Lead and Children – A Look at Childhood Blood Lead Levels in Oklahoma, 1995-2003

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Acknowledgements

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Background

- According to the Centers for Disease Control and Prevention, about 1 in every 22 children in America have high levels of lead in their blood (blood lead level ≥ 10 µg/dL)

- More than 3 million children 6 years of age and younger have lead poisoning

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Lead Poisoning

- Can damage a child's brain and nervous system
- Can slow a child's growth
- Can result in developmental delays and cause learning and behavior problems
- Can cause hearing problems and headaches

How do children get lead poisoning?

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- Ingestion
  - Most lead poisonings are caused by ingesting lead dust
  - Children absorb approximately 50% of the lead they take into their bodies
  - Young children have more hand to mouth activity

Lead Exposure Sources

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- Lead-based paint, commonly used in housing before 1978
- Lead in soil that originated from leaded paint, gasoline, and industrial sources
- Drinking water contaminated with lead from leaded solder, brass fittings and obsolete lead-service lines
- Lead brought into the home by adults from occupational lead exposure or engaging in hobbies which use lead materials

Blood Lead Screening

- A blood test (vein or capillary) is used to determine lead levels
- Blood lead levels are measured and reported as micrograms of lead per deciliter of whole blood (µg/dL)
- Elevated blood lead level (EBLL) is defined as blood lead level ≥ 10 microgram/deciLiter (µg/dL) of blood

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Objectives

- <u>OK-PHETS Objective</u>: To develop a comprehensive environmental public health tracking network in Oklahoma to monitor the impact of environmental hazards upon the health effects of Oklahomans

- <u>Specific Objective</u>: To determine relationships between elevated blood lead poisoning and environmental lead hazards

Data

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- **OSDH data**
  - OCLPPP, 1995-2003
- **DEQ data**
  - Lead Toxic Release Inventory (1995-2002)
  - Lead Air Emission Inventory (1995-2002)
  - Superfund
  - Lead Mining
  - Lead SDWIS (1995-2003)
- **2000 Census data**

Methods

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- Data were gathered, organized, and analyzed using Microsoft Access/Excel and SAS
- Binomial confidence intervals were used to determine statistical differences between rates of populations of interest
- Cases were geocoded based on physical street address using Arcview
- SaTScan software was utilized to identify potential clustering of elevated blood lead levels
- Data were statistically analyzed using SAS

OCLPPP, 1995-2003

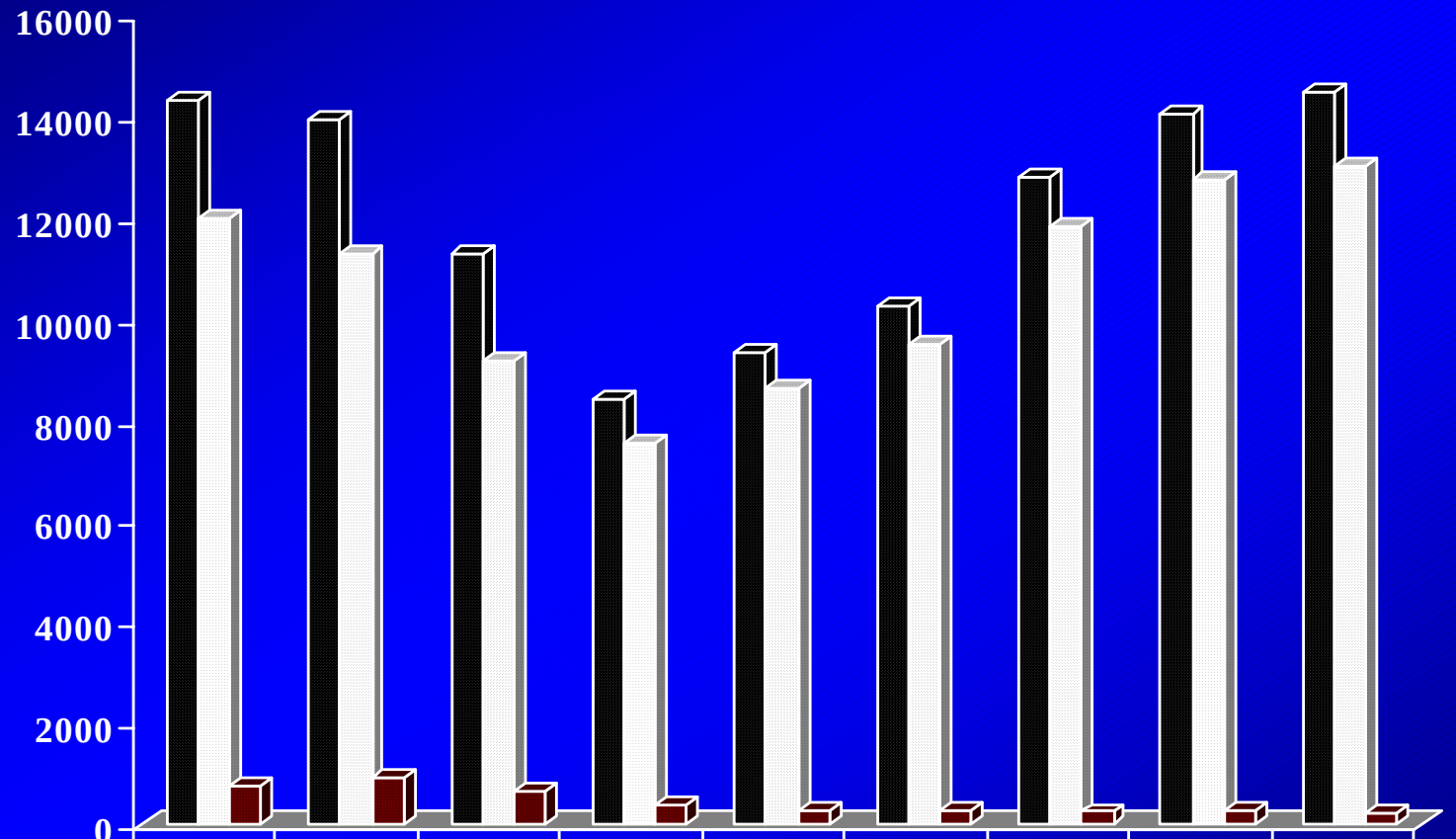
- **Received 109,053 specimen reports**

- **A total of 82,647 children were screened for lead poisoning in Oklahoma State**

  - Range: 7,544 children in 1998 to
    13,019 children in 2003

  - Average: 10,628 children per year

OCLPPP, 1995-2003



	1995	1996	1997	1998	1999	2000	2001	2002	2003
Blood Samples	14325	13951	11302	8409	9329	10248	12826	14071	14492
Number of Children	11976	11271	9176	7544	8630	9473	11817	12729	13019
Elevated BLL	735	925	660	374	257	241	236	249	224

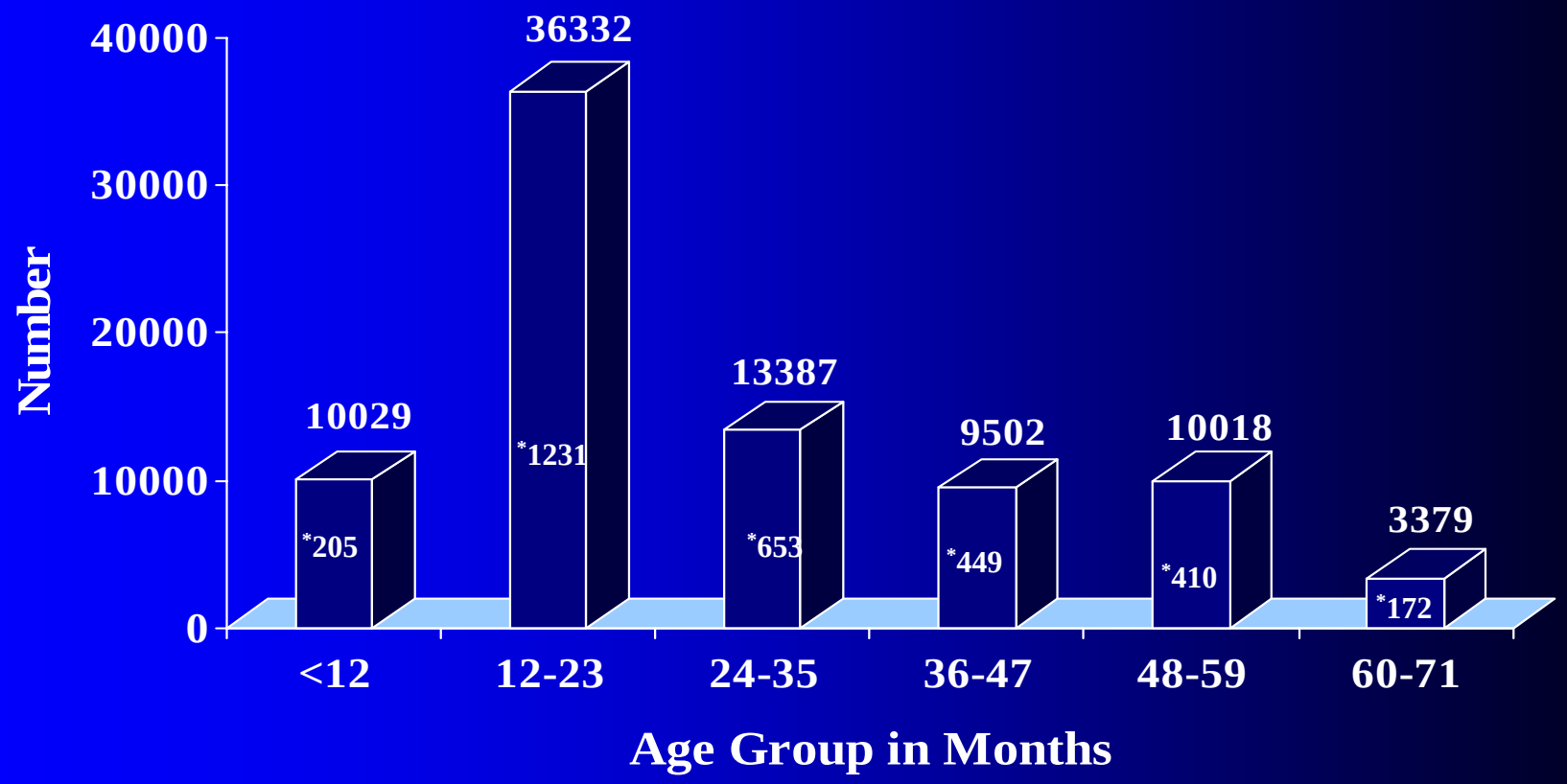
EBLL by Selected Characteristics, OCLPPP, 1995-2003

