PROCEEDINGS

October 18-20, 1999

1999

American Fisheries Society

Forum on Contaminants in Fish

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August 31, 2000

Prepared for
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List of Acronyms

AAR	AMAP Assessment Report: Arctic Pollution Issues
AEPS	Arctic Environmental Protection Strategy
AFS	American Fisheries Society
AMAP	Arctic Monitoring and Assessment Program
ARL	acceptable risk level
ATSDR	Agency for Toxic Substances and Disease Registry
BFD	blackfoot disease
BMI	body mass index
DMA	dimethylarsinic acid
DSMA	disodium methanearsenate
EPA	U.S. Environmental Protection Agency
FCI	fish consumption index
FDA	U.S. Food and Drug Administration
GI	gastroenterological
GL	Great Lakes
HEAST	Health Effects Assessment Summary Table (EPA)
HSDB	Hazardous Substance Data Bank, National Library of Medicine
IARC	International Agency for Research on Cancer
iAs	inorganic arsenic
IRIS	Integrated Risk Information System
LOAEL	lowest observed adverse effect level
MCL	maximum contaminant level
MDL	method detection limit
MMA	monomethylarsonic acid
MSMA	monosodium methanearsenate

NAS	National Academy of Sciences
NCP	Arctic Environmental Strategy — Northern Contaminants Program
NOAEL	no observed adverse effect level
NRC	National Research Council
PBT	persistent bioaccumulative toxics
PCB	polychlorinated biphenyl
POD	point of departure
POP	persistent organic pollutant
PSA	public service announcement
PUFA	polyunsaturated fatty acid
QSAR	quantitative structure activity relationship
RBSC	risk-based screening concentrations
RfD	reference dose
SAB	Science Advisory Board
SMR	standard mortality ratio
tdi	tolerable daily intake
TEQ	toxicity equivalent
TERA	Toxicological Excellence for Risk Assessment
WHO	World Health Organization
WIC	Women, Infants, and Children

Acknowledgments

This proceedings document was prepared under Assistance Agreement CX826989-01 between the U.S. Environmental Protection Agency (EPA) and the American Fisheries Society (AFS). Betsy Fritz was AFS's manager for the project. Jeffrey Bigler was EPA's project officer for the project. EVS Environment Consultants (EVS) under contract to AFS prepared the proceedings document. Steve Ellis was EVS's project manager for this contract.

The following steering committee members and other individuals contributed their time and expertise to develop the 1999 forum's program, select priorities, and facilitate forum discussions:

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This proceedings was written on behalf of the AFS Water Quality Section.

Executive Summary

The fourth American Fisheries Society (AFS) Forum on Contaminants in Fish took place during October 18-20, 1999 in Alexandria, Virginia. This conference, which was sponsored by AFS in partnership with the U.S. Environmental Protection Agency (EPA), was attended by 120 individuals representing 41 states, 7 federal agencies, 14 Native American organizations, 3 universities, and 10 private organizations. During the three-day conference, attendees listened to presentations from 17 speakers, participated in breakout sessions to discuss state fish consumption advisory programs and the consistency of these programs with the EPA, Office of Water guidance, and discussed the communication of fish advisories during a workshop focusing on what has and has not worked to communicate health risk information on contaminants in fish.

Invited speakers at the 1999 forum presented information on a range of topics that have been grouped into six main categories: 1) effectiveness of fish advisories; 2) Tribal Issues; 3) Arctic monitoring of environmental contaminants; 4) chemical updates; 5) comparative dietary risk; and 6) national consistency of fish advisory programs. A brief overview of the forum presentations is provided below.

EFFECTIVENESS OF FISH ADVISORIES

Dr. Henry Anderson of the Wisconsin Division of Public Health presented information on the effectiveness of Great Lakes sport fish consumption advisories and recent outreach efforts to target high risk fish consumers. Telephone surveys administered to adult residents in Great Lakes states during 1993-1994 showed that half the sport fish consumers were unaware of the fish advisory for PCBs in the Great Lakes. The lowest awareness was among women, minority groups, and persons with no high school degree. In December 1998, the Consortium for the Health Assessment of Great Lakes Sport Fish hosted a workshop to discuss strategies for distributing sport fish health advisory information throughout the Great Lakes basin. One outcome of this meeting was the development of a poster designed to target women. This poster, which will be provided to health care provider offices and schools, displays a warning message, unique to each state, about eating sport fish and how to obtain a copy of the current advisory. In addition to distributing the poster, the Wisconsin Division of Public Health is targeting minority groups by posting warning signs at boat landings and along shores where larger numbers of minority anglers fish.

TRIBAL ISSUES

Two speakers provided presentations during the forum session on Tribal Issues.

Barbara Harper, representing the Yakama Indian Nation, suggested that there is an important distinction that should be made between protecting the health of people belonging to a defined cultural group and protecting the culture of the people. She proposed that risk assessment should not only address humans as receptors, but should consider the culture itself as a receptor. Writing a fish advisory that protects a culture will need information not only about the people's exposure and sensitivity to contaminants in fish, but also the people's relation to the ecology of the fish. Barbara's presentation provided a framework for incorporating ecological and cultural components into the risk assessment process.

James Ransom of the Haudenosaunee Environmental Task Force described the changes that have occurred to the Mohawk Nation following the fish advisory for PCBs in the St. Lawrence River. While the fish advisory has been successful in reducing fish consumption by the Mohawk community, the contamination of the St. Lawrence River has destroyed the subsistence lifestyle of the Mohawk people. As the community switched from a high protein diet consisting of fish, local wildlife and fresh vegetables to store-bought food, the physical health of the community has declined. The spiritual and mental health of the Mohawk community has also suffered as the increased emphasis on non-traditional activities such as casinos, smoke shops, and gas stations, which carry strong individual values associated with making money, clash with the traditional community-based value system.

ARCTIC MONITORING OF ENVIRONMENTAL CONTAMINANTS

Two speakers provided presentations on the monitoring and assessment of environmental contaminants in Arctic regions.

Mark Palmer from Canada's Indian and Northern Affairs office provided an overview of the Arctic Monitoring Assessment Program (AMAP). This international program was established in 1991 to design and implement a monitoring program to assess the effects of anthropogenic pollutants in all compartments of the Arctic environment: atmospheric, terrestrial, fresh water, marine, and human populations. The results of the AMAP were recently published in two reports. Exposure to persistent organic pollutants (POPs) was the primary human health concern identified. The AMAP reports recommend that Arctic peoples continue to eat traditional food and breast feed their children. Dietary advice should be developed for women of childbearing age and pregnant women which promotes the consumption of fewer contaminated food items while maintaining the nutritional benefits of their traditional diet.

Dr. Lyle Lockhart from Canada's Department of Fisheries and Oceans presented data on the environmental dynamics of mercury in northern Canada. It appears that mercury in the Arctic is derived partly from natural sources and partly from anthropogenic sources, mostly combustion of fuels and garbage. Virtually all of the anthropogenic emissions of mercury occur outside the Arctic in temperate zones. Anthropogenic emissions discharge gaseous mercury into the atmosphere where air mass movements disperse it through the hemisphere. In the Arctic, mercury is scavenged from the air into snow and deposited on the land and in northern waters. Once in the northern ecosystem, mercury accumulates in the food chain. Sediment cores from northern lakes show that inputs of mercury are higher than they were in pre-industrial times. Native people in northern Canada continue to derive a large part of their diets from traditional foods including fish, marine mammals, and terrestrial wildlife. Canada recommends that Native peoples continue to consume these foods because of their high nutritional value. When concentration of mercury in traditional foods warrants the issuance of advisories, recent advisories have provided advice on the quantity that may be consumed by establishing separate tolerable daily intake doses for adults, and women of childbearing age and children.

CHEMICAL UPDATES

Five speakers provided updates on chemicals that are common contaminants of concern in fish tissue.

Dr. William Farland of EPA's Office of Research and Development provided an update on EPA's reassessment of dioxin. The integrated summary and characterization, a new toxicity equivalence factor chapter, and a dose-response chapter revision will be available on the EPA web site. By midsummer 2000, a draft comprehensive strategy for how EPA will address the regulatory implications of the findings of the dioxin reassessment should be available. EPA has compiled a new emission database which indicates that a significant decline in emissions has occurred from 1987 to 1995. Fish consumption represents a quarter to one-third of the total diet intake of dioxins. For an adult, the total estimate is about 70 pg/day, 30 percent less than estimated in 1994. The reassessment concludes that toxicity effects are at body burdens that are at or within an order of magnitude of the general population exposure. The cumulative impact of dioxins, incremental exposures over background level, emission sources that have not been characterized, and coplanar PCB contributions to total toxicity equivalence are some issues receiving EPA attention.

Dr. James Cogliano of EPA's National Center for Environmental Assessment provided an overview of recent developments in assessing the health risks of exposure to PCBs. EPA's current cancer assessment concludes that all PCB mixtures can pose a cancer risk, although different mixtures have different potencies. To distinguish the cancer potential of different environmental PCB mixtures, EPA's cancer assessment considers the environmental processes that alter PCB mixtures and recommends a three-tier approach for selecting an upper-bound cancer slope factor for PCB mixtures based on how environmental processes affect different exposure scenarios. PCBs also have significant adverse health effects other than cancer, including neurotoxicity, reproductive and developmental toxicity, immune system suppression, liver damage, skin irritation, and endocrine disruption. EPA addresses these effects through a reference dose (RfD). Since the development of the RfDs for Aroclor 1016 and Aroclor 1254, there has been mounting scientific evidence of adverse neurodevelopmental effects from PCBs. Effects have been observed for maternal plasma PCB concentrations as low as three parts per billion, near current background levels in the United States. EPA is currently evaluating this new information and updating its non cancer assessment of PCBs. A draft is expected in 2001. EPA is shifting its focus away from characterizing environmental samples in terms of Aroclors. An interim approach is now focusing on estimating total PCBs. Alternative approaches for estimating total PCBs include summing Aroclor concentrations, summing homologue groups, or summing individual PCB congeners. EPA's analytical chemists are developing a standard method for PCB analyses.

Dr. Charles Abernathy of EPA's Office of Water provided an overview of the forms of arsenic that are associated with adverse health effects in humans and discussed the types of cancer and non-carcinogenic health effects that have been reported after exposure to inorganic arsenic. He discussed the recent National Academy of Sciences (NAS) report which concluded that EPA's current MCL of 50 μg/L for arsenic in drinking water is not protective and should be revised downward as soon as possible. The forms of arsenic found in fish and shellfish were discussed. The majority of arsenic in fish and shellfish is organic, primarily arsenocholine and arsenobetaine. These forms of arsenic appear to have little or no toxicity. The inorganic fraction of arsenic, consisting of arsenite (+3) and arsenate (+5), in fish and shellfish are the putative carcinogens.

Dr. Kathryn Mahaffey of EPA's National Center for Environmental Assessment discussed EPA's research strategy for mercury and provided an overview of reference doses being used in the United States and other countries to protect the fetus. EPA's research strategy for mercury, which is available on EPA's web site (http://www.epa.gov/ncea/mercstra.htm), describes a research program for the next five years that will provide information, methods, models, and data needed to support EPA's regulatory decisions on mercury. The research will address a number of major uncertainties related to both risk assessment and risk management. The scientific questions that will be addressed by the proposed research strategy fall into four categories: 1) human health and wildlife effects of methylmercury; 2) mercury transport, transformation, and fate; 3) human exposure to methylmercury through the aquatic food chain; and 4) risk management of mercury and methylmercury. EPA's current reference dose for methylmercury, 0.1 μg/kg/day, was proposed to be protective of the fetus. Similar values proposed by Canada, Germany, and the U.S. ATSDR range from 0.15 to 0.3 μg/kg/day. A committee from the National Academy of Sciences has been formed to help EPA evaluate the level at which adverse effects of methylmercury occur. The target date for the committee's report is June 2000.

Dr. Tom Hornshaw of Illinois EPA's Office of Chemical Safety described efforts to develop a health protection value for chlordane. He reviewed relevant laboratory studies on chlordane and presented the LOAELs and NOAEL's that exist in the scientific literature. Candidate health protection values for chlordane ranged from 0.15 to 1.6 μg/kg/day for different health endpoints. The lowest value, 0.15 μg/kg/day, based on liver effects has been proposed to the membership of the Great Lakes Task Force as the recommended chlordane health protection value. If the members of the task concur with this recommendation, this value will be added to the Great Lakes Protocol.

COMPARATIVE DIETARY RISK

Dr. Edward Ohanian of EPA's Office of Water provided an overview of EPA's Comparative Dietary Risks Project. While fish advisories are generally based solely on considerations of potential adverse health effects caused by contaminants, fish is an excellent source of low-fat protein and may provide important nutritional and health benefits. To fully evaluate the risks and benefits of fish consumption, risk assessors and risk managers should weigh both the adverse health effects from consuming contaminated fish as well as the risks associated with reducing fish consumption and switching to substitute food sources. The report, *Comparative Dietary Risks: Balancing the Risks and Benefits of Fish Consumption*, published in August 1999 by TERA provides a framework for evaluating risk and benefits on a common scale. A fish consumption index (FCI) is proposed as a representation of the net risk, or benefit, associated with eating contaminated fish.

STATE FISH ADVISORY PROGRAMS: NATIONAL CONSISTENCY

An important objective of the1999 American Fisheries Society Forum on Contaminants in Fish was the presentation and discussion of similarities and differences among state fish advisory program methods and the consistency of these methods with guidance published by the EPA, Office of Water. Dr. Betsy Southerland of EPA's Office of Water presented an overview of State program methods based on responses provided to a questionnaire developed jointly by EPA and the State of Nebraska. A national summary of the responses to this questionnaire is provided in Section 3.0 of this Proceedings. Questionnaire responses indicated that 11 states conducted both routine monitoring and use risk assessment methodologies in agreement with EPA Office of Water guidance. A discussion of state program consistency is presented in Section 4.0. Conference attendees were divided into six geographical regions and spent a total of four hours discussing the need and rationale for national consistency between state fish advisory programs and the merits of EPA's guidance documents for assessing chemical contaminant data for use in fish advisories. The results of these discussions are presented in Section 5.0 of these Proceedings. One of the important issues identified in these discussions was the lack of adequate funding and staff for states to adequately manage fish monitoring and advisory programs. Conference participants voiced greater support for consistency in terms of methods and approaches than in specifying specific default values for risk assessment or the specific details of sampling protocols. Most participants supported the flexibility of EPA's current guidance documents that provide a framework for the monitoring and assessment of contaminants in fish, while encouraging States and Tribes to development site-specific programs to meet local needs. Many conference attendees that were less than enthusiastic about national consistency supported regional consistency between States and Tribes for shared waterbodies.

RISK COMMUNICATION WORKSHOP

Another objective of the1999 American Fisheries Society Forum on Contaminants in Fish was to discuss the risk communication of fish advisories and specifically what does and does not work well. The workshop on risk communication featured presentations from Lisa Weaver of the Arkansas Department of Health and Dr. Richard Brooks of the University of Wisconsin followed by an open discussion among workshop attendees. Both speakers provided examples of identifying target audiences, designing messages, selecting communications modes, and developing tools for outreach activities. These presentations are summarized in Section 5 of these Proceedings. Some of the risk communication techniques that participants felt worked well are listed below:

- Whenever possible, present the message in a way that provides a solution; for example, “Eat smaller and younger fish”
- Give people information and alternatives from credible sources that they can trust
- Translate the message into terminology that people can understand and conduct readability testing on your materials
- Make the message vivid using images or promotional materials people will remember and want to talk about

I. Introduction

The fourth American Fisheries Society Forum on Contaminants in Fish took place during October 18-20, 1999 in Alexandria, Virginia. This conference, which was sponsored by AFS in partnership with the U.S. Environmental Protection Agency, was attended by approximately 120 individuals. Conference participants included representatives from 41 states, 14 Native American organizations, 7 federal agencies within the United States and Canada, 3 universities, and 9 private organizations. Conference speakers included scientists, public health specialists, and regulators involved with fish contaminant monitoring programs in the United States and Canada.

During the three-day conference, attendees listened to presentations from 17 speakers, participated in breakout sessions to discuss state fish consumption advisory programs and the consistency of these programs with the EPA, Office of Water guidance, and discussed the communication of fish advisories during a workshop focusing on what has and has not worked to communicate health risk information on contaminants in fish.

The goals of the conference were to:

- Discuss the consistency between state fish advisory programs and guidance developed by the EPA Office of Water
- Discuss the need/preference for national consistency between fish advisory program methods and assessment techniques
- Present recent information on a range of topics relevant to the monitoring, assessment, and communication of risks and benefits associated with consuming contaminated fish
- Present and discuss risk communication techniques that have and have not worked for presenting fish advisory information

These proceedings summarize the presentations and discussions that occurred during the three-day conference, as well as information on state fish advisory programs that was compiled prior to and after the conference. This document as been organized into five main sections and several appendices. Section 1 provides an introduction to the conference objectives and the organization of this Proceedings. Section 2 provides a summary of the presentations given by conference speakers. Section 3 provides a summary of state responses to a questionnaire developed jointly by EPA and the state of Nebraska to obtain information about state programs for monitoring and assessing chemical contaminants in fish. Section 4 provides a discussion on the consistency of state programs with EPA Office of Water guidelines. Section 5 summarizes the conference discussions on the need/preference for national consistency between fish advisory program methods and assessment techniques, and summarizes comments received on EPA's guidance documents for assessing chemical contaminant data for use in fish advisories. Section 6 provides a summary of the presentations given by speakers during the workshop on risk communication of fish advisories.

2. Conference Presentations

This section of the proceedings summarizes the presentations made by 13 speakers at the 1999 Forum on Contaminants in Fish. Biosketches for these individuals are shown in Appendix A.

Invited speakers at the 1999 forum presented information on a range of topics. Representatives from the American Fisheries Society and EPA provided introductory presentations on the forum perspectives. The other forum presentations have been grouped into six main categories: 1) effectiveness of fish advisories; 2) Tribal Issues; 3) Arctic monitoring of environmental contaminants; 4) chemical updates; 5) comparative dietary risk; and 6) national consistency of fish advisory programs.

Forum speakers were asked to provide written summaries of their presentations to be included in these proceedings. A small number of speakers were unable to provide summaries of their presentation; their talks have been summarized from taped transcripts. The forum presentation on national consistency in fish advisory programs provided by Dr. Betsy Southerland of EPA's Office of Water is not summarized in these proceedings. The content of Dr. Southerland's talk, which summarized state responses to a questionnaire on state programs for monitoring and assessing chemical contaminants in fish, was updated and revised following the conference. A small number of states had not provided responses to the questionnaire prior to the conference and many states had not answered all of the questions, or had provided answers to different questions that appeared to contradict each other. These issues were resolved with the state's after the conference. A national summary of state responses to the questionnaire that discusses national consistency is provided in Section 3.0.

PERSPECTIVES

Ghassan N. Rassam
Executive Director
American Fisheries Society

Welcome to the fourth American Fisheries Society forum on contaminants in fish. I would like to talk to briefly talk to you about the history of these meetings. The first forum was held in 1990. The outcome of that meeting was a five-year state/federal action plan that proposed seven federal assistance programs or activities. Implementation of the action plan resulted in the preparation of a series of U.S. Environmental Protection Agency (EPA) guidance documents on assessing chemical contaminant data for use in fish advisories, a series of fish consumption studies, a number of training workshops, and a national listing of fish and wildlife consumption advisories. In 1996, 45 states, the District of Columbia, four tribal organizations, ten federal agencies, and five conservation and industry groups were brought together for a second AFS forum on contaminants in fish. Participants at this forum reviewed the progress that had been made on the 1990 action plan and identified 24 potential activities that would be needed in a new action plan. The third AFS forum on contaminants in fish was held in 1997. Participants presented and discussed a new state/federal action plan that prioritized state needs for supporting fish consumption advisory programs and presented the latest results of human health studies involving fish consumption. This is an impressive record, and, indeed, I'm convinced that the fourth forum will build on these achievements and provide direction for a future action plan.

The four forums on contaminants in fish have been sponsored by AFS in partnership with EPA. What does AFS bring to this partnership? AFS is a group of scientists and fisheries managers who apply the best science available to solving practical issues. The various discipline-oriented sections of AFS, such as the Water Quality Section, include expertise that spans geography and bureaucracy. More than that, AFS as an organization is uniquely situated to do two things, and do them rather well. First, AFS provides an objective scientific platform for disparate groups, often with conflicting priorities, to get together to share views and develop action plans. Second, AFS provides channels for the communication of these plans and other information that results from these forums. In today's world, especially with environmental issues and issues related to human health, there are often many different, conflicting priorities. AFS, because of its legacy, because of its long history, and because of the objectivity that it brings to these forums, serves an important function, and I hope that this will continue in the future in this partnership with EPA.

James Hanlon
Deputy Director Office of Science and Technology
Office of Water
U.S. Environmental Protection Agency

EPA is pleased to support this fourth forum on contaminants in fish in cooperation with the American Fisheries Society. This national forum has been a real platform and basis for the development of a Fish Consumption Advisory Program which certainly EPA's Office of Water, and I think the agency at large, considers a real success story. The program was kicked off with a meeting back in 1990. At that time, there were probably less than five states using risk-based methodologies for the development of fish consumption advisories and no national guidance, or direction, on how to develop advisories. Based on that initial meeting, and the action plan developed as a result of that meeting, there now exists a series of EPA guidance documents that are used by more than 40 states in the development of risk-based fish consumption advisories.

- Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 1. Fish Sampling and Analysis. Second Edition. EPA 823-R-95-007.
- Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits. Second Edition. EPA 823-B-97-009.
- Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 3. Overview of Risk Management. EPA 823-B-96-006.
- Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 4. Risk Communication. EPA 823-R-95-001.
- Guidance for Conducting Fish and Wildlife Consumption Surveys. EPA 823-B-98-007

Another milestone in the development of the Fish Consumption Advisory Program has been the effort to get information on fish consumption advisories out to the public on a consistent basis across the country. We've done that in cooperation with the states and the tribes. Consumption advisory information is now available in the form of an electronic database called the National Listing of Fish and Wildlife Consumption Advisories. We're pleased to announce that within the last couple of months we've taken another step forward by providing public Internet access to this information (http://fish.rti.org) and added the ability for states to update their advisory data (http://notes.tetratech-ffx.com/fishhome.htm).

Another highlight of EPA’s Fish Consumption Advisory Program has been the sponsorship of a series of technical conferences and workshops that have focused on the technical issues or the science underlying the Fish Consumption Advisory Program. Separate conferences have been held on PCBs, mercury, and bioaccumulation. EPA has also supported a series of workshops that have been held in conjunction with the forum meetings to address issues specific to the Fish Consumption Advisory Program. For example, after the conclusion of the agenda of this meeting, there will be a workshop on the communication of advisories: what works and what doesn't work.

EPA also recently completed a compilation of mercury fish tissue monitoring data. This document contains a state-by-state summary of available mercury fish tissue data collected during the period 1990 through 1995. EPA plans to use this data to develop tools which may help predict the uptake of mercury in fish.

- The National Survey of Mercury Concentrations in Fish. Data Base Summary 1990-1995. EPA 823-R-99-014

EPA has also conducted a variety of public outreach activities. In particular, we published a document in cooperation with the Centers for Disease Control entitled, "Should I Eat the Fish I Catch?" (http://www.epa.gov/ost/fish/fisheng.pdf). EPA distributed in excess of 100,000 of these to health care professionals across the country. This has largely been modeled on documents that many of the states have developed that have been very successful in terms of communicating the risks that may be associated with contaminated fish to the public.

EPA recently completed a series of fact sheets which summarize the fate, toxicology, regulatory basis, and advisory experience for individual chemicals. Currently there are fact sheets developed for four chemicals:

- Dioxins (http://www.epa.gov/ost/fish/dioxin.pdf)
- Mercury (http://www.epa.gov/ost/fish/mercury.html)
- PCBs (http://www.epa.gov/ost/fish/pcbs.pdf)
- Toxaphene (http://www.epa.gov/ost/fish/toxaph.pdf).

EPA has also recently initiated a national study of chemical residues in lake fish tissue as part of the Agency's persistent bioaccumulative toxic (PBT) initiative. This study is a multi-year effort to collect and analyze fish from a number of lakes across the country to look at what chemicals are detected and identify those that may pose a general concern. The design is to collect samples from approximately 800 lakes across the country over a four-year period. The tissue samples will be analyzed for more than 80 individual analytes. The study design will allow us to look at regions of the country, identify different contamination patterns, characterize fish contaminants in urban versus rural areas, and industrial versus non-industrial areas. It will also provide us a basis for follow-up action. If there are samples that come out of a particular region or a particular water body that are of concern, that could be the basis for follow-up, more intensive sampling.

These are some of the accomplishments of EPA's Fish Consumption Advisory Program, and I think you can all be proud of the progress that's been made in this program. So where are we going? The guidance documents and the basis for the program have been developed using a cooperative model. The guidance documents were developed by teams of individuals representing the states, EPA, and other federal agencies. Your experience in developing the guidance documents has led to the success and the acceptance of those documents to date.

What we want to do during this meeting is to learn from that experience. Basically, our objective is to improve the overall consistency in terms of the management decisions that are being made by the states in the implementation of the Fish Consumption Advisory Program. We would like to critically review your experience with the guidance documents, with the protocols, and give us feedback in terms of what's working, what portions of the documents you use on a regular basis, what portions of those documents are you not using on a regular basis, and why. If you found something else that works better, we really need to know that, so that in the next iteration of those documents those improvements can be made.

In February of 1998, Secretary Glickman and Administrator Browner submitted the Clean Water Action Plan to President Clinton. This plan includes some 140-plus individual key actions in terms of commitments that were made by federal agencies to assess their programs and to take steps forward in terms of managing our nation's waters. One of those key actions involves the Fish Consumption Advisory Program. Basically, EPA will review the guidance documents that I've referred to and, in cooperation with other federal agencies, assess the degree to which individual states are using the guidance documents and then, following the review, take appropriate actions. This is a key effort, and the discussions to be held on national consistency at this meeting will assist us in making this assessment.

