United States
Environmental Protection
Agency

Office of Water
Washington, DC 20460

EPA–823-R-07-008
September 2007

Proceedings of the 2007 National Forum on Contaminants in Fish

All sections of the 2007 Proceedings are available from our web site at:
http://www.epa.gov/waterscience/fish/forum/2007/

Index of Abstracts

[This page intentionally left blank.]

Booths

New Efforts to Communicate the EPA-FDA Consumer Advisory on Mercury in Fish and Shellfish

Erica Fleisig, U.S. Environmental Protection Agency

Primary Contact Information:
Erica Fleisig, Environmental Scientist
National Fish and Wildlife Contamination Program, U.S. EPA - 4305T
1200 Pennsylvania Avenue, NW, Washington DC 20460
Tel: 202-566-1057 Email: fleisig.erica@epa.gov

The U.S. Environmental Protection Agency (EPA) and U.S. Food and Drug Administration (FDA) work together to provide advice for women of childbearing age and young children about how to receive the nutritional benefits of eating fish and shellfish and reduce their exposure to the harmful effects of mercury. In 2004, the two agencies released the brochure, *What You Need to Know about Mercury in Fish and Shellfish*, targeting women of childbearing age and physicians. Available in eight languages (English, Spanish, Chinese, Vietnamese, Cambodian, Portuguese, Korean, and Hmong), approximately 5 million copies of this brochure have been distributed to more than 200,000 members of U.S. medical and public health organizations. Recently, EPA also produced a poster, *One Fish, Two Fish, Don't Fish, Do Fish*, and a key tag that remind kids and adults about EPA's and FDA's recommendations for selecting and eating fish and shellfish that are lower in mercury. EPA also continues to distribute the brochure, *Should I Eat the Fish I Catch?* (available in English, Spanish, Korean, Vietnamese, Hmong, and Cambodian), which discusses ways to reduce health risks from eating fish containing chemical pollutants.

A Quick and Accurate Method for Determining Mercury Levels in Fish Tissue Utilizing Direct Mercury Analysis

Johan Nortje and Amy Schmaling, Milestone, Inc.

Primary Contact Information:
Johan Nortje, Milestone, Inc.
25 Controls Drive, Shelton CT 06484
Tel: 203-925-4240 Email: jwn@milestonesci.com

Amy Schmaling, Milestone, Inc.
25 Controls Drive, Shelton CT 06484
Tel: 203-925-4240 Email: amy@milestonesci.com

The determination of mercury (Hg) in freshwater and saltwater species has become a primary focal point of both private and public institutions. Traditionally, cold vapor atomic absorption spectrophotometry has been used to measure Hg levels in fish. Although effective, this technique is a time- and labor-consuming method that relies on complicated sample preparation. In contrast, the Hg levels determined for this presentation were generated using Milestone, Inc.'s DMA-80 Direct Mercury Analyzer. Described in EPA Method 7473, this instrument rapidly analyzes a sample (with no wet chemistry or sample prep required) via thermal decomposition and subsequent conversion of Hg to its elemental state by means of catalytic reduction. The total

Hg in the sample is then measured by a dual-cell atomic absorption spectrophotometer, with total analysis time approximately 5–6 minutes. Because no wet chemistry is used, there is no complicated waste disposal with which to contend. Our results show that the direct Hg analysis is both an accurate and precise method for determining Hg concentrations in fish tissue and other environmental samples. During the poster session, Milestone will be running fish samples real time on the DMA-80 to demonstrate the process.

Posters

Body Burden of Mercury, the Role of Fish Consumption, and Possible Elevated Coronary Risk in a Sample of Kuwaiti Citizens

Mey Akashah, Jaafar Behbehani, Martha Fay, and John Evans

Primary Contact Information:
Mey Akashah, Sc.D. candidate
Harvard School of Public Health; Exposure, Epidemiology and Risk Program
Landmark Center West, Room 422
P.O. Box 15677, 401 Park Drive, Boston, MA 02215
Tel.: 617-230-6004 Email: makashah@post.harvard.edu

Recently there has been a great deal of debate surrounding the health benefits related to fish consumption and the concomitant risks stemming from methylmercury (MeHg) ingestion, especially with regard to cardiovascular health. Polyunsaturated fatty acids, which are abundant in some species of fish, have been widely shown to improve cardiovascular health, while emerging evidence also suggests that exposure to mercury (Hg) through fish may actually result in increased risks of cardiovascular disease. It was our intention to assess whether elevated levels of mercury exist in Kuwait as a result of fish consumption and whether these values might be associated with increased risks of cardiovascular disease. We used, as a basis for our analysis, findings from a study conducted by Salonen et al. (1995), which showed that increased risk of myocardial infarction (MI) was associated with elevated hair Hg levels in a sample of 1,833 Finnish males. We first examined fish consumption as it related to blood Hg levels in a sample of 189 Kuwaiti citizens aged 64–83 years and 59 citizens aged 39–63. We next estimated the potential risk of MI that might exist in this population if it were subjected to the same relative risks that Salonen et al. found to be associated with elevated levels of hair Hg in the Finnish sample.

Mercury Bioaccumulation and Trophic Transfer in Sympatric Snapper Species from the Gulf of Mexico

Michael S. Bank[1], Edward Chesney[2], James P. Shine[1], Amund Maage[1,3], and David B. Senn[1]

[1] Harvard School of Public Health, [2] Louisiana Universities Marine Consortium, [3] National Institute of Nutrition and Seafood Research, Bergen, Norway

Primary Contact Information:
Michael S. Bank, Ph.D.
Harvard University, School of Public Health, Department of Environmental Health
Landmark Center West, 4th Floor
401 Park Drive, P.O. Box 15677, Boston, MA 02215, USA
Tel: 617-384-8544 Email: mbank@hsph.harvard.edu

Consumption of marine fish is a major route of toxic methyl mercury (MeHg) exposure to ocean apex predators and human populations. Here we explore the influence of trophic structure on total mercury (Hg) accumulation in red snapper (RS, *Lutjanus campechanus*) and gray snapper (GS, *Lutjanus griseus*) from the coastal Louisiana region of the Gulf of Mexico, west of the Mississippi River. The objectives of this investigation were to: (1) determine the effectiveness of the use of off-shore recreational fishing charter boats and marinas as sources of fish samples, and (2) compare species differences in Hg bioaccumulation, trophic position, and carbon sources. Our data show that length-normalized Hg concentrations (>97% as MeHg in tissue of both species) were 230% greater ($P < 0.001$) in GS ($n = 45$) than in RS ($n = 34$) collected from the same general area. Stable C and N isotope signatures ($\delta^{15}N$ and $\delta^{13}C$) indicate that GS occupy a slightly higher trophic position (~30% of one trophic position higher) on the Gulf food web in comparison to RS, and that GS appear to incorporate higher trophic positioned prey, continually, and at smaller sizes. Hg was strongly correlated with combined $\delta^{15}N$ and $\delta^{13}C$ ($r^2 = 0.83$) in pooled species data, arguing that most of the substantial difference in Hg bioaccumulation between RS and GS can be explained by modest differences in their trophic position, and, to a lesser degree, carbon sources, which had low variation and high overlap among species. These observations demonstrate that even minor to moderate differences in trophic position and food habits in sympatric species can create relatively large differences in bioaccumulation regimes, and they underscore the importance of quantitative characterization of trophic structure in marine MeHg bioaccumulation studies.

National Study of Historical Mercury Advisory Sites

Jeanine Boyle[1], Robert Lordo[1], and Jeffrey Bigler[2]

[1] Battelle; [2] U.S. Environmental Protection Agency

Primary Contact Information:
Jeanine Boyle, Battelle
397 Washington Street, Duxbury, MA 02332
Tel.: 781-952-5327 Email: boylej@battelle.org

The U.S. Environmental Protection Agency (EPA) is conducting a national study of mercury (Hg) levels in fish tissue at historical (pre-1996) Hg advisory sites. EPA's Data Quality Objectives (DQO) process was used to design a study to:

- Characterize current mercury Hg from fish tissue on a regional or national basis, using data from a representative sample of historical Hg advisory sites.
- Evaluate differences between the new Hg tissue data and the historical tissue data on a site-by-site basis.
- Using the current EPA national guidance (National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, 2000) and the new Hg tissue data, determine which percentage of sites in the United States would support a change to existing meal consumption advice based on current data.

EPA's National Listing of Fish Advisories (NLFA) database was used to identify eligible sites for this study. The database is a compilation of information on all existing local advisories in the United States, including 983 freshwater sites in the conterminous United States (freshwater lakes, rivers, and reservoirs) where Hg advisories were issued prior to 1996. Of the 983 sites, a total of 100 sites were randomly selected using a stratified sampling design to serve as a representative national sample. Each site has been researched to verify that the pre-1996 advisory was listed for Hg contamination and that the data used to support establishment of the advisory are available.

In the summer/fall of 2007, fish will be collected from the 100 selected sites. At each selected site, 15 fish (of a common species cited in the advisory) will be collected from a common size category. The fish will be composited in groups of five and analyzed at Battelle's Marine Science Laboratory in Sequim, WA. Tissue (fillet) samples will be analyzed for total Hg using EPA Method 1631e, modified for tissue. These Hg concentrations will be summarized and analyzed using statistical methods to address study objectives. All field and laboratory activities will adhere to procedures specified in a project-specific Quality Assurance Project Plan (QAPP) that was developed based on EPA's National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories.

Risk from Consumption of Subsistence Foods: Data from the Aleutians

J. Burger and M. Gochfeld, Rutgers University

Primary Contact Information:
Dr. Joanna Burger
Rutgers University
Nelson Labs, 604 Allison Road, Piscataway, NJ 08854-8082
Tel: 732-445-4318 E-mail: Burger@Biology.Rutgers.Edu

Most studies of subsistence diets examine the consumption of wild-caught fish, and many examine only one contaminant, usually polychlorinated biphenyls (PCBs) or mercury (Hg). Yet, subsistence peoples, or anyone relying on wild-caught foods, may also consume a range of food, including kelp and other algae, shellfish and other invertebrates, fish, birds, and even marine mammals. We examined the levels of radionuclides and Hg (as well as PCBs in some fish) in a wide range of organisms consumed by Aleuts living in the Aleutians. While anthropogenic radionuclides were generally low, some natural ones were higher than expected. Mercury levels ranged widely in subsistence foods, suggesting the need for selection among foods, particularly for at-risk populations (such as children or pregnant women). This work was supported by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) (DOE DE-FC01-06EW07053) and the National Institute of Environmental Health Sciences (NIEHS) (P30ES005022).

The Fish Mercury Project: Monitoring, Advisory Development, Stakeholder Involvement, and Risk Communication in the Sacramento–San Joaquin Delta Watershed

Robert Brodberg[1], Alyce Ujihara[2], Jay Davis[3], Mark Stephenson[4], Autumn Bonnema[4],Tivo Cheatham-Rojas[5], Margy Gassel[1], Letitia Grenier[3], Wes Heim[4], Ilinisa Hendrickson[5], Jennifer Hunt[3], Gary Ichikawa[4], Billy Jakl[4], Jessica Kaslow[5], Susan Klasing[1], Aroon Melwani[3], Sue Roberts[1], Elana Silver[5], and May Lynn Tan[5]

[1] Office of Environmental Health Hazard Assessment; [2] California Department of Public Health; [3] San Francisco Estuary Institute; [4]California Department of Fish and Game; [5] Impact Assessments, Inc.

