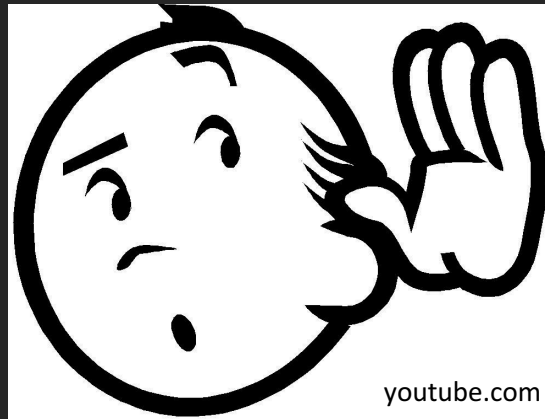


# RACIAL SEGREGATION, ENVIRONMENTAL INJUSTICE, AND NOISE POLLUTION IN THE U.S.



**November 6, 2017**

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UC Berkeley, School of Public Health  
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# To be discussed

- Racial segregation
- Environmental injustice
- Application: noise pollution

# Racial segregation

**def.** the distribution and separation of a specific demographic group across a geographic region, such as a metropolitan area; spatial form of **social inequality**

# Why segregation matters

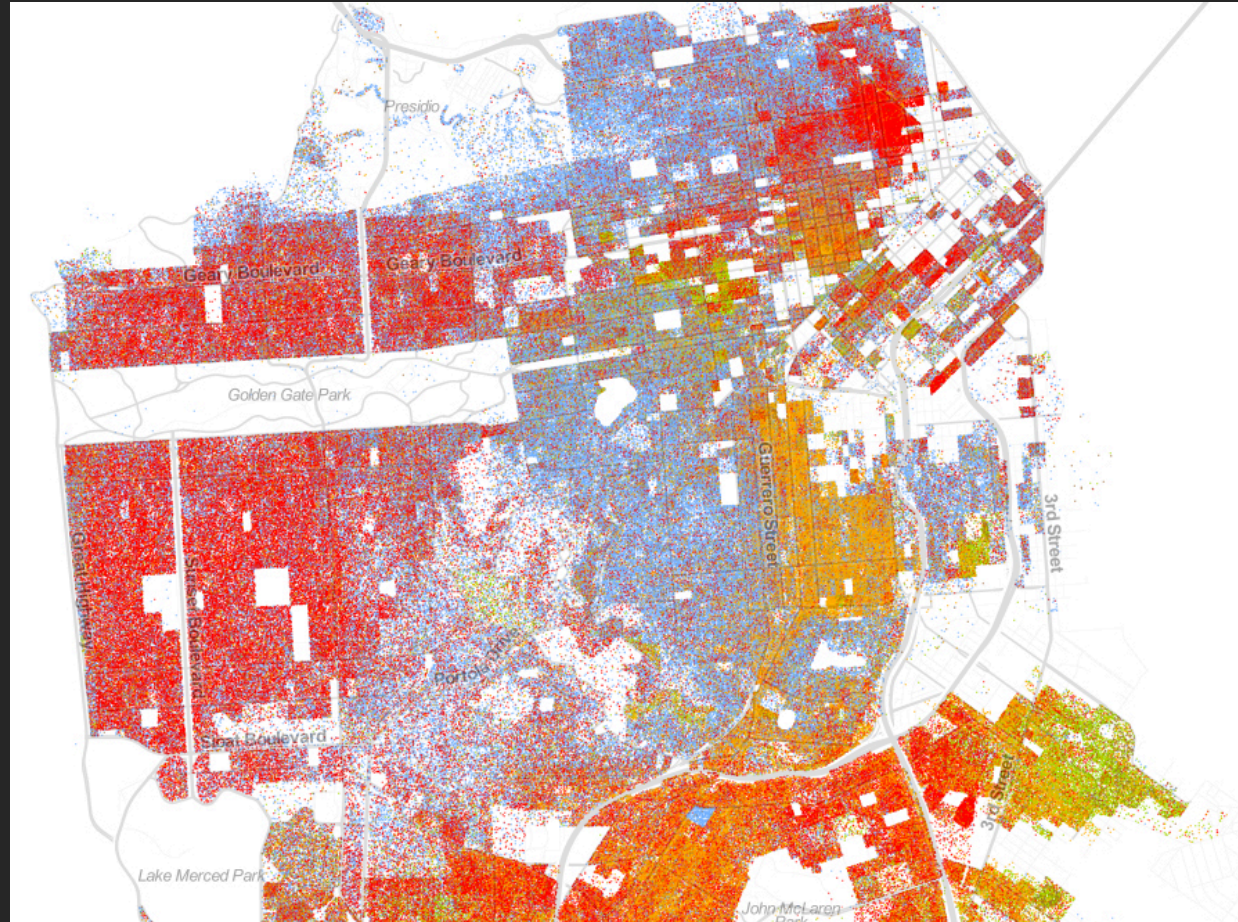
- Separates groups from opportunity, amenities, and resources to the detriment of social, political, and economic standing, and environmental health



# Racial segregation visualized

The city of San Francisco is

- 45% Non-Hispanic White
- 14% Hispanic
- 7% Black
- 31% Asian
- 3% Other



Dustin Cable at University of Virginia's Weldon Cooper Center for Public Service



# Racial segregation visualized

## Map Key

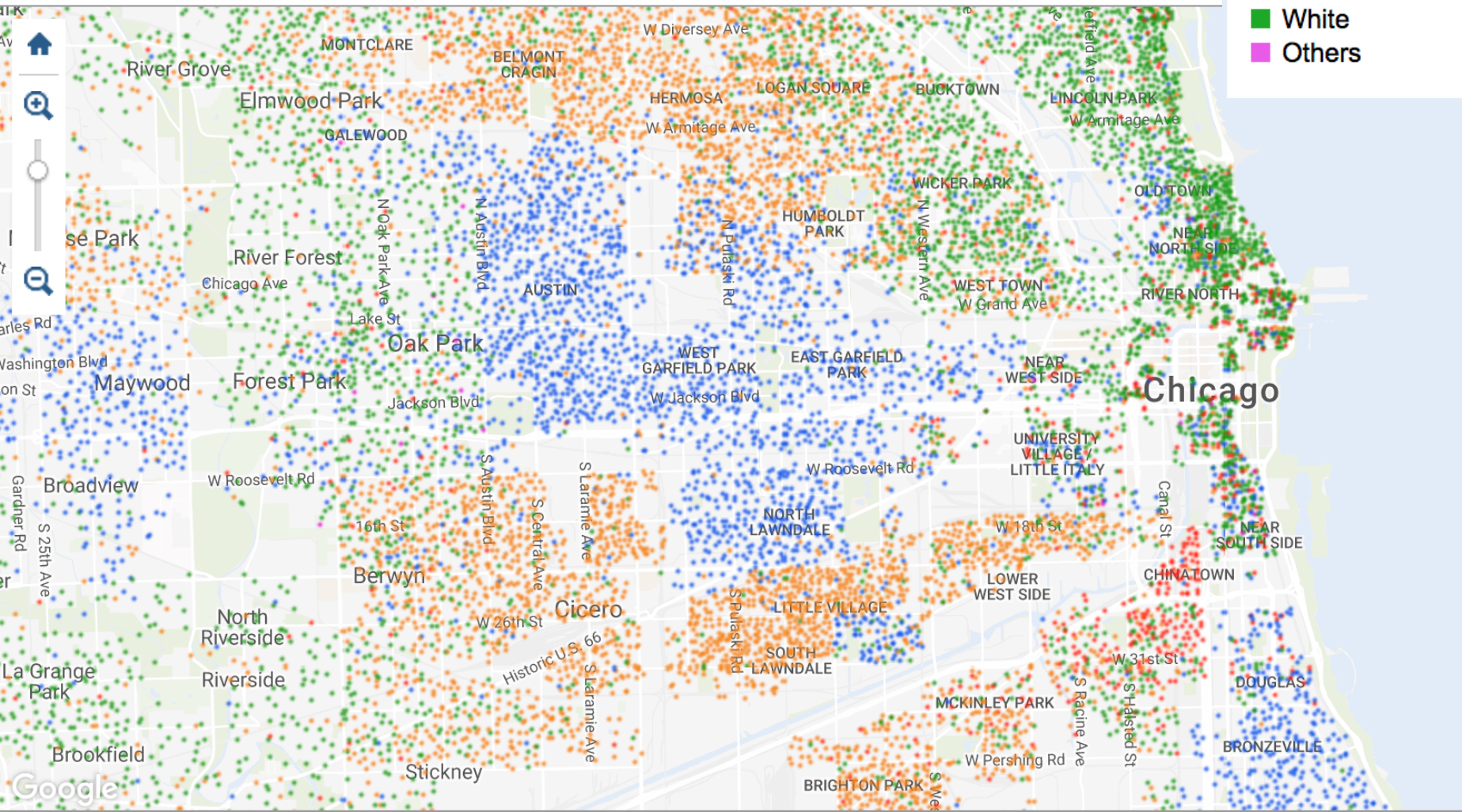
One dot = 120 people

### CENSUS GROUP

- Black
- Hispanic
- Asian
- White
- Others

## Mapping

New government rules will require all cities and towns rec





# Racial segregation visualized

## Map Key

One dot = 120 people

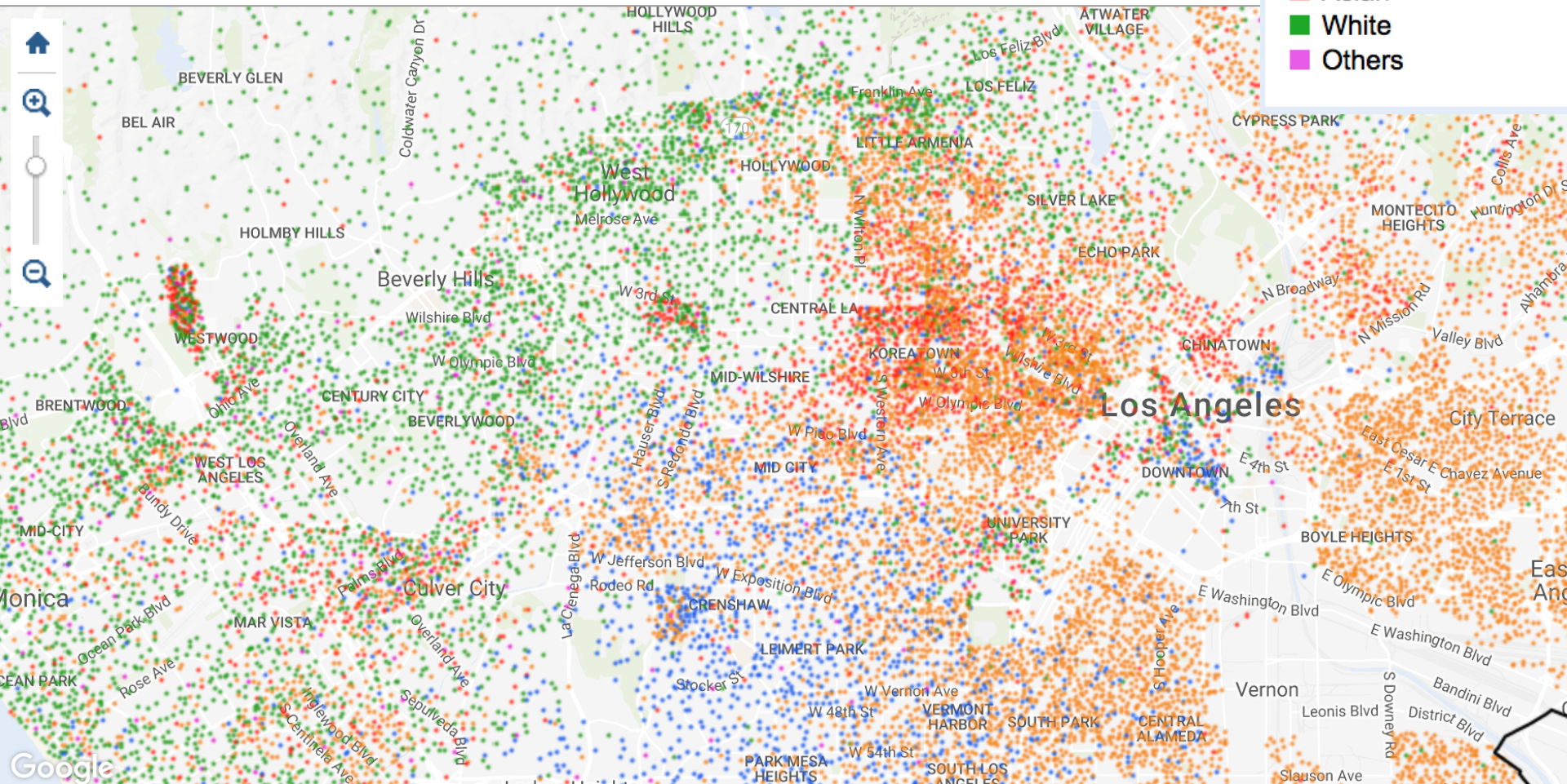
## CENSUS GROUP

- Black
- Hispanic
- Asian
- White
- Others

The New York Times  
Published: July 8, 2015

## Mapping Segregation

New government rules will require all cities and towns receiving



# Dimensions of segregation

- 1. Evenness**
- 2. Isolation**
- 3. Concentration**
- 4. Centralization**
- 5. Clustering**

Massey DS, Denton NA. 1989. Hypersegregation in U.S. metropolitan areas: black and Hispanic segregation along five dimensions. *Demography* 26(3):373-391.

Morello-Frosch R, Lopez R. 2006. The riskscape and the color line: examining the role of segregation in environmental health disparities. *Environ Res* 102(2):181-196.

# Composition vs. segregation

- If we use composition to operationalize segregation we assume that composition directly reflects racial/ethnic unevenness in a metro area (not necessarily true!)
- Likely better to compare neighborhood composition to the racial distribution of a larger area

Morello-Frosch R, Lopez R. 2006. The riskscape and the color line: examining the role of segregation in environmental health disparities. *Environ Res* 102(2):181-196.

# **Race/Ethnicity, Residential Segregation, and Exposure to Ambient Air Pollution: The Multi-Ethnic Study of Atherosclerosis (MESA)**

| Miranda R. Jones, PhD, Ana V. Diez-Roux, MD, PhD, Anjum Hajat, PhD, Kiarri N. Kershaw, PhD, Marie S. O'Neill, PhD, Eliseo Guallar, MD, DrPH, Wendy S. Post, MD, MS, Joel D. Kaufman, MD, MPH, and Ana Navas-Acien, MD, PhD

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- G-score

Developed by Getis and Ord,<sup>1</sup> the local  $G_i^*$  statistic is calculated as:

$$G_i^* = \frac{\sum_{j=1}^n w_{ij} x_j - \bar{x} \sum_{j=1}^n w_{ij}}{S \sqrt{\frac{N \sum_{j=1}^n w_{ij}^2 - (\sum_{j=1}^n w_{ij})^2}{N-1}}},$$

Where, in this study,  $i$  is the focal census tract for which the local  $G^*$  index is estimated,  $x_j$  is the proportion of Blacks in tract  $j$  (which is a neighboring tract when it does not equal the focal tract),  $w_{ij}$  is a spatial weight between focal tract  $i$  and neighboring tract  $j$  (used to weight the contribution of the racial/ethnic composition of each tract  $j$  to the estimation of  $G_i^*$ ),  $\bar{x}$  is the mean proportion of Blacks across all  $N$  tracts in the surrounding metropolitan area or county, and

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{N} - (\bar{x})^2}.$$

Kershaw KN, Robinson WR, Gordon-Larsen P, Hicken MT, Goff DC, Carnethon MR, Kiefe CI, Sidney S, Diez Roux AV. Association of Changes in Neighborhood-Level Racial Residential Segregation With Changes in Blood Pressure Among Black Adults The CARDIA Study.