Characteristics		Total Tested	Elevated Blood Lead Levels (EBLL)	Lead Rate
Gender:	Male	41436	1689	4.08[a]
	Female	38898	1356	3.49[b]
Race:				
	Caucasian	22240	815	3.66[a]
	Native American	8306	210	2.53[b]
	Black	3805	162	4.26[a]
	Pacific Islander/Hawaiian	507	15	2.96[ab]
	Multiracial/Other	169	5	2.96[ab]
Ethnicity:	Hispanic	5604	230	4.10
	Non-Hispanic	28977	1073	3.70

EBLL by Selected Characteristics, OCLPPP, 1995-2003

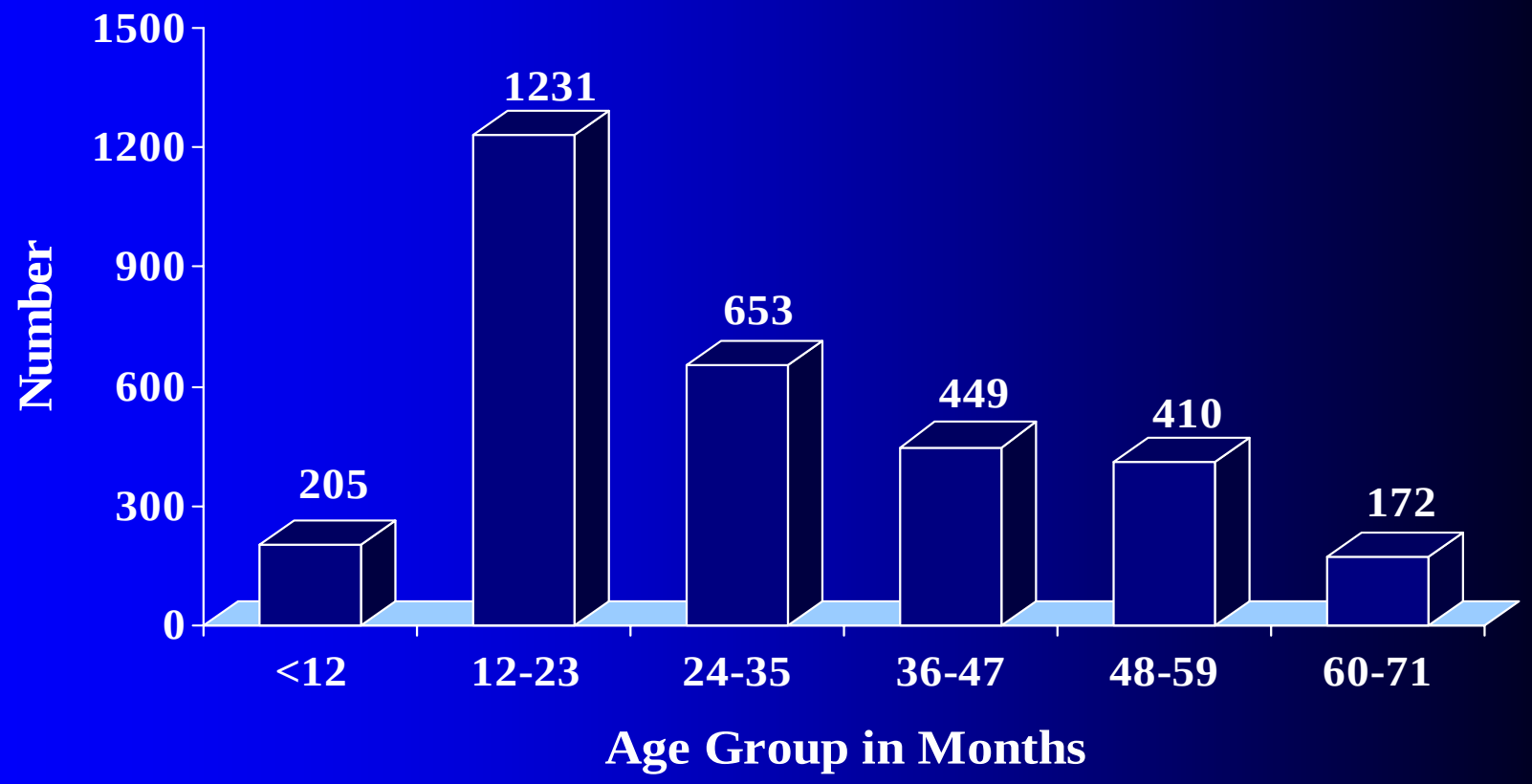
Characteristics	Total Tested	Elevated Blood Lead Levels (EBLL)	Lead Rate
Age Group (in Months):			
<12	10029	205	2.04[a]
12-23	36332	1231	3.39[b]
24-35	13387	653	4.88[c]
36-47	9502	449	4.73[cd]
48-59	10018	410	4.09[d]
60-71	3379	172	5.09[c]

