

US EPA ARCHIVE DOCUMENT

National Listing of Fish Advisories

NEWSLETTER

Recent Advisory News

New Jersey governor lifts public health advisories for most New Jersey waterways

The public health advisories for recreational use of several New Jersey waterways due to damage caused by Hurricane Sandy are now being lifted. Damage to wastewater treatment plants, which prompted the advisories, has been restored and boating, fishing and crabbing are now allowed in the Hudson River, Passaic River, Hackensack River, Newark Bay, Kill Van Kull and Arthur Kill, Sandy Hook Bay and Barnegat Bay. However, recreational and commercial shellfish harvesting is still prohibited. The public health advisory remains in place for Raritan River and Raritan Bay. For updates on this advisory, all boaters, anglers and crabbers are encouraged to visit the Hurricane Sandy Web page at <http://www.nj.gov/dep/special/hurricane-sandy/> Current fish consumption advisories can be found at <http://fishsmarteatsmartnj.org>. Link to original article: http://www.state.nj.us/dep/newsrel/2012/12_0152.htm

Source: State of New Jersey Department of Environmental Protection. 12/7/2012.

Minnesota targets mercury levels in newborns

The EPA has issued a \$1.4 million grant to increase fish consumption education in Minnesota's portion of Lake Superior. The funding, provided by the federal Great Lakes Protection Fund, will pay for a combined study and education effort for women of child-bearing age in Cook County — to find out how much fish they eat and to educate them on how much and what kinds of fish are safe to eat. The effort is a direct response to a study released in February 2012 by the Minnesota Department of Health that showed one out of every 10 babies born in the Lake Superior region of Minnesota has unsafe levels



of mercury in his or her bloodstream. It is hoped that this effort will help women along the North Shore reduce their exposure to mercury and avoid the health risks associated with eating contaminated fish.

Link to original article: <http://www.duluthnewstribune.com/event/article/id/245546/>

Source: Myers, J. Duluth News-Tribune. Minnesota. 10/5/2012.

Presque Isle Bay committee discusses de-listing, research

In 1991, Presque Isle Bay, off the coast of Erie, Pennsylvania, was listed on the Great Lakes Water Quality Agreement's Areas of Concern (AOCs) List due to the occurrence of liver tumors in brown bullhead catfish and contaminants in sediments. Changes to improve Erie's city wastewater treatment facility have led to fewer toxins entering the waterway and therefore fewer fish tumors, fueling an effort to remove Presque Isle Bay from the AOC List. Some members of the Presque Isle Bay Public Advisory Committee fear that removing the Bay from the AOC List could result in less funding for future research projects such as a proposed study to monitor and evaluate the fish tumors.



Link to original article: <http://www.goerie.com/article/20121218/NEWS02/312179929/Presque-Isle-Bay-committee-discusses-delisting-research>

Source: Massing, D. Erie Times-News. Pennsylvania. 12/18/2012.

Western North Carolina lakes join list with mercury warning for fish

The North Carolina Division of Public Health has added two more lakes (Nantahala and Chatuge) in Western North Carolina to a fish consumption advisory due to mercury contamination. These two lakes join two other lakes, Lake Fontana and Santeelah Lake, which were already under a mercury fish advisory. The source of the mercury is unknown, but it is expected that it may come from coal plants or coal-fired boilers. The current advisory recommends that women who are pregnant, nursing or are of childbearing age and children under 15 avoid eating the following: walleye and largemouth bass from Fontana Lake and Santeelah Lake; smallmouth bass, walleye, yellow perch and largemouth bass from Nantahala Lake; and white bass and largemouth bass from Lake Chatuge. The advisory further recommends that other adults limit their fish intake to 6 ounces per week of the fish listed. The advisory does not limit recreational activities in the lakes.

Link to original article: <http://www.smokymountainnews.com/outdoors/item/9501-wnc-lakes-join-list-with-mercury-warning-for-fish>

Source: Johnson, B. Smoky Mountain News. North Carolina. 12/19/2012.

Recent Publications

Please note: The following abstracts are reprinted verbatim unless otherwise noted.

Nationwide monitoring of mercury in wild and farmed fish from fresh and coastal waters of Korea

Mercury (Hg) concentrations were monitored in wild and cultured fish collected from fresh and coastal waters in the Korean peninsula from April 2006 to August 2008 nationwide. Total Hg concentrations were reported for 5043 fish samples, including 78 species from 133 locations. Significant interspecies variation was noted in the Hg levels. The average Hg concentration in each fish species ranged from 6.31 $\mu\text{g kg}^{-1}$ for mullet (*Mugil cephalus*) to 200 $\mu\text{g kg}^{-1}$ for

mandarin fish (*Siniperca scherzeri*). Among the species collected, the maximum concentration of Hg, 1720 $\mu\text{g kg}^{-1}$, was measured in an Amur catfish (*Silurus asotus*). Only wild freshwater fish exceeded the WHO ingestion standard. Wild freshwater piscivorous fish samples from a large artificial upstream lake contained the highest Hg levels. Hg concentrations were compared between fish groups categorized as wild and farmed fish from freshwater and coastal waters. Although the wild freshwater fish had similar size ranges, their Hg concentrations were higher than those of the other groups. Compared to the feed of farmed marine and freshwater fishes, the prey of wild freshwater fish had a higher Hg concentration, and the total Hg concentrations in freshwater and associated sediment samples were higher than those in coastal water and associated sediment samples. In the freshwater environment, piscivorous fish bioaccumulated two times more Hg than carnivorous and omnivorous fish and four times more than planktivorous fish. The difference in Hg concentrations among trophic groups might have been due to differences in the size of fish, in addition to the variations among different trophic groups. These data will be useful for developing the fish consumption advisory as a management measure to reduce Hg exposure.

