A Decade of Monitoring Mercury in Fish: What Have We Learned?

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Background

- Mercury in Fish study original goal was to screen LMB at 50 lakes throughout the state
- Data indicated additional species and lakes needed sampling
- Now sample 97 lakes for all available gamefish on a 5 year rotating basis
- Advice is typically updated annually

Mercury in Fish - Risk

- Mercury is a neurotoxin
- Sensitive population
  - Children up to the age of 15
  - Women of child bearing age
- 99% of exposure is through fish consumption

Mercury in Fish - Risk

- EPA's reference dose is based on human studies of a high-fish-consumption-rate population in the Faroe Islands

- Mercury - effects are subtle with low level exposures
  - Cognitive thinking
  - Memory
  - Attention span
  - Fine motor skills
  - Visual spatial skills

Benefits of Eating Fish

- Benefits to Eating Fish
  - Good source of high quality protein
  - High in Omega-3 fatty acids
  - High in vitamins and essential minerals
- Advice needs to balance risks vs. benefits
  - Eat a variety of low mercury fish
  - Eat smaller fish

EPA/FDA Joint Advice

- Pregnant and breastfeeding women, women who may become pregnant, and children beginning at age 2 should eat 8 to 12 ounces per week of a variety of lower mercury fish

- Lower mercury = less than 0.5 mg/kg

- List of fish consists mainly of commercially caught ocean fish and shell fish

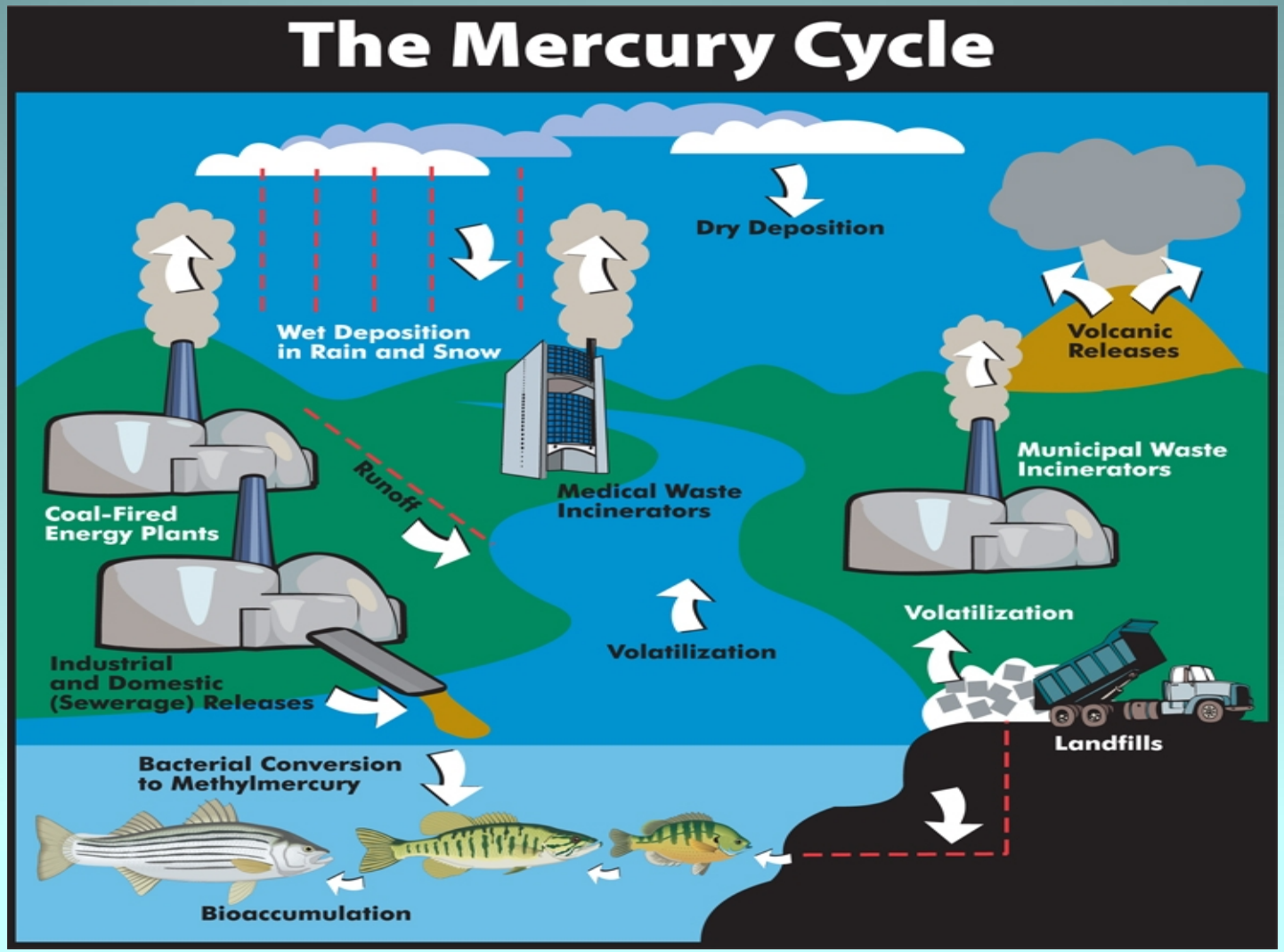
ODEQ Consumption Advisory Levels for Mercury

Fish Tissue Concentrations (mg/kg)	**Consumption Rate** (Meals per Month) **Sensitive Population**	**Consumption Rate** (Meals per Month) **General Population**
< 0.5	No Restriction	No Restriction
0.5 – 1.0	2 meals per month	No Restriction
1.0 – 1.5	No Consumption	2 meals per month
> 1.5	No Consumption	No Consumption

Sensitive population is defined as children less than 15 and women of childbearing age (15-45). General population is men older than 15 and women older than 45

Meal size is 8 oz. with the assumption that younger children will eat smaller meals

How Do Fish Accumulate Mercury?



Factors Affecting Mercury Concentration in Fish

- Mercury Load

  The amount of mercury entering a waterbody

- Methylation Rate

  The amount of mercury converted to methyl-mercury, the biologically available form

- Biomagnification Rate

  The efficiency of the foodweb to increase mercury concentrations as it moves through the food web

