Th

Motivation

. Reservoir recreation is a highly-valued ecosystem s

. However, visits to Oklahoma state parks adjacent to voirs has fallen by half since 1999.

. Decreased visitation could be due to environmental

e Impact of Climate Varia
the Demand for R

Brannon Daniels and Max Melstrom, Department o

ervice.

reser-

Ab

This poster presents research on the impact of
tion in Oklahoma. Increased air temperatures
clining lake water conditions and algae bloom
States. We relate state park visitation at reserv
ing events. Our visitation model is estimated

tion and Water Condition
eservoir Recreation

of Agricultural Economics, Oklahoma State Universi

ostract

f climate and water conditions on reservoir recrea-
are known to impact recreation demand while de-
n events are a growing concern in the United
voirs to water levels, water quality and swim warn-
using panel data on Oklahoma park visits with a

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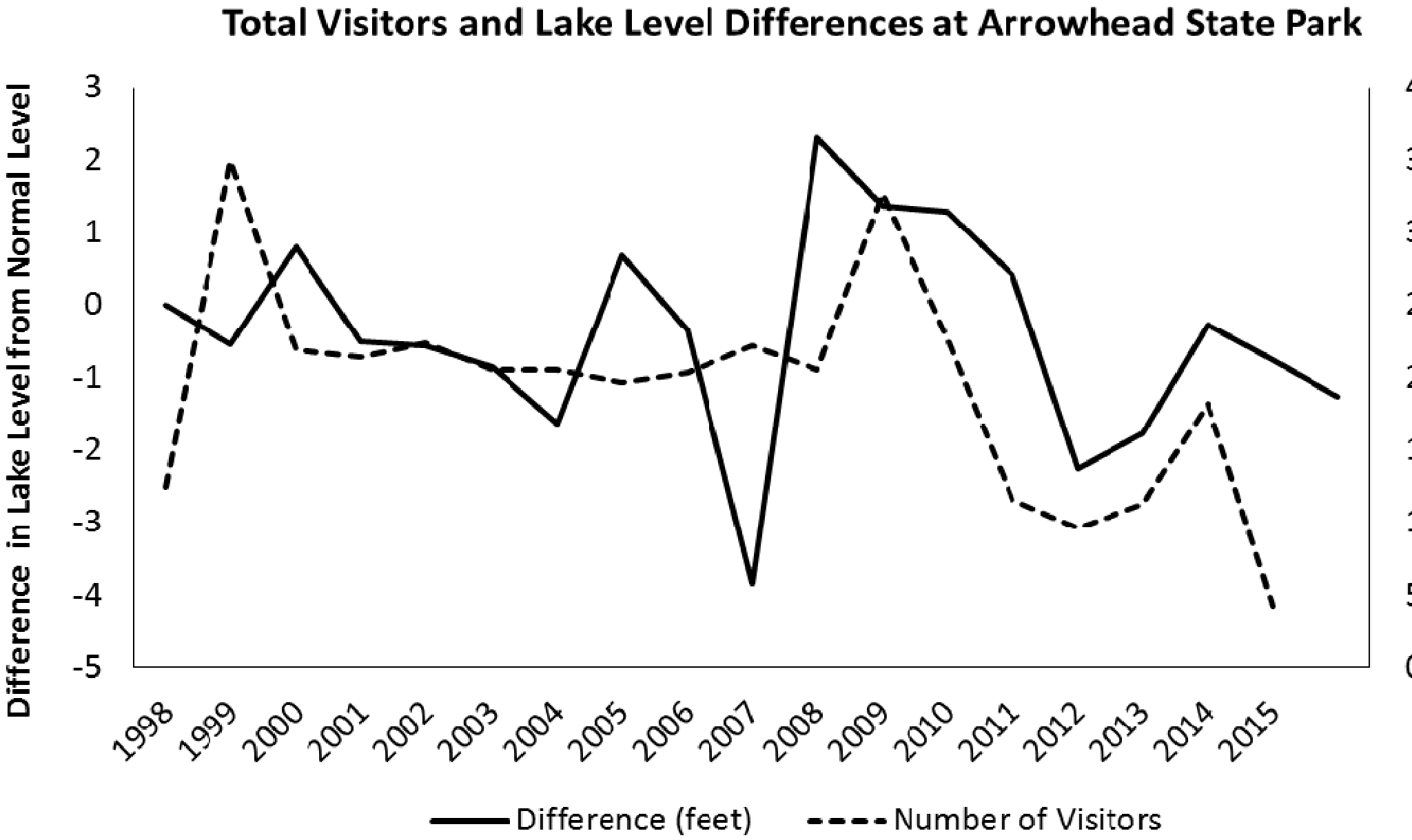
ity

Summary of the Results

We find the decline in visitation parks is not entirely related to climate and water conditions.

