Is childhood lead poisoning still a public health problem?

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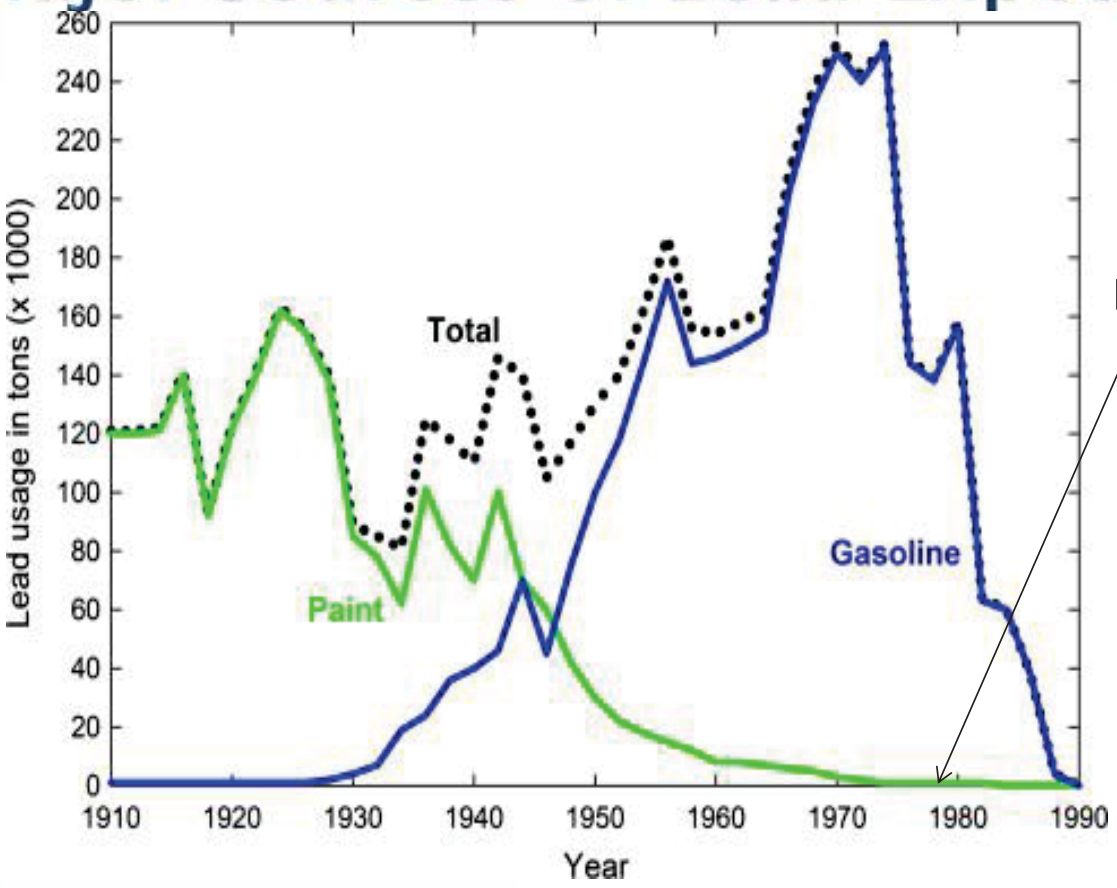
March 12, 2014

We will cover:

- State and national data
- Cognitive and social impacts
- Screening tools and the lead risk map