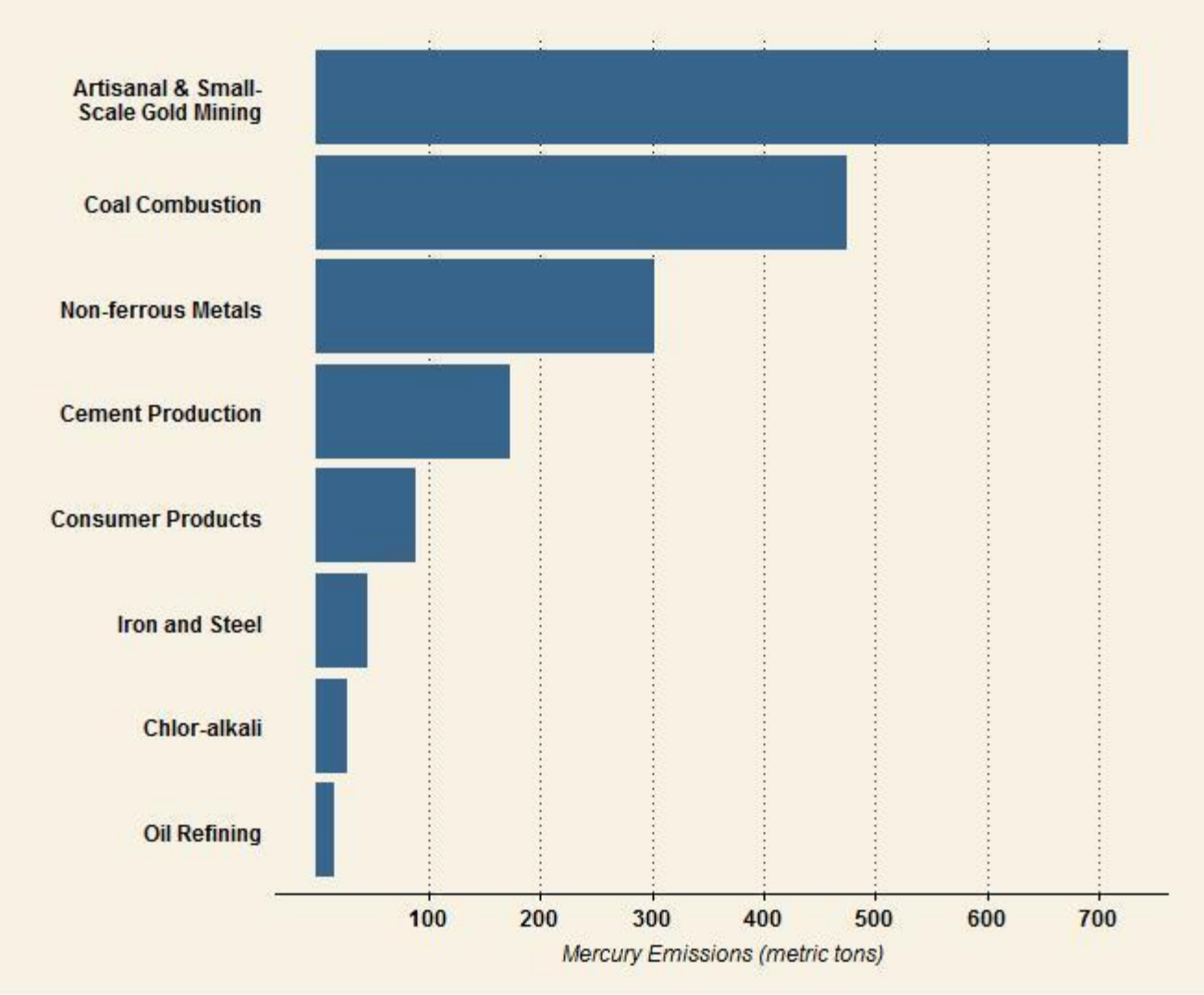
Mercury Load Sources

- Natural (10%)– volcanoes, geothermal areas, mineral deposits

- Anthropogenic (30%) – coal-fired utilities and industry, cement production, mining and smelting, artisanal and small scale gold mining

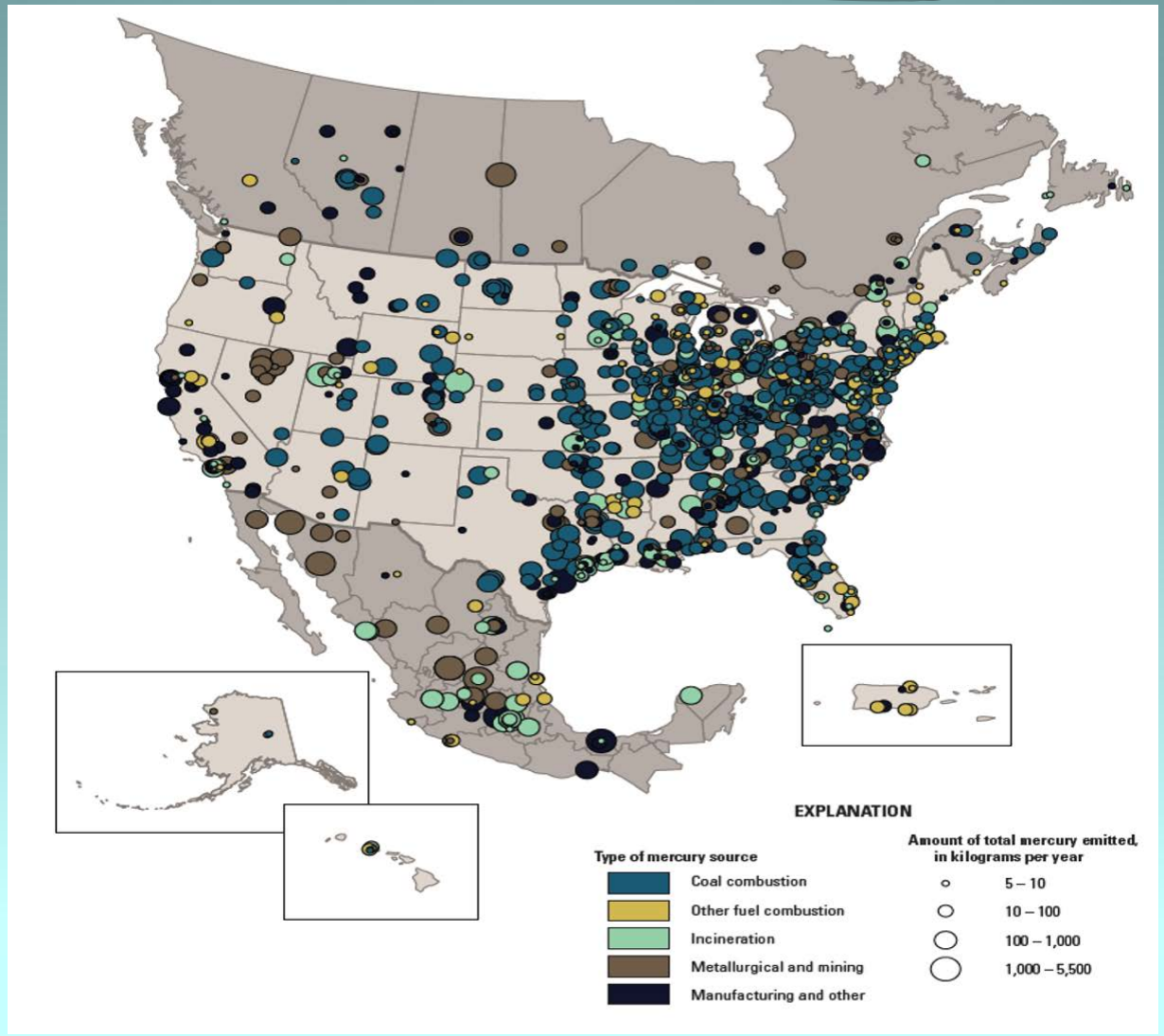
- Re-emissions (60%) – previously released mercury that has built up in soils and oceans – evaporation, forest and range fires

Global Anthropogenic Sources



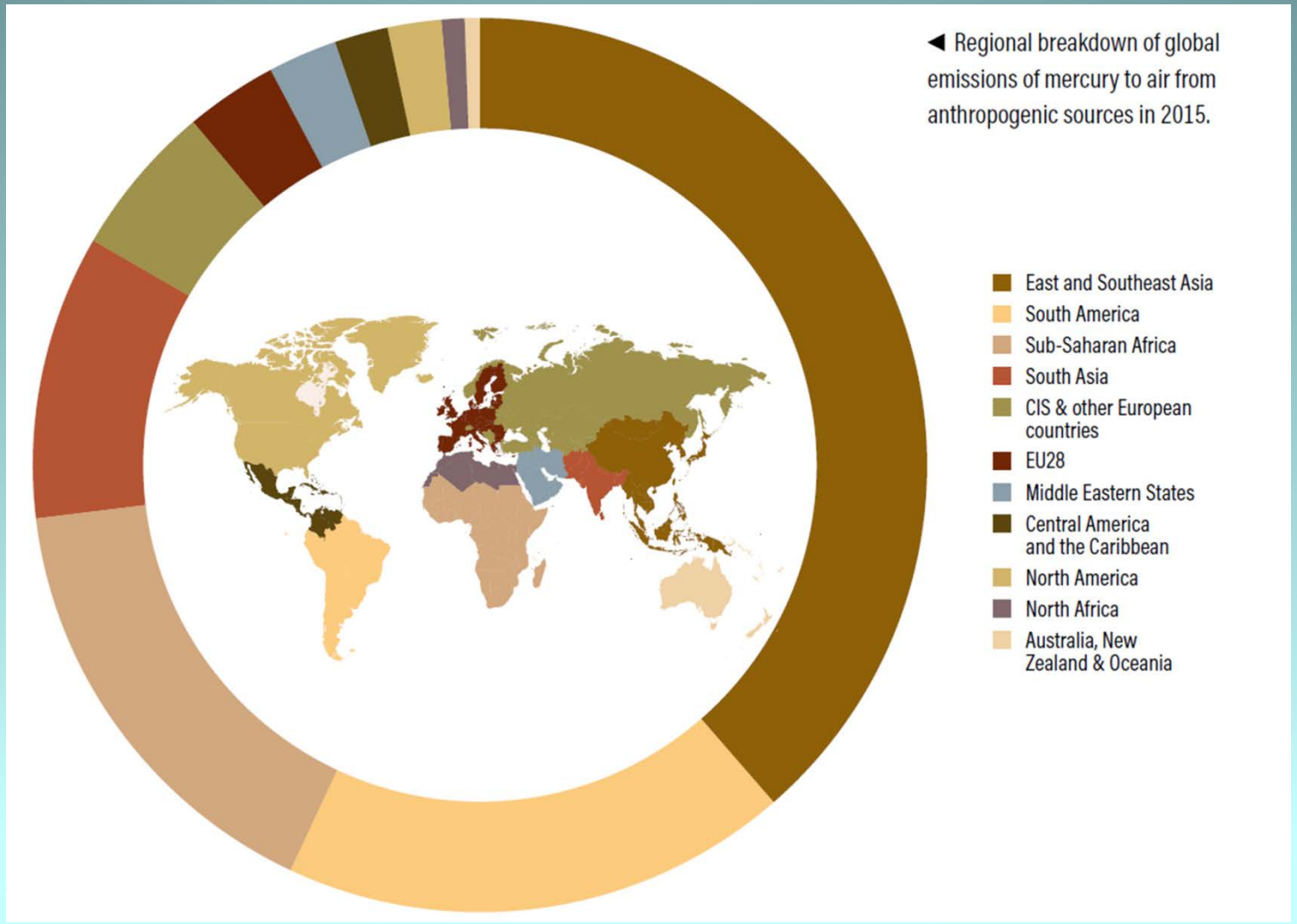
Source: UNEP Global Mercury Assessment (2013)