Age Group of Children (N=95,655) Screened for *EBLL, OCLPPP, 1995-2003



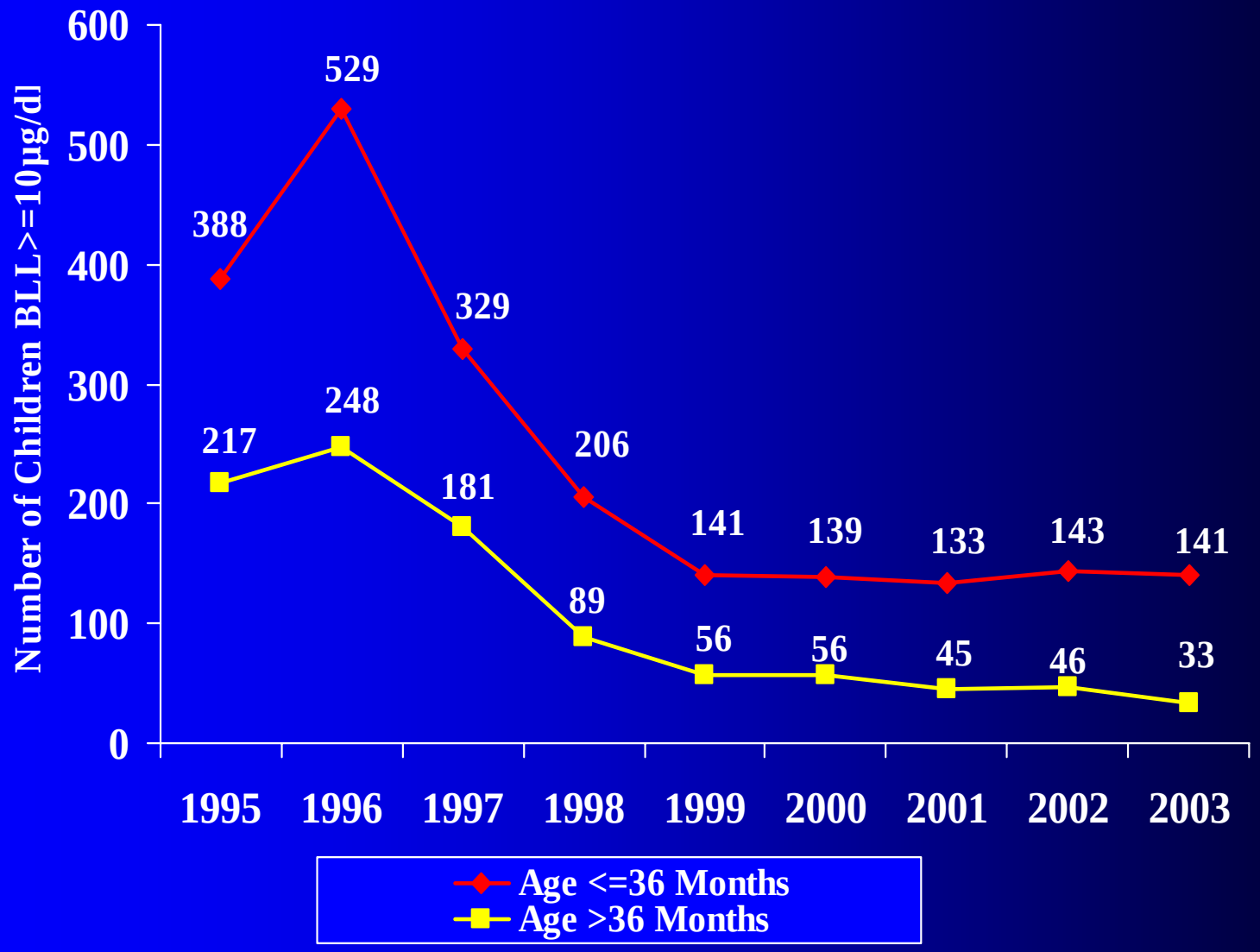
*BLL≥10µg/dL

Age Group of Children (N=3,120) with *EBLL, OCLPPP, 1995-2003



*BLL≥10µg/dL

Trend in Number of Lead-Poisoned Children, OCLPPP, 1995-2003



Blood Lead Levels by Age Group (All Tested), OCLPPP, 1995-2003

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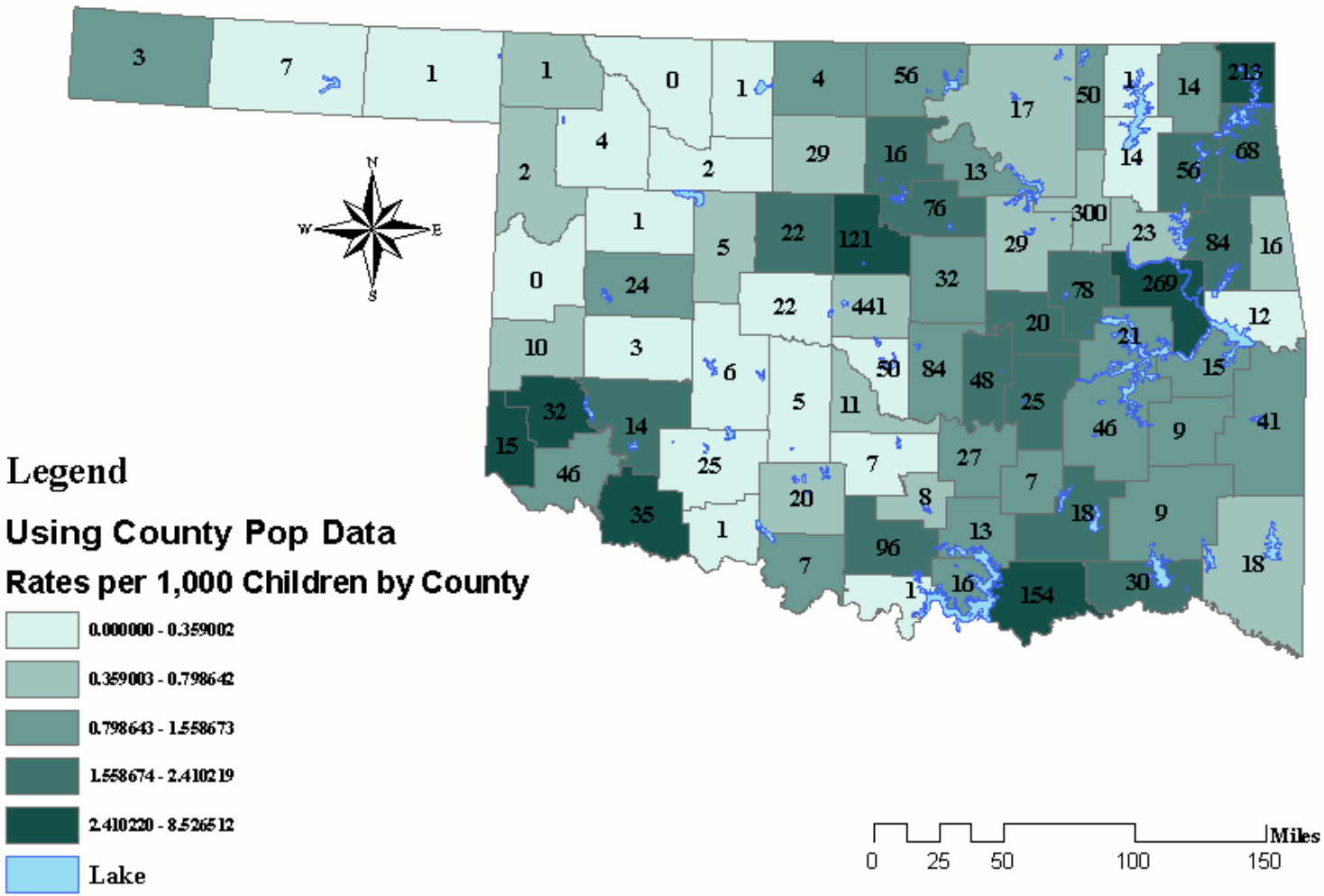
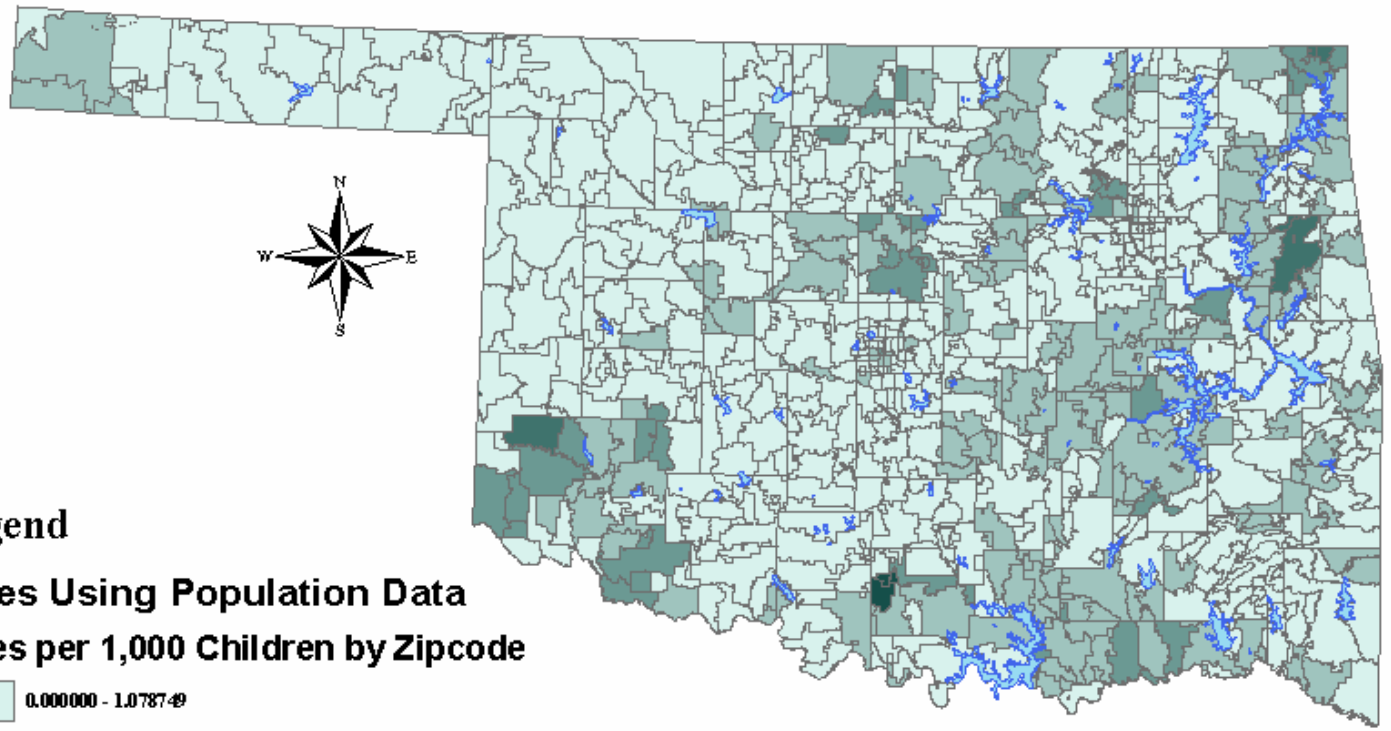
Age (Months)	Pb <10 µg/dL	Pb = 10-19 µg/dL	Pb = 20-44 µg/dL	Pb = 45-69 µg/dL	Pb = 70 µg/dL	Total (Percent)
<12	9,824	177	25	3	0	10,029 (12.13%)
12-23	35,101	1,084	139	6	2	36,332 (43.96%)
24-35	12,734	587	60	6	0	13,387 (16.20%)
36-47	9,053	401	46	2	0	9,502 (11.50%)
48-59	9,608	363	44	3	0	10,018 (12.12%)
60-71	3,207	150	21	0	1	3,379 (4.09%)
Total (Percent)	79,527 (96.22%)	2,762 (3.34%)	335 (0.41%)	20 (0.02%)	3 (0.004%)	82,647 (100.00%)

Number (N=3,120) and Rates of Elevated Blood Lead Level, Among Children Age 6 Years and Under, by County of Residence, OCLPPP Data, Oklahoma, 1995-2003



Rates of Elevated Blood Lead Level Among Children, Age 6 Years and Under, by Zipcode of Residence, OCLPPP Data, Oklahoma, 1995-2003



