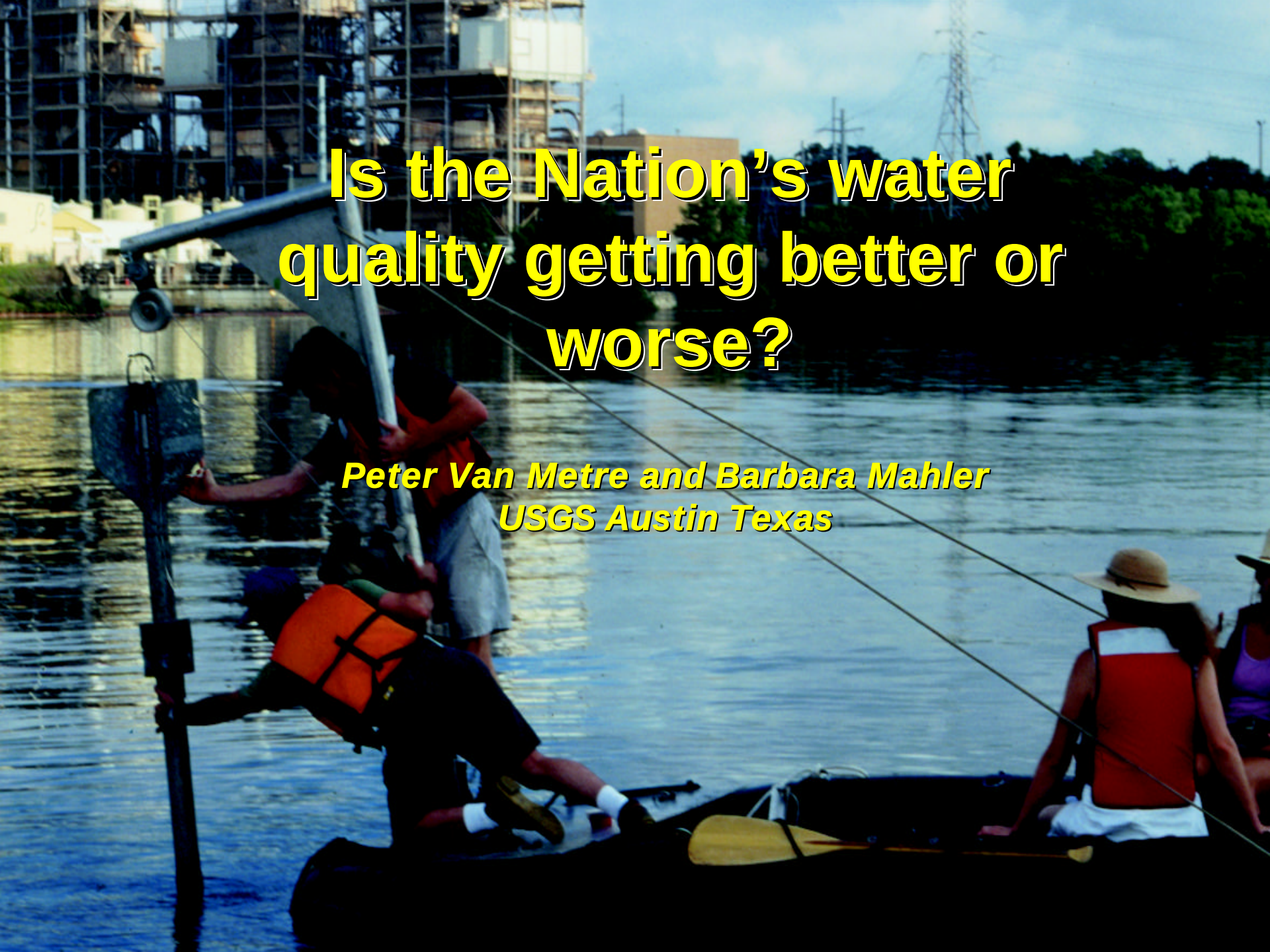


Is the Nation's water quality getting better or worse?

Peter Van Metre and Barbara Mahler
USGS Austin Texas

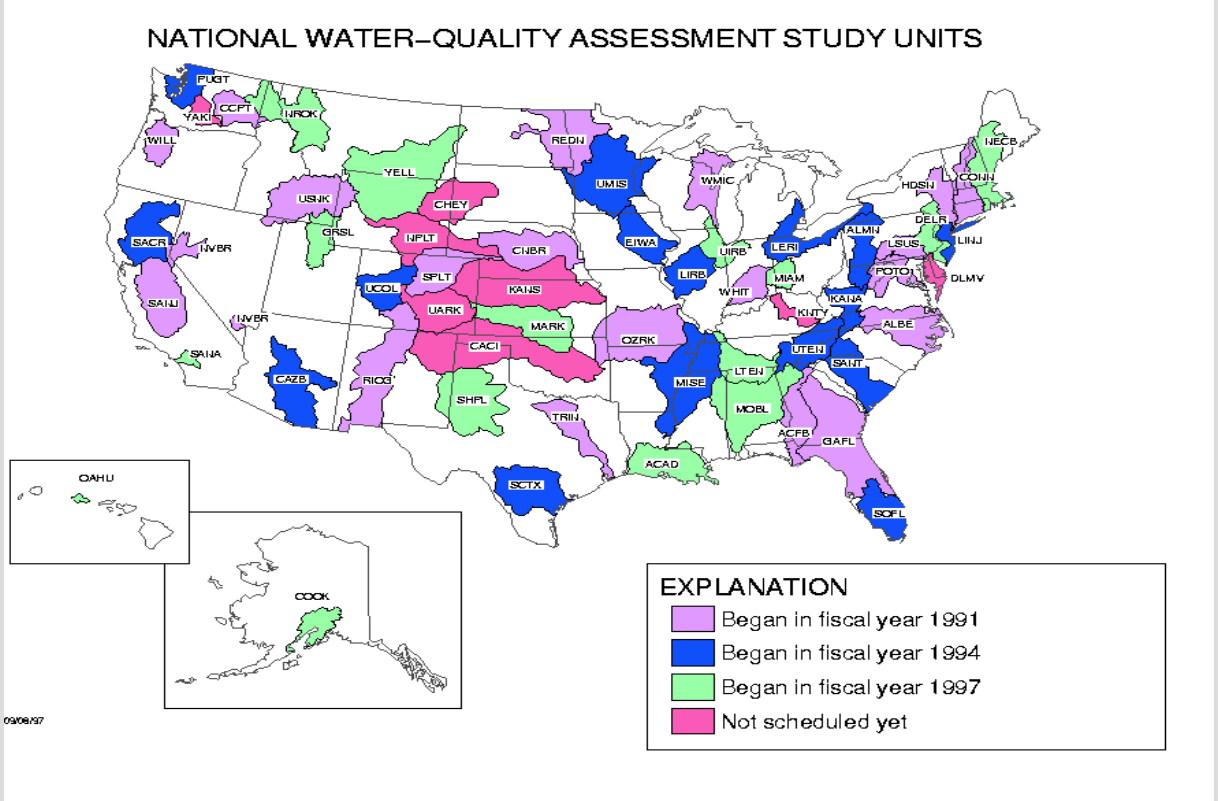
USGS National Water-Quality Assessment (NAWQA) Program:

Objectives

- **STATUS** -- Describe the quality of the Nation's water resources in a Nationally consistent manner
- **TRENDS** -- Assess long-term trends and changes in water quality
- **UNDERSTANDING** -- Identify, describe, and explain factors that govern water quality

NAWQA

- **Multiple Scales** – Study Units for river basin and major aquifers; National Synthesis for national aggregations
- **Stratified, Cyclic Design** – Sampling on decadal cycle stratified by land-use and physiographic regions
- **Focus on cause and effect** – Shift in second decade from assessment to topical studies (e.g. urbanization, ag pesticides, Hg, transport between GW and SW, etc.)

