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Fish and Shellfish Program NEWSLETTER

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In This Issue

https://www.epa.gov/fish-tech

This issue of the *Fish and Shellfish Program Newsletter* generally focuses on mercury.

Recent Advisory News

Mercury and Fish Advisories Issued for Nine Waterways in Louisiana

On July 28, 2018, the Louisiana Departments of Health, Environmental Quality, and Wildlife and Fisheries issued a series of fish consumption advisories for nine bodies of water. These most recent advisories include one new warning and updates to eight previously issued warnings.

Advisories are precautions and are issued when unacceptable levels of mercury are detected in fish or shellfish.

Fish sampling is conducted by the Department of Environmental Quality. The Department of Health uses this data to determine the need for additional advisories or to modify existing advisories. Each advisory lists the specific fish, makes consumption recommendations, and outlines the geographic boundaries of the affected waterways.

Because of mercury contamination, there are now fish consumption advisories for 48 waterways in Louisiana and one for the Gulf of Mexico.

Louisiana fish consumption advisories are based on the estimate that the average resident eats four meals of fish per month (1 meal = ½ pound). Consuming more than this from local water bodies may increase health risks.

There are small amounts of mercury in the sediments of streams, lakes, rivers, and oceans. Nearly all fish contain trace amounts of mercury. They absorb mercury as they feed on aquatic organisms. Larger predator fish contain more mercury than smaller fish. It is recommended that smaller fish be consumed instead of larger ones.

Dr. Jimmy Guidry, State Health Officer, said people are exposed to low levels of mercury throughout their lives.

"Eating contaminated fish is one way we are exposed to mercury. Health effects from harmful levels of mercury can include nervous system and kidney damage," Guidry said. "Young children and developing fetuses are more sensitive to the toxic effects of mercury.

Therefore, consumption advisories are issued at lower fish tissue concentrations for women of childbearing age and children under seven years of age."

The table below lists the new and updated fish advisories.

New or Updated Fish Advisories for Louisiana Waterbodies Issued July 28, 2018		
Waterbody Name	**Location**	**Advisory Details**
Two O'Clock Bayou*	From Louisiana Highway 190 in St. Landry Parish to Craft Lake, includes Cowan Bay, Close Lake, and Craft Lake	Women of childbearing age and children less than seven years of age should consume no more than two meals** per month of largemouth bass and bowfin combined.
Bayou des Cannes	From its origin near Ville Platte in Evangeline Parish to where it enters the Mermentau River	Women of childbearing age and children less than seven years of age should consume no more than one meal per month of bowfin, crappie, largemouth bass, and freshwater drum combined from the advisory area.
Chicot Lake	Evangeline Parish	Women of childbearing age and children less than seven years of age should consume no more than two meals per month of black crappie, bowfin, and largemouth bass combined.
Cocodrie Lake	Includes Cocodrie Lake in Evangeline and Rapides parishes	Women of childbearing age and children less than seven years of age should consume no more than six meals per year of bowfin OR no more than one meal per month of black crappie, warmouth, bluegill sunfish, big mouth buffalo, and largemouth bass combines. Other adults and children seven years of age or older should consume no more than two meals per month of bowfin OR no more than three meals per month of black crappie and largemouth bass combined.
Crooked Creek Reservoir	Evangeline Parish	Women of childbearing age and children less than seven years of age should consume no more than one meal per month of largemouth bass and bowfin combined.
Henderson Lake	Includes Henderson Lake, Lake Bigeux, and all waters within the area bounded on the north by the St. Landry/St. Martin Parish Line, on the east by the West Atchafalaya River levee (or Hwy. 3177), on the south by Hwy. 3177, and on the west by the West Atchafalaya Basin levee	Women of childbearing age and children less than seven years of age should consume no more than two meals per month of largemouth bass and bowfin combined.
Bayou Plaquemine Brule	This area includes Bayou Plaquemine Brule from its origin near Opelousas in St. Landry Parish to where it enters the Mermentau River	Women of childbearing age and children less than seven years of age should consume no more than one meal per month of bowfin, largemouth bass, crappie, flathead catfish, and freshwater drum combined from the advisory area.
Bayou Queue de Tortue	From its headwaters near Cankton, Louisiana to its confluence with the Mermentau River east of Lake Arthur, Louisiana	Women of childbearing age and children less than seven years of age should consume no more than one meal per month of bowfin and largemouth bass combined OR no more than two meals per month of crappie, warmouth, bluegill sunfish, and freshwater drum combined.
Seventh Ward Canal	Vermillion Parish	Women of childbearing age and children less than seven years of age should consume no more than one meal per month of bowfin OR no more than two meals per month of largemouth bass, flathead catfish, white crappie, and freshwater drum combined.

* Two O'Clock Bayou is the new advisory, all others are updates.
** A meal is considered to be half a pound of fish for adults and children.

The full text for each advisory can be found at www.ldh.la.gov/EatSafeFish or by calling 1-888-293-7020.

Massachusetts Freshwater Fish Consumption Advisory List August 2017

In August 2017, the Massachusetts Department of Public Health Bureau of Environmental Health added one advisory to its Fish Consumption Advisory List, shown in the following table. For the complete advisory list, see here.

New and Updated Advisories for August 2017			
Waterbody	**Town(s)**	**Fish Advisory**	**Hazard**
Silver Lake	Pittsfield	P6*	PCBs**

*P6 - No one should consume any fish from this water body.
**PCBs - Polychlorinated biphenyls

For more information contact the Massachusetts Department of Public Health Bureau of Environmental Health at 617-624-5757.

