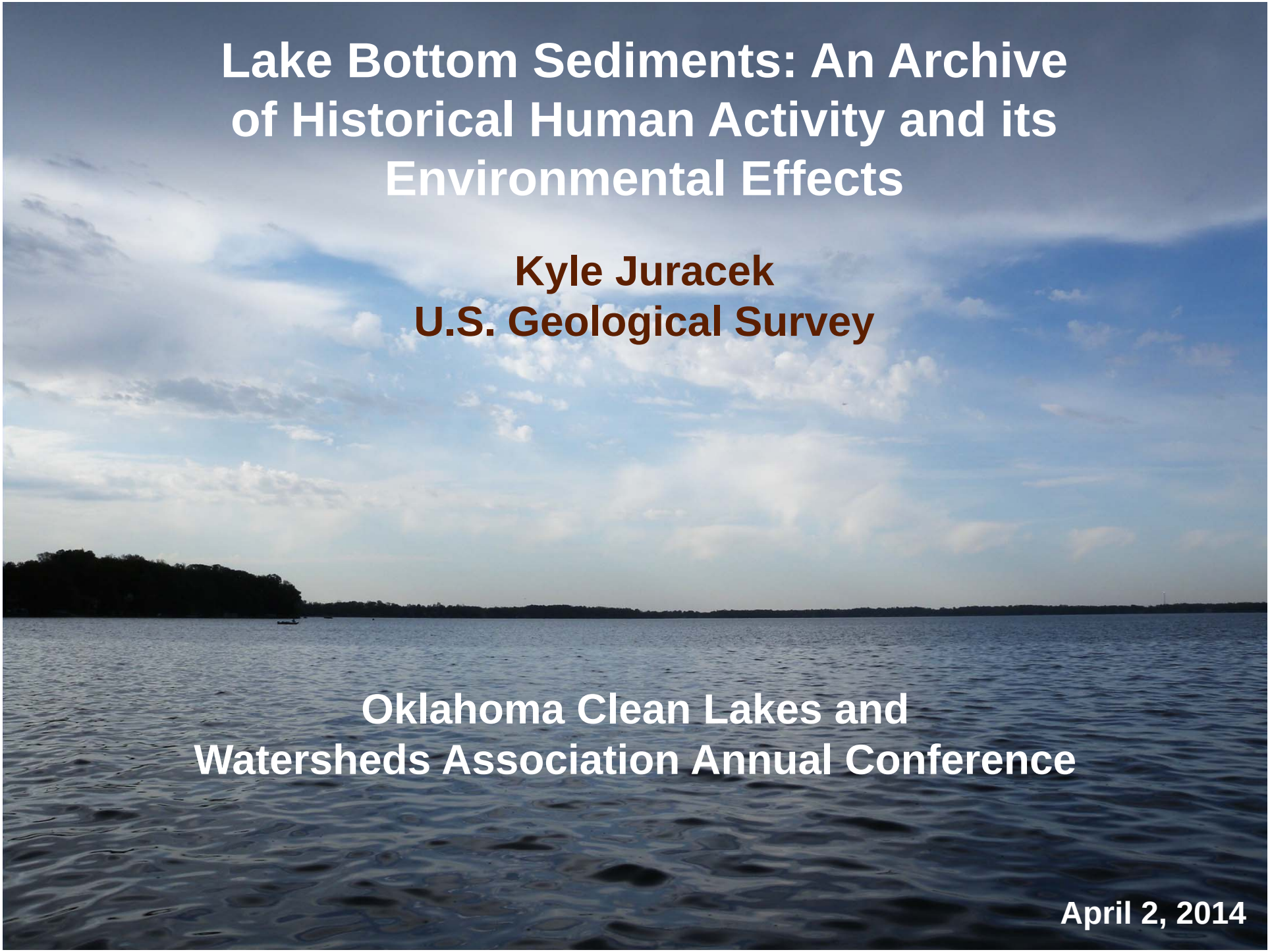


Lake Bottom Sediments: An Archive of Historical Human Activity and its Environmental Effects

