Use of Multi-Media Monitoring to Develop a Statewide Mercury TMDL

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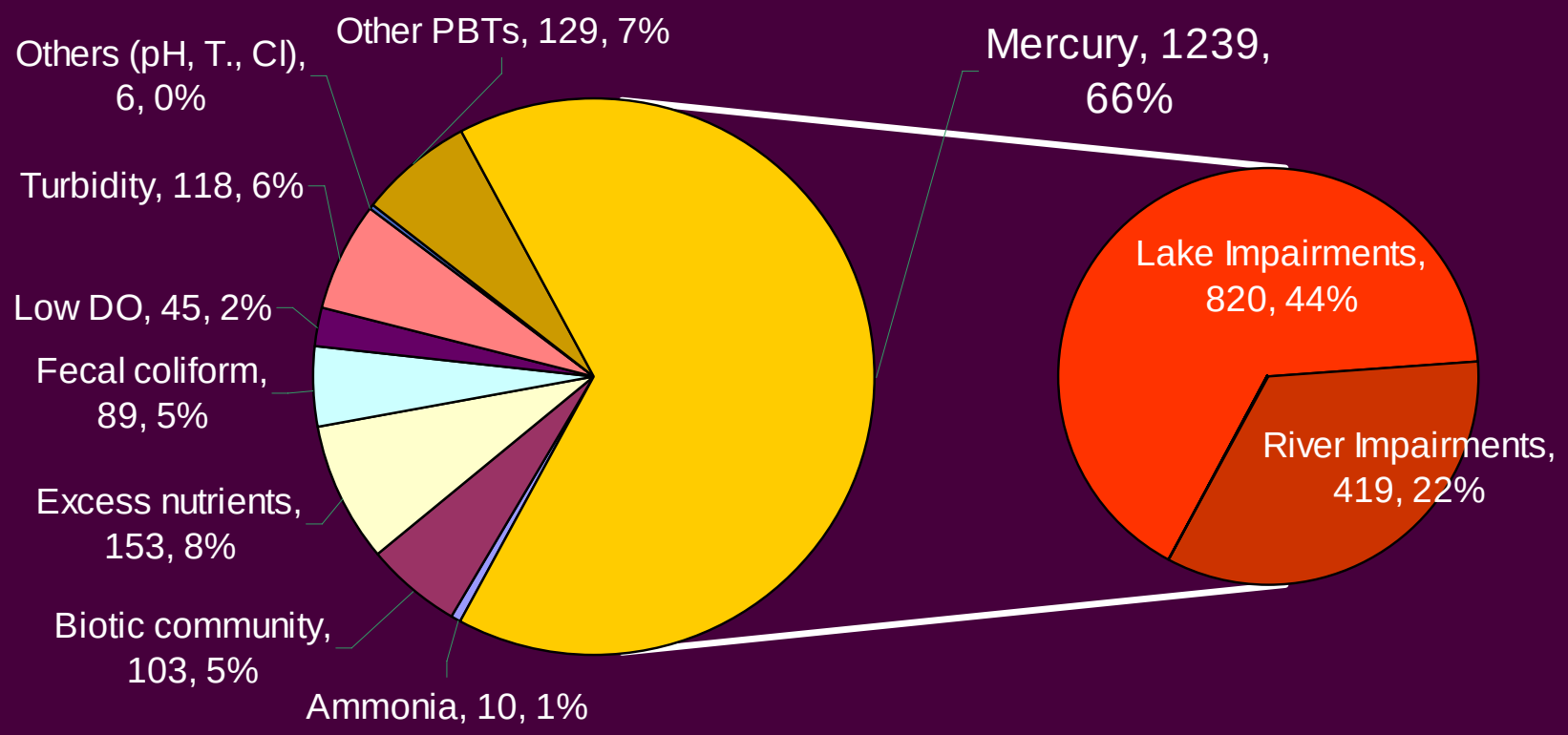
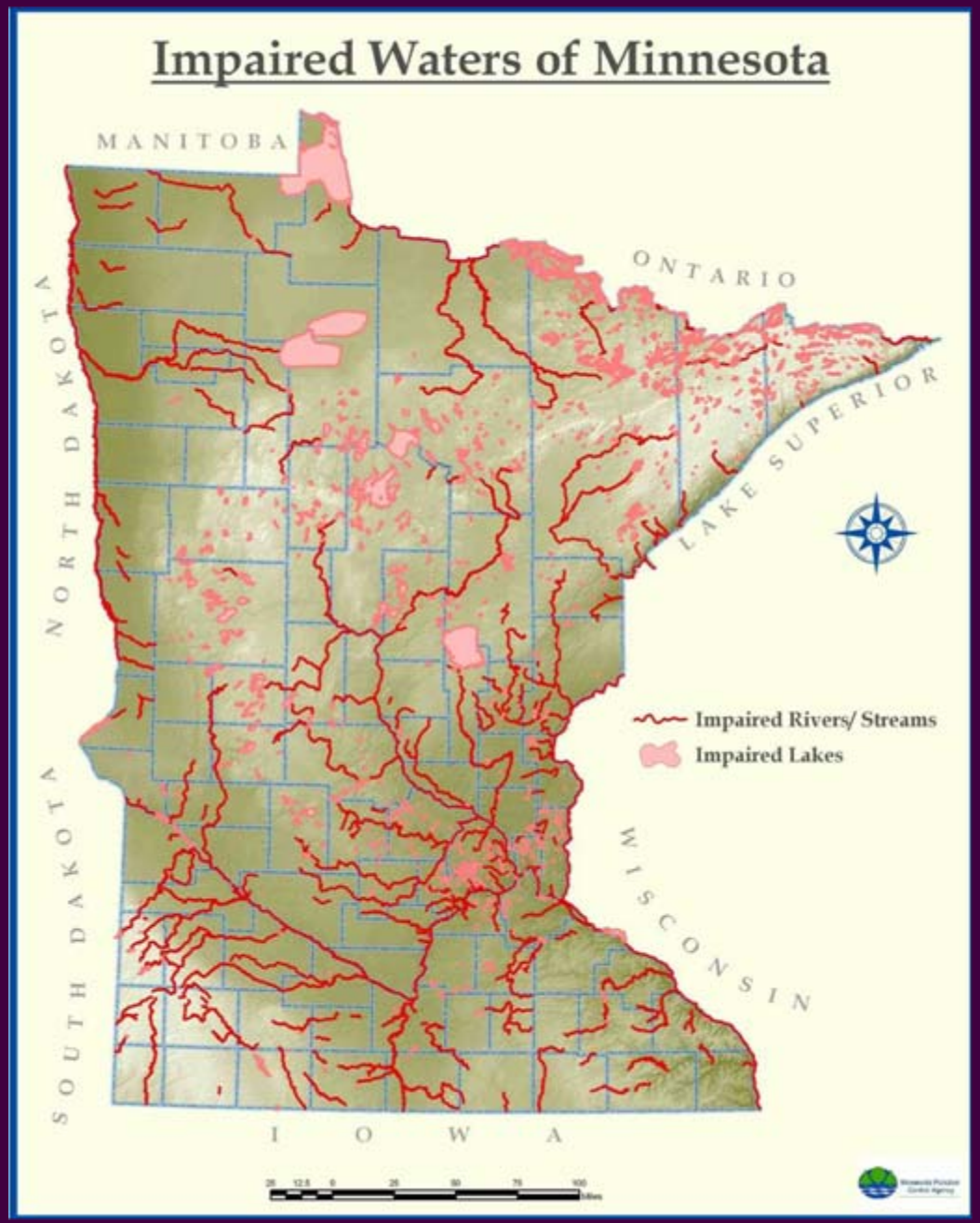
Minnesota's Impaired Waters 2004