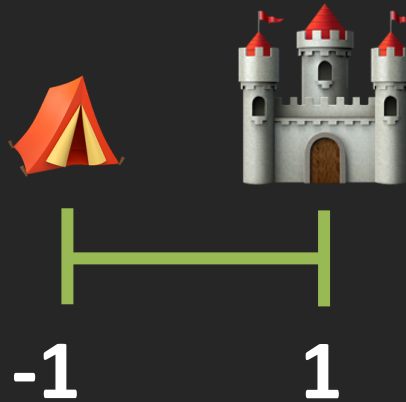
# **Local Residential Segregation Matters: Stronger Association of Census Tract Compared to Conventional City-Level Measures with Fatal and Non-Fatal Assaults (Total and Firearm Related), Using the Index of Concentration at the Extremes (ICE) for Racial, Economic, and Racialized Economic Segregation, Massachusetts (US), 1995–2010**

**Nancy Krieger**  • **Justin M. Feldman** •  
**Pamela D. Waterman** • **Jarvis T. Chen** •  
**Brent A. Coull** • **David Hemenway**

- $D_m$  – Dissimilarity index
- ICE – index of concentration at the extremes

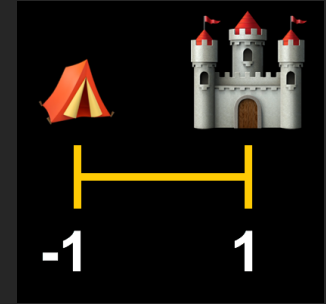


# Index of concentration at the extremes



ICE for income

# ICE for income



$$ICE_{ij} = (A_{ij} - P_{ij}) / T_{ij}$$

$\uparrow$   $\uparrow$   $\nwarrow$   
 $\geq 80^{\text{th}}$   $\leq 20^{\text{th}}$  Total #  
%tile %tile households

$i$  = census tract

$j$  = metro area

# Segregation and health

- **Place-level:** food security, proximity to health services, parks, and open space; social capital, cohesion, and crime; traffic density, abandoned properties, and housing quality
- **Individual-level:** social support, income, poverty, working conditions, educational status, diet/nutritional status, psychosocial stress, health behaviors

# Environmental justice

“the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies” (US EPA, 2015).

Injustice: Any circumstance where one population avoids hazards from a practice that negatively impacts the environment of another population

# Flavors

1. Rights-based (Agyeman 2005)
2. Distributive (Bell 2004) \*Most common
3. Procedural (Fry 2015)

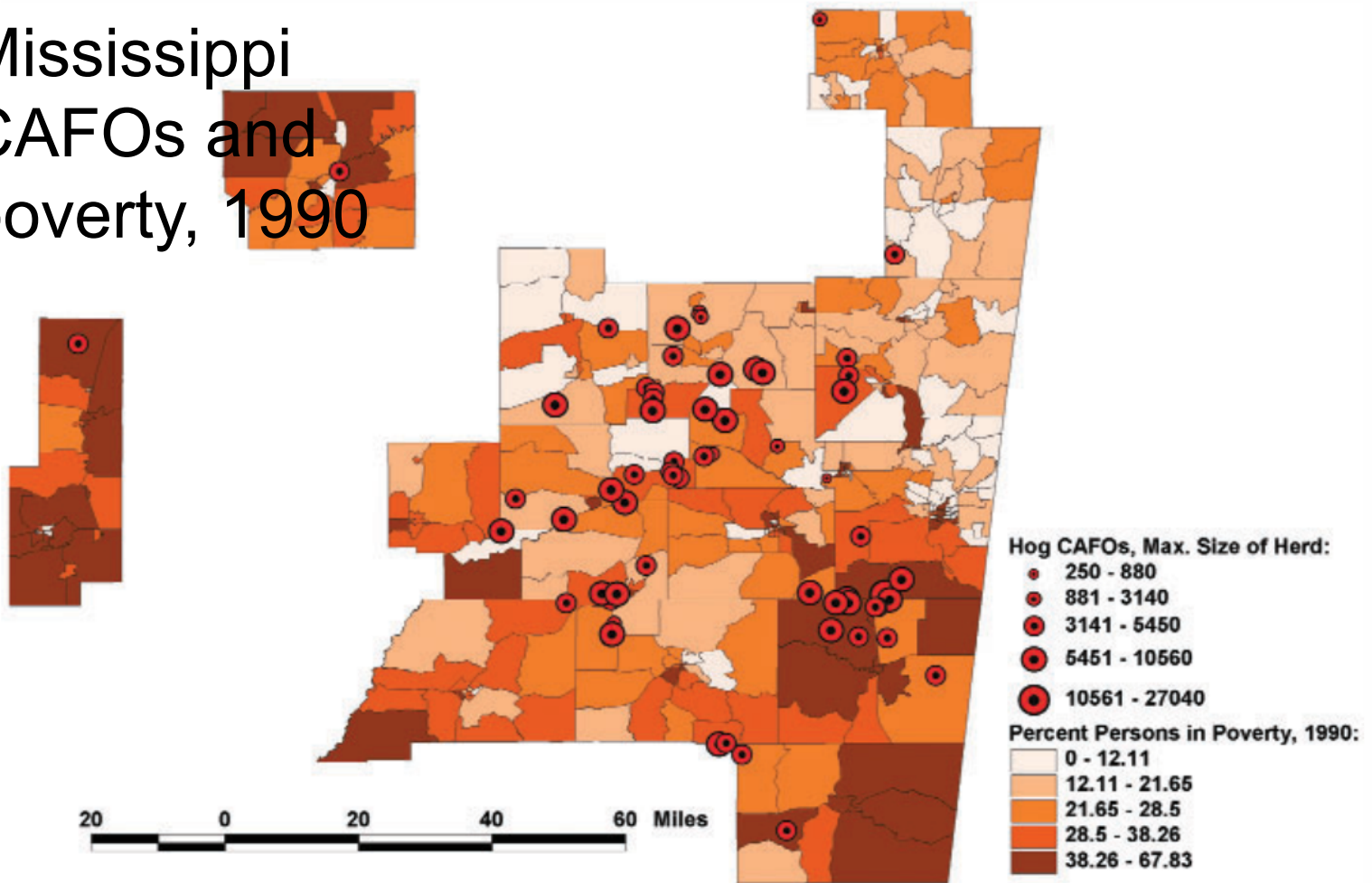


# EJ example

- CAFOs more likely to be sited in areas of poverty
- Often also areas with many minorities
- Mirabelli found that schools in North Carolina with low SES/low white enrollment were 3x more likely to be located within 3 miles of a CAFO

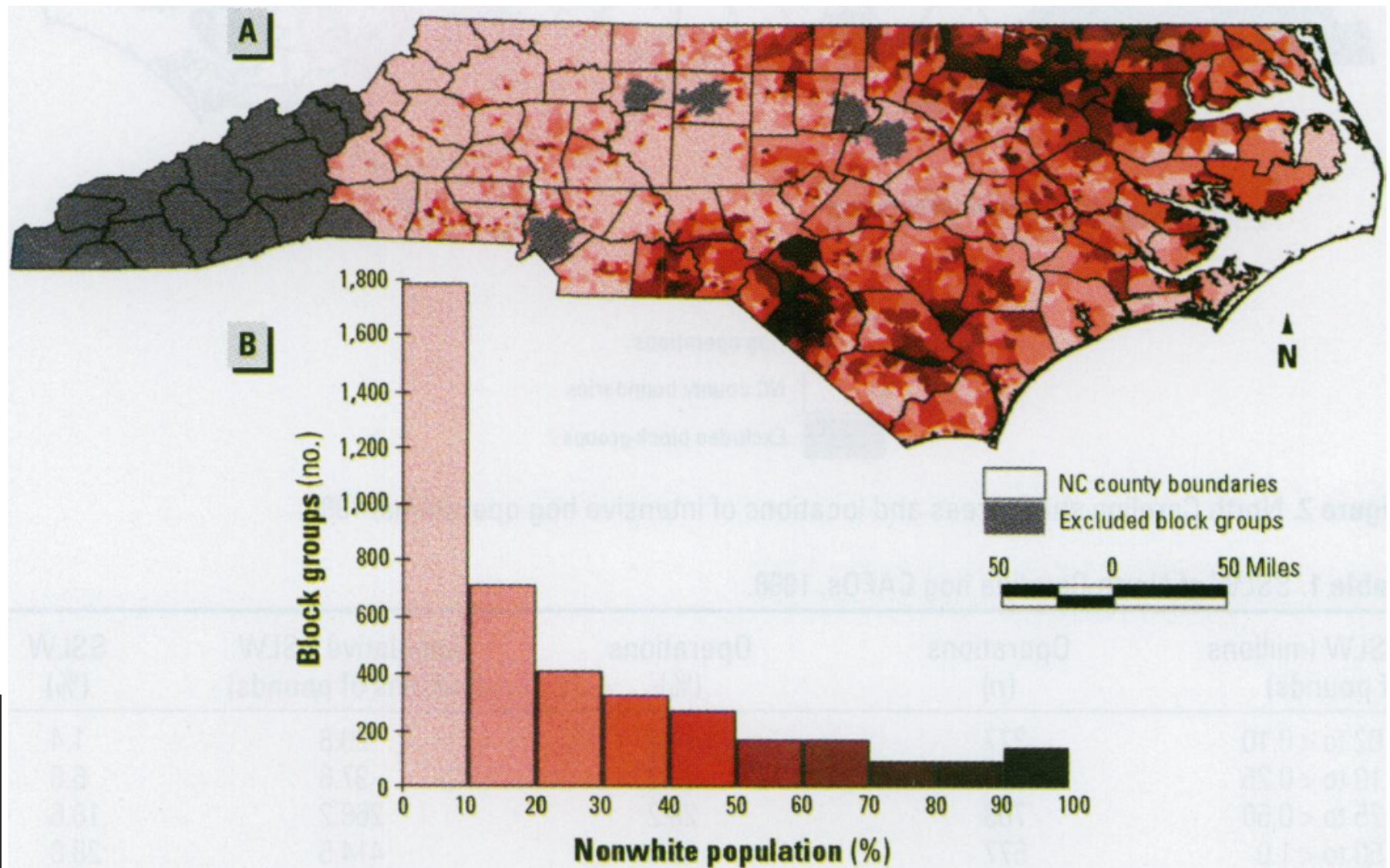
# EJ example

Mississippi  
CAFOs and  
poverty, 1990



**Figure 4.** Hog CAFOs in proximity to percentage of poverty, Mississippi hog counties, 1990.

Greensboro  
Winston-Salem | Durham  
| Raleigh



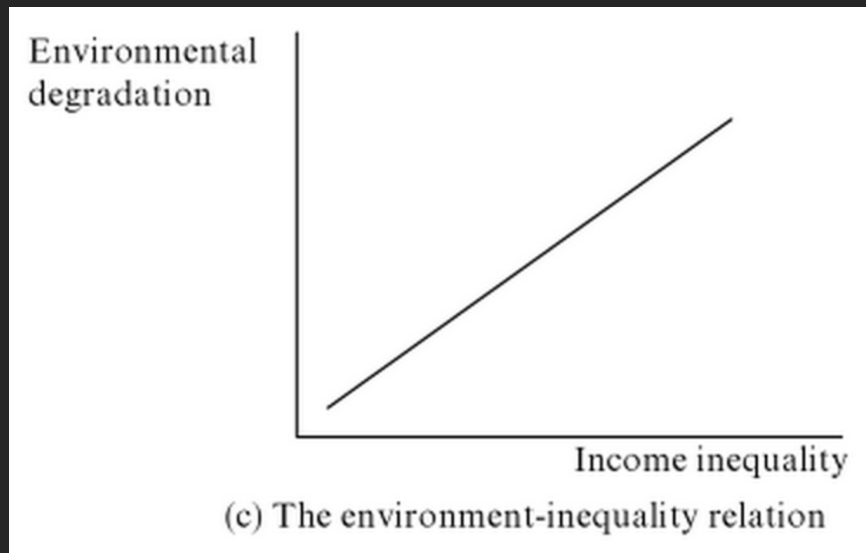
**Figure 4.** (A) The percentage nonwhite population in North Carolina, 1990. (B) The number of block groups in each category of the percentage nonwhite population.

# Mechanisms for environmental Eij

- **Rational choice:** economics; cheaper to site in these neighborhoods because of zoning and land prices
- **Sociopolitical:** follow the path of least political resistance
- **Racial discrimination:** minority communities are purposely targeted

# EJ and segregation

- Unequal societies are more likely to pollute or otherwise degrade their environments
  - Disproportionately affects the disadvantaged
- Inequality makes people value the present more than the future leading to excess pollution



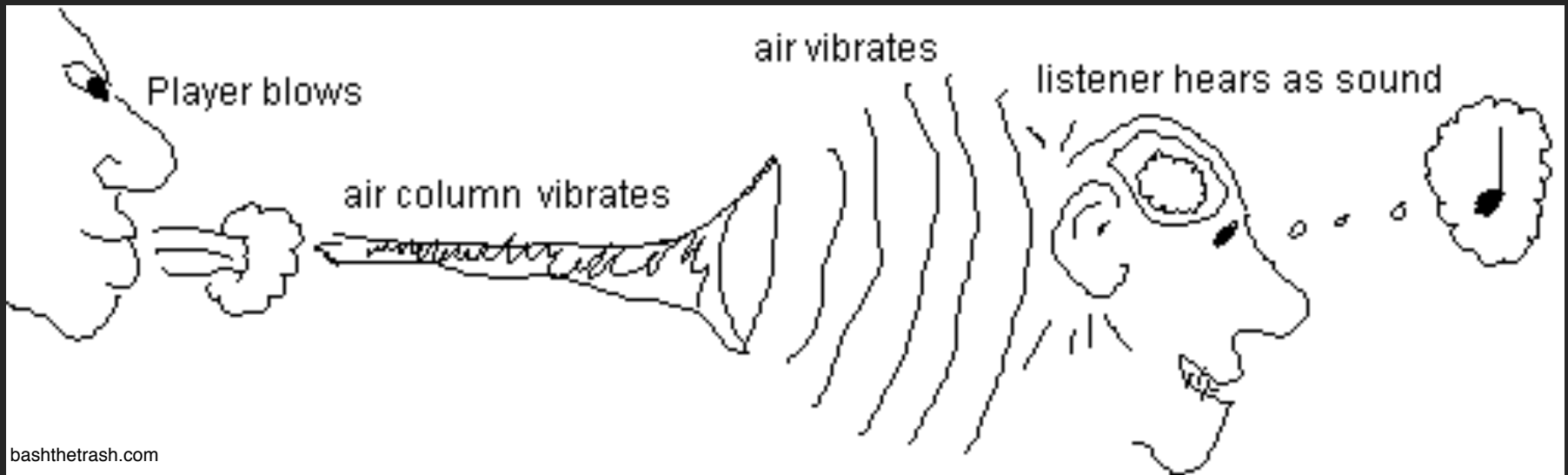
# A case study

## **Race/Ethnicity, Socioeconomic Status, Residential Segregation, and Spatial Variation in Noise Exposure in the Contiguous United States**

*Joan A. Casey,<sup>1</sup> Rachel Morello-Frosch,<sup>2</sup> Daniel J. Mennitt,<sup>3</sup> Kurt Frstrup,<sup>4</sup> Elizabeth L. Ogburn,<sup>5</sup> and Peter James<sup>6</sup>*

Casey JA, Morello-Frosch R, Mennitt DJ, Frstrup K, Ogburn EL, James P. 2017. Race/ethnicity, socioeconomic status, residential segregation, and spatial variation in noise exposure in the contiguous United States. *Environ Health Perspect* 125(7):077017. 10.1289/EHP898.