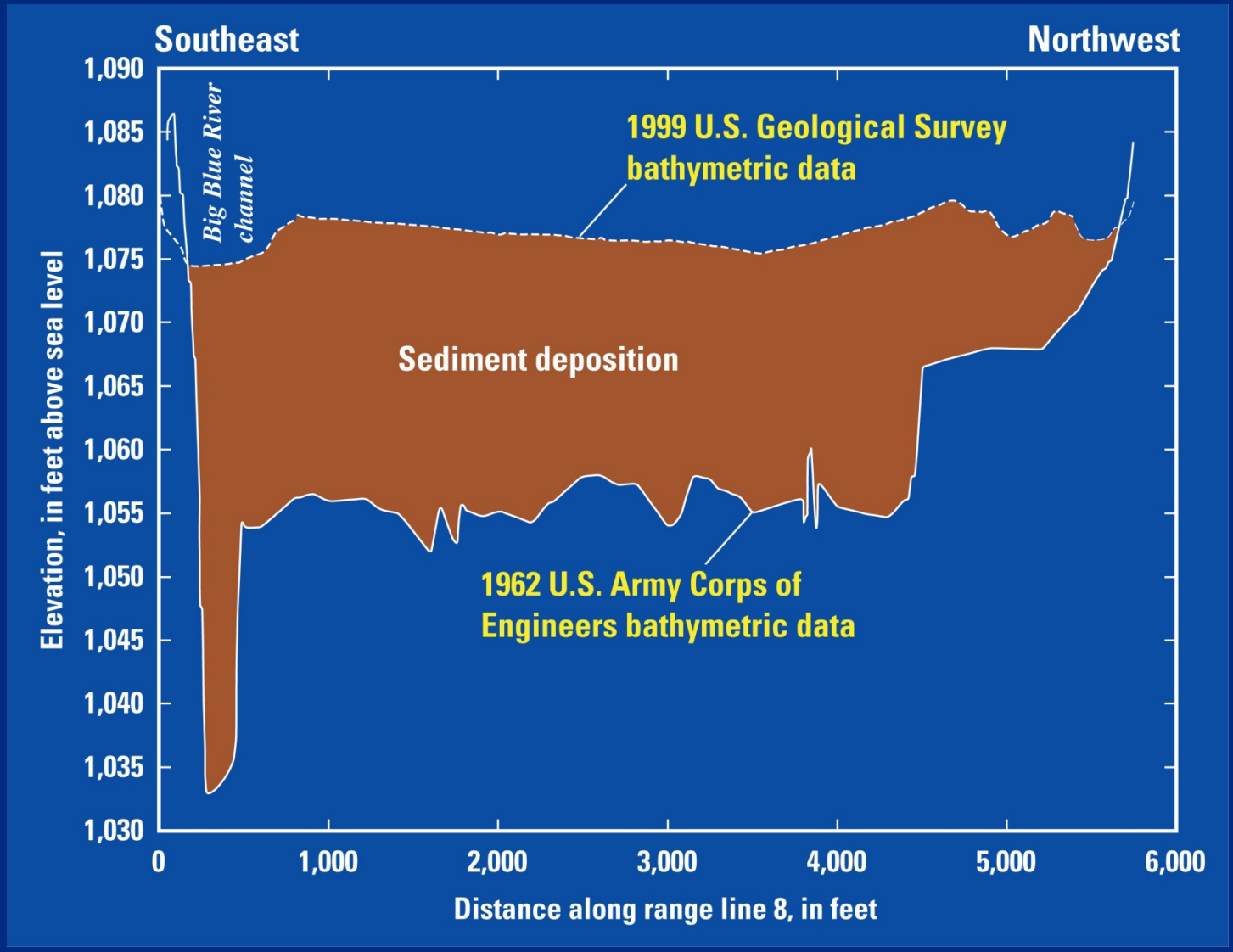
Kyle Juracek
U.S. Geological Survey

Oklahoma Clean Lakes and Watersheds Association Annual Conference

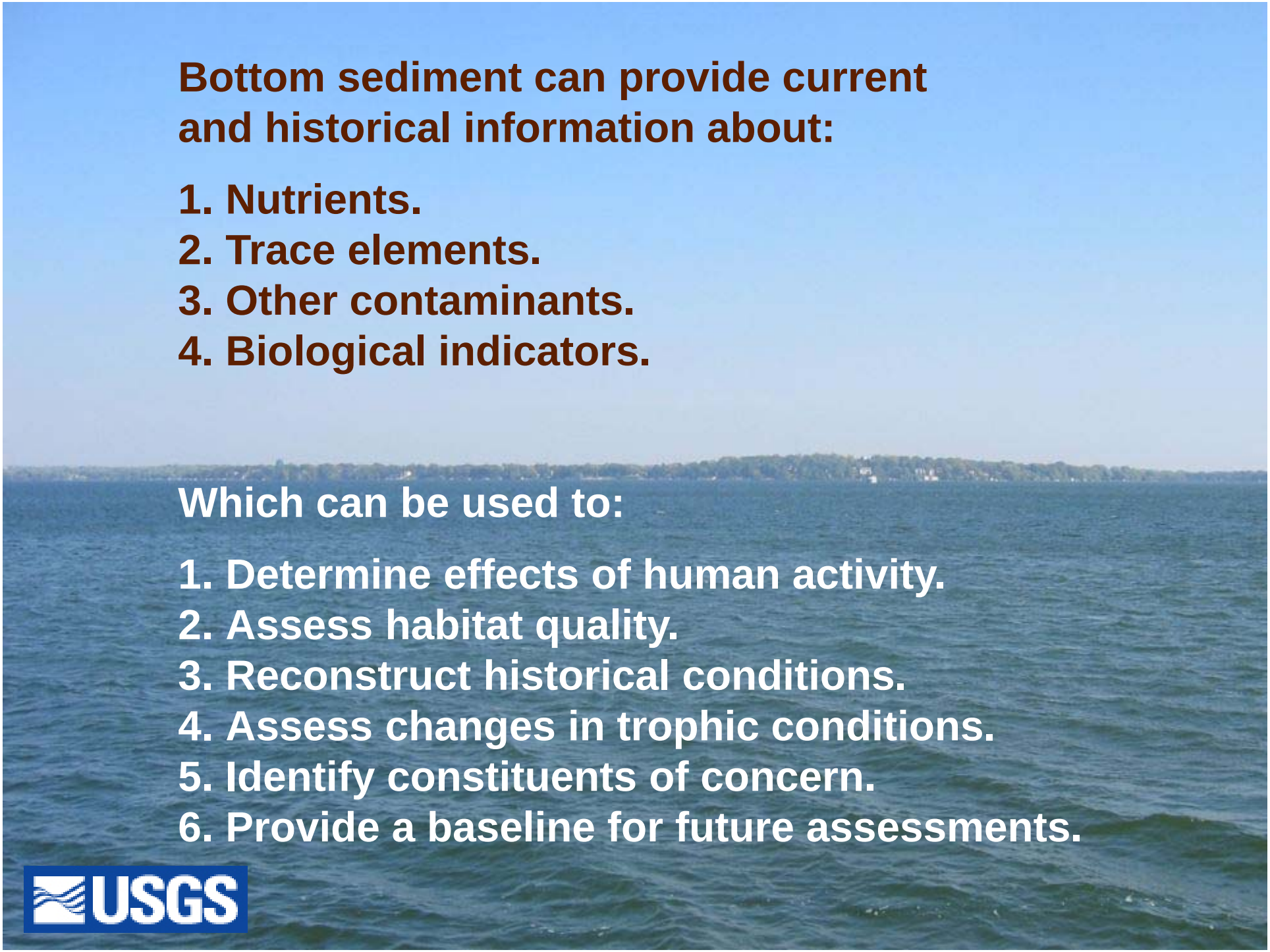
April 2, 2014


Every lake has a story to tell…
…and part of that story is told by the bottom sediment.
USGS

Sediment Deposition in Tuttle Creek Lake



USGS



Bottom sediment can provide current and historical information about:

1. Nutrients.
2. Trace elements.
3. Other contaminants.
4. Biological indicators.

Which can be used to:

1. Determine effects of human activity.
2. Assess habitat quality.
3. Reconstruct historical conditions.
4. Assess changes in trophic conditions.
5. Identify constituents of concern.
6. Provide a baseline for future assessments.

USGS

Top 20 Hazardous Substances from the CERCLA Priority List of Hazardous Substances for 2011

*1. Arsenic
*2. Lead
*3. Mercury
4. Vinyl Chloride
*5. PCBs
6. Benzene
*7. Cadmium
*8. Benzo(a)pyrene
*9. PAHs
*10. Benzo(b)fluoranthene
11. Chloroform
*12. Aroclor 1260
*13. DDT
*14. Aroclor 1254
*15. Dibenzo(a,h)anthracene
16. Trichloroethylene
*17. Chromium, hexavalent
*18. Dieldrin
*19. Phosphorus, white
*20. Hexachlorobutadiene

*Hydrophobic

USGS

http://www.atsdr.cdc.gov/SPL/index.html

Sediment-Quality Guidelines

Trace element	USEPA (1997)		MacDonald et al. (2000)		Bio-accumulation index[1]
	TEL	PEL	TEC	PEC	
Arsenic	7.24	41.6	9.79	33.0	moderate
Cadmium	.676	4.21	.99	4.98	moderate
Chromium	52.3	160	43.4	111	moderate
Copper	18.7	108	31.6	149	high
Lead	30.2	112	35.8	128	moderate
Mercury	.13	.696	.18	1.06	high
Nickel	15.9	42.8	22.7	48.6	moderate
Silver	.733	1.77	--	--	moderate
Zinc	124	271	121	459	high

Values in milligrams per kilogram.

USGS

[1]source: Pais and Jones (1997)

Sediment Core Collection

Gravity Coring

Box Coring

USGS

Constituent Histories

- Selenium
- Lead
- Copper
- DDE
- Biological indicators

Constituent Histories

- Selenium
- Lead
- Copper
- DDE
- Biological indicators

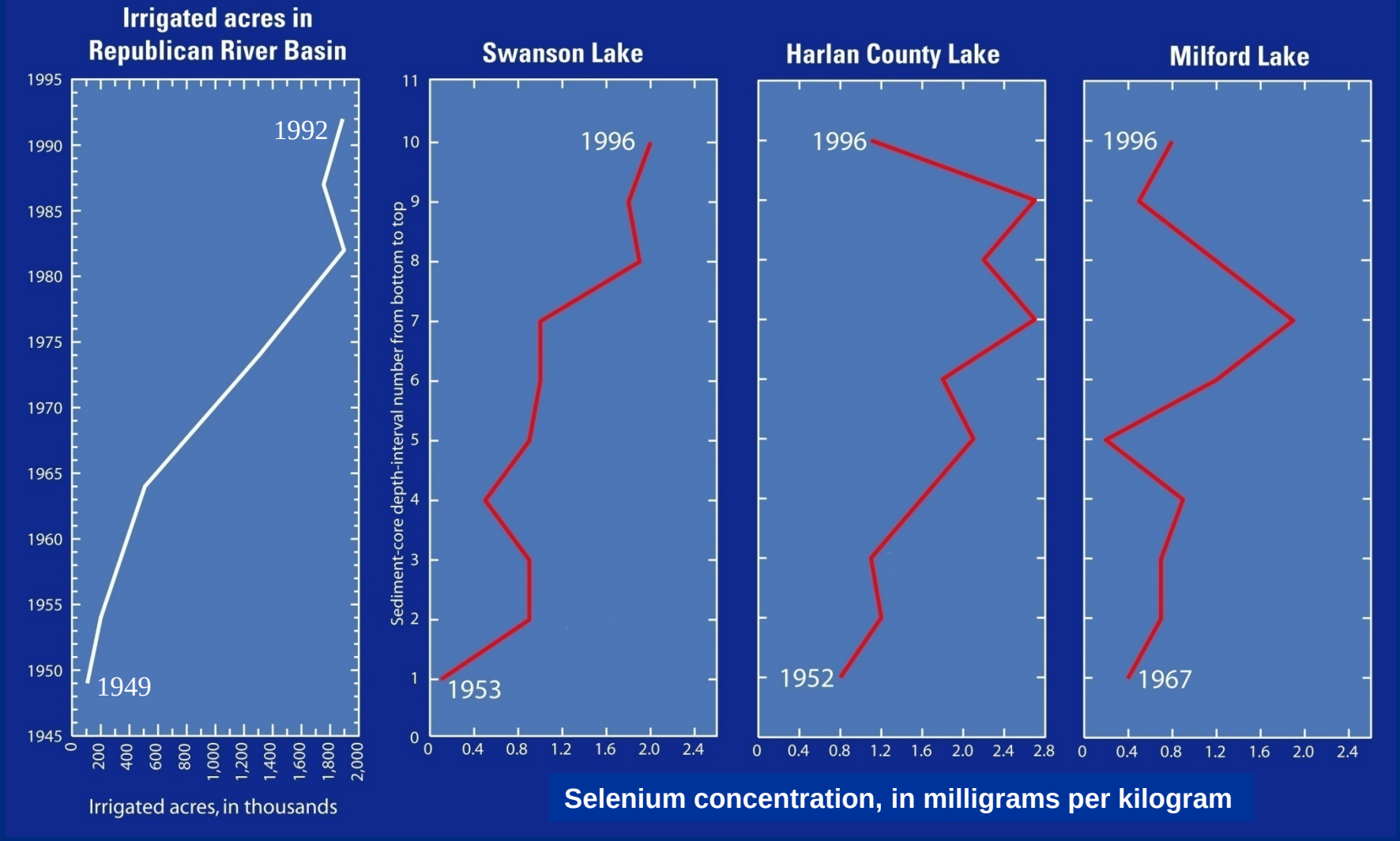
An American coot embryo from Kesterson National Wildlife Refuge, California, with selenium-induced developmental abnormalities including a deformed lower bill and no eyes.