North American Mercury Emission Point Sources



Source: NOAA (2013)

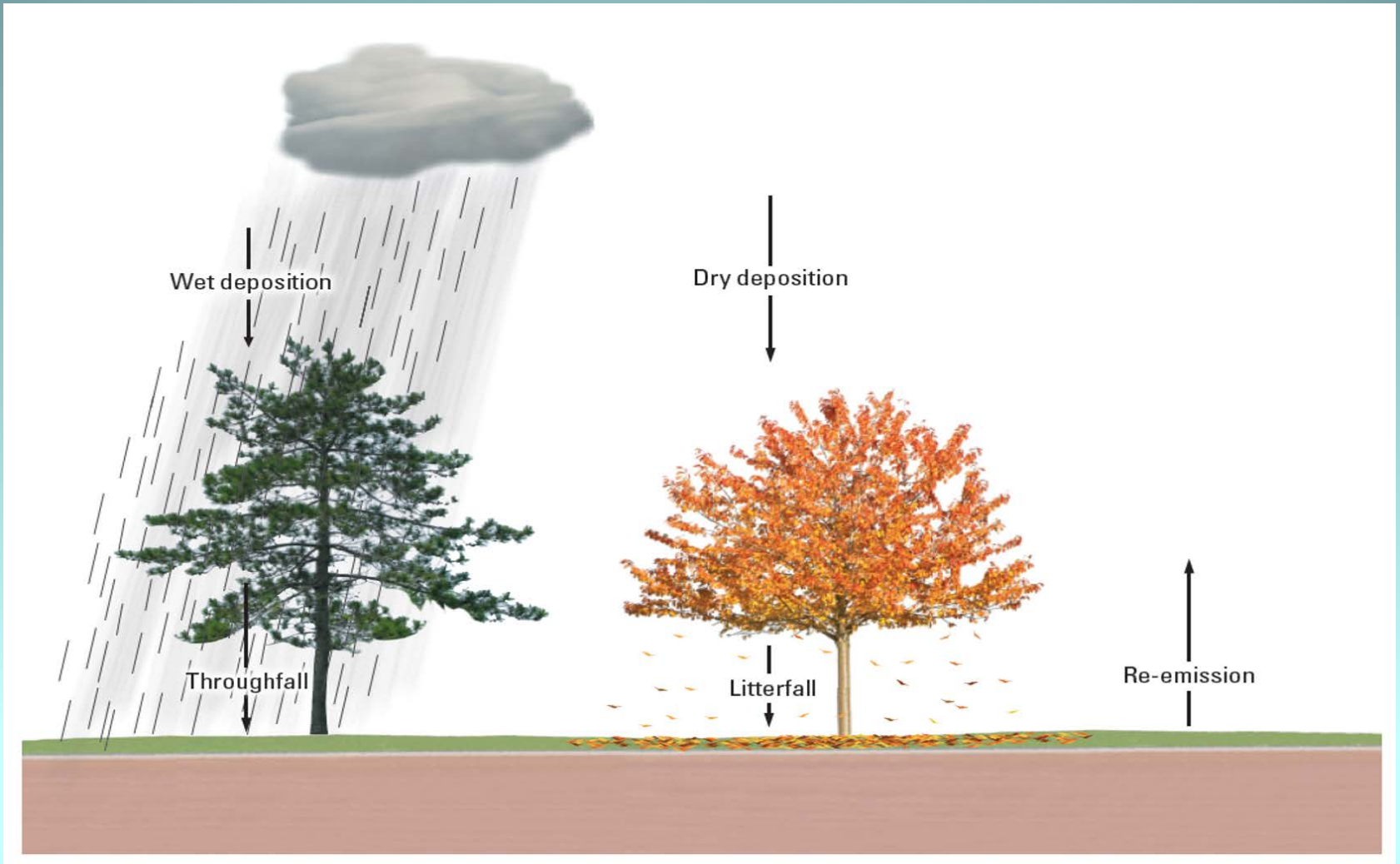
Global Anthropogenic Mercury Emissions



Source: UNEP Global Mercury Assessment, 2018

Mercury Load

Deposition



Mercury Load Deposition

- Sources Can Be

  Local – within 10s of miles

  Regional – within 100s of miles

  Global - 1000s of miles away

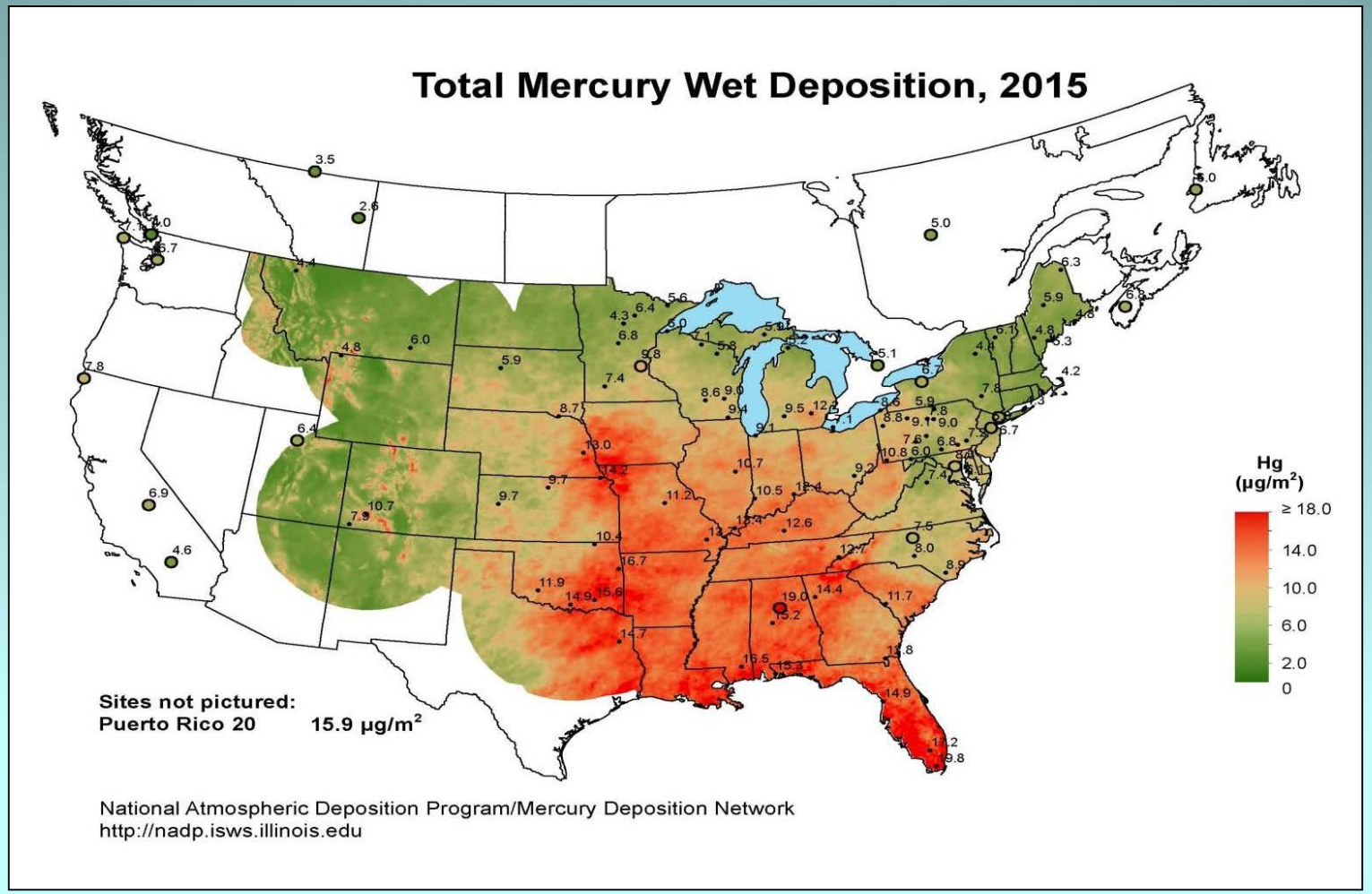
- 20% of mercury deposited in the US originated in North America

