Why Monitor for Mercury? An Overview of Bioaccumulation, Concentrations, Fish Advisories and Criteria in NJ

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Mercury - PBT

- Persistent
- Bioaccumulative
- Toxic
- Inorganic Hg $\Rightarrow$ Methylmercury
- Food Chain Biomagnification

Bioaccumulation

- Accumulation from food, water
- Bioaccumulation Factors (BAFs):
  - Total Hg (EPA, 1995)
    - TL 3 - 27,900 L/Kg
    - TL 4 - 140,000 L/Kg
  - Methyl Hg (EPA, 1997)
    - TL 3 - 1.6×10^{6} L/Kg
    - TL 4 - 6.8×10^{6} L/Kg

Biomagnification

(Illustrative Example)

Trophic Level	**Concentration of Mercury**
Water	1 ng/L = 1 ppt
Bacteria and phytoplankton	10 pg/g of water
Protozoan/zooplankton	100 pg/g
Insect larvae	1 ng/g = 1 ppb
Fish fry	10 ng/g
Minnows	100 ng/g
Medium-sized fish	1 µg/g = 1 ppm
Large predators (fish, birds, humans)	10 µg/g

Acute Toxicity (EPA)

Species	Total Hg LC_{50s} (µg/L)	Methyl Hg LC_{50s} (µg/L)
Freshwater Organisms	2.2 to 2,000	1.2 to 350
Rainbow Trout	155	24
Saltwater Organisms	3.5 to 1,700	5 to 2,490
Striped Bass	90	-
Killifish	-	5.3 (10 d)

Chronic Toxicity (EPA)

Species	Total Hg EC_{50s} (µg/L)	Methyl Hg EC_{50s} (µg/L)
Rainbow Trout (64 d)	-	0.04 (growth)
Chironomus (48 hr)	29	-
Copepod	-	0.1 - 1
Sea Urchin (48 hr)	7.8	-

Effects based on Body Burden

(Jarvinen & Ankley, 1999)

- Brook Trout: 5 - 7 µg/g
  - Mortality, ⇓ growth, deformities
- Walleye: 1.7 - 3.1 µg/g
  - Reduced weight, length and GSI
- Fathead Minnow:
  - 1.3 µg/g = Reduced wt and length
  - 4.5 µg/g = No spawning

