Overview of Mercury: Fate in the Environment and Associated Concerns

Joy Taylor Morgan, M.S.
MDEQ-Air Quality Division
Toxics Unit

Mercury Switch Informational Meeting

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Mercury Overview

- What is Mercury?
- Environmental Fate Overview
- Health Issues
- Progress on Reductions

SOLID

1.5 VOLTS
CAUTION: DO NOT CONNECT IMPROPERLY,
CHARGE OR DISPOSE OF IN FIRE. BATTERY
MAY EXPLODE OR LEAK.
Made in U.S.A.
Patented
BATTERY
SIZE AAA

“Mad as a Hatter”

- 19th century mercury nitrate was used to make felt hats.
- US Public Service banned use in 1941
- Workers suffering from mercury poisoning were called “mad hatters.”

EVEREADY
ENERGIZER
NEW
FIRST
LOW MERCURY
4
AA
RAYOVAC
High Performance
MERCURY
ILLUMINATIONS
QUICKSILVER
A Magical Mystery Ma
Can You Find Your Way To The Center?

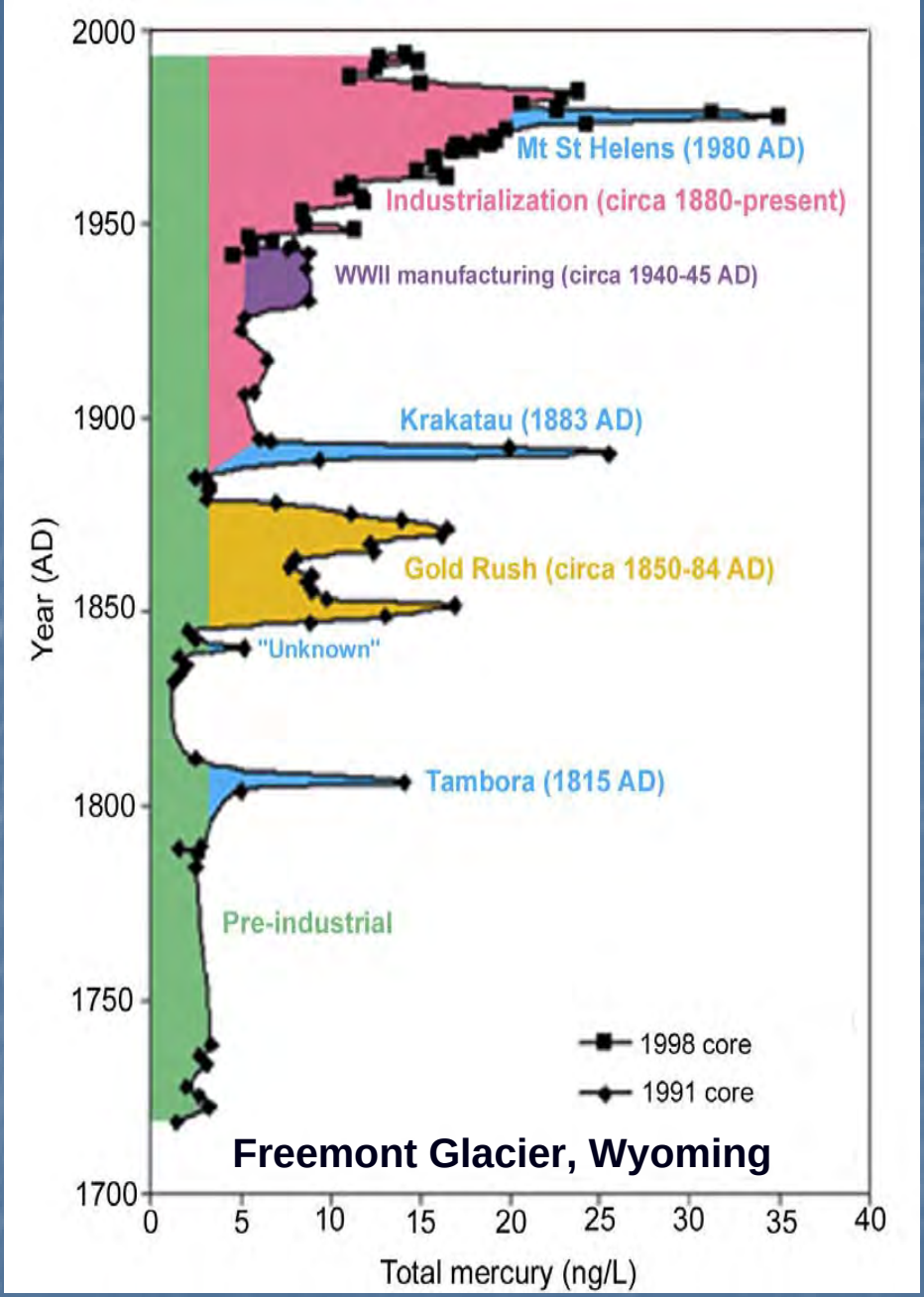
Sewage Sludge Incinerators

Municipal Waste Incinerators

Coal-Fired Electric Utilities

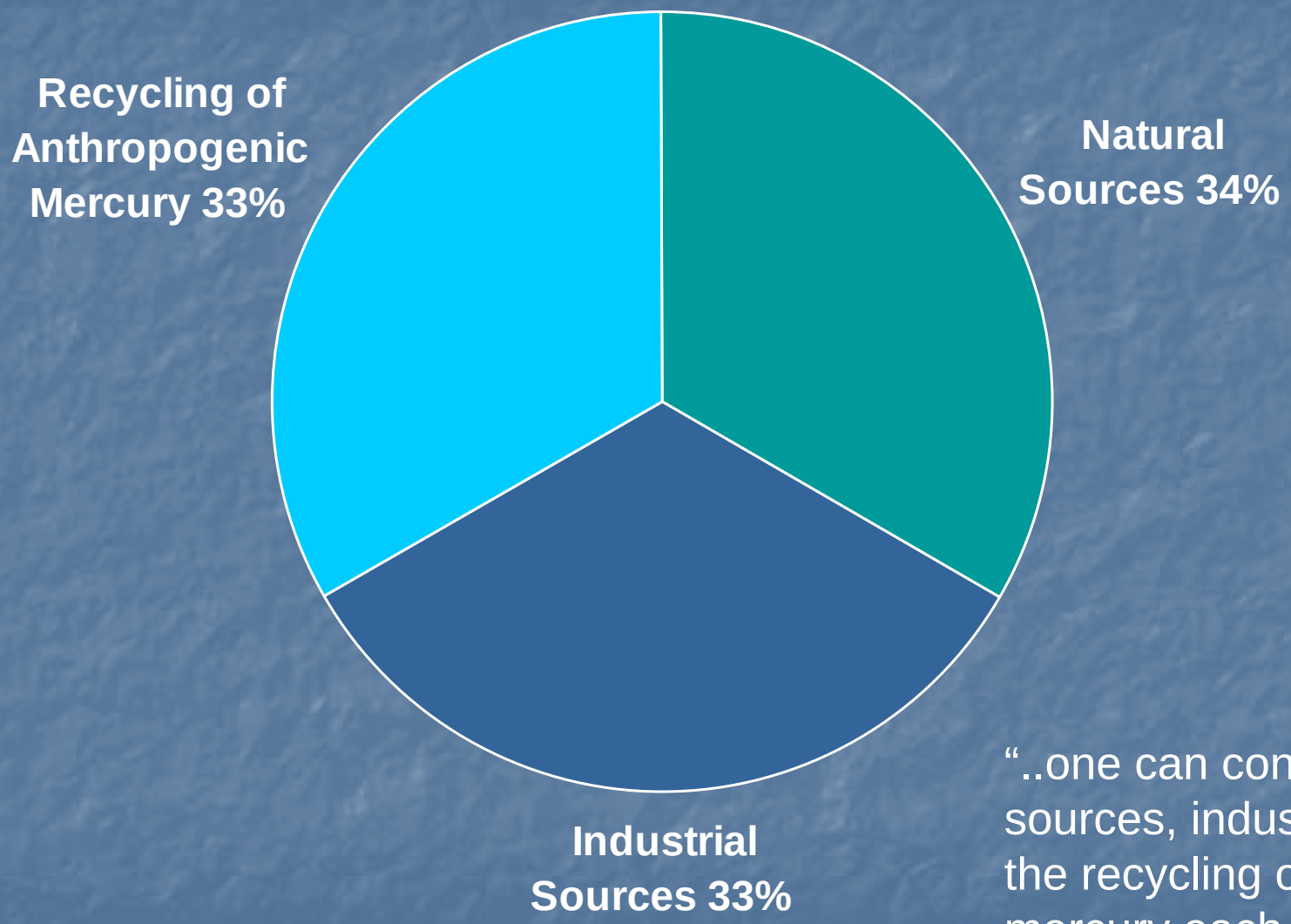
Natural vs. anthropogenic mercury?