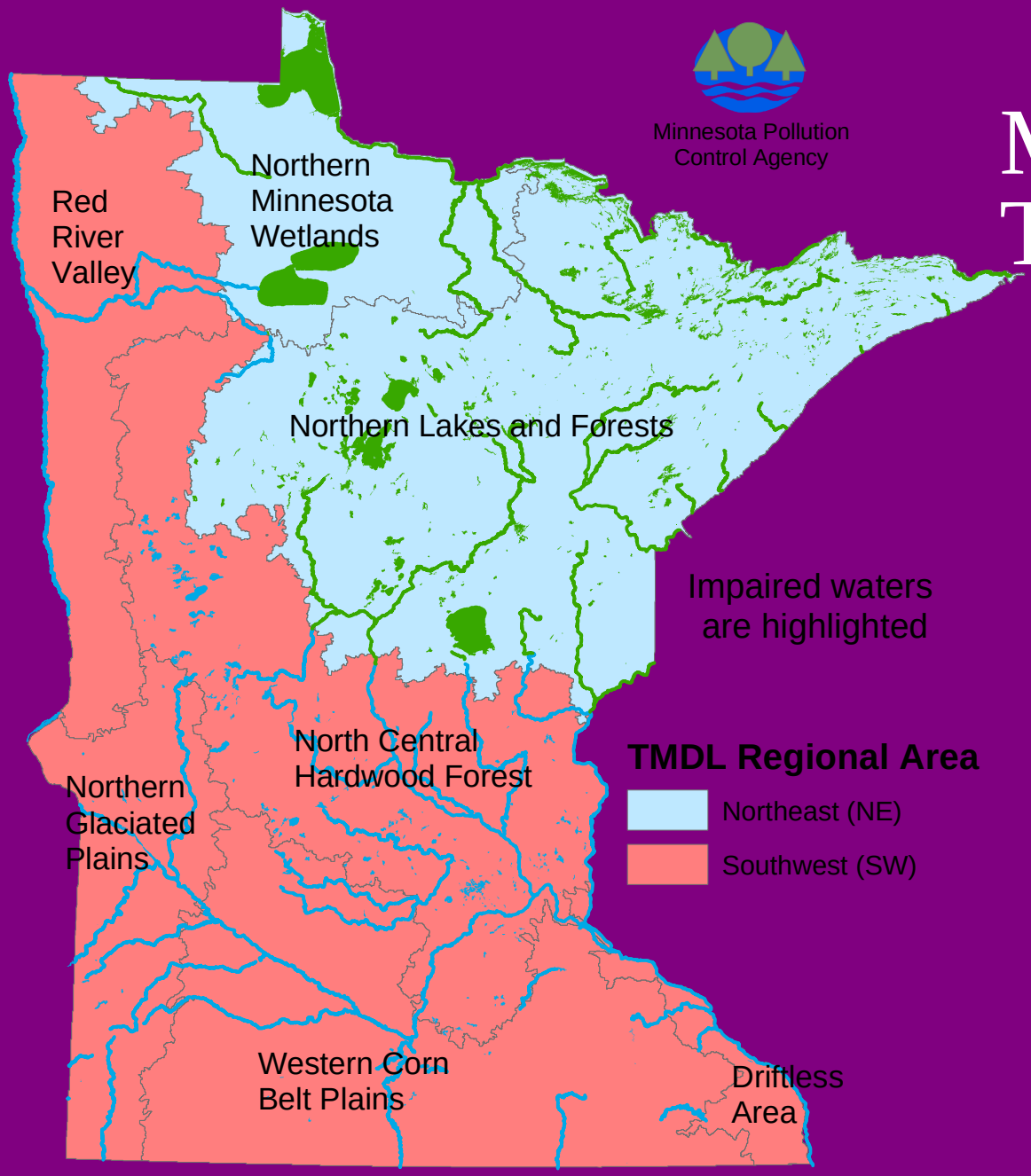




Waters Impaired by Mercury in Fish

FCA more restrictive than 1 meal/wk for moms & kids (>0.2 ppm for a fish size class)