Wildlife

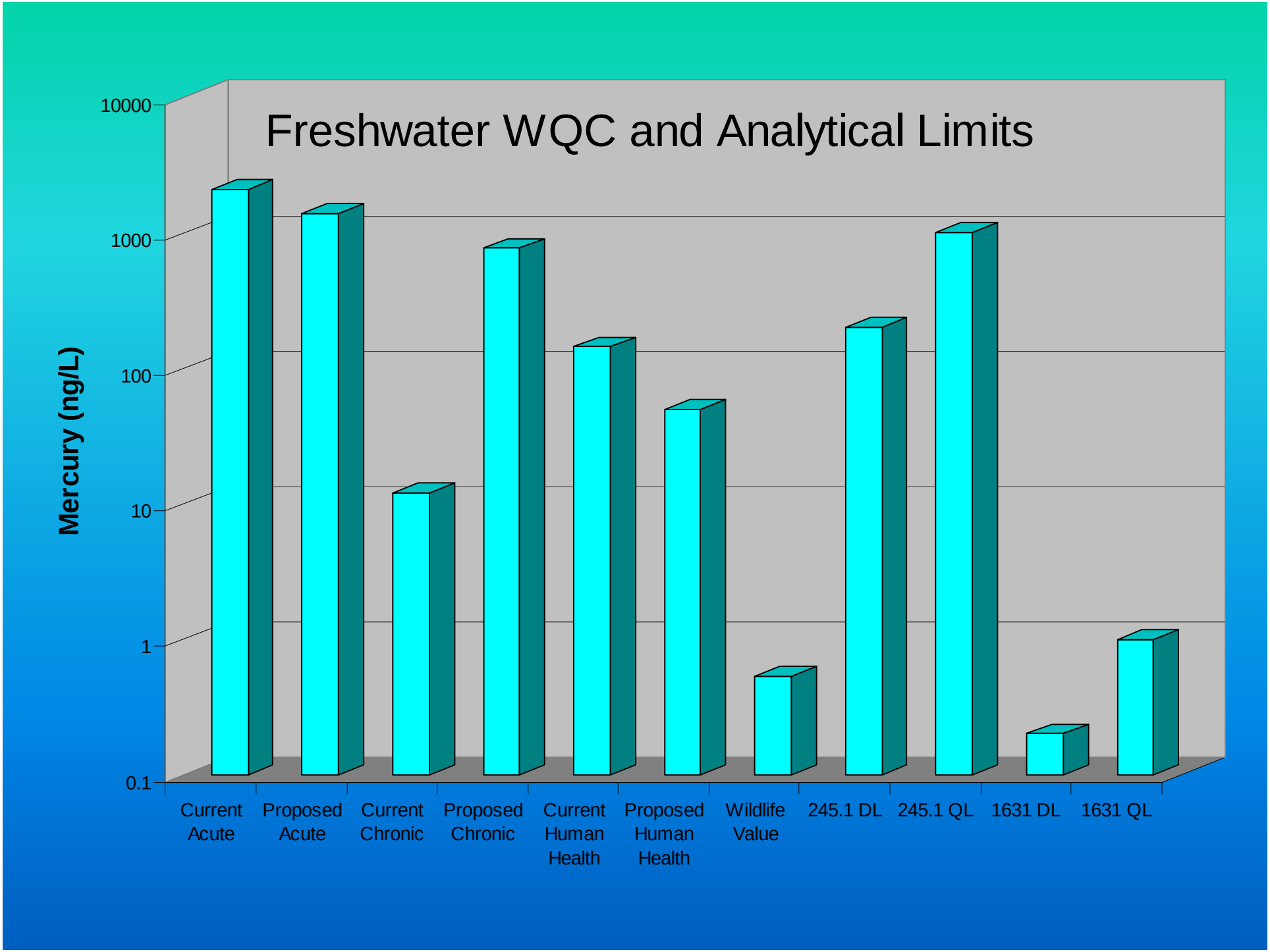
- Top of the Food Chain - greatest exposure = Piscivorous avian and mammalian species
- Neurotoxicity
- Teratogen, mutagen
- Embryocidal, Cytochemical & Histopathological effects (Eisler, 1987)

Human Effects

- Exposure primarily through fish consumption
- Unborn and Young Children
  - Central Nervous System
    - Learning & Developmental Delays
- Older Children and Adults
  - Subtle neurological effects
  - Neurological damage