Studies show that anthropogenic activities have typically increased available Hg concentrations in ecosystems by a factor of 2 – 10



source: USGS, Shuster et al., 2002

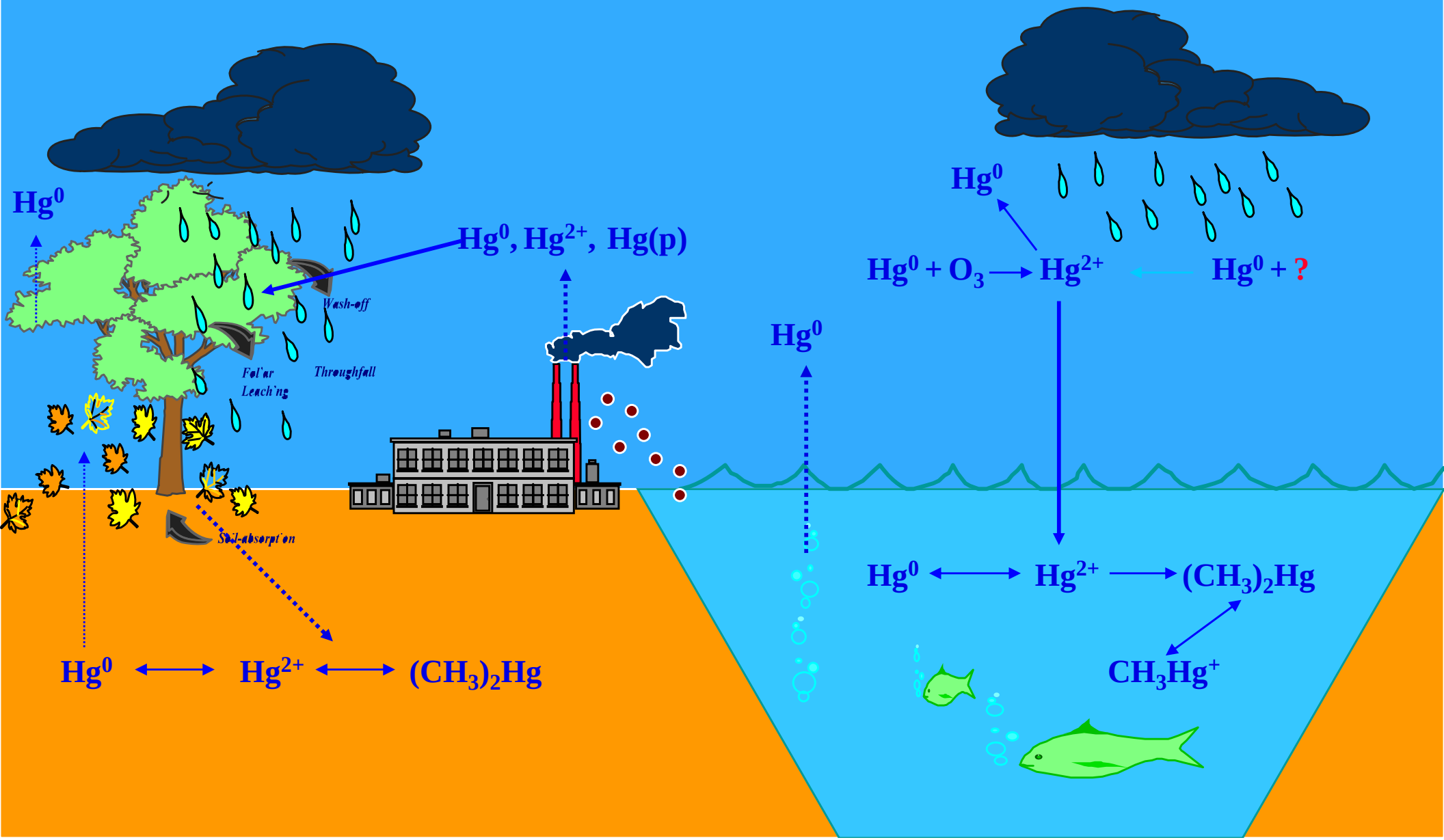
Sources of Atmospheric Mercury



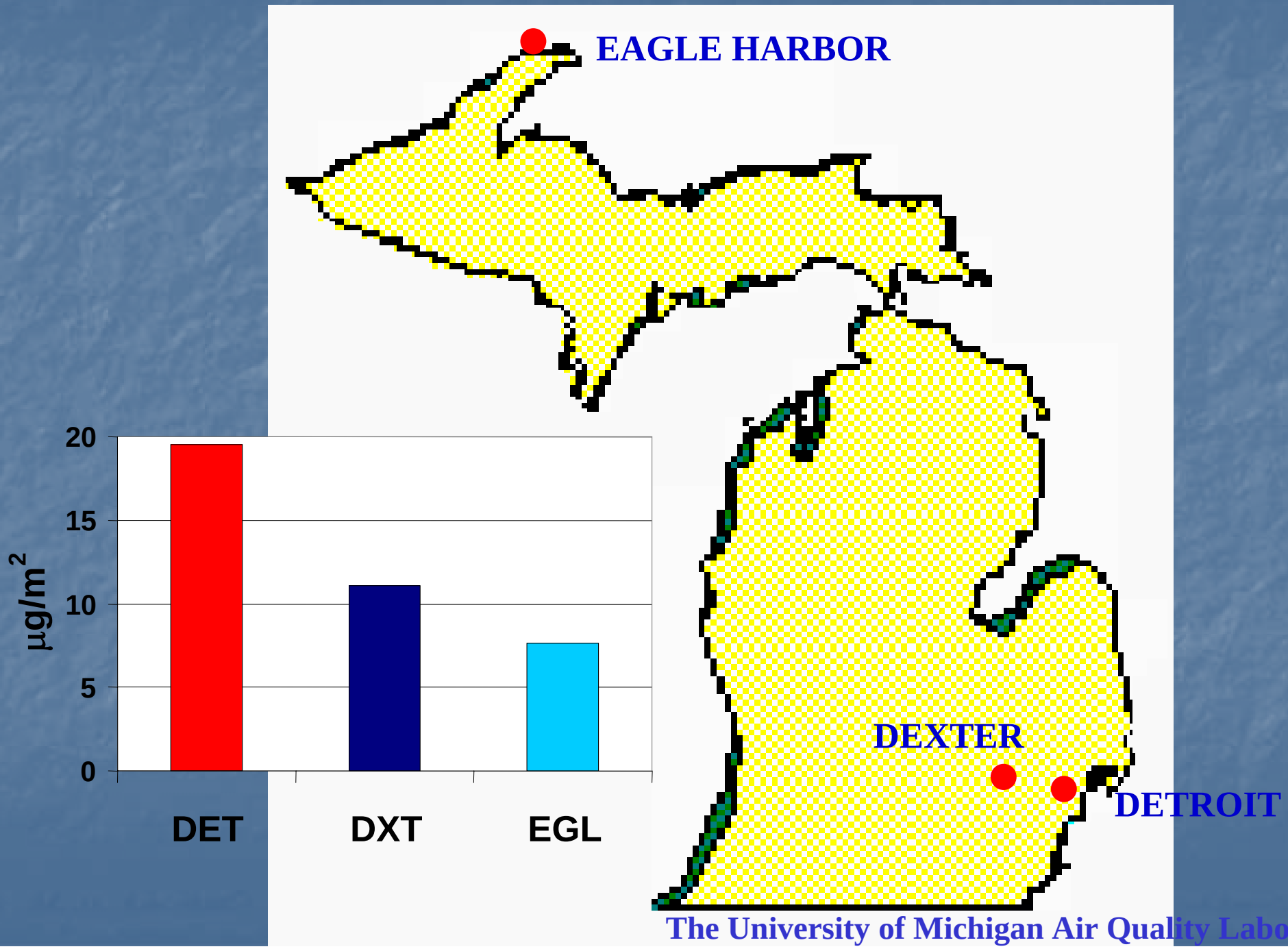
"..one can conclude that natural sources, industrial sources and the recycling of anthropogenic mercury each contribute about one-third of the current Hg^0 burden in the global atmosphere (Pirrone et al., 1996)."