Primary Contact Information:
Robert K. Brodberg, Ph.D.
Cal/EPA, Office of Environmental Health Hazard Assessment
Mail Stop 12-B, P.O. Box 4010, Sacramento, CA 95812-4010
Tel: 916-323-4763 Email: rbrodberg@oehha.ca.gov

Fish contamination has been a serious environmental and public health concern in California's Sacramento-San Joaquin Delta watershed. Historic data show that mercury (Hg) accumulates in fish in some areas at levels that may pose health risks to frequent consumers of these fish. However, many waterbodies and fish species have not been tested. The Fish Mercury Project (FMP), funded by the California Bay-Delta Authority, is a collaborative, 3-year effort to protect human health by characterizing Hg contamination in fish, develop consumption guidelines for the public, and reduce human exposure to Hg in fish through risk communication.

Monitoring activities, which will be completed this summer, have included commonly consumed species in about 100 locations. The information gained from the FMP will shed light on the spatial and temporal trends of Hg contamination in fish from the watershed and support the development of consumption guidelines to protect public health.

Consumption guidelines have been developed for several river tributaries where Hg concentrations in fish were highest: the Cosumnes, Mokelumne, and Feather Rivers. Regional advisories have been developed for the San Joaquin River and separately for the south Delta. Mercury concentrations in fish in the southern Delta were low enough to recommend consumption of a meal per week or more for most fish species.

Risk communication activities include the development of multilingual educational materials, the posting of warning signs, and the conduct of training and capacity building activities. The FMP has also provided small grants to community-based groups to develop educational activities targeting hard-to-reach populations that fish in the watershed.

The project has also undertaken an innovative approach by directly involving diverse stakeholders in the planning and implementation of project activities. By involving stakeholders, who include tribal, environmental justice, angler, environmental advocacy, and community-based groups, the project can best addresses the concerns of the populations that may be impacted by local fish contamination problems. Development of the draft south Delta and San Joaquin River advisories will be used to discuss how the project has linked monitoring, advisory development, risk communication, and stakeholders.

The Use of Passive Samplers (SPMD and POCIS) for Monitoring Dioxin and Pesticide Levels in Maine Surface Waters

Lucner Charlestra[1], Howard Patterson[2], David L. Courtemanch[3], Aria Amirbahman[4]

[1] Sen. George Mitchell Center for Environmental and Watershed Research, University of Maine; [2] Department of Chemistry, University of Maine; [3] Maine Department of Environmental Protection; [4] Department of Civil and Environmental Engineering, University of Maine

Primary Contact Information:
Lucner Charlestra, Ph.D. student
5710 Norman Smith Hall
University of Maine, Orono, ME 04469
Tel: 207-745-7408 Email: Lucner_Charlestra@umit.maine.edu

Paper mill effluents may contain dioxins that are generated due to chlorine bleaching of pulp and paper. Semipermeable Membrane Devices (SPMDs) loaded in canisters were deployed for 36 days to monitor dioxin at one site upstream of a paper mill at Riley, and in three downstream sites at Snoopy, Livermore, and Livermore Falls. After retrieval, SPMD samples were analyzed according to EPA method 1613B. Water concentration estimates varied from 0.005 pgL^{-1} for 2,3,7,8-TCDF at one of the downstream sites to 0.098 pgL^{-1} for OCDD at the upstream site.

Pesticide sampling with the Polar Organic Chemical Integrative Sampler (POCIS) were carried out in four water bodies: Pleasant River, Pleasant River Lake, Pork Brook, and Bog Brook. POCIS samples were extracted with methanol and analyzed by a 6890 GC coupled with a 5973

MSD (Agilent Technologies). Mean concentrations of phosmet ranged from 5.90 ng/2 POCIS-sample (at Pork Brook) to 19.52 ng/2 POCIS-sample (at Bog Brook), and ranged from non-detect to 6473 ng/2 POCIS-sample (at Pleasant River) for hexazinone. The overall results showed a promising opportunity of using the POCIS device to monitor the pesticides used on the blueberry fields in Washington and Hancock Counties.

Keeping our Traditions and Our Families Alive: Aroostook Band of Micmacs Fish Consumption Advisory

Shannon Kirk and Fred Corey

Primary Contact Information:
Fred E. Corey
Aroostook Band of Micmacs
8 Northern Road, Presque Isle, ME 04769
Tel: 207-764-7765 Email: fcorey@micmac-nsn.gov

The Aroostook Band of Micmacs Indian Tribe has developed a culturally relevant fish consumption advisory based on safe eating guidelines developed by the Maine Bureau of Health. The fish consumption advisory is utilized to provide fish consumption information to tribal members of the Aroostook Band of Micmacs and is distributed with all fishing licenses issued by the Tribe. The fish consumption advisory is also featured in tribal newsletters, posters, and brochures.

Reducing Risks to the Anishinaabe from Methylmercury: A GIS-Based Fish Consumption Advisory Program for Walleye

Adam DeWeese[1], Neil E. Kmiecik[1], and Jeffery A. Foran[2]

[1] Great Lakes Indian Fish and Wildlife Commission; [2] ESHI, LLC, Whitefish Bay, WI

Primary Contact Information:
Adam DeWeese
Biological Services Division, Great Lakes Indian Fish and Wildlife Commission
P.O. Box 9, Odanah, WI 54861
Tel: 715-682-6619, ext. 189 Email: adeweese@glifwc.org

Since 1989, the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) has collected data on mercury (Hg) concentrations in walleye from lakes in the 1837 and 1842 treaty-ceded lands of northern Wisconsin, Michigan, and Minnesota. Beginning in 1996, GLIFWC used these data to produce color-coded, geographic information system- (GIS-) based consumption advisory maps providing lake-specific information on the amount of methylmercury (MeHg) in walleye. GLIFWC received a U.S. Environmental Protection Agency Science to Achieve Results (STAR) grant in 2003 to enhance and evaluate its efforts to reduce risks associated with subsistence-based consumption of MeHg-contaminated walleye. As part of this grant, GLIFWC's maps were revised to ensure that they were culturally sensitive and that they adequately protected the health of tribal members. Tribal leaders, health care providers, fish harvesters, children, and elders were trained in the use of the maps. Tribal health care providers were asked to train mothers with

young children and women of childbearing age through tribal health programs. The efficacy of these interventions was evaluated through a series of targeted surveys designed to document changes in knowledge and behavior after implementation of the program. A description of the advisory program and results of the surveys will be presented.

Field Data and Predicted Impacts from a Municipal Waste Combustion Facility

Kristen Durocher[1], Tareq Adham[2], Brian Stormwind[3], and Bill Davidson[4]

[1] ENSR, Belmont, NH; [2] ENSR, Raleigh, NC; [3] ENSR, Westford, MA; [4] Montgomery County Division of Solid Waste Services, Rockville, MD

Primary Contact Information:
Kristen Durocher, ENSR
171 Daniel Webster Highway, Suite 11, Belmont, NH 03220
Tel: 603-524-8866 Email: kdurocher@ensr.aecom.com

During the planning process for a municipal waste resource recovery facility, public concern was raised regarding potential human health effects associated with exposure to facility-related emissions. Given this concern, a multimedia monitoring program was designed. Samples were collected in 1994–1995 before construction of the facility (pre-operational phase). Since the facility became operational in 1995, regular sampling events have been implemented (1996, 2001, 2004 and 2007). Samples have been collected from locations predicted to have the highest deposition. Pre-operational and operational-phase monitoring has included analysis of total Hg in various non-air media, including farm pond surface water and fish tissue. While pre- and post-operation monitoring data indicate no evidence of facility impacts on fish from sampled farm ponds, levels of Hg in fish remained of particular interest to the public. Fillet and whole-body fish tissue Hg data are available for trophic level four fish (largemouth bass) and trophic level three fish (bluegill and green sunfish). Measured concentrations from field-collected fish were compared to concentrations predicted in accordance with current U.S. U.S. Environmental Protection Agency guidance (1998 and 1999) for evaluating risk to human health from exposure to emissions from combustion facilities. This comparison indicates that the model may overestimate Hg fish tissue concentrations by as much as a factor of 20 for trophic level four fish species. Further review of the model parameters indicate that the bioaccumulation factors used in the model may be several orders of magnitude greater than site-specific bioaccumulation factors.

The Selection of Fish Consumption Rates as a Risk Management Decision

Ellen S. Ebert and Russell E. Keenan, AMEC Earth & Environmental, Inc.

Primary Contact Information:
AMEC Earth & Environmental, Inc.
15 Franklin Street, Portland, ME 04101
Tel: 207-879-4222 Email: ellen.ebert@amec.com and russell.keenan@amec.com

The derivation of chemical-specific statewide water quality criteria (WQC) for substances that bioaccumulate in fish tissue is largely dependent on the selection of a fish consumption rate,

particularly for those compounds in which ingestion of water is a minor source of exposure in comparison to ingestion of fish. For such substances, the magnitude of the WQC is inversely proportional to the fish consumption rate that is chosen for the derivation. In turn, the resulting WQC can have a substantial economic impact on point-source dischargers to regulated waterbodies.

Selection of an appropriate fish consumption rate for developing WQC involves data gathering, analysis, interpretation, and professional judgment because there is enormous variability in the amounts of fish that people consume. Upon examining these data, however, an important unifying trend is that at higher fish consumption rates, there are fewer people who consume fish at that rate. As a result, the selection of a fish consumption rate for deriving WQC involves an implicit risk management decision, which is not a purely scientific question. It is very important that the variable levels of protection afforded by the selection of fish consumption rates are understood and quantified, if possible, so that the implications of competing choices are transparent. This poster will discuss and demonstrate the levels of protection, from a population risk perspective, that are represented by alternative choices in the selection of fish consumption rates for the purpose of deriving WQC in a more informed manner.

Spatial Trends in Tissue Levels of PCBs, Dioxins/Furans and PFOAs/PFOSs across the Delaware River Basin: Implications for Control Strategies and Consumption Advice

Thomas J. Fikslin and Gregory J. Cavallo, Delaware River Basin Commission

Primary Contact Information:
Thomas J. Fikslin, Ph.D., Head, Modeling and Monitoring Branch
Delaware River Basin Commission
25 State Police Drive, P.O. Box 7360, West Trenton, NJ 08628
Tel: 609-883-9500, ext. 253 Email: Thomas.Fikslin@drbc.state.nj.us

The Delaware River Basin Commission (DRBC) has been conducting monitoring for contaminants in fish tissue since 1990 at locations along the mainstem of the Delaware River, an interstate waterbody bordered by Delaware, New Jersey, New York, and Pennsylvania. These data are then used by the states to issue consumption advice. The mainstem Delaware River flows from relatively pristine headwaters through the urban areas of Philadelphia, PA, Trenton, NJ, and Wilmington, DE, to the ocean at the mouth of Delaware Bay.

Hydrophobic contaminants such as polychlorinated biphenyls (PCBs), dioxins/furans, perfluorooctanoic acids (PFOAs)/perfluorooctane sulfonates (PFOSs), and other emerging contaminants are frequently characterized as ubiquitous and difficult to readily control. Therefore, consumption advisories are the principal tool to minimize exposure through fish and water consumption. Our data, however, indicate that for many of these pollutants, contaminant levels in fish collected in less impacted portions of the Delaware River are frequently significantly lower than in those collected from urban areas. Data are presented for contaminants of historical interest, such as PCBs, and for emerging contaminants, including dioxins/furans, octanoic acids, and sulfonates. This has significant implications for both control strategies and consumption advice. Differences within the Delaware River watershed imply local sources of these pollutants. Strategies for identifying sources and reducing their pollutant loads are

therefore more practical. Control strategies can also be prioritized to areas where reductions in the loadings of these pollutants will result in reductions in the severity of consumption advice. In addition, advice can also identify areas of the watershed where fish are less contaminated and advice is less stringent.

