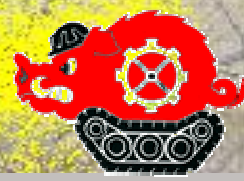
Phosphorus Loads Upstream (Arkansas) and Downstream (Oklahoma) Of Lake Frances:

Are Differences Due to Monitoring Program Design, Natural Variation, or The Lake?

Thomas Soerens

University of Arkansas



Arkansas Water Resources Center

112 Ozark Hall * University of Arkansas
Fayetteville, Arkansas 72701
(479) 575-4403 * (479) 575-3177 FAX

"The Arkansas Water Resources Center (AWRC) has a statewide mission to plan and conduct water resource research. AWRC cooperates closely with colleges, universities, and other organizations in Arkansas to address the state's water and land-related problems, promote the dissemination and application of research results, and provide for the training of scientists in water resources."

Acknowledgements

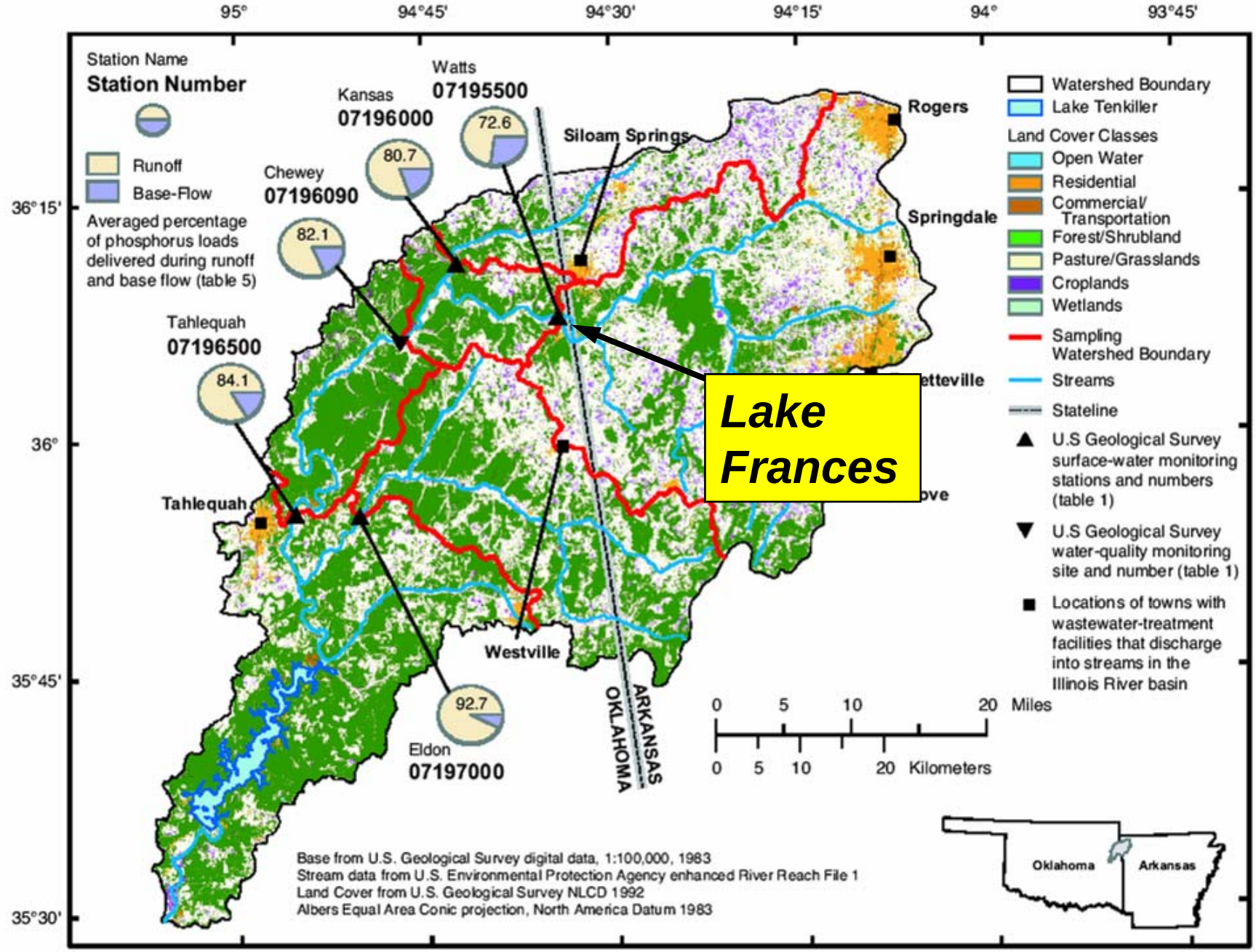
- *Gim Goh, UA Civil Engineering*
- *Brian Haggard, UA/USDA*

Outline

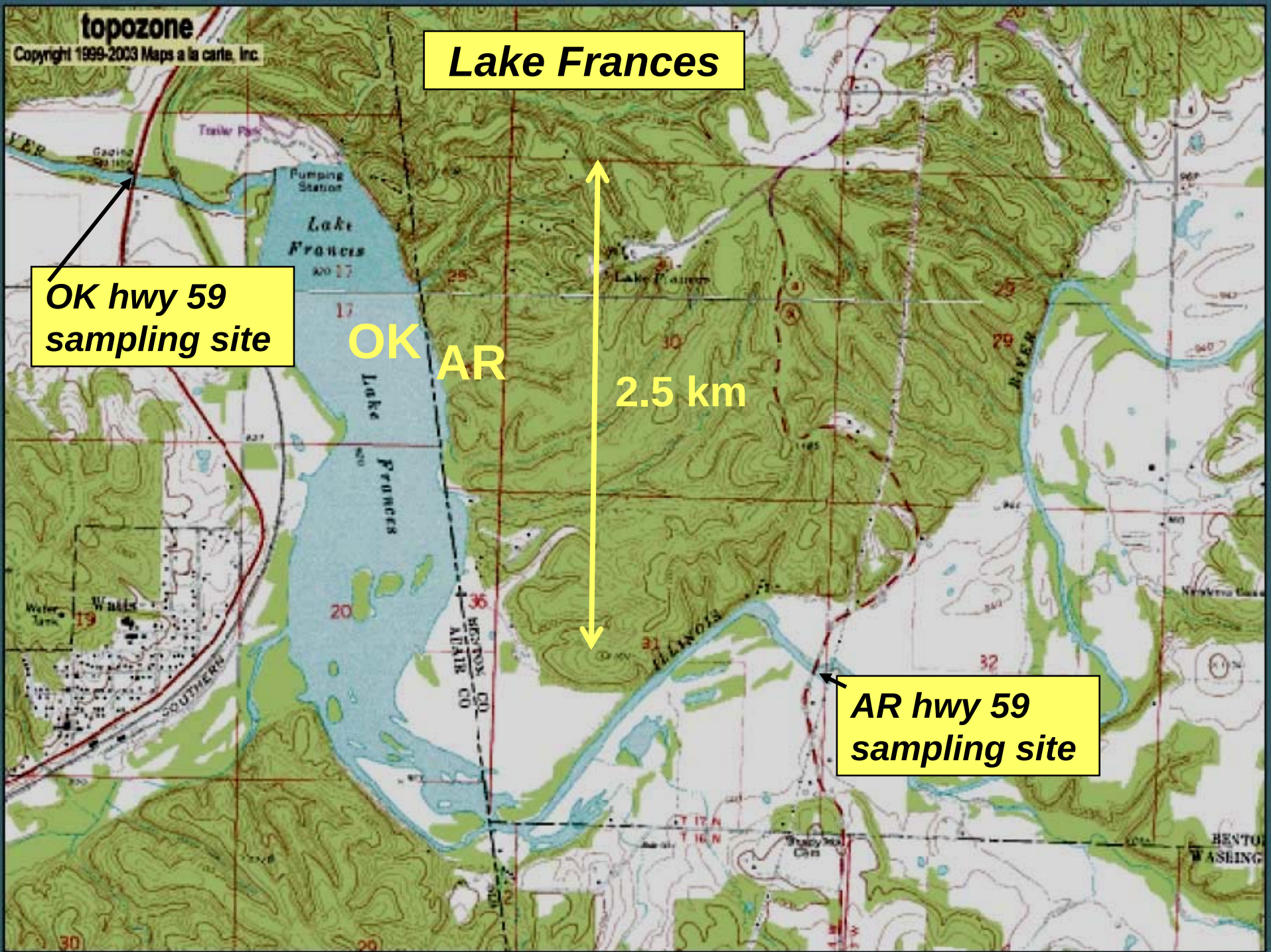
- *Background and history*
  - *Illinois River in Oklahoma and Arkansas*
  - *Lake Frances*
- *Possible differences between AR and OK loads*
  - *Lake*
  - *Variation*
  - *Monitoring program*
- *Summary, conclusions, future*