Minnesota Mercury TMDL Regions



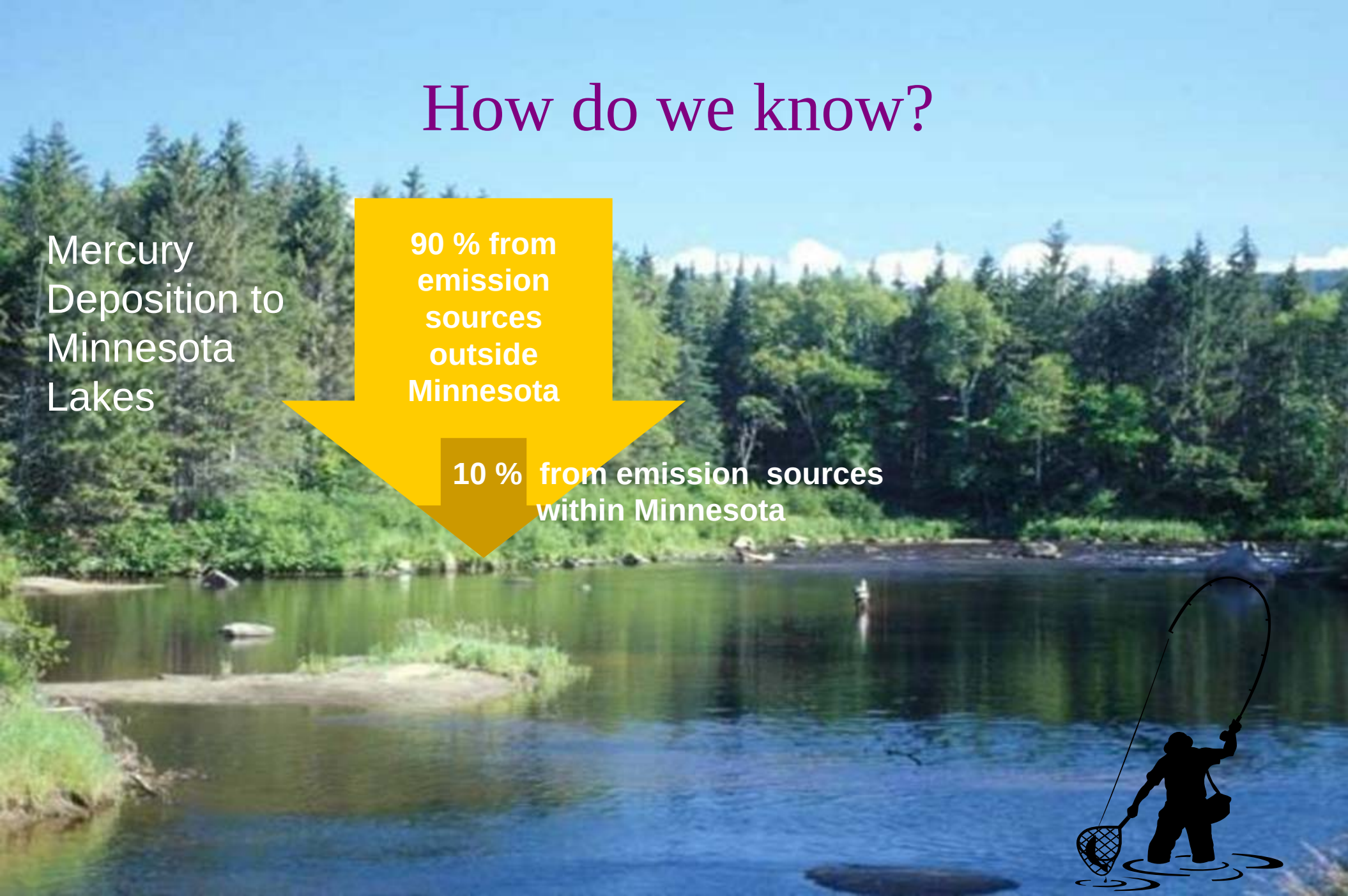
TMDL REGION	Dominant Mercury Transport Process
Northeast (NE)	Forest & wetland hydrology
Southwest (SW)	Erosion from cultivated land

Target Level & Reduction Factor

	NE	SW
Target fish mercury concentration	0.2 mg/kg	0.2 mg/kg
Mercury concentration for standard length walleye ($WE40_{90}$)	0.572 mg/kg	0.405 mg/kg
Reduction Factor (RF) = ($WE40_{90}$ – 0.2) ÷ $WE40_{90}$)	65%	51%
Anthropogenic RF = ($WE40_{90}$ – 0.2) ÷ $WE40_{90}$) ÷ 70%	93%	73%

How do we know?

Mercury Deposition to Minnesota Lakes

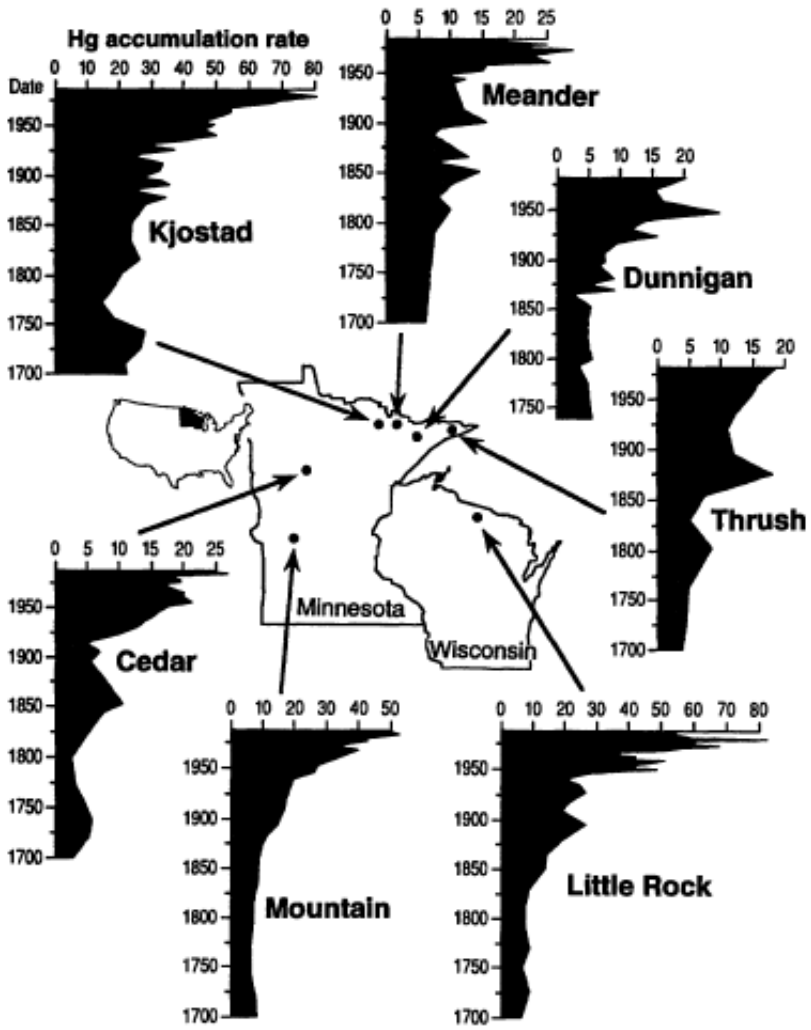


Total Mercury Deposition is Based on Sediment Cores

Engstrom and Swain collecting a sediment core

Swain, Engstrom, Brigham, Henning, and Brezonik. 1992. Science 257, 784-787

Fig. 1. Stratigraphic increases in Hg accumulation rates (in micrograms per square meter per year) in representative sediment cores from the profundal region of each of the study lakes. The other detailed Hg profiles (not illustrated) are of similar shape and magnitude. Whole-basin increases in Hg accumulation are calculated from these profiles and from an additional 6 to 14 cores from each lake. Chronology and sedimentation rates are provided by ^{210}Pb dating.