Source: https://www.mass.gov/files/documents/2016/11/ol/freshwater-fish-consumption-advisories.pdf and https://www.mass.gov/lists/fish-consumption-advisories

EPA News

EPA New England Trains 30 Federal and State Environmental Workers on the National Rivers and Streams Assessment

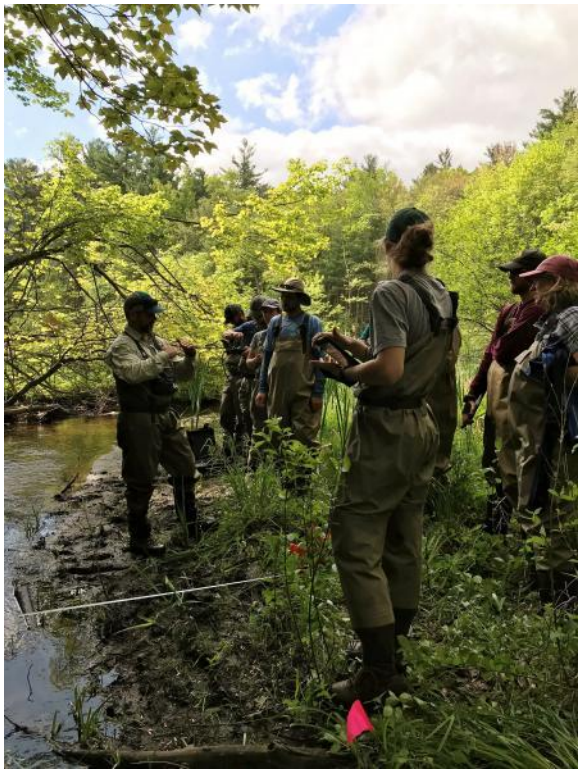
On May 31, 2018, U.S. Environmental Protection Agency (EPA) Region 1 office in New England held a four-day training session at the EPA Chelmsford Laboratory for approximately 30 state and federal workers participating in the EPA National Rivers and Streams Assessment (NRSA). The NRSA, the third nationwide survey, will measure the health of waterways to evaluate the effectiveness of protection and restoration efforts and take action to prevent pollution. Training for the group included a visit to the Merrimack River in North Chelmsford to practice water and fish sampling techniques.

Background

The Town of Chelmsford Conservation Commission gave EPA permission to use the Deep Brook Reservation for the wadeable stream portion of the training. This area had a variety of habitat and diverse stream conditions, making it ideal for trainees to learn. Training was led by EPA staff and its contractors, and participants included state staff from Vermont, New Hampshire, and Connecticut, as well as EPA staff. EPA lab boats and equipment were used in the training, and some participants received special training in fish sampling so they can help the states of Vermont and New Hampshire use EPA's two electrofishing boats when conducting the NRSA.

Over the summers of 2018 and 2019, the NRSA conducted and will conduct sampling at about 24 randomly selected sites in each state, for a total of 1,808 sample locations nationwide, half from rivers and half from streams. The NRSA is done every five years as part of the yearly National Aquatic Resource Surveys. In other years, the survey covers wetlands, coastal waters, and lakes. It will address rivers and streams for the two-year period (2018-2019).

The survey is designed to estimate portions of rivers and streams that are in good, fair, or poor condition, and serves as a scientific report card on the waters surveyed. It will examine ecological, water quality, and recreational indicators, and assess how widespread key "stressors," such as nutrients, fish tissue contaminants, and bacteria, are across the country.



Participants learning and practicing water sampling techniques. *(Image courtesy of EPA)*

The NRSA is a collaborative effort that involves many state environmental and natural resource agencies, federal agencies, universities, and other organizations. In many states, state water quality staff will conduct the water quality sampling and habitat assessments. In others, field work will be conducted by staff under contract to EPA.

Those trained will take measurements and collect samples at each site using consistent methods so that results can be compared nationally. To sample one site, it takes a daily field team of four to five people. These teams collect a variety of data including temperature, dissolved oxygen, fish assemblage and river and stream habitat information. Samples are also collected to analyze for nutrients, acidity, benthic macroinvertebrate assemblage, bacteria (as an indicator of possible fecal contamination) and contaminants in fish tissue among other indicators.

Data will be made available to the public in 2021 as part of the final report on the condition of our rivers and streams. The results of the NRSA will be available in a variety of formats to reach a range of audiences, including, for example, a streamlined written report, factsheet, storymap, and data dashboard.

For more information on the NRSA, visit https://www.epa.gov/national-aquatic-resource-surveys.

For more information on EPA's regional laboratory in Chelmsford, Massachusetts, visit https://www.epa.gov/aboutepa/about-region-1s-new-england-regional-laboratory.

For additional questions and information, contact David Deegan at deegan.dave@epa.gov or 617-918-1017.

Source: https://www.epa.gov/newsreleases/epa-new-england-trains-30-federal-and-state-environmental-workers-national-rivers-and

Other News

FISH Project Reduces Mercury in Women on the North Shore of Minnesota

In 2017, the Minnesota Department of Health (MDH) reported that its Fish are Important to Superior Health (FISH) project to increase efforts to improve advice to women about eating fish is yielding positive results for the health of women on the state's North Shore.

This major project aimed to reduce mercury blood levels in women through changes in fish consumption. Women involved in a follow-up group were found to have decreased mercury levels in their blood, but they did not lower their consumption of healthy, low-mercury fish.

The FISH project started after a 2011 study by MDH showed that 10% of newborns tested in the North Shore-Arrowhead region of the state had mercury above levels of concern in their blood. Too much mercury can cause lasting problems with understanding and learning.

The study results spurred a collaboration among Sawtooth Mountain Clinic, Grand Portage Health Service, North Shore Health, Grand Portage Band of Lake Superior Chippewa Trust Lands, and MDH to reduce mercury exposure in women in the area and pilot an in-clinic screening for high mercury exposure. Nearly 500 women from Cook County, Grand Portage, and the surrounding area participated in the FISH Project.

Participants provided information about which fish they ate and how often they ate fish. They also had a blood sample analyzed for mercury and healthy fatty acids. They received information about healthy diets that included which type (species) of fish to eat and how often they can safely eat fish.

Women in the FISH Project reported eating more fish than women nationally. They also had higher fatty acid levels and blood mercury levels, but about the same percentage of women in the project as nationally (3%) had mercury levels above the level of concern. Mercury levels were lowest in blood collected in the spring and highest in fall samples. Results from FISH support the findings of the 2011 study.

