Study of Historic Mercury Advisory Sites

NEWMOA- Chicago
November 17, 2009

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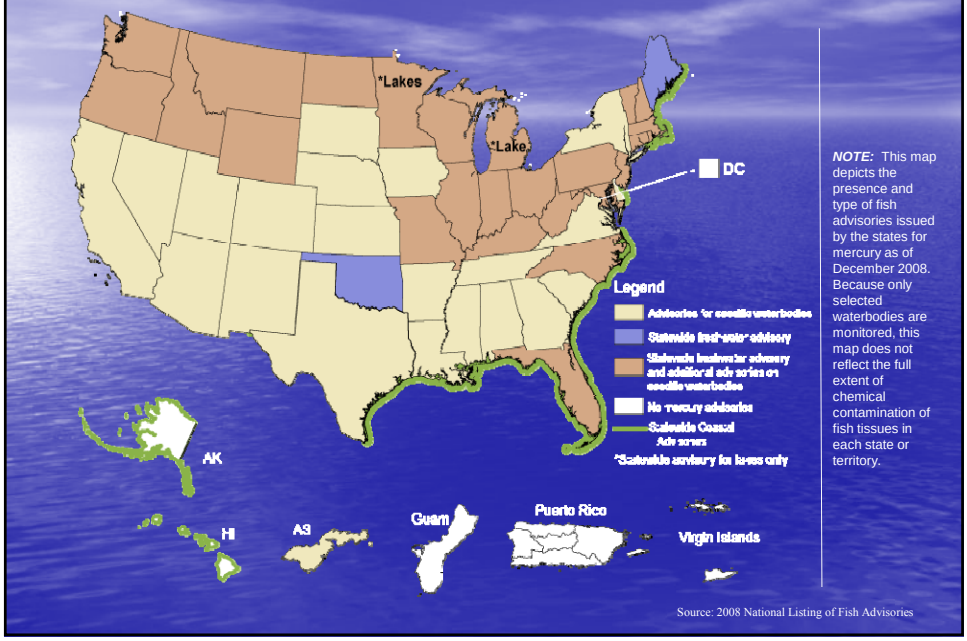
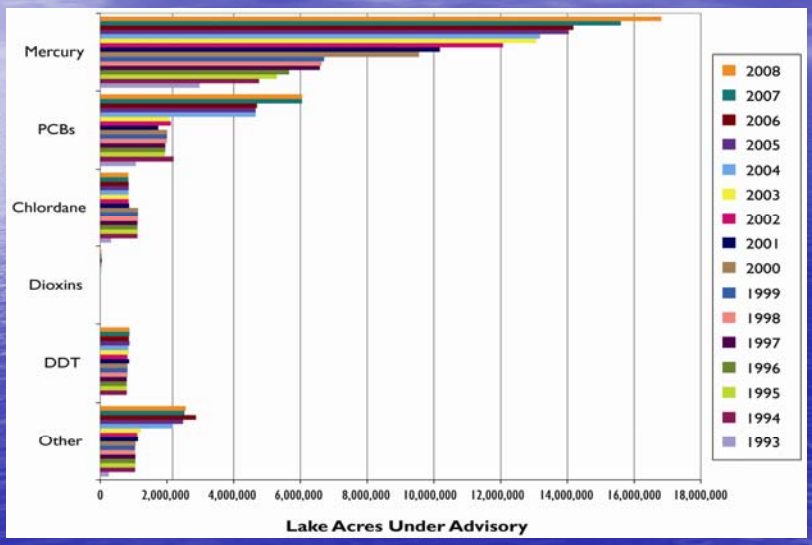
Fish Consumption Advisories for Mercury



NOTE: This map depicts the presence and type of fish advisories issued by the states for mercury as of December 2008. Because only selected waterbodies are monitored, this map does not reflect the full extent of chemical contamination of fish tissues in each state or territory.

Source: 2008 National Listing of Fish Advisories

Number of Lake Acres Under Advisory for Various Pollutants, 1993-2008



Source: 2008 National Listing of Fish Advisories

Project overview

Study Goals

- Examine the basis for existing (pre-'96) advisories in terms of methodology and mercury concentration
- Assess trends in mercury concentration over time?
- Assess appropriate meal consumption advice using EPA's *National Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories* (EPA 2000).
- Determine if new mercury tissue data support changes to existing consumption recommendations based on current national guidance.