Pirrone N, Keeler G, & Nriagu J. 1996. Regional Differences in Worldwide Emissions of Mercury to the Atmosphere. *Atmospheric Environment* 30(17): 2981-2987.

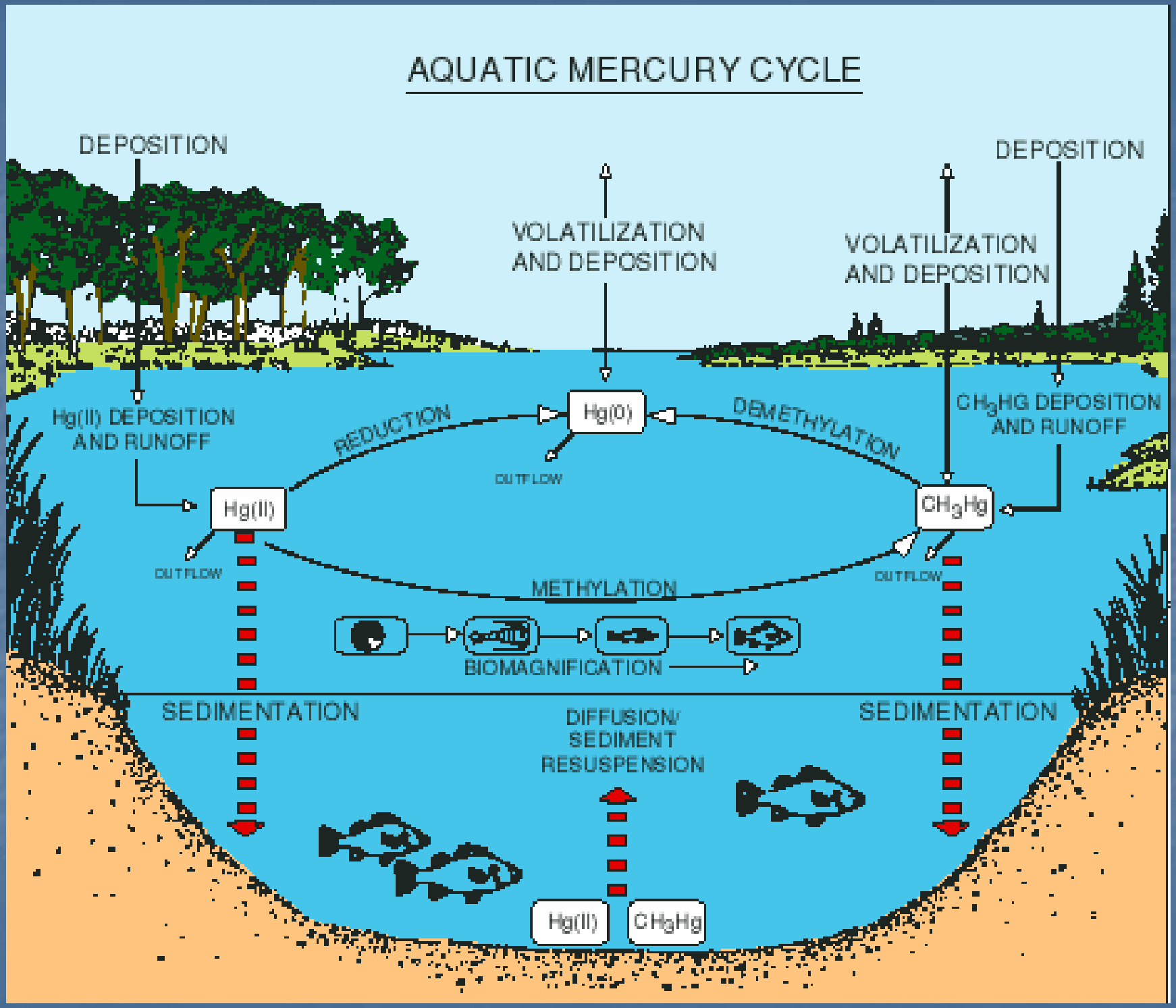
MERCURY CYCLE IN THE BIOSPHERE



Annual Hg Wet Deposition 1996

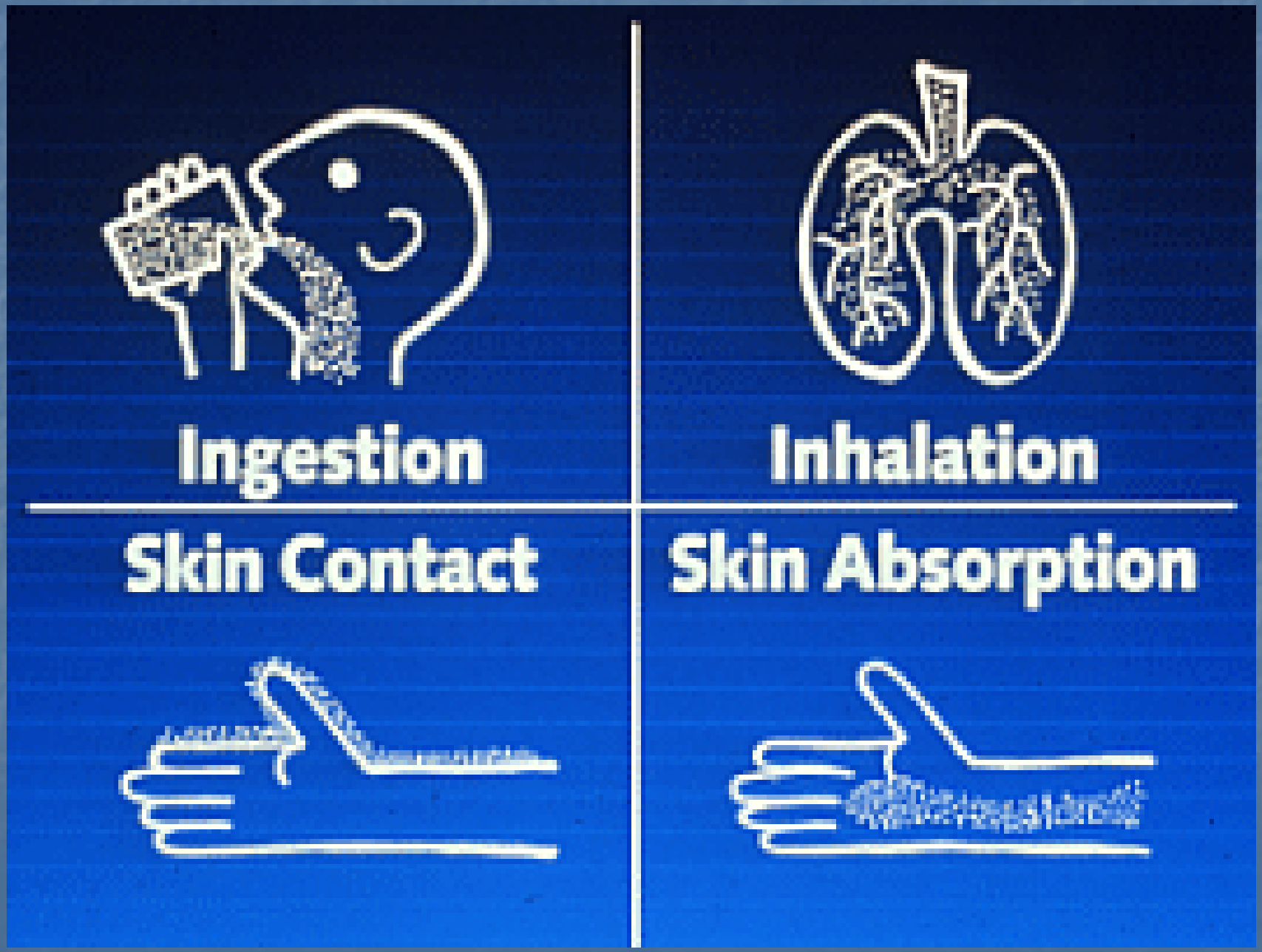


The University of Michigan Air Quality Laboratory



http://www.healthbenchmarks.org/Mercury/AquaticCycle.cfm

All Forms of Mercury are Toxic



Health Effects of Mercury by Type

Elemental	Inhalation	Nervous system, lung, kidney
Inorganic (mercuric salts)	Inhalation, ingestion, skin absorption	Nervous system, lung, GI tract, kidney, eyes
Methylmercury	Ingestion	Nervous, immune & cardiovascular systems, kidney

Elemental or Metallic Mercury

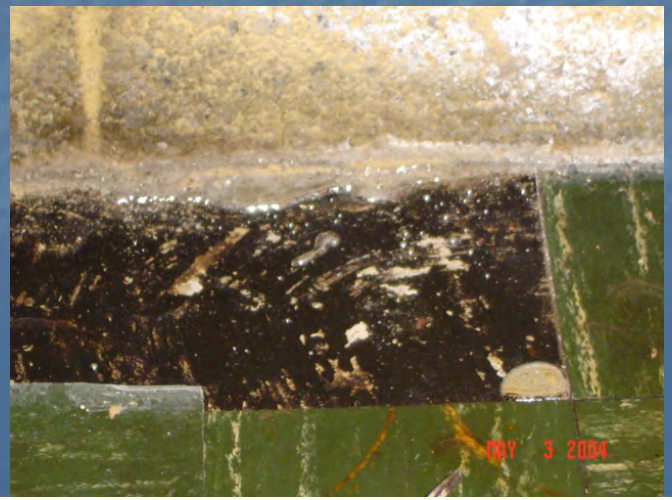
Also known as: **Quicksilver**

Swallowing Metallic Mercury

- Very poor absorption