An important finding from the project is that women did not stop eating fish as a result of the project. Studies have shown that fish can provide important nutrients that help fetuses and babies develop, as long as they are low in mercury and other contaminants. The fatty acids, vitamins, and minerals in fish are also important for adults.

"Fish and fishing is our history and a strong part of the culture of the communities along the North Shore," said Rita Plourde, CEO of Sawtooth Mountain Clinic. "Our board of directors and staff appreciate any opportunity to improve the care of our patients and the health of our communities. Together with our patients, we wholeheartedly agreed to do whatever was needed to educate and ultimately reduce mercury exposure in women who are or may become pregnant, thereby reducing mercury levels in future babies. Now we know we can eat fish wisely and give birth to healthy babies!"

Some of the women in the FISH project were asked to participate in a follow-up clinic visit six months after their initial visit. Changes at the follow-up were positive: the project did not cause women to eat less low-mercury fish, and fatty acid levels did not change. In fact, many women said they ate more fish. Mercury levels declined in the follow up group and the participants with elevated mercury reduced their consumption of fish species shown to contribute most to higher mercury exposure.

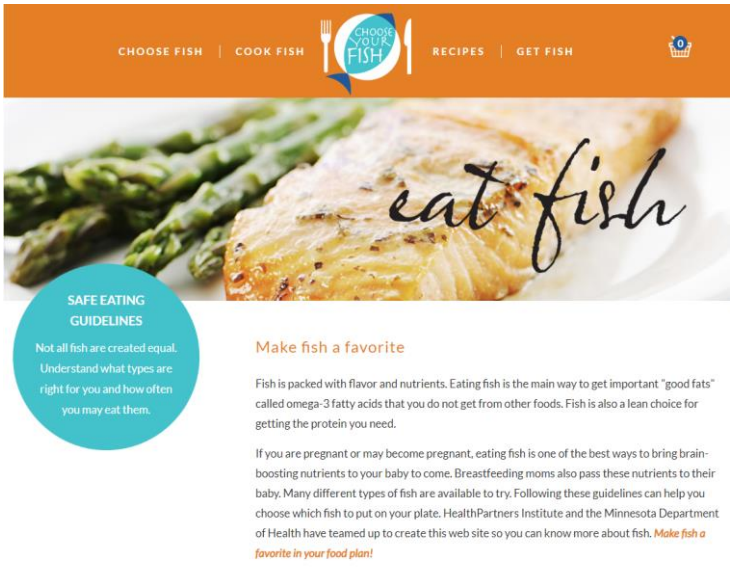
The FISH project clinics are now including screening for high mercury in future prenatal visits. Community education and Women, Infants, and Children Special Supplemental Nutrition Program visits will include information about choosing which fish to eat and how often. The Sawtooth Mountain Clinic has more information on its website here: FISH Project.

The goals of the FISH project are aligned with a campaign launched in May 2017 by MDH and HealthPartners. The goal of this campaign is to equip women who are or may become pregnant with the information they need to choose the right fish to eat.

“We want women and children to eat fish. The benefits outweigh risks if they choose fish low in mercury and other contaminants,” said Pat McCann, research scientist for MDH.

The campaign highlights the health benefits of eating fish before and during pregnancy and the importance of choosing the right fish to reduce exposure to mercury or other contaminants.

Based on findings from the FISH project and other research, a brochure and ChooseYourFish.org website were launched to reach more women and families and make it easier for them to follow MDH’s fish consumption guidelines. The website provides easy access to information on the web and on mobile devices. Both the brochures and website describe how often different types (species) of fish can be eaten to provide safe yet beneficial meals. The website also features simple recipes, videos, and tips for selecting and cooking fish. Versions of the brochures were designed for the North Shore and Grand Portage communities and will be distributed by FISH Project partners.



Screen capture of Chooseyourfish.org.

These efforts were supported in part through funding from the EPA Great Lakes Restoration Initiative. A video – "New Information for Women to Choose the Best Fish" (YouTube) – highlights the key points of the new campaign.

MDH gives fish consumption recommendations for pregnant women, women who could become pregnant, and children under age 15, as well as for men, boys age 15 and older and women not planning to become pregnant. In general, men, boys 15 years and older, and women who are not and will not become pregnant can eat fish about three times more often than the guidelines for pregnant women and younger children.

To learn more about MDH's recommendations, visit Fish Consumption Guidance.

For more information, contact:

- Paula Schaefbauer at paulas@grandportage.com or 218-475-2235
- Joyce Klees at joyce@sawtoothmountainclinic.org or 218-387-2330
- Patricia McCann at patricia.mccann@state.mn.us or 615-201-4915
- David Martinson at David.P.Martinson@HealthPartners.com or 612-883-6324

Source: http://www.health.state.mn.us/news/pressrel/2017/fishproject050817.html

The Big Picture of Great Lakes Mercury Pollution

On January 23, 2018, *Science Daily* posted the following article from Michigan Technological University on its website.

Mercury is a widespread environmental toxicant and pollutant. Although a global issue, mercury regulations vary worldwide. Depending on where one lives in relation to mercury emissions, regional remediation makes minimal impacts for local fish consumption advisories. This is particularly true in a sensitive landscape like Michigan's Upper Peninsula, where nearly 80% of inland lakes are impaired.

For the Keweenaw Bay Indian Community (KBIC), the problem culminates in the question, when can we eat the fish? A simple answer is elusive, but a study led by Michigan Technological University (Michigan Tech) provided insights as to what must be done to make the fish safe to eat.

The KBIC's question helped guide biogeochemical modelers, environmental engineers, and social scientists to bridge global-chemical transport models and the local impacts on the KBIC and Michigan's Upper Peninsula. The study was published in the Royal Society of Chemistry's peer-reviewed journal *Environmental Science: Processes & Impacts*, and the work is part of a National Science Foundation program looking at the dynamics of coupled natural and human systems.

Sensitive Communities

Mercury is an atmosphere-surface exchangeable pollutant (ASEP) along with PCBs, PAHs, and other persistent organic pollutants. ASEP molecules are invisible, tasteless world-hoppers that can travel great distances.

