

Mercury in Commercial and Sport-caught Fish: Apples and Oranges

Background

On August 19, 2009, the US Geological Service issued its report on, “Mercury in Fish, Bed Sediment, and Water from Streams Across the United States, 1998–2005.” (<http://pubs.usgs.gov/sir/2009/5109/pdf/sir20095109.pdf>). The media was very quick to pick up on this information. But there is no new news to share about mercury in fish. Mercury is a naturally occurring metallic substance. Minute quantities of mercury are in air, water, soil, and all living matter. The study confirms what has been known for years – that mercury is ubiquitous. Mercury was detected in all fish sampled from 291 streams across the U.S. Concentrations in about a quarter of the fish sampled exceeded the methylmercury fish tissue criterion (0.3 parts per million, wet weight) for the protection of humans who consume average amounts of fish, established by the U.S. Environmental Protection Agency (EPA). Differences exist between heavy metal contaminants of inland (sport fish and subsistence consumption) and commercially harvested fish (includes vertebrate fish, crustaceans and mollusks). State advisories have been in place for years to educate consumers on fish consumption safety of locally caught fish. State fish consumption advisories are available on the EPA web site at: <http://www.epa.gov/waterscience/fish/states.htm>

The USGS study reports that mercury was detected in all fish in the study and that concentrations at 27 percent of sampled sites exceeded the U.S. Environmental Protection Agency human-health criterion of 0.3 micrograms per gram wet weight. The study design targeted specific sites (including a basin with known mercury contamination from historical gold mining) and fish species and sizes, so results do not represent a true nationwide percentage of exceedances. The most commonly collected fish were largemouth bass (*Micropterus salmoides*), smallmouth bass (*Micropterus dolomieu*), brown trout (*Salmo trutta*), pumpkinseed (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), spotted bass (*Micropterus punctulatus*), rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarkii*), and channel catfish (*Ictalurus punctatus*). Mercury comparisons across species should be viewed with caution as different species accumulate mercury at different rates, and concentrations generally increase with increasing age or length of the fish.

To the untrained eye, the headline may imply that mercury in seafood is a problem. This is an “apples and oranges” situation between commercial and sport-caught fish. The information presented in the study relates to fish that are typically recreationally caught. Commercially caught and sold fish (includes finfish, shellfish and mollusks) is safe and beneficial to consume.

EPA and FDA guidances for fish consumption

The EPA provides guidance to states, tribes, local governments and others on scientifically sound, cost-effective methods for developing and managing noncommercial fish consumption advisories on local waters.

On January 8, 2001, the Environmental Protection Agency (EPA) announced its recommended Clean Water Act section 304(a) water quality criterion for methylmercury. The criterion, 0.3 milligram (mg) methylmercury per kilogram (kg) fish tissue wet weight (also expressed as 0.3 ppm), describes the concentration of methylmercury in freshwater and estuarine fish and shellfish tissue that should not be exceeded to protect consumers of fish and shellfish among the general population. The criterion is based on eating approximately two-8-ounce fish meals a month. The criterion was the first time EPA issued a water quality criterion expressed as a fish and shellfish tissue value rather than as a water column value. EPA recommends that the criterion be used as guidance by states, territories, and authorized tribes in establishing or updating water quality standards for waters of the United States and in issuing fish and shellfish consumption advisories. States and authorized tribes do not have to use EPA's current recommendations, provided that their new or revised water quality criteria for methylmercury protect the designated uses and are based on scientifically defensible methodology.

The US Food and Drug Administration (FDA) protects public health with respect to levels of chemical contaminants in all foods, including fish and shellfish, sold in interstate commerce. The FDA uses an action level of 1 mg/kg (1 part per million) for methylmercury in fish as an administrative. The FDA action level defines the extent of contamination at which FDA may regard food as adulterated and represents the limit at or above which FDA may take legal action to remove products from the marketplace. The FDA's jurisdiction in setting action levels is limited to contaminants in food shipped and marketed in interstate commerce; it does not include food that is caught locally by recreational or subsistence fishers. FDA also issues fish consumption advice on fish and shellfish sold in commerce in cases where detected contaminant levels may pose public health concerns for some consumers. Generally, an action level is different from a fish advisory limit—and even more different from the methylmercury criterion.

The underlying assumptions used in the FDA methodology were never intended, as local fish advisories are, to be protective of recreational, tribal, ethnic, and subsistence fishers who typically consume fish and shellfish from the same local bodies of water repeatedly over many years. EPA and FDA have agreed that the use of FDA action levels for the purposes of making local advisory determinations is inappropriate. Furthermore, it is EPA's belief that FDA action levels and tolerances should not be used as a basis for establishing a state's or tribe's methylmercury criterion.

