 0.2 ng/L

Mercury in Watersheds

- In 1998, of 21,800 impaired waterbodies
  - 33 states listed at least one mercury impairment
  - 5.6 million impaired acres of Lakes, Estuaries, Wetlands
  - ~43,500 Hg impaired miles of Stream/River/Coastal
  - ~4,000 were listed for metals (including mercury)
  - ~1,100 were listed specifically for mercury
    - **~8 states listed atmospheric deposition as source**
    - **~650 segments impaired by atmospheric deposition**

MeHg Criterion Implementation Issues

- Information collection
  - Analytical method for MeHg in fish
  - Field sampling plan -- collection to analysis
  - Translation -- MeHg in fish to Hg in water or effluent
- Water Quality Standards
  - Variances
  - Use attainability analyses
  - Status of use impairment based on fish tissue residue data

MeHg Criterion Implementation Issues - 2

- Permits
  - Determining need for water quality-based effluent limits (WQBELs) for NPDES permits for point sources
  - Permitting prior to TMDLs
  - Pollution prevention as permit limits
- Development of effective pollution management/source control strategies

MeHg Criterion Implementation Issues - 3

- Impairment Decisions and TMDLs
  - Will require nontraditional approaches
  - May need consistent nationwide approach to deal with air sources and reductions expected from other control/reduction activities
  - Determining attainment of the water quality criterion
- In the short run, our most useful public health tool will be fish advisories

Websites for mercury

- General
  - www.epa.gov/mercury
- CWA 304(a) Criterion 01/2001
  - www.epa.gov/ost/criteria/methylmercury/criteria.html
  - Criterion Document, FR Notice, Fact Sheet
- Fish Advisory page
  - www.epa.gov/ost/fish

Websites for mercury -- 2

- Mercury Study Report to Congress 12/1997
  - www.epa.gov/oar/mercury.html
- Utility Air Toxics Determination 12/2000
  - www.epa.gov/mercury/actions.htm#utility
- EPA's Mercury Research Strategy 12/2000
  - www.epa.gov/ORD/WebPubs/final/
- NRC Report -- Toxicological Effects of Methylmercury 07/2000
  - www.nap.edu/catalog/9899.html

Supplemental Information

80% of Hg from combustion is from 4 sources

- Coal-fired utility boilers -- 33%
- Municipal waste combustion -- 19%
- Commercial / industrial boilers -- 18%
- Medical waste incinerators -- 10%
  - MSRC, 1997

144 Mg (158 tons) Hg / yr emitted from U.S. anthropogenic sources

- 87% from combustion point sources
- 10% from manufacturing point sources
- 2% from area sources
- 1% miscellaneous sources
  - Data from 1994-1995, MSRC

17

Water Quality Standards and Fish Advisories

("Apples and Oranges or 1 Kettle of Fish?")

National Forum on Contaminants in Fish
May 9, 2001

Rick Greene
Delaware DNREC

Topics

- ✓Similarities/Differences
- ✓Linking WQS and FA
- ✓Barriers
- ✓Charge to Participants

Similarities/Differences (General #1)

Dimension	WQS	FA
Purpose	Protect "beneficial uses"	Protect public health
Focus	Water	Fish flesh
Statutory Basis	CWA	State Authority
Approach	Regulatory	Advisory

Similarities/Differences (General #2)

Dimension	WQS	FA
Responsibility	State Environmental	State Health
Maturity	30 plus years	10 plus years
Costs	Salaries	Collection/Analysis
Sampling	Easy	Hard
Fed Guidance	Extensive	Flexible

Similarities/Differences (Technical/Risk Assessment)

Dimension	WQS	FA
Data Variability	"Noisy"	Damped
Detection Limit Problems	Frequent for PBTs	Seldom, except for some PBTs
R.A. Expertise Required	Basic understanding	Considerable
Exposure Route for Fish	Water (BCF)	Water, sediment, and water (BAF)

Algebra 101

$$AWQC = \frac{RL \times BW}{q^* \times FI \times BCF}$$

$$SV_f = \frac{RL \times BW}{q^* \times FI}$$

Therefore, $AWQC = SV_f / BCF$

Similarities/Differences
(Risk Management)

Dimension	WQS	FA
Target CA Risk Level	10^{-6} or 10^{-5}	10^{-5} or "ignore"
Mitigating Factors	M.Z., design flows, bioavailability, fate	Trimming and cooking
Professional Judgement	Limited	Considerable
Interstate Waters	Must protect downstream use	Often inconsistent

Similarities/Differences
(Risk Communication)

Dimension	WQS	FA
Findings Reflected In:	305(b) Report, project reports	Fishing guides, PSAs, fact sheets, community groups
Audience	EPA, public	Fish consumers
Responsibility	Environmental agency	Health agency

Linking WQS and FA Programs

- ✓Narrative Water Quality Criteria
- ✓303(d) Listing Rationale
- ✓TMDLs

Delaware Narrative WQC

Section 4.1(a)(iii): Waters of the State shall be free from pollutants that may endanger public health.

Section 9.2(c): Waters of the State shall be maintained to prevent adverse toxic effects on human health resulting from ingestion of chemically contaminated aquatic organisms.

CWA 303(d) Listing

- ✓Delaware listing rationale states that issuance of a "no consumption" or "limited consumption" fish consumption advisory constitutes a violation of Section 4.1(a)(iii) and 9.2(c) of Delaware's Water Quality Standards.

TMDL

- ✓ Provides the framework for linking pollutant sources, mass loading, fate and transport, bioaccumulation, and waterbody goals (a.k.a. WQS).
- ✓ Can be exceedingly complex for PBTs (e.g., coupling to eutrophication; air-water and sediment-water exchange, complex mixtures).

Barriers to Effective Linkages

- ✓"We have a failure to communicate."
- ✓Need Nat'l Goals and Strategies for PBTs.
- ✓Bridge the gap from BCFs to BAFs (need technical guidance, time and $).
- ✓TMDL Lawsuits: A mixed blessing

Charge to Participants

- ✓Acquaint yourself with WQS or FA counterpart.
- ✓Establish common goals: improve water quality and lift advisories (the "prize").
- ✓Share data and thoughts with TMDL program.
- ✓Urge EPA to complete BAF TSD and sampling guidance.

Water Quality Standards and Fish Advisories:

Apples and Oranges, Most Definitely

National Forum on Contaminants in Fish
May 9, 2001

Randall Manning
Georgia DNR/EPD

Topics

- Differences
- What's Working, and Not
- Barriers
- What Can Be Done

Differences

- Regulatory std vs health protective advice
  - Single number / multiple tiers or ranges
  - Enforceable / non-enforceable
  - Data quality, quantity
  - Scientific uncertainty

What's Working

- We are talking here

What's (Not) Working

- Inconsistencies in
  - Listing processes (impaired vs partial, etc.)
  - Advisory conservativeness
  - Judicial interpretations (TMDLs)

Barriers

- Different agency mandates/missions
- Constraining fish advisories for unintended uses

What Can Be Done?

- Guidance developed with input from States
- Consistent application across regions

Question

- How to correct what's already done?

POLYCHLORINATED BIPHENYLS IN FOUR FRESHWATER FISH SPECIES FROM THE WILLAMETTE RIVER, OREGON: ANALYSIS OF 209 PCB CONGENERS AND AROCLOR MIXTURES*

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INTRODUCTION

Polychlorinated biphenyls (PCBs) are a group of organic chemicals comprising 209 individual chlorinated biphenyl congeners that continue to be of environmental concern due to their widespread distribution, persistence, and chronic toxicity to fish, wildlife, and humans [1-4]. Approximately 150 of the 209 PCB congeners are observed in commercial PCB mixtures manufactured until 1979 in the United States under the trade name Aroclor [5,6]. Nine technical grades of Aroclor were produced in the United States: 1221, 1232, 1016, 1242, 1248, 1254, 1260, 1262, and 1268. With the exception of Aroclor 1016, which is 41 percent chlorine by mass, the last two digits in the numerical name reflect the percent chlorine by mass in the technical mixture [7].

Currently, the majority of state fish contaminant monitoring programs assess potential PCB contamination by analyzing tissue samples for Aroclors [8]. Although Aroclor analysis is typically less costly than the analysis of individual PCB congeners [9], several studies have shown that Aroclor analyses can be imprecise due to qualitative and quantitative errors that arise when gas chromatography/mass spectrometry spectra for environmental samples are compared with characteristic patterns for different Aroclors [10-12]. Furthermore, available data indicate that bioaccumulated PCBs are more toxic and more persistent than the original Aroclor mixtures [13].

Recently, the US Environmental Protection Agency (EPA) updated its guidance document for assessing chemical contaminant data for use in fish advisories [9]. This document encourages states to develop the capability to perform PCB congener analysis and provides some recommendations for the analysis of specific PCB congeners. The objectives of this investigation were to analyze the full suite of 209 PCB congeners and Aroclor mixtures in a range of fish species representing different trophic levels to allow total PCB concentrations based on Aroclors and individual congeners to be compared and to provide data that may assist states in selecting which congeners should be included in fish contaminant monitoring programs.