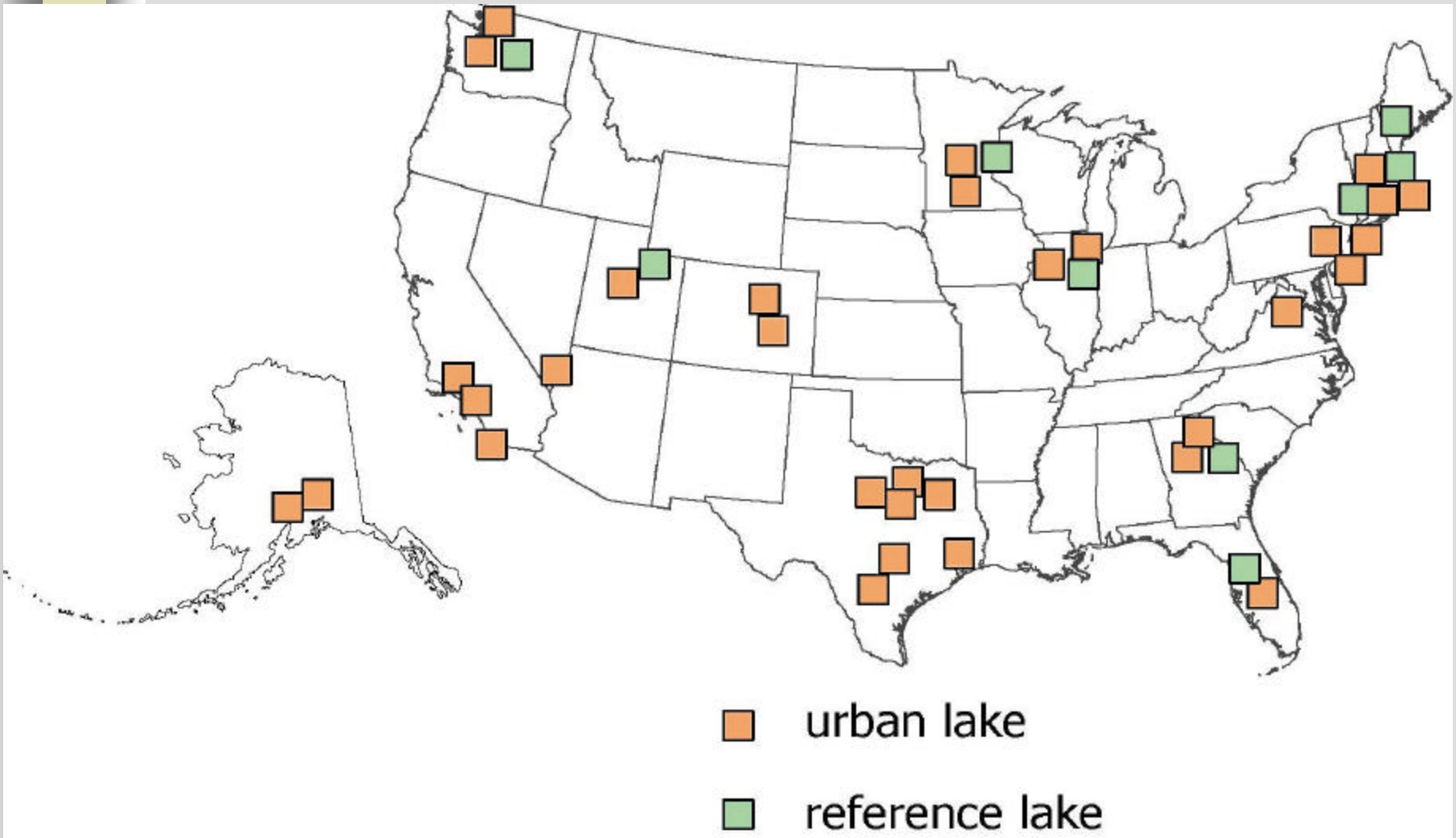


NAWQA Reconstructed Trends Study

- Identify trends, or lack of trends, for PACs in urban and reference settings across the U.S.
- Determine causes of trends: e.g. land use change, regulatory actions

Lakes Sampled from 1996-2001

33 urban lakes, 9 reference lakes



What contaminants can we study in cores?

SQGs by EPA, Environment Canada, etc.

Metals

- Arsenic*
- Cadmium*
- Chromium
- Copper
- Mercury*
- Nickel
- Lead*
- Zinc

Organochlorines

- DDT*
- DDE*
- DDD*
- Total PCBs*
- Dieldrin*
- Chlordane*

PAHs

- Naphthalene
- Fluorene
- Phananthrene
- Anthracene
- Fluoranthene
- Pyrene
- Benz(a)Anth.
- Chrysene
- Benzo(a)pyrene*
- Total PAH*

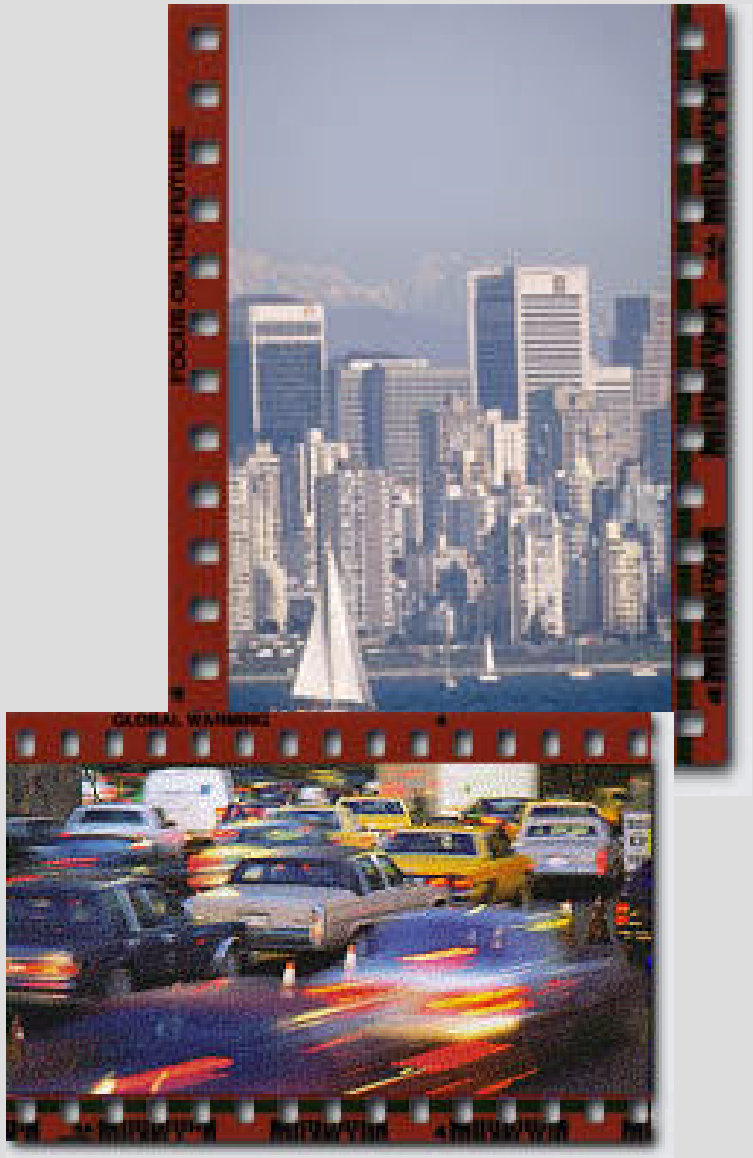
*EPA/ATSDR top 20 priority pollutant

Why Use Sediment Cores to Quantify Trends?

- Can correlate to long-term trends in environmental conditions
- Immediate measures of trend using same analytical method for all samples
- Makes use of natural integration over space/time
- Simultaneously evaluate many sediment-bound contaminants

Why focus on urban? Why stratify?