State and National Data

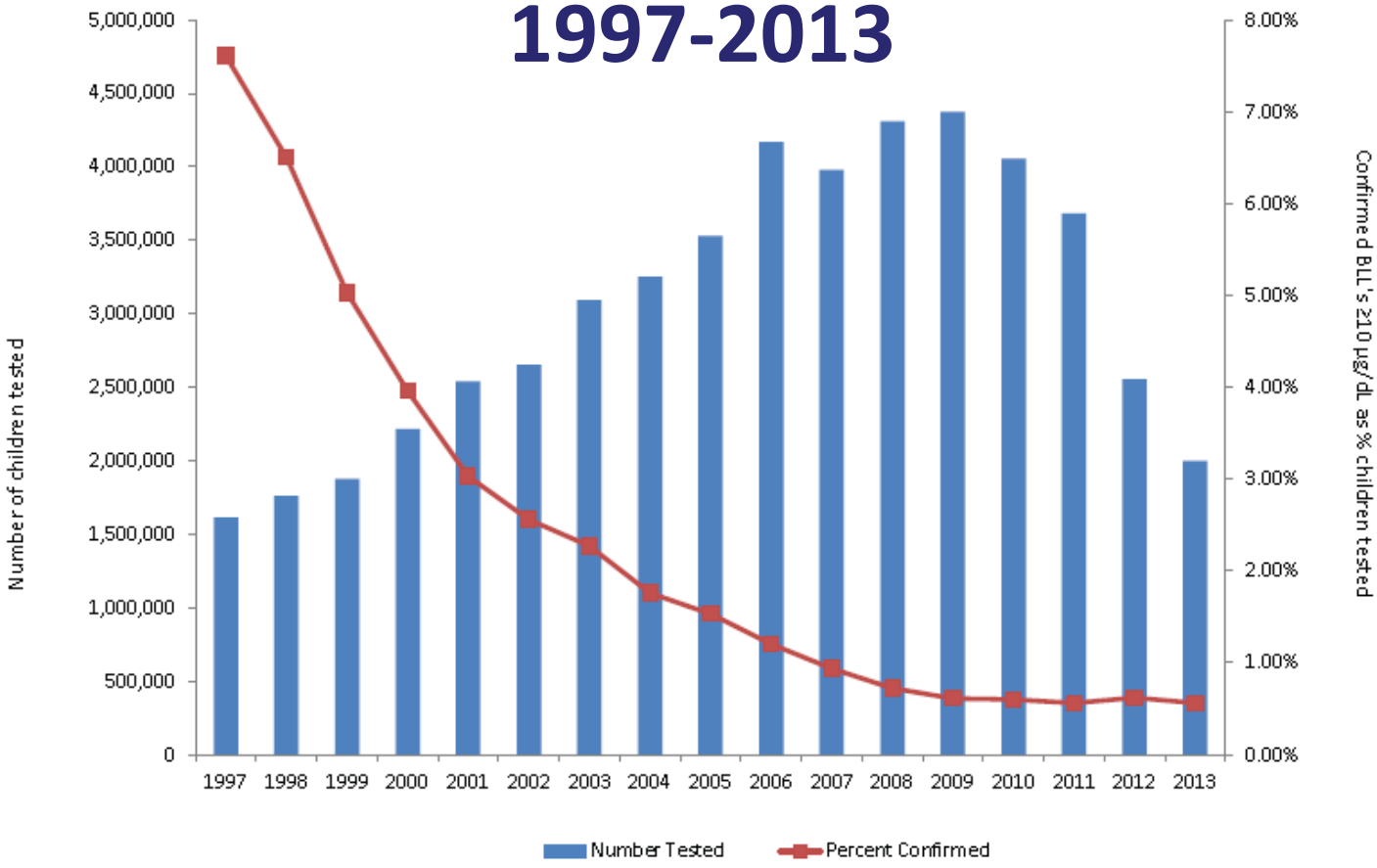
Major Sources of Lead Exposure



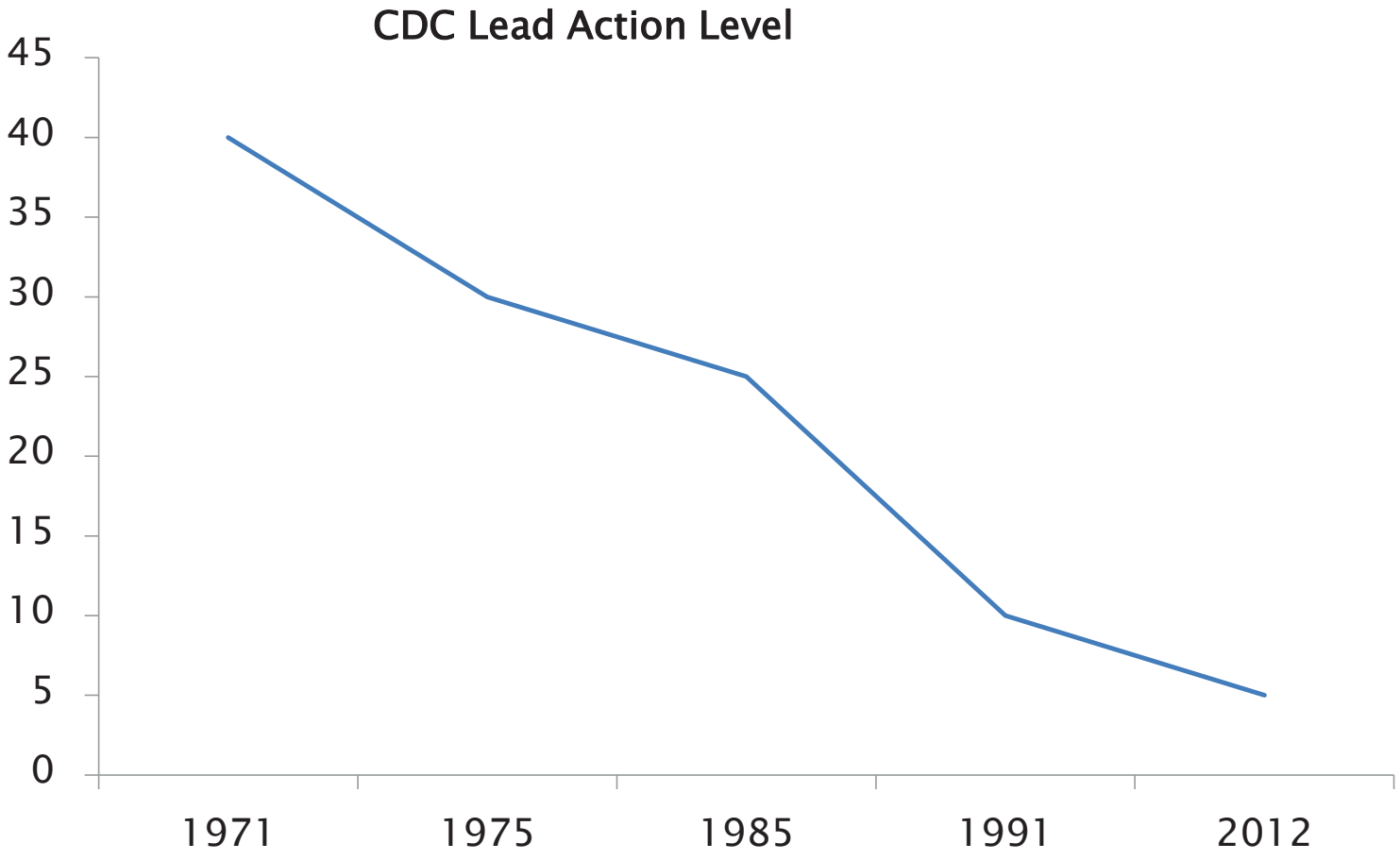
Lead Paint Banned

*Laidlaw et al. 2008

US Totals Blood Lead Surveillance, 1997-2013

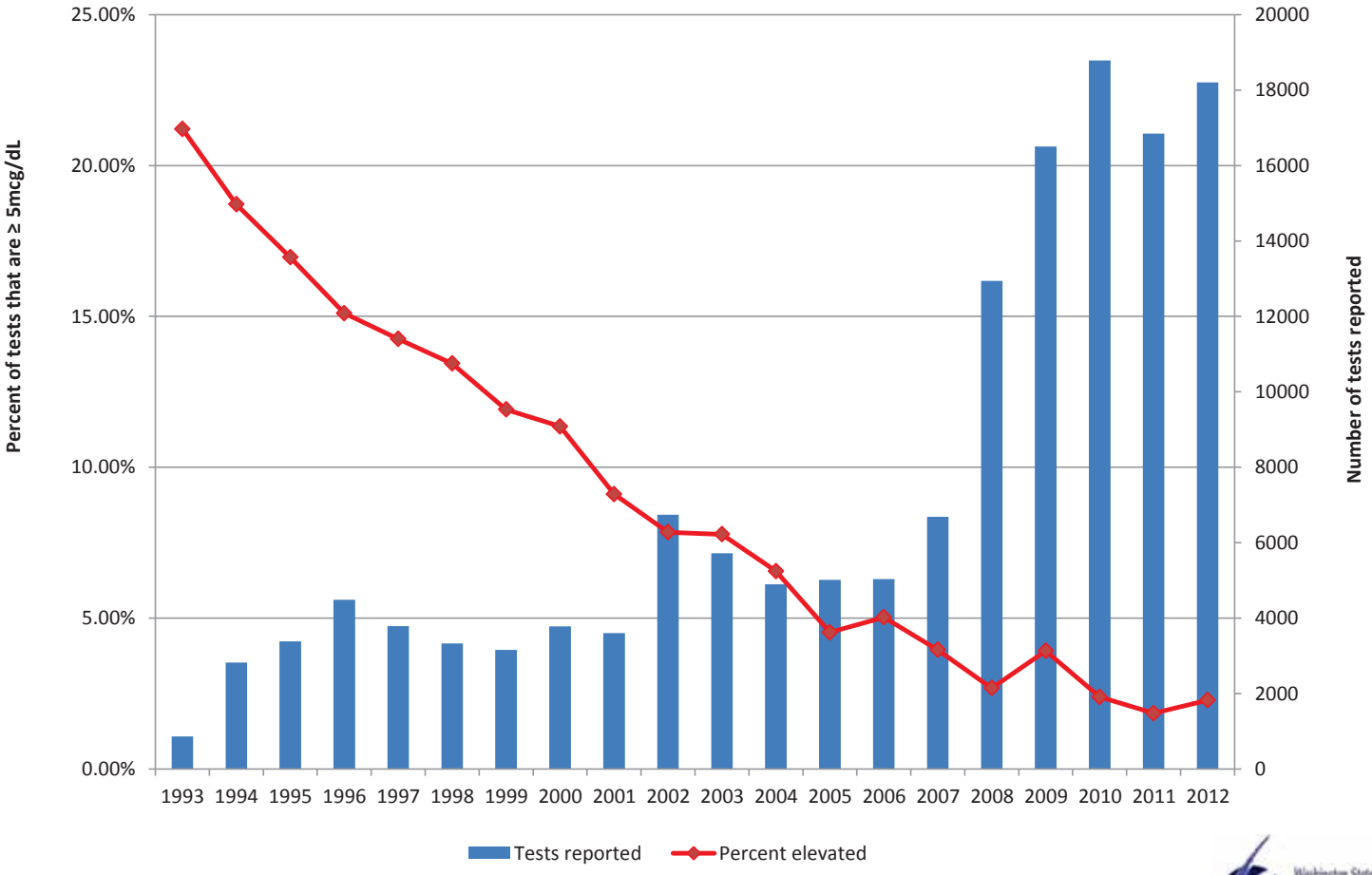


Source: http://www.cdc.gov/nceh/lead/data/index.htm

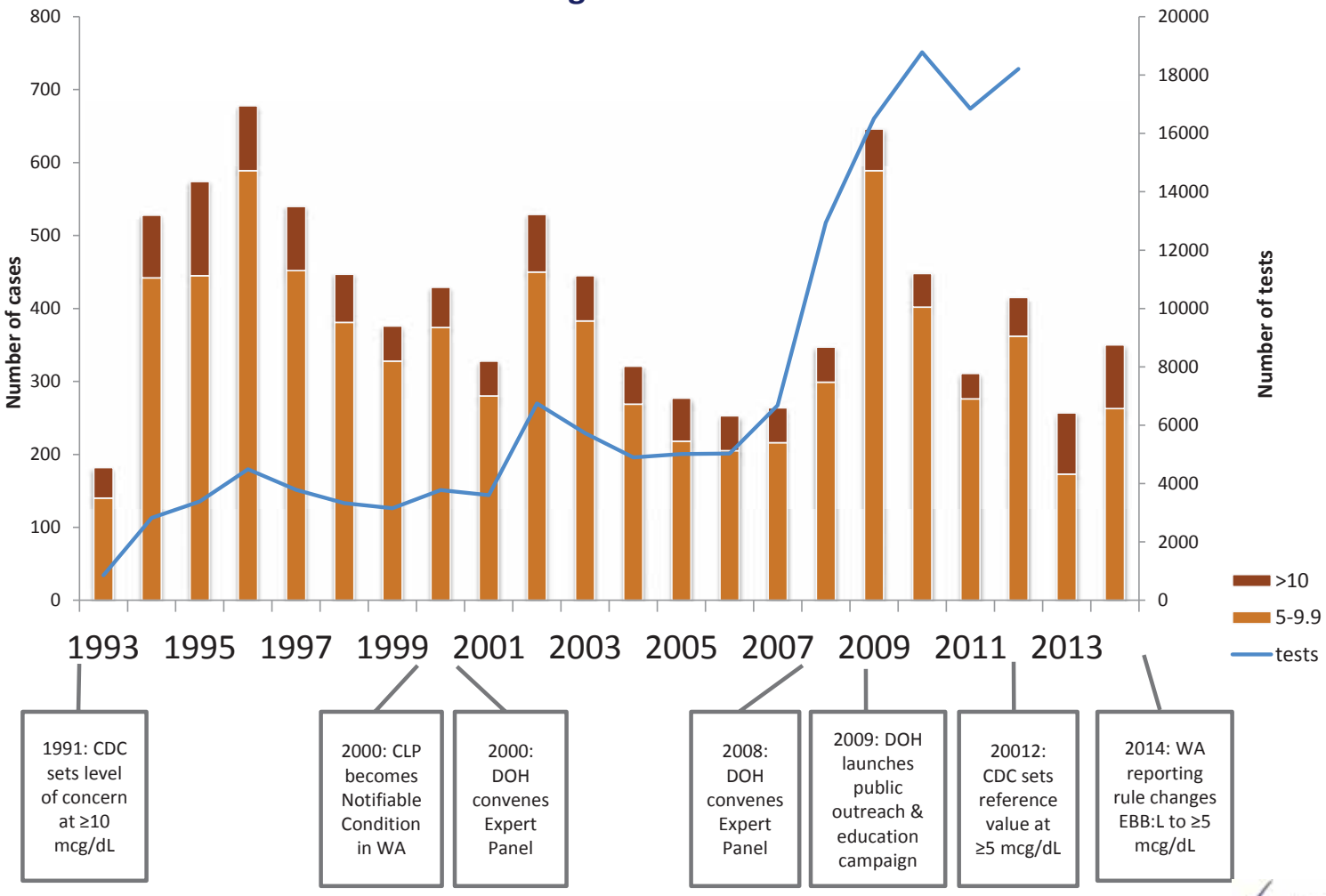


Source: A Review of Evidence of Health Effects of Blood Lead Levels <10 ug,dL in Children Reported by a Work Group of the Advisory Committee on Childhood Lead Poisoning Prevention

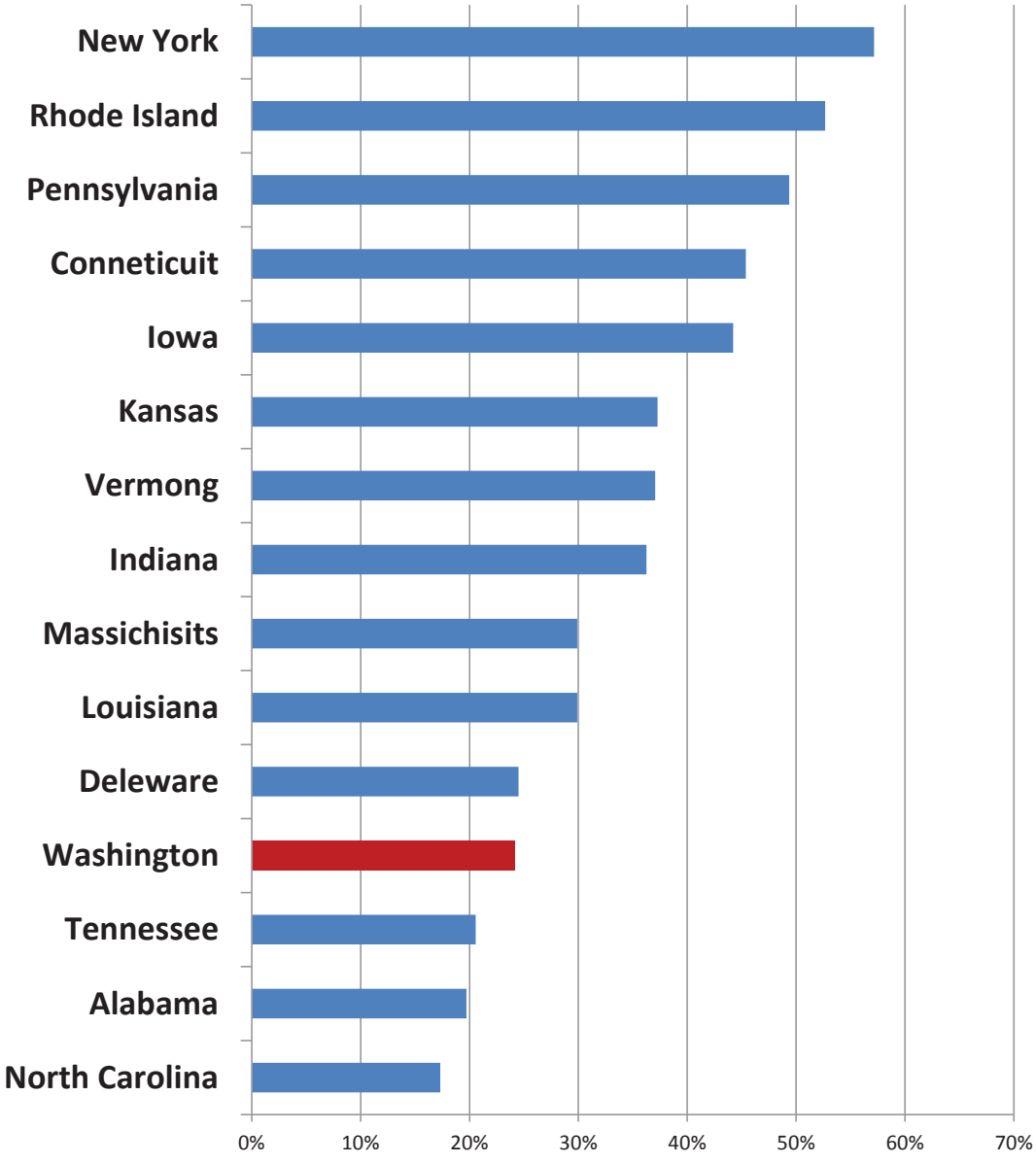
Washington: Among Children under 6 who are tested, percentage who have reported blood lead levels ≥ 5 mcg/dL



Childhood Lead Screening Tests and Elevated Results in Children 6 and Under in Washington State 1993-2013



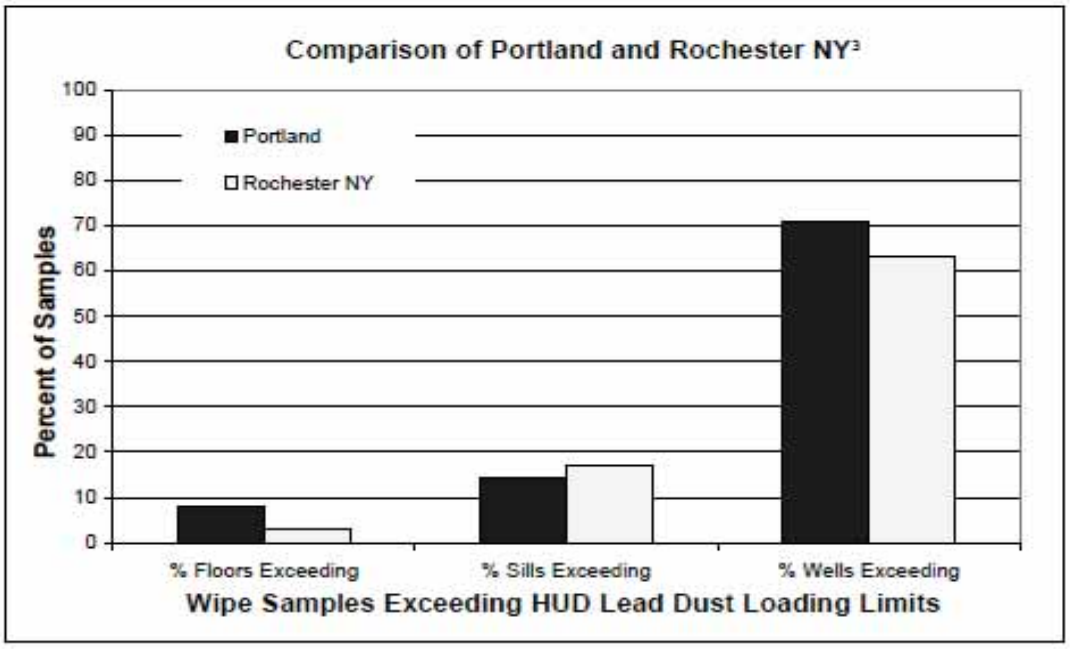
Health



Proportion of Pre - 1950 Housing in Washington State Compared to states that do universal screening

Data Source: ACS 5-year estimates 2009-2013

Lead wipe results in NY vs OR



[7] Lanphear, B.P., Weitzman, M., Winter, N.L., et. al. Lead-Contaminated House Dust and Urban Children's Blood Lead Levels. Am. J. Public Health, 86(10), 1416-1421, 1996.

Lead Program in WA State

- 2.0 FTE's, with Support
  - Elizabeth Long, Epidemiologist
  - Amanda Jones, Health Services Consultant
- Surveillance: Receives all lead tests performed in the state
- Outreach
  - Mailing in Child Profile
  - Website

How much does it take to poison a child?