Oklahoma and Arkansas

Illinois River in Arkansas-Oklahoma


95°
94°45'
94°30'
94°15'
94°
93°45'
36°15'
36°
35°45'
35°30'
Station Name
Station Number
Runoff
Base-Flow
Averaged percentage of phosphorus loads delivered during runoff and base flow (table 5)
Watts
07195500
72.6
Kansas
07196000
80.7
Chewey
07196090
82.1
Tahlequah
07196500
84.1
Eldon
07197000
92.7
Siloam Springs
Rogers
Springdale
Tahlequah
Westville
OKLAHOMA
ARKANSAS
Lake Frances
Watershed Boundary
Lake Tenkiller
Land Cover Classes
Open Water
Residential
Commercial/ Transportation
Forest/Shrubland
Pasture/Grasslands
Croplands
Wetlands
Sampling Watershed Boundary
Streams
Stateline
U.S Geological Survey surface-water monitoring stations and numbers (table 1)
U.S Geological Survey water-quality monitoring site and number (table 1)
Locations of towns with wastewater-treatment facilities that discharge into streams in the Illinois River basin
0 5 10 20 Miles
0 5 10 20 Kilometers
Base from U.S. Geological Survey digital data, 1:100,000, 1983
Stream data from U.S. Environmental Protection Agency enhanced River Reach File 1
Land Cover from U.S. Geological Survey NLCD 1992
Albers Equal Area Conic projection, North America Datum 1983
Oklahoma
Arkansas

USGS 03-4168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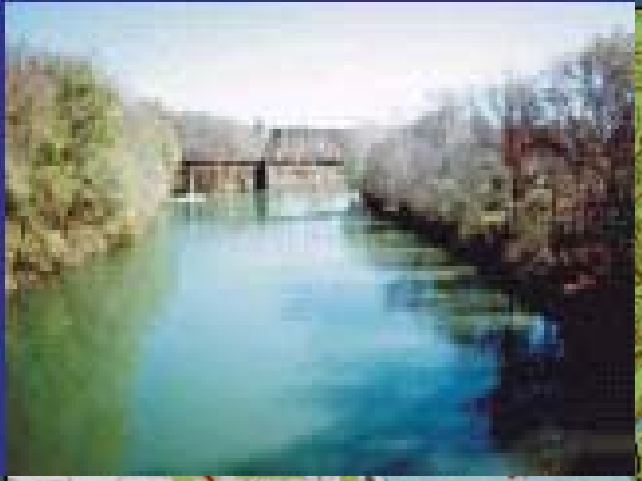
Lake Frances
OK hwy 59 sampling site
OK
AR
2.5 km
AR hwy 59 sampling site
Lake Frances
Pumping Station
Trailer Park
Walls
SOUTHERN
ILLINOIS
RIVER



Loads upstream of lake different than loads downstream?

Illinois River - background

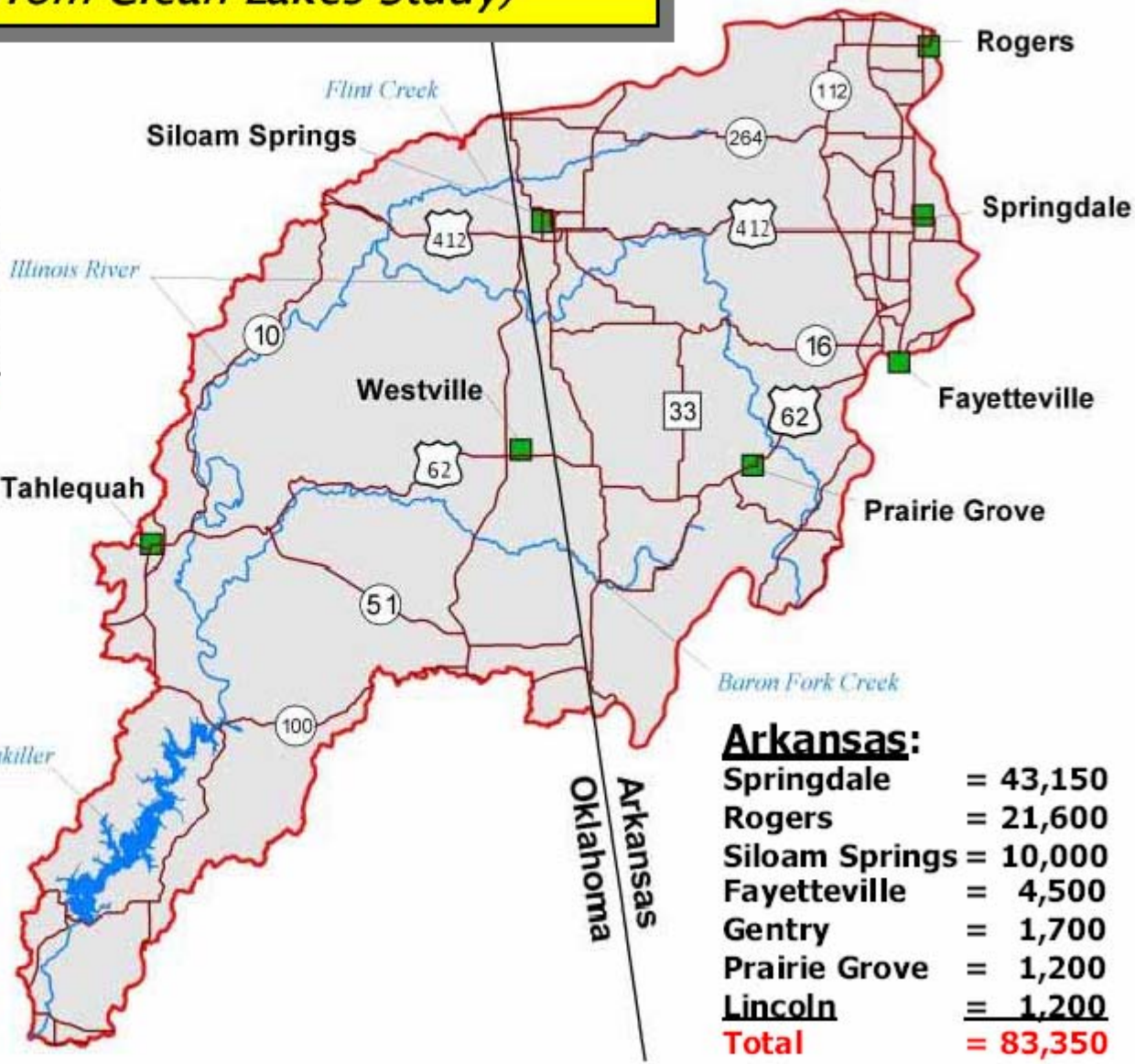
- *Designated as an Oklahoma scenic river*
- *Illinois River and Lake Tenkiller in Oklahoma are major recreational areas*
- *Impacted by point sources and nonpoint sources in Arkansas*
- *Lawsuit between Oklahoma and Arkansas reached the U.S. Supreme Court*

Background: Illinois River - Lawsuit

- *Oklahoma sued Arkansas (1986)*
  - *to stop Fayetteville discharge*
  - *U.S. Supreme Court 1992:*
    - *AR must meet OK water quality standard*
      - *No P limits in Arkansas except Fayetteville*
    - *AR-OK Arkansas River Compact Commission*
      - *oversees agreement*

- *Compact commission recommendations*
  - *Arkansas Reduce Phosphorus by 40%*
    - *use avg. load from 1980 to 1993 as baseline*
    - *use 5 year moving avg*
  - *Note: lawsuit began over point sources, focus has shifted to nonpoint sources*

Phosphorus Loads to Lake Tenkiller
(in kilograms/year, from Clean Lakes Study)