METHODS

Carp (*Cyprinus carpio*), largescale sucker (*Catostomus macrocheilus*), northern pikeminnow (*Ptychocheilus oregonensis*), and smallmouth bass (*Micropterus dolomieui*), were collected from designated reaches of the Willamette River, Oregon during August 11-18, 1999 using a boat-mounted electrofishing unit. Stunned fish of the desired species that met the study length objectives were sacrificed by a sharp blow to the base of the skull with a wooden club. Each fish was measured for fork length and weight, double-wrapped in heavy duty aluminum foil, and placed in a sealed plastic bag with a waterproof tag stating the species name, collection date, collection location, and size. Each specimen was then immediately placed on dry ice in a cooler. All fish were processed within sixty minutes of capture. Coolers were shipped at the end of each day's collection activities for next-day delivery to Axys Analytical Services (Axys) laboratory located in Sidney, British Columbia.

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All processing of fish samples was conducted in a laboratory clean room. Composite fillet or whole body samples were created by homogenizing the tissue using a Virtis mixer or an Oster blender. The smallmouth bass composite sample consisted of scaled fillets including the belly flap tissue from both sides of five fish. Composite whole body samples comprised of five or eight individual fish were analyzed for the other three fish species (Table 1).

Table 1 Sample type, fish size, and collection locations for analyzed fish

Species	Sample Type	Number of Fish Per Composite	Mean Fork Length (mm)	Mean Weight (g)	Collection Location (River Mile)
Smallmouth bass	F	5	230	290	34.4 - 43
Carp	WB	5	531	2,930	34.4 - 43
Largescale sucker	WB	8	369	601	50 – 56.5
Northern pikeminnow	WB	8	304	318	50 – 56.5

Note: F = scaled fillet with skin; WB = whole-body

PCB Aroclors were measured using Axys Method CL-T-03, Version 3. Sample extracts were spiked with isotopically labeled surrogate standards and analyzed by low resolution gas chromatography/mass spectrometry (GC/MS) using a Finnigan INCOS mass spectrometer equipped with a Varian 3400 gas chromatograph. Accuracy was assessed by calculating the percent recovery of spiked isotope standards. The average percent recoveries of PCB 101, PCB 180, and PCB 209 standards was 67 percent. Detection limits for Aroclor analyses ranged from 0.3 to 2.2 µg/kg with a median value of 0.8 µg/kg.

EPA Method 1668 was used to measure tissue concentrations of individual PCB congeners. High resolution GC/MS analysis was conducted using a Micromass Autospec Ultima high resolution mass spectrometer equipped with a HP 5890 gas chromatograph. Accuracy was assessed by calculating the percent recovery of 12 spiked isotope standards (PCB 77, 105, 114, 118, 123, 126, 156/157, 167, 169, 170, 180, and 189). The average percent recovery of these standards was 83 percent. Detection limits for congener analysis were typically less than 5 ng/kg.

RESULTS

Aroclor 1242, 1254, and 1260 were detected in all four fish species (Table 2). The highest concentrations were observed for Aroclor 1254 in all species except northern pikeminnow, which had a slightly higher concentration of Aroclor 1260.

Table 2 Aroclor concentrations (µg/kg) and percent chlorination of PCBs in Willamette River Fish

Species	Aroclor 1242	Aroclor 1254	Aroclor 1260	Percent Chlorination
Smallmouth bass	1.2	15	11	57.4
Carp	7.7	87	40	56.5
Largescale sucker	6.7	53	36	57.0
Northern pikeminnow	3.7	58	62	57.6

The PCB congener analysis was used to determine the overall percent chlorination for each of the fish samples. Percent chlorination was determined by multiplying the concentration of each detected congener by the weight fraction of chlorine associated with that congener and then summing the resulting values for all congeners. The percent chlorination of PCBs detected in these fish species was similar, ranging from 56.5 to 57.6 percent (Table 2).

Total PCB concentrations were calculated by summing the three detected Aroclors and by summing the concentrations of detected individual PCB congeners (Table 3). With the exception of northern pikeminnow, total PCB concentrations calculated by summing Aroclor concentrations were higher than values calculated by summing individual congeners.

Table 3 Comparison of total PCB concentrations (µg/kg) calculated by summing Aroclors and individual PCB congeners

Species	Sum of Aroclors	Sum of Congeners	Relative Percent. Difference
Smallmouth bass	27.2	20.6	27.6
Carp	134.7	117.8	13.4
Largescale sucker	95.7	91.9	4.0
Northern pikeminnow	123.7	123.7	0.0

One hundred seventy two PCB congeners were detected in all four fish species; 23 congeners were not detected in any of the samples (PCB 2, 5, 7, 10, 12, 13, 14, 23, 35, 36, 39, 55, 73, 78, 80, 104, 106, 112, 140, 142, 161, 186, 192). Hexachlorobiphenyls (Hexa-CBs)and pentachlorobiphenys (Penta-CBs) comprised 65 to 71 percent of the mass of detected PCBs in the Willamette River fish (Table 4).

Table 4 PCB homologue concentrations (µg/kg) in Willamette River fish

Homologue Group	IUPAC #	# Congeners	Smallmouth Bass	Carp	Largescale Sucker	Northern Pikeminnow
Mono-CB	1 – 3	3	0.006	0.004	0.009	0.004
Di-CBs	4 – 15	12	0.025	0.182	0.103	0.088
Tri-CBs	16 – 39	24	0.295	2.372	1.777	1.270
Tetra-CBs	40 – 81	42	1.842	17.337	9.984	10.580
Penta-CBs	82 – 127	46	5.605	33.046	24.852	31.677
Hexa-CBs	128 – 169	42	8.568	43.576	38.931	55.751
Hepta-CBs	170 - 193	24	3.450	17.450	13.034	19.804
Octa-CBs	194 - 205	12	0.636	3.141	2.560	3.533
Nona-CBs	206 – 208	3	0.091	0.389	0.358	0.483
Deca-CBs	209	1	0.087	0.310	0.310	0.530
Totals		209	20.605	117.807	91.918	123.720

Table 5 shows the PCB congeners that contributed 95 percent of the total PCB congener concentration for each of the four fish species. PCB 118, 153, 168, and 187 were the top four PCB congeners by mass in all four species, comprising 19.9 to 29.7 percent of the total PCB concentration. These results show that between 12 to 18 congeners comprise fifty percent of the total PCB concentration, while 83 to 91 congeners need to be measured to comprise ninety-five percent of the total PCB concentration in these fish species.

Table 5 Percent contribution by mass of individual PCB congeners

	Smallmouth Bass			Carp			Largescale Sucker			Northern Pikeminnow		
Rank	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent
1	118	6.3	6.3	118	6.5	6.5	153	6.0	6.0	153	8.9	8.9
2	153	5.8	12.1	153	4.7	11.1	168	6.0	12.0	168	8.9	17.8
3	168	5.8	17.9	168	4.7	15.8	118	5.5	17.5	118	7.8	25.6
4	187	4.3	22.2	187	4.2	19.9	187	3.3	20.8	187	4.0	29.7
5	129	2.8	25.0	147	3.0	22.9	147	3.2	24.0	180	3.0	32.6
6	138	2.8	27.8	149	3.0	25.9	149	3.2	27.2	193	3.0	35.6
7	160	2.8	30.6	129	2.3	28.2	129	2.7	29.9	129	2.6	38.3
8	163	2.8	33.4	138	2.3	30.6	138	2.7	32.6	138	2.6	40.9
9	147	2.3	35.7	160	2.3	32.9	160	2.7	35.3	160	2.6	43.5
10	149	2.3	38.0	163	2.3	35.2	163	2.7	38.1	163	2.6	46.1
11	180	2.3	40.3	52	2.2	37.4	110	2.2	40.3	147	2.3	48.5
12	193	2.3	42.6	66	2.1	39.6	115	2.2	42.5	149	2.3	50.8
13	105	2.0	44.7	180	1.9	41.5	66	2.1	44.6	146	2.3	53.1
14	146	2.0	46.7	193	1.9	43.4	180	2.0	46.6	105	1.9	55.0
15	110	2.0	48.7	105	1.8	45.2	193	2.0	48.5	110	1.7	56.8
16	115	2.0	50.7	83	1.7	46.9	105	1.8	50.4	115	1.7	58.5
17	66	1.9	52.6	99	1.7	48.6	132	1.7	52.1	170	1.5	60.0
18	132	1.7	54.3	90	1.7	50.3	146	1.7	53.8	66	1.4	61.3
19	170	1.6	55.9	101	1.7	52.0	83	1.5	55.4	52	1.2	62.6
20	83	1.6	57.5	113	1.7	53.7	99	1.5	56.9	90	1.2	63.8
21	99	1.6	59.1	146	1.6	55.3	170	1.5	58.4	101	1.2	65.0
22	141	1.3	60.4	132	1.5	56.9	90	1.3	59.7	113	1.2	66.2
23	90	1.2	61.6	170	1.2	58.1	101	1.3	61.1	83	1.1	67.3
24	101	1.2	62.8	141	1.1	59.2	113	1.3	62.4	99	1.1	68.5
25	113	1.2	64.1	174	1.0	60.2	52	1.2	63.6	132	1.1	69.6