Legend

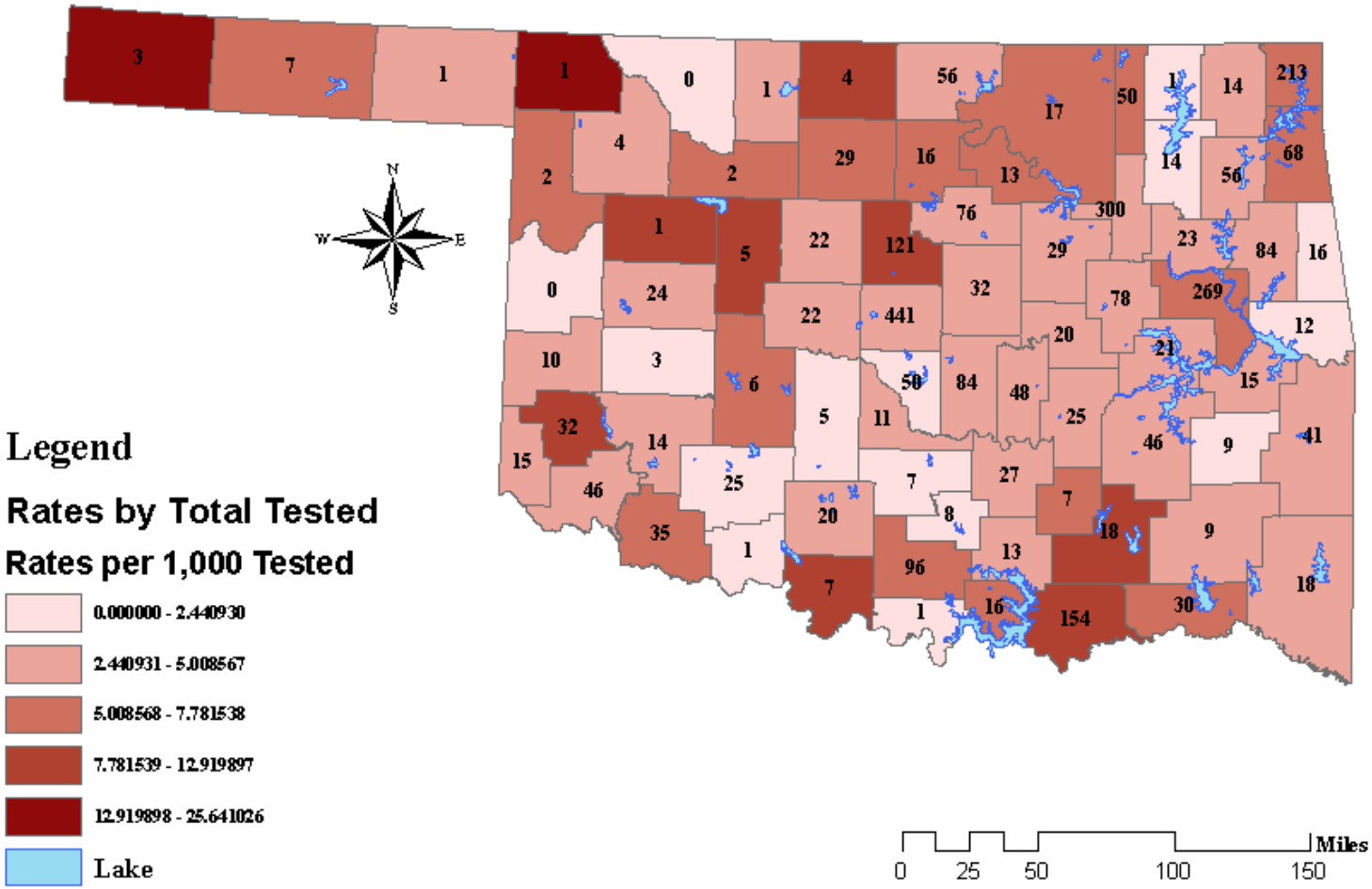
Rates Using Population Data

Rates per 1,000 Children by Zipcode

- 0.000000 - 1.078749
- 1.078750 - 4.065041
- 4.065042 - 14.336918
- 14.336919 - 35.598706
- 35.598707 - 88.888889
- Lake

0 25 50 100 150 Miles

Number (3,120) and Rates for Elevated Blood Lead Level, Among Children Age 6 Years and Under, by County of Residence, OCLPPP Data, Oklahoma, 1995-2003