Project overview

Study Objectives

- Develop Statistically-based set of sample locations
- Collect fish samples of a target species from sites across the country where mercury advisories were issued prior to 1996.
- Determine current mercury concentrations in fish.
- Analyze Current advisories relative to EPA protocols and current Hg concentration data

Project overview

Project Statistical Basis

- 100 sites with existing advisories selected using a statistically-based, regionally stratified design
- Sites selected to be representative ***Nationally*****, NOT** regionally or by state.
- Uniform sampling, sample preparation, and analysis of fish tissue yielded a uniform, valid dataset for 2007 Hg concentrations.
- The historic data set is highly variable, with early advisories sometimes resulting from analysis of a single fish or unknown number of fish, and often lacking metadata.
- Therefore, time-series trend data between historical Hg concentrations and 2007 data could not be supported statistically.

Methods

- Develop statistical study design that would allow a national assessment
- Collect fish and prepare composites according to EPA 2000 guidance.
- Analyze fish filets using EPA method 1631e (modified for tissue).
- Report mean mercury concentration based on composite analysis by site.
- Assign meal consumption advice using 2007 Hg concentration data and standard inputs as defined in EPA's guidance manual.
- Compare meal advice derived from 2007 data to state-issued advice in place at each site.
- On a site-by-site basis, review historical fish-tissue data and application of state methodology to assess meal consumption advice.

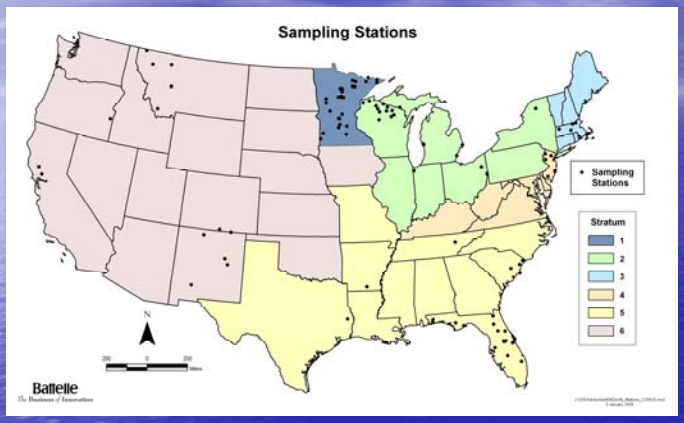
Project milestones

- Field Collections Complete: November 2007
- Mercury Analysis Complete: March 2008
- Draft Study Report Submitted to EPA: July 2008
- Final Draft Manuscript Submitted to EPA: September 2009

EPA Guidance for Assessing Chemical Contaminant Data for Use In Fish Advisories (EPA 2000)

- Recommends methods for sampling, sample preparation and analysis
- Provides methodologies for Risk Assessment and setting Fish Consumption Limits
- Includes default values for RA input values -RfD, meal size and body weight
- Provides guidance on Risk Management and Risk Communication

Map of selected stations and strata



- Stratum 1: Minnesota only (30)
- Stratum 2: Other Great Lakes states (22)
- Stratum 3: Northeast (6)
- Stratum 4: Mid-Atlantic (5)
- Stratum 5: Southeast (22)
- Stratum 6: Western and North Central states (15)