Source: Kim, C. K., T. W. Lee, et al. (2012). "Nationwide monitoring of mercury in wild and farmed fish from fresh and coastal waters of Korea." *Chemosphere* 89(11): 1360-1368.

A multidisciplinary approach to promoting healthy subsistence fish consumption in culturally distinct communities

Methyl mercury is a potent neurotoxin that causes developmental delays in young and unborn children and has been linked to neurological and cardiovascular degeneration in adults. Methyl mercury is the basis of a state-sponsored fish advisory to limit consumption of local fish in North Carolina. This study employed methods and analytic constructs from the behavioral and social sciences to assess the determinants of subsistence fishing and to promote informed fish consumption among culturally distinct and lower income subsistence fishers in southeastern North Carolina. Formative research revealed that Native American and African American were more likely than Latino resi-

Conferences

Society of Toxicology 52nd Annual Meeting and ToxExpo

March 10-14, 2013, San Antonio, Texas

<http://www.toxicology.org/AI/MEET/AM2013/>

International Conference on Mercury as a Global Pollutant

July 28-August 2, 2013, Edinburgh, Scotland

<http://www.mercury2013.com/>

International Society of Exposure Science (ISES)-23rd Annual Meeting

August 20-23, 2013, Basel, Switzerland

http://www.isesweb.org/Meetings/mtgs_fut.htm

American Fisheries Society 143rd Annual Meeting

September 8-12, 2013, Little Rock, Arkansas

<http://afs2013.com/>

The Society of Environmental Toxicology and Chemistry (SETAC) North America 34th Annual Meeting

November 17-21, 2013, Nashville, Tennessee

http://www.setac.org/events/event_details.asp?id=244644

dents to know of the fish advisory, and to practice procurement and preparation strategies that are mistakenly believed to render locally caught fish safe for consumption. Fish advisories were developed for each community to promote informed fish consumption intentions among residents who consume local fish. The interventions were successful in increasing knowledge and healthy intentions among most residents. Adherence to some safe fish consumption practices were constrained by cultural and economic factors. These results demonstrate the utility of multidisciplinary approaches for assessing and reducing human exposure to methyl mercury through subsistence fish consumption.

Source: Driscoll, D., A. Sorensen, et al. (2012). "A multidisciplinary approach to promoting healthy subsistence fish consumption in culturally distinct communities." *Health Promot Pract* 13(2): 245-251.

Mercury in the pelagic food web of Lake Champlain

Lake Champlain continues to experience mercury contamination resulting in public advisories to limit human consumption of top trophic level fish such as walleye. Prior research suggested that mercury levels in biota could be modified by differences in ecosystem productivity as well as mercury loadings. We investigated relationships between mercury in different trophic levels in Lake Champlain. We measured inorganic and methyl mercury in water, seston, and two size fractions of zooplankton from 13 sites representing a range of nutrient loading conditions and productivity. Biomass varied significantly across lake segments in all measured ecosystem compartments in response to significant differences in nutrient levels. Local environmental factors such as alkalinity influenced the partitioning of mercury between water and seston. Mercury incorporation into biota was influenced by the biomass and mercury content of different ecosystem strata. Pelagic fish tissue mercury was a function of fish length and the size of the mercury pool associated with large zooplankton. We used these observations to parameterize a model of mercury transfers in the Lake Champlain food web that accounts for ecosystem productivity effects. Simulations using the mercury trophic transfer model suggest that reductions of 25–75% in summertime dissolved epilimnetic total mercury will likely

allow fish tissue mercury concentrations to drop to the target level of $0.3 \mu\text{g g}^{-1}$ in a 40-cm fish in all lake segments. Changes in nutrient loading and ecosystem productivity in eutrophic segments may delay any response to reduced dissolved mercury and may result in increases in fish tissue mercury.

Source: Miller, E., C. Chen, et al. (2012). "Mercury in the pelagic food web of Lake Champlain." *Ecotoxicology* 21(3): 705-718.