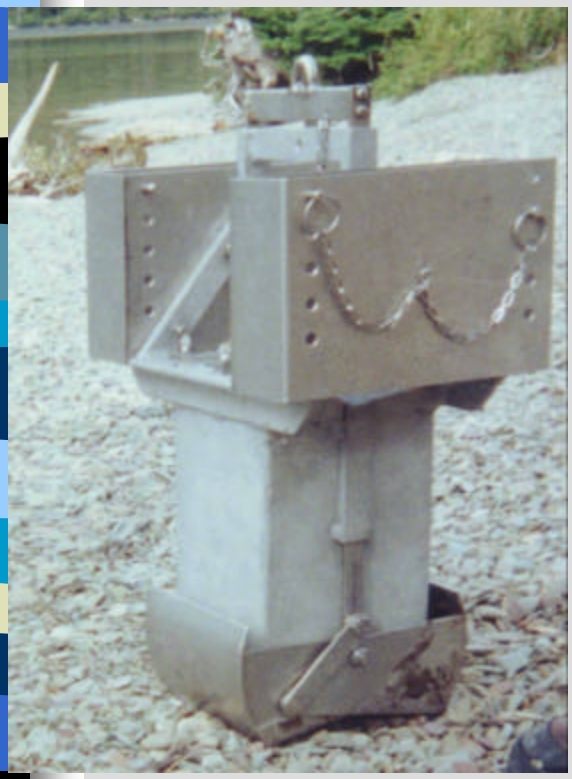
- Only about 5.3% of US is urban, but it's the fastest growing land use type
- And it's where 80% of Americans live
- Concentration of people, cars, and industry leads to lots of contamination
- Knowing the above, to efficiently study urban vs non-urban, we stratify