- Low risk
- May collect in appendix
  - re-positioning may be helpful in draining
  - surgery very risky
  - no medical evaluation needed if small amount

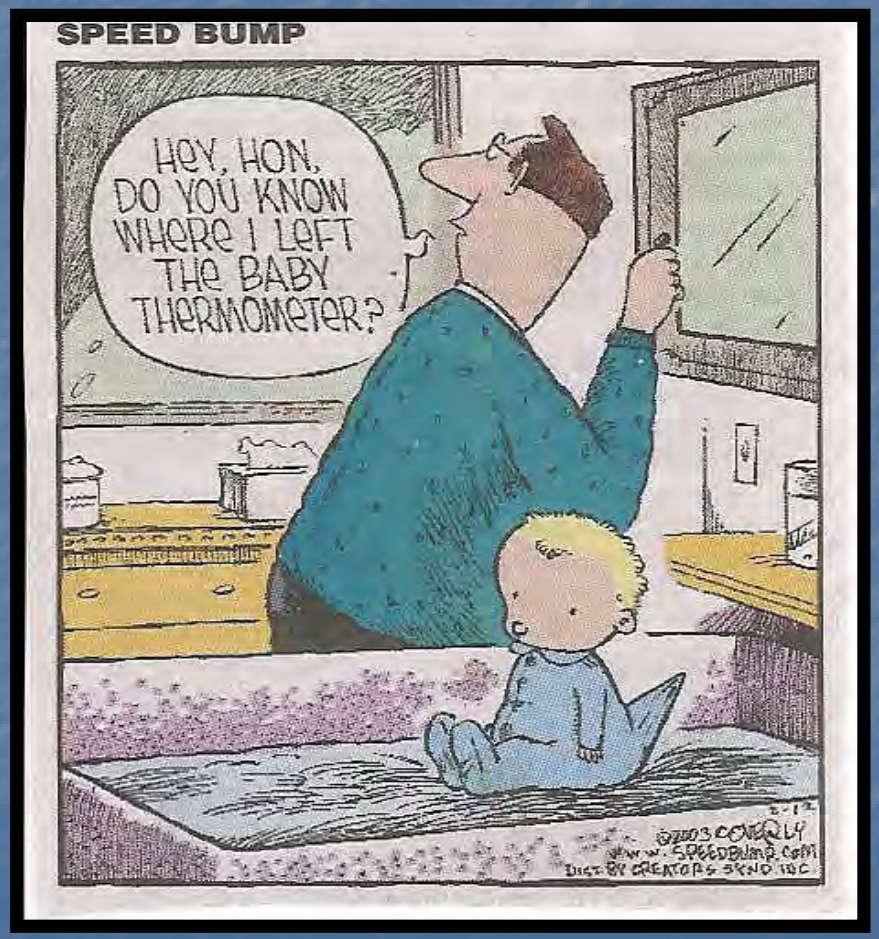
It's the vapors

- Your body absorbs between 70 to 75% of the mercury vapor that is inhaled
- Very little absorption via ingestion or dermal contact



Lincoln Park Home Clean-Up 1989

Thermometer exposures 2001



- 3,550 other elemental mercury exposures
  - 686 in children < 6 yrs
- 17,457 reported mercury thermometer breakages reported to PCC's
  - 7,465 in children <6 yr
  - 17 had moderate and 2 had severe outcome
  - 43 mod, 5 severe, 1 death (in adult)

Methylmercury Reference Dose

- Several studies throughout the world have examined the exposure risk from fish consumption
- RfD (Reference Dose) 0.1ug/kg/day
- Safe dose for a lifetime, includes sensitive populations