Study on the Effectiveness of the Mississippi Delta Fish Advisory

Henry Folmar[1], Jennifer Schimek[2], Camille Heaton[2], and Jeffrey Bigler[3]

[1] Mississippi Department of Environmental Quality; [2] RTI International; [3] U.S. Environmental Protection Agency

Primary Contact Information:
Henry Folmar
Mississippi Department of Environmental Quality
P.O. Box 10385, Jackson, MS 39289-0385
Tel: 601-961-5529 Email: Henry_Folmar@deq.state.ms.us

In 2001, Mississippi Department of Environmental Quality (MDEQ) launched an extensive outreach campaign to inform Mississippi Delta residents of the regional fish consumption advisory issued for dichloro-diphenyl-trichloroethane (DDT) and toxaphene. Under a U.S. Environmental Protection Agency outreach grant, members of academia, government, state agencies, and the environmental community assembled to assess the effectiveness of the Delta fish advisory. As part of the study, a survey and methodology for conducting the survey were developed. The survey is anticipated to occur in spring 2008.

Cooperative Seafood Monitoring in Louisiana, Mississippi, and Alabama Following Hurricane Katrina

Henry Folmar[1], Chris Piehler[2], Fred Leslie[3], and Neil Sass[4]

[1] Mississippi Department of Environmental Quality; [2] Louisiana Department of Environmental Quality; [3] Alabama Department of Environmental Management; [4] Alabama Department of Public Health

Primary Contact Information:
Henry Folmar
Mississippi Department of Environmental Quality
P.O. Box 10385, Jackson, MS 39289-0385
Tel: 601-961-5529 Email: Henry_Folmar@deq.state.ms.us

Hurricane Katrina made landfall along the Mississippi-Louisiana border near the mouth of the Pearl River on August 29, 2005. Following the storm and the devastation left in her wake, there were concerns about the safety of consuming seafood from the northern Gulf area that was impacted by the storm. The states of Louisiana, Mississippi, and Alabama, with tremendous support from their federal partners, came together to conduct an intensive evaluation of the resource. A coordinated sampling effort was planned and conducted, using consistent target species, sampling protocols, and analytical methods. The Louisiana and Mississippi samples were analyzed by U.S. Food and Drug Administration Laboratories, while the Alabama samples

were analyzed by the Alabama Department of Environmental Management. The target species for the study included species of commercial and recreational importance, including red drum, speckled trout, white trout, flounder, croaker, spot, mullet, red snapper, blue crabs, and shrimp (brown and white). Oysters were also sampled in Louisiana. Over 500 samples were collected from more than 75 sites in the three-state area. The samples were analyzed for polycyclic aromatic hydrocarbons (PAHs), pesticides, polychlorinated biphenyls (PCBs), and metals. The states evaluated the results individually, then the group evaluated the results collectively. The results indicated that there were some elevated levels of mercury (Hg), as expected, there were a few measurable concentrations of PCBs, and there were some elevated levels of cadmium and arsenic in the hepatopancreas or mustard of blue crabs, but that there were no concentrations found that would warrant additional fish consumption advisories, and that there appeared to be no increase in contaminant levels as a result of the storm.

Lowering Contaminants in Farmed Atlantic Salmon Through Dietary Modifications

Erin Friesen, Dave Higgs, Michael Ikonomou, Shannon Balfry, Brent Skura, Tony Farrell, Janice Oakes, Greg Deacon, Jason Mann, David Maenz, Ann Gannam, and Age Oterhals

Primary Contact Information:
Erin Friesen, Ph.D. Candidate
The University of British Columbia
Food Science Program, Department of Fisheries and Oceans, West Vancouver Laboratory
Vancouver, BC, Canada V6T 1Z4
Tel: 604-666-0034 Email: efriesen@interchange.ubc.ca

Public confidence in farmed fish products fell with the release of several studies that indicated that farmed salmon contained higher levels of persistent organic pollutants (POPs) than their wild counterparts. Ingredients commonly used in aquaculture feeds, marine fish oil, and to a lesser extent, fishmeal, are considered to be the main sources of POPs in cultured fish. Due to additional concerns regarding the increasing price and demand for these limited resources, we conducted a feeding that examined the use of plant-, animal-, and contaminant-reduced lipid sources and plant and animal protein sources as alternatives to fish oil and fish meal in Atlantic salmon feed with the objective of dramatically reducing flesh POP concentrations.

Triplicate groups of Atlantic salmon (mean initial wt 84 g) were fed one of seven dietary treatments for 24 weeks. Fish meal and fish oil were used in diet 1 as the control treatment, diet 2 was a cost-effective dietary treatment currently used by the aquaculture industry in British Columbia, diets 3–5 utilized alternative dietary lipids (flaxseed oil, poultry fat, or crude super de-gummed canola oil), and diets 6 and 7 were formulated to contain low levels of POPs by using both alternative lipids (crude super de-gummed canola oil) and proteins (canola or soy concentrate meal), in addition to activated carbon-treated anchovy oil. Following this initial 24-week feeding interval, the fish were switched to dietary treatments based on 100% anchovy oil (diets 1–5) or 100% contaminant-reduced anchovy oil (diets 6 and 7) and fed for another 12 weeks. This "wash out" period was conducted to restore the levels of omega-3 highly unsaturated fatty acids, viz., eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA).

At the end of the first interval, the nutritive value of the dietary treatments was assessed on the basis of fish growth performance, fillet proximate and fatty acid composition, apparent digestibility coefficients, fish health, fish cardiovascular performance, and flesh POP concentrations. Lower growth parameters were noted for fish fed diets 6 and 7, and these differences remained for diet 6 during phase 2 of the feeding trial. Fillet fatty acid compositions were found to reflect dietary treatments, and the levels of EPA and DHA almost completely restored when the fish were returned to fish oil-based diets. Flesh levels of polychlorinated dibenzodioxins, polychlorinated dibenzofurans, polychlorinated biphenyls, and polybrominated diphenyl ethers were lowered with the use of alternative dietary lipids.

Knowledge of Advisories and Fish Consumption Patterns among Women Presenting to Outpatient Clinics at the Medical University of South Carolina

Ivar L. Frithsen[1], William Goodnight[2], and Joyce Nicholas[3]

[1] Medical University of South Carolina, Department of Family Medicine; [2] Medical University of South Carolina, Department of Obstetrics and Gynecology; [3] Medical University of South Carolina, Department of Bioinformatics, Biostatistics, and Epidemiology

Primary Contact Information:
Ivar L. Frithsen, M.D., M.S.
Medical University of South Carolina, Department of Family Medicine
295 Calhoun Street, Box 250192, Charleston, SC 29425
Tel: 843-792-2281 Email: frithse@musc.edu

The objectives of this study were to determine awareness of fish consumption advisories and if racial disparities exist in knowledge of advisories among women seen in outpatient clinics at the Medical University of South Carolina (MUSC) in Charleston, SC. The study also sought to determine fish consumption patterns and advisory information sources in the same population.

Researchers from three departments at MUSC developed a survey that was completed by women presenting to the MUSC Family Medicine Center and the MUSC Women's Health Center from July 2006 through May 2007.

Results indicate there is an overall lack of awareness concerning fish consumption advisories with racial and socioeconomic disparities in advisory knowledge. Respondents generally consume fish at levels that are within the limits of the latest federal advisory, although some at-risk women consume species of fish they are advised to avoid. Information on advisories is often attained via mainstream media.

Further investigation into disparities in awareness of fish consumption advisories is necessary to improve future educational interventions. Women who are considered at risk of harm from contaminants eat less fish than current guidelines suggest. Novel educational interventions should be developed to encourage safe consumption of fish.

Moving Toward a Risk/Benefit Paradigm for Sport Fish Consumption

Susan Klasing, Margy Gassel, and Robert Brodberg, California Environmental Protection Agency

Primary Contact Information:
Margy Gassel
Office of Environmental Health Hazard Assessment (OEHHA)
1515 Clay Street, 16th Floor, Oakland, CA 94612
Tel: 510-622-3166 Email: mgassel@oehha.ca.gov

Fish provide unique nutritional benefits while also serving as a significant exposure pathway for several chemicals of concern. Fish consumption advice is generally provided to the public from disparate arms of the biomedical community: physicians and nutritionists, who focus on the health benefits of eating fish, and toxicologists, who concentrate on the risks from exposure to contaminants that may be found in fish. The conflicting messages that often result likely confuse the consumer, who may then ignore recommendations to limit consumption of contaminated fish or, alternatively, avoid eating fish altogether. Only recently has there been a more focused attempt to craft unified guidance that addresses benefits and risks of fish consumption, although beneficial aspects are generally only discussed qualitatively. Even so, research has indicated that such advisories may reduce consumers' willingness to eat fish without sufficient regard for the benefits of fish consumption.

Health and nutrition organizations generally advise eating at least two 3-ounce (cooked) servings of fish per week, particularly fatty fish, corresponding to 24 grams of fish per day. The 1999–2002 National Health and Nutrition Examination Survey showed that average fish consumption in the United States is just 14 grams per day. Estimates of the appropriate intake of very long chain omega-3 fatty acids found in fish (docosahexaenoic acid and eicosapentaenoic acid, or DHA + EPA) vary appreciably, ranging from approximately 160 mg per day to more than 1,000 mg per day, depending, in part, on age and cardiovascular disease risk factors of the consumer. In the United States, average intake of DHA and EPA is 103 mg per day, well below most recommendations. Fish consumption advice designed solely to reduce fish contaminant exposures may unwittingly exacerbate this problem, as many low-contaminant fish are also low in omega-3 fatty acids.

The traditional risk paradigm (i.e., maintaining average exposures well below the reference dose and using very conservative acceptable cancer risk levels) that is justified when contaminants are present in environmental media that can be remediated, differentially avoided, or replaced, is overly conservative when considering fish consumption. Conversely, recommending "safe" levels of fish consumption, based on contaminant concentrations, in quantities unlikely to benefit consumers (e.g., one fish meal per month or less) should also be reconsidered. States and Tribes have the authority to issue fish consumption advisories and, as such, may establish a risk/benefit paradigm to more appropriately balance the risks and benefits of fish consumption to promote the overall health of the fish consumer. OEHHA is working to modify its paradigm and has incorporated changes in recent draft advisories.

Women's Health Care Provider Mercury and Fish Consumption Communication Assessment

Sherry Godlewski[1], Jane Korey[2], Bethany Fleishman[2], Nancy Serell [2], and Pamela Schnepper[1]

[1] New Hampshire Department of Environmental Services; [2] Dartmouth Toxic Metals Research Program

Primary Contact Information:
Sherry Godlewski
Environmental Health Educator
New Hampshire Department of Environmental Services
29 Hazen Drive, Concord, NH 03302
Tel: 603-271-6801 Email: sgodlewski@des.state.nh.us

A healthy diet is critical to proper fetal development. Low-level mercury (Hg) exposure during pregnancy has been associated with impaired fetal neurodevelopment. Fish consumption is a major source of exposure to Hg but also the primary source of omega-3 fatty acids in the diet of most American women. Omega-3 fatty acids are necessary for the proper development of the visual and nervous systems, therefore an important part of a pregnant woman's diet. A small percentage of women in the United States have blood Hg levels above the U.S. Environmental Protection Agency (EPA) reference dose, while the majority of women are deficient in omega-3 fatty acids. The goal of the U.S. Food and Drug Administration and EPA Hg fish consumption advisory is to ensure that women continue to eat fish and shellfish because of the nutritional benefits, while encouraging them to make choices that reduce potential Hg exposure.