Sampling, from remote reference to urban

Corers used

Box Corer



Piston Corer

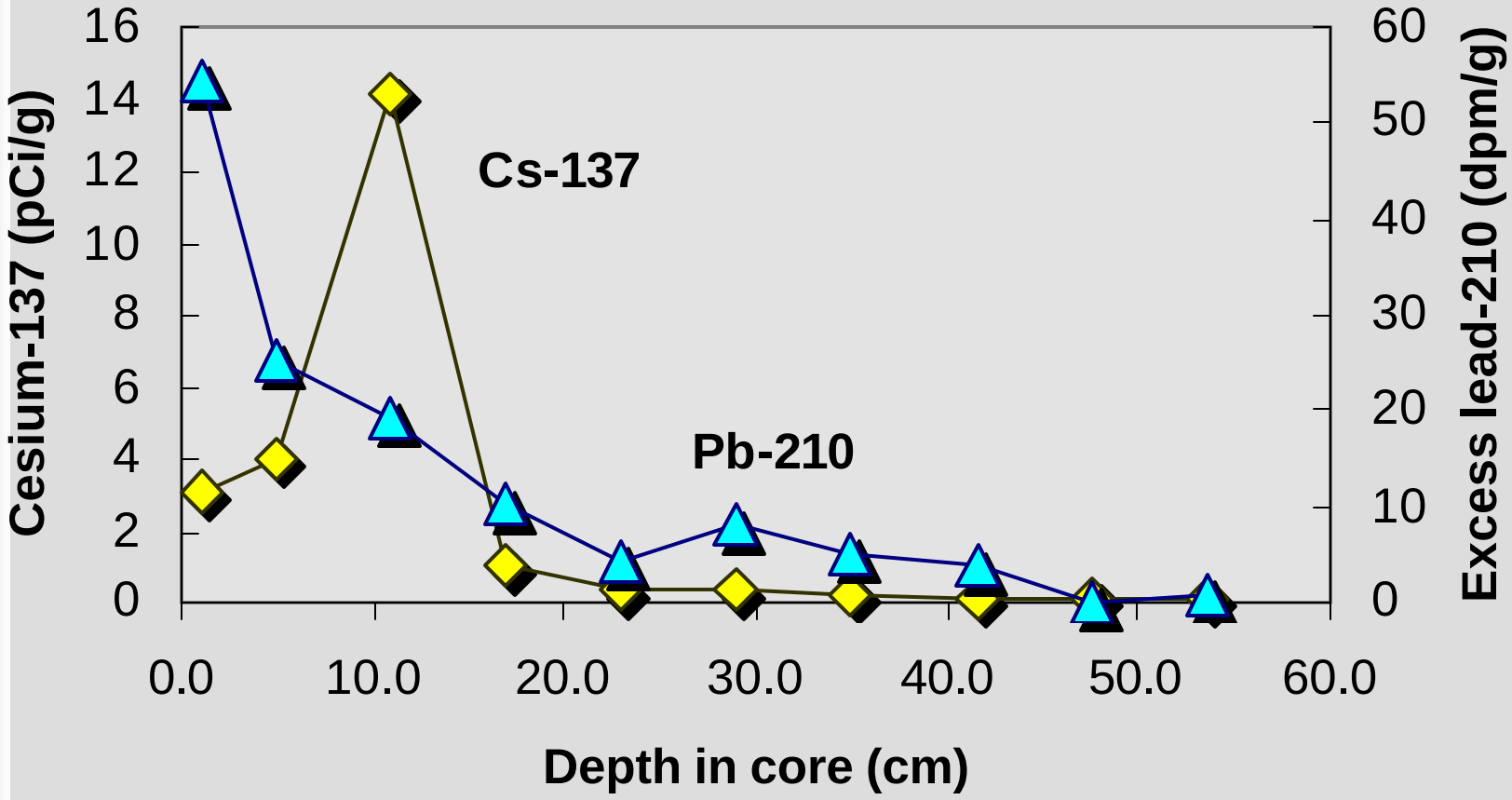
Gravity Corer

An undisturbed box core

Subsampling a core

Step 1, Age Dating

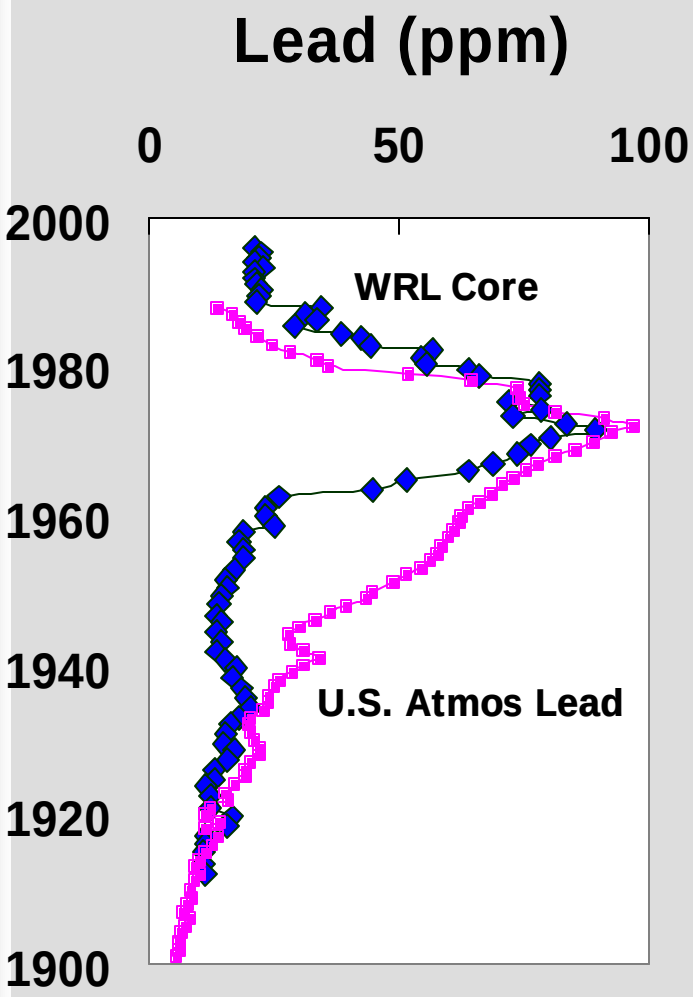
Lake Harriet, Minneapolis

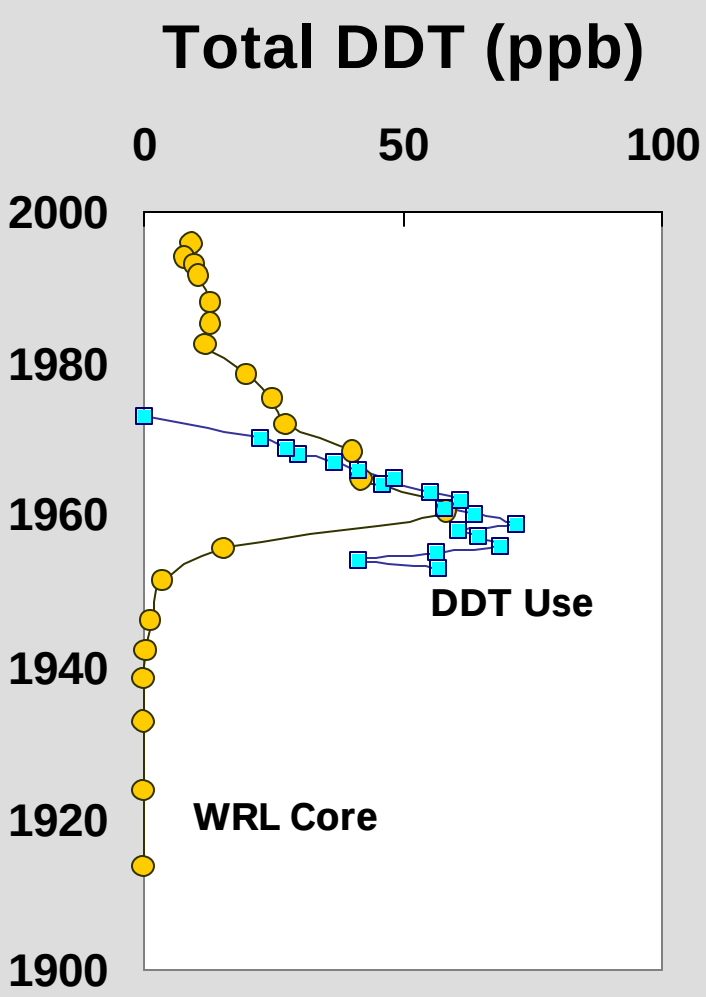


National Trends Approach

- 41 lakes tested for HOCs, 1970-top of core
- 42 lakes tested for metals, 1975-top of core
- Kendall's tau used at alpha > 90%
- Decadal means also compared (70s vs 90s)
- And concentrations compared to SQGs

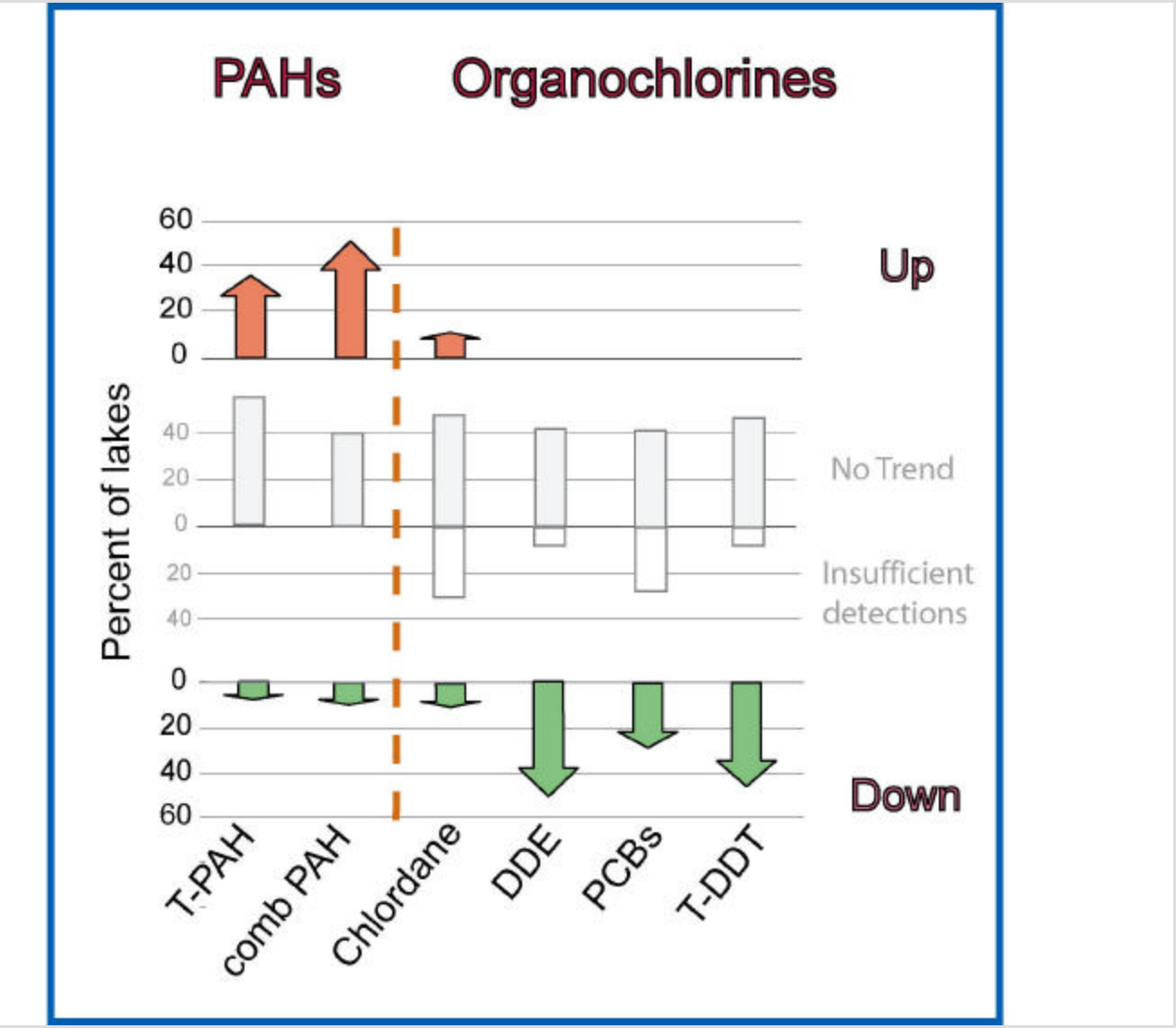
What will Kendall tau from the 1970s tell us about historical trends?