Note: In March 2004, EPA and FDA issued a joint national fish advisory about mercury in fish and shellfish specifically for women who may become pregnant, pregnant women, nursing mothers, and parents of young children. The national advisory is available in Cambodian, Chinese, Hmong, Vietnamese, Korean, Portuguese, and Spanish at <http://www.epa.gov/waterscience/fish/publicinfo.html>

Key Points for Consideration:

1. The fish sampled by USGS is not representative of the fish primarily consumed in the US. (See the National Fisheries Institute's top ten consumed seafoods <http://www.aboutseafood.com/about/about-seafood/Top-10-Consumed-Seafoods>)
2. The 0.3 ppm methylmercury criterion level from EPA is a guidance level that allows states and tribes to make their own decisions concerning regulation based upon specific circumstances. It is not a regulatory standard. This water quality criterion describes the maximum advisable concentration of methylmercury in freshwater and estuarine fish and shellfish tissue to protect consumers of fish and shellfish among the general population. EPA expects the criterion recommendation to be used as guidance by States, authorized Tribes, and EPA in establishing or updating water quality standards for US waters. Because consumption of fish and shellfish is the primary route of human exposure to methylmercury, EPA is expressing this water quality criterion as a fish and shellfish tissue value rather than as a water column value.
3. The 0.3 ppm methylmercury criterion level developed by EPA is considered to be the amount of methylmercury in fish, when consumed by an adult at 17.5 grams fish/day that would provide a level of exposure equivalent to the reference dose of 0.1 ug/kg/day.

Note: 1 "ug" is one microgram which equals one millionth of a gram and is expressed as 1/1,000,000 of a gram (1×10^{-6}), or 1/1000 of a milligram. One kilogram (kg) is approximately 2.2 pounds.

This reference dose considers the lowest dose not expected to cause harm to humans (1.0 ug/kg/day) and divides it by a 10-fold uncertainty factor to account for potential interspecies variation and data gaps. The reference dose is calculated based upon application of a 10-fold uncertainty factor from the lowest levels of exposure that do not show effect in humans. The calculation of the 0.3 ppm level also assumes that the typical human is already exposed to 0.027 ug/kg/day of methylmercury, so that an additional contribution of methylmercury at a level of 0.073 ug/kg/day from fish consumption would cause the reference dose to be reached.

4. Comparing reference doses to fish guidance levels is similar to apples and oranges. The EPA reference dose is expressed in terms of the daily amount of exposure to methylmercury relative to one's body weight. The FDA action level is based on the concentration of methylmercury in the fish. If the average adult (assumed at 70 kilograms or 154 pounds) consumed 17.5 grams (0.62 ounces) of fish per day, all of the fish contained methylmercury at 0.3 ppm (0.3 mg methylmercury/kg fish), and the "baseline" exposure to methylmercury from all other non-fish sources was 0.027 ug/kg/day, the average daily exposure would be approximately equal to the reference dose of 0.1 ug/kg/day.

Calculating exposure to methylmercury from fish consumption:

Methylmercury exposure = 17.5 g fish/day x 0.3 mg methylmercury/kg fish = 0.0175 kg x 300 ug/kg = 5.25 ug/day.

Dose of methylmercury for 70 kg adult = 5.25 ug/day divided by 70 kg = 0.075 ug/kg/day. Contribution of methylmercury from other (non-fish) sources = 0.027 ug/kg/day; total exposure = 0.102 ug/kg/day; roughly equivalent to the reference dose.

References

1. California Office of Environmental Health Hazard Assessment. Fish [Consumption Advisories] (<http://www.oehha.ca.gov/fish.html> Accessed August 27, 2009)
2. California Office of Environmental Health Hazard Assessment., 2009. 2009 Update of California Sport Fish Advisories. (<http://www.oehha.ca.gov/fish/pdf/DiscAdvyUpdates032309.pdf> Accessed August 27, 2009)
3. Scudder, B.C., Chasar, L.C., Wentz, D.A., Bauch, N.J., Brigham, M.E., Moran, P.W., and Krabbenhoft, D.P., 2009, Mercury in fish, bed sediment, and water from streams across the United States, 1998–2005: U.S. Geological Survey Scientific Investigations Report 2009–5109 (<http://pubs.usgs.gov/sir/2009/5109/> Accessed August 27, 2009)
4. U.S. EPA, 2001. Human Health Criteria, Methylmercury Fish Tissue Criterion Fact Sheet. (<http://www.epa.gov/waterscience/criteria/methylmercury/factsheet.html> Accessed August 27, 2009).
5. U.S. EPA, 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury EPA-823-R-01-001 (<http://www.epa.gov/waterscience/criteria/methylmercury/document.html> Accessed August 27, 2009)
6. U.S. EPA 2009. Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion. Final. (<http://www.epa.gov/waterscience/criteria/methylmercury/pdf/guidance-final.pdf> Accessed August 27, 2009)

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