# Sound waves, they're how we hear!





# Sound pressure is measured in decibels (dBA)

## AVERAGE ABILITY TO PERCEIVE CHANGES IN NOISE LEVELS

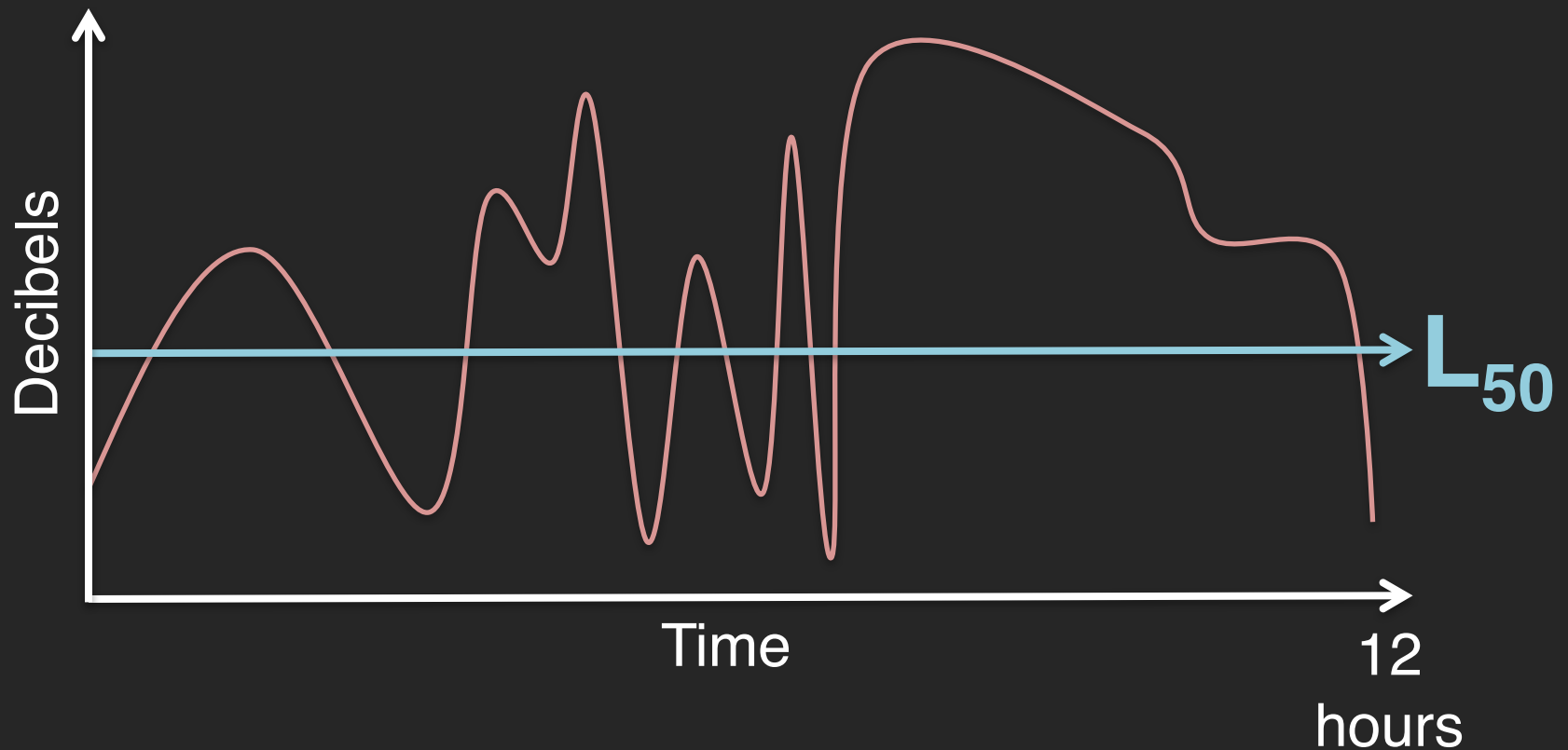
| Change (dBA) | Human Perception of Sound                        |
|--------------|--------------------------------------------------|
| 2-3          | Perceptible                                      |
| 5            | Readily noticeable, increase in noise complaints |
| 10           | A doubling or halving of the loudness of sound   |

Source: Beranek and Neuman. *Fundamentals and Abatement of Highway Traffic Noise* (1973).

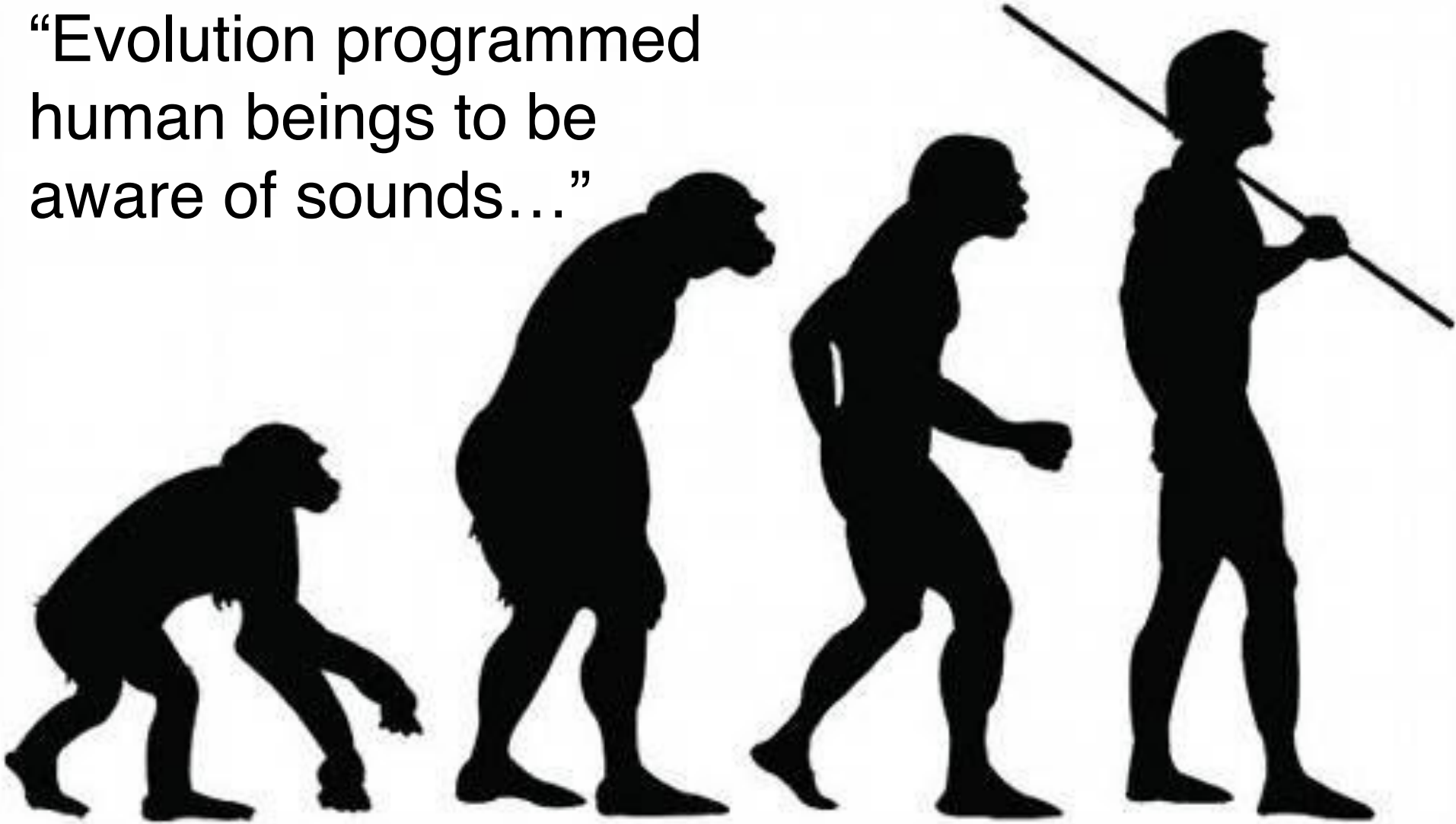
Noise is **unwanted** sound



# Noise is not constant

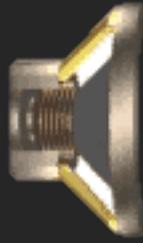


“Evolution programmed  
human beings to be  
aware of sounds...”



“....as possible  
sources of  
**danger**”

(Basner et al. *Lancet* 2014)



Noise **activates** the  
autonomic nervous system



ubrn.org

The WHO estimated  
**> 1 million**  
disability adjusted life years  
**lost** annually due to  
environmental noise





# Noise is associated with multiple health outcomes

sleep disturbance

stress/annoyance

impaired cognitive performance

increased blood pressure

cardiovascular disease

adverse birth outcomes

In the United States, we observe  
**disparities** in many of these same  
health outcomes

race/ethnicity

socioeconomic status

# Double jeopardy

socioeconomic disadvantage and  
**disproportionate** environmental  
exposures

seen with air pollution, hazardous waste  
facilities, animal feeding operations

Social inequality   
worse environmental quality

Racial segregation associated with worse  
air pollution  
air toxics  
heat-risk related land cover  
for **everyone**

# What about **noise**?

## Research question

are there racial/ethnic or socioeconomic disparities in noise exposure in the United States?

# PRIOR STUDIES

old, relatively small, mixed results

recent Minnesota study reported neighborhood level nonwhite race and poverty were associated with more noise

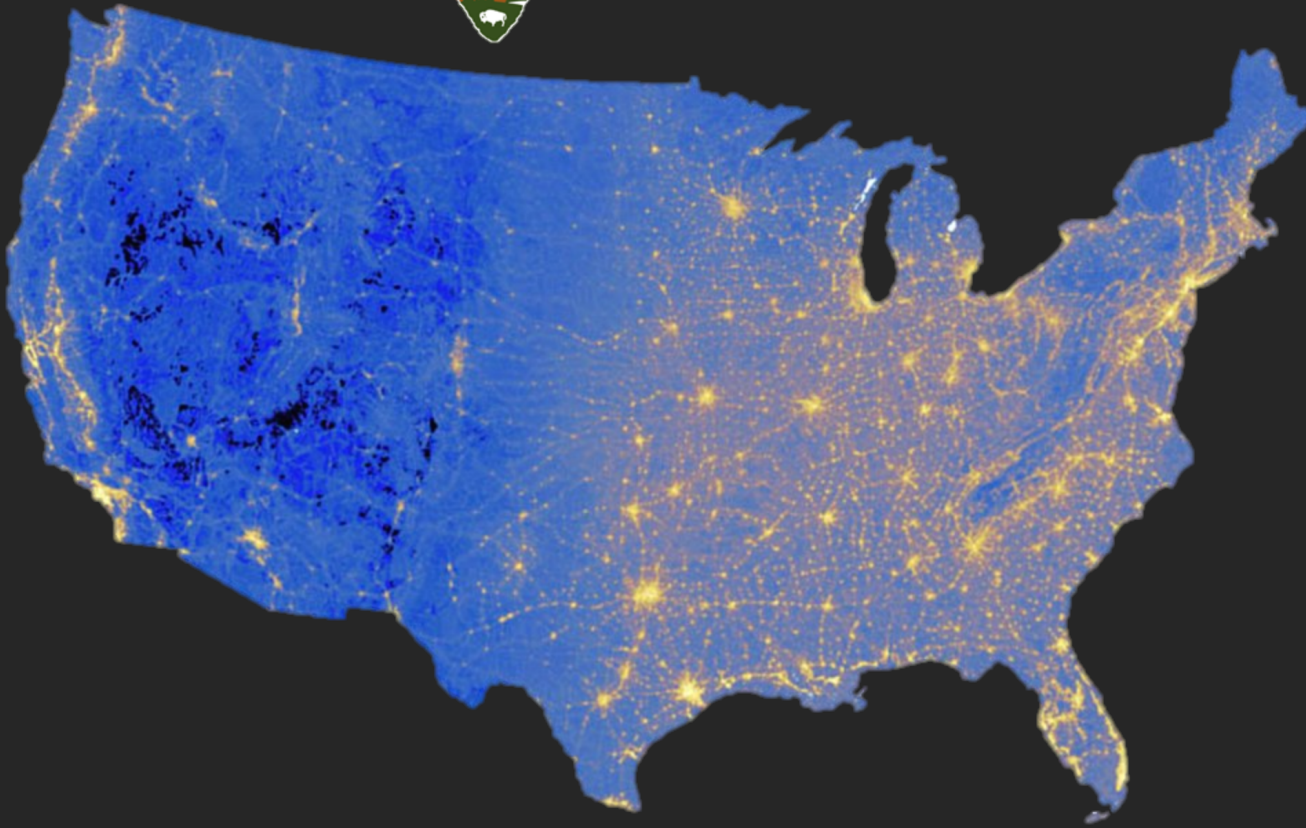
Noise last characterized nationwide in the 1970s

# METHODS

## 1. Outcome: nighttime $L_{50}$ noise



National Park Service



# METHODS

## 2. Racial and socioeconomic data

American Community Survey 5-year estimates (2008-2012)

Race/ethnicity

Poverty

Household income

Education

Housing tenure

Linguistic isolation

Unemployment

Racial segregation

0

.....