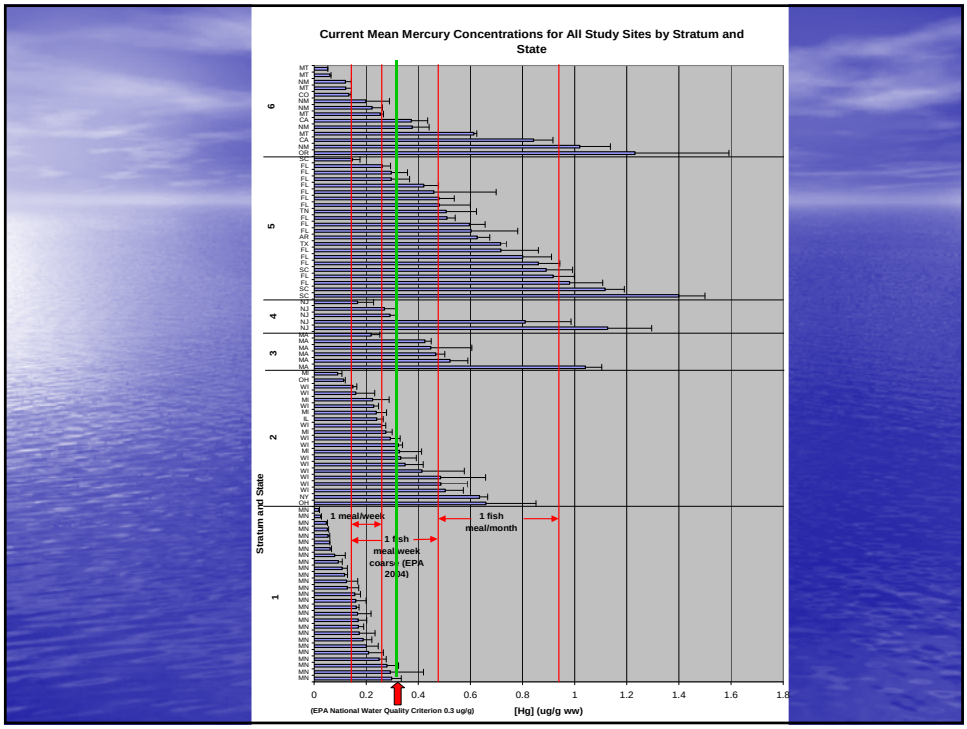
Analytical results for 2007 collections

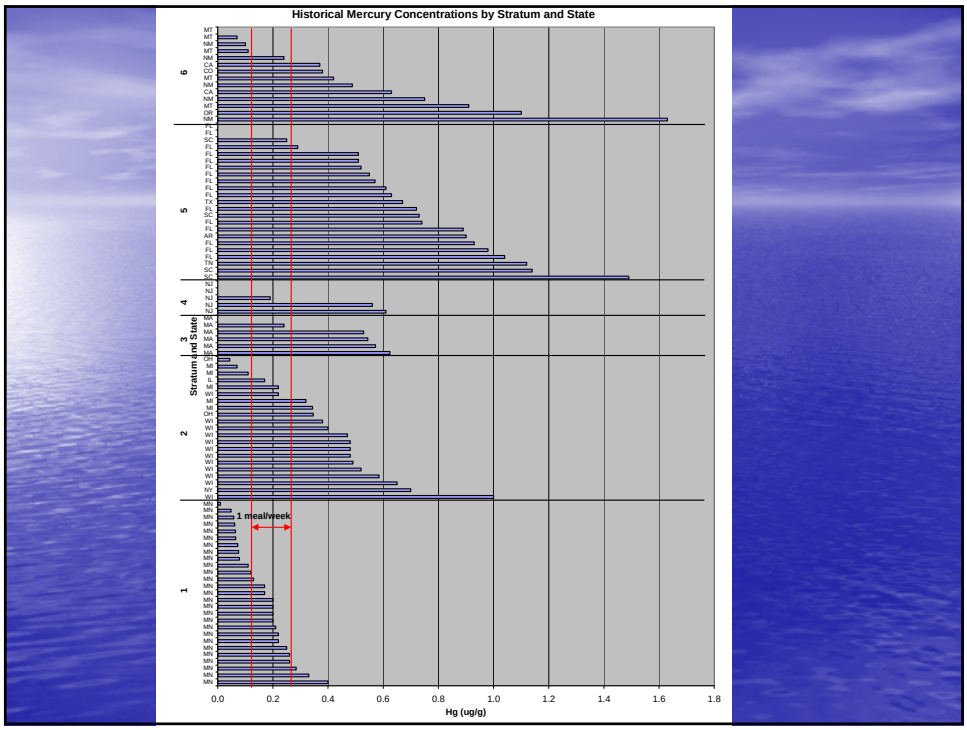
- Samples obtained from 95 locations
- Results reported as arithmetic mean of 3 composite samples of the target species at each site
- Highest mercury concentration (mean per water body): 1.40 ppm in large mouth bass from South Carolina
- Lowest mercury concentration (mean per water body): 0.019 in common carp from Minnesota
- Average mercury concentration (all sites/species 2007): 0.386 ppm

