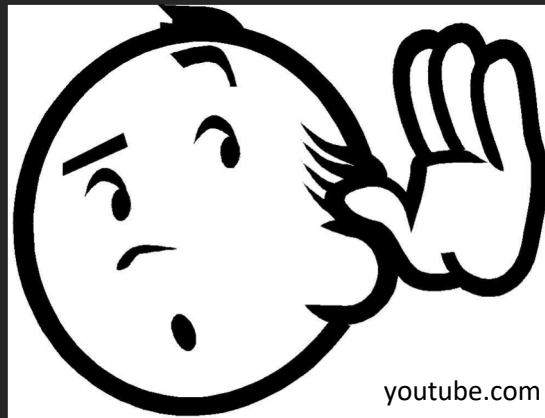


RACIAL SEGREGATION, ENVIRONMENTAL INJUSTICE, AND NOISE POLLUTION IN THE U.S.



October 29, 2018

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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**

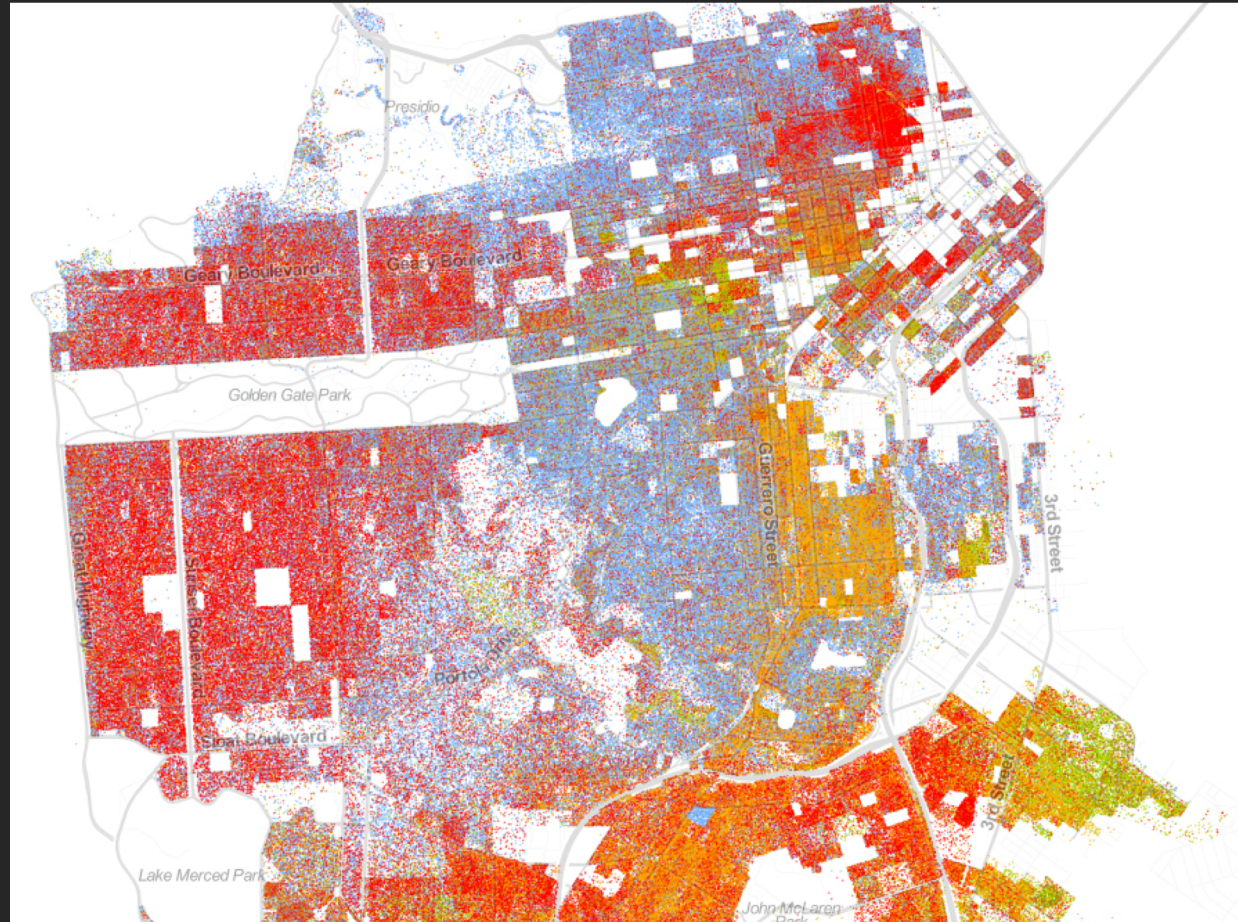
Why segregation matters

- 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

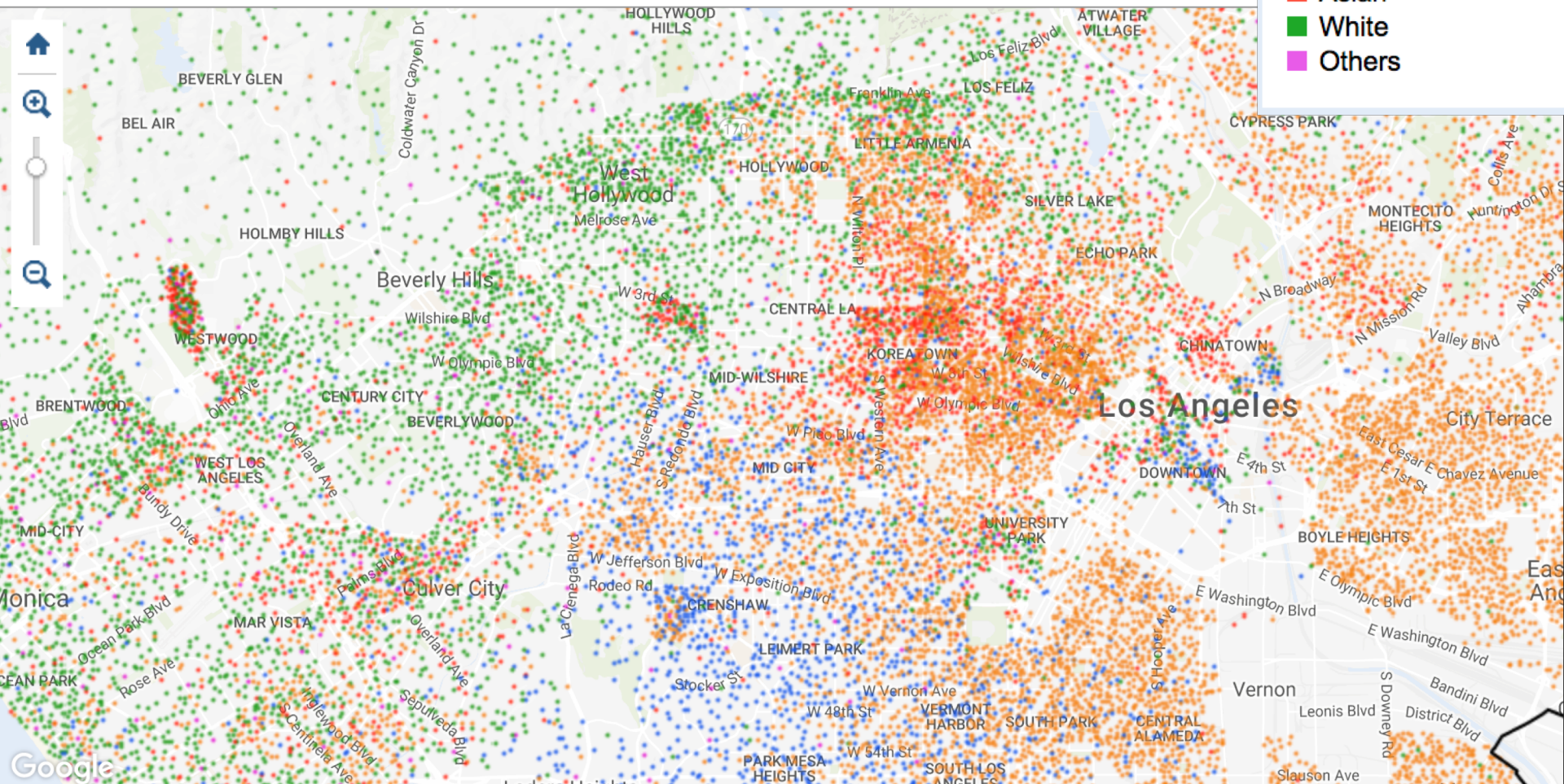
CENSUS GROUP

- Black
- Hispanic
- Asian
- White
- Others

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,¹ 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

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

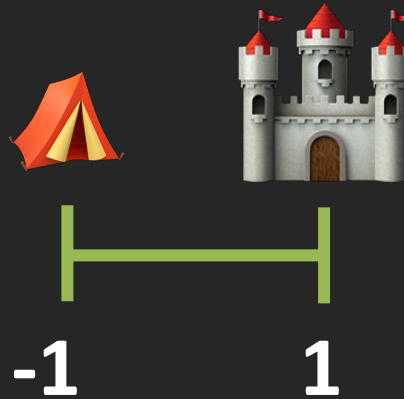
Kershaw KN, Robinson WR, Gordon-Larsen P, Hicken MT, Goff DC, Carnethon MR, Kiefe CI, Sidney S, Diez Roux AV. Association of Changes in Neighborhood-Level Racial Residential Segregation With Changes in Blood Pressure Among Black Adults The CARDIA Study.

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**

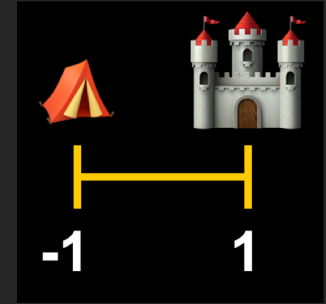
- D_m – Dissimilarity index
- ICE – index of concentration at the extremes

Index of concentration at the extremes



ICE for income

ICE for income



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

↑
≥
80th-
%tile

↑
≤
20th-
%tile

↙
Total #
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)



Calf Source, Wisconsin

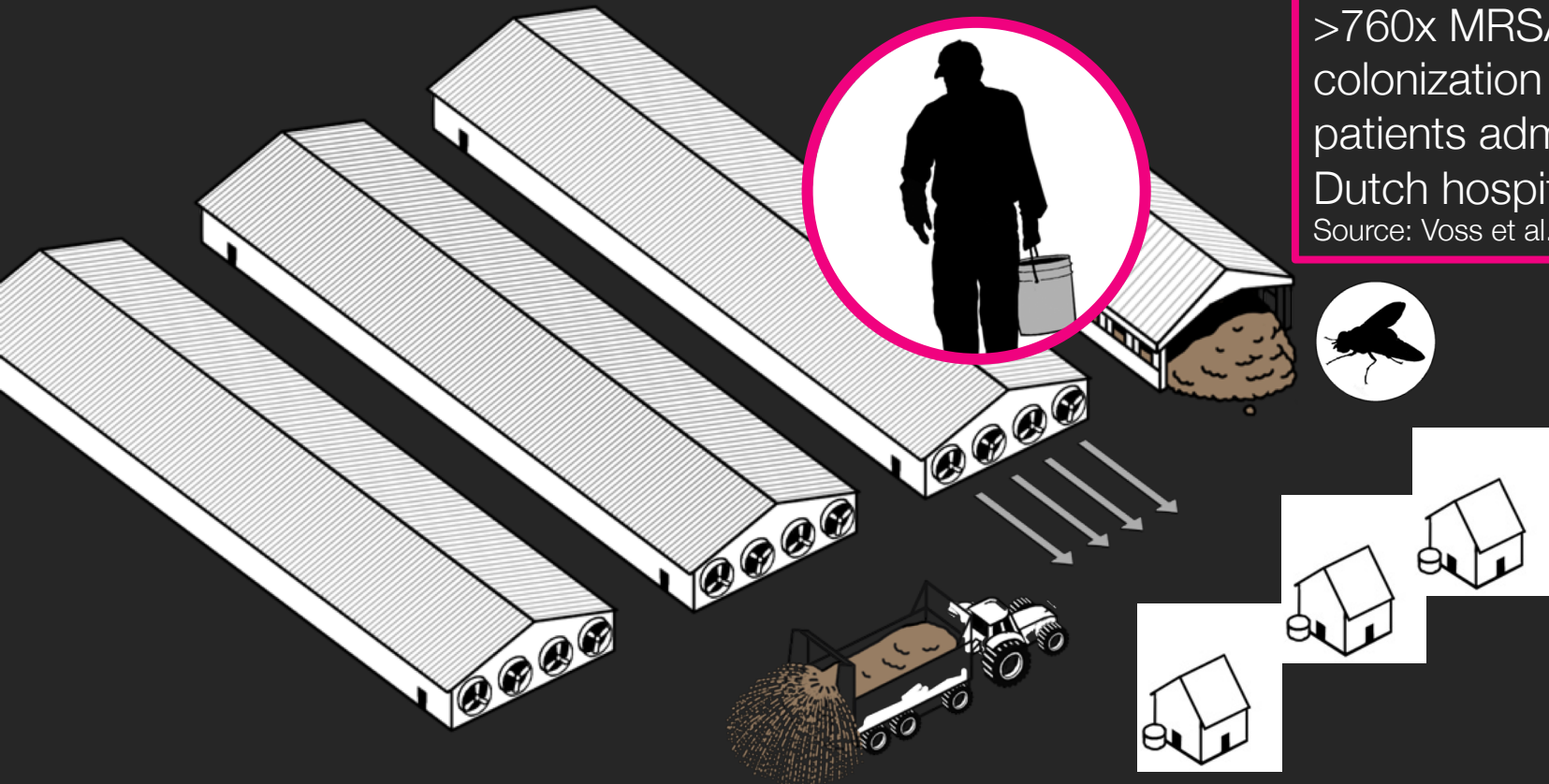
Source: George
Steinmetz for
NYTimes
Magazine, 2016



Gary's Gobbler's, Iowa

Source: George
Steinmetz for
NYTimes Magazine,
2016

on-site and proximate exposure



>760x MRSA
colonization rate of
patients admitted to
Dutch hospitals
Source: Voss et al. 2005 EID

