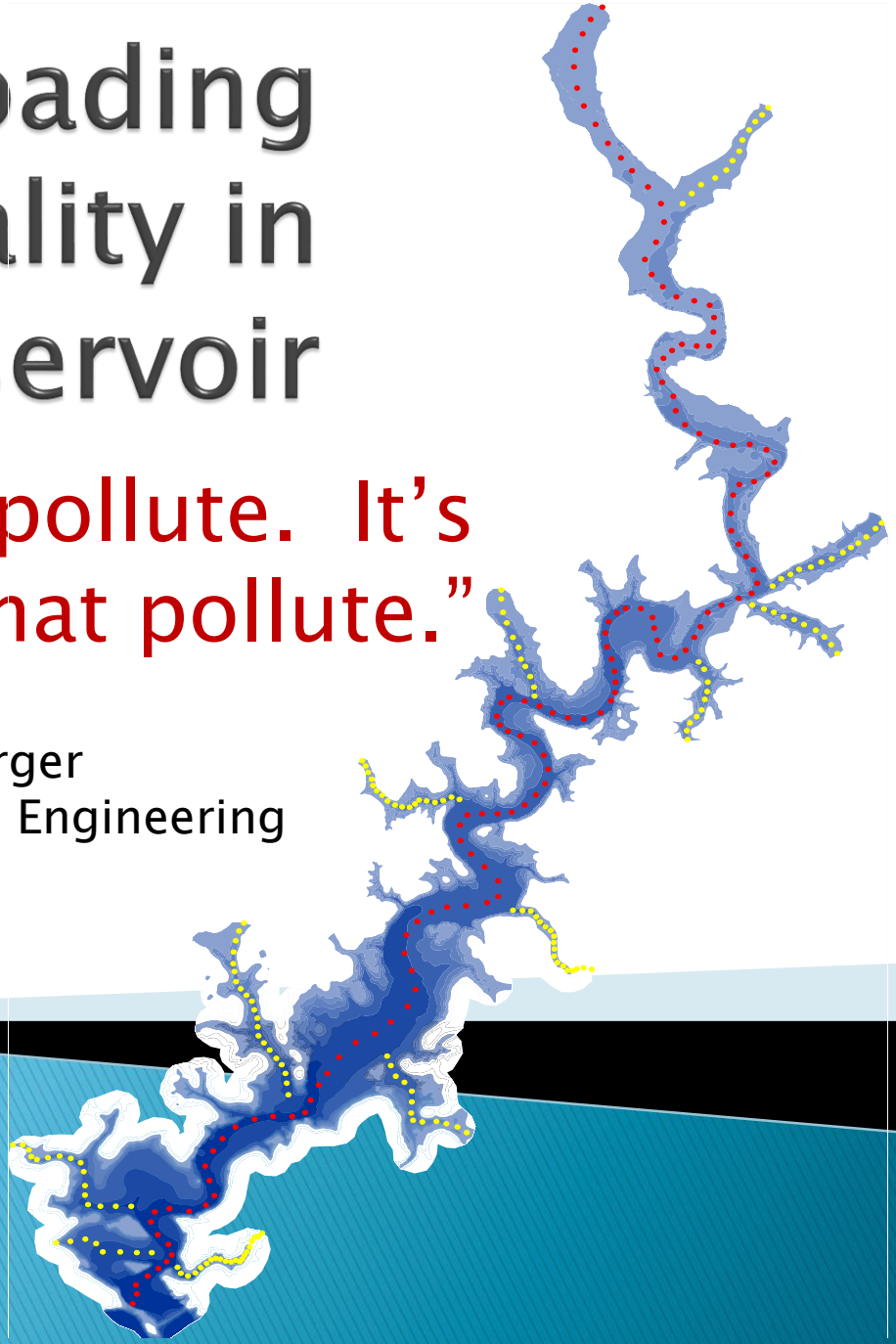
Impact of P loading on Water Quality in Tenkiller Reservoir

"Chickens don't pollute. It's people with chickens that pollute."

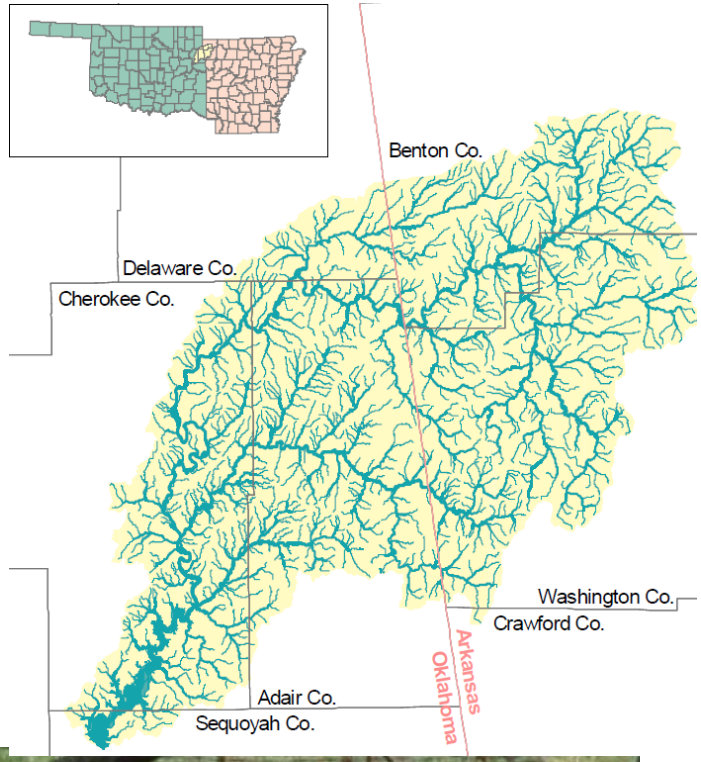
Scott A. Wells, Vanessa Wells, Chris Berger
Department of Civil and Environmental Engineering
Portland State University

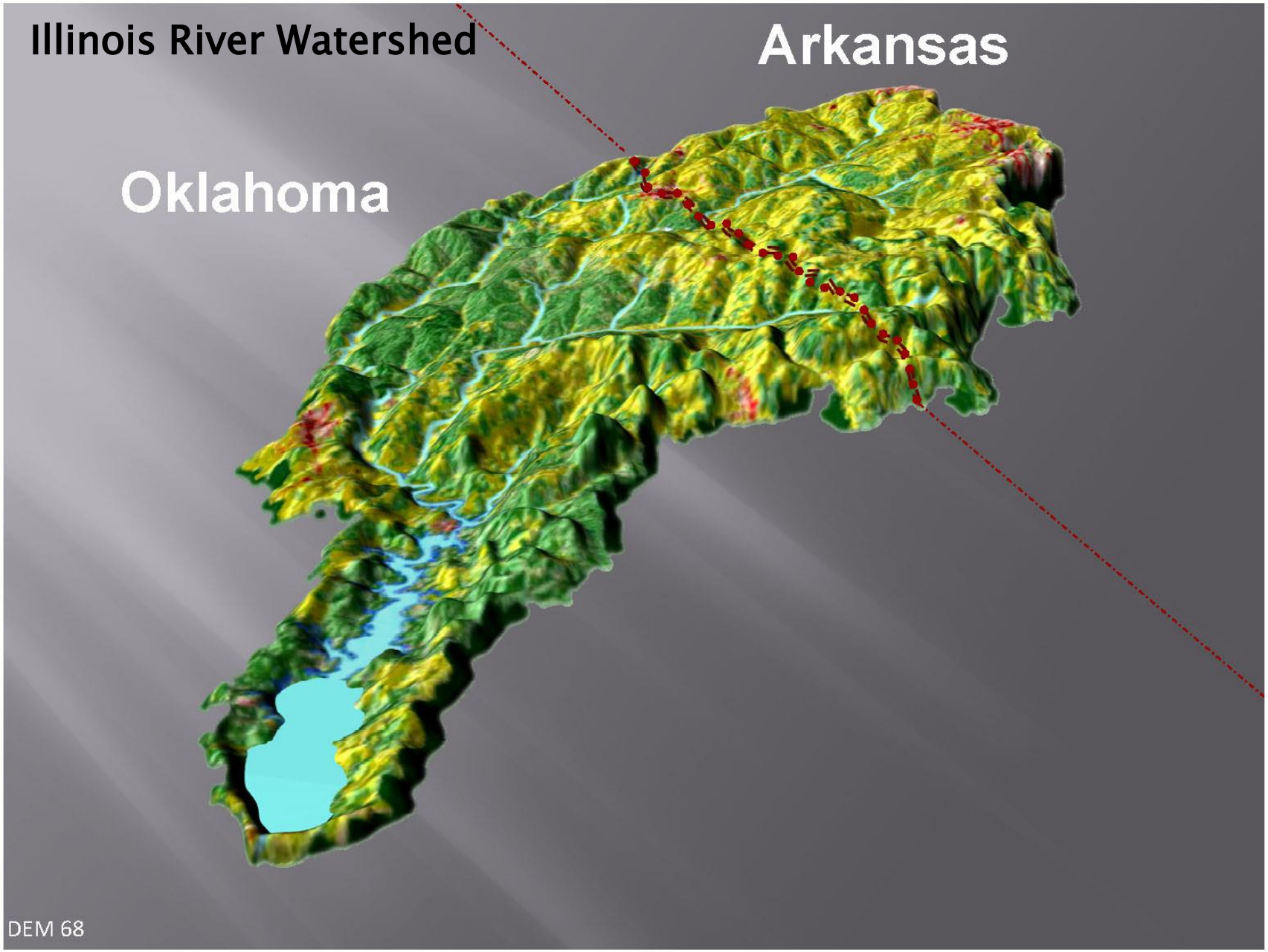


Portland State UNIVERSITY

Overview

- Background issues
- Court case
- Model development/calibration
- Management scenarios
- Current status





Fischer 2009

Muddy Water in Illinois River

Illinois River at US-59 Bridge
Watts, OK

DEM 163

Fischer 2009

Periphyton in Illinois River

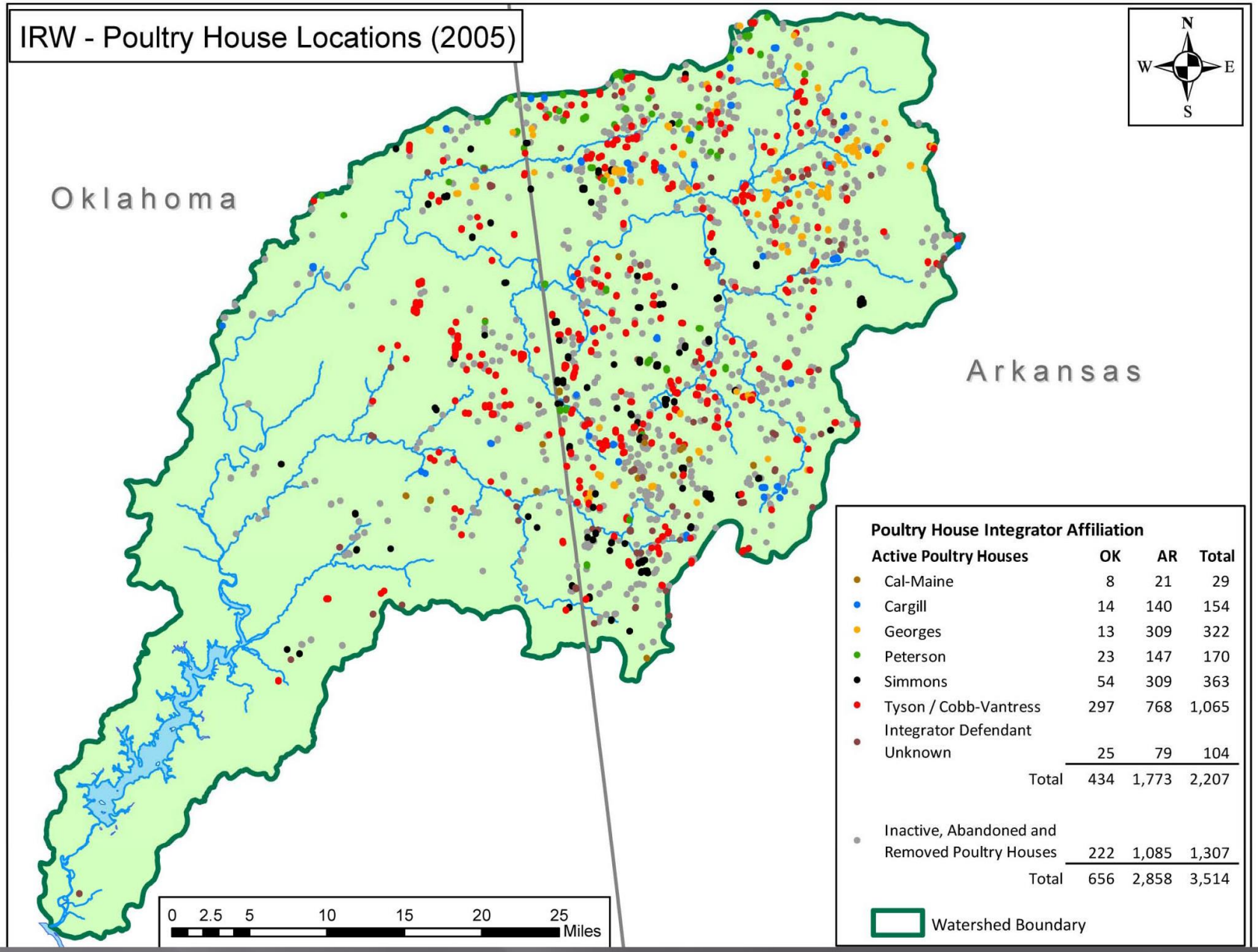
Algae “sheen” in upper part of reservoir