Nevertheless, there is strong evidence air temperature influences visitation, even controlling for seasonality

changes and thus declines in ecosystem service valu



Hypotheses

ues.

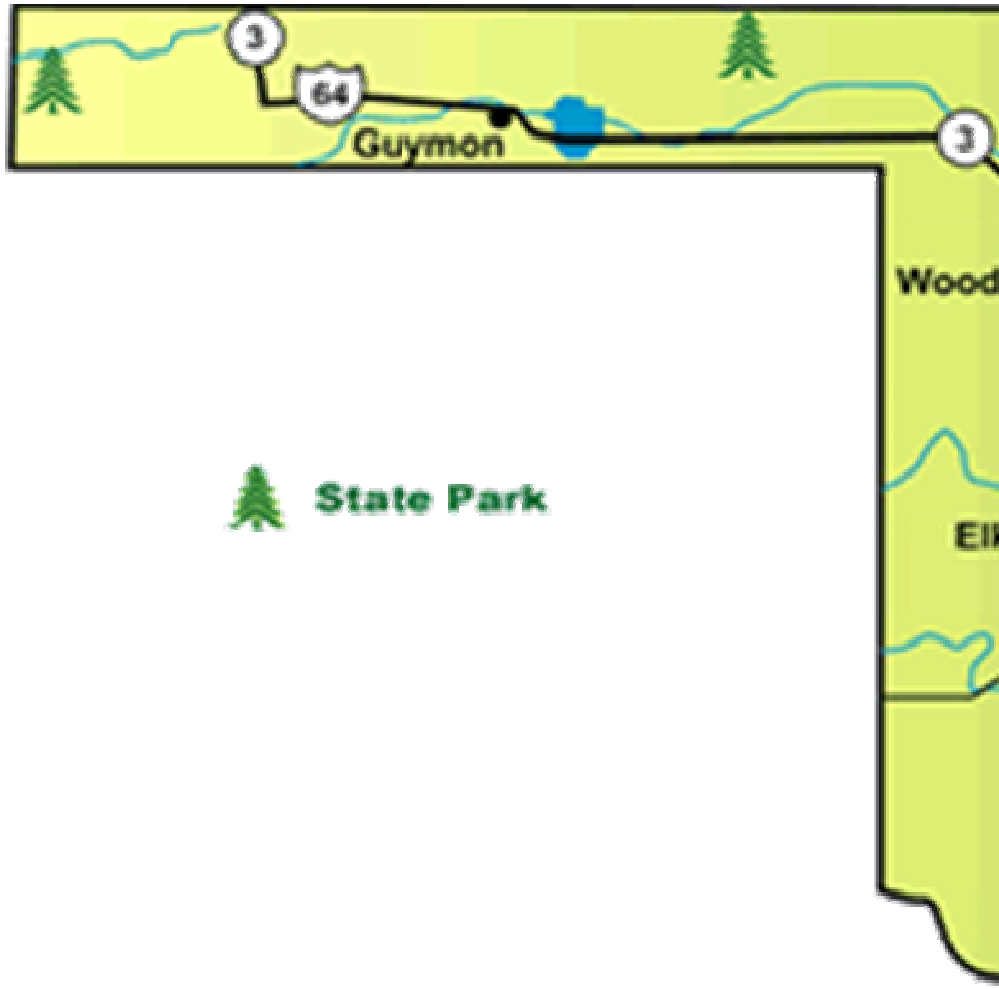
time series from 1998 to 2015.