	Smallmouth Bass			Carp			Largescale Sucker			Northern Pikeminnow		
Rank	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent	PCB	Percent	Cumulative Percent
26	177	1.1	65.1	92	0.9	61.1	141	1.2	64.8	141	0.9	70.5
27	52	1.0	66.1	177	0.9	62.0	174	1.1	65.9	158	0.9	71.4
28	158	1.0	67.2	61	0.8	62.9	177	0.9	66.8	177	0.8	72.2
29	174	0.9	68.1	70	0.8	63.7	158	0.9	67.7	164	0.7	72.9
30	128	0.8	68.9	74	0.8	64.6	92	0.7	68.4	156	0.6	73.5
31	166	0.8	69.7	76	0.8	65.4	135	0.7	69.2	157	0.6	74.1
32	92	0.7	70.4	135	0.8	66.3	151	0.7	69.9	167	0.6	74.8
33	183	0.7	71.1	151	0.8	67.1	154	0.7	70.6	128	0.6	75.4
34	185	0.7	71.8	154	0.8	68.0	64	0.7	71.3	166	0.6	76.0
35	130	0.7	72.5	64	0.8	68.8	194	0.6	71.9	183	0.6	76.6
36	135	0.6	73.1	84	0.7	69.5	61	0.6	72.5	185	0.6	77.2
37	151	0.6	73.8	179	0.7	70.2	70	0.6	73.1	174	0.6	77.8
38	154	0.6	74.4	158	0.7	70.9	74	0.6	73.7	61	0.6	78.4
39	194	0.6	75.1	44	0.7	71.5	76	0.6	74.3	70	0.6	78.9
40	203	0.6	75.7	47	0.7	72.2	128	0.6	74.9	74	0.6	79.5
41	137	0.6	76.3	65	0.7	72.8	166	0.6	75.5	76	0.6	80.1
42	178	0.6	76.9	49	0.6	73.5	183	0.6	76.1	92	0.6	80.6
43	64	0.5	77.4	69	0.6	74.1	185	0.6	76.7	137	0.6	81.2
44	109	0.5	77.9	183	0.6	74.7	130	0.6	77.3	203	0.5	81.7
45	179	0.5	78.5	185	0.6	75.4	164	0.5	77.8	130	0.5	82.2
46	156	0.5	79.0	56	0.6	76.0	179	0.5	78.3	135	0.5	82.7
47	157	0.5	79.5	86	0.6	76.6	203	0.5	78.8	151	0.5	83.2
48	61	0.5	80.0	87	0.6	77.2	56	0.5	79.3	154	0.5	83.7
49	70	0.5	80.5	93	0.6	77.8	49	0.5	79.8	109	0.5	84.2
50	74	0.5	81.0	95	0.6	78.4	69	0.5	80.2	44	0.4	84.6
51	76	0.5	81.5	97	0.6	78.9	84	0.5	80.7	47	0.4	85.0
52	164	0.5	81.9	98	0.6	79.5	44	0.4	81.1	65	0.4	85.5
53	84	0.4	82.4	100	0.6	80.1	47	0.4	81.6	209	0.4	85.9
54	190	0.4	82.8	102	0.6	80.7	65	0.4	82.0	64	0.4	86.3
55	209	0.4	83.2	108	0.6	81.3	156	0.4	82.4	86	0.4	86.6
56	86	0.4	83.6	119	0.6	81.9	157	0.4	82.9	87	0.4	87.0
57	87	0.4	84.0	125	0.6	82.5	136	0.4	83.3	97	0.4	87.4
58	97	0.4	84.5	128	0.6	83.1	86	0.4	83.7	108	0.4	87.7
59	108	0.4	84.9	166	0.6	83.7	87	0.4	84.1	119	0.4	88.1
60	119	0.4	85.3	136	0.5	84.2	97	0.4	84.5	125	0.4	88.5
61	125	0.4	85.7	130	0.5	84.8	108	0.4	85.0	164	0.4	88.8
62	198	0.4	86.1	194	0.5	85.3	119	0.4	85.4	178	0.3	89.2
63	199	0.4	86.5	203	0.5	85.8	125	0.4	85.8	198	0.3	89.5
64	167	0.4	86.9	31	0.4	86.2	109	0.4	86.2	199	0.3	89.9
65	49	0.4	87.3	42	0.4	86.7	137	0.4	86.6	190	0.3	90.2
66	69	0.4	87.6	109	0.4	87.1	20	0.4	87.0	56	0.3	90.5
67	136	0.3	88.0	178	0.4	87.5	28	0.4	87.4	49	0.3	90.8
68	85	0.3	88.3	164	0.4	87.9	178	0.4	87.8	69	0.3	91.1
69	116	0.3	88.7	198	0.4	88.3	93	0.4	88.1	42	0.3	91.4
70	117	0.3	89.0	199	0.4	88.7	95	0.4	88.5	179	0.3	91.7
71	44	0.3	89.3	20	0.4	89.0	98	0.4	88.9	84	0.3	92.0
72	47	0.3	89.6	28	0.4	89.4	100	0.4	89.2	195	0.3	92.3
73	65	0.3	90.0	82	0.3	89.7	102	0.4	89.6	196	0.3	92.5
74	196	0.3	90.3	85	0.3	90.1	31	0.4	90.0	93	0.3	92.8
75	172	0.3	90.6	116	0.3	90.4	167	0.4	90.3	95	0.3	93.1
76	82	0.3	90.9	117	0.3	90.8	198	0.4	90.7	98	0.3	93.3
77	56	0.3	91.2	60	0.3	91.1	199	0.4	91.0	100	0.3	93.6
78	93	0.3	91.5	156	0.3	91.4	190	0.3	91.4	102	0.3	93.8
79	95	0.3	91.8	157	0.3	91.7	209	0.3	91.7	31	0.3	94.1
80	98	0.3	92.0	167	0.3	92.1	42	0.3	92.0	172	0.3	94.3
81	100	0.3	92.3	137	0.3	92.4	195	0.3	92.3	206	0.2	94.6
82	102	0.3	92.6	88	0.3	92.7	85	0.3	92.6	20	0.2	94.8
83	60	0.3	92.9	91	0.3	93.0	116	0.3	92.9	28	0.2	95.0
84	195	0.3	93.2	190	0.3	93.2	117	0.3	93.2			
85	206	0.3	93.5	144	0.3	93.5	82	0.3	93.4			
86	20	0.3	93.7	196	0.3	93.8	144	0.3	93.7			
87	28	0.3	94.0	209	0.3	94.0	196	0.3	94.0			
88	171	0.3	94.3	172	0.2	94.3	60	0.3	94.2			
89	173	0.3	94.5	48	0.2	94.5	172	0.3	94.5			
90	144	0.3	94.8	171	0.2	94.7	206	0.3	94.7			
91	31	0.3	95.0	173	0.2	94.9	123	0.2	94.9			
92				195	0.2	95.2	171	0.2	95.1			

DISCUSSION

PCBs are currently analyzed as Aroclor equivalents, homologue groups, or as individual congeners [9]. As of May 2000, Aroclor analysis was the predominant measure of PCB concentration in state fish contaminant monitoring programs [8]. Based on state responses to a questionnaire developed by EPA's Office of Water and the State of Nebraska, 23 states analyze only Aroclors, 14 states analyze both Aroclors and selected PCB congeners, three states analyze only selected congeners; and ten states provided no information [8]. Aroclor analysis is less costly than analyzing individual congeners; however, several studies have noted that PCBs often cannot be adequately described by reference to Aroclors due the subjective assignment of Aroclor speciation and response factors and the assumption that Aroclors are representative of weathered PCB profiles [7,10-14].

The results obtained in this study demonstrate two potential problems with estimating PCB concentrations from Aroclor analysis. First, the PCB congener patterns detected in Willamette River fish are not well described by the commercial PCB Aroclor mixtures as the percent chlorination of PCB congeners lies between that of Aroclor 1254 (54 percent chlorination) and Aroclor 1260 (60 percent chlorination). Second, total PCB concentrations calculated by summing Aroclors overestimated total PCB congener concentrations in three of the four species analyzed. This later result contradicts other studies [12, 14], which have reported that PCB concentrations derived from Aroclors may underestimate total PCBs. This discrepancy may illustrate the difficulties inherent in representing fish PCB profiles as commercial PCB mixtures.