Mercury statistics (mean, min, max, std) for 2007 study data reported by stratum

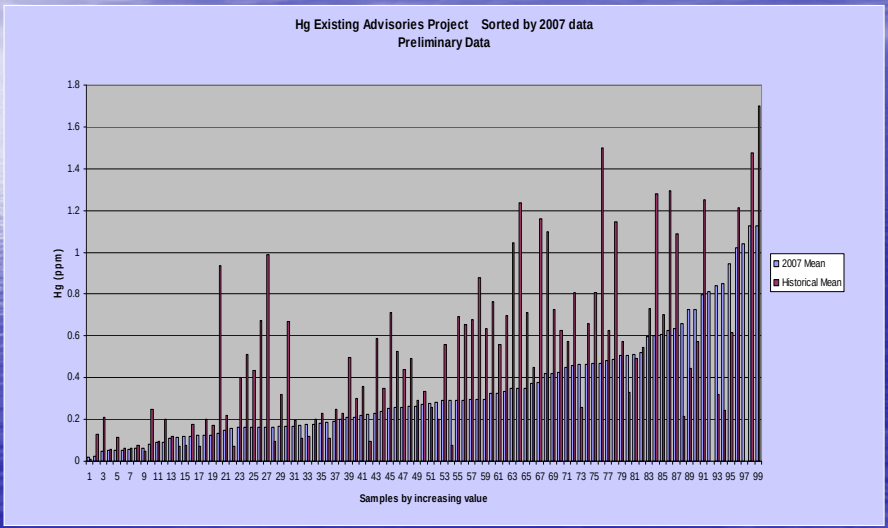
Stratum	# Sites in Sample Frame	# Sites in Sample	Mean Hg Conc. (ppm)	Standard Deviation of Conc. (ppm)	Minimum Conc. (ppm)	Maximum Conc. (ppm)
1	581	27	0.142	0.080	0.019	0.298
2	128	21	0.327	0.161	0.091	0.659
3	35	6	0.521	0.275	0.219	1.041
4	29	5	0.533	0.415	0.167	1.127
5	132	22	0.647	0.299	0.147	1.400
6	85	14	0.402	0.380	0.052	1.232

Remember, Hg results not representative by stratum or by state!


Current Mean Mercury Concentrations for All Study Sites by Stratum and State
Stratum and State
1 meal/week
1 fish meal/month
1 fish meal/week coars (EPA 2004)
(EPA National Water Quality Criterion 0.3 ug/g)
[Hg] (ug/g ww)


Historical Mercury Concentrations by Stratum and State
Stratum and State
1 meal/week
Hg (ug/g)

Mercury- Historical and 2007 concentrations



Historical vs 2007 data

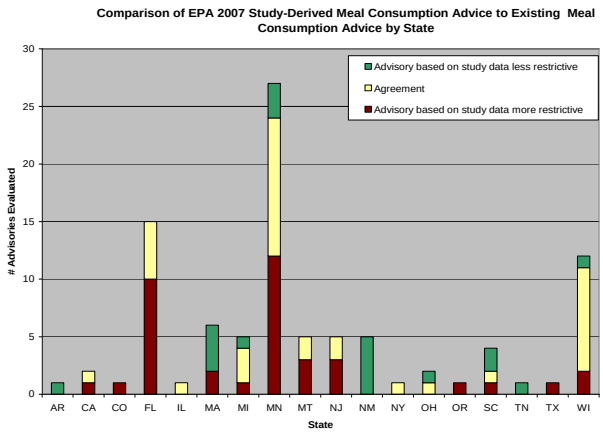
- Reviewed the mercury tissue data that was used to issue the historic (pre-1996) advisory at 91 of the 95 sites.
- The historic data set is highly variable, with early advisories sometimes resulting from analysis of a single fish or unknown number of fish, and often lacking metadata. Time series comparison with the 2007 Hg data is not supportable.
- However, even though robust statistical comparisons are not possible, the differences between the historic values were determined and summed.
- The overall mean Hg concentration from the historical data is 0.442 ppm (compared to 0.386 ppm for the 2007 data).
- The sum of the total increase in average fish tissue Hg concentration is 4.012 ppm, the sum of the total decrease is 10.203 ppm.
  - The average decrease (n=61) is 0.167 ppm
  - The average increase (n=30) is 0.134 ppm