1

No  
segregation

Total  
segregation



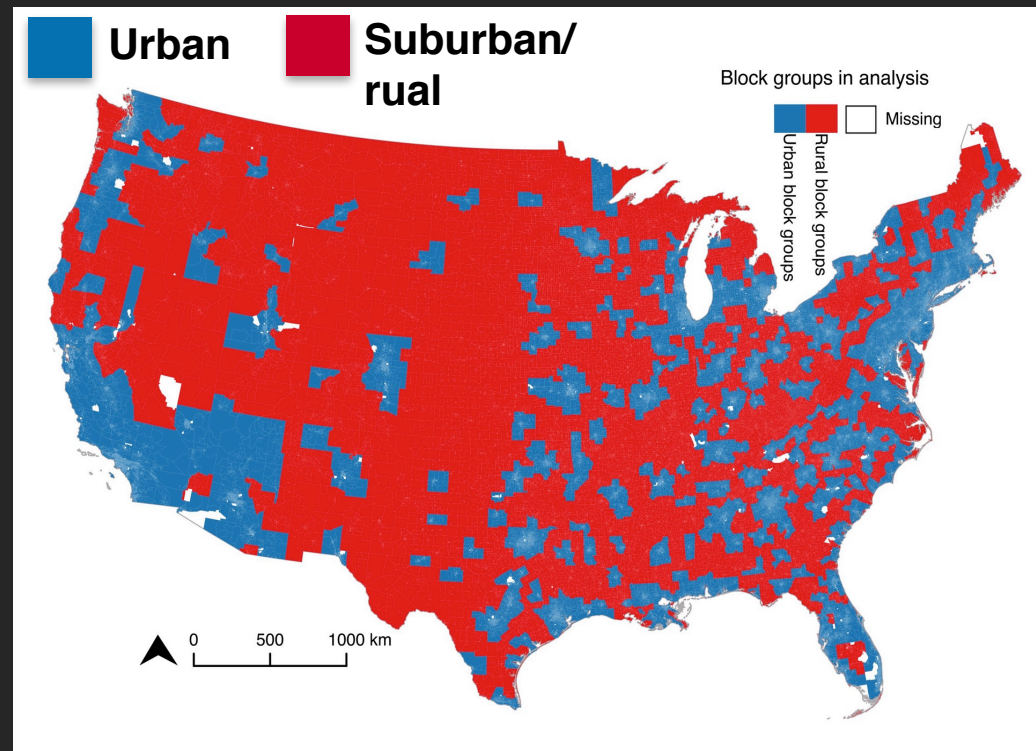
# METHODS

## 3. Block group = unit of analysis

excluded block groups missing data (<1%)

stratified by urban and suburban/rural

today, only urban results,  
n = 175,373 (82%)



# METHODS

## 4. Statistical analysis

spatial error model

14 separate regressions

polynomial terms

accounted for population density

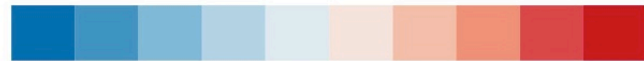
# RESULTS

non-linear relationships

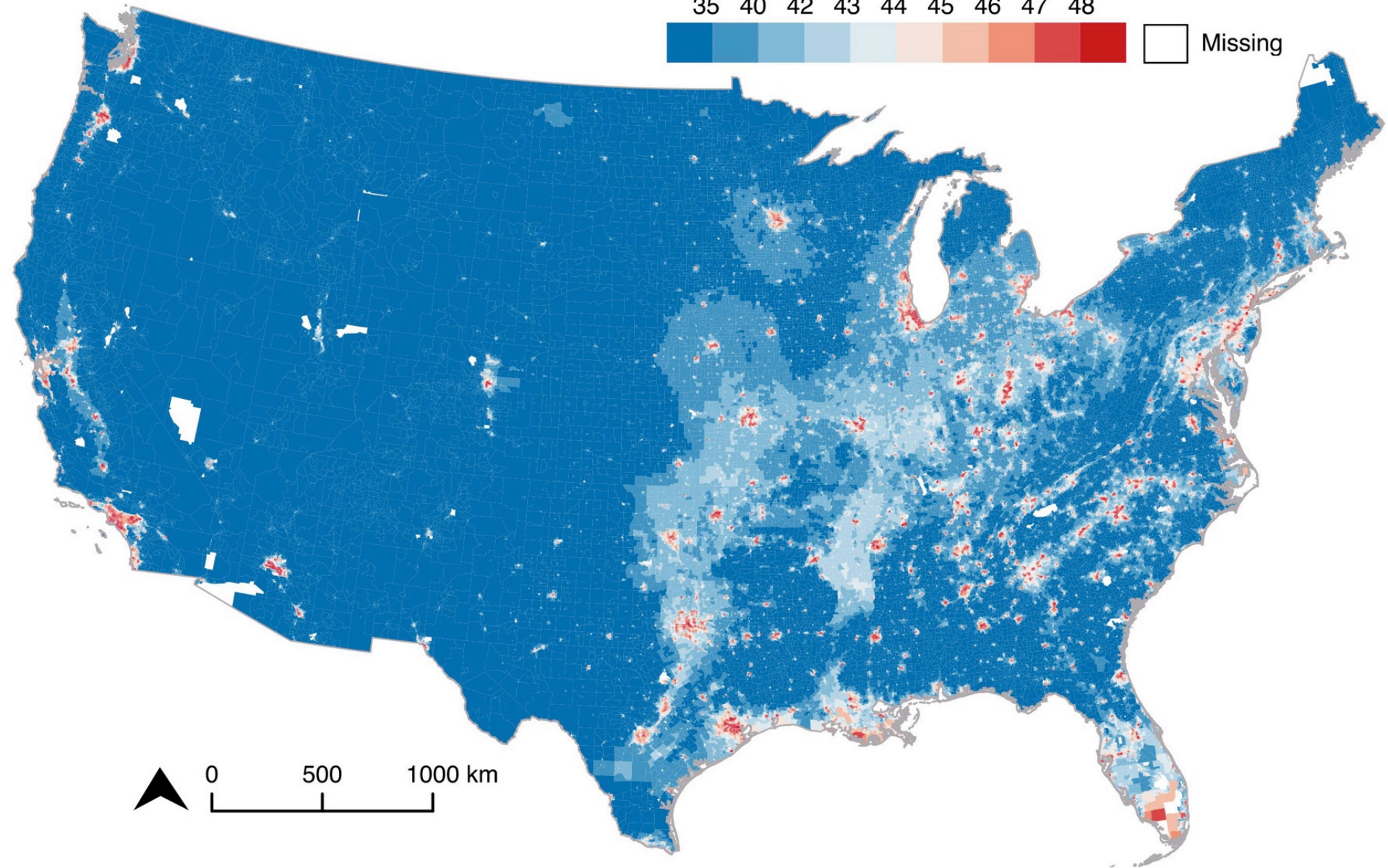
generally observed evidence of  
disparities