Mercury in groupers and sea basses from the Gulf of Mexico: Relationships with size, age, and feeding ecology

We analyzed total mercury concentration in muscle tissue of 15 serranid species ($n = 1,401$ fish) collected from the Gulf of Mexico and also developed a comprehensive model relating two commonly used mercury analysis methods. There was considerable interspecific and intraspecific variability in mercury within groupers and sea basses. Mean mercury concentration for individual species ranged from 0.03 to 0.91 mg/kg wet weight across all size ranges, and for legally harvestable grouper and sea bass concentrations were 0.32 mg/kg and 0.09 mg/kg, respectively. Mercury in individual fish ranged from 0.01 to 3.3 mg/kg. Approximately 23% of all grouper samples analyzed contained mercury at concentrations that exceeded the U.S. Environmental Protection Agency's methylmercury consumption guidance criterion for humans (0.3 mg/kg). Mercury in legally harvestable individuals of some species exceeded 0.5 mg/kg, and harvestable black grouper *Mycteroperca bonaci* had a mean mercury concentration greater than 1.0 mg/kg. A positive relationship was observed between total mercury content and both fish length and fish age. For species that feed principally on fishes (e.g., gag *M. microlepis* and scamp *M. phenax*), mean mercury concentration was greater than that for species that feed mainly on invertebrates (e.g., red grouper *Epinephelus morio* and sand perch *Diplectrum formosum*). Although overall mean mercury concentrations were relatively low, for six species the maximum mercury concentration was at a level that has been associated with sublethal effects on fish physiology and with human health risks. Current grouper management regulations in the Gulf of Mexico select for a fishery of the largest and oldest indi-

viduals, which have the greatest mercury burdens. The species- and size-specific mercury data from this study can be used to inform at-risk human populations, refine regional fish consumption advisories, and further our understanding of mercury bioaccumulation in these important fishery species.

Source: Tremain, D. M. and D. H. Adams (2012). "Mercury in groupers and sea basses from the Gulf of Mexico: Relationships with size, age, and feeding ecology." *Transactions of the American Fisheries Society* 141(5): 1274-1286.

Toxicological significance of mercury in yellow perch in the Laurentian Great Lakes region

We assessed the risks of mercury in yellow perch, a species important in the trophic transfer of methylmercury, in the Great Lakes region. Mean concentrations in whole perch from 45 (6.5%) of 691 waters equaled or exceeded $0.20 \mu\text{g/g w.w.}$, a threshold for adverse effects in fish. In whole perch within the size range eaten by common loons (<100 g), mean concentrations exceeded a dietary threshold ($0.16 \mu\text{g/g w.w.}$) for significant reproductive effects on loons in 19 (7.3%) of 260 waters. Mean concentrations in fillets of perch with length ≥ 15.0 cm, the minimum size retained by anglers, exceeded the USEPA criterion ($0.3 \mu\text{g/g w.w.}$) in 26 (6.4%) of 404 U.S. waters and exceeded the Ontario guideline ($0.26 \mu\text{g/g w.w.}$) in 35 (20%) of 179 Ontario waters. Mercury levels in yellow perch in some waters within this region pose risks to perch, to common loons, and to mercury-sensitive human populations.

Source: Wiener, J. G., M. B. Sandheinrich, et al. (2012). "Toxicological significance of mercury in yellow perch in the Laurentian Great Lakes region." *Environ Pollut* 161: 350-357.

Selenium: Mercury molar ratios in freshwater fish from Tennessee: Individual, species, and geographical variations have implications for management

Vertebrates, including humans, can experience adverse effects from mercury consumed in fish. Humans often prefer large predatory fish that bioaccumulate high mercury levels. Recent attention has focused on the role of selenium countering mercury toxicity, but there is little research on the selenium: mercury molar ratios in freshwater fish. We examine selenium: mercury mo-

lar ratios in freshwater fish from Tennessee at Poplar Creek which receives ongoing inputs of mercury from the Department of Energy's Oak Ridge Y-12 facility. Our objective was to determine variation of the ratios within species that might affect the protectiveness of selenium against mercury toxicity. Within species, the ratio was correlated significantly and positively with fish length only for two species. There was great individual variation in the selenium: mercury molar ratio within each species, except striped bass. The lack of a clear relationship between the selenium: mercury molar ratio and fish length, and the intraspecific variation, suggests that it would be difficult to use the molar ratio in predicting either the risk from mercury toxicity or in devising consumption advisories.

Source: Burger, J., M. Gochfeld, et al. (2012). "Selenium: Mercury molar ratios in freshwater fish from Tennessee: Individual, species, and geographical variations have implications for management." *EcoHealth* 9 (2): 171-182.

The tale of sushi: History and regulations

This article is an exploration of the history of sushi consumption in the United States and how the ingredients of sushi are regulated. The article delineates the course of sushi's culinary history in Japan, and will attempt to present an overview on the incremental process by which sushi as a cuisine evolved from a humble street food with scarce recognition to an immensely sophisticated popular cuisine in Japan and America. After describing and analyzing the historical background of sushi, the article will present the underpinnings of the confounding set of etiquettes that center the art of consuming sushi. This article will also examine sushi as an exemplary form of successful, multi-directional product of globalization. It is intriguing to observe sushi as a circulating global commodity that internalizes and promotes regional dietary preferences and cultural practices. The second half of the article will discuss both the health benefits and health hazards associated with the sushi cuisine. While the seafood, seaweed, and seasoning involved with eating sushi have high nutritional value, sushi consumers need to be aware of the perilous nature of mercury poisoning and the biological contaminants that are

embedded in improperly processed sushi fish. The FDA's current consumer advisory scheme on mercury poisoning is incomprehensible, conflicts with the guidelines that Environmental Protection Agency (EPA) delineates, and its inspection and surveillance guidelines are in practice difficult to enforce. The last section of the article will trace the development of the Seafood Hazard Analysis and Critical Control Point (HACCP) plan and compare its prospective policy visions and practical guidelines with the Hong Kong Food and Environmental Hygiene Department's (FEHD) Sushi Surveillance Guidelines.