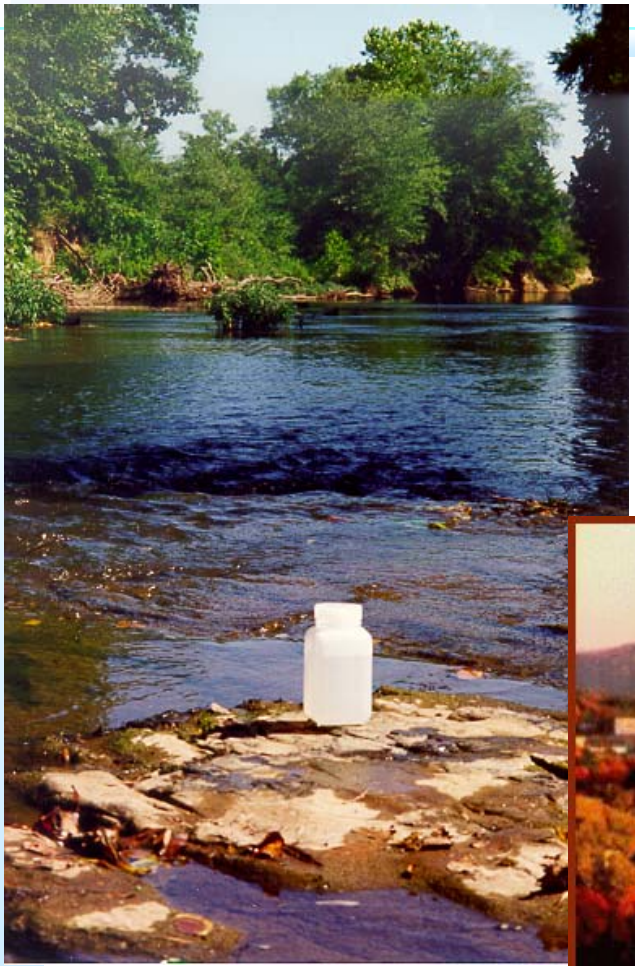
Oklahoma:

Tahlequah	= 4,700
Westville	= 2,900
Midwestern Nursery	= 600
Cherokee Nation	= 530
Watts	= 500
Total	= 9,230

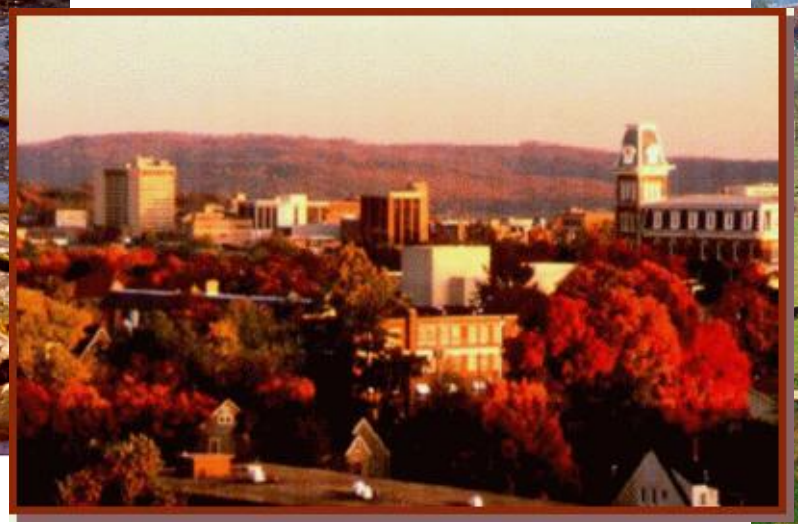
Arkansas:

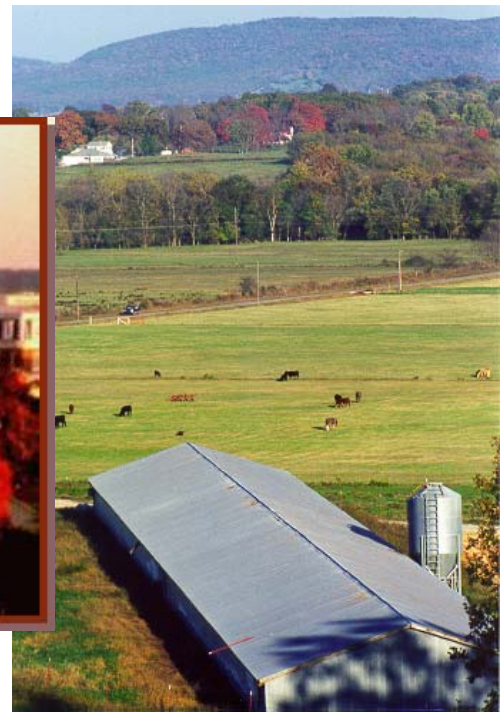
Springdale	= 43,150
Rogers	= 21,600
Siloam Springs	= 10,000
Fayetteville	= 4,500
Gentry	= 1,700
Prairie Grove	= 1,200
Lincoln	= 1,200
Total	= 83,350

Northwest Arkansas

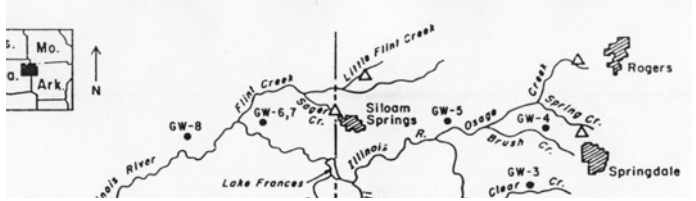


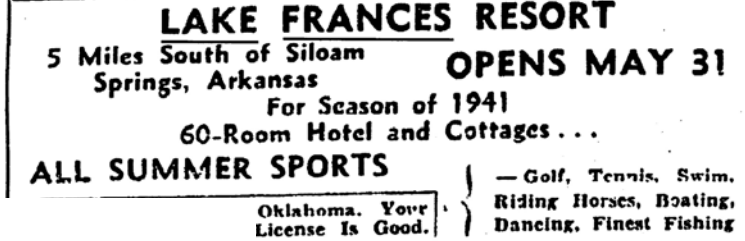
- Abundant water resources
- Agricultural production
- Population growth
- Urban development






Lake Frances
Resort Opens




LAKE FRANCES RESORT
5 Miles South of Siloam Springs, Arkansas
OPENS MAY 31
For Season of 1941
60-Room Hotel and Cottages . . .
ALL SUMMER SPORTS
— Golf, Tennis, Swim, Riding Horses, Boating, Dancing, Finest Fishing
Oklahoma. Your License Is Good.

WATTS, Aug
Oklahoma sports
have a 90-day
and a classy plac
day in the woods
northeaster
Lake Fr
homa-Arka
here has r
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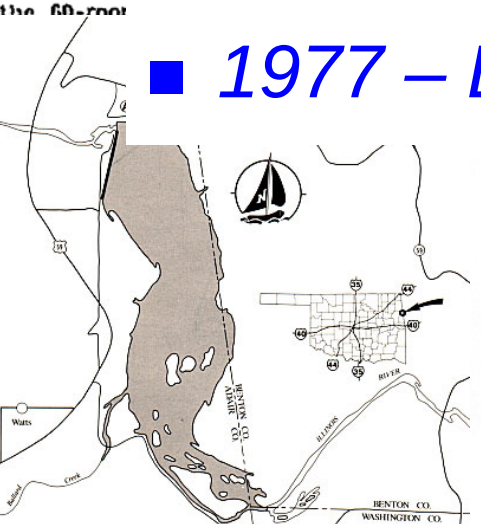
Bloomber
the 60-roo

Lake Frances - History

- *1931 – wooden dam completed, resort opens*
  - *golf, tennis, swimming, horses, boating, dancing, fishing*
- *1943 – embankment partially washed out*
- *1954 – Siloam springs purchases lake, rebuilds dam, builds treatment plant*
- *1971 – concerns about lake water quality*
- *1977 – Lake "in late stages of eutrophication"*




The Forgotten Resort

BY IVY COFFEY

Towering pine trees hide the hilltop hotel, which decades ago was the thriving center of a border resort and attracted throngs of Oklahoma and Arkansas vacationers.

The abandoned hideaway at Lake Frances Resort, near Siloam Springs, Ark., can be reached only from the Arkansas side. Only the oldtimers at nearby Watts, Okla., know the old hotel is hidden away in the trees. But a number of persons, residents and visitors, thinks the scenic area deserves more attention, that it should be enjoyed by more people.

Guards patrol the grounds of the hotel, which still contains some furniture. A few houses near the building are occupied.

The resort in its heyday offered cabins, tennis courts, a swimming pool and a large dance pavilion. The shell of the swimming pool remains. The dance pavilion burned and weeds claimed the tennis court.

Though the resort was abandoned as a recreational and fun center, Lake Frances is

Lake Frances - History

- *1978 – concerns about safety of dam*
- *Early 1980s – Fayetteville, AR proposes WWTP discharge into Illinois River*
- *1983 – Lake Frances clean lakes study*
  - *Point sources = 65% of P load*
- *1985 – study it again.*

Sooners Fight Plan to Dump Effluent

By Kevin Donovan
Staff Writer

FAYETTEVILLE, Ark. — Pledging a court battle if necessary, Oklahomans and several Arkansas allies told a citizen's advisory committee here Thursday night that the Illinois River cannot assimilate the sewage Fayetteville is considering dumping into it.

"Oklahoma is not like Arkansas, in that there's not an awful lot of clear water streams. The only significant one is the Illinois River," said Wayne Mitchell, chairman of the Oklahoma Scenic River Commission, at a public hearing.

Mitchell said the proposal to build a waste water treatement plant five miles upstream from the Oklahoma border — one of four alternatives being considered by the committee — threatens to harm one of Oklahoma's most popular fishing and recreational areas.