- 5 µg/dL – Definition of childhood lead poisoning
- 2 liters – estimated blood volume of a 2 year old

- $\frac{5\mu g}{\cancel{dl}} \times \frac{10\ \cancel{dl}}{1\ \cancel{L}} \times 2\cancel{L} = 100\cancel{mcg} \times \frac{1\ gram}{1000000\ \cancel{mcg}} =$

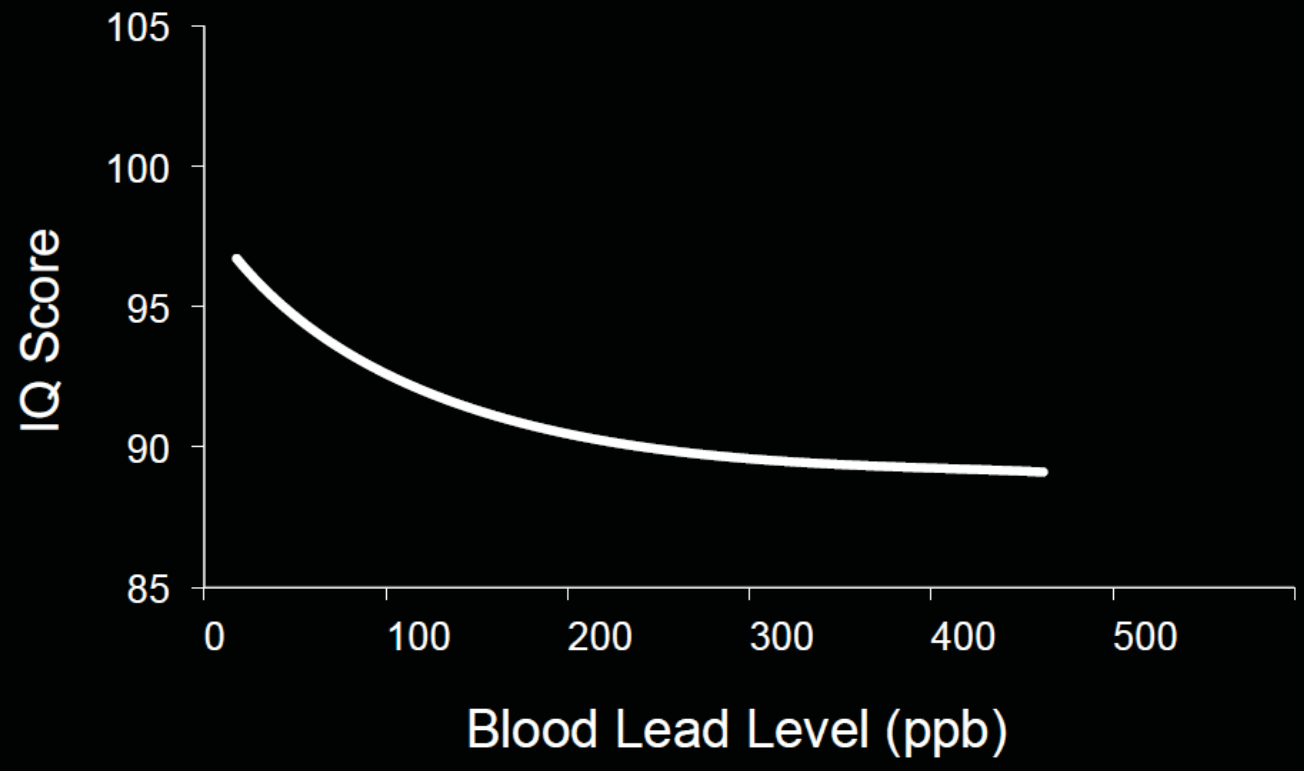
$$0.0001\ grams$$

- Reference 1: one grain of salt weighs 0.0003 grams
- Reference 2: a cubic centimeter of water weighs 1 gram

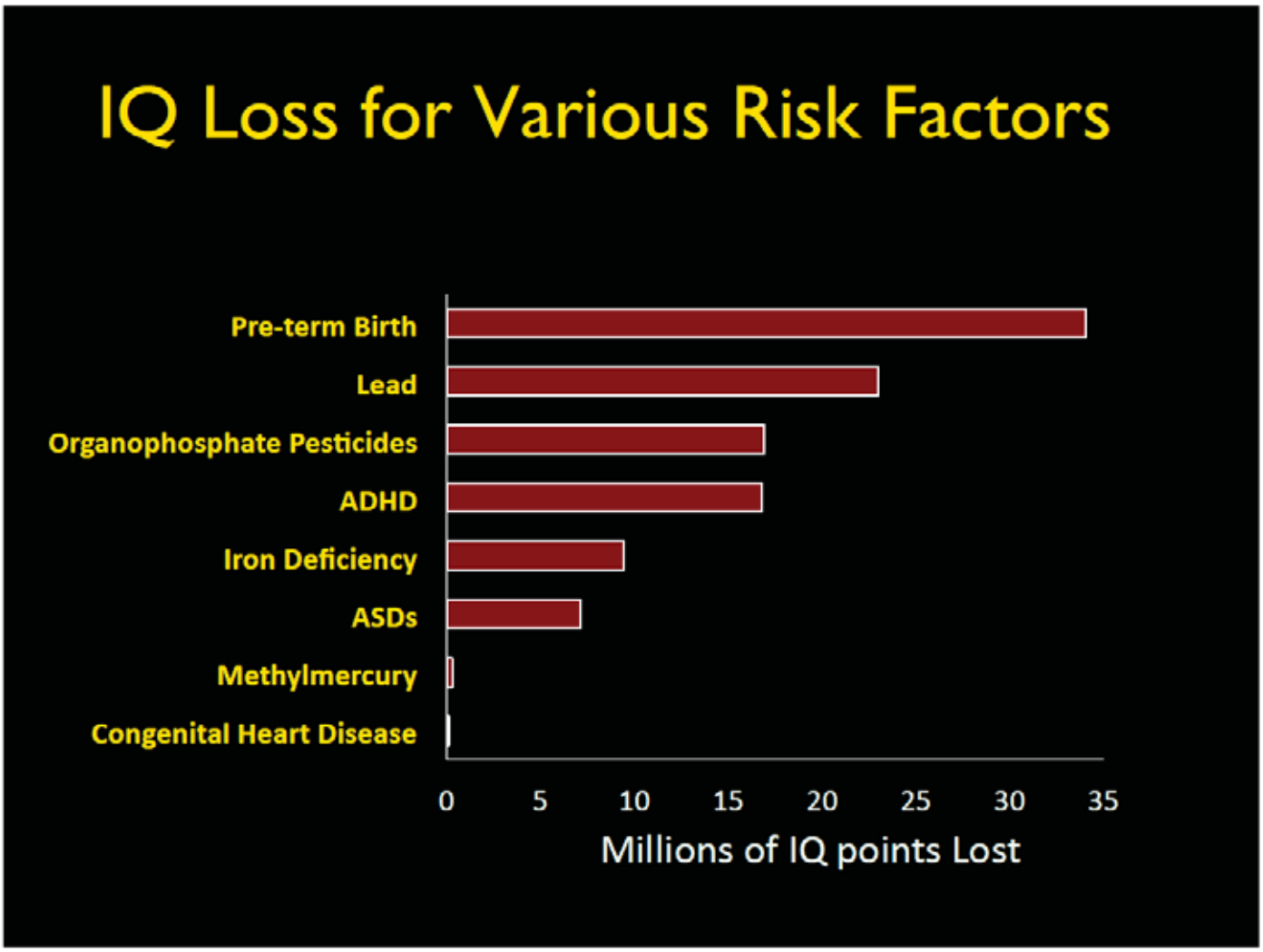
Cognitive and Social Impacts

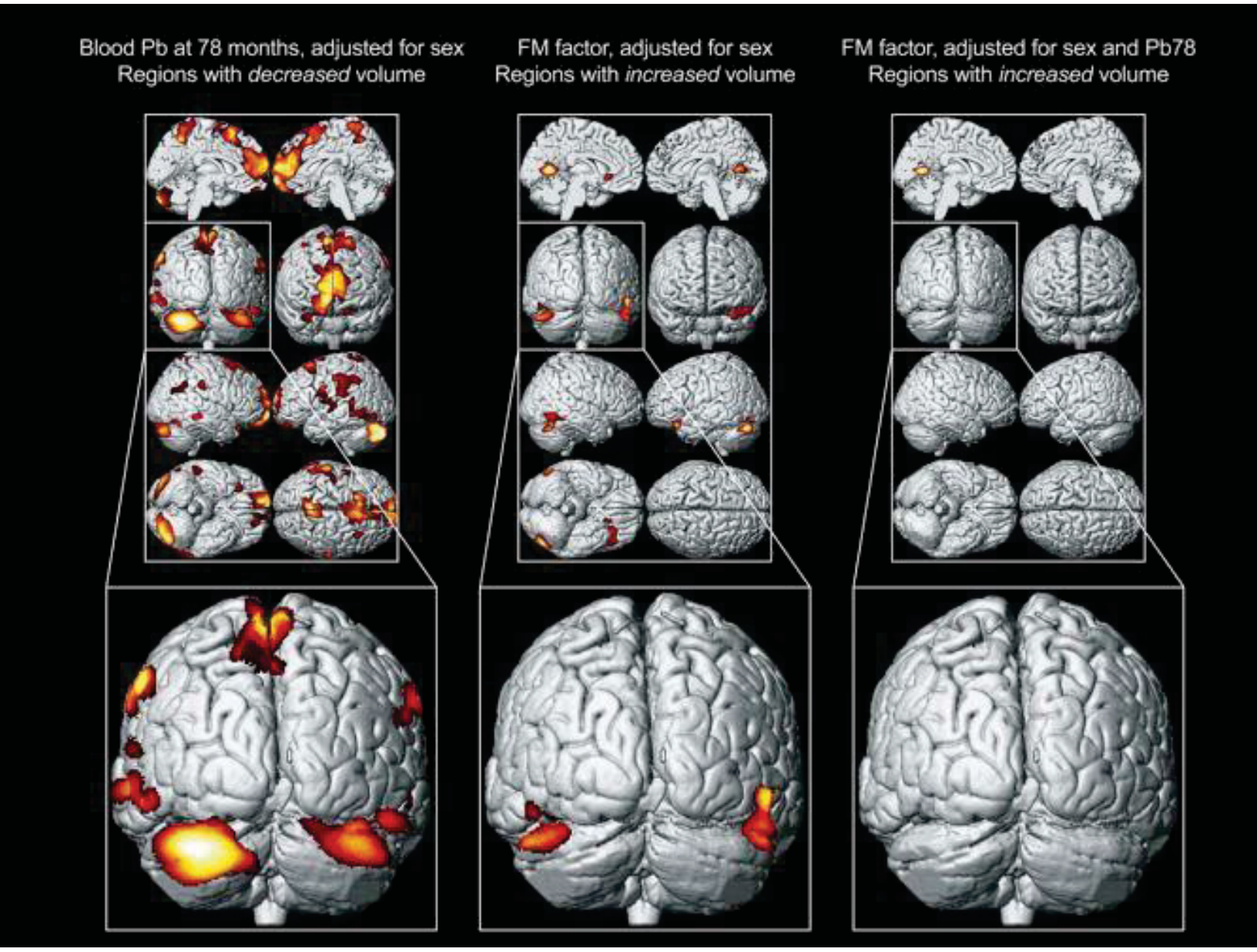
The Ongoing Search for a Threshold

Lead Toxicity and IQ Deficits

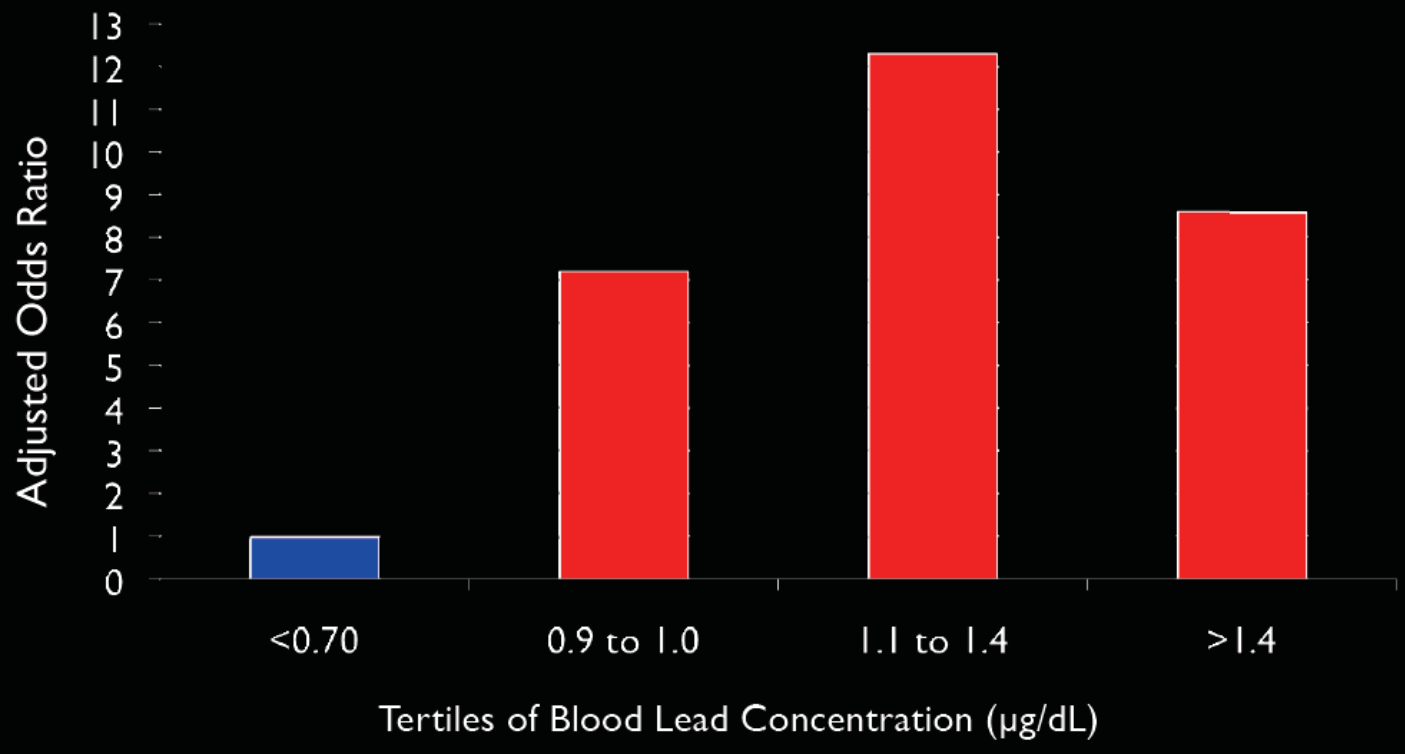


Lanphear BP, et al. EHP 2005;113:894-899.