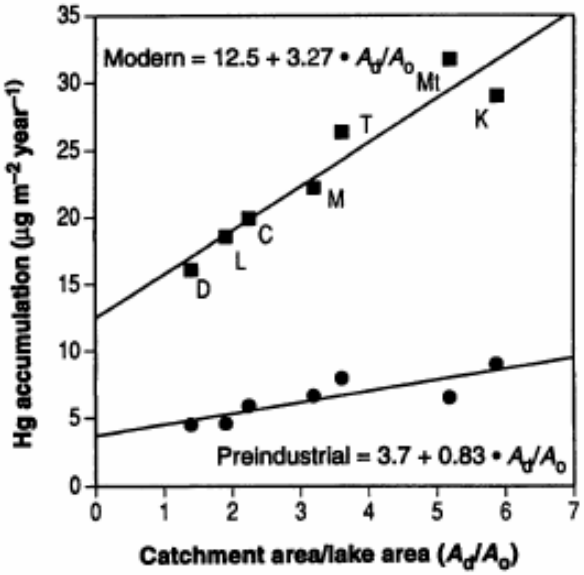
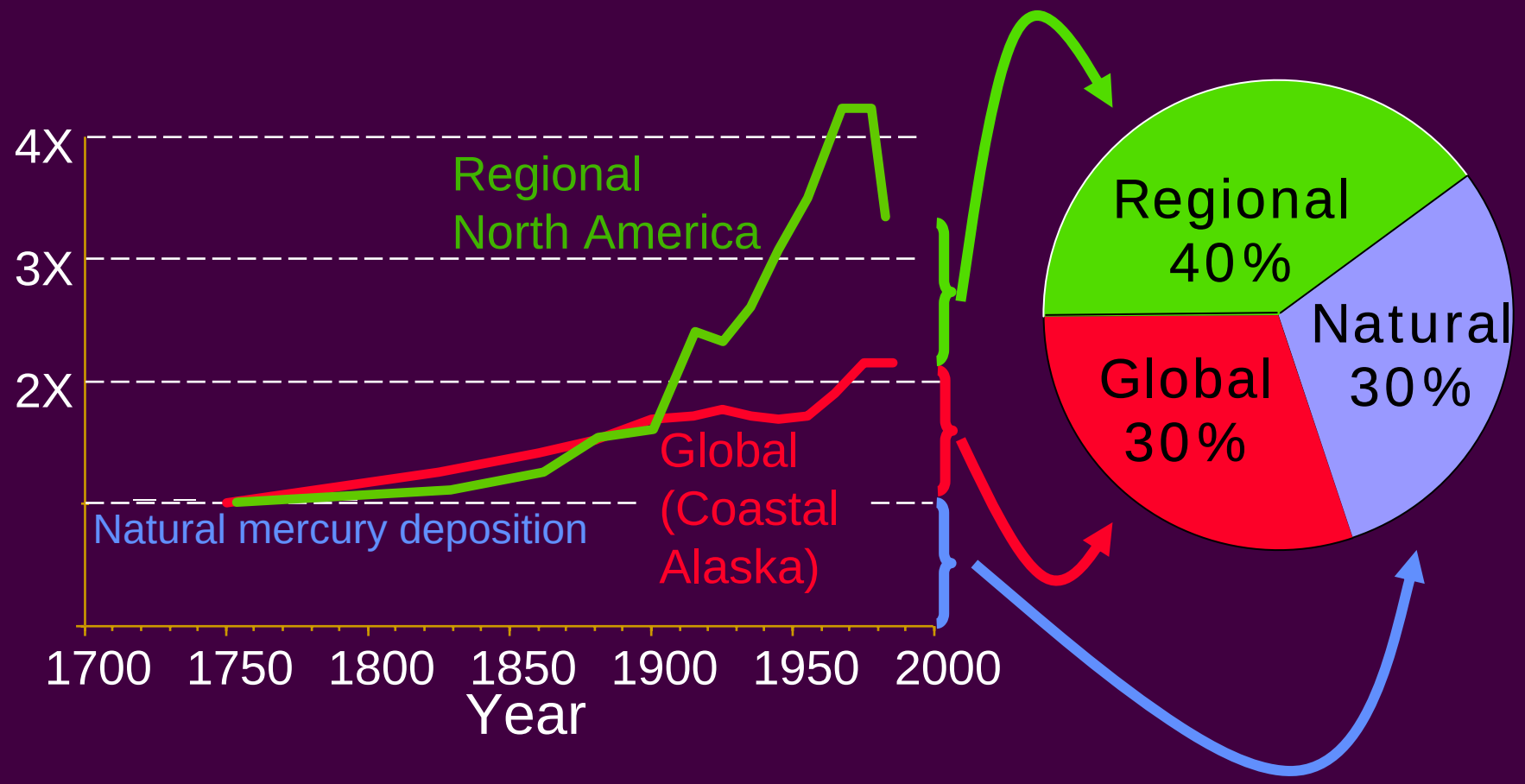


Fig. 2. Whole-basin Hg accumulation rates as linear functions of the ratio of terrestrial catchment area to lake area (A_d/A_o). Modern rates (■) represent the last decade, and preindustrial rates (●) are those before about 1850. The intercept of each regression line predicts the rate of atmospheric Hg deposition to the lake surface, and the ratio of the slope to the intercept estimates the proportion of the atmospheric Hg flux transported to the lake from the catchment (see text). Lake codes are: Dunnigan (D), Little Rock (L), Cedar (C), Meander (M), Thrush (T), Mountain (Mt), and Kjostad (K).

Sources of Atmospheric Mercury Deposition in North-Central US (Engstrom and Swain 1997 ES&T)

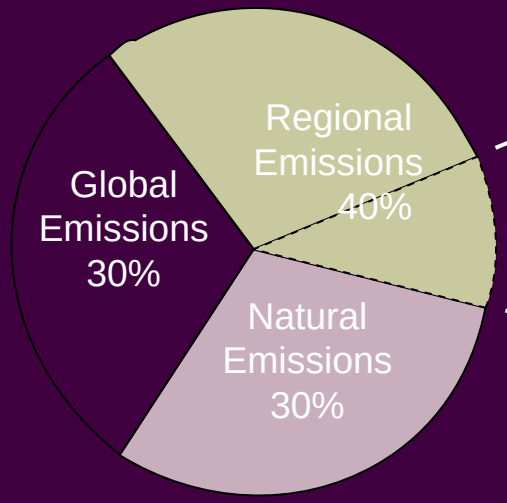


Atmospheric Deposition: Sediment Core Findings

- ~70% current Hg deposition in MN from anthropogenic emissions *(30% global + 40% regional)*
- Annual atmospheric deposition ~ 12.5 µg/m2
- Atm Dep peaked ~1970s in some parts of MN
- Deposition now relatively uniform across state; no known fish tissue hot spots