Illinois River Watershed Bird Production (2000-2007)

Year	Birds Produced
2000	117,119,742
2001	138,044,793
2002	137,595,261
2003	140,688,827
2004	160,147,813
2005	157,851,957
2006	150,087,828
2007	129,402,498
TOTAL	**1,130,938,719**

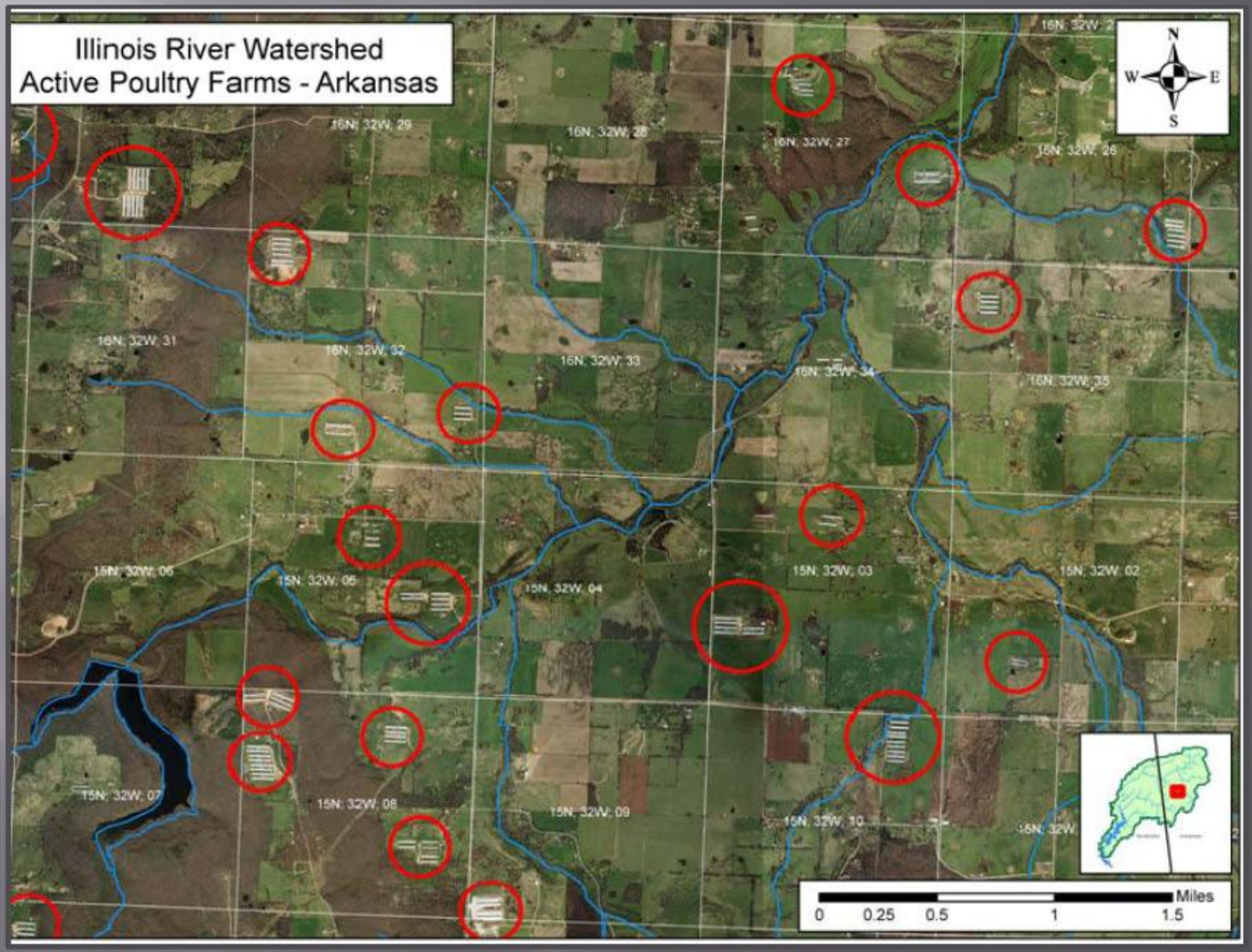
Notes: 2000 is a partial year for George's and Peterson; 2005 is a partial year for Cal-Maine; 2007 is a partial (½) year for all Defendants

Fischer 2009



Source: Oklahoma Ex. 2499; Oklahoma Exhibit 2530

Close Proximity of Poultry Grow-Out Operations in IRW



Typical poultry feed

- Corn
- Soybeans
- Milling/baking wastes
- Fats
- Phosphates
- Na and K salts
- Amino acids
- Trace minerals
  - Cu
  - Zn
- Vitamins
- Antibiotics
  - Arsenic compounds (stopped using this in early 2000's…)
  - Others

"You are what you eat"

Constituents in Defendants' Poultry Waste and Sources in Defendants' Poultry Feed

Poultry Waste Constituent	Average Concentration in Defendants' Poultry Waste (mg/kg)	Waste Constituent Sources in Defendants' Poultry Feed
Calcium	37,922.32	Calcium phosphates ,calcium carbonate, calcium iodate
Nitrogen	31,726.81	Amino acids, feather meal, meat and bone meal, poultry byproduct meal
Potassium	29,008.56	Potassium sulfate
Phosphorus	19,723.31	Calcium phosphates
Sodium	7,578.49	Sodium chloride
Chloride	3,508.86	Sodium chloride
Sulfate	3,759.88	Potassium sulfate, Iron sulfate, copper sulfate
Iron	1,442.77	Iron sulfate,
Manganese	718.89	Manganese oxide
Zinc	488.47	Zinc oxide, zinc propionate
Copper	420.16	Copper chloride, copper sulfate
Arsenic	19.75	Roxarsone (3-nitro-4-hydroxyphenylarsonic acid)

Source: Fisher Report, pp 35-38; Oklahoma Exhibit 2523.

Poultry Waste Disposal
West of AR-59
~0.1 mi north of Summers, AR
04/27/2006
Source: STOK0047671

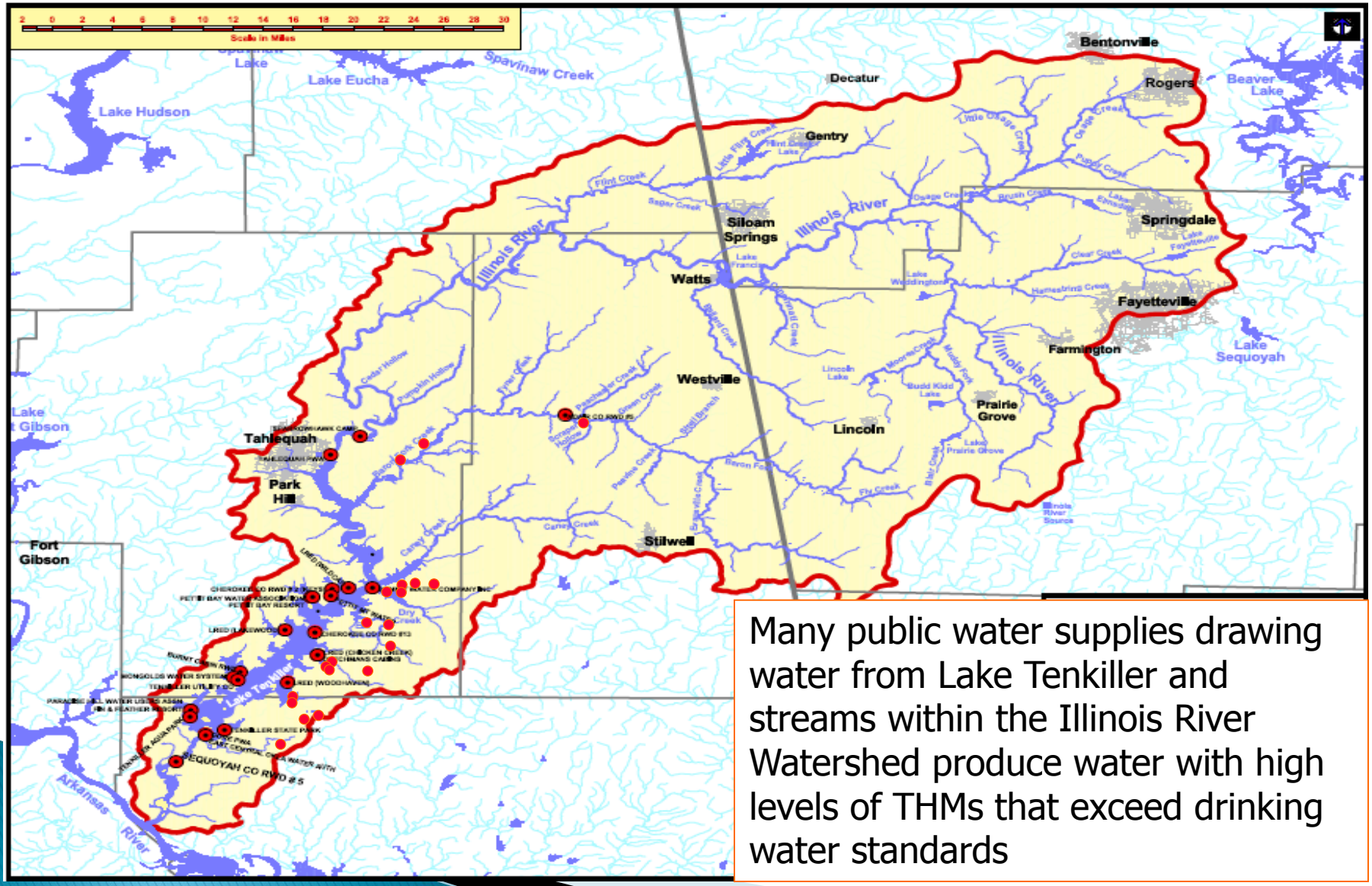
Prudent Use of P in Illinois Watershed: Fertilizer sold, land P deficits based on crop grown, litter application

	Oklahoma	Arkansas
Excess P_2O_5 from fertilizer and litter (tons) in watershed	1,348	6,700

Total excess fertilizer and litter P_2O_5 in Illinois watershed for 2002 = 8,048 tons.

G. V. Johnson

Water Treatment Can Generate High Levels of THMs



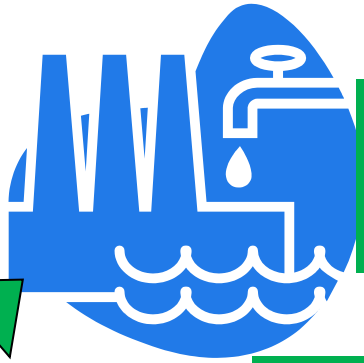
Many public water supplies drawing water from Lake Tenkiller and streams within the Illinois River Watershed produce water with high levels of THMs that exceed drinking water standards

THMs Related To Eutrophication

Poultry Waste Disposal
High Nutrient Levels

2005:04:14 11:35:33

Withdrawal



Public
Water
Supply

Chlorine
Disinfection

Runoff

Source Water Eutrophication
Algal Growth

2005:04:20
10:56:49

THMs
(potential carcinogens)

msnbc.com

Feathers fly at poultry pollution trial

Oklahoma takes on Tyson and other big producers over waste in watershed

The Associated Press
updated 2:29 p.m. PT,Thurs., Sept . 24, 2009

TULSA, Okla. - Attorneys for Oklahoma and the Arkansas poultry industry traded barbs in federal court Thursday, disputing whether the companies knew for decades that over-application of chicken waste on farmland was polluting the Illinois River watershed.

"They have been aware of these problems, and the evidence pointing in their direction for years," said Oklahoma Attorney General Drew Edmondson, who presented the first part of the state's opening remarks in its pollution lawsuit against 11 poultry companies. As he spoke, photographs of poultry litter piled high near barns and river banks flashed on monitors.

Robert George, an attorney for Tyson Foods Inc., one of the defendants in the case, responded in his opening statement that Oklahoma was launching an attack on "hardworking farmers" and defended the use of poultry litter as a valuable resource.

poultry litter in the river valley, state attorney David Page set two glass jars filled with dark brown waste on a table before U.S. District Judge Gregory Frizzell.

"What's in this waste?" he asked before ticking off its contents: phosphorus, nitrogen, arsenic, estrogen, antibiotics and harmful pathogens.