EPA's Office of Water has initiated intensive discussions with tribal governments across the country regarding the establishment of water quality standards. If you total up all the Indian Country within the borders of the United States, it would encompass an area about the size of New England. Across that area, however, there are to date only 13 tribes which have adopted water quality standards. EPA's Office of Water has initiated discussions with the tribes, and we're on a path to either work with the tribes for them to adopt water quality standards for the remaining waters or to put in place federal standards. We welcome the presentations on tribal perspectives on fish consumption advisories to be held at this meeting.

Other presentations at this meeting will address several other important topics including PBTs in arctic regions; current risk assessment issues for mercury, arsenic, PCBs, dioxins, and furans; and EPA’s Comparative Dietary Risk project which is examining the risk/benefit issues of fish consumption. Thank you all for investing your valuable time to participate at this meeting.

EFFECTIVENESS OF ADVISORIES

Henry Anderson
Wisconsin Bureau of Public Health

Sport Fish Consumption Advisory Effectiveness

Henry A. Anderson, M.D.[1], Larry P. Hanrahan, Ph.D.[1], Claire Falk, MS[1], Laurie Draheim, MSPH[1], Dyan Steenport[1], Joe Olson[1], Marty Kanarek, Ph.D.[2]

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Background

Individuals who consume sport fish are exposed to contaminants including polychlorinated biphenyls (PCBs) and mercury. Sport fishing advisories, published and distributed by state governments, give sport fish consumers information about the fish they should and should not eat. Advisory programs depend upon three components: comprehensive fish tissue monitoring; risk assessment procedures and policy; and information outreach strategy. Currently, all but 3 states give their residents consumption advice about the sport fish they catch that limits the angler's exposure to contaminants. Currently mercury and PCBs account for the majority of the advisories. Two characteristics of sport fish consumption advisories are they contain categorical or detail information by species, size and location and most contain specific information for women. Some key messages are: eat fewer or the least contaminated fish, target location and species least contaminated, consume smaller, younger fish that are lower on the food chain, clean your catch properly (i.e., remove fat and skin (PCB)) and cook your catch properly (i.e., do not eat drippings (PCB)).

Consortium for the Health Assessment of Great Lakes Sport Fish Consumption

In 1978 the Great Lakes Water Quality Agreement was initiated to protect and restore the basin and control effects of persistent toxic substances. The Great Lakes Critical Programs Act in 1990, mandated funds to the Agency for Toxic Substances and Disease Registry (ATSDR) for epidemiological research to study the short and long term human health effects of consumption of contaminated GL sport caught fish.

In 1992, Health Departments from five GL states, Wisconsin, Michigan, Ohio, Illinois and Indiana established the Consortium for the Health Assessment of Great Lakes Sport Fish Consumption. This program, funded by the ATSDR, was established to study: 1) Current body burden levels of GL sport fish consumers, 2) the reproductive effects of consumption of GL sport fish, 3) advisory awareness among GL basin residents and 4) conduct an advisory outreach program basin wide. Other government agencies collaborating with the Consortium are: Universities in Wisconsin and Illinois; Lorain County Health Department, Ohio; Wisconsin State Laboratory of Hygiene, Madison, Wisconsin; Marquette University, Milwaukee, Wisconsin; the National Institute of Occupational Health and Safety, Cincinnati, Ohio; and National Center for Environmental Health, Centers for Disease Control and Prevention, Atlanta, GA.

Great Lakes Basin Wide Survey

To study advisory awareness among the general population, a survey was administered to adult residents who lived in the eight GL states, PA, MI, WI, NY, MN, OH, IL and IN. The survey obtained information about fish consumption habits (commercial, all sport and GL sport caught fish) and advisory awareness and compliance. Between April 1993 and February 1994, the random digit dialed survey was administered to 8000 GL basin residents, 2000 person in each of four waves and approximately 1000 persons per state. Half the consumers of Great Lakes (GL) sport fish were unaware of the PCB advisory; the lowest awareness was among minority groups, women and persons with no high school degree. The survey found that cooking and cleaning was the most common risk reduction practice. The Consortium concluded that each state needed to re-evaluate sport fishing advisory communication programs. Each state would benefit from use of multiple messages to target low awareness groups such as women who do not fish, minorities and those with less than a high school education.

Frequent and Infrequent Great Lakes Sport Fish Consumer Cohorts

In Fall 1993, men and women who had obtained a license in 1992 to conduct charter boat services on Lakes Michigan, Huron and Erie and a sample of Wisconsin Anglers were administered a telephone survey. If the respondent had had a child since 1970, their spouse was interviewed. Approximately 1800 charter captain households and 129 Wisconsin angler households completed the survey and 532 subjects donated a blood sample for chemical analysis. Referent subjects were administered the same telephone survey in 1994. Referent subjects were frequency matched to the charter captain sample by geographic region and reported eating less than 6 meals of GL sport fish in each year for the last 20 years. Over 1,200 households completed the survey and 100 subjects donated a blood sample. Frequent GL sport fish consumers have elevated body burdens when compared to referents, but levels are lower than in the past. PCB body burden levels varied by exposure group, gender, and lake from which the fish was caught. PCB body burden levels correlated to age, body mass index (BMI), sport fish consumption histories, with years eating GL sport fish being the best predictor of PCB level. Coplanar PCBs levels correlated with GL lake trout and salmon consumption, BMI, age and gender. Furan body burden levels correlated with GL lake trout consumption, age, gender and lake. Sport fish consumption was not correlated with dioxin levels.

Great Lakes Basin Wide Sport Fish Advisory Outreach Program

In December 1998, the Consortium for the Health Assessment of Great Lakes Sport Fish Consumption hosted a 2-day workshop in Madison, WI to discuss strategies for the distribution of the sport fish health advisory throughout the GL basin. Representatives from seven Great Lake states attended this ATSDR funded workshop and obtained information from experts on outreach strategies. In addition, each state shared advisory outreach materials their state is currently using. This workshop provided an excellent forum for exchange of information and education for state collaborators.

Since the workshop, regular teleconferences have been held to design and develop state-specific outreach materials. To develop a poster to be distributed to health care provider offices and schools GL basin wide, Wisconsin staff worked with a local artist and an advertising/graphic design agency. The four color, 16 x 20 poster, being targeted toward women, is a batik of three pumpkinseed fish in a fresh water environment. At the bottom of the poster is a warning message, unique to each state, about eating sport fish and how to obtain a copy of the advisory. Some of the different messages that the states have chosen for their fish poster include:

Wisconsin message, "Hook into Healthy Fish. For a line on eating Wisconsin fish, and a free recipe, call your local health department."

"Before YOU take a bite, Learn more about pollutants in fish that may harm you or your children. For a line on eating Minnesota fish, call the Minnesota Department of Health, 651-215-0950 or 800-657-3908"

"Maximize the Benefits and Minimize the Risk of Eating Indiana Fish. Reel in your copy of the Indiana Fish Consumption Advisory. Call 317-233-7808"

"Fish Smart – Eat Smart. For a line on eating Ohio caught fish, call 1-800-755-GROW (4769)"

"Before Taking a Bite, Learn about chemicals in fish you catch. NYS Dept of Health 1-800-458-1158"

The Consortium is hoping the poster will attract women's attention and they will take the initiative to call their local health department and ask for a copy of the advisory. To distribute the posters, most of the collaborating states are sending a postcard that contains a copy of the poster, to the health care provider offices or other institutions. The postcard offers a free copy of the poster to those interested in displaying it.

The outreach materials will be distributed in a variety of places such as Women, Infants, and Children (WIC) clinics, Ob/Gyn clinics, pediatric clinics, health fairs, state fairs, and fishing shows. All outreach products aim to encourage women and minorities to follow their state's fishing advisory when they decide to eat sport fish.

Promoting Wisconsin's Sport Fishing Advisory

In addition to distributing the poster to physicians offices and schools, the Wisconsin Division of Public Health have printed signs and posted them at boat landings and along shores where larger numbers of minority anglers fish. Signs containing warnings about PCB and mercury contaminated fish were posted on 15 bodies of water. The signs are generic and manufactured from weather resistant yellow plastic. The warnings on the signs were designed using a general text template so the signs can be modified to communicate the specific advisory for postings on several different bodies of water. Approximately 250 signs were printed and volunteers from local communities were asked to help post the signs and maintain them throughout the 1999-fishing season. Wisconsin is also designing a brochure containing advisory information to be distributed to women who use WIC clinic services. Other efforts to distribute the advisory in Wisconsin are listed below:

1) Teachers are being educated about the environmental impact of PCB and mercury contamination and the importance of following the advisory. They are encouraged to include this information in their curriculum.

2) The fish advisory is being mailed directly to physicians, WIC clinics and prenatal clinics so health care providers can refer to the booklet to give proper advise to their patients.

3) A 10-minute video is being developed with the Department of Natural Resources and the Hmong American Partnership of Fox Valley, Inc., Appleton, Wisconsin.

4) A fact sheet, containing advisory information is being developed and will be distributed to physicians.

5) Workshops with the Hmong communities are being planned to educate the Hmong anglers.

Consortium for Improving the Effectiveness of Mercury Fish Consumption Advisories

This program is a collaborative effort involving the Wisconsin Division of Public Health and the State of Maine, Bureau of Health. The program will estimate the prevalence of the mercury sport fishing advisory awareness among women of childbearing age, determine the most effective method(s) of disseminating health information to women and determine the mercury body burden level among this sub-population. There are four components to the project: 1) 12-state telephone survey; 2) hair mercury analyses; 3) intervention phase; and 4) follow-up telephone survey in Maine and Wisconsin.

The Wisconsin Division Public Health contracted with the Wisconsin Survey Research Laboratory, Madison, Wisconsin, to conduct a 12-state random digit dialed telephone survey of 3,000 women of childbearing age (18-44 years of age). The national telephone survey was conducted from December 1998 to August 1999 to obtain information about fish consumption habits (commercial and sport fish) demographics, sport fishing health advisory awareness and the methods most favored by women for receiving this type of information. The states involved in the telephone survey include Arkansas, California, Connecticut, Florida, Louisiana, Maine, Minnesota, Montana, New Mexico, New Jersey, North Carolina, and Wisconsin. Five hundred women were interviewed in Maine and Wisconsin and 200 women were interviewed in each of the other 10 states.

The telephone survey was used to: 1) Characterize fish consumption habits; 2) determine the prevalence of women who are aware of the state's fish consumption health advisory; 3) among the women who are aware of the fish advisory, determine the modes by which they received the message and the proportions of women who follow the advisory, and 4) determine the modes by which the women prefer to receive information. The results of the telephone survey will be used to develop targeted interventions to successfully distribute the advisory and the information about mercury in sport fish to women who are unaware of it.

To estimate the mercury body burden level among this sub-population, all women who complete the survey were invited to donate a hair sample for mercury analysis. The biological sample analysis will strengthen the study by validating the mercury exposure self-reported information obtained through the survey of fish and non-fish consumers. All women who completed the telephone survey were asked if they would like to participate in the hair analysis phase of the project. Hair samples returned by volunteers were sent to Battelle Labs, Seattle, Washington, for analysis of total mercury content. After laboratory analyses are complete, each woman will receive their individual hair mercury results.

The information obtained from the telephone survey will be used to develop intervention(s) for use in Wisconsin and Maine during the fishing season of 2000. The intervention(s) will include information about how to avoid exposure to mercury through consumption of sport fish and will help to determine the best method to deliver sport fish advisory information to women of childbearing age. In the winter of 2001, a follow-up telephone survey will be conducted in Maine and Wisconsin to assess the effectiveness of the intervention phase.

The results of the study will benefit women of childbearing age and their offspring. The program will obtain information about the proportion of women who are aware of the advisory and how to successfully distribute advisory information to women who are not getting the message. By increasing the proportion of women who are aware of the advisory, the program will decrease mercury exposure to the women and their offspring. In addition, the intervention design will be shared with other states so that their advisory information will be distributed successfully to this sub-population. The end result is to ensure that women of childbearing age are getting the advisory information so that they will limit their exposure to mercury and other contaminants through consumption of sport fish.

TRIBAL ISSUES

Barbara Harper
Yakama Indian Nation

Tribal Technical Issues in Risk Reduction Through Fish Advisories

Barbara Harper, Yakama Indian Nation, and
Stuart Harris, Confederated Tribes of the Umatilla Indian Reservation

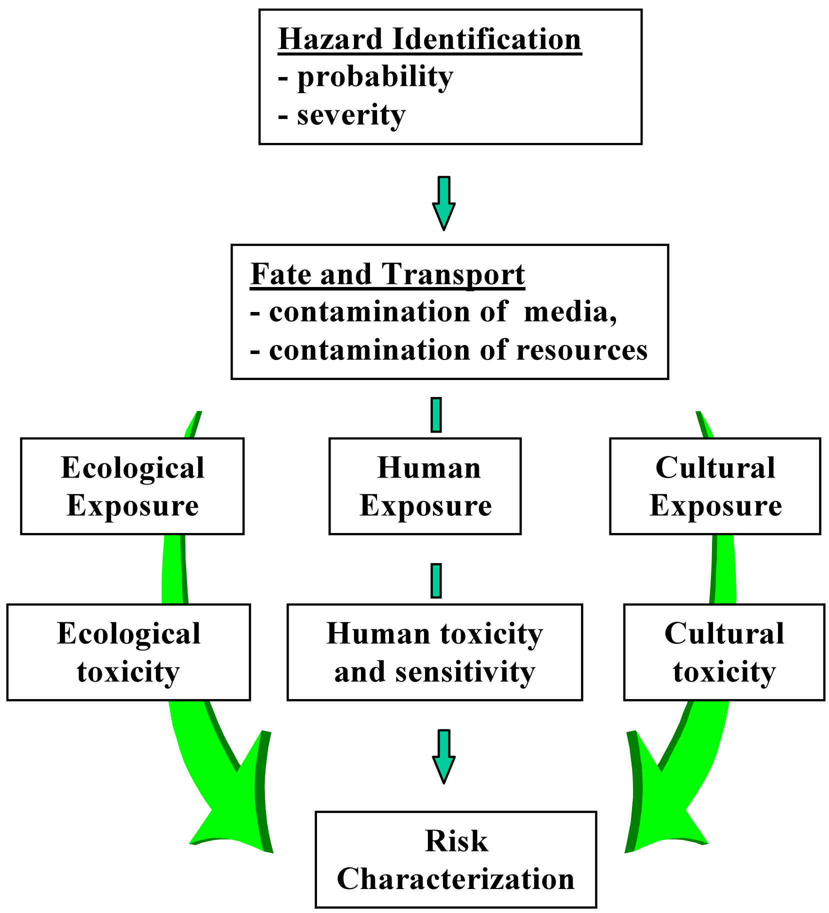
The Yakama Nation and the Confederated Tribes of the Umatilla Indian Reservation are located in the Columbia River Basin, which has many salmon runs, including several runs listed as threatened or endangered, many tribal and state hatcheries, and a large watershed. The river is heavily laden with heavy metals from mining, agricultural chemicals from intensive orchards and vineyards, radionuclides from Hanford, runoff from dairy farms, and PCBs from various sources. Salmon play a central and irreplaceable role in Tribes' culture and nutrition. The Yakima River, which forms a reservation boundary and is a tributary to the Columbia River, has a DDT fish advisory, although few people know about it. We operate under Treaties signed in 1855 between our individual tribes and the United States which guaranteed many rights relating to traditional lifestyles and religion. We are also natural resource Trustees along with the federal government. We operate our environmental programs on a shoestring with federal grants rather than with stable funding, which prevents effective implementation.

There are many issues relating to the evaluation of tribal health risk and, even more importantly, the health of the people as they exist within their eco-cultural communities. There is a difference between protecting the health of people belonging to a defined cultural group and protecting the culture of the people. We need to think not only about human people as receptors, but about the culture itself as a receptor. We should be very uncomfortable about having to write a fish advisory in the first place. Writing a fish advisory that protects a culture needs to use more information about people (their exposure and their sensitivity), and also their relation to the ecology of the contaminated fish. Really, there is just a single cultural community that is comprised of human and fish peoples and their rules for behaving and mutually surviving. It has been explained that the fish community existed first, and accepted people as community members, but only if human people follow certain rules of participating in the ecology, including a nutritionally adequate level of respectful consumption (a sacrament), and protecting the fish members from contamination and habitat degradation in return for being protected from starvation. Writing a fish advisory to protect some community members from other members is very disquieting, and causes many consequences of its own.

Tribal Sovereignty. Sovereignty is not understood well at the state or even the federal level, and we still run into people who think that intergovernmental consultation is not a state requirement, but only a federal requirement. At the county level, there is no understanding at all, and the lower in the civic chain decision making occurs, the less control EPA has over it. Jurisdiction is a tremendous problem. We recommend that EPA add a special section explaining federal Treaty and Trusteeship obligations, and how they also apply to states, in the next revision of the Guidance document.

Setting the context. Figure 1 shows an expanded concept of the risk assessment process, with ecological and cultural components in addition to human exposure. Some of the major technical issues within the human exposure process are discussed here. We will not discuss the cultural toxicity aspect, but we have developed an initial set of metrics.

Figure 1. Risk Trident: Risk assessment with additional ecological and cultural components, plus an expanded risk characterization step that pulls all the pieces together, tells the whole story about what and what is at risk from contamination.



Hazard ID (fish tissue concentrations). The biggest issue with hazard identification is with the data that is **not** collected. EPA has 25 target analytes, while we know that many or most fish in the Columbia River system are contaminated with over 100 chemicals simultaneously. We take a total-risk perspective, not a single contaminant or action level approach.

Multiple exposures. The issue of multiple contaminants is significant, and it is the norm, at least in the Columbia River system, for over 100 contaminants to be identified in fish tissues. While only a few might be at concentrations that trigger an action in any given fish, the combined risk for one fish or for the many species which comprise the native diet can be quite high. If these chemicals are in the fish, they are also in the water and/or sediment, so other routes of exposure are important. The toxicity of a mixture of dozens of carcinogens plus dozens of noncarcinogens, and the probability of secondary target tissues taking on a more important role needs to be examined. The Relative Source Contribution (as done for some common drinking water contaminants) is a start.

Exposure Assessment. There are many things that go into exposure assessment, including characteristics of the fish (size, ecological niche, lifecycle, etc.) and characteristics of the person or community. The factors that might vary the most among populations include ingestion rates, patterns of species and parts of the fish eaten, exposure duration, and the clustering of co-risk factors in tribal communities.

Ingestion rates. In order to estimate ingestion rates, one must first identify what segment of the population is of concern with respect to data collection (higher exposure, higher sensitivity, special lifestyle such as traditional subsistence). The policy determination of selecting what population segment to protect will determine what specific data is collected about exposures and sensitivity. The CRITFC study[1] surveyed a cross section of tribal members (with telephones, transportation, and so on). It did not specifically target subsistence individuals. The 99^{th} percentile ingestion rate was 390 g/d. Our study[2] specifically targeted traditional members with a more subsistence lifestyle, and determined an ingestion rate of 540 g/d (fresh, dried, smoked), and also confirmed that many fish parts are eaten although specific organ amounts were not estimated. We recommend that the definition of subsistence be clarified to reflect an actual subsistence lifestyle rather than simple membership in an ethnic group.

Community characteristics. There are family-specific fishing patterns and attention must be paid to the role of the fishing family within the community relative to tribal distributions of fish, the strong ethic of sharing, and providing for ceremonial/religious events. These families need special attention.

Dose-response. The dose response curve will vary among human populations just as it does among mouse strains. The 10x safety factor that is supposed to account for this may not be

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[1] CRITFC, 1994. CRITFC: *A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, and Warm Springs Tribes of the Columbia River Basin*. (Columbia River Inter-Tribal Fish Commission, Portland, OR.

[2] Harris, S.G. and Harper, B.L. "A Native American Exposure Scenario." Risk Analysis, 17(6):789-795, 1997.

enough and may not account for all the variables, and we cannot make a blanket assumption that the Reference Dose (RfD) is protective for the most sensitive population. As the Guidance Document says, “it should not be categorically concluded that all doses below the RfD are acceptable (or will be risk free) and that all doses above the RfD are unacceptable (or will result in adverse effects).”

If toxicity data is incomplete or if there is no RfD, an “average toxicity” and quantitative structure activity relationship (QSAR) approach could be used to develop a placeholder (rebuttable) RfD. This approach neither rewards chemicals for lacking data nor penalizes them by assuming that they are overly toxic, but uses a reasonable approach acceptable by many groups.

Co-risk, Sensitivity, and Dose-Response. The RfD safety factors, or the 10x factor used to capture the range of human variability, clearly did not consider the many co-risk factors that effect the response to chemicals. Co-risk factors are unique to individuals, but they may be clustered in certain population groups. These factors should be incorporated into individual and population risk estimates, especially if there are community-level differences. These factors include underlying health status (individual and community) and medications, baseline diet composition and quality, genetics, socioeconomic status, access to health care, quality of replacement protein (with PUFA), age, gender, pregnancy, and lactation. We recommend a more thorough discussion of these factors and how they are distributed between communities.

Risk Characterization (the most overlooked part of risk assessment)

It is a risk policy decision what information to include in risk characterization. The people who are at risk MUST be able to designate what risk information is be used to characterize *their* risk, or risk to *their* health, *their* ecosystem, *their* culture, and *their* future generations.

- The terms highly exposed populations and sensitive subpopulations are used almost interchangeably. We need to make a clear distinction between them. Some populations are both highly exposed AND sensitive. We might express this concept by the equation “**risk = exposure x toxicity x sensitivity,”** with toxicity referring to characteristics inherent to the chemical and sensitivity as characteristics inherent in the receptor.
- From a public health perspective, and from a tribal perspective, human health is inseparable from ecological health, and there are aspects of ecological injury, economic impacts, and cultural impairment that affect human health. To capture these ripple effects, we might use the equation “**health risk to an individual = health effects + α(ecological risk) + β(economic risk) + γ(cultural risk).**
- The risk to the entire community, or to the members of the present generation includes everyone who is exposed, even if exposed at low levels. There is a community contaminant burden that must be accounted for. There is no *de minimi* level of concern either for human exposure and also for cultural risk, which occurs at

any amount of contamination over background. A single-generation risk might be expressed as "**this generation's risk = the sum of everyone's health + ecological + economic + cultural risk) x (proportion of this generation affected)**

- Finally, lifecycle risk refers to all the exposure that occurs, whenever it occurs. We do not accept temporal discounting. Risk must be summed for as long as the material remains intrinsically hazardous, remains in the environment, or for as long as the impact (including mutations) persist in the population.

Risk Management - Changing the Perspective

Uncertainty. While the estimation of uncertainty is a technical issue, it also needs to be included under risk management. We need to use uncertainty information to know how bad the problem could be. The Precautionary Principle is an approach to making decisions in the face of uncertainty that complements risk assessment.

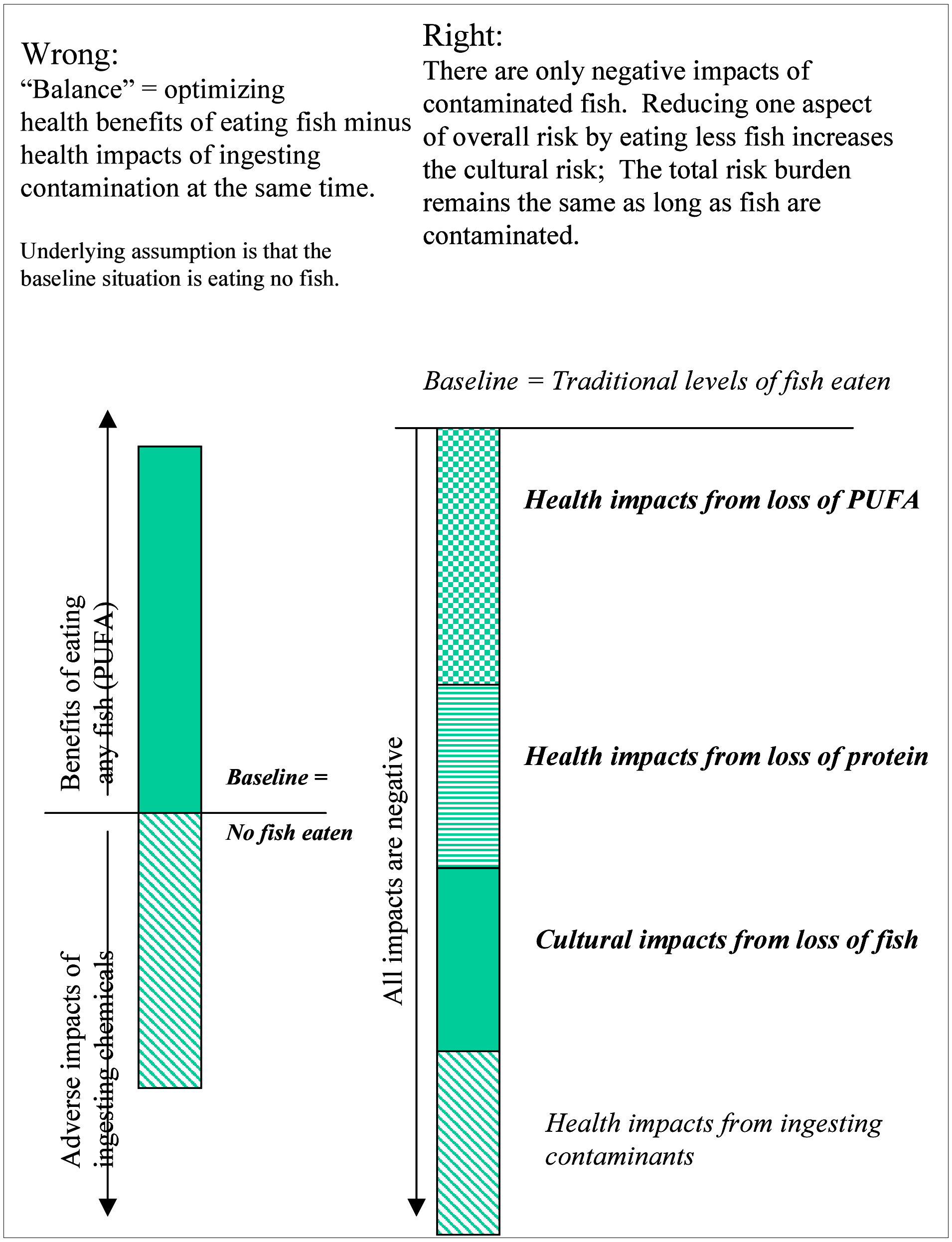
Perspectives and Options for risk reduction. Limiting fish consumption is seen as the "easy" way to get rapid risk reduction, but for tribes there are likely to be no acceptable "tradeoffs." Tribal peoples may not have an option of avoiding fish consumption for cultural and religious reasons as well as economic reasons.