Eventually, they make their way to the Great Lakes where they move through the air, landscape, water, and animals. Researchers can describe ASEP movement and impacts through policy, socioeconomic pressures, ecosystem

services, stressors like climate change, and land use as well as biogeochemical cycling. The study's lead researcher is Judith Perlinger, professor of environmental engineering at Michigan Tech. She says the project is an example of using state-of-the-art science to answer a community-relevant question.

"We're taking phenomena that act on a global scale and predicting what they will do," Perlinger says, adding that working with the KBIC is a key piece of the project.

Perlinger's team, consisting of six institutions, 36 researchers, and 11 partnering organizations, uses GEOS-Chem, a global three-dimensional Eulerian chemical transport model. It has been widely used to better understand tropospheric chemistry and composition. For ASEPs, GEOS-Chem sorts through the emission sources, migration, exchange rates, and resting places of the pollutants and is coupled with mass balance modeling to understand the aquatic dynamics of the system.

Sensitive Landscapes

In their study published in *Environmental Science: Processes & Impacts*, Perlinger and her team focus on mercury and three different policy scenarios through 2050.

In the first, they analyzed aspirational targets where all mercury emissions from anthropogenic sources are eliminated; in the second, they examined a moderate reduction based on policy-in-action; and in the third, they assessed a minimal-regulation scenario with no policy action.

They found little would change within the lifetimes of the KBIC community. Noel Urban, professor of environmental engineering and a project researcher who focuses on the biogeochemistry of the pollutants, says the process would likely take generations to reach levels that the community considers safe.

"People assume that what is deposited in a forest is also deposited the same in a lake, which isn't true, so models have been miscalculating," Urban says, adding that the feedback between land and aquatic systems also takes longer than researchers previously thought. "This is apparent in the Great Lakes, and the Upper Peninsula is a particularly sensitive landscape to mercury."

In terms of tracking mercury, Urban takes fish mercury concentration data from lakes and estimates mercury in fish from similar waterbodies along with the Great Lakes Indian Fish and Wildlife Commission (GLIFWC), one of the project's research partner organizations. They found that mercury persists differently depending on the size of the lake.

Urban, Perlinger, and their team plan to continue sampling in local Upper Peninsula lakes, assessing the regional impacts in the Great Lakes and vetting their findings through global models. Their transdisciplinary work deepens the understanding of mercury cycling and the accuracy of modeling, evaluates multi-scale policy, and offers insight into the best practices for engaging local indigenous communities in global research.

Reference

J. A. Perlinger, N. R. Urban, A. Giang, N. E. Selin, A. N. Hendricks, H. Zhang, A. Kumar, S. Wu, V. S. Gagnon, H. S. Gorman, and E. S. Norman. 2018. Responses of deposition and bioaccumulation in the Great Lakes region to policy and other large-scale drivers of mercury emissions. *Environmental Science: Processes & Impacts* 20:195-209.

For more information, contact J.A. Perlinger at jperl@mtu.edu.

Source: https://www.sciencedaily.com/releases/2018/01/180123101934.htm

The Dragonfly Mercury Project

On February 16, 2018, the Remedial Action Plan Office of Lakehead University in Ontario, Canada, posted on InfoSuperior a blog about the Dragonfly Mercury Project, a new continent-wide initiative to better understand varying mercury levels in the environment. The Dragonfly Mercury Project is a "citizen science" initiative and a collaboration among the University of Maine, the U.S. Geological Survey (USGS), Dartmouth College, the University of Wisconsin-LaCrosse, and the National Park Service.

Mercury is an element that is widely distributed throughout the environment in varying forms and concentrations. Although it is naturally occuring, elevated levels can be released into the environment by processes from human activities. For example, coal combustion is the largest anthropogenic source of mercury being released to the environment in the U.S. Mercury is a natural constituent in coal; when coal is combusted for power production, mercury is released into the atmosphere as a byproduct. Atmospheric mercury falls out onto the surrounding environment with precipitation and is eventually transported to bodies of water.

Globally, the largest source of anthropogenically-emitted mercury is artisanal and small-scale gold mining (source: https://www.epa.gov/international-cooperation/mercury-emissions-global-context#types). In the U.S., coal combustion is the largest single source: "In the United States, power plants that burn coal to create electricity account for about 42% of all manmade mercury emissions (Source: 2014 National Emissions Inventory, version 1, Technical Support Document (December 2016)(PDF)" https://www.epa.gov/mercury/basic-information-about-mercury).

Atmospheric mercury deposited in waterways can become "methylated" and highly toxic in a complex process, which is assisted by bacteria. The "methylation" process occurs most readily in water with high concentrations of dissolved organic carbon and low pH. Toxic methylmercury is readily absorbed and accumulated in biological tissue working its way up the food chain from small aquatic organisms, to fish, waterfowl, and humans.

So where do dragonflies fit in? The Dragonfly Mercury Project is looking at dragonfly larvae for information about mercury levels in national parks across the U.S. Dragonfly larvae are ideal for tracking environmental mercury. They accumulate relatively high levels of mercury because:

- They spend most of their life cycle (several years) in a freshwater aquatic environment where mercury methylation occurs.
- They are long-lived and eat many small insects, thereby "bioaccumulating" mercury over a long period.

- They are found across North America, from Alaska, through Canada, to Florida.

The citizen science project employs the work of students and park visitors to collect the larvae. Once the method is learned, dragonfly larvae are much easier to collect than fish. Collecting them is also engaging for kids. That's why the Dragonfly Mercury Citizen Science Project was started. The project now spans the U.S.

Scientists like dragonfly larvae as well, for a number of reasons:

- The larvae are relatively large, with plenty of material for laboratory analysis.
- Laboratory analysis is relatively inexpensive.
- The larvae provide a good representation of the variability of mercury concentrations across locations.

To learn more about the Dragonfly Mercury Project or get involved, visit https://www.nps.gov/articles/dragonfly-mercury-project.htm.

The Schoodic Institute at Acadia National Park offers additional information and several training videos on their website: https://www.schoodicinstitute.org/what-we-offer/educational-scientific-partnerships/dragonfly-mercury-project/.