IQ Loss for Various Risk Factors
Pre-term Birth
Lead
Organophosphate Pesticides
ADHD
Iron Deficiency
ASDs
Methylmercury
Congenital Heart Disease
0
5
10
15
20
25
30
35
Millions of IQ points Lost


Blood Pb at 78 months, adjusted for sex
Regions with *decreased* volume
FM factor, adjusted for sex
Regions with *increased* volume
FM factor, adjusted for sex and Pb78
Regions with *increased* volume

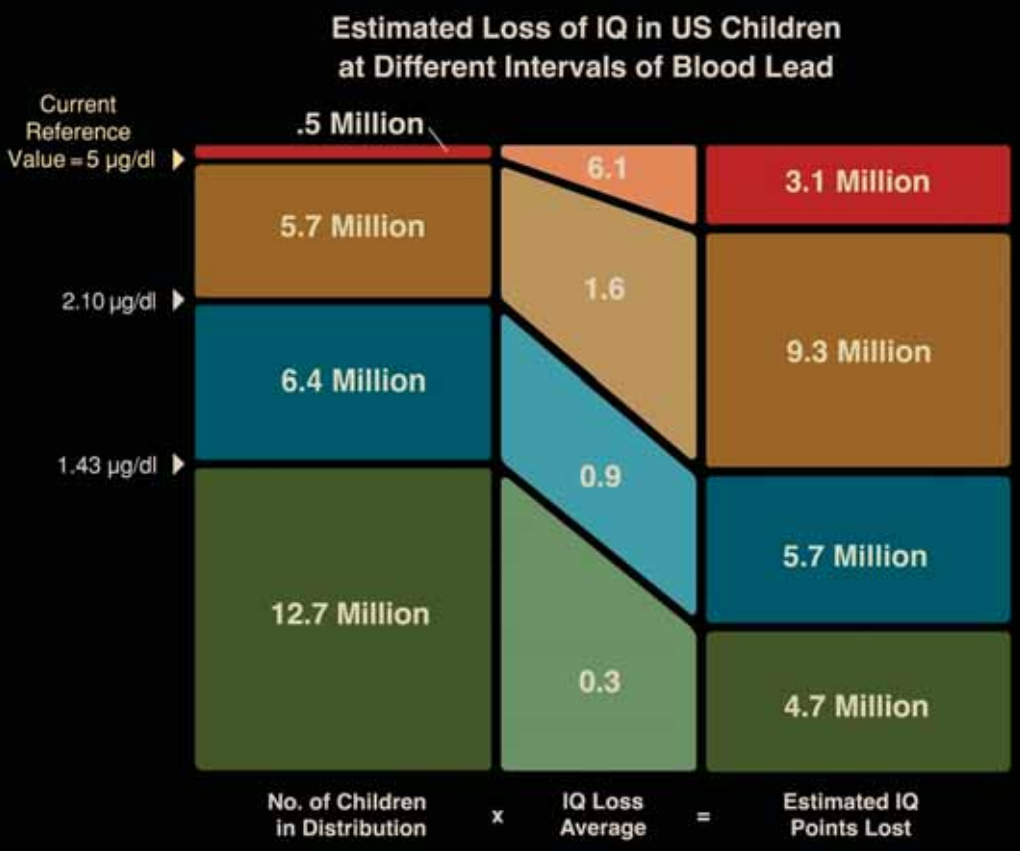
Risk of Conduct Disorder by Blood Lead Concentration in US Children, 8 to 15 years, NHANES 2001-2004



Braun J, et al. Environ Health Perspect 2008;116:956-62.

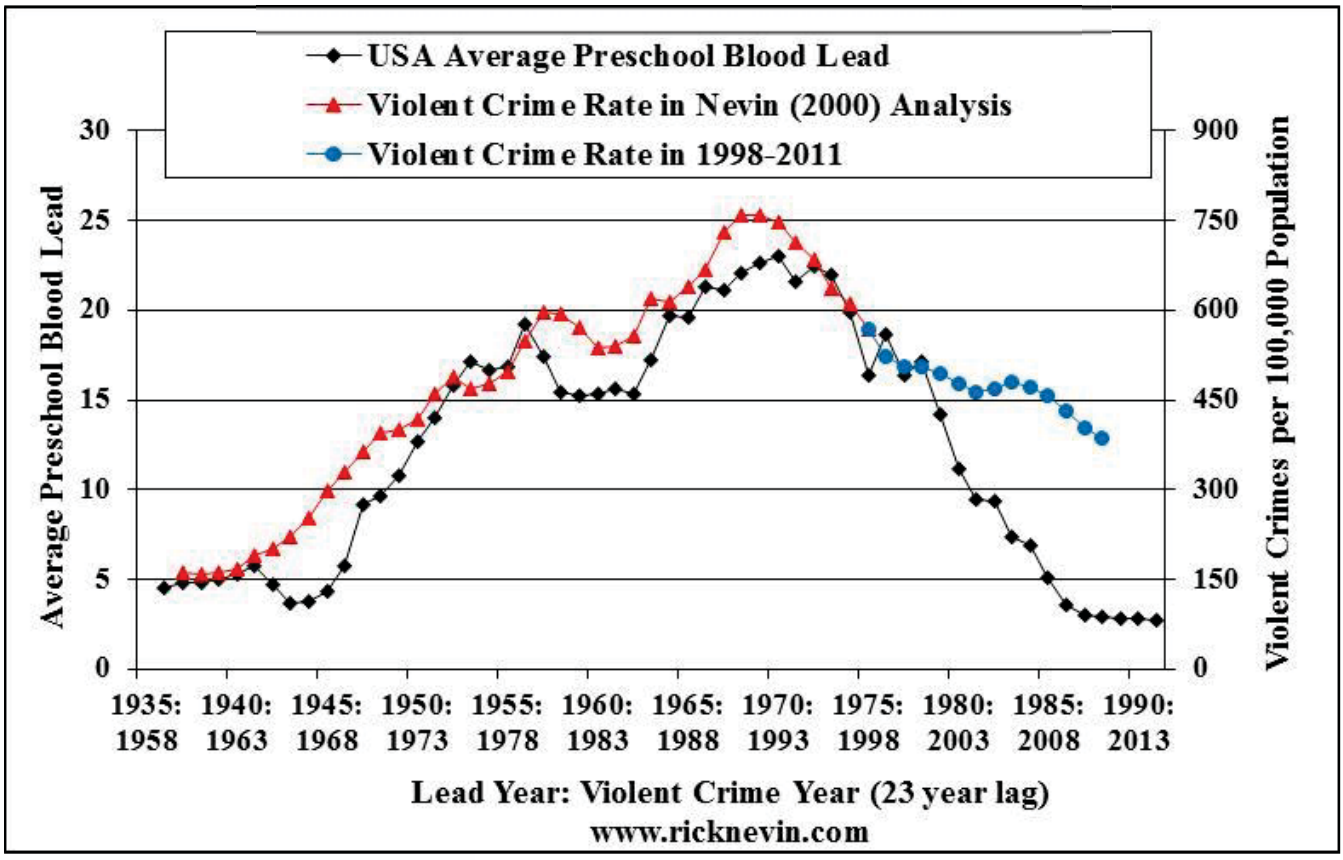
The Prevention Paradox

The majority of IQ points lost due to lead exposure occur in children who have low to moderate blood lead levels.



Using the current reference value of 5 g/dl we will only protect 3.1 million IQ points (about 18% of the total). Adapted from Bellinger D. EHP 2011;120:501-507.

Lead and Crime



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Cost of Lead Poisoning – USA

- What Does Lead Poisoning Cost?

Total Cost (Billions of Dollars)				
Cognitive	IQ & Earnings	Special Education	ADHD	Total
	$28.1	$1.04	$0.17	$29.3
Behavioral	Crime	Juvenile Delinq.	Teen Pregnancy	
	$46.0	$1.43	$4.94	$52.4
Health	Adult Health			
	$126.9			$126.9
			Total:	$209

Source: Wolpaw Reyes, J. (2014, May 7). The Costs and Benefits of Preventing Lead Exposure: Putting Economics into the Picture [Webinar]. NIH.
http://www.niehs.nih.gov/research/supported/dert/programs/peph/webinars/lead_exposure/index.cfm

Washington State Department of Health

Putting 200 Billion into Perspective

- Market Capitalization of Pfizer, Verizon, or Toyota
- GDP of the Czech Republic, Iraq, or New Zealand
- The EPA's budget for 20+ years
- About $600 for every person in America

Cost of Lead Poisoning – WA

Annual income lost in Washington from BLLs > 2ug/dl estimated to be between: **$675 Million to $2.3 Billion.**

Estimated cost per house for:

- Average cost for interior & exterior assessment -- $636
- Interim controls -- $12,000
- Full abatement -- $19,000

Estimated cost to fully abate lead-based paint in all Washington homes:
$5.9 Billion.

2009 Washington State Lead Chemical Action Plan, Dept.s of Ecology & Health

The Affordable Care Act requires insurers (except those that are “grand-fathered”) to cover lead screening for young children and pregnant women without cost to the consumer.

Average cost for BLL screening with a follow-up test: $21.50.

Screening tools and the lead risk map

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CDC Risk Questionnaire*

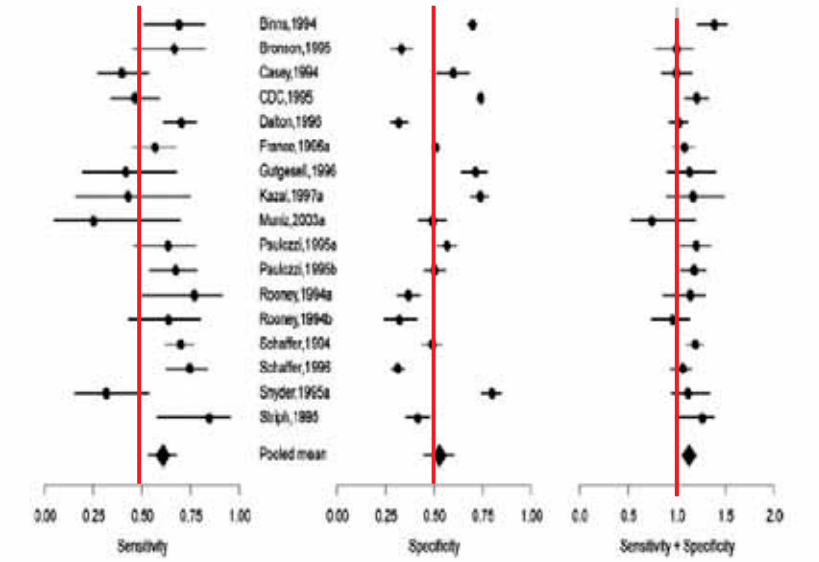
- Does your child live in or regularly visit a house that was built before 1950?
- Does your child live in or regularly visit a house built before 1978 with recent or ongoing renovations or remodeling (within the last 6 months)?
- Does your child have a sibling or playmate who has or did have lead poisoning?

*CDC: Screening Young Children for Lead Poisoning 1997: CH3 P.67

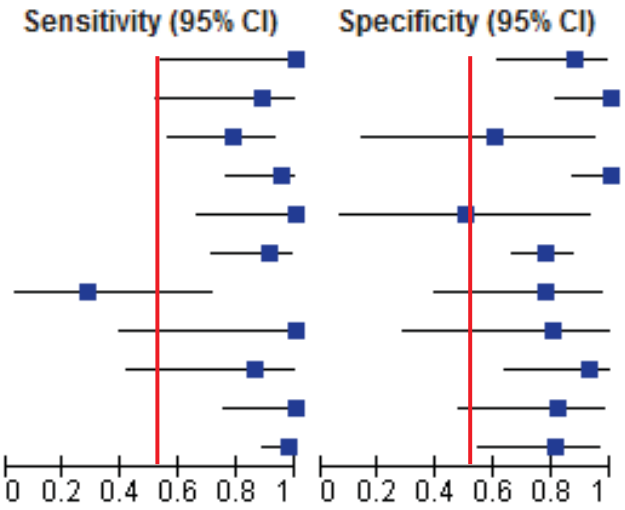
Washington State Department of Health

Sensitivity + Specificity – Does the CDC risk questionnaire work?

