

Can GIS help save money?

Using GIS to direct targeted screening for childhood lead poisoning in North Carolina



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Work of Kim, Overstreet, Hull, and Miranda

The Children's Environmental Health Initiative

CEHI is a research, education, and outreach program committed to fostering environments where all children can prosper.



Effects of Lead Exposure

- Symptomatic

- * encephalopathy
- * wrist drop (paralysis)
- * colic
- * anemia

- Asymptomatic

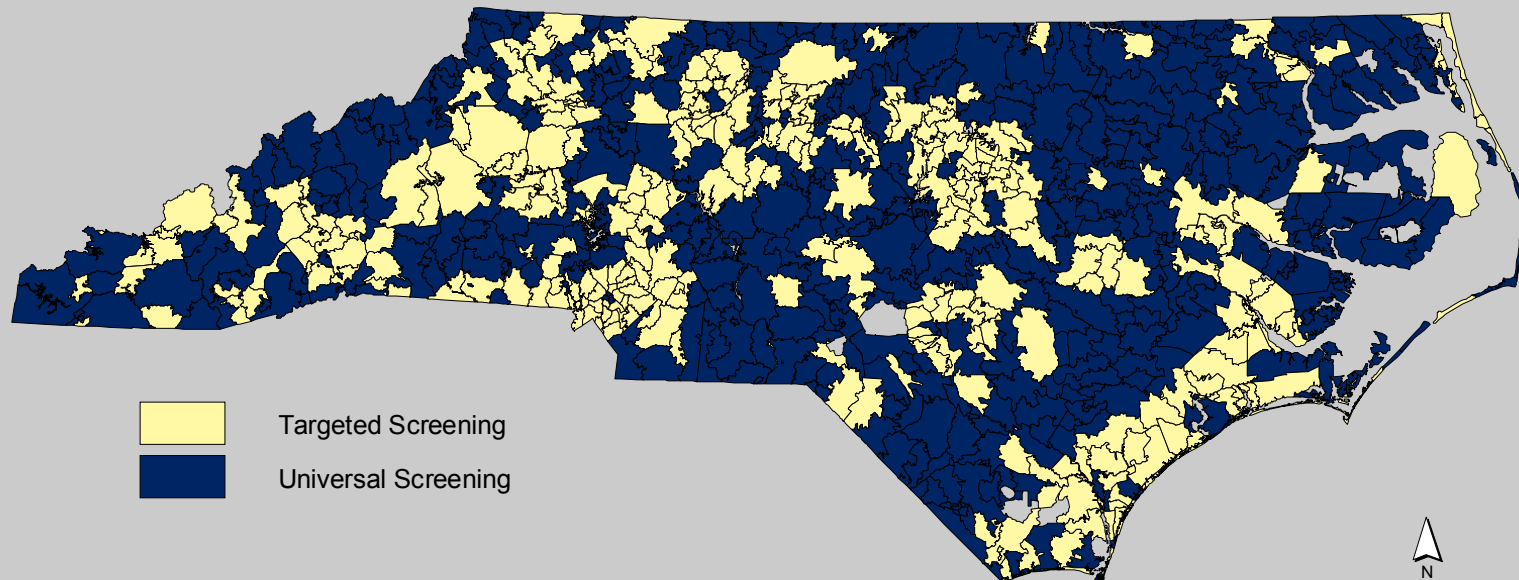
- * damaged central nervous system
- * reduced hearing threshold
- * decreased attention span
- * behavioral and learning disorders
- * lowered IQ



Zip code Based Screening in NC

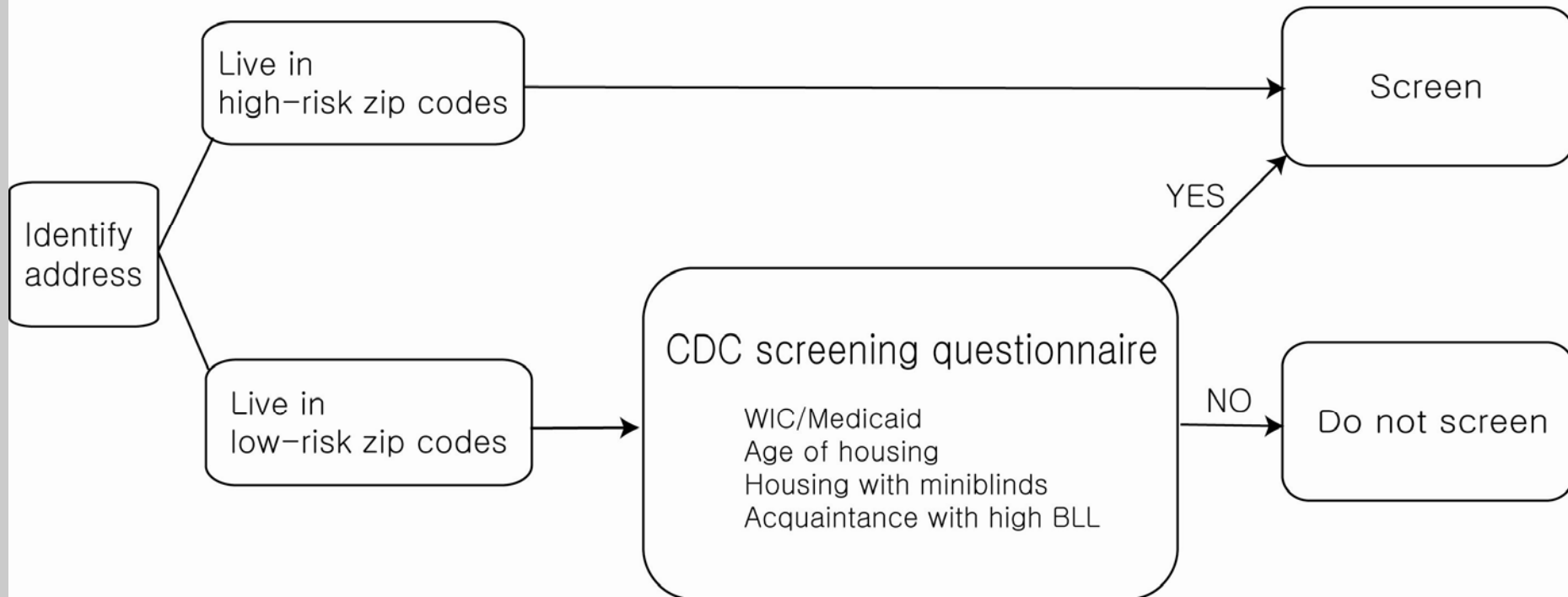
- CDC recommended state specific targeted lead screening (1997)
- NC state used zip codes to identify high-risk areas from 1998-2003
- 479 high-risk & 314 low-risk zip codes in NC (1998-2003)