# Anthropogenic L50 Nighttime Noise (dBA)

35 40 42 43 44 45 46 47 48

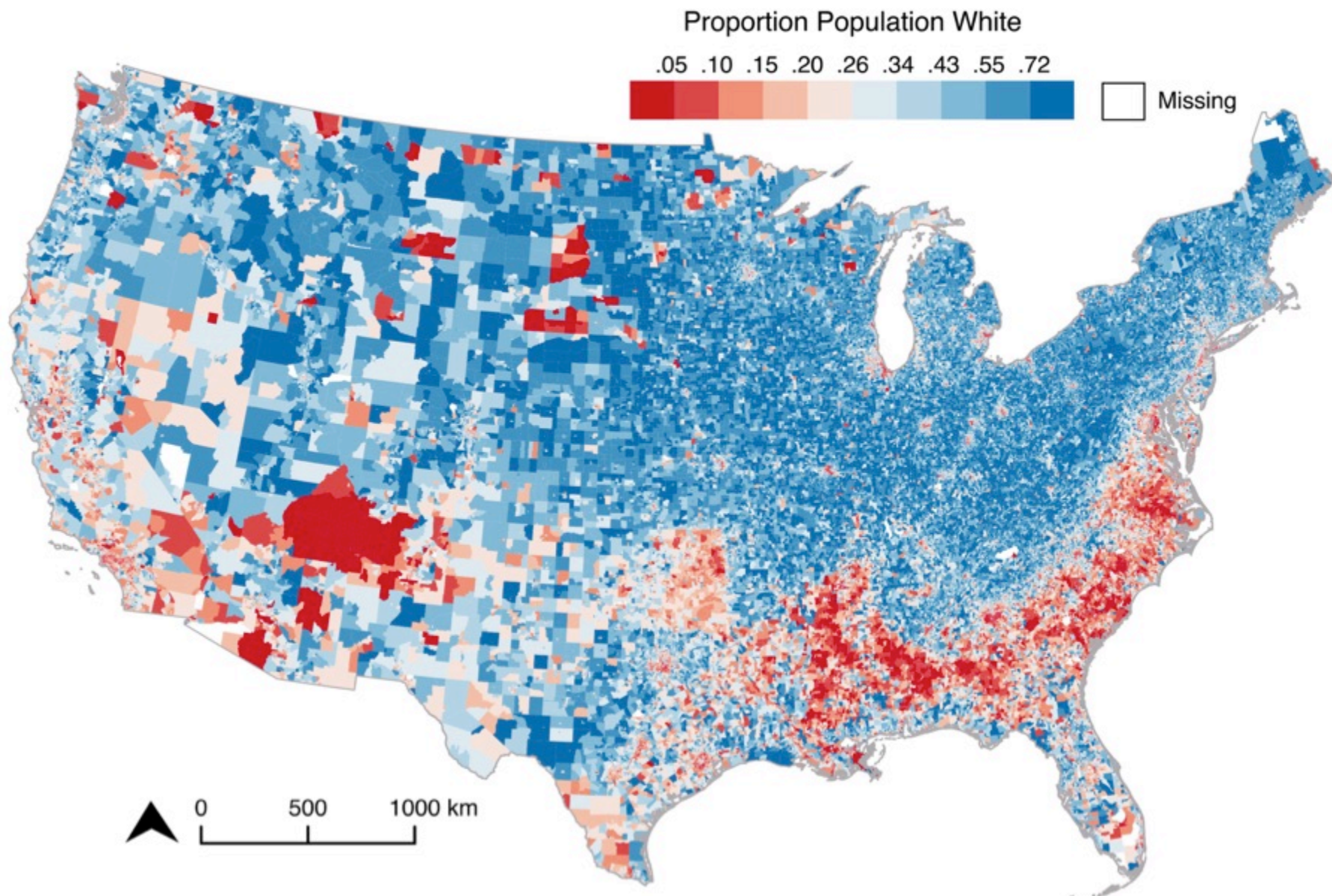


Missing



0 500 1000 km





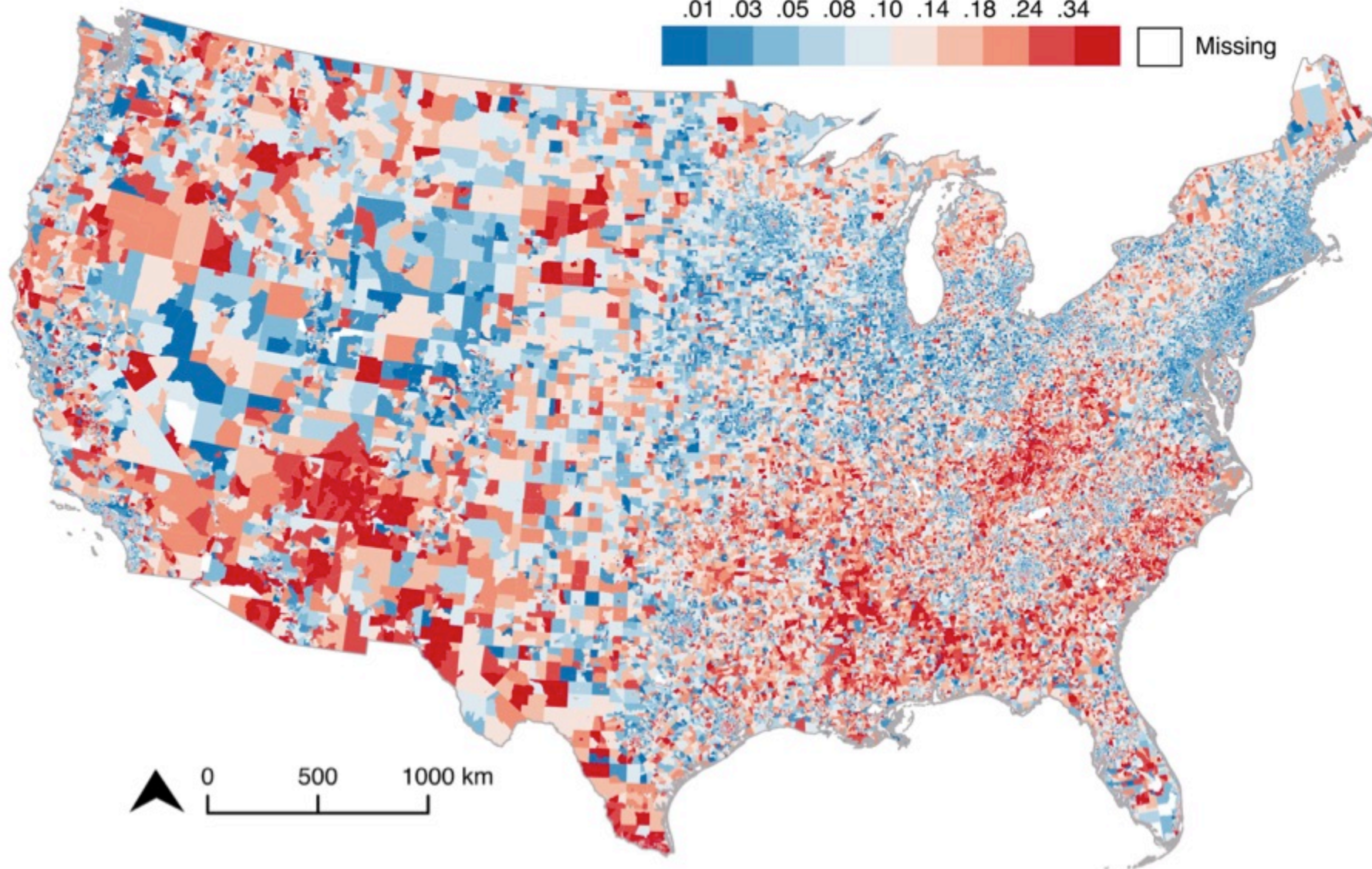


# Proportion Household Income Below Poverty Threshold

.01 .03 .05 .08 .10 .14 .18 .24 .34



Missing

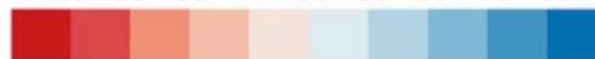


0 500 1000 km

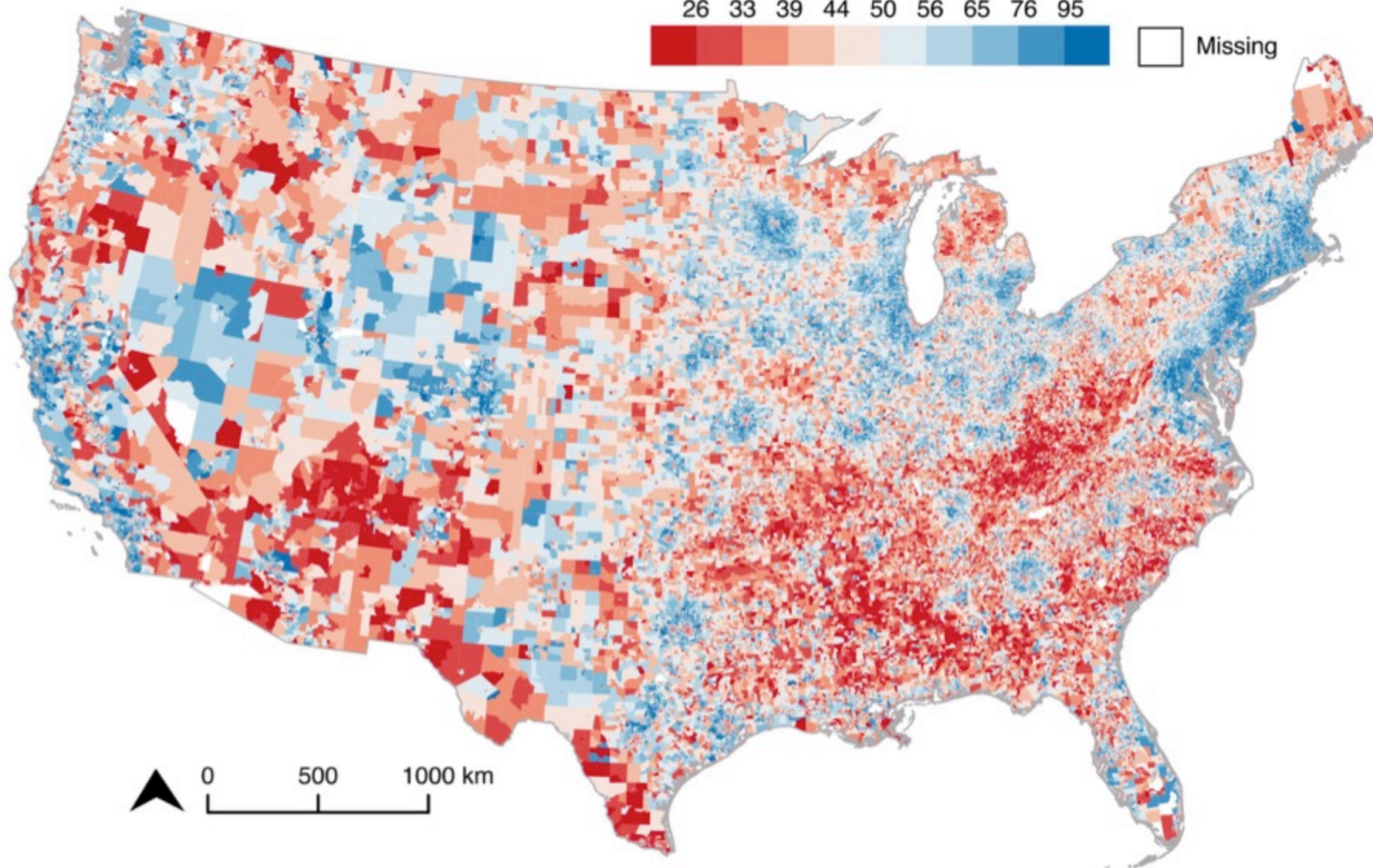


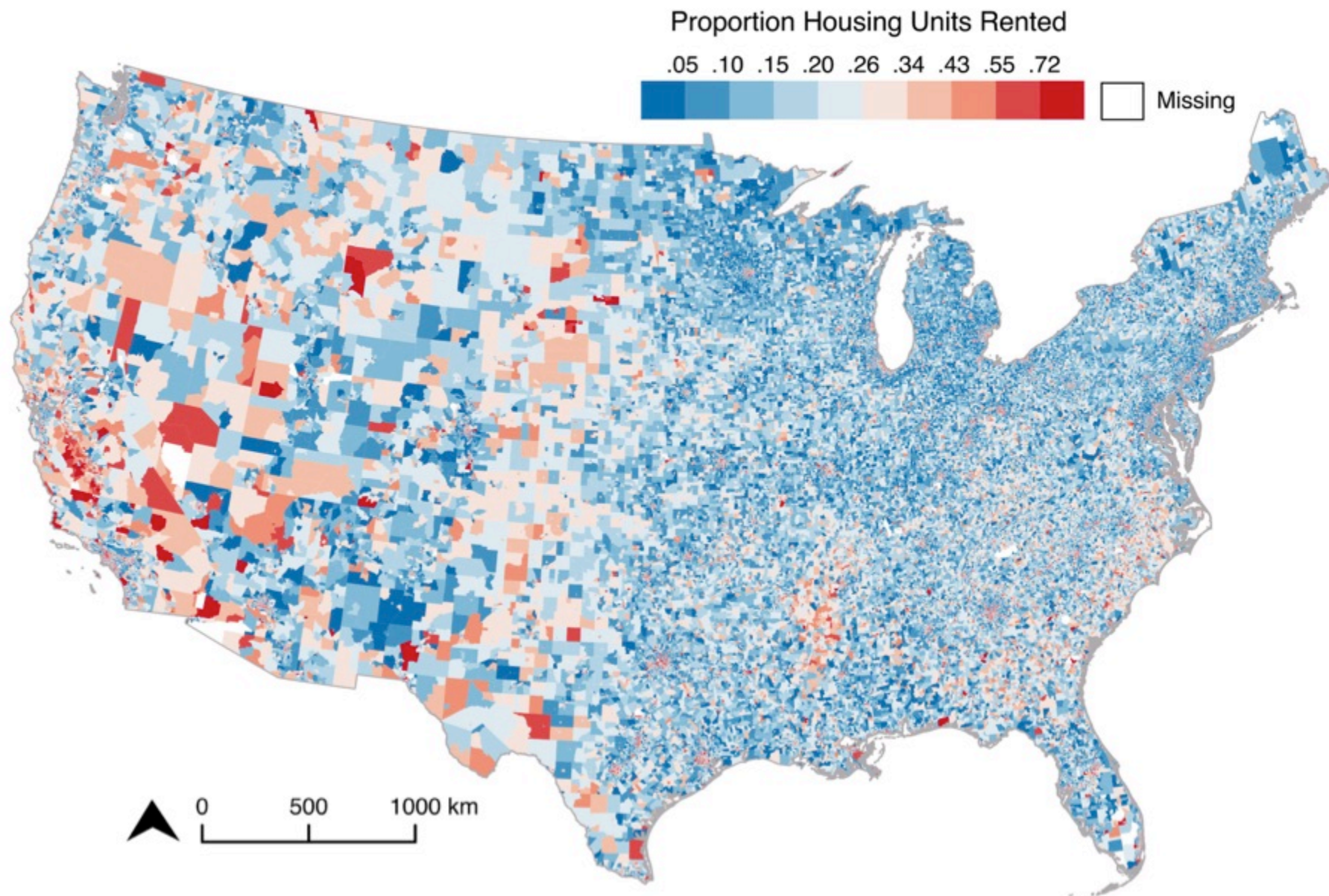
Median Household Income, Thousands (\$)

26 33 39 44 50 56 65 76 95



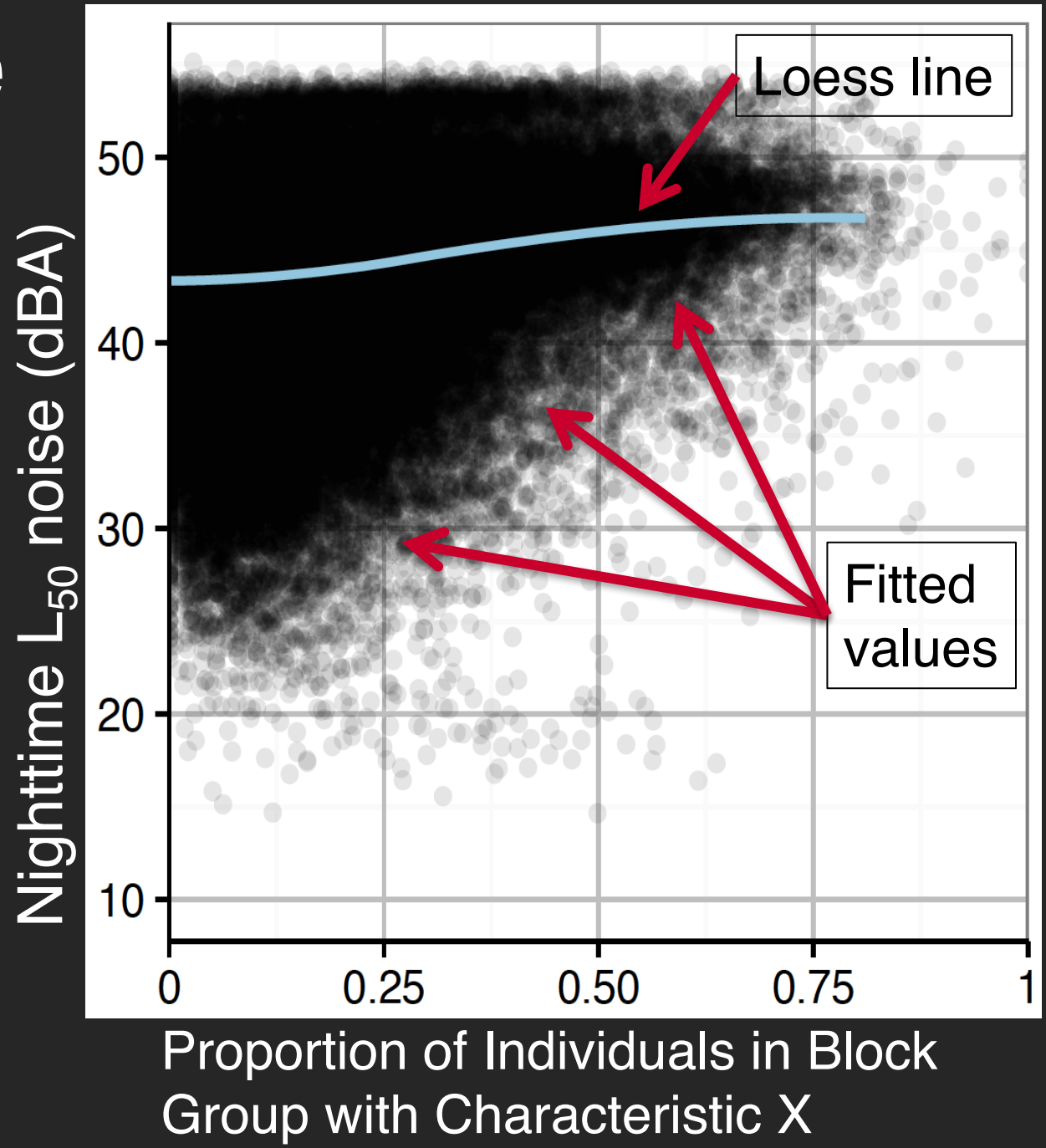
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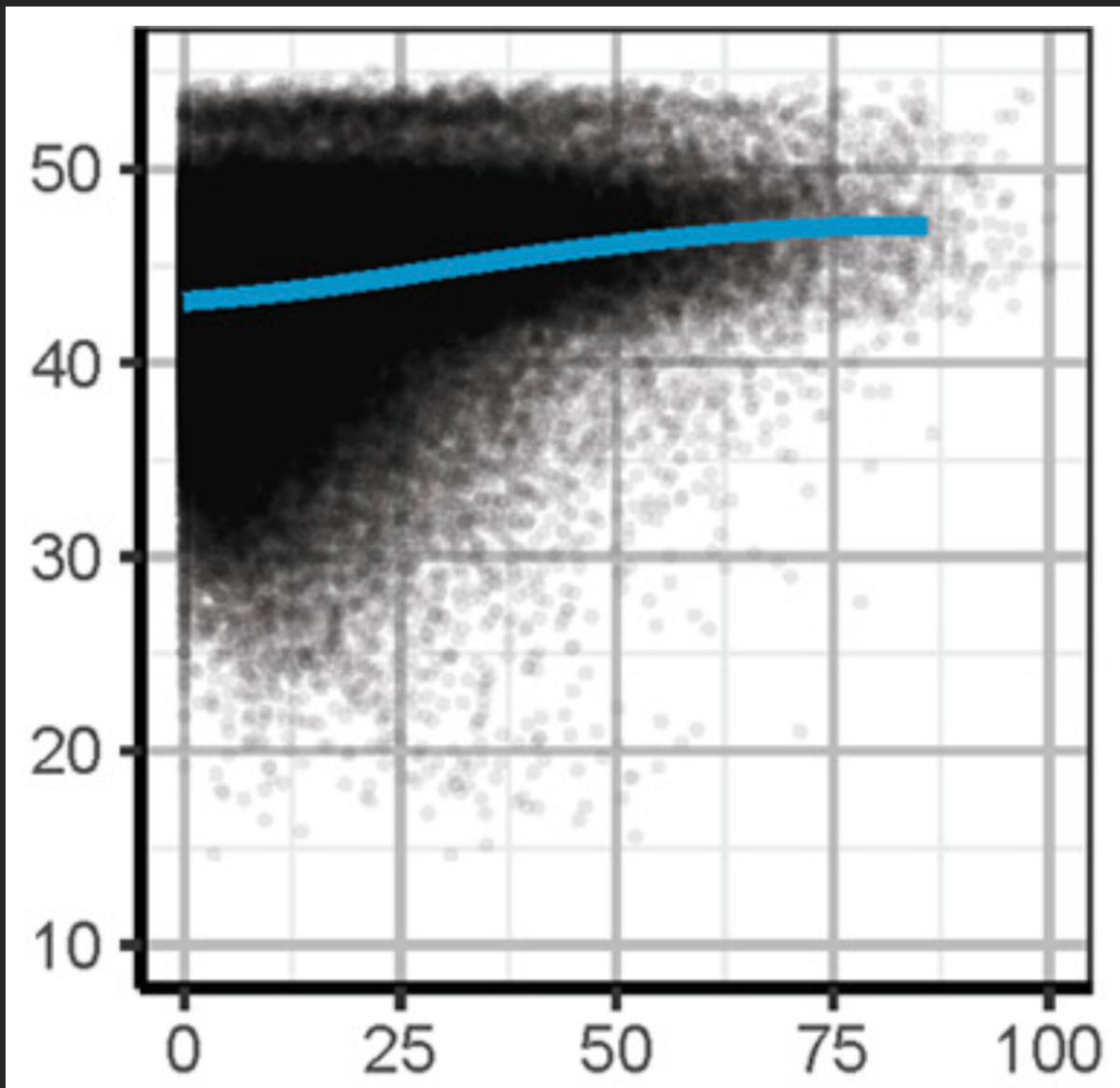