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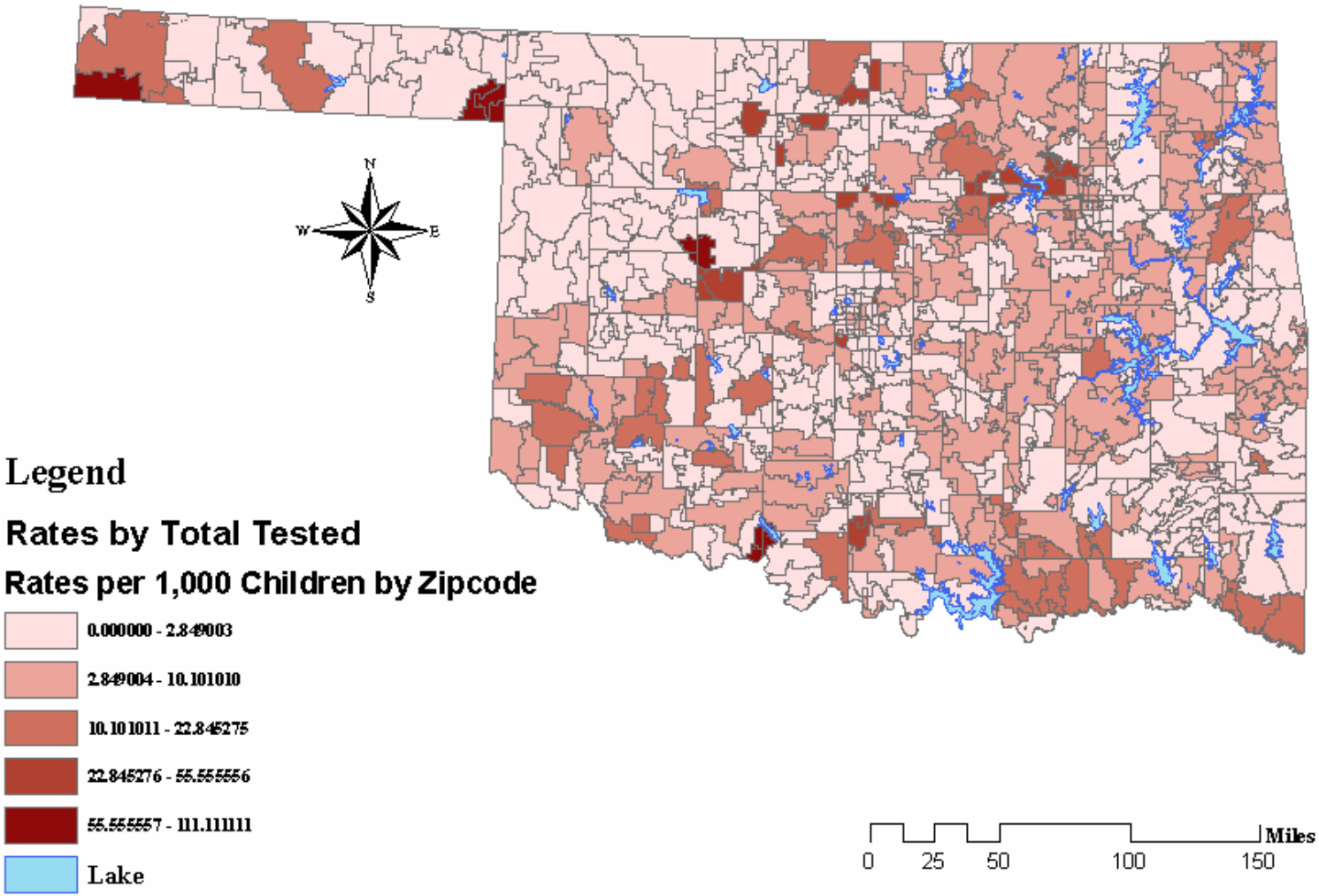
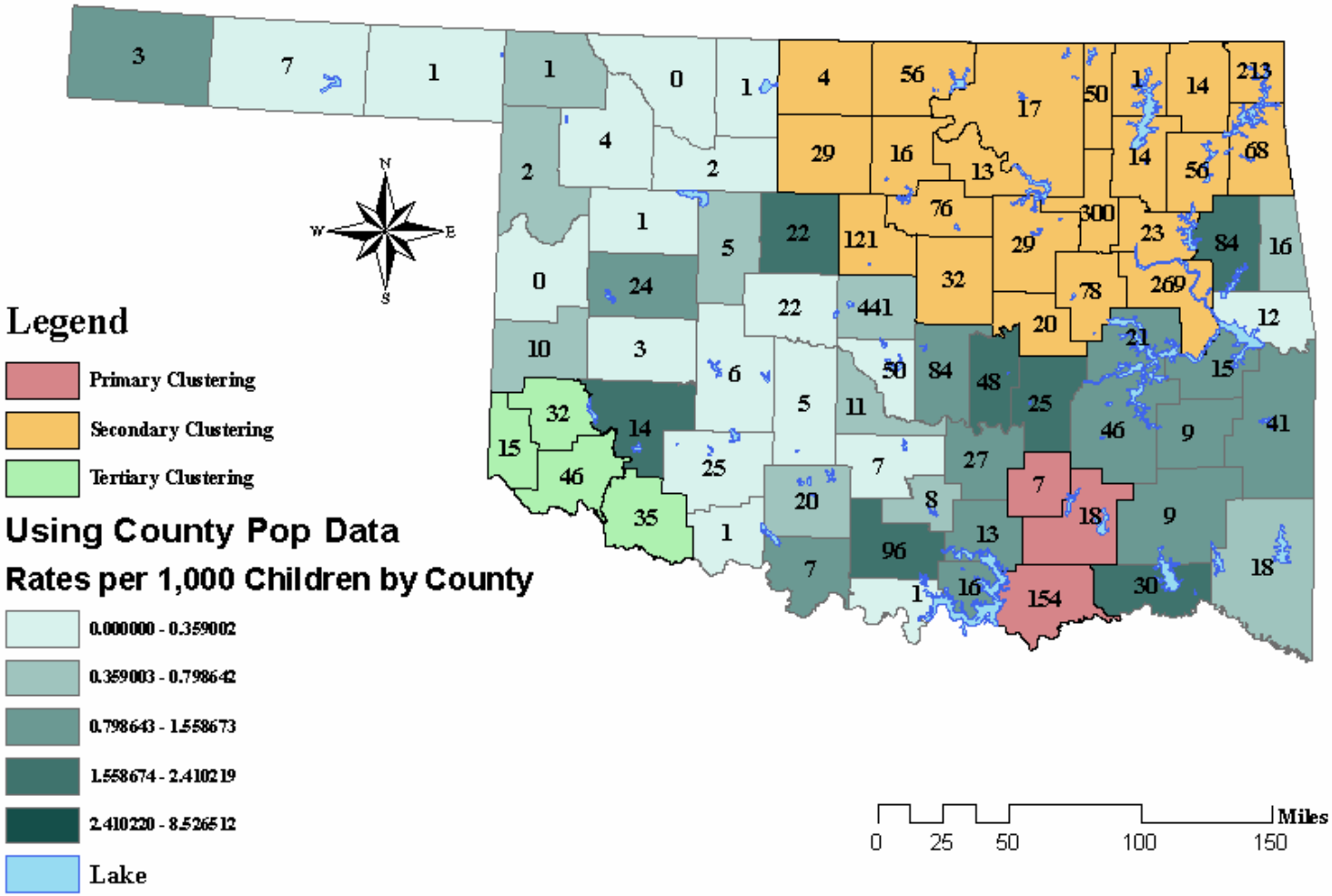
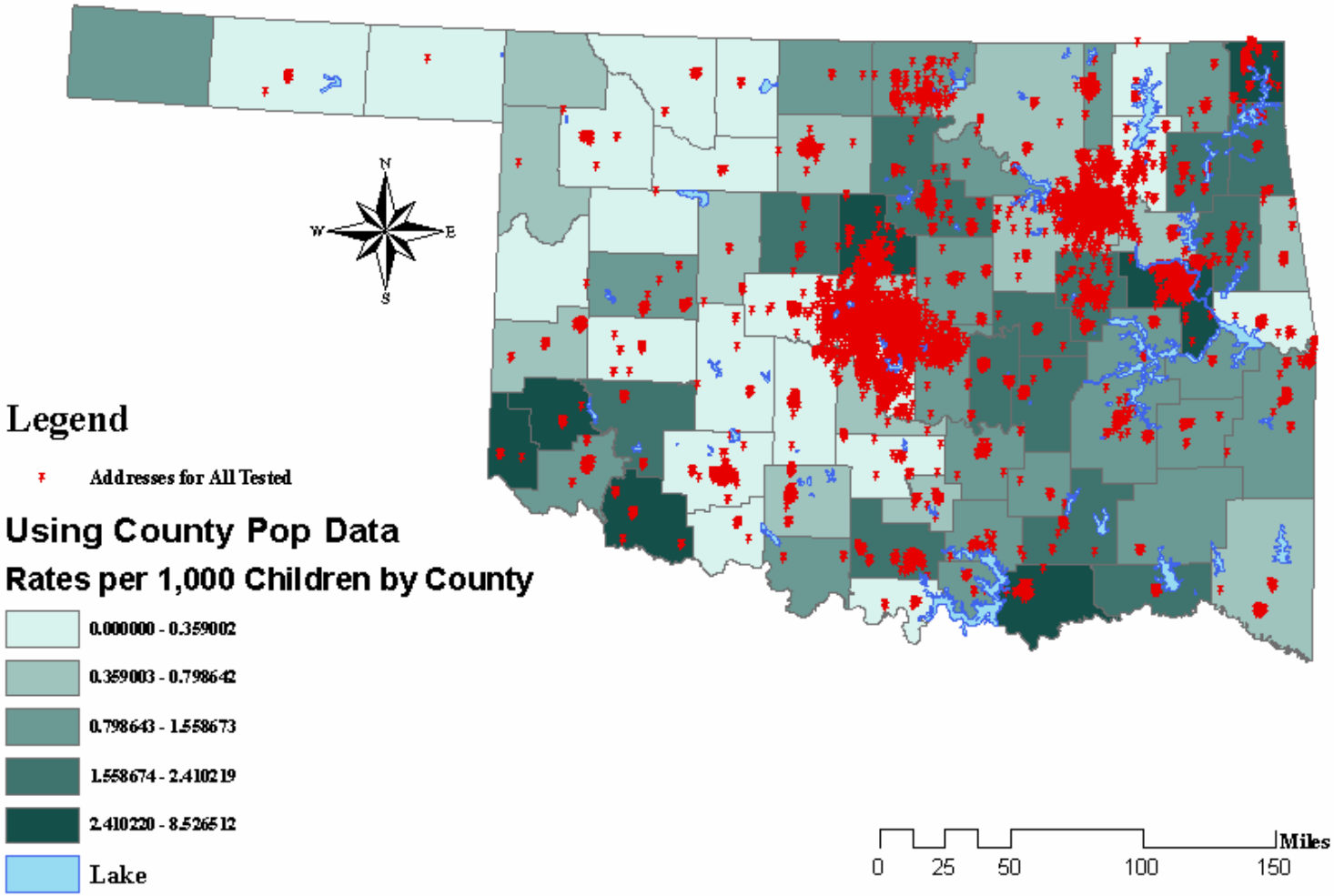


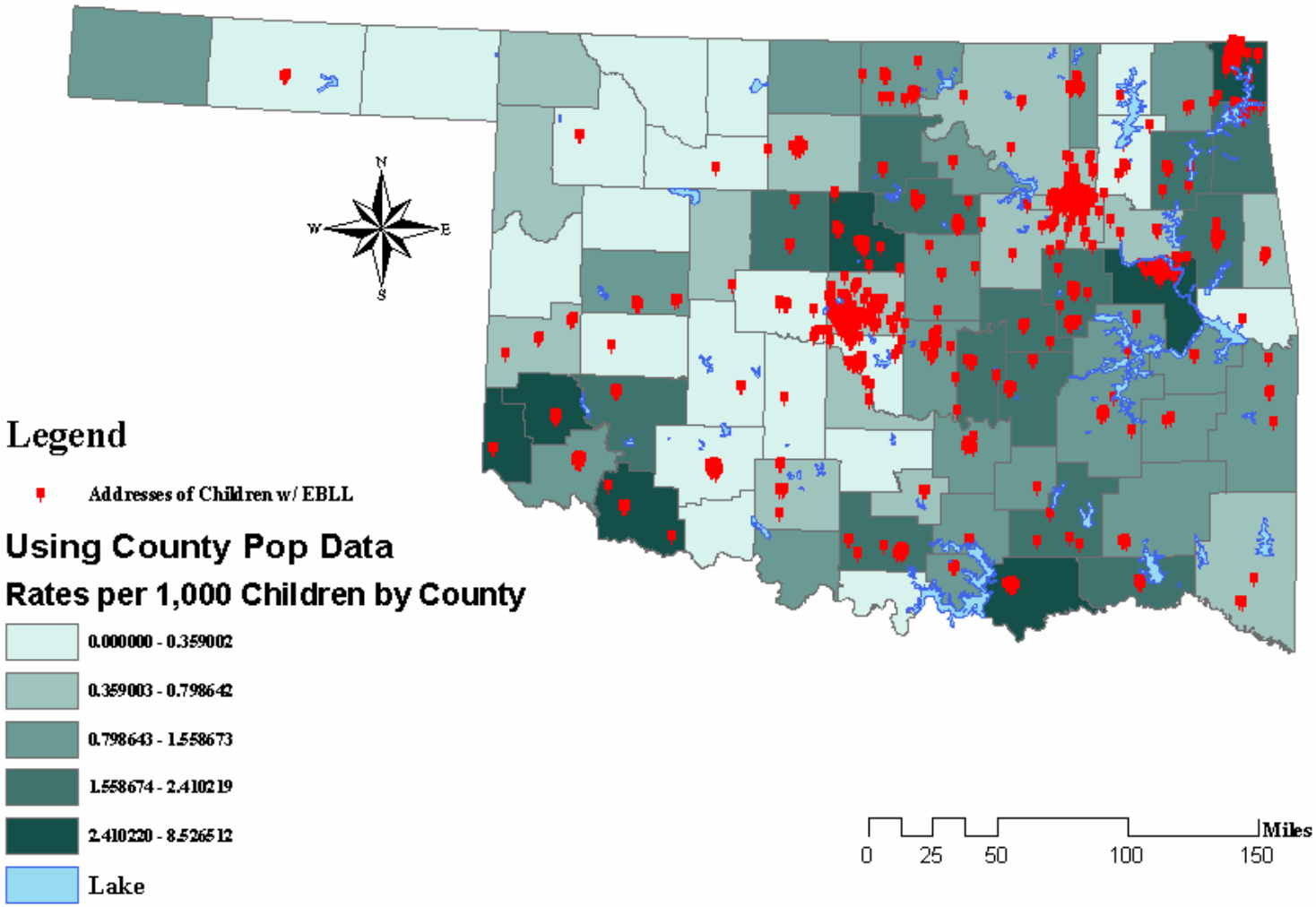
Potential Clustering of Cases with EBLL Identified by SaTScan, by County of Residence, OCLPPP Data, Oklahoma, 1995-2003