Source: Hsin-I Feng, C. (2012). "The tale of sushi: History and regulations." *Comprehensive Reviews in Food Science and Food Safety* 11(2): 205-220.

Baseline radionuclide specific activity in commercial fishes of Kuwait

Radionuclide concentration in commercial fish species of Kuwait has been determined primarily with the intention of creating the baseline for ^{210}Po , ^{137}Cs , ^{40}K , ^{226}Ra , ^{224}Ra , ^{228}Ra , and ^{90}Sr . This baseline information can be useful for issuing food advisories and determining annual intakes and radiation doses due to fish consumption. The highest fresh weight concentration of ^{210}Po and ^{90}Sr was in Battan and the lowest in So-baity. Highest fresh weight ^{40}K concentration was observed in Meid and the lowest in Battan. The ^{224}Ra , ^{226}Ra and ^{228}Ra concentrations were highest in Meid, whereas the lowest was in Nuwaibi. In all the collected fish samples, ^{137}Cs was below the detection limit.

Source: Al-Ghadban, A. N., S. Uddin, et al. (2012). "Baseline radionuclide specific activity in commercial fishes of Kuwait." *Aquatic Ecosystem Health & Management* 15(sup1): 45-49.

Mercury in waterfowl from a contaminated river in Virginia

Many bodies of water around the world are contaminated with mercury from historic industrial and mining activities or ongoing atmospheric deposition, resulting in numerous fish consumption advisories. However, concerns about mercury have only rarely led to consumption advisories on waterfowl. In contrast with fish, waterfowl frequently disperse long distances to new watersheds, so hunters and wildlife managers

do not know whether waterfowl at a pristine site have spent time at a contaminated site elsewhere. We sampled tissue mercury concentrations of mallards (*Anas platyrhynchos*), wood ducks (*Aix sponsa*), and Canada geese (*Branta canadensis*) at a site contaminated with mercury, during the breeding and hunting seasons. We found that many mallards had bioaccumulated mercury to levels that had the potential to produce reproductive effects and exceeded consumption advisories set for fish by regulatory agencies, whereas this was true for only a few wood ducks and Canada geese. We also documented that mercury-exposed waterfowl from this contaminated site were harvested by hunters as far as 1,054 km away. Our results suggest the need for more proactive sampling of waterfowl for mercury, and likely other bioaccumulating contaminants, in order to allow hunters to make more informed choices about consumption of their harvest.

Source: Cristol, D. A., L. Savoy, et al. (2012). "Mercury in waterfowl from a contaminated river in Virginia." *The Journal of Wildlife Management* 76(8): 1617-1624.

Moving beyond a top-down fisheries management approach in the northwestern Mediterranean: Some lessons from the Philippines

The management of fisheries resources in the northwestern Mediterranean is traditionally centralized and developed within the framework of coastal states and European Union common policies. In general, it has not been sufficiently effective in reversing the declining situation of fisheries resources and fishers in this region. This paper discusses the feasibility of moving away from a top-down approach in fisheries management towards a more participative and convergent mode of governance in the region. More specifically, the study focuses on MPAs as a fisheries management tool and evaluates their current establishment and management system in the French Mediterranean as a case study for the region. A brief review of the experiences on fisheries and MPA management in the Philippines is also presented to obtain insights on bottom-up and collaborative management approaches. Finally, possible opportunities for adopting a more decentralized and

coordinated approach in fisheries management within the French socio-political system, and possibly in the northwestern Mediterranean region, are discussed. These include the existence of fishing community organizations in the region, such as the *prud'homies* in France and *cofradías* in Spain, starting with management strategies that are simpler to enforce and more acceptable to direct users, e.g., fishery reserves, and exploring co-management arrangements to manage fisheries at ecologically meaningful but operationally manageable scales as has been proposed by some development organizations. However, effective changes in the system would require major national policy and institutional reforms, social preparation and organizational strengthening which would take time and resources.

Source: Arceo, H. O., B. Cazalet, et al. (2013). "Moving beyond a top-down fisheries management approach in the northwestern Mediterranean: Some lessons from the Philippines." *Marine Policy* 39: 29-42.