EPA [9] encourages states to develop the capability to perform PCB congener analysis and recommends that at a minimum the 18 congeners recommended by NOAA [15] be analyzed and summed to determine total PCB concentration. PCB congeners of potential environmental importance identified by McFarland and Clarke [2] and dioxin-like congeners identified by Van den Berg et al. [16] are also recommended for consideration. Table 6 lists the congeners identified by EPA [9] and the 75 congeners monitored by Delaware to estimate total PCB concentrations [14]. The data collected in this investigation demonstrate that total PCB concentrations estimated by summing the 18 congeners recommended by NOAA would substantially underestimate total PCB concentrations in Willamette River fish. These 18 congeners comprised 29.1 to 35.0 percent of the total PCB concentration. The highest priority and second priority congeners recommended by McFarland and Clarke [2] comprised between 41.6 to 51.2 percent of the total PCB concentration. The 12 dioxin-like PCB congeners comprise between 9.1 and 12.2 percent of the total PCB concentration.

Greene [14] found that only four congeners contributed greater than 5 percent of the mass of total PCB and recommended that a comprehensive congener list should be analyzed if the objective is to account for total PCB concentration. This investigation provides additional support for this recommendation. The 75 congeners analyzed by Greene [14] comprised between 63.2 to 69.4 percent of the total PCB measured in Willamette River fish (Table 6). To ensure that the analysis of a suite of PCB congeners is appropriate for estimating total PCB concentrations, it is recommended that site-specific analyses be conducted which analyze a comprehensive, or complete, suite of PCB congeners to determine which congeners should be included in state fish contaminant monitoring programs.

Table 6 Percent of total PCB concentration in Willamette River fish comprised of different suites of PCB congeners

		McFarland and Clarke [2]				
PCB #	NOAA [15]	Highest Priority	Second Priority	Combined	Dioxin-Like PCBs [16]	Greene [14]
8	●					●
18	●		●	●		●
28	●					●
37			●	●		●
42						●
44	●		●	●		●
47						●
49			●	●		●
52	●					●
60			●	●		●
64						●
66	●					●
70			●	●		●
74			●	●		●
77	●	●		●	●	●
80						●
81			●	●	●	●
82						●
84						●
86						●
87		●		●		●
90		●		●		
91						●
92						●
95						●
97						●
99						●
101	●	●		●		●
105	●	●		●	●	●
110						●
114			●	●	●	●
118	●	●		●	●	●
119			●	●		●
120						●
123			●	●	●	●
126	●	●		●	●	●
127						●
128	●	●		●		●
137						●
138	●	●		●		●
141						●
146						●
149						●
151			●	●		●
153	●	●		●		●
156		●		●	●	●
157			●	●	●	●
158			●	●		●
166						●
167			●	●	●	●
168			●	●		●
169	●	●		●	●	●
170	●	●		●		●
171						●
174						●
177						●
179						●
180	●	●		●		●
183		●		●		●
184		●		●		
185						●
187	●		●	●		●
189			●	●	●	●
190						●
191						●

PCB #	NOAA [15]	McFarland and Clarke [2] Highest Priority	McFarland and Clarke [2] Second Priority	McFarland and Clarke [2] Combined	Dioxin-Like PCBs [16]	Greene [14]
195		●		●		●
196						●
198						●
200						●
201			●	●		●
203						●
205						●
206		●		●		●
207						●
208						●
209		●		●		●
						●

Species	Percent of Total PCB	Percent of Total PCB	Percent of Total PCB	Percent of Total PCB	Percent of Total PCB	Percent of Total PCB
Bass	30.9	26.9	16.6	43.5	10.3	65.1
Carp	30.3	24.7	17.7	42.4	9.7	63.2
Sucker	29.1	25.3	16.3	41.6	9.1	63.5
Pikeminnow	35.0	31.5	19.8	51.2	12.2	69.4

REFERENCES

1. Kalantzi, O.I., R.E. Alcock, P.A. Johnston, D. Santillo, R.L. Stringer, G.O. Thomas, and K.C. Jones. 2001. The global distribution of PCBs and organochlorine pesticides in butter. *Environ. Sci. Technol.* **35**:1013-1018.

2. McFarland, V.A. and J.U. Clarke. 1989. Environmental occurrence, abundance, and potential toxicity of polychlorinated biphenyl congeners: Considerations for a congener-specific analysis. *Environmental Health Perspectives* **81**:225-239.

3. Eisler, R. 1986. Polychlorinated biphenyl hazards to fish, wildlife and invertebrates: A synoptic review. *U.S. Fish and Wildlife Services Biological Report* **85**. Patuxent Wildlife Research Center, Laurel, Maryland.

4. Agency for Toxic Substances and Disease Registry. 1998. Toxicological profile for selected PCBs. U.S. Department of Health and Human Services, Public Health Service, Atlanta, Georgia.

5. Frame, G.M., J.W. Cochran, and S.S. Bowadt. 1996. Complete PCB congener distributions for 17 Aroclor mixtures determined by 3 HRGC systems optimized for comprehensive, quantitative, congener-specific analysis. *J. High Resolution Chromatography* **19**:657-668.

6. United States Environmental Protection Agency. 1999. Fact sheet. Polychlorinated biphenyls (PCBs) update: Impact on fish advisories. EPA-82-F-99-019. Office of Water, Washington, DC.

7. Newman, J.W., J.S. Becker, G. Blondina, and R.S. Tjeerdema. 1998. Quantification of Aroclors using congener-specific results. *Environmental Toxicology and Chemistry* **17**:2159-2167.

8. American Fisheries Society. 2000. Proceedings American Fisheries Society Forum on Contaminants in Fish, October 18-20, 1999. Prepared for American Fisheries Society, Bethesda, MD. EVS Environment Consultants, Seattle, WA.

9. United States Environmental Protection Agency. 2000. Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish sampling and Analysis. Third Edition. EPA-823-B-00-007. Office of Water, Washington, DC.

10. Draper, W.M., D. Wijekoon, R.D. Stephens. 1991. Speciation and quantification of Aroclors in hazardous wastes based on PCB congener data. *Chemosphere* **22**:147-163.

11. United States Environmental Protection Agency. 1996. PCBs: Cancer dose-response assessment and application to environmental mixtures. EPA-600-P-96-001F. Office of Research and Development, Washington, DC.

12. Finley, B.L., P.K. Scott, and C. Kirman. 2000. PCBs in Passaic River sediments: Some analytical considerations. *Soil and Sediment Contaminantion* **9**:167-179.

13. Cogliano, V.J. 1998. Assessing the cancer risk from environmental PCBs. *Environmental Health Perspectives* **106**:317-323.

14. Greene, R.W. 1999. Chemical Contaminants in Finfish from the Chesapeake and Delaware Canal and Implications to Human Health Risk. Delaware Department of Natural Resources and Environmental Control, Dover, DE.

15. NOAA (National Oceanic and Atmospheric Administration). 1989. Standard Analytical Procedures of the NOAA National Analytical Facility. 2nd ed. NOAA Tech. Mem. NMFS F/NWC-92, 1985-86. National Status and Trends Program, U.S. Department of Commerce, Rockville, MD.

16. Van den Berg, M., L. Birnbaum, A.T.C. Bosveld, B. Brunström, P. Cook, M. Feeley, J.P. Giesy, A. Hanberg, R. Hasegawa, S.W. Kennedy, T. Kubiak, J.C. Larsen, F.X.R. van Leeuwen, A.K. Djien Liem, C. Nolt, R.E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D. Tillitt, M. Tysklind, M. Younes, F. Waern, and T. Zacharewski. 1998. Toxicity equivalency factors (TEFs) for PCBs, PCDDs, PCDFs for humans and wildlife. *Environ. Health Perspect.* **106**:775-792.

Part IV

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Appendix B

Biosketches of Presenters at the 2001 Fish Forum

Thomas M. Armitage, Ph.D.
Program Manager, Office of Water
U.S. Environmental Protection Agency
Washington, DC

Dr. Thomas Armitage has worked as a scientist and program manager in several different offices of the U.S. Environmental Protection Agency. In EPA's Office of Water, Dr. Armitage managed programs to provide technical guidance and assistance to states for assessing the human health and ecological risks associated with toxic contaminants in sediments and fish. He also worked on technical guidance for monitoring pathogens in recreational waters. In EPA's National Estuary Program, Dr. Armitage developed guidance for management of estuarine and coastal resources, and in EPA's Office of Pesticide Programs, he worked as an environmental toxicologist. Before joining EPA, Dr. Armitage was a legislative fellow in the U.S. Senate responsible for environmental issues and worked as a biologist for Betz Environmental Engineers. Dr. Armitage holds an undergraduate degree in biology, masters degrees in biology and business administration, and a doctorate in marine science.

Denis R. Borum
Environmental Scientist
Office of Science and Technology (OST)
U.S. Environmental Protection Agency
Washington, DC

Denis R. Borum is an environmental scientist with the Health and Ecological Criteria Division of OST. He is the lead scientist on human exposure assessment issues for both the surface water and drinking water programs. He has substantial expertise in the Office's regulatory activities and risk assessment programs. Mr. Borum managed the recently published revisions to the Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health. This guidance incorporates the latest scientific knowledge in the areas of cancer and noncancer risk assessments, exposure assessment, and in bioaccumulation assessment, and will set the course for water quality criteria development over the next 10 to 20 years.