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

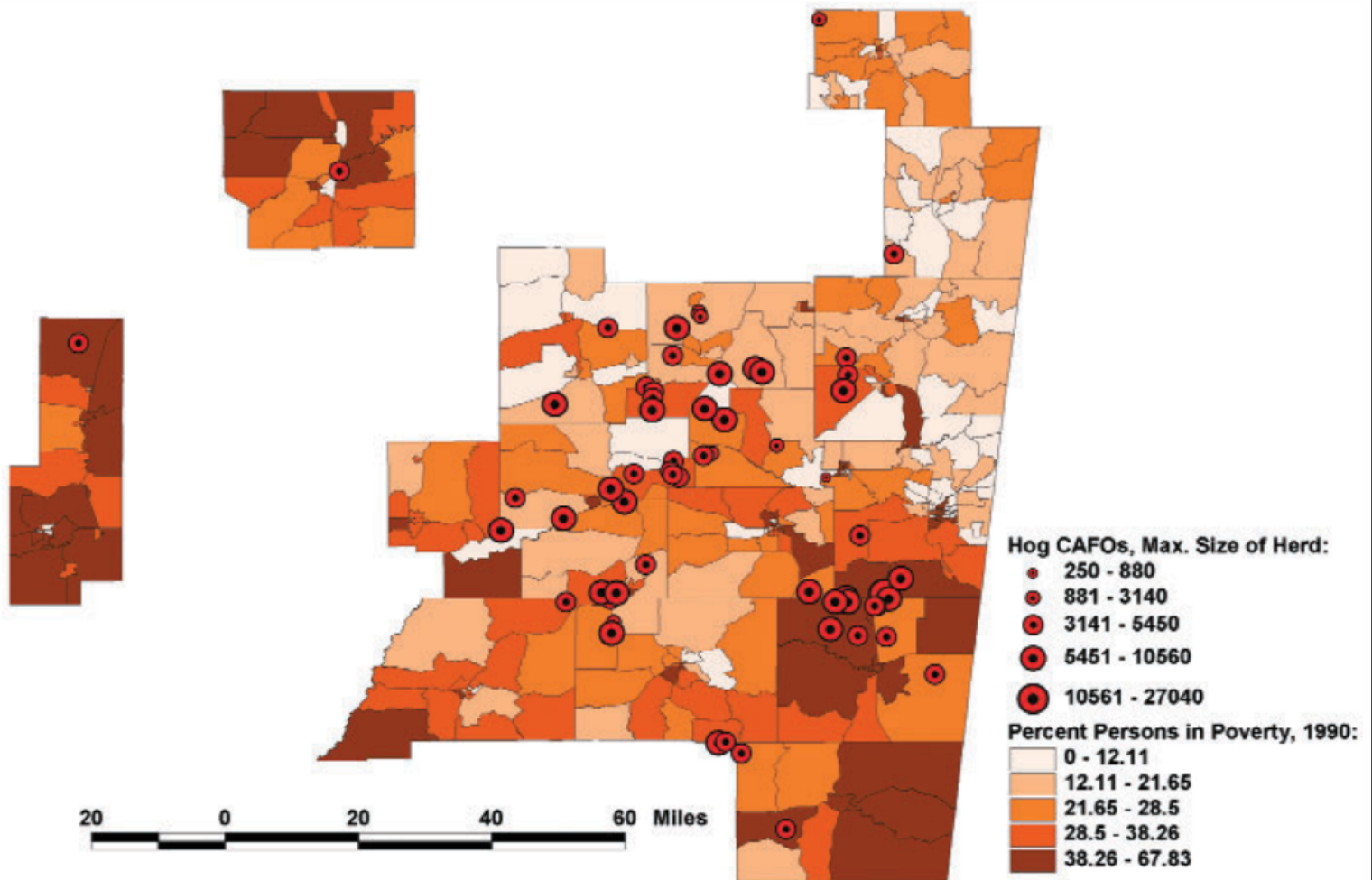


Figure 4. Hog CAFOs in proximity to percentage of poverty, Mississippi hog counties, 1990.

Greensboro
Winston-Salem | Durham
| Raleigh

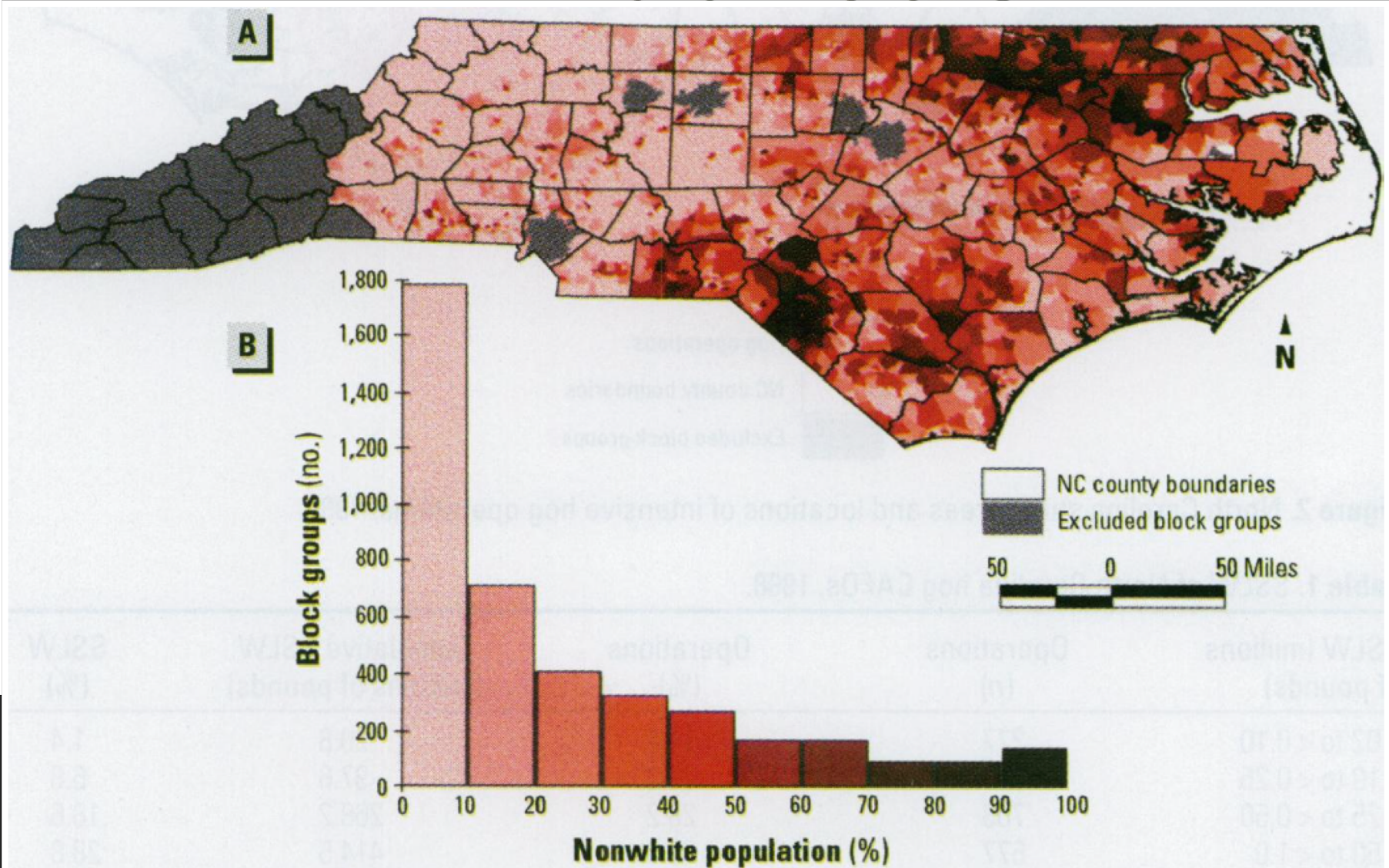


Figure 4. (A) The percentage nonwhite population in North Carolina, 1990. (B) The number of block groups in each category of the percentage nonwhite population.

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

Longitudinal EJ

- Hazardous waste treatment, storage and disposal facility (TSDF) locations
- Two early studies (Oakes et al. 1996 and Been & Gupta 1997) found no relationship
- Pastor et al. looked in LA using a distance approach

Pastor et al. 2001

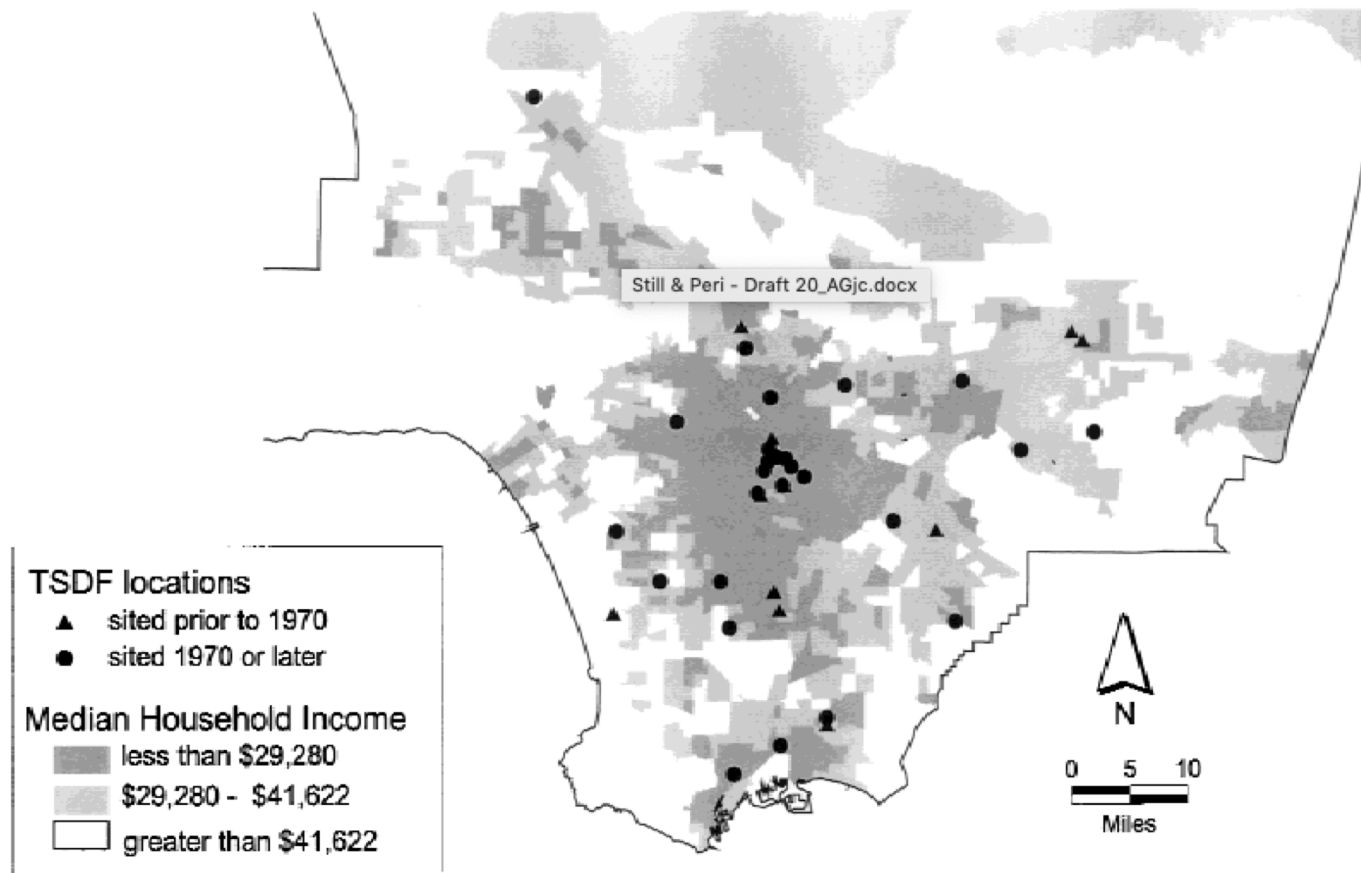


FIGURE 2

High Capacity Hazardous Waste TSDs and Median Household Income, 1990, Los Angeles County, California

Note: Each category contains one-third of all Los Angeles County census tracts.

Pastor et al. 2001

Comparison of the Characteristics of Tracts That Would Receive a TSDF in 1970–90 With All Other Tracts in Los Angeles County in 1970

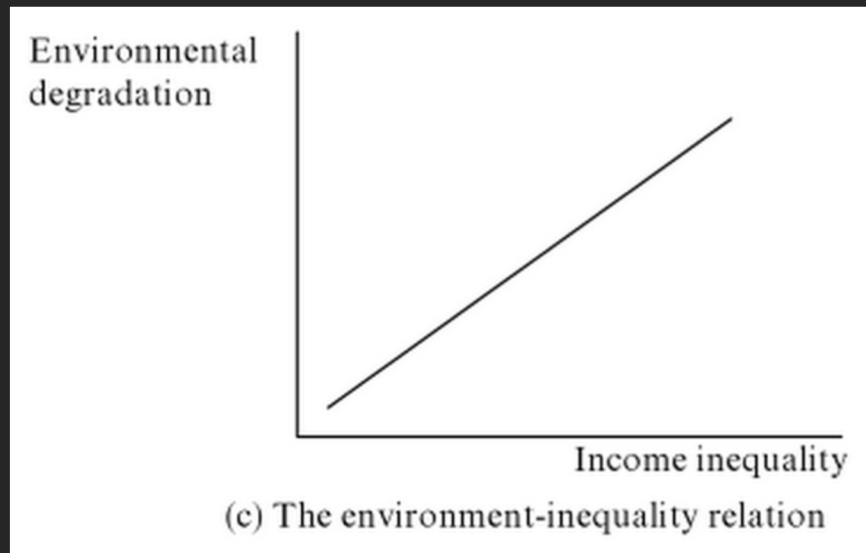
Variable	1970 Average	TSDF Sited Within 1/4 Mile Between 1970–90 (Difference)	TSDF Sited Within 1 Mile Between 1970–90 (Difference)
% Minority	31.8	22.2***	22.2***
% African American	10.8	15.4**	11.0***
% Latino	10.0	4.3	9.0***
Household Income	\$10,032	-\$1,908***	-\$1,603***
Home Value	\$26,042	-\$4,621***	-\$4,270***
Median Rent	\$138	-23.0***	-21.3***
% College Educated	12.6	-4.9***	-5.2***
% Single Family Housing	64.4	-9.2**	-1.4
Population Density	8,724.1	-1933.9*	446.0
% Blue Collar	46.1	9.8***	9.4***
N (depends on variable)	1604–1640	34–35	161–164

*p < .10. **p < .05. ***p < .01.