Expanding perceptions of subsistence fish consumption: Evidence of high commercial fish consumption and dietary mercury exposure in an urban coastal community

Through collaborative partnerships established between current researchers and The Moton Community House (a local community center), African American women (ages 16-49 yrs) from the Southeast Community of Newport News, Virginia, USA were surveyed to assess the reproducibility and consistency of fish consumption patterns (ingestion rates, exposure frequencies, weight, and fish consumption rates) derived from a community-specific fish consumption survey. Women were also surveyed to assess the reliability of the survey responses, and to estimate daily mercury intake. Fish consumption patterns were reproducible and the survey responses were reliable. Comparison between years revealed that fish consumption patterns remained consistent over time. In addition, the high fish consumption rate estimated in 2008 (147.8 g/day; 95% CI: 117.6-185.8 g/day) was confirmed with a rate (134.9 g/day; 95% CI: 88-207 g/day) not materially different and still considerably higher than mean fish consumption rates reported for U.S. women. Daily mercury intake rates were estimated using consumption data from 2008 and three consumption scenarios

(canned white, canned light, and no tuna) due to confirmed differences in mercury concentration between canned white and light tuna. Arithmetic mean daily mercury intake rates were 0.284 µg/kg bw/day (95% CI: 0.229-0.340 µg/kg bw/day) using canned white tuna, 0.212 µg/kg bw/day (95% CI: 0.165-0.259 µg/kg bw/day) using light tuna, and 0.197 µg/kg bw/day (95% CI: 0.151-0.243 µg/kg bw/day) using no tuna. Approximately 58%-73% of the daily mercury intake rates for African American women in the Southeast Community exceeded US EPA's oral reference dose (RfD) of 0.10 µg/kg bw/day for mercury. In addition, 2% of the rates exceeded a level (1.00 µg/kg bw/day) documented to produce adverse health effects. Past and current investigations confirmed that even though women in this community were not subsistence fishers, they are subsistence fish consumers.

Source: Holloman, E. L. and M. C. Newman (2012). "Expanding perceptions of subsistence fish consumption: Evidence of high commercial fish consumption and dietary mercury exposure in an urban coastal community." *Sci Total Environ* 416: 111-120.

Fish consumption, low-level mercury, lipids, and inflammatory markers in children

There is considerable evidence that consuming fish has numerous health benefits, including a reduced risk of cardiovascular disease. However, fish is also the primary source of human exposure to mercury (Hg). In a cross-sectional study of 9-11 year old children (N=100), we measured fish consumption, blood lipids, total blood Hg, diurnal salivary cortisol (4 samples collected throughout the day), and performed a proteomic analysis of serum proteins using spectral count shotgun proteomics. Children who consumed fish had a significantly more atheroprotective lipid profile but higher levels of blood Hg relative to children that did not consume fish. Although the levels of blood Hg were very low in these children (M=0.77 µg/L; all but 1 participant had levels below 3.27 µg/L), increasing blood Hg was significantly associated with blunted diurnal cortisol levels. Blood Hg was also significantly associated with acute-phase proteins suggesting systemic inflammation, and several of these proteins were found to significantly reduce the association between Hg and diminished cortisol when included in the model. This study of a pediatric population is the first to document an association between blood Hg, systemic inflammation, and endocrine disruption in humans.

Without a better understanding of the long-term consequences of an atheroprotective lipid profile relative to blunted diurnal cortisol and systemic inflammation, a determination of the risk-benefit ratio for fish consumption by children is not possible.

Source: Gump, B. B., J. A. MacKenzie, et al. (2012). "Fish consumption, low-level mercury, lipids, and inflammatory markers in children." *Environ Res* 112: 204-211.

Heavy metals concentrations in fish and shellfish from eastern Mediterranean Sea: Consumption advisories

The present study evaluate concentrations of arsenic (As), cadmium (Cd), chromium (Cr), lead (Pb), manganese (Mn), nickel (Ni), vanadium (V) and zinc (Zn) in fish and shellfish from the Gulf of Catania. Heavy metal analysis was carried on with an ICP-MS, and consumption rates advisory for minimizing chronic systemic and non cancer endpoints in child and adults have been estimated. Among metals investigated, only Cd and Pb have a limit set by European Community for human consumption, and the thresholds were not been exceeded in analyzed species. The As, toxic in its inorganic form, have not a regulatory limit yet, but the Environmental Protection Agency and the World Health Organization provide a reference dose, a cancer slope factor and a tolerable intake, applicable in the risk factors assessment. Arsenic target hazard quotient (THQ) values, suggest that human should minimizing meals/week of analyzed species to avoid deleterious effect during lifetime, furthermore, with As cancer risk assessment, for most of the fish, the risk for cancer is greater than the acceptable lifetime risk of 10⁻⁵. Our results give important finding about the consumption limits on certain metals, especially for As, all for minimizing potential health risks in population.

Source: Copat, C., G. Arena, et al. (2012). "Heavy metals concentrations in fish and shellfish from eastern Mediterranean Sea: Consumption advisories." *Food Chem Toxicol* 53C: 33-37.