For more information, the Dragonfly Project can be contacted using the following link: https://www.nps.gov/common/utilities/sendmail/sendemail.cfm?o=488AD7B798D6A18392B712A1F810AAA3798D548648ACAC914F0CE08011C0&r=/articles/dragonfly-mercury-project.htm.

Source: http://infosuperior.com/blog/2018/02/16/the-dragonfly-mercury-project/

Mercury Rising: Are the Fish We Eat Toxic?

On May 3, 2018, *Science Daily* posted the following article from Université de Montréal.

The amount of mercury extracted from the sea by industrial fishing has grown steadily since the 1950s, potentially increasing mercury exposure among the populations of several coastal and island nations to levels that are unsafe for fetal development.

These are the findings of a study carried out by researchers from Université de Montréal's Department of Biological Sciences and published in *Scientific Reports*.

The study combined data on the amount of mercury fished out of oceans and seas from 1950 to 2014 and the weekly consumption of fish and seafood by the populations of 175 countries between 1961 and 2011.

By comparing this data, which was published by the Food and Agriculture Organization of the United Nations (FAO), postdoctoral fellow Raphaël Lavoie was able to estimate these populations' per capita intake of methylmercury, a highly toxic form of mercury.

Working under the direction of Professor Marc Amyot, Lavoie estimated that the people of 38% (66 of 175) of the countries examined by the study might be exposed to methylmercury levels higher than the maximum deemed safe for fetal development. The highest-risk countries include the Maldives, Iceland, Malaysia, Lithuania, Japan, Barbados, and South Korea.

When humans ingest excessively high levels of methylmercury, the toxin's molecules can penetrate the blood-brain barrier and impact cerebral development, especially in children and fetuses.

Industrialization has released vast quantities of mercury into the atmosphere, which have settled in oceans and waterways. This mercury is absorbed by sea organisms, many of which are consumed by humans.

Since 1950, demand for seafood has skyrocketed while technological breakthroughs have enabled more intensive forms of industrial fishing. Since the 1990s, when overfishing drastically reduced stocks, industrial fishing has gradually migrated to deep-sea and international waters.

"The global marine catch totals 80 million tons of fish per year, which means that we are also pulling out increasingly large amounts of mercury," said Amyot.

Commercial fishing vessel. *(Image courtesy of National Oceanic and Atmospheric Administration)*

Of the industrial fishing areas listed by the FAO, the Northwest Pacific currently exports the most fish, and the most methylmercury. The Western Central Pacific holds second place, while the Indian Ocean ranks third.

"Together, these three fishing areas exported 60% of the mercury resulting from global seafood production in 2014," said Lavoie.

The people in these regions are some of the world's top seafood consumers. Species high up on the food chain contain the highest concentrations of mercury. From 1950 to 2014, large fish represented approximately 60% of the global catch (by weight) and nearly 90% of the mercury ingested by consumers from fish.

According to the FAO, to be safe for fetal development, the threshold for methylmercury consumption is 1.6 micrograms for each kilogram of a person's body weight per week (1.6 µg/kg/week).

"By comparing FAO data on global seafood consumption, we observed that from 2001 to 2011 the populations of 38% of the 175 countries we analyzed would have been exposed to weekly doses of methylmercury far above the maximum safe level of consumption for fetal development," said Lavoie. "Many of these populations are in coastal and island nations, especially developing countries."

For instance, during that 10-year period, people in the Maldives would have consumed an average of 23 µg/kg/week of methylmercury, or more than 14 times what is deemed safe. The next highest-ranking were people in Kiribati (8

µg/kg/week), Iceland (7.5 µg/kg/week), Malaysia and Samoa (6.4 µg/kg/week), French Polynesia (5 µg/kg/week), Lithuania, Japan, and Barbados (4.8 µg/kg/week), and South Korea (4.7 µg/kg/week).

By contrast, the global average for mercury exposure over the same 2001 to 2011 period was estimated at 1.7 µg/kg/week. In Canada, exposure totalled 1 µg/kg/week.

Lavoie and Amyot said their estimates are conservative. The global catch by the fishing industry, including artisanal and illegal fishing, is probably 50% higher than the FAO data indicates, they said.

Both researchers believe these estimates could help authorities find ways to reduce the risk of mercury exposure, especially among high-risk populations such as children and pregnant women.

Some methods of preparing and consuming fish seem to reduce the risk of methylmercury contamination, they pointed out. In a recent study, they found that cooking fish or consuming it in combination with certain polyphenols contained in foodstuffs like tea could reduce the bioavailability of methylmercury in the human body.

This is good news, because contrary to prevailing opinion, the methylmercury we consume may not be fully absorbed.

For more information, contact Raphael A. Lavoie using the form at the following link https://www.nature.com/articles/s41598-018-24938-3/email/correspondent/c1/new.

Source: https://www.sciencedaily.com/releases/2018/05/180503142644.htm

Research Institute helps GLIFWC, Tribes Track Fish Contamination

The following article, written by Charlie Otto Rasmussen, appeared in the Spring 2018 edition of *Mazina'igan: A Chronicle of the Lake Superior Ojibwe*, published by the GLIFWC.

For native people bound to traditional homelands, airborne pollution is a problem. Food comes from your home territory. In the Great Lakes region, mercury deposited directly into the environment through precipitation can make fish unsafe for humans to eat.

"It's so important to know what's in the fish you eat. That's especially true for everyone who includes fish as a significant part of their diet," said Christine Polkinghorne, lead scientist at Lake Superior Research Institute (LSRI). "You have to know if there are toxins present."

According to Polkinghoroe, some mercury is naturally occurring, existing as natural deposits, while human activity accounts for a significant volume of the toxin that is introduced into the environment each year. Burning coal to produce electricity, household waste incineration, and mining activity are primary contributors. Once released into Ceded Territory ecosystems, bacteria transform inorganic mercury into the more toxic compound, methylmercury.