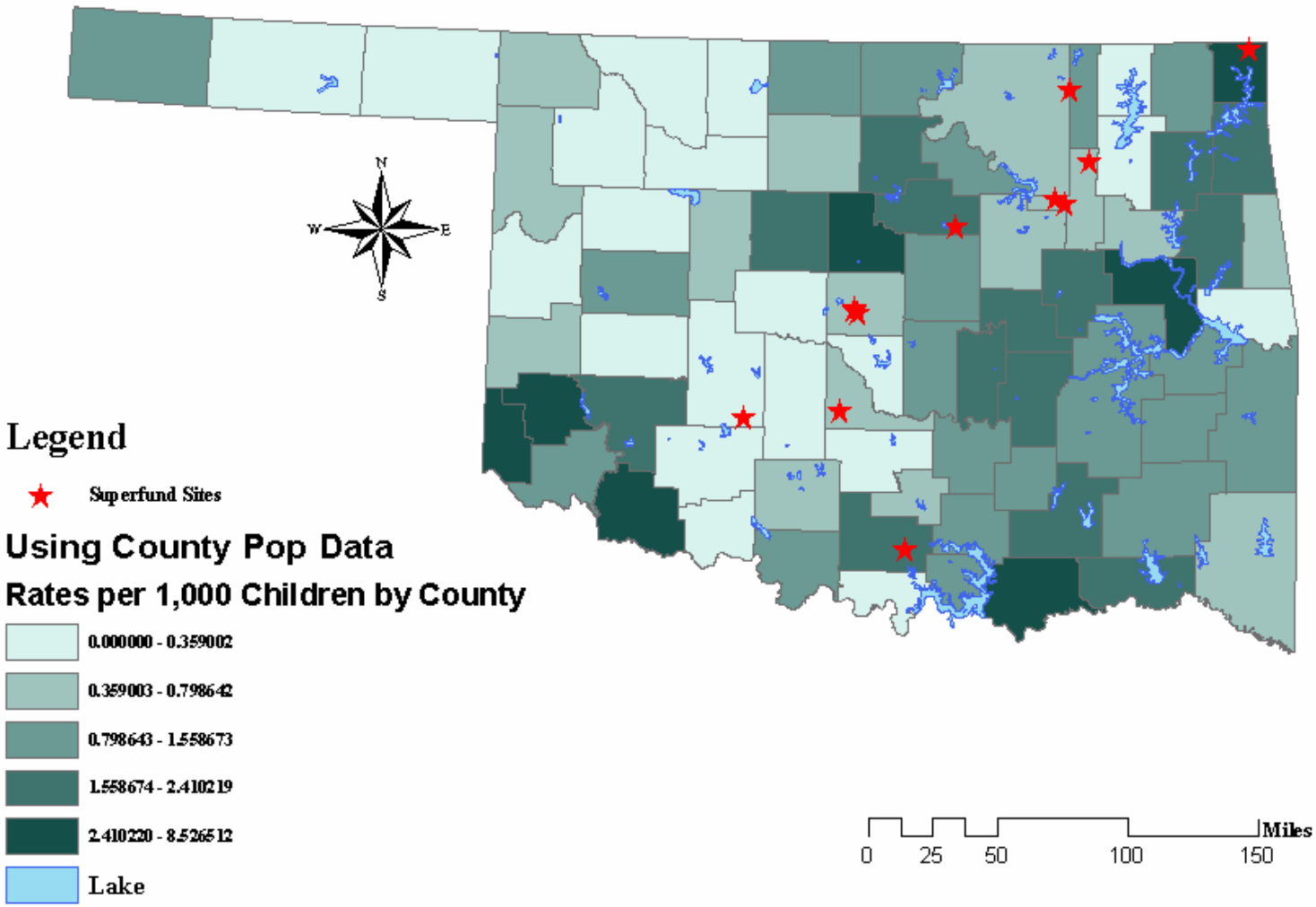
Geocoded Location of Cases with Known Addresses (N=44,423), for All Children Tested for Elevated Blood Lead Level, OCLPPP Data, Oklahoma, 1995-2003



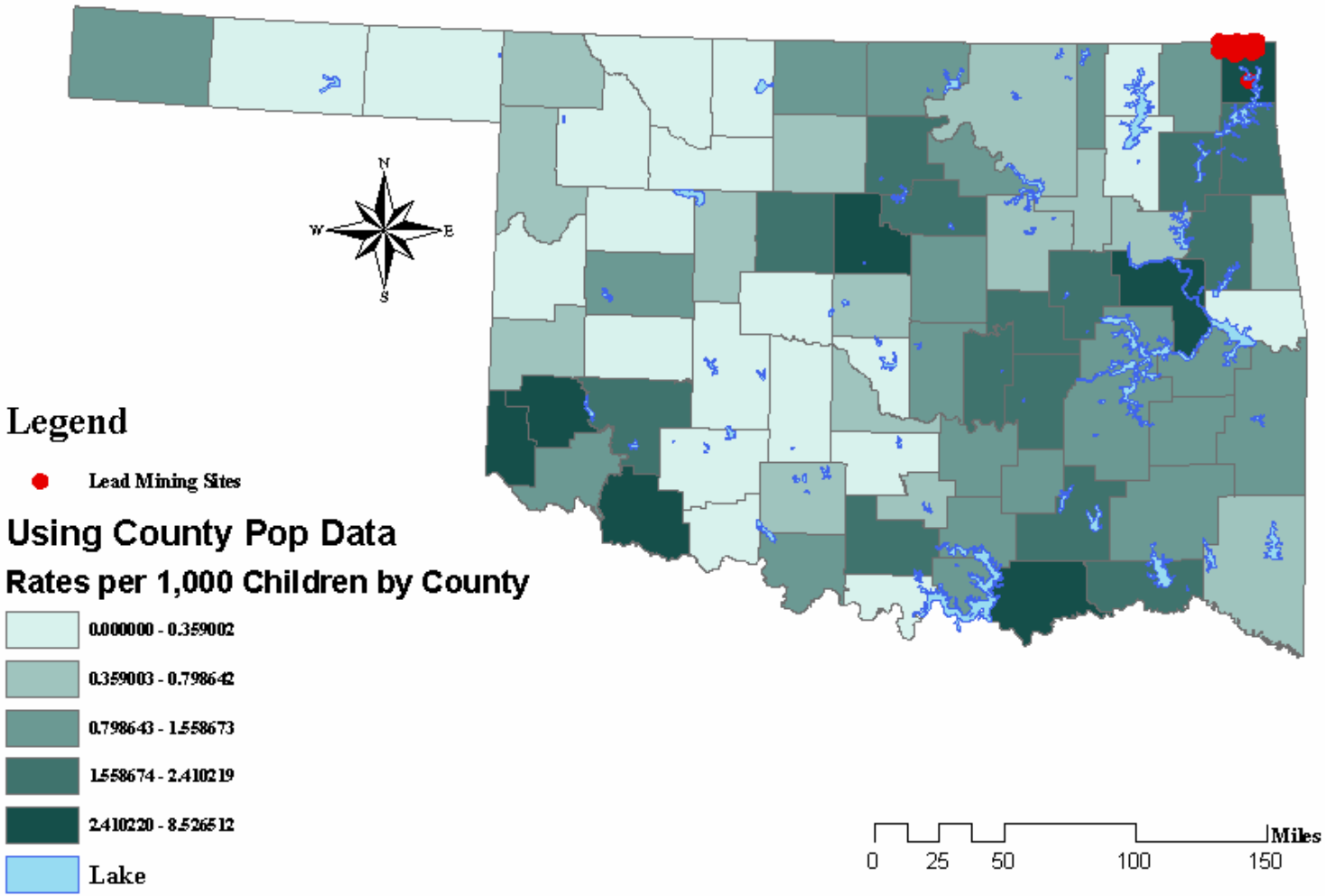
Geocoded Location of Cases with Known Addresses (N=1,822), for Children Tested for Elevated Blood Lead Level, OCLPPP Data, Oklahoma, 1995-2003



