# Comparative Analysis of Service Area Boundaries and Drinking Water Quality Disparities

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Office of Policy – Office of the Administrator
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# Background and Motivation

**Background:** Executive Orders 12898 and 14096 direct EPA to identify disproportionate impacts of its rules and policies on minority and low-income populations.

**Motivation:** We have limited evidence on how our conclusions in regulatory impact analyses might be affected by the selection of service area boundary type.

**Research Objectives:**

1. Provide evidence on the extent of disparities in drinking water quality.
2. Test the sensitivity of environmental justice analyses to the selection of service area boundary representation.

# Research Methods

We take five steps to answer our primary research question.

1. Generate five indicators of drinking water quality for every public water system.
2. Estimate public water system demographic shares according to each specific boundary type.
3. Calculate demographic-specific population-weighted average drinking water quality indicators.
4. Compute relative risk ratios from a population of EJ concern to an exclusive comparison group.
5. Compare how the relative risks differ according to the service area representation for groups of EJ concern.

# The Drinking Water Quality Indicators

We construct **5 indicators of drinking water quality** for each public water system**:**

- Health-based violations of the Safe Drinking Water Act (count 2015-2023)
- Lead Action Level Exceedances (count 1991-2023)
- Disinfection byproduct concentrations (average 2006-2019)
- PFAS detected (count of unique substances detected 2013-2023)
- Total Coliform detection share (average 2006-2019)

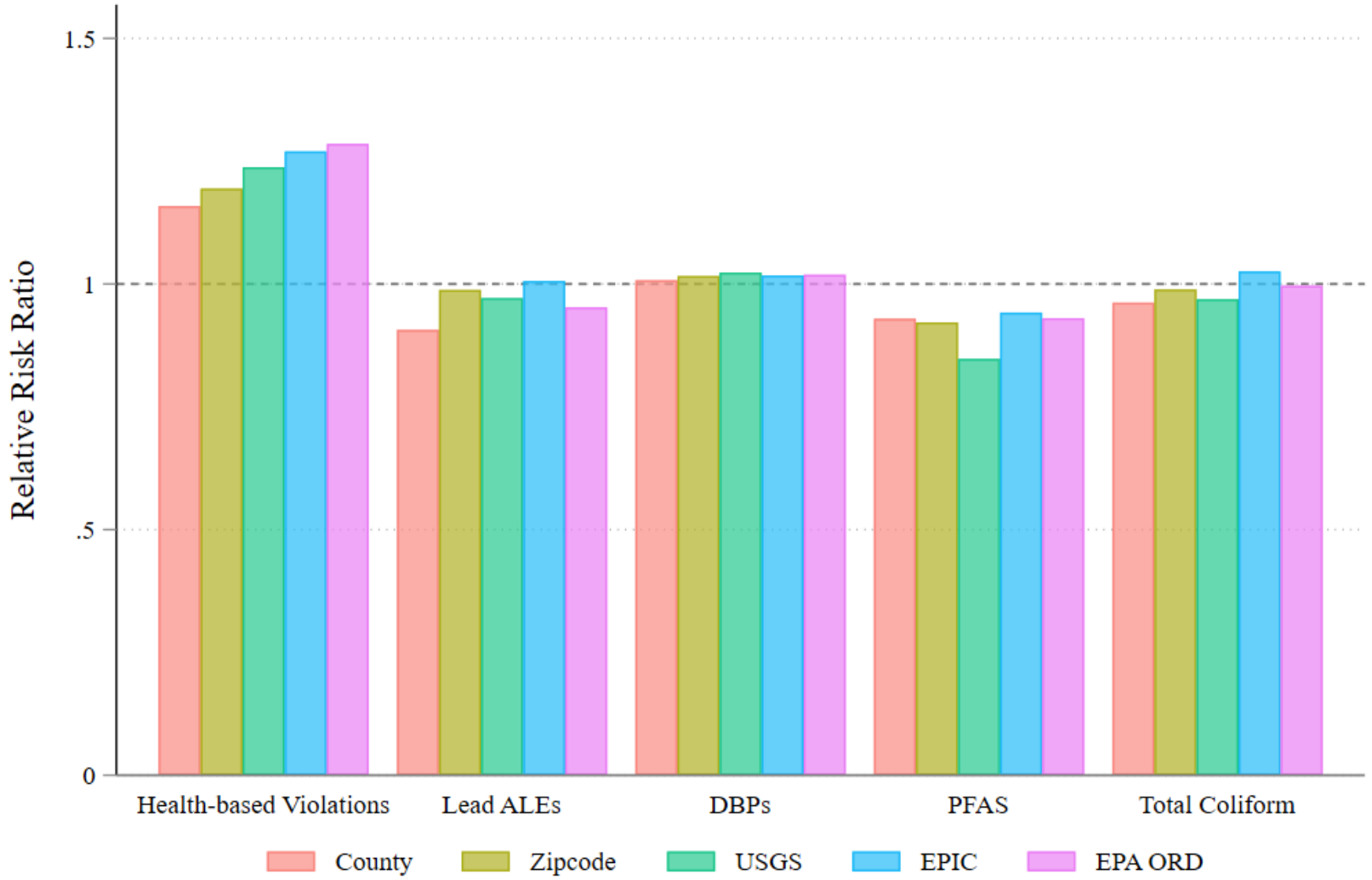
# The Service Area Boundaries

We **compare 5 approaches** for approximating service area boundaries nationally:

