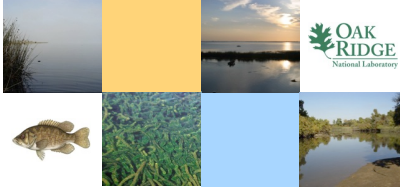


Managing mercury bioaccumulation in fish: lessons learned from 20 years of monitoring in Oak Ridge, TN


Dr. Teresa Mathews, Oak Ridge National Laboratory



160 Plant Biotechnology Building

12:20 p.m.

6 February 2013

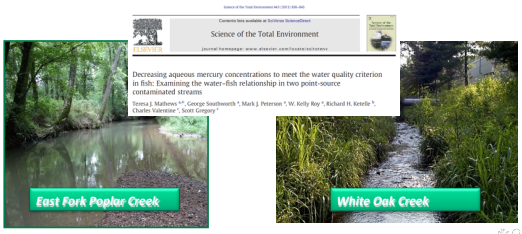


Curriculum Vitae


- **Education**
 - B.A. in Biology and French, New York University, 1999
 - Ph.D. in Coastal Oceanography, Stony Brook University, 2007
- **Research Experience**
 - Research Assistant (harmful algal blooms, Lyon, France), 2000
 - Research Fellow (trace element cycling, IAEA Marine Environmental Lab in Monaco, 2005)
 - Postdoctoral Researcher (Uranium bioavailability, transfer, and toxicity, Cadarache, France, 2008)
 - Research scientist Oak Ridge National Laboratory (Biological Monitoring and Abatement Program, 2009-present)

Outline

- Mercury in the aquatic environment
- Mercury at Oak Ridge:
 - East Fork Poplar Creek vs White Oak Creek
- Other related projects
- Implications for future remediation in EFPC and in other mercury contaminated streams




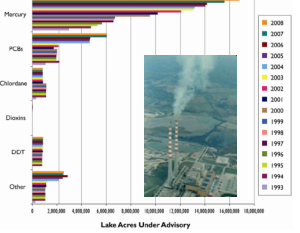
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Mercury (Hg)

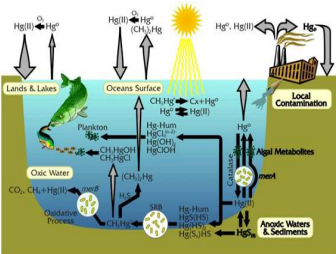
- Naturally occurring in environment
- Anthropogenic activities (e.g. coal combustion) have increased mobilization
- Affects more watersheds than other contaminants of concern





Lake Acres Under Advisory

Global Biogeochemical Cycle for Mercury

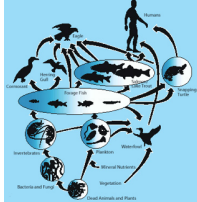


- Multiple chemical forms or "species"
- *Methylmercury is most toxic form
- Methylmercury builds up in aquatic food chains
- *Mercury toxicity is intimately linked with aquatic ecosystems

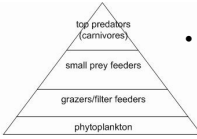
Hg: "Total Mercury" = inorganic mercury + methylmercury
MeHg: Methylmercury

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Biomagnification



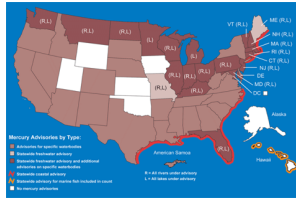
- Biomagnification: progressive bioconcentration of metal with increasing trophic level
- Mercury, especially methylmercury, is one of the only metals known to biomagnify
- Largest dose of Hg to humans is through the consumption of contaminated fish



↑ biomagnification

Why should we care about metal bioaccumulation?

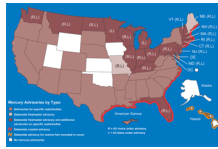
- Methylmercury is a potent neurotoxin
- Minimata disease was caused by eating contaminated seafood



- Mercury contamination is widespread
- Even areas that have no industrial inputs are affected because of atmospheric deposition

**EPA guidelines for mercury are based on a fish tissue concentration (not water concentration)

- Ambient Water Quality Criterion (AWQC) for MeHg: 0.3 mg/kg in fish fillet
- >95% of Hg in fish fillet is MeHg
- MeHg is not easily measured, and is not easily controlled



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Mercury contamination at Oak Ridge