Still & Peri - Draft 20_AGjc.docx

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



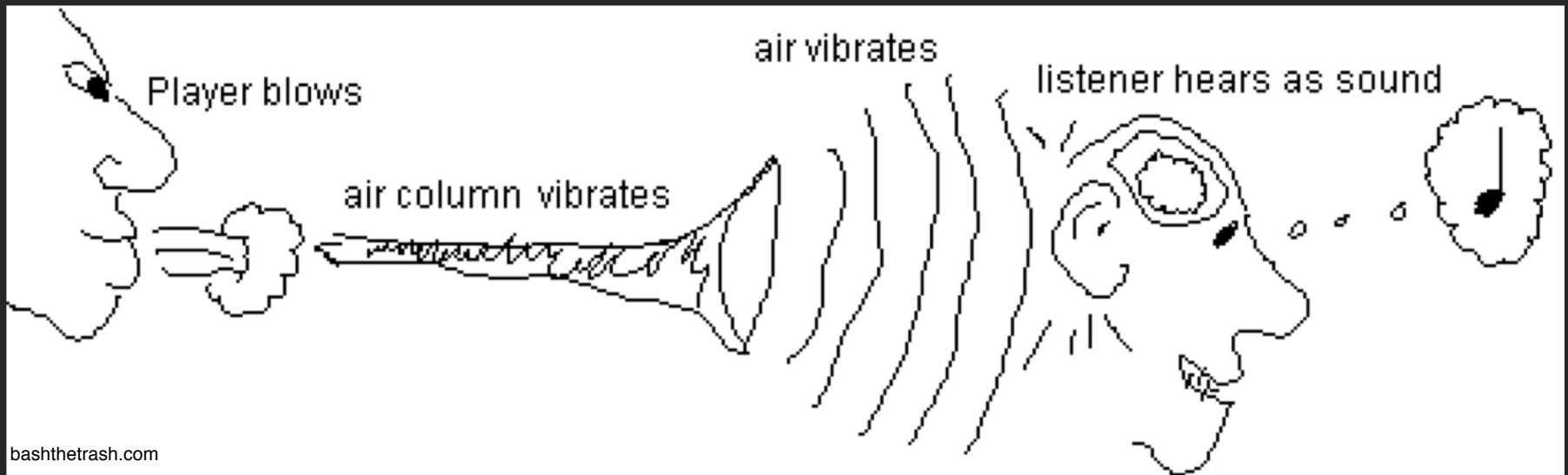
A case study

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

Joan A. Casey,¹ Rachel Morello-Frosch,² Daniel J. Mennitt,³ Kurt Frstrup,⁴ Elizabeth L. Ogburn,⁵ and Peter James⁶

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

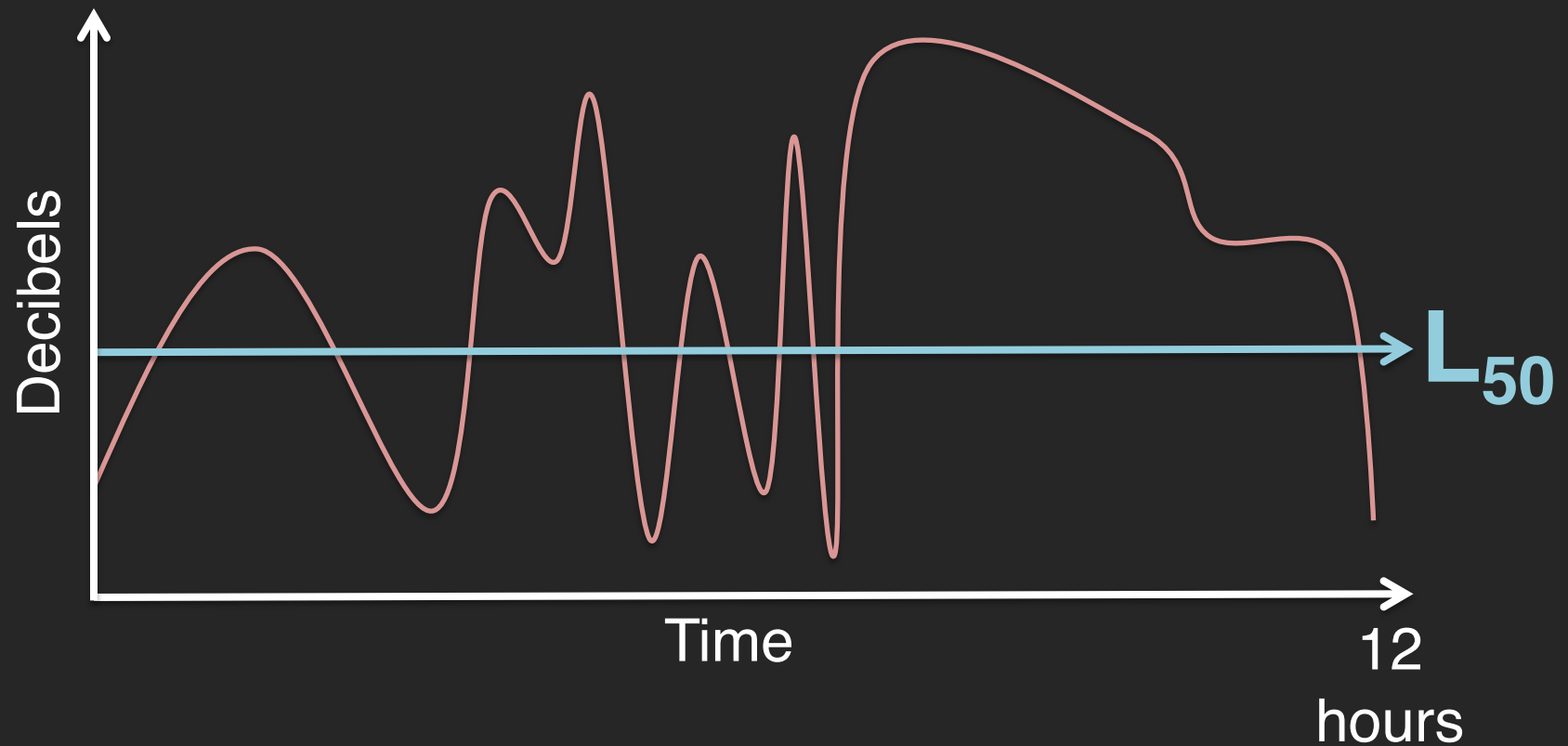
Change (dBA)	Human Perception of Sound
2-3	Perceptible
5	Readily noticeable, increase in noise complaints
10	A doubling or halving of the loudness of sound

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

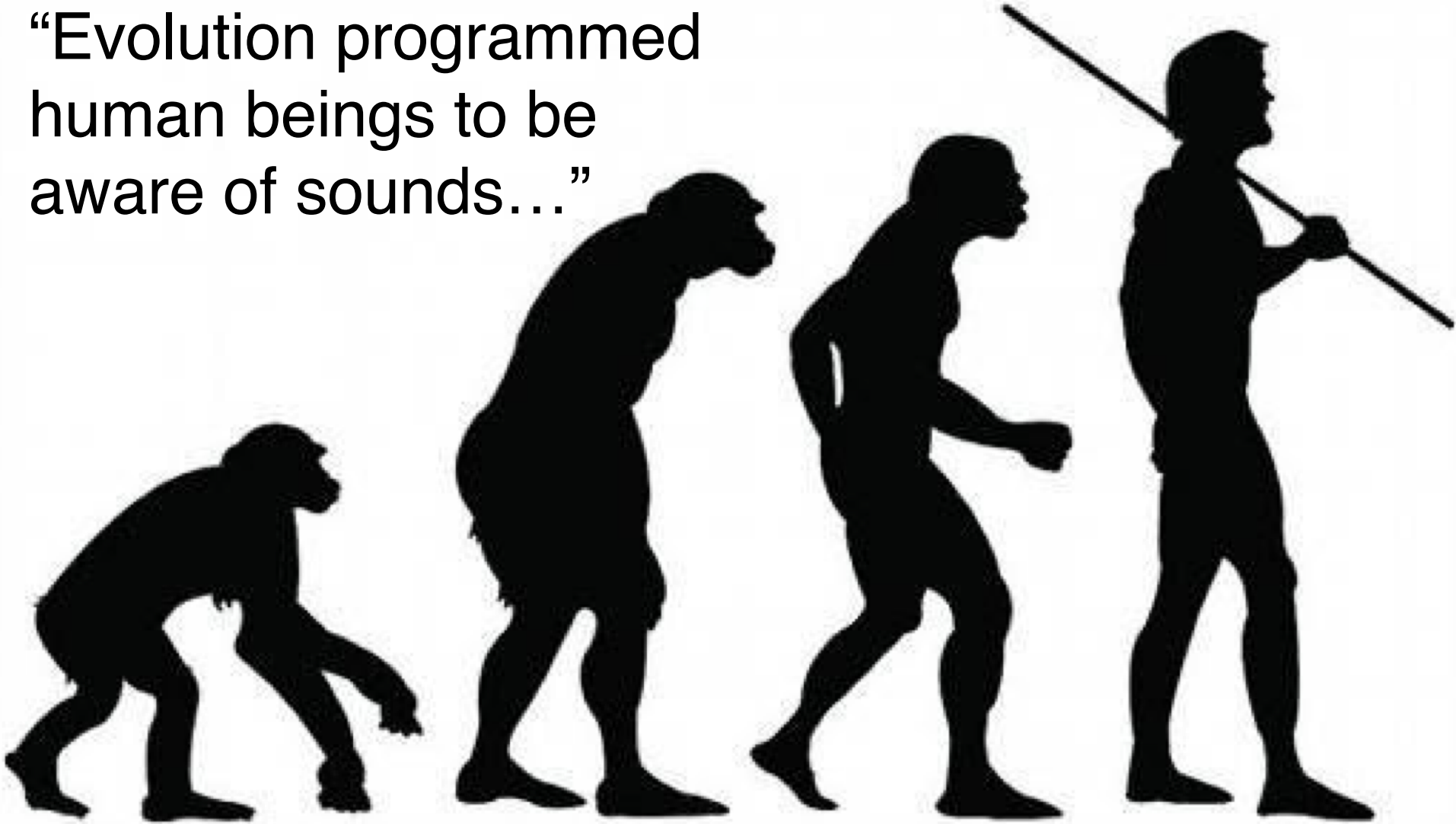
Noise is **unwanted** sound



Noise is not constant

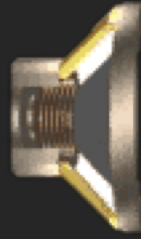


“Evolution programmed
human beings to be
aware of sounds...”



“....as possible
sources of
danger”

(Basner et al. *Lancet* 2014)



Noise **activates** the
autonomic nervous system



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

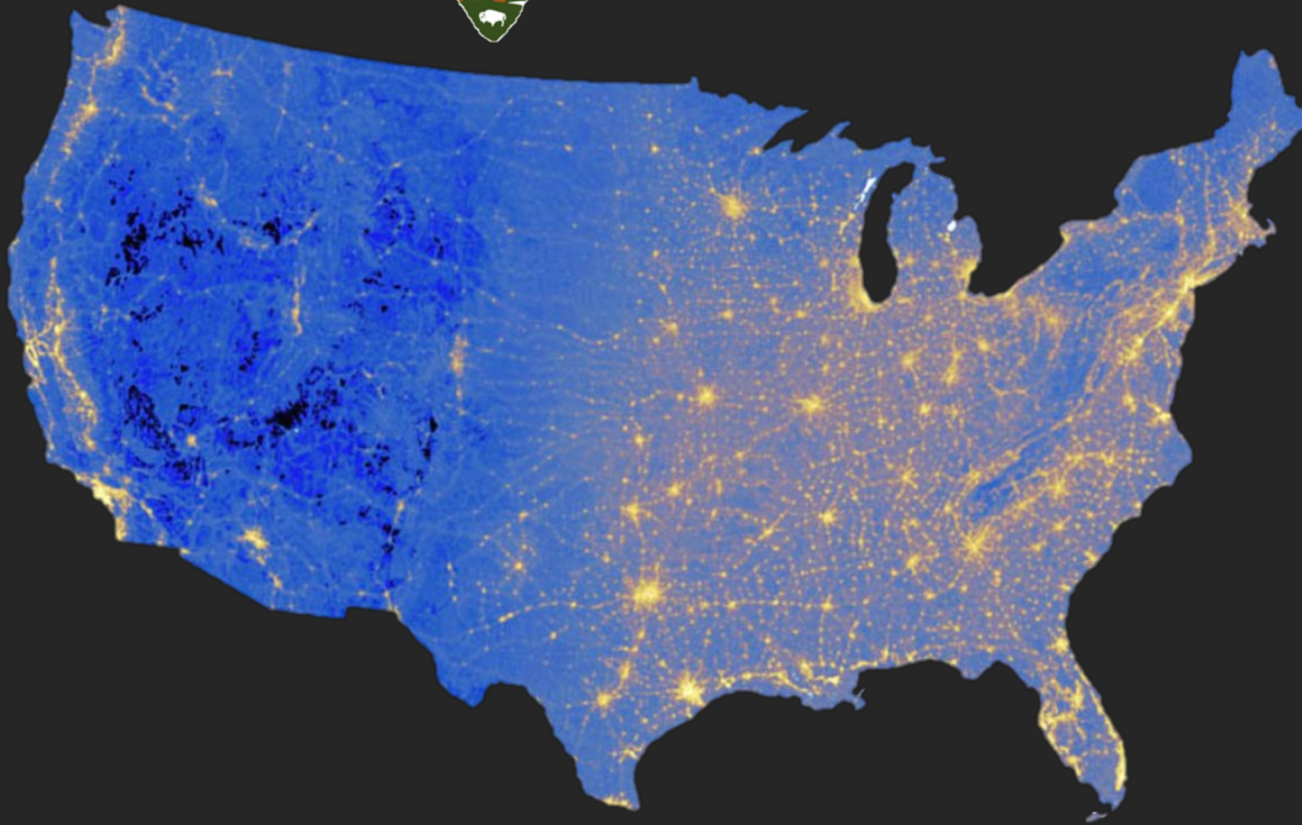
Noise last characterized nationwide in the 1970s