Rick Greene
Environmental Engineer
Delaware Dept. Natural Resources and Environmental Control
Dover, DE

Rick Greene is responsible for all technical aspects of Delaware's surface water toxics program, including monitoring of water, sediment and biota; data assessment and interpretation; policy and regulatory development; and agency representation. Mr. Greene has been the architect of Delaware's fish contamination advisory program. This has involved crafting a MOU between participating agencies, development of an annual toxics in biota monitoring plan, oversight of a large fish consumption survey, performing numerous risk assessments, and working with risk managers in issuing all current consumption advisories in Delaware. Mr. Greene also developed the toxics provisions of Delaware's Surface Water Quality Standards and successfully linked

narrative provisions in those standards to fish consumption advisories in order to support Clean Water Act Section 303(d) listing decisions and subsequent TMDLs.

Michael S. Haire
Office of Water
U.S. Environmental Protection Agency
Washington, DC

Michael Haire has been with EPA, Office of Water since 1999. He has been a key member of the team revising the Total Maximum Daily Load (TDML) regulation (40 CFR Part 130). Additionally, he has provided technical guidance and assistance to the states as they developed TMDLs for a variety of pollutants in various water types. In addition to his focus on TMDLs, he has worked closely with ASIWPCA, ECOS, and the states to provide guidance on listing and monitoring methodologies. Before joining EPA, Mr. Haire worked for the Maryland Department of the Environment (MDE) as the director of the Technical and Regulatory Services Administration. In this position, Mr. Haire was responsible for the state's water quality standards program, water quality monitoring program, shellfish certification program, TMDL program, environmental health program, and emergency response program. Before coming to MDE, Mr. Haire worked in private industry for J.E. Greiner Engineering and the Martin Marietta Corporation. Mr. Haire holds undergraduate degrees in civil engineering and biology and graduate degrees in marine biology and business administration.

Stuart Harris
Natural and Cultural Resources Coordinator
Confederated Tribes of the Umatilla Indian Reservation
Pendleton, Oregon

Stuart Harris is a natural and cultural resources coordinator and staff scientist for the Confederated Tribes of the Umatilla Indian Reservation. The Umatilla Indian Reservation, located near Pendleton, Oregon, is occupied by the descendants of three Columbia Plateau tribes—the Cayuse, the Walla, and the Umatilla tribes. Mr. Harris has published several articles on risk analysis from a Native American perspective and on tribal technical issues in risk reduction through fish advisories.

Alan Levy, Ph.D.
Senior Scientist, Division of Market Studies
Center for Food and Safety Applied Nutrition
Food and Drug Administration
Washington, DC

Alan Levy is a Senior Scientist in the Division of Market Studies at the Center for Food Safety and Applied Nutrition, Food and Drug Administration. Levy specializes in consumer behavior issues related to food safety, food labeling and health education policies. He is a regular Consultant to the National Institutes of Health, Centers for Disease Control and Prevention, U.S.

Department of Agriculture, Health Care Financing Administration, Federal Trade Commission, Environmental Protection Agency and the Department of Energy. Levy is a well-known author with recent publications in the *Journal of Public Policy and Marketing¸ American Journal of Agricultural Economics, The Electricity Journal, and Journal of Consumer Affairs*. Levy's most current research focuses on dietary supplement labeling, warning labels, consumer acceptance of biotechnology and new food processing technologies, and safe food handling practices. Levy holds a doctorate in Social Psychology from Columbia University and a bachelor's degree in Physics from Michigan State University.

Kathryn R. Mahaffey, Ph.D.
Director, Division of Exposure Assessment
Office of Science Coordination and Policy
Office of Prevention, Pesticides, and Toxic Substances
U.S. Environmental Protection Agency
Washington, DC

Kathryn Mahaffey is a risk assessor who has specialized in food safety and lead exposure reduction. She has a doctorate from Rutgers University in biochemistry and nutrition and has completed post-doctoral training in neuro-endocrinology. Dr. Mahaffey has worked for EPA since 1993, and she is currently the director of the Division of Exposure Assessment, Office of Science Coordination and Policy, Office of Prevention, Pesticides, and Toxic Substances. Before joining EPA, Dr. Mahaffey served as the Food and Drug Administration's project manager for lead contamination of food and was a branch chief of National Institute for Occupational Safety and Health (NIOSH) where she devised screening methods to evaluate chemicals for development of NIOSH policy statements and maintained electronic data bases, including the Registry of Toxic Effects of Chemical substances. Dr. Mahaffey worked in a science advisory group in the Office of the Director of the National Institute of Environmental Health Sciences (NIEHS), where she wrote NIEHS's *Mercury Report to Congress*. She was also a faculty member at the University of North Carolina School of Medicine. Dr. Mahaffey has conducted research on nutritional status and lead toxicity; the health effects of chemicals; the cumulative risk of exposure to multiple heavy metals including lead, cadmium, and arsenic; mother-to-child lead transmission; and other related topics. Dr. Mahaffey's research on lead and mercury resulted in more than 100 peer-reviewed papers and chapters in numerous books. She published the first national estimates of the prevalence of lead toxicity for the United States, which were instrumental in the phase-down and removal of lead additives from gasoline. She was one of the primary authors of EPA's *Mercury Study Report to Congress* and was a co-lead in developing EPA's *Mercury Research Strategy*. She also served on EPA's clean air science advisory board.

Randall O. Manning, Ph.D., DABT
Coordinator, Environmental Toxicology Program
Georgia Department of Natural Resources, Environmental Protection Division
Atlanta, Georgia

Randall Manning is the Coordinator of the Environmental Toxicology Program with the Georgia Department of Natural Resources Environmental Protection Division. He is responsible for

providing toxicology and risk assessment support to the division. His interest in fish consumption advisories began in 1991, when he coordinated the development of guidelines for a monitoring strategy and risk-based advisories. Dr. Manning worked with focus groups to acquire input for the program and to develop communication strategies. He continues to manage the fish advisory program and speaks frequently on fish consumption and risk. He is particularly interested in uncertainties regarding fish consumption rates and patterns and potential benefits from fish consumption as they relate to risk communication.

Deborah Rice, Ph.D.
National Center for Environmental Assessment
U. S. Environmental Protection Agency
Washington, DC

Deborah Rice received a Ph.D. in toxicology from the University of Rochester and is currently a risk assessor in neurotoxicology with the National Center for Environmental Assessment at the U.S. Environmental Protection Agency. She is the co-author of the background document to derive a reference dose for methylmercury and is the chair of the working group for the derivation of a reference dose for PCBs. Before joining EPA, Dr. Rice was a research scientist in the Toxicology Research Division of Health Canada, where she headed a research program to characterize nervous system impairment produced by developmental exposure to the major environmental pollutants lead, methylmercury, and PCBs. Robust behavioral impairment was observed as a result of ongoing exposure to lead at blood lead concentrations as low as 10 μg/dl. Dr. Rice identified impairment in visual, auditory, and somatosensory function as a result of developmental methylmercury exposure; delayed neurotoxicity as a result of early exposure was also documented, as well as an age-exposure interaction in functional decrement in aging monkeys. Dr. Rice identified behavioral deficits in monkeys exposed postnatally to an environmentally relevant congener mixture of PCBs, and who9 had blood PCB concentrations typical of environmentally exposed humans. Dr. Rice is currently an Associate Editor for the journals *Neurotoxicology, Neurotoxicology and Teratology, and Environmental Research*. She has authored or co-authored more than 100 research articles and book chapters on neurotoxic effects of specific agents, methodologycal approaches for neurotoxicology research, and risk assessment.

Rita Schoeny, Ph.D.
Associate Director of the Health and Ecological Criteria Division
Office of Science and Technology
Office of Water
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Washington, DC

Rita Schoeny is Associate Director of the Health and Ecological Criteria Division of the Office of Science and Technology, in the U.S. Environmental Protection Agency's Office of Water. She received her B.S. in biology at the University of Dayton and a Ph.D. In microbiology from the School of Medicine of the University of Cincinnati. After completing a postdoctoral fellowship at the Kettering Laboratory, Department of Environmental Health, she was appointed

Assistant Professor in that department of the U.C. Medical School. Dr. Schoeny holds appointments as Volunteer Associate Professor of Environmental Health (University of Cincinnati) and Adjunct Professor of Toxicology at the University of Kentucky, Lexington. She regularly lectures at colleges and universities on risk assessment.

Dr. Schoeny joined the U.S. EPA in 1986. 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 Carcinogen Risk Assessment Verification Endeavor (CRAVE). She 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 and principles of human health risk assessment. Dr. Schoeny is the recipient of several awards including a U.S. EPA Silver Medal (ACTION) Award, U.S. EPA Bronze Medals, the Greater Cincinnati Area Federal Employee of the Year Award and the University of Cincinnati Distinguished Alumnae Award. She was the ORD lead and co-author of the Mercury Study Report to Congress. This is a multi-volume work on exposure, health and environmental effects of mercury emissions from anthropogenic U.S. sources. Current focal points of her office are determining appropriate priorities for assessment leading to regulation of water contaminants and development of risk assessment frameworks for microbial agents and for sensitive human subpopulations.