- **1970s** - Deposition was 5X pre-industrial levels

  Current – 3X Pre-industrial levels

Mercury Load

Deposition

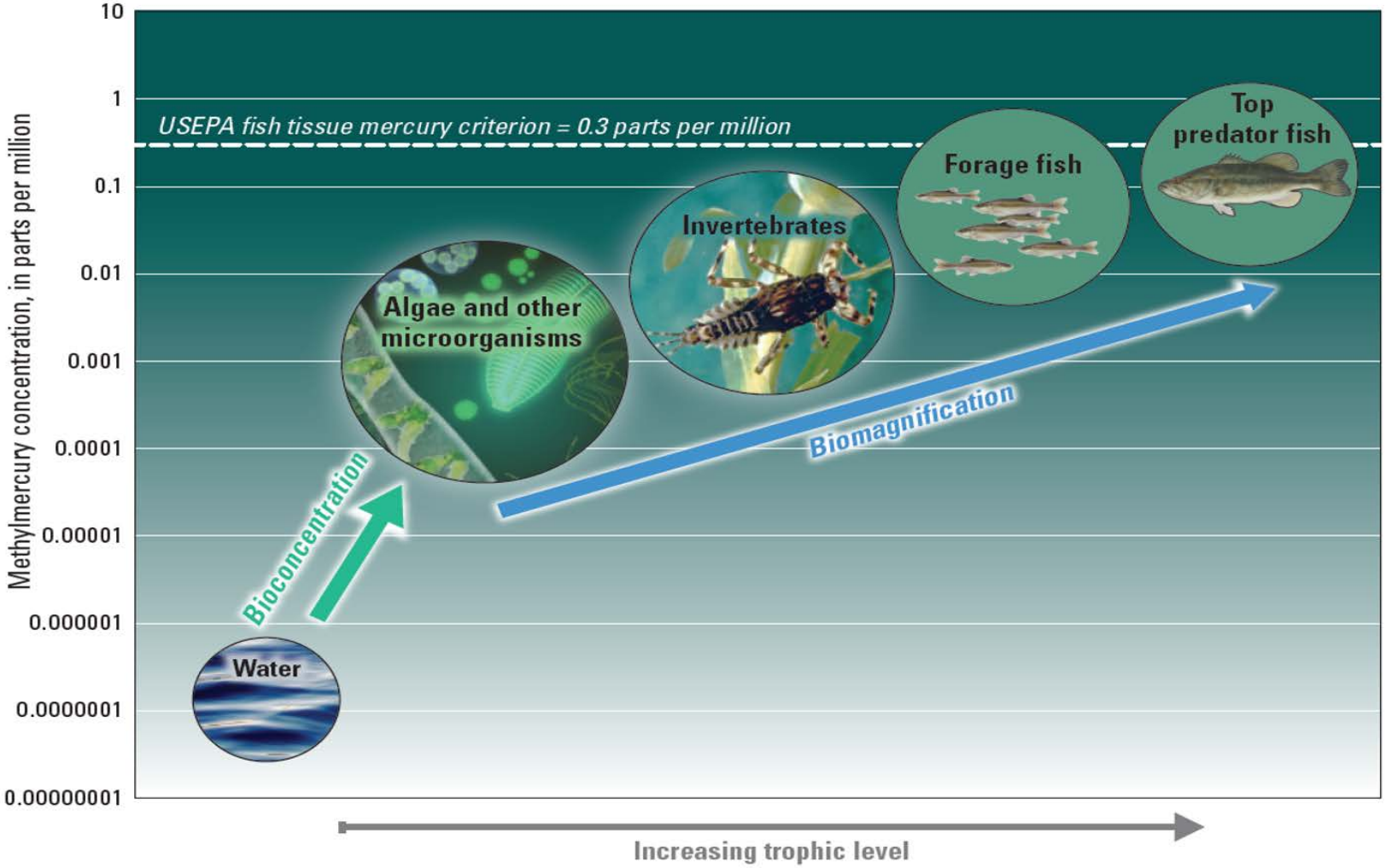


Methylation Rate

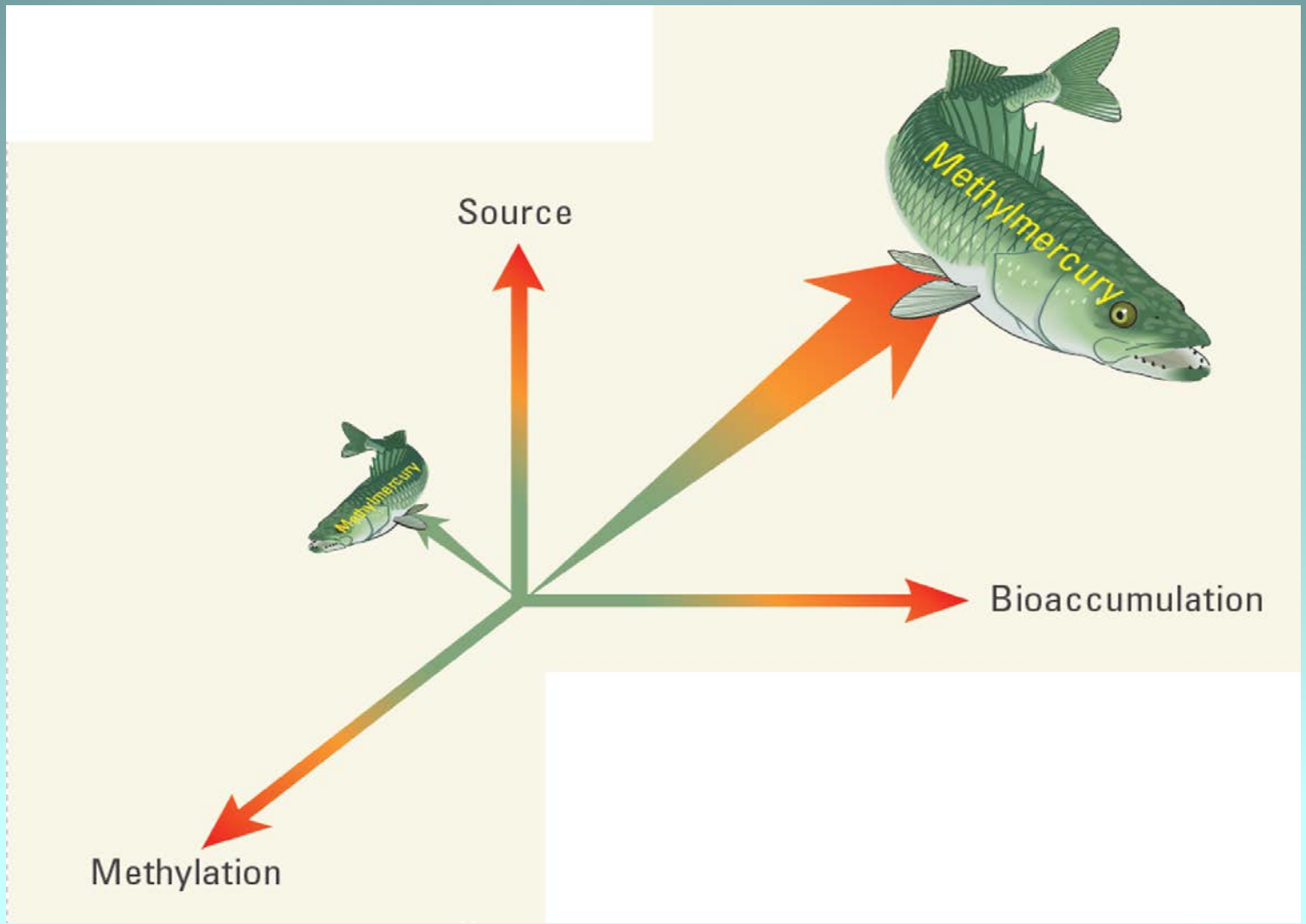
Production of Methylmercury

- Occurs at the sediment/water interface
- Facilitated by a few species of sulfate-reducing bacteria
- Requires a source of light and carbon
- Water quality factors – low pH, low alkalinity, low dissolved oxygen, low turbidity, high DOC