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

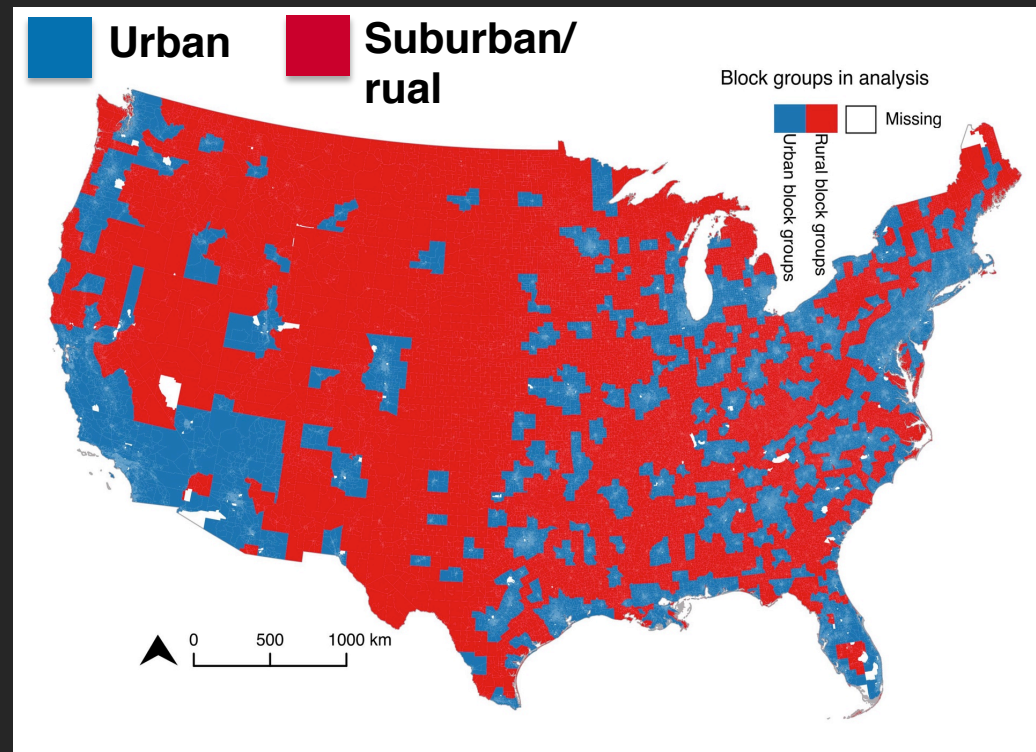
METHODS

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

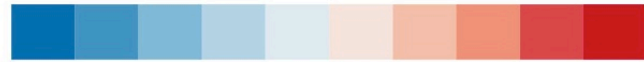
RESULTS

non-linear relationships

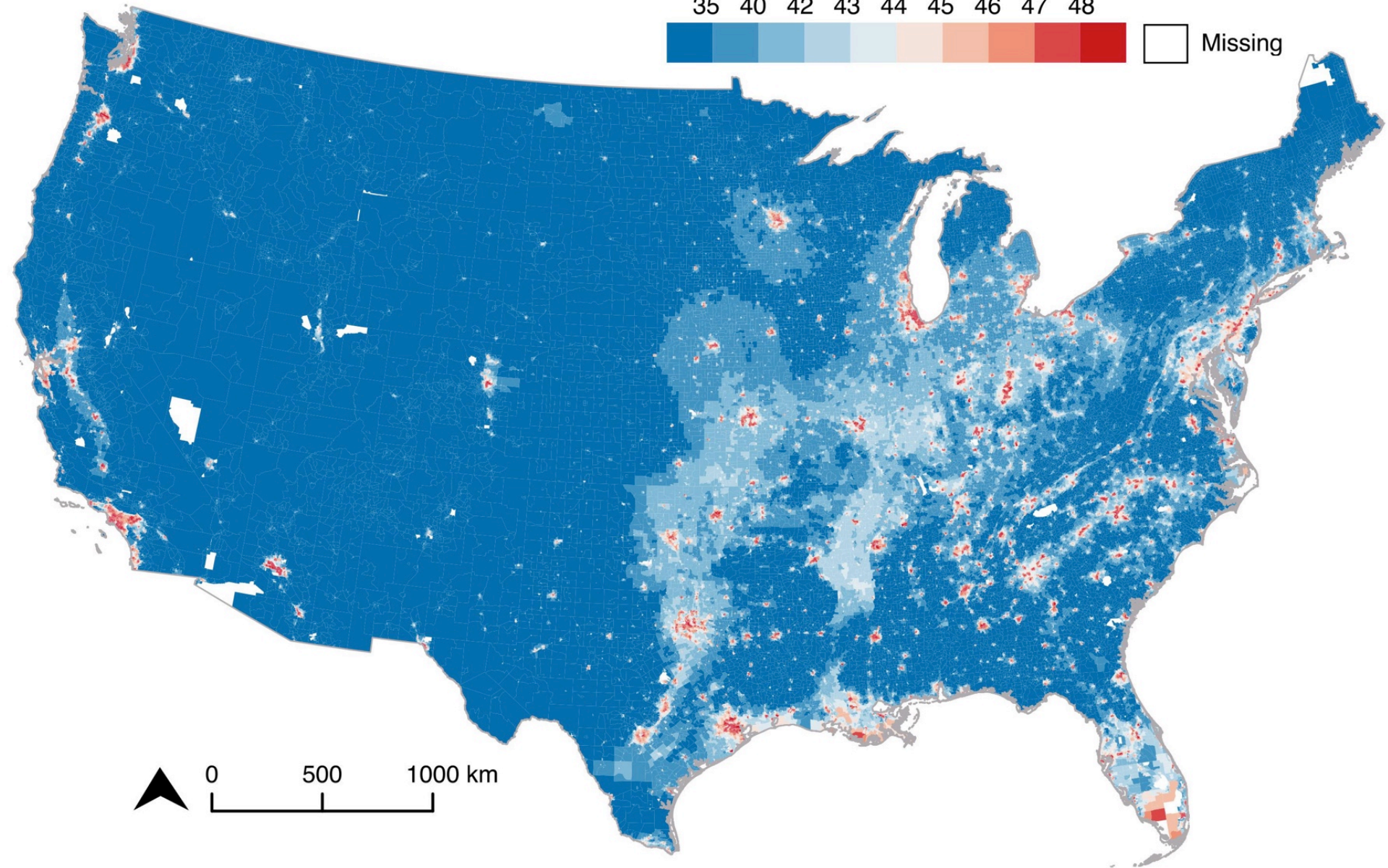
generally observed evidence of
disparities

Anthropogenic L50 Nighttime Noise (dBA)