Meal consumption advice: 2007 collection data

- Using 2007 Hg data, we derived meal consumption advice for each site and species using EPA guidance methodology and standard inputs.
- We compared the resulting meal advice to the state-issued advice in place at each of the sites.

Of the 95 sites studied, we found agreement in meal consumption advice at 38 sites (42%, weighted), i.e., advice would change at 58% (weighted) of sites using current data and EPA methodology and standard inputs.

Meal consumption advice: 2007 collection data

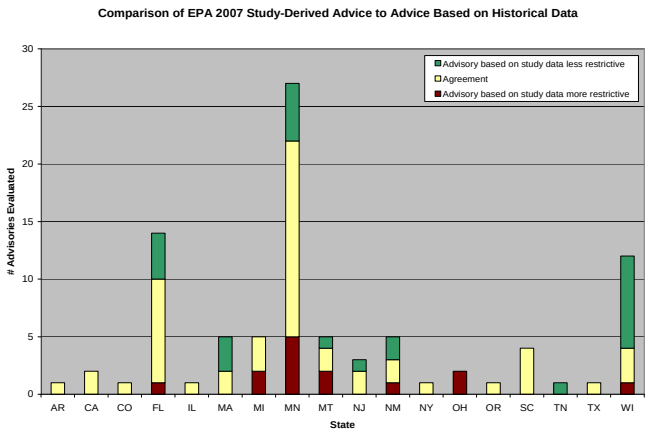


Meal consumption advice: historical data

- Using the historical data means, we derived meal consumption advice for each site and species using EPA guidance methodology and standard inputs.
- We compared this consumption advice to the state-issued advice at each of the sites.

Of the 91 sites where comparisons are possible, we found agreement at 52 sites (57%), i.e., *more of the variation in advice is due to methods and inputs than changes in HG concentrations.*

Meal consumption advice: historical data



Conclusions:

- Results of this study demonstrate that a combination of new data and application of EPA's risk-based approach would lead to a change in existing meal consumption advice at 58% of the historic mercury advisory sites across the United States.
- While many states (14 of the 18 in this study) use EPA methodology in the assessment of meal advice, we found that the low comparability is primarily due to variability in input parameters (esp oral reference dose) between state programs.
- More recent data collections using uniform methodologies are needed to adequately reflect current conditions in recreationally-important water bodies.
- Applying a standard methodology and using standard input variables such as those provided in EPA's guidance manual would substantially increase comparability among state programs and help to ensure appropriate fish consumption advice and protection of public health among recreational and subsistence fish consumers.

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Acknowledgements:

Jeanine Boyle, Battelle Memorial Institute

Patricia Cunningham, RTI International

Jeff Bigler, U.S. EPA, Office of Water

Robert Lordo, Battelle Memorial Institute

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Report on Mercury Findings: EPA's National Lake Fish Tissue Survey