1998 Zip Code Level Screening Recommendation



Zip Code based screening procedure in NC (Ideal)

When a child 12–24 month of age visit a clinic
(or a child 24–72 month of age if never been tested)



Alternative: Parcel-based Screening

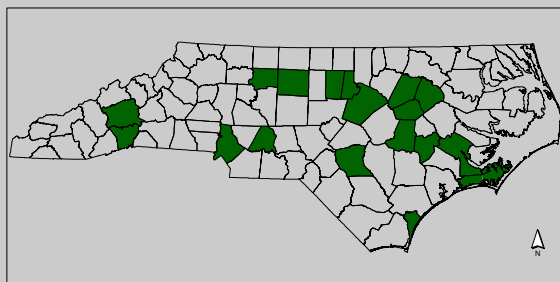
- Smaller geographic units:
 - better identify high risk areas
 - not widely known by parents or pediatricians
 - have not used as screening criteria
- Rapid development in GIS technology
- Alternative: Parcel-based screening by GIS model

Research Question

1. Can parcel-based screening improve outcomes compared to zip code-based screening?
 - (1) Screening rate
 - (2) EBLL detection rate
 - (3) Cost per elevated case

2. Can we design a web-based GIS to help providers and parents easily identify children at risk for lead exposure?

Zip code based screening in 18 NC counties ('99-'03)



Low-risk zip codes (N=203)
(Targeted screening)

High-risk zip codes (N=222)
(Universal screening)

Overall
(N=425)

Population under 3 years old*

339,783

173,271

513,054

Number of screens**

103,671

47,120

150,791

Screening rate

30.5%

27.2%

29.4%

of elevated BLL \geq 10
(% among screens)

1,982

1,503

3,485

(1.9%)

(3.2%)

(2.3%)

of elevated BLL \geq 5
(% among screens)

26,623

15,504

42,127

(25.7%)

(32.9%)

(27.9%)

*North Carolina State Center for Health Statistics

**Children's Environmental Health Branch, NCDENR

Estimating Pb risk at each parcel: Deciles & Priorities

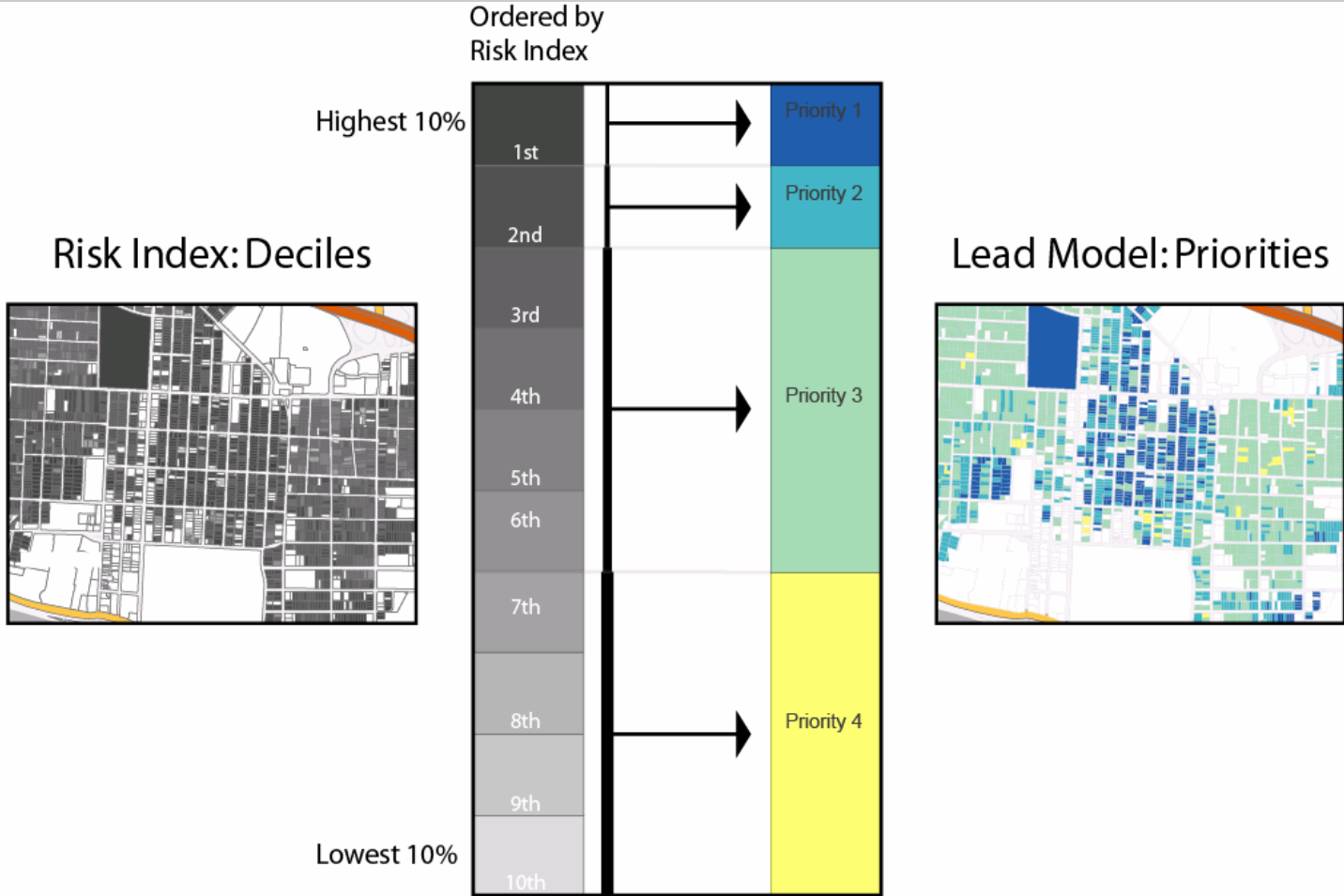
Unified GIS
Lead screening
Tax assessor
Census