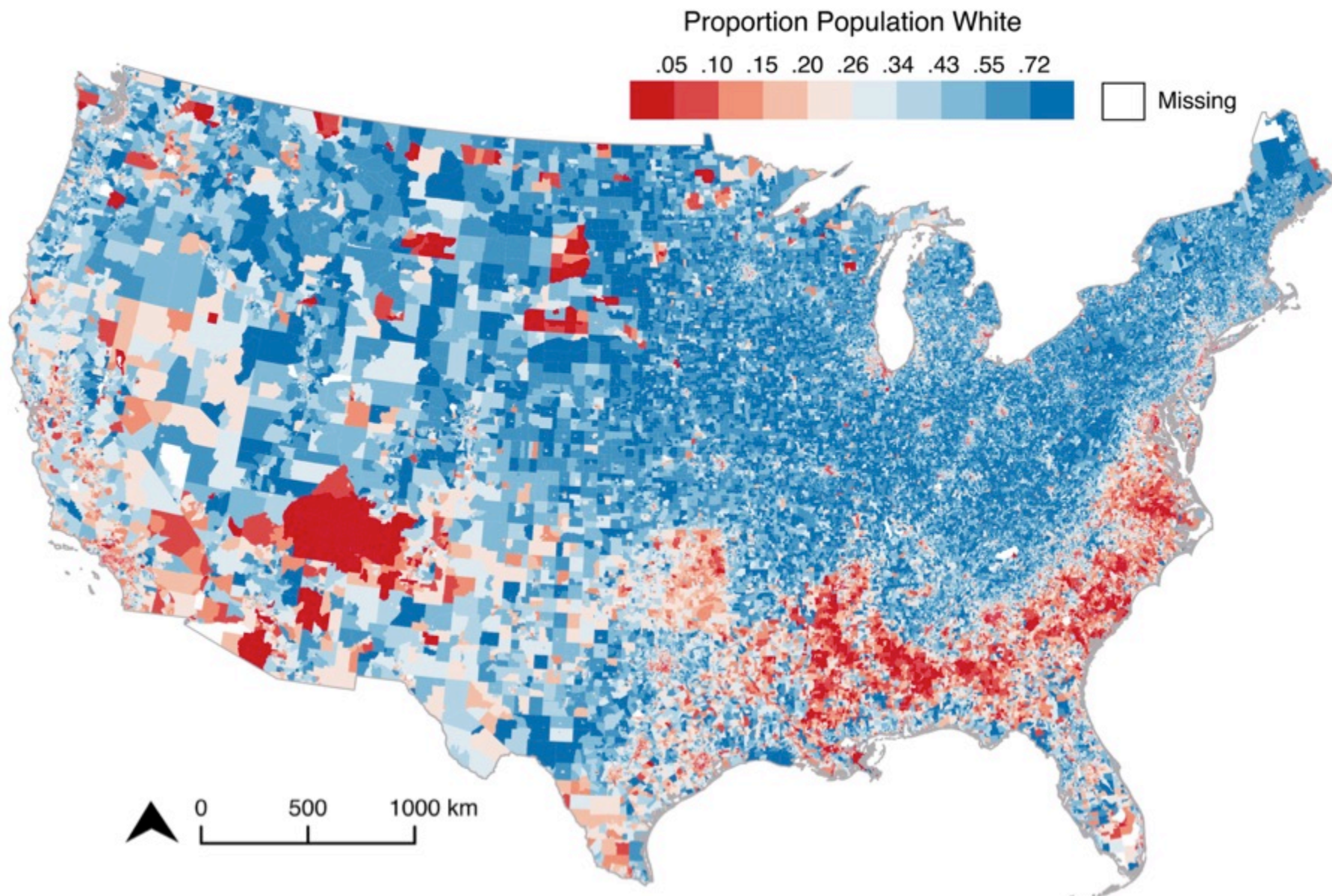
35 40 42 43 44 45 46 47 48



Missing



0 500 1000 km

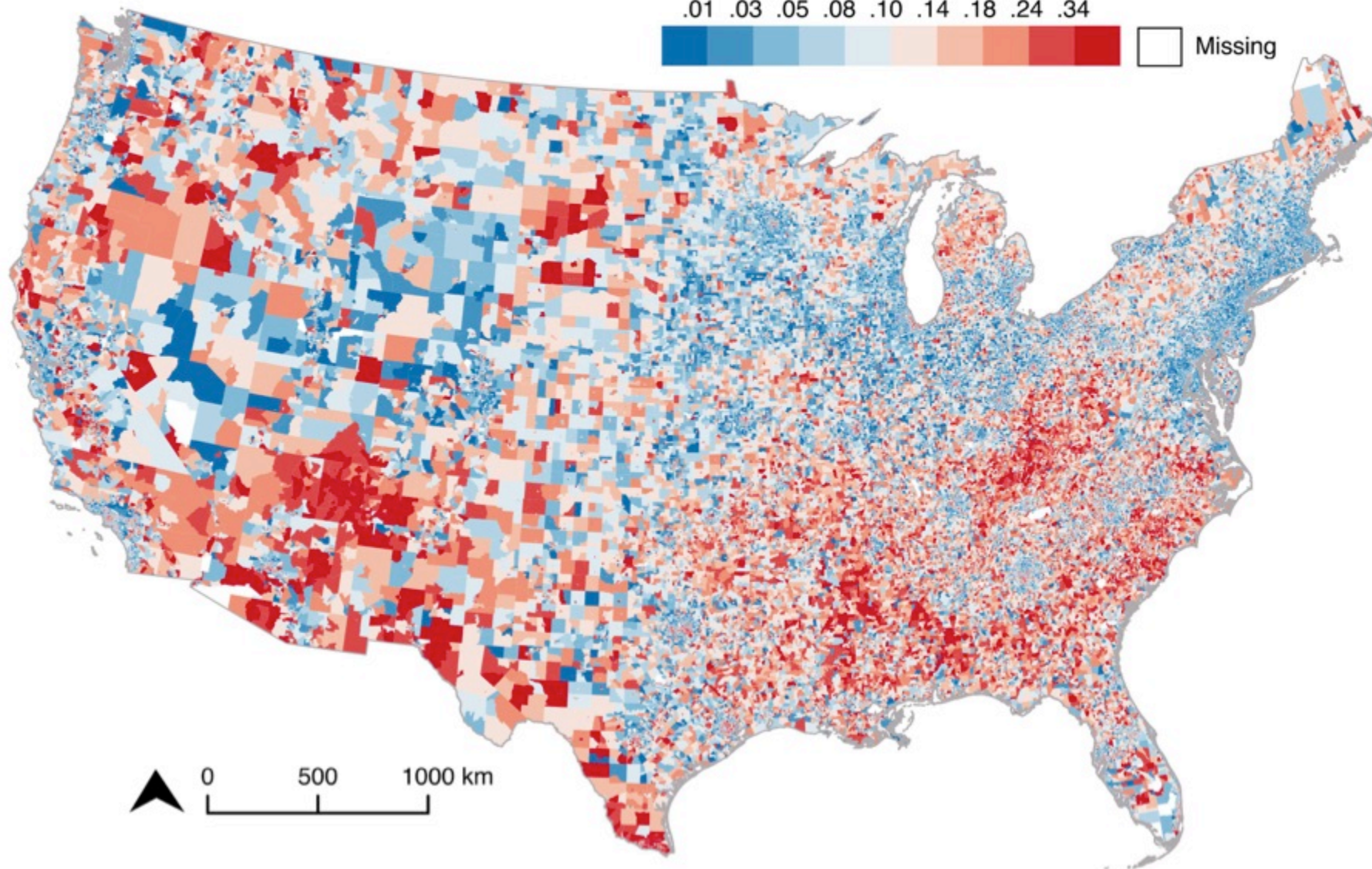


Proportion Household Income Below Poverty Threshold

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



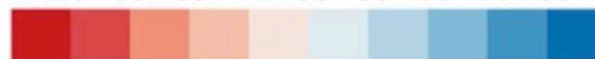
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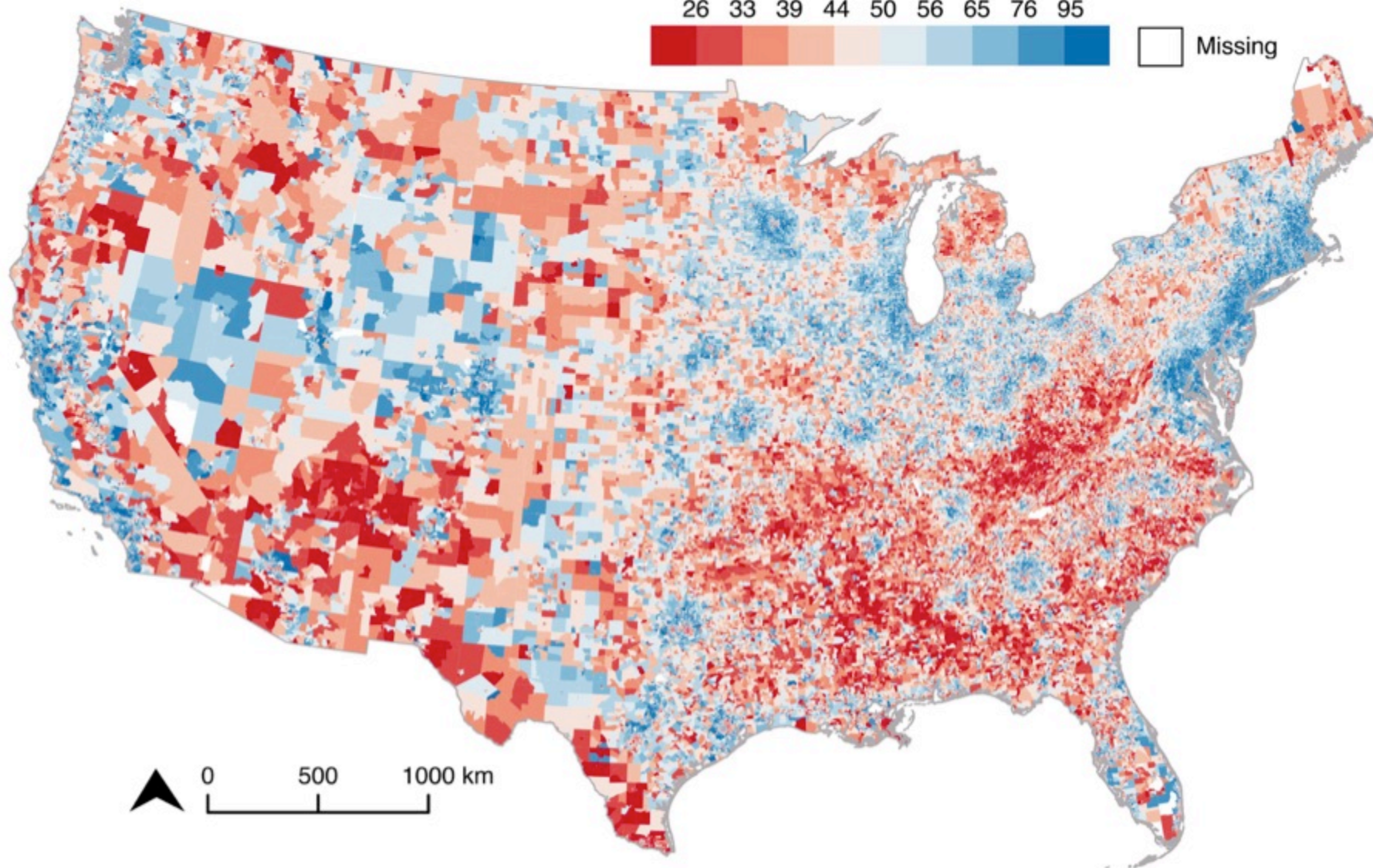
0 500 1000 km

Median Household Income, Thousands (\$)

26 33 39 44 50 56 65 76 95

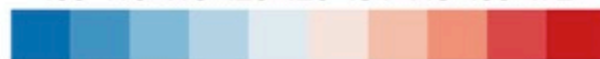


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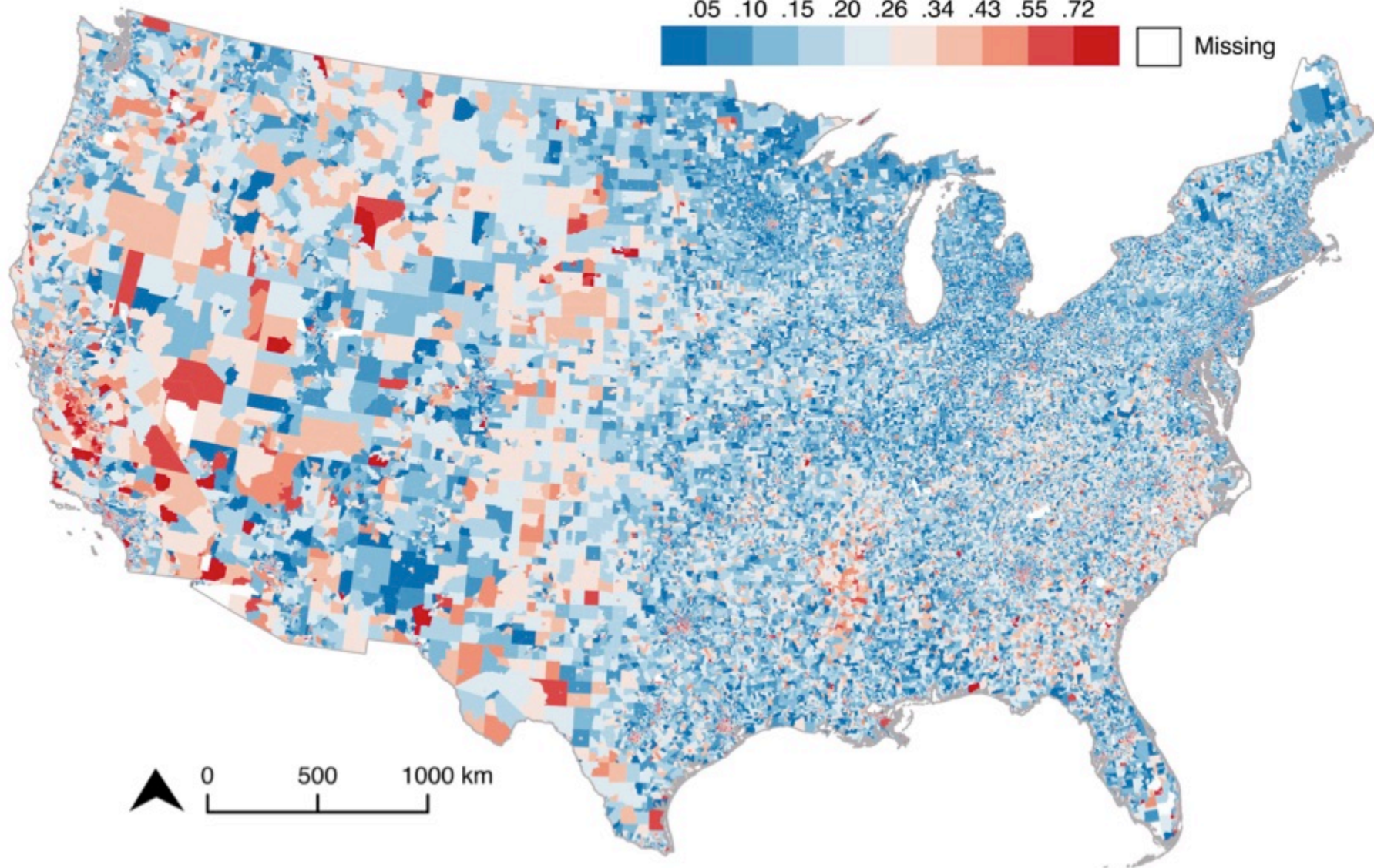


Proportion Housing Units Rented

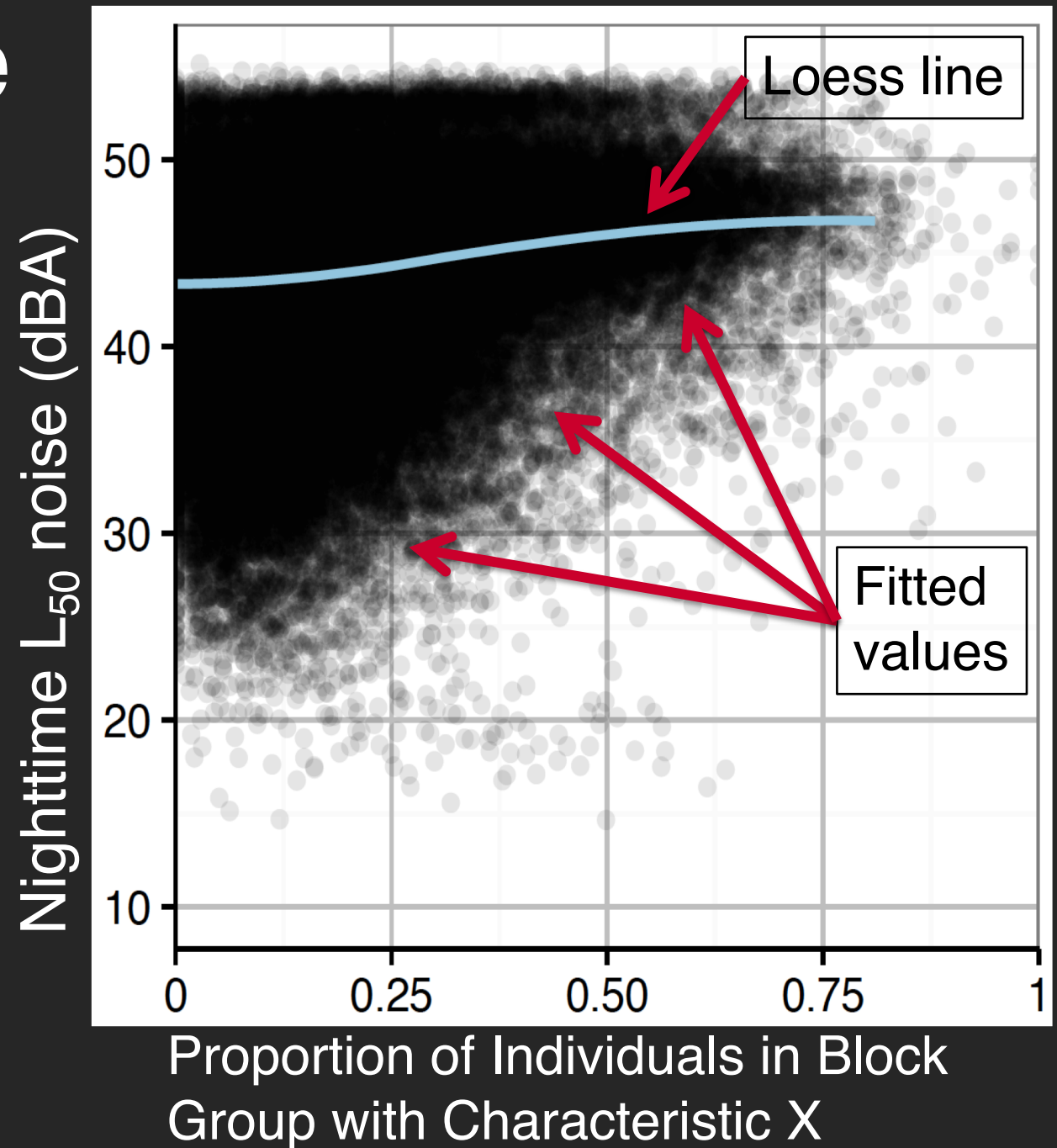
.05 .10 .15 .20 .26 .34 .43 .55 .72



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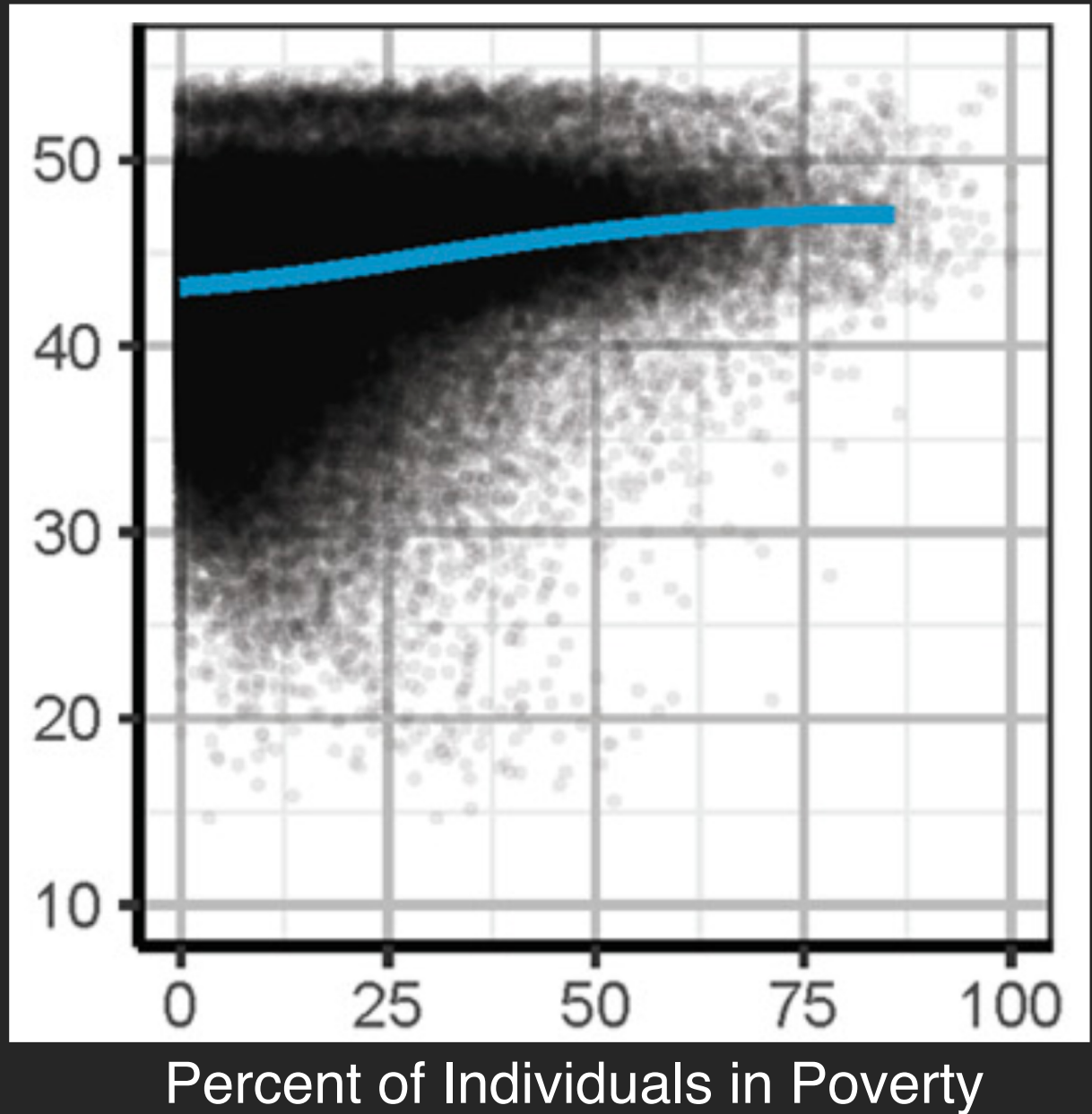