Lead Risk Questionnaire*



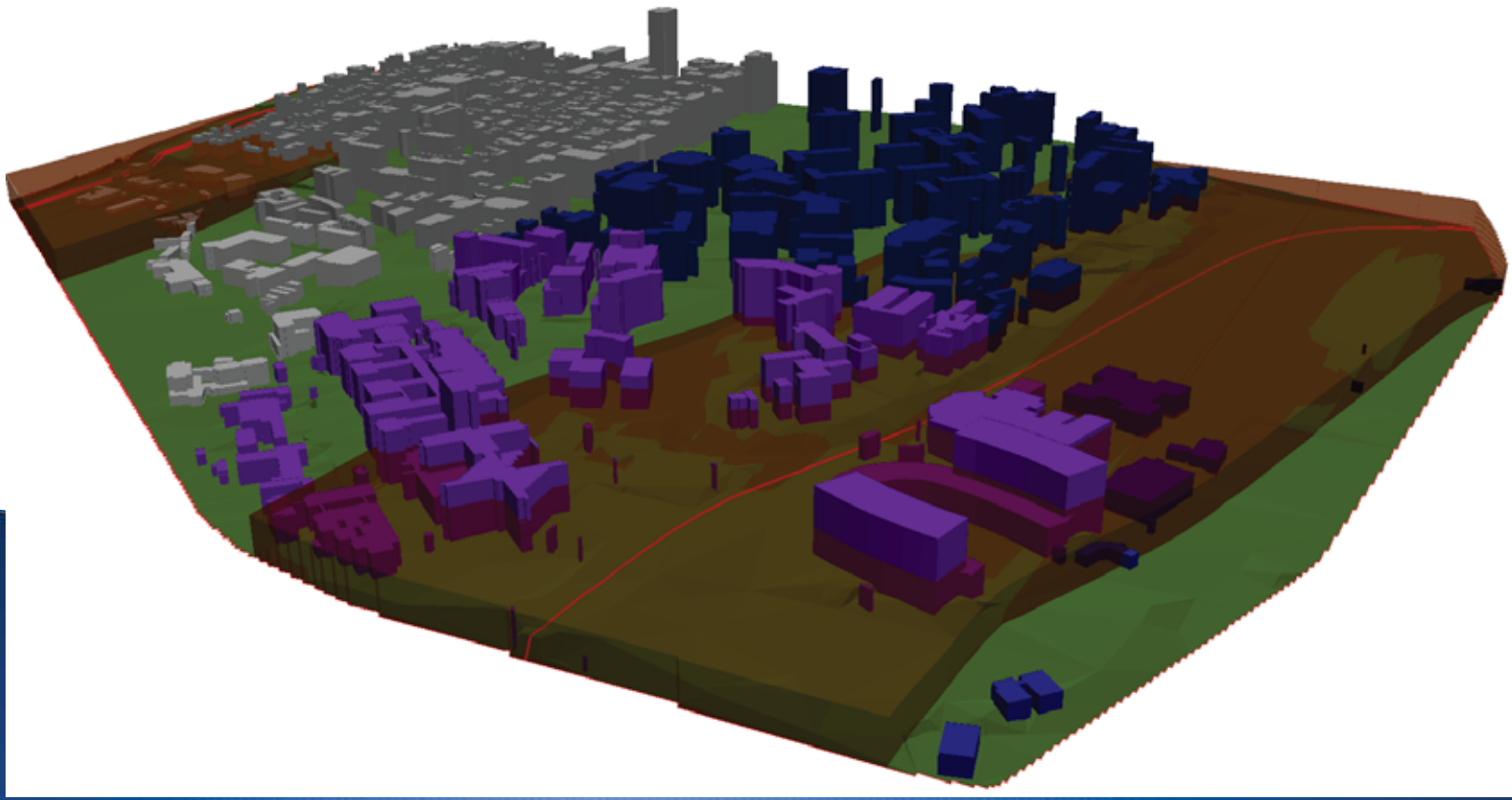
MRI for bone infection**



*EM Ossiander 2012. A Systematic Review of Screening Questionnaires for Childhood Lead Poisoning.

**Lee K, Gibson G. 2009. A Meta Analysis of FDG PET/CT versus MRI in Diagnosing Diabetic Foot Osteomyelitis

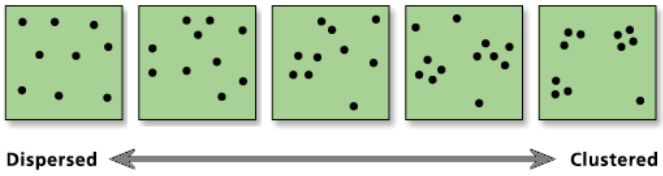
Creating a Risk Map



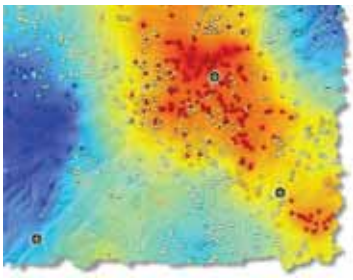
Spatial epidemiology: the "Where"

- The analysis of the spatial/geographical distribution of the incidence of disease
- Objectives:
  - Description of spatial patterns

  - Identification of disease clusters

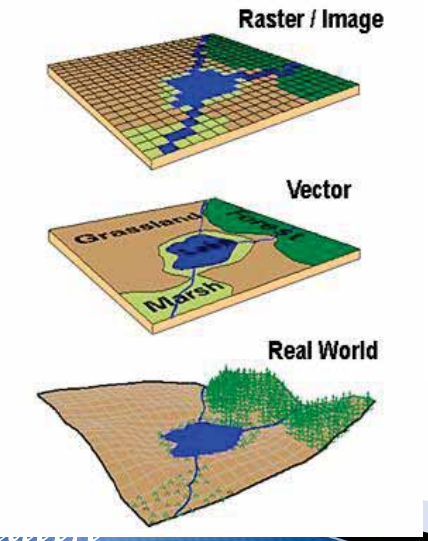


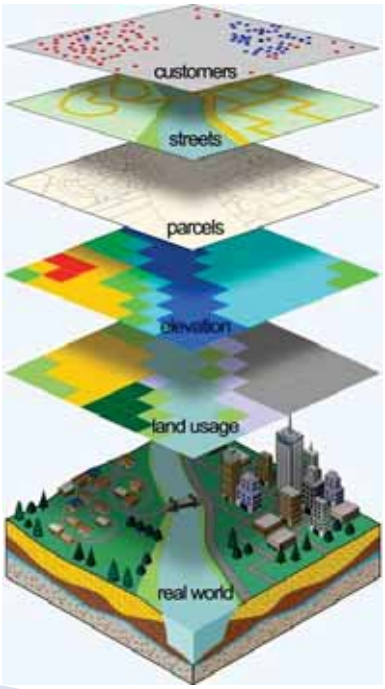
  - Explanation or prediction of disease risk



Geographic Information Systems (GIS)

- GIS lets us visualize, question, analyze, interpret, and understand data to reveal relationships, patterns, and trends





How we chose the variables

- Literature
  - Mostly focuses on 10 mcg/dL and up
- Previous analyses
  - Some not published, incomplete documentation
- Analysis of combined dataset
  - Non-random sample
  - Incomplete matching
  - Missing addresses
  - Generalized risk factors

Washington State Department of Health

- Age of housing – Pre 1940
- Black race
- Low income
- Proximity to an airport
- Proximity to a major roadway

Literature

- Hispanic ethnicity
- Tacoma smelter

Previous analysis

- American Indian/Alaska Native race
- Previous elevated case

Current analysis

- Proximity to lead emitting industry
- Land use type

Assumption

Washington State Department of Health

How we got the data

Washington State Health Care Authority +

United States Census Bureau +

DEPARTMENT OF ECOLOGY State of Washington +

FEDERAL AVIATION ADMINISTRATION +

WSDOT +

AMERICAN COMMUNITY SURVEY U.S. CENSUS BUREAU =

Washington State Department of Health +

USGS science for a changing world

Dataset used for analysis

Model formulation

- Simplest way is to <u>average</u> all values

  HSI = [(SV1 + SV2 + SV3+SV4)/4]

- <u>Weights</u> can be incorporated to give some criteria priority over others

  HSI = [(2SV1 + SV2 + SV3 + SV4)/5]

- <u>Multiplication</u> can be used to have a reduction effect
  - 0 * anything = 0; 50% * anything reduces the value by half
    - Gives some variables greater control over final value

      HSI = SV1 x [(SV2 + SV3 + SV4)/3]

Risk variable weights

Variable	Weight
Pre-1940 housing	35%
Census blocks with elevated cases	15%
Income	10%
Hispanic	10%
Black	5%
American Indian	5%
High traffic roadway proximity	5%
Airport proximity	5%
Toxic release site proximity	5%
Historic Tacoma smelter proximity	5%
Total	**100%**

Land use variable weights

Land Cover Type	Weighted value
Medium intensity residential	1.0
Low intensity residential	0.61
Developed open space	0.11
High intensity residential	0.11
Evergreen forest	0.02
Cultivated crops	0.02
Pasture	0.02
All other land cover	0.01

Final Model

- RI = RV1 x [RV2 + RV3 + RV4 + RV5 + RV6 + RV7 + RV8 + RV9 + RV10 + RV11]

- Risk Index = Land Use Weight x [Housing + Previous Elevated + Income + Hispanic + Black + American Indian + Roadways + Airport + Toxic Release Site + Tacoma Smelter Plume]