Women's health care providers in New Hampshire have been distributing the brochure *Is It Safe to Eat the Fish We Catch?* to educate pregnant women about the potential risks of Hg exposure. Unfortunately, this communication material omits emphasis on the known nutritional benefits of fish consumption for pregnant women. Due to confusion about the Hg warnings, some pregnant women have decided that it is safer to avoid eating fish. Therefore, there is a need to correct the risk perception regarding Hg and fish consumption and to evolve the understanding of the advisory message from "don't eat fish" into "eat healthy fish."

The New Hampshire Department of Environmental Services is using a grant from EPA's Healthy Communities Program to evaluate and redesign our women's medical provider outreach materials using a community-based social marketing approach. Information collected though interviews with pregnant women in their health care providers' offices will define their understanding of the Hg fish consumption advisory and identify the likely features to improve communication through a new brochure.

The information transmitted to pregnant women through their health care providers is likely to have an impact on their behavior during their pregnancy. To understand how this information is delivered and to assess the improvements with the new brochure, a questionnaire to assess current risk communication practices and their effectiveness has been developed and distributed to approximately one hundred New Hampshire health care provider offices. Questions were designed to establish a baseline from which to evaluate any improvements achieved through the new brochure. In addition, questions used in a similar survey of New Hampshire women's health

care providers in 2002 were selected to investigate if there have been changes in risk communication practices over time.

Saginaw Bay Watershed Fish Consumption Needs Assessment

Kory J. Groetsch and Linda D. Dykema

Primary Contact Information:
Kory J. Groetsch, Michigan Department of Community Health
201 Townsend Street, 4th Floor, Office 4-054, Lansing, MI 48913
Tel: 517-335-9935 Email: groetschk@michigan.gov

The Saginaw Bay Watershed (SBW) has many large fisheries. Several fish species (perch, walleye) are safe to eat. Numerous waters have contaminated (dioxins, dichloro-diphenyl-trichloroethane, polychlorniated biphenyls, mercury) fish, requiring fish consumption advisories. Bottom-feeding fish are often the most contaminated. Michigan Department of Community Health (MDCH) acquired a private foundation grant to conduct a needs assessment of people fishing the SBW. This assessment measured fish consumption patterns and fishers' awareness about state fish consumption advisories. A total of 1,088 fishers were interviewed from four contaminated fisheries. Of the 1,088 people interviewed, 907 fishers reported eating fish from Michigan waters. Of the 907 fish consumers, 790 people reported their race as white; 106 were non-white, and 11 did not provide race. Sixty-six percent of non-white fish consumers reported eating bottom-feeding fish (catfish and carp) and 90 percent reported eating fish other than walleye. In comparison, only 14 percent of the white population reported eating bottom-feeding fish and 29 percent reported eating fish other than walleye. Results are being used to target health education toward the most "at risk" fish consumers.

Overview of the 2007 Michigan Fish Consumption Advisory Program

Kory J. Groetsch, Joe Bohr, and Linda D. Dykema

Primary Contact Information:
Kory J. Groetsch, Michigan Department of Community Health
201 Townsend Street, 4th Floor, Office 4-054, Lansing, MI 48913
Tel: 517-335-9935 Email: groetschk@michigan.gov

The Michigan Fish Consumption Advisory Program has existed since the 1970s. The program is a multidepartment effort between the Michigan Departments of Environmental Quality, Community Health, and Natural Resources. Over the last several years, changes have been made in how the program functions. This poster provides an overview of these changes, new outreach materials, and how the current program operates.

Connecticut River Fish Tissue Contaminant Study (2000): Ecological and Human Health Risk Screening

Greg Hellyer, U.S. Environmental Protection Agency, New England Regional Laboratory

Primary Contact Information:
Greg Hellyer, U.S. EPA, New England Regional Laboratory
Ecosystem Assessment – Ecological Monitoring Team (ECA)
11 Technology Drive, North Chelmsford, MA 01863
Tel: 617-918-8677 Email: hellyer.greg@epa.gov

This collaborative federal and state (VT, NH, MA, and CT) study's goals were to provide a baseline of tissue contaminant data from several fish species, to understand better the risk to human health from eating Connecticut River fish, and to learn what threat eating these fish poses to other mammals, birds, and fish. The study also will assist future trend analysis and current statistical comparison, furthering ecological and human health risk screening in support of consistent State fish advisories. This was one of the first such studies of fish tissue contamination along the mainstem of a large, multistate river in the United States.

Smallmouth bass (SMB), yellow perch (YP), and white suckers (WS) were sampled in seven or eight Reaches during 2000 from the mainstem of the Connecticut River and composite samples were analyzed for total mercury (Hg), coplanar (dioxin-like) polychlorinated biphenyls (PCBs), and organochlorine pesticides, including dichloro-diphenyl-trichloroethane (DDT) and its breakdown products. Additionally, dioxin and furan analysis was performed on 12 samples (one SMB, YP, and WS from each of four Reaches). State of Connecticut hatchery-raised brook trout were the "control" fish species.

Levels of contaminants were compared to U.S. Environmental Protection Agency and other current human health subsistence and recreational (sport) fisher and ecological risk screening criteria, and were statistically compared between Reaches and species. Fish weight, length, "condition" (a measure of health), and age (of selected SMB) were also assessed and compared with contaminant levels. Screening levels did not consider vulnerable populations, such as women of childbearing age and young children.

1. Key findings and conclusions are:Total Hg concentrations in all three species of fish were significantly higher in upstream Reaches than in downstream Reaches. Mercury poses a risk to recreational and subsistence fishers and to fish-eating wildlife.
2. Risk from dioxin-like (coplanar) PCBs was generally lower in upstream Reaches than in downstream Reaches, although this varied by fish species and was different for the humans/mammals, birds, or fish that ate them. Dioxin-like PCBs pose a risk to recreational and subsistence fishers and to fish-eating mammals and fish-eating birds.
3. Dioxin toxicity, in the 12 fillet composites analyzed, posed a varying risk to both subsistence and recreational fishers and fish-eating wildlife, even when dioxin-like PCB toxic equivalents (TEQs) (a standardized measure of dioxin toxicity) were not included in the risk calculations. Since risk associated with dioxin is not available for the remainder of the fish samples, these PCB TEQs underestimate human health and ecological risk from consumption of Connecticut River fish.

4. DDT and related breakdown products from chemical, physical, and biological weathering, pose a risk to human subsistence fishers and to fish-eating birds, but not to recreational fishers or fish-eating mammals.

Characteristics Associated with Elevated PBDE Serum Levels: Findings from a U.S. Cohort of Frequent and Infrequent Consumers of Sport-caught Fish

Henry A. Anderson[1], Pamela Imm[1], Lynda Knobeloch[1], Mary Turyk[2], Victoria Persky[2], John Mathew[3], and Carol Buelow[3]

[1] Wisconsin Department of Health and Family Services, Madison, WI; [2] University of Illinois at Chicago, Chicago, IL; [3] Wisconsin State Laboratory of Hygiene, Madison, WI

Primary Contact Information:
Pamela Imm, M.S.
1 West Wilson Street, Room 150, Madison, WI 53703
Tel: 608-267-3565 Email: immpb@dhfs.state.wi.us

Polybrominated diphenyl ethers (PBDEs) bioaccumulate in the environment and have been detected in a variety of foods, including fish, meat, poultry, and dairy products. However, in contrast to polychlorinated biohenyls (PCBs) and 1,1-dichloro-2, 2-bis(4-chlorophenyl)ethylene (DDE), diet and consumption of sport-caught fish is not the major route of exposure to these chemicals, which have been used as flame retardants in foams, fabrics, and plastics. PBDEs are common contaminants of household dust and continue to be present in a wide variety of consumer products. Serum levels vary greatly from person to person.

This study was designed to assess exposure among an existing cohort of frequent and infrequent consumers of sport-caught fish who lived in five Great Lake states. Findings are based on completed laboratory results for 478 of 529 volunteers. Preliminary analyses show that lipid-adjusted serum PBDE levels are positively associated with DDE and PCB levels. Years of sport-caught fish consumption and annual consumption rates for shellfish were also correlated with PBDE levels.

Lipid-adjusted PBDE levels in serum were positively associated (for the high and low PBDE groups and for PBDE as a continuous variable) with:

- Age
- Obesity
- Income less than $45,000 USD/year
- Water bed use
- Hours spent outdoors
- DDE and PCB levels
- Years of sport-caught fish consumption
- Shellfish meals per year.

Congeners BDE 47 and 99 were found in the majority of blood serum samples (97% for females, 98% for males for congener 47 and 62% for males and females for congener 99). For congener BDE 28, only 12 percent of males and 7 percent of females had detectable levels in their serum. Dietary components other than fish were not associated with PBDE levels.

Upon receipt of all laboratory analysis, we will evaluate independent variable interactions and conduct multivariate and regression analyses.

Environmental Justice and Fish Consumption in the Detroit River Area of Concern

Victoria J.M. Kalkirtz, Michelle A. Martinez, and Alexandria Teague, Master's Practicum, School of Natural Resources and Environment, University of Michigan, Ann Arbor, MI

Primary Contact Information:
Victoria J.M. Kalkirtz
Tel: 708-769-5363 Email: vjmk@umich.edu

Alexandria Teague
Tel: 253-224-7941 Email: adwt@umich.edu

Michelle A. Martinez
Tel: 734-4346 Email: mamz@umich.edu

Our research seeks to assess the efforts of scientists and policymakers to mitigate risk of human exposure to fish toxicity. We will critique the success of such a process through the perspective of those who are most affected—fish consumers. We seek to identify those who use the Detroit River as a food source, identify the reasons for their fishing, and determine how they perceive the risk of fish contamination. This information will then be presented to agencies and institutions concerned with risk mitigation in hopes of closing communication gaps. We will conduct surveys and interviews of institutional stakeholders involved in the information updating process to assess both the perception of fish contamination in the Detroit River Area of Concern (AOC), and the incorporation of new information into the updating process. Study results will be used to generate creative solutions that incorporate Environmental Justice theory and practice, and provide policy suggestions that will make consumption advisories more effective for the population they serve. This study is a part of a larger integrated assessment entitled, "What are the Causes, Consequences and Correctives of fish contamination in the Detroit River AOC that cause health consumption advisories?" lead by Dr. Donna Kashian at the Cooperative Institute for Limnology and Ecosystems Research (CILER).

Evaluation of Spatiotemporal Variation in Louisiana's Fish-Tissue Mercury Concentrations using NDMMF

Adrienne Katner[1], Shannon Soileau[1], Chris Piehler[2], and Dianne Dugas[1]

[1] Louisiana Department of Health and Hospitals, Office of Public Health, Section of Environmental Epidemiology and Toxicology, New Orleans, LA; [2] Louisiana Department of Environmental Quality, Baton Rouge, LA

Primary Contact Information:
Adrienne Katner
Louisiana Department of Public Health
Section of Environmental Epidemiology and Toxicology (SEET)
1450 L & A Road, Metairie, LA 70001-6235
Tel: 504-219-4580 Email: ALKatner@dhh.la.gov

This assessment was conducted to evaluate basinwide and site-specific spatiotemporal trends in fish-tissue mercury (Hg) contamination from Louisiana's water basins. The assessment is based on fish-tissue Hg data collected from 279 sample stations between 1994 and 2006. This is the first comprehensive review of Louisiana's fish-tissue Hg data. Data comprise 12,117 samples composited from 35,602 fish and 51 fish species. No significant change in fish-tissue Hg levels at the statewide level was observed throughout the 14-year program history. Significant spatial variability was observed on a basinwide level; basins of primary concern were identified. The U.S. Geological Survey's (USGS's) National Descriptive Model of Mercury in Fish-Tissue (NDMMF) was used to explore site-specific spatiotemporal variability within these basins. To maximize sampling resources, creel data were used in conjunction with NDMMF to identify species of potential concern. Recommendations for future sampling efforts are made.