Prototype



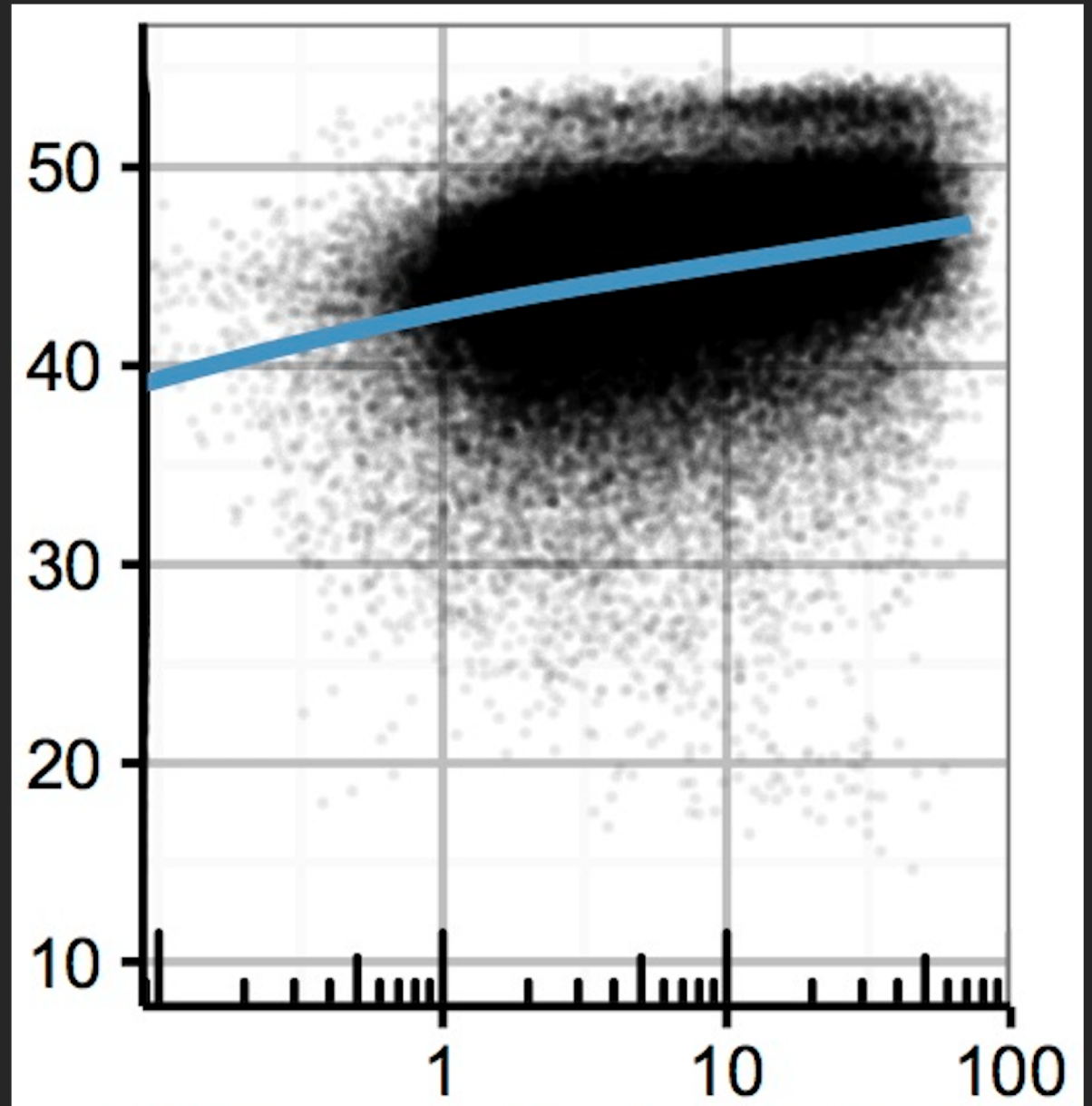
Poverty

Nighttime L_{50} noise (dBA)



Linguistically isolated households

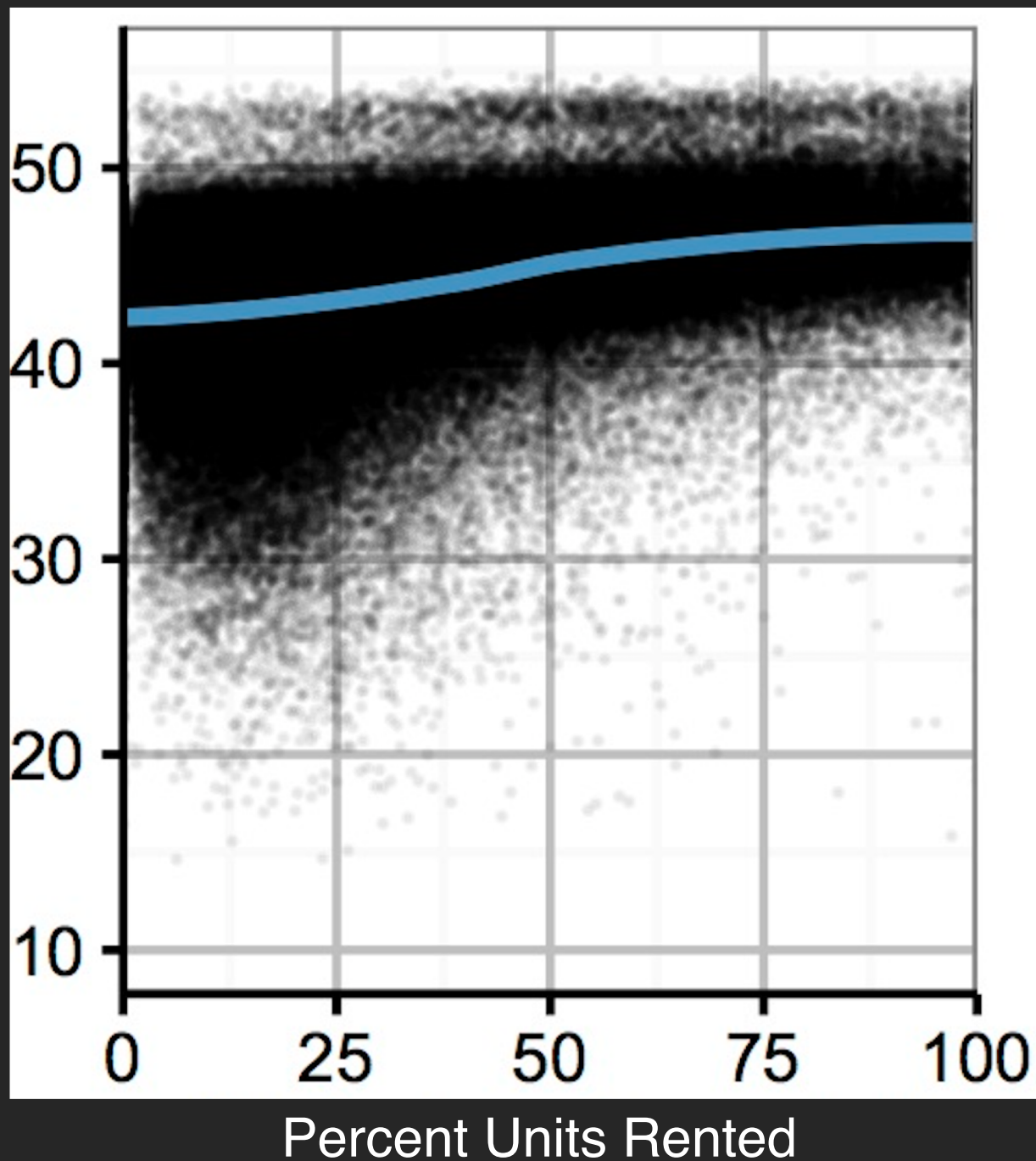
Nighttime L_{50} noise (dBA)



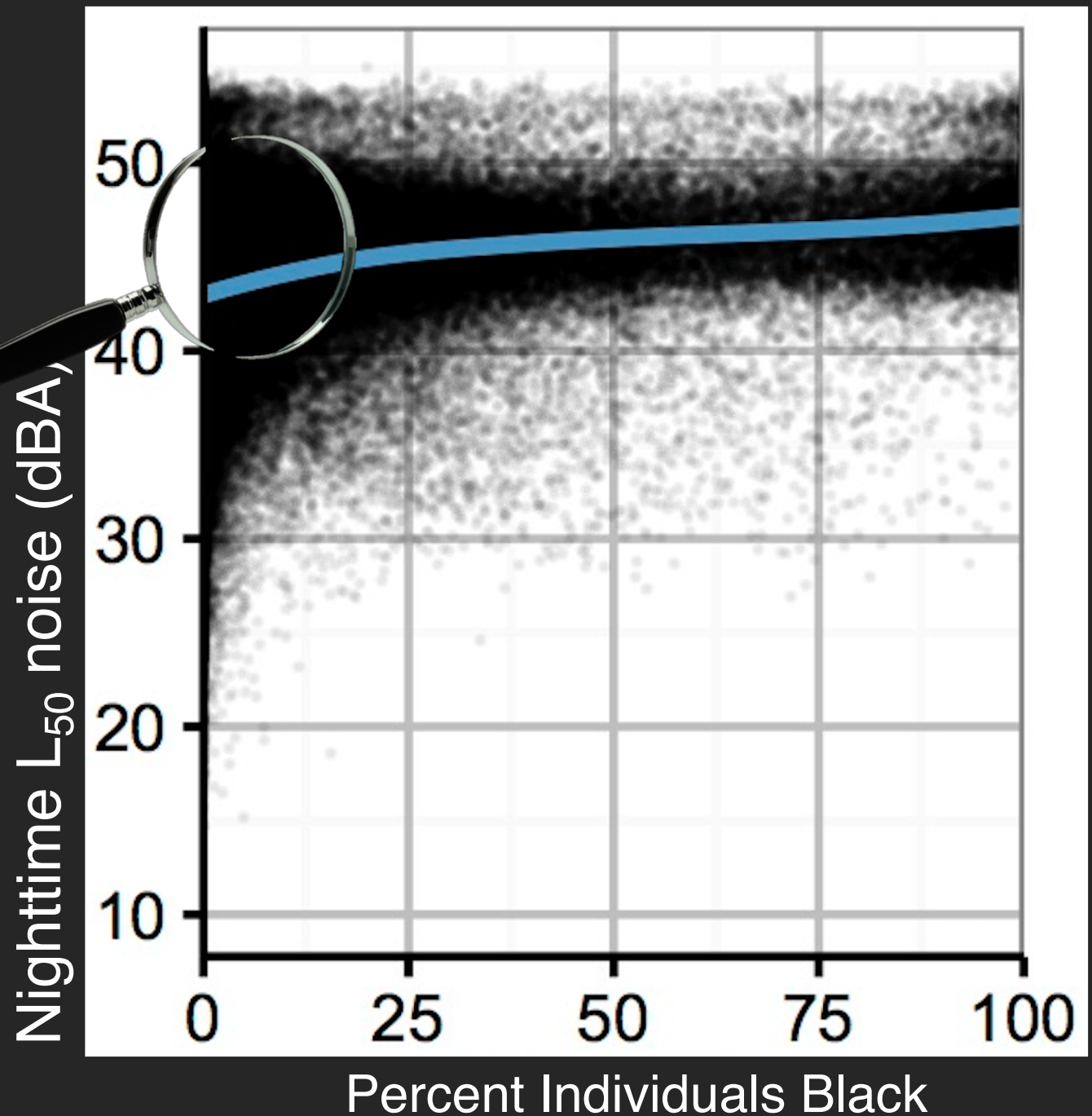
Percent Households in Linguistic Isolation

Rented homes

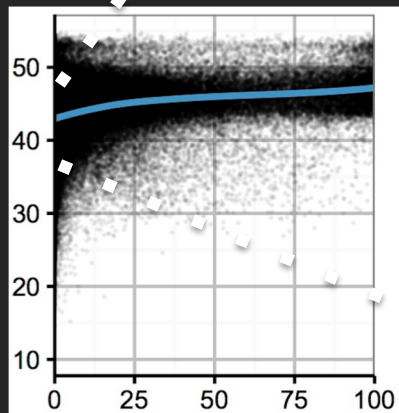
Nighttime L_{50} noise (dBA)