Biomagnification Rate



Source: USGS, Mercury in the Nation's Streams, 2014



Source: USGS (2014), Mercury in the Nation's Streams

Survey of Mercury in Fish

- DEQ has sampled and analyzed fish from 97 lakes since 2007
- Lakes are targeted for sampling every 5 years
- Multiple sites on larger lakes
- All available game fish species are targeted
- Prefer a wide size range of consumable fish

Sample Collection

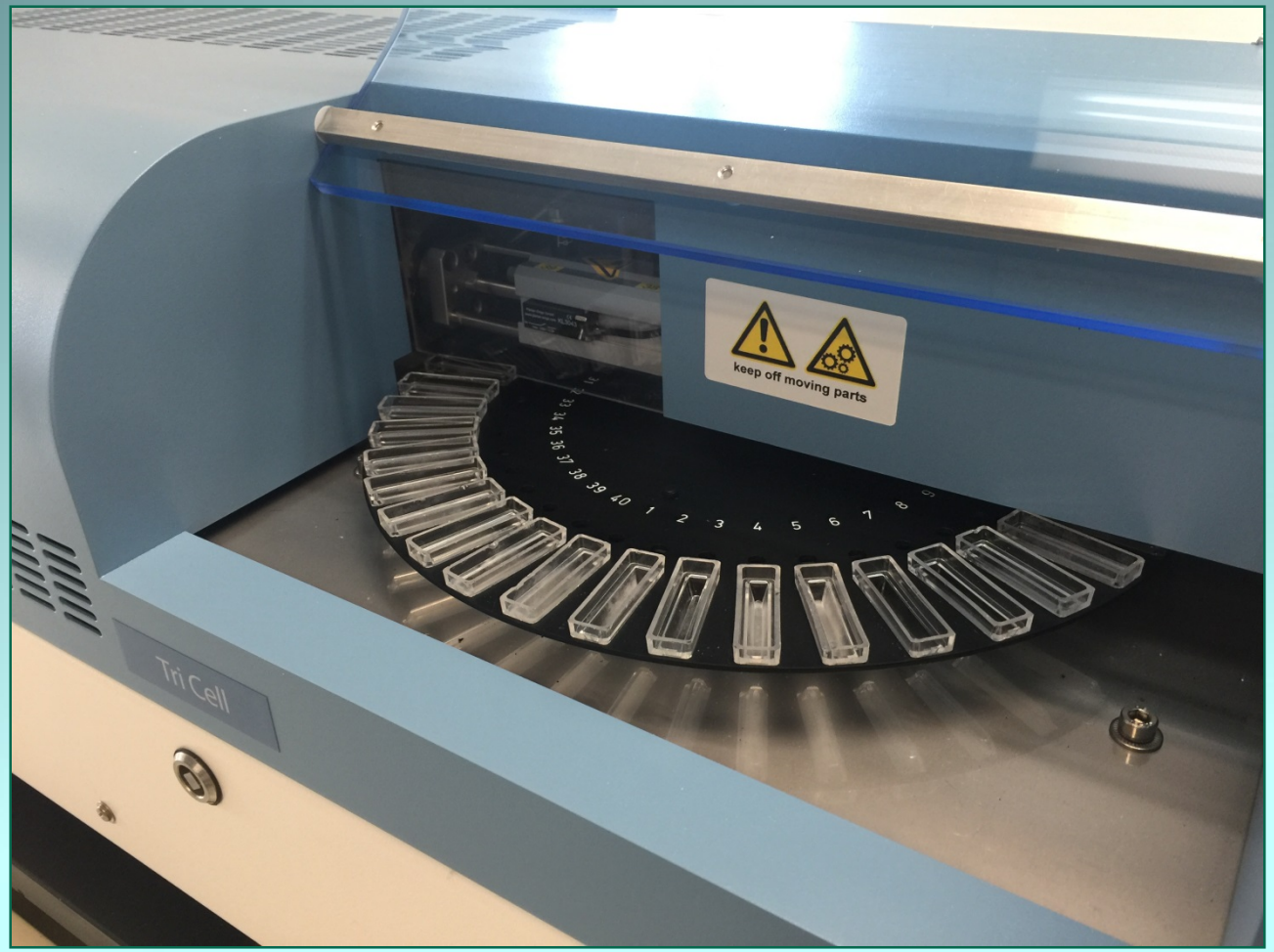
Sample Collection

- Use electrofishing, gill nets, and occasionally rod and reel

- Cooperate with ODWC and others to collect hard to get species

Field Processing of Fish Samples

Field Processing of Fish Samples



The sample is placed on the DMA-80 autosampler for direct mercury analysis.

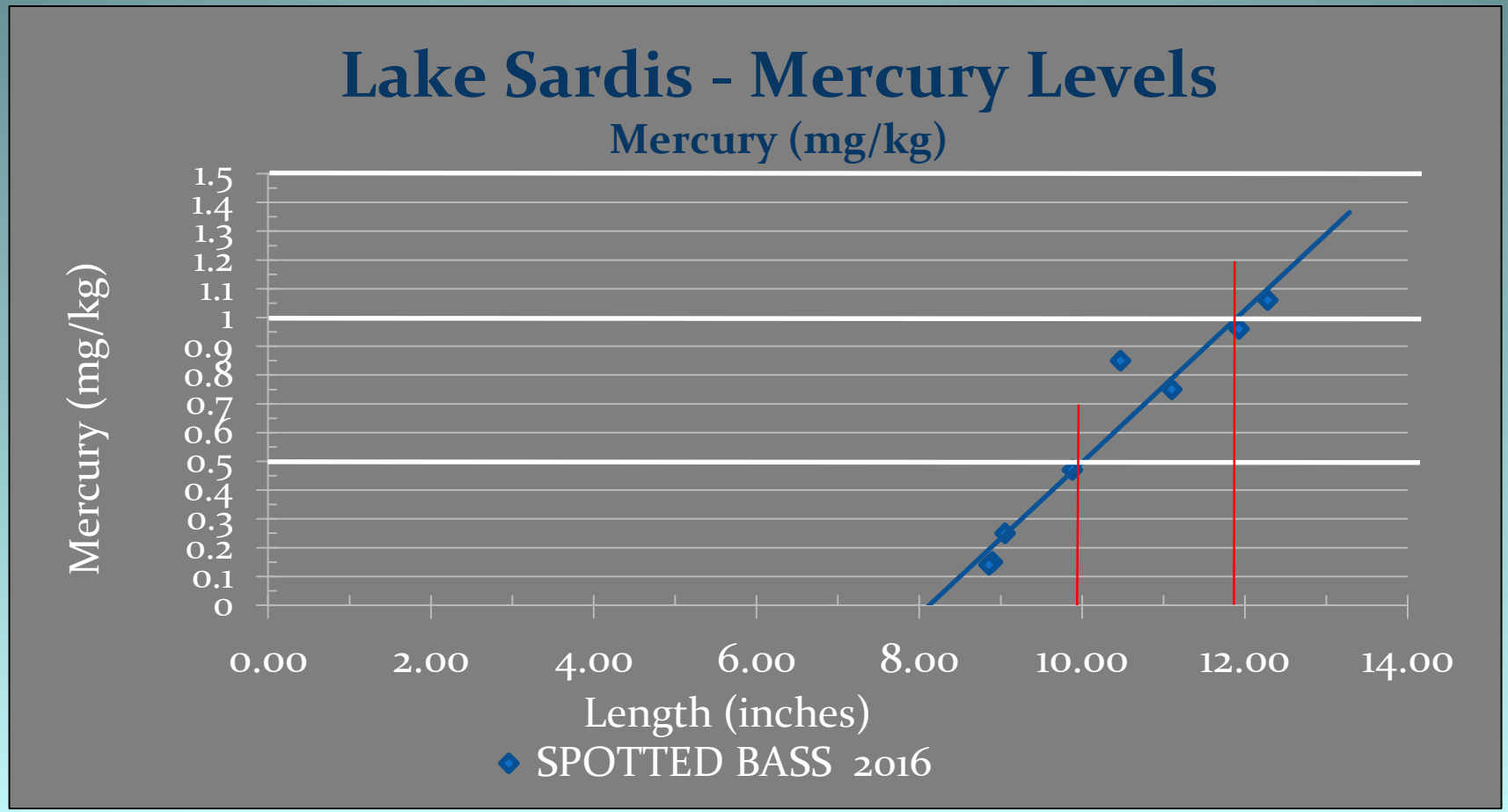
Data Analysis and Interpretation

- Generally, there is a positive relationship between length and Hg concentration in fish
- Length vs. concentration graphs are developed
- Lake-specific consumption advice is developed for each species based on length