Alan H. Stern, Dr.P.H., DABT
Chief, Bureau for Risk Analysis
Division of Science, Research and Technology
New Jersey Department of Environmental Protection
Trenton, NJ

Alan Stern received a doctorate in public health from the Columbia University School of Public Health in 1987. 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. He is board certified in toxicology, and adjunct associate professor in the Department of Environmental and Community Medicine of the University of Medicine and Dentistry of New Jersey. He recently 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.

Elizabeth Southerland, Ph.D.
Director of Standards and Health Protection Division
Office of Water
U.S. Environmental Protection Agency
Washington, DC

Elizabeth Southerland has worked for the U.S. Environmental Protection Agency since 1984 as an environmental engineer and manager of water quality programs. Currently, Dr. Southerland is director of the Standards and Health Protection Division in EPA's Office of Water. The Division is responsible for overseeing the approval/disapproval of state and tribal water quality standards as well as developing national assessments of water pollution and advice on how to prevent public health effects from this pollution. Ongoing work in the Division regarding chemical contamination in fish includes monitoring contaminants in fish from lakes and reservoirs throughout the United States, developing national guidance and data on fish consumption advisory programs, and preparing public education materials on avoiding risks from fish contamination.

Dwain Winters
Office of Water
U.S. Environmental Protection Agency
Washington, DC

Dwain Winters, director of EPA's Dioxin Policy Project, is responsible for overall coordination of EPA dioxin policy and the development of EPA's policy response to the EPA Dioxin Science Reassessment. Dwain is also co-coordinator of the EPA Dioxin Exposure Initiative, an effort to identify and characterize the major sources and pathways of human exposure to dioxin and related compounds.

Appendix C

Sunday Fish Advisory
Breakout Session Questionnaire and Responses

Special Sunday Fish Advisory Breakout Session Questionnaire

State/Tribal Fish Advisory Contact **State/Tribal Affiliation**

Does your state or tribal organization issue Fish Consumption Advisories (FCAs)?

1. Questions/issues for discussion about mercury:

Do you issue FCAs based on mercury levels in fish?

Do you use the FDA action level as a basis for advice?

A. EPA RfD for mercury:

Do you use the EPA IRIS reference dose (RfD) of 0.1 µg/kg/day?

If not, what "RfD" do you use?

If yes, is it used for everyone or just the sensitive population?

Future plans for changes?

B. Tiered advice

Do you provide separate advice for the general population and the sensitive population?

If yes, what RfDs are used and what is the basis for these RfDs?

C. General/statewide advice

Does your program provide advice for untested waters?

Is it based on your data?

Other basis?

Are you using or referencing the EPA national mercury advice in your advisory?

Are you using or referencing the FDA national mercury advice in your advisory?

D. Commercial fish

Do you provide consumption advice to consumers for commercial fish?

_____

If yes, for everyone or just the sensitive population?

_____

Have you incorporated the FDA mercury advice?

_____

Have you developed your own mercury advice for commercial fish?

_____

What data were used?

_____

What species were involved and what meal advice was given?

_____

Do you factor in commercial fish consumption into your risk assessment for locally caught fish?

_____

Should a Relative Source Contribution (RSC) be used?

_____

E. Trigger levels - fish tissue concentrations

At what mercury tissue concentration do you begin giving advice to limit consumption?

_____

What meal size/body weight assumption is used?

_____

Do you use different meal size/body weight ratios for different populations?

_____

Fish Advisory Breakout Sessions CHESAPEAKE-DELAWARE ESTUARY STATES	DC	DE	MD	VA	WV
Do you issue Fish Consumption Advisories (FCAs)?	Yes	Yes	Yes	Yes	Yes
1. Questions/issues for discussion about mercury:					
Do you issue FCAs based on mercury levels in fish?	Hg is not a pollutant of concern in DC	Yes	Yes	Yes	Not at this time; need more data
Do you use the FDA action level as a basis for advice?	Yes	No	No, but would be considered for no consumption advisories	No longer, now use risk assessment methodology	NR
A. EPA RfD for mercury:					
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	Yes	Yes	Yes	Yes, but other portions of equation result in 0.5 not 0.3	Yes
If yes, is it used for everyone or just the sensitive population?	General population	RfD used for each population (child, woman, adult), but each group has a separate screening value	Everyone	Everyone	NA
Future plans for changes?	NR	Not now; but we review methods yearly	May move toward sensitive population currently investigating	Not in near future	NR
B. Tiered advice					
Do you provide separate advice for the general population and the sensitive population?	Yes	No	Yes	Yes	No; advisories are toward the sensitive population
If yes, what RfDs are used and what is the basis for these RfDs?	NR	NA	Same RfDs, the advice is more restrictive toward sensitive population	# of meals differ	NA
C. General/statewide advice					
Does your program provide advice for untested waters?	No	No	No	No	No
Is it based on your data? Other basis?	NA	NA	NA	No, VA Dept of Environmental Quality	NA
Are you using or referencing the EPA national advice in your advisory?	Yes, if needed	Currently considering using EPA advisory in our advisory	Yes	Yes	Yes, soon
Are you using or referencing the FDA national advice in your advisory?	Yes, if needed	No	Yes	No	NR

Fish Advisory Breakout Sessions CHESAPEAKE-DELAWARE ESTUARY STATES	DC	DE	MD	VA	WV
D. Commercial fish					
Do you provide consumption advice for commercial fish?	No	No	NR	Yes, previously for kepone, but not mercury/depending on if there is commercial fishing	NR
If yes, for everyone or just sensitive populations?	NA	NA	NR	Everyone	NR
Have you incorporated the FDA advice?	NR	NR	NR	No	NR
Have you developed your own advice for commercial fish?	NR	No	NR	No	NR
What data were used?	NR	NA	NR	NA	NR
What species and meal advice?	NR	NA	NR	NA	NR
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	NR	No	NR	No	NR
Should an RSC be used?	NR	Point of argument in our program; varying answers	NR	NR	NR
E. Trigger levels - fish tissue concentrations					
At what mercury tissue concentration do you begin giving advice to limit consumption?	Based on FDA and EPA action levels	Child = 119 ppb Women of child-bearing age = 263 ppb Adult = 216 ppb	0.3 ppm	0.5 ppm	0.028 ppm
What meal size/body weight assumption is used?	NR	Child - 12.1 g/day (3oz meal once/week), BW= 14.5 kg; Women of child-bearing age - 24.2 g/day (6 oz meal once/week), BW= 64 kg; Adult - 32.3 g/day (8 oz meal once/week), BW = 70 kg	Was 6.5 g/day, moving toward 18 g/day	8 oz meal size	70 kg = adult 14.5 kg = child
Do you use different meal size/body weight ratios for different populations?	NR	Yes, see above	Yes	Yes, meal size	227 g = adult 52.5 g = child

Fish Advisory Breakout Sessions GREAT LAKES STATES AND TRIBES	**IA**	**IL**	**MN**	**NY**	**PA**	**WI**	**GLIFWC**
Do you issue FCAs?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Questions/issues for discussion about mercury:							
Do you issue FCAs based on mercury levels in fish?	No, not until levels exceed FDA limit.	Yes	Yes	Yes	Yes, as of 4/11/01	Yes	Yes
Do you use the FDA action level as a basis for advice?	Yes	No	No	Yes	No	No	No
A. EPA RfD for mercury:							
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	No	No, > 0.5 ppm for Do Not Eat advisory	Yes	No, We do not use RfD when generating advice.	Yes	Yes	Yes, we follow this RfD for risk evaluations
If yes, is it used for everyone or just the sensitive population?	NA	Everyone	Just sensitive population	Advice for women and children differs from general population.	Written for sensitive populations, but all are urged to follow advice.	Just sensitive population	Everyone
Future plans for changes?	Discussed this at agency level	Probably	NR	Possible	NR	NR	No.
B. Tiered advice							
Do you provide separate advice for the general population and the sensitive population?	No	No	Yes	Yes	Not really, see above comment	Yes	Yes
If yes, what RfDs are used and what is the basis for these RfDs?	NA	NA	0.3 ug/kg/day	Generally, we use FDA tolerance/action levels	NA	Adult IRIS value	Based on 0.1ug/kg-day, we use a concentration in fish of 0.5 ppm for sensitive populations and 1.0 ppm for general population.
C. General/statewide advice							
Does your program provide advice for untested waters?	No	No	Yes	Yes	Yes, statewide advisory for one meal per week	Yes	No, other than identifying them as untested.
Is it based on your data? Other basis?	NA	NA	Yes	Precautionary, based on potential for untested analytes or waters to have contaminated fish	No, it is just precautionary	Yes	NA