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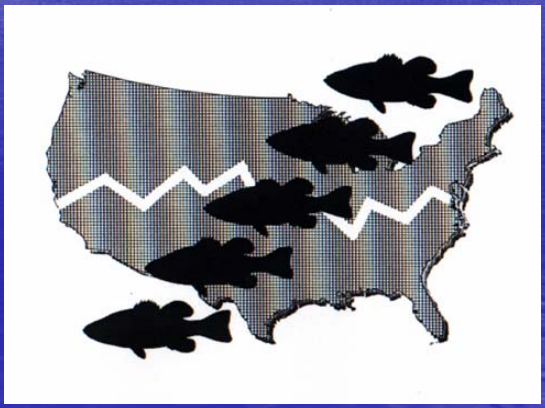
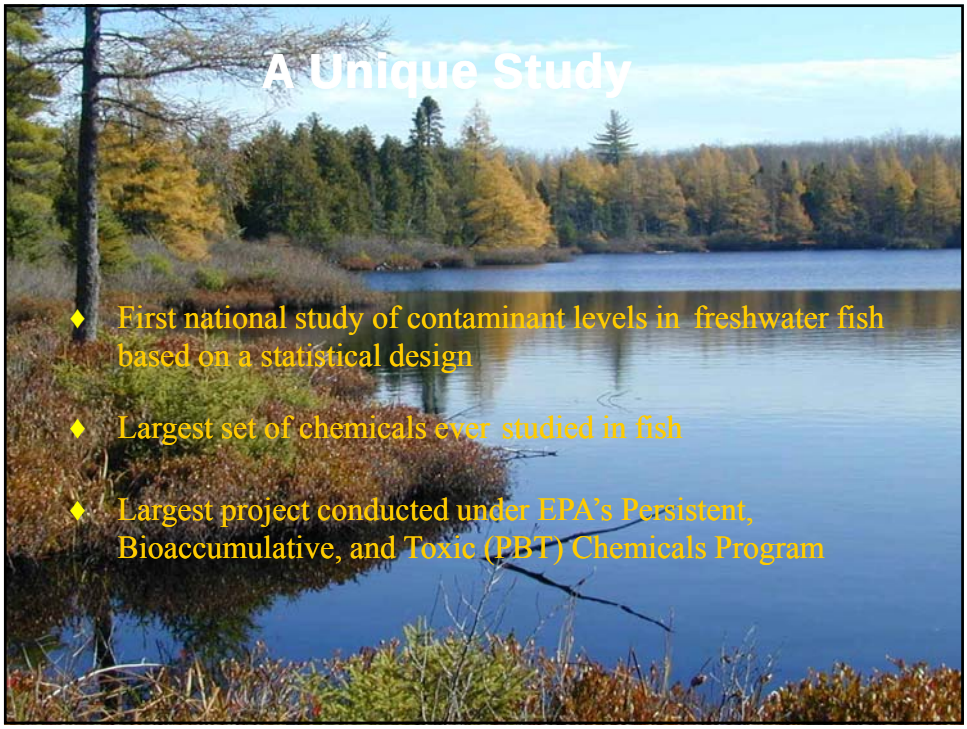
Office of Science & Technology



Presentation Overview

Study Design Summary
Report Preview
Results Overview
Future Monitoring



Study Objective

- *The objective of the National Lake Fish Tissue Study was to estimate the national distribution of the mean levels of selected persistent, bioaccumulative, and toxic chemical residues in fish tissue from lakes and reservoirs in the contiguous United States.*
- Study results:
  - Provide the first national estimates of median concentrations of PBT chemicals in fish tissue.
  - Define a national baseline for assessing progress of pollution control activities.

2008 Fish Advisories

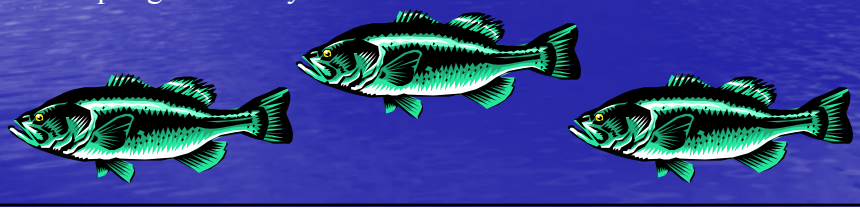
CHEMICAL	NO. OF ADVISORIES	LAKE ACRES UNDER ADVISORY
Mercury	3,361	16,808,032
PCBs	1,025	6,049,506
Dioxins	123	35,400
DDT	76	876,520
Chlordane	67	842,913