Courtesy H. M. Ohlendorf, U.S. Fish and Wildlife Service

Selenium in Reservoir Bottom Sediment: Republican River Basin

USGS

Irrigation History and Selenium Depositional Profiles in Reservoirs



USGS

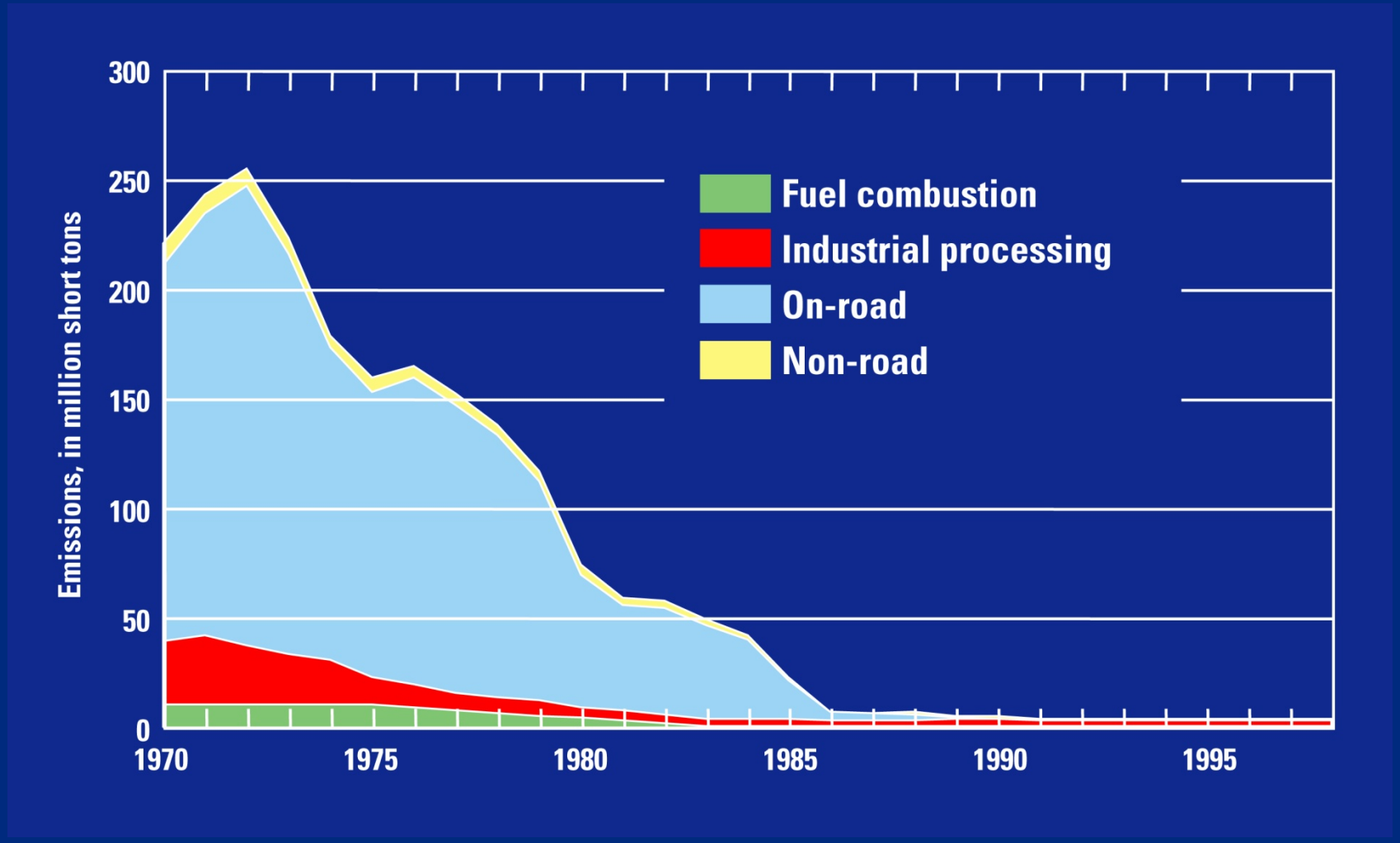
(Juracek and Ziegler, 1998)

Constituent Histories

- Selenium
- Lead
- Copper
- DDE
- Biological indicators

USGS

Total Lead Emissions in U.S. 1970 to 1998

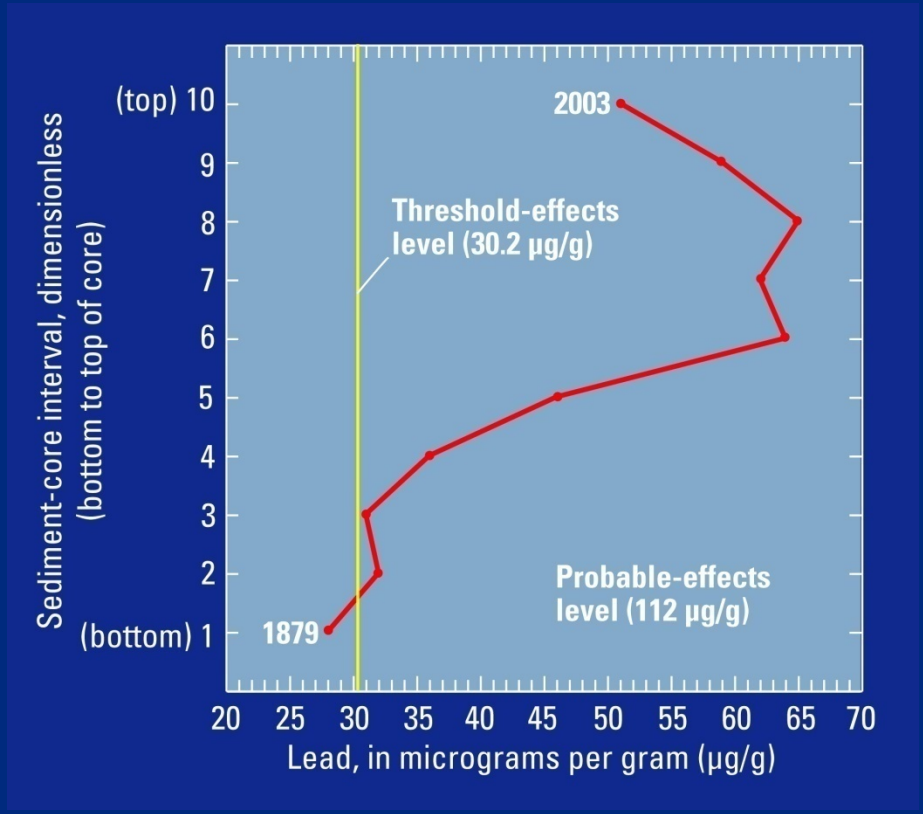


USGS

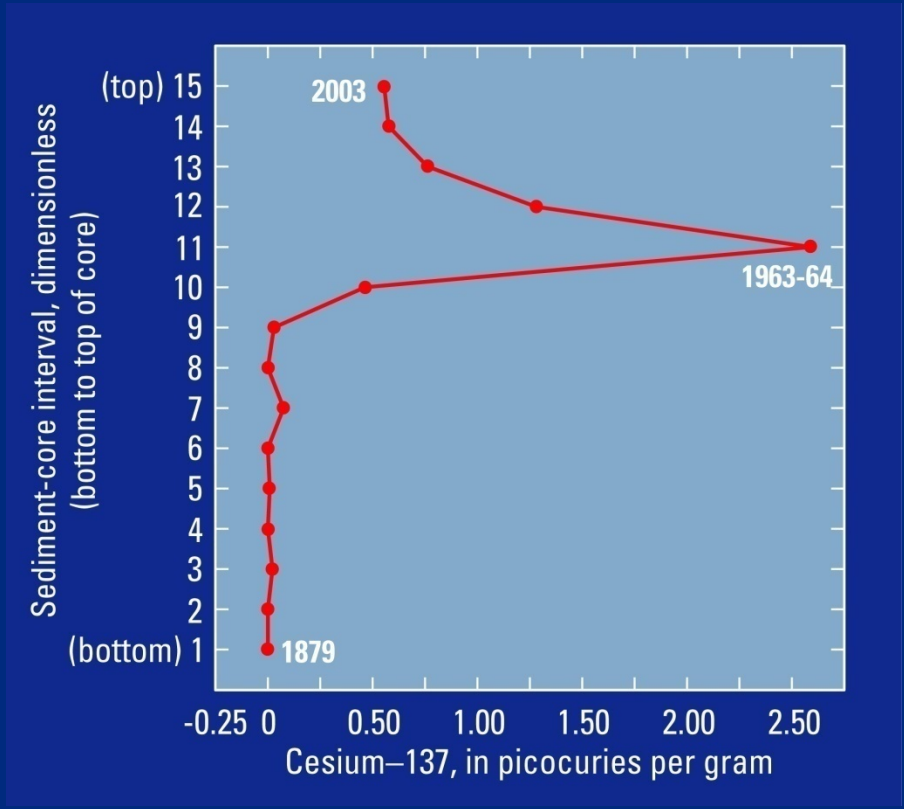
Modified from USEPA (2000)

Lead in Bottom Sediment of Crystal Lake: Decades for Recovery Following Phase Out of Leaded Gas