# Prototype



# Poverty

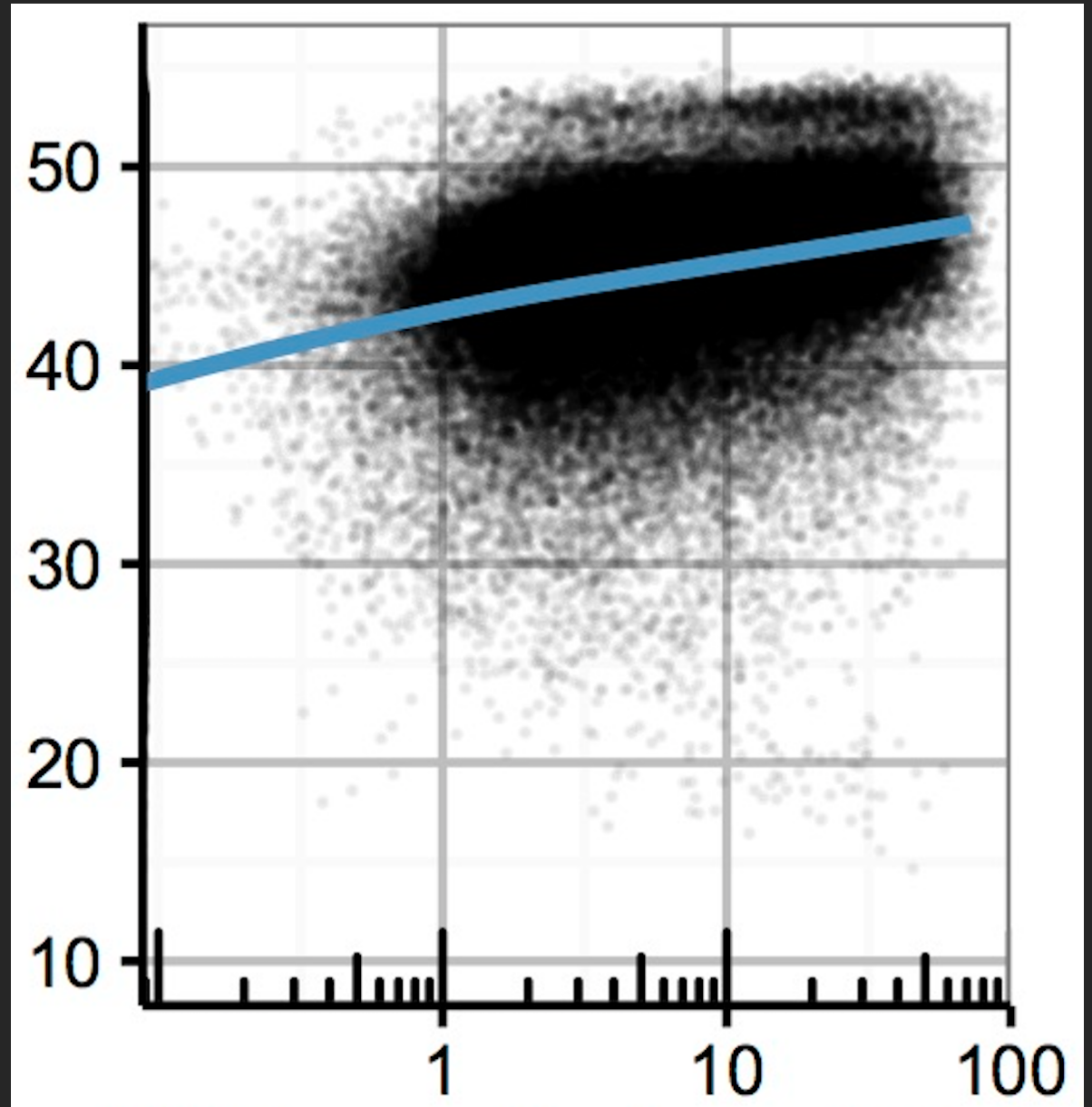
Nighttime  $L_{50}$  noise (dBA)



Percent of Individuals in Poverty

# Linguistically isolated households

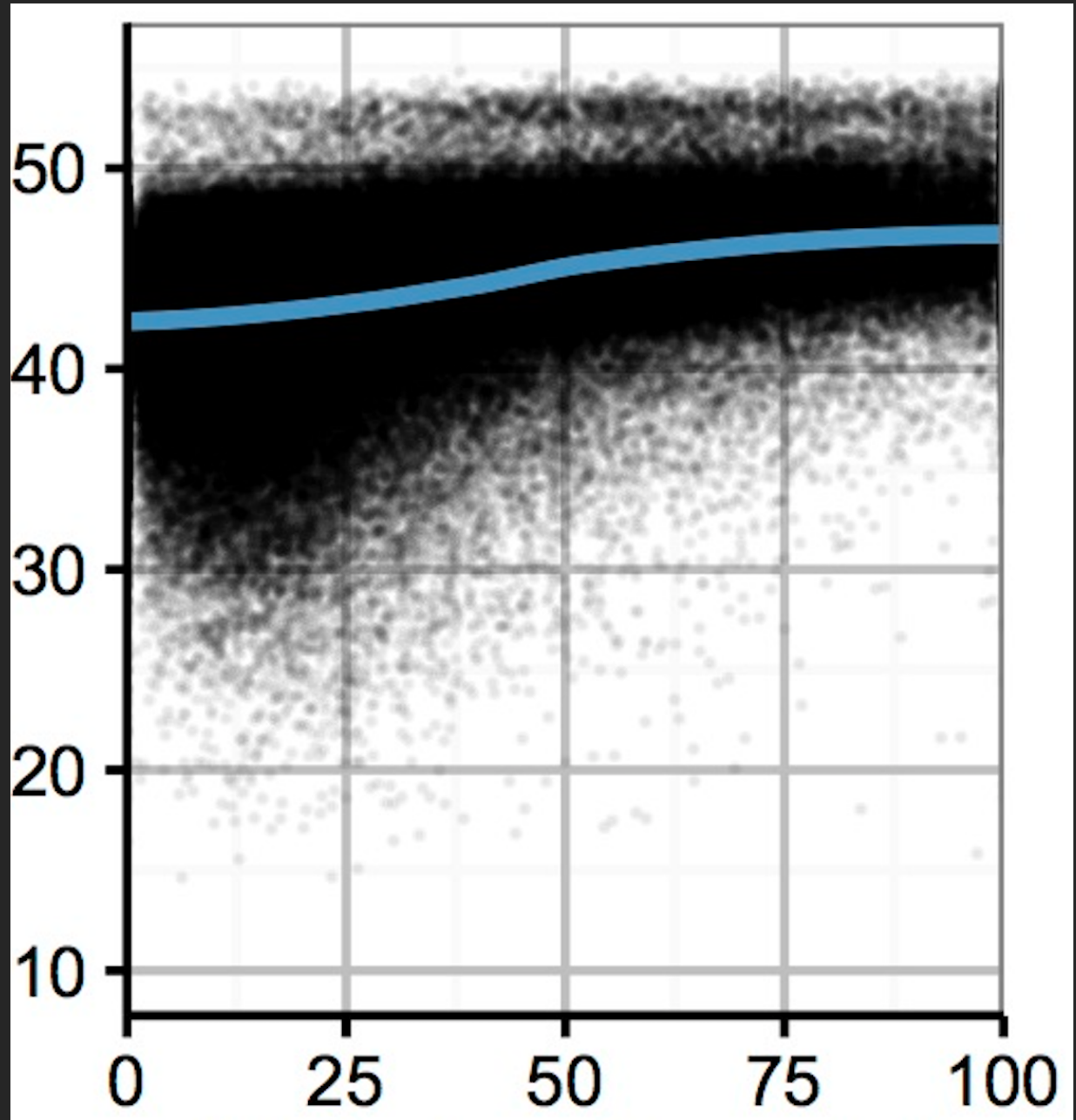
Nighttime  $L_{50}$  noise (dBA)



Percent Households in Linguistic Isolation

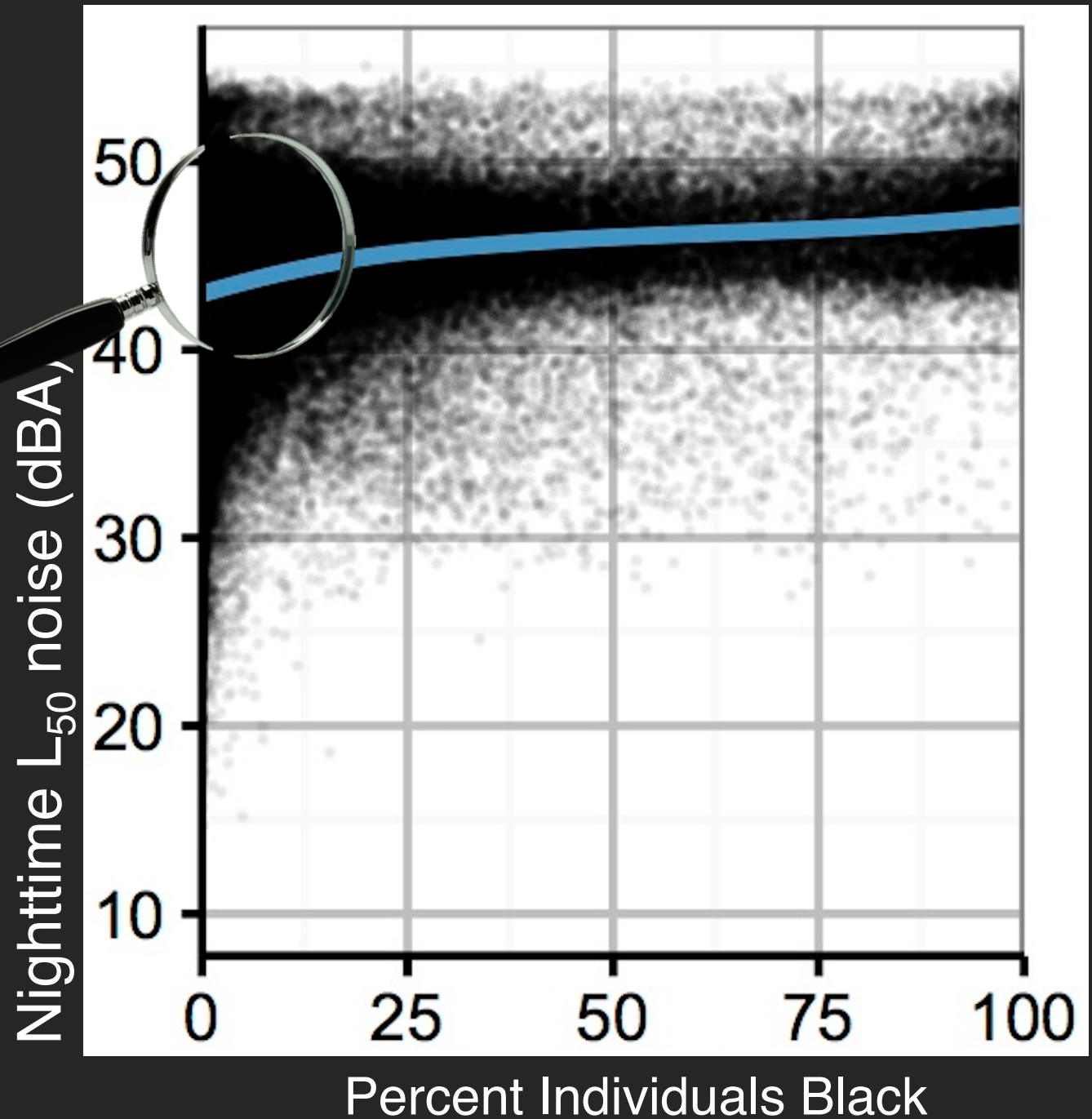
# Rented homes

Nighttime  $L_{50}$  noise (dBA)