Development of a Computer Assisted Personal Interview Software System for Collection of Tribal Fish Consumption Data

Lon Kissinger[1], Ann H. Williams[2], Beth Mittl[3], Merwyn Lasrado[3], Samuel Iwenofu[4], Roseanne Lorenzana[1], Rebecca Calderon[2], Vanessa Olivo[3], Cynthia Helba[3], and Pauline Capoeman[4]

[1] U.S. Environmental Protection Agency Region 10, Office of Environmental Assessment; [2] National Health and Environmental Effects Research Laboratory, Human Studies Division Epidemiology & Biomarkers Branch; [3] WESTAT; [4] Quinault Indian Nation

Primary Contact Information:
Lon Kissinger, Toxicologist
Office of Environmental Assessment, Risk Evaluation Unit
U.S. EPA – Region 10, Mail Stop: OEA-095 1200 6th Avenue, Seattle, WA 98101
Tel: 206-553-2115 Email: kissinger.lon@epa.gov

Native Americans who consume seafood often have higher seafood consumption rates and consequently greater exposures to contaminants in seafood than the general U.S. population. Defensible and quantifiable tribal seafood consumption rates are needed for development of water quality standards by Tribes as well as assessment of seafood contaminant risks to tribal members. U.S. Environmental Protection Agency (EPA) Region 10 has over 200 Tribes, and seafood consumption information is only available for a small number of them. Additional tribal

seafood consumption data are needed to characterize variations in tribal seafood consumption practices. The expense and resources necessary to conduct well-designed tribal seafood consumption surveys have been obstacles to data collection. In 2003, EPA Region 10 and the National Health and Environmental Effects Research Laboratory (NHEERL) developed a proposal to create computer assisted personal interview (CAPI) software that would serve as a tool for Tribes to conduct well-designed seafood consumption surveys using fewer resources. NHEERL and WESTAT, in partnership with EPA Region 10, developed a Microsoft Access-based CAPI survey instrument derived from methodology used in a 2000 Suquamish Tribe seafood consumption survey. The Suquamish survey was the most recent of a number of Pacific Northwest seafood consumption surveys utilizing similar methodology. The CAPI has two main components, a 24-hour recall of seafood consumption and a survey of seafood consumption throughout the year. Consumption questions are asked at the species level followed by questions at the species group level. Assignment of species to groups is based on behavioral characteristics expected to influence organism contaminant concentrations (e.g., feeding behavior). Seafood consumption by children, seafood consumption at tribal events, sources of seafood, seafood parts consumed, and seafood harvest locations are also recorded. A booklet of species and preparation images is used to support CAPI administration. The CAPI may be deployed on multiple laptops, allowing multiple interviewers to collect data in the field. Field data may then be integrated on a central computer. CAPI query and data reporting capabilities allow calculation of basic seafood consumption statistics on either a complete survey data set or data subsets. The Quinault Indian Nation participated in customizing the CAPI for Quinault use, followed by CAPI pilot testing in the spring of 2006. Quinault Indian Nation members were trained in survey administration techniques and software use and then conducted pilot interviews with Quinault Indian Nation members. Post pilot survey evaluations of interviewers and survey participants supported conclusions that the software was both easy to use and accurately recorded Quinault seafood consumption.

**This is an abstract of a proposed presentation and does not necessarily reflect EPA policy.*

Fish Mercury and Selenium Screening Results from Wyoming, and Fish Mercury Levels from Seminoe Reservoir

Geoff Klein and Steven Wolff, Wyoming Game and Fish Department

Primary Contact Information:
Geoff Klein, Wyoming Game and Fish Department
3030 Energy Lane, Casper, WY 82604
Tel: 307-473-3414 Email: geoff.klein@wgf.state.wy.us

Fish from 31 Wyoming lakes were sampled for mercury (Hg) and selenium contamination. Ten lakes yielded fish exceeding the 0.3 ppm screening value; these lakes were selected for more comprehensive sampling. Seminoe Reservoir was the first of the waters to be sampled extensively. Five species were collected; walleye exceeded 0.3 ppm Hg at 32 cm, longnose sucker at 39 cm, white sucker at 45 cm, brown trout at 51 cm, and rainbow trout at 59 cm.

Fish Consumption Habits, Attitudes, and Beliefs among Women of Childbearing Age in Los Angeles and Orange Counties

Diana Lee[1], G. Margillo[2], G. Jaimes[2], and S. Groner[3]

[1] California Department of Health Services, Environmental Health Investigations Branch; [2] Impact Assessments, Inc., La Jolla, CA; [3] S. Groner & Associates, Inc., Long Beach, CA

Primary Contact Information:
Diana M. Lee, MPH, RD
California Department of Health Services, Environmental Health Investigations Branch
850 Marina Bay Parkway, Bldg. P-3, Richmond, CA 94804-6403
Tel: 510-620-3665 Email: Diana.Lee@cdph.ca.gov

The Fish Contamination Education Collaborative (FCEC) is a partnership of community agencies in Los Angeles and Orange Counties, local heath departments, and state and federal agencies working together to convey information to promote safe fish consumption. To address polychlorinated biphenyl (PCB) and dichloro-diphenyl-trichloroethane (DDT) fish contamination issues related to contaminated sediments off Palos Verdes Shelf, the U.S. Environmental Protection Agency Region 9 Superfund program has supported the FCEC to provide angler and family outreach and education and health provider training.

As part of the outreach efforts to educate women of childbearing age about safe fish consumption, the FCEC conducted a pilot study from January 2007 to April 2007 with about 400 ethnically diverse women of childbearing age in Los Angeles and Orange Counties to assess their fish consumption habits, attitudes, and beliefs (CAB). The CAB study conducted an initial assessment with an education intervention aimed at increasing knowledge of women of childbearing age about local and national fish consumption advisories, and a follow-up assessment 30 days later.

Preliminary results will be presented on the following objectives:

1. **Knowledge** – To obtain an average score of at least 80 percent at the initial knowledge assessment following the educational intervention, and an average score of at least 70 percent at the follow-up.
2. **Attitudes and Beliefs** – To achieve an increase in the number of women with the following beliefs:
   - Women of childbearing age and their children are more vulnerable to health effects from eating contaminated fish
   - Health risks from eating contaminated fish are serious
   - Following fish consumption advisories will reduce health risks for women of childbearing age and their children
   - Women will express confidence in their ability to follow at least one fish consumption recommendation.
3. **Behavior** – after the educational intervention, women will make at least one change in their fish consumption practices in accordance with either local or national fish consumption advisories.

Human Exposure to Dioxin-like Compounds in Fish and Shellfish Consumed in South Korea

Kyu-Tae Lee[1], Jong-Hyeon Lee[1], Jung-Suk Lee[1], Kun-Ho Park[1], Seung-Kyu Kim[1], Won-Joon Shim[2], Sang-Hee Hong[2], Un-Hyuk Im[2], John P. Giesy[3,4], and Jae-Ryong Oh[2]

[1] Institute of Environmental Protection and Safety, Seoul, Korea; [2] South Sea Institute, Korea Ocean Research and Development Institute, Republic of Korea; [3]Zoology Department, National Food Safety and Toxicology Center, Center for Integrative Toxicology, Michigan State University; [4] Department of Biology and Chemistry, City University of Hong Kong, Kowloon, Hong Kong, SAR, China

Primary Contact Information:
Jong-Hyeon Lee, Ph.D.
Director, Institute of Environmental Protection and Safety, Neo Environmental Business Co.,
Room 913, Byuksan Digital Valley II, Gasan-dong 481-10, Geumcheon-gu, Seoul, 153-783, Korea
Tel: 02-863-4744 Email: jhlee@neoenbiz.com

Dietary intake is the most important source of exposure to dioxins for the general population, accounting for more than 90 percent of the daily intake. The objective of this study was to assess current exposure to dioxin-like compounds in fish and shellfish consumed by the general population in Korea. Residues of polychlorinated dibenzo-*p*-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs), and dioxin-like polychlorinated biphenyls (DL PCBs) were quantified in 32 fishes and shellfishes collected from domestic fisheries markets. The relative toxic equivalent (TEQ) contribution of DL PCBs was greater than 50 percent. The concentrations of 2,3,7,8-tetrachlorodibenzo-p-dioxin equivalents (TEQ_{WHO}) were compared to guidelines suggested for the protection of human health by the World Health Organization (WHO). The TEQ concentration in herring was greatest, followed by dried anchovy and Sailfin sandfish. The exposure to dioxin-like compounds from current fish consumption patterns was estimated to 72 pg TEQ_{WHO}/day, which is equal to 1.2 pg TEQ_{WHO}/kg, body weight/d. This was below 4 pg TEQ_{WHO}/kg, bw/d of the current tolerable daily intake (TDI) guideline in Korea. The relatively great exposure was determined to be due to the greater fish consumption rate in Korea, rather than greater concentrations of residues in the food. Fish consumption advisories should be introduced to reduce the potential health risk from fish consumption in Korea.

Magnitude and Sources of Methylmercury Exposure among Recreational Anglers in Coastal Louisiana

Rebecca Lincoln[1], Edward Chesney[2], James Shine[1], Donna Vorhees[3], Philippe Grandjean[1], and David Senn[1]

[1] Department of Environmental Health, Harvard School of Public Health; [2] Louisiana Universities Marine Consortium; [3] The Science Collaborative, Ipswich, MA

Primary Contact Information:
Rebecca Lincoln, Harvard School of Public Health
Department of Environmental Health
Landmark Center, Room 409 West
401 Park Drive, Boston, MA 02215
Tel: 617-384-8827 Email: rlincoln@hsph.harvard.edu

The goal of this study was to characterize mercury (Hg) exposure among recreational anglers in coastal Louisiana. While the average U.S. population consumes relatively few fish species, recreational anglers may consume a wide variety of species at a comparatively higher frequency. In addition to their unique exposure pattern, anglers are a useful group to study because of their expert knowledge of the source and types of fish they eat.

In summer and fall of 2006, 402 recreational anglers were recruited in coastal Louisiana. Anglers completed a survey detailing their species-specific fish consumption and describing the people with whom they share their catch. Hair samples were collected and analyzed for total Hg using EPA Method 7473.

Anglers' median hair Hg concentration was 0.81mcg/g (range: 0.1–10.7 mcg/g). Calculated Hg intake (mcg/day), based on existing species-specific concentration data, was a significant predictor of hair Hg concentration (beta=0.015, $p<0.0001$). For this population of anglers, we estimate that more than 60 percent of Hg intake resulted from consumption of locally caught fish. Forty percent of participants reported sharing their catch with young children or women of childbearing age.

Recreational anglers in coastal Louisiana have a Hg exposure pattern that is different in amount and source from the general population, and their Hg intake rates may exceed levels currently considered safe. This study provides new insight into the impact of specific fish species on anglers' Hg exposures, and identifies sensitive subpopulations that may be exposed by sharing anglers' catch.