Cost-Risk-Benefit. The Guidance states that the underlying assumption is that tradeoffs between risk reduction and social economic and other costs will be required. This is unacceptable to many tribes. We recommend that EPA greatly strengthen statements about cultural requirements to eat nutritionally-fulfilling amounts of fish regardless of contamination levels. The cultural use of fish is not a "perceived benefit of fish consumption." It is a baseline situation that is not an option or choice, but an absolute requirement. Natural resource valuation must understand and incorporate this.

Figure 2 (left panel) illustrates the point that the risk-benefit approach assumes that a person starts from a position of not eating any fish and has a viable choice of eating or not eating fish. That person can therefore can weigh the health improvements of eating any amount of fish against the adverse impacts of ingesting contaminants at the same time. It assumes that benefits of polyunsaturated fatty acids over none to begin with minus health effects of ingesting contaminants results in a point of "zero risk."

The right panel illustrates the situation where the baseline traditional subsistence situation is eating traditional amounts of fish, and being genetically accustomed to that amount of fish. All impacts are negative -- having to eat contaminated fish + having to use contaminated fish in religious ceremonies + having contaminants in ecological foodwebs + harm to Trust resource (and cultural resource) + disproportionate unfairness and exposure burden (all the negatives of contaminating a cultural resource, key foodweb species and human nutritional resource).

Figure 2. Perspective on two baselines: no consumption with a choice whether to eat fish, versus baseline high consumption where only negative impacts result from contamination.



Risk-Based Consumption Limits and Acceptable Risk. The assumption that acceptable lifetime excess risk in individual people lies between E-4 and E-6 for individual contaminants is not necessarily accepted by Tribes, and is clearly not acceptable for cultural use. Each tribe, as a sovereign nation, will decide for itself what acceptable risk is, and has the right to choose no-risk (such as zero discharge) where appropriate to protect cultural resources and uses.

There are additional issues with respect to population risk. Tribes are not the high-end of the general population; they are a discrete group with a unique lifestyle protected by Treaties and federal Trust obligations. The "central tendency" of traditional lifestyles MUST be kept separate from the "central tendency" of the general population.

Environmental Justice: Having a Voice about Choosing whom to protect (who gets to choose who to protect and how much to protect them?)

- A Risk Deficit has already occurred due to unequal protection in the past. Tribes have already borne disproportionate risk for many generations, so they deserve disproportionate over-protection for an equal period of time.
- Small populations may need *more* protection. The argument that small populations deserve less protection because their numbers are fewer is backwards.
- Defining subpopulations above an acceptable risk level is described as a federal or state decision, but the exposed people are seldom if ever a real voice in this decision.
- Environmental justice is not just a matter of evaluating exposure better or communicating better (although these are necessary) – ultimately tribes need equal protection, not just equal communication. Tribal risk is a risk assessment, not a risk communication problem.
- Environmental justice is also about listening. In addition to explaining the health risks of following certain traditional consumption patterns, agencies need to learn about the consequences of breaking those consumption patterns.

Competing rights (the right to pollute versus the right to remain unexposed) remains an issue at the forefront of Treaty rights and Trusteeship.

Trusteeship and the Concept of Managing Risk versus Protecting People & Resources

- "Managing health risks through fish advisories" as a concept needs to be revised to "protecting people and their eco-cultural resources."
- Fish (salmon for us) are not only a Trust resource with Tribes as trustees, they are also a cultural resource.
- We would like to discuss methods for evaluating holistic and eco-cultural risk, and how to use this information in setting fish advisories.
- We recommend that EPA add clear statements about federal Trusteeship and Treaty obligations and how fish advisories fit into this goal.

TRIBAL ISSUES, CONT.

James Ransom, Director
Haudenosaunee Environmental Task Force

Introduction

Good afternoon. I would like to thank Steve Ellis and the conference organizers for allowing me to speak at this gathering. I am James Ransom, Director, Haudenosaunee Environmental Task Force. I work with the Six Nations of the Haudenosaunee Confederacy (Mohawks, Oneidas, Onondagas, Cayugas, Tuscaroras, and Senecas) helping them to develop environmental programs.

I am from the community of Akwesasne or the St. Regis Mohawk Reservation. We are located on the St. Lawrence River at the point where Quebec and Ontario in Canada and New York State come together. Overhead 1 is a map of the communities that I work with and it also shows where Akwesasne is located.

Conflict

Three of four Chiefs with felony convictions in the United States are from the St. Regis Mohawk Tribal Council. A $687 million smuggling ring that went through Akwesasne was broken up in 1997. Two Mohawk men were killed in 1990 at St. Regis in what was called the "Gambling Wars." What I hope to show you is that the issuance of a fish advisory by our community in 1986 played a huge role in the events that followed.

Kaswentha

To understand this connection, you must understand the Kaswentha or Two-Row Wampum Belt. This is a treaty of peace that was made 500 years ago between the Haudenosaunee and the Dutch. It consists of two purple rows of wampum beads separated by three white rows of wampum beads. The two purple rows symbolize two vessels traveling down the river of life together, side-by-side. One vessel, a ship, is for the Dutch and other Europeans who later became the Canadians and Americans. The other vessel, a birch-bark canoe, is for the Mohawk, Haudenosaunee, and other Native peoples.

The purpose of this treaty is that as we travel the river of life together, the ship and canoe are to help each other from time to time. We are not to try and steer the other's vessel. The content of each vessel describes elements of each society, lifestyles, philosophies, science, governance, and laws. I will share some of what is in the canoe with you next.

Content of the Canoe

Akwesasne or St. Regis is like most Native communities. We were a fishing, farming, hunting, trapping, and gathering community. These lifestyles helped to support an earth-based value system. We call the earth our Mother, the animal and plant life our brothers and sisters, the waters the bloodlines of our Mother earth. Our philosophies are based on looking out for the next seven generations to come. When we make decisions today, we must ensure that the seventh generation to come can look back and say we made the right decision for them.

One of the buzzwords of today is sustainable development. There was no concept of this for us. We were sustainable societies. Everything we needed was provided by the natural world. We followed the natural laws. It required that we only take from the natural world what we need and that we use all that we take. There was no waste. We also must be thankful every day for what we get. These common sense approaches to living allowed us to survive and thrive for hundreds and thousands of years.

Interference by the Ship

This all changed for the Mohawks of Akwesasne in the 1950s. The “Progress” of the Ship interfered with the progress of the Canoe. In 1958, the St. Lawrence - FDR Power Project was constructed on the St. Lawrence River just upriver from Akwesasne. Low-cost hydroelectric power allowed two new industries to open, Reynolds Metal Company, an aluminum smelter, and General Motors Powertrain, an automobile parts manufacturer. It allowed a third industry, ALCOA, an aluminum smelter, to expand operations.

By the early 1960s, cattle within the territories of the Mohawks began feeling the effects of fluoride poisoning from the aluminum smelters. By 1981, PCB contamination of the General Motors site came to light. In 1983, it became a federal superfund site. By 1987, PCB problems at ALCOA and Reynolds became known as well. By 1989, a six-mile stretch of the Grasse River and a two-mile stretch of the St. Lawrence River became a federal superfund site because of PCB contamination.

Effects on the Canoe

In 1986, a 67-inch length, 200 pound lake sturgeon was caught by Mohawk fishermen in the St. Lawrence River. Parts of it were sent for PCB analysis. The results were alarming as 3.41 parts per million (ppm) of PCBs were found in the meat, 7.95 ppm in the eggs, and 10.20 ppm in the liver. The New York State PCB fish standard for human consumption is 2.0 ppm.

It was decided by the Mohawk community to issue a fish advisory after these results were received. The advisory reads:

> To minimize potential adverse health effects, the St. Regis Mohawk Health Services recommends that:

- You eat no more than one meal (½ pound) per week of fish from any body of water in or around the St. Regis Mohawk Reservation.

- Women of child bearing age, infants, and children of the age of 15, should not eat fish with elevated contaminant levels. All fish taken from the St. Lawrence River should be considered contaminated. Therefore, health advice should be followed.

Do Fish Advisories Work - From the Ship's Perspective

Several studies have since been undertaken that have indicated the fish advisory has been successful in reducing fish consumption by the Mohawk community. A study of Mohawk women from 1986 to 1992 (Fitzgerald et al., 1995) found a decline in the number of local fish meals:

> "Mohawk women who participated in the study period reported eating less local fish..."

- 8.5 local fish meals annually for 1986-89 participants.
- 3.3 for 1990 participants.
- 1.5 for 1991-92 participants.

The decline was not limited to just women though. In a sample of 103 men surveyed from 1992 to 1995, it showed large declines as well:

> "The hypothesis that the Mohawk men were heavy fish eaters was confirmed."

- 8 local fish meals per month more than two years before the interview.
- 3 meals per month two years before the interview.
- 2 meals per month during the previous year.

Do Fish Advisories Work - From the Canoe's Perspective

The issuance of the fish advisory had a profound effect on the ability of the Canoe to maintain its path. Contamination of the St. Lawrence River resulted in a destruction of a subsistence lifestyle for the Mohawk people. It destroyed hunting, fishing, farming, trapping, and gathering activities. These were replaced by economies of the Ship. You can correlate the widespread arrival of gas stations, smoke shops, bingo halls, casinos, and smuggling in Akwesasne to this destruction.

There was also a tremendous change in diet. As a community, we went from the high protein source of fish and nutritious quality of locally caught animals and fresh vegetables, to store bought food.

The changes in lifestyles and diet have led to harmful effects on the physical health of our people. Fifty years ago, diabetes was almost unheard of in our community. Today, it is running rampant in our community and is increasingly effecting the young and old. Hypothyroidism and upper respiratory illnesses are now effecting our community.

Equally important has been the effect on the spiritual and mental health of our community. It is more difficult to be thankful to a box of macaroni and cheese than it is for fresh caught fish. The activities of the Ship that have come into our community are in conflict with existing community values. Gambling is not a traditional activity. Gas stations, smoke shops, and casinos are new to the community. They carry strong individual values associated with making money that clash with the community-based value system.

The clashing of these values was never more evident than during the "Gambling Wars of 1990 as over 200 state troopers and Quebec and Ontario Provincial police occupied our territories after two Mohawk men were killed. It was evident in 1997 as the $687 million smuggling ring through Akwesasne was busted. It is evident today as a Chief from the St. Regis Mohawk Tribal Council pled guilty to federal racketeering charges.

Conclusion

It is important to not end on a negative note. It is too easy to be a victim in all that has happened at Akwesasne. Instead, we look to the future generations to come and work towards ensuring that they will have a future. We are undertaking environmental projects to maintain our relationship with the natural world. We have been exploring aquaculture, or fish farming. We are showing you can grow clean fish in a contaminated river environment by minimizing the pathways of exposure.

We have seen neighboring industries invest over $500 million in environmental clean-ups of their facilities. They have greatly reduced discharges of their industrial waste waters to the St. Lawrence River. We are actively participating in a Natural Resources Damage Assessment Program for the St. Lawrence River.

Finally, we continue to be thankful to the rest of Creation for fulfilling their responsibilities as given to them by the Creator.

Thank you.

ARCTIC MONITORING OF ENVIRONMENTAL CONTAMINANTS

Mark Palmer
Indian and Northern Affairs
Government of Canada

Arctic Monitoring and Assessment Program

The Arctic Monitoring and Assessment Program (AMAP) was established in 1991 to implement one of five programs adopted by the Arctic Environmental Protection Strategy (AEPS). The AEPS was adopted by the Ministers of eight Arctic countries in 1991 including the United States, Canada, Denmark, Finland, Iceland, Norway, Sweden and Russia. The responsibility for AEPS including AMAP was transferred to the Arctic Council following a conference in Alta, Norway in 1997.

"The primary objectives of AMAP are:

- to measure the levels and assess the effects of anthropogenic pollutants in all compartments of the Arctic environment, including humans;
- to document trends in pollution;
- to document sources and pathways of pollution;
- to examine the impacts on Arctic flora and fauna, especially those used by indigenous people;
- to report on the state of the Arctic environment;
- to give advice to Ministers on priority actions needed to improve Arctic conditions."[3]

Between 1991 and 1996, AMAP designed and implemented a monitoring program and drafted the first assessment report. The monitoring program was based on existing National and International activities as well as traditional knowledge and new initiatives developed to fill in information gaps needed to complete the assessment. By the time the project was finished, over 400 separate studies/reports were utilized.

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3. AMAP, 1998. AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme(AMAP), Oslo, Norway, p. 4.

The results of AMAP were produced in two reports. The *AMAP Assessment Report: Arctic Pollution Issues* (AAR) is a technical/scientific assessment detailing the present situation of the Arctic environment. The second report *Arctic Pollution Issues: A State of the Arctic environment report* is a concise summary of the AAR, including recommendations for use by the ministers of the eight Arctic countries.

AMAP was designed to determine the level of contaminants in all compartments of the environment including the atmospheric, terrestrial, freshwater, marine and human populations. In 1991 persistent organic contaminants, heavy metals and radioactivity were identified as the key issues to be addressed. In 1993 AMAP modified its mandate to include acidification and Arctic haze, oil pollution, climate change and ozone depletion.

Before a summary of the conclusions and recommendations contained in the AMAP Report are provided it should be noted that it is impractical to accurately summarise this much information in a short presentation. The AMAP report itself which summarizes the work from all eight countries was over 800 pages in length. A few key conclusions from three areas including contaminants sources and pathways, levels trends and effects, and human exposure are listed below.

Contaminant Sources and Pathways

- sources exist for many of the Persistent Organic Pollutants (POPs) with no link to local sources;
- the main sources of heavy metal pollution are Europe and North America;
- local point sources have been identified for POPs;
- mines can raise background levels up to 20 miles from the site;
- oil releases are minor except for catastrophic events;
- high concentrations of radioactive wastes have the potential for release;
- atmospheric and ocean currents are the main transport mechanisms to the north.

Levels, Trends and Effects

- animals highest on the food chain are most exposed;
- levels in some Arctic birds and mammals exceed threshold levels that may be associated with biological effects;
- mercury seems to be increasing in sediments and marine mammals;
- biomagnification is the main factor influencing species exposure.

Human Health

- exposure to POPs is the primary concern;
- exposure to radionuclides is primarily through the terrestrial food chain;
- cadmium and mercury tend to accumulate in the long marine food chain;
- complicated due to social, cultural and spiritual factors;
- communications with involvement of local residents is essential;

AMAP recommendations dealing with human health get a lot of attention from Arctic people. Since there are too many to cover in relation to the transport of contaminants and the levels and effects of contaminants only the key human health recommendations will be covered. The two related to health advice are:

- "Apply communication and consultation approaches that enhance the development of local information and advice for indigenous peoples about contaminant exposure and effects";
- "Advise Arctic peoples to continue to eat traditional food and to breast feed their children, and develop dietary advice for girls, women of child-bearing age and pregnant women which promote the use of less contaminated food items while maintaining nutritional benefits"[4]

Canadian scientists started investigating environmental issues in the north in the 1970s and 1980s. The late 1980s saw a coordinated approach combining knowledge and resources. In 1991 a federal program, The Arctic Environmental Strategy - Northen Contaminants Program (NCP) provided funding for a six year period.

The objective of the NCP were to:

- measure contaminant levels in the Canadian north;
- investigate sources, pathways and fate of contaminants;
- assess effects of contaminants provide information to assist northerners in informed decision making;
- pursue international agreements.

The work carried out in northern Canada is summarized in two reports, the *Canadian Arctic Contaminants Assessment Report* and the *Highlights of the Canadian Arctic Contaminants*

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4. AMAP, 1998. AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme(AMAP), Oslo, Norway, p. 25.

Assessment Report. The conclusions of these reports are similar to those found in the AMAP Report.

The NCP has evolved over time from a program built primarily on science to a balanced program between science and communications/education. The program is based on partnerships with all levels of government and Aboriginal peoples making decisions on a consensus basis. The management structure is reviewed on an annual basis to ensure a truly successful program.

As with any program mistakes are often made in order to make improvements (i.e. no community involvement, information that could not be understood). Some of the earlier communications efforts related to releasing study results, and on occasion health advisories, assisted in improving both communications and partnerships. In order to have good partnerships and communications you must involve the community from the start of the study and provide them with the capacity to understand the information.

In order to make sure this is followed the NCP has develop the *Guidelines for Responsible Research*. All projects must have appropriate approval and involvement at the community level prior to being initiated. In addition all projects go through a social/cultural review to ensure the interests of Aboriginal people are protected.

In conclusion, the communication/education efforts associated with any program dealing with health and safety of individuals are the most important and often the most complicated component. Approximately 50% of the resources in the NCP are used to support partnership, communications and education efforts.

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ARCTIC MONITORING OF ENVIRONMENTAL CONTAMINANTS, CONT.

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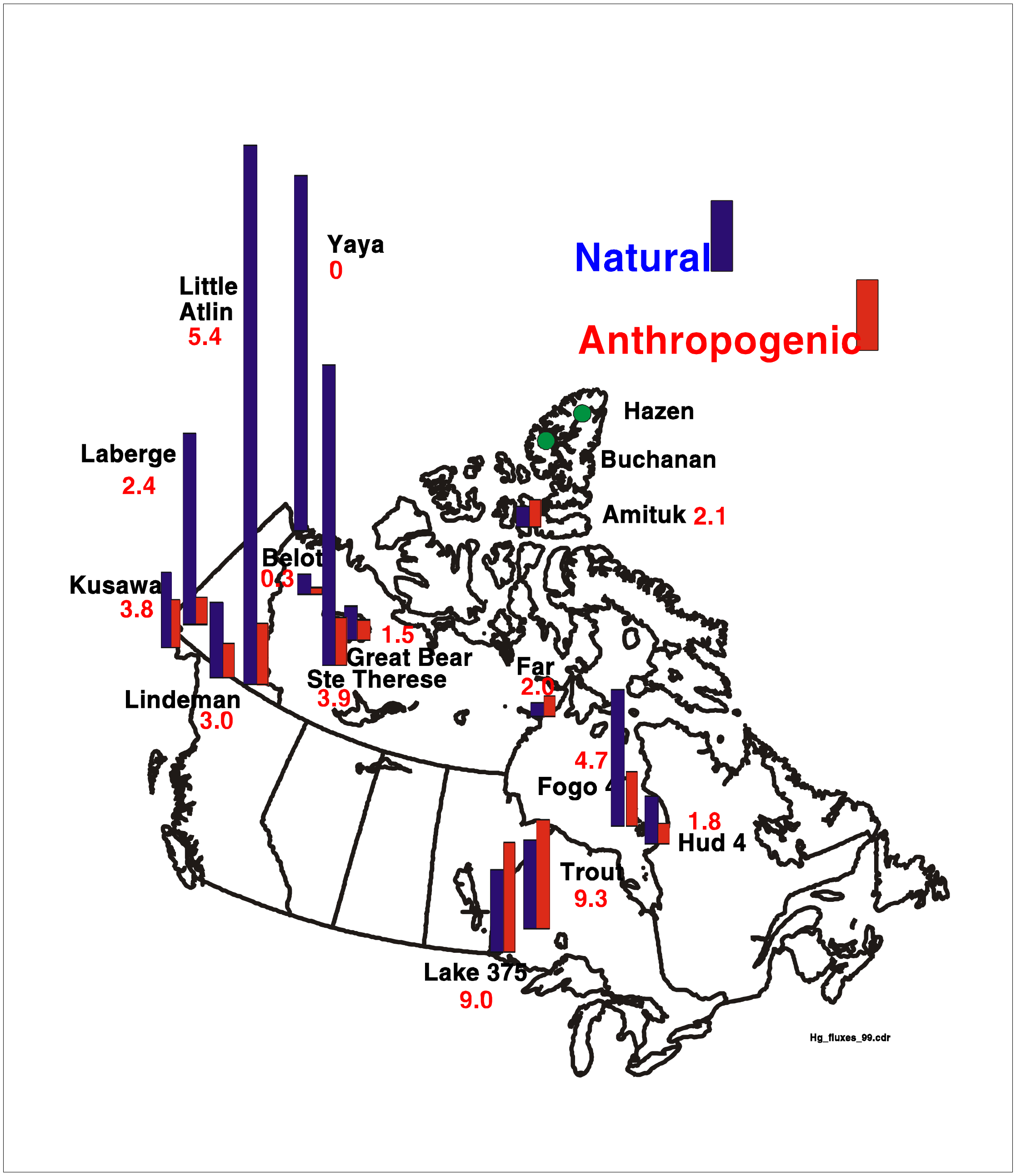
Environmental Dynamics of Mercury

Native people in northern Canada continue to derive a large part of their diets from traditional foods including fish, marine mammals and terrestrial wildlife. Government publications recommend the use of these foods for their nutritional value. Studies over the past 30 years have shown that northern animals contain chemical residues of several kinds, especially organochlorine compounds and mercury. In Canada, the Federal Department of Health has used a guideline level of 0.5 $\mu g\ g^{-1}$ (wet weight) of mercury to regulate the sale of commercial fish products. However, with subsistence fisheries there is no point of inspection for regulation of sales and consumption rates are sometimes higher than the average for most Canadians. In recognition of that, the recommendation for subsistence use of fish is lower at 0.2 $\mu g\ g^{-1}$. Recent evaluations have tried to go beyond the simple alternative of eating the fish or not eating them and have aimed at regulating the quantity eaten. This has been done by using an established tolerable daily intake (tdi) figure (provisionally 0.47 $\mu g\ kg\ bw^{-1}\ day^{-1}$ for adults other than women of child-bearing age) and an average body weight of 60 kg. Taking these values and knowing the amount of mercury in the fish, it is simple to calculate the amount of fish that can be consumed without exceeding the tdi. The concentration of mercury in the fish is the arithmetic mean of the sample expressed in $\mu g\ g^{-1}$ wet weight. For example, a recent set of data for lake trout from Cli Lake, Northwest Territories, showed a mean mercury content of 0.876 $\mu g\ g^{-1}$. Taking the tdi of 0.47 $\mu g\ kg\ bw^{-1}\ day^{-1}$, an advisory was issued advising that consumption not exceed 225 g per week for adults other than women of child-bearing age. At the time the advisory was issued it was also recommended that children and women of child-bearing age restrict consumption to half the recommended amount. Since then, a lower tdi of 0.2 $\mu g\ g^{-1}$ has been adopted for women of child-bearing age and young children. If such a consumption advisory were issued today, two levels of consumption would be cited, one based on the tdi of 0.47 $\mu g\ kg\ bw^{-1}\ day^{-1}$, and a second based on a tdi of 0.2 $\mu g\ kg\ bw^{-1}\ day^{-1}$.

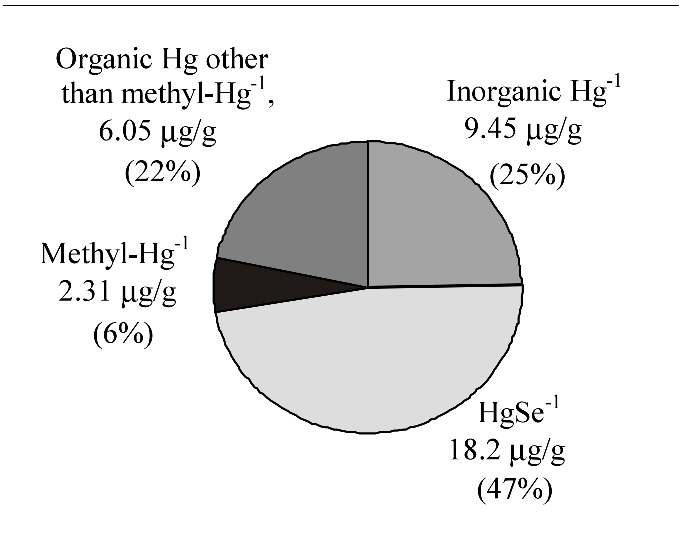
We have a limited but growing set of data describing levels of mercury in fish from isolated lakes in the Canadian Arctic. These data show that predaceous fish like lake *trout (Salvelinus namaycush*), northern pike (*Esox lucius*) and walleye (*Stizostedion vitreum*) often have muscle levels of mercury over the 0.5 $\mu g\ g^{-1}$ level set for commercial fish and almost always exceed the 0.2 $\mu g\ g^{-1}$ level set to protect subsistence consumers. The meaning, if any, to the fish themselves is unknown. Fish that do not generally feed on other fish (e.g. whitefish, suckers, grayling) tend to have lower levels than the predators. Often there is a relationship between mercury levels and fish size or age and so one potential strategy to limit human intake of mercury is to eat the smaller, younger fish.

Figure 1. Natural and anthropogenic fluxes of mercury to isolated lakes in Canada as calculated from lake sediment cores. The total recent flux was calculated from the sediment layers deposited since 1950 and the historic flux was calculated from the slices at the bottom of the core. The anthropogenic flux was taken to be the excess of the total recent flux over the historic flux. The figure beside each set of bars is the anthropogenic flux in µg/m/yr.



In fish, our experience indicates that most of the mercury is present in the form of methylmercury. Toxicological evaluations of fish data are made on the assumption that the mercury in the fish is methylmercury. In marine mammals, however, there are at least four forms of mercury present. We have used a fractionation protocol to estimate the four types separately with the results shown in Figure 2. The independent measurement of total mercury yielded the same as value as the sum of the four measurements and so the fractionation procedure retains all the mercury. The identification of methylmercury is the most certain of the four "species" shown, the remainder being defined operationally by the procedure used to isolate them. The large fraction identified as HgSe had a 1:1 molar ratio of Hg:Se and is consistent with previous diffraction work. Martoja and Berry (1980) identified 15 nm-sized mercuric selenide granules in livers of cetaceans from the Mediterranean Sea and Nigro (1994) definitively identified the presence of an inert mercuric selenide compound in dolphins. Different whale organs contain quite different amounts of both mercury and selenium with liver having the highest concentrations of Hg. The major questions deriving from the fractionation work are those associated with the toxicology either for the whales themselves or for the people consuming them. For example, if HgSe is a form of inert mercury stored in the animals, should it be given the same weight as if it were methylmercury when trying to determine safe amounts for human consumption? Experimental toxicology studies will have to be conducted.