Fish Advisories

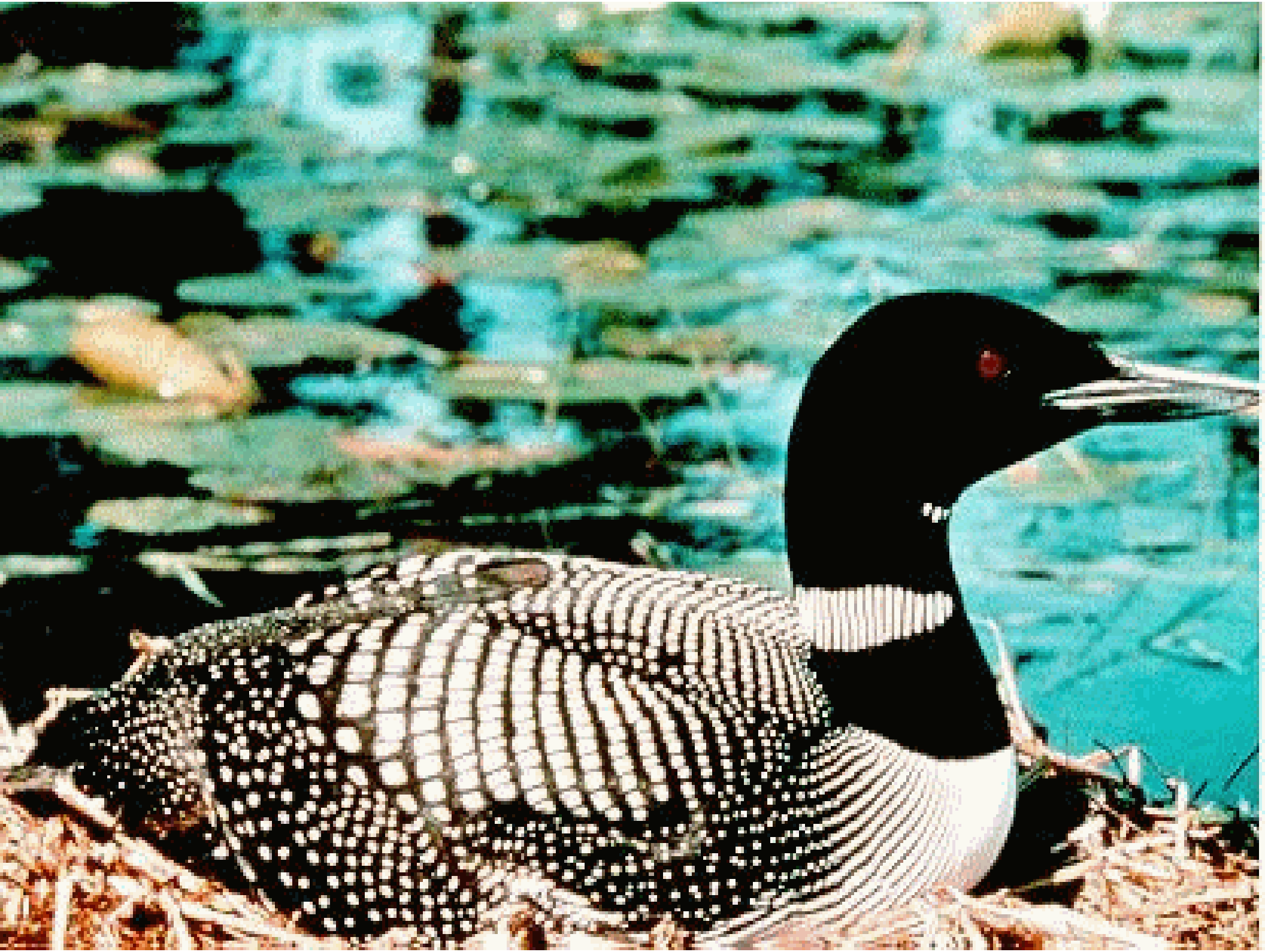
- MDCH Advisory for Michigan:
- One meal/week: rock bass, perch, crappie >9” and any size largemouth bass, smallmouth bass, walleye, northern pike or muskie
- Sensitive population – limit consumption to one meal/month
- EPA/FDA – Sensitive pop - Do not eat swordfish, tilefish, shark or king mackerel

Inland Lakes with Fish Mercury Exceeding the Advisory Trigger Level

- Statewide, 68% of the lakes have some fish > 0.5 ppm; 10% (or <) have some fish > 1.5 ppm

Mercury Blood Levels

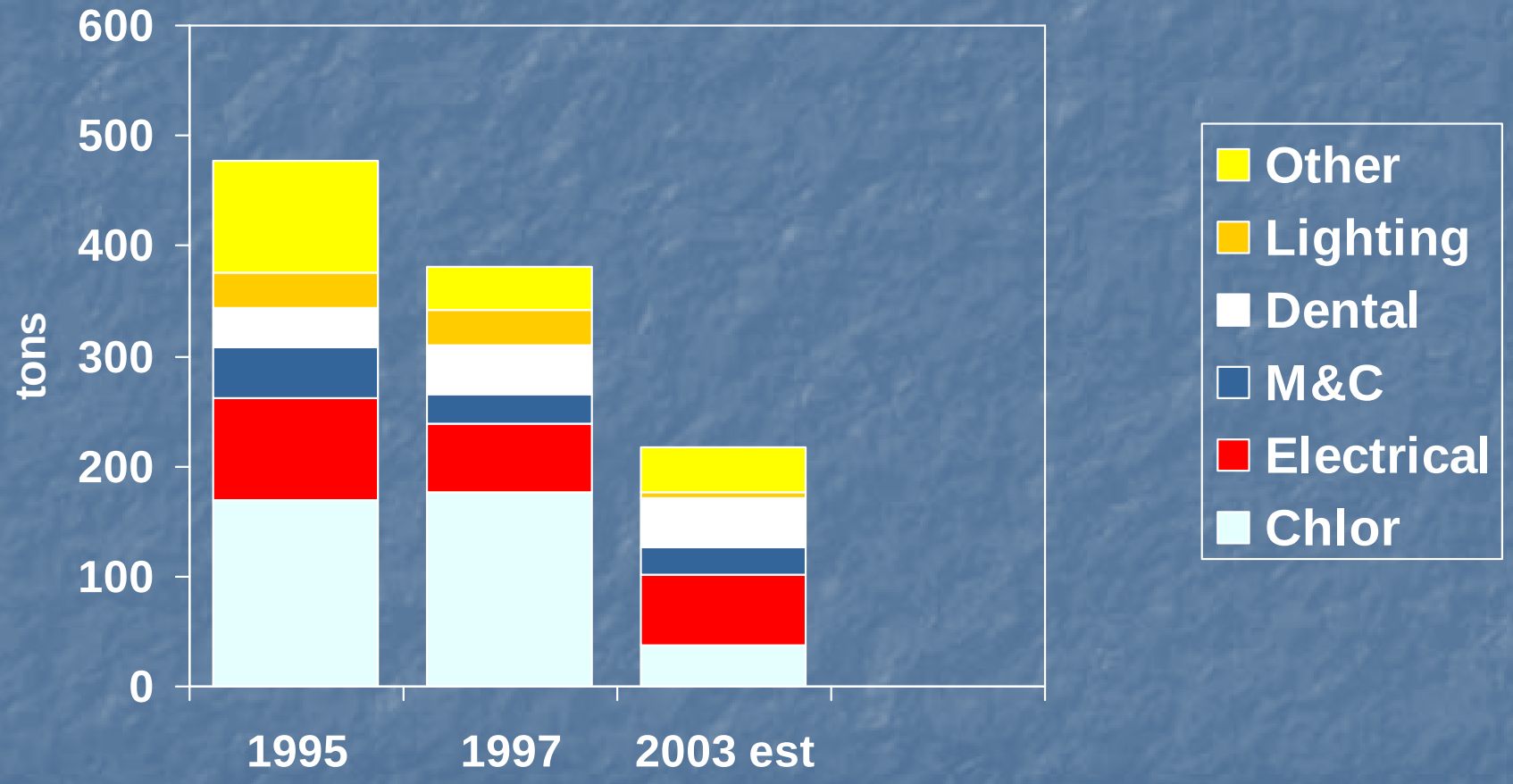
- It has been estimated that between 300,000 - 600,000 infants born annually in the U.S. are exposed to levels of methylmercury above the USEPA RfD (Mahaffey, 2004).
- Decrease in IQ in children