Statistical
Model



Lead
exposure
risk Index





Stat Model

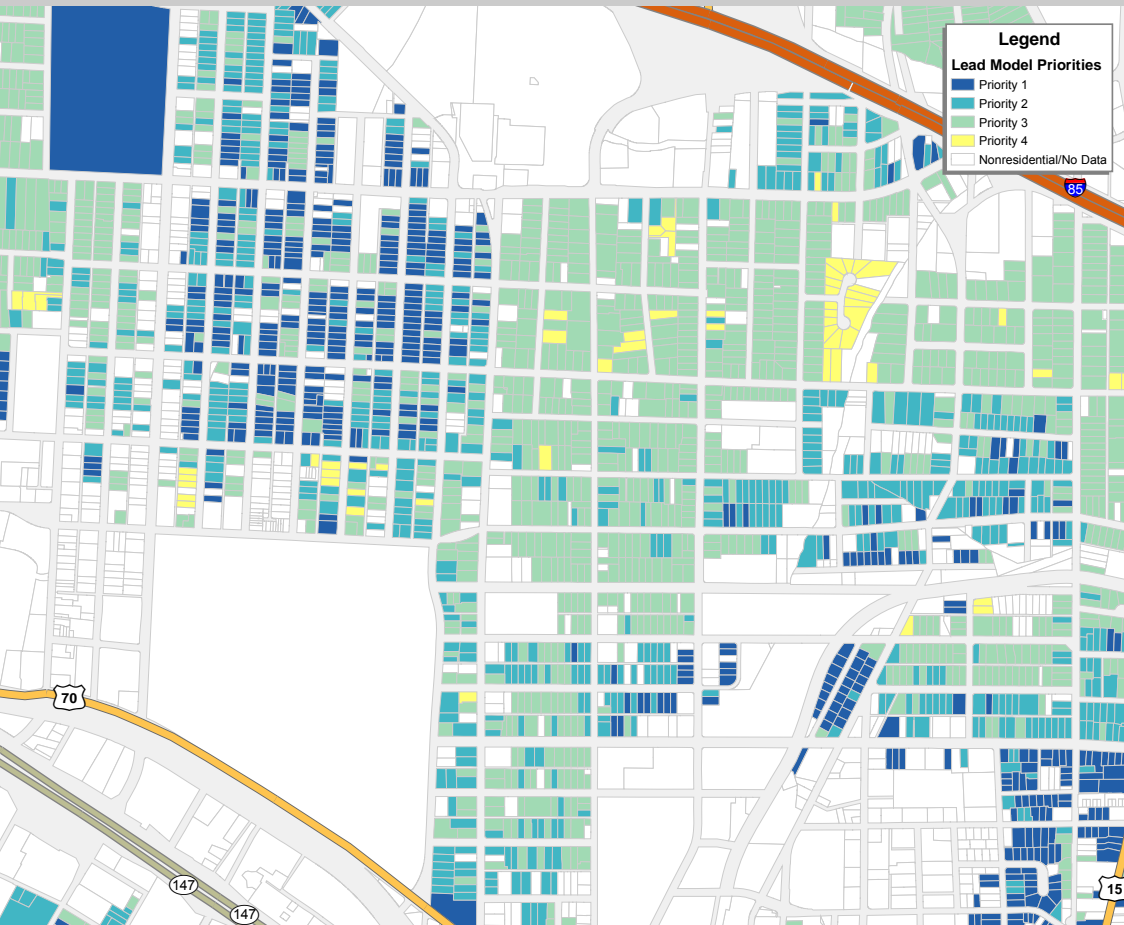
Linear regression	Number of obs =	98618
	F(26, 63710) =	9946.75
	Prob > F =	0.0000
	R-squared =	0.7849
Number of clusters (parc_id) = 63711	Root MSE =	.59707