Figure 2. Pie chart showing arithmetic mean concentrations of mercury (with percentages in parentheses) of the four 'species' of mercury in beluga whale liver.



The data from sediment allow estimation of amounts of mercury being added to a lake and how that has changed over time. The basic tool for the core work is dating sediment layers with lead-210, and natural radioactive isotope derived from the decay of radon gas. Usually lead-210 dates can be determined for about 100-150 years which is enough to span much of the industrial development of North America. We have used lead-210 dated cores to estimate natural and anthropogenic inputs of mercury to isolated lakes in Canada and the results are shown in Figure 1. The assumptions in these calculations are that all natural processes were operating at the time deep layers were deposited and that those have continued to operate. The increases in mercury in recent layers are taken to represent additional loadings due to recent activities. We have tested the fidelity of core records to known records of mercury pollution at several sites and the conclusions from the cores were consistent with the known information (Lockhart et al., 1999). The natural fluxes were generally higher in northwestern Canada than in the central and eastern sites. Several of our sites in northwestern Canada are lakes fed by glaciers and they have a large input of powdered rock containing some mercury, hence the large natural fluxes. The anthropogenic fluxes were higher in more southerly sites with fluxes there being similar to U.S. border states (Swain et al., 1992). There has been some recent decrease in inputs of mercury to lakes in north-central USA (Engstrom & Swain, (1997); however, we have not seen evidence of that in the Arctic yet, possibly because of greater influence of transport processes bringing material into northern Canada from Eurasia. Sediment cores are always subject to possible artifacts that make interpretation difficult. One of these is particle mixing after particles have been deposited. For example, actions by benthic animals may move particles from one layer of sediment to another and compromise the historical record of those layers. We have recently obtained cores from a lake on northern Devon Island where visible laminations of the sediment are evident and so particle mixing in these sediments must have been minimal or non-existent. In this core the mercury at the top is about double the levels at the bottom, a result consistent with recent inputs about double historic inputs.

Studies of gaseous mercury in the air have been conducted at Alert on northern Ellesmere Island. These studies have shown that gaseous mercury in the air is converted to particulate mercury in the spring (Schroeder et al., 1998); the particulate mercury is readily scavenged by snow and deposited to the land or water surface. Measurements of mercury in snow from the Arctic have much higher concentrations just before melt than snow in southern Canada. The source of the anthropogenic component of mercury to isolated northern lakes is the snow and ultimately the air. The sources of mercury to the air are largely from combustion activities at temperate latitudes notably burning of coal and other fossil fuels, burning garbage and industrial activities (Pacyna and Keeler, 1995).

Until recently we assumed that the mercury in fish from isolated northern lakes was simply an unfortunate consequence of the geological features of their drainage basins. However, a number of studies have shown the mercury that mercury moves about on a planetary scale, particularly with air mass movements. For example, Slemr & Langer, (1992) estimated that mercury in the air of the northern hemisphere is increasing at a rate of about 1.46 per cent per year. We have seen evidence of similar increases in seals and whales from the Canadian Arctic (Wagemann et al., 1996), in lake sediments (Lockhart et al., 1998) and recently in sea birds (Braune, 1999). There are also data from human samples comparing people and their sealskin clothing from Greenland in the late 1400s with contemporary people maintaining a traditional lifestyle. Hair from modern people contains considerably more mercury than hair from Greenlanders alive several hundred years ago. This apparent increase in inputs of mercury is potentially the most troublesome observation we have to date.

We are unsure whether the atmospheric loadings of mercury to lakes are driving accumulations in aquatic animals. An experiment at the Experimental Lakes Area of northwestern Ontario is just getting underway and we expect it to provide the answer to that question. Three different stable isotopes of mercury are being added to the lake to simulate atmospheric input to the lake, input to the upland part of the drainage, and input to wetlands bordering the lake. These isotopes can be distinguished by mass spectrometry and so analyses of the fish after the additions will tell us how effectively these different additions drive concentrations in the fish.

The driving questions behind most mercury studies in Canada are the safety of foods consumed by families who maintain a lifestyle dependent on fishing and hunting. The weight of evidence to date indicates that subsistence consumers should continue to use traditional foods. When concentrations of mercury in traditional foods warrant the issuance of advisories, then consumption should be limited to amounts stated in advisories. People are not the only consumers of fish. Fish-eating wildlife can also accumulate high levels of mercury and we have some indications that they are suffering effects from that. For example, studies in Nova Scotia have shown that reproduction of common loons is impaired when the concentration of mercury in the fish they eat exceeds 0.38 $\mu g/g^{-1}$ (Burgess et al., 1998).

In summary, concern about mercury in northern Canada derives mostly from the risks it may pose to northern native people who consume fish and wildlife as a regular part of their diets. It appears that mercury in the Arctic derives partly from natural sources and partly from anthropogenic activities, mostly combustion of fuels and garbage. Virtually all of the anthropogenic emissions of mercury occur outside the Arctic in temperate zones. Anthropogenic emissions discharge gaseous mercury into the air and air mass movements disperse it throughout the hemisphere. In the Arctic it is scavenged from the air into snow, especially around polar sunrise, and is deposited on northern land and water. Once in northern ecosystems, some of it is taken up biologically and contaminates organs of fish and wildlife and, ultimately, people who consume the fish and wildlife. Sediment cores from northern lakes show that inputs of mercury to the Arctic are higher then they were in pre-industrial times. We see this also is in increasing concentrations in fish, marine mammals and sea birds. Some of the levels are high enough to raise questions about the implications for the animals themselves. Levels of mercury in fish have resulted in consumption advisories for some predaceous species like lake trout, northern pike and walleye.

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CHEMICAL UPDATES: DIOXINS/FURANS

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This presentation was designed to give an update on the scheduled release of several chapters of the dioxin reassessment requested by the Science Advisory Board (SAB). It also addresses dioxin emissions, dioxin levels in fish as a component of the general population diet, highly contaminated fish and high-end consumers; updates dioxin health effects; discusses TEF values; and addresses margins of exposure and incremental exposures.

Dioxin reassessment information releases

In January, a copy of the integrated summary and characterization and a new toxicity equivalence factor chapter will be posted on the EPA website. These topics were requested by the SAB as part of a review on the dioxin reassessment. A dose-response chapter revision will be available shortly after the other two chapters and will also be available online. Public review, a peer-review meeting, and a Science Advisory Board meeting will occur between January and May 2000. A CD-ROM with all background chapters will be created. In mid-summer 2000, a draft comprehensive strategy discussing how EPA will deal with the regulatory implications of the findings of the dioxin reassessment should be available; this will be available for discussion in a public forum.

Dioxin emissions, sources, and pathways to water

In order to update information on dioxin emissions and sources, EPA compiled an emissions inventory, characterized as the best available information in any country with regard to dioxin emissions. Two years were required to collect the information obtained from various sources; the database is available on the EPA website. Based on a review of the data, a significant decline in dioxin emissions was observed from 1987 to 1995, particularly from major sources. Data gaps in the emissions database included emission data from uncharacterized sources that are not currently in any database and other potentially missed sources. Uncharacterized sources are primarily from small operations which may potentially emit large volumes of dioxins (e.g. backyard burning). Eight to nine of these uncertain sources were identified in the characterization.

Currently, the dioxin pathway to water is primarily from indirect sources, e.g. urban runoff and soil erosion, and not direct input from chemical industry. Most dioxin is released into the air, particularly from combustion, and falls to the ground where it is carried into waterways via runoff or erosion processes.

Dioxin levels in fish as a component of the general population diet

EPA and FDA have completed or nearly completed national food surveys to identify consumption levels of beef, pork, fish, and dairy in order to identify dioxin exposure levels from diet. Diet as an exposure pathway is important because over 95-98 percent of dioxin exposure is through food intake. On average, 6 grams of freshwater and saltwater fish are consumed per day. Fish represent a quarter to one third of the total intake of dioxins in the diet and approximately 25–35 percent of a total 1-picogram-per-kilogram-per-day TEQ intake. For an adult, the total estimate is about 70 picograms of intake per day, which is 30% less than 1994 estimates. This also includes the PCBs and the dioxin-like PCBs that can contribute to the toxicity equivalence factor.

Highly-contaminated and high-end consumers

Deviations from "average" consumption levels and consumption of fish harvested from highly-contaminated waterbodies are likely to result in a significant difference in dioxin intake for that day. However, as addressed in the reassessment, it is important to understand the effects of body burden levels on dioxin effects. With a half-life of seven years in the body, dioxin's cumulative impacts in the body should be considered. Body burden is currently the best metric for understanding the difference between health effects in animals and in humans. Although a spike of dioxin exposure may produce significant effects in developing children, the contribution of body burden to health effects appears to be useful to look at health effects in the general population. The implications of individual fish meals and high-end consumers should be framed in such a way that a meal's impact on body burden is taken into account. For example, has body burden increased significantly and has the individual exceeded average population exposures? These are issues currently being considered by EPA.

Dioxin health effects update

Noncarcinogenic endpoints — As more information becomes available on populations exposed at near-background levels, associations have been made between low levels of exposure and health effects. Changes in offspring have been associated with maternal exposure, subtle effects have be seen in primates exposed to very low levels, and rats with body burdens similar to human background levels have shown changes in sexual behavior and several developmental endpoints.

Carcinogenic endpoints — Studies have suggested an increase in overall cancer due to dioxin exposure, although no particular endpoint or tumor type has been identified. 2,3,7,8-TCDD was rated a human carcinogen by the International Agency for Research on Cancer in 1997, and EPA will probably be issuing a statement that dioxin and related compounds are likely to be carcinogens. Chemicals that act like 2,3,7,8-TCDD are classified as highly likely to be carcinogens and are identified as likely known human carcinogens. Other compounds have been identified with lower potencies.

Toxicity Equivalence Factors (TEFs)

Dioxin is a complex mixture and there are rarely incidences when one is exposed to simply one congener. However, some European cases have been identified in which a few individuals were exposed only to 2,3,7,8-TCDD. TEFs are used to come up with an order of magnitude estimate for what EPA thinks the potency of compounds are, assuming additivity of the mixture. Thirty to fifty percent of the total toxicity equivalence is due to co-planar PCBs or dioxin-like PCBs. PCB-126 and PCB-169 are currently receiving attention from EPA with regard to dioxin effects. PCB-77 will also be targeted, but to a lesser extent because of its lower potency and rarity in samples. EPA suggests that PCBs need to be considered if one is interested in dioxin-like toxicity because they account for 30-50 percent of the toxicity.

Margin of exposure and incremental exposures

A debate exists around the range where adaptive effects become adverse effects. Although dioxin compounds can alter biological processes, the point at which alterations such as enzyme induction produce adverse effects becomes unclear. Effects are at body burdens that are at or certainly within an order of magnitude of the general population exposure. Therefore, background exposures need to be reduced by decreasing environmental loading or intercepting dioxins as they move through the environment and into food supplies.

The issue of incremental exposures above background concentrations in food is currently being addressed by EPA to better understand the significance of the risk. For example, a one-in-a-million risk is about a one percent increase over the average daily intake. Several issues still need to be discussed, such as what is a significant increment of exposure over background? Arguments have been made that if background levels are close to toxicity now, perhaps a 1 percent increase is too much or perhaps chasing that last one percent should be reconsidered. Over the next year, EPA will have to give some guidance and these issues will need to be addressed.

CHEMICAL UPDATES: ARSENIC

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Introduction

Arsenic is a metalloid with valence states of: -3, 0, +3, and +5 (Welch *et al*, 1988). It is found to a limited extent as the element (valence 0) and the -3 state generally occurs under anaerobic conditions. Arsenate (+5) or arsenite (+3) are the primary inorganic arsenic (iAs) species in water; their relative proportions depend on the water's redox potential and pH (Irgolic, 1994).

There are many sources of arsenic that may contaminate drinking water. Natural sources include the geologic formations (e.g., rocks, soil, and sedimentary deposits), geothermal and volcanic activity. Arsenic concentrations in the earth's crust vary, but generally reported to range from 1.5 to 5 mg/kg in igneous and sedimentary rocks (NAS, 1977, ATSDR, 1998). It is commonly present in the sulfide ores of other metals including copper, lead, silver, and gold. There are over 100 arsenic-containing minerals, such as arsenic pyrites, realgar, lollingite, and orpiment. Geothermal water can also be a source of iAs in surface and ground waters. Welch *et al.* (1988) identified 14 areas in the western U.S. where dissolved iAs concentrations ranged from 80 to 15,000 μg/L.

Anthropogenic sources of arsenic include wood preservatives, agricultural and industrial uses, mining and smelting. Their impact on arsenic levels in water depends on the level of human activity, distance from the pollution sources, and dispersion and fate of the released arsenic. About 90% of the U.S. annual industrial arsenic use is for production of chromated copper arsenate (Reese, 1998; 1999), a wood preservative used to pressure-treat wood for construction of decks, fences or other outdoor applications. Agricultural uses included pesticides, herbicides, insecticides, defoliants, and soil sterilants. Inorganic arsenic pesticides are no longer used; the last agricultural application was canceled in 1993 (58 FR 64579). It is presently only used in sealed ant bait and wood preservatives. Organic arsenicals are still a constituent of some currently used pesticides. The most widely used is monosodium methanearsonate (MSMA), applied to cotton to control broadleaf weeds (Jordan, et al., 1997), Small amounts of disodium methanearsenate (DSMA) are also applied to cotton fields as herbicides. Other organic arsenicals (e.g., roxarsone and arsanilic acid) have been used as feed additives for poultry and swine to increase rate of weight gain, optimize feed efficiencies, improved pigmentation, and disease treatment and prevention. These additives undergo little or no degradation before excretion (NAS, 1977).

Adverse Health Effects

Arsenicals exist in several forms which vary in toxicity and occurrence, so it is important to consider those forms that can exert toxic effects and are found in drinking water and/or food. For example, the metallic form of arsenic (0 valence) is not absorbed from the stomach and intestines and does not appear to exert adverse effects. On the other hand, arsine (AsH_3) is toxic, but not present in water or food.. Arsenobetaine and arsenocholine, the primary organic forms found in fish and shellfish, appear to have little or no toxicity (Sabbioni et al., 1991). Accordingly, EPA will focus on the toxic forms of iAs [arsenite (+3) and arsenate (+5)] found in drinking water (NRC, 1999).

Inorganic arsenic can exert toxic effects after acute (short-term) or chronic(long-term) exposure. From human poisoning incidents, the LD_{50} of iAs has been estimated to range from 1 to 4 mg/kg (Vallee et al., 1960, Winship, 1984). At nonlethal, but high doses, iAs can cause gastroenterological (GI) effects, shock, neuritis and vascular effects in humans (Buchanan, 1962). These incidents usually occur after accidental exposures. Although acute or short-term exposures to high doses of iAs can cause adverse effects, such exposures do not typically occur in the US. EPA's primary concerns are the long-term, chronic effects of exposure to low concentrations of iAs in drinking water.

Cancer— The first reports that drinking water containing iAs was associated with cancer came from southwest Taiwan (Tseng et al., 1968; Tseng, 1977). The villages were divided into three groups based on exposure to iAs (0 to 0.29, 0.30 to 0.59 and $\geq$0.60 mg of iAs/Liter). A dose- and age-related increase in skin cancer was found. Limitations included those caused by the grouping of villages into wide exposure groups and the lack of experimental detail. These studies and corroborating ones by Albores et al. (1979) and Cebrian et al. (1983) and exposures to iAs in medicines (Cusick et al. 1982) and in pesticides (Roth, 1956; Luchtrath, 1972) were the basis for EPA's classification of iAs as a known human carcinogen (Group A) for skin cancer by the oral route (US EPA, 1988).

Exposure to iAs in drinking water has also been associated with the development of internal cancers. Chen et al. (1985) used standard mortality ratios (SMRs - a ratio of observed to expected deaths in a population caused by an agent) to examine the increase in cancers in Taiwan. They observed an increased mortality for bladder, kidney, lung, liver and colon cancers. A subsequent report from Taiwan gave similar results (Wu et al., 1989). Corroborating studies have come from South America. In Argentina, SMRs were calculated and significant increases in bladder, lung and kidney cancers were reported (Hopenhayn-Rich et al., 1996; 1998). In a population of approximately 400,000 in northern Chile, Smith et al. (1998) found increases in bladder and lung cancers. The reports from Argentina and Chile confirm the earlier Taiwan studies on the association between exposure to iAs in drinking water and the development of internal cancers.

There have only been a few studies of iAs exposure via drinking water in the U.S. and most have not considered cancer as an endpoint. Recently, Lewis et al. (1999) used SMRs to examine a cohort of 4,058 people from Utah. They reported an increase in prostate cancer in males, but no significant association between iAs exposure and bladder cancer. However, Utah has a low incidence of bladder cancer and also a low population of smokers and smoking is a well-known risk factor for bladder cancer.

Noncancer— Many noncarcinogenic effects have been reported in humans after exposure to drinking water highly contaminated with iAs. The most commonly observed signs of iAs exposure are in the skin. They include alterations in pigmentation and palmar-planter keratoses which are localized primarily on the hands, the soles of the feet and the torso. The presence of hyperpigmentation and keratoses on parts of the body not exposed to the sun is characteristic of iAs exposure (Yeh, 1973, Tseng, 1977). The same alterations have been reported in patients treated with Fowler's solution (1% potassium arsenite; Cusick et al., 1982).

Chronic exposure to iAs is often associated with alterations in GI function. For example, noncirrhotic hypertension is a relatively specific manifestation of iAs exposure. This is not commonly found in iAs-exposed individuals and may not become a clinical observation until the patient presents with GI bleeding (Morris et al., 1974; Nevens et al., 1990). Physical examination may reveal spleen and liver enlargement and histopathological examination of tissue specimens may demonstrate periportal fibrosis (Nevens et al., 1990; Ghua Mazumder et al., 1997). There have been a few reports of cirrhosis after iAs exposure, but alcohol consumption is a confounding factor (NRC, 1999).

Development of peripheral vascular changes after iAs exposure has been reported In Taiwan, blackfoot disease (BFD) has been the most severe manifestation of this effect. BFD is an extreme peripheral vascular insufficiency which may result in gangrene of the feet and other extremities. Less severe cases, e.g., Raynaud's Disease, have been described in Chile (Zaldivar et al., 1974) and Mexico (Cebrian, 1987). In the U.S., increased SMRs for hypertensive heart disease were noted in both males and females from Utah after exposure to iAs-contaminated drinking water (Lewis et al., 1999). These reports indicate that iAs affects the cardiovascular system.

Although peripheral neuropathy may be present after exposure to short-term high doses of iAs (Buchanan, 1962), there are no studies that definitely document this effect after exposure to low levels of iAs in drinking water. Hindmarsh et al. (1977) and Southwick et al. (1983) have reported limited evidence of this effect in Canada and the US, respectively, but it was not reported in studies from Taiwan, Argentina or Chile (Hotta, 1989).

There have been a few, scattered reports in the literature that iAs can affect reproduction and development in humans (Borzysonyi et al., 1992; Desi et al., 1992; Tabacova et al., 1994) After reviewing the available literature, the National Research Council panel (NRC, 1999) wrote that "nothing conclusive can be stated from these studies." Based on the studies reviewed above, it is evident that iAs contamination of drinking water can cause dermal and internal cancers, affect the GI system and alter cardiovascular function.

The National Academy of Sciences (NAS) Report

Due to controversy surrounding the risk assessment of iAs, EPA asked the NRC arm of the NAS to: 1) review the EPA's characterization of potential human health risks from ingestion of iAs in drinking water; 2) review the available data on the carcinogenic and noncarcinogenic effects of iAs; 3) review the data on the metabolism, kinetics and mechanism(s)/mode(s) of action of iAs; and 4) identify research needs to fill data gaps. To accomplish this task, NRC convened a panel of scientific experts, several of whom had conducted research on iAs (NRC, 1999).

Human Health Effects—NRC concluded that there is sufficient evidence that chronic ingestion of iAs, at concentrations of ≥ 300 to 400 micrograms/liter (μg/L), causes bladder, lung and skin cancers. At somewhat higher doses, iAs causes adverse noncancer effects on the GI and cardiovascular systems. There are few data to address the possible association of these diseases at lower exposure levels At the present time, there is insufficient evidence to judge whether iAs can affect reproduction or development in humans. However, iAs can pass through the placenta (Concha et al., 1998) and more study is needed. In animal experiments, intraperitoneal administration of iAs can cause malformations and oral dosing has been reported to alter fetal growth and viability. It has not been found to be essential for human well-being or involved in any required biochemical pathway. NRC recommended additional studies to characterize the dose-response curve for iAs-induced cancer and noncancer health endpoints. They also stated that the reported beneficial effects of iAs in animals should be carefully monitored. In addition, the potential effects of iAs on human reproduction should be investigated.

Disposition —Data from humans show that iAs is readily absorbed and transported through the body. It has a half-life in the body of approximately 4 days and is primarily excreted in the urine. In humans, the arsenate form (+5 valence) is reduced to arsenite (+3). The arsenite is sequentially methylated to form monomethylarsonic acid (MMA) and dimethylarsinic acid (DMA). Methylation decreases acute toxicity and facilitates urinary excretion. Variations in methylation of iAs have been observed in different human populations. Such changes may be due to genetic differences, species and dose of iAs ingested, nutrition, disease and possibly other factors. Whether MMA and DMA play a role in the development of the cancer and noncancer endpoints is not presently known (NRC, 1999). NRC recommended that experiments be conducted on the factors affecting interspecies differences in iAs disposition including use of human tissue when available.

Mode(s) of Action —A number of possible modes of action have been proposed iAs-induced cancers. Although the key events in the cancer process caused by iAs are not known, there are sufficient data to support the conclusions of NRC (1999) and the statement of EPA's Arsenic Expert Panel Report (ERG, 1997) that: "Arsenic exposure induces chromosomal abnormalities without direct reaction with DNA" (ERG, 1997). There is strong evidence against a mode of action for iAs involving direct reaction with DNA. For example, one of the hallmarks of direct reactivity is multi-species carcinogenic activity. For iAs, long-term bioassays in mice, rats, dogs and monkeys are uniformly negative (Furst, 1983). The kinds of genetic alterations seen in both *in vivo* and *in vitro* studies of iAs are at the level of loss and rearrangement of chromosomes which are the result of errors in either DNA repair or in chromosome replication. The NRC (1999) and the EPA panels (ERG, 1997) looked at several possible modes of action. These included changes in DNA methylation patterns that could affect gene expression and/or repair, oxidative stress, potentiation of effects of mutations by other agents, cell proliferative effects and interference with normal DNA repair processes. Both reports further examination of the dose-response shapes associated with these effects concluded that they involve processes that have either thresholds of dose at which there would be no response or sublinearity of the dose-response relationship (response decreasing disproportionally with dose).

The NRC report (1999) concluded "For arsenic carcinogenicity, the mode of action has not been established, but the several modes of action that are considered plausible (namely, indirect mechanisms of mutagenicity) would lead to a sublinear dose-response curve at some point below the point at which a significant increase in tumors is observed ... However, because a specific mode (or modes) of action has not yet been identified, it is prudent not to rule out the possibility of a linear response." On this last point, they cite the EPA 1996 proposed revisions to the Guidelines for Carcinogen Risk Assessment. That proposal contains an example of a case similar to iAs. While not ruling out linearity, recommends using a linear dose only for screening purposes recognizing that the linear approach would probably overestimate risk at low, environmental exposures

For noncancer effects, inhibition of cellular respiration in mitochondria by iAs may be the focal point of its toxicity. In addition, iAs causes oxidative stress and this could play a role in the development of adverse health effects. NRC (1999) recommended that biomarkers of iAs exposure and cancer appearance be thoroughly studied as such data might better characterize the dose-response effects of iAs at lower exposure levels. For noncancer effects, a greater understanding of iAs's effects of cellular respiration and subsequent effects of methylation and oxidative stress are needed (NRC, 1999).

Risk Characterization—There is a large data base on the effects of iAs on humans. Oral or inhalation exposure to iAs can induce many adverse health effects. Specifically, exposure to iAs in drinking water has been reported to cause many different human illnesses, including cancer and noncancer effects At the request of EPA, NRC (1999) reviewed the iAs health effects data base. They concluded that the studies on bladder cancer from Taiwan provided the current best available data for the risk assessment of iAs-induced cancer. Corroborating studies come from Argentina and Chile. NRC modeled the data using a Poisson regression model and found a 1% response level of male bladder cancer at approximately 400 μg of iAs/L. The 1% level was used as a Point of Departure (POD). A linear extrapolation from the POD to zero gives a risk of 1 to 1.5 per 1,000 at the current MCL of 50 μg/L. Since some studies show that lung cancer deaths may be 2 to 5-fold higher that the bladder cancer deaths, the combined cancer risk could be even greater. The NRC panel also noted that the MCL of 50 μg/L is less than 10-fold lower than the 1% response level for male bladder cancer. Based on its review, the consensus opinion of the NRC panel was that the current MCL of 50 μg/L does not meet the EPA's goal of public-health protection. They recommended a downward revision as soon as possible.

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CHEMICAL UPDATES: PCBS

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EPA's current cancer assessment concludes that all PCB mixtures can pose a cancer risk, although different mixtures have different potencies. Supporting this conclusion is the recent bioassay of Aroclors 1016, 1242, 1254, and 1260, each of which caused significant increases in liver cancer in rats. These mixtures contain overlapping groups of congeners that, together, span the range of congeners most often found in environmental mixtures. This study strengthens the case that all PCB mixtures can cause cancer. To distinguish the cancer potential of different environmental mixtures, EPA's assessment considers the environmental processes that alter PCB mixtures: partitioning into different environmental media, potential chemical transformation in sediments, and bioaccumulation selectively through the food chain. These processes can either increase or decrease the potency of a PCB mixture. Bioaccumulated mixtures found through the food chain pose the greatest concern.

EPA provides a three-tier approach that considers how environmental processes affect different exposure scenarios:

1. **Highest risk and persistence** (upper-bound slope, 2 per mg/kg-d). Used for pathways where environmental processes tend to increase risk: food chain exposure, sediment or soil ingestion, dust or aerosol inhalation, and early-life exposure (all pathways and mixtures).