Lead



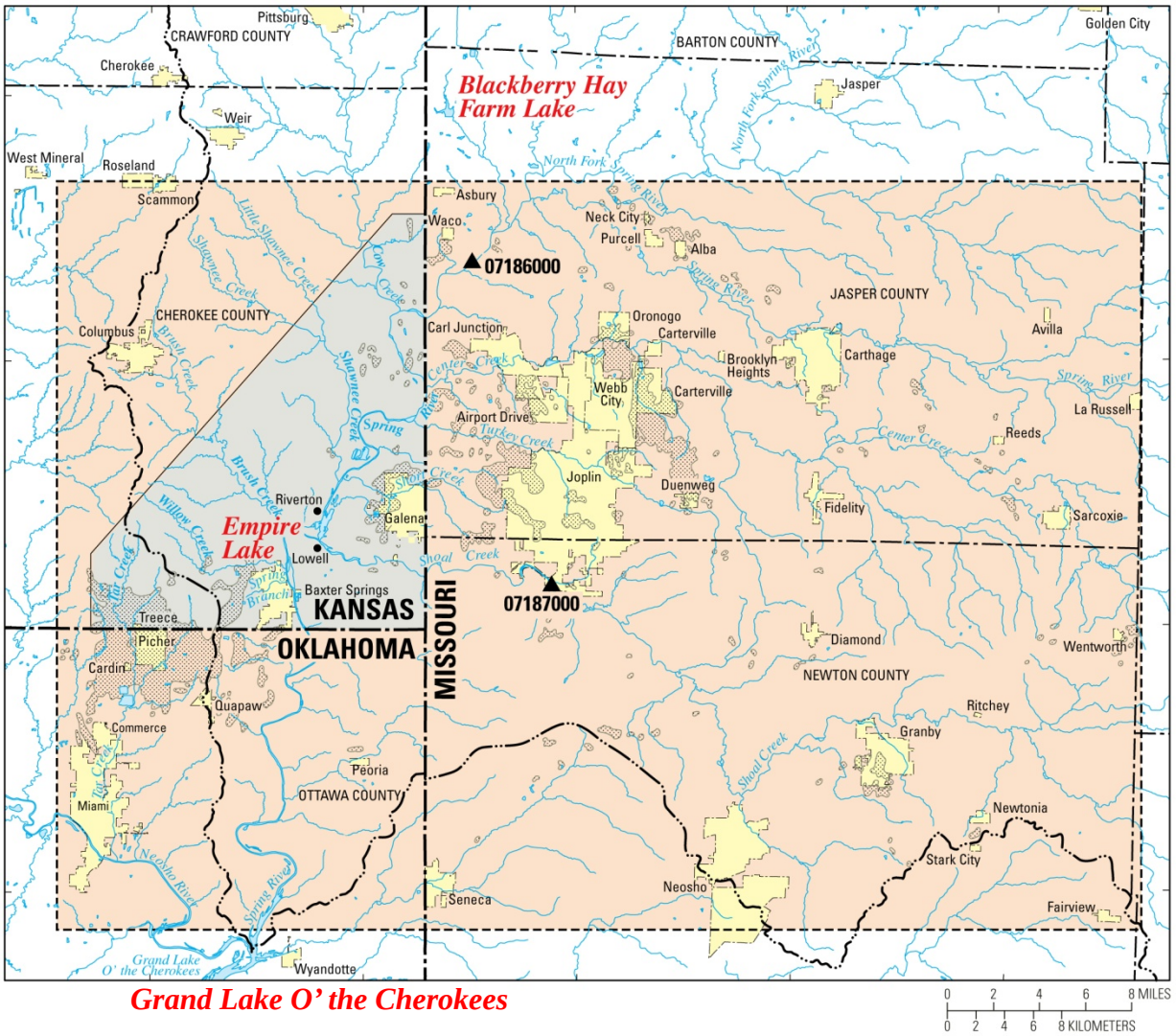
Cesium-137



USGS

(Juracek, 2004; Juracek and Ziegler, 2006)

The Tri-State Mining District



Grand Lake O' the Cherokees

Tri-State Mining District

Cherokee County superfund site

Lead and zinc mined areas (Brichta, 1960)

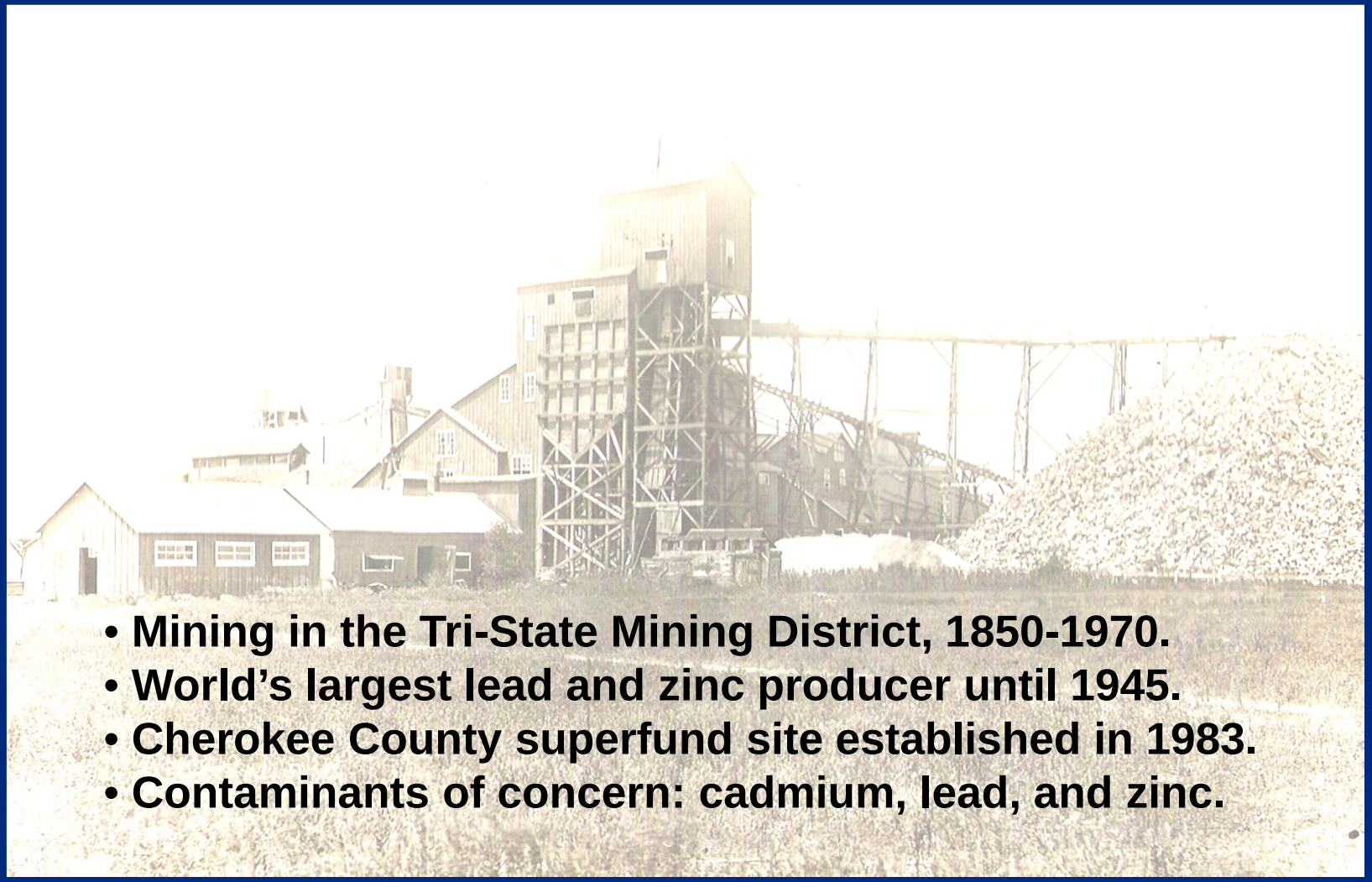
Boundary of Spring River Basin

07187000 ▲ U.S. Geological Survey stream-flow-gaging station and number

Index map

USGS

Tri-State History

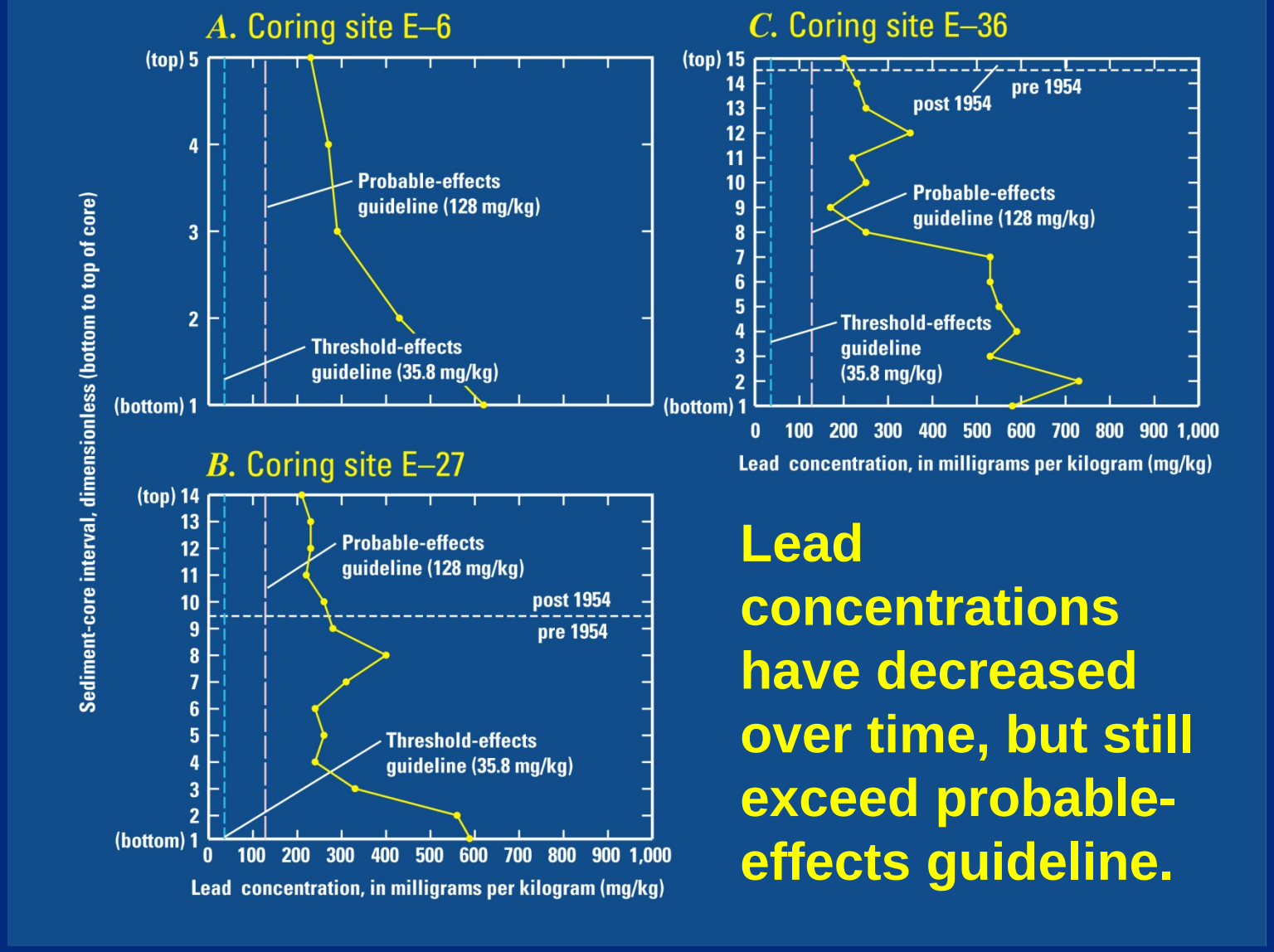


- Mining in the Tri-State Mining District, 1850-1970.
- World's largest lead and zinc producer until 1945.
- Cherokee County superfund site established in 1983.
- Contaminants of concern: cadmium, lead, and zinc.