ln_bll	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
yr_blt	-.0031788	.0001023	-31.07	0.000	-.0033793	-.0029783
kg_hmdin	-1.87e-06	1.69e-07	-11.09	0.000	-2.20e-06	-1.54e-06
kb_p_blk	.0021971	.0000904	24.29	0.000	.0020199	.0023744
kb_p_hisp	.0018249	.000261	6.99	0.000	.0013132	.0023365
kgp_puba	.0027929	.0007525	3.71	0.000	.001318	.0042678
spring	.0111798	.0064645	1.73	0.084	-.0014905	.0238502
summer	.1111346	.0063966	17.37	0.000	.0985972	.1236719
fall	.0742122	.0064237	11.55	0.000	.0616218	.0868026
bun	7.295517	.2003045	36.42	0.000	6.90292	7.688114
cart	7.402273	.2016376	36.71	0.000	7.007063	7.797483
crav	7.402847	.201178	36.80	0.000	7.008538	7.797156
cumber	7.390142	.2014116	36.69	0.000	6.995375	7.784909
dur	7.134675	.2005455	35.58	0.000	6.741606	7.527745
edge	7.497772	.2006525	37.37	0.000	7.104493	7.891051
forsyth	7.309356	.1999976	36.55	0.000	6.91736	7.701351
guilf	7.300647	.2002503	36.46	0.000	6.908156	7.693138
henders	7.389835	.2024236	36.51	0.000	6.993084	7.786585
lenoir	7.462692	.2003952	37.24	0.000	7.069917	7.855467
mecklen	7.286496	.2006551	36.31	0.000	6.893212	7.67978
nash	7.492959	.2018266	37.13	0.000	7.097378	7.888539
new_han	7.349719	.2011447	36.54	0.000	6.955475	7.743963
orange	7.217861	.2018593	35.76	0.000	6.822217	7.613505
stanly	7.463936	.2005888	37.21	0.000	7.070782	7.857091
wake	7.286902	.2009776	36.26	0.000	6.892986	7.680818
wayne	7.470401	.2009351	37.18	0.000	7.076568	7.864234
wilson	7.354532	.2018108	36.44	0.000	6.958983	7.750082

Log (BLL) is a function of:

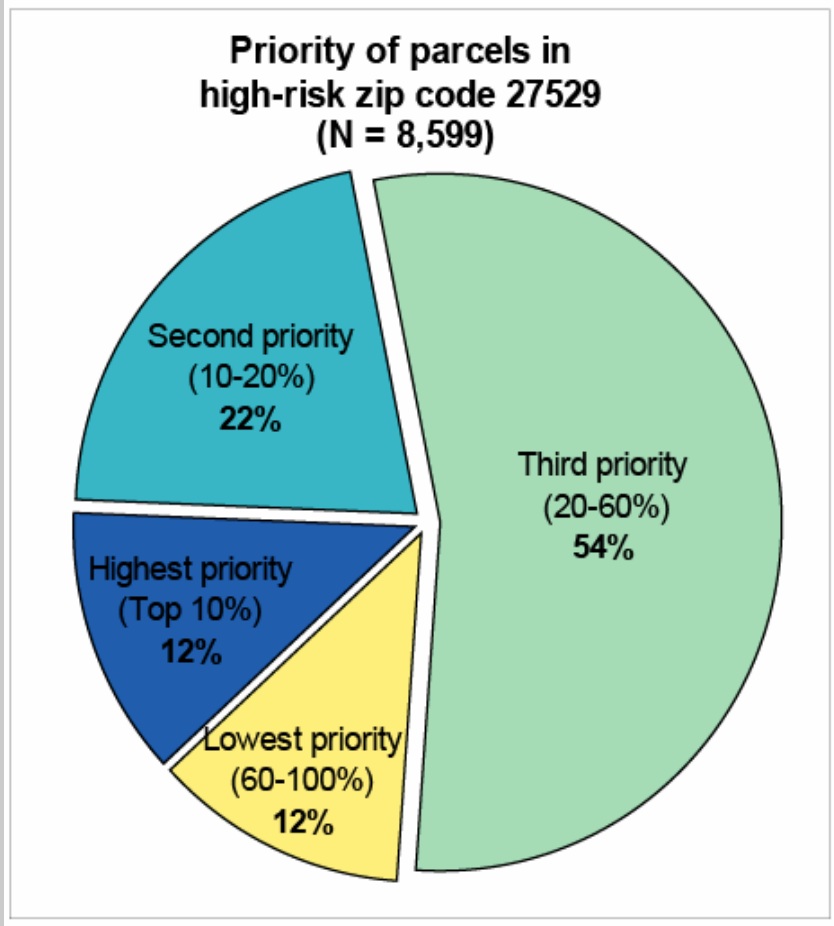
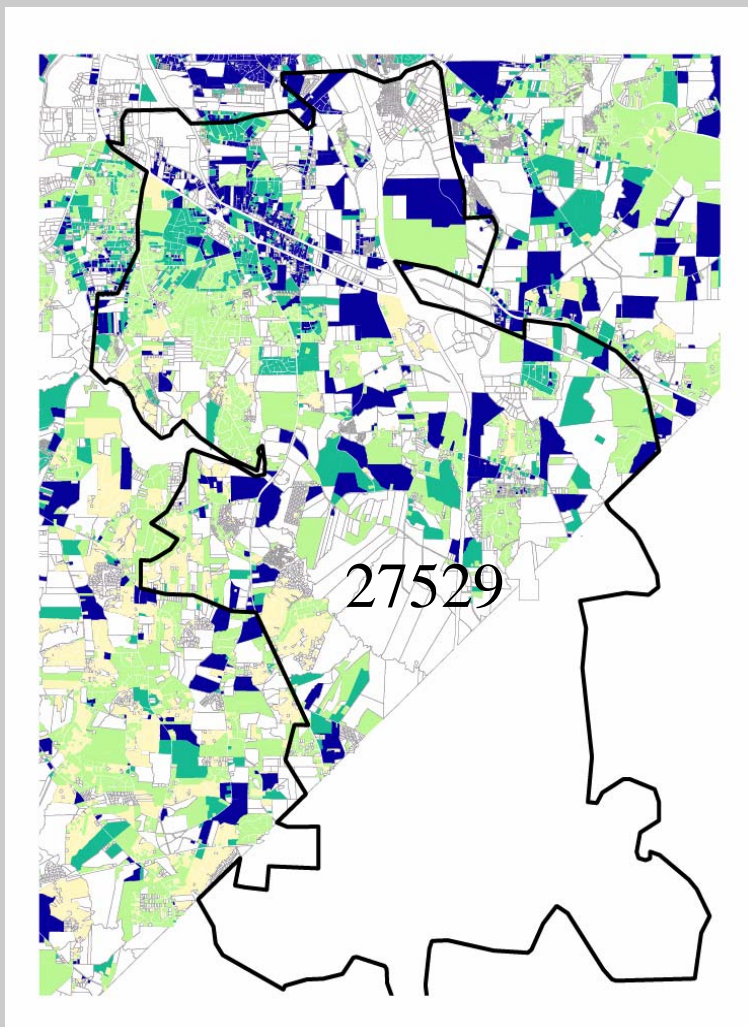
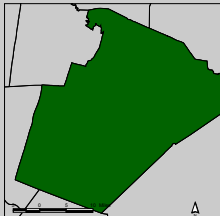
- Age of housing
- Median HH income
- % African American
- % Hispanic
- % public assistance
- Seasonal dummies
- County specific constants