Mercury in NJ Waters

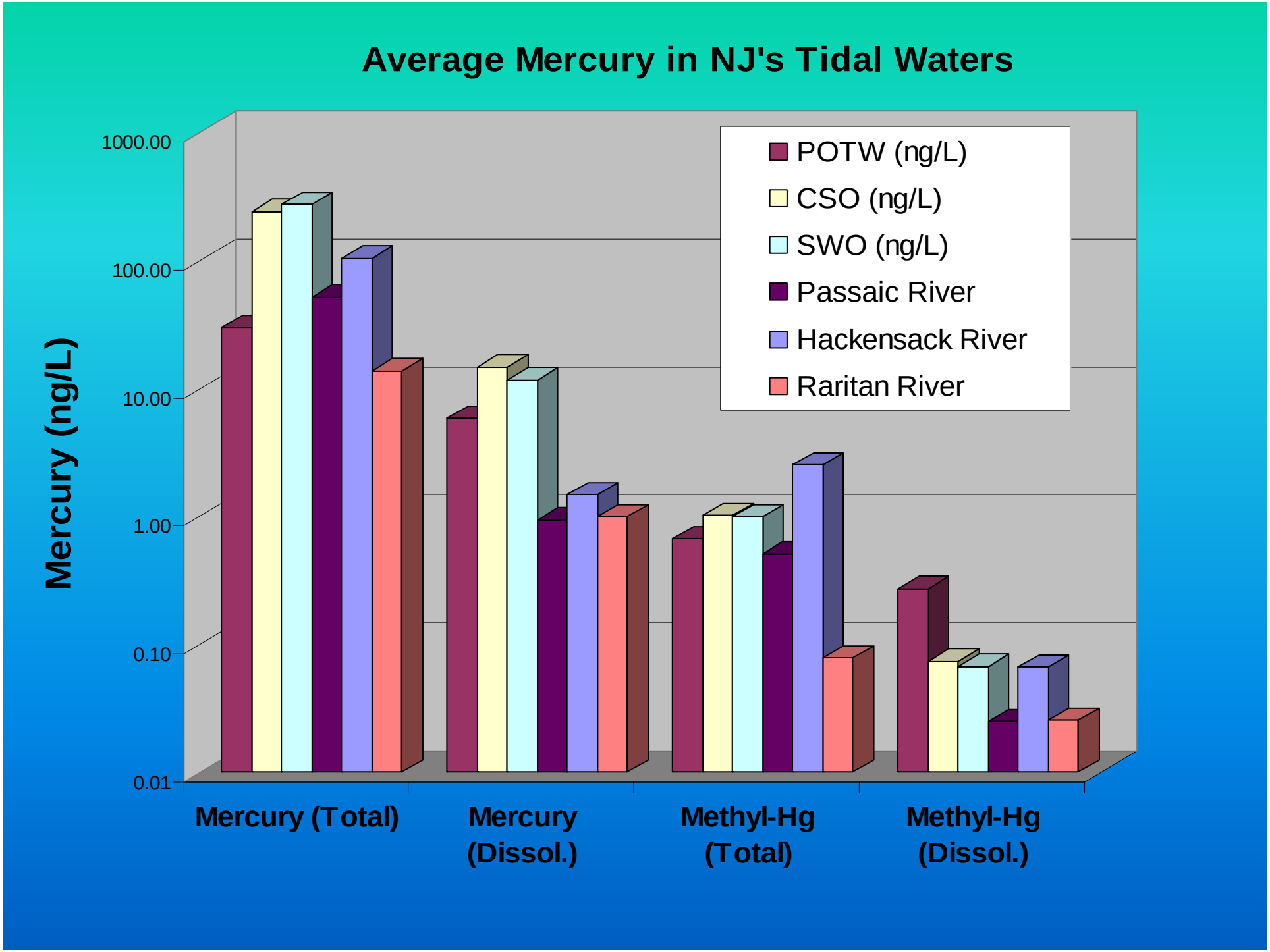
- Ambient Stream Monitoring Network:
  - Mostly NDs in the 1990's
  - Detection limits were above Aquatic WQC
- Clean Techniques
- Method 1631


Freshwater WQC and Analytical Limits
Mercury (ng/L)
10000
1000
100
10
1
0.1
Current Acute
Proposed Acute
Current Chronic
Proposed Chronic
Current Human Health
Proposed Human Health
Wildlife Value
245.1 DL
245.1 QL
1631 DL
1631 QL

Current and Proposed NJ Mercury Surface Water Quality Criteria				
Mercury Criterion	Fresh Water: Current (µg/L)	*Fresh Water: Proposed (µg/L)*	Saltwater: Current (µg/L)	*Saltwater: Proposed (µg/L)*
Acute Aquatic Life	2.1	*1.4*	1.8	*1.8*
Chronic Aquatic Life	0.012	*0.770*	0.025	*0.940*
Human Health	0.144	*0.050*	0.146	*0.051*

Mercury in Surface Water - NJ Lake

Date	Location	Total Diss. Hg (ng/L)	Dissolved Methyl Hg (ng/L)
April	Impacted	1.59	0.062
	Reference	1.32	0.066
	Brook	56.6	0.104
August	Impacted	10.3	0.280
	Reference	1.3	0.030
	Brook	103	0.307