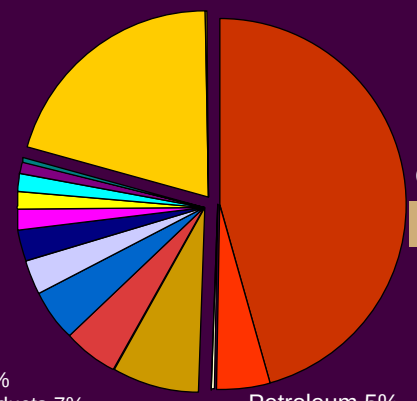
Sources of Minnesota's Mercury Deposition

Sources of Atmospheric Mercury Deposition to Minnesota



MN Emissions (~10%)

Minnesota Mercury Emissions (2000)



Energy 51%

Material Processing 21%

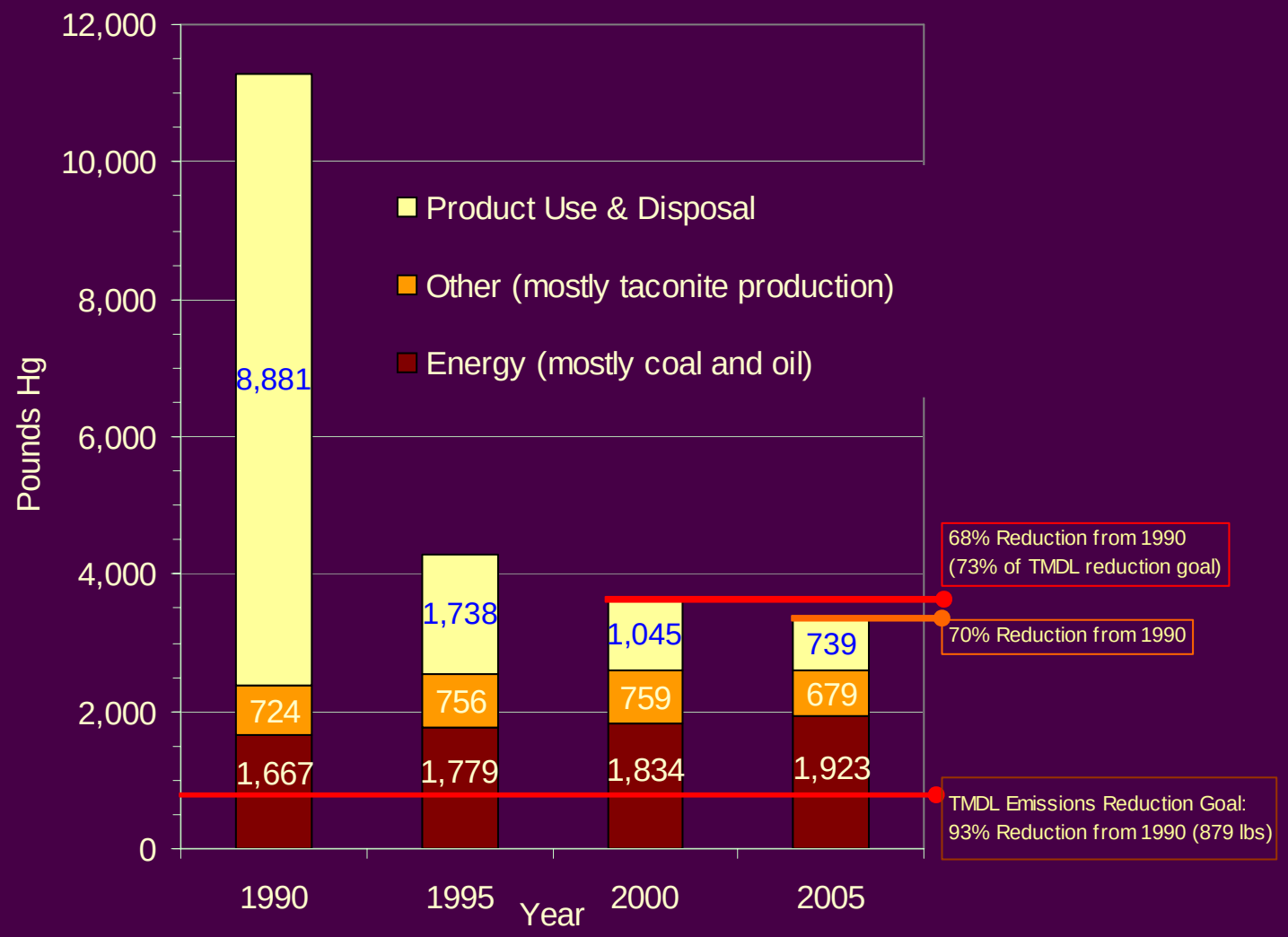
Taconite processing 21%

Medical waste incineration 0.2%
Fluorescent lamp breakage 0.9%
Recycling mercury from products 1.4%
On-site household waste incineration 2%
Crematories 2%
Dental preparations 3%
Sewage sludge incineration 3%
Smelters that recycle cars and appliances 5%
Municipal solid waste combustion 5%
Volatilization from disposed products 7%

