Tissue Analysis for Mercury and PCBs from a New York City Commercial Seafood Market

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2009 National Forum on Contaminants in Fish
Portland, Oregon, November 2–5

Why NYC Commercial Seafood Market Study?

- New York City Health and Nutrition Examination Survey - "**NYC HANES**"
- General Population Getting Seafood from the largest NYC Seafood Wholesale Source

Goals of EPA Fish Tissue Study

- Determine the Hg concentration in a sample of the 20 most commonly consumed seafood species consumed by New Yorkers
- Determine the PCBs concentration in a sample of the 5 species which are potentially high with PCBs
- Provide an empirical tool to support NYCDOHMH's public health message "Eat Fish, Choose Wisely"

EPA Hg Fish Tissue Study (Sampling)

- **Fulton Fish Market (NYC)**
  - Largest wholesale market in the US
  - 22* most commonly consumed species of fin and shell fish
  - Composite of 3 specimens per sample for most species
  - Target sample size (N = 10 - 15)
  - Super samples for small species (e.g., shrimp, clams, crabs)

* Additional species collected but constrained by small (<4) sample size

New Fulton Fish Market since 2005
(Fulton Fish Market since 1807)

- http://www.newfultonfishmarket.com/


FRESH SEAFOOD
14 05 2008

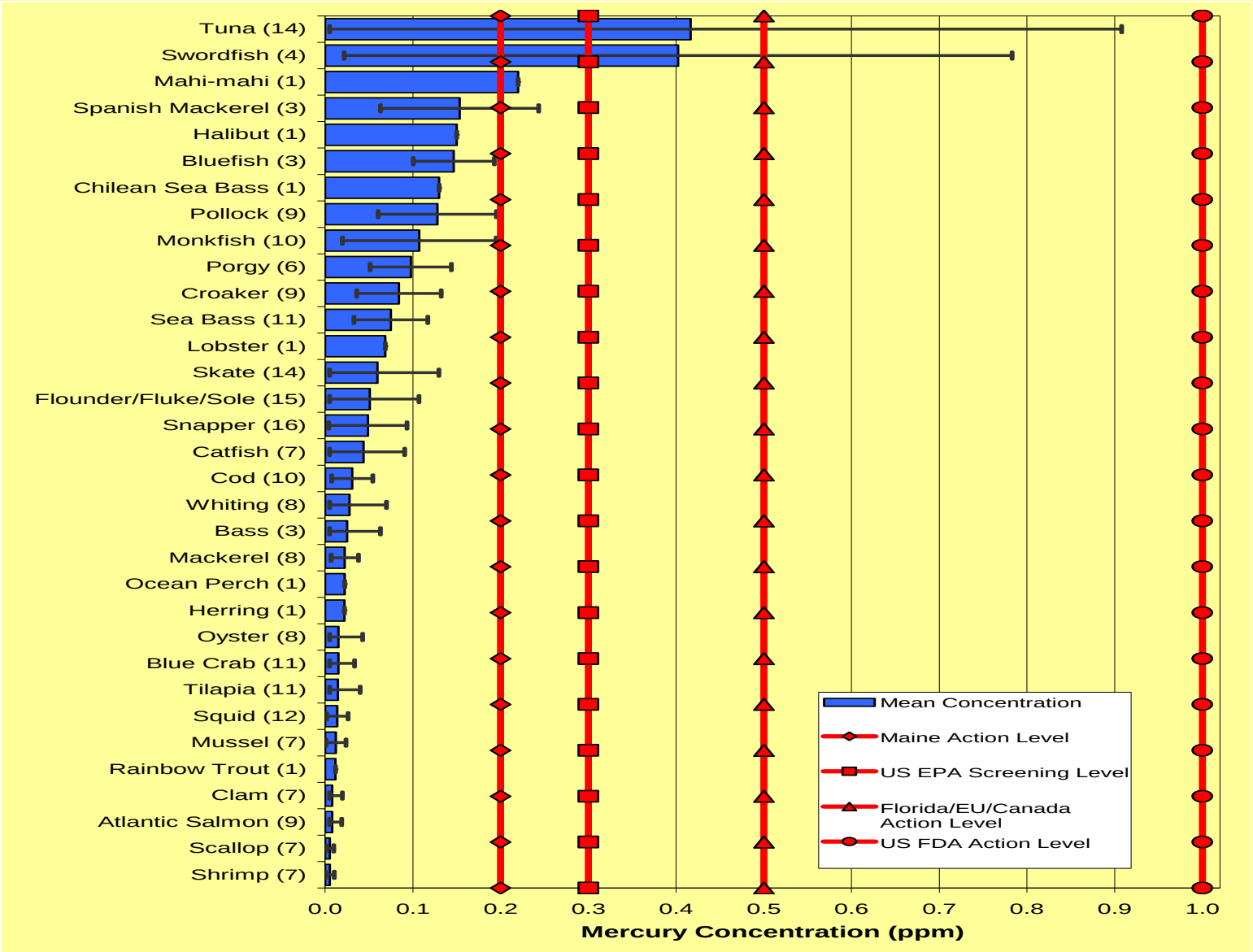
EPA Fish Tissue Study (Analysis)