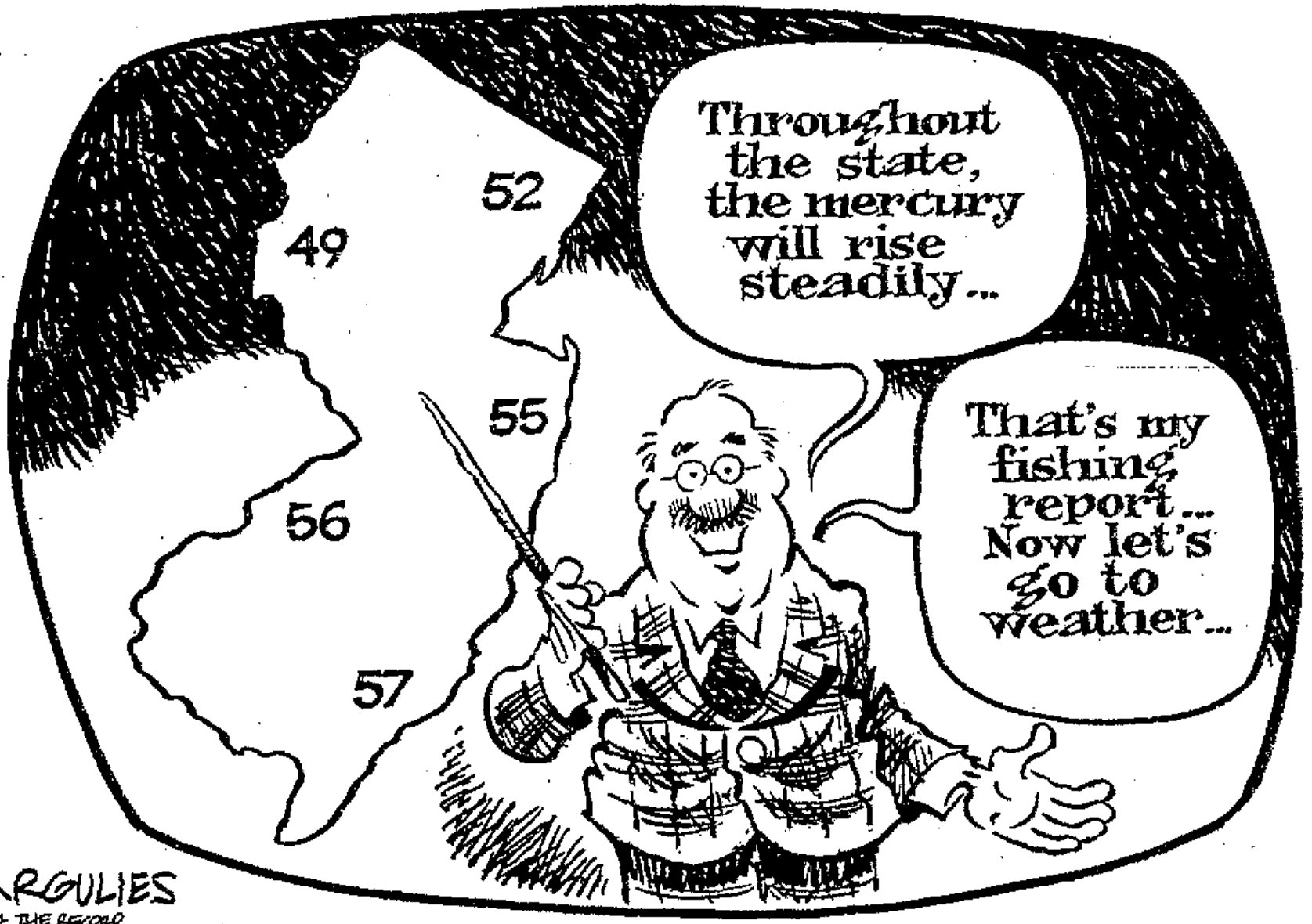

Average Mercury in NJ's Tidal Waters
Mercury (ng/L)
1000.00
100.00
10.00
1.00
0.10
0.01
POTW (ng/L)
CSO (ng/L)
SWO (ng/L)
Passaic River
Hackensack River
Raritan River
Mercury (Total)
Mercury (Dissol.)
Methyl-Hg (Total)
Methyl-Hg (Dissol.)