Mitchell and others warned they would fight any federal grant applications made by Fayetteville for the plant should the Fayetteville City Board eventually opt for the Illinois River site. Failing that, Mitchell said, Oklahoma authorities would pursue a lawsuit to stop construction.

Opposition to the Illinois River proposal also came from the Illinois River Property Owners Association of Arkansas, whose spokesman said the water quality of the river is already below many in Oklahoma, and it can't take much more pollution than it's got now," Peyton said.

Chet Bynum, of Norman, a member of a citizens group called the Illinois River Conservation Council, echoed

saturation point for pollutants.

"The assimilative capacity has been reduced to the point that it can't handle secondary treated sewage," such as would be pumped into the Illinois under the proposal, she

daily.

The Wh
Plant alrea

Lake-Cleaning Methods Could Harm Illinois River

WATTS (AP) — Methods as simple as planting water lilies and cattails could help clean Lake Frances in eastern Oklahoma, but what's best for the lake could be damaging to the Illinois River, a researcher says.

Dr. Stephen Threlkeld, assistant pro

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r.
eservoir

said the three Arkansas cities evidently dump their sewage into tributary streams that feed Lake Frances via Osage Creek.

The cities are not violating Arkansas standards by doing so, as these streams have been authorized by their state authorities for such dumping, he said.

Threlkeld said he had studied possible restorative techniques for the lake.

"It would be possible to clean up Lake Frances in a variety of ways, but

ave negative ef-
s River down-

d one solution
st-effective and
kansas officials
ge-treatment fa-

lant beds of wa-
just upstream
ust might take
oblem," he said.
f you take care
t taking care of
get toxic blue-
he lake."
that if this hap-
d water would
ver, killing fish

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oblem inexpen-
sibilities exist."

Lake Frances Spillway Hazard Cited

By John Greiner

The spillway on Lake Frances Dam in Adair County needs to be enlarged to ensure that it remains safe, an inspection report by the Water Resources Board's engineering division said Tuesday.

A summary of the Lake Frances Dam safety inspection was released by the board during its meeting.

The board took no action on a recommendation to give the city of Siloam Springs, Ark., which has responsibility for the dam, time to review the report and determine costs to correct conditions.

The report basically means inspectors think the spillway should be enlarged to ensure embankment safety, said Terry Thurman, chief of the Water Resources Board's engineering division.

The spillway is designed to ensure that excess water flows over it and not over the embankment part, which could be washed away, he said.

The dam orginally was completed in the 1930s, but a severe flood of the Illinois River in 1943 washed out the embankment, he said.

It was not rebuilt until 1954, he said, when it was rebuilt to withstand flood waters of the magnitude which washed out the dam in 1943.

Computations indicate the dam and spillway can only handle about 20 percent of the probable maximum flood without overtopping the embankment, the report said.

The probable maximum flood is defined as a flood which may be expected from the most severe combination of weather and river conditions reasonably possible in the region.

The Lake Frances Dam embankment would be overtopped by 8 feet of water during a probable maximum flood condition, Thurman said.

One-half of a probable maximum flood, predicted in a 500 to 700 year period, cou
4.3 feet of water to flow over the to
embankment, the report said.

In another related action, the Water R
Board voted to issue an order to the owne
tle Cooley Lake Dam and Spillway that th
breached by May 19.

Thurman said the lake actually h
drained. The dam sits above a large ap
complex in Tulsa and breaching the da
mean making a hole in it large enough to
water from being stored in the lake bed.

The water board also issued an order
town of Kellyville lower the Kellyville
Creek County by 2 feet to preserve the da
lake.

State Tells Arkansas of Cost To Rebuild Shaky Border Dam

WATTS (AP) — Oklahoma officials have told their Arkansas counterparts that up to $3 million may be needed to rebuild a hazardous dam at Lake Frances on the border of the two states south of Siloam Springs, Ark.

Paul Wilson, chief engineer of the Oklahoma Water Resources

son said.

The 1978 inspection report said that at maximum flood stage, the present spillway at Lake Frances could accommodate only 20 percent of the flow. The remainder would go over the top of the concrete-and-earth dam.

Two state inspections in 1980 found there had

been no improvements made to the dam since the 1978 report.

A 6,000-foot earthen dam was built in 1931.

Dam equipment has fallen into disrepair and the control gates and power generating equipment were swept away long ago, Wilson said.

1983 Lake Frances study

- *Total P "declines only slightly" between upstream and downstream stations.*
- *Form of total P:*
  - *85% in reactive form upstream*
  - *54% in reactive form downstream*
- *"…sedimentation is eliminated as a major net phosphorus sink."*
- *Study focused on baseflow*

Arkansas Plants Labeled Polluters

Study Traces Source of Lake, River Deterioration

By Randy Ellis

resentatives from the offices of

nois flows westward and empties into Lake Frances along the Oklahoma-Arkansas border.

discharge, according to Herbert James Grimshaw, environmental specialist supervisor with the Oklahoma Water Re-

1983: "…60 to 90 percent of pollutants in Lake Frances come from (Arkansas) plants' discharge…"

1983: "…estimate was flawed by faulty sampling methods and did not give enough blame (to NPS)…"

University of Oklahoma in conjunction with the Oklahoma Water Resources Board.

Stephen Threlkeld, assistant professor at the University of Oklahoma's Biological Station at Kingston, presented his findings to an audience of about 35 people. Among those attending

of phosphorous pollutants in Arkansas upstream of the point where it converges with Osage Creek. Osage Creek is polluted by discharge from sewage treatment plants at Springdale and Rogers, the study says.

After the Illinois River and Osage Creek combine, the Illi-

Threlkeld … percent of the … plants in Lake … from discharge … Springdale and … plants.

That estimate … challenged by Arkansas … ity experts. Jo… time chief wa…

Lake Frances … Springdale an…

States Prepare To Study River

FAYETTEVILLE, Ark. (AP) — State and federal officials were urged Tuesday night to ensure that special interests don't influence the results of two studies of the Illinois River being undertaken by Arkansas and Oklahoma.

… ng on the proposed studies, an audi… people told officials of the two states and … Environmental Protection Agency what

1985: "…officials were urged … to ensure that special interests don't influence the results of two studies…"

ity and aesthetics seem to be the main concerns people have about the river. Larry Edmison, direc-

1985: "…challenged what he called omissions and discrepancies in the studies and urged that differences between the studies be reconciled…"

"We believe the results … cost-effective and environmentally sound … management of wastewater-treatment facilities in the watershed," he said.

Board OKs Lake Study Agreement

An agreement with the University of Oklahoma for a $102,000 study of a northeastern Oklahoma lake under the federal clean lakes program was approved Tuesday by the Oklahoma Water Resources Board.

The study is for Lake Frances on the Illinois River in Adair County. Ron Jarman, head of the water quality division of the state agency, said

A federal Environmental Protection Agency grant to the Oklahoma Pollution Control Coordinating Board will provide $71,855 of the money. OU will provide services equal to $30,856, the state's share of the project.

The agreement commits OU to do technical work including sampling,

Lake Frances - History

- *Late 1980s – Lake Frances gets **really nasty***
  - *shallow and mucky, boats running aground*
  - *Algae in lake and downstream*
  - *EPA study: "…Lake Frances outflow was the most turbid water sampled in the Illinois River Basin."*
- *March 12, 1990 Article…*

Stink Between States

Polluted Lake Frances Poses Problems

By Dave Seldon
Assistant State Editor

WATTS — When Siloam Springs, Ark., recently considered selling Lake Frances for $1, Oklahoma didn't figure it was much of a bargain.

The once picturesque reservoir on

Siloam Springs, a northwestern Arkansas town of about 10,000 people, continues to maintain regulatory control over the reservoir, but 95 percent of its surface area is in Oklahoma.