Lead risk priorities at tax parcel level

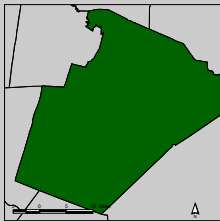


Will screening based on parcel-level priorities detect more cases of elevated BLL?

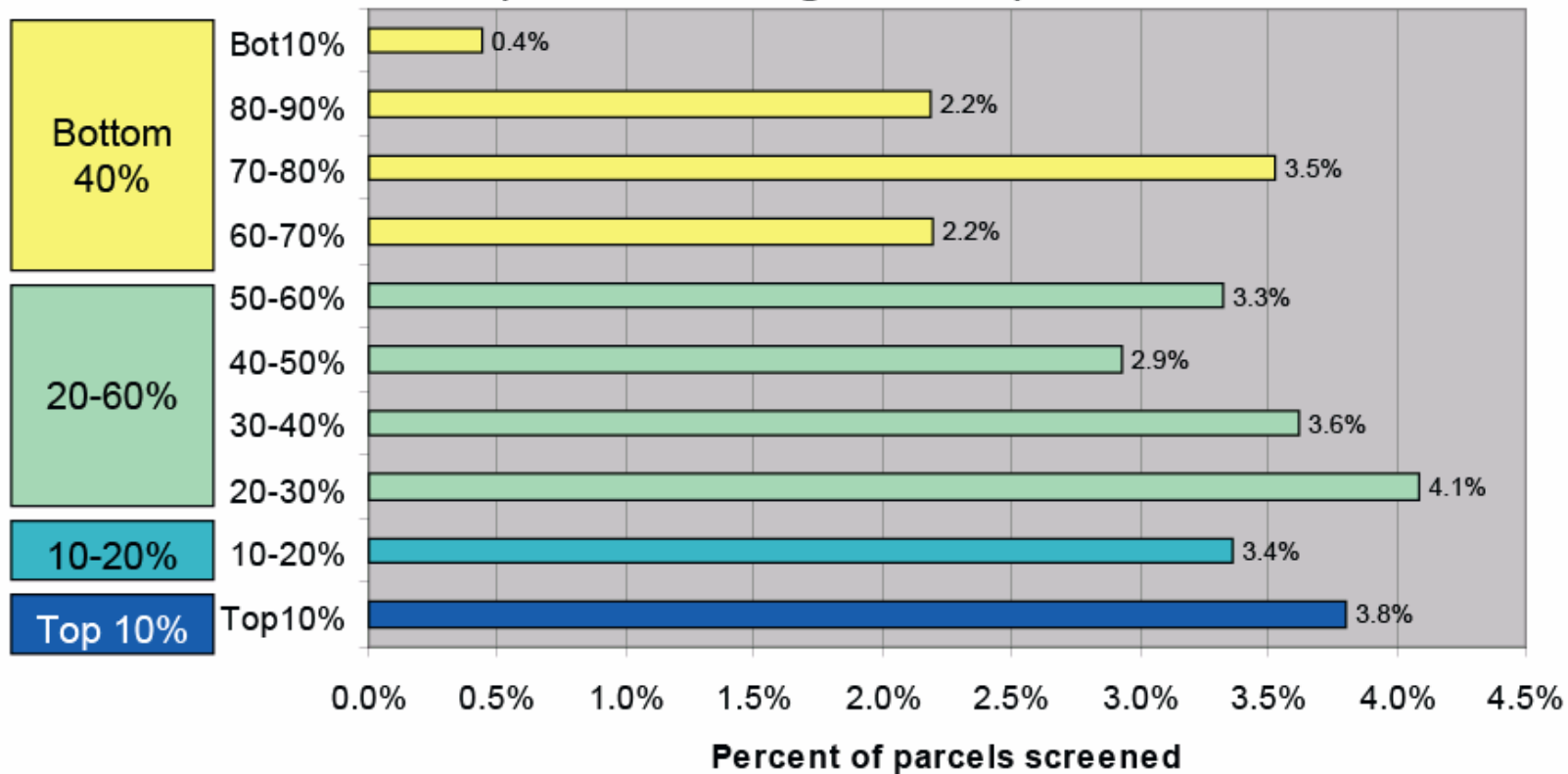
Parcel priorities in a high-risk zip code (Wake County)