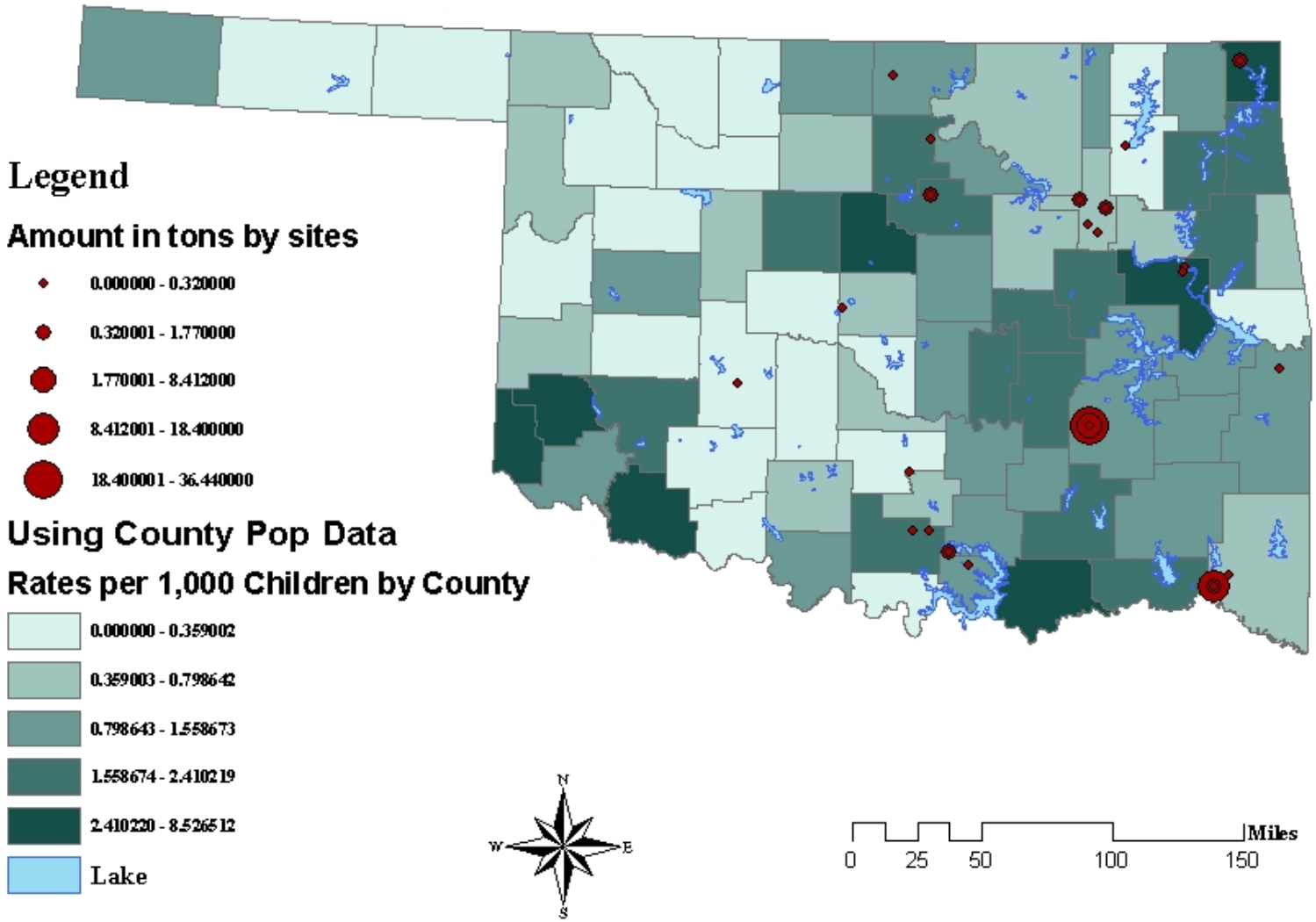
Rates of Elevated Blood Lead Level Among Children, Age 6 Years and Under, and Superfund Sites, OCLPPP Data, Oklahoma, 1995-2003



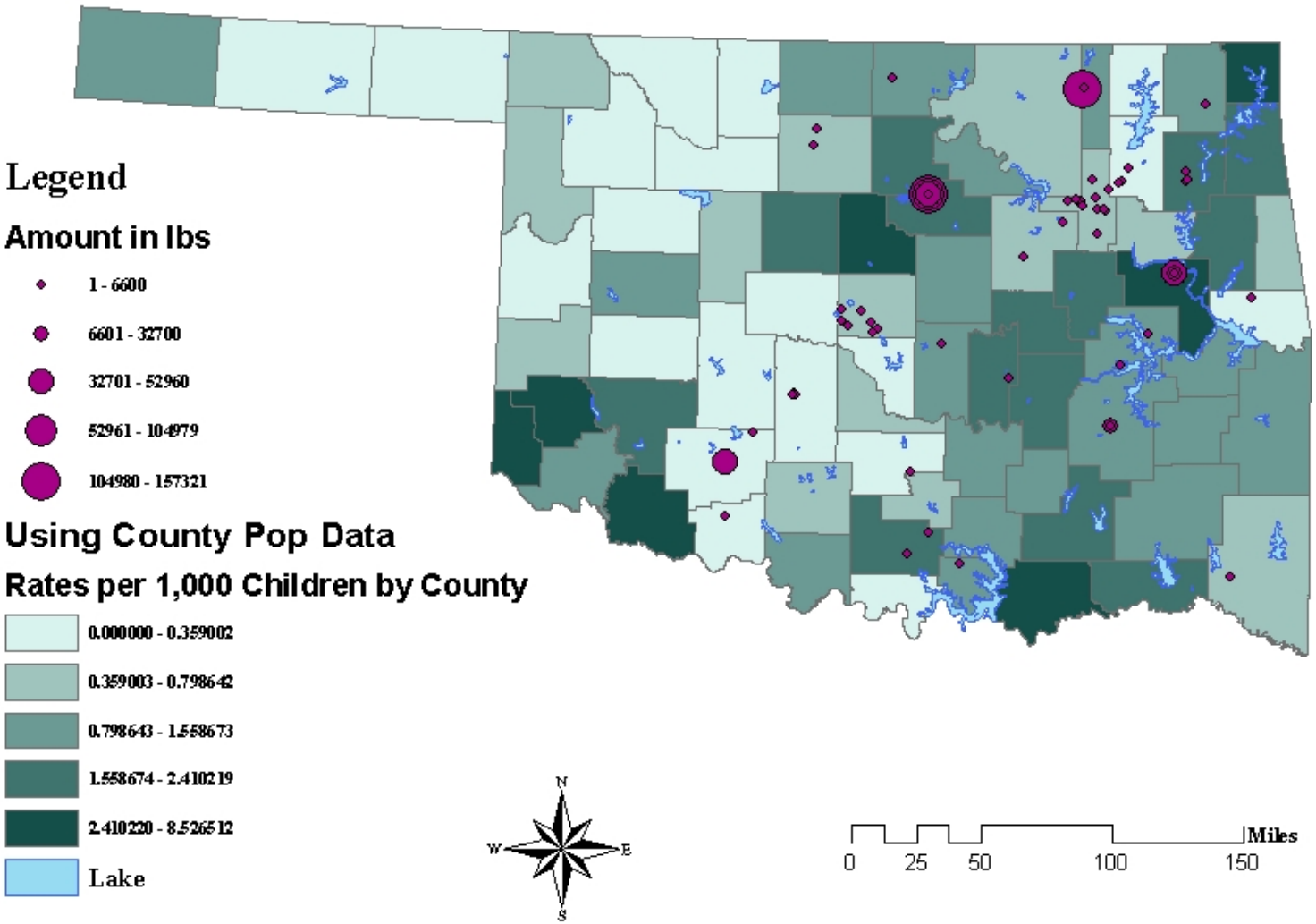
Rates of Elevated Blood Lead Level Among Children, Age 6 Years and Under, and Lead Mining Sites, OCLPPP Data, Oklahoma, 1995-2003



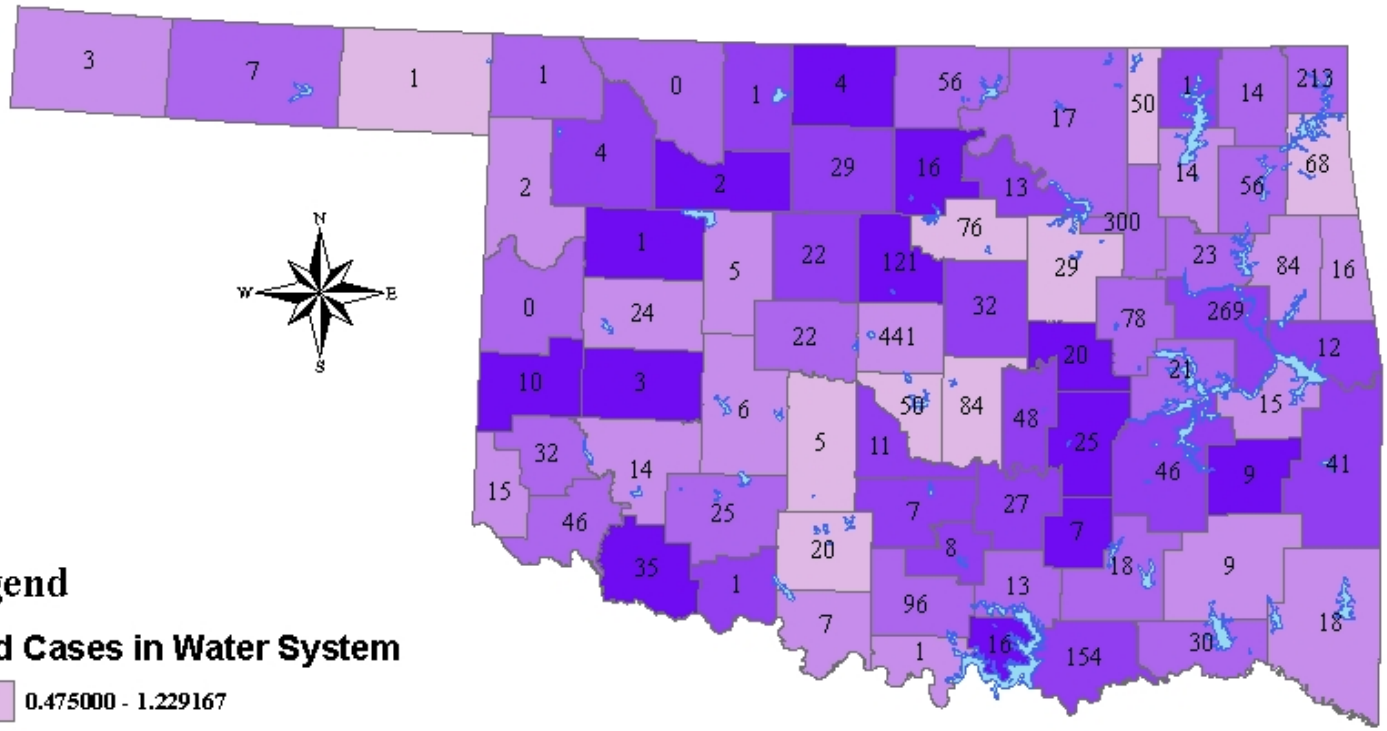
Rates of Elevated Blood Lead Level Among Children, Age 6 years and Under, and Lead Air Emission Inventory Sites (1995-2002) OCLPPP Data, Oklahoma, 1995-2003