Surface Water Wildlife Criterion

- Developed by NJDEP, USFWS, EPA
- Used Great Lakes Water Quality Initiative
- Concern for Piscivorous Wildlife: Bald Eagle, Peregrine Falcon, Osprey
- Accounts for PBT characteristics
- Test Dose = 0.078 mg/kg - day

Wildlife Criterion

- Total mercury criterion for the protection of wildlife = 0.00053 µg/L
- 0.53 ng/L
- 530 pg/L

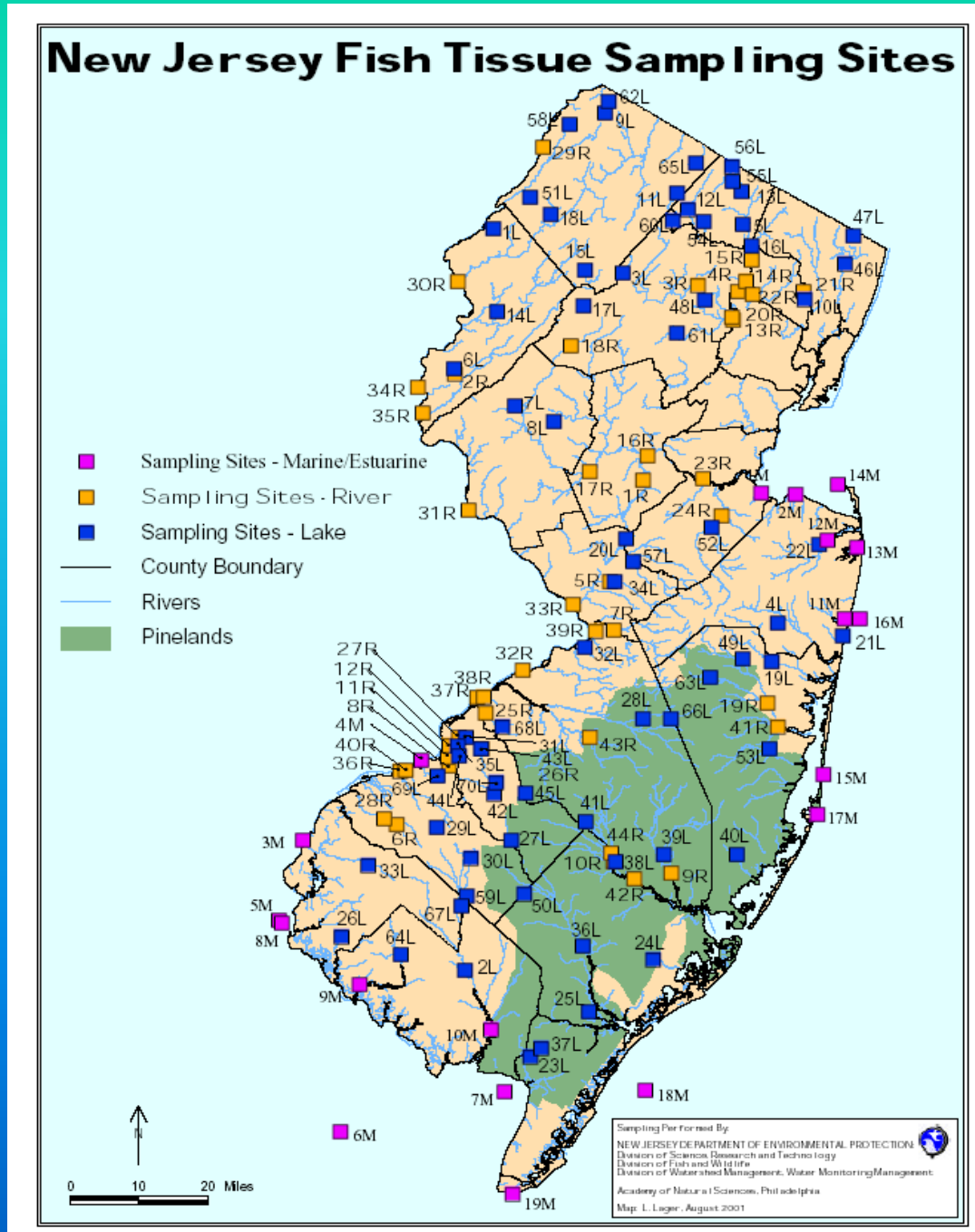

Throughout the state, the mercury will rise steadily...
That's my fishing report... Now let's go to weather...