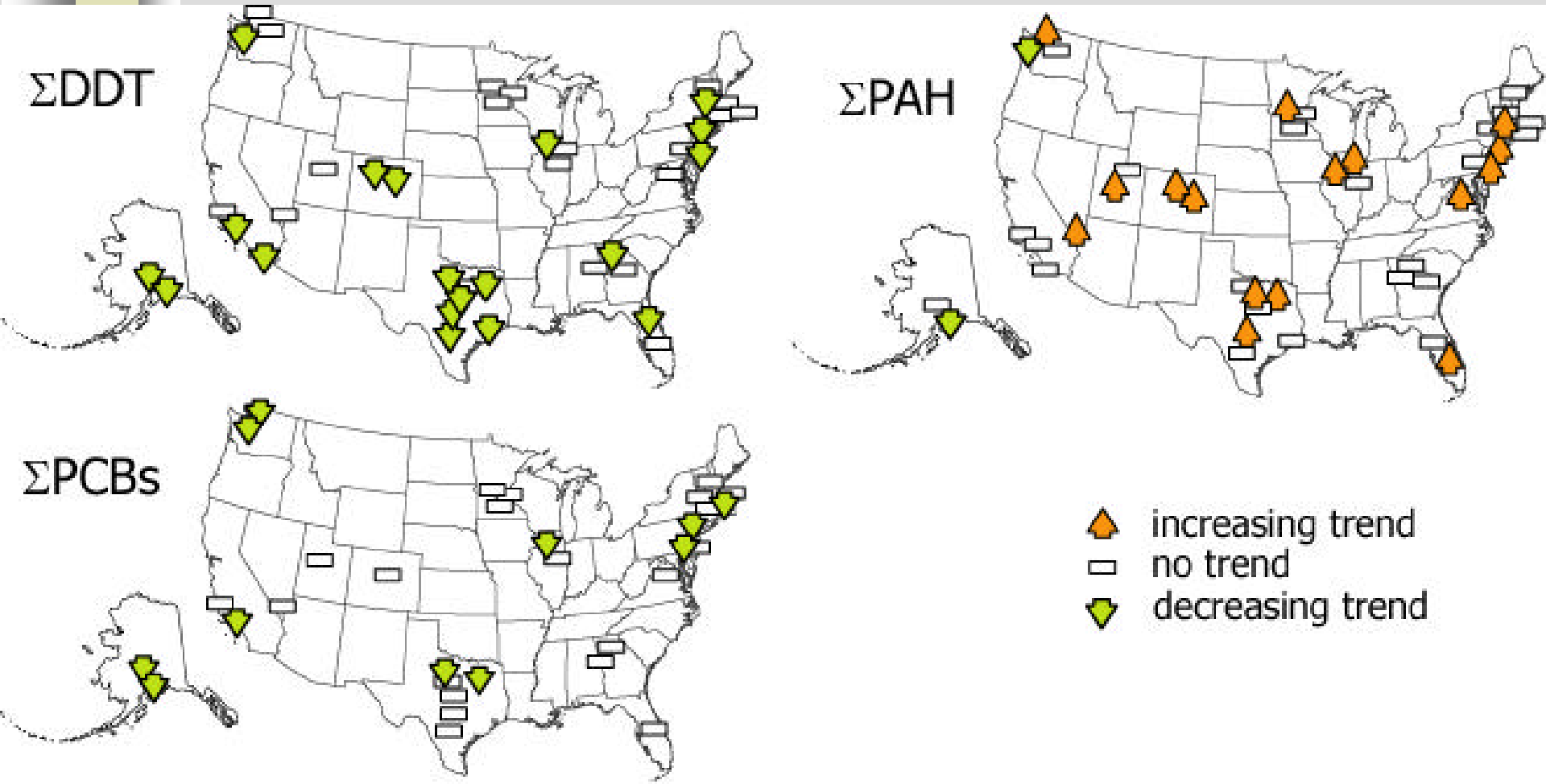


National Trends in HOCs

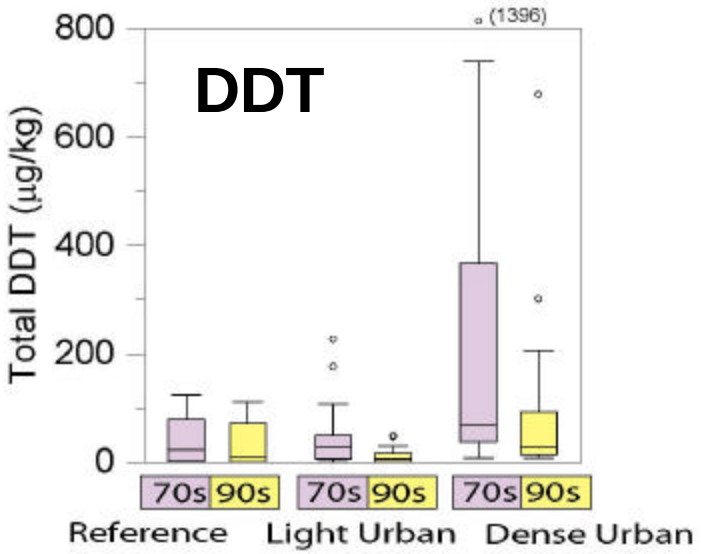
PAHs are up, OCs are down…

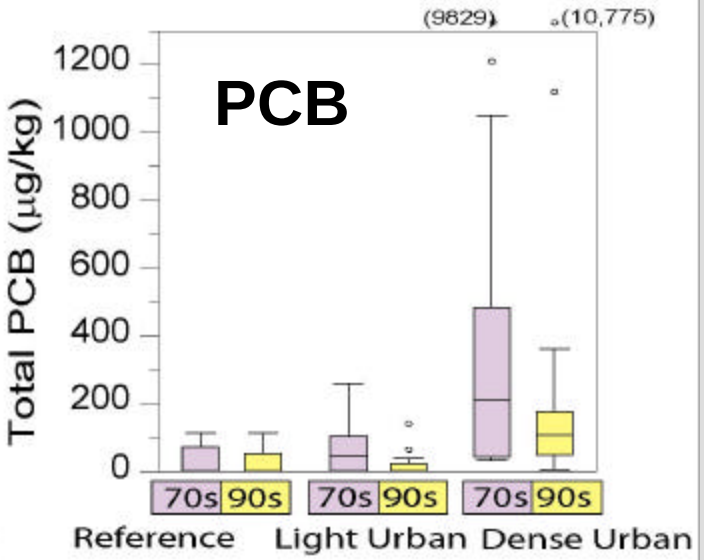


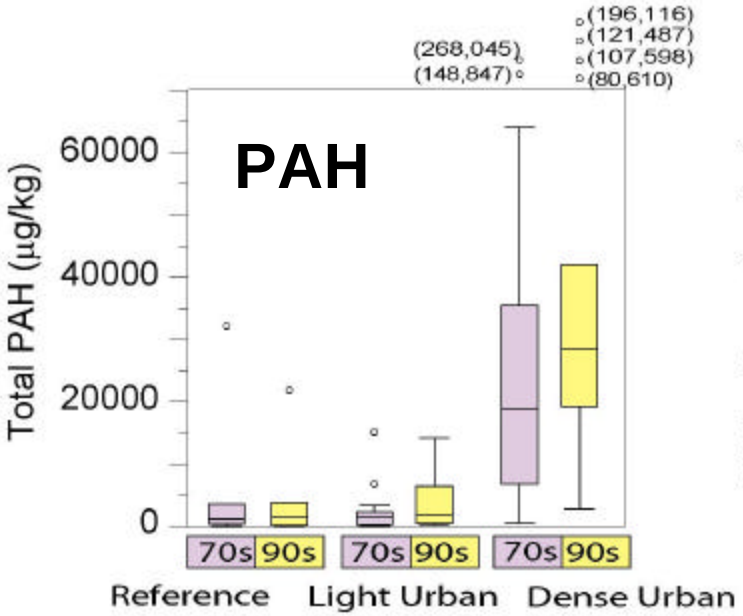
Map view