Biotic interactions in temporal trends (1992-2010) of organochlorine contaminants in the aquatic food web of Lake Laberge, Yukon Territory

Declines in 6 organochlorine (OC) contaminant groups; chlordane (CHL), DDT, HCH, toxaphene (CHB), PCB and chlorinated benzenes (CBz) were measured in biota of a sub-Arctic lake (Lake Laberge, YT) following the closure of a commercial fishery in 1991. This study examined morphological (length, weight, age), biochemical (lipid content, $\delta^{13}\text{C}$, $\delta^{15}\text{N}$), population and OC data for 9 fishes and zooplankton between 1993 and 2003 (2010 for lake trout) to investigate causes for the OC declines. Growth dilution was a major factor influencing the decrease of OCs in lake trout, round whitefish and possibly zooplankton most notably in the early 2000s. A decline in lipids of most fish species also contributed to OC declines, although no such change was evident for zooplankton. It is suspected that increases in fish populations or climate variations over the 1990s, may have contributed towards a shift in plankton community composition. From 1991 to 1999, CPUE increased for 7 of the fish species and declined for 2 others. Concurrently, the zooplankton community shifted from an abundance of *C. scutifer* in 1993 to dominance by *D. pambolensis* in 2001. Nitrogen and carbon stable isotope data suggested that food web interactions for most fish species have not changed over time. Although concentrations of OCs have declined in many fishes, the "rate" of OC transfer (using slopes of log OC vs. nitrogen isotope ratios) through the food web was greater in 2001 than in 1993. Overall, the declines in OC concentrations in the fish from Lake Laberge occurred concurrently with changes in their growth, lipid, and abundance, suggesting that ecosystem responses to the closure of the fishery were in part responsible for the lower contaminants in these fishes. As a result of this study, the Yukon government rescinded the health advisory for limiting the consumption of fish from Lake Laberge.

Source: Ryan, M. J., G. A. Stern, et al. (2012). "Biotic interactions in temporal trends (1992-2010) of organochlorine contaminants in the aquatic food web of Lake Laberge, Yukon Territory." *Sci Total Environ* 443C: 80-92.

Fate of geothermal mercury from Yellowstone National Park in the Madison and Missouri Rivers, USA

Mercury is a worldwide contaminant derived from natural and anthropogenic sources. River systems play a key role in the transport and fate of Hg because they drain widespread areas affected by aerial Hg deposition, transport Hg away from point sources, and are sites of Hg biogeochemical cycling and bioaccumulation. The Madison and Missouri Rivers provide a natural laboratory for studying the fate and transport of Hg contributed by geothermal discharge in Yellowstone National Park and from the atmosphere for a large drainage basin in Montana and Wyoming, United States of America (USA). Assessing Hg in these rivers also is important because they support fishery-based recreation and irrigated agriculture. During 2002 to 2006, Hg concentrations were measured in water, sediment, and fish from the main stem, 7 tributaries, and 6 lakes. Using these data, the geothermal Hg load to the Madison River and overall fate of Hg along 378 km of the Missouri River system were assessed. Geothermal Hg was the primary source of elevated total Hg concentrations in unfiltered water (6.2–31.2 ng/L), sediment (148–1100 ng/g), and brown and rainbow trout (0.12–1.23 μg total Hg/g wet weight skinless filet) upstream from Hebgen Lake (the uppermost impoundment). Approximately 7.0 kg/y of geothermal Hg was discharged from the park via the Madison River, and an estimated 87% of that load was lost to sedimentation in and volatilization from Hebgen Lake. Consequently, Hg concentrations in water, sediment, and fish from main-stem sites downstream from Hebgen Lake were not elevated and were comparable to concentrations reported for other areas affected solely by atmospheric Hg deposition. Some Hg was sequestered in sediment in the downstream lakes. Bioaccumulation of Hg in fish along the river system was strongly correlated ($r^2 = 0.76\text{--}0.86$) with unfiltered total and methyl Hg concentrations in water and total Hg in sediment.

Source: Nimick, D. A., R. R. Caldwell, et al. (2012). "Fate of geothermal mercury from Yellowstone National Park in the Madison and Missouri Rivers, USA." *Sci Total Environ* 443C: 40-54.

(n-3) fatty acids and cardiovascular health: Are effects of EPA and DHA shared or complementary?

Considerable research supports cardiovascular benefits of consuming omega-3 PUFA, also known as (n-3) PUFA, from fish or fish oil. Whether individual long-chain (n-3) PUFA have shared or complementary effects is not well established. We reviewed evidence for dietary and endogenous sources and cardiovascular effects on biologic pathways, physiologic risk factors, and clinical endpoints of EPA [20:5(n-3)], docosapentaenoic acid [DPA, 22:5(n-3)], and DHA [22:6(n-3)]. DHA requires direct dietary consumption, with little synthesis from or retroconversion to DPA or EPA. Whereas EPA is also largely derived from direct consumption, EPA can also be synthesized in small amounts from plant (n-3) precursors, especially stearidonic acid. In contrast, DPA appears principally derived from endogenous elongation from EPA, and DPA can also undergo retroconversion back to EPA. In experimental and animal models, both EPA and DHA modulate several relevant biologic pathways, with evidence for some differential benefits. In humans, both fatty acids lower TG levels and, based on more limited studies, favorably affect cardiac diastolic filling, arterial compliance, and some metrics of inflammation and oxidative stress. All three (n-3) PUFA reduce ex vivo platelet aggregation and DHA also modestly increases LDL and HDL particle size; the clinical relevance of such findings is uncertain. Combined EPA+DHA or DPA+DHA levels are associated with lower risk of fatal cardiac events and DHA with lower risk of atrial fibrillation, suggesting direct or indirect benefits of DHA for cardiac arrhythmias (although not excluding similar benefits of EPA or DPA). Conversely, EPA and DPA, but not DHA, are associated with lower risk of nonfatal cardiovascular endpoints in some studies, and purified EPA reduced risk of nonfatal coronary syndromes in one large clinical trial. Overall, for many cardiovascular pathways and outcomes, identified studies of individual (n-3) PUFA were relatively limited, especially for DPA. Nonetheless, the present evidence suggests that EPA and DHA have both shared and complementary benefits. Based on current evidence,