For decades, farmers in northeastern Oklahoma have emptied litter from their chicken houses and spread the droppings on their fields as a cheap fertilizer to grow other crops.

The state argues runoff from the fields has polluted the Illinois River with harmful bacteria that threatens the health of the tens of thousands of people who raft and fish there each year.

But George countered that Oklahoma failed to take into account the waste from cattle operations and municipal water treatment plants, among other sources. The industry also argued that Arkansas and Oklahoma have sanctioned the practice of spreading

TULSA WORLD

Poultry litter trial judge hears of waste contents

• A geologist testifies about a range of analysis he did for the state.

BY CURTIS KILLMAN
World Staff Writer

An estimated 354,000 tons of poultry waste containing phosphorus, copper, zinc, arsenic and other elements were produced in the Illinois River watershed during 2005, an expert testified Tuesday

• The amount of copper and zinc contained in the poultry feed exceeded the bird's nutritional needs.
• Phosphorus in poultry waste was 3.5 times more than that found in cattle waste.

The poultry industry has maintained that cattle are responsible for much of the phosphorus pollution in the watershed.

The state also showed several photos taken both from the ground and air of poultry farm operations in the watershed.

A 8 ■ ■ Thursday, October 15, 2009

Testimony shakes up case

A witness for the ate in its poultry wsuit offers demonstration r the court.

DAVID HARPER

tap water with a jar of chicken litter to give U.S. District Judge Gregory Frizzell an up-close look at what the two look like when they are combined.

The demonstration — to which the defense objected — shook up what was otherwise a technical day of testimony as Fisher discussed scientific sampling and analysis of the soil and water in the Illinois River watershed.

The state is suing 11 poultry companies, saying that they are legally responsible for the handling and disposal of poultry waste — also known as litter — that the state says has damaged portions of the watershed.

On Wednesday, Fisher further discussed the phosphorous, copper, zinc and arsenic, which the state asserts are contaminants found in the watershed that can be traced to the poultry industry.

Fisher, who is also a geochemist, discussed testing done on fields, run-off water from those properties, ground water as well as sediment from streams and Lake Tenkiller.

The lake, according to Fisher, is where poultry waste components are transported by the flow of water within the watershed.

Fisher discussed his opinion that increased production of poultry within the watershed over time has prompted a rise in associated contaminants in the lake.

Once again, it was a day full of objections over evidentiary matters and subsequent requested explanations by the attorneys of the court's rulings. At one point, Frizzell remarked that if he was going to have to detail the rationale behind all of his decisions "we're going to be here until next June."

Frizzell drew laughter from the gallery when he wryly remarked that eventual appeals in the case might extend all the way to the "International Court in the Hague."

David Harper 581-8359
david.harper@tulsaworld.com

Poultry lawyers contest expert witness' claims

BY DAVID HARPER
World Staff Writer

Defense attorneys used

explained further the involvement of three of his children and some of their friends in the

Impact of poultry waste described

• A scientist testifying for the state calls poultry litter a "major source" of chemicals found in the watershed.

BY CURTIS KILLMAN
World Staff Writer

A "substantial" portion of the phosphorus in the Illinois River watershed can be traced to runoff from fields laden with poultry litter, a scientist testified Tuesday.

Geochemist Roger Olsen, testifying for the state in federal court in Tulsa, said he based his conclusions on

the watershed.

Olsen's testimony was allowed despite repeated objections from attorneys for Tyson Foods Inc. and other poultry companies that are defendants in the case.

Tyson attorney Thomas Green maintained that Olsen can say various chemical constituents may be found in the watershed but shouldn't be able to testify regarding its association to any "particular site or grower."

Green also said there were a "jillion" other sources of contamination that Olsen had not addressed.

The state is suing 11 poultry companies, claiming that they are legally responsible for the handling and disposal of poultry waste — also known

Oklahoma.

Poultry litter, a byprc of raising chickens and keys, is commonly use area farmers as fertilize forage crops.

U.S. District Judge Gre Frizzell permitted the mony, noting that Olser outlined the findings in a viously submitted report

Olsen's linking of po waste to runoff to water contamination came at end of a day filled with ence-based testimony.

He said he also anal poultry waste and cattle nure to compare conce tions of common cher components and found poultry waste has si cantly higher concentra of arsenic, copper, potass

from 188 times more cop-

wastewater treatment plant

A 14 ■ ■ Tuesday, January 5, 2010

Witness can't recall seeing algae

• A school counselor gives a layman's perspective at a poultry pollution trial.

BY CURTIS KILLMAN
World Staff Writer

A government regulator, a scientist and a school counselor who loves to fish offered three perspectives on

described avid fisherman, as he described his experiences fishing portions of the Illinois River for the past 30 years.

Duncan, who was featured in a video played in court during the poultry industry's opening statements in September, said he fishes the Illinois River and its tributaries 40 to 50 times a year, mostly on the Arkansas part of the stream.

"It is my religious place," he said

While the video played, Duncan pointed out several large nurseries and wastewater treatment plants bordering portions of the river.

He also recalled having numerous encounters with cattle during his fishing trips in a flat-bottom boat.

During cross-examination, an attorney for the state asked Duncan whether he recalled seeing the "dozens upon dozens" of poultry houses that were near the Illinois River during his be-

In other testimony Monday, a hydrologist retained by the poultry industry faulted the state's expert witness testimony, given earlier in the trial.

Steven P. Larson's analysis dealt with state data on concentrations of phosphorus, copper, zinc and arsenic in samples of groundwater samples and runoff from fields.

Earlier Monday, an Arkansas Natural Resources Commission official detailed

Area students race their aquatic creations against the clock at OSU-Tulsa. **A11**

Halt to poultry litter sought

• Lawyers for poultry firms say in closing arguments that a moratorium would be a hardship.

BY CURTIS KILLMAN
World Staff Writer

Lawyers for the state are urging a federal judge to impose a moratorium on the application of poultry litter in the Illinois River watershed.

The request came Thursday during closing arguments in the final day of trial for the state's pollution lawsuit against 11 poultry companies.

Robert Nance, an attorney for the state, urged U.S. District Judge Gregory Frizzell to impose a moratorium on the application of poultry litter as fertilizer in the watershed.

Nance suggested that the moratorium could be temporary and might be lifted after the court establishes sufficient controls.

Farmers in the area commonly use poultry litter, which contains poultry waste and has high concentrations of phosphorus, as fertilizer for crops.

Attorneys for the poultry companies opposed the moratorium, saying it isn't necessary and would cause an economic hardship on the poultry and cattle industries.

Mark Hopson, an attorney for Tyson Foods Inc., quoted from earlier defense experts who testified that an injunction could be cost-prohibi-

SEE **POULTRY** A12

Oklahoma Attorney General Drew Edmondson (center) and others involved with the state's lawsuit against 11 poultry companies walk toward a federal courthouse in Tulsa for closing arguments on Thursday. CORY YOUNG/Tulsa World

The allegations

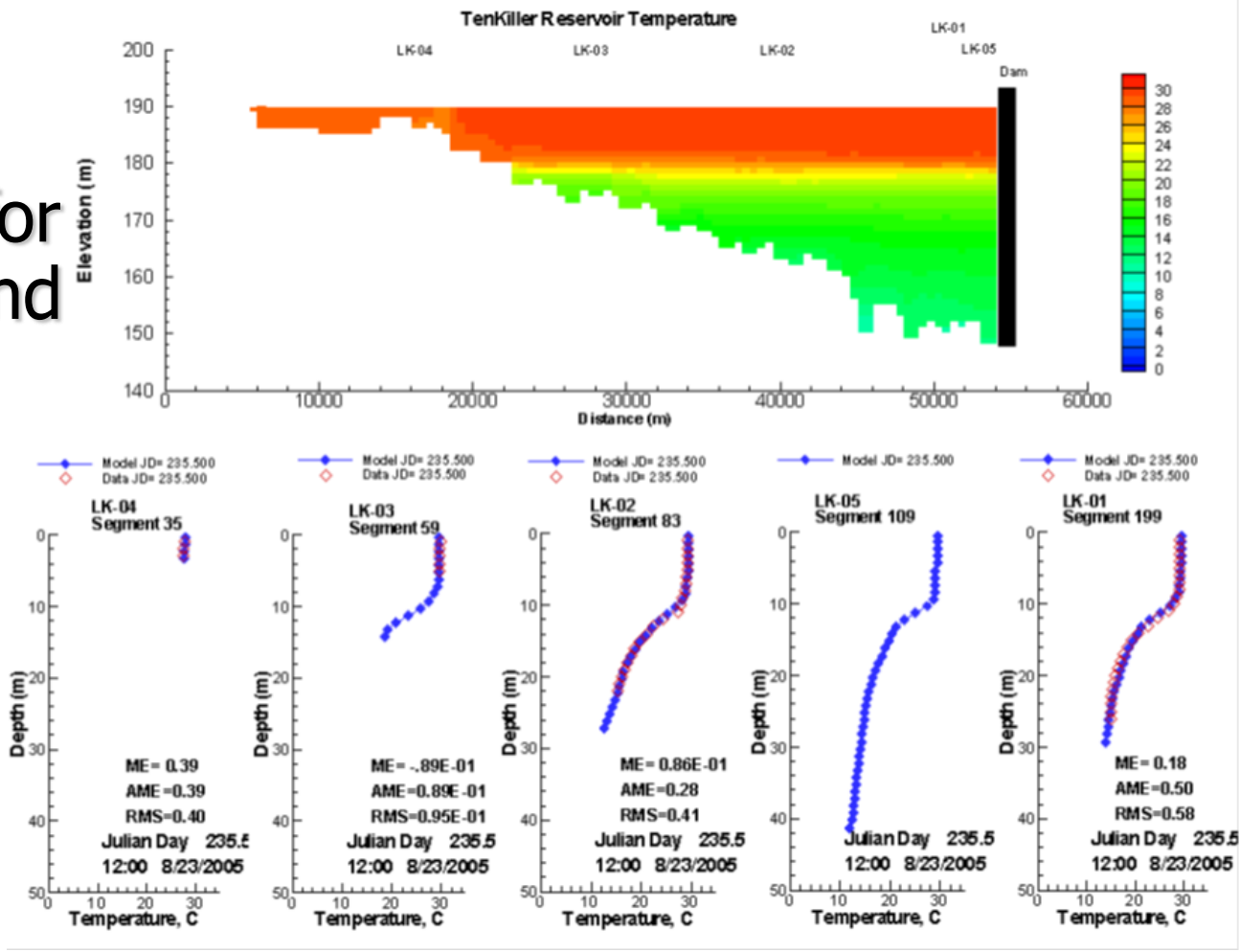
- Violation of state and federal public-nuisance laws
- Violation of trespass laws
- Violation of two state statutes governing pollution of waterways

The defendants

Tyson Foods Inc.
Tyson Poultry Inc.
Tyson Chicken Inc.
Cobb-Vantress Inc.
Cal-Maine Foods Inc.
Cargill Inc.
Cargill Turkey Production LLC
George's Inc.
George's Farms Inc.
Peterson Farms Inc.
Simmons Foods Inc.