Photo: Baxter Springs Heritage Center and Museum

USGS

Lead in Empire Lake Bottom Sediment



Lead concentrations have decreased over time, but still exceed probable-effects guideline.

USGS

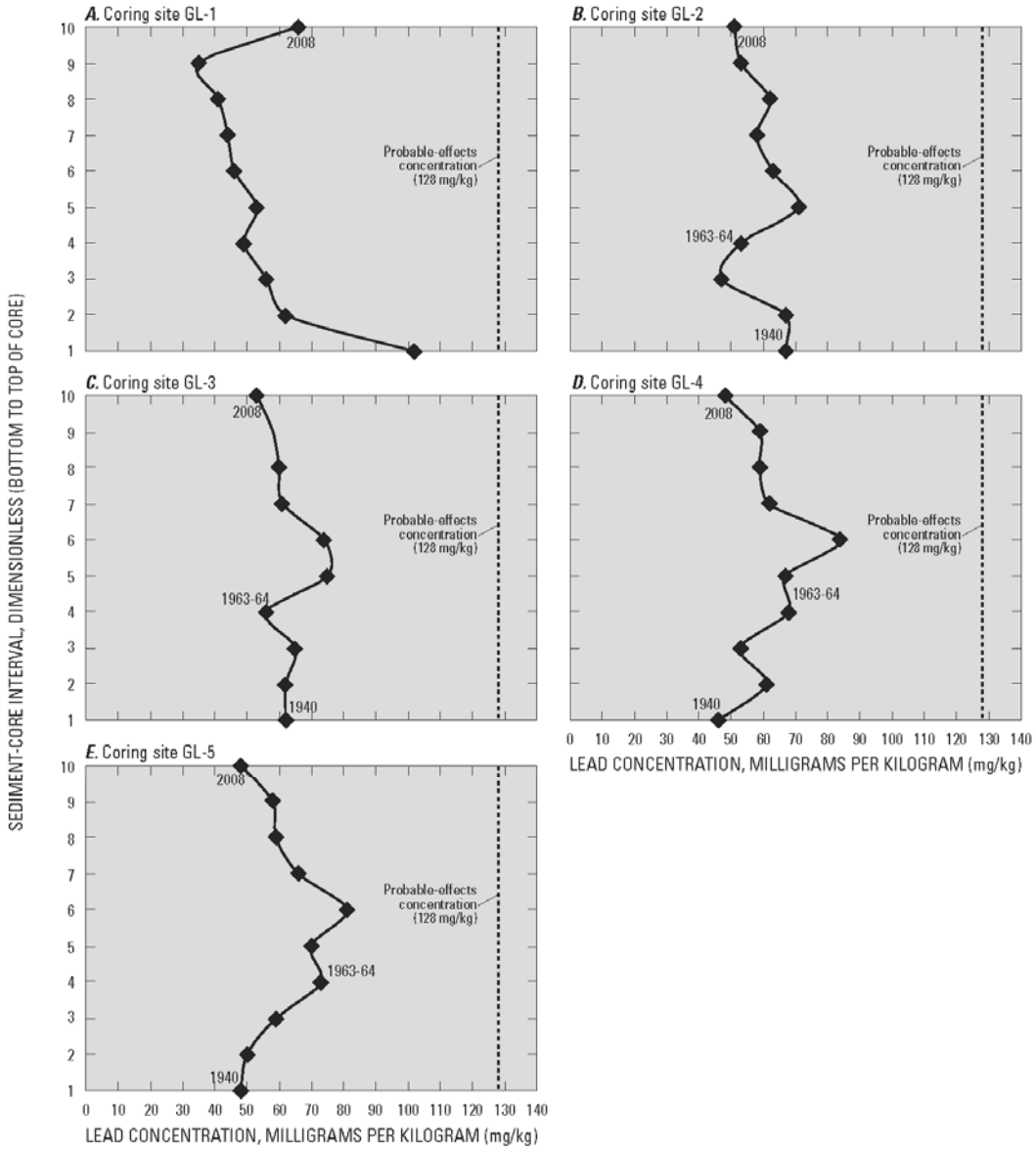
(Juracek, 2006, 2008)

Lead in Grand Lake O' the Cherokees Bottom Sediment

Lead concentrations have decreased since about the 1980s.

Lead concentrations were less than the probable-effects guideline.

Median lead concentration was about 5 times less than Empire Lake.



(Juracek and Becker, 2009)