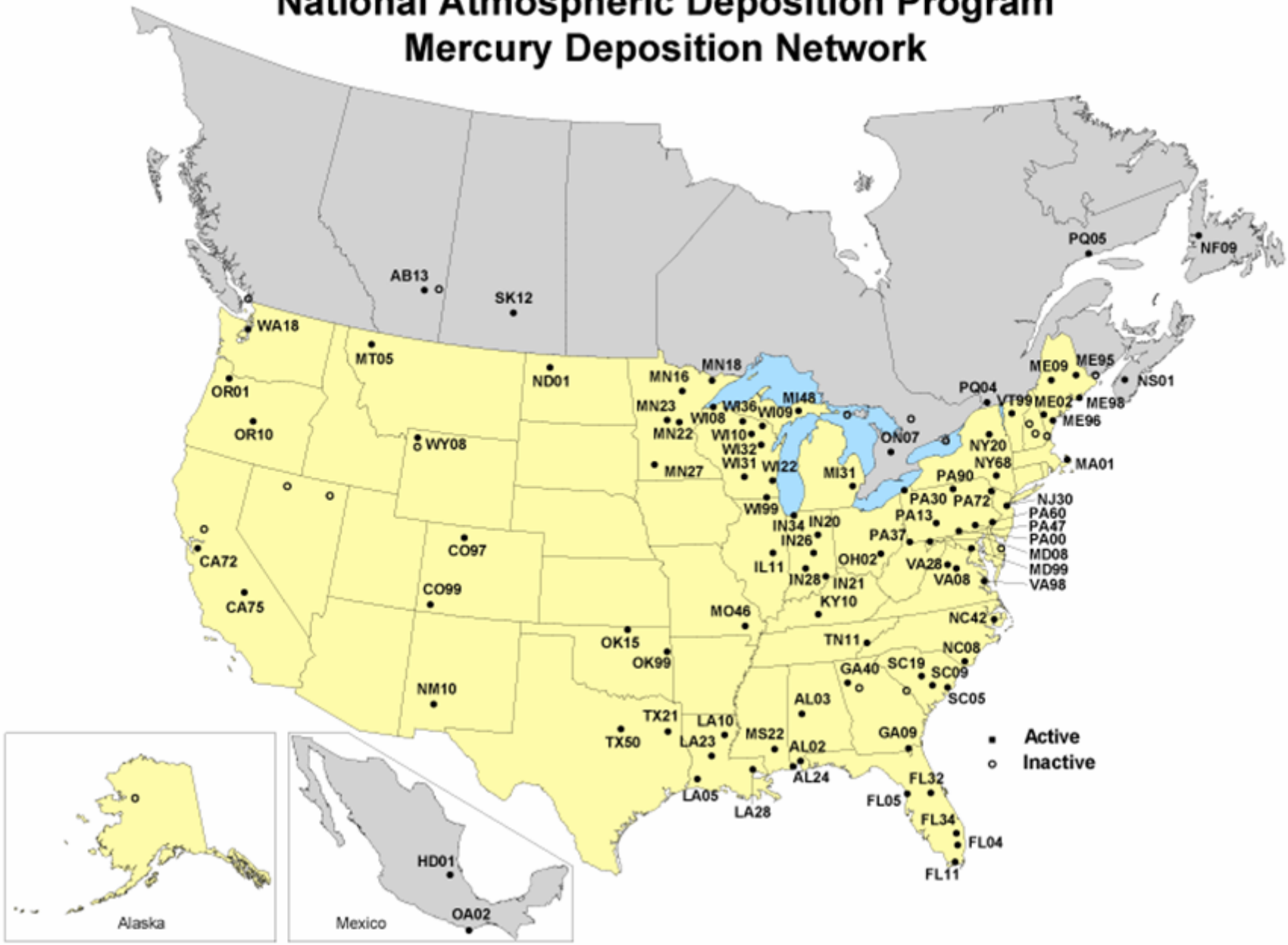
Purposeful Use 28%

Source: Minnesota Pollution Control Agency March 2004

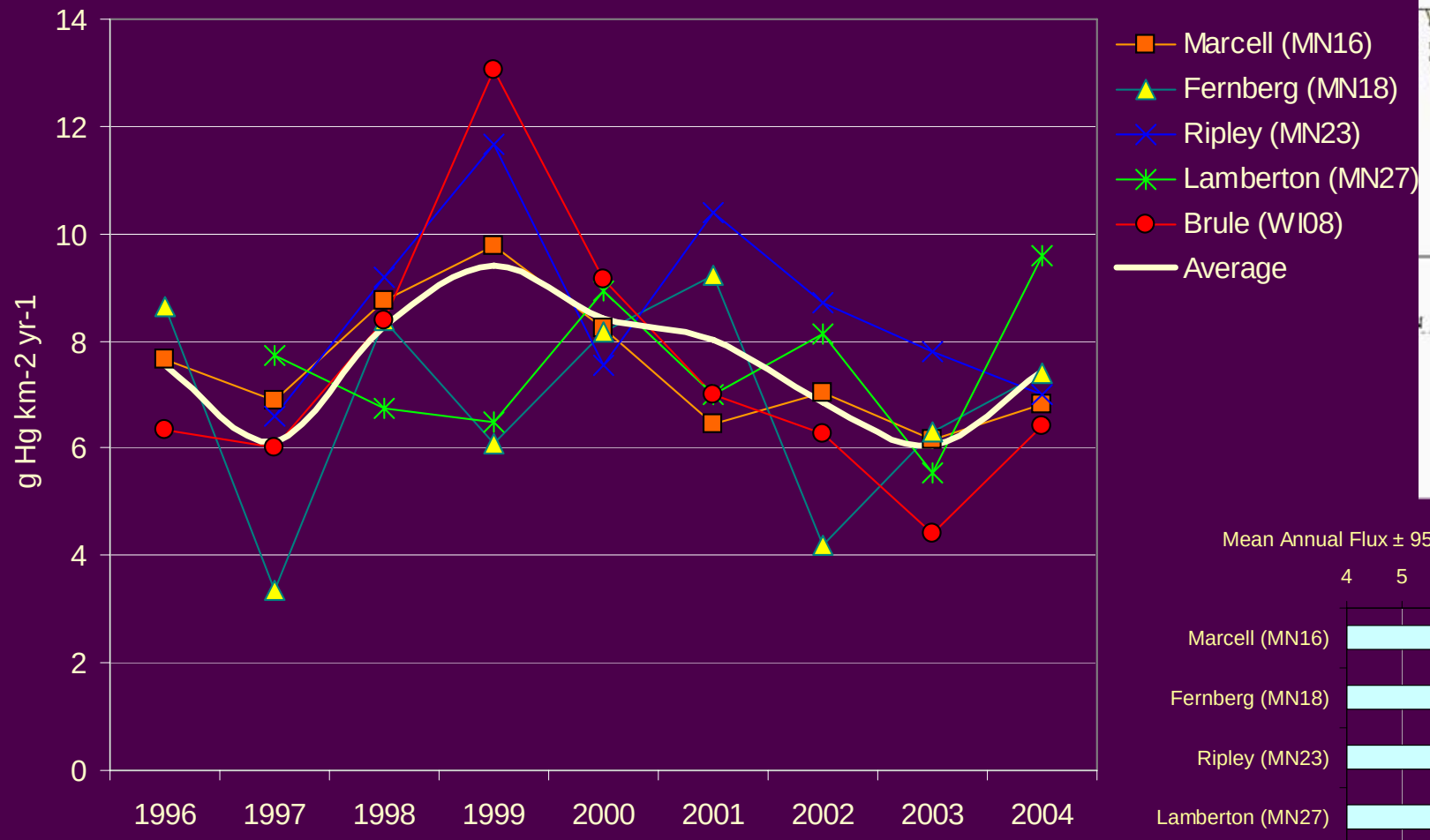
Minnesota Mercury Emissions, 1990, 1995, 2000 and Projected 2005