- Hg and subset of 5 species analyzed for PCBs
- Hg and PCBs performed by EPA R2's Edison Lab
- Composite of 3 specimens per sample, more for super samples
- Edible tissue
  - soft shell crab – whole specimen
  - blue claw crab – muscle tissue only
- DNA sequencing on representative specimen from all samples

DNA Sequencing Technology

- Genetic Sequence from a genome
- DNA Barcoding
- Cytochrome C Oxidase subunit 1 (cox1)
- Accurately assign a specimen to a given species
- Performed by EPA's ORD Lab in Cincinnati

Hg Results


Tuna (14)
Swordfish (4)
Mahi-mahi (1)
Spanish Mackerel (3)
Halibut (1)
Bluefish (3)
Chilean Sea Bass (1)
Pollock (9)
Monkfish (10)
Porgy (6)
Croaker (9)
Sea Bass (11)
Lobster (1)
Skate (14)
Flounder/Fluke/Sole (15)
Snapper (16)
Catfish (7)
Cod (10)
Whiting (8)
Bass (3)
Mackerel (8)
Ocean Perch (1)
Herring (1)
Oyster (8)
Blue Crab (11)
Tilapia (11)
Squid (12)
Mussel (7)
Rainbow Trout (1)
Clam (7)
Atlantic Salmon (9)
Scallop (7)
Shrimp (7)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Mercury Concentration (ppm)
Mean Concentration
Maine Action Level
US EPA Screening Level
Florida/EU/Canada Action Level
US FDA Action Level

Risk Communication

- Propose arraying species into bins as per NYCDOHMH pamphlet (for pregnant and breastfeeding women and children)

- Estimated Allowed Serving - ounces per week allowed based on tissue concentration and allowable intake as per the RfD for HgCH3

Table 14. Estimated Allowed Servings per Week for an Adult Female Based on Mercury Concentrations by Market Name [a]

Market Name of Species	Mean Mercury (mg/kg)	Mean Mercury Plus Two Standard Deviations (mg/kg)	Allowed Servings per Week using Mean Mercury	Allowed Servings per Week using Mean Mercury Plus Two Standard Deviations
Tuna *	0.42	0.91	0	0
Swordfish *	0.40	0.78	0	0
Mahi-mahi *	0.22	N/A	0	N/A
Spanish Mackerel	0.15	0.24	1	0
Halibut	0.15	N/A	1	N/A
Bluefish	0.15	0.19	1	1
Chilean Sea Bass	0.13	N/A	1	N/A
Pollock	0.13	0.20	1	1
Monkfish	0.11	0.19	1	1

[a] Estimates were predicted using the following exposure assumptions: Serving size = 8 ounces of fish fresh weight, Adult female weight = 65 kg, RfD for methyl mercury = $1x10^{-4}$ mg/kg/day (U.S. EPA IRIS database), and the person consumes only the one type of fish or shellfish.

* These concentrations yield estimates indicating less than one serving a week can be eaten by an adult female; however, they correspond to two servings per month for tuna and swordfish and four servings per month for mahi-mahi, assuming 30 days in a month.

Estimated Allowed Serving – By adult

women: None or Less than weekly – tuna, swordfish, mahi-mahi

Thunnus albacares - Yellowfin Tuna

Estimated Allowed Serving – By adult women: None or Less than weekly – tuna, swordfish, mahi-mahi

Xiphias gladius - Swordfish

Estimated Allowed Serving – By adult

women: None or Less than weekly – tuna, swordfish, mahi-mahi

Coryphaena hippurus - Mahi-Mahi

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Market Name of Species	Mean Mercury (mg/kg)	Mean Mercury Plus Two Standard Deviations (mg/kg)	Allowed Servings per Week using Mean Mercury	Allowed Servings per Week using Mean Mercury Plus Two Standard Deviations
Porgy	0.098	0.14	2	1
Croaker	0.084	0.13	2	1
Sea Bass	0.075	0.12	2	1
Lobster	0.069	N/A	2-3	N/A
Skate	0.060	0.13	3	1
Flounder / Fluke / Sole	0.051	0.11	3-4	1
Snapper	0.049	0.093	4	2
Catfish	0.044	0.091	4	2
Cod	0.031	0.054	6	3
Whiting	0.028	0.070	7	2
Bass	0.025	0.063	8	3