Polybrominated Diphenyl Ethers (PBDEs) and Polychlorinated Biphenyls (PCBs) in Fish, Beef, and Fowl Purchased in Food Markets in Northern California USA

William J. Luksemburg[1], Richard J. Wenning[2], Andrew Patterson[1], Martha Maier[1], and Scott Braithwaite[2]

[1] Vista Analytical Laboratorios; [2] ENVIRON International Corporation

Primary Contact Information:
William J. Luksemburg, Vista Analytical Laboratory
1104 Windfield Way, El Dorado Hills, CA 95762
Tel: 916-673-1520 Email: billux@vista-analytical.com

Food basket surveys and exposure studies conducted over the past decade suggest that one of the main routes of human exposure to polychlorinated dibenzo-p-dioxins and furans (PCDDs/Fs) and biphenyls (PCBs) is likely through the consumption of food products such as eggs, meats, fish, and dairy products. More recently, studies of human milk, blood, and adipose tissues also demonstrate human exposure to polybrominated diphenyl ethers (PBDEs). The contamination of Belgium store-bought chicken products in 1999 and, more recently, concerns regarding farm-raised fish products in the United States, Ireland, and elsewhere by PCDDs/Fs and PCBs has heightened concerns about the occurrence of other persistent organic pollutants (POPs), including PBDEs, in consumer food products. In the United States, for example, recent studies have shown the edible portions of farm-raised fish containing higher levels of PCDDs/Fs, PCBs, and PBDEs than in wild fish.

In this study, fillets from several species of freshwater and ocean fish (both farm-raised and wild), as well as ground beef, ground deer, and meat from several species of fowl (chicken, turkey, duck, goose, and pheasant), were purchased from food markets in the cities of Sacramento and El Dorado Hills, CA. Foods were tested for PCDDs/Fs, PCBs, and PBDEs, and the results used to evaluate human exposure through the consumption of store-bought consumer food products.

Contaminant Levels in Rainbow Trout and Their Diets from Missouri Department of Conservation Coldwater Hatcheries

Michael J. McKee[1], George B. Kromrey[2], and Carl E. Orazio[3]

[1]Resource Science Division, Missouri Department of Conservation; [2]Fisheries Division, Missouri Department of Conservation; [3]Columbia Environmental Research Center, U.S. Geological Survey

Primary Contact Information:
Michael McKee
Aquatic Health Unit Resource Science Center, Missouri Department of Conservation
1110 S. College Avenue, Columbia, MO 65201
Tel: 573-882-9909, ext. 3255 Email: Mike.McKee@mdc.mo.gov

Contaminants, including organochlorine insecticides (OCIs), polychlorinated biphenyls (PCBs), lead (Pb), cadmium (Cd), and mercury (Hg), have been found to occur in fish foods and can accumulate in fish tissues. Trout are routinely reared in hatcheries on commercial diet and

released for public "put and take" fisheries. To ensure that contaminant levels in trout tissue are safe for consumption, trout and their diets from five coldwater hatcheries operated by the Missouri Department of Conservation (MDC) were investigated. All hatcheries used the same diet type and supplier. The diets from each hatchery were found to have low levels (< 50 parts-per-billion or ppb wet weight) of OCIs, PCBs, and Hg. Lead and cadmium occurred at higher levels, ranging up to 148 ppb for Cd and 230 ppb for Pb. Three composite fillet samples containing eight fish each were analyzed from each hatchery. The levels in the fillet tissues were low (<50 ppb) for all contaminants, and each contaminant was below levels of concern for human consumption. The ratio of the contaminant concentration in the fillet to the concentration in the diet was calculated as a means of estimating transfer efficiency from diet to fillet. The metals Pb and Cd had extremely low ratios (<0.1), indicating a low efficiency in transfer from the diet to the fish fillet tissue. Consequently, even though these metals were elevated relative to other contaminants in the fish diet, they occurred at low levels in the fillet tissue. OCIs and PCBs had ratios ranging from about 0.4 to 0.6, showing moderate transfer efficiency from the diet to fish fillet tissue. Mercury had the highest transfer efficiency with an average ratio of 0.83. Based on these data, trout from MDC hatcheries investigated are safe for release and human consumption.

PFCs in Minnesota Fish

Pat McCann, Minnesota Department of Health

Primary Contact Information:
Pat McCann
Health Risk Assessment, Environmental Health Division
Minnesota Department of Health
625 North Robert Street, St. Paul, MN 55155
Mailing Address: P.O. Box 64975, St. Paul, MN 55164-0975
Tel: 651-201-4915 Email: patricia.mccann@health.state.mn.us

Perfluorochemicals (PFCs) have been detected in fish from Minnesota waters. Results from PFC analysis of fish fillets from Minnesota will be presented. These results will be interpreted for fish consumption advice using the Minnesota Department of Health derived "reference dose" (RfD) for perfluorooctane sulfonate (PFOS). Future fish collection and analysis plans will be outlined.

Pharmaceuticals and Personal Care Products (PPCPs), Hormones, and Alkylphenol Ethoxylates (APEs) in the North Shore Channel of the Chicago River

Elizabeth Murphy[1], Todd Nettesheim[1], Lawrence Zintek[2], Larry B. Barber[3], James M. Lazorchak[4], Angela L. Batt[4], Marc A. Mills[5], Clifford P. Rice[6], Heiko L. Schoenfuss[7], David T. Lordi[8], Sam Dennison[8], Tom Minarik[8], Leanne Stahl[9], and Blaine Snyder[10]

[1] Great Lakes National Program Office, U.S. Environmental Protection Agency (U.S. EPA); [2] Chicago Regional Laboratory, U.S. EPA; [3] U.S. Geological Survey, Boulder, CO; [4] Office of Research and Development, National Exposure Research Laboratory, U.S. EPA; [5] Office of Research and Development, National Risk Management Research Laboratory, U.S. EPA; [6] Agricultural Research Service, U.S. Department of Agriculture; [7] St. Cloud State University; [8] Research and Development, Metropolitan Water Reclamation District of Greater Chicago; [9] Office of Water, U.S. EPA; [10] Tetra Tech, Inc.

Primary Contact Information:
Elizabeth Murphy, MPH, Great Lakes Fish Monitoring Program Manager
U.S. Environmental Protection Agency
Great Lakes National Program Office, Mail Code G-17J
77 W. Jackson Boulevard, Chicago, IL 60604-3590
Tel: 312-353-4227 Email: Murphy.Elizabeth@epa.gov

The U.S. Environmental Protection Agency's (EPA's) Great Lakes National Program Office (GLNPO) and EPA Region 5 have developed a study to supplement and enhance the Office of Water's (OW's) national pilot project, which is designed to investigate the occurrence of PPCPs in fish tissue. The national OW study will determine the concentrations of 39 PPCPs in composited fish fillets and liver samples from five sites, plus one reference site, where waters are dominated by waste water treatment plant (WWTP) effluents. In the OW study, the Great Lakes site was selected to be the North Shore Channel of the Chicago River.

The supplemental study on the North Shore Channel is a collaborative partnership between the GLNPO, EPA Region 5, the Chicago Regional Laboratory (CRL), the OW, the Office of Research and Development (ORD), the U.S. Geological Survey (USGS), the U.S. Department of Agriculture (USDA), the Illinois Department of Natural Resources (IL DNR), and the Metropolitan Water Reclamation District of Greater Chicago. The four main objectives of the supplemental study are to: (1) determine if there is reproductive impairment to resident fish; (2) estimate whole fish and fillet concentrations of PPCPs, APEs, and hormones; (3) estimate effluent and stream concentrations of PPCPs, APEs, and hormones; and (4) document seasonal differences in concentrations of these compounds in effluent, stream, and fish.

Creation of a Geographic Information System to Identify At-Risk Populations in New Jersey and New York for Consumption of Contaminated Fish and Seafood

Maureen O'Neill, U.S. Environmental Protection Agency

Primary Contact Information:
Maureen O'Neill
U.S. Environmental Protection Agency, Office of the Regional Administrator
290 Broadway, 26th Floor, New York, NY 10007
Tel: 212-637-5025 Email: oneill.maureen@epa.gov

The objective of this study was to identify at-risk populations, particularly women of childbearing years and young children, for consumption of contaminated fish and seafood via the use of geographically and demographically defined seafood consumption patterns and fish/seafood contamination data. Among all females of reproductive age (15 to 45 years) in the United States, an estimated 16.4 percent eat fish at least once per day (CDC/NCHS, 1999-2002).[*]

Many species of fish and shellfish contain trace amounts of mercury (Hg) and other pollutants, with some containing levels that may harm an unborn baby or young child's developing nervous system. Based on the distribution of blood Hg concentrations among the adult female participants in the Centers for Disease Control (CDC) 1999–2000 National Health Assessment and Nutrition Examination Survey (NHANES) and the number of U.S. births in 2000, it has been estimated that > 300,000 newborns each year may have been exposed *in utero* to methyl mercury (MeHg) concentrations associated with an increased risk of adverse neurodevelopmental effects (CDC/NCHS, 1999–2002).

Creation of a geographic information system (GIS), utilizing national and regional (Northeast) seafood consumption estimates (e.g., NHANES, U.S. Food and Drug Administration), seafood contamination studies, U.S. Census data, and other data sources, is underway. State and local/metropolitan area fish and seafood consumption and contamination profiles will be incorporated, when available, to further identify specific demographic and socioeconomic subpopulations.

Dose estimates will be derived for commercial, recreational, and subsistence seafood consumers. Fish/seafood consumption profiles will include meal size, portions of fish consumed, and cooking method, when available. Literature searches and database reviews are underway to identify current and/or local sources of fish and seafood contamination data to supplement or replace national-scale data.

The anticipated application of this technique is to provide health care providers, state and local health departments, and policy analysts an effective method for targeting vulnerable populations. Interventions include counseling about which fish to avoid and the best low-contaminant sources of omega-3 fatty acids. This information can be used by public health professionals to advise their patients of current advisories and healthy seafood choices. This will permit focusing scarce resources on those most likely at risk of heightened exposure to consumption of contaminated fish and shellfish.

[*] CDC/NCHS (Centers for Disease Control and Prevention/National Center for Health Statistics). 1999–2002. *National Health and Nutrition Examination Survey*. Hyattsville, MD: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Determining Sediment Management Goals and Remediation Scenarios to Minimize Human Health Risk from Contaminated Sediment in Peninsula Harbour, Lake Superior, Canada.