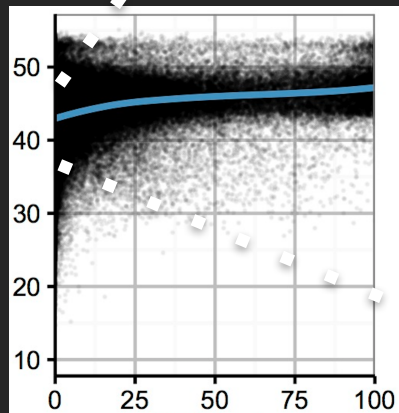


Percent Units Rented

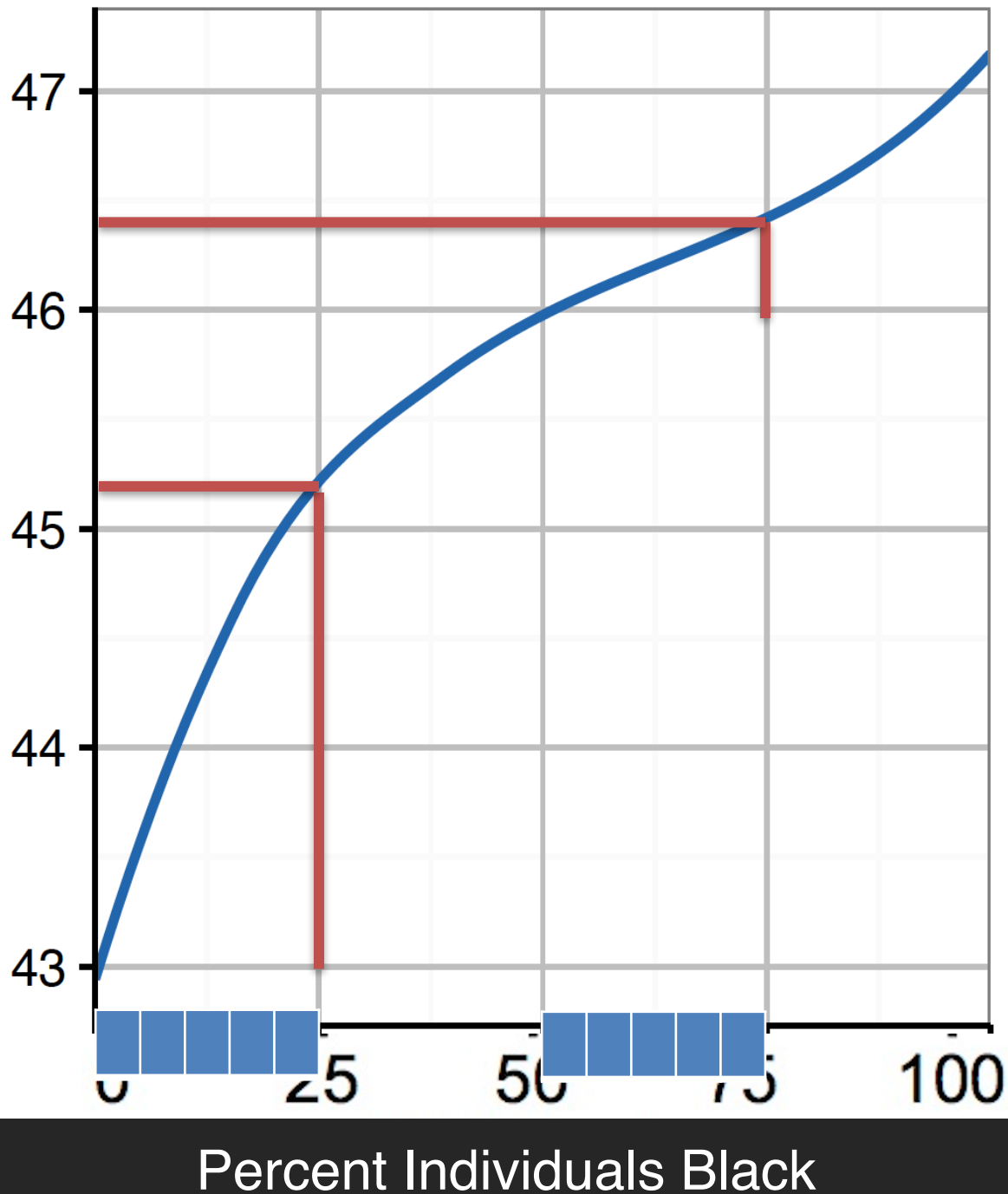
Black  
race/  
ethnicity



Black  
race/  
ethnicity



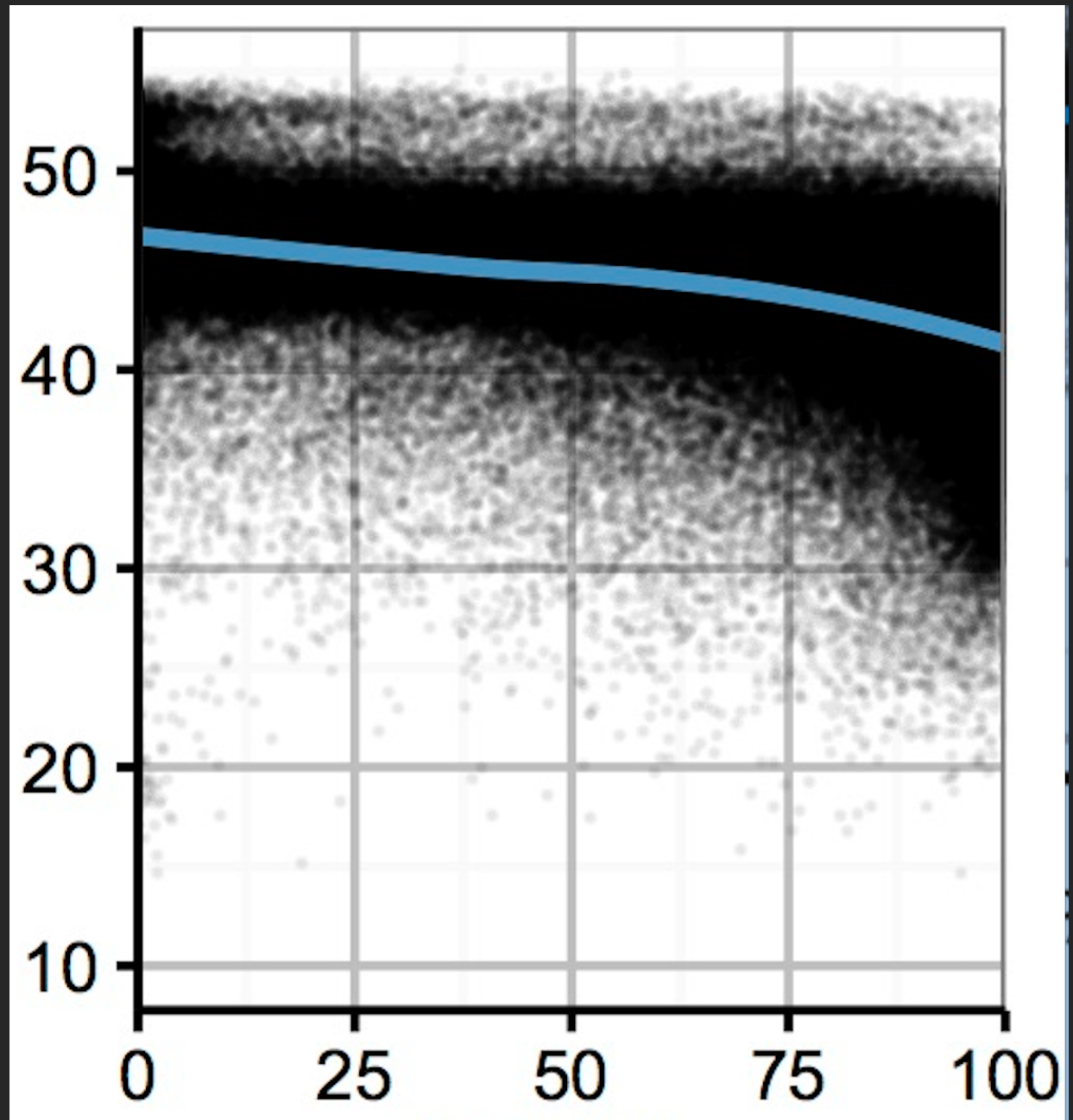
Nighttime  $L_{50}$  noise (dBA)





White  
race/  
ethnicity

Nighttime  $L_{50}$  noise (dBA)

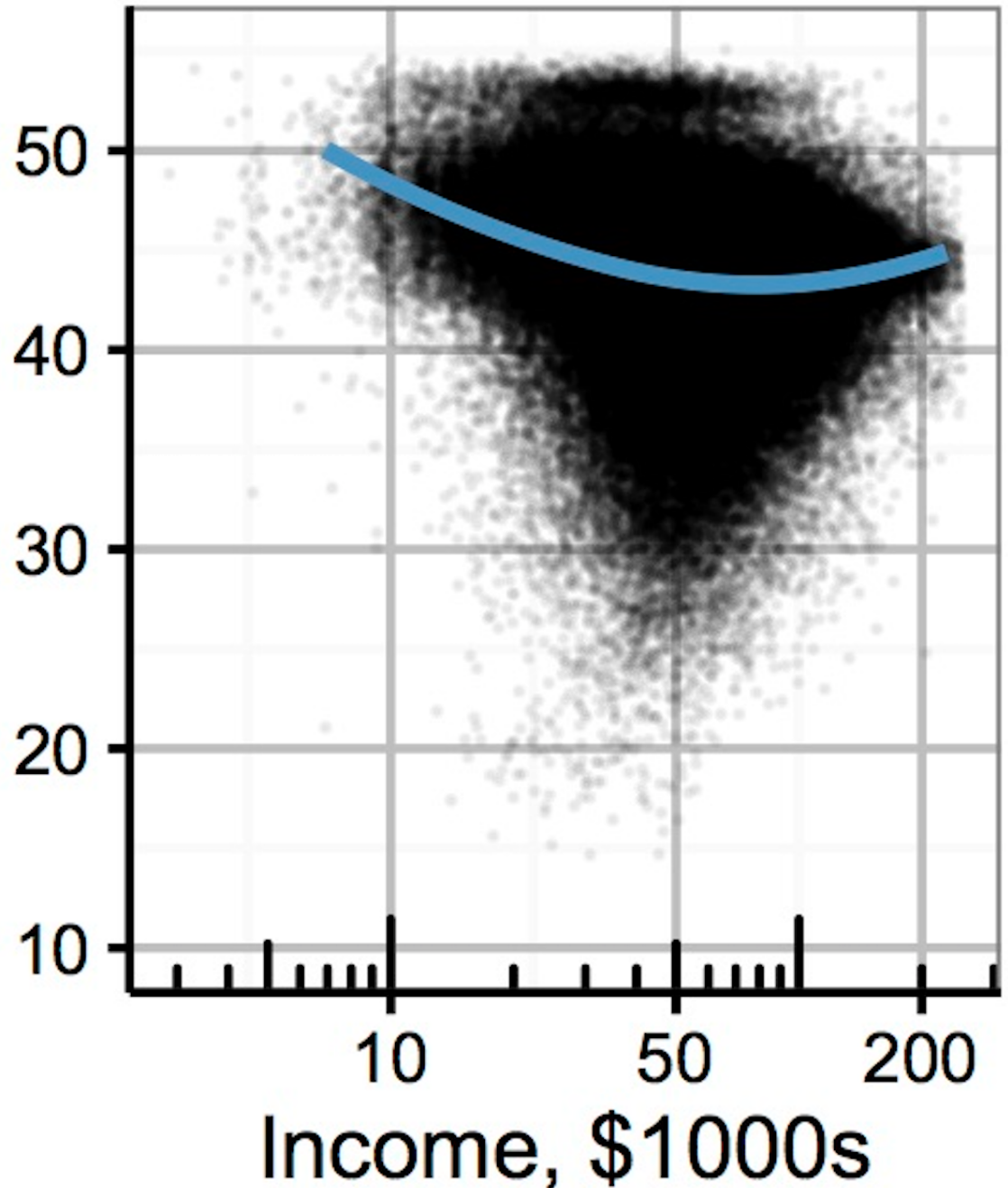


Percent Individuals White

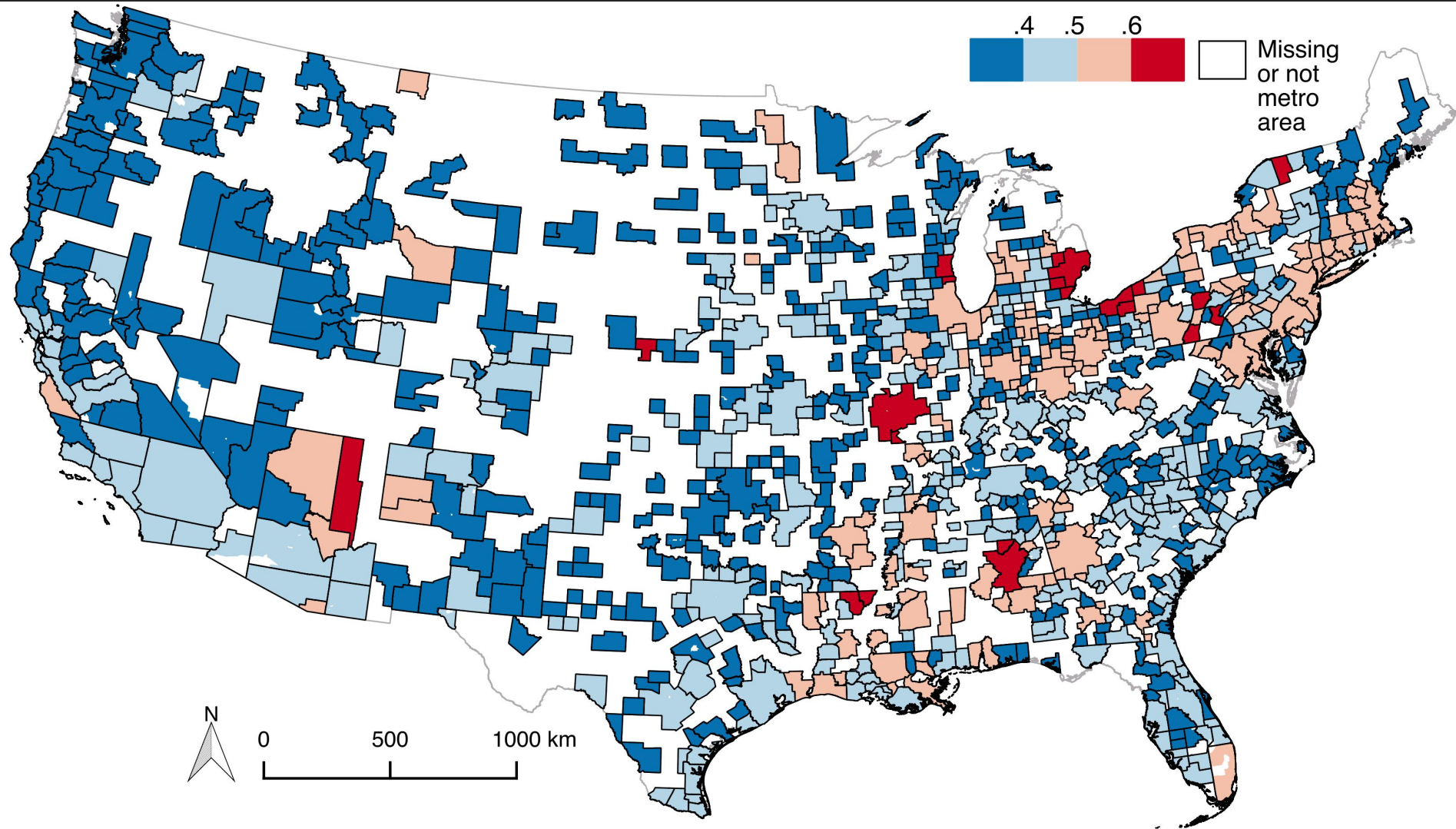
# Median income

Neighborhoods with median annual incomes < \$25,000 were ~2 dBA louder than those with incomes > \$100,000