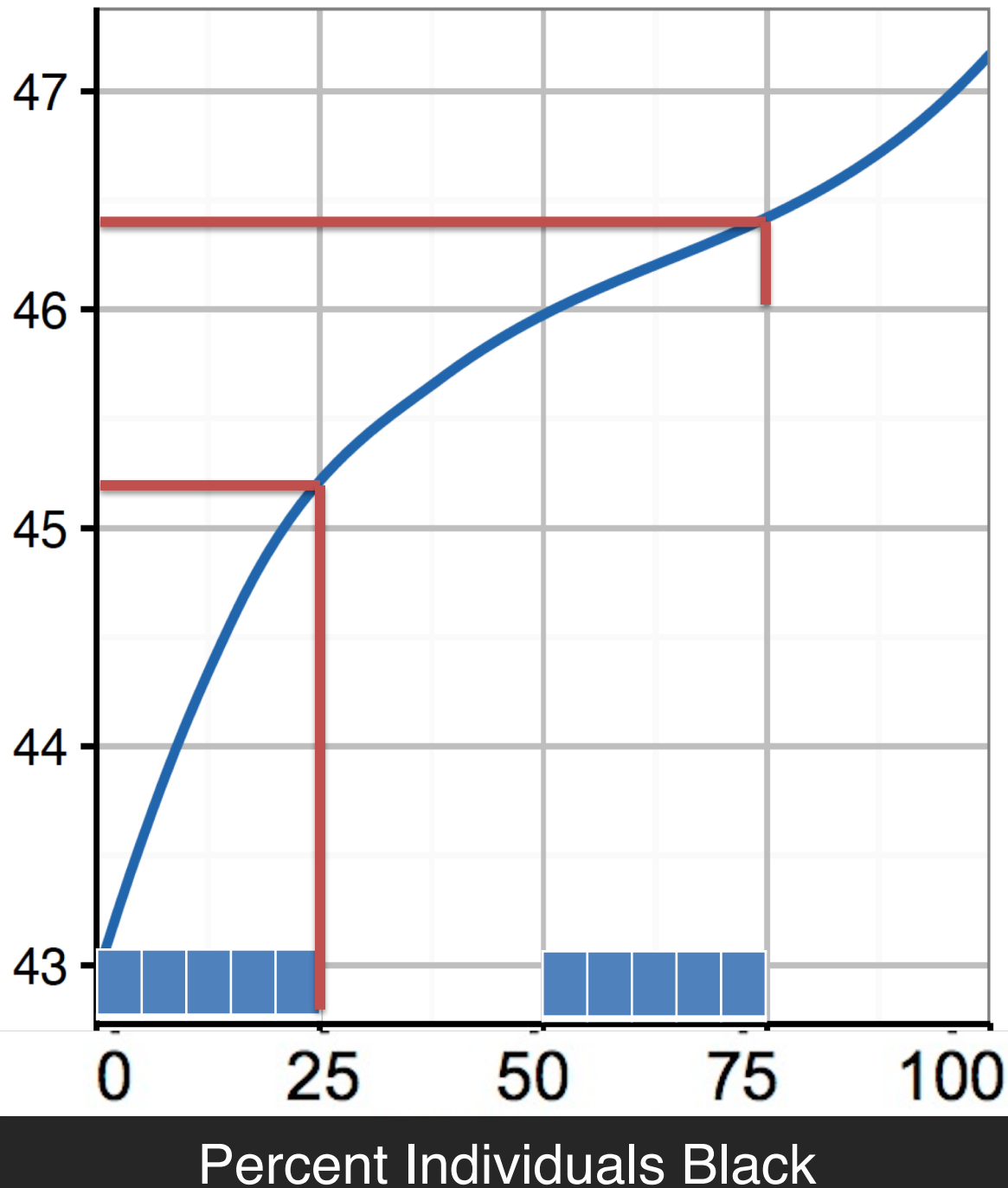
Black
race/
ethnicity



Black
race/
ethnicity

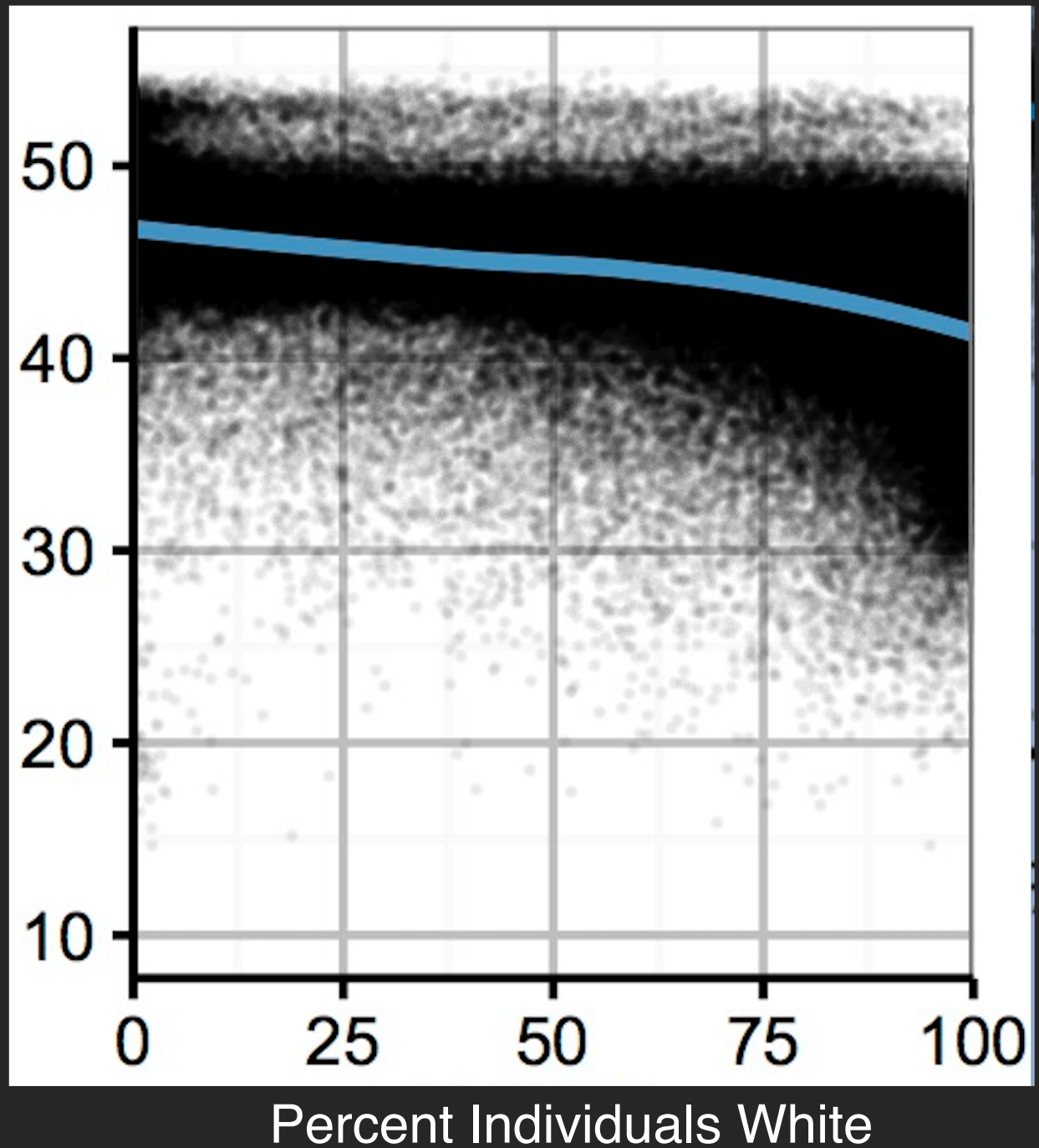


Nighttime L₅₀ noise (dBA)



White
race/
ethnicity

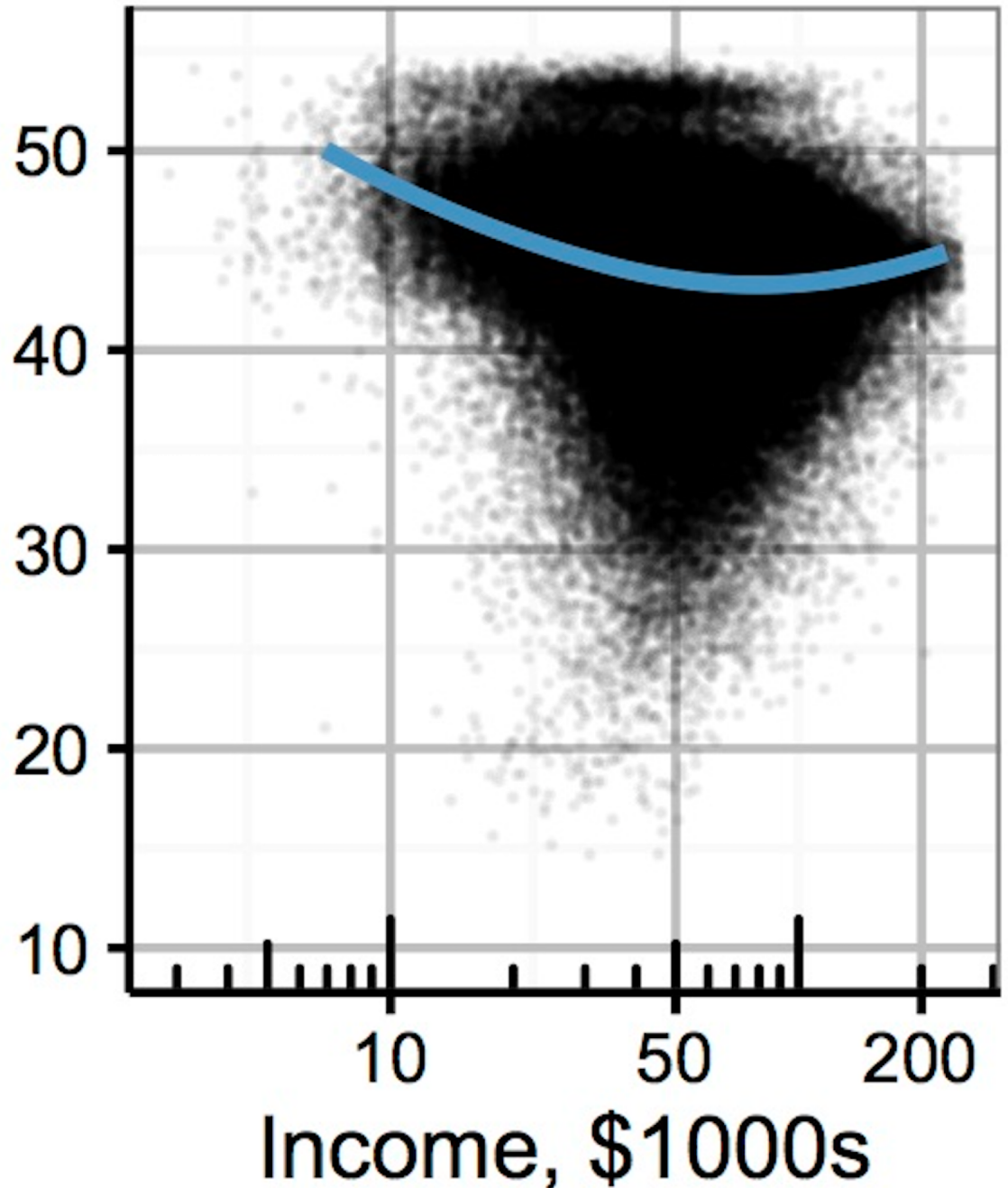
Nighttime L_{50} noise (dBA)