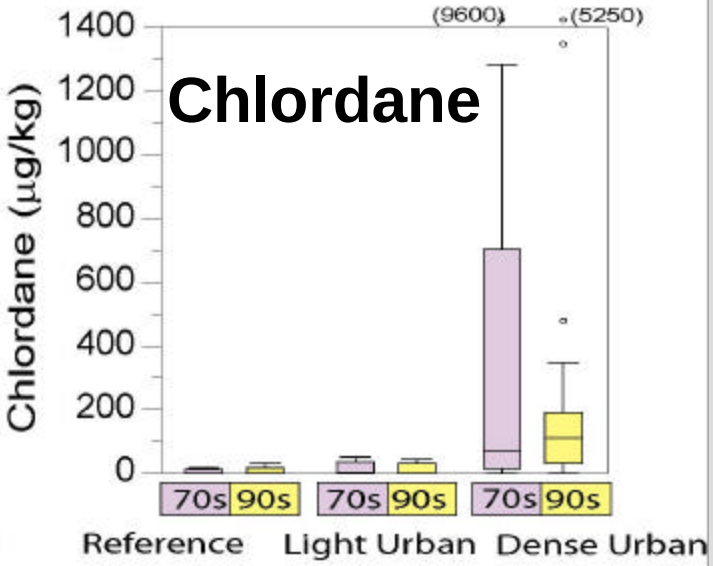

ΣDDT
ΣPAH
ΣPCBs
increasing trend
no trend
decreasing trend

Decadal change







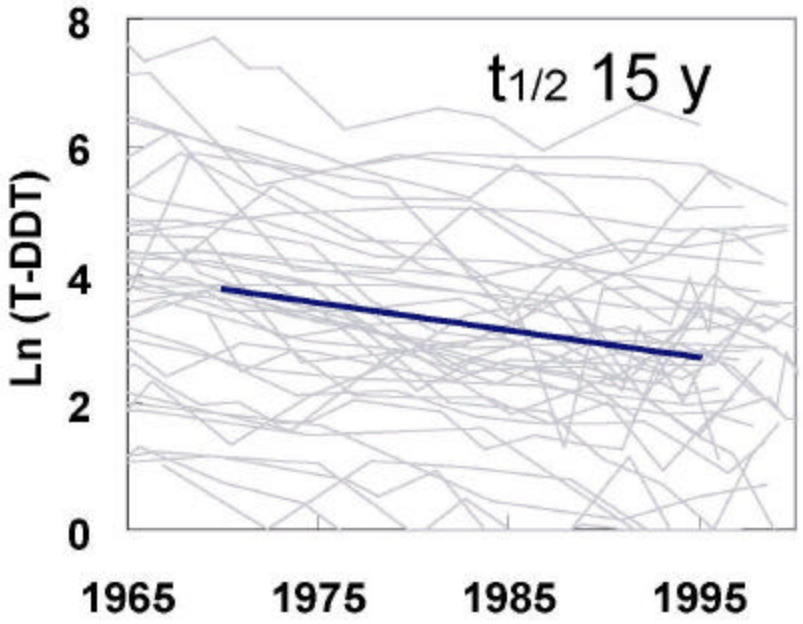


Land Use

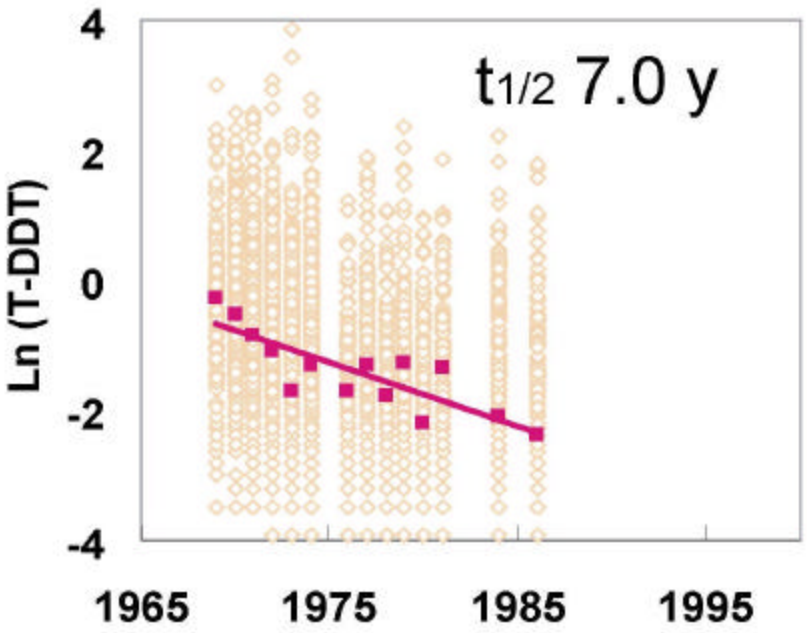
DDT and PCBs decreasing slower in cores than in fish