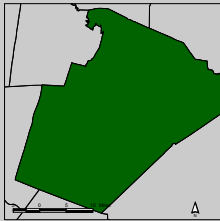
Parcels with screens in high-risk zip codes: Wake



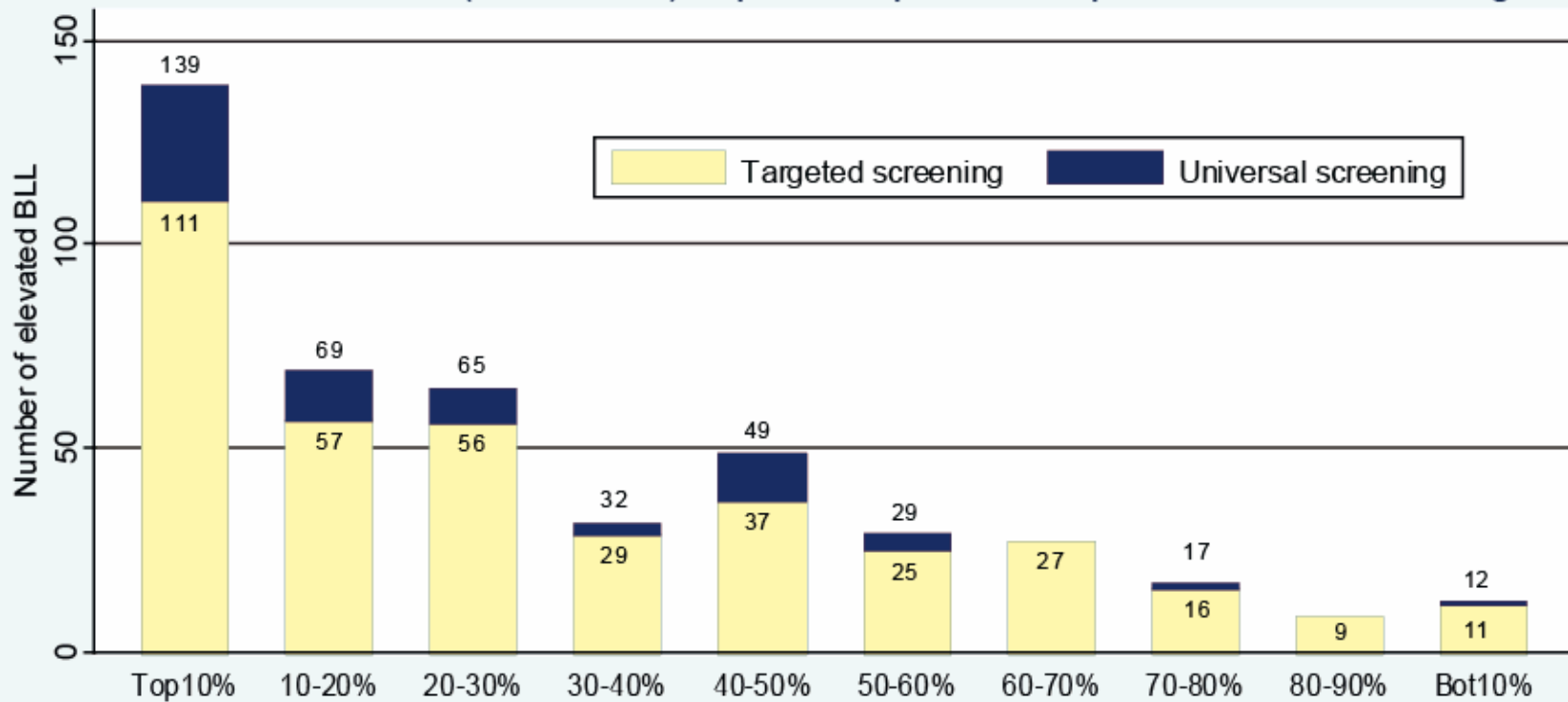
**Percentage of parcels with screens by each decile:
All high-risk zip-codes in Wake county
(Overall screening rate: 3.1%)**