Estimated Allowed Serving – By adult women: Weekly – Spanish mackerel, halibut, Chilean sea bass, pollock, monkfish

Dissostichus eleginoides - Chilean Sea Bass

Estimated Allowed Serving – By adult women: Weekly – Spanish mackerel, halibut, Chilean sea bass, pollock, monkfish

Lophius americanus - Monkfish

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Market Name of Species	Mean Mercury (mg/kg)	Mean Mercury Plus Two Standard Deviations (mg/kg)	Allowed Servings per Week using Mean Mercury	Allowed Servings per Week using Mean Mercury Plus Two Standard Deviations
Ocean Perch	0.022	N/A	8-9	N/A
Herring	0.022	N/A	9	N/A
Oyster	0.015	0.043	13	4
Blue Crab	0.015	0.033	13	5-6
Tilapia	0.014	0.040	13-14	5
Squid	0.014	0.026	14	7
Mussel	0.012	0.024	16	8
Rainbow Trout	0.012	N/A	16-17	N/A
Clam	0.0081	0.020	24-25	10
Atlantic Salmon	0.0081	0.019	24-25	10
Scallop	0.0055	0.0099	36-37	20
Shrimp	0.0054	0.010	36-38	19

[a] Estimates were predicted using the following exposure assumptions: Serving size = 8 ounces of fish fresh weight, Adult female weight = 65 kg, RfD for methyl mercury = $1x10^{-4}$ mg/kg/day (U.S. EPA IRIS database), and the person consumes only the one type of fish or shellfish.

* These concentrations yield estimates indicating less than one serving a week can be eaten by an adult female; however, they correspond to two servings per month for tuna and swordfish and four servings per month for mahi-mahi, assuming 30 days in a month.

Estimated Allowed Serving – By adult

Women: Daily - squid, mussels, rainbow trout, clams, Tilapia, Atlantic salmon, scallops, shrimp

Salmo salar - Atlantic Salmon

Estimated Allowed Serving – By adult

Women: Daily - squid, mussels, rainbow trout, clams, Tilapia, Atlantic salmon, scallops, shrimp

Oreochromis niloticus niloticus - Tilapia

Estimated Allowed Serving – By adult

Women: Daily - squid, mussels, rainbow trout, clams, Tilapia, Atlantic salmon, scallops, shrimp

Oncorhynchus mykiss - Rainbow Trout

Estimated Allowed Serving – By adult

Women: Daily - squid, mussels, rainbow trout, clams, Tilapia, Atlantic salmon, scallops, shrimp