CE-QUAL-W2

2-D (vertical-longitudinal), unsteady model for hydrodynamics and water quality for rivers, reservoirs, lakes, estuaries supported by the Corps of Engrs, ERDC

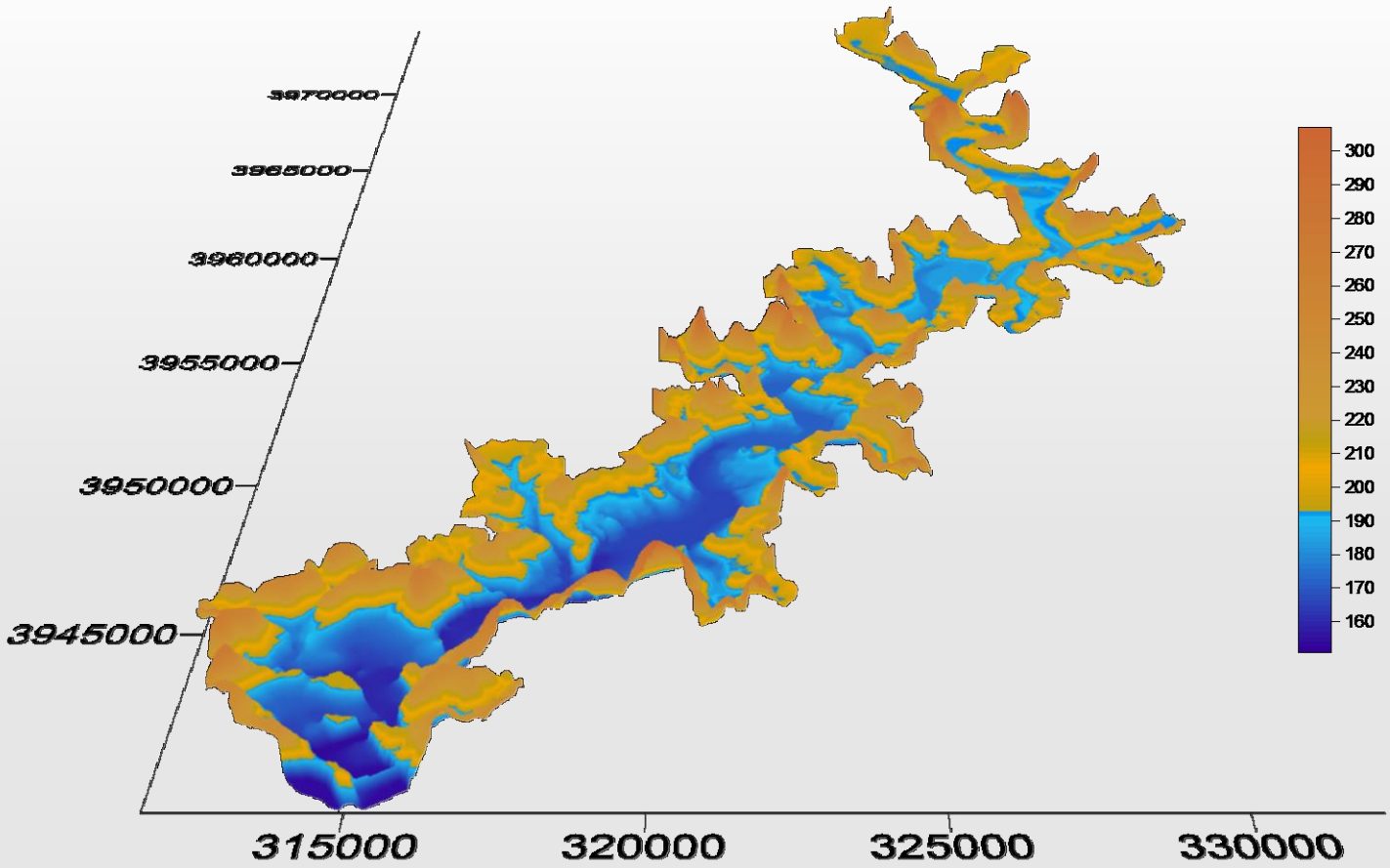


CE-QUAL-W2 state variables

- Temperature,
- Velocity (U, W)
- Water surface elevation
- Conductivity
- Inorganic suspended solids groups
- Labile and refractory dissolved organic matter groups
- Total inorganic carbon
- # CBOD groups including CBODP and CBODN groups
- # generic groups (bacteria, tracer, toxics, water age)
- N - P Labile/refractory particulate organic matter
- # algal groups
- # periphyton groups
- # macrophyte groups
- # zooplankton groups
- NH_4-N
- PO_4-P
- NO_3-N+NO_2-N
- Alkalinity
- Organic sediment model (0 order, 1st order)

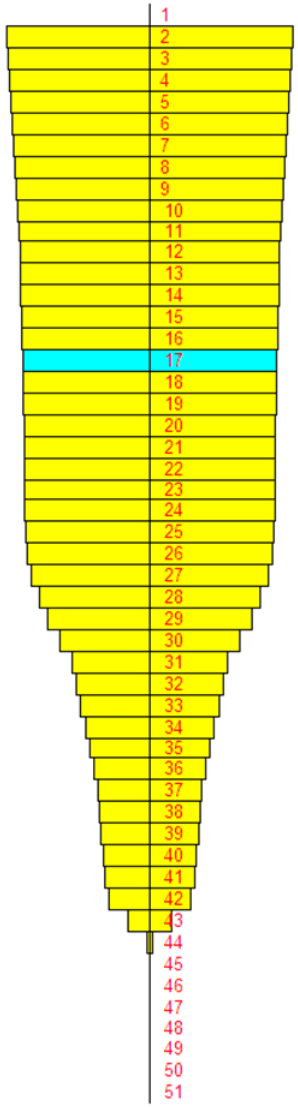
From these a set of derived variables are computed, such as TOC, TKN, TotP,TotN, pH, carbonate system, etc.

Model – bathymetry



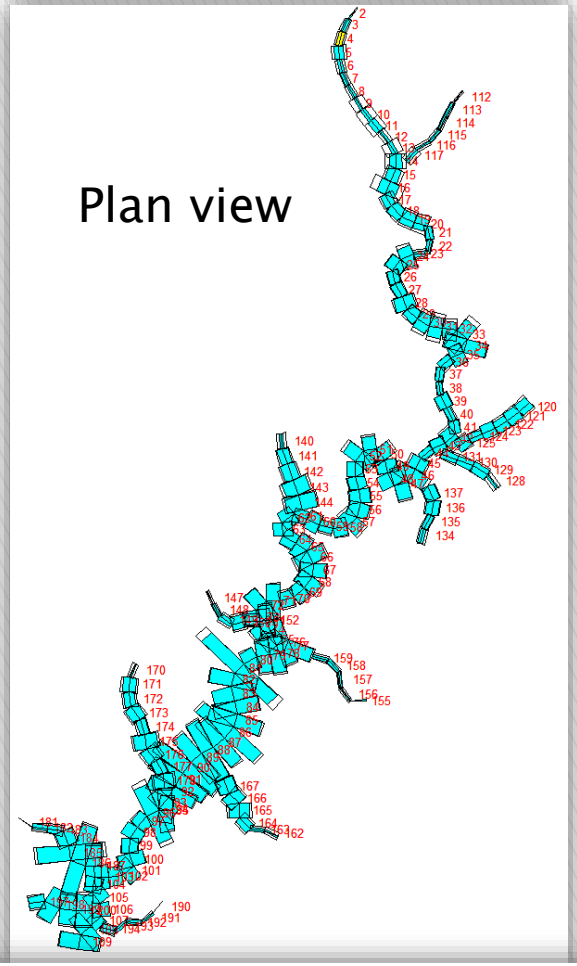
54 km length of main branch

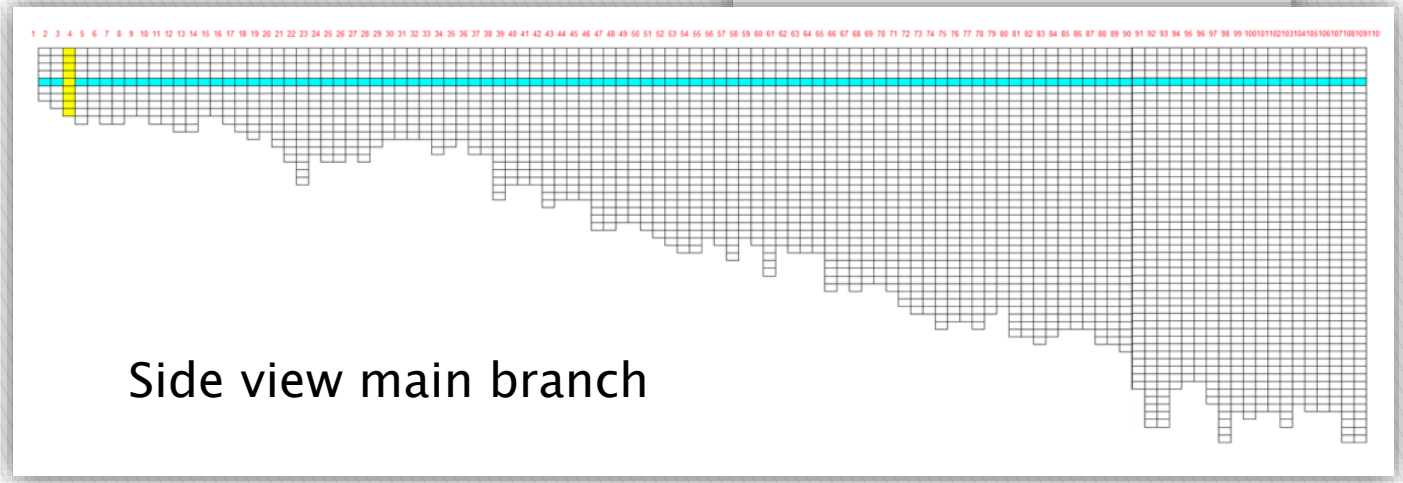
Model Grid



Segment end view

200 model segments, 13 branches, 500 m segment length, 1 m vertical layer height, 51 vertical layers





Boundary condition and calibration data

- Meteorological data
  - Air temp, dew point temp, wind speed/direction, cloud cover, solar radiation
- Inflows
- Outflows
- Water quality boundary data (temp, nutrients, organic matter, DO, SS, etc.)

- Water level data
- Temperature profiles and continuous probes in outflow
- Dissolved oxygen and nutrient profiles and grab samples
- Algae data