Miranda Henning[1], Michael Bock[1], Erik Martin[1], Allison Piper[1], Christopher Stubbs[2], Ioannis Benekos[2], Timothy Barber[3], and Roger Santiago[4]

[1] ENVIRON International Corporation, Portland, ME; [2] ENVIRON International Corporation, Emeryville, CA; [3] ENVIRON International Corporation, Cleveland, OH; [4] Environment Canada, Remediation Technologies Program, Downsview, Ontario, Canada

Primary Contact Information:
Allison Piper
ENVIRON International
136 Commercial Street, Suite 402
Portland, ME 04101
Tel: 207-347-4413 Email: apiper@environcorp.com

Risks to human health from mercury and polychlorinated biphenyls (PCBs) in fish from Peninsula Harbour, Lake Superior, were evaluated in order to aid Environment Canada and other stakeholders in making decisions regarding remediation of sediment in this deep, northern embayment. Although a fish consumption advisory is currently in place for Peninsula Harbour, our analysis conservatively assumed that neither sport anglers nor subsistence anglers comply with it. Thus, while some fish consumption scenarios considered may be hypothetical, the adult sport angler scenario that targets lake trout and derives half of his or her fish diet from Peninsula Harbour is a reasonably likely, yet sufficiently conservative, scenario. The risk assessment concluded that, while such anglers are not likely to experience adverse health effects from methylmercury in fish, they may be adversely affected by PCBs in fish if they derive more than 5 percent of their fish diet from Peninsula Harbour. A target fish tissue concentration was back-calculated by solving the risk equation for the concentration term, while holding risk constant at the target level. A food web bioaccumulation model was then used to calculate numerical sediment management goals for PCBs from the target fish tissue concentration. The risk-based sediment management goal for PCBs protective of sport anglers was found to be 0.11 mg/kg, while the spatially weighted average PCB concentration in Jellicoe Cove and the rest of Peninsula Harbour sediment was 0.14 mg/kg and 0.12 mg/kg, respectively. A geographic information system (GIS) was used to estimate the area and volume of sediment requiring remediation in order to yield spatially weighted average concentrations of PCBs equal to the sediment management goal. Despite the relatively slight exceedance of the sediment management goal, extensive remediation would be necessary to achieve the goal, because the PCBs are distributed over an extensive area of the harbour. Therefore, alternative sediment management strategies were evaluated, which focused on source control through hot spot remediation. To assess the utility of a hot spot-focused strategy, we calculated the area and volume of sediment warranting remediation based on various definitions of the hot spot, as well as the residual risks that would remain following remediation.

Role of Selenium in Prevention and Treatment of Mercury Toxicity

Nicholas V.C. Ralston and Laura J. Raymond, University of North Dakota

Primary Contact Information:
Nicholas V.C. Ralston, Ph.D.
Energy & Environmental Research Center, University of North Dakota
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018
Tel: 701-777-5066 Email: nralston@undeerc.org

High-level mercury (Hg) exposure is particularly harmful to fetal neurodevelopment, but consequences appear to depend upon molar ratios of Hg to selenium (Se). Selenium is an essential nutrient required for certain enzyme (Se-enzyme) activities that protect against oxidative damage in brain and other tissues. The extremely high binding affinities between Hg and Se (10^{45}) result in sequestration of cellular Se as insoluble HgSe and thus prevent synthesis of Se-enzymes. Several of the 25–35 known Se-proteins are active in detoxification of oxygen radicals. Therefore, it is not suprising that oxidative damage is a major pathological finding of Hg toxicity. The protective effects of Se against Hg toxicity have been recognized for over 50 years. Supplemental Se replaces Se lost to Hg binding, thus maintaining Se-enzyme synthesis. Maternal consumption of foods that contain Hg in molar excess of Se is distinctly harmful, but consumption of similar amounts of Hg in foods with Se in molar excess of Hg has not been associated with harmful effects. Maternal consumption of pilot whale meat (Hg:Se ratio 4:1) harmed children in the Faroes, but consumption of ocean fish meats (average Hg:Se ratio 0.1:1) were not associated with adverse effects in the Seychelles, even though total Hg exposures appeared to be greater. Rat studies employing diets that reflect the range of methylmercury (MeHg) exposures from low to toxic in the presence of dietary Se at low, normal, or rich levels confirm the importance of the Hg:Se ratio in the Hg issue. Resistance to MeHg toxicity was directly proportional to dietary Se in the normal range of consumption. Levels of MeHg exposure that were lethal to animals fed low-Se diets were harmless to animals fed Se at levels slightly less than the average Se concentration present in ocean fish. These studies further indicate that although blood Hg reflects MeHg exposure, blood Hg:Se molar ratios provide better criteria for recognizing risk of MeHg toxicity ($r^2= 0.96$, $p<0.00001$). Although ocean fish are rich in Se, it is important to note that environmental availability of Se results in dramatic variability in freshwater fish Se. As a result, Hg levels that are safe in freshwater fish from areas with normal or rich Se may constitute major Hg toxicity risks in areas where Se availability is poor, such as those that occur in "Hg hotspot" regions of the Northeastern United States.

Importance of Selenium in Seafood Safety Issues Regarding Mercury

Nicholas V.C. Ralston[1] and J. John Kaneko[2]

[1] University of North Dakota Energy & Environmental Research Center; [2] PacMar, Inc.

Primary Contact Information:
Nicholas V.C. Ralston, Ph.D.
Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018
Tel: 701-777-5066 Email: nralston@undeerc.org

Assessments of health risks associated with mercury (Hg) exposure from fish consumption are currently based on Hg concentrations in the fish in relation to Hg concentrations in the blood. However, the protective effects of selenium (Se) against Hg toxicity have been recognized for over 50 years, and have since been demonstrated in all animal models evaluated. Since interactions between Se and Hg and their molar ratios in seafood are essential factors in evaluating risks associated with dietary Hg exposure, considering Hg content alone is inadequate. In this study, the absolute and molar concentrations of Hg and Se were determined in edible portions from 420 individual fish representing 15 species of pelagic fish collected from the central North Pacific Ocean near Hawaii. A molar excess of Se in relation to Hg was observed in almost all fish species evaluated. The rank order of mean Se:Hg molar ratios was striped marlin (17.6)> yellowfin tuna (14.1)> mahimahi (13.1)> skipjack tuna (12.8)> spearfish (11.4)> wahoo (10.8)> sickle pomfret (6.7)> albacore tuna (5.3)> bigeye tuna (5.2)> blue marlin (4.1)> escolar (2.4)> opah (2.3)> thresher shark (1.5)> swordfish (1.2)> mako shark (0.5). With a Se:Hg molar ratio of less than 1, mako shark was the only fish containing a net molar excess of Hg. Mako shark may be hazardous for human consumption since its Se:Hg ratio approaches that of pilot whale meat (~0.25), an uncommon food known to be associated with adverse effects on child development. Although ocean fish are generally Se rich, it is important to recognize that the amount of protective Se present in freshwater fish can vary dramatically. Mercury concentrations that are not associated with harm in Se-rich ecosystems could be harmful under low-Se conditions. Comprehensive criteria that incorporate the absolute and relative amounts of Se and Hg present in fish will be needed to improve environmental Hg assessments and enhance seafood safety.

Measurement of Mercury in Fish Using a Muscle Biopsy Procedure

P. Hammen[1], L. Doolittle[1], H. A-Eisa[1], J.R. Stahl[2], H. Jackson[2], and C.R. Santerre[1]

[1] Purdue University; [2] Indiana Department of Environmental Management

Primary Contact Information:
Charles R. Santerre, Ph.D., Professor of Food Toxicology
Foods and Nutrition, Purdue University, Stone Hall, Room 205
700 West State Street, West Lafayette, IN 47907-2059
Tel: 765-496-3443 Email: santerre@purdue.edu

Traditionally, fish are collected from local waters and combined into a composite sample prior to analysis for mercury (Hg) and other contaminants. Each sample composite is composed of fish of similar size. Due to improvements in the measurement of Hg using gold amalgamation/atomic absorption spectrophotometry, improved techniques are evolving that permit analysis of muscle biopsies from fish. This approach allows for a larger number of Hg measurements to be conducted to improve the quality of fish consumption advisories. This approach also does not require that fish be sacrificed in order to generate mercury data. For this study, fish were collected across Indiana using electro-shocking to create 180 composite samples. At the same time, two muscle biopsy plugs (approximately 20 mg/plug) were collected from a region below the dorsal fin of each fish using a 14-gauge needle (total = 525 fish biopsies). Mercury analysis was then conducted on the biopsy plugs and compared to the composite samples.

Predicting the Impact of Foods on Mercury Bioavailability

S-M Shim[1], M.G. Ferruzzi[1], Y-C Kim[2], E.M. Janle[1], and C.R. Santerre[1]

[1] Purdue University; [2] University of Massachusetts

Primary Contact Information:
Charles R. Santerre, Ph.D., Professor of Food Toxicology
Foods and Nutrition, Purdue University, Stone Hall, Room 205
700 West State St., West Lafayette, IN 47907-2059
Tel: 765-496-3443 Email: santerre@purdue.edu

The effects of phytochemical-rich foods on bioaccessibility were investigated using an *in vitro* digestion. Total mercury (Hg) in the aqueous phase following a simulated digestion of fish along with food sources was used to measure bioaccessibility. Green tea (31–2,000 mg), black tea (31–2000 mg), soy protein (50–100 mg), and sodium copper chlorophyllin (SCC, 0.1–25 mg) significantly reduced Hg bioaccessibility in a dose-dependent manner (by 82–92%, 88–91%, 44–87%, and 49–89%, respectively). Grapefruit juice (0.5–10 mL) did not provide a dose-response relationship. Wheat bran (50–1,000 mg) decreased Hg bioaccessibility (84%); oat bran and psyllium only reduced bioaccessibility (by 59–75%, 15–31%, respectively) at concentrations greater than 500 mg. Mercury uptake by TC7 clone of Caco-2 cells was measured after 6 hours incubation at 37 °C. There was a lower cellular uptake of Hg with black tea when compared to green tea at both 31 and 62.5 mg; soy protein decreased Hg uptake at 100 mg; SCC caused a significant reduction at 1–25 mg; and grapefruit juice (0.5–10 mL) had no effect. Wheat bran reduced cellular Hg uptake more than oat bran at 100–1,000 mg; but psyllium (50–1,000 mg)

had no significant effect on cellular Hg uptake. Our study predicts that foods can reduce methylmercury bioavailability following fish consumption.

Fish Consumption Advisories: The Iowa Approach

Stuart Schmitz[1], John Olson[2], and Kenneth Krier[2]

[1] Iowa Department of Public Health; [2] Iowa Department of Natural Resources

Primary Contact Information:
Stuart C. Schmitz, P.E.
Iowa Department of Public Health
321 East 12th Street, Des Moines, IA 50319
Tel: 515-281-8707 Email: SSchmitz@idph.state.ia.us

Every year, Iowa Department of Natural Resources (IDNR) fisheries biologists collect fish samples for laboratory analyses to determine the wholesomeness of Iowa fish for human consumption. This monitoring is conducted as part of the U.S. Environmental Protection Agency (EPA) Region 7 Regional Ambient Fish Tissue (RAFT) monitoring program. Since 1977, nearly 800 fish tissue samples from over 200 sites on Iowa rivers and lakes have been collected and analyzed for contaminants as part of RAFT monitoring.

Prior to 2006, the need for consumption advisories for Iowa waters was determined by comparing contaminant levels in Iowa fish to "action levels" for mercury (Hg), polychlorinated biphenyls (PCBs), and chlordane published by the U.S. Food and Drug Administration (FDA). In recent years, many states have abandoned the use of the FDA action levels in favor of a more protective "risk based" approach. Thus, in late 2005, the Iowa Department of Public Health (IDPH), in cooperation with IDNR, developed a hybrid protocol that utilized FDA "action levels" along with risk-based health comparison levels established by EPA, the Agency for Toxic Substances and Disease Registry (ATSDR), and other environmental agencies.

The Iowa approach to fish consumption advisories is to:

- Provide advice that is protective of public health
- Account for and recognize the health benefits of including fish in the diet of all individuals
- Simplify the consumption advice to three levels:
  1. Unlimited consumption
  2. One-meal-per-week consumption
  3. No consumption.