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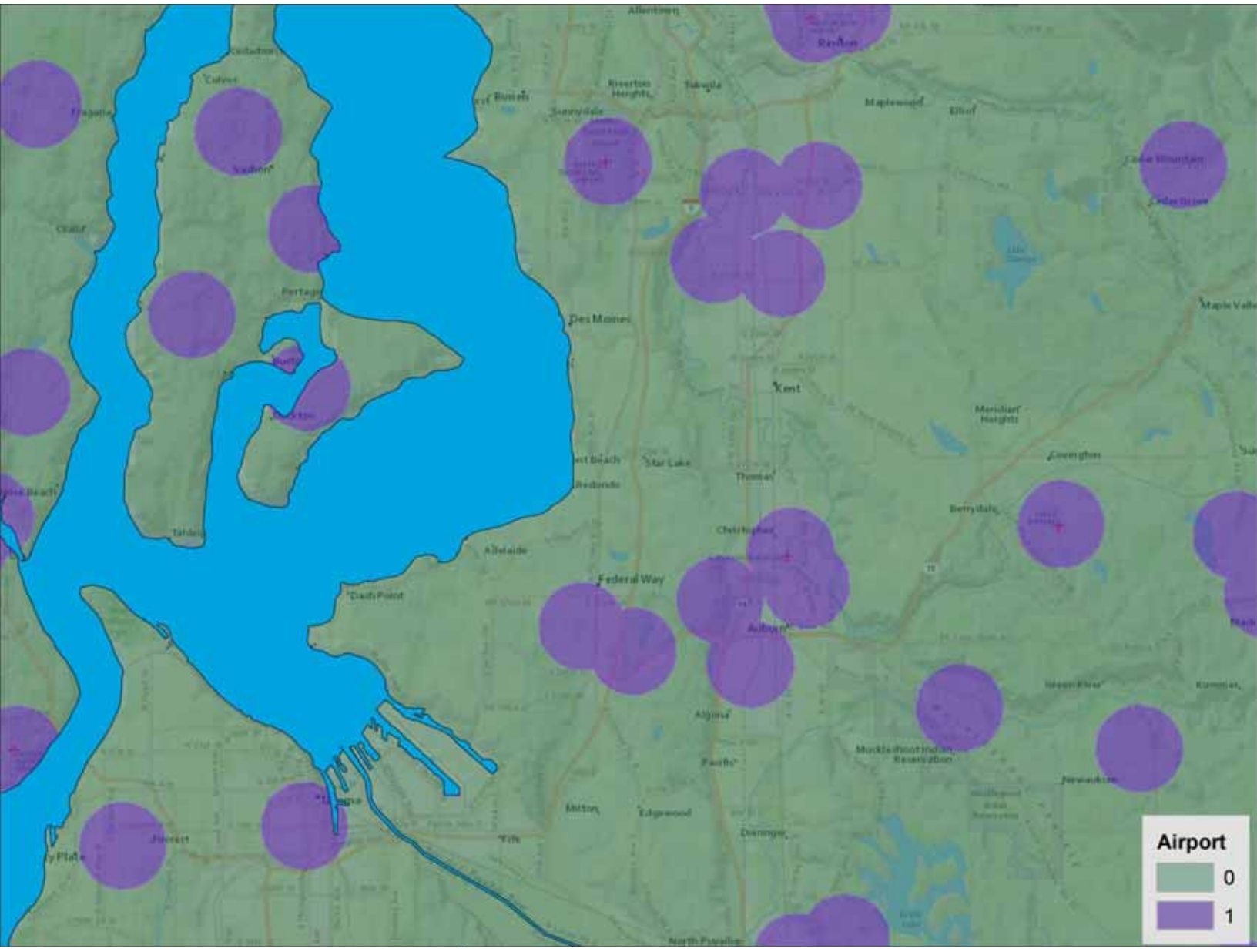
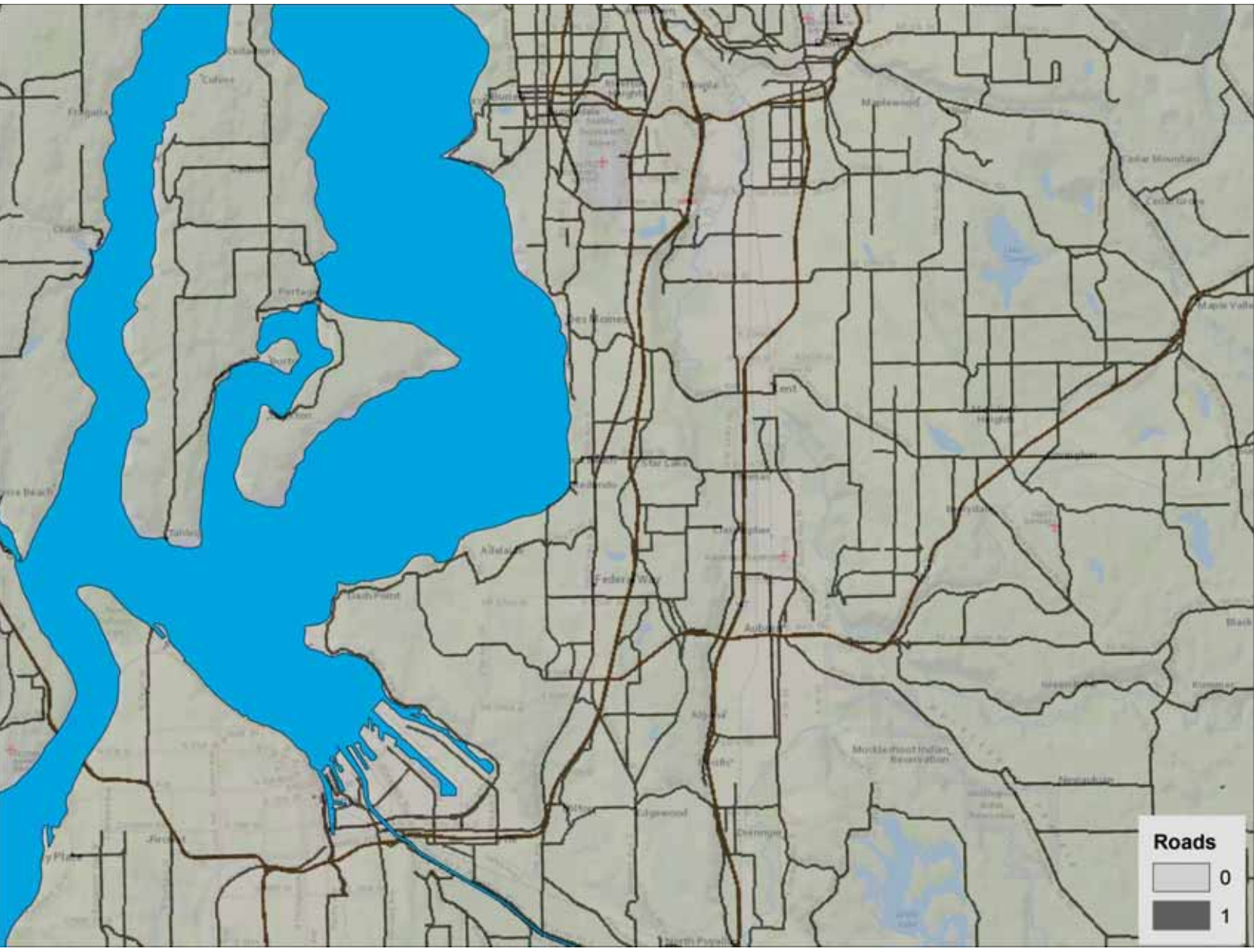
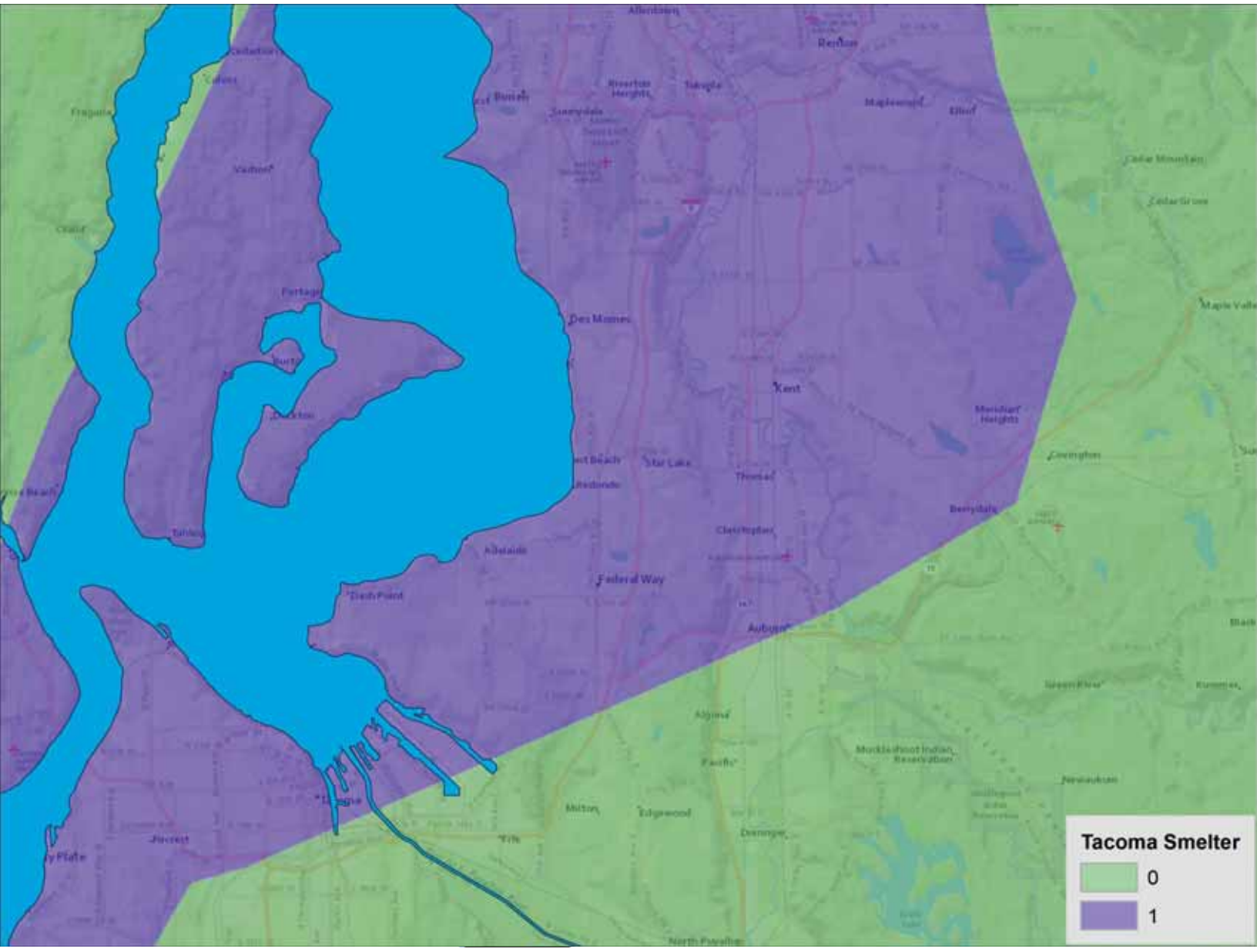
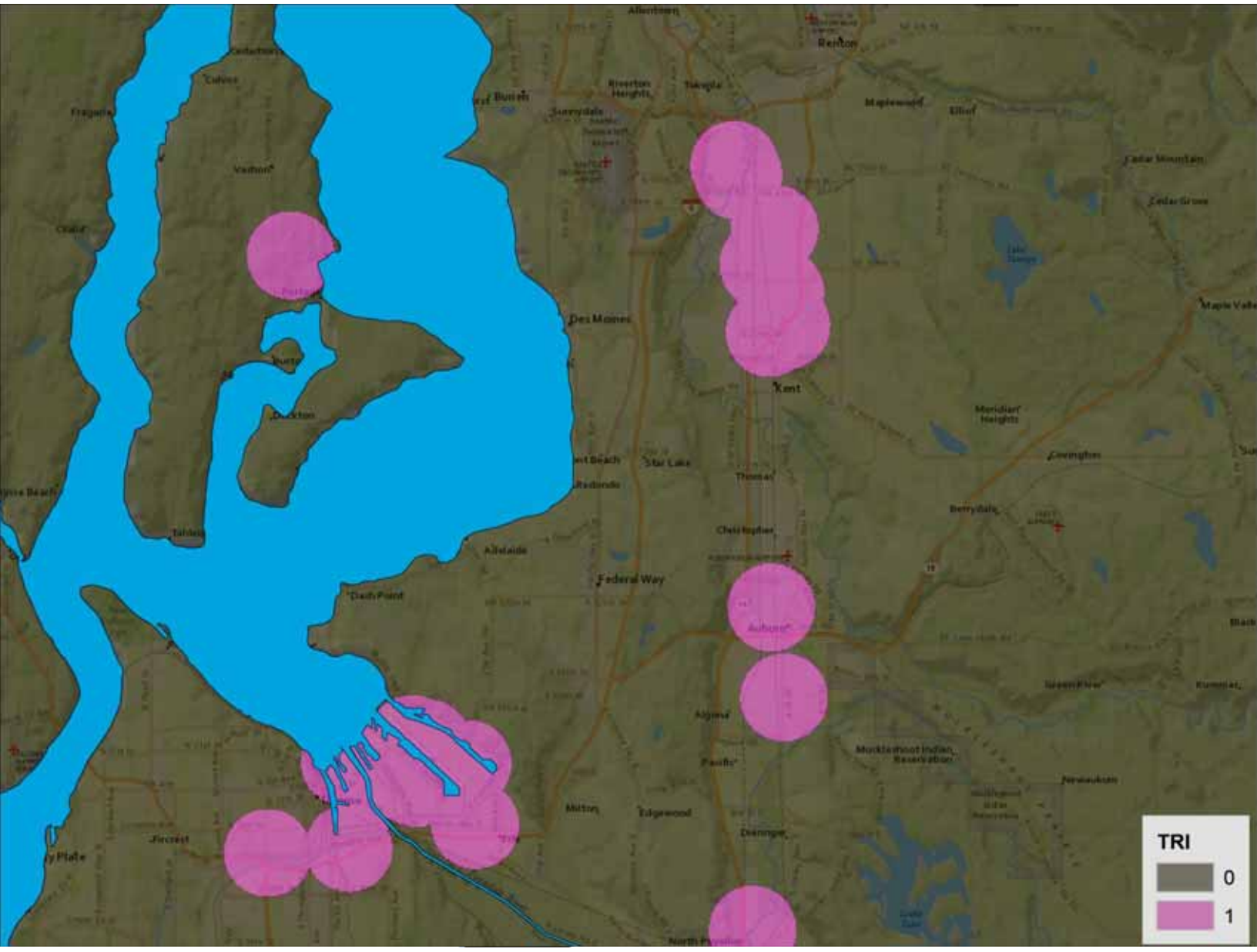
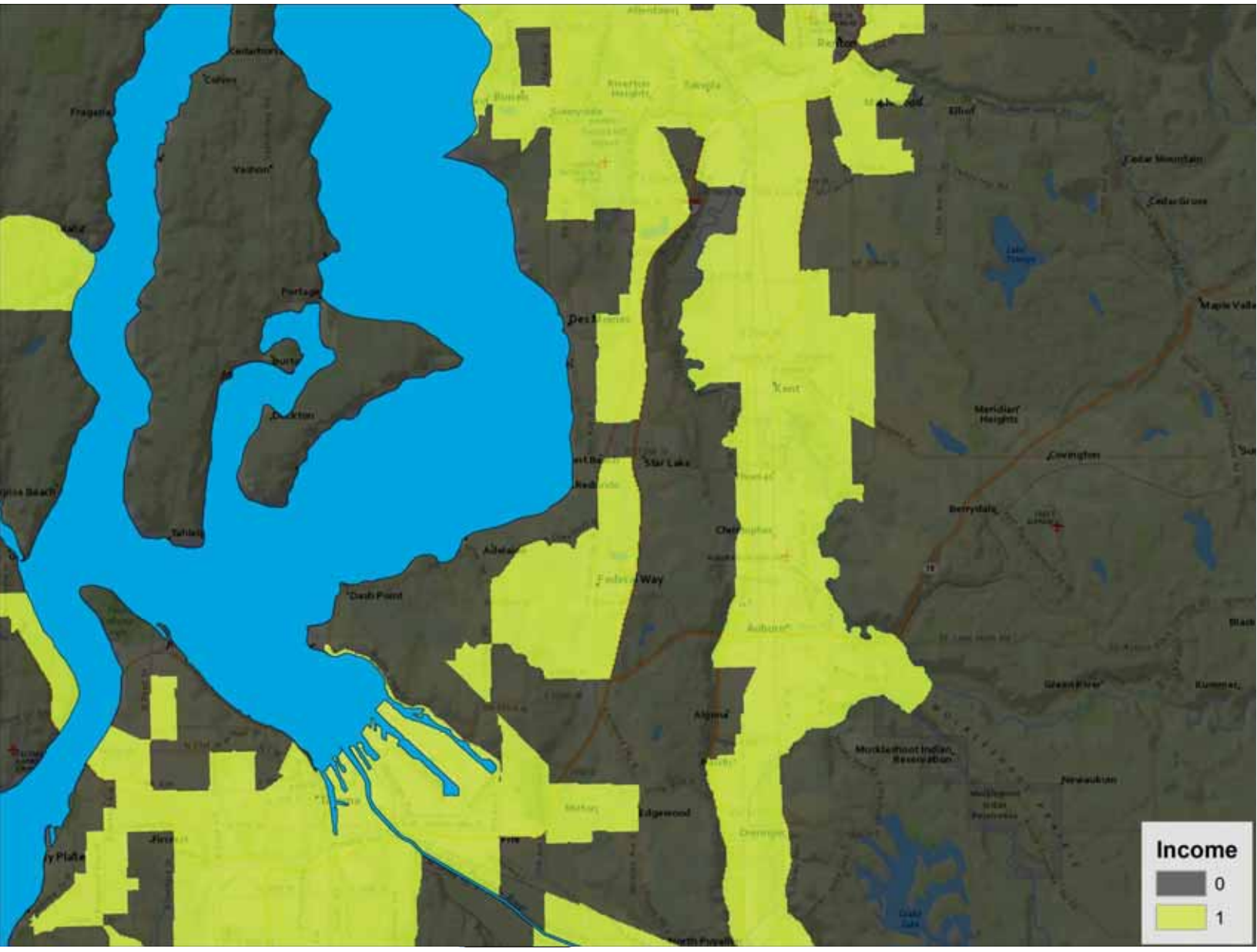
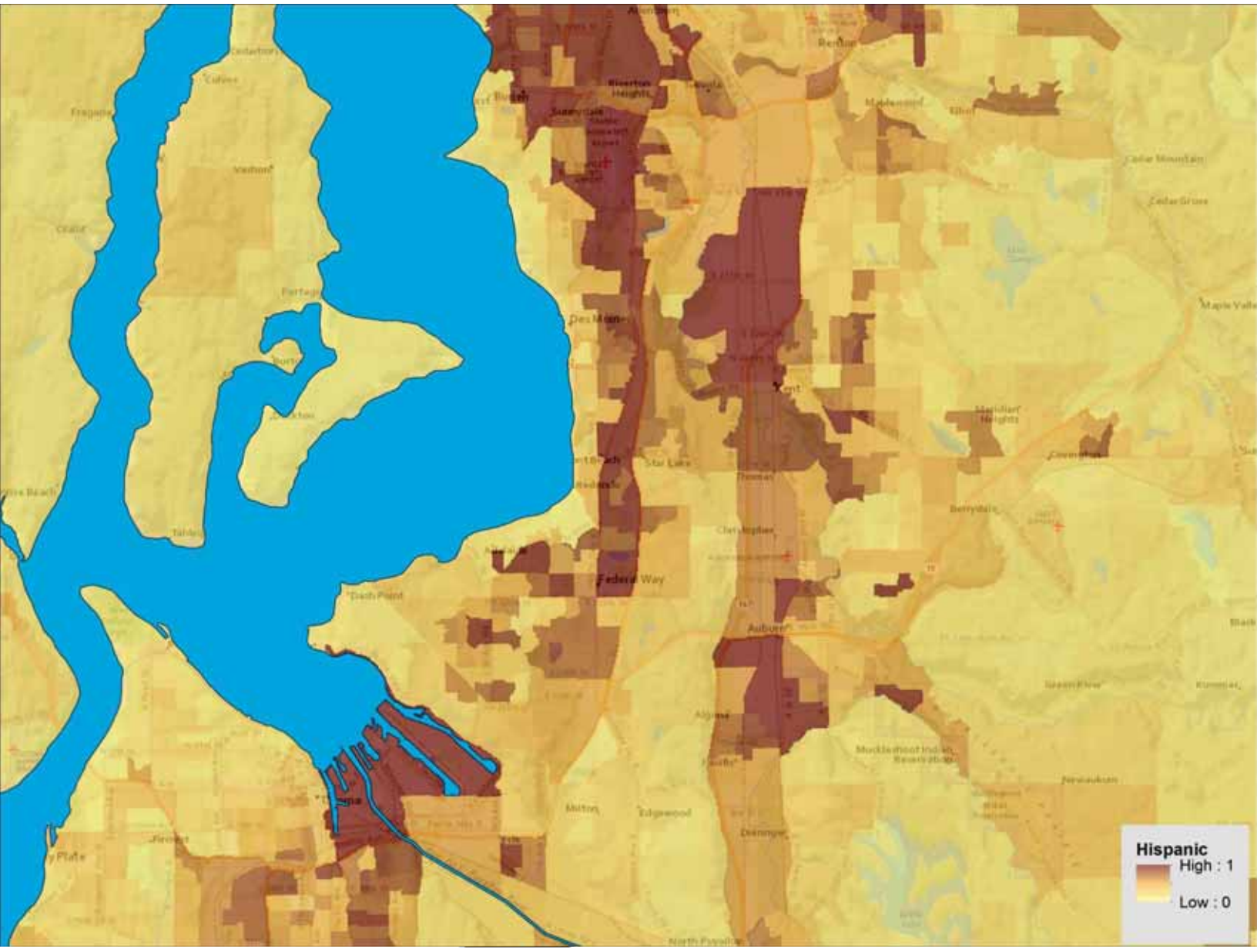