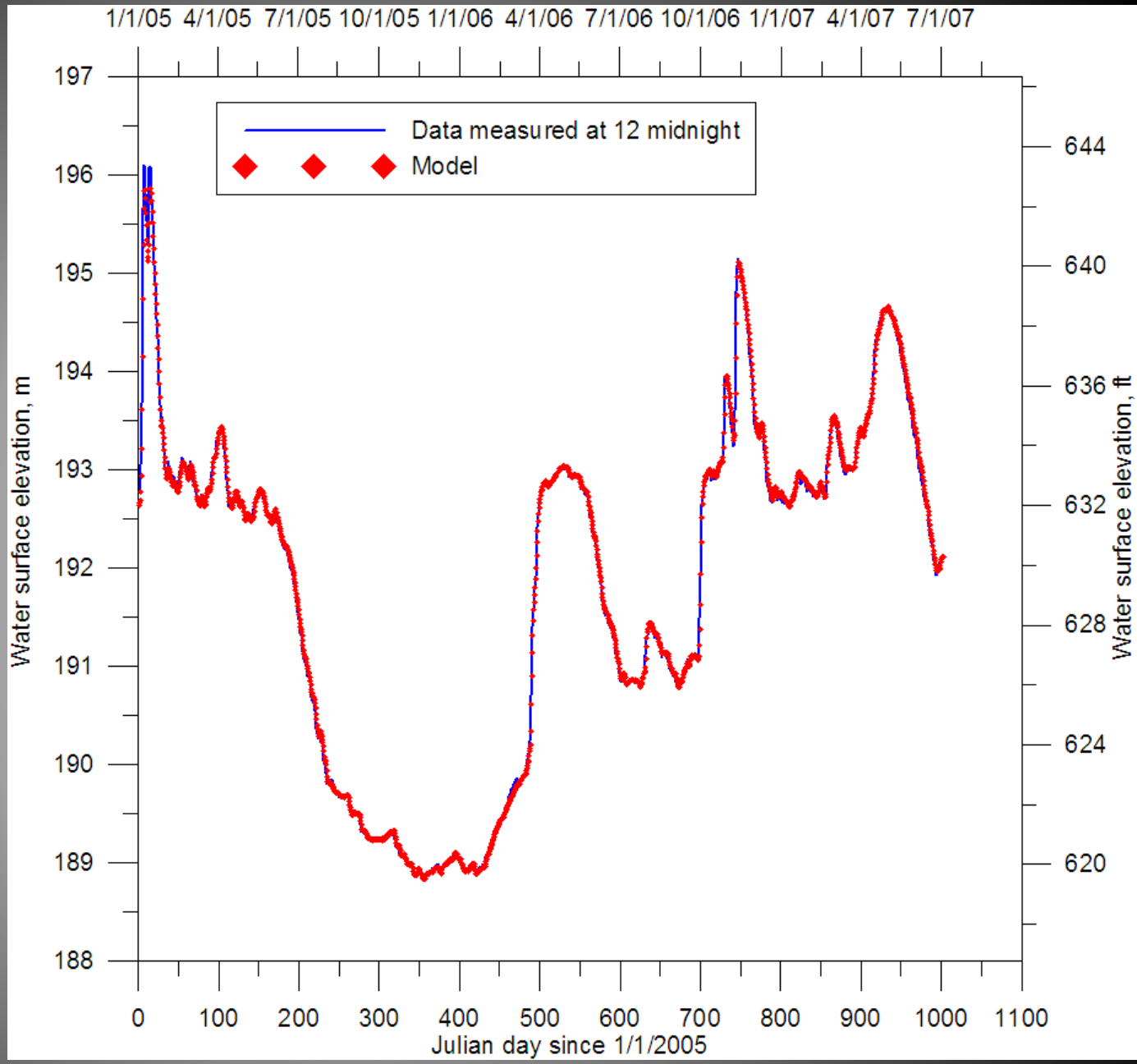
Model set-up data

Model calibration data

January 2005-September 2007

Tenkiller Water level

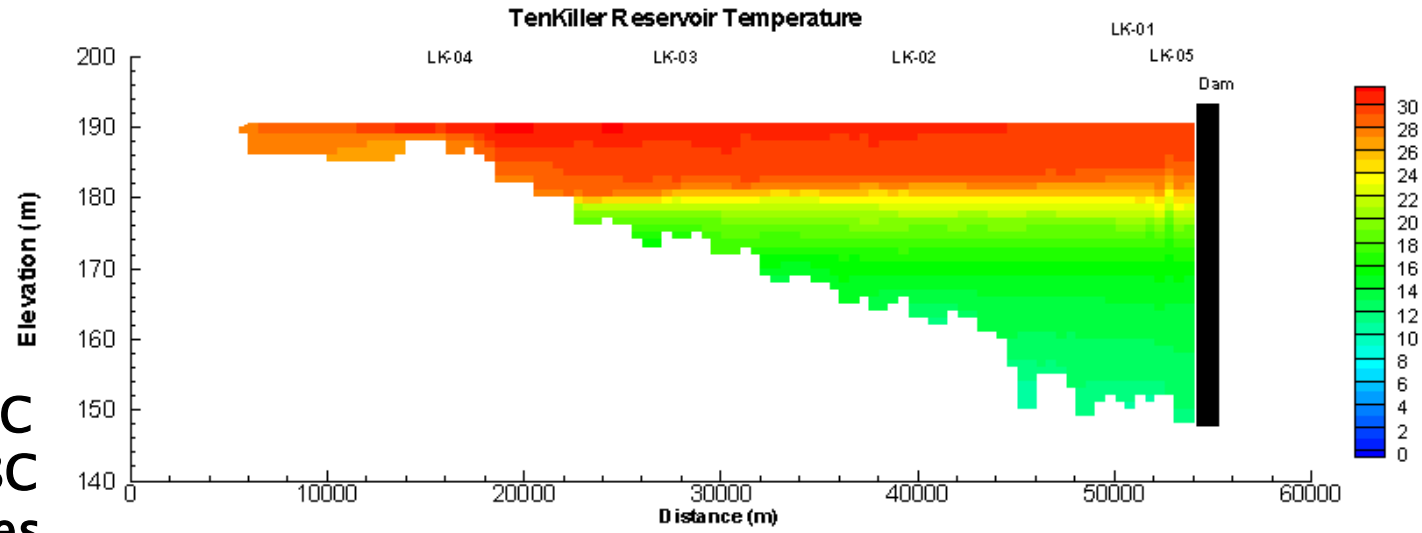
2005-2007

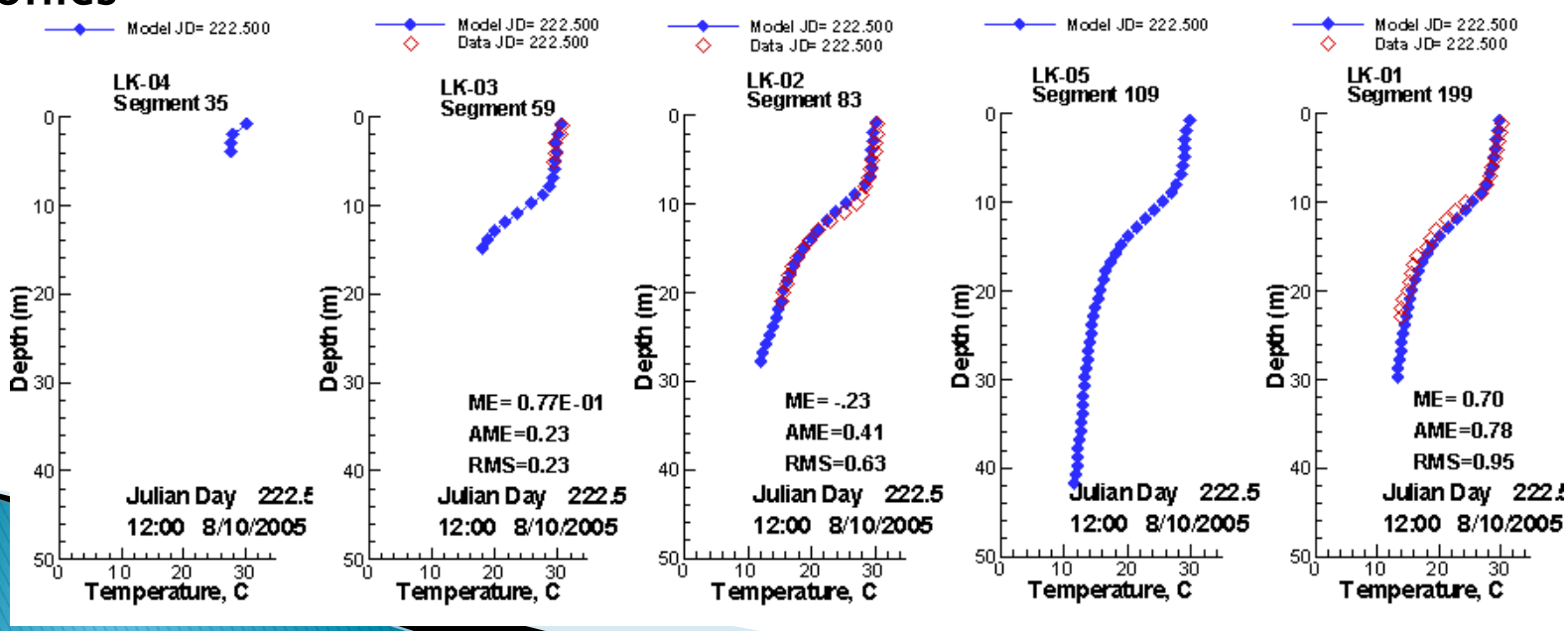


Location	# of comparisons, N	Mean error, m	Absolute mean error, m
Segment 109 at Tenkiller dam	1002	0.00	0.02