"It ends up bioaccumulating,"' Polkinghorne said. Mercury concentrations move up the food chain. Larger, older fish often harbor higher levels of mercury.

Housed on the University of Wisconsin-Superior campus, LSRI has analyzed fish tissue for GLIFWC for more than two decades. In coordination with the Enforcement Division, GLIFWC researchers purchase walleye samples from tribal spearers at boat landings every spring. Fish samples from the Great Lakes, including whitefish and siscowet trout, are similarly acquired from Lake Superior commercial fishermen along with research crews conducting routine assessments. Additional tribal food fish, such as muskellunge, whitefish, northern pike, cisco, and burbot, have been sampled at LSRI as well.

Polkinghorne said that while there have been technological advances in processing samples, LSRI is careful to adhere to original testing procedures to produce accurate results over time.

"Quality control is a really important part of what we do," she said. "The methods are still the same, but the instruments are easier to use."

Using food processors familiar to household kitchens, lab technicians grind fish tissue to help "homogenize" entire fillets, Polkinghorne said. Flesh is further broken down with chemicals including nitric and sulfuric acid. Once processing is complete, the resulting solution is analyzed for mercury in a FIMS 100, a compact machine about the size of a 12-pack. The entire procedure is regularly monitored by an independent quality assurance manager.

Processed fish tissue samples. *(Image courtesy of GLIFWC)*

"We have a high level of confidence in the data we produce here," Polkinghorne said. The work ultimately helps GLIFWC circulate sound advice about how much fish can be safely eaten.

LSRI conducts fishery pollutant assessments for additional tribal resource organizations including departments from Fond du Lac Band, Grand Portage Band, Lac du Flambeau Band, and 1854 Treaty Authority.

For more information, contact Lynne Plucinski, Mazina 'Igan Assistant Editor, at 715-682-6619.

Source: http://www.glifwc.org/Mazinaigan/Spring2018/inc/pdf/flipbook.pdf, page 18

Mercury Cycling and Effects on Ecological Communities

The USGS Forested and Rangeland Ecosystem Science Center (USGS FRESC) has several active studies focused on mercury and its effects on ecological communities. According to USGS FRESC, mercury contamination is a serious issue that impacts both ecosystem and human health on a global scale. In its organic (methylmercury) form, mercury is highly bioaccumulative and is among the most toxic compounds commonly found in the environment. Mercury is a relatively distinctive contaminant in the sense that the risk of deleterious environmental effects is more strongly related to ecological factors that control its cycling than to its inputs and sources.

Even with limited inorganic mercury loading, an ecosystem can suffer serious harmful impacts. The ecological risk of mercury toxicity is directly related to the production of the bioaccumulative and toxic form, methylmercury, which is driven by specific biogeochemical parameters. Importantly, those parameters are directly linked to landscape scale factors such as land use, landscape disturbance, habitat type, water inundation and wetting and drying cycles, organic carbon and nutrient cycling, and inputs from upland terrestrial habitats. Bioaccumulation is driven by population dynamics, habitat use, and food-web structure.

The Contaminant Ecology Research Laboratory (CERL) at the USGS FRESC in Corvallis, Oregon, is actively engaged in a broad suite of ongoing mercury studies across the U.S., with a strong focus on habitats and locations within the Pacific Northwest. CERL's research focuses on two primary themes: (1) Landscape and food web factors that influence mercury bioaccumulation; and (2) The effects of mercury exposure on vertebrate physiology, behavior, and reproduction. Within those themes some of CERL's active research includes studies about:

- Hydrologic alteration and its effects on mercury bioaccumulation and risk through food webs
- Landscape scale patterns of mercury bioaccumulation across the U.S.
- Sublethal effects of mercury exposure to fish and wildlife
- Toxicological interactions between mercury and other contaminants

Additionally, USGS FRESC recently completed a collaborative initiative to synthesize the drivers of variation in mercury distribution, cycling, and bioaccumulation across western North America. See https://www.sciencedirect.com/journal/science-of-the-total-environment/special-issue/101M3DWRM6P.

Active Projects of USGS FRESC Contaminant Ecology Research Lab

- Effects of Reservoir Management on Mercury Bioaccumulation
- Mercury Bioaccumulation and Maternal Transfer in White Sturgeon
- Landscape Patterns and Source Attribution of Mercury in Fish from National Parks across the U.S.
- Endocrine Disruption in Response to Mercury Exposure
- Patterns in Mercury Exposure of Fishes across the Chesapeake Bay Watershed
- Interactions between mercury and other contaminants on toxicological responses in the California Condor
- Citizen Science as a cost-effective tool for monitoring mercury bioaccumulation at a National Scale: The Dragonfly Mercury Project (See *The Dragonfly Mercury Project* article on page 9 of this newsletter)
- Mercury-disease interactions in amphibian populations

For more information, contact Collin Eagles-Smith at ceagles-smith@usgs.gov or 541-750-0949.

Source: https://www.usgs.gov/centers/fresc/science/mercury-cycling-and-effects-ecological-communities?qt-science_center_objects=0#qt-science_center_objects

Recently Awarded Research

Deciphering Sources and Accumulation Pathways of Mercury in the Tributaries and Lake of a Forested Watershed Using Stable Mercury Isotopes

On September 15, 2017, the National Science Foundation (NSF) awarded Vivien Taylor of Dartmouth College a grant to better understand the production and movement of methylmercury in the environment. Concentrations of mercury, a potent neurotoxin, frequently exceed levels safe for consumption by humans and wildlife in fish from freshwater lakes. The most toxic form of mercury is methylmercury, which is also the form of mercury that accumulates in wildlife and humans. The environmental factors that control the transformation of mercury to methylmercury in the environment are complex, and the sources of mercury and the environmental conditions involved in production and movement of methylmercury throughout the forests of the northeastern U.S. are not well understood. This project will use an emerging analytical technique developed by collaborators at the University of Michigan that relies on discrimination between subtle differences in the masses of mercury isotopes to identify the sources of mercury in a northern New England lake, with the goal of advancing the application of this cutting-edge new method. Importantly, application of this method will significantly improve current understanding of the sources of mercury in soil and water, the potential for production of methylmercury, and the accumulation of mercury in wildlife. It is estimated the project will be completed by August 2019.