Sampling Design 1

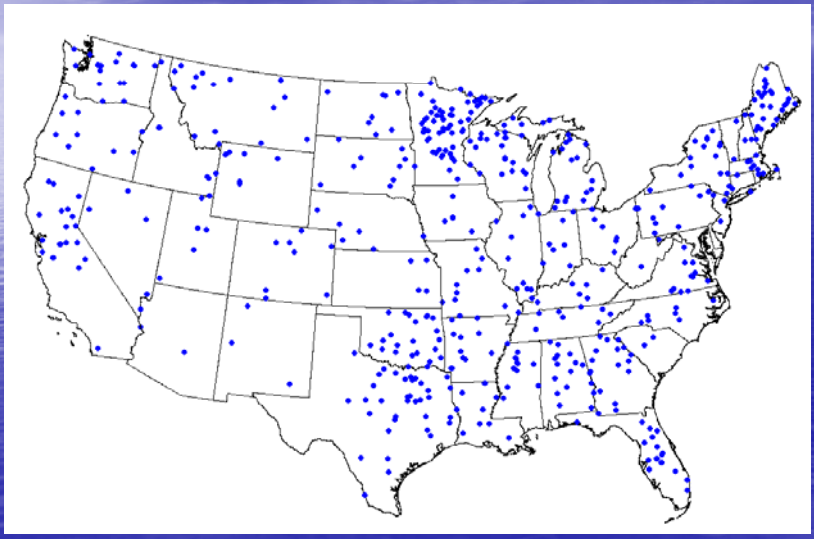
- Random selection of lakes and reservoirs in 4 national annual statistical subsets
- 500 lakes and reservoirs in the lower 48 states sampled over 4 years (2000-2003)
- Exclusion of Great Lakes due to existing monitoring programs
- Lake criteria
  - Permanent water body with permanent fish population
  - Minimum surface area of one hectare (~2.5 acres)
  - 1000 square meters of open, unvegetated water
  - Depth of at least one meter

Sampling Design 2

- Six size categories of lakes ranging from 1 hectare to > 5000 hectares with varying probabilities for each size category
- Two fish composites per site (predators and bottom dwellers) with 5 adult fish per composite
- Preparation of 560 g of tissue for analysis
- Collection of replicate samples from 10% of the lakes to estimate sampling variability

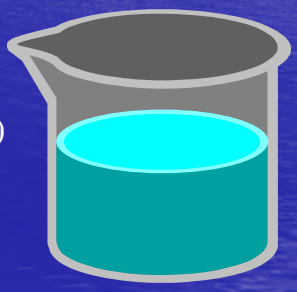


500 Sampling Locations



Target Chemicals

- Fish tissue analyzed for 268 chemicals, including PCB congeners and breakdown products.
  - 2 metals (Hg and As [5 forms])
  - 17 dioxins/furans
  - 159 PCB congener measurements
  - 46 pesticides
  - 40 semi-volatile organics (e.g., PAHs)
- PBDE analysis added for Year 4 samples only.



Key Milestones

ACTIVITY	DATE
Produce study design document	June 1999
Complete sample collection	November 2003
Distribute final year of analytical data	April 2005
Release all raw data to the public	October 2005
Publication of Journal Article (EM&A)	December 2008
Release of Final EPA Report	November 2009

Essential Results Information

The following information is critical for interpreting the results:

- Predator and bottom-dwelling species did not occur together at every sampling site.
  - The target lake was sampled if either composite type occurred.
  - 486 predator composites and 395 bottom-dweller composites were collected from the 500 sampling sites.
- Results from each composite type comprise nationally representative samples, but differences in occurrence define different sampled populations.
  - Predator results can be extrapolated to 76,559 lakes.
  - Bottom-dweller results can be extrapolated to 46,190 lakes.
- Developing national estimates of tissue concentrations requires use of sample weights due to the unequal probability design.