Constituent Histories

- Selenium
- Lead
- Copper
- DDE
- Biological indicators

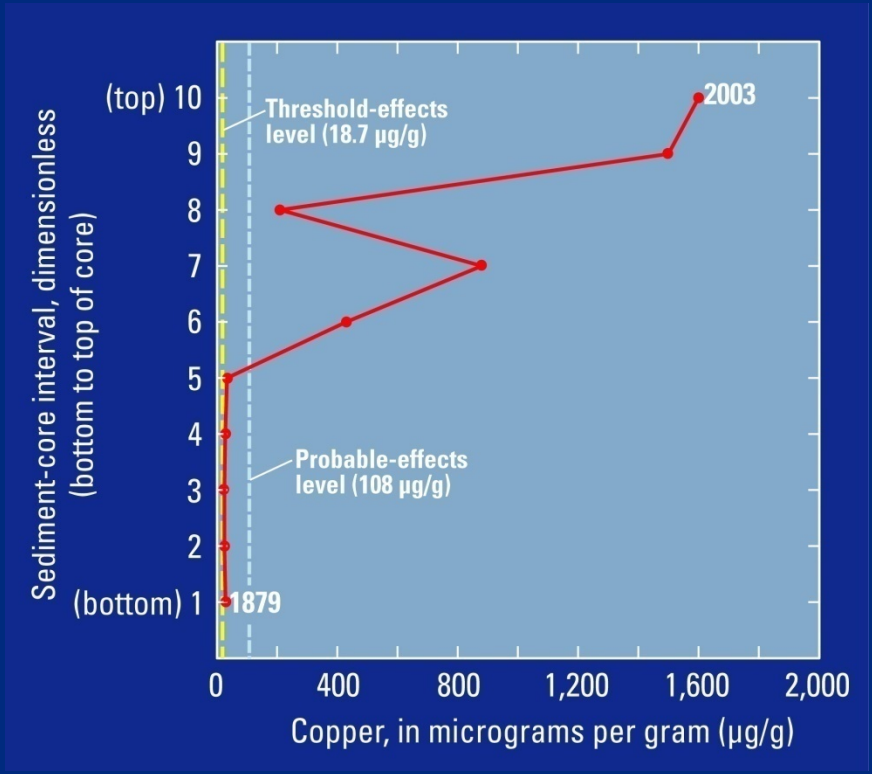
USGS

Copper Sulfate to Control Algal Blooms

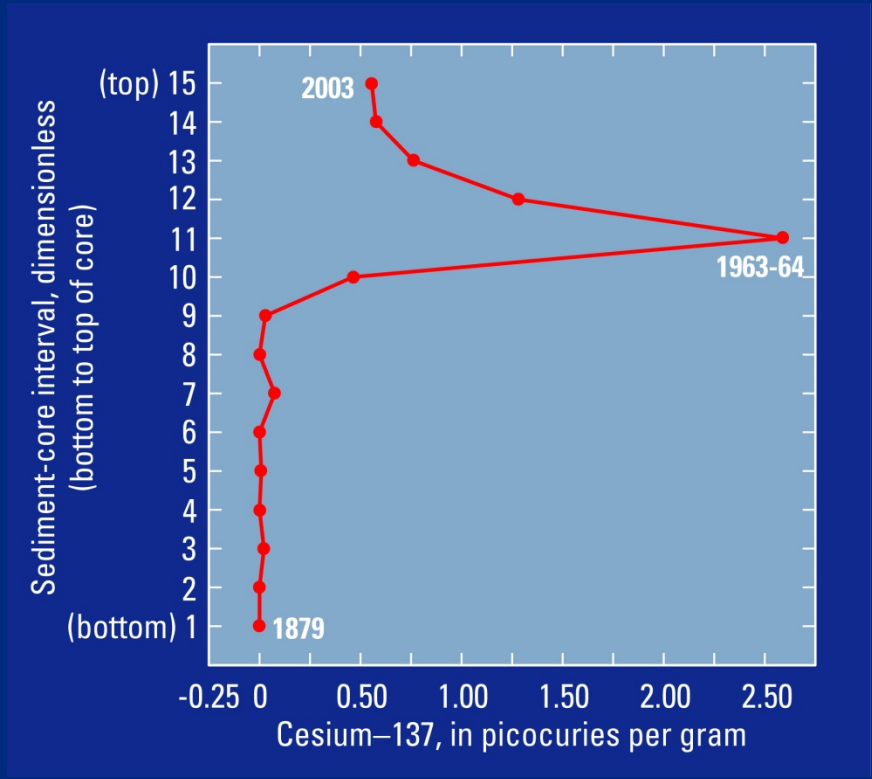
USGS

Copper in Bottom Sediment of Crystal Lake Documents Copper Sulfate Use

Copper



Cesium-137



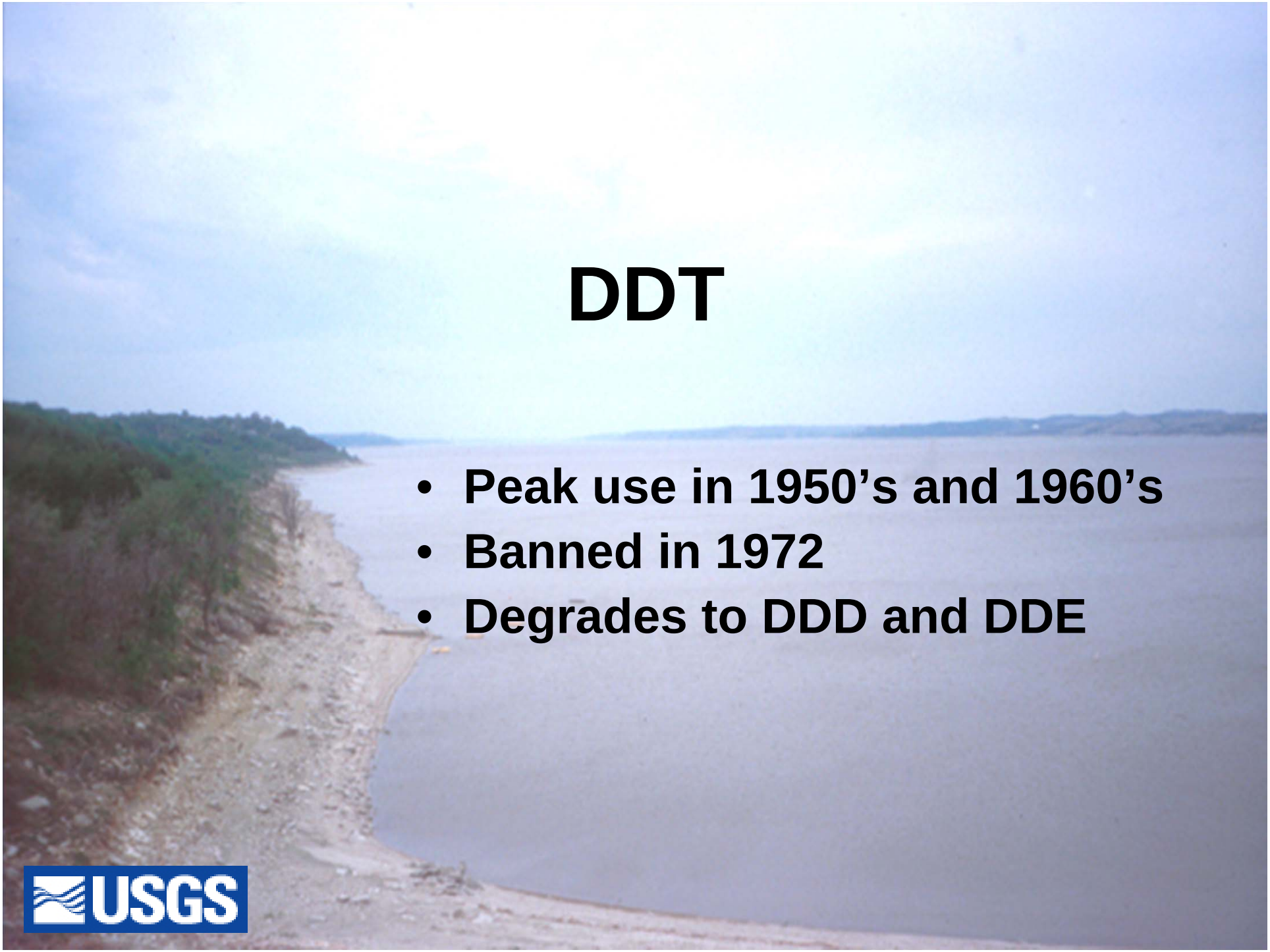
USGS

(Juracek, 2004)

Constituent Histories

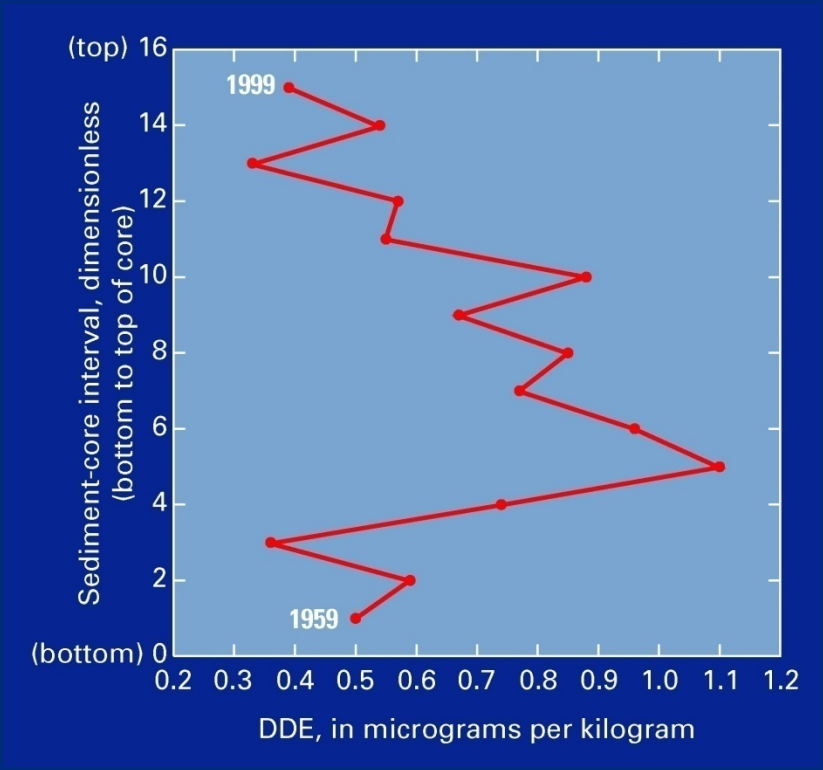
- Selenium
- Lead
- Copper
- DDE
- Biological indicators

USGS

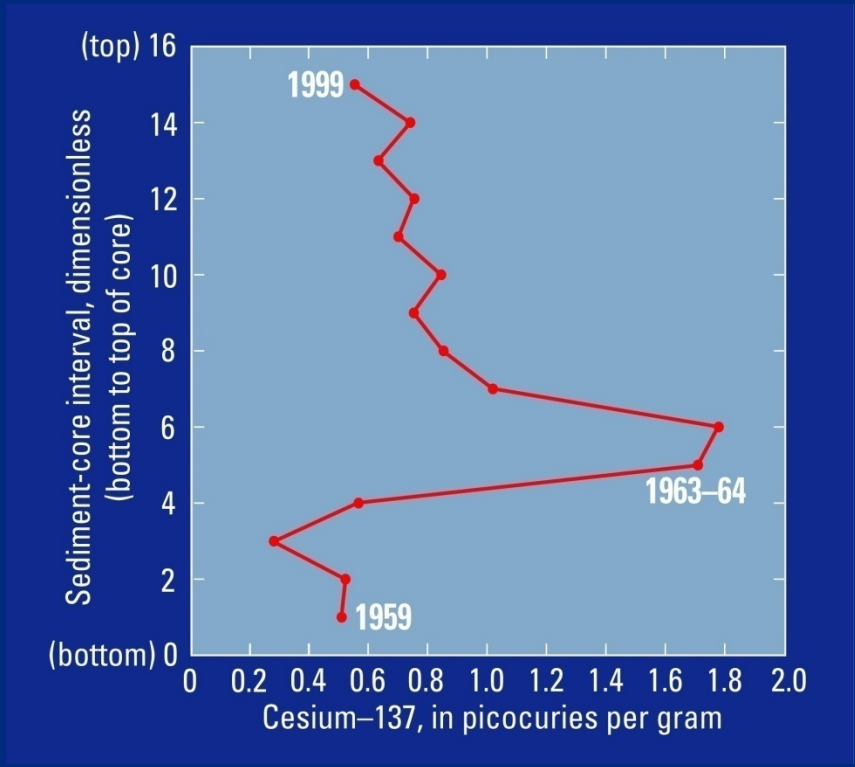

DDT
• Peak use in 1950’s and 1960’s
• Banned in 1972
• Degrades to DDD and DDE
USGS

DDE in Bottom Sediment of Tuttle Creek Lake Documents History of DDT Use in Basin