Total DDT

Cores



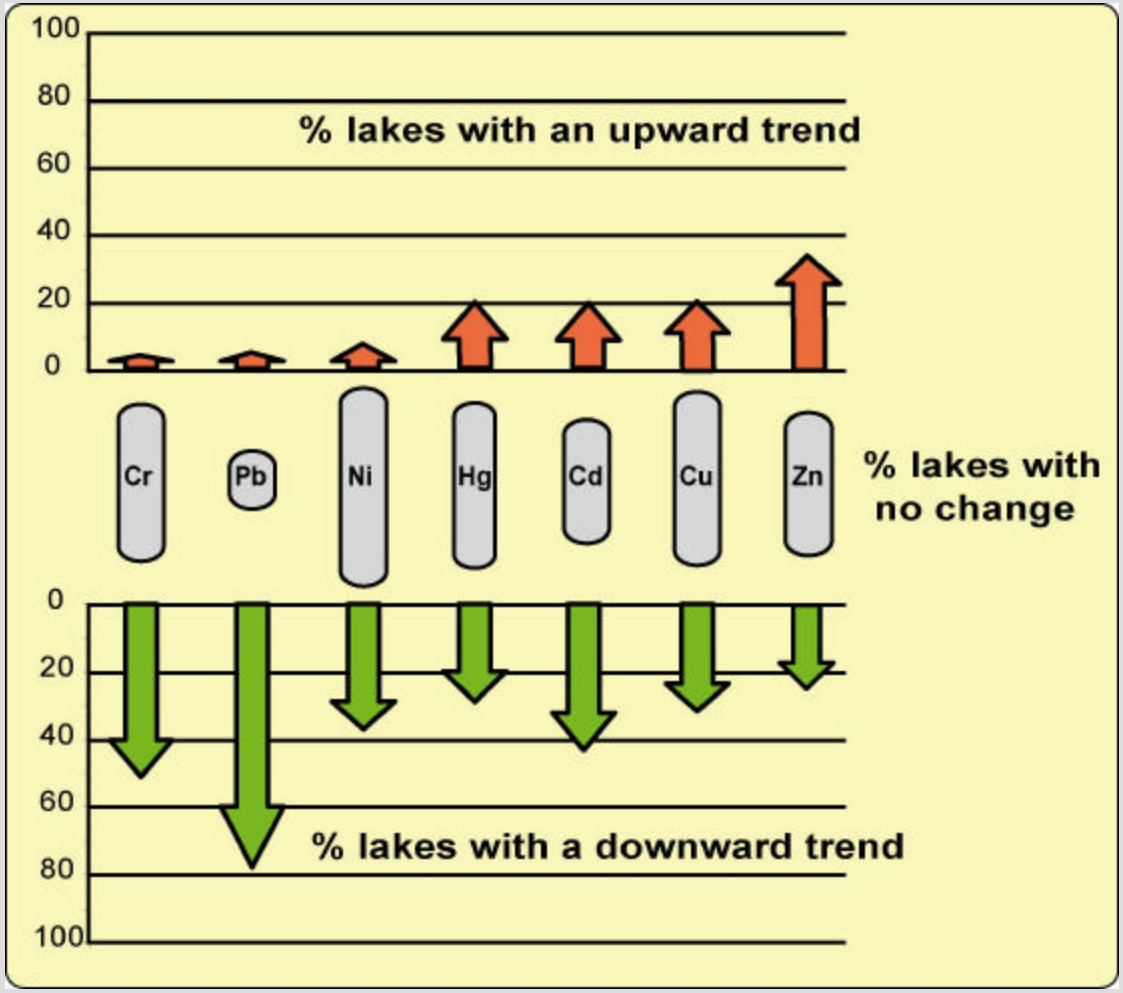
Fish

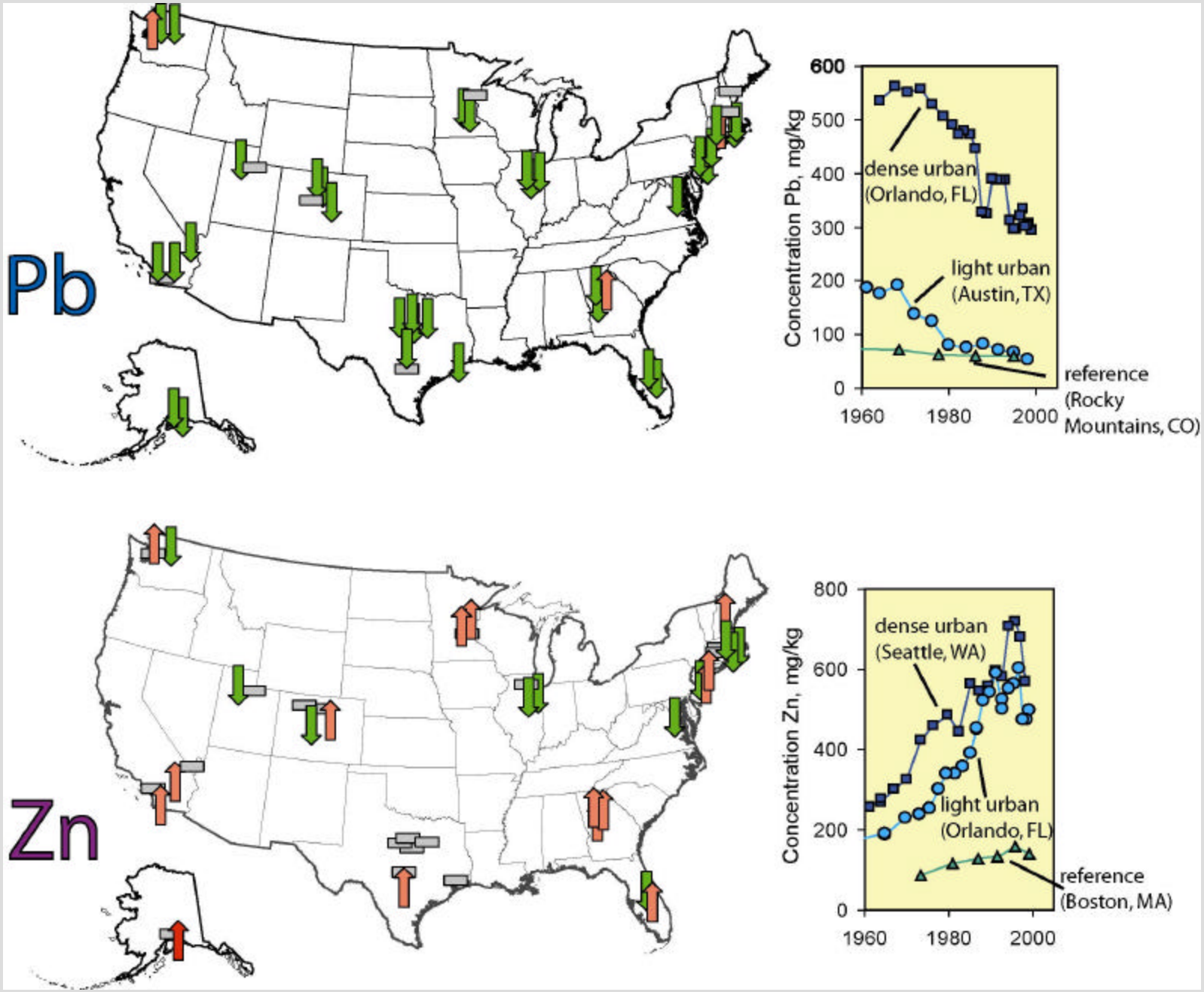


NCBP fish data, USFWS

But there are patterns Nationally
Trends from 1975 to Present

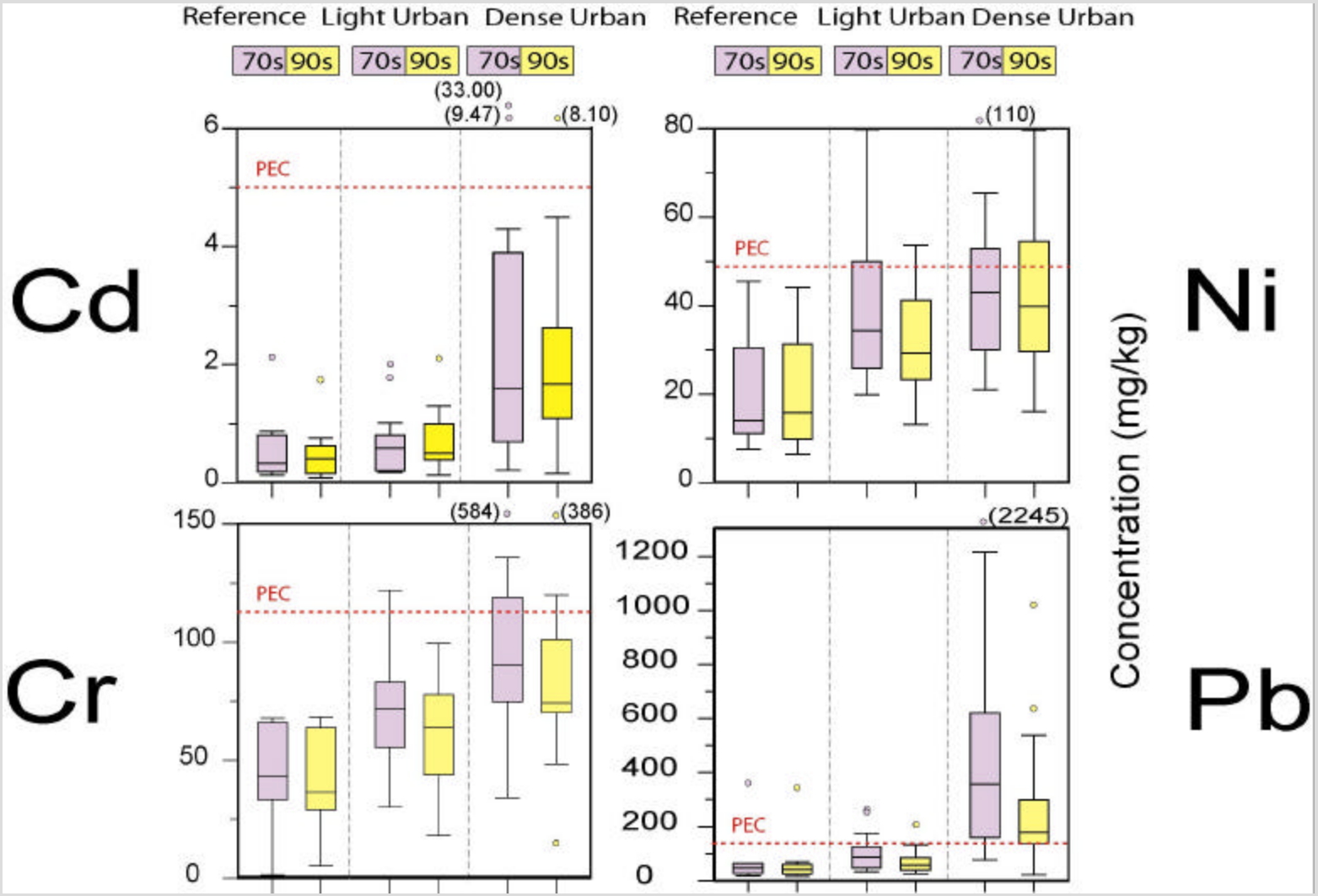
Downward trends > upward trends for all metals except zinc