2. **Lower risk and persistence** (upper-bound slope, 0.4 per mg/kg-d). Used for pathways where environmental processes tend to decrease risk: ingestion of water-soluble congeners, inhalation of evaporated congeners, and dermal exposure (if no absorption factor has been applied to estimate an internal dose; otherwise, the highest slope is used with an internal dose estimate).

3. **Lowest risk and persistence** (upper-bound slope, 0.07 per mg/kg-d). Used when congener or homologue analyses verify that congeners with more than four chlorines comprise less than one-half percent of total PCBs.

Since EPA's cancer assessment was published, two case-control studies have found associations between non-Hodgkin lymphoma and PCBs in adipose tissue or serum. These findings further support the concern for cancer. On the other hand, a 1999 mortality study of people employed in

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[5] **The information contained in this abstract does not represent EPA policy.**

a capacitor plant found no increase in overall cancer mortality, nor significant increases in mortality from six cancers associated with PCBs in other studies. The applicability of this mortality study, however, is limited by the inclusion of minimally exposed workers (the majority of the cohort had never worked with PCBs), the young cohort (average age was 57 at end of study), and few cancer deaths (for example, 29 cancer deaths among hourly workers who worked with PCBs for a year or more), leading to low statistical power. Consequently, the recent mortality study does not diminish the support for a cancer concern, nor does it indicate a need to update the cancer assessment.

PCBs also have significant adverse health effects other than cancer, including neurotoxicity, reproductive and developmental toxicity, immune system suppression, liver damage, skin irritation, and endocrine disruption. EPA addresses these effects through an RfD. For Aroclor 1016, an RfD of 0.07 μg/kg-d was based on reduced birthweight in monkeys. For Aroclor 1254, an RfD of 0.02 μg/kg-d was based on decreased antibody responses and other effects in monkeys.

Since these RfDs were developed, there has been mounting scientific evidence of adverse neurodevelopmental effects from PCBs. Two series of studies (from Lake Michigan and Lake Ontario) have found associations between neurobehavioral effects in children and their mothers' consumption of PCB-contaminated fish. Another series of studies from the Netherlands has found an association between decreases in cognitive functioning and dietary (mostly dairy) exposure to PCBs and dioxins. Effects were seen for maternal plasma PCB levels as low as 3 ppb, near current U.S. background levels. EPA is considering the new information and is updating its noncancer assessment of PCBs. A draft is expected in 2001.

With respect to analytical chemistry, to recognize how partitioning, transformation, and bioaccumulation alter PCB mixtures in the environment, EPA is shifting its focus away from characterizing environmental samples in terms of Aroclors. An interim approach is now focusing on estimating total PCBs. Some alternatives are summing Aroclor levels, summing homologue group levels, and summing congener levels. EPA's analytical chemists are developing a standard method for PCB analyses. In the future, congener or homologue analyses may become preferred for their ability to estimate the dioxin toxic equivalence of a mixture and to verify whether PCBs found in water or air are, as expected, of low chlorine content and persistence.

Finally, some new information about the variable composition of Aroclor 1254 has come to light. A different approach to manufacturing Aroclor 1254 was introduced in the 1970s. This approach yielded a “heavy” Aroclor 1254 with higher concentrations of some congeners of medium-to-high chlorine content. The dioxin toxic equivalence of this mixture was increased five-fold. About 20 percent of the Aroclor 1254 made during this period was of the “heavy” variety. We do not have toxicity testing of this “heavy 1254.” It would have been tested in the recent cancer bioassay of Aroclors 1016, 1242, 1254, and 1260, but prior to the study, the polychlorinated dibenzofurans were removed before the mixture was fed to the rats.

CHEMICAL UPDATES: MERCURY

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This presentation was designed to address EPA's research strategy for mercury, give an update on more recent government levels for mercury, summarize some of the newer studies on the health effects of mercury, and outline EPA's schedule for mercury issues in the next year. EPA has been active in evaluations on mercury, including a report to Congress, and all are available through EPA and one of their websites. Over the next year and a half, EPA will make determinations on regulations of mercury emissions from electrical power utilities, mercury in water, and further activities under various international agreements.

Research Strategies

Jon Herrmann and Kathryn Mahaffey have been heading development of a research strategy for EPA. Jon Herrmann has been investigating risk management issues, particularly the use of engineering controls to reduce the release of mercury from combustion. Kathryn Mahaffey has been researching the human health effects of mercury and methods of risk communication. The draft research will be available through EPA's National Center for Environmental Assessment website.

The purpose of the research strategy is to provide EPA with scientific information in order to support the various regulatory decisions that are made for wildlife and people. Of great concern is the environmental transport and fate of mercury once released from combustion and non-combustion sources. The research strategy will identify the remaining questions and the research gaps. The EPA draft report will examine the range of exposure that occurs to humans and wildlife
and how to manage the risk of mercury released into the environment.

Particular attention in the draft report has been given to the use of engineering controls. Reports from Europe recently showed that decreases in mercury concentrations were due to engineering controls. This is encouraging news that supports the long-range efforts to lower mercury levels in fish. In response, EPA has designated the largest portion of monetary support to be directed towards the development of engineering controls and to people who are concerned with both the health and availability of fish in the food supply.

Recent Government Levels

Adult-based reference levels have been around since the 1970s and were updated in 1990 by WHO. Their primary endpoint is to reduce the prevalence of paresthesia in adults. However, these numbers do not serve their purpose and there is a lot of indication that the fetus is substantially more sensitive than adults to methylmercury. As a result, there have been recent updates for fetal protective numbers.

In 1990, WHO expressed that maternal hair mercury in the range of 10 to 20 ppm was associated with the risk of some developmental deficits in the fetus. EPA's RfD of 0.1 μg/kg body weight/day is based on a benchmark dose of about 11 ppm mercury in maternal hair, which is within WHO's range. In 1998, in order to protect the fetus, Health Canada issued a provisional tolerable intake for mercury of 0.2 μg/kg body weight/day. A report from Germany recommends that women with a blood level above 5 µg/L of organic mercury limit their consumption of fish to protect the fetus. They are also looking for other sources of organic mercury that may be potential exposures, such as peculiar medicinal products. The recommended blood level translates to approximately 0.15 μg/kg body weight/day. ATSDR released a report indicating that an intake of 0.3 μg/kg body weight/day was an acceptable or tolerable level of mercury intake.

The differences between intake levels may seem insignificant, but when translated into maternal hair mercury levels, it is significantly different from the 10-to-20 ppm range proposed by WHO. For example, the EPA reference dose corresponds to a maternal hair mercury level of around 1 ppm. This level is not thought to be associated with risk, but considered to be a safe level. As the RfD increases above 0.1 μg/kg body weight/day, the magnitude of risk increases.

Newer Studies on Health Effects

A group in French Guiana, at the French equivalent of the National Institutes of Health, released a report where the range of exposure in maternal hair was from about 0.4 to 25 ppm. This is roughly the same range that was found in both the Faroe Islands and the Seychelles studies. The mean levels of mercury were about the same as the Faroes and the Seychelles and about a third of the samples had hair mercury levels above 10. In the French Guiana study, deficits in performance on neuropsychological tests were found. Unfortunately, the level at which the deficits begin to occur are not clearly described.

New Zealand considers elevated mercury levels to occur when hair mercury levels rise above 6 ppm. Studies from this country showed decrements in performance on tests of intellectual function when hair mercury levels were 6 ppm or higher.

Recent work has been conducted on visual and auditory evoked potentials, measurements of electrical currents which are generated when neurons function. Two studies, one on a fish-eating population in the Madeira Islands and another evaluation in the Faroe Islands, found delays in the transmission of auditory and visual evoked potentials associated with increasing levels of mercury. These decrements are also apparent when maternal hair mercury levels are 10 ppm and higher. This type of decrement has also been noted in milder cases of Minamata-type disease. A study out of Brazil, published in 1999, has shown decrements in motor function, attention and visiospatial performance based on various neuropsychological tests. It was also found that when hair mercury levels rose above 10 ppm, decrements increased.

As time progresses, more studies are coming forth to be considered in addition to the Faroes and Seychelles. Epidemiology assessments strengthen as similar effects are seen by various investigators in different populations.

Exposure levels in the U.S. are the highest among North American tribes and people of Asian and Pacific Island ancestry. Asian and Pacific Island groups are a growing concern because their diets are high in fish and they comprise approximately 4 percent of the national population. Other populations of concern are recreational anglers, subsistence fishers, and those who are following a diet regime which emphasizes the consumption of fish. A recent study in North Carolina found that hair samples from individuals living in a river population was over 90% organic mercury. This evidence shows that elevated hair mercury levels come from the consumption of fish, not just occupational exposure.

EPA's Schedule for Decisions Regarding Mercury Issues

Over the next year, EPA will have a number of activities going on with respect to mercury. The research strategy report will be released shortly and will be available on the website. Some regulatory determinations will be made. The analysis of how much mercury is coming from fish will be expanded, including the range and distribution. A committee has been formed out of the National Academy of Sciences to aid EPA in determining the level at which adverse effects of methylmercury occur. This committee is expected to issue a report to EPA in June 2000. The report from NAS will be used to reassess the reference dose for methylmercury. Finally, later in the year there will be a determination of whether utility emissions of mercury will be regulated.

CHEMICAL UPDATES: CHLORDANE

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Chlordane is an insecticide that works through the nervous system. It has frequently been used in the Corn Belt states and subsequently has contaminated reservoirs in these states. In this region, the Great Lakes protocol has been used to issue PCB fish advisories since 1997, but only for Lake Michigan. In order for IEPA to use the Great Lakes protocol to issue advisories for every water body in Illinois, it was necessary to develop a health protection value for chlordane. This presentation discusses the development of the proposed health protection value, 0.15 μg/kg/d. Illinois is already using the value to issue advisories and has proposed the value to the Great Lakes states to be adopted in the Great Lakes protocol.

Development of a Health Protection Value for Chlordane

Based on a literature review, candidate health protection values were calculated for several noncarcinogenic endpoints. A brief discussion of literature used to develop these values is presented below along with the candidate protection values. The revised EPA reference dose and the selection of the most appropriate health protection value are also discussed.

Effects on the Immune System

Based on available literature, studies of the effects of chlordane on the immune system are difficult to interpret and may be contradictory. Several studies dosed dams during pregnancy and identified no-effect levels for effects on the immune system in offspring of dosed dams. They found a decrease in response in the offspring of mice at 0.16 mg/kg dosed to the adult with no effects on the B cell immunity. A companion study, where offspring were dosed at 6 weeks, found an increase in cell-mediated immunity at 4 mg/kg with no effects on the B cells. At 4 mg/kg, another study found a lowest-effect level for decreases in granulocyte-macrophyte precursors and in spleen-forming and liver-forming stem cells in bone marrow of offspring, but no effects on mature cell numbers later on. Another study showed a significant decrease in the natural killer response in male offspring at 200 days but not 100 days post-dose. In contrast, females had a significant increase natural killer response at 100 days but not at 200 days. Another study found a NOAEL for decreased delayed-type hypersensitivity in offspring at 4 mg/kg. In order to establish a candidate health protection value, the NOAEL for decreased cell-mediated response at 0.16 was selected because of its sensitivity and serious effects. A candidate health protection value of 1.6 μg/kg/d was established based on immune effects.

Reproductive and Developmental Effects

Relatively little information exists on human studies and animal studies regarding reproductive and developmental effects of chlordane. Of the studies available, it was found that at 1 mg/kg/d, chlordane does not appear to be teratogenic. The lowest NOAEL for teratogenicity was 50 mg/kg/d. The LOAEL for decreased fertility and survival in rats was found to be 16 mg/kg/d. However this study had questionable effects on growth, eye opening, and other developmental markers since there was not a clear dose-response relationship. To develop the candidate health protection value, the LOAEL for defects in developmental markers was chosen, 1 mg/kg/d, and with uncertainty factors calculated in, a candidate health protection value of 1 μg/kg/d for reproductive and developmental effects was established.

Nervous System Effects

Contrary to the reproductive database, a relatively large database on nervous system effects was available for review. In one long-term bioassay, NOAELs for tremors in rats and mice were 6 and 3.9 mg/kg/d. Another long-term bioassay identified a NOAEL for gross central nervous system symptoms and microscopic lesions at 1.21 mg/kg/d; another study identified a LOAEL for decreases in brain ATPases in rats at 1.25 mg/kg/d. The NOAEL for the gross CNS symptoms and lesions in mice was used with uncertainty factors to get a candidate health protection value of 1.21 μg/kg/d for nervous system effects.

Endocrine System Effects

A few studies were reviewed addressing endocrine system effects. A LOAEL for an increase in prostate androgen receptors was 19.5 mg/kg; a LOAEL for increased plasma corticosterone was 0.16 mg/kg/d; a LOAEL for decreased size of seminiferous tubules and disturbed spermatogenesis in mice was 100 mg/kg/d. For the candidate health protection value, 0.16 mg/kg/d was utilized for a protection value of 0.16 μg/kg/d.

Old and New EPA Reference Doses and Liver Effects

The old reference dose of 0.06 μg/kg/d relied on a NOAEL for hypertrophy in rats at 0.055 mg/kg/d. This value was questioned as to whether it was an adaptive response. Therefore, the entire chlordane database was reviewed and the new reference dose used a lifetime study showing liver necrosis at 0.15 mg/kg/d; the new reference dose is 0.5 μg/kg/d. The NOAEL for liver necrosis at 0.15 mg/kg/d was used for the candidate health protection value which was 0.15 μg/kg/d, similar to the endocrine protection value.

Choosing the Most Appropriate Health Protection Value for Chlordane in Fish

It was decided that cancer was not going to be used as a specific endpoint in the development of the health protection value. Instead, a non-cancer endpoint was used to develop the actual critical value. This guidance would be accompanied with a blanket statement stating that if guidelines are followed, lifetime cancer risk would not be greater than 1 in 10,000. However, if the new reference dose is multiplied by the new cancer potency factor, the lifetime cancer risk is 1.75×10^{-4}, slightly greater than 1 in 10,000. Using a 1 in 10,000 cancer goal and the new potency factor, no more than one meal a week with dioxin concentrations in fish at 0.3 mg/kg is recommended.

Several issues were identified when the candidate values were reviewed and one value was to be chosen. There was uncertainty associated with selecting the most appropriate endpoint and whether the value would be protective of other endpoints. Another major issue was whether the liver is the most sensitive endpoint in humans; some evidence has shown that the nervous system may be the most sensitive target in humans.

It was decided that a proposed health protection value based on liver effects, 0.15 μg/kg/d, would be recommended to the Great Lakes task force. Using the same assumptions used for the PCB advisory, chlordane intake from fish consumption should be limited to no more than 10.5 μg/d. Using the assumptions of a 50% reduction from cleaning and cooking and a meal size of 0.5 lb per meal, consumption advisories are as follows: consumers in the no-restriction group are limited to total chlordane concentrations of 0.15 mg/kg in fish; no more than one meal a week at 0.16 mg/kg to 0.65 mg/kg; one meal per month at 0.66 mg/kg to 2.8 mg/kg; 6 meals per year, 2.8 mg/kg to 5.6 mg/kg. Using the proposed health protection value of 0.15 μg/kg/d and the new slope factor, the cancer risk for consumers should be no greater than 5.2 in 100,000; lifetime risk would not be greater than 1 in 10,000. This candidate health protection value will go to the Great Lakes task force, and if accepted, the value will be added to the current value for PCBs in the Great Lakes Protocol.

COMPARATIVE DIETARY RISK

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A. Fish Consumption Advisories

The States and the four United States territories and Native American tribes have primary responsibility for protecting their residents from health risks of consuming contaminated noncommercially caught fish and wildlife. This effort is undertaken by issuing consumption advisories for the general population, including recreational and subsistence fishers, as well as for sensitive subpopulations (such as pregnant women, nursing mothers, and children). These advisories inform the public that high concentrations of chemical contaminants such as methylmercury and PCBs have been found in certain species of fish from specific bodies of water and usually recommend limits on the number of fish meals which can safely be consumed within a specified time period. Fish consumption advisory programs have focused on assessing potential human health risks such as carcinogenic, developmental, reproductive, hepatic, neurological effects or other systemic effects from eating contaminated fish. This health risk-based approach for estimating safe fish consumption limits within a specified time period does not consider potential health benefits of fish consumption.

Human health effects associated with specific contaminants found in fish tissue have been extensively reported in the literature (e.g., EPA Integrated Risk Information System [IRIS], Fish Consumption Advisories, USFDA Action Levels, ATSDR Tox Profiles, etc.) and will not be addressed in this presentation. Thus, the main focus of this presentation will be on: (1) exploring some of the available tools for developing a comparative dietary risk for comparing potential heath risks of consuming contaminated fish while considering potential health benefits by not eating fish and (2) identifying specific needs for developing a framework for risk tradeoff analyses.

B. Fish Consumption, Risks, and Benefits

There have been several studies reporting that, while fish advisories are generally based solely on considerations of potential adverse health effects (carcinogenic, developmental, reproductive, hepatic, neurological effects or other systemic effects) caused by contaminants (e.g., chlordane, DDT, PCBs, methylmercury) encountered in fish flesh, fish is an excellent source of low-fat protein and may provide important nutritional and health benefits. Also, some recent reports have suggested that health benefits of eating even contaminated fish may outweigh the potential risks caused by the presence of contaminants e.g., Anderson and Weiner, 1995).

In 1988, the California Department of Health Services conducted a workshop called “Balancing the Scales: Weighing the Benefits and Risks of Fish Consumption.” Workshop participants addressed the nutritional composition of fish, cardiovascular effects from omega-3 (n-3) polyunsaturated fatty acids (docosahexaenoic or DHA and eicosapentaenoic or EPA acids) and benefits of fish oil consumption, along with potential contaminant exposures and associated health risks. Since the initial findings reported at the workshop, there are additional scientific data on potential health benefits of consuming fish. Putting risks into perspective is even more important when fish are part of a traditional subsistence diet, which is important to a population's cultural identity.

This Forum on Contaminants in Fish has addressed beneficial aspects of fish consumption during past meetings and has identified benefits from fish as one of its top issues needing research and guidance.

1. Potential Nutritional Benefits

There are some nutritional benefits associated with eating fish. Unlike dairy products, beef, and eggs, fish provides a low-fat source of protein and a “heart healthy” combination of unsaturated fatty acids. Furthermore, fish is a rich source of omega-3 fatty acids, a class of fatty acids that are essential for the development of the nervous system and that may have other beneficial health effects such as suppressing cardiovascular heart disease risk factors. Fish supplies a number of minerals and vitamins that tend to be low in the United States diet, including calcium, iron, selenium, zinc, vitamins A, B3, B6, B12, and D.

2. Potential Health Benefits

There is some evidence for an association between decreased risk of coronary heart disease or myocardial infarction and consumption of fish. Several studies have demonstrated a decrease in cardiovascular heart disease risk factors in genetically predisposed individuals when diets are high in fish oils. Conversely, there are a number of other studies which failed in finding a relationship between fish intake and cardiovascular heart disease, including myocardial infarction. Moreover, the studies that do show a decrease in cardiovascular heart disease with increasing fish consumption are not able to discern whether that effect derives from omega-3 fatty acids or indirectly because diets rich in fish have lower levels of fat, saturated fatty acids, and cholesterol. Thus, the relationship between fish intake and cardiovascular disease remains a matter of controversy and conjecture. In addition, there are some controversial research data suggesting that eating fish may be associated with reduced incidences or severity of a number of other endpoints (lung damage from smoking, rheumatoid arthritis, smoking-related chronic obstructive pulmonary disease, childhood asthma, plaque psoriasis, colon cancer, and gastrointestinal disease).

3. Socio-Cultural Considerations of Fish Consumption

It is well known that food, and fish in particular, may also be an important part of a culture, serving economic, social, and religious functions. Specific foods are often seen as having special nutritional or medicinal qualities, and methods of food preparation is frequently part of a person's cultural identity. These cultural factors are extremely important and should be carefully considered in evaluating risks and benefits from consumption of contaminated fish for some target fish-dependent communities.

C. Risk Tradeoff Analysis

To fully evaluate the risks and benefits of fish consumption, risk assessors and risk managers should carefully weigh target risks (adverse health effects from consuming contaminated fish) as well as the countervailing risks (consequences of reducing fish consumption and the nutritional or health benefits of the substituted foods). Graham and Wiener (1995) explored the issues of target and countervailing risks in ***"Risk vs. Risk: Tradeoffs in Protecting Health and the Environment."*** For example, if a fish consumption advisory recommends reducing consumption of fish contaminated with a particular chemical, and: (1) The fish in the diet is replaced with fruits and vegetables, the individual may trade a decreased cancer risk from contaminants in fish (target risk) for an increased cancer risk from increased ingestion of toxic pesticides (countervailing risk); (2)The fish in the diet is replaced with beef, the individual may be trading a decreased risk of mortality from cancer (target risk) for an increased risk of mortality from heart disease (countervailing risk), due to an increased consumption of saturated fatty acids; and (3) The consumption of local fish high in PCBs is replaced with an increased consumption of canned tuna with high methylmercury, the individual may be trading increased risk of developmental toxicity and cancer from PCBs (target risk), for an increased risk of neurological disease from methyl mercury (countervailing risk). Furthermore, countervailing risks can go beyond the health implications of food substitutions and include social, economic, religious and cultural impacts (Wheatley and Paradis, 1996).

D. TERA Comparative Risk Framework

Research results of a cooperative agreement between the EPA and Toxicological Excellence for Risk Assessment (TERA) *"Comparative Dietary Risks: Balancing the Risks and Benefits of Fish Consumption*" was published in August 1999. Copies of this report could be obtained by contacting TERA at 1757 Chase Avenue, Cincinnati, OH 45223; (513)542-TERA; or www.tera.org. This TERA effort builds upon previous work from a series of documents developed by the EPA on *"Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories."* The four-volume set includes Volume 1-Fish Sampling and Analysis, Volume 2-Risk Assessment and Fish Consumption Limits, Volume 3-Overview of Risk Management, and Volume 4-Risk Communication. A multidisciplinary team of experts from academia, industry, State and Federal government served as authors of the TERA framework and made an excellent attempt in searching for innovative models to evaluate risks and benefits (both qualitatively and quantitatively) on a common scale. The result of using this framework is the fish consumption index (FCI), which is a crude quantitative representation of the net risk (or benefit) associated with eating contaminated fish. It provides a mechanism by which users can weigh the possible health risks versus the possible health benefits of eating contaminated fish and obtain a sense of whether they have a net risk or benefit.

Specifically, FCI, which is an estimate of relative, but not of absolute, risk, is derived by combining the total benefit and the total risk for each consumption rate: $Benefit_i + Risk_i = FCI$. Total benefit is calculated by summing the benefits associated with each individual health endpoint. The possible benefit is a function of the background incidence of that health endpoint in the United States population, the relative reduction in risk of that end point caused by eating fish, the biological severity (0 to 3, ranging from none to maximum) of that health endpoint, and the amount of fish eaten. Total risk is derived by summing the risks associated with each individual chemical (or for each endpoint by a single chemical). The possible risk is a function of the increased risk of that health end point above the background incidence associated with a particular fish consumption rate and the severity score (0 to 3, ranging from no-observed-adverse-effect level to frank effects level) of that health endpoint. The current version of the framework does not attempt to quantify socio-cultural benefits.

It is noteworthy that this report has done an outstanding job in summarizing key elements of the risk communication process as applied to the comparative dietary risk framework, emphasizing that risk communication is a process of information exchange between the target audience and the risk communicator.

The TERA framework has identified numerous areas that need further research and development. The two paramount needs are: First, better estimations of benefits are needed for the general population and its sensitive subgroups. Second, better risk information is needed on the chemicals that commonly contaminate fish. According to the authors, “These gaps are sufficiently large so as to prevent any definitive conclusions from this study or any overall recommendations regarding existing fish consumption advisory programs of the U.S. or other countries.”

E. A Framework for Risk Tradeoff Analysis

As noted in the TERA framework, further studies are needed to confirm and extend the preliminary findings. Some major needs for a comparative dietary risk analysis associated with fish consumption are listed below:

1. Potential Health Risks

- Latest findings associated with health risks (carcinogenic, developmental, reproductive, hepatic, neurological effects, or other systemic effects) of consuming contaminated fish

- Concordance of health effects, both noncarcinogenic and carcinogenic, between laboratory animals and humans
- Methods (dose additivity, response additivity, etc) to assess potential health risks from exposures to chemical mixtures in contaminated fish and evaluate multiple endpoints
- Methods for estimating noncarcinogenic risk above RfD
- Application of risk characterization principles by insuring clarity in hazard dose-response and exposure characterizations and transparency in risk conclusions and comparisons in order to facilitate informed risk management decisions

2. Potential Health Benefits

- Health benefits of consuming marketplace *vs* freshwater sport fish to address some of the controversy surrounding cardiovascular effects of fish
- Benefits of fish consumption to pregnant women, infants and young children, as well as health impacts of larger consumption rates
- Comparison of nutritional and contaminant contents of the diet with and without the contaminated fish
- Role of changes in fishing-related behaviors such as fishing location, species and amount eaten, and fish-cleaning methods

3. Socio-Cultural Impacts

- A scale to measure socio-economic impacts to directly compare with those used to measure health risks and benefits.
- Quantitative information on specific fish consumption behaviors of population groups to combine socio-cultural data with biological data in developing risk assessments and consequent risk management
- Environmental justice issues associated with risk of contamination faced by fish-dependent communities

4. Modeling Risk Tradeoffs

- Severity schemes to compare health risks and benefits of fish consumption
- Consideration and quantification of uncertainty surrounding estimates of potential risks and benefits
- Sensitivity analysis for risks/benefits input variables

F. Next Steps

In 2000, the EPA will conduct an internal and external peer review of the TERA Report, as per the Agency's peer review policy, to confirm and extend these preliminary findings. Also, the Agency will develop a specific research plan to address the data gaps identified during the peer review process.

NOTE:

The views expressed in this presentation are those of the author and do not necessarily reflect the views and policies of the U. S. Environmental Protection Agency.