Temperature calibration

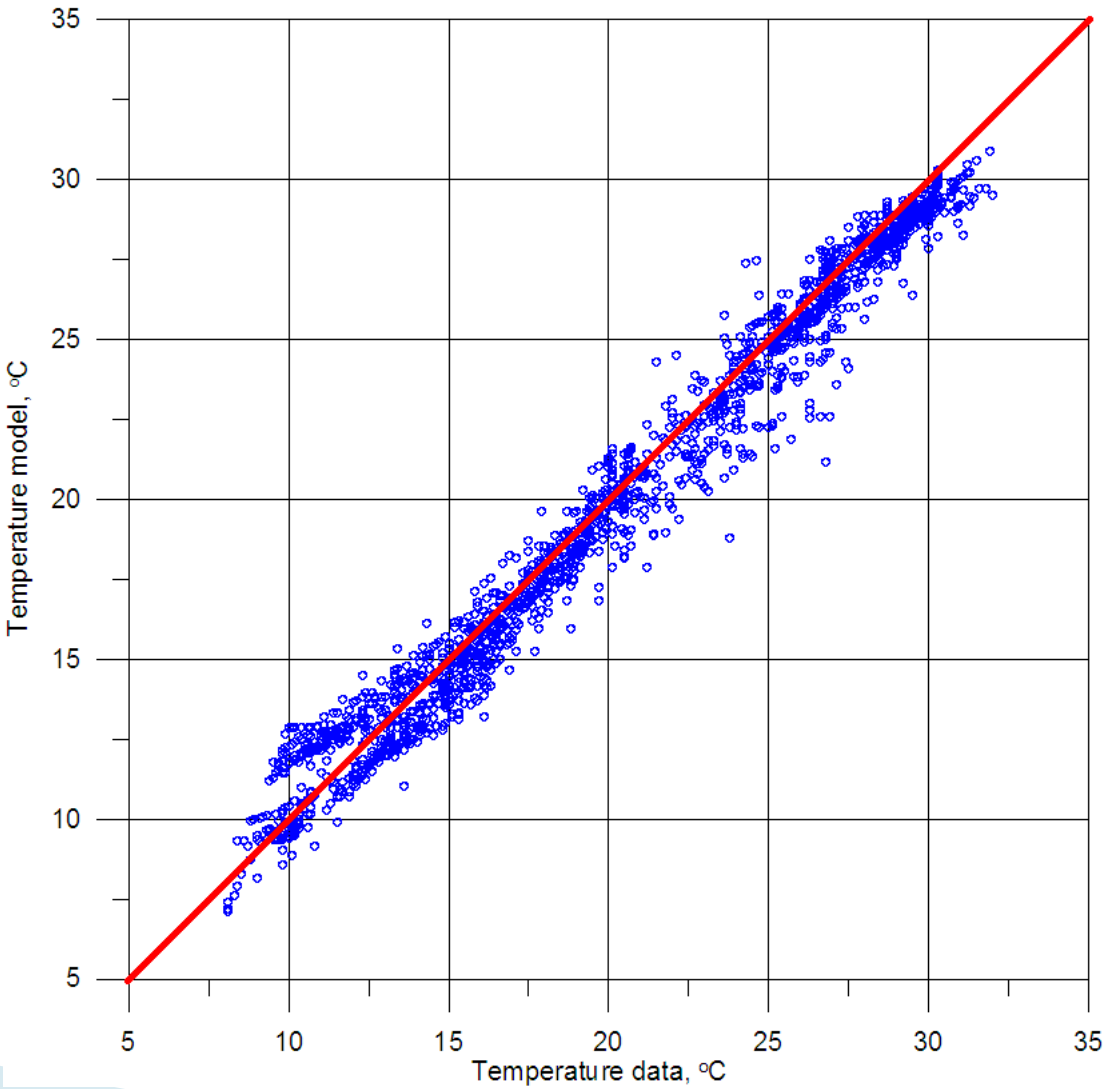
ME=-0.06C
AME=0.78C
117 profiles



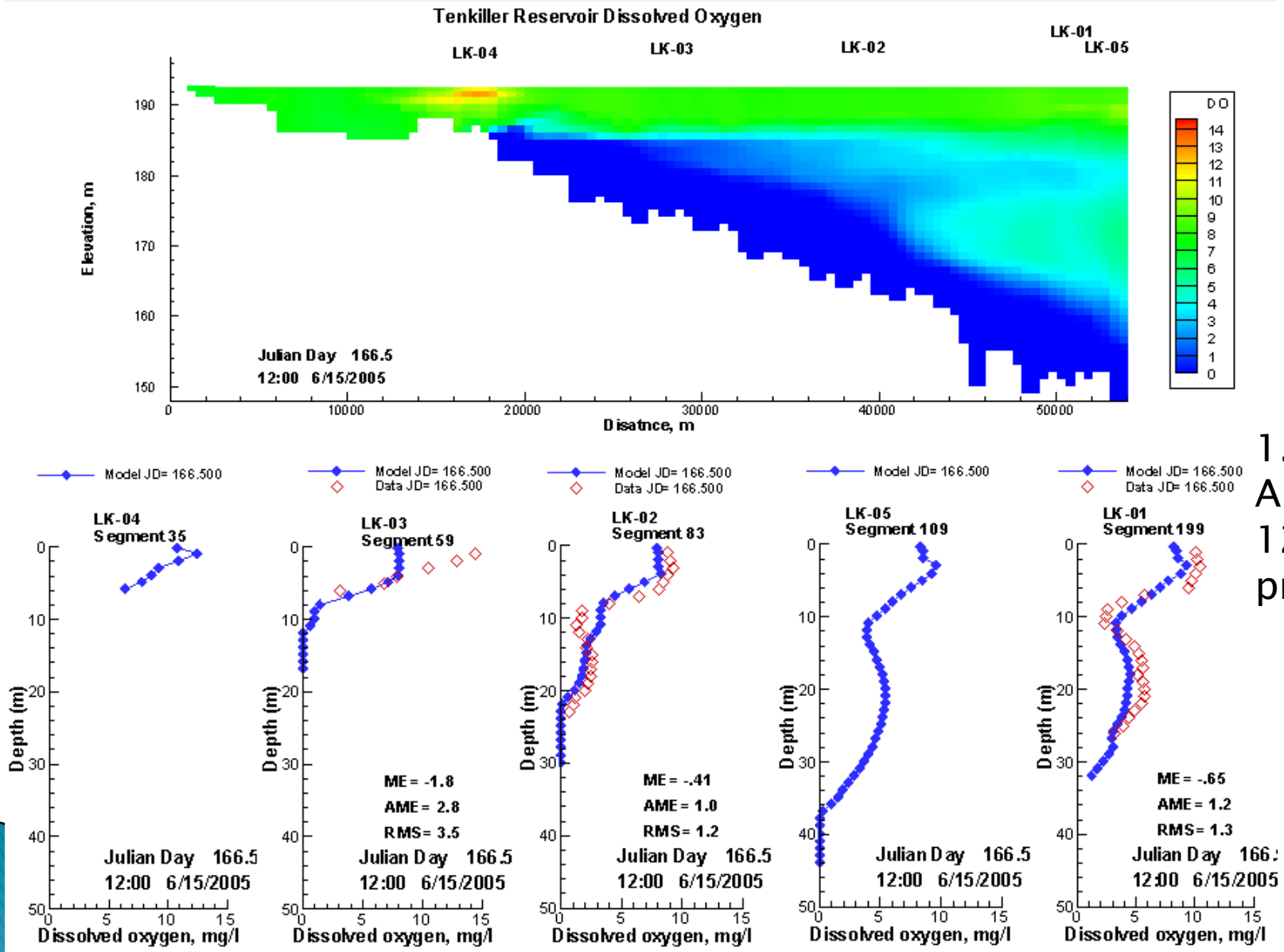


Tenkiller Temperature Profile Comparison

- Comparison of all measurements at all locations compared to model predictions

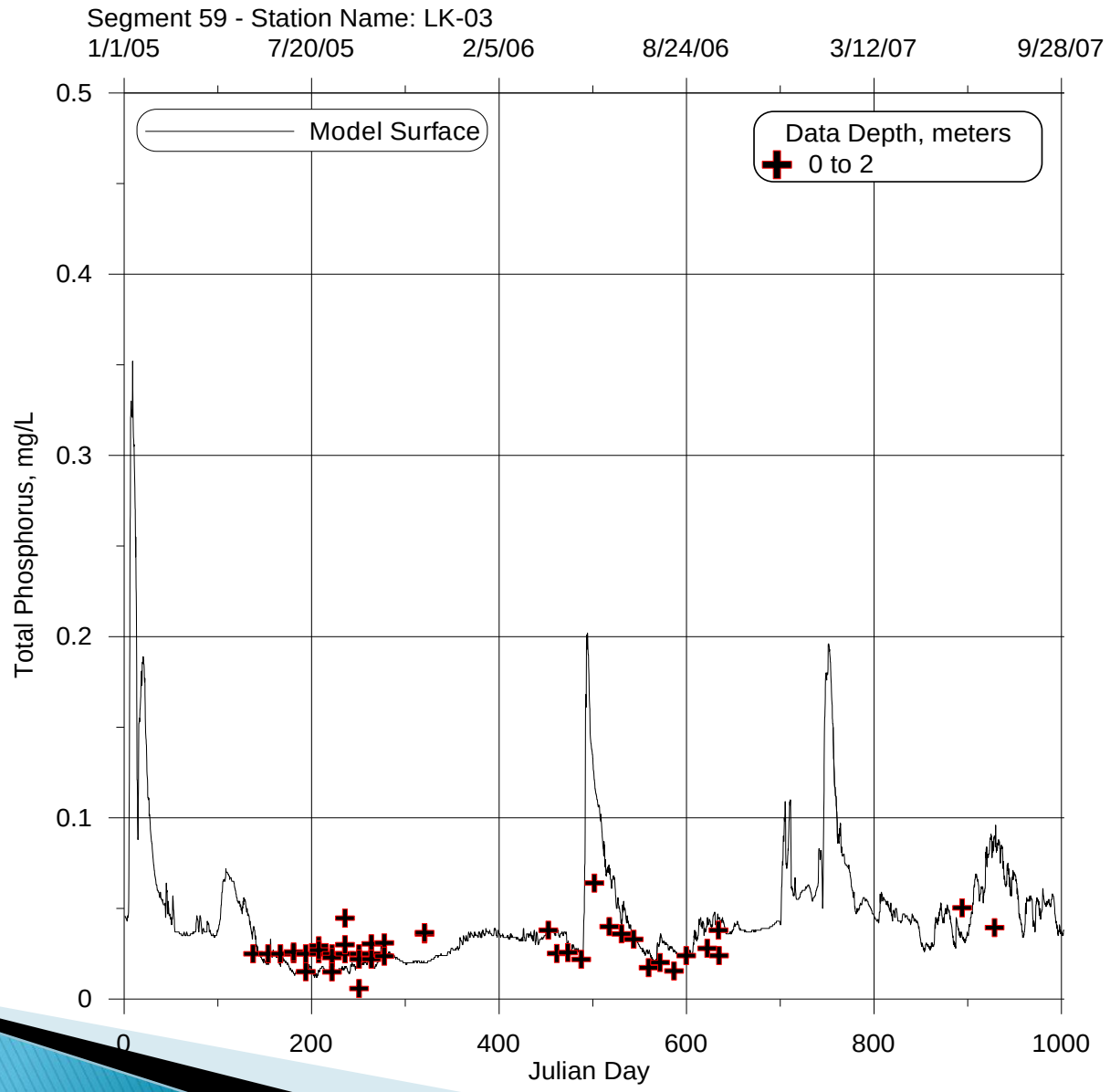


Dissolved oxygen calibration

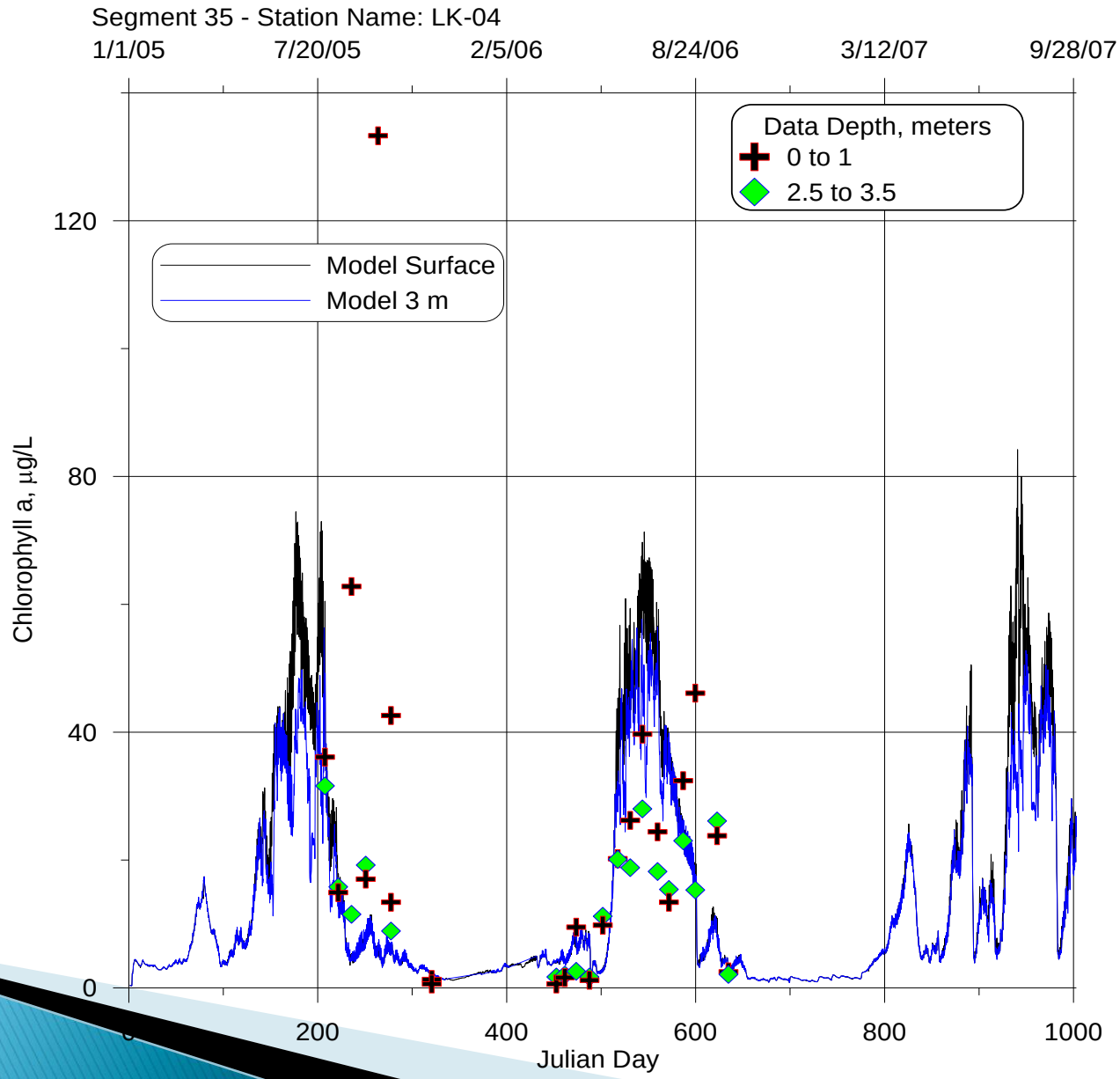


1.5 mg/l
AME
128
profiles

Total P calibration



Chlorophyll a calibration



Model set-up for long-term simulation

- 50 year scenarios
- Repeat hydrologic, meteorological, and water quality data from 1997-2007 for 5 10-year periods
- Vary P load based on scenarios

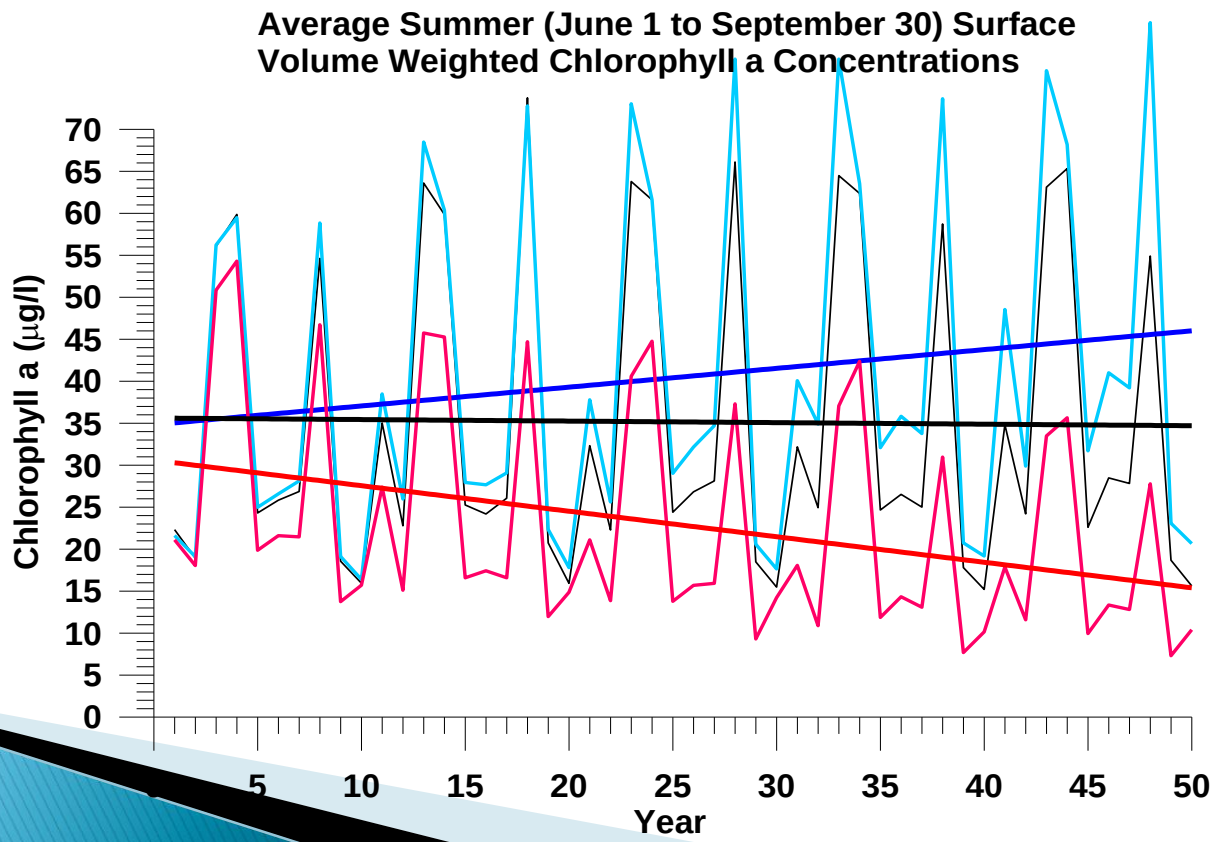
- Base case
- Cessation
- Natural conditions
- Growth
- Historical conditions (reproduce 1950-1999 historical conditions)