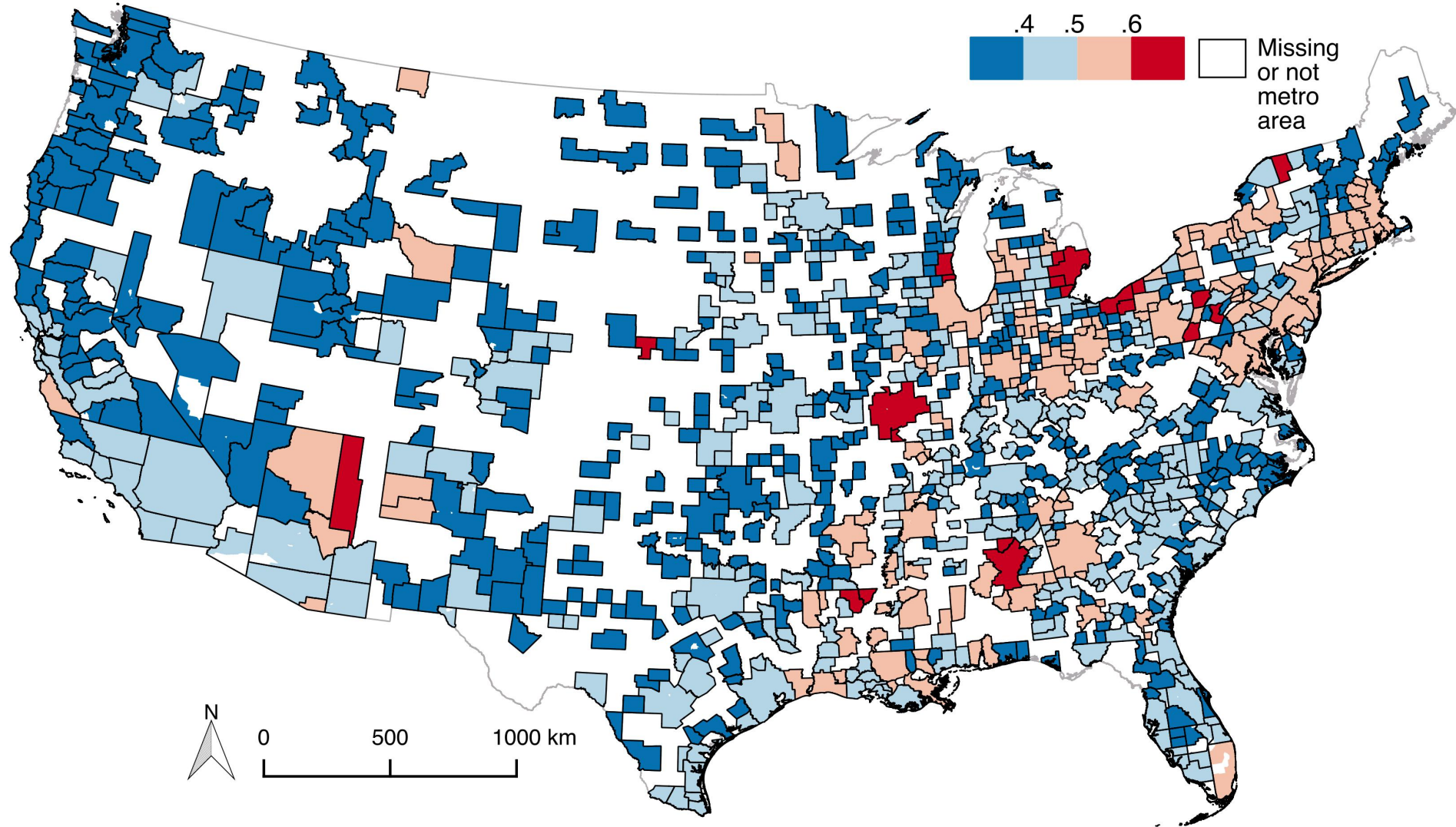
Median income

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

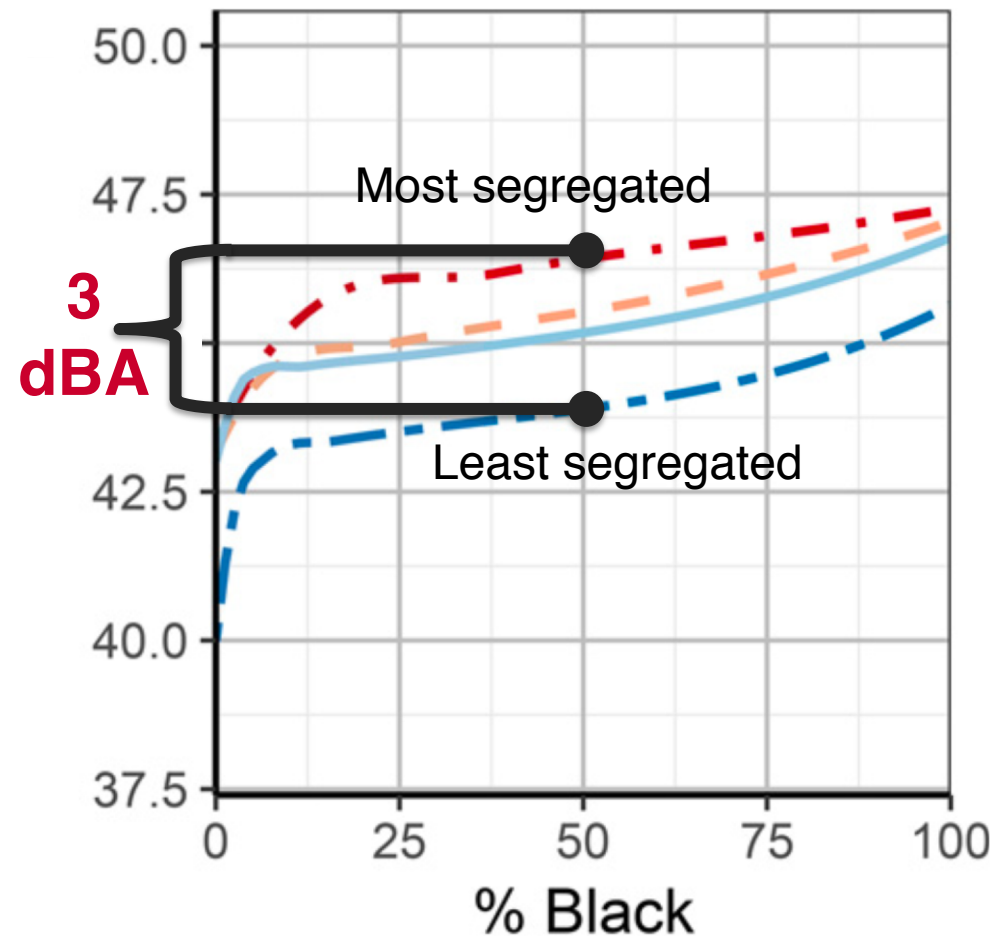
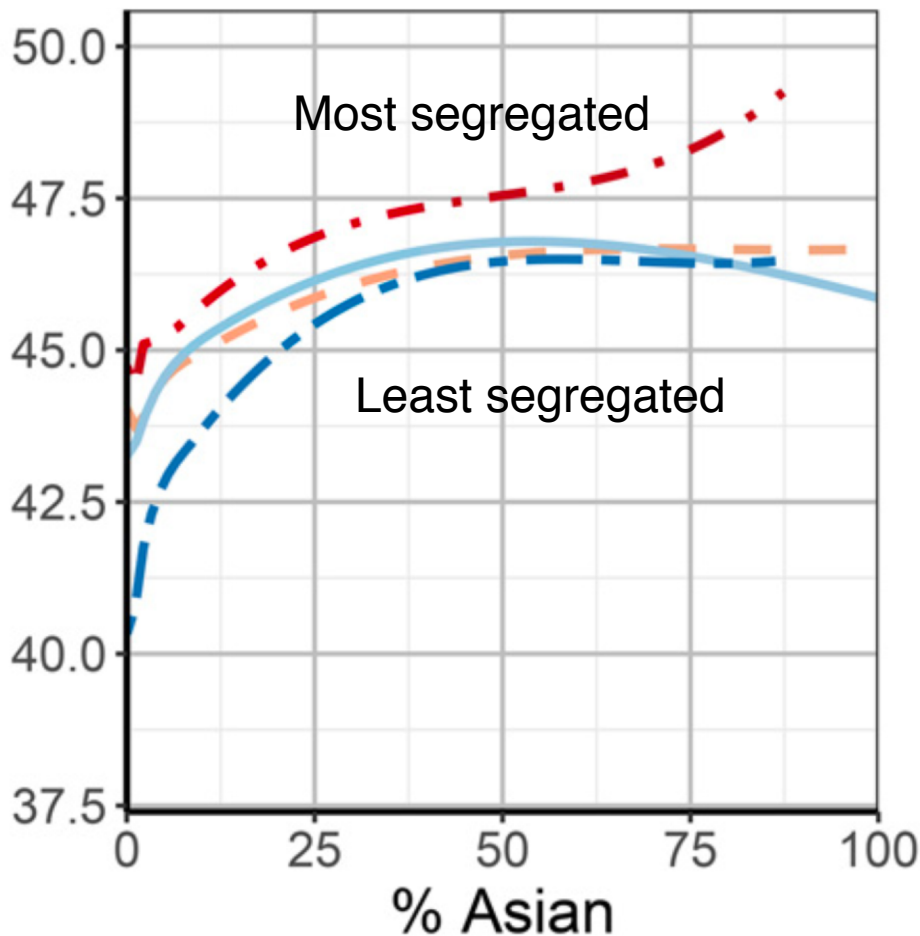
Nighttime L_{50} noise (dBA)



Residential racial segregation



Race/ethnicity and nighttime noise, by segregation

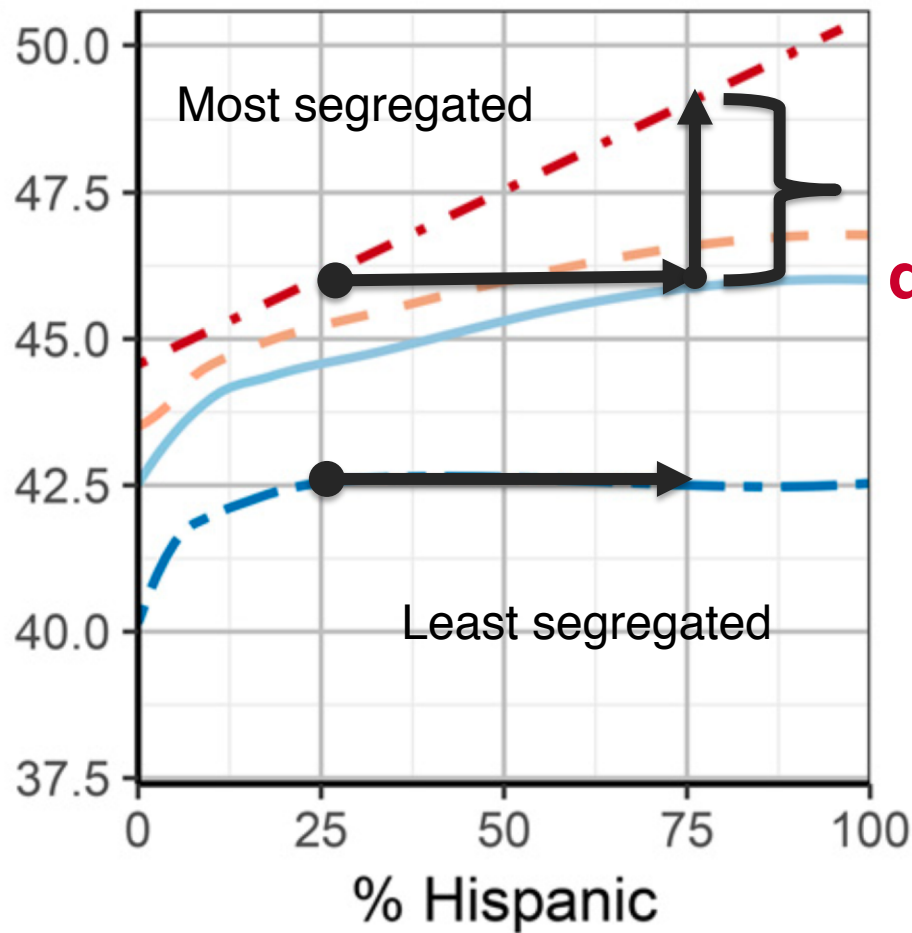


Least
segregated

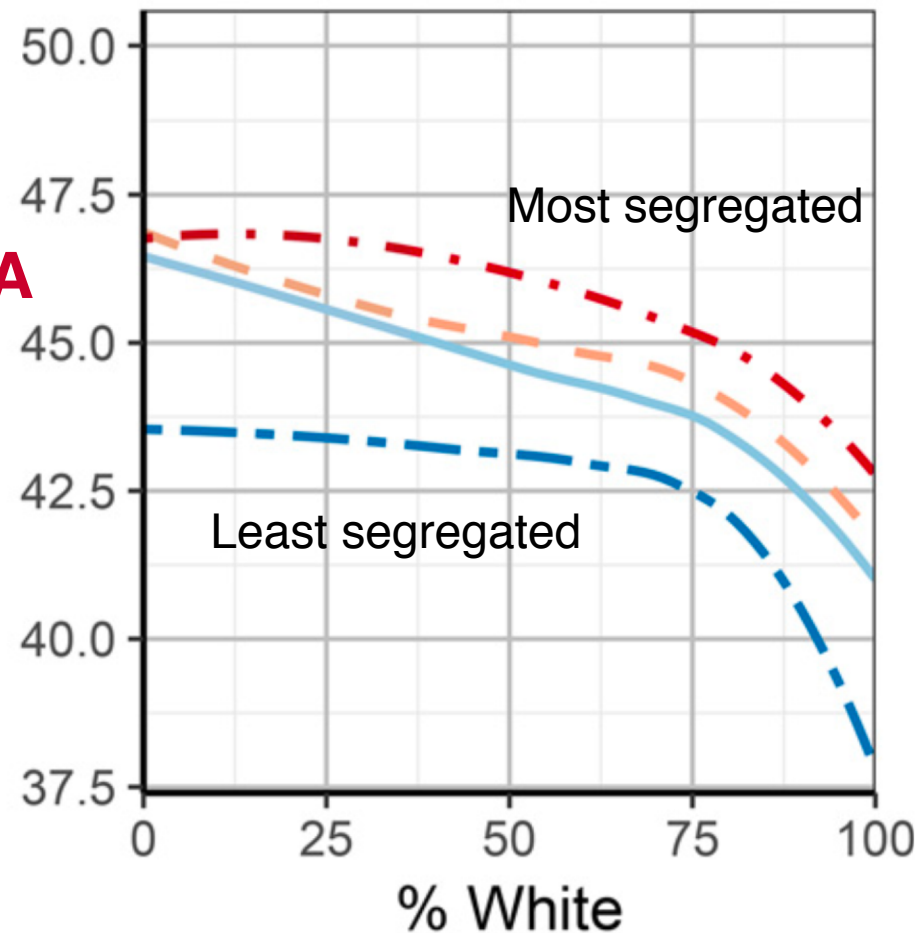


Most
segregated

Race/ethnicity and nighttime noise, by segregation



3
dBA

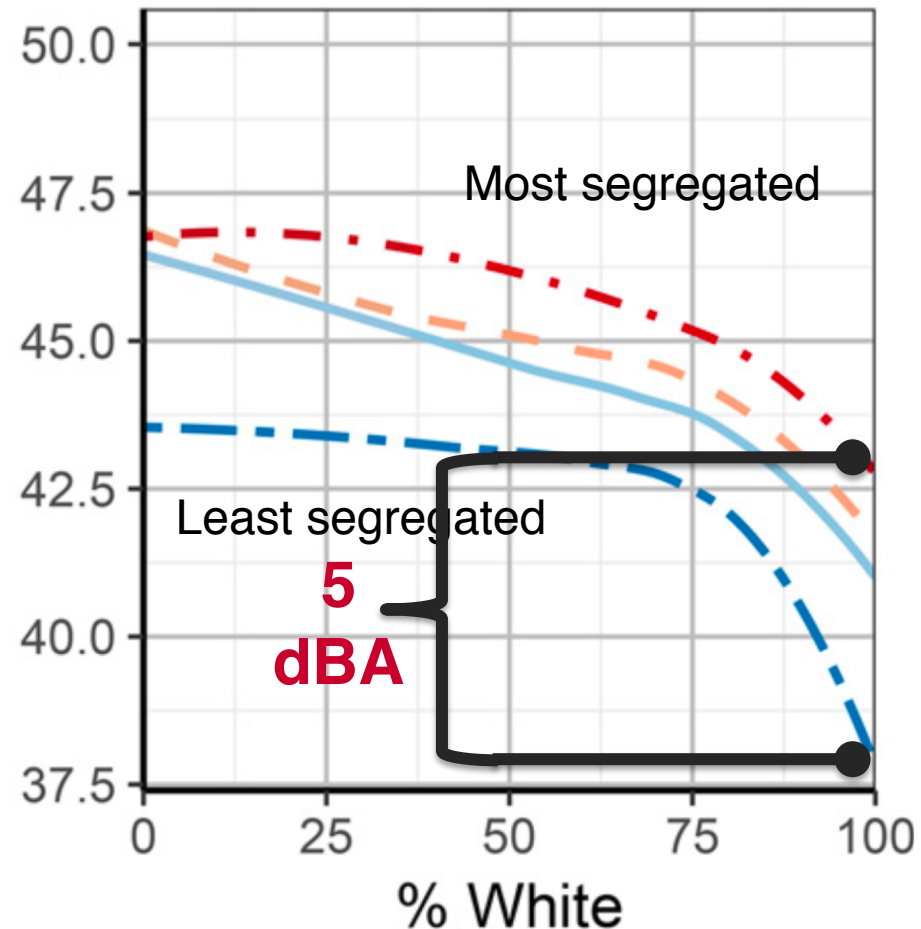
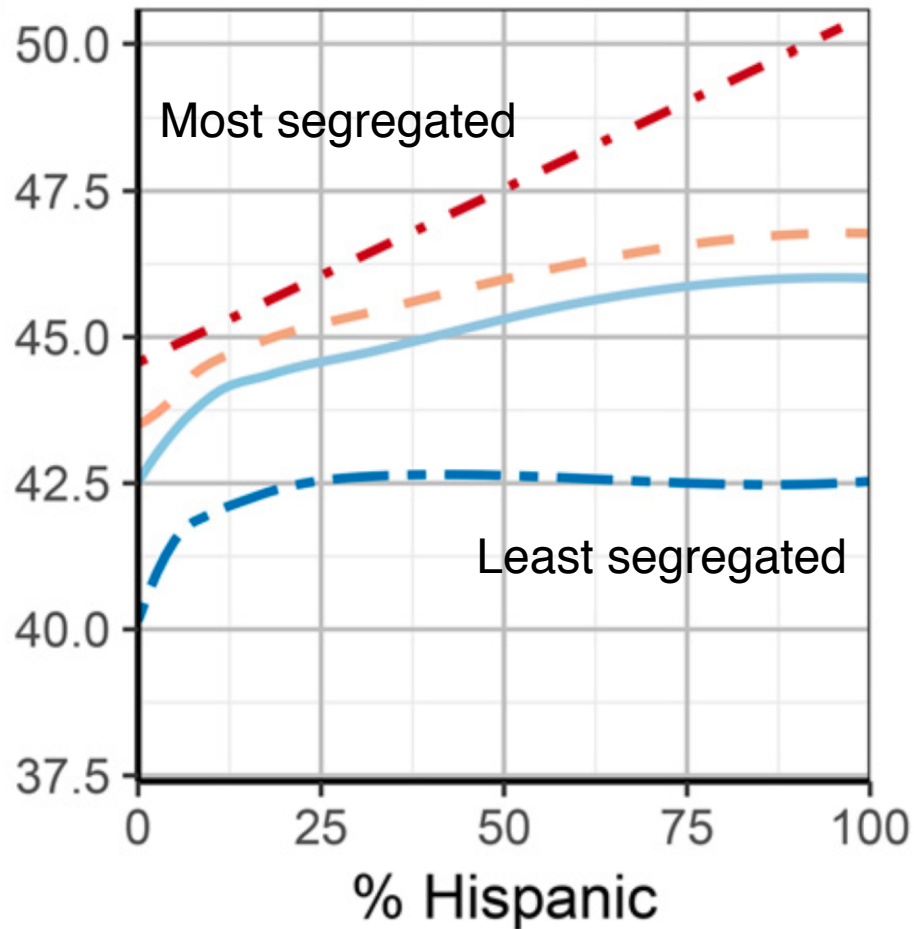


Least
segregated



Most
segregated

Race/ethnicity and nighttime noise, by segregation



CONCLUSION

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

black 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!

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Johns Hopkins University

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U.S. Parks Service

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