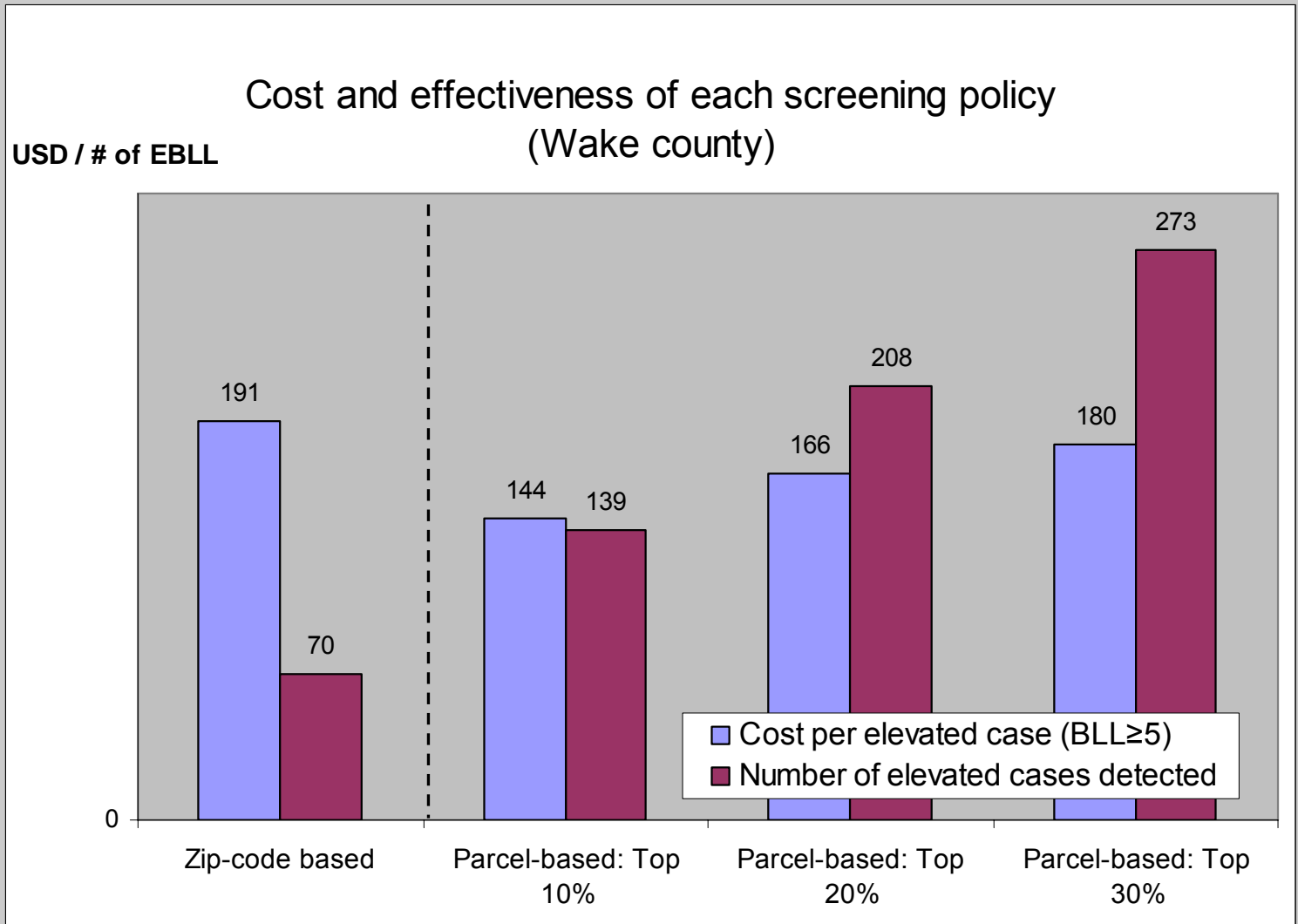
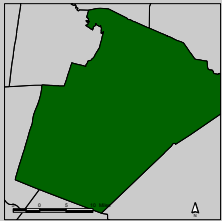
Number of elevated cases detected: Wake



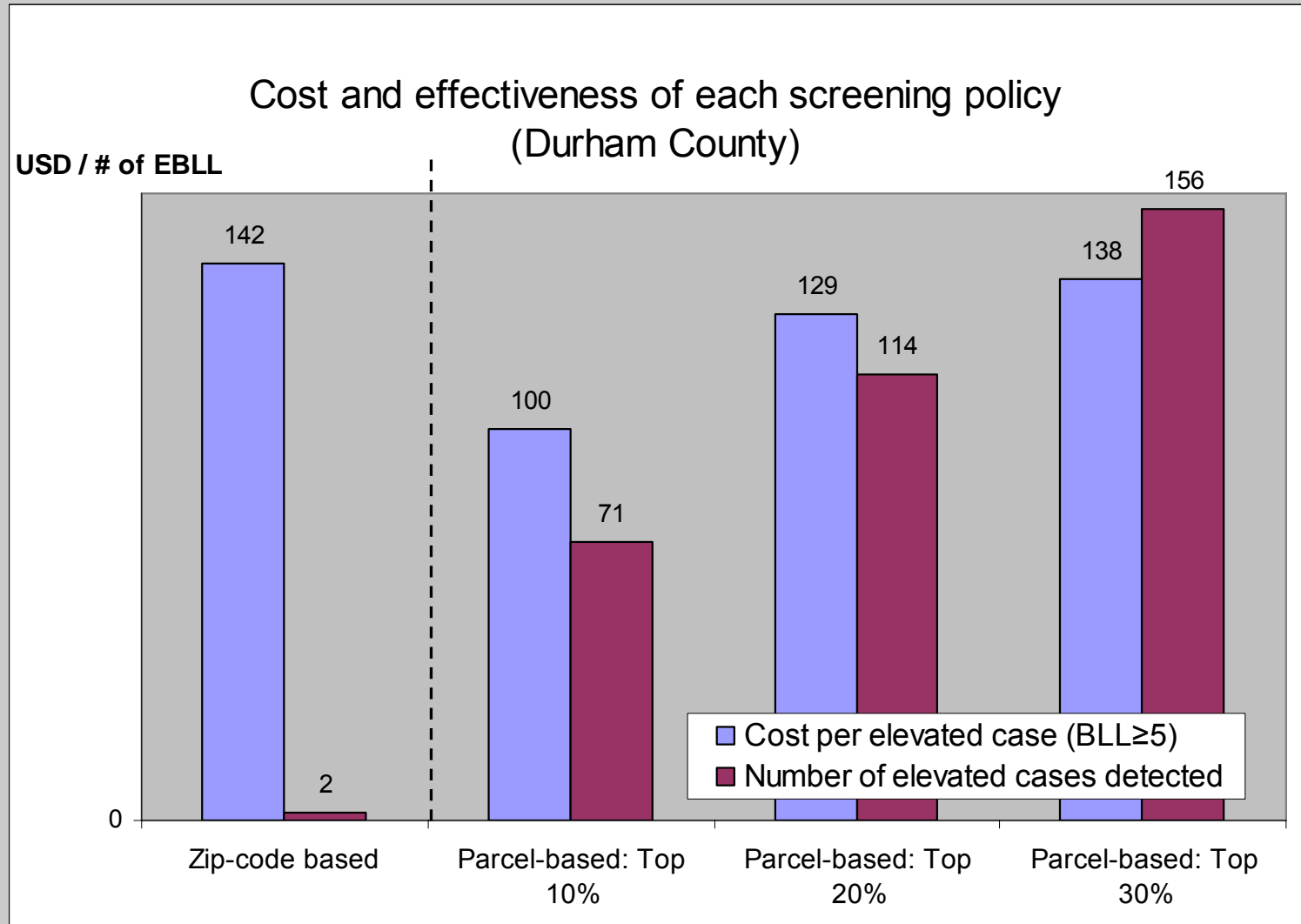
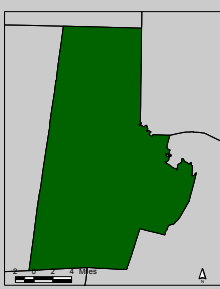
Number of elevated BLL (2004-2005) captured zip code vs. parcel based screening