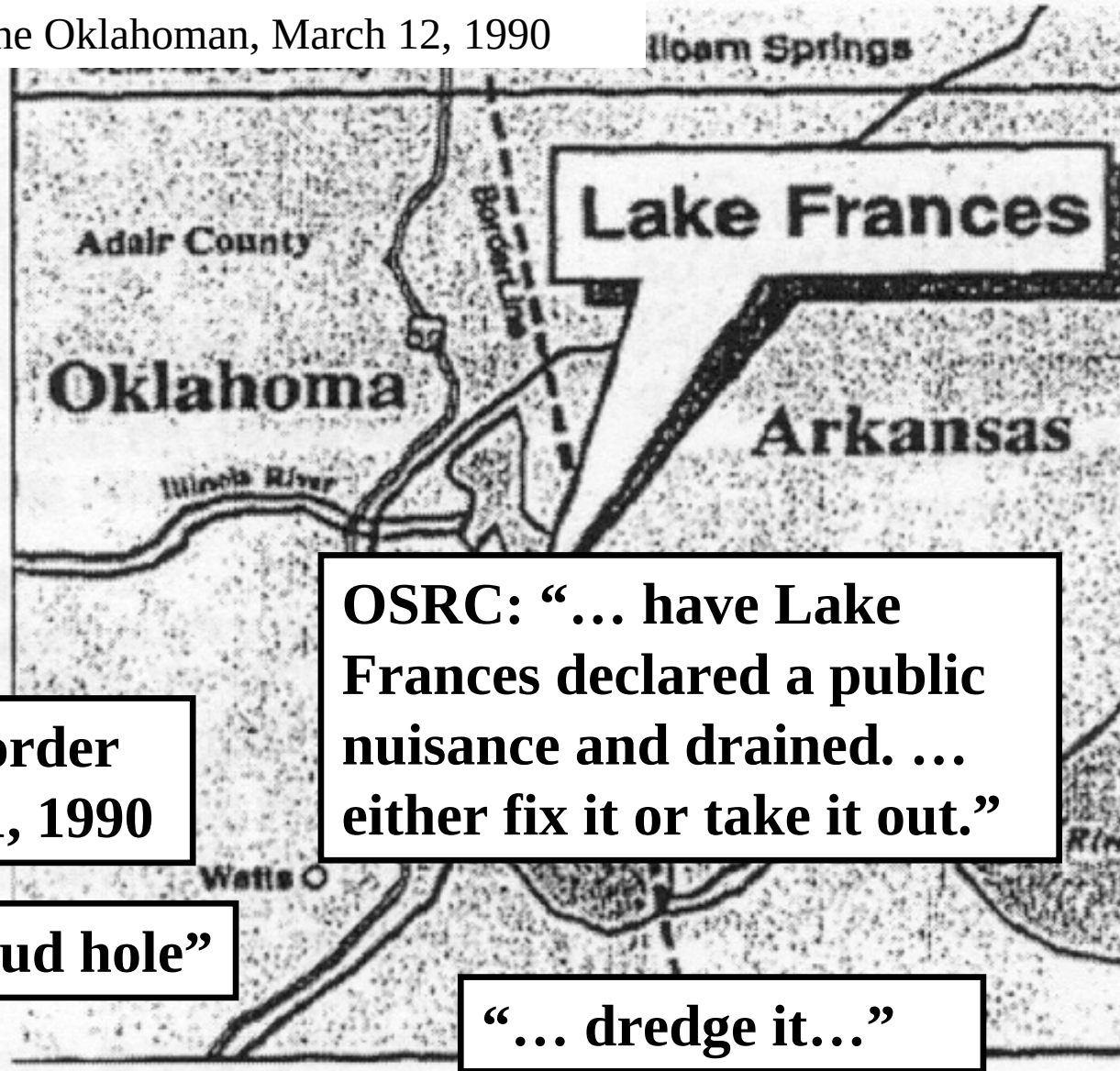
The lake's troubled history began 12 years after it was completed when an

The Oklahoman, March 12, 1990

Lake Frances Causes Stink Amid States

By Dave Seldon
Assistant State Editor

WATTS — When Siloam Springs, Ark., re-



Dam is unsafe. Court order to repair dam by July 1, 1990

OSRC: "… have Lake Frances declared a public nuisance and drained. … either fix it or take it out."

"shallow, polluted mud hole"

"… dredge it…"

"…creates a foul odor and clouds the Illinois for 12 miles"

"… open the gates…"

River straddles the Oklahoma-Arkansas border and

…It was purchased as a

…nspection
…my Corp
…termine
that the dam was unsafe.
But until recently, the

main spillway.

…of a problem that has re-
sulted from prolonged

Lake Frances - History –

- *May 4, 1990 – **Dam busts***
  - *Top several feet break off*

Evacuees Home As Lake Drops

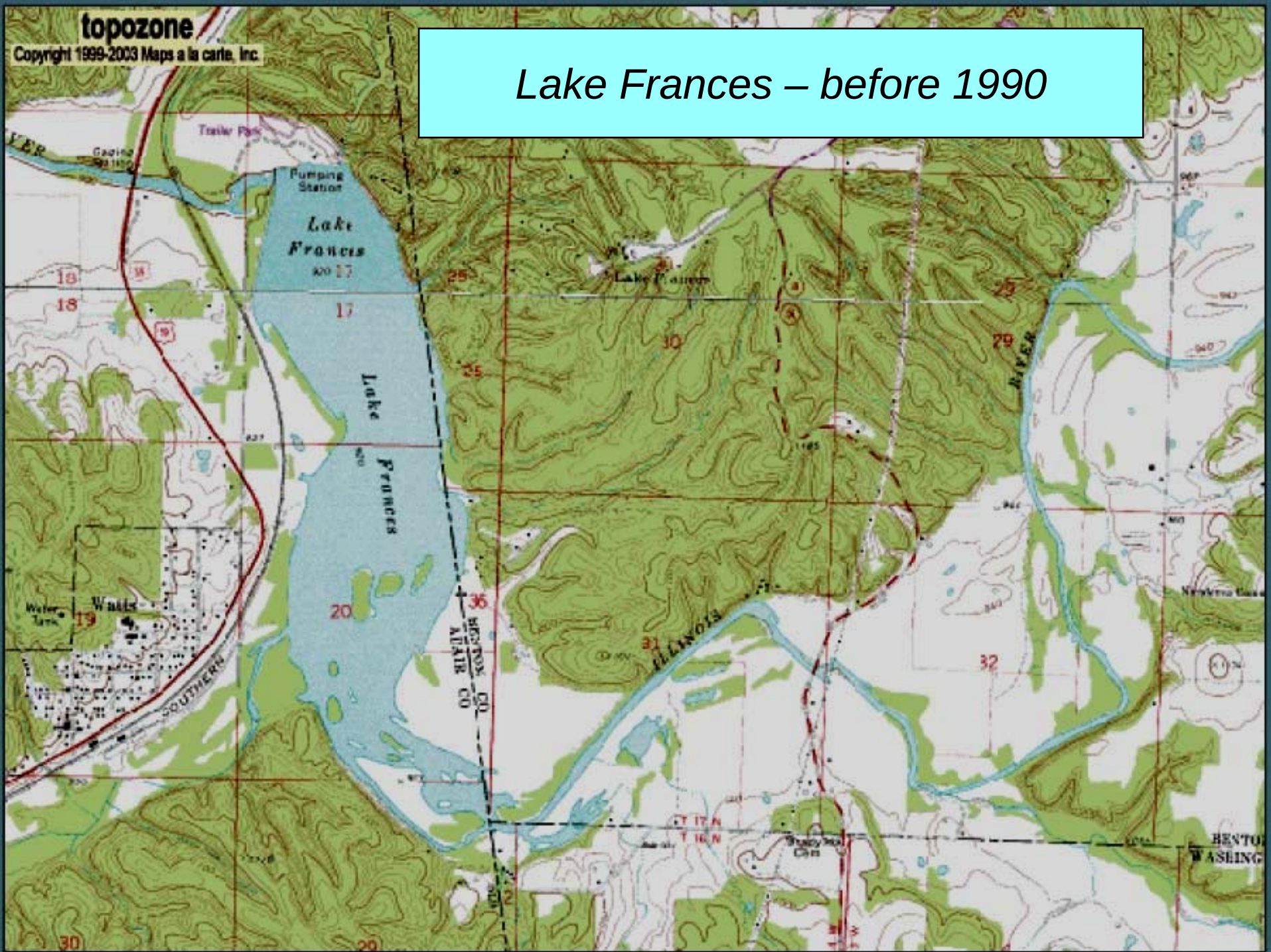
Residents were warily returning to their homes in eastern sections of the state after rain-swollen Lake Frances washed away a large piece of its concrete dam and left giant cracks in the concrete structure.

Authorities in Adair County said more than 100 people were evacuated below the dam Friday, but allowed to return hours later when authorities determined it was sound.

one mile northeast of Bristol in northeastern Ellis County. Bristol is about 30 miles southeast of Dallas.

Ten Texans and one Oklahoman have died in flooding during the last two weeks.