increasing consumption of either would be advantageous compared to little or no consumption. Focusing on their combined consumption remains most prudent given the potential for complementary effects and the existing more robust literature on cardiovascular benefits of their combined consumption as fish or fish oil for cardiovascular benefits.

Source: Mozaffarian, D. and J. H. Wu (2012). "(n-3) fatty acids and cardiovascular health: Are effects of EPA and DHA shared or complementary?" *J Nutr* 142(3): 614S-625S.

Risk-benefit analysis of fish consumption: Fatty acid and mercury composition of farmed southern bluefin tuna, *Thunnus maccoyii*

The docosahexanoic acid (DHA) and eicosapentaenoic acid (EPA) contents and total mercury concentration were measured in whole tissue composites of all edible tissues of wild caught and farmed southern bluefin tuna (*Thunnus maccoyii*, SBT) and each of the marketed tissue cuts (akami, chu-toro and o-toro) of these fish. Rapid lipid accumulation during culture resulted in a net reduction in mercury concentration of SBT composite tissues and an increase in the concentration of the dietary essential fatty acids. Moreover, the increased affinity of lipid for certain tissue cuts (o-toro) over that of others (e.g. akami), resulted in cross carcass variation in the mercury concentration of fish muscular tissue. Results highlight the potential for farming to be used as a tool to improve the flesh quality of fish species which could otherwise provide limited dietary essential fatty acids to consumers and potentially contain elevated contaminant levels.

Source: Balshaw, S., J. W. Edwards, et al. (2012). "Risk-benefit analysis of fish consumption: Fatty acid and mercury composition of farmed southern bluefin tuna, *Thunnus maccoyii*." *Food Chem* 131(3): 977-984.

Hair mercury levels and food consumption in residents from the Pearl River Delta: South China

The Pearl River Delta (PRD) is located in the Southern part of China and is the main region for fish culture in Guangdong Province. In order to assess the potential health risks associated with dietary consumption of mercury, hair samples from 91 urban, town and fishing vil-

lage residents, 37 species of fish, cereal, vegetables, and meat samples were collected. The average total mercury (THg) and methylmercury (MeHg) concentrations in hair were 1.08 ± 0.94 and 0.58 ± 0.59 $\mu\text{g/g}$, respectively. Daily Hg intake via fish consumption is significantly correlated with THg and MeHg accumulated in human hair ($r = 0.48, p < 0.01$; $r = 0.43, p < 0.01$). The estimated daily intake of Hg via different food types showed that both fish and cereal consumption were the two main routes of Hg exposure for residents in the sampling areas. Besides food intake, smoking was also an important source for daily THg intake in the smoke group, contributing 11–18% to EDI of THg.

Source: Shao, D., Y. Kang, et al. (2013). "Hair mercury levels and food consumption in residents from the Pearl River Delta: South China." *Food Chem* 136(2): 682-688.

Factors influencing blood mercury levels of inhabitants living near fishing areas

Methylmercury (MeHg), a well-known neuro-toxicant, is usually emitted by industrial and other man-made activities; it is ingested with seafood and shellfish, and accumulates in the human body. The aim of this study was to compare the differences in blood levels of total mercury (T-Hg) and MeHg in residents of 4 coastal sites and 4 inland sites around Taiwan. Meanwhile, the potential question is warranted to find out the association between dietary intake and MeHg accumulation. We found that coastal residents had significantly higher mean blood T-Hg levels (mean: 16.1 $\mu\text{g/L}$, range: 0.9–184.9 $\mu\text{g/L}$) than inland residents (mean: 11.8 $\mu\text{g/L}$, range: 0.8–146.6 $\mu\text{g/L}$). The same was for blood MeHg levels: coastal residents (mean: 16.5 $\mu\text{g/L}$, range: 0.9–184.9 $\mu\text{g/L}$), inland residents (mean: 11.8 $\mu\text{g/L}$, range: 2.1–133.4 $\mu\text{g/L}$). These elevated levels were positively associated with seafood and shellfish consumption. However, the nature of their residential area may also be an important factor, because the highest T-Hg and MeHg levels were found in residents of a relatively non-industrialized area. To protect vulnerable population—especially children and pregnant women—it is important to know whether locally caught or raised and consumed fish has any source of Hg and MeHg pollution.