Fish Advisory Breakout Sessions GREAT LAKES STATES AND TRIBES	**IA**	**IL**	**MN**	**NY**	**PA**	**WI**	**GLIFWC**
Are you using or referencing the EPA national advice in your advisory?	No	No	No	Yes, reference	Yes, we referenced it in the 4/11/01 press release	Yes, some	Yes
Are you using or referencing the FDA national advice in your advisory?	No	No	Yes, for the "Do not eat" species only, not 12 oz limit	Yes, reference	No	Yes, for commercial advisory	No
D. Commercial fish							
Do you provide consumption advice for commercial fish?	No	No	Yes	Yes, we refer to FDA/EPA advisories	No	Yes	Yes, information about trimming and safe species
If yes, for everyone or just SP?	NA	NA	Everyone and sensitive population	Everyone	NA	Sensitive population	Everyone
Have you incorporated the FDA advice?	No	No	Yes, for "Do Not Eat" advisories	No, not officially as ours	NA	Yes	Yes
Have you developed your own advice for commercial fish?	No	No	Yes	No	NA	No	No
What data were used?	NA	NA	EPA Report To Congress	NA	NA	NA	Our own GLIFWC data
What species and meal advice?	NA	NA	Variety	NA	NA	NA	Lake Superior commercial species,
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	No	No	No	No, not in a formally defined way	NR	Yes	They are one and the same for Lake Superior
Should an RSC be used?	?	Maybe	?	Conceptually, yes	NR	NR	No opinion at this time
E. Trigger levels - fish tissue concentrations							
At what Hg tissue concentration do you begin giving advice to limit consumption?	1.0 ppm (FDA action level)	0.5 ppm	0.05 ug/g for sensitive populations; 0.16 ug/g for general population	We have a blanket meal/week for all fish; meal/month if > 1ppm	At 0.12 ppm we give advice for 2 meals/month (can't recall exact value)	NR	NA to our method
What meal size/body weight assumption is used?	NR	8oz / 70kg	Great Lakes Protocol 8 oz / 70kg	8 oz	EPA assumptions	8 oz / 70 kg scaled up and down	NA to our method
Do you use different meal size/body weight ratios for different populations?	No	No	No	No, not formally	No, not really	No	NA to our method

Fish Advisory Breakout Sessions NORTHEAST STATES	**CT**	**MA**	**ME**	**NH**	**VT**
Do you issue Fish Consumption Advisories (FCAs)?	Yes	Yes	Yes	Yes	Yes
1. Questions/issues for discussion about mercury:					
Do you issue FCAs based on mercury levels in fish?	Yes	Yes	Yes	Yes	Yes
Do you use the FDA action level as a basis for advice?	No	Yes	No	No	No, not for mercury
A. EPA RfD for mercury:					
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	Yes	Yes	Yes	Yes	Yes
If yes, is it used for everyone or just the sensitive population?	Sensitive populations	Everyone	Sensitive populations	Sensitive populations	Sensitive populations
Future plans for changes?	No	Maybe	No	No, not unless USEPA changes the RfD	NR
B. Tiered advice					
Do you provide separate advice for the general population and the sensitive population?	Yes	Yes	Yes	Yes	Yes
If yes, what RfDs are used and what is the basis for these RfDs?	0.3 ug/kg/d	Use FDA for this as it is historically more protective	Use old EPA of 0.3 ug/kg/day	We use the original RfD of 3E-04 mg/kg/day based on protection of parestheisa to assess risks posed to general adult population	NR
C. General/statewide advice					
Does your program provide advice for untested waters?	Yes	Yes	Yes	Yes	Yes
Is it based on your data? Other basis?	Yes	Yes	Yes, random sampling of statewide waters	Yes	Yes
Are you using or referencing the EPA national advice in your advisory?	No	No	No	No	No
Are you using or referencing the FDA national advice in your advisory?	Yes	Yes	Yes, on commercial fish only	Yes, we include recent FDA advice issued Jan 2001	No
D. Commercial fish					
Do you provide consumption advice for commercial fish?	Yes	Yes	Yes	Yes	Somewhat in booklet for women
If yes, for everyone or just SP?	Everyone	Everyone	Both sensitive populations and everyone (tiered)	We issue separate advice to "at risk" populations and the general adult population	Sensitive populations only
Have you incorporated the FDA advice?	Yes	Yes	Yes with some modifications (e.g., tuna)	Yes	Somewhat in booklet for women - no shark, swordfish, king mackerel, tilefish

Fish Advisory Breakout Sessions **NORTHEAST STATES**	**CT**	**MA**	**ME**	**NH**	**VT**
Have you developed your own advice for commercial fish?	Yes	No	Yes, some modifications of FDA advice	Yes, we issued separate advice for white tunafish for sensitive populations and for shark, swordfish, king mackerel, and tuna for the general adult population	NR
What data were used?	NMFS and FDA	Using FDA for now	FDA	FDA and EPA	NR
What species and meal advice?	NR	NR	see Maine brochure	Sensitive populations advice is white tuna = 1 meal/wk; general population advice is shark, swordfish, king mackerel = 2 meal/mo	NR
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	No	No	No	No not at this time	No
Should an RSC be used?	?	Maybe, for low and conservative levels	Depends on level of freshwater fish intake assumed	Maybe in the future	Yes -definitely worth thinking about and coming up with a regional value
E. Trigger levels - fish tissue concentrations					
At what Hg tissue concentration do you begin giving advice to limit consumption?	0.2 ppm	0.2 - 0.3 ppm for statewide and 0.5 ppm for local advisories	0.2 ppm	0.2 ppm	at least 1 meal/mo at 0.84 ppm; begin advice when you can't eat
What meal size/body weight assumption is used?	227 g	8oz/70kg and 3.5oz/15kg	8 oz meal/wk 60 kg	General adult population assumes 8 oz meal/ 70 kg; women of reproductive age assumes 8 oz meal/ 64 kg; young children assumes 3.5 oz meal/ 15 kg	8 oz meal size and 62 kg
Do you use different meal size/body weight ratios for different populations?	No	Yes	Long discussion	Yes	No

Fish Advisory Breakout Sessions SOUTHERN STATES	**AL**	**GA**	**MO**	**NC**	**OK**	**SC**	**TN**
Do you issue Fish Consumption Advisories (FCAs)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Questions/issues for discussion about mercury:							
Do you issue FCAs based on mercury levels in fish?	Yes	Yes	Not yet	Yes	Yes	Yes	Yes
Do you use the FDA action level as a basis for advice?	Yes	No	No	No	Use 1 ppm, but got there a different way	No	Yes
A. EPA RfD for mercury:							
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	No, use FDA action level 1 ppm	Yes	Not decided yet, but probably will	Yes; but we also use 0.3 ug/kg-d for the general public	No; 0.3 ug/kg-d	No, use 0.3 ug/kg-d	Unsure
If yes, is it used for everyone or just the sensitive population?	NA	Everyone	NA	Sensitive populations	Everyone, but different risk level for sensitive populations	For the non-sensitive population	NR
Future plans for changes?	NR	Possible	NR	NR	Possibly going to use 0.1 up/kg-d	NR	NR
B. Tiered advice							
Do you provide separate advice for the general population and the sensitive population?	Yes, for women of child-bearing age and children	No	Yes	Yes	Yes	Yes	Don't know
If yes, what RfDs are used and what is the basis for these RfDs?	Depends on the contaminant	NA	Not different RfDs, just SWAG tiers	0.3 ug/kg-d	Used old RfD 0.3 ug/kg-d, low risk level for sensitive populations	Recommend women/children not eat any fish from areas with mercury advisories	Don't know
C. General/statewide advice							
Does your program provide advice for untested waters?	No	Yes	Yes	Yes	No	No	No
Is it based on your data? Other basis?	NA	No	Yes	Yes	NA	NA	NA
Are you using or referencing the EPA national advice in your advisory?	No	Yes	Not yet	Yes	No	Yes, we mention it	Unsure
Are you using or referencing the FDA national advice in your advisory?	Yes	Yes	No, and probably won't unless we do comparison of saltwater commercial fish versus MO sport caught fish	Yes	No	Yes, we mention it	Yes

Fish Advisory Breakout Sessions SOUTHERN STATES	AL	GA	MO	NC	OK	SC	TN
D. Commercial fish							
Do you provide consumption advice for commercial fish?	No	No	No, but see previous answer	Yes	No	Yes	Yes
If yes, for everyone or just SP?	NA	NA	NA	Everyone	NA	Everyone	Everyone
Have you incorporated the FDA advice?	NA	NA	No	Yes	NA	No	Yes
Have you developed your own advice for commercial fish?	NA	NA	No	Yes	No	Yes, for king mackerel	No, don't think so
What data were used?	NA	NA	NA	FDA data, NC state data	NA	Data from NC, SC, GA, FL	State collected
What species and meal advice?	NA	NA	NA	King mackerel, shark, swordfish, tilefish	NA	King mackerel	catfish ?
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	NA	NA	No	Yes- High Mercury group (women of child bearing age and children = no consumption and general public No more then 1 meal per week) includes shark, swordfish, king mackerel, tilefish, largemouth bass, bowfin, chain pickerel and Low Mercury group (Women of child bearing age and children = 2 meals/week and general public 4 meals/week) includes farm-raised catfish, canned tuna, small ocean fish, small freshwater fish, shellfish and other fish bought at restaurants and stores (This is proposed and will be finalized after May, 2001	No	No	No
Should an RSC be used?	NR	NR	If we had good consumption data that would be protective	No	NR	NR	NR
E. Trigger levels - fish tissue concentrations							
At what Hg tissue concentration do you begin giving advice to limit consumption?	1 ppm	0.23 ppm	NA	Detection limit	1 ppm	0.25 ppm	NR
What meal size/body weight assumption is used?	4 oz/150 lb	4-8 oz/70 kg	8 oz	3 oz uncooked for adults; 3 oz uncooked for children	8 oz/70 kg	8 oz / 70 kg	NR
Do you use different meal size/body weight ratios for different populations?	No	No	Probably will use 3 oz for children	Yes	Yes, we use 8 oz/70 kg for adults and 8 oz/35 kg for children	No	NR