Elsewhere in Oklahoma, flooding remained a problem. The U.S. Corps of Engineers said nine lakes had either filled or would exceed flood control pools but no dams were in danger of over-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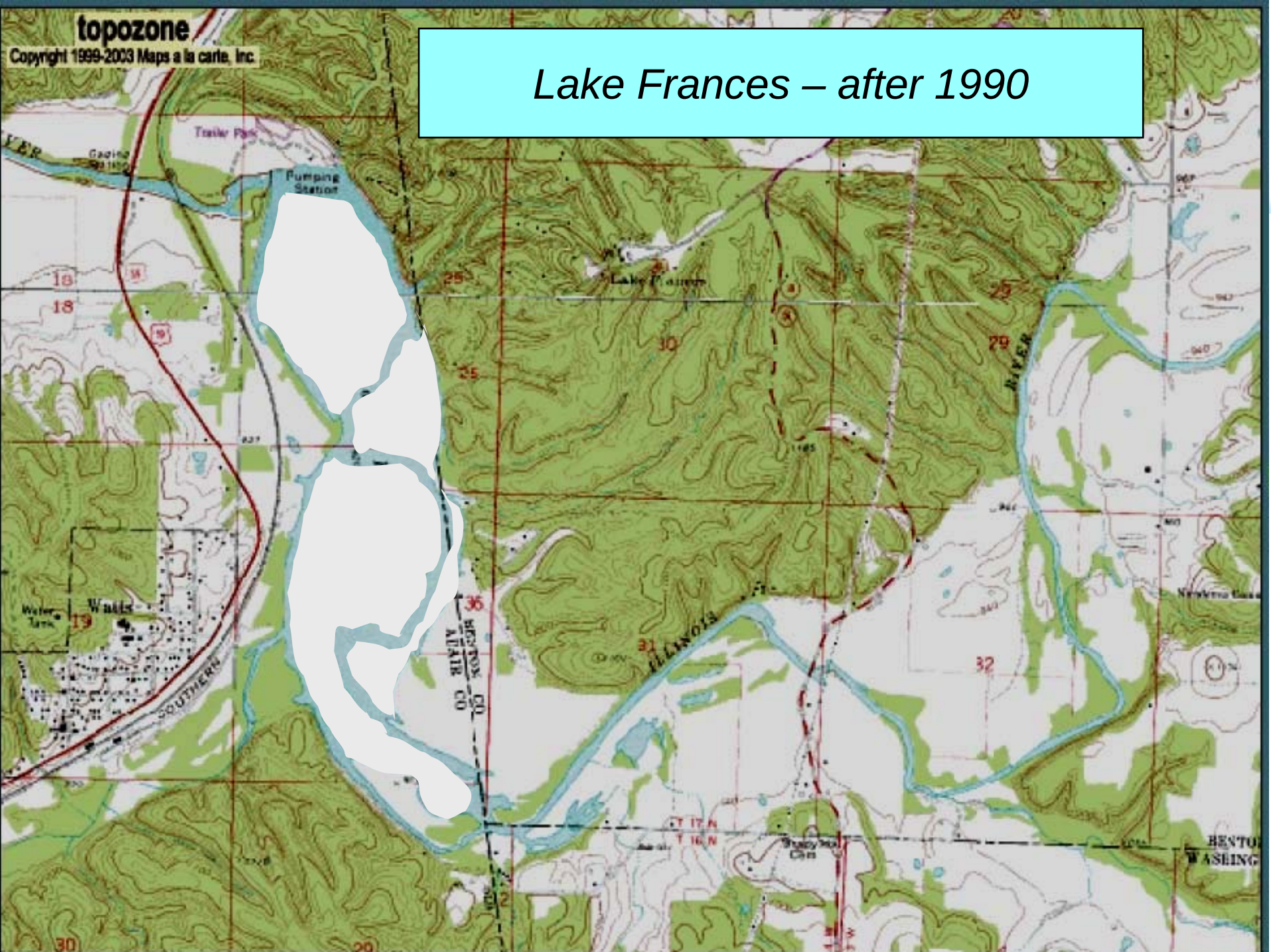
Lake Frances – before 1990
Lake Frances
Pumping Station
Trailer Park
Walls
SOUTHERN
ILLINOIS
RIVER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Lake Frances – after 1990
Pumping Station
Trailer Park
Lake Frances
ILLINOIS
RIVER
SOUTHERN
Water Tank
Wells
BENTON
WASHING

Lake Frances – after dam break

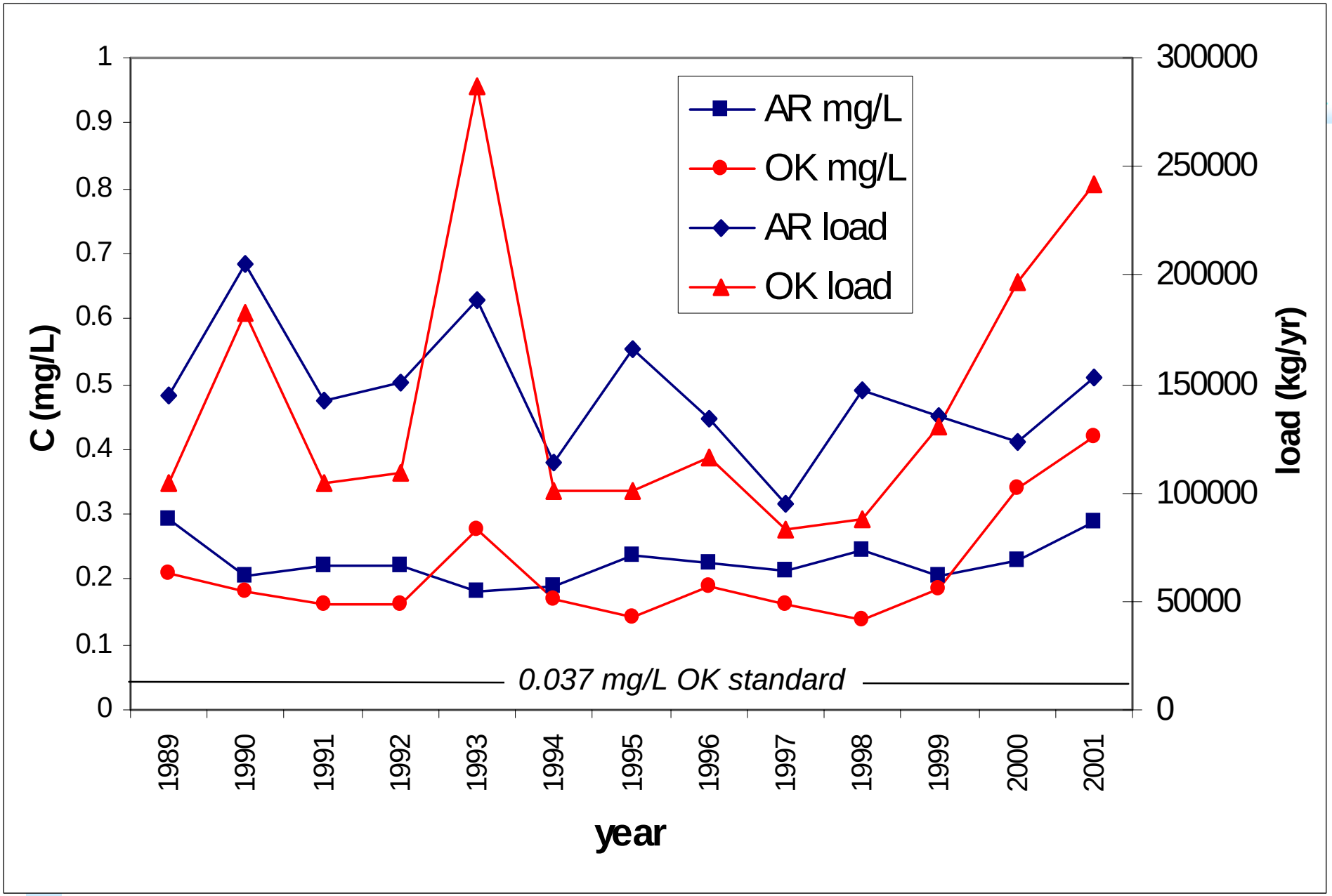
What's happening in "lake"now?

- *Lots of nutrient rich sediment*
- *Phosphorus flux?*

Why would lake make a difference?