- Large amounts (> 10 million kg) of inorganic Hg were used for industrial processes in 50's and 60's
- Spills and releases of Hg contaminated creeks, floodplains, and downstream sediments
- Hg remediation has focused on source control (water treatment systems, sewer relining, pipe re-routing, soil removal)
- Several streams continue to exceed state and federal regulatory limits in both water and fish






East Fork Poplar Creek	White Oak Creek
<ul style="list-style-type: none"> • 25 km long • Flow: 210-2801 L/s • ~350,000 kg Hg initially released • As of 2007, ~400 ng/L aqueous Hg 	<ul style="list-style-type: none"> • 7 km long • Flow: 70-264 L/s • ~30,000 kg Hg released • As of 2007, ~50 ng/L aqueous Hg
<ul style="list-style-type: none"> • Fish in both creeks have exceeded AWQC of 0.3 mg/kg in fish fillet • Current cleanup target for EFPC is 200 ng/L 	

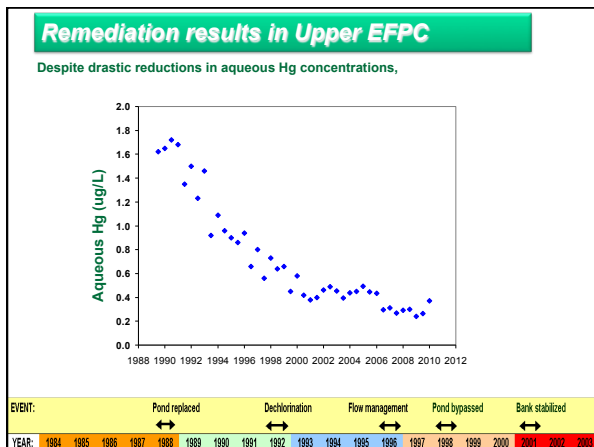
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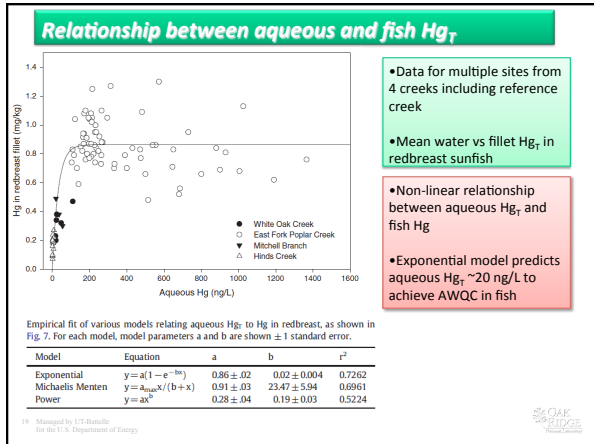
Bioaccumulation monitoring approach

- Monitoring of resident sunfish primarily (redbreast, rockbass)
- Five sites throughout length of 25 km stream (EFPC); four sites in WOC
- Twice yearly sampling for fish; water sampling varies with site and creek
- 6-8 individual fish fillets/site
- Edible sized fish targeted, similar sizes between sites and years

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Conclusions

- Mercury’s behavior in the environment is complex
- Methylmercury is formed by bacteria in aquatic sediments; this most toxic form of mercury biomagnifies in aquatic food chains
- The relationship between total mercury in water and methylmercury is not straightforward
- On the Oak Ridge Reservation, much work has been done to clean up mercury in East Fork Poplar Creek, but fish tissue concentrations still exceed EPA regulatory limits
- Recent success in cleaning up mercury in White Oak Creek has given us much insight as to clean up strategies and targets—we have much more work to do!
- Need greater investment into basic research on mercury methylation and bioaccumulation in stream ecosystems


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Source monitoring using caged clams

Links between aquatic and terrestrial systems?



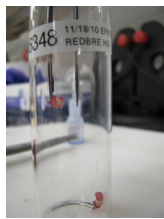
Field methods



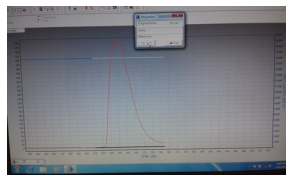
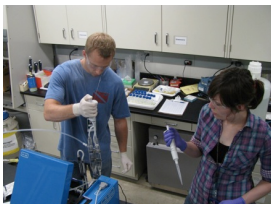
Lab methods



Non-lethal sampling



Mercury analysis



Sincerest Appreciation to:

ORNL's Ecological Assessment Team

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Neil Giffen John Smith
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Kitty McCracken Trent Jett
Gail Morris Tracy Clem
Kelly Roy



Savannah River Lab

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