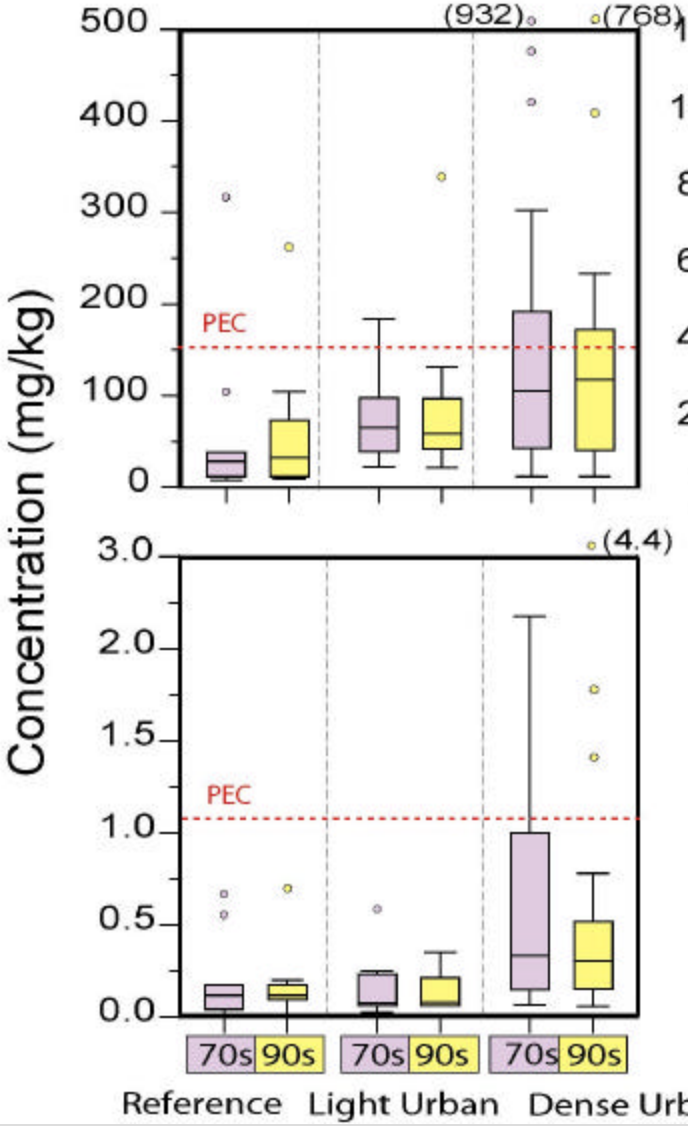

Pb
Concentration Pb, mg/kg
600
500
400
300
200
100
0
1960
1980
2000
dense urban
(Orlando, FL)
light urban
(Austin, TX)
reference
(Rocky
Mountains, CO)
Zn
Concentration Zn, mg/kg
800
600
400
200
0
1960
1980
2000
dense urban
(Seattle, WA)
light urban
(Orlando, FL)
reference
(Boston, MA)


Cr
Cd
Hg
Ni

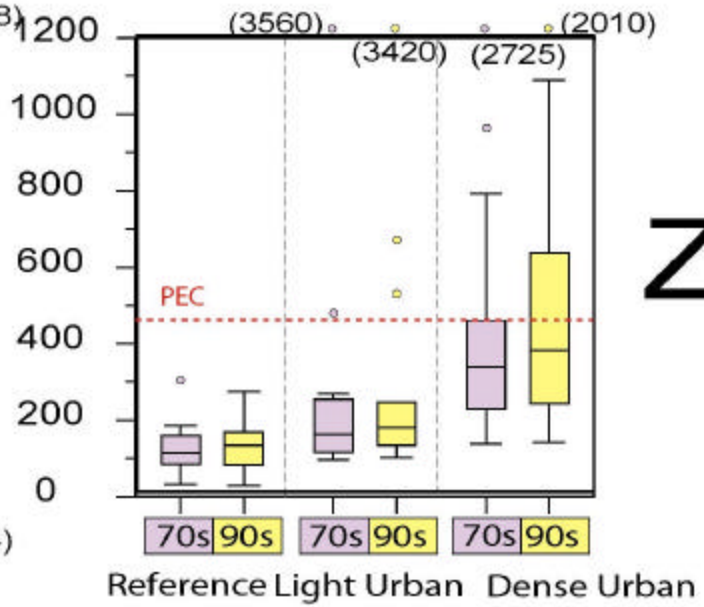
The catch – decreases are small and urban levels are still high



Cu

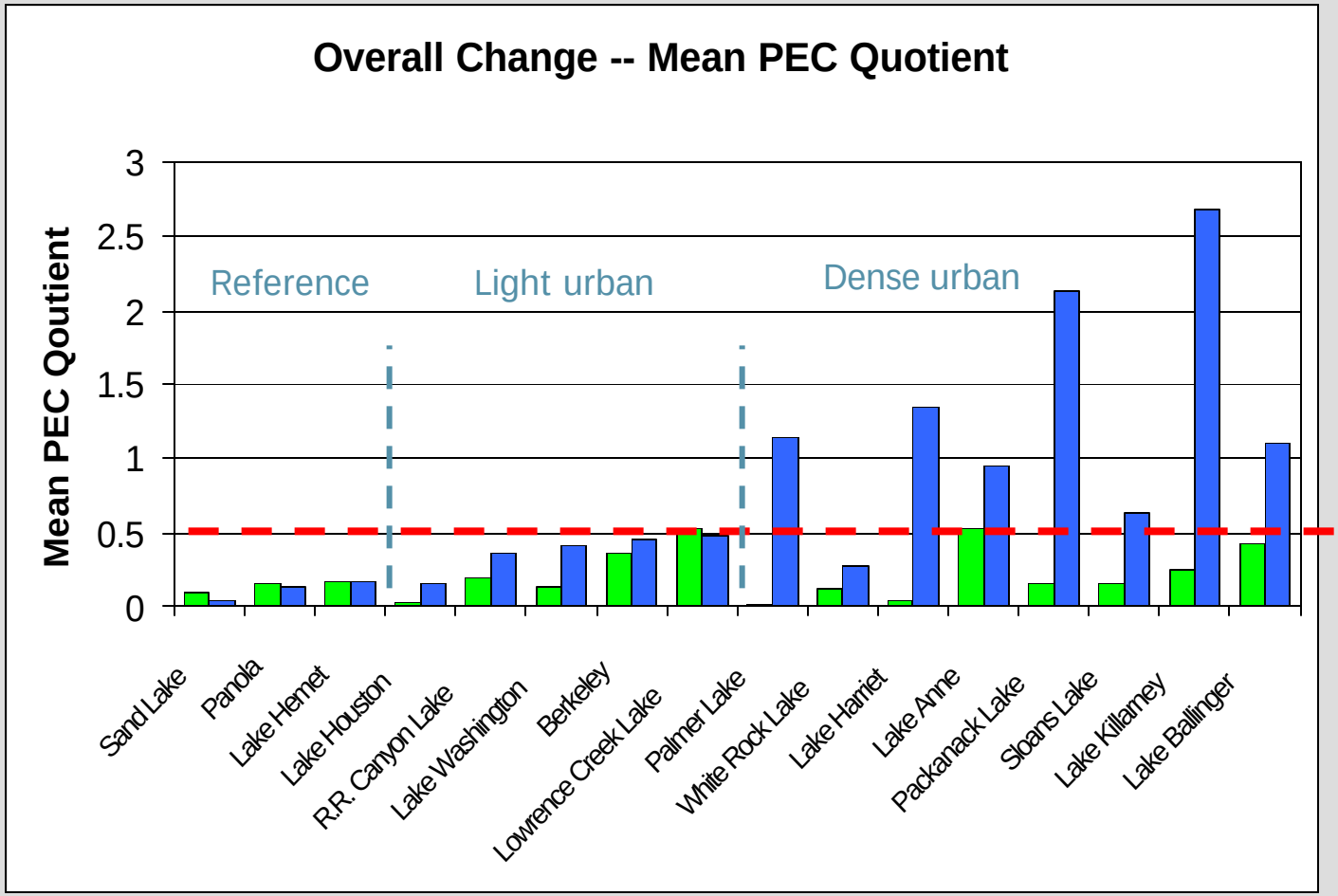

Concentration (mg/kg)
500
400
300
200
100
0
(932)
(768)
PEC
3.0
2.0
1.5
1.0
0.5
0.0
(4.4)
PEC
70s 90s 70s 90s 70s 90s
Reference Light Urban Dense Urban

Zn


1200
1000
800
600
400
200
0
(3560)
(3420)
(2725)
(2010)
PEC
70s 90s 70s 90s 70s 90s
Reference Light Urban Dense Urban

Hg

Overall effect of urbanization



Mean PEC Quotient is a summary of the 16 contaminants with "reliable" consensus-based SQGs (MacDonald et al, 2000)

Summary: National Trends in PACs

- Organochlorines decreasing, 12-15 yr half life for DDT and PCBs
- PAHs increasing, especially rapid increase with urbanization
- Metals decreasing except Zn, decreases widespread but small in magnitude
- Overall toxicity probably slightly greater now than in 1970s, for similar land use
- Urbanization causes decline in sediment quality