In the past, there has been an effort to promote consistent advisories between neighboring states. In light of the difficulty of achieving this goal, the Iowa program is proposing that neighboring states should instead focus on a consistent message that can be communicated to the public. This consistent message would include information such as:

- Fish is a healthy food – source of lean protein and essential fatty acids

- Fish should be part of the healthy diet of all individuals, including pregnant or nursing mothers and young children
- Environmental chemicals are present in fish tissue at low concentrations, and they bioaccumulate in larger and older fish
- Exposure to larger amounts of environmental chemicals can be avoided by restricting consumption of larger sized freshwater predator fish (such as bass, walleye, and pike), and certain varieties of saltwater fish (such as mackerel, shark, swordfish, and tilefish).

Temporal Trends of Mercury Concentrations in Wisconsin Walleye (*Sander vitreus*), 1982–2005

Paul W. Rasmussen, Candy S. Schrank, and Patrick A. Campfield

Primary Contact Information:
Candy Schrank
Wisconsin Department of Natural Resources
101 South Webster Street, Madison, WI 53707-7921
Tel: 608-267-7614 Email: candy.schrank@wisconsin.gov

The Wisconsin Department of Natural Resources has monitored mercury (Hg) in several species of fish since the early 1970s primarily for fish consumption advisory purposes. We selected skin-on fillets of walleye (*Sander vitreus*) from inland lakes collected over the years 1982 to 2005 to assess temporal trends of Hg concentrations. While individual lakes are of interest, sample sizes and unbalanced collections across fish lengths, seasons, or years prevent estimates of temporal trends of walleye Hg concentrations within most lakes. We evaluated temporal trends over all lakes using mixed effects models (3,024 records from 421 lakes). Relationships between Hg concentrations and a suite of lake chemistry, morphometry, and other variables were also explored. Mercury concentrations generally increased with walleye length, but the relationship varied among lakes. The best fitting mixed effects models suggested that the overall rate of change in walleye Hg across all lakes in the dataset varied with latitude over the time period of 1982 to 2005. Season of collection was also an important predictor variable. Hg concentrations were highest in walleye captured in the spring and lowest in the fall. Other variables such as gender, lake area, and total alkalinity were also important predictors.

Use of Health Inspectors to Explore Commercial Fish Contamination Issues

Janet Scully and Marita Santos, Los Angeles County Department of Public Health

Primary Contact Information:
Janet Scully, MPH
Toxics Epidemiology Program, Los Angeles County Department of Public Health
695 South Vermont Avenue, 14th Floor – South Tower
Los Angeles, CA 90005
Tel: 213-738-6121 Email: jscully@ph.lacounty.gov

To address human health risks posed by the fish contamination related to the Palos Verdes Shelf (PVS) Superfund Site, the U.S. Environmental Protection Agency (EPA) funds a participatory outreach and education project called the Fish Contamination Education Collaborative (FCEC). This presentation will describe how the Los Angeles County Department of Public Health (LAC-DPH) collaborated with state, federal, and local agencies and community-based organizations to develop creative ways to address fish contamination issues in Southern California.

Because previous studies show that contaminated white croaker was being sold to markets, the LAC-DPH created a Commercial Fish Vendor Program. Its goals were to: (1) explore the presence of white croaker and other locally caught fish sold in markets and by wholesalers, and (2) assess the record-keeping quality of market owners. As a participating agency in the FCEC, the LAC-DPH collaborated with several agencies. Through a series of internal and external planning meetings, trainings of Environmental Health staff, development of inspection tools and educational materials, and implementation and evaluation of the program, LAC-DPH was able to accomplish its FCEC goals.

Approximately 405 independent fish markets and 65 wholesalers were targeted for inspection. A 4-hour training was conducted for the 35 Inspectors. The training was designed to educate them about fish contamination issues, fish identification, and the inspection process. Furthermore, existing tools were adapted and new materials were designed to assist Inspectors in the inspection process.

In the end, white croaker was identified during two inspections and the record-keeping quality was encouraging. Of the 470 markets and wholesalers visited, only approximately 5.5 percent of market owners did not have invoices for the fish purchased. This project was more than just an endeavor to explore contaminated fish in markets. It truly became a model for collaborative efforts between health department programs, nonprofit organizations, and other local agencies. With limited resources and funding, we were able to create a sustainable infrastructure to address a vital public health matter.

A National Assessment of PBDEs in Lake Fish Tissue

Leanne Stahl, Office of Water, U.S. Environmental Protection Agency

Primary Contact Information:
Leanne Stahl
U.S. EPA, OW/OST, Mail Code 4305T
1200 Pennsylvania Avenue, NW, Washington, DC 20460
Tel: 202-566-0404 Email: stahl.leanne@epa.gov

The U.S. Environmental Protection Agency (EPA) conducted a national freshwater fish contamination survey called the National Study of Chemical Residues in Lake Fish Tissue (or the National Lake Fish Tissue Study). The study was designed to estimate the national distribution of selected persistent, bioaccumulative, and toxic chemicals in fish tissue for lakes and reservoirs of the contiguous United States. Polybrominated diphenyl ethers (PBDEs), a subgroup of brominated chemicals that are used as flame retardants, were added in the final year of the 4-year survey because recent studies have shown that PBDE levels are increasing over time in human tissues and breast milk. The increasing levels are of concern because PBDEs have been associated with endocrine disruption, reproductive and developmental toxicity, neurotoxicity, and cancer in rodent studies.

A total of 352 fish samples were analyzed for PBDEs, including fillets from 195 predator composite samples and whole bodies from 157 bottom-dweller composite samples. These samples were collected from 166 statistically selected lakes and reservoirs in the lower 48 states. Each lake or reservoir was sampled for both predator (e.g., bass or trout) and bottom-dweller (e.g., carp or catfish) composites, and each composite consisted of five adult fish that were similar in size. The concentrations of 46 PBDE congeners were determined down to the ng/kg level (wet weight) in the tissue samples using Draft EPA Method 1614 (August 2003), a high-resolution gas chromatography, high-resolution mass spectrometry procedure being developed by EPA. About half of the total PBDEs in both the predator (fillet) and bottom-dweller (whole-body) samples consisted of a single congener, PBDE-47. Eight congeners accounted for about 95 percent of the total PBDEs in the predator and bottom-dweller samples, including 28, 33, 47, 49, 99, 100, 153, and 154.

EPA Pilot Study of PPCPs in Fish Tissue

Leanne Stahl[1], John Wathen[1], Blaine Snyder[2], John O'Donnell[3], and Jennifer Pitt[2]

[1]Office of Water, U.S. Environmental Protection Agency; [2]Tetra Tech, Inc., Owings Mills, MD; [3]Tetra Tech, Inc., Fairfax, VA

Primary Contact Information:
Leanne Stahl
U.S. EPA, OW/OST, Mail Code 4305T
1200 Pennsylvania Avenue, NW, Washington, DC 20460
Tel: 202-566-0404 Email: stahl.leanne@epa.gov

Obtaining environmental data on emerging contaminants is a priority area of interest for the U.S. Environmental Protection Agency (EPA), particularly the subset of emerging contaminants that

includes pharmaceuticals and personal care products (PPCPs). Increasing evidence indicates widespread occurrence of PPCP compounds in surface water, sediments, and municipal effluent, but data on the accumulation of PPCP compounds in fish tissue are scarce. In response, the Office of Science and Technology within EPA's Office of Water initiated a pilot study to investigate the occurrence of PPCP chemicals in fish tissue called the EPA Pilot Study of Pharmaceuticals and Personal Care Products in Fish Tissue.

The targeted study design for this pilot involved collecting fish samples from five effluent-dominated streams in various parts of the country (Chicago, IL; West Chester, PA; Orlando, FL; Dallas, TX; and Phoenix, AZ) and from one reference site (East Fork Gila River, Gila National Forest, NM). At each site, sampling teams collected 18 to 24 adult fish of the same resident species in the vicinity of wastewater treatment plant discharges. Field sampling was conducted from August through November 2006. Fish samples from each site were divided into six composites, each containing three or four fish. All fish were frozen and shipped whole to an analytical laboratory at Baylor University. The laboratory analyzed fillet and liver tissue from the fish composites for 24 pharmaceutical compounds using a high-performance liquid chromatography-tandem mass spectrometry (HPLC-MS/MS) method, and for 10 personal care products using a gas chromatography-tandem mass spectrometry (GC-MS/MS) method. The pharmaceutical compounds included analgesics, antibiotics, antidepressants, antihistamines, anti-hypertension drugs, and anti-seizure medications. Personal care product chemicals included fragrances/musks, surfactants, and ultraviolet filters. Results for all fish tissue samples should be available in winter 2008.

Mercury Exposure and Fish Consumption among Low-income Pregnant Women in a Private Obstetrics Practice – Preliminary Results

May Lynn Tan, Alyce Ujihara, Lori Copan, Diana Lee, and Svetlana Smorodinsky

Primary Contact Information:
May Lynn Tan
California Department of Health Services
Environmental Health Investigations Branch
850 Marina Bay Parkway, Building P-3, Richmond, CA 94804-6403
Tel: 510-620-3627 Email: mtan@dhs.ca.gov

Fishing is a culturally important activity to the ethnically diverse population living in the Sacramento–San Joaquin Delta. Unfortunately, due to mercury (Hg) runoff from abandoned gold mines, many fish in this region are contaminated with methylmercury (MeHg), a neurodevelopmental toxin.

We partnered with a private practice obstetrician and his staff in Sacramento, CA, to characterize fish-consumption practices among 180 ethnically diverse, low-income pregnant patients, and to measure their blood Hg levels. Trained medical assistants conducted interviews and provided educational sessions. Protocols were developed to guide clinical staff in communicating Hg test results to the women, follow-up, and education.

Preliminary results will be presented on the following research objectives:

1. Characterize Hg exposure among a population of mostly low-income, pregnant women through a fish intake questionnaire and blood mercury tests.
2. Assess the feasibility of incorporating blood Hg testing into clinical practice, and the extent to which Medi-Cal and other health insurance providers will cover such testing.
3. Through training and education, increase knowledge among office staff and patients about health risks and benefits of fish consumption and ways to reduce exposure to mercury.

Mercury Exposure in Anglers and Attendees of a Coastal Alabama Fishing Tournament

Kimberly A. Warner, Oceana

Primary Contact Information:
Kimberly A. Warner
Oceana
2501 M Street, NW, Suite 300
Washington, DC 20037
Tel: 202-467-1932 Email: kwarner@oceana.org

Mercury (Hg) exposure and seafood consumption preferences and patterns were assessed in a small survey of anglers and attendees of the Alabama Deep Sea Fishing Rodeo in 2006. This area in the northern Gulf of Mexico receives some of the highest Hg deposition in the United States and a number of popular sport fish from the Gulf were found to have higher Hg levels in a survey the previous year. The estimated average seafood consumption rate, 55 g/day, is 2.7 times the national average. Mercury levels in hair samples from 65 participants ranged from 0.01–4.05 ppm, with Rodeo anglers having the highest average concentration (0.93 ppm) and females the lowest (0.55 ppm). Thirty-seven percent of anglers and 10 percent of females had hair Hg levels above 1 ppm, the EPA reference dose. Fifteen participants (23%) reported one or more symptoms of Hg toxicity listed on the survey; however, reported symptoms were not correlated with hair Hg levels. The frequency of fish meals and the Hg levels in top consumed seafood were positively related to hair Hg levels (r^2 =0.54; p< 0.0001).

Results from this survey were compared to national and regional data. Female Hg levels from this survey were double the national average reported for women of childbearing age. Mercury levels in this coastal survey were four times higher than those found in a similar survey in inland, northern Alabama. This finding may be partly explained by the lower seafood consumption and lower Hg levels in the top consumed fish in the inland population.