Reporting the Results

- Analytical results are presented in three tiers:
  - Non-detected chemicals
  - Rarely-detected chemicals
  - Commonly-detected chemicals
- Five chemicals are highlighted as commonly detected:
  - Mercury
  - PCBs
  - Dioxins and furans
  - Total DDT
  - Chlordane

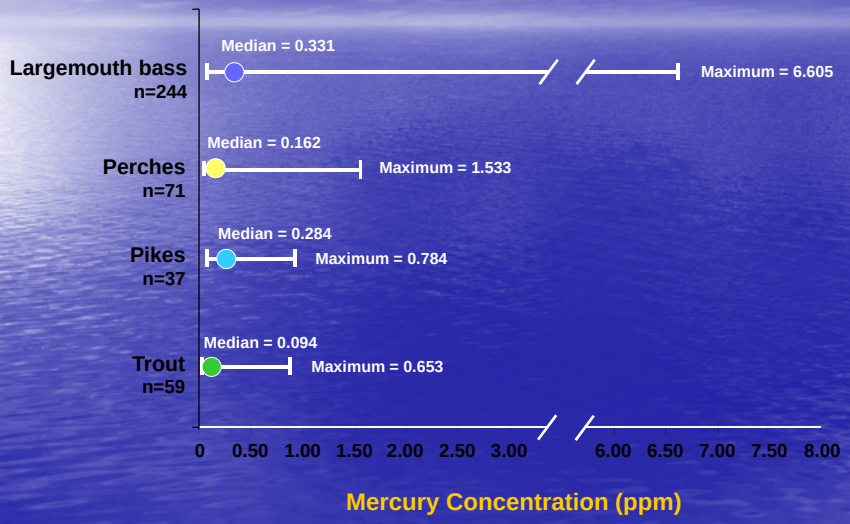
Chemical Detections

CHEMICAL	PREDATORS	BOTTOM DWELLERS
Mercury	100%	100%
PCBs	100%	100%
Dioxins/furans	81%	99%
Total DDT	78%	98%
Chlordane	20%	50%

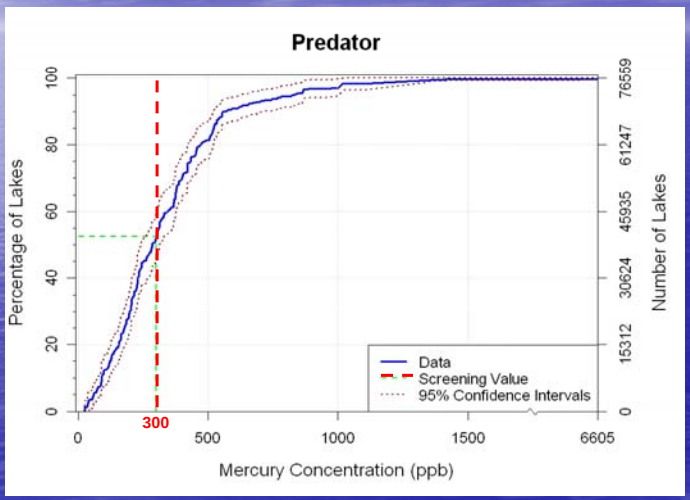
Tissue Concentrations

Chemicals	Predators (ppb)		Bottom Dwellers (ppb)	
	Median	Maximum	Median	Maximum
Mercury	285	6605	69	596
PCBs	2	705	14	1266
Dioxins/furans	6×10^{-6}	8×10^{-3}	4×10^{-4}	2.4×10^{-2}
DDT	1.5	1481	13	1761
Chlordane	<MDL	100	2	378

Median Mercury Concentrations



Cumulative Density Plot - Mercury



Summary of Mercury Results

- Mercury was detected (> 2 ng/g (ppb)) in 100% of the composite samples collected for this study
- Concentrations in predators ranged from 23 ppb to a maximum of 6,605 ppb
- The mean mercury concentration was 352 ppb for predators and 96 ppb for bottom dwellers.
- Fillets of predators in 48.8% of the sampled population of lakes had tissue concentrations that exceeded the 300 ppb human health screening value for mercury
- This population represents a total of 36,422 lakes nationwide.

Future Direction

- EPA Pilot Study of Pharmaceuticals and Personal Care Products (PPCPs) in Fish Tissue
- Participate in the Large Rivers Survey being led by the Office of Wetlands, Oceans, and Watersheds
- ~925 sample locations for Hg, persistent organics
- ~150 urban waters sample locations for PPCPs and PFCs
- Participate in next National Lakes Assessment