49
52
55
56
57
MARGULIES
©2004 THE RECORD
www.northjersey.com/margulies

NJ Fish Consumption Advisories

- First NJ Hg Advisories - 1994
  - Largemouth Bass and Chain Pickerel
  - Statewide and Pinelands Advisories
  - 28 Water Body-Specific Advisories

Background (cont.)

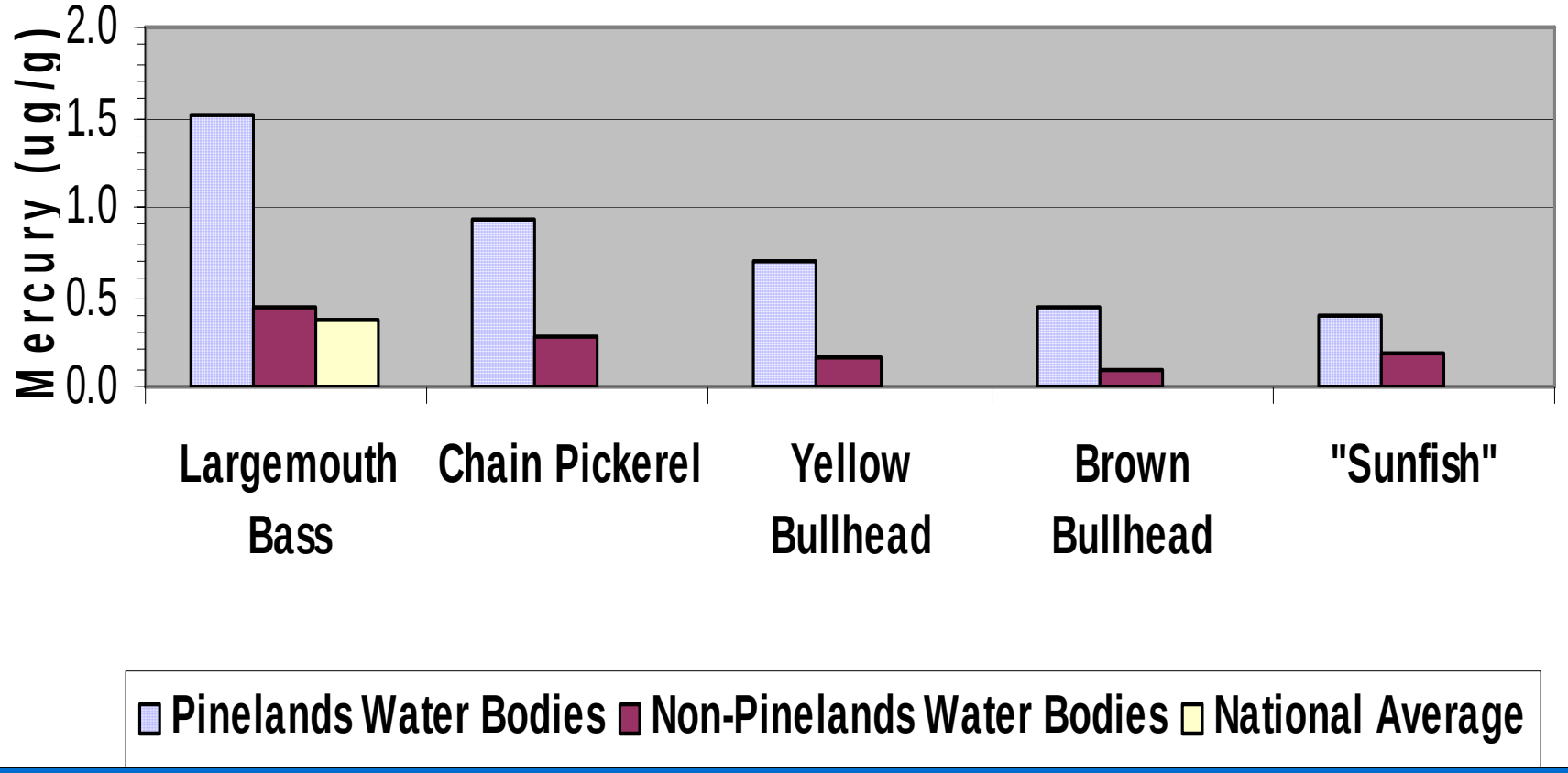
- Nationwide (EPA, 2004):
  - 45 States have Hg Advisories (2,436)
  - 39 have PCB Advisories (873)
  - 21 States have Statewide Hg Advisories for freshwaters
  - 12 with Coastal Hg Advisories