Outcomes of screening strategies: Wake county



Outcomes of screening strategies: Durham county



Implication for screening strategy

- Parcel-based screening out performs zip code based screening in both of these counties
- Screening top 10% parcels would save USD50,000 ~60,000 in detecting 1,000 elevated BLL cases
- Screening top 30% parcels would detect 300~400 more elevated cases given the budget constraint of USD 100,000

Implementation of parcel-based targeted screening

- **Web-GIS screening**
 - Facilitate access to lead risk map by parents and pediatricians
 - Create simplified web-based GIS interface
 - Allow address searching to determine risk level

Test



1:1000

916 Sedgefield st

Search

Address Search

Legend

Layers

- Day Care Centers
- Doctors Offices
- Religious Institutions
- Roads
- Lead Model
 - Priority 1
 - Priority 2
 - Priority 3
 - Priority 4



Simplified GIS interface with basic address search



Summary/Discussion

- Can GIS help save money? *yes*
“GIS-based approach would save costs for detecting cases or detect more cases given budget constraint”
- Web-based GIS: easily identify the risk priority for residence of each child
- Quality GIS data: minimizes problems by self-reported risk factors

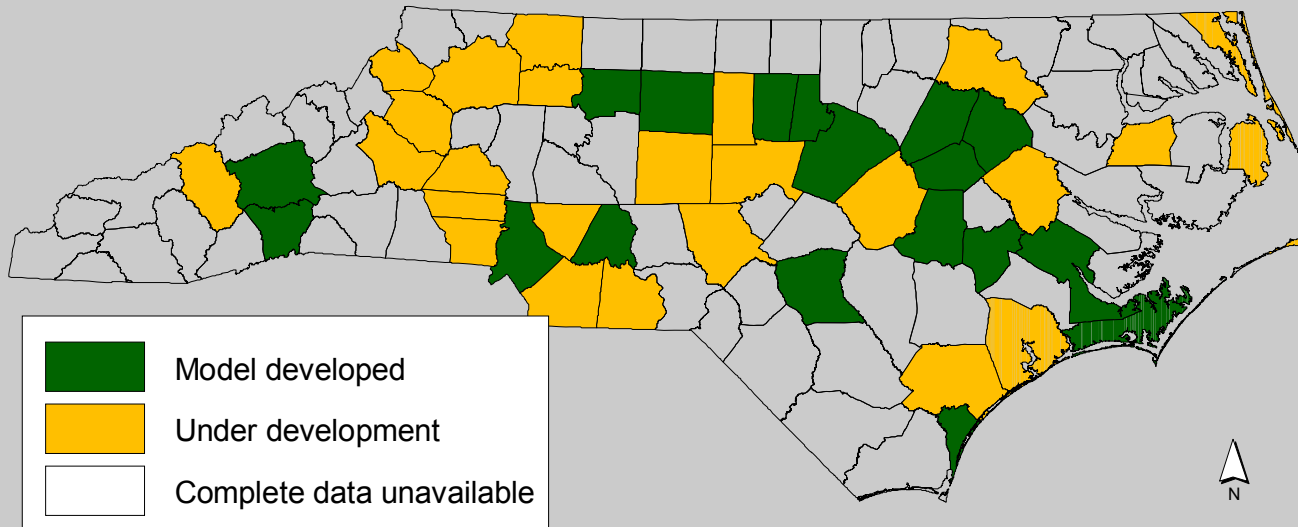
Acknowledgements

State of North Carolina NC Childhood Lead Poisoning Prevention Program, Department of Environment and Natural Resources

Centers for Disease Control and Prevention

Counties who provided GIS data for analysis free of charge

N.C. Tax Parcel Level Model Development Progress



Questions/Comments?