Mercury Effects in Wildlife

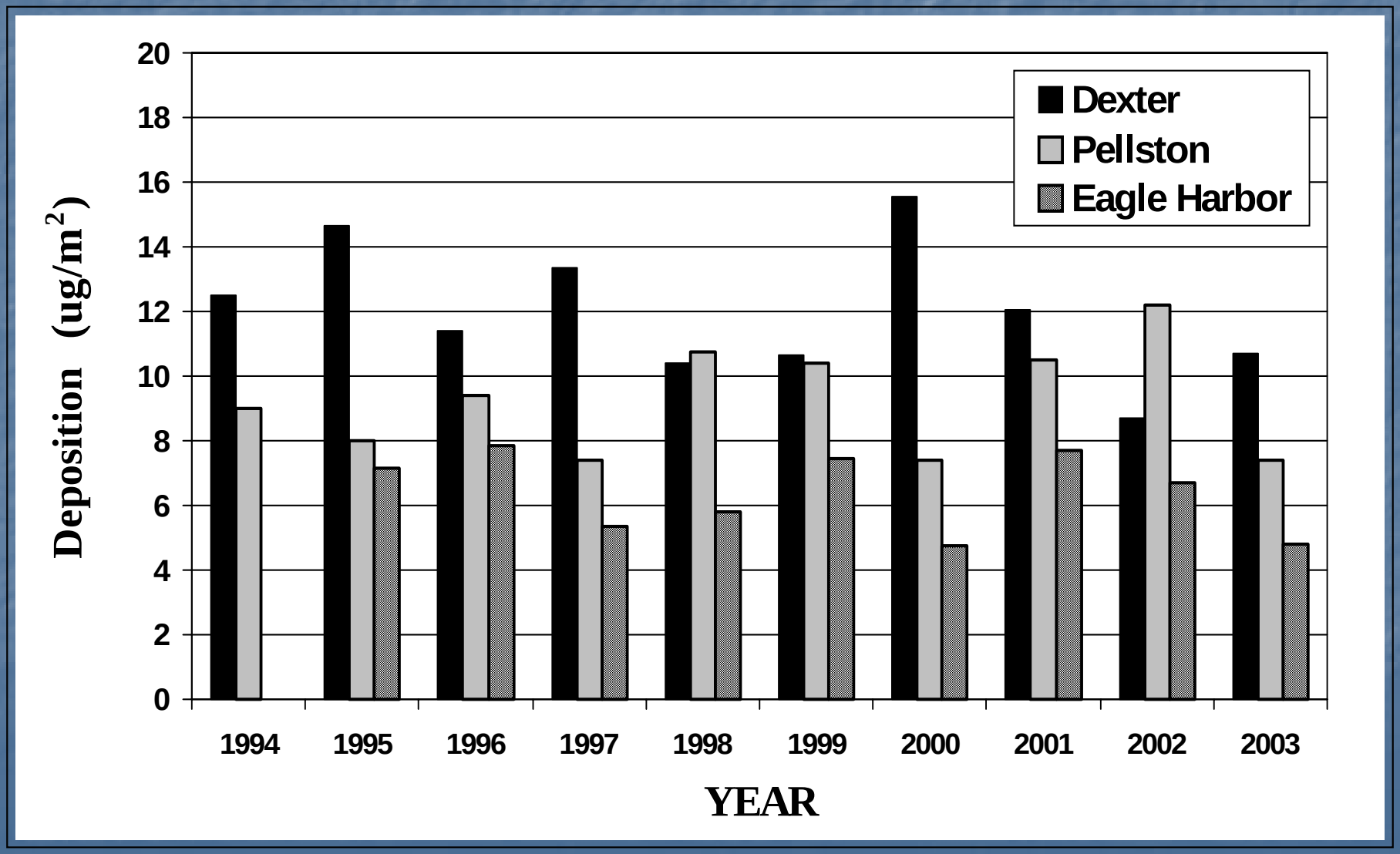
- Mink are affected at ≥ 1 ppm in food
- Ducks are affected at ≥ 0.5 ppm in food
- Subtle effects include reduced reproduction, weight loss, nervous system damage, behavioral changes in offspring
- 2003 Loon study showed moderate risk to chicks at MI sites

U.S. Mercury Use



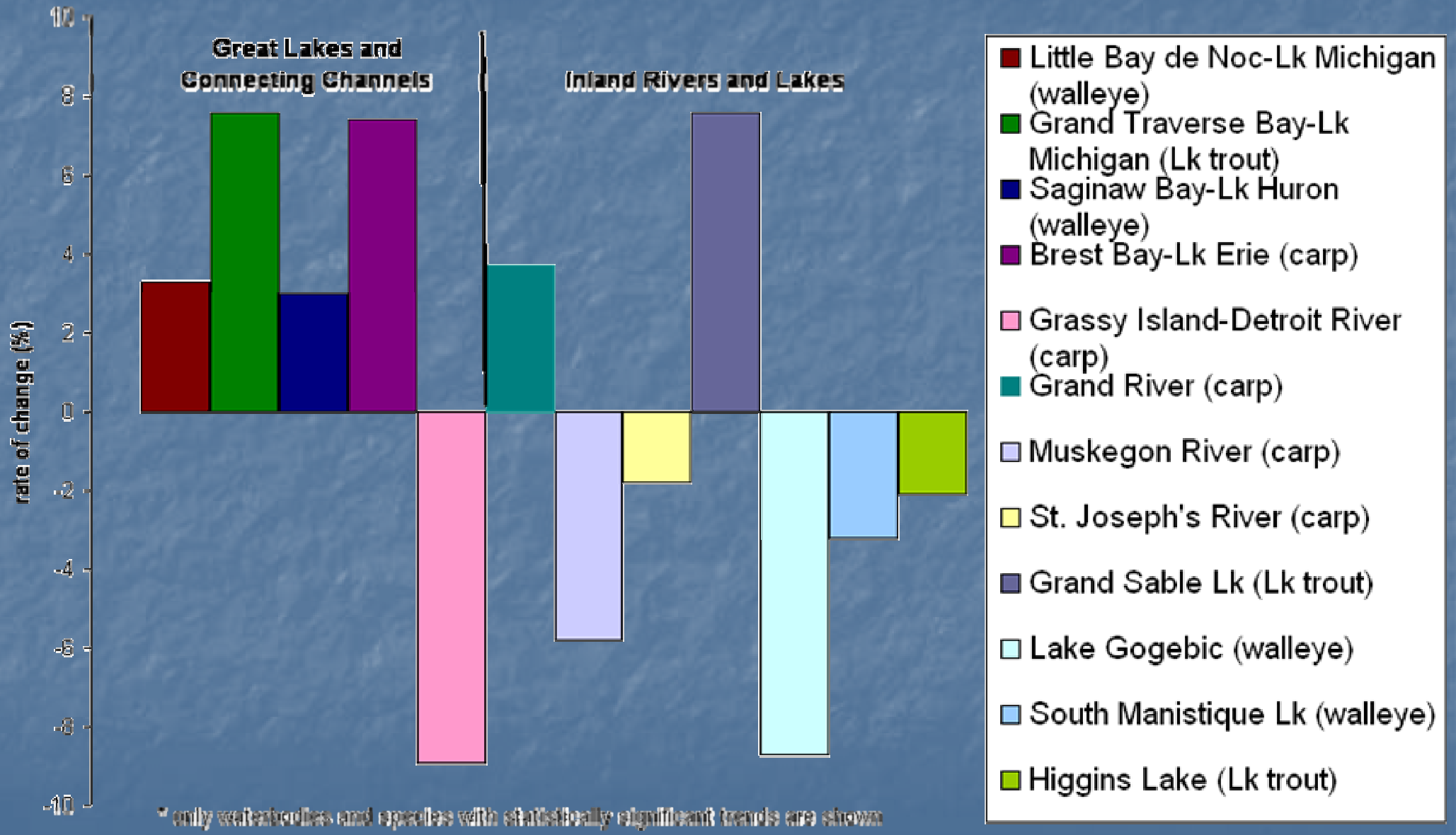
Source: US Geological Survey, *Minerals Yearbook, 1996, 1997*. Chlorine Institute Annual Report to EPA, 2004; National Electrical Manufacturer's Association, direct communication, 2004.