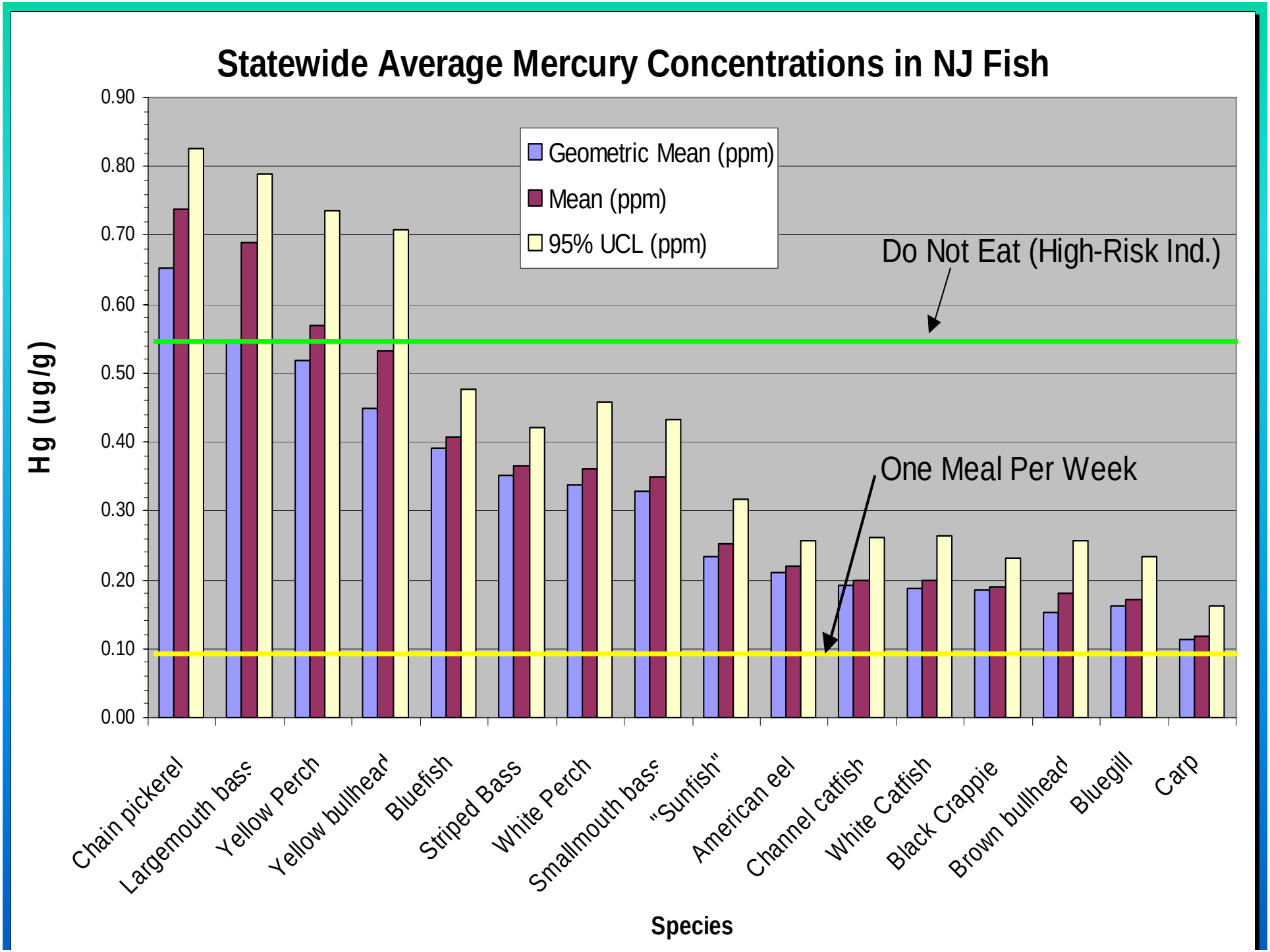

New Jersey Fish Tissue Sampling Sites
Sampling Sites - Marine/Estuarine
Sampling Sites - River
Sampling Sites - Lake
County Boundary
Rivers
Pinelands
0 10 20 Miles
Sampling Performed By:
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Science, Research and Technology
Division of Fish and Wildlife
Division of Watershed Management, Water Monitoring Management
Academy of Natural Sciences, Philadelphia
Map: L. Luger, August 2001

Average Hg Concentrations in Freshwater Fish in NJ

- Statewide:
  - 0.36 µg/g (26 Species; range ND - 8.9)
  - 0.35 µg/g (14 freshwater species; n>20)
- Pinelands: 0.80 µg/g (5 species)
  - Range 0.05-**8.9** µg/g
- Non-Pinelands: 0.23 µg/g (5 species)
  - Range 0.01-**3.9** µg/g
- Nationwide: All Fish: 0.26 µg/g

Average Mercury in Fish from Pinelands and Non-Pinelands Waters




Statewide Average Mercury Concentrations in NJ Fish
Hg (ug/g)
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Geometric Mean (ppm)
Mean (ppm)
95% UCL (ppm)
Do Not Eat (High-Risk Ind.)
One Meal Per Week
Chain pickerel
Largemouth bass
Yellow Perch
Yellow bullhead
Bluefish
Striped Bass
White Perch
Smallmouth bass
"Sunfish"
American eel
Channel catfish
White Catfish
Black Crappie
Brown bullhead
Bluegill
Carp
Species

Statewide Mercury Advisory for Freshwater Recreational Fish

- **General Population**
  - **Eat No More Than One Meal Per Week**
- **High-risk Individual**
  - **Eat No More Than One Meal Per Month**

Conclusions:
Mercury Monitoring is Needed!

- Bioaccumulates
- Food Chain Biomagnification
- Concerns with Impacts on Fish and Wildlife
- Concerns with Human Health
- Fish Advisories
- Control Efforts Reducing Hg?

Additional Information

- New Jersey Fish Consumption Advisories:
  - www.FishSmartEatSmartNJ.org
- NJ Mercury Task Force Report:
  - www.state.nj.us/dep/dsr/mercury_task_force.htm

Acknowledgements

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  - NJDEP
  - NJ Department of Health & Senior Services
  - NJ Department of Agriculture