Background data

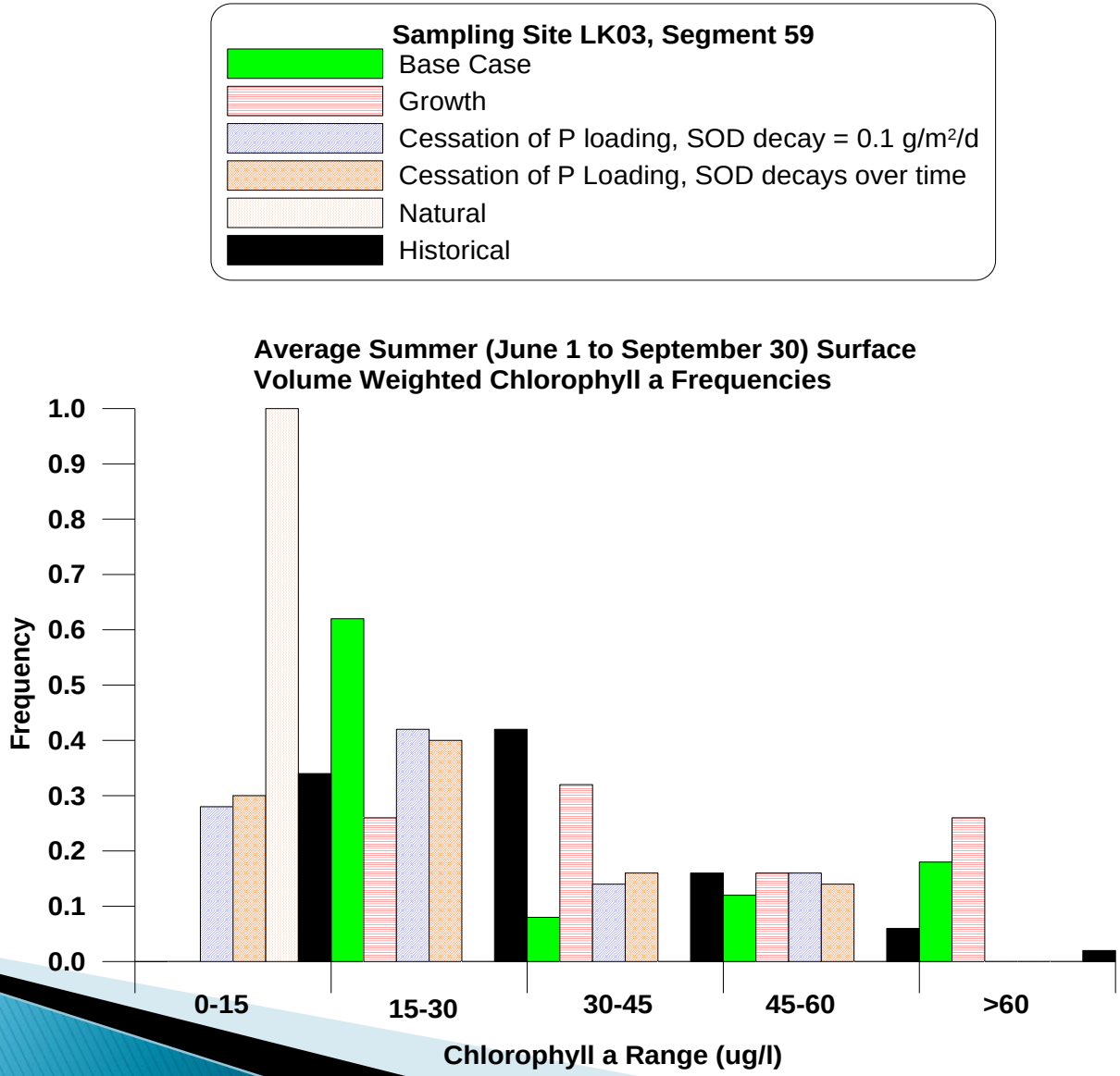
Scenarios

Chlorophyll a impacts

Linear trend - Cessation SOD decline
Equation Y = -0.3039681633 * X + 30.59259216
Residual mean square = 159.6
Linear trend - Base
Equation Y = -0.01828404322 * X + 35.6112391
Residual mean square = 346.4
Linear trend - Growth
Equation Y = 0.2237537191 * X + 34.81100016
Residual mean square = 413.0

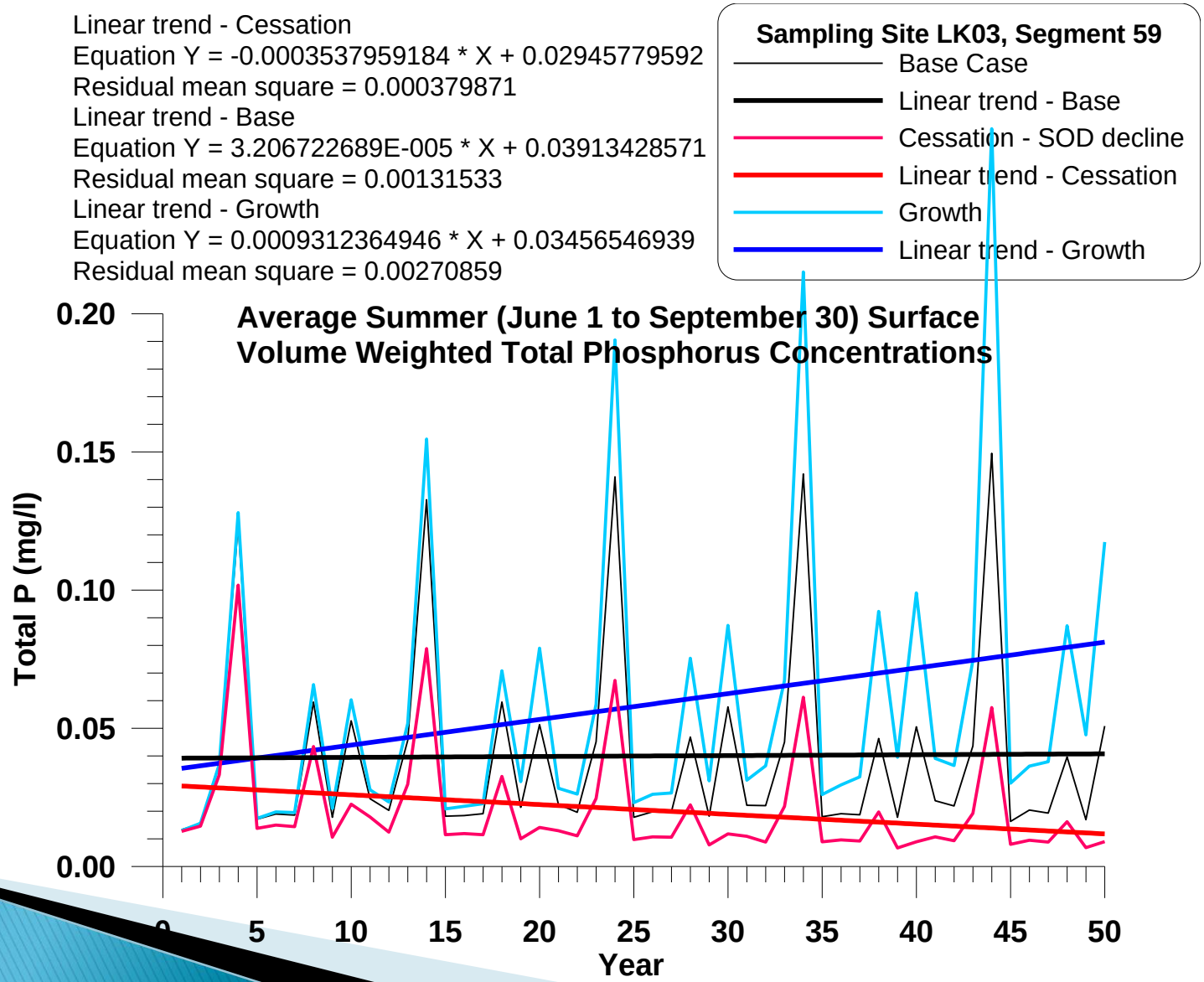


Chlorophyll a impacts



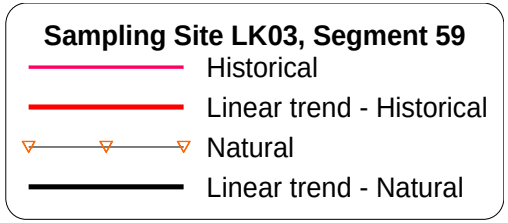
Total P impacts

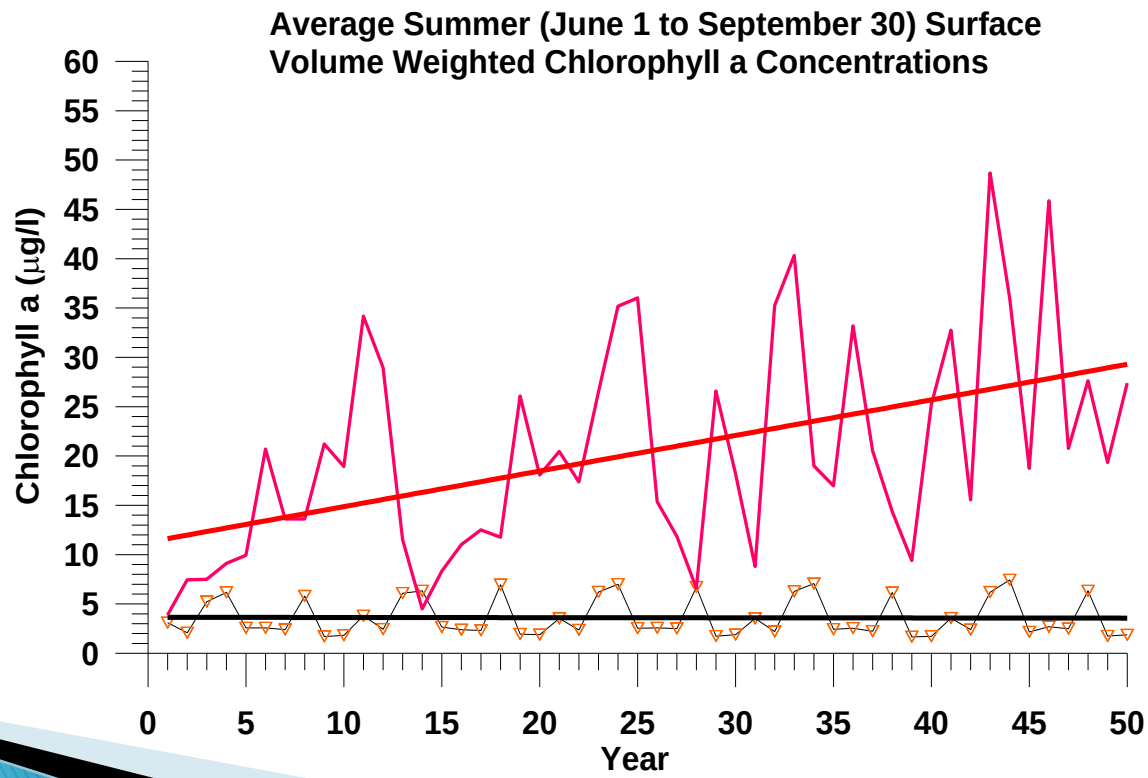
Linear trend - Cessation
Equation Y = -0.0003537959184 * X + 0.02945779592
Residual mean square = 0.000379871
Linear trend - Base
Equation Y = 3.206722689E-005 * X + 0.03913428571
Residual mean square = 0.00131533
Linear trend - Growth
Equation Y = 0.0009312364946 * X + 0.03456546939
Residual mean square = 0.00270859



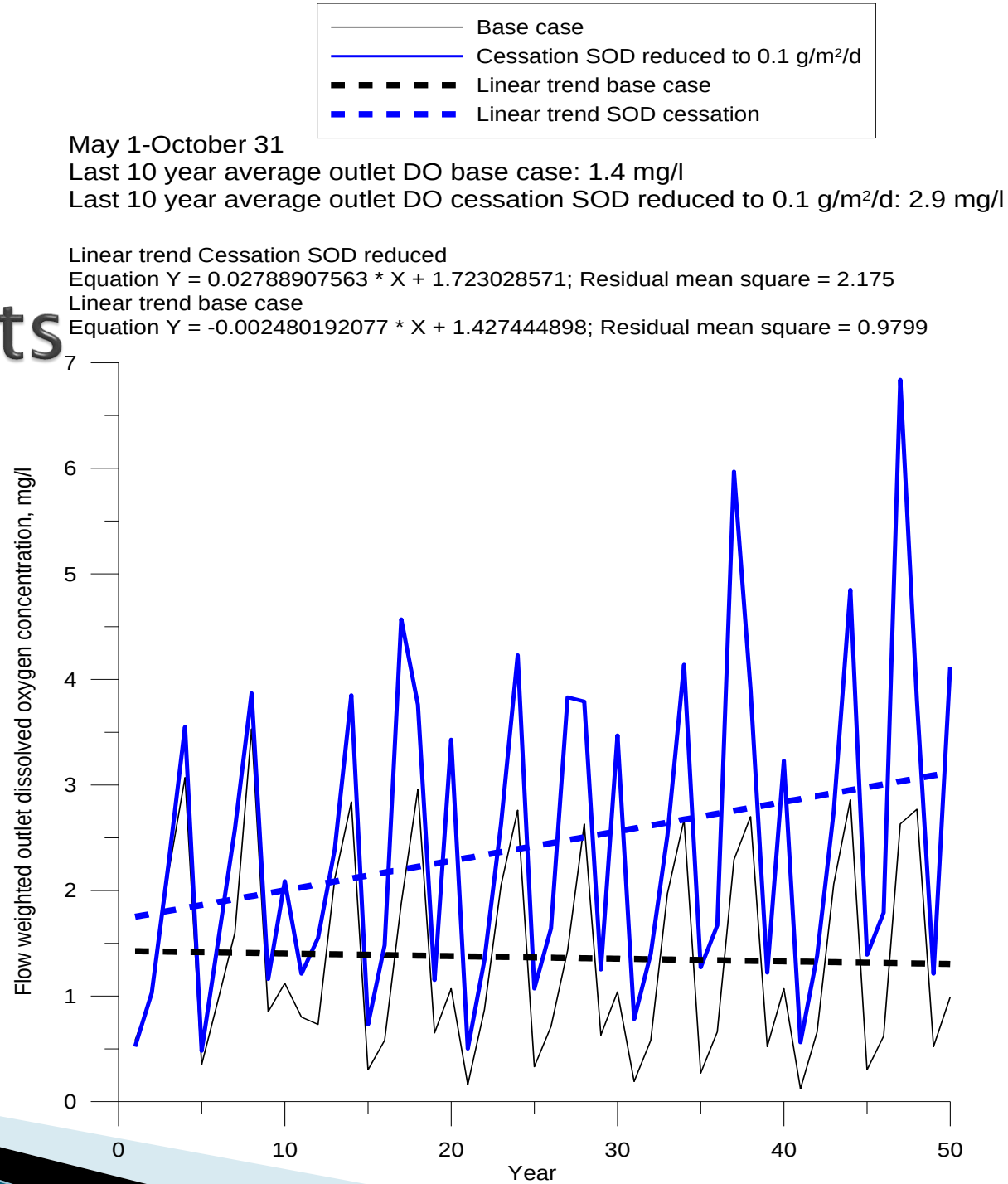
Chloropyll a impacts

Linear trend - Historical
Equation Y = 0.3606743097 * X + 11.2525511
Residual mean square = 93.95
Linear trend - Natural
Equation Y = -0.001611466987 * X + 3.637268408
Residual mean square = 3.798