Airport
0
1

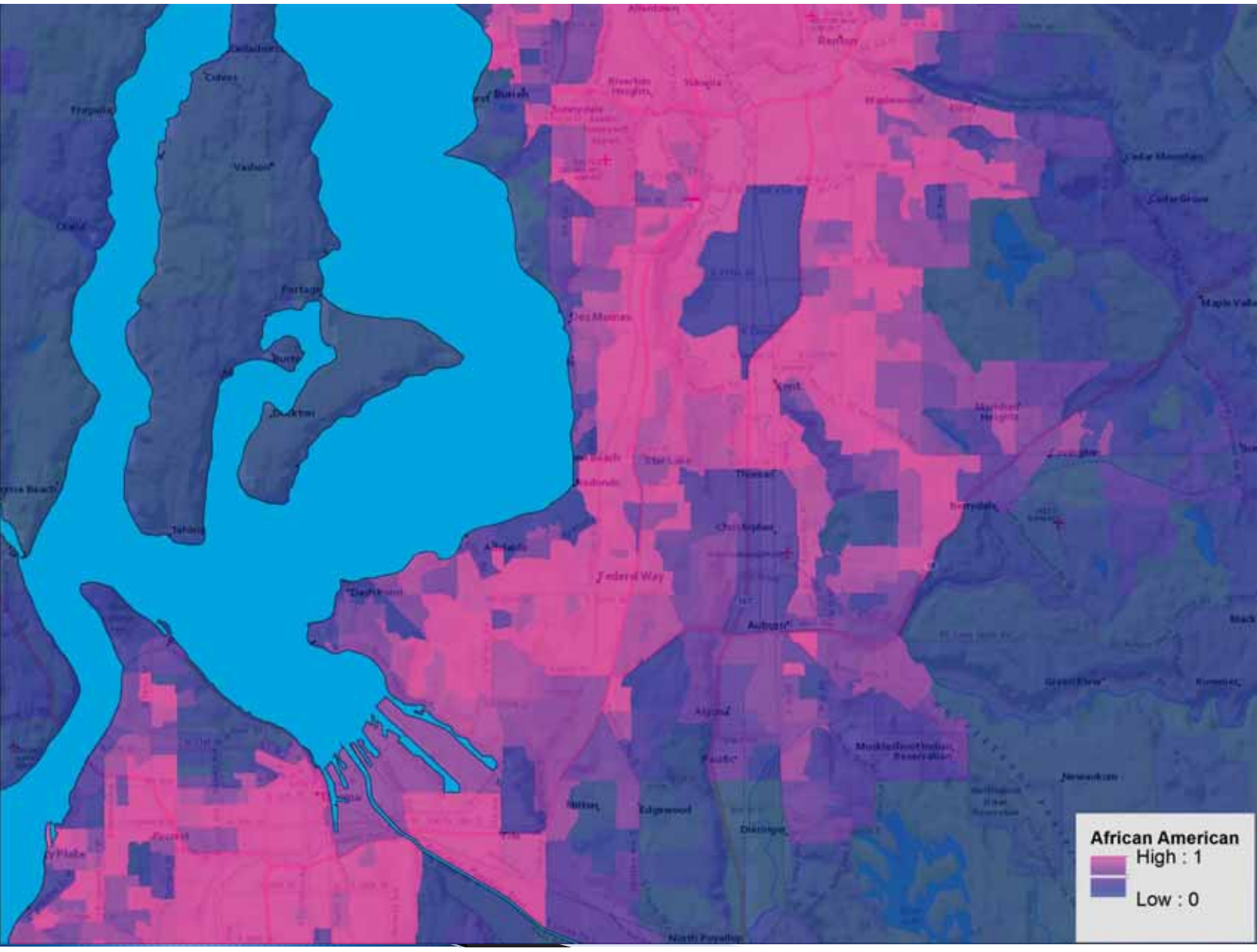

Roads
0
1

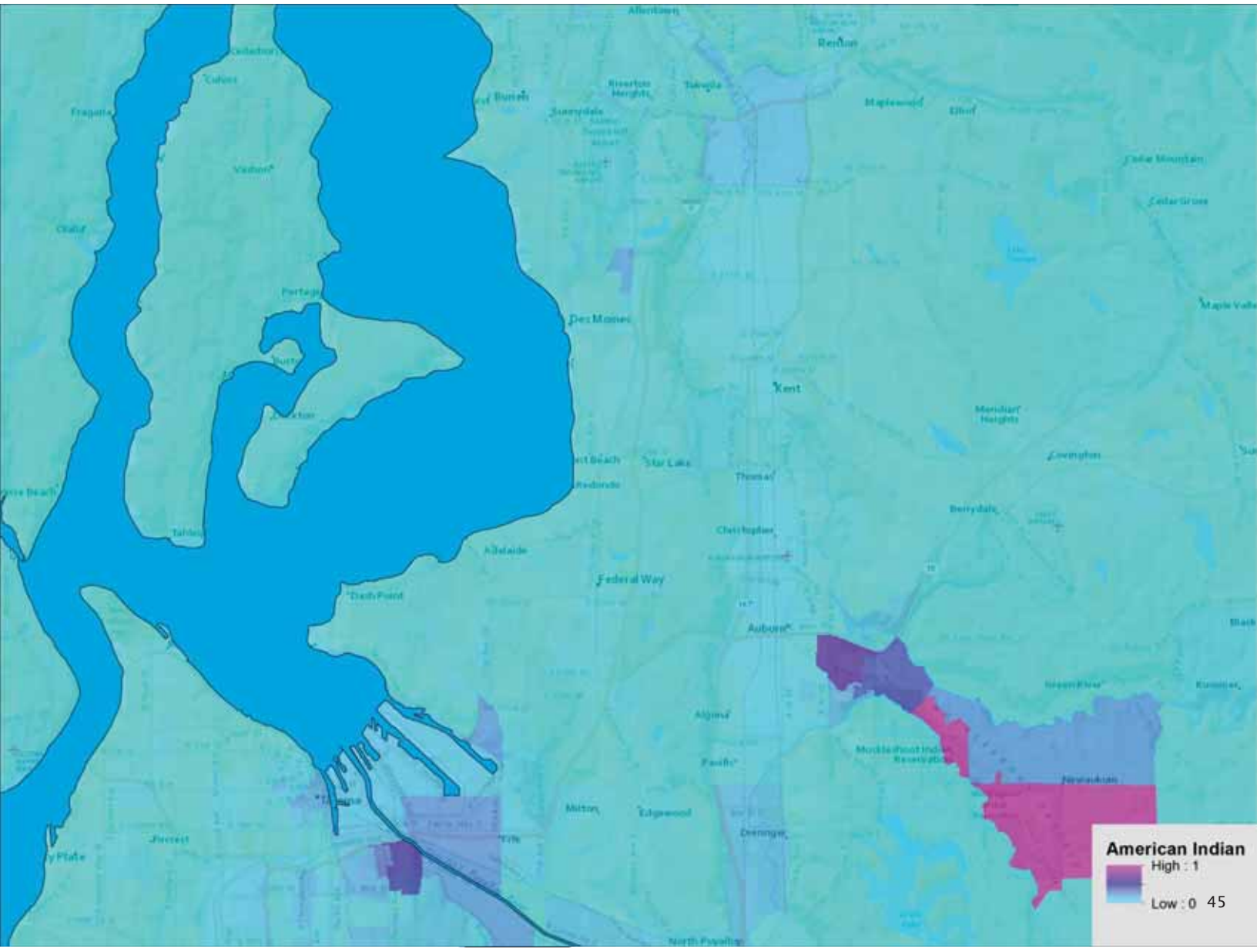

Tacoma Smelter
0
1


Renton
Kent
Federal Way
Des Moines
Auburn
Algona
Pacific
Milton
Edgewood
Dieringer
Muckleshoot Indian Reservation
Maple Valley
Black Diamond
Enumclaw
TRI
0
1