Risk Assessment and Communication

- EPA provides risk assessment guidance but states make their own determination regarding advisory levels
- Risk assessment and communication is complex because of the healthy benefits of eating fish
- We want people to continue to eat fish but make smart choices
- Communication is through DEQ website, booklets, and posters

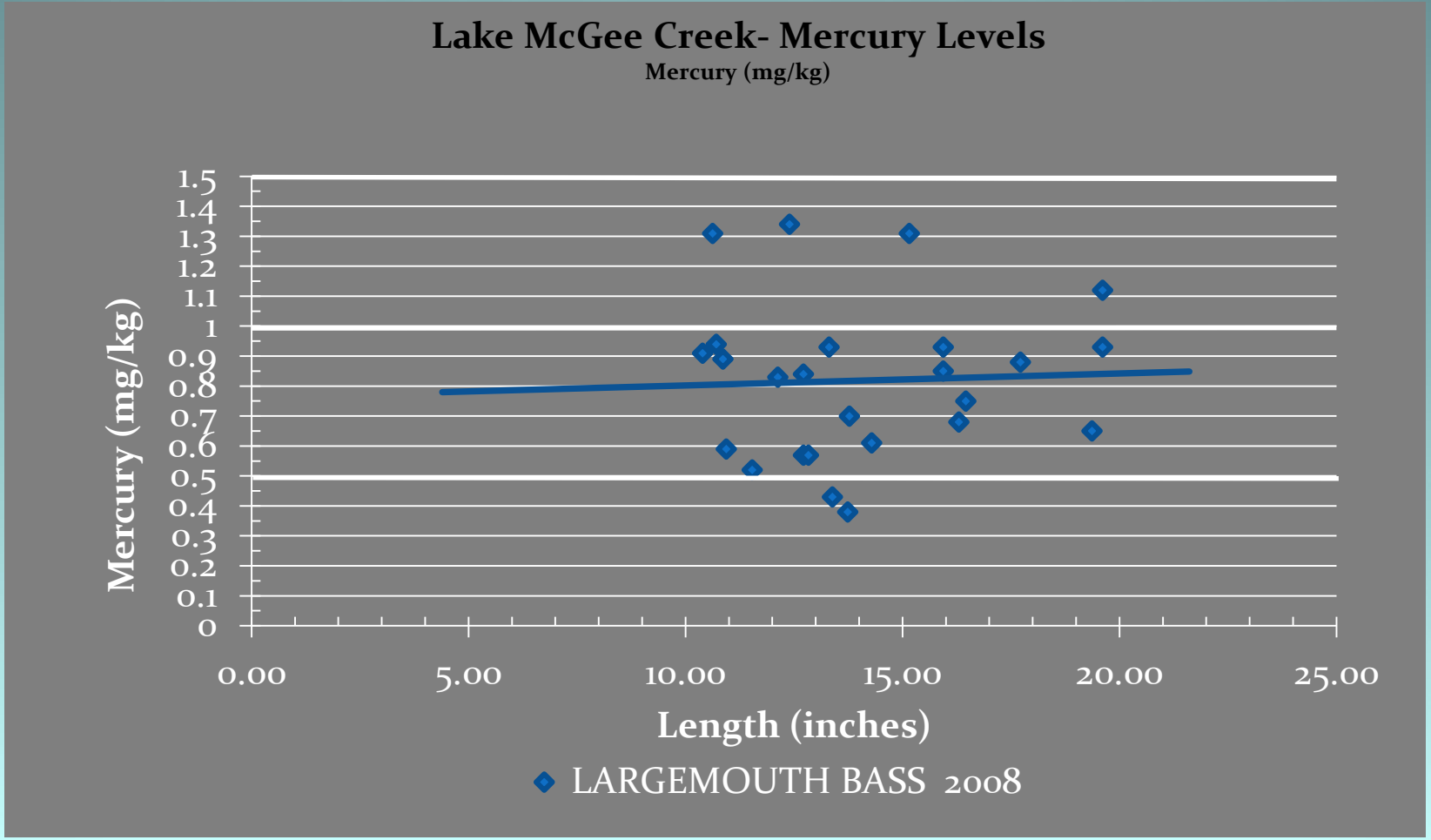
Survey of Mercury in Fish: Results



Sensitive Population: No Restriction under 10 inches
2 meals per month 10-12 inches
No meals per month 12 inches and over

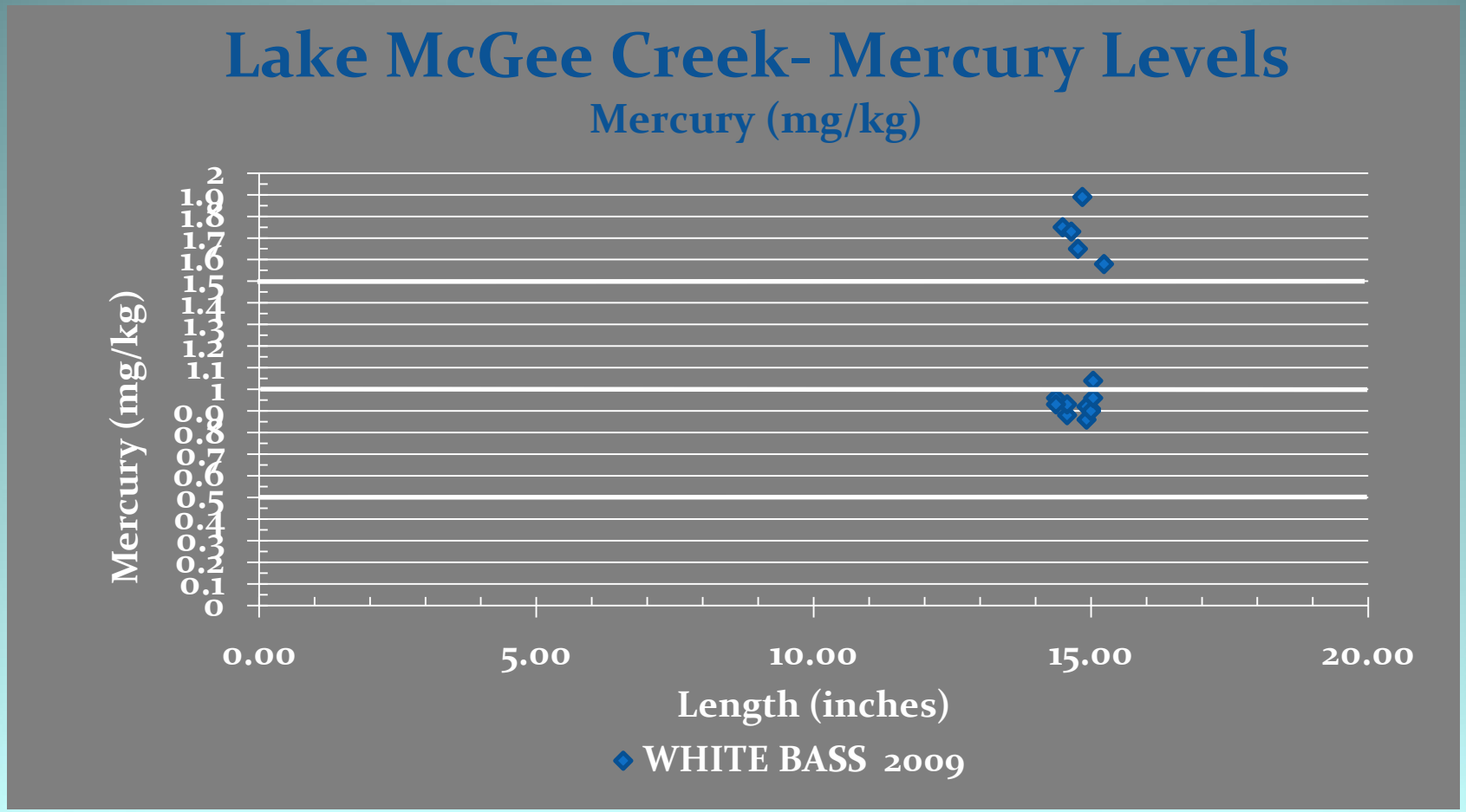
General Population: No Restriction under 12 inches
2 meals per month 12 inches and over