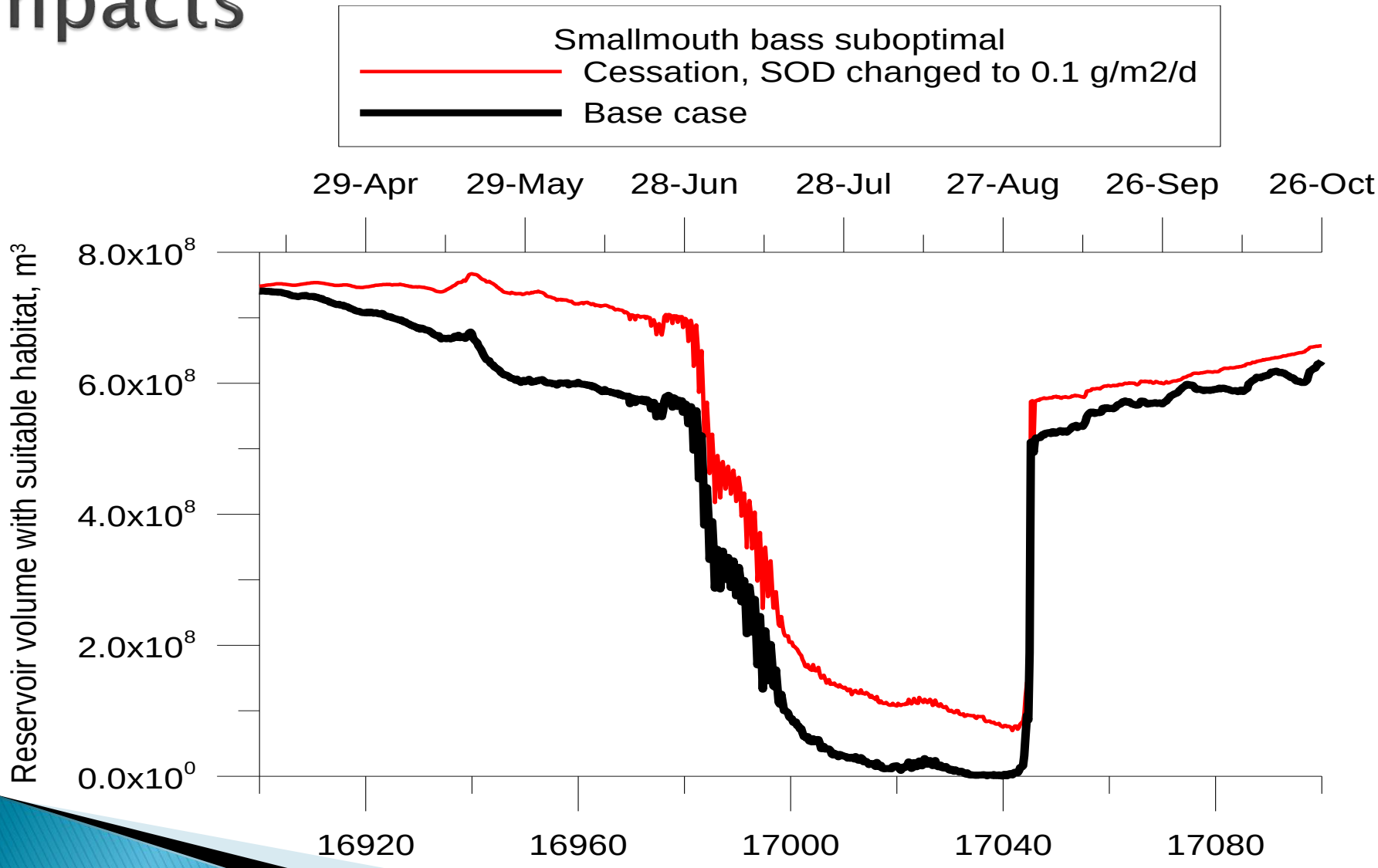




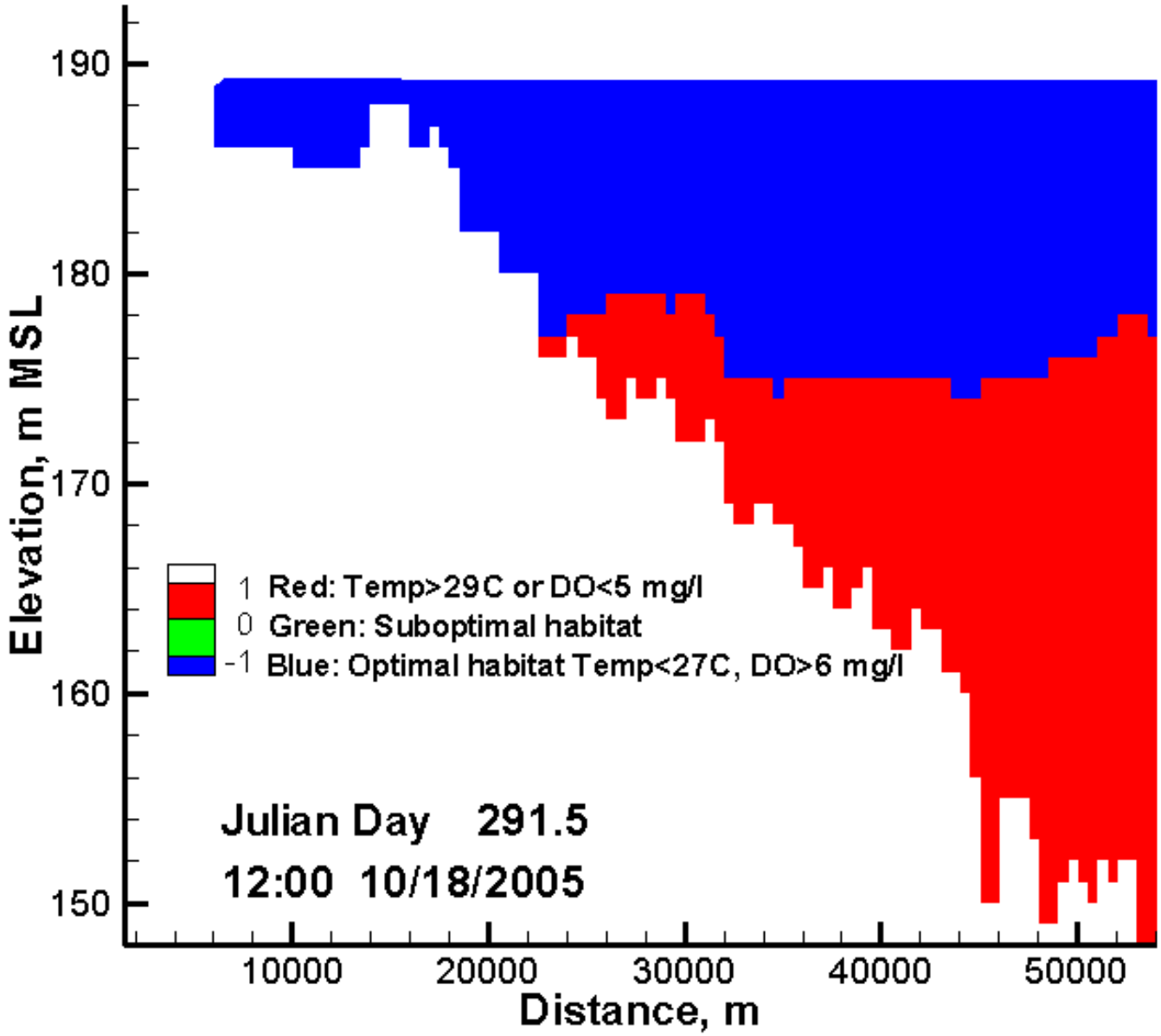
Dissolved oxygen impacts



Fish habitat impacts



Fish habitat "squeeze"



Conclusions and summary

- CE-QUAL-W2 model calibrated to almost 3 years of field data from Jan 2005- Sept 2007
- 50-year scenarios set-up to evaluate the impact of P loading from watershed
- Even with cessation, P loading effects linger for close to 50 years – still not close to "natural" condition
- The natural condition showed that severe reductions in Total P can restore lake water quality

Conclusion

Ex-attorney general puzzled at poultry suit ruling delay

DECISION AWAITED
Drew Edmondson: The state filed the lawsuit in 2005, alleging that several poultry production companies have polluted the Illinois River watershed with poultry waste.

By CURTIS KILLMAN World Staff Writer
Published: 8/29/2011 2:21 AM
Last Modified: 8/29/2011 7:52 AM

Former Oklahoma Attorney General Drew Edmondson says he's surprised over how long it has taken a judge to issue a ruling in the state of Oklahoma's poultry industry pollution lawsuit.

"I did not anticipate that it would be this long waiting on a ruling," Edmondson said. "I don't know what would justify this kind of a delay and certainly have made no inquiry."

It has been more than 500 days since the poultry industry pollution trial ended in U.S. District Court in Tulsa.

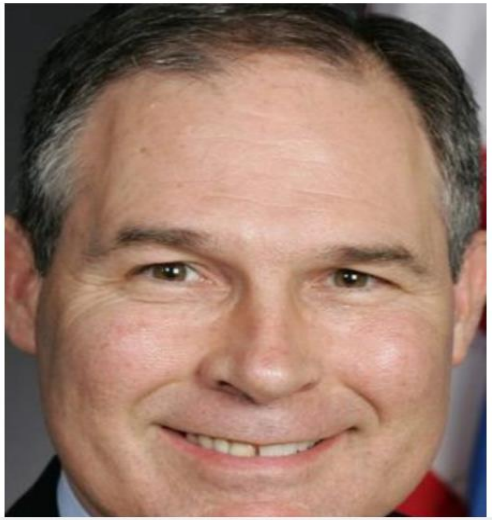
U.S. District Judge Gregory Frizzell presided over the bench trial involving the state of Oklahoma's allegations that several poultry production companies have polluted the Illinois River watershed with poultry waste.

Edmondson filed the lawsuit June 13, 2005, against 14 poultry companies.

Oklahoma, Arkansas agree on pact to study Illinois River

February 2013

Tweet g+1 0 Pin it 0 Share 0



Posted: Thursday, February 21, 2013 12:00 am | *Updated: 10:32 pm, Tue Sep 24, 2013.*

CURTIS KILLMAN World Staff Writer | 0 comments

A group dedicated to protecting the Illinois River is expressing guarded optimism over a water-quality pact that was hammered out in secret between the states of Oklahoma and Arkansas.

Officials with the Tahlequah-based group Save the Illinois River Inc. said that after discussing terms of the agreement with Attorney General Scott Pruitt and his staff on Tuesday, they believe that the pact will "protect Oklahoma's interests in the Illinois River watershed."

"It's not a perfect agreemer than we had hoped for." R

Kellogg said the terms of the agreement mean Oklahoma's phosphorus limit "will be enforceable for the first time since its adoption."

The joint study will be conducted by a third party group with no ties to businesses in either state, according to the statement from Pruitt.

"We have confidence in the three Oklahoma members, who, along with three members from Arkansas, will make up the technical advisory committee overseeing the study," Kellogg said.

The agreement announced Wednesday has no connection to the lawsuit between the state of Oklahoma and various poultry companies over pollution in the Illinois River watershed, Clay said.

The poultry industry pollution lawsuit initiated by former Attorney General Drew Edmondson in 2005 concluded with a trial that ended Feb. 18, 2010.

U.S. District Judge Gregory Frizzell presided over the bench trial but has yet to issue a ruling.