DDE



Cesium-137



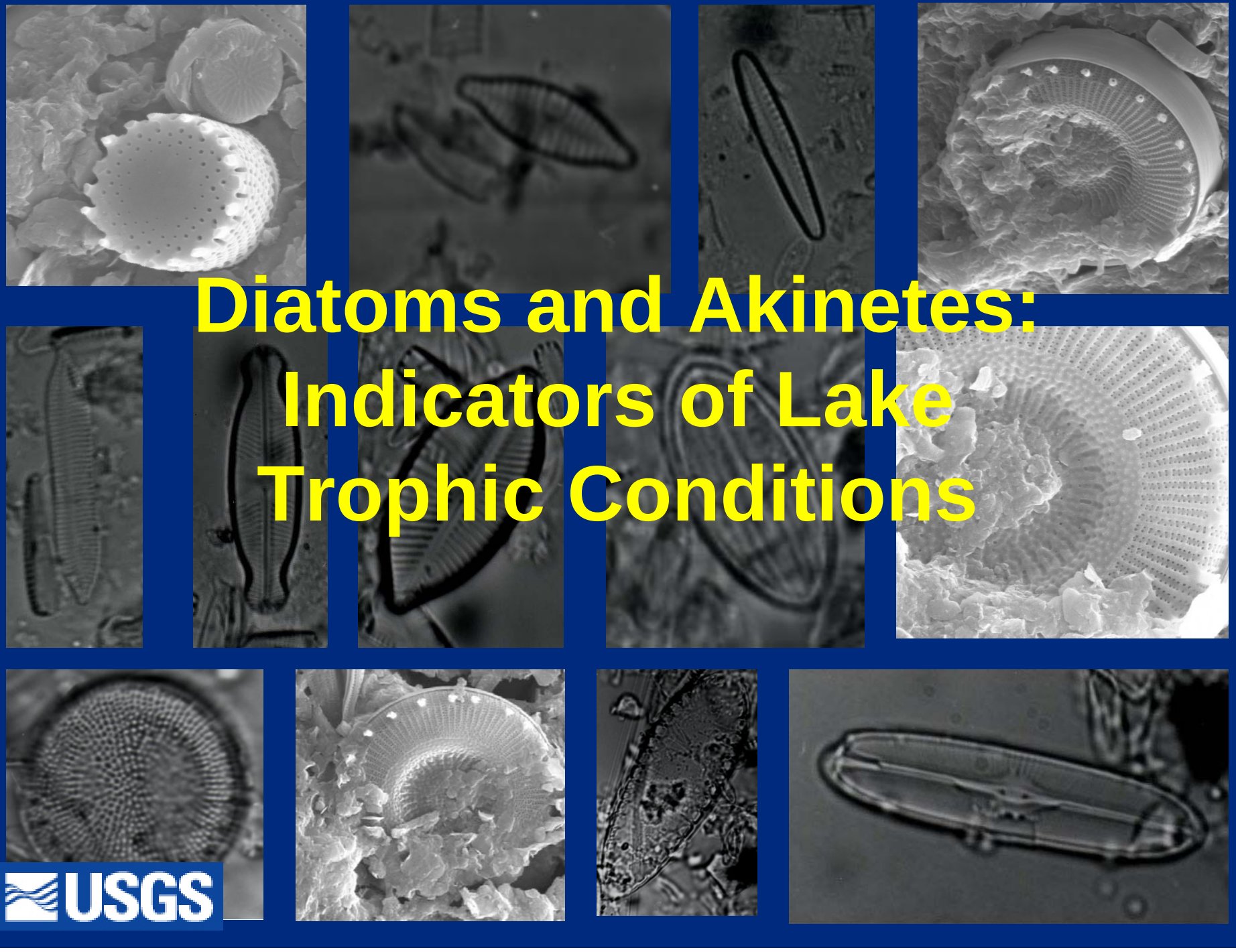
USGS

(Juracek and Mau, 2002)

Constituent Histories

- Selenium
- Lead
- Copper
- DDE
- Biological indicators


Eutrophication: A Common Problem for Lakes
(microcystis bloom)
USGS

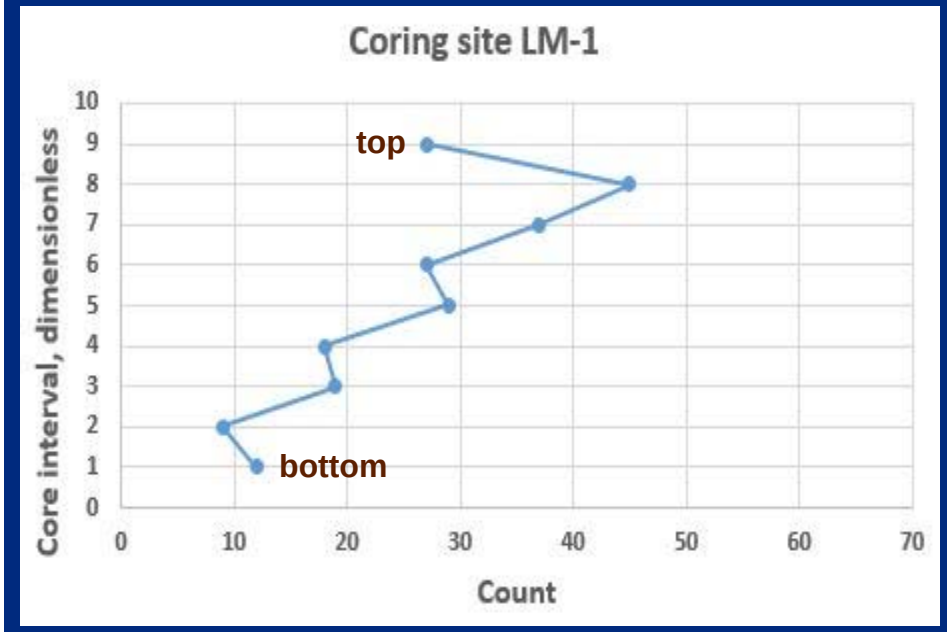


Diatoms and Akinetes: Indicators of Lake Trophic Conditions

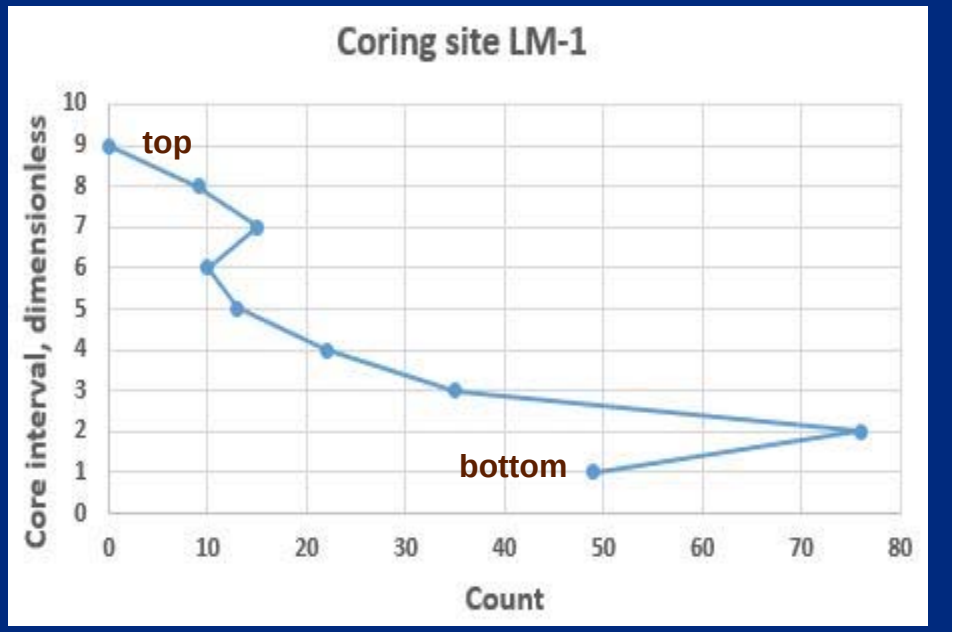
USGS

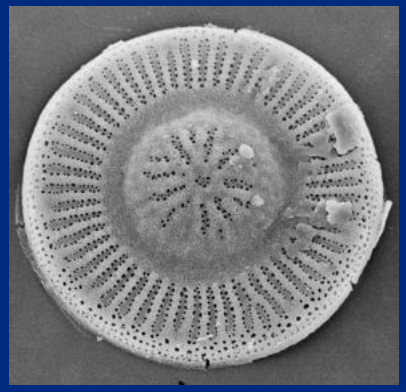
Lake Maxinkuckee Possibly Has Become Less Eutrophic in Recent Decades

Cyclotella bodanica
(oligotrophic indicator)



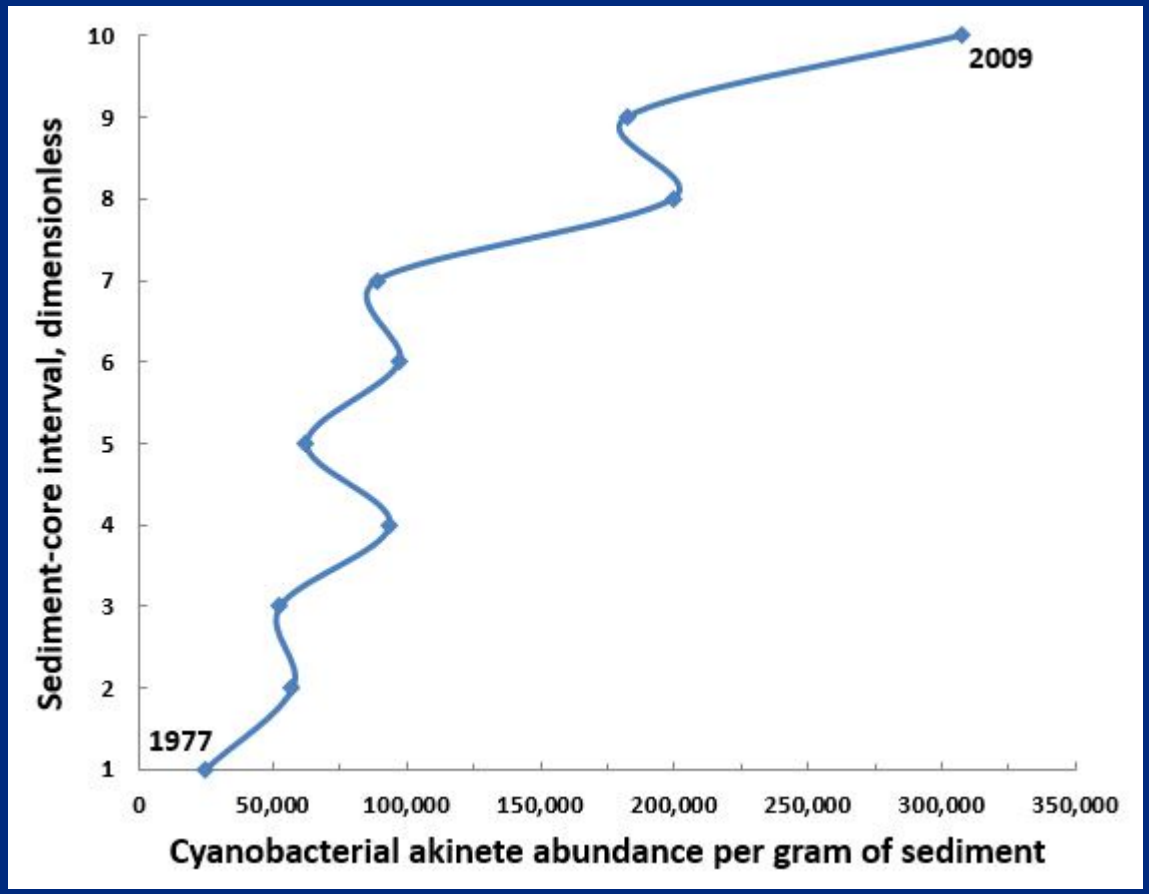
Cyclotella pseudostelligera
(eutrophic indicator)