Annual Mercury Deposition Totals From Event-Precipitation Samples Collected At Three Michigan Sites From 1994-2003



Annual Rates of Change in Mercury Concentrations Measured in Whole Fish Collected

(from Fixed Station Trend Monitoring Sites)



* only waterbodies and species with statistically significant trends are shown

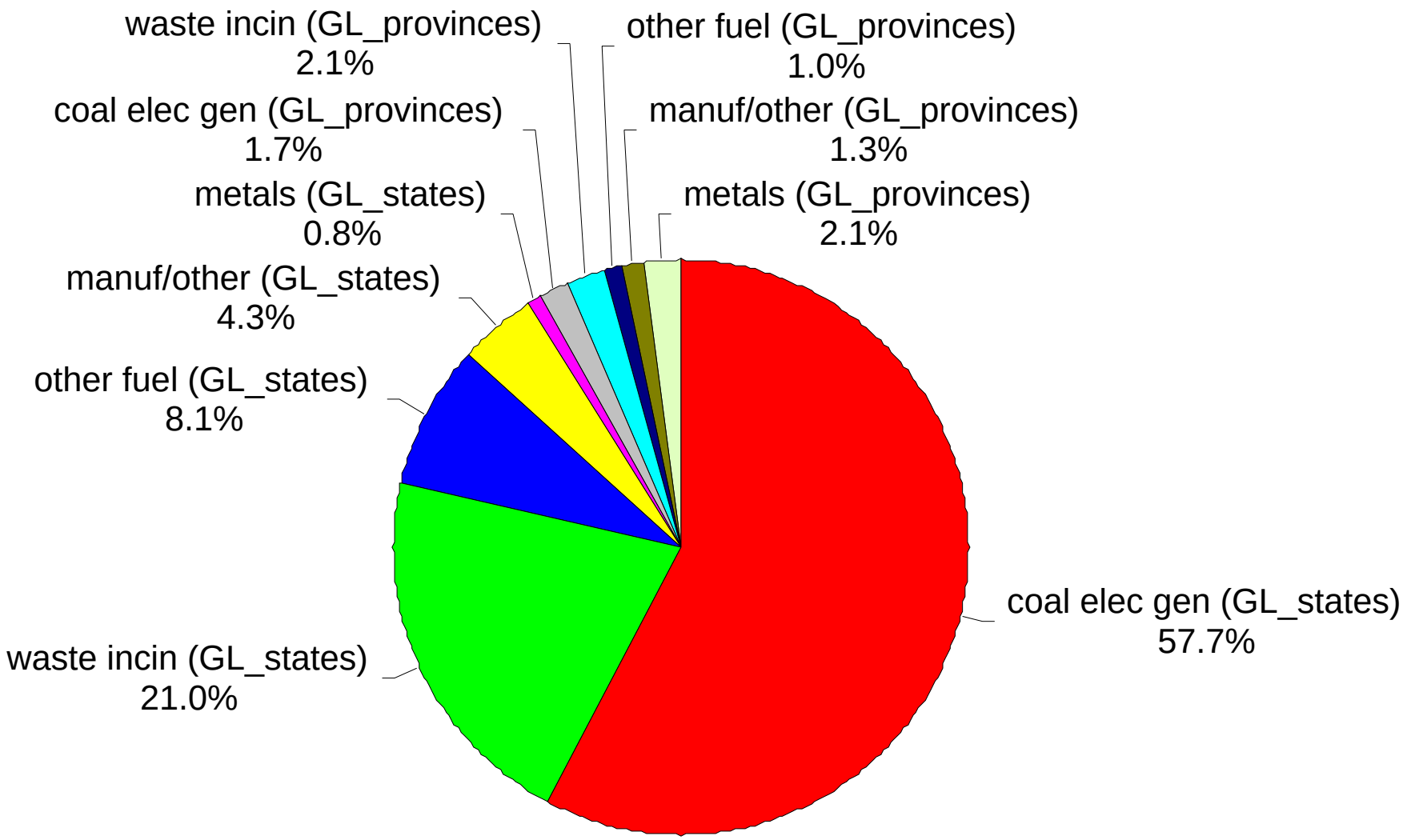
Mercury in Michigan

- 1970-1980 Collection of fish and sediment core samples
- 1988 State-wide Fish Consumption Advisory issued by MDCH
- 1991 Governor Engler Announced the Development of a State-wide Mercury Reduction Strategy.
- 1992 Michigan Environmental Science Board (MESB) was Convened - 1993 Final Report Released
- 1993 Michigan's Mercury Action Plan Signed by MDEQ, MDCH & MPSC
- 1996 Michigan's Mercury Pollution Prevention (M2P2) Task Force's Final Report Released
- 2002 – Governor Granholm recommended phasing out mercury, PCBs and dioxins

Questions?