3. State Fish Monitoring and Assessment Programs

INTRODUCTION

In March 1999, EPA's Office of Water and the State of Nebraska jointly developed a questionnaire to obtain information about State programs for monitoring and assessing chemical contaminants in fish. The questionnaire (see Appendix B) contained 98 questions divided into nine main subject areas:

- Fish Tissue Monitoring Program
- Types of Fish Advisories
- Sample and Analyses Procedures
- State Advisory Program Funding
- Other Uses of State Advisory Data
- Risk Assessment Methodology
- Targeting Fish Consumers
- Risk Management
- Risk Communication Procedures

In preparation for 1999 National Forum of Chemical Contaminants in Fish, the members of the AFS Conference Steering Committee requested from EPA the results of EPA's survey of state fish consumption advisory programs to use as the basis for developing the conference materials as well as the basis for the information and analysis included in this proceedings document. State responses to the survey questions were compiled (Appendix C) and used to create a set of U.S. maps that graphically illustrate state responses to key questions (Appendix D) and a fact sheet for each state describing its fish contaminant advisory program (Appendix E). All states were provided an opportunity to review and approve their respective fact sheets. Approval from all 50 states was obtained by May 2000.

This information formed the basis for conference discussions on the need for national consistency among states and the extent to which state programs are consistent with EPA, Office of Water guidance for assessing chemical contaminant data for use in fish advisories (See Section 4.0 of this document).

This section of these proceedings provides a summary of the questionnaire responses obtained from state contacts. Each question is presented followed by a brief summary of the state responses.

NATIONAL SUMMARY

All figures cited in this section are located in Appendix D.

1. Does your state or tribal agency conduct routine monitoring to obtain information about the concentrations of chemical contaminants in fish tissue for assessing human health risks?

Thirty-five states conduct routine monitoring to obtain information about the concentrations of chemical contaminants in fish tissue (Figure D-1). Twelve of the 15 states that do not conduct routine monitoring instead conduct one-time, nonrecurring, or special surveys in particular fishing areas, watersheds, or basins to obtain information for assessing human health risks.

2. What kind of data does your state or tribal agency collect to evaluate chemical contaminant levels in fish? (Please check all that apply.)

All states except New Jersey and Utah responded that they captured fish and sent tissues to a lab to determine contaminant concentrations. Several states also use other types of data to estimate contaminant levels in fish. Missouri and Idaho estimate contaminant concentrations in fish from monitored water quality. Missouri, Montana and Arizona, estimate contaminant concentrations in fish from monitored sediments. Four states responded that they also used other methods to evaluate chemical contaminant levels in fish. Connecticut uses the results of water and sediment sampling to determine if fish should be sampled; Missouri monitors benthic invertebrates; Maryland targets fish for sampling if other studies or agencies have discovered substances which have the potential to bioaccumulate in fish, and Arizona conducts avian tissue sampling. New Jersey did not respond to this question. Utah indicated the question was not applicable.

3. How does your state or tribe conduct monitoring of contaminants in fish tissue for fish advisories? (Please check all that your agency uses.)

Forty states conduct one-time, nonrecurring or special surveys in particular fishing areas, watersheds, or basins (Figure D-2). Twenty-nine states monitor the same fishing areas, watersheds, or basins, at regular intervals. Fifteen states indicated they used other methods besides these two options. Five states, Georgia, Kentucky, North Carolina, Oklahoma, and South Carolina, exclusively conduct regular monitoring of fish tissue contaminants for their fish advisory programs. New Jersey did not respond to this question. Utah indicated the question was not applicable.

4. Please estimate the number of stations from which your state or tribal agency collected fish tissue that was analyzed for contaminants and was used for the fish advisory program in 1998.

Responses to this question were quite variable (Figure D-3). Three states, Alaska, Idaho, and Utah indicated that no collections of fish tissue were analyzed for contaminants in 1998. Thirteen states analyzed fish tissue for chemical contaminants at 1-10 stations, five states at 11–20 stations, seven states at 21–30 stations, eight states 31–50 stations, seven states at 51–100 stations, and six states at greater than 100 stations. The six states that analyzed fish from more than 100 stations during 1998 were Louisiana, Minnesota, North Carolina, Ohio, South Carolina, and Wisconsin. New Jersey did not respond to this question.

5. How frequently does your state resample fish from waterbodies where advisories are in effect?

Sixteen states responded that fish were resampled annually from waterbodies with current advisories (Figure D-4). The majority of states, 35, indicated that they resampled fish less frequently than annually. Approximately half of these states reported that they sampled at least once every five years, while the other states commented that the sampling frequency depended on funding, the specific waterbody being sampled, or that it followed no set schedule. New Jersey did not respond to this question. Alaska, Utah, and Wyoming responded that the question was not applicable.

6. In approximately how many waterbodies is fish tissue monitoring conducted within your state each year?

Fish tissue monitoring is reported as conducted in 1–10 waterbodies in 16 states, 11–20 waterbodies in 10 states, 21–30 waterbodies in 5 states, 31–40 waterbodies in six states, and >40 waterbodies in 10 states. Three states, South Carolina, Wisconsin, and Minnesota, responded that they monitor between 60–100 waterbodies. New Jersey did not respond to this question. Idaho and Utah responded that the question was not applicable.

7. Please check how your state determines which sites to monitor (select all answers that apply).

Most states use several different criteria to select sites for fish tissue monitoring. Thirty-nine states responded that they use the pollution potential of an area as a criterion, 25 states use fixed-station sites, 22 use the degree of angling pressure the site receives as a criterion, and 18 states use randomly selected sites. Fourteen states employ other methods, such as the accessibility of the site, public concern and requests, the presence of other scientific studies being conducted at the site, and where existing fish advisories are located. New Jersey did not respond to this question. Utah responded that the question was not applicable.

8. How many river, stream, or canal miles were assessed at least once during the last 3 years specifically for the fish advisory program?

This question was difficult for the states to answer. Four states indicated that the number of miles their state had assessed was unknown and 14 states did not respond or said the question did not apply, either because they did not monitor or did not know the number of river miles assessed. Of the states that did provide a response, 10 assessed 1 to 100 miles, 8 states assessed 101 to 500 miles, one state assessed between 500 and 1,000 miles, and seven states assessed more than 1,000 miles. The seven states which assessed more than 1,000 miles of state waters were Iowa, Illinois, Maryland, Minnesota, Missouri, Mississippi, and Nebraska.

9. How many lake or reservoir acres were assessed at least once during the past 3 years specifically for the fish advisory program?

This question was difficult for the states to answer. Three states responded that the number of lake acres assessed was unknown. Fourteen states did not respond or indicated that question was not applicable because they either did not have monitoring programs or did not know how many acres had been assessed. Of the states that did provide a response, 4 states assessed 0 lake acres, 15 states assessed between 1 and 100,000 lake acres, and five states assessed between 100,000 and 1,000,000 lake acres. Four states assessed over 1,000,000 lake acres: Illinois assessed 1,012,000 acres, Florida assessed more than 2,000,000 acres, New York assessed 2,400,000 acres, and Michigan assessed 24,500,000 acres.

10. How many square miles of estuarine waters were assessed at least once during the past 3 years specifically for the fish advisory program?

This question was not applicable to the states which do not contain estuarine waters. Six states reported that they assessed from 1 to 500 square miles of estuarine waters, two states, Connecticut and Delaware, assessed between 500 and 1,000 square miles and two states, California and Maryland, assessed over 1,000 square miles of estuarine waters. Six states did not provide a response to this question.

11. How many miles of marine coastline (coastal waters) were assessed at least once during the past three years specifically for the fish advisory program?

This question was not applicable to the 27 states that do not have a marine coastline. Twenty-three states responded to this question. Seven states responded that they assessed 0 miles of marine coastline; three states reported that they had assessed less than 100 miles of marine coastline. The responses by Connecticut and New York indicated that they assess the largest amount of coastal waters, 380 and 600 miles, respectively. Seven states did not respond to this question. Thirty states responded that the question did not apply because they do not have coastlines and/or do not have fish tissue monitoring programs.

Types of Fish Advisories

12. Does your state issue fish consumption advisories advising individuals to restrict fish consumption?

Forty-seven states responded that they issue advisories warning individuals to limit fish consumption (Figure D-5). Arizona, Hawaii, and South Dakota responded that they do not issue fish consumption advisories advising individuals to restrict fish consumption.

13. Does your state issue fish consumption advisories advising individuals not to consume any fish or any fish of a particular species from a particular waterbody?

Forty-four states responded that they do issue fish consumption advisories that advise individuals not to consume any fish from particular waterbodies (Figure D-6). The states that responded that they do not issue this type of advisory are Idaho, Montana, Nebraska, Oklahoma, South Dakota, and Washington.

14. Fish consumption advisories issued in your state pertain to (check all that apply):

Thirty-eight states responded that they issue advisories for specific fish species; 30 states issue advisories for the entire fish community; 28 states issue advisories for specific size class(es) for the given species analyzed, and 12 states issue advisories for selected trophic groups. Five states responded that they issue advisories for other groups, such as separate mercury advisories for cold-water and warm-water fish (Maine), advisories that use length-contaminant relationships (New York), and advisories that differ depending on the contaminant (Alabama).

15. Does your state issue statewide or region-wide "blanket" advisories based on your sampling effort?

Most states do not issue statewide or region-wide fish consumption advisories. Sixteen states reported that they issued statewide fish advisories and eight states reported they issued region-wide advisories. Six states provide no response to this question.

16. Do you have legally enforced advisories or bans within your state (e.g., are fines or citations given for fishing in posted waters)?

Ten states indicated that they have legally enforced advisories or bans within their state (Figure D-7). Forty states responded that they did not have legally enforced advisories or bans. South Carolina reported that they did not legally enforce consumption advisories but they would levy fines or give citations to individuals collecting shellfish in waters that had been closed to harvesting due to bacterial contamination.

17. Does your state issue commercial fishing bans?

Twenty-one states responded that they do issue commercial fishing bans (Figure D-8).

18. If your state or tribe has commercial fishing bans in a waterbody, do they include consumption information for sport and subsistence fishers?

Of the 21 states that issue commercial fishing bans, 15 include consumption information for sport and subsistence fishers.

19. In addition to chemical contaminants, does your state or tribe also issue fish and/or shellfish advisories (closures) for biological contamination (e.g., bacteria or viruses)?

Twenty-seven states responded that they issue fish and/or shellfish advisories for biological contamination (Figure D-9).

Sample Preparation and Analyses Procedures

20. Fish consumption advisories (no consumption and/or restricted consumption advisories) issued in your state are based on the analysis of (check all that apply):

Many states base fish consumption advisories on the chemical analysis of more than one type of fish sample (Figure D-10). The largest number of states, 36 states, analyzed fillet samples with the skin off and 32 states analyzed fillet samples with the skin on. Few states analyzed whole fish samples. Five states analyzed whole fish with the skin on and one state analyzed whole fish with the skin off. Six states responded that they used other sample types. Three of those states indicated that they beheaded and gutted smelt for analysis, two states used the edible portions, one state used skin-off steaks for sturgeon, and North Dakota reported that they planned to begin using muscle plug data. Two states indicated that the question was not applicable for their state.

21. Does your state target the collection of particular indicator species, and on what is this decision based? (Check all that apply.)

The most common basis for targeting the collection of a particular indicator species was the availability of the species (34 states). Twenty-six states indicated that the desire to maintain consistency with past collections was the basis for their decisions. Twenty states used EPA target species recommendations, eleven states used angler survey data, and six states used citizen requests. Twelve states reported that their decisions were based on other reasons, most commonly, the species' potential to bioaccumulate contaminants (i.e., bottom feeders and fatty fish). Eight states reported that they did not target the collection of indicator species. One state, Alaska, responded that the question did not apply.

22. Does your state collect multiple size classes, by species, and submit these individual size classes for residue analyses?

Thirty states responded that they routinely collected multiple size classes of fish for residue analyses (Figure D-11). Eighteen states responded that they did not routinely collect fish for analysis; however, three of these states indicated that they did collect multiple size classes of fish under certain circumstances. Alaska responded that this question was not applicable; Wyoming did not provide a response.

23. Are individual fish samples or composite samples submitted for residue analyses in your state?

The majority of states, 30, submitted both individual and composite samples for residue analysis (Figure D-12). Twelve states submitted only composite samples and six states submitted only individual fish samples for analysis. New York indicated that it had normally submitted individual samples but submitted composite samples in special cases. Two states, Alaska and Utah, responded that the question was not applicable.

24. If individual fish samples are used, how many "individual fish" are needed to support an advisory determination in a waterbody?

Of the 37 states which use individual fish samples, four states used 1 fish, four states used 3 fish, seven states used 5 fish, and one state, Texas, reported that they had used both 3 and 5 fish to support an advisory determination (Figure D-13). Twenty states reported that they used a different number of fish to support an advisory determination.

25. If composite samples are used, how many "individual fish" are combined in each of your state's composite samples for residue analysis?

Of the states which used composite fish samples to support an advisory determination, 26 states reported that 5 or more fish were the target number for composites submitted for residue analysis (Figure D-14). Two states required two fish, six states required three fish, and five states required four fish per composite sample. Nineteen states reported that they used a different number of fish per composite sample. Many of these states commented that 5 was the target number, but that they often accepted from 3 to 5 fish for composite samples.

26. If composite samples are used, how many composite samples are needed to support an advisory determination in a waterbody?

Three composite samples in exceedance of human health criteria were required by 10 states to support an advisory determination, 2 composite samples were required by seven states, and 1 composite sample was required by nine states (Figure D-15). Seventeen states used other numbers of composite samples; for example, three states require more than 4 samples. Other states did not have set policies regarding the number of samples necessary to support an advisory determination, or the number of samples required depended on the site and/or on the variability of the data.

27. Assuming a state finds residue levels in exceedance of state criteria, how many years of sampling are required at a given waterbody before a fish consumption advisory can be issued?

Most states, 30, indicated that one year of sampling was required to issue a fish advisory once residue levels exceed state criteria; five states required two years, and one state (Kansas) required three or more years (Figure D-16). Thirteen states indicated that an advisory could be issued on a different schedule from those previously mentioned, five of these states—New Hampshire, Vermont, Idaho, Louisiana, and Arkansas—issued advisories in one year or less. Nevada and New Jersey did not have a set protocol for dealing with this issue. Three states reported that the question was not applicable.

28. If commercial fish consumption bans are issued in your state, on which of the following sample types are they based? (Check all that apply.)

Of the states which issued commercial fishing bans, 13 states based their decision on fillet samples with the skin off, 12 states based their decision on fillet samples with the skin on, two states based their decisions on whole fish samples with the skin on, and one state based its decision on whole fish samples with the skin off (Figure D-17). Two states used other sample types; Hawaii would occasionally take fish off market shelves to have it analyzed, and Massachusetts analyzed lobster meat and tomalley together. The question was not applicable to 29 states, and two states did not respond to the question.

29. How many fish tissue samples must be analyzed and found to be in exceedance of state criteria before a commercial fishing ban is issued?

Before commercial fishing bans were issued, eleven states required that three or more samples exceed state criteria, Kentucky required that two samples exceed state criteria, and Alabama required that one sample exceeded criteria. Twenty-six states responded that the question was not applicable because their states did not issue commercial fishing bans; nine states responded that the question was not applicable, and one state did not respond to the question.

30. How many years of sampling are conducted at a given waterbody before a commercial fishing ban can be issued?

Before a commercial fishing ban can be issued, eight states indicated that the waterbody had to be sampled for one year, three states require sampling for two years, and one state, California, requires sampling for three or more years (Figure D-18). This question was not applicable to the 26 states that do not issue commercial fishing bans.

31. Once an advisory is issued for a specific waterbody, what must occur for the state to rescind the advisory?

When an advisory had been issued, 13 states required that the residue levels decline below the state criterion for at least two years before the advisory was rescinded (Figure D-19). Ten states require that the levels decline below a state criterion for at least one year, and two states require that the levels decline for at least three years. Twenty-two states followed another schedule or procedure. Two states responded that the question did not apply, and one state did not respond to the question.

32. Approximately how many fish tissue samples are submitted for analyses by your state each year?

Six states submitted less than 6 samples per year for fish tissue analysis, four states submitted 21–30 samples, one state submitted 31–40 samples, four states submitted 41–50 samples, and two states submitted 51–60 samples. Greater than 60 samples were submitted by 27 states. Ten of those states had submitted less than 250, five of those states had submitted between 250 and 1,000 samples and four of those states had submitted more than a thousand samples. One state responded that the question was not applicable, and five states did not respond to the question.

33. What pollutants does your state currently screen for in fish tissue samples? (Check all that apply.)

States screen for different pollutants in their jurisdictional waters. The most commonly analyzed chemicals were mercury (47 states), PCBs (39 states), DDT and its metabolites (36 states), chlordane (34 states), cadmium (33 states), and dieldrin (33 states).

34. Circle the pollutants listed in question 33 (above) that are of primary human health concern in your state waters (specify up to 5 pollutants).

Mercury was considered a pollutant of primary human health concern in 36 states, PCBs in 31 states, Chlordane in 17 states, dioxins/furans in 15 states, and DDT and its metabolites in 14 states.

35. If your state analyzes for PCBs, what specifically is analyzed?

Sixteen states that analyze PCBs analyze selected Aroclor groups, 12 states analyze all Aroclor groups, 11 states analyze a combination of both Aroclors and congeners, and six states analyze individual congeners (Figure D-20). Four states did not respond, and six states indicated that the question was not applicable.

State Advisory Program Funding

36. How many dollars are spent annually in your state on routine fish tissue field collection activities?

Twenty-six states provided information on their annual spending for fish tissue collection: seven spent less than $1,000, three states spent $1,000 to $4,999, six states spent $5,000 to $9,999, three states spent $10,000 to $24,999, and seven states spent $25,000 to $50,000. Eleven states indicated spending $50,000 or more annually for routine fish collection. Of those eleven states, three reported that they spent $75,000 to $80,000; California spent $200,000; Virginia spent $320,000; New York spent a variable amount with a $100,000 baseline and a maximum of $500,000. The other five states did not identify the amount spent above $50,000. Ten states did not provide information on the amount spent for fish collection activities.

37. What is the funding source for your state's fish tissue collection activities?

Forty-five states provided at least some information on funding sources for fish tissue collection activities. EPA provided funding to 13 of the states through general funds, Section 106, 205j, and EPA Block and Fell Grants alone or in addition to other federal and state funding sources. State funds such as general funds, spill funds, and department appropriations provided funding for 26 states. Fishing licensing fees or sales tax revenues helped to fund at least three state programs. At least three states had programs with no funding but used cooperative programs in order to conduct monitoring programs.

38. How many dollars are spent annually in your state on laboratory analyses of fish tissue samples?

Sixteen states spent more than $50,000 annually on laboratory analyses of fish tissue samples. Of those states, five spent more than $300,000. New York spent a minimum of $600,000 and a maximum of $5 million, with an average of $1.2 million; South Carolina spent $536,720; California and Maine spent $400,000 each, and Michigan spent $320,000 annually. Six states spent between $25,000 and $50,000 annually, four states spent $10,000 to $24,999 annually, three states spent between $5,000 and $9,999 annually, five states spent between $1,000 and $4,999, and four states spent less than $1,000 annually. Nine states did not provide information on annual spending for tissue analysis.

39. What is the funding source for your laboratory analyses activities?

Forty-five states provided information on the source of laboratory analysis funding. Thirty states indicated that at least a portion of the funding came from state sources such as general funds, spill funds, and department appropriations. Eleven states received funding from EPA; three of these states (Iowa, Kansas, and Nebraska) use the EPA Region 7 laboratory, which provides analyses at no cost to the state.

40. If no funding is currently available, is your state seeking funding to conduct a monitoring and assessment program?

Twenty-four states indicated that they did not have sufficient funding currently available to conduct a monitoring and assessment program. Thirteen of those states were currently seeking funding for such a program and 11 were not seeking funding. Thirteen states indicated that the question was not applicable and 13 states did not respond to the question.

Other Uses of State Advisory Data

41. For your state's biennial 305(b) water a quality report, what use support designation is assigned to waterbodies placed under fish consumption advisory?

Twenty-eight states reported that they assigned a waterbody in which a fish consumption advisory was in effect to a user support designation of **not supporting** in their biennial 305(b) water quality report (Figure D-21). Twenty-one states designated such waterbodies as **partially supporting**, two states listed such waters as **threatened**, and four states listed them as **fully supporting**. Four states did not make this type of assessment, six states did not respond to the question and two states found the question to be not applicable.

42. If fish consumption advisories have been issued for waterbodies in your state, does your state place these waterbodies on the state's 303(d) list of impaired waters?

Thirty-four states listed waterbodies under fish advisories on their 303(d) list of impaired waters, but seven states did not list them as impaired (Figure D-22). Seven states did not provide information regarding the listing of waters under fish advisories, and two found the question to be not applicable.

43. If commercial fishing bans have been issued for waterbodies in your state, does your state place these waterbodies on the state's 303(d) list of impaired waters?

Of the states which issued commercial fishing bans, 13 placed those waterbodies on their 303(d) list of impaired waters, and six responded that such waterbodies were not placed on the 303(d) list. This question did not apply to 25 of the states, and six did not respond.

44. Is "fish consumption" an assigned beneficial use for waters in your state?

Twenty-six states indicated that "fish consumption" was an assigned beneficial use for waters in their state. Nineteen states did not use "fish consumption" as an assigned beneficial use. Six states did not respond.

45. If yes, where have these criteria for beneficial use been established?

The beneficial use criterion for fish consumption was listed in the state water quality standards for 22 states. Two states listed their criteria in the SOP for assessing beneficial uses (or a related document). Three states (Delaware, Florida, and Maine) listed their criteria in other documents. Six states did not respond and 18 found the question to be not applicable.

Risk Assessment Methodology

46. What current method(s) does your state use to calculate "carcinogenic" health risks for individuals who consume fish harvested from your state's waters? (Specify all methods used.)

Risk assessment methodology was the only method used by 21 states to calculate "carcinogenic" health risks (Figure D-23). North Carolina responded that it uses risk assessment methodology in conjunction with literature reviews and Wildlife Resource Commission consumption surveys. Ten states use only the Food and Drug Administration (FDA) action levels. Both risk assessment methodology and FDA action levels were used together by 11 states. Two states—Virginia and Maryland—used risk assessment methodology, FDA action levels, and other methods concurrently. Two states responded that they did not calculate carcinogenic rates.

47. What carcinogenic risk level (i.e., individual risk within an exposed population) does your state use to issue advisories and/or post waterbodies?

Four states responded that they used only a carcinogenic risk level of 1:10,000 (10^{-4}) (Figure D-24). Seven states used only a carcinogenic risk of 1:100,000 (10^{-5}). Six states responded that they only used a carcinogenic risk of 1:1,000,000 (10^{-6}). Nine states responded that they used FDA action levels for carcinogenic risk calculations. Five states responded that they used other carcinogenic risk levels. Three states—Georgia, Tennessee, and Hawaii—indicated that they used both 1:10,000 (10^{-4}) and 1:100,000 (10^{-5}) carcinogenic risk levels. Connecticut responded that it used 1:10,000 (10^{-4}), 1:100,000 (10^{-5}), and 1:1,000,000 (10^{-6}) carcinogenic risk levels. West Virginia used 1:10,000 (10^{-4}) in conjunction with FDA action levels. Maryland responded that it used 1:10,000 (10^{-4}), 1:100,000 (10^{-5}) and FDA action levels together. Kentucky responded that it used 1:100,000 (10^{-5}), and the FDA action levels concurrently. Massachusetts indicated that it used 1:100,000 (10^{-5}), the FDA action levels, and sometimes more conservative risk levels depending on the situation. North Dakota indicated that it used 1:100,000 (10^{-5}) and detection for special groups. Indiana used 1:1,000,000 (10^{-6}) along with the weight of evidence based on RfD or some other human protection value. Some states used other carcinogenic risk levels such as the Great Lake Protocols, literature reviews, and risk management. Six states responded that the question was not applicable, and three states did not respond to the question.

48. What resource does your state use to obtain cancer potency factors to help calculate "carcinogenic" health risks? (Check all that apply.)

The most common resource used by the states was EPA's IRIS database, used by 40 states (Figure D-25). EPA's HEAST resource was the next most common, being used in 19 states. Seventeen states used other resources. Of the states which used other resources, the most commonly mentioned sources were literature, the ATSDR, and other EPA documents. Fifteen states responded that they used IARC monographs as a resource. The less frequently chosen resources were EPA toxicology one-liner database, and the Hazardous Substance Data Bank (HSDB) of the National Library of Medicine. Five states responded that the question was not applicable and three states did not respond to the question.

49. What current method(s) does your state use to calculate "noncarcinogenic" health risks for individuals who consume fish harvested from your state's waters? (Specify all methods used.)

Nineteen states responded that they used Hazard Index calculations exclusively to calculate "noncarcinogenic" health risks (Figure D-26). Twelve states used the FDA action levels exclusively to calculate health risks. Seven states used both the Hazard Index and the FDA action levels concurrently. One state, Massachusetts, used qualitative judgement in addition to both the Hazard Index calculations and the FDA action levels. Three states responded that they used the Hazard Index and another approach, most commonly literature reviews. Two states responded that they used FDA action levels and another source, such as the pharmacokinetic model. Four states indicated that they exclusively used other sources to determine "noncarcinogenic" health risks. Three people did not respond to the question.

50. What noncarcinogenic risk level (i.e., individual risk within an exposed population) does your state use to issue advisories and/or post waterbodies?

Nineteen states responded that they used FDA action levels to calculate the noncarcinogenic risk used to issue advisories (Figure D-27). Fourteen states reported that they used a Hazard Index = 1.0, 11 states reported that they used a Hazard Index >1.0, and three states reported that they used a Hazard Index <1.0. Ten states indicated that they used other values, such as the Great Lakes Protocol. Three states did not respond to the question, and one state indicated that the question was not applicable.

51. What resource does your state use to obtain potency factors (reference dose) to help calculate noncarcinogenic health risks? (Check all that apply.)

The most commonly used resource for obtaining potency factors is EPA's IRIS, used by 38 states (Figure D-28). Other data sources are used by 21 states, such as the ATSDR, Toxicology Excellence for Risk Assessment (TERA), the World Health Organization (WHO), other scientific literature, and other EPA literature. EPA's HEAST was used in 20 states to obtain RfDs for calculating health risks. Twelve states employed the HSDB and nine states used EPA's Toxicology One-Liners Database for calculating health risks. Six states did not respond to the question, and two states responded that the question was not applicable.

52. Of all the fish advisories currently in effect in your jurisdiction, including those issued in 1998 and in earlier years, what percentage were issued based on each of these methods? Please write down your best estimate of the percentage for each method.