Source: Lee, C. C., J. W. Chang, et al. (2012). "Factors influencing blood mercury levels of inhabitants living near fishing areas." *Sci Total Environ* 424: 316-321.

Assessment of prenatal mercury exposure in a predominately Caribbean immigrant community in Brooklyn, NY.

Prenatal mercury exposure and its fetotoxic effects may be of particular concern in urban immigrant communities as a result of possible contributing cultural factors. The most common source of exposure in these communities is ingestion of fish and shellfish contaminated with methylmercury. Other sources of exposure may occur in ritualistic practices associated with Hispanic and Caribbean-based religions. This study 1) assessed total mercury levels in both random urine specimens from pregnant women, and in cord blood; and 2) examined environmental sources of exposure from a convenience sample in a predominantly Caribbean immigrant population in Brooklyn, New York. A questionnaire designed in collaboration with health professionals from the Caribbean community assessed the frequency of fish consumption, ritualistic practices, occupational exposures, and use of dental amalgams and mercury-containing skin and household products. The geometric mean for total mercury in cord blood was 2.14 $\mu\text{g/L}$ (95%CI: 1.76-2.60) ($n = 78$), and 0.45 $\mu\text{g/L}$ (95%CI: 0.37-0.55) ($n = 183$) in maternal urine corrected for creatinine ($\mu\text{g/g}$). Sixteen percent of cord blood mercury levels exceeded the estimated equivalent of U.S. Environmental Protection Agency's Reference Dose (5.8 $\mu\text{g/L}$ blood). Predictors of cord blood mercury included maternal fish consumption and foreign birth of the mother. Predictors of urine mercury included foreign birth of the mother, number of dental amalgams, and special product use. There were no reports of mercury use in ritualistic practices or in cosmetics; however some women reported use of religious medals and charms. This study characterized risk factors for mercury exposure in a sample of urban, predominantly Caribbean-born blacks. Findings may help target interventions in this population, which might include appropriate fish selection and consumption frequency during pregnancy, and safe handling of mercury-containing products in the home.

Source: Geer, L. A., M. D. Persad, et al. (2012). "Assessment of prenatal mercury exposure in a predominately Caribbean immigrant community in Brooklyn, NY." *J Environ Monit* 14(3): 1035-1043.

Prenatal exposure to mercury and fish consumption during pregnancy and attention-deficit/hyperactivity disorder–Related behavior in children

Objective: To investigate the association of prenatal mercury exposure and fish intake with attention-deficit/hyperactivity disorder (ADHD)-related behavior.

Methods: For a population-based prospective birth cohort recruited in New Bedford, Massachusetts (1993-1998), we analyzed data for children examined at age 8 years with peripartum maternal hair mercury measures ($n = 421$) or maternal report of fish consumption during pregnancy ($n = 515$). Inattentive and impulsive/hyperactive behaviors were assessed using a teacher rating scale and neuropsychological testing.

Results: The median maternal hair mercury level was $0.45 \mu\text{g/g}$ (range, 0.03 - $5.14 \mu\text{g/g}$), and 52% of mothers consumed more than 2 fish servings weekly. In multivariable regression models, mercury exposure was associated with inattention and impulsivity/hyperactivity; some outcomes had an apparent threshold with associations at $1 \mu\text{g/g}$ or greater of mercury. For example, at $1 \mu\text{g/g}$ or greater, the adjusted risk ratios for mild/ markedly atypical inattentive and impulsive/hyperactive behaviors were 1.4 (95% CI, 1.0-1.8) and 1.7 (95% CI, 1.2-2.4), respectively, for an interquartile range ($0.5 \mu\text{g/g}$) mercury increase; there was no confounding by fish consumption. For neuropsychological assessments, mercury and behavior associations were detected primarily for boys. There was a protective association for fish consumption (>2 servings per week) with ADHD-related behaviors, particularly impulsive/hyperactive behaviors (relative risk = 0.4; 95% CI, 0.2-0.6).

Conclusions: Low-level prenatal mercury exposure is associated with a greater risk of ADHD-related behaviors, and fish consumption during pregnancy is protective of these behaviors. These findings underscore the difficulties of balancing the benefits of fish intake with the detriments of low-level mercury exposure in developing dietary recommendations in pregnancy.

Source: Sagiv, S. K., S. W. Thurston, et al. (2012). "Prenatal exposure to mercury and fish consumption during pregnancy and attention-deficit/hyperactivity disorder-Related behavior in children." *Arch Pediatr Adolesc Med*: 1123-1131.

Additional Information

For more information about specific advisories within a state, contact the appropriate state agency listed on EPA's NLFA website at <http://fishadvisoryonline.epa.gov/Contacts.aspx>



For more information about the NLFA or EPA's Fish Advisory Program, contact:

The NLFA Newsletter at Fish_Advisory@epa.gov or Jeff Bigler, National Program Manager, Fish Advisory Program

Telephone: 202.566.0389

E-mail: bigler.jeff@epa.gov

U.S. Environmental Protection Agency
Office of Science and Technology (4305T)

1200 Pennsylvania Avenue, NW, Washington, DC 20460