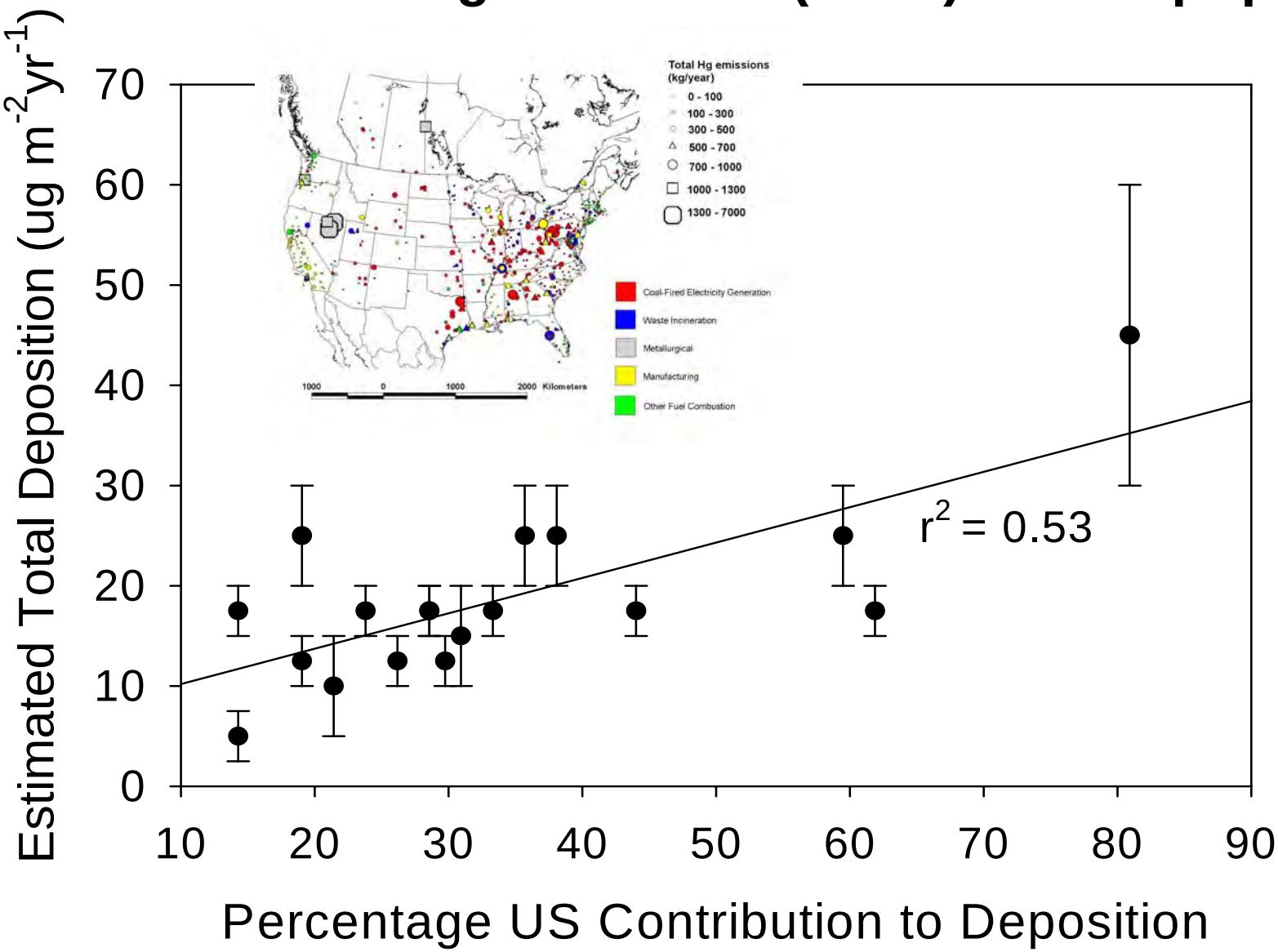
Emissions of Ionic Mercury (RGM) from Different Anthropogenic Source Sectors in Great Lakes States and Provinces (~1999-2000)

[Total RGM emissions = 13.4 metric tons/year]



(slide courtesy of Rob Mason, Univ. of CT)

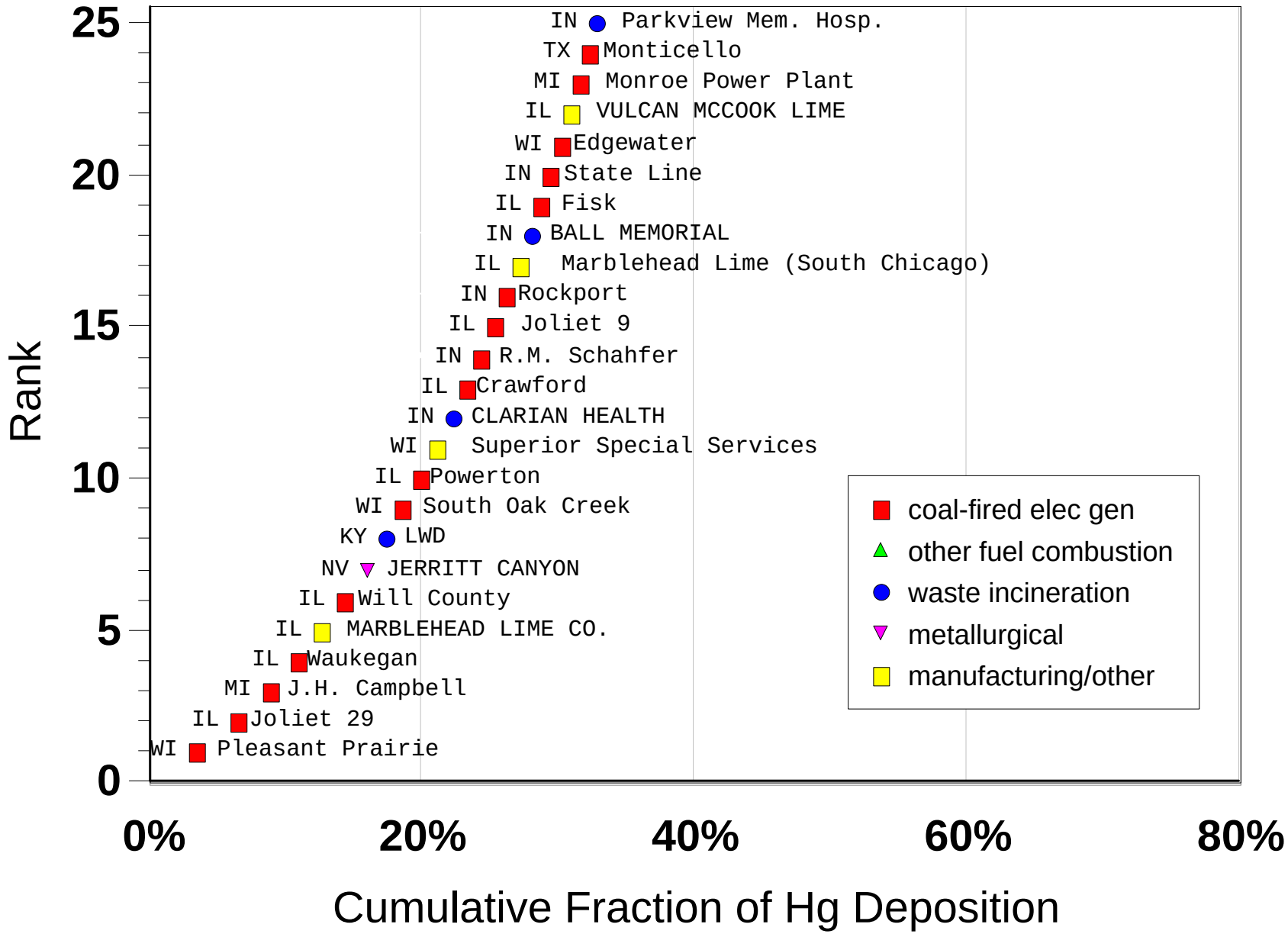
Data from Seigneur et al. (2004) model paper



the Seigneur et al. (2004) paper shows that, for regions where deposition is high, the impact of local/regional sources is the main cause for these elevated concentrations.

[Seigneur et al., (2004), "Global Source Attribution for Mercury Deposition in the United States", *ES&T* **38**, 555-569.]

Top 25 Contributors to 1999 Hg Deposition Directly to Lake Michigan



Cost of Mercury's Developmental Effects

- EPA estimates that there is a range of costs that would be avoided if IQ did not decrease ($0.8-$3 million/yr)
- Harvard "The resulting loss of intelligence causes diminished Economic productivity that persists over the entire lifetime of these children. This lost productivity is the major cost of methyl mercury toxicity, and it amounts to $8.7 billion annually...Of this total, $1.3 billion each year is attributable to mercury emissions from American power plants. "

- Trasande, L. et al. Public health and economic consequences of methylmercury toxicity to