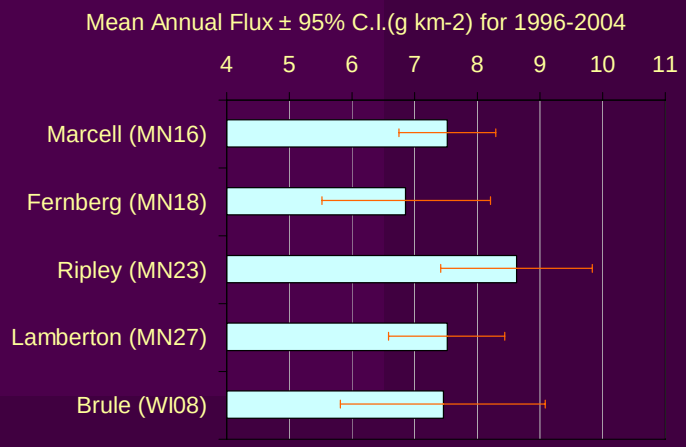


National Atmospheric Deposition Program
Mercury Deposition Network

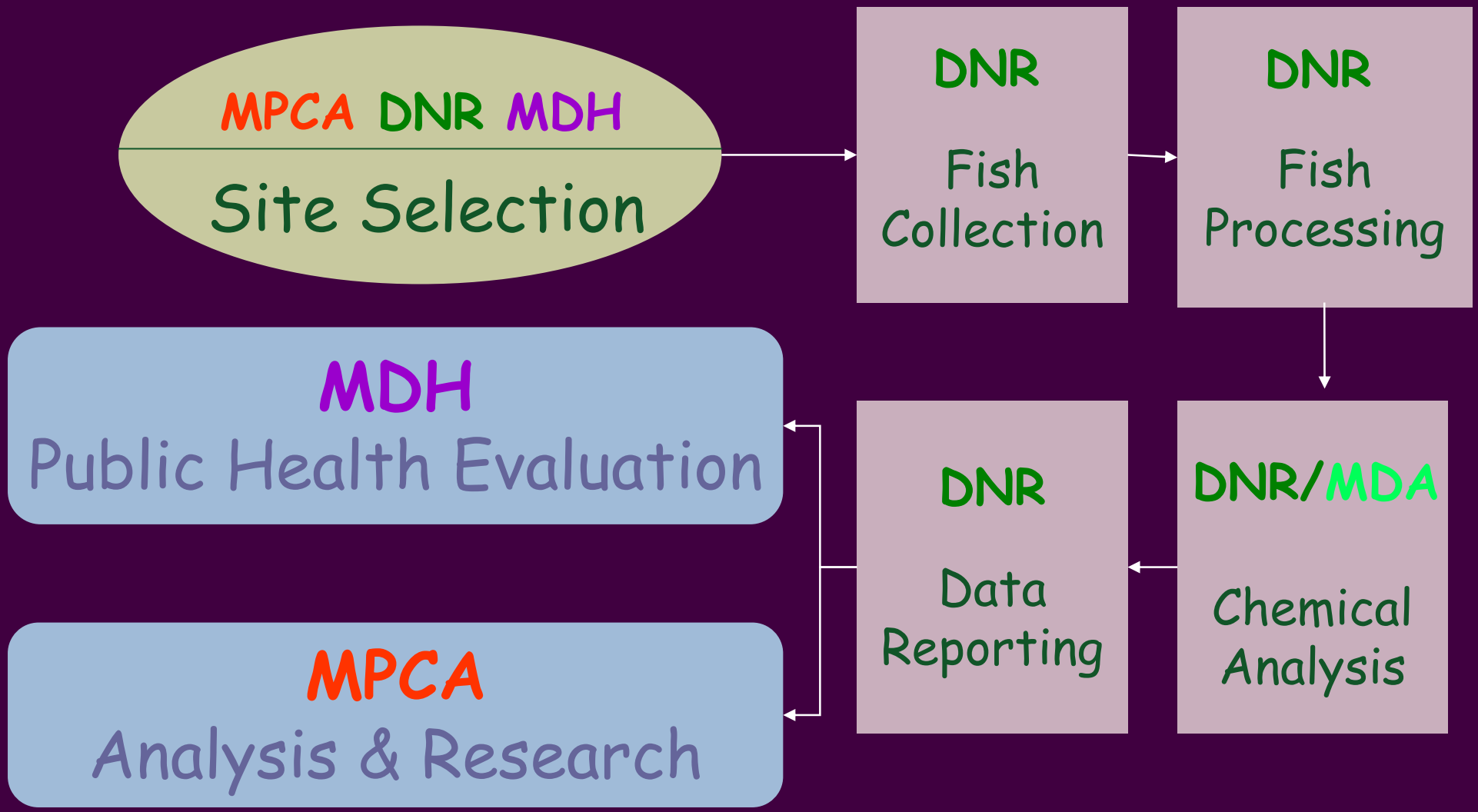


Annual Wet Deposition at MN Sites

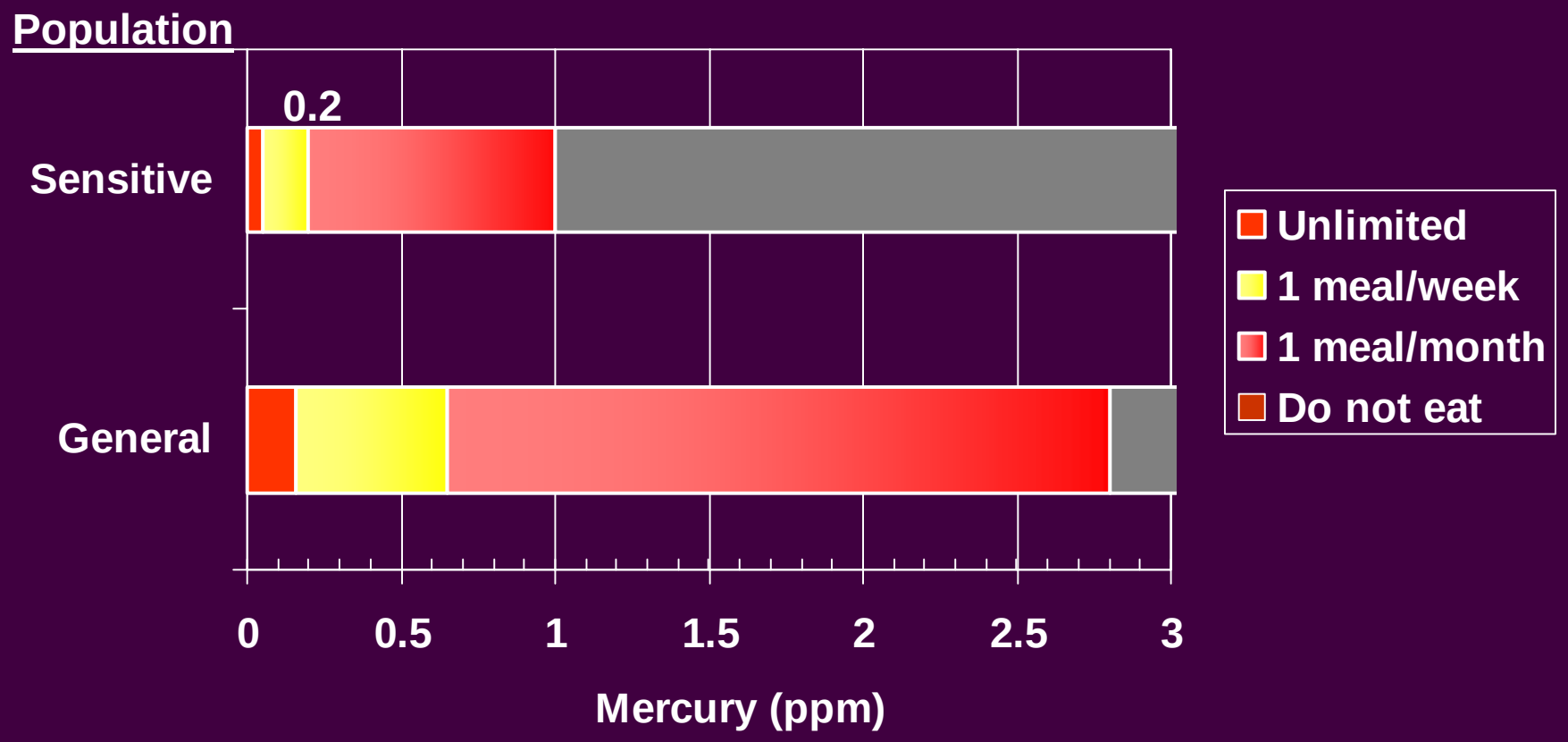




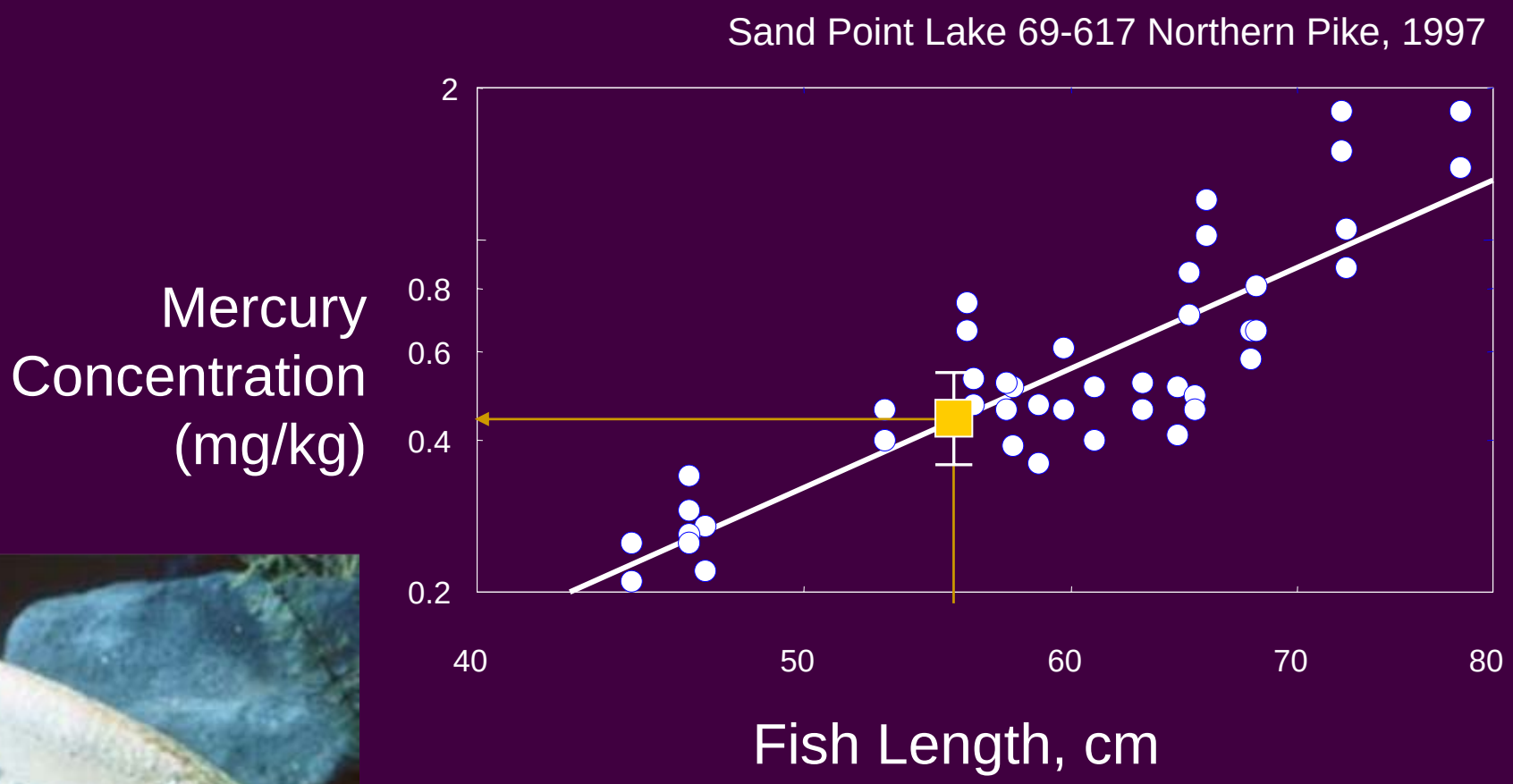
Fish Contaminant Monitoring Process



Minnesota's Fish Consumption Advisory Levels Applied to Fish Size Classes



Calculating Standard Concentration of Northern Pike



Water Point Sources of Mercury – Existing, Expanding, & New

- Data from about 37 facilities, averaged 5 ng/L Hg
- WLA not to exceed 1% of total mercury load allocation *[11 kg/yr]*
- In 1990, water point sources about 1.2% of total
- New & expanding water sources can expand up to the current WLA of 11 kg/yr
- Mercury minimization plan required

Summary of Monitoring Data Needed to Prepare the Statewide Mercury TMDL

- Fish tissue mercury data to show spatial differences and includes data from 1988–1992
- Sediment core data sufficient to est. whole basin mercury fluxes
- Wet deposition stations across the state to show uniform deposition
- Wastewater effluent data to estimate WLA

Future TMDL Monitoring Needs

- Fish tissue trends
- Dry deposition (as well as Wet Dep)
- Follow up intensive lake sediment core study
- Wasteload allocation studies (upstream/downstream)

Questions?

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