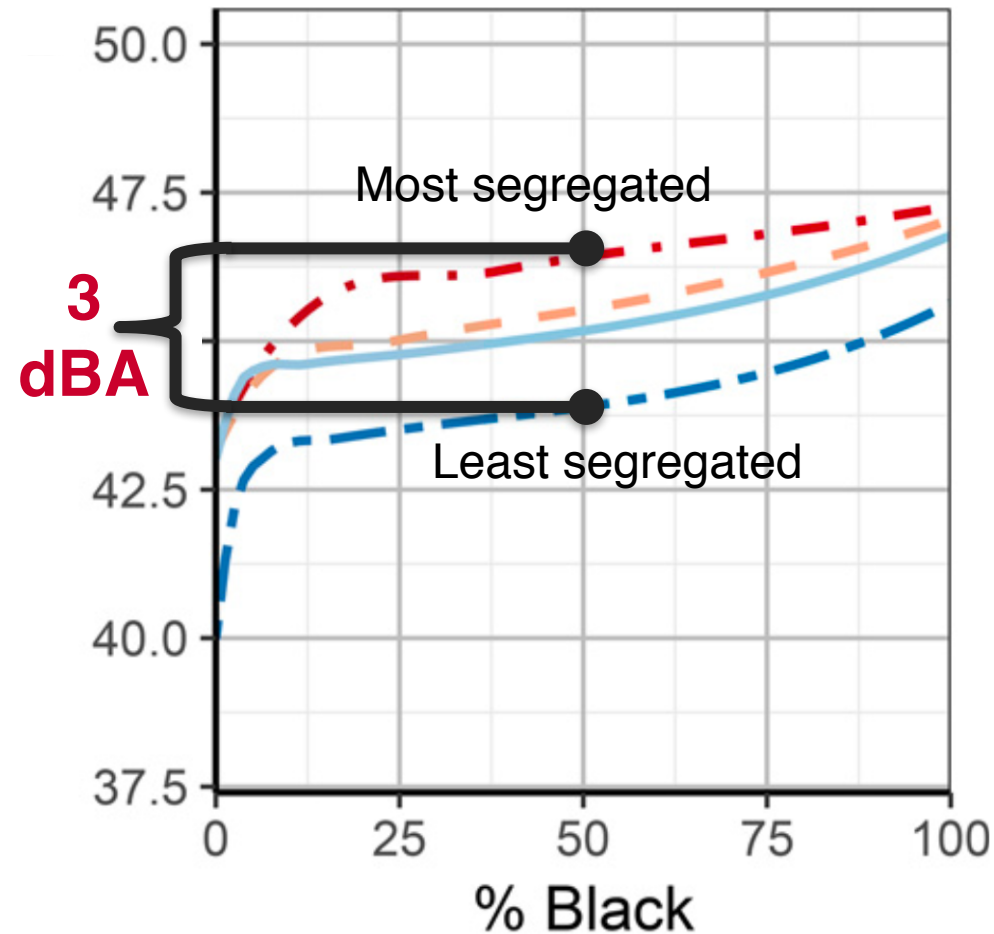
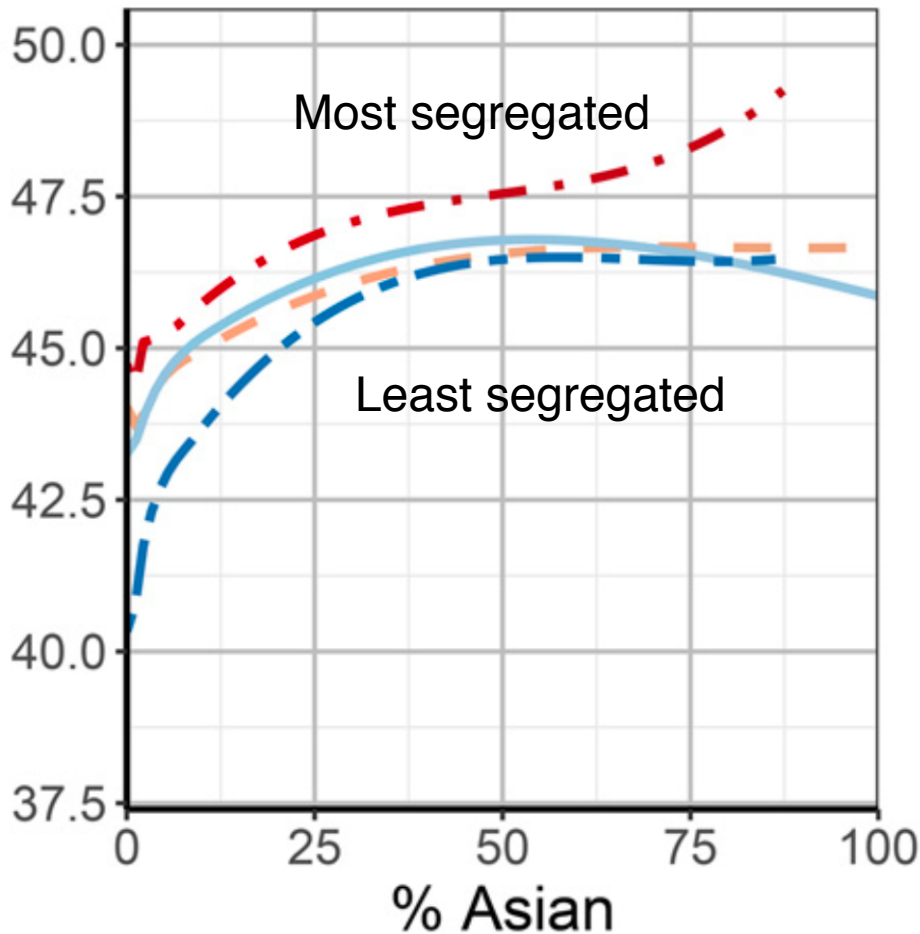
Nighttime  $L_{50}$  noise (dBA)



# Residential racial segregation



# Race/ethnicity and nighttime noise, by segregation



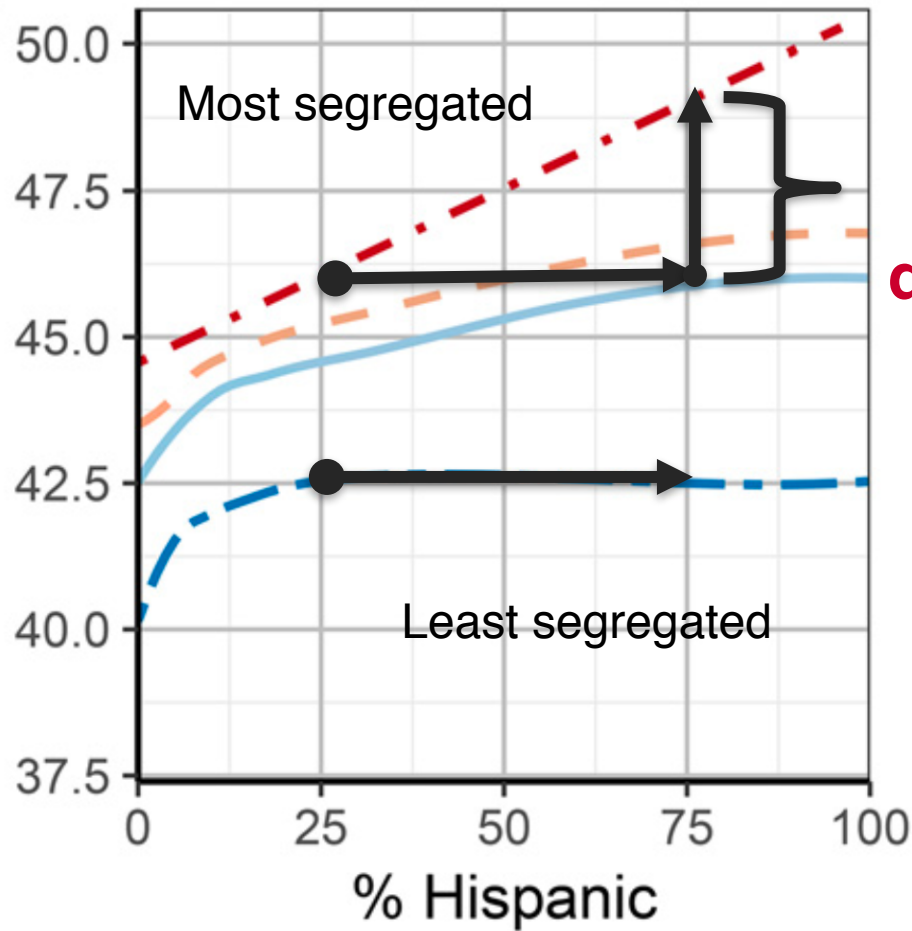
Least  
segregated



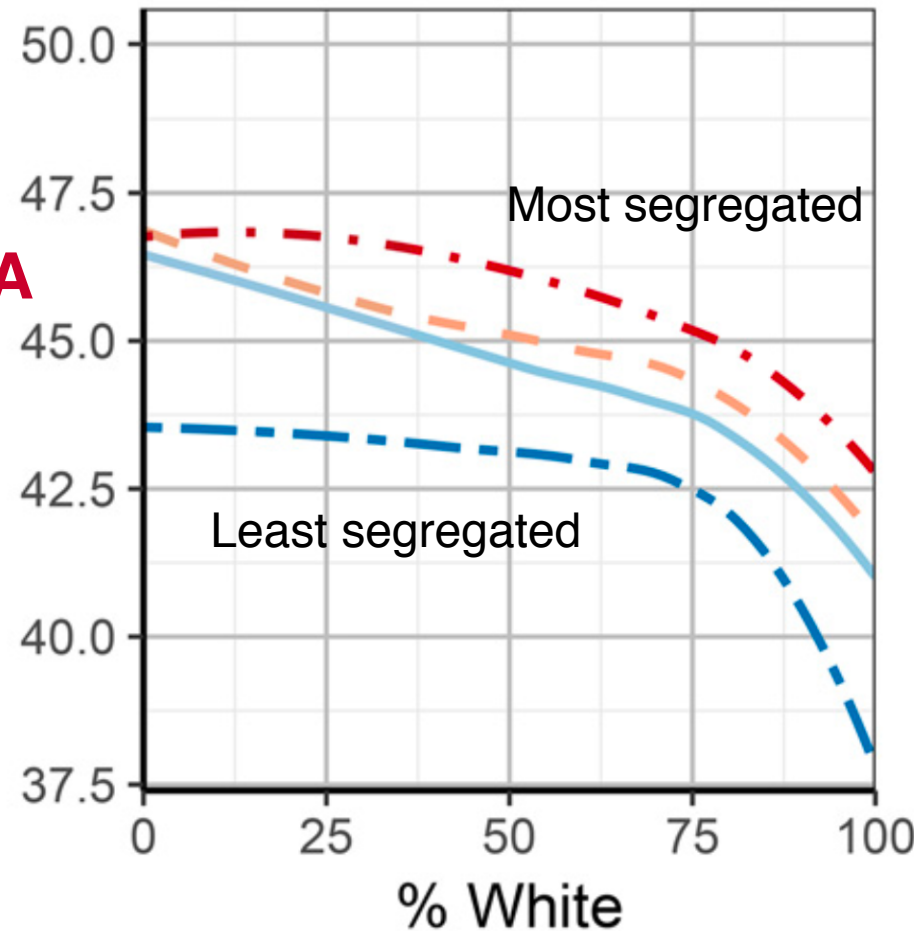
Most  
segregated



# Race/ethnicity and nighttime noise, by segregation



3  
dBA

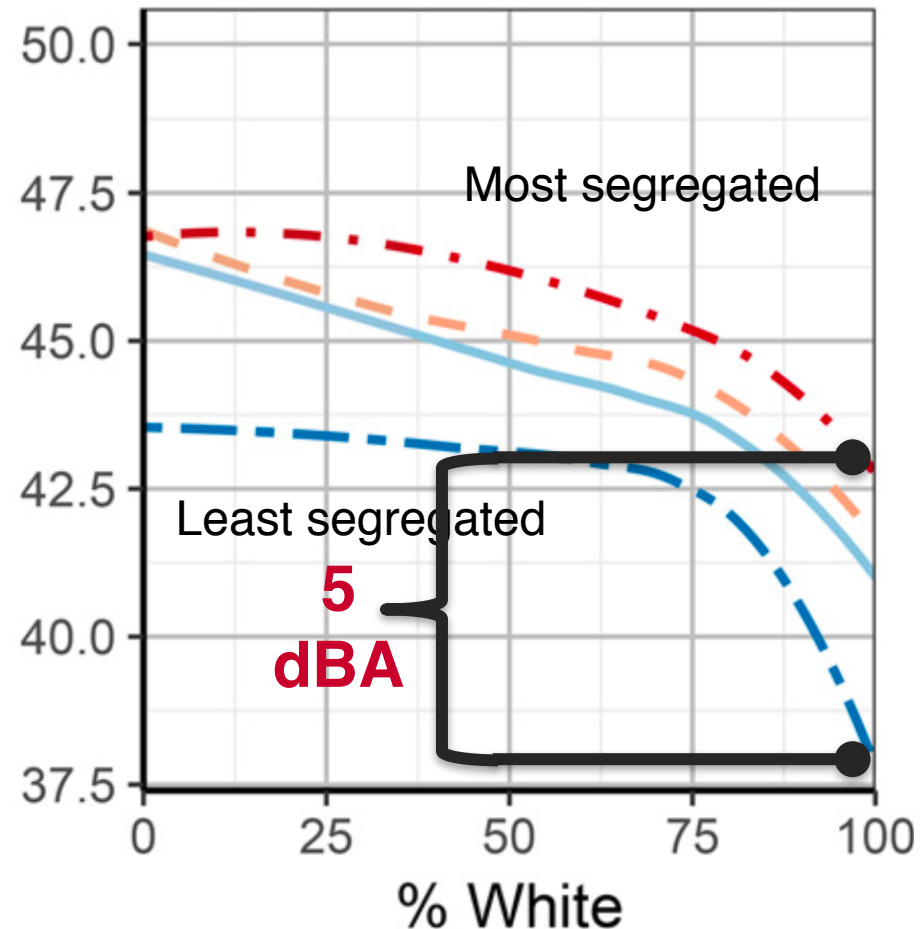
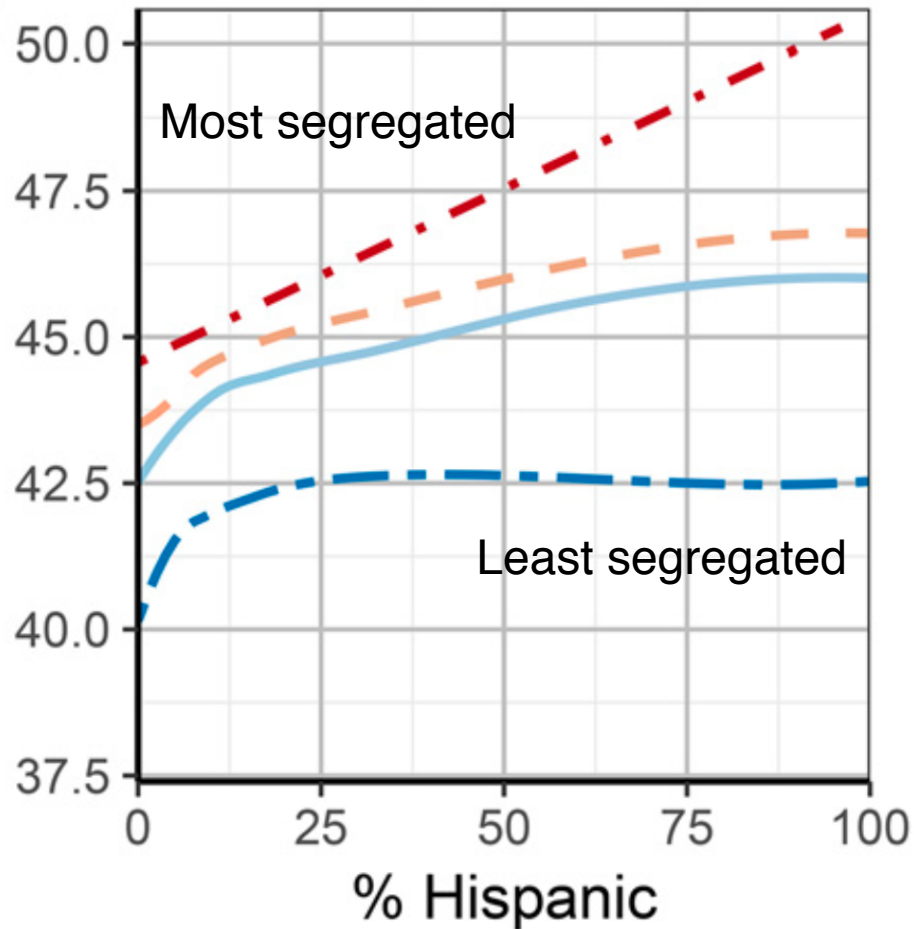


Least  
segregated

- - <0.4    — 0.4 to <0.5    - - 0.5 to <0.6    · · >0.6

Most  
segregated

# Race/ethnicity and nighttime noise, by segregation





# CONCLUSION

fairly consistent **inequities** in noise exposure across the continental U.S.

block groups in more segregated metro areas were **noisier** for everyone,  
but racial/ethnic disparities persisted

# CONCLUSION

poorer individuals might have less ability  
to cope with noise

triple jeopardy?

time to consider new noise regulation in  
the United States

# Thanks for listening!

## COLLABORATORS

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