- *P source or sink*
- *Ballard Creek (~10% of flow)*
  - *Unnamed creek*

Illinois River concentrations and loads

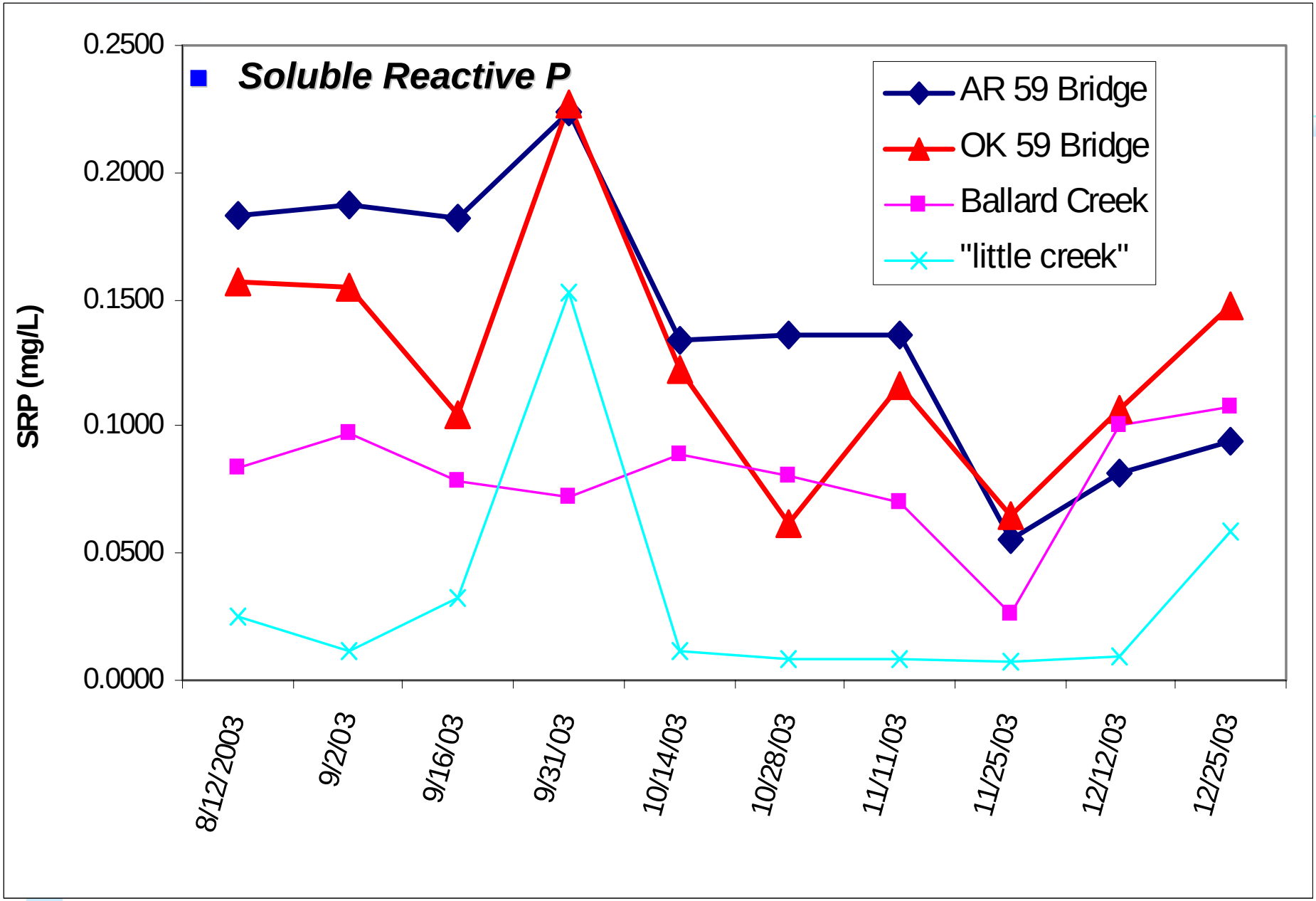


Why would loads be different?

- *Effects of Lake Frances*
  - *The lake*
  - *Two streams between sampling stations*
- *Natural variation and error*
- *Monitoring program design*