USGS

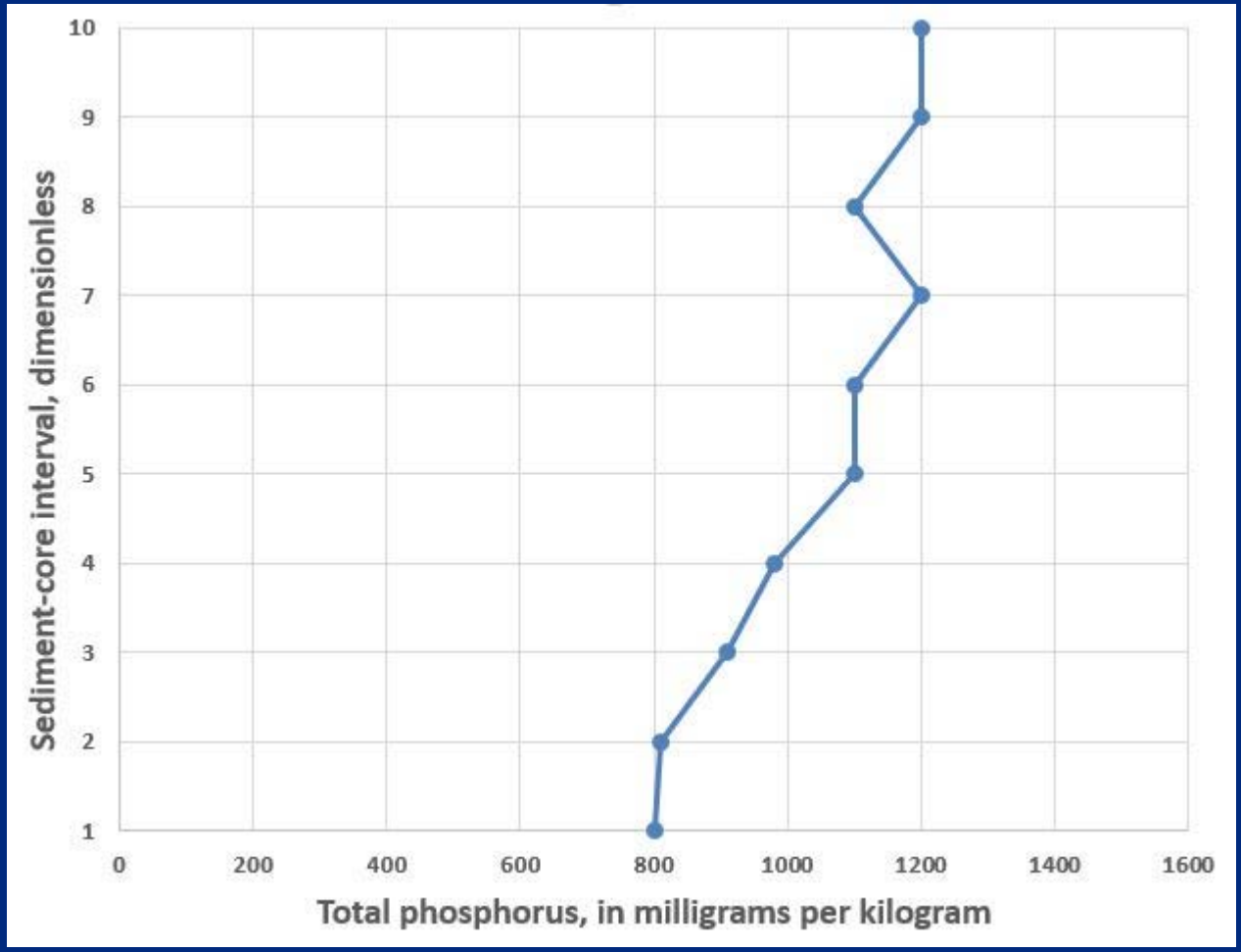
Cyanobacterial Akinetes Indicated Clinton Lake Became More Eutrophic



USGS

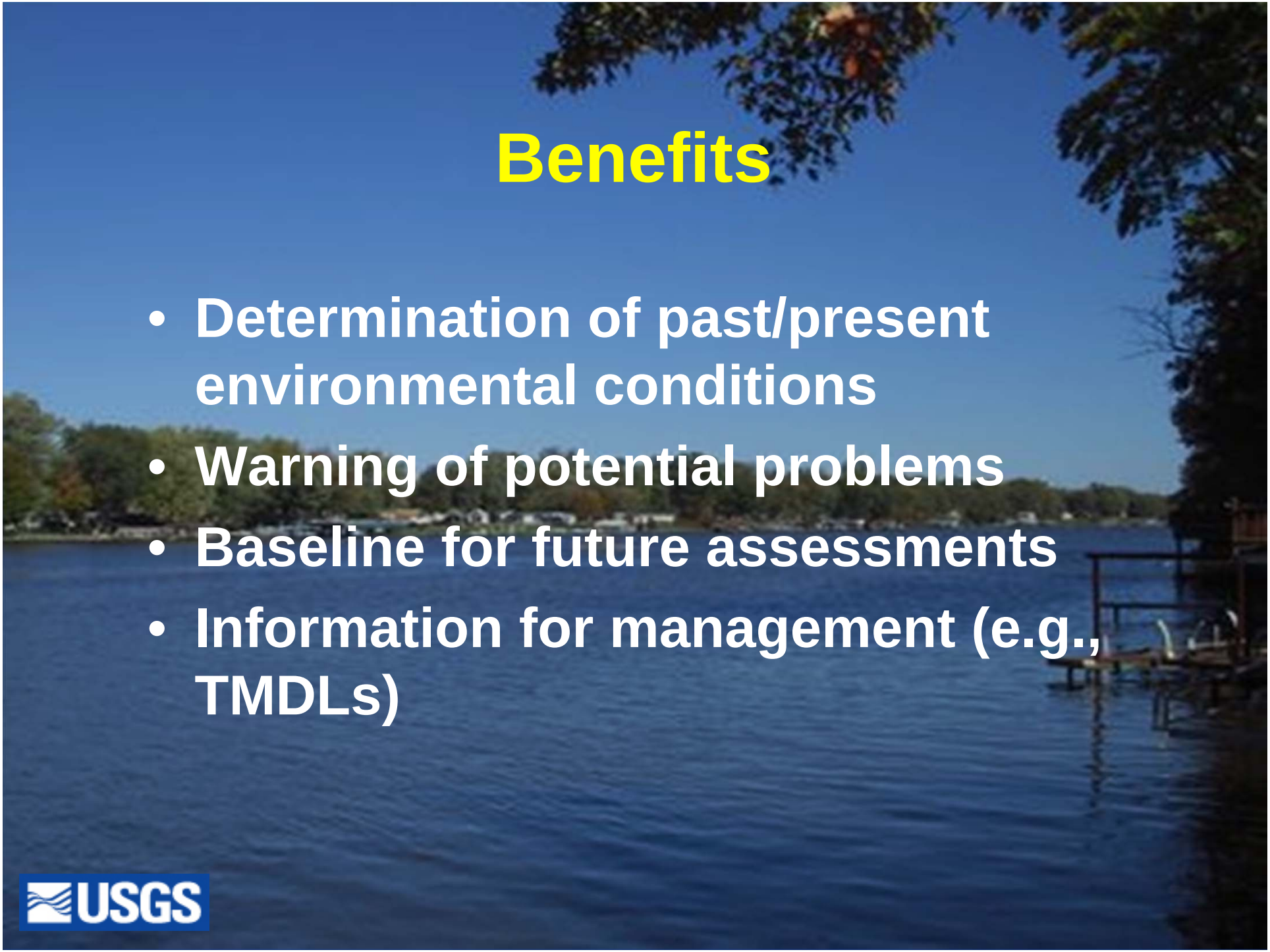
(Juracek, 2011)

Increase in Akinete Abundance at Clinton Lake Possibly Related to Increase in Phosphorus



USGS

(Juracek, 2011)



Benefits

- Determination of past/present environmental conditions
- Warning of potential problems
- Baseline for future assessments
- Information for management (e.g., TMDLs)

USGS


Has your lake’s story been told?
USGS

Questions?

For more information

web: ks.water.usgs.gov/Kansas/ressed/
email: kjuracek@usgs.gov

USGS