Survey of Mercury in Fish: Results



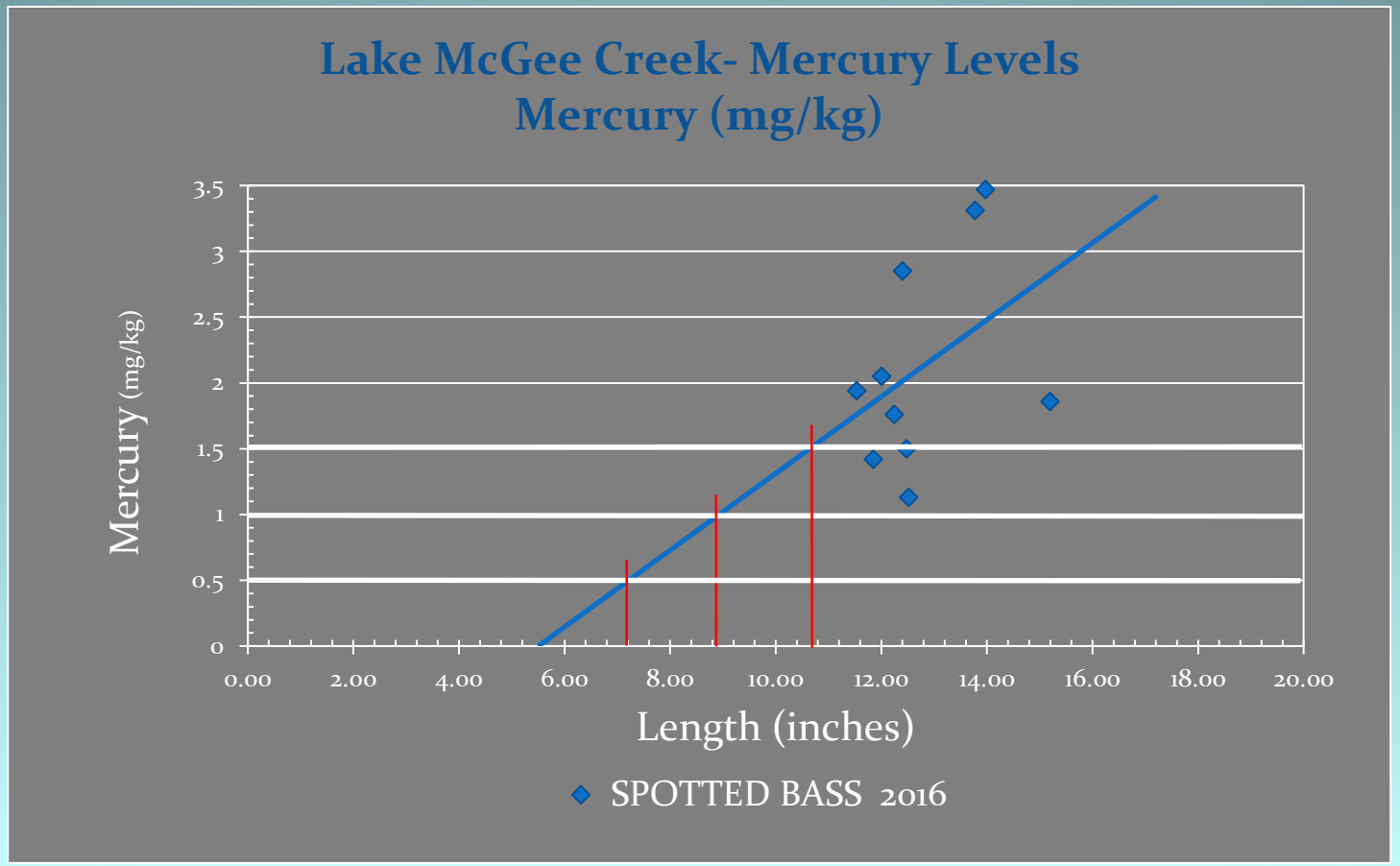
Sensitive Population: **2 meals per month all sizes**
General Population: **No Restriction**

Survey of Mercury in Fish: Results



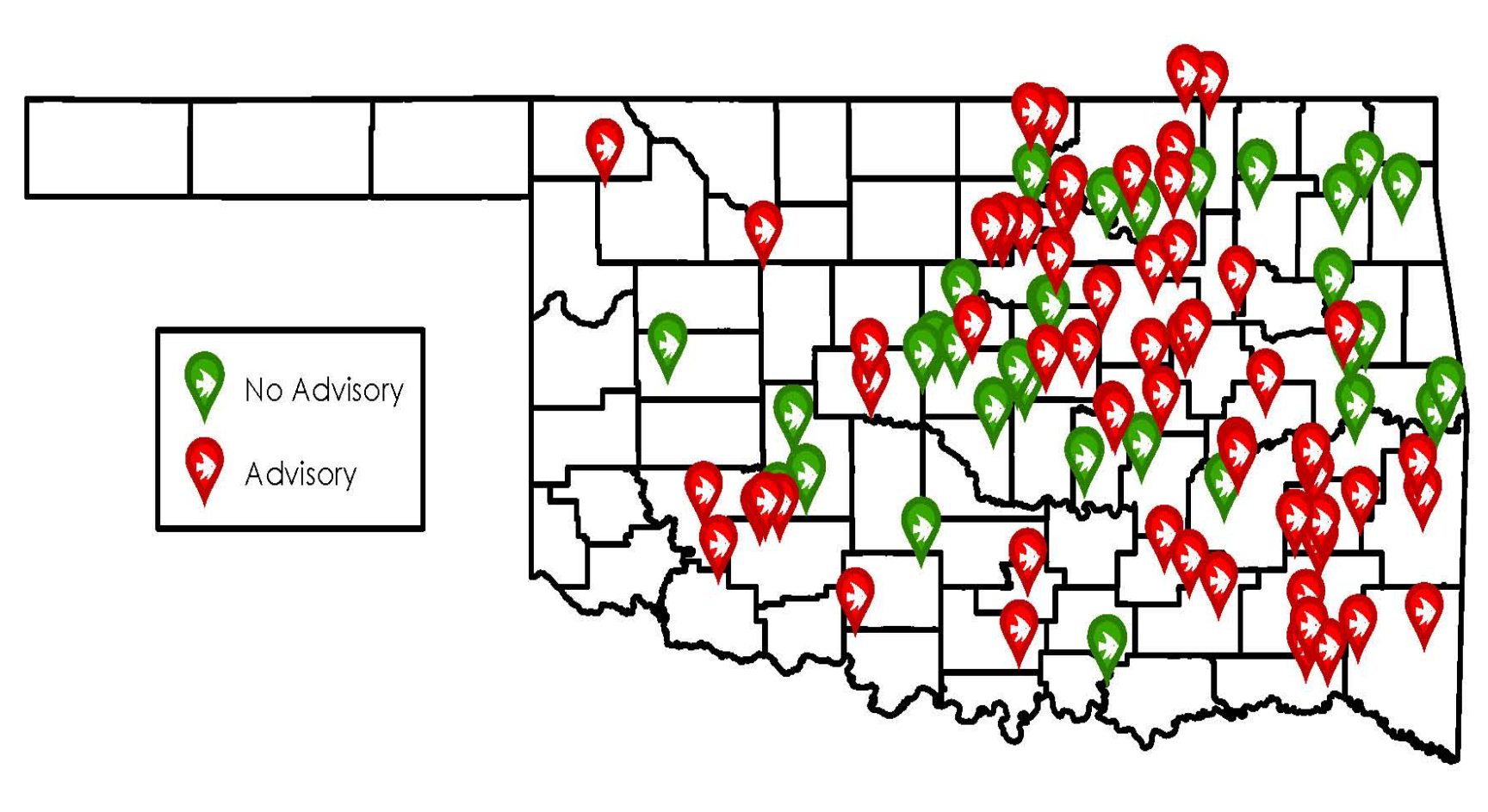
Sensitive Population: Do not eat
General Population: 2 meals per month 12 inches and over