For more information, contact Vivien Taylor at Vivien.F.Taylor@Dartmouth.edu.

Source: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1738614&HistoricalAwards=false

Transformation of Elemental Mercury Dispersed by Flooding During Hurricane Harvey

On October 1, 2017, the NSF awarded Nathan Yee, Jeffra Schaefer, and John Reinfelder of Rutgers University-New Brunswick a grant to train graduate and undergraduate students to carry out field work and laboratory mercury analyses associated with their research into the transformation of elemental mercury in floodplain and river sediments. In August 2017, Hurricane Harvey caused catastrophic flooding in southeastern Texas and dispersed liquid elemental mercury from an unknown source to an area east of Houston. Preliminary measurements performed days after the hurricane showed mercury concentrations exceeding 2,500 micrograms per kilogram in floodplain sediments of the San Jacinto River. Because mercury is a highly toxic element, the hurricane-induced contamination may pose a significant threat to public health. This project aims to elucidate the geochemical controls on the methylation of elemental mercury in San Jacinto River sediments. Floodplain and river sediment samples will be collected and analyzed for mercury methylation activity. An examination of the transformations of elemental mercury in San Jacinto River sediments dispersed by Hurricane Harvey is a unique opportunity to investigate the fate of elemental mercury in sediments shortly after release and will provide critical information for

the development of accurate contaminant transport models and future remediation efforts. All the laboratory analyses have been completed and a manuscript is currently being drafted for publication.

For more information, contact Nathan Yee nyee@envsci.rutgers.edu.

Source: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1760534&HistoricalAwards=false

Methanotrophic-mediated Methylmercury Transformation: An Important Yet Poorly Understood Biogeochemical Process

The NSF, on August 17, 2017, awarded funds to Baohua Gu of the University of Tennessee Institute of Agriculture to understand how methane-oxidizing bacteria take up and degrade methylmercury. Methylmercury is a very potent neurotoxin produced by some microbes. Once formed, methylmercury can easily biomagnify, that is, the concentrations of methylmercury in organisms increase as one goes up the food chain. Other microbes have the ability to degrade methylmercury, thus limiting this process of biomagnification. These known systems of methylmercury degradation, however, do not appear to be significant in most environments. Recent work, however, has found that different microbes, through a process yet to be full elucidated, degrade methylmercury under more environmentally relevant conditions. This process may thus be very important in controlling methylmercury bioaccumulation and its toxicity. In this project, Mr. Gu and his research team will delineate this process and determine how wide-spread it may be in the environment. It is estimated that research will be completed August 2020.

For more information, contact Baohua Gu at bgu@utk.edu.

Source: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1724430&HistoricalAwards=false

Tech and Tools

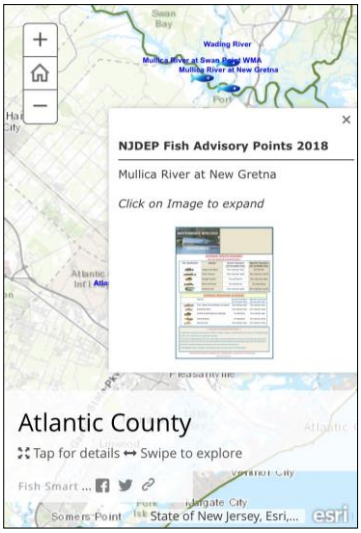
New Jersey Fish Consumption Advisories in a Mobile-Friendly Map

The New Jersey Department of Environmental Protection offers a mobile-friendly map on its website where users can look at advisories by county and waterbody. Swipe through the different counties, zoom in and out of the map, and tap the waterbody for more information on the advisory.

The map can be accessed here.

For more information, contact Gary Buchanan at Gary.Buchanan@dep.nj.gov or 609-984-6070.

Source: https://www.state.nj.us/dep/dsr/njmainfish.htm



Screen capture of the mobile-friendly map.

Recent Publications

Journal Articles

The list below provides a selection of research articles on mercury:

- Climate and productivity affect total mercury concentration and bioaccumulation rate of fish along a spatial gradient of subarctic lakes
  Ahonen, S.A., B. Hayden, J.J. Leppanen, and K.K. Kahilainen. 2018. Climate and productivity affect total mercury concentration and bioaccumulation rate of fish along a spatial gradient of subarctic lakes. *Science of the Total Environment* 637-638:1586-1596.

- Bioaccumulation of non-essential hazardous heavy metals and metalloids in freshwater fish: Risk to human health
  Ali, H., E. Khan. 2018. Bioaccumulation of non-essential hazardous heavy metals and metalloids in freshwater fish: Risk to human health. *Environmental Chemistry Letters* 1-15.

- Variation in fish mercury concentrations in streams of the Adirondack region, New York: A simplified screening approach using chemical metrics
  Burns, D.A. and K. Riva-Murray. 2018. Variation in fish mercury concentrations in streams of the Adirondack region, New York: A simplified screening approach using chemical metrics. *Ecological Indicators* 84:648-661.

- Oxidative stress profiles in brain point out a higher susceptibility of fish to waterborne divalent mercury compared to dietary organic mercury
  Cardoso, O., S. Puga, F. Brandao, J. Canario, N. O'Driscoll, et al. 2017. Oxidative stress profiles in brain point out a higher susceptibility of fish to waterborne divalent mercury compared to dietary organic mercury. *Marine Pollution Bulletin* 122(1-2):110-121.

- What's hot about mercury? Examining the influence of climate on mercury levels in Ontario top predator fishes
  Chen, M.M., L. Lopez, S.P. Bhavsar, and S. Sharma. 2018. What's hot about mercury? Examining the influence of climate on mercury levels in Ontario top predator fishes. *Environmental Research* 162:63-73.

- Regional and temporal trends in blood mercury concentrations and fish consumption in women of child bearing age in the United States using NHANES data from 1999–2010
  Cusack, L.K., E. Smit, M.L. Kile, and A.K. Harding. 2017. Regional and temporal trends in blood mercury concentrations and fish consumption in women of child bearing age in the United States using NHANES data from 1999-2010. *Environmental Health* 16:10.