Fish Advisory Breakout Sessions WESTERN STATES AND TRIBES	**AK**	**AZ**	**CA**	**CO**	**ID**	**MT**	**NE**	**NM**	**UT**	**WY**
Do you issue Fish Consumption Advisories (FCAs)?	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Questions/issues for discussion about mercury:										
Do you issue FCAs based on mercury levels in fish?	No	Yes/No - not purely on Hg levels alone. Do risk analysis.	Yes	Yes	Yes	Yes	Yes	Yes	No	No -we sample but no advisories ever issued
Do you use the FDA action level as a basis for advice?	No	No	Yes, in some cases	No	No	Yes, but not in the advisory	No	No	NR	NA
A. EPA RfD for mercury:										
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	NR	Yes; although we consider it flawed at best	Yes	Yes	No, 0.4 ug/kg/day	Yes	Yes	NR	NR	NR
If yes, is it used for everyone or just the sensitive population?	NR	Everyone	Sensitive populations	Everyone	NA	Everyone	Everyone	NR	NR	NR
Future plans for changes?	NR	NR	NR	We will be informally reviewing	Yes	Maybe - to get EPA and FDA guidance to work together	No	NR	NR	NR

Fish Advisory Breakout Sessions **WESTERN STATES AND TRIBES**	**AK**	**AZ**	**CA**	**CO**	**ID**	**MT**	**NE**	**NM**	**UT**	**WY**
B. Tiered advice										
Do you provide separate advice for the general population and the sensitive population?	NR	Yes	In some cases	Yes; advisories list general population and pregnant women and children	Yes	No	Yes	Yes	No	NR
If yes, what RfDs are used and what is the basis for these RfDs?	NR	EPA	0.1ug/kg/d and 0.3 ug/kg/d from IRIS	NR	0.4 ug/kg/d adult; and 0.2 ug/kg/d child	NA	<0.1ug/kg/day for sensistive populations; 0.1 ug/kg/day general population	NR	NA	NR
C. General/statewide advice										
Does your program provide advice for untested waters?	NR	No	No	No	No	No	No	No	No	No
Is it based on your data? Other basis?	NR	NA	NA	NA	NA	NA	NA	NA	NA	NA
Are you using or referencing the EPA national advice in your advisory?	NR	We will in the future	Probably in the future	No	No	Yes	Yes	No	NR	NR
Are you using or referencing the FDA national advice in your advisory?	NR	NR	Probably in the future	No	No	No	Yes	No	NR	NR
D. Commercial fish										
Do you provide consumption advice for commercial fish?	NR	No	Probably in the future	No	No	No	Only thru recent FDA guidance	No	NR	No - no commercial fishery
If yes, for everyone or just SP?	NR	NA	Sensitive populations	NA	NA	NR	Sensitive populations	NA	NR	NA
Have you incorporated the FDA advice?	NR	NA	Yes	NA	No	No	Yes, we will in the fall	NR	NR	NR
Have you developed your own advice for commercial fish?	NR	NA	No	NA	No	No	No	NR	NR	NR
What data were used?	NR	NA	NA	NA	NA	NA	NA	NR	NR	NR
What species and meal advice?	NR	NA	NA	NA	NA	NR	NA	NR	NR	NR

Fish Advisory Breakout Sessions **WESTERN STATES AND TRIBES**	**AK**	**AZ**	**CA**	**CO**	**ID**	**MT**	**NE**	**NM**	**UT**	**WY**
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	NR	NR	No	NR	No	No	No	NR	NR	NR
Should an RSC be used?	NR	NR	When data are adequate	NR	Yes	NR	NR	NR	NR	NR
E. Trigger levels - fish tissue concentrations										
At what Hg tissue concentration do you begin giving advice to limit consumption?	NR	No trigger level, use risk analysis	Tissue level depends on the population (general/ sensitive) and the risk analysis.	0.5 ppm in edible tissue - wet weight	0.5 ppm	Begin at the detection level. For adults there are groups of <0.1, 0.1-0.2, 0.2-0.4, and 0.4-0.8 for adults and women.	0.25 ppm sensitive population. This advice will change as we are increasing ingestion rate from 5 to 8 oz week	detection l	NR	Currently under discussion
What meal size/body weight assumption is used?	NR	NR	8 oz/ 70 kg based on size/weight chart	NR	8 oz. (75 kg)	NR	5 oz/wk (154 lb). Trying to develop policy to evaluate multiple meal sizes across various body weights	6 oz (70 k	NR	NR
Do you use different meal size/body weight ratios for different populations?	NR	Yes	No	adult 8 oz; child 4 oz	Yes	No	No	NR	NR	NR

Fish Advisory Breakout Sessions **WESTERN STATES AND TRIBES**	Huslia Village Council (AK)	Maniilaq Association (AK)	Ouzinkie Tribe (AK)	Sitka (AK)	Ute of Uinta & Ouray Reservation (UT)
Do you issue Fish Consumption Advisories (FCAs)?	No	Sometimes	Yes, paralytic shellfish poisoning levels	No	No
Questions/issues for discussion about mercury:					
Do you issue FCAs based on mercury levels in fish?	No	In association with Fish and Game	No	No, we do not have authority or funding for monitoring	We would if we determined advisory was warranted
Do you use the FDA action level as a basis for advice?	Unknown	Not always	No	No, for reference	Yes
A. EPA RfD for mercury:					
Do you use the EPA IRIS RfD of 0.1 µg/kg/day? If not, what "RfD" do you use?	Yes, State uses a higher level ?	Yes	No	No	Yes, same as FDA
If yes, is it used for everyone or just the sensitive population?	Uses a very high level statewide	Everyone	NA	NA	Yes, as a baseline and an additional notice for pregnant women and children
Future plans for changes?	Unknown	NR	NR	NR	As additional information warrants
B. Tiered advice					
Do you provide separate advice for the general population and the sensitive population?	Yes	No	No	No	Yes
If yes, what RfDs are used and what is the basis for these RfDs?	Use Federal level	NA	NA	NA	RfD for general populationn; < 1/2 RfD for sensitive population
C. General/statewide advice					
Does your program provide advice for untested waters?	No	No	No	NR	No
Is it based on your data? Other basis?	NA	NA	NA	NR	Yes (Bottle Hollow Mercury Bioaccumulation Study)
Are you using or referencing the EPA national advice in your advisory?	NR	Yes	NR	NR	No
Are you using or referencing the FDA national advice in your advisory?	NR	Yes	NR	NR	Yes

Fish Advisory Breakout Sessions **WESTERN STATES AND TRIBES**	Huslia Village Council (AK)	Maniilaq Association (AK)	Ouzinkie Tribe (AK)	Sitka (AK)	Ute of Uinta & Ouray Reservation (UT)
D. Commercial fish					
Do you provide consumption advice for commercial fish?	Yes	No	No	No	No, no commercial fisheries
If yes, for everyone or just SP?	Sensitive population	NA	NA	NA	NA
Have you incorporated the FDA advice?	No	No	NR	NR	NA
Have you developed your own advice for commercial fish?	No	No	NR	NR	NA
What data were used?	Standard federal level	NA	NR	NR	NA
What species and meal advice?	Northern pike and sheefish on posted lands	NA	NR	NR	Sportfishery for trout
Do you factor in commercial fish consumption into your risk assessment for locally caught fish?	No, mostly subsistence fishers	No	NR	Yes, for amounts consumed not contaminants concerns	No
Should an RSC be used?	Unknown	NR	NR	?	Yes, if a commercial fishery, large consumption in the community,- or subsistence fisheries
E. Trigger levels - fish tissue concentrations					
At what Hg tissue concentration do you begin giving advice to limit consumption?	EPA level	NR	NR	NR	0.1 ug/kg/day; 1 ppm (dry wt) average of samples tested (use composites)
What meal size/body weight assumption is used?	We use whole fish	NR	NR	NR	8 oz/meal (170 pounds)
Do you use different meal size/body weight ratios for different populations?	No	NR	NR	NR	Yes limited meals in a month for different populations