400000
350000
300000
250000
200000
150000
100000
50000
0

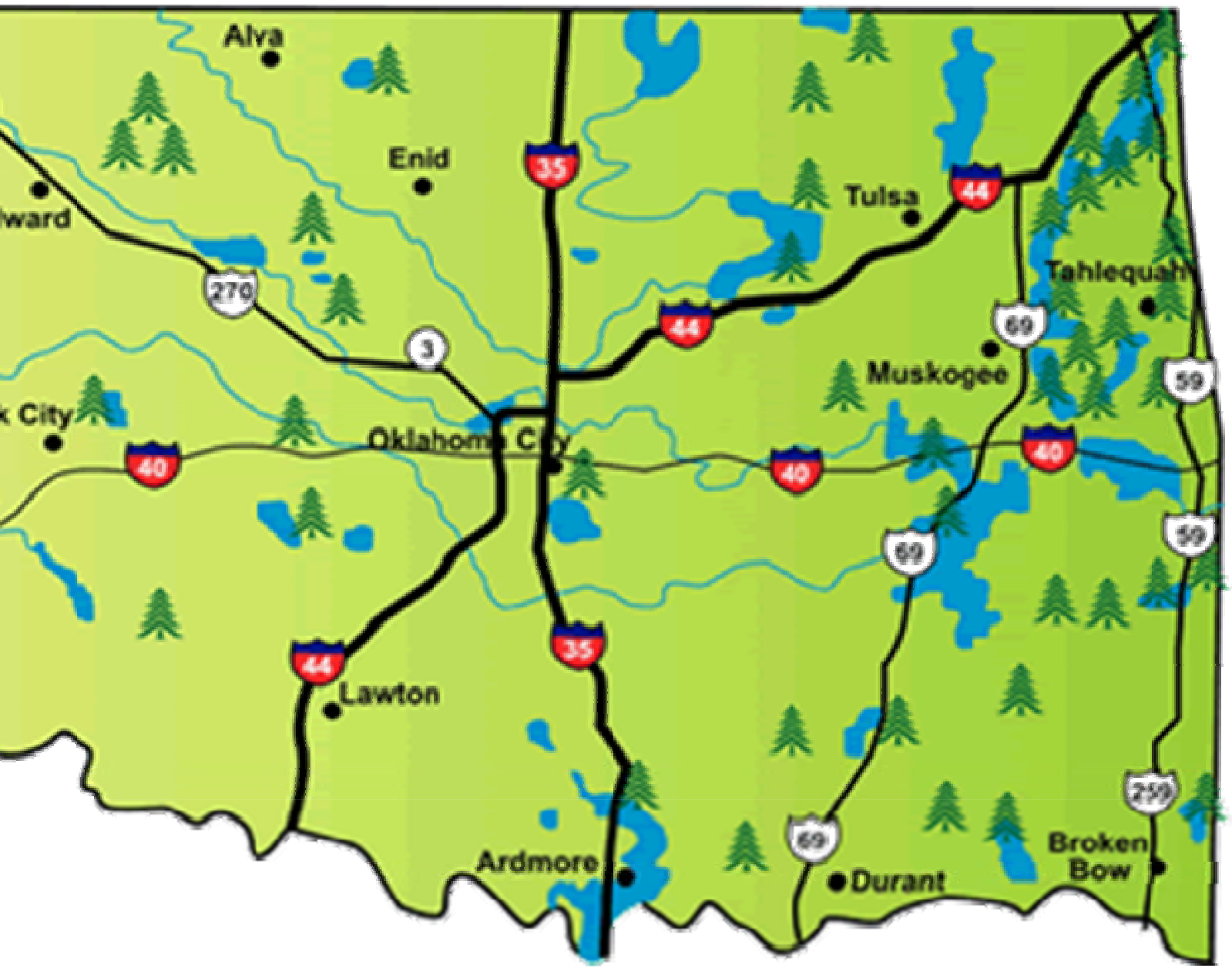
Visitors

Lakes

- Broken Bow
- Eufaula
- Foss
- Fort Cobb
- Fort Gibson
- Grand Lake
- Hudson
- Keystone
- Spavinaw
- Tenkiller
- Texoma
- Thunderbird
- Tom Steed



Visitation Model Spe



ecification and Results

(e.g. the popularity of summer months for outdoor recreation).

There is modest evidence changes in water elevation levels relative to normal levels affects visitation.