Lake sampling

- *4 sites, sampled same time*

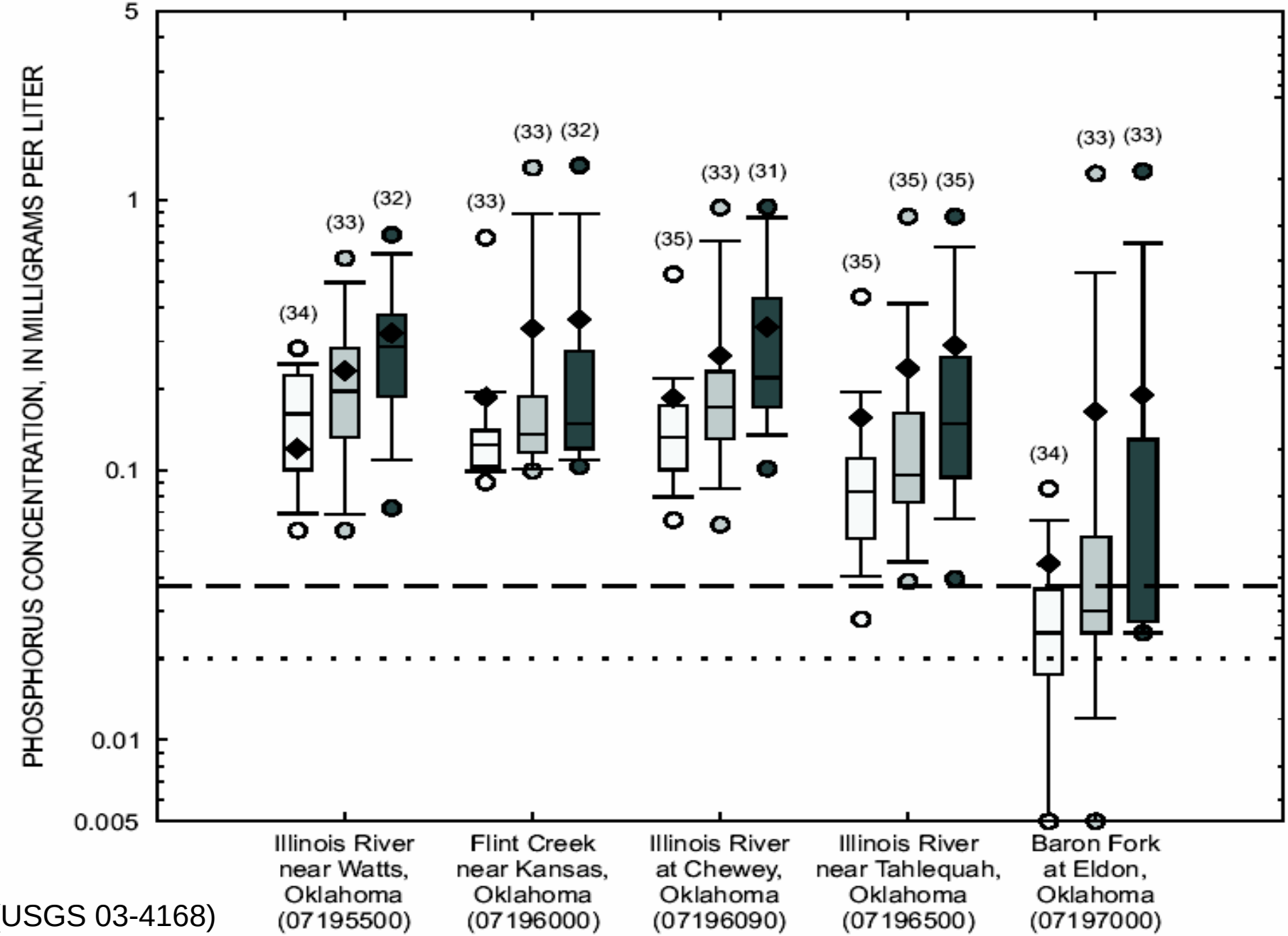


Sediment sampling – P flux

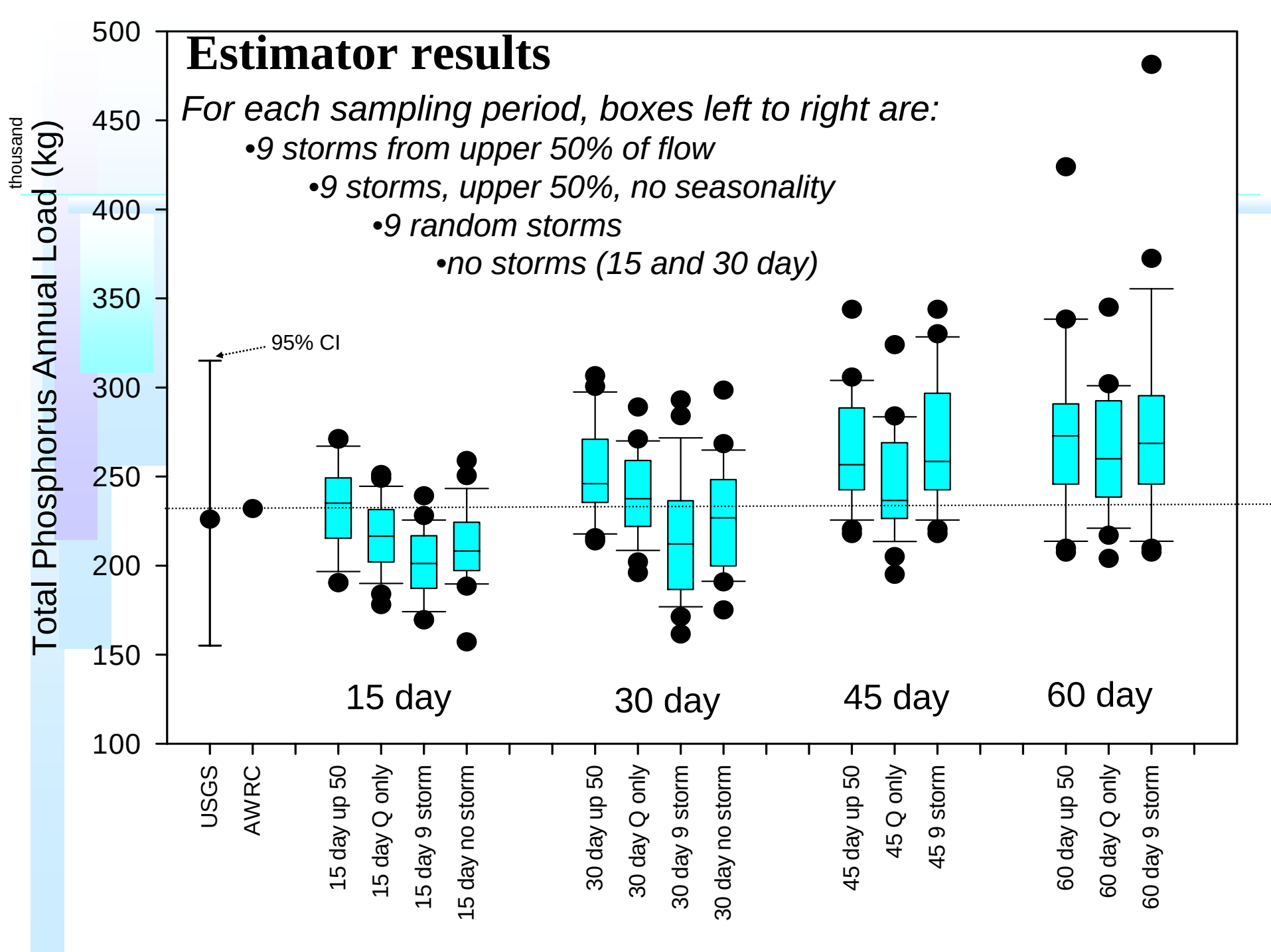
- *A whole lotta P flux going on*
  - *Anaerobic: ~ 16 (mg/m^2)/day*
    - *16 is eutrophic, Lake Euchy is 4*
  - *Aerobic: 0.2 – 4*
    - *Very high*
- *A lot of high nutrient sediment*

Variation

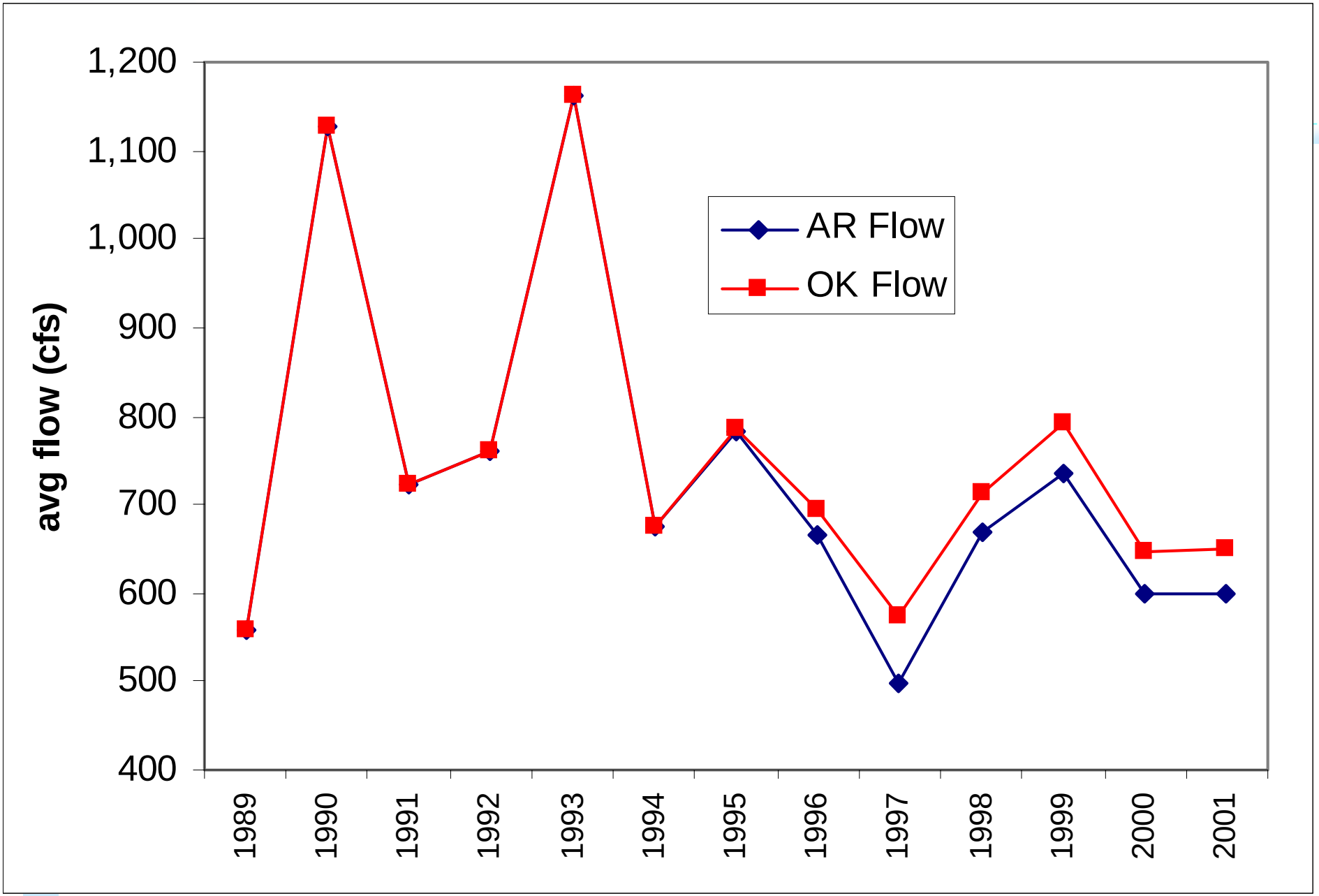
- *Sampling and load calculation*



(USGS 03-4168)


Estimator results
For each sampling period, boxes left to right are:
•9 storms from upper 50% of flow
•9 storms, upper 50%, no seasonality
•9 random storms
•no storms (15 and 30 day)
Total Phosphorus Annual Load (kg)
thousand
500
450
400
350
300
250
200
150
100
95% CI
15 day
30 day
45 day
60 day
USGS
AWRC
15 day up 50
15 day Q only
15 day 9 storm
15 day no storm
30 day up 50
30 day Q only
30 day 9 storm
30 day no storm
45 day up 50
45 Q only
45 9 storm
60 day up 50
60 day Q only
60 day 9 storm

Variation – flow calculation



Monitoring Program Design

- *Loads for Illinois River agreement*
  - *AR: Monthly sampling; Load = flow*C*
  - *OK: now doing targeted storm sampling (USGS)*
- *Also:*
  - *USGS – Arkansas*
  - *AWRC - autosampler*

Monitoring program design

- *Oklahoma*

Year	Storm sampling	Regression years	coeff. for Q	Load (kg)	Flow-wt C (mg/L)
1998	None			87876	0.138
1999	Start	1997-1999	0.703	130314	0.184
2000	Full	1998-2000	1.09	197346	0.341
2001	Full	1999-2001	1.12	241702	0.417

Summary

- *Lake Frances*
  - *A lot of Phosphorus-laden sediment*
  - *Not an obvious source or sink of P,*
    - *But a source now that point sources are down?*
  - *Tributaries not significant*
- *Variation*
  - *Load differences within error/variation*
  - *Doesn't explain trends*
- *Monitoring Program design*
  - *OK is getting more accurate*
  - *OK changes may explain trend*

Conclusions (opinion)

- *Lake can be a long-term source of P*
- *Differences between stations due to:*
  - *Monitoring program differences*
  - *Variation and error*

Future - monitoring

- *New proposed monitoring plan for whole Illinois River watershed*

Future – Lake Frances

- *Plant something (cattails?)*
  - *Probably too much trouble*
- *Dredge*
  - *Good idea, but who pays? Why?*
- *Blow up (rest of dam)*
  - *Potential sediment spike worth it?*
    - *It's not much of a lake now*
- *Leave it alone*
  - *likely*

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"The Arkansas Water Resources Center (AWRC) has a statewide mission to plan and conduct water resource research. AWRC cooperates closely with colleges, universities, and other organizations in Arkansas to address the state's water and land-related problems, promote the dissemination and application of research results, and provide for the training of scientists in water resources."