- Reductions in fish-community contamination following lowhead dam removal linked more to shifts in food-web structure than sediment pollution
  Davis, R.P., S.M.P. Sullivan, and K.C. Stefanik. 2017. Reductions in fish-community contamination following lowhead dam removal linked more to shifts in food-web structure than sediment pollution. *Environmental Pollution* 231:671-680.

- Mercury, polychlorinated biphenyls, selenium, and fatty acids in tribal fish harvests of the Upper Great Lakes
  Dellinger, M.J., J.T. Olson, B.J. Holub, and M.P. Ripley. 2018. Mercury, polychlorinated biphenyls, selenium, and fatty acids in tribal fish harvests of the Upper Great Lakes. *Risk Analysis* Online publication.

- Prenatal mercury exposure and features of autism: a prospective population study
  Golding, J., D. Rai, S. Gregory, G. Ellis, et al. 2018. Prenatal mercury exposure and features of autism: a prospective population study. *Molecular Autism* 9:30.

- Current progress on understanding the impact of mercury on human health
  Ha, E., N. Basu, S. Bose-O'Reilly, J.G. Dorea, E. McSorley, M. Sakamoto, and H.M. Chan. 2017. Current progress on understanding the impact of mercury on human health. *Environmental Research* 152: 419-433.

- Effects of oral exposure to inorganic mercury on the feeding behaviour and biochemical markers in yellowfin bream (*Acanthopagrus australis*)
  Harayashiki, C.A.Y., A. Reichelt-Brushett, K. Cowden, and K. Benkendorff. 2018. Effects of oral exposure to inorganic mercury on the feeding behavior and biochemical markers in yellowfin bream (*Acanthopagrus australis*). *Marine Environmental Research* 134:1-15.

- Total mercury exposure in early pregnancy has no adverse association with scholastic ability of the offspring particularly if the mother eats fish
  Hibbeln, J., S. Gregory, Y. Iles-Caven, C.M. Taylor, A. Emond, and J. Golding. 2018. Total mercury exposure in early pregnancy has no adverse association with scholastic ability of the offspring particularly if the mother eats fish. *Environment International* 116:108-115.

- Modern science of a legacy problem: mercury biogeochemical research after the Minamata Convention
  Hsu-Kim, H., Eckley, C. S., Selin, N. E. 2018. Modern science of a legacy problem: mercury biogeochemical research after the Minamata Convention. *Environmental Science: Processes & Impacts* 20:582-583.

- Factors affecting mercury stable isotopic distribution in piscivorous fish of the Laurentian Great Lakes
  Lepak, R.F., S.E. Janssen, R.Yin, D.P. Krabbenhoft, J.M. Ogorek, J.F. DeWild, M.T. Tate, T.M. Holsen, and J.P. Hurley. 2018. Factors affecting mercury stable isotopic distribution in piscivorous fish of the Laurentian Great Lakes. *Environmental Science and Technology* 52(5): 2768-2776.

- A case study and a meta-analysis of seasonal variation in fish mercury concentrations
  Mills, N., D. Cashatt, M.J. Weber, and C.L. Pierce. 2018. A case study and a meta-analysis of seasonal variation in fish mercury concentrations. *Ecotoxicology* 27(6):641-649.

- Hair mercury (Hg) levels, fish consumption and semen parameters among men attending a fertility center
  Mínguez-Alarcón, L., M.C. Afeiche, P.L. Williams, M. Arvizu, C. Tanrifut, C.J. Amarasiriwardena, J.B. Ford, R. Hauser, and J.E. Chavarro. 2018. Hair mercury (Hg) levels, fish consumption and semen parameters among men attending a fertility center. *International Journal of Hygiene and Environmental Health* 221(2): 174-182.

- Spatial and ontogenetic variation in mercury in Lake Superior basin sea lamprey (*Petromyzon marinus*)
  Moses, S.K., C.N. Polkinghorne, W.P. Mattes, K.M. Beesley. 2018. Spatial and ontogenetic variation in mercury in Lake Superior basin sea lamprey (*Petromyzon marinus*). *Bulletin of Environmental Contamination and Toxicology* 100(1):95-100.

- Mercury bioaccumulation in offshore reef fishes from waters of the Southeastern USA
  Sinkus, W., V. Shervette, J. Ballenger, L.A. Reed, C. Plante, and B. White. 2017. Mercury bioaccumulation in offshore reef fishes from waters of the Southeastern USA. *Environmental Pollution* 228:222-233.

- Decadal changes in the edible supply of seafood and methylmercury exposure in the United States
  Sunderland, E.M., M. Li, and K. Bullard. 2018. Decadal changes in the edible supply of seafood and methylmercury exposure in the United States. *Environmental Health Perspectives* 126(1):017006-1-6.

- Differences in mercury exposure among Wisconsin anglers arising from fish consumption preferences and advisory awareness
  Stevens, A.L., I.G. Baird, and P.B. McIntyre. 2017. Differences in mercury exposure among Wisconsin anglers arising from fish consumption preferences and advisory awareness. *Fisheries* 43(1):31-41.

Upcoming Meetings and Conferences

Fish Passage 2018 - International Conference on River Connectivity
December 10-14, 2018
Albury, New South Wales, Australia

National Shellfisheries Association 111th Annual Meeting
March 7-11, 2019
New Orleans, Louisiana

Aquaculture 2019
March 7-11, 2019
New Orleans, Louisiana

11th International Conference on Toxic Cyanobacteria
May 5-10, 2019
Kraków, Poland

Additional Information

This monthly newsletter highlights current information about fish and shellfish.

For more information about specific advisories within the state, territory, or tribe, contact the appropriate state agency listed on EPA's National Listing of Fish Advisories website at https://fishadvisoryonline.epa.gov/Contacts.aspx.

For more information about this newsletter, contact Sharon Frey (Frey.Sharon@epa.gov, 202-566-1480).