Twenty-one states responded that 90–100 percent of advisories that were currently in effect were issued using risk assessment methods. Nine states responded that 90–100 percent of advisories that were currently in effect were issued using FDA action levels. One state, North Dakota, responded that 100 percent of advisories that were currently in effect were issued using the pharmacokinetic method. Nine states responded that both the FDA and risk assessment methods were used to issue advisories that were current in their states. Two states reported that FDA, risk assessment and other methods were used to issue advisories currently in effect in their states. One state, Washington, reported using risk assessment methods in conjunction with other methods to issue current advisories in their state.

53. Does your state or tribal agency have a plan to reevaluate data from sites where outdated methods were used to issue fish advisories?

Twenty states reported that they did have a plan to reevaluate data used with outdated methods to issue fish advisories. Twenty states reported that they did not have a plan to reevaluate advisories issued using outdated methods. Seven states did not respond to the question, and three indicated that the question was not applicable.

54. Is your state currently re-evaluating the method or approach used to establish fish advisories?

Twenty-two states responded that they were currently re-evaluating methods used to establish fish advisories. Twenty-five responded that they were not currently re-evaluating their methodologies or approaches used to establish fish advisories. Three states did not respond to the question.

55. What default value does your state use in its risk assessments as a daily fish consumption rate for recreational fishers?

Eight states reported that they used 6.5 g/day as the default daily fish consumption rate for recreational fishers (Figure D-29). There were no states which indicated that they used 15 g/day as the default consumption rate. Seven states reported that they used 30 g/day as the default recreational fisher consumption rate in their state. The majority of states, 26, reported that they used other consumption rates, most of which included a range of consumption rate values. Two states used Great Lakes Protocol, a few states had no default several states used site-specific rates. Eight states gave no response to the question, and one state indicated that this question was not applicable.

56. What default value does your state use in its risk assessments as a daily fish consumption rate for subsistence fishers?

The subsistence default daily fish consumption rate in four states was 6.5 g/day (Figure D-30). The consumption rate of 15 g/day was not reported as being used by any of the 50 states. The subsistence daily consumption default rate was 30 g/day for six states and 87 g/day in one state, Maryland. Other consumption rates were used by 22 states. The other rates included a different default rate, a variable rate or a range of values. Eight states provided no response, and eight states indicated that this question was not applicable.

57. What default value does your state use in its risk assessments as a daily fish consumption rate for children?

No states reported their default consumption rate for children as 2.0 g/day (Figure D-31). One state reported their default consumption rate for children was 4.0 g/day and eight states reported 6.5 g/day. Twenty-three states reported that they used other consumption rates for children. The majority of other default values were reported as different default values, variable default values, or a range of default values. Ten states did not provide a response, and eight states indicated that this question was not applicable.

58. What default value does your state use for exposure duration in its cancer risk assessments?

Eight states indicated that they used 30 years and 25 states indicated that they used 70 years as their default exposure durations in cancer risk assessments (Figure D-32).

One state, Massachusetts reported that they used 70 years and actual situational exposure durations. Three states—California, New York, and Arkansas—indicated that they use other exposure durations. California was considering either 30 or 70 years. New York adjusted the exposure duration to reflect the waterbody and population being evaluated, and Arkansas was not sure what default exposure duration they used in their cancer risk assessments. No response was given by 11 states, and the question was not applicable to three states.

59. What default value does your state use to estimate life expectancy in its risk assessments?

The most common age used to estimate life expectancy in risk assessments was 70 years, reported by 32 states as their exclusive answer (Figure D-33). One state reported using 75 years as the life expectancy, and no states reported that they used 80 years. Massachusetts reported that they used both 70 years and actual situation exposure data. Colorado reported that they used the chronic exposure for non-cancer endpoints. Eleven states did not respond, and three indicated that the question was not applicable.

60. What meal frequency values does your state usually recommend in its advisories? (Specify all that are used.)

The majority of states indicated more than one meal frequency value in their advisories, depending on the severity of the contamination. The most common response to this question was one meal per month, indicated by 28 states. Twenty-six states responded that they do not issue meal frequencies in their advisories. One meal per week was indicated by 23 states and unlimited meal frequency was reported by 20 states. Two meals per month, two meals per week, three meals per month, and three meals per week were reported the least frequently, chosen by a total of 13 states among all four options. The use of other frequencies was reported by 17 states. Eight of these states reported that they used the value of six meals per year in their advisories. Other states indicated that the frequency depended on the level of contaminants, available data, or the waterbody and species under consideration.

61. What assumption does your state make in its risk assessments about meal size for adults? (Specify all that are used.)

The most common response, from 36 states, was that they assumed adult meal size to be 8 oz (227 g) for risk assessment calculations (Figure D-34). Three states responded 4 oz (114 g), one state responded 16 oz (454 g), and no states responded 12 oz (341 g). Five states used other meal sizes. Nebraska and Kansas both used 5 oz, Delaware used 6 oz for women of childbearing age, and the other states used values varying with population and waterbody. Five states did not provide a response, and two responded that the question was not applicable.

62. What assumption does your state make in its risk assessments about meal size for children? (Specify all that are used.)

In risk assessment calculations, the child meal size was estimated as 4 oz by 11 states and 8 oz by ten states (Figure D-35). Thirteen states responded that they used other meal sizes. Four of those states did not conduct child risk assessments. Three states used 3 oz; two states used 5 oz, and the remainder of the states used variable values depending on the circumstances. Nine states did not respond, and the question was not applicable for eight states.

63. What default value does your state use for body weight of an adult male consumer in its risk assessments?

Forty-two states used 70 kg as the default body weight of an adult male consumer (Figure D-36). Only one state used 71 kg, and none of the states used 60 kg. Seven states did not respond to the question.

64. What default value does your state use for body weight of an adult female consumer (including pregnant women and nursing mothers) in its risk assessments?

Twenty states reported using a default body weight of 70 kg for adult women, 10 states reported using a value of 60 kg, and four states reported using a value of 65 kg (Figure D-37). Other weights, ranging from 52–64 kg, were used by five states. One state responded that they were unsure what default value was being used. There was no response from 11 states, and one state indicated that the question was not applicable.

65. What default value does your state use for body weight of a child in its risk assessments?

It was reported in 16 states that risk assessments for children were not conducted (Figure D-38). In four states, the default child body weight was 10 kg; in four other states, child body weight was assumed to be 14.5 kg; and in two states, child body weight was assumed to be 15.5 kg. Twelve states used other weights which were from the Great Lakes Protocols, variable depending on circumstances, unknown, or other default values ranging from 15–35 kg. Eleven states provided no response to the question, and four states responded that the question was not applicable.

66. Please specify what age range or ranges your state uses to calculate risk with respect to children. (Please specify all age ranges used in your state's risk assessments for children.)

Fifteen states responded that they did not conduct risk assessments for children (Figure D-39). Of the states which did conduct risk assessments, 11 used an age range of <6 years, six states used <12 years, and three states used <15 years. Other age ranges are used by eight states: two of those states used <7 years, one state used a range from 1–7 years, one state used <18 years for all contaminants except mercury, and the other age ranges were variable. Seven states did not provide an answer to the question, and two states responded that the question was not applicable to their state.

67. What assumption does your state make in its risk assessments about the amount of the pollutant absorbed by the body after ingestion (percent absorption by the gut) (e.g., in pharmacokinetic modeling)?

The majority of states, 28, assumed that 100 percent absorption occurs after ingestion (Figure D-40). Of those states, California indicated that 100 percent absorption was assumed if it was supported by data, and Minnesota used that assumption for all contaminants except mercury, which was assumed to absorb 5.9 percent to blood. No states reported that they assumed 75 percent or 50 percent absorption. Eleven states, including the two previously mentioned, reported that they used different absorption rates than those listed. Twelve states had no response and one state indicated that the question was not applicable.

68. Does your state use "contaminant reduction factors" in its risk calculations to account for contaminant losses of PCBs and other organochlorine pollutants from fish tissues during cleaning, preparation, and cooking of the fish?

Over half of the states, 28, reported that they did not use contaminant reduction factors (Figure D-41). Fifteen states indicated that they used contaminant reduction factors in risk calculations to account for organochlorine pollutant loss. There was no response from five states, and the question was not applicable for three states.

69. If yes, what are the pollutants and their associated contaminant reduction factors (% reduction in pollutant level) assumed by your state?

Fifteen states used contaminant reduction factors in their risk assessment calculations to account for contaminant loses in food preparation and cooking. Of these states, 13 used a value of 50 percent for PCBs, one state used a value of 31 percent for PCBs, and two states used 0 percent for mercury. One state, North Carolina, indicated that it used

10 percent for dioxin. Thirty states did not use contaminant reduction factors. California had not yet determined contaminant reduction factors, but was considering including values of 30 percent or 50 percent for all contaminants except mercury, which would have a value of 0 percent. Oregon did not use reduction factors unless compelling test data warranted the use. Five states did not respond to the question.

70. If contaminant reduction factors are used, what is their basis?

Seventeen states, including two which answered "No" to question 68, responded that they used scientific literature reviews as the basis for their contaminant reduction factors. Michigan reported that they used both scientific literature and conducted their own research. No other states reported that they conducted their own research. Four states—Ohio, Pennsylvania, Minnesota, and Louisiana—reported that they used the Great Lakes Protocol in conjunction with scientific literature reviews. Five states did not respond to the question, and it was not applicable to 30 states, although California and Oregon provided responses anyway.

71. How does your state evaluate health risks for fish samples contaminated with multiple chemicals with the same human health endpoints (e.g., two organochlorine pesticides)?

The most common response to this question, from 18 states, was that the state does not evaluate health risks for fish samples with multiple chemicals with the same health endpoint (Figure D-42). Cumulative risk was assessed in eight states; either cumulative risk or single-contaminant risk, depending on chemicals involved, was assessed in seven states; and single-contaminant risk was calculated based on the most conservative carcinogenic risk value in four states. Eight states responded with a different method. Three of those states had not dealt with the problem of multiple chemicals at the time they responded to the questionnaire. The other states had a variety of responses which included the use of the most sensitive endpoint, individual evaluation, and the summing of contaminant level fractions. Two states did not provide a response to this question, and three states indicated that the question was not applicable.

72. Regarding mercury, does your state assign different noncarcinogenic toxicity values to different populations (i.e., does the state use an RfD of 1 x 10-4 mg/k/day for women of child-bearing age and/or children versus using an RfD of 3 x 10-4 for adults in the general population)?

Different noncarcinogenic toxicity values were not assigned to different populations for mercury assessments in 28 states (Figure D-43). Seventeen of the states responded that they did assign different toxicity values for mercury. Three states did not respond to this question, and two states indicated that the question was not applicable.

73. What is the mercury toxicity value (i.e., RfD) used for each of the following populations—adults, women of childbearing age or nursing mothers, and children?

Most states (19 states) assigned a mercury toxicity value of approximately 3.0 or 3.4 x 10^{-4} mg/kg/day to adults in the general population (Figure D-44). Georgia, Nebraska, Illinois and Arizona assigned a toxicity value of one x 10^{-4} mg/kg/day for adults, Michigan assigned a value of two x 10^{-4} mg/kg/day for adults, and North Carolina, Maryland, Florida and Louisiana assigned a value of approximately 4.0 or 4.3 x 10^{-4} mg/kg/day.

For women of childbearing age or nursing mothers, 12 states assigned a mercury toxicity value of approximately one x 10^{-4} mg/kg/day (Figure D-45).

For women and children, Mississippi, Arkansas and Massachusetts assigned a value of 3 x 10^{-4} mg/kg/day, Colorado, New Jersey and Minnesota used values of approximately 0.7 or 0.75 x 10^{-4} mg/kg/day, and Georgia used a value of 0.5 x 10^{-4} mg/kg/day.

Ten states used a mercury toxicity value of 1.0 or1.5 x 10^{-4} mg/kg/day for children (Figure D-46). Twelve states did not respond to the question, and six states indicated that the question was not applicable.

74. When your state receives method detection limits (MDLs) as the reportable concentration for contaminants from the laboratory, what value do you use for non-detects in your risk assessment?

Twenty-six states reported that they used half of the pollutant's MDL for the detection limit (Figure D-47). Eleven states reported that they used zero for the detection limit, one state used the maximum likelihood indicator, five states used the pollutant's MDL, and five states used other values. The question was not answered by six states, and was not applicable for three states.

75. Does your state screen for lead in its fish tissue samples?

Twenty-seven states reported that they screened fish for lead. Screening for lead was not undertaken in 20 states (Figure D-48). Two states did not respond to the question and one state responded that the question was not applicable.

76. What assessment method do you use for lead since lead does not currently have an associated RfD in IRIS? (Specify)

Since lead does not currently have an associated RfD in IRIS, the states used a variety of different methods for lead screening, such as the uptake biokinetic model used by Delaware, Hawaii, Maine, and New Hampshire, FDA methods used by Alabama, Ohio and Missouri, and state-specific methods, among others. Twenty states reported that they do not screen for lead, and three states did not respond to the question.

Targeting Fish Consumers

77. Are health risks being assessed in your state for target groups of people whose culinary habits may differ from the customs of the majority of Americans regarding meal preparation and consumption?

Thirty-five states responded that there were no health risks being assessed for groups with alternative culinary habits (Figure D-49). Health risk assessments were being conducted for alternative diets by 13 states. Two states did not respond to the question.

78. Has your state identified the primary waterbodies fished by these target population(s)?

The same number of states conducting health risk assessments had also identified primary waterbodies used by the target populations. Thirty-three states had not identified primary waterbodies, three states did not provide any information, and one state responded that the question was not applicable.

79. Has your state made efforts to identify the fish species and the sizes of fish consumed by these target populations?

Seventeen states had made efforts to identify size and species of fish consumed by target populations. Twenty-eight states had not made efforts, four did not respond, and one indicated that the question did not apply.

80. If yes, has your state used any of the following procedures to obtain information from these target populations?

Of the states which had made efforts to identify fish consumed by target populations, 17 had used creel surveys, one had used fishing license surveys, 16 had used anecdotal information, and two had used behavioral risk surveillance surveys. Five states did not respond to the question, and the question did not apply to 23 states.

81. Has your state altered its monitoring approach to address the needs of these target populations?

There were eleven states which had altered their monitoring approach to address the needs of target populations. Thirty-four states had not altered their approach, four did not respond to the question, and one state indicated that the question was not applicable.

82. If your state has altered its monitoring approach to address the needs of these target populations, what actions have been taken? (Check all that apply.)

Of the states which had altered their monitoring approach, five had added stations in waterbodies where the targeted populations frequently fish and nine had targeted species consumed by the target populations for residue analyses. Three states used other actions; California used target populations to determine sampling stations and Oregon and Wisconsin had unique advisories.

83. If your state is not currently addressing the concerns of populations with a perceived higher risk, is there a plan to do so in the future?

Seventeen states not currently addressing the concerns of target populations planned to do so in the future. Sixteen did not have future plans to address the needs of higher-risk populations.

Risk Management

84. Who prepares risk assessments on behalf of your state or tribal fish advisory program?

Thirty-five states used the public health department to prepare risk assessments for the state or tribal fish advisory program (Figure D-50). Eighteen states used the environmental department to prepare risk assessments. Florida used a consultant in addition to the state health department; Colorado used the fisheries agency to at least partly prepare assessments; and seven states used other organizations, such as local government and interagency task forces. Two states did not respond to the question, and one state reported that the question is not applicable.

85. Does your state or tribe have written procedures for evaluating the health risks associated with contaminants in fish?

Twenty-five states had written procedures for evaluating health risks associated with contaminated fish. Twenty-two states did not have written procedures. Three states did not respond to the question.

86. Does your state or tribe have a group or committee that oversees the fish advisory program/processes?

Twenty-seven states had a group or committee which oversees the fish advisory program or process. Twenty-one states did not have an oversight committee. Two states did not respond.

87. If the answer to question 86 is yes, what professional disciplines are represented on that committee?

Oversight committees in 26 states had members of the toxicology/epidemiology profession represented. Twenty-five states used fisheries professionals, 22 states used water pollution assessment/control professionals, 13 states used risk communication professionals, nine states used analytical chemists, and four states used hazardous waste management professionals. Six states used representatives from other professional disciplines on their oversight committees. Nebraska, Maine and New York had health professionals on their committees. Nebraska also had a state senator, a private citizen, and a member of the state wildlife federation. Illinois used a food safety professional, New York also used representatives from biology and chemistry disciplines, and Arkansas had a member of the Department of Environmental Quality on their committee. Virginia chose professional disciplines as needed. For 21 states the question was not applicable, and three states did not respond.

88. Who in your state or tribe makes the ultimate risk management decision to issue, modify, or rescind fish advisories?

Most often, in 33 states, the ultimate risk management decisions were made by the head of the public health agency or department (Figure D-51). In 18 states, the ultimate decisions were made by the head of the environmental agency. The head of the fisheries agency makes the decisions in four states—Delaware, Iowa, Kentucky, and Louisiana. In Wisconsin the Governor's office worked with the state health department to make final decisions. Four states indicated that other positions made the final decisions on these matters. Montana used the state epidemiologist to make the final decision, California and Washington used health officials, and Pennsylvania used an interagency work group. Two states did not respond to the question.

Risk Communication Procedures

89. How often does your Agency revise the fish consumption advisory listings and release the information to the public?

Thirty-one states revised and released advisory listings whenever the data become available. Twenty-four states, however, released information annually on a specific date. The most common times for annual advisories were during the spring months (March, April and May), January, June/July and November. Six states responded that they used other schedules. North Carolina used a web page, California used (and Maine was considering) a biennial schedule, and Massachusetts released mercury and PCB information at different times of the year. Three states did not respond to the question, and the question was not applicable for one state.

90. Where can the public obtain copies of your agency's printed advisory materials?

The general public can obtain printed advisory materials in a variety of ways. State public health departments, state fisheries offices, and businesses that issue fishing licenses were the most commonly used outlets by the states; 36, 35 and 32 states, respectively, used these locations to disseminate information. In 32 states, printed information was available at other state agencies. Printed materials could be obtained at local public health departments in 21 states. Printed advisories were available in WIC clinics in 15 states and doctors' offices in nine states. Tribal organizations had printed advisory materials in five states. Printed materials were available in tourist offices in four states, other organizations in four states, and town halls in three states. Twelve states made information available at sources other than the ones previously listed. Two states did not respond to the question, and one state indicated that the question was not applicable.

91. How are your Agency's fish advisories communicated to the public? (Check all that apply.)

There were not only a variety of locations to make printed information available to the public, but a variety of ways to communicate the information. The most common way for states to communicate information was through press releases distributed to media sources, used in 46 states. Forty states mailed information to the public upon request, 34 states posted signs, 32 states used the Internet to communicate fish advisories, 30 states had information in annual fishing regulations booklets, 29 states had printed pamphlets or fact sheets, 22 states had public meetings, and 21 states used targeted newspaper stories to communicate fish advisories to the public at the time of this questionnaire.

92. Does your state or tribal fish advisory distribution plan specifically target some populations to receive advisory information?

Thirty-two states have an advisory distribution plan that specifically targets some populations. Fifteen states do not specifically target particular populations to receive advisory information. Two states did not respond to the question, and one state indicated that the question was not applicable.

93. If yes, please identify all targeted populations.

Of the states which targeted populations, 19 targeted pregnant or nursing women, 17 targeted sport fishers, 16 targeted women of childbearing age, 11 targeted subsistence fishers, and eight targeted members of the general population. Three states—Ohio, Maine, and Michigan—targeted new parents, and Oklahoma targeted tourists. Three states targeted other populations: North Carolina and Indiana targeted children specifically, and Massachusetts targeted family practice physicians, obstetrician/gynecologists, and medical clinics. Two states did not respond to the question, and 16 states indicated that the question was not applicable.

94. Are your state or tribal fish consumption advisories distributed to the public in languages other than English?

Seventeen states distributed advisory information in languages other than English (Figure D-52). Thirty-two states did not distribute information in any other language besides English. One state did not respond.

95. If yes, please specify all languages that apply.

Spanish was the most common language into which states translated fish consumption advisories, occurring in 14 states. Other languages used for fish consumption advisories included: Vietnamese in 9 states, Laotian in 8 states, Cambodian in 5 states, Hmong in 4 states, Chinese and Korean in 3 states each, and Russian, Bosnian and Thai in 1 state each. Three states used a different language; Hawaii and Alaska translated information into Japanese and Tagalog, Hawaii also used Llacano, Alaska also translated information into native languages in the area of the advisory, and Massachusetts translated into Portugese. Thirty-two states indicated that the question was not applicable, and one state did not respond.

96. Does your state or tribe evaluate the effectiveness of the fish consumption advisories?

Nineteen states evaluated the effectiveness of fish consumption advisories. Twenty-eight responded that they did not evaluate effectiveness. Three states did not respond to the question.

97. If yes, how is their effectiveness determined? (Check all that apply.)

Of the states that evaluated the effectiveness of fish consumption advisories, seven responded that they mailed questionnaires. Three states (Nebraska, Nevada, and New York) indicated that they mailed questionnaires to anglers and one state mailed to subsistence fishermen. One state, Maryland, mailed questionnaires to the general public and one state, Wisconsin, mailed them to various groups depending on the study. Six states responded that they used focus groups to determine effectiveness of advisories. Five states said that they used telephone surveys; Maine called women of childbearing age, Maryland called the general public, Wisconsin called various groups in the public depending on the study, and New York called licensed anglers. Four states responded that they used creel surveys, four states responded that they used feedback forms/postcards in their regulation pamphlets, and three states used questions included in their state's behavior risk factor survey. Five states used other methods, such as site visits during low tide (Alaska), university studies (Tennessee), ethnic group leaders (Vermont), and a children's program (Ohio). Five states did not respond to the question, and 27 states indicated that the question was not applicable.

98. To your knowledge, have there been any studies in your state (including federal, tribal, and university-based studies) to evaluate human tissue contaminant levels (e.g., in blood, urine, breast milk, or adipose tissues) or adverse human health effects related to fish consumption?

Fifteen states responded that, to their knowledge, there had been no studies to evaluate human health affects from fish contaminants in their state. Twenty-one states indicated that there had been assessment of human health affects. Seven states responded that they did not know if there had been human health assessments in their states. Four states did not respond to the question.

4. Consistency of State Programs With EPA Office of Water Guidance

INTRODUCTION

The EPA Office of Water has developed the following guidance documents to assist states and Native American Tribes to design fish contaminant monitoring programs, evaluate potential risks to fish consumers, and communicate these risks to the public.

- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories*. Volume 1. Fish Sampling and Analysis. Second Edition. EPA 823-R-95-007.
- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories*. Volume 2. Risk Assessment and Fish Consumption Limits. Second Edition. EPA 823-B-97-009.
- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories*. Volume 3. Overview of Risk Management. EPA 823-B-96-006.
- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories*. Volume 4. Risk Communication. EPA 823-R-95-001.
- *Guidance for Conducting Fish and Wildlife Consumption Surveys.* EPA 823-B-98-007.

An objective of the fourth AFS Forum on Contaminants in Fish was to discuss the extent to which state fish contaminant monitoring programs are consistent with EPA's guidance. State responses to a questionnaire developed jointly by the State of Nebraska and EPA, and reviewed and agreed upon by the participating states and the AFS Steering Committee, were used to assess the procedures and methodologies currently being used by states to assess chemical contaminants in fish (see Section 3). In this section, state responses to the questionnaire are used to identify the states that are consistent with the two main recommendations stressed in EPA's guidance documents. These recommendations are 1) routine monitoring of chemical contaminants in fish tissue, and 2) use of risk assessment methodology.

ROUTINE MONITORING OF CHEMICAL CONTAMINANTS IN FISH TISSUE

EPA recommends that states conduct routine monitoring and chemical testing of fish tissue in waterbodies to obtain information about the potential human health risks to fish consumers. Based on state responses to the questionnaire shown in Appendix B, 35 states are consistent with EPA's recommendation to routinely monitor fish for chemical contaminants.

To be effective, a routine monitoring program should collect and analyze enough samples to characterize chemical concentrations in waterbodies and target fish species that are being consumed by the public. The cost to support the monitoring program will depend on a number of factors including the size and number of waterbodies to be monitored, the number of chemicals that are analyzed, the number and characteristics of the fish species that are being consumed, and the frequency with which routing monitoring is conducted. Tables 1 and 2 show the annual funding spent on fish tissue field collection activities and laboratory analyses, respectively, for the 35 states that reported they conduct routing monitoring of chemical contaminants in fish tissue.

Table 1. Funds spent annually on routine fish tissue field collection activities

>$50,000	$25,000–$50,000	$10,000–$24,999	$5,000–$9,999	$1,000–$4,999	<$1,000	No Response
California	Alabama	Nebraska	Arkansas	North Dakota	New Hampshire	Iowa
Connecticut	Florida		Delaware	Vermont	Nevada	Georgia
Indiana	Illinois		Kansas		South Dakota	Minnesota
Maine	Kentucky		Missouri			North Carolina
Maryland	Massachusetts		Oklahoma			Pennsylvania
Mississippi	Michigan		Wisconsin			Tennessee
New York						Wyoming
Ohio						
South Carolina						
Virginia						

Table 2. Funds spent annually on laboratory analyses of fish tissue samples

>$50,000	$25,000 - $50,000	$10,000 - $24,999	$5,000 - $9,999	$1,000 - $4,999	<$1,000	No Response
California	Delaware	Alabama	North Dakota	Arkansas	Iowa	North Carolina
Connecticut	Florida	Kentucky		New Hampshire	Nevada	Pennsylvania
Georgia	Kansas	Massachusetts		Vermont		
Illinois	Nebraska	Missouri				
Indiana	South Dakota	Oklahoma				
Maryland						
Maine						
Michigan						
Minnesota						
Mississippi						
New York						
South Carolina						
Tennessee						
Virginia						
Wisconsin						

USE OF RISK ASSESSMENT METHODOLOGY

EPA guidance recommends that states use risk assessment methodology to calculate carcinogenic and noncarcinogenic health risks. Forty of the 48 states that provided information on their risk assessment methods indicated that they currently use risk assessment methodology, either exclusively or in combination with other approaches, to support their state fish advisories programs (Table 3). Sixteen states exclusively use risk assessment methodology for chemicals with both carcinogenic and noncarcinogenic health endpoints. Twenty-one states exclusively use risk assessment methodology to assess carcinogenic health risks and 20 states exclusively use risk assessment methodology to assess noncarcinogenic health risks. Sixteen states exclusively use FDA action levels to evaluate health risks of chemicals with either carcinogenic or noncarcinogenic health endpoints. Eight of these states indicated that they are currently re-evaluating the methods or approaches they used to issue fish advisories.