Rates of Elevated Blood Lead Level Among Children, Age 6 years and Under, and TRI Lead Emission Sites (1995-2002) OCLPPP Data, Oklahoma, 1995-2003



Number of Elevated Blood Lead Level Cases, Age 6 Years and Under, and Ratio of SDWIS 90th Percentile Lead Occurrences to Public Water Supply Systems per County, OCLPPP Data, Oklahoma, 1995-2003

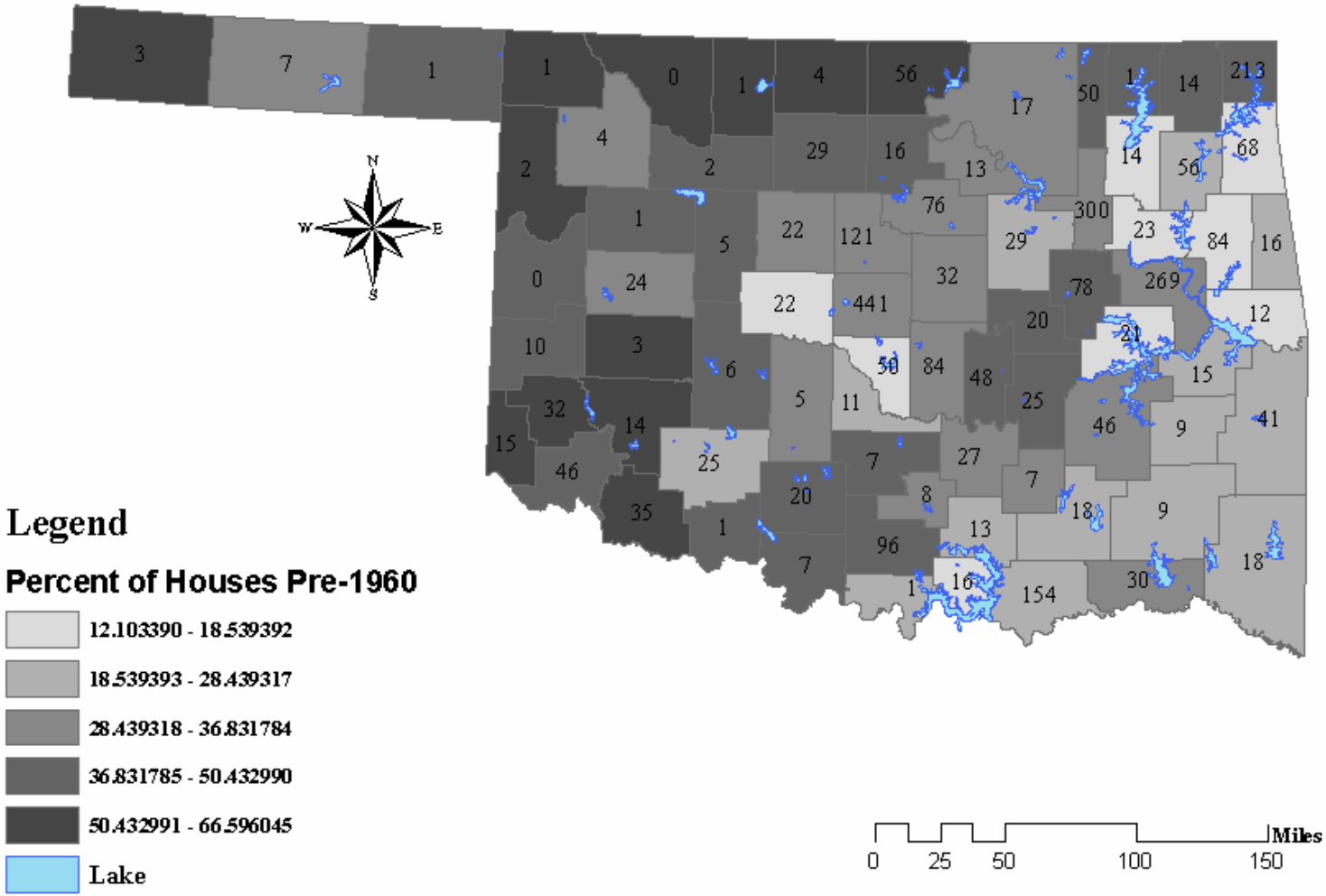


Legend

Lead Cases in Water System

- 0.475000 - 1.229167
- 1.229168 - 1.687500
- 1.687501 - 2.153846
- 2.153847 - 2.730769
- 2.730770 - 3.750000
- Lake

Rates of Elevated Blood Lead Level Among Children, Age 6 Years and Under, and Proportion of Houses Built Before 1960, OCLPPP Data, Oklahoma, 1995-2003



Blood Lead Level Model 1

Blood lead level =

$\beta_0 + \beta_1 *$ Age $+ \beta_2 *$ Age2 $+ \beta_3 *$ Male $+ \beta_4 *$ Black $+ \beta_5 *$ Indian $+ \beta_6 *$ Asian $+ \beta_7 *$ Other $+ \beta_8 *$ Hispanic $+ \beta_9 *$ $TRI_3 + \beta_{10} *$ $AEI_3 + \beta_{11} *$ $Superfund_3 + \beta_{12} *$ Ottawa $+ \beta_{13} *$ SDWIS $+ \beta_{14} *$ Housing Age $+ \varepsilon$

Variable	Parameter Estimate	t-value	p-value
Intercept	0.84268	6.30	<0.0001
Age	0.09661	14.27	<0.0001
Age^2	-0.00128	-12.71	<0.0001
Male	0.12068	2.55	0.0107
Black	0.20183	2.68	0.0074
Indian	-0.17124	-2.25	0.0242
Asian	-0.19047	-1.02	0.3067
Other	0.32812	3.43	0.0006
Hispanic	-0.00915	-0.11	0.9098
TRI_3	0.19925	3.60	0.0003
AEI_3	-0.55622	-6.58	<0.0001
$Superfund_3$	0.25813	2.50	0.0125
Ottawa	0.47046	4.17	<0.0001
SDWIS	0.82774	15.80	<0.0001
Housing Age	0.00967	3.60	0.0003

Adj. R^2: 0.034

Blood Lead Level Model 2

Blood lead level =

$\beta_0 + \beta_1 *$ Age $+ \beta_2 *$ Age2 $+ \beta_3 *$ Male $+ \beta_4 *$ Black $+ \beta_5 *$ Indian $+ \beta_6 *$ Asian $+ \beta_7 *$ Other $+ \beta_8 *$ Hispanic $+ \beta_9 *$ SDWIS $+ \beta_{10} *$ Housing Age $+ \beta_{11} *$ Nat. Zinc $+ \beta_{12} *$ Yaffe $+ \beta_{13} *$ Ottawa $+ \varepsilon$

Variable	Parameter Estimate	t-value	p-value
Intercept	1.0591	7.93	<0.0001
Age	0.0961	14.2	<0.0001
Age^2	-0.00127	-12.62	<0.0001
Male	0.11873	2.51	0.012
Black	0.21317	2.84	0.0045
Indian	-0.19659	-2.59	0.0097
Asian	-0.1742	-0.94	0.3496
Other	0.33036	3.46	0.0005
Hispanic	0.00523	0.06	0.9482
SDWIS	0.69003	12.67	<0.0001
Housing Age	0.01039	3.86	0.0001
Nat. Zinc	0.70984	2.78	0.0054
Yaffe	0.85237	7.23	<0.0001
Ottawa	0.12254	1.28	0.2006

Adj. R^2: 0.0342

Results

- Demographic statistics
  - Annual EBL cases have declined while children tested has increased
  - EBL rates more frequent in males than females
  - EBL rates more frequent in whites and blacks than in Native Americans
  - There is no difference in EBL rate between ethnicities
  - EBL rates are higher among children over 12 months of age

Results (cont.)

- Visual analysis of county rates showed clustering in SW, SE, and NE Oklahoma
- Statistical analysis using SaTScan revealed significant clustering in SE, NE, and SW Oklahoma

Results (cont.)

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- Regression analysis on childhood blood lead levels in OK revealed significant relationships between blood lead levels and age, sex, race, proximity to TRI, Air Emission Inventory, and Superfund sites, ratio of SDWIS 90% Lead incidences to PWS systems, and % of housing built before 1960.
- Nat. Zinc, Yaffe, and Ottawa county were also sig. related to childhood blood lead levels.
- While statistically significant, the relationships are not very strong.

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Future Considerations

- Water quality and housing age data are difficult to assign to individuals
- Better handling of geographic data (i.e. rural routes, p.o. boxes)
- More specific housing data for cases
- More complete demographic data