Survey of Mercury in Fish: Results

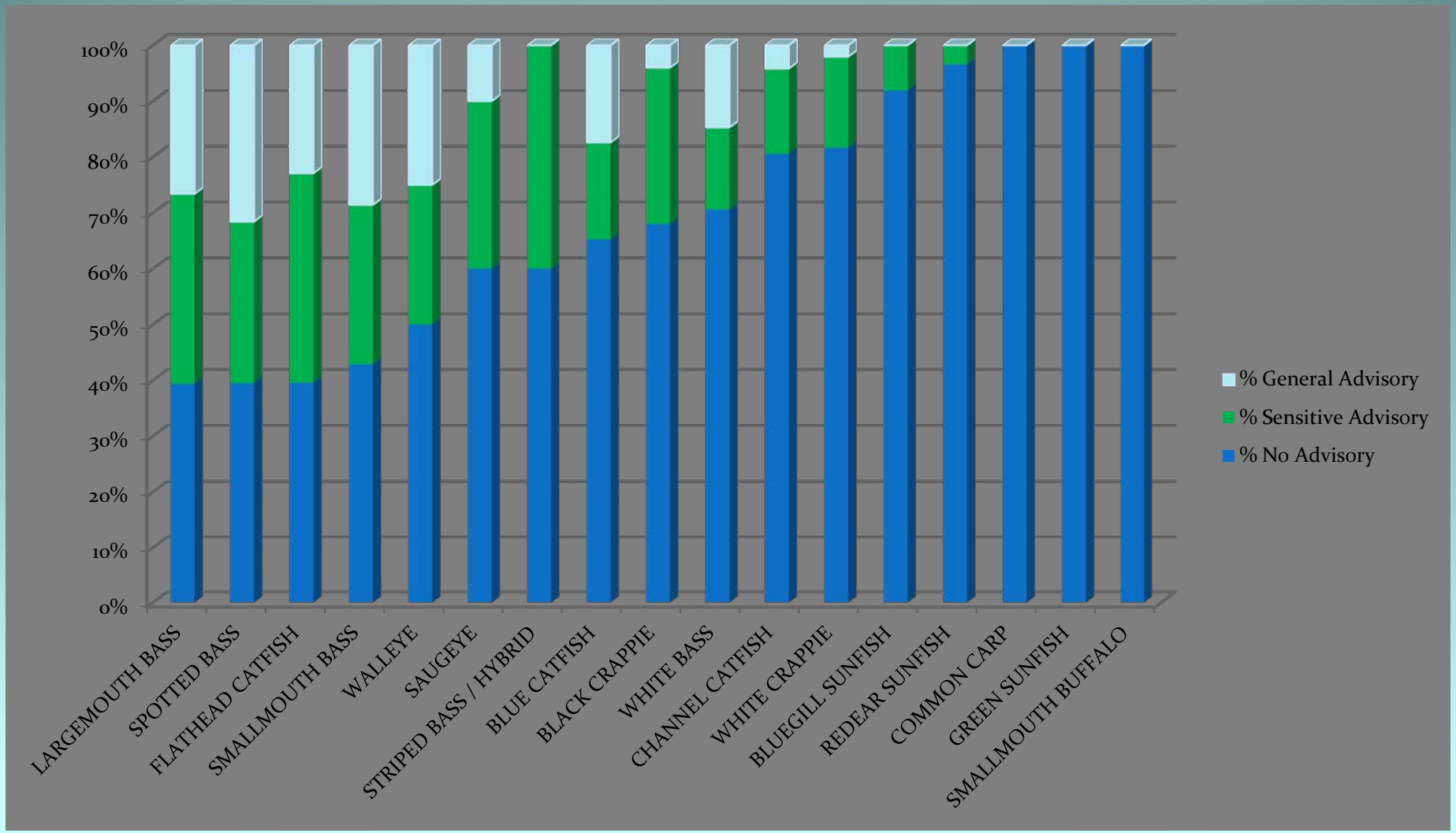


Sensitive Population: Do not eat
General Population: Do not eat

Status of Oklahoma Lakes



Advisories by Species



What We Have Learned

- Lakes in SE OK have some of the highest Hg values in the nation

- Lakes in NE OK have low Hg values despite similar wet deposition levels as SE OK

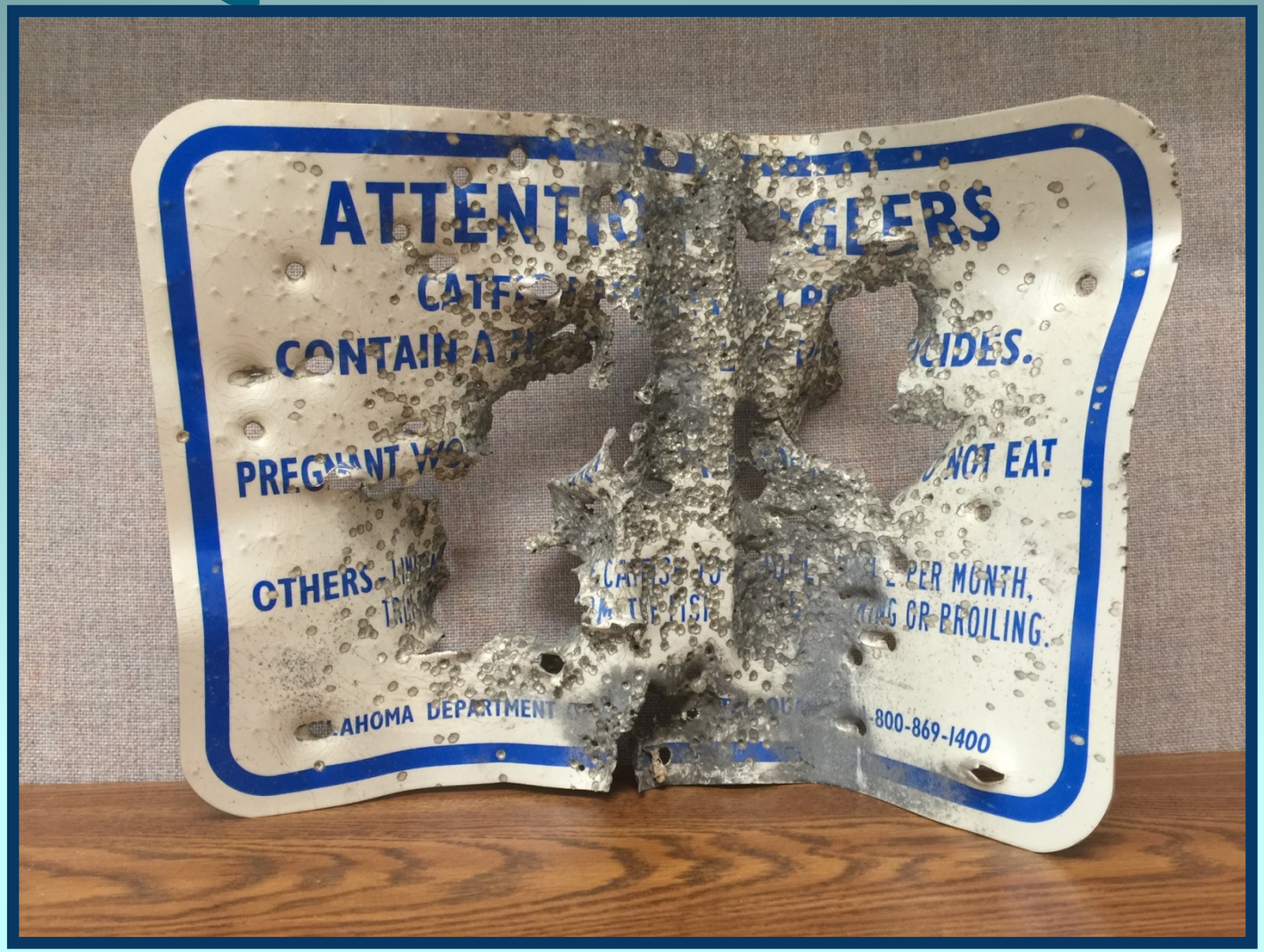
- The differences in fish Hg levels between NE and SE OK are likely due to differences is forest type and WQ conditions

- While some regionalization of Hg concentrations is seen, it is not consistent enough to regionalize consumption advice

Going Forward

- Issue updated advisories
- Sample 25 lakes in 2019
- Fill in gaps where needed
- Follow risk/benefit studies
- Evaluate our message

Questions?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