penaeus vannamei - White Shrimp

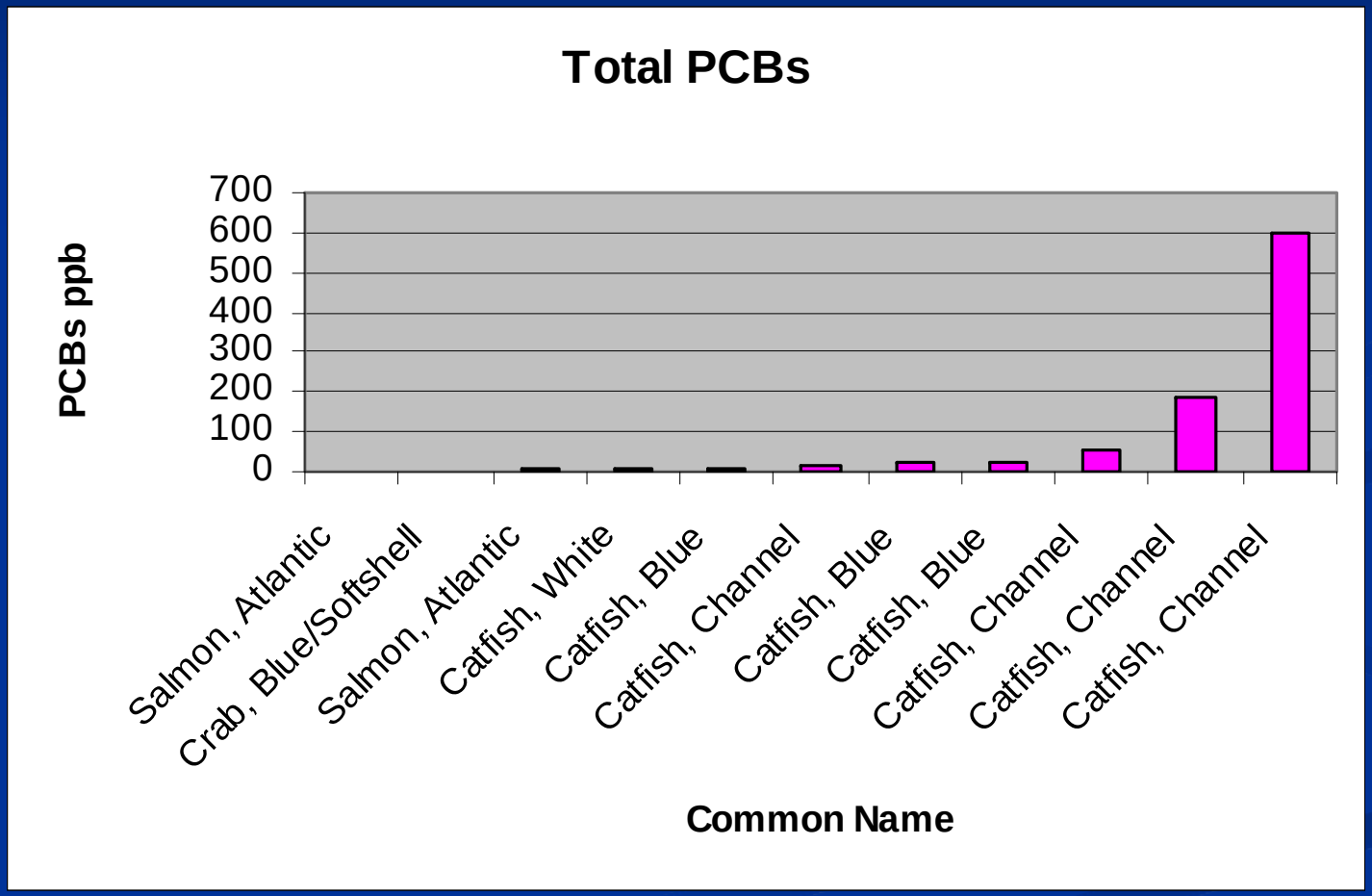
PCBs results

- Limited PCBs Analysis (N=50)
- 5 Species (salmon, crab, tuna, catfish, and mackerel)
- Large portion of non detects preclude a statistical analysis
- PCBs were detected in all 8 catfish, 1 blue crab and 2 Atlantic salmon

PCBs results

Count of result value	Detect_flag		
Common Name	N	Y	Grand Total
Catfish, Blue		3	3
Catfish, Channel		4	4
Catfish, White		1	1
Crab, Blue/Hardshell	6		6
Crab, Blue/Softshell	3	1	4
Mackerel, Atlantic	7		7
Mackerel, Spanish	3		3
Salmon, Atlantic	8	2	10
Scallop, Sea	1		1
Swordfish	1		1
Tuna, Bigeye	7		7
Tuna, Yellowfin	3		3
Grand Total	**39**	**11**	**50**

PCBs results



Biokinetic Model for Methylmercury

- Based on the 1-compartment model proposed by Clarkson et al. (1988), the steady state concentration of mercury in blood (µg/L), in an adult woman (bw=60 kg) who ingests methylmercury in the diet daily, will be approximately 0.95 x daily dose (µg Hg/day).

- Assumptions are:
- Absorption fraction (AF)=0.95
- Blood fraction of absorbed dose (BF)= 0.05
- Blood volume (BV) = 4.2L (0.07 x bw)
- Elimination rate coefficient (ke) = 0.014 d^-1
- Dosing interval (DI)= 1 d
- Dose (D) = X ug

- $Css = (D \times AF \times BF)/(ke*BV*DI)$

- Clarkson et al. 1988. In Biological Monitoring of Metals. Clarkson et al (eds). Plenum Press: NY. ISBN 0-306-42809-1

Acknowledgments

- **Mark Maddaloni, EPA R2 – RARE Grant Recipient**
- Maureen O'Neill, EPA R2
- Stan Stephansen, EPA R2
- Dennis Santella, EPA R2
- Henry Kahn, EPA ORD DC
- Cheryl Itkin, EPA ORD DC
- Mike Borst, EPA R2 Edison
- John Bourbon, EPA R2 Edison
- Beverly Comfort, EPA RTP
- Carolyn Esposito, EPA Edison
- John Martinson, EPA ORD CI
- Wendy McKelvey, NYC DOHMH

Questions?

- *Morone saxatilis* Striped bass

For a copy of the final report, e-mail: Chang.Moses@epa.gov