Income
0
1


Hispanic
High : 1
Low : 0

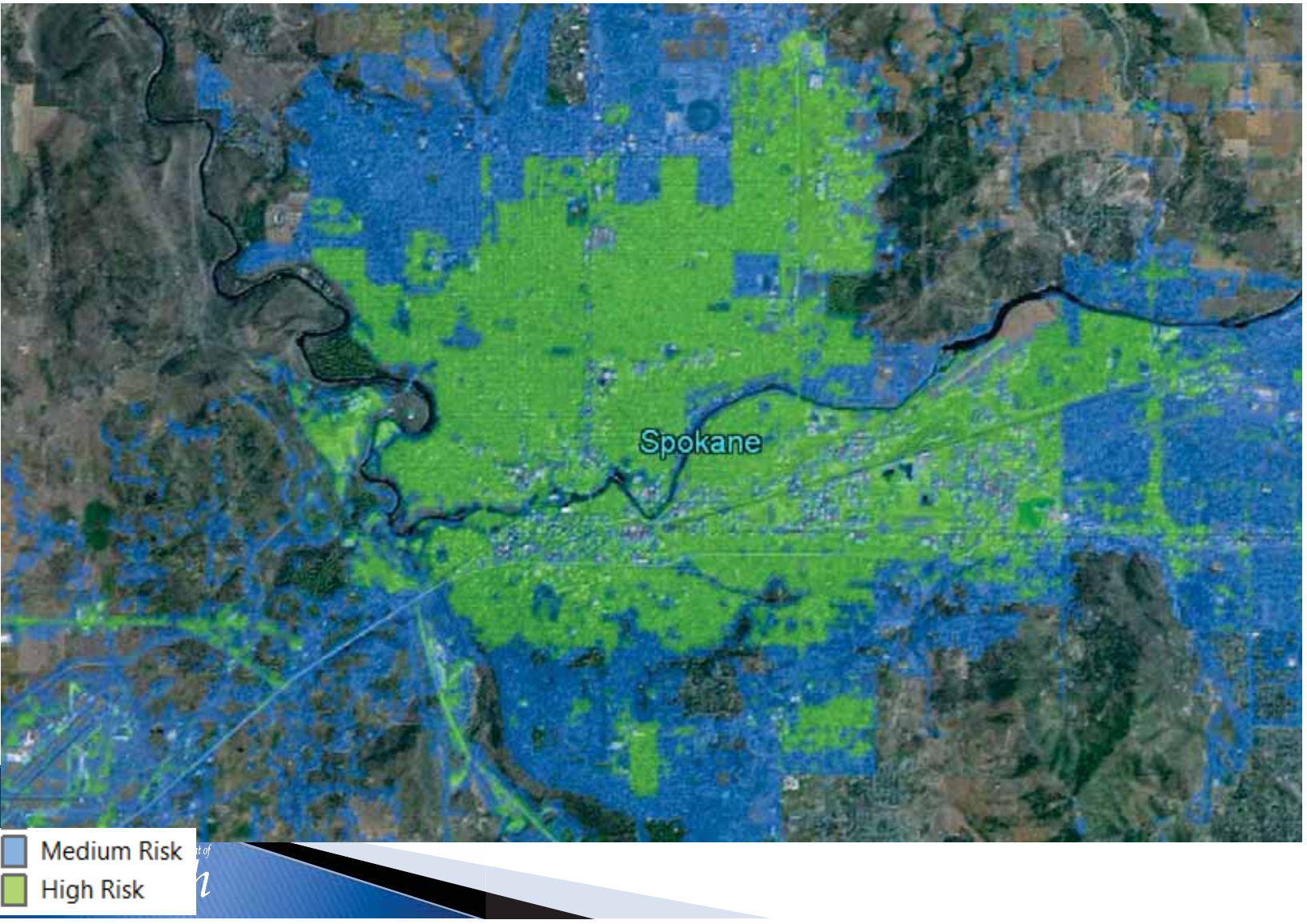

African American
High : 1
Low : 0

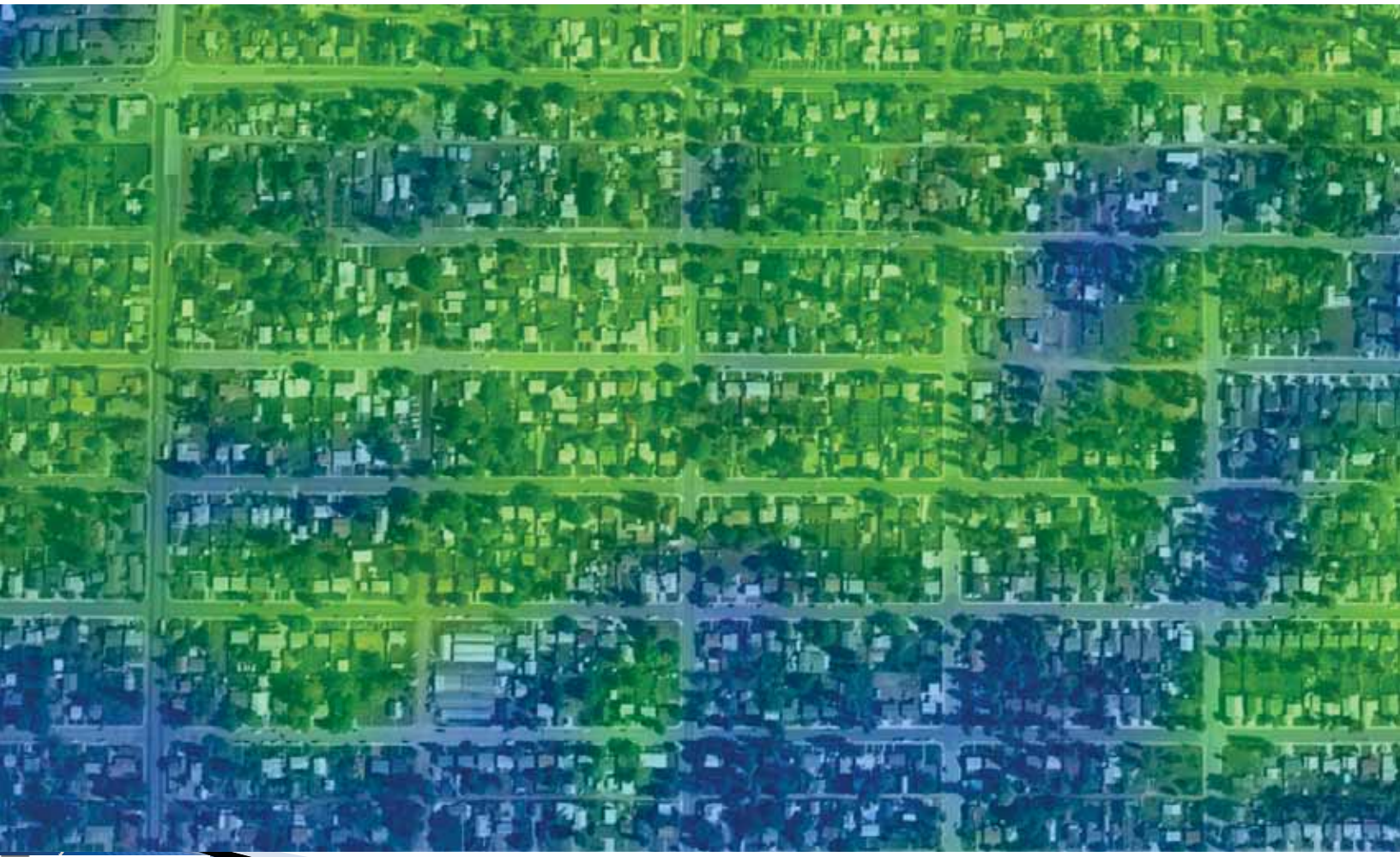

American Indian
High : 1
Low : 0


Pre-1940
High : 1
Low : 0

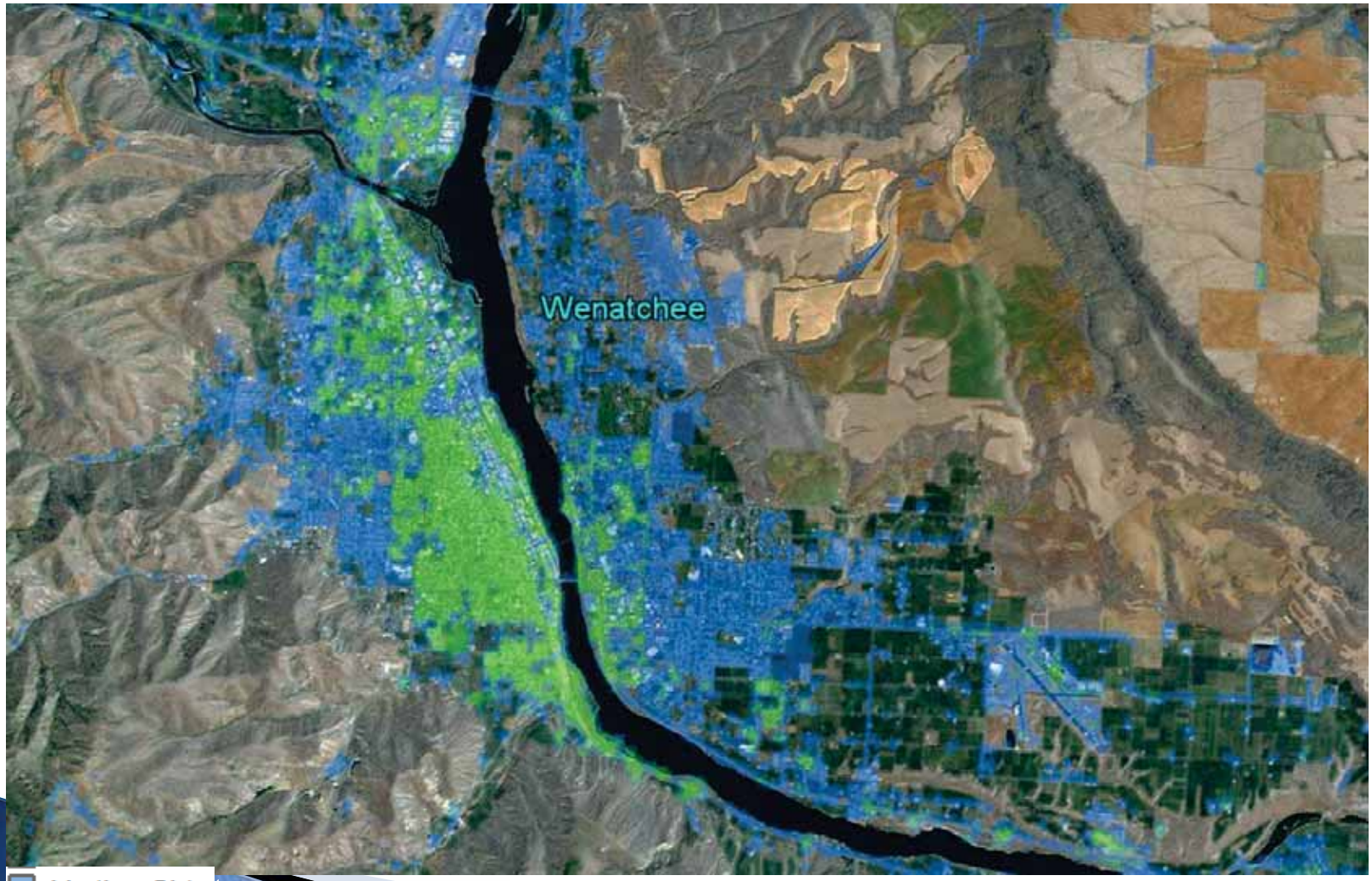

Land Class
High : 1
Low : 0


Risk Map
High Risk
Medium Risk
Low Risk
Renton
Maplewood
Cedar Mountain
Cedar Grove
Colvos
Fragaria
Vashon
Olalla
Portage
Dockton
Des Moines
Kent
Meridian Heights
Covington
Star Lake
Redondo
Berrydale
Christopher
Federal Way
Dash Point
Auburn
Green River
Kummer
Algona
Muckleshoot Indian Reservation
Newaukum
Pacific
Milton
Edgewood
North Puyallup


Spokane
Medium Risk
High Risk



Medium Risk
High Risk


Wenatchee
Medium Risk
High Risk

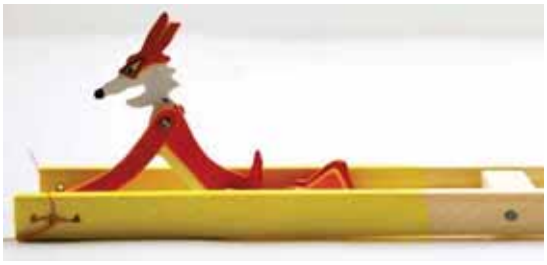

Medium Risk
High Risk

Risks we can't map

Azarcon

Greta

?



Hashmi Surma Special

"Pure kohl from the waters of ZamZam"

Hashmi Kohl Aswad

Hashmi Kajal

Photo credits: www.CPSC.gov, www.nyc.gov

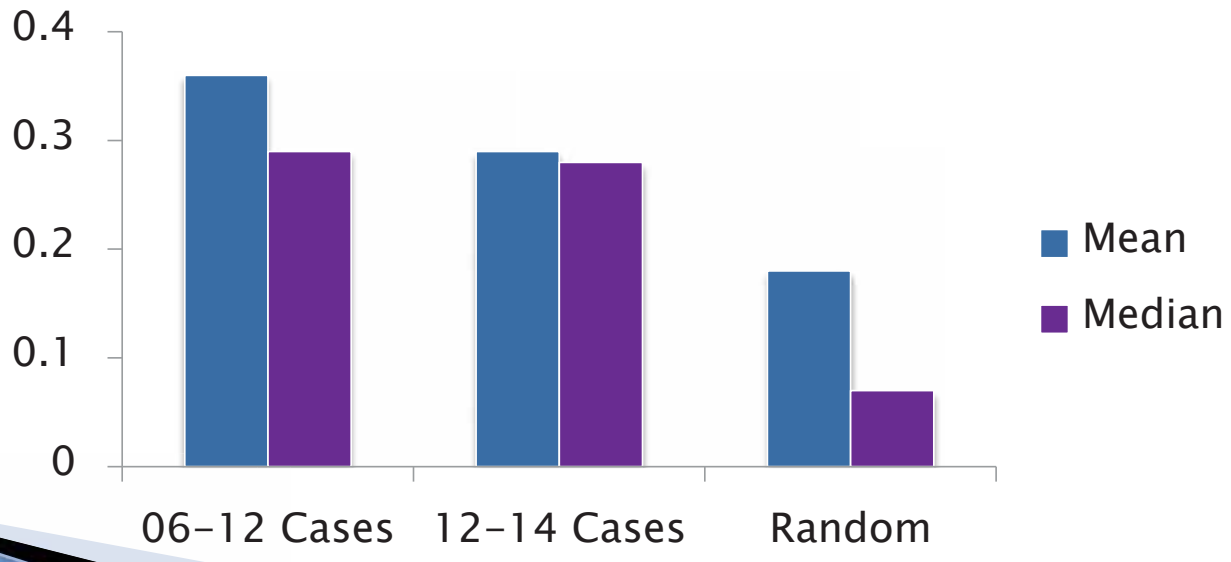
Limitations

- The predictive power of the map is only as good as the data and the data are:
  - non-random
  - Have missing addresses
  - Are generalized to block group and census tract levels
  - Overfit? – We have some 'noise' variables in there
  - Underfit? – We are missing some 'signal' variables

Validation

Sample	n	Min	Mean	Median	Max
2006-2012 Cases	1933	0	0.36	0.36	0.94
2013-2014 Cases	255	0	0.29	0.28	0.82
Random locations	19296	0	0.18	0.07	0.89

*Mann-Whitney P-Value <0.001



Washington State Department of Health

Next Steps

- Put it on the Washington Tracking Network
- Improve the map as we get more data – parcel data, improved screening data, more exposure data
- Do outreach to providers targeting those that are in both high-risk & low-screening rate neighborhoods

Thank You

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