There is mixed evidence that BGA events and turbidity affect visitation.

There is no evidence that the levels of rainfall and wind speed events over a month affect visitation.

Discussion and Conclusions (Preliminary)

Lake levels affect visitation. A 1-foot shift away from

. Lake levels, blue-green algae (BGA) blooms and w
clarity (turbidity) influence park visitation.

. Measures of climate variability including temperatu
rain and wind-speed influence park visitation.

. Changes in above factors contribute to visitation de

Data and Methods

. Oklahoma Tourism and Recreation Department pro
monthly visit data for 20 parks on 13 lakes, from ‘9

. The Oklahoma Mesonet provided temperature, rain
wind data.

ater

ure,

cline.

vided

8-‘15.

and

. We estimate a log-linear visitation model usi

ation as an exponential function of climate a

$$\ln(Visits_{ij}) = \beta_1|\Delta Lakelevel_{ij}|+\beta_2 Turbidity_{ij}$$

$$\beta_4 Temp_{ij}+\beta_5 Temp_{ij}^2+\beta_6 Rain_{ij}+\beta_7$$

. 4 versions of model: with and without the tim

	Model 1—No time trend		**Model 2—Tim trend**	
Variable	Parameter	P-value	Parameter	P-v
Difference in lake level from normal	-0.019	0.021	-0.012	0
BGA event	-0.429	0.000	-0.057	0
Turbidity				

ng OLS. The results are similar to modeling visit-
nd water conditions, estimated using NLS.

$+\beta_3 BGAevent_{ij}+$

$Wind_{ij}+\beta_8 Timetrend_i+\sum_i \Phi(Month_i)+\sum_j \Phi(Park_j)$

ne trend, and with and without turbidity (MI):

ne		Model 3—No time trend, fill in missing turbidity with MI		Model 4—Time trend, fill in missing turbidity with MI
value	Parameter	P-value	Parameter	P-value
.101	-0.021	0.017	-0.012	0.101
.625	-0.531	0.000	-0.067	0.576
	-0.005	0.080	-0.001	0.674

normal elevation results in a 1%-2% decline in visits.

Air temperatures affect visitation but the effect is non-linear. Visits increase when temps rise from a low base, but decrease when temps rise from a high base.

The significance of the time trend suggests part of the visitation decline is due to factors not accounted for as variables in the model.

The occurrence of BGA events has increased over time, but the model does not provide strong evidence BGA events are impacting visitation.

Future Directions

- Army Corps of Engineers provided water level and bloom data.
- Turbidity data came primarily from Oklahoma Wate source Board. However, there was a large fraction o months and parks with no data, so multiple imputat (MI) (Rubin, 1987) was used to fill in for missing d

References

- D.B. Rubin. *Multiple Imputation for Nonresponse in Surveys*. John Wil Sons, New York, 1987.

The participants in this project would like to acknowledge that possibility was made through funding provided by Oklahoma NSF EPSCOR award number IIA-1301789

BGA

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ion
lata.

ey &

Avg rainfall	-0.110	0.665	-0.238	0
Avg wind speed	-0.043	0.022	0.012	0
Avg air temp	0.097	0.001	0.021	0
Avg air temp^2	-0.001	0.005	-0.0005	0
Time trend			-0.006	0
Observations		3,407		3

- A parameter with a negative estimate provides evidence that
  provides evidence that variable has a positive effect on visita
- All p-values are calculated under the null hypothesis that the
- The time trend variable captures the effect of a constant annu
  itation unrelated to the other variables in the model.

.374	-0.030	0.561	-0.280	0.316
.963	-0.030	0.103	0.002	0.891
.002	0.093	0.003	0.070	0.009
.013	-0.001	0.016	-0.0004	0.036
.000			-0.006	0.000
,407		3,265		3,265

variable has a negative effect on visitation, while a positive estimate
tion.

true value is zero.

ual change (possibly related to unobserved influential factors) in vis-

A lack of turbidity data for many park-month combinations motivated use of MI. We are working with other EPSCoR researchers to instead fill in this missing turbidity data with predictions from LandSat imagery.

The results of this study will be presented at the Southern Agricultural Economics Association 2016 Annual Meeting in San Antonio.