Of the 35 states that conduct routine monitoring, 30 currently use risk assessment methodology, either exclusively or in combination with other approaches, to support their state fish advisory programs (Table 3). Fifteen states exclusively use risk assessment methodology for chemicals with carcinogenic health endpoints and 13 states exclusively use risk assessment methodology for chemicals with noncarcinogenic health endpoints. Eleven states exclusively use risk assessment methodology to support their state fish advisory programs and conduct routine monitoring of fish tissue (California, Connecticut, Delaware, Georgia, Kansas, Maine, Minnesota, Nebraska, New Hampshire, Ohio, and Oklahoma).

Based on state responses to the questionnaire developed jointly by the State of Nebraska and EPA, and reviewed and agreed upon by the participating states and the AFS Steering Committee, only three states, Arizona, New Mexico, and Rhode Island, have programs that are inconsistent with the two main recommendations stressed in EPA's guidance documents: 1) routine monitoring of chemical contaminants in fish tissue, and 2) use of risk assessment methodology.

Table 3. Summary of state risk assessment methodologies used to support fish advisories

State	Conduct Routine Monitoring	Cancer			Noncancer			Re-evaluating method(s)
		RAM only	FDA only	Comb. Appr.	RAM only	FDA only	Comb. Appr.	
Alabama	✔		✔			✔		✔
Alaska			✔				✔	✔
Arizona			✔			✔		✔
Arkansas	✔		✔			✔		
California	✔	✔			✔			✔
Colorado		✔			✔			
Connecticut	✔	✔			✔			✔
Delaware	✔	✔			✔			
Florida	✔			✔			✔	
Georgia	✔	✔			✔			
Hawaii		✔			✔			
Idaho								
Illinois	✔				✔			
Indiana	✔			✔		✔		
Iowa	✔		✔			✔		
Kansas	✔	✔			✔			✔
Kentucky	✔			✔			✔	✔
Louisiana		✔					✔	✔
Maine	✔	✔			✔			✔
Maryland	✔			✔			✔	✔
Massachusetts	✔			✔			✔	
Michigan	✔		✔				✔	✔
Minnesota	✔	✔			✔			
Mississippi	✔			✔		✔		✔
Missouri	✔			✔		✔		
Montana					✔			
Nebraska	✔	✔			✔			✔
Nevada	✔		✔					
New Hampshire	✔	✔			✔			
New Jersey			✔		✔			✔
New Mexico			✔			✔		✔
New York	✔			✔			✔	
North Carolina	✔			✔			✔	✔
North Dakota	✔	✔					▲	
Ohio	✔	✔			✔			
Oklahoma	✔	✔			✔			
Oregon		✔			✔			✔
Pennsylvania	✔			✔		✔		✔
Rhode Island			✔			✔		✔
South Carolina	✔	✔					▲	
South Dakota	✔			✔			✔	
Tennessee	✔	✔				✔		
Texas		✔			✔			
Utah						✔		
Vermont	✔			✔	✔			✔
Virginia	✔			✔			✔	
Washington		✔			✔			✔
West Virginia				✔			✔	✔
Wisconsin	✔	✔					▲	
Wyoming	✔							
Total	**35**	**21**	**10**	**14**	**20**	**12**	**15**	**22**

NOTE: RAM - risk assessment methodology; FDA - FDA action level; Comb. Appr. - combined approach; ▲ - Other approach only

5. National Consistency Discussions

An important objective of the 1999 American Fisheries Society Forum on Contaminants in Fish was the presentation and discussion of similarities and differences among state fish advisory program methods and the consistency of these methods with guidance published by the EPA, Office of Water. Conference attendees were divided into six geographical regions (Table 3) and spent a total of four hours discussing the need and rationale for national consistency between state fish advisory programs and the merits of EPA's guidance documents for assessing chemical contaminant data for use in fish advisories. The discussions were organized into four areas: programmatic issues, sampling and analysis procedures, risk assessment methodology, and risk management. The information gathered from the breakout sessions was presented to the attendees during the conference and is summarized below. Specific comments directed towards EPA's guidance documents are provided at the end of this section.

PROGRAMMATIC ISSUES

The discussion on programmatic issues concerned the practice of issuing fish advisories restricting versus banning fish consumption. All states agreed that there should be national consistency for advisories that ban fish consumption. Most states indicated that there should be some national consistency for advisories that tell people not to eat specific fish species. The discussion groups identified several issues which they felt would assist states and Tribal fish advisory programs. These issues are listed below:

- The states need appropriate funding and staffing to support the programs required to issue appropriate advisories.
- The states want flexible guidelines that recognize that there are good reasons for local differences.
- For the most part, the states support the application of a consistent, flexible methodology for fish advisory programs.
- The states support the concept of regional consistency for shared waterbodies.
- Tribes also have the need to integrate cultural issues, spirituality, and other practices that bear on decisions regarding fish consumption.

Table 4. Discussion Groups

GROUP 1-NORTHEAST
Facilitator—Tom Armitage

States
Connecticut
Maine
Massachusetts
New Jersey
New Hampshire
Rhode Island
Vermont

GROUP 2-GREAT LAKES
Facilitator—Jerry Schulte

States	Tribes
Illinois	Fond du Lac Reservation
Indiana	Grand Portage Indian Reservation
Michigan	Great Lakes Indian Fish and Wildlife Commission
Minnesota	Menominee Indian Tribe of Wisconsin
New York	Mille Lacs Band of Ojibwe
Ohio	Tuscarora Environment Program
Pennsylvania	
Wisconsin	

GROUP 3-EAST
Facilitator—Steve Ellis

States
Delaware
Kentucky
Maryland
Tennessee
Virginia
Washington DC
West Virginia

GROUP 4-SOUTH
Facilitator—Rita Schoeny

States	Tribes
Alabama	Seminole Tribe of Florida
Florida	
Georgia	
Louisiana	
Mississippi	
North Carolina	
South Carolina	
Texas	

GROUP 5-CENTRAL
Facilitator—Bob Gray

States	Tribes
Arkansas	Kaw Nation of Oklahoma
Colorado	Kanza Health Center
Iowa	Pueblo of Picuris
Kansas	Three Affiliated Tribes
Missouri	
Nebraska	
New Mexico	
North Dakota	
Oklahoma	
South Dakota	
Wyoming	

GROUP 6-WEST
Facilitator—Betsy Southerland

States	Tribes
Alaska	Confederated Tribes of Chehalis Reservation
Arizona	Colorado River Indian Tribes
California	Nez Perce Tribe
Hawaii	Puyallup Tribe of Indians
Idaho	Tanana Tribal Council
Montana	
Nevada	
Oregon	
Utah	
Washington	

SAMPLING AND ANALYSIS PROCEDURES

A small majority of states indicated that they were in agreement with EPA recommendations for sampling and analysis procedures. For the most part, EPA guidance on sampling and analysis procedures that were flexible received the highest support from state and Tribal participants. Participants in the Great Lakes and northeast regions appeared to have the lowest compliance with EPA recommendations. Few states agreed with EPA's recommendation on specific chemicals to be monitored. Many states indicated they did not have sufficient funds to monitor EPA's recommended list of chemicals, did not suspect the presence of those chemicals in all waters, or felt that the list did not include important chemicals of concern.

Approximately one-half of the states indicated they perceived a need for national consistency of sampling and analysis procedures. Many states that were consistent with EPA recommendations did not necessarily want the recommendations to be required or to be nationally consistent. This trend reflected the desire for flexible guidance that would allow states to alter some of their methods as they felt appropriate. For example, participants suggested that some methods would work well for a large lake, but would be a completely inappropriate for a small pond. The study objectives, specific characteristics of the waterbody, the target population of concern, the amount of historical data, available funding, and the expected variability of the measured parameters are all factors which could affect the sampling and analysis procedures selected.

Several states indicated that they sometimes obtain information on fish contaminants from other state or federal agencies which are not required to adhere to EPA guidelines. In these cases, the states would not be able to achieve national consistency, even though they had the desire to do so.

The discussion groups identified the following issues under this topic:

- States support the use of best professional judgement in fish assessments and believe this is a deterrent to any national guidance that is not flexible.
- Many states do not support the concept of a uniform list of chemicals to be monitored. States prefer that EPA maintain a list of suggested chemicals, develop a process for adding or removing chemicals from the list, and provide guidance on the priority for analysis of chemicals if funding is limited.

RISK ASSESSMENT METHODOLOGIES

In general, there was very little agreement among the states on specific EPA recommendations for risk assessment methodologies. Most states followed EPA guidance on the default parameters for adult meal size and the use of one-half the detection limit when chemical concentrations are reported as not detected.

Some participants were concerned that the questions in the EPA/Nebraska questionnaire on risk assessment default values were a precursor to developing nationally recommended default values. Many states felt that national consistency in default values would be beneficial, but they did not favor national guidance that mandated the use of those default values. In keeping with the recurring theme of flexibility, participants felt that the choice of using default values should be made by each state.

One of the topics of discussion was what measurement of PCBs should be performed for risk assessment and monitoring programs. Many participants had strong opinions either for Aroclors or congener-specific analysis. Some of the concerns expressed were the added cost of analysis for congeners versus Aroclors, uncertainty in the toxicity values to be used with different PCB measurements, and the lack of knowledge of whether the added cost of PCB congener analysis would change the issuance of advisories based on Aroclors.

There was substantial agreement among states concerning the benefits of national consistency for default consumption rates and toxicity default values. However, states and Tribes want to have the flexibility to make adjustments as necessary for their situation.

There was a large amount of discussion of contaminant reduction factors, which adjust for preparation or cleaning methods that would reduce contaminants in fish before consumption. It was also emphasized that sometimes the contaminants are not necessarily reduced by these methods, but rather increased, so it might be beneficial to change the terminology. Not many states were using these reduction factors, but many were interested in more information, even though they might not make changes to their advisories.

RISK MANAGEMENT

The need for national consistency of written procedures for evaluating health risks associated with contaminants in fish was discussed. Topics brought up during group discussions were the role of public information, the right to know, and how that then plays against the interests of state and Tribal entities in making appropriate decisions for their populations. Overall, participants indicated that full disclosure of all data needs to be balanced with interpreting and dispensing the results in a way that people can understand and that leads to correct decisions for different groups.

GUIDANCE RECOMMENDATIONS

The work groups were not explicitly asked to list their comments for additions or modifications to the following EPA guidance documents. To obtain this information, in some cases, professional judgement was used to express a comment in terms of a possible change to the guidance documents. General comments and recommendations are listed under the heading of

Programmatic Issues. Other comments are organized underneath the relevant guidance document to which they pertain.

- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 1. Fish Sampling and Analysis. Third Edition - Draft* EPA 823-R-99-007. July 1999.
- *Guidance For Assessing Chemical Contaminant Data For Use In Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits. Third Edition - Draft.* EPA 823-R-99-008. August 1999.

I. Programmatic Issues

1. EPA should recommend that the public be advised about state waters not subject to fish advisories.
2. Consistency in fish contaminant monitoring programs and advisories are most important on shared state waterways; consistency is less important on other waterbodies.
3. Currently there is no national repository or clearinghouse to share outreach materials for communicating risks of consuming fish and wildlife among states. It is recommended that such a repository be developed.
4. A national database of fish tissue chemical concentrations would allow states to make regional comparisons of measured chemical concentrations.
5. States would benefit from a consistent recommendation by all federal agencies regarding fish contaminant monitoring and risk assessment procedures.
6. The states need additional funding to conduct fish monitoring programs.

II. Comments and Recommendations — Volume I

1. Document should stress the concept of flexibility to develop an appropriate sampling and analysis program. Consistency in the application of the methodology and process proposed by EPA for designing and monitoring fish contaminant concentrations is more important than consistency in the numbers of fish sampled.
2. The recommended sample type for analysis should depend on the study objectives and the sample type consumed by the target population. For example, a study designed to measure only concentrations of mercury should probably analyze fillets without skin, because mercury accumulates in muscle tissue.
3. The document should address the implications of deviations from the recommended study design, such as unequal numbers of fish in composite samples, sizes of fish exceed the size range recommended for composite samples; and unequal number of replicates at sampling locations. The document should convey the concept that any data is better than nothing.
4. The document should provide guidance for study designs examining chemical contaminant levels in threatened, endangered, or candidate ESA species, where concerns exist about the impact of the study on fish populations.
5. The document should provide guidance on the recommended number of samples necessary to characterize different types (lakes, rivers, estuaries) and sizes of waterbodies. The recommendation should consider, or provide data, on the range and mobility of recommended target species and the cost of monitoring.

6. The document should enhance the guidance for selecting the appropriate number of fish that will comprise a composite sample. The guidance document currently provides tables that assume a coefficient of variation of 50 and 100 (CV) percent for illustrating the statistical power of study designs with different numbers of replicates and numbers of fish per composite sample. Additional data on the measured CV for different fish species and chemicals would be helpful.

7. The document should provide more explicit guidance, and a recommendation of whether the exceedance of screening levels and possible issuance of an advisory should be based on a statistical test. If so, what types of statistical tests and statistical power are recommended?

8. EPA should provide more explicit guidance on recommended criteria that should be met for an existing advisory to be rescinded. Important issues that should be addressed include the length of monitoring required to demonstrate tissue chemical concentrations are below risk-based screening concentrations (RBSCs), whether the comparison to RBSCs should be statistically based, and how to interpret data analyzed by different laboratories or using different methods.

9. The document should clearly indicate that the list of target chemicals is a recommendation that should be considered in the absence of site specific data. Additional information is needed on chemicals not on the EPA target list that are being monitored by state and federal programs. Additional guidance on selecting target chemicals and their priority for analysis is requested. This should be related to land uses, geological characteristics, and regional differences. The document should consider discussing study designs that archive tissue for subsequent analysis and the holding-time limitations for both listed and non-listed target chemicals.

10. Additional guidance is needed on the analysis of PCBs. A cost-benefit discussion of the choice of analyzing Aroclors or PCB congeners would be helpful. Additional guidance on what congeners should be analyzed would be helpful, as well as presentation of data sets comparing the various measures of PCBs, calculation of total PCB concentration, and a comparison of the risk estimates for the different measures of PCB concentration.

11. The document should provide guidance on the measurement and interpretation of lead in fish tissue.

12. The document should reevaluate the recommendation for analyzing PAHs, which are rapidly metabolized in fish tissue.

13. Additional information on organophosphate pesticides in fish tissues and the need for including these chemicals in monitoring programs is requested.

14. The document should discuss what samples may or should be used for other purposes such as ecological risk assessment.

15. The document should provide information on the different sample types that are being analyzed by federal agencies and large regional state programs.

16. Additional data is needed on conversion factors for contaminant levels in different sample types (e.g., fillet with skin, fillet without skin, whole-body, liver, eggs) and fish species.

III. Comments and Recommendations — Volume 2

1. Additional guidance is needed for the interpretation and risk assessment of chemicals that have detection limits higher than risk-based screening concentrations.
2. Additional guidance should be provided on how regional data should be used in the risk assessment process. What inferences, if any, should be made by comparing local fish chemical concentrations that exceed risk-based screening criteria with data collected in regional studies.
3. The document should describe how FDA action levels are calculated and provide the rationale for their use or non-use. Additional guidance is requested on the risk assessment of fish species that are harvested for both commercial and non-commercial uses from the same waterbody.
4. The document should provide guidance on the nutritional benefits of eating fish and how this should be incorporated into the risk assessment methodology.
5. The document should recommend default exposure parameters for elderly individuals.
6. The document should provide a default value for the meal size of shellfish.
7. Several states (14) use contaminant reduction factors in their risk calculations to account for cleaning and cooking losses. It is recommended that additional data be provided on studies that have examined changes in contaminant concentrations due to processing and cooking methods.
8. The document should provide additional guidance, or information, on the selection of an acceptable risk level (ARL). Information on ARLs used by different state and federal programs would be helpful.
9. The document should provide additional guidance on interpreting the relative risk associated with fish consumption to other lifestyle choices.
10. It is recommended that the guidance document consider the risk assessment of Native Americans as a separate population, rather than the upper end of a distribution describing fish consumption. The risk assessment methodology should consider Tribal cultural values and resource management philosophies in addition to chemical exposure.
11. The document should describe and evaluate the QSAR approach for chemicals without toxicity values.

6. Workshop on Communication of Advisories

The professional judgment of public health communicators is important for designing effective communication programs, but our paramount concern is addressing the needs of the audiences with whom we hope to communicate. The risk communication session of the conference was designed to encourage the exchange of ideas among public health communicators. Lisa Weaver and Richard Brooks presented their communication strategies, summarized below. Their presentations were followed by a question-and-answer session and an open-mike discussion. The purpose of the open forum was to allow exchange of effective communication ideas—what has worked, what has not worked. Some of the risk communication techniques that participants felt worked well are listed below:

- Whenever possible, present the message in a way that provides a solution; for example, “Eat smaller and younger fish”
- Give people information and alternatives from credible sources that they can trust
- Translate the message into terminology that people can understand, and conduct readability testing on your materials
- Make the message vivid using images or promotional materials people will remember and want to talk about

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Arkansas Department of Health
Division of Health Education and Promotion

Mercury in Fish: Arkansas' Communication Approach

In 1992, government officials were notified by Louisiana health officials that fish in the Ouachita River in Louisiana had tested positive for mercury above the recommended levels. Officials in Arkansas began testing for mercury in the Ouachita River which runs through the southern part of the state. Mercury was found to be a problem in Arkansas as well.

Directly after the mercury in fish issue was discovered an advisory on consumption of fish was issued through news releases. The governor appointed a task force in 1993 to determine the extent of the problem and to protect and educate the public. The task force itself was made up of representatives from the Arkansas Department of Health, Arkansas Game and Fish Commission and the Department of Pollution Control and Ecology. Many others became involved in addressing the problem through the development of an advisory group which was formed to work with the task force.

Although some initial education efforts, such as, news releases and a fish consumption brochure began when the problem was found, focus group research to help determine the most effective educational messages / methods were not conducted until early 1995.

In the beginning there were problems with the educational efforts. One of the states most prominent television stations displayed a picture of a scull and crossbones as they were informing the public about the advisory. This sensationalism created a scare and many people stopped fishing. The Arkansas Game and Fish Commission reported a 30% drop in the fishing licenses sold. In the beginning little was known about the extent of the problem and which fish species were affected so blanket advisories had to be issued until more was known. Lastly, as a result of the limited knowledge and the urgency to get some information out to the public there was little time to target the message and message delivery system. All of these issues created a true challenge for the task force and advisory group to address.

The ATSDR provided funding for focus group research in 1995. The focus groups were conducted to determine appropriate messages and dissemination methods for reaching the targeted populations. Six focus groups were held which were broken down into three target groups: women of reproductive age, frequent consumers of fish, and the general public. Besides the focus groups with the target populations, an informal focus group was held with secondary providers (groups of professionals who would be needed to assist in educating the population).

Based on the information received from the focus groups, secondary providers and the task force members two key messages emerged: *Eat Fish Safely and Mercury in Fish is a Problem We Can*

Learn to Live With and Still Enjoy Fishing in Arkansas. These messages would be used again and again throughout the educational efforts. The task force decided, based on the research information, that a multi-media campaign was needed to address the issue. The campaign consisted of several methods: print media, electronic media and coordination / communication to educate the target populations.

The print media consisted of a variety of methods, i.e, poster, brochures, flyers, questions/answer guide for professionals, fishing regulation guides, lesson plans, coloring book, newspaper supplement, and pharmacy displays.

The poster was designed to be educational and visually appealing. A nationally syndicated outdoor sports cartoonist and an outdoor sports/writer and radio host helped design the poster.

In an effort to create a identifiable campaign look, cartoons from the poster where used on other educational materials which were developed. The original fish consumption advisory brochure was discontinued and two separate brochures were produced. An educational brochure titled, "Mercury in Fish in Arkansas: What You Should Know" was developed to appeal to the fishing community and be graphically accurate. Again the cartoon pictures were used, as well as, fish graphics designed by a nationally recognized fish illustrator. The brochure contained only educational information that would not change since the brochure was full color and more expensive to print. The second brochure was the fish consumption advisory brochure which listed the bodies of water under advisory and contained maps of the areas affected. Since this brochure contained information that changed when new data was received it was printed in black and white.

To specifically address women of reproductive age a brochure, "Mother and Child: What You Should Know About Eating Fish From Some Arkansas Waters" was developed. The brochure also used the cartoons and specific messages aimed at this target group. It was distributed to local health department units, human services offices, primary care and OB/Gyn physician offices.

The same graphics *(cartoons from poster)* were used to publish information in a mail flyer, a full page / color ad in the Earth Day Supplement of the statewide newspaper and to advertise through a pharmacy display. The flyer was developed by a television station. The flyer was mailed to over 50,000 households in the area of the state affected most by the advisories. The Earth Day Supplement ad reached over 180,000 households statewide. The pharmacy displays were sent to all pharmacies in the counties and surrounding counties of the affected areas.

Lesson plans were developed which included activities such as the, "Class Fish Fry." The lesson plans were developed for elementary and junior/senior high school students. The Arkansas Department of Health created a partnership with the cooperative extension service - home economist to help develop a coloring book, "Spinner the Fish." The coloring book contains a positive message about eating fish safely and has an educational "parents page."

The Arkansas Game and Fish Commission place information in their fishing regulations guide every time it is produced.

Although many forms of print media are used, the use of electronic media has also been a determining factor of success in the educational campaign. The electronic media has helped the campaign efforts to reach a wide range of our target population and provided a visual / audio version of the key messages.

Three videos were produced to help educate the public about the mercury in fish issue. One videos message is aimed at women of reproductive age while the other two focus on frequent consumers of fish. The videos were distributed to county health departments for loan to the public.

Nine public service announcements (PSAs) have been developed. Two of the PSAs were taken from the videos produced early. Since the focus group research found that having a local personality whom they could relate to would be more effective, seven of the PSAs feature a local outdoor sports writer/radio host as the spokesperson. Air time on two television stations was purchased and matched. One station even donated in excess of a three-to-one ratio, produced a free station editorial during the newscast and a free 30 minute public affairs program.

The task force contracted with the Arkansas Educational Telecommunications Network to produce a 30 minute documentary about mercury in fish in Arkansas. This documentary, along with a 60 minute panel discussion and call-in show, aired statewide. More than 260 calls were received during that hour. Task force and advisory-group representatives participated in the project.

The campaign has made use of extensive coordination and communication strategies. The mercury task force put together an advisory group of representatives of over 30 agencies / organizations and community members to assist them in their efforts. The advisory group met once a quarter to review research and educational strategies and to discuss and solve any problems. Media was also invited to all advisory committee meetings. Advisory group members assisted the task force in developing and disseminating educational information to the public. The involvement and regularly scheduled meetings helped to assure that any information given to the public from the various groups were accurate and consistent. Diverse groups have been trained to help get information to the public, i.e., cooperative extension home economists, sanitarians, health educators, nurses, game and fish staff, 4-H club leaders, nutritionists, etc.

The campaign uses various information to evaluate its success. Each of the materials developed contains an evaluation postage-paid reply post card. A couple of the materials have the post cards attached to the educational material itself. The campaign also uses the 1-800 telephone hotline to provide target population feedback and demographics (race, sex, caller location, information requested and message delivery information). We have found that from 1996-1999 the information on race and sex received from the 1-800 number closely mirrors the population of Arkansas as reported in the 1990 census. Figures 1 and 2 show the race/sex demographics from the 1-800 number verses the 1990 Arkansas population census. Figure 3 shows the distribution of calls among management areas (a geographical division of the state in order to provide supervision of services) and areas under a mercury in fish advisory.

The last two years have been particularly difficult. The mercury task force was dissolved at the end of fiscal year 1997. Since that time the budget for educational efforts has continued to be reduced more and more. All of the educational methods: print, electronic and communication/coordination continue to be used, however, on a much smaller scale. The technical work group continues to meet to address changes to the advisories.

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When We Give Advice: Principles for Communicating Health Messages

How Risk is Understood and Target Audiences

Target materials may work with some audiences and offend others, however, if information is not targeted it would not work. Due to information over-saturation in our society, messages must be very good, targeted, and responsive to people's needs and wants. Experts know what people need, but only people know what their wants are, and that is important when tying to reach people with a message. Emphasizing the positive is a more productive way to convey a message than listing all of the things that people should not do. The thought is that people need to be warned about what is dangerous in their environment, but not so much that they are turned off or scared to death. Readability testing is also necessary because between 20 and 30 percent of the population can not read above an 8th grade level. If education materials are written at a higher level, the message would miss approximately one-third of the target audience.

Designing Messages

In health education, the right behavior change should be simple, easy, convenient and understandable, not difficult. One model for message design consists of four components, designed after the Italian opera approach, AIDA: attention, interest, design, and action. You want to get people's attention, appeal to their interest and desire and then tell them what the proper action is to take. For example, instead of appealing to fishermen, who pride themselves on their catch, direct efforts to women of childbearing age and present the risk in context of the development of the child and then lead them into the action step in a non-threatening manner.

Another model for message design is known as the transtheoretical model, or stages-of-change model. The purpose of this model is to change people's behavior over the long term. The first stage is precontemplation, "I'm not thinking about the issue or risk." The second stage is contemplation, "I should be thinking about the issue or risk?". The third stage is preparation, "This is going to affect me, I'm at risk, maybe I should change my behavior." The fourth, and final, stage is action, "I'm going to stop putting myself at risk; I'm going to stop this action." However, many people will relapse and need social support. That is why the context is important, to provide recommendations and social support, information and alternatives from credible sources.

Overall, get people's attention by making the message vivid and using metaphors and similes. Multimedia is a great resource for communicating information to a large audience. Before this can be effective, however, it is important to know your audience, what they do know, what they do care about, what matters to them, how you can piggy-back your message onto what matters to them, how to reinforce that message, and how to get credible people to carry the message to other people they care about. Building partnerships is a vital component of health education because one person cannot do it all.