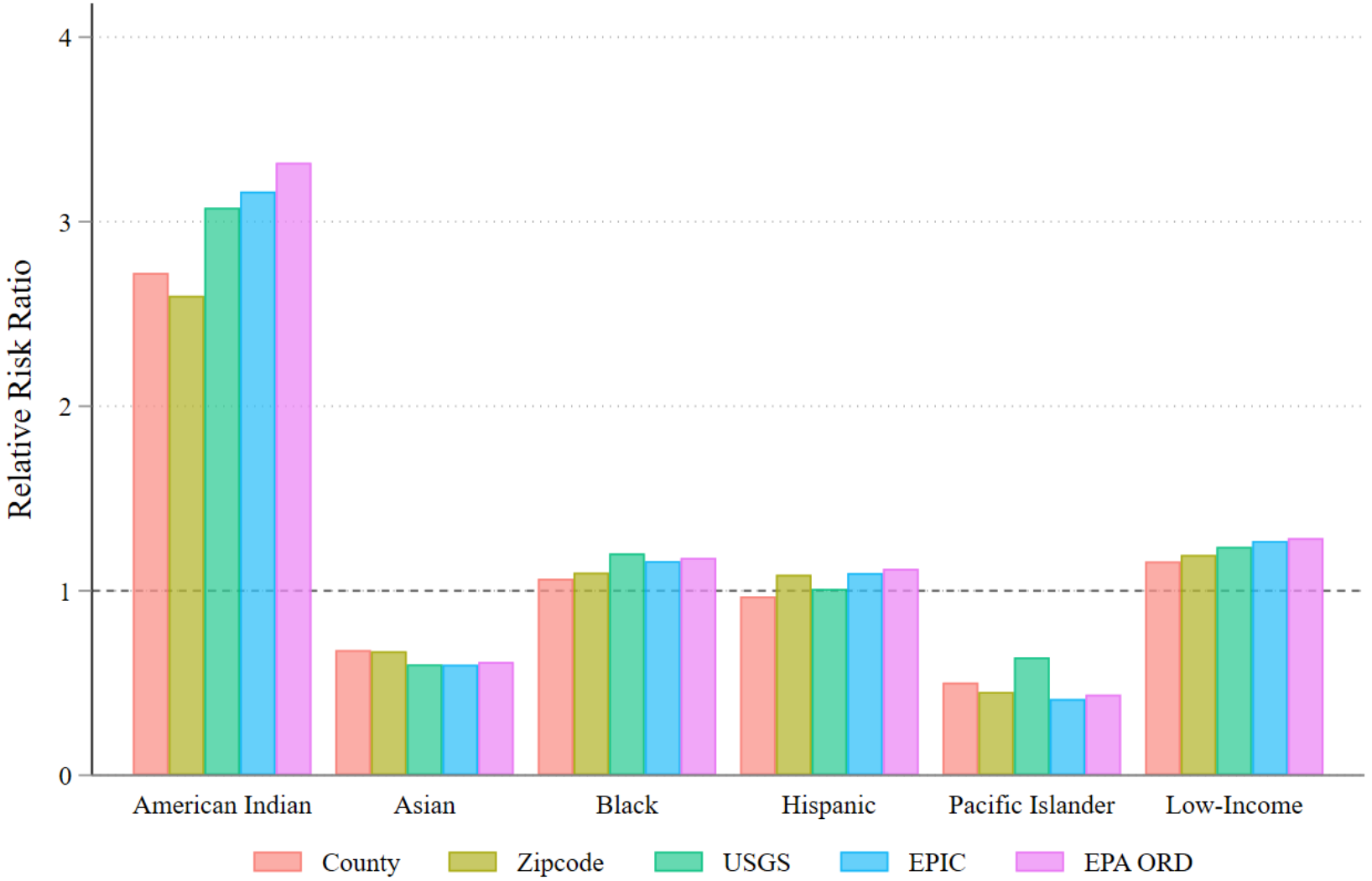
- County served
- Zip code served
- United States Geological Survey (USGS)
- Environmental Policy Innovation Center (EPIC)/SimpleLab boundaries
- Hall & Murray (EPA/ORD) boundaries

# Relative Risk for Low-Income Individuals

- Interpretation:
  - 1 → No disparate risk
  - RR > 1 → potential EJ concern
  - RR < 1 → lower risk for EJ communities
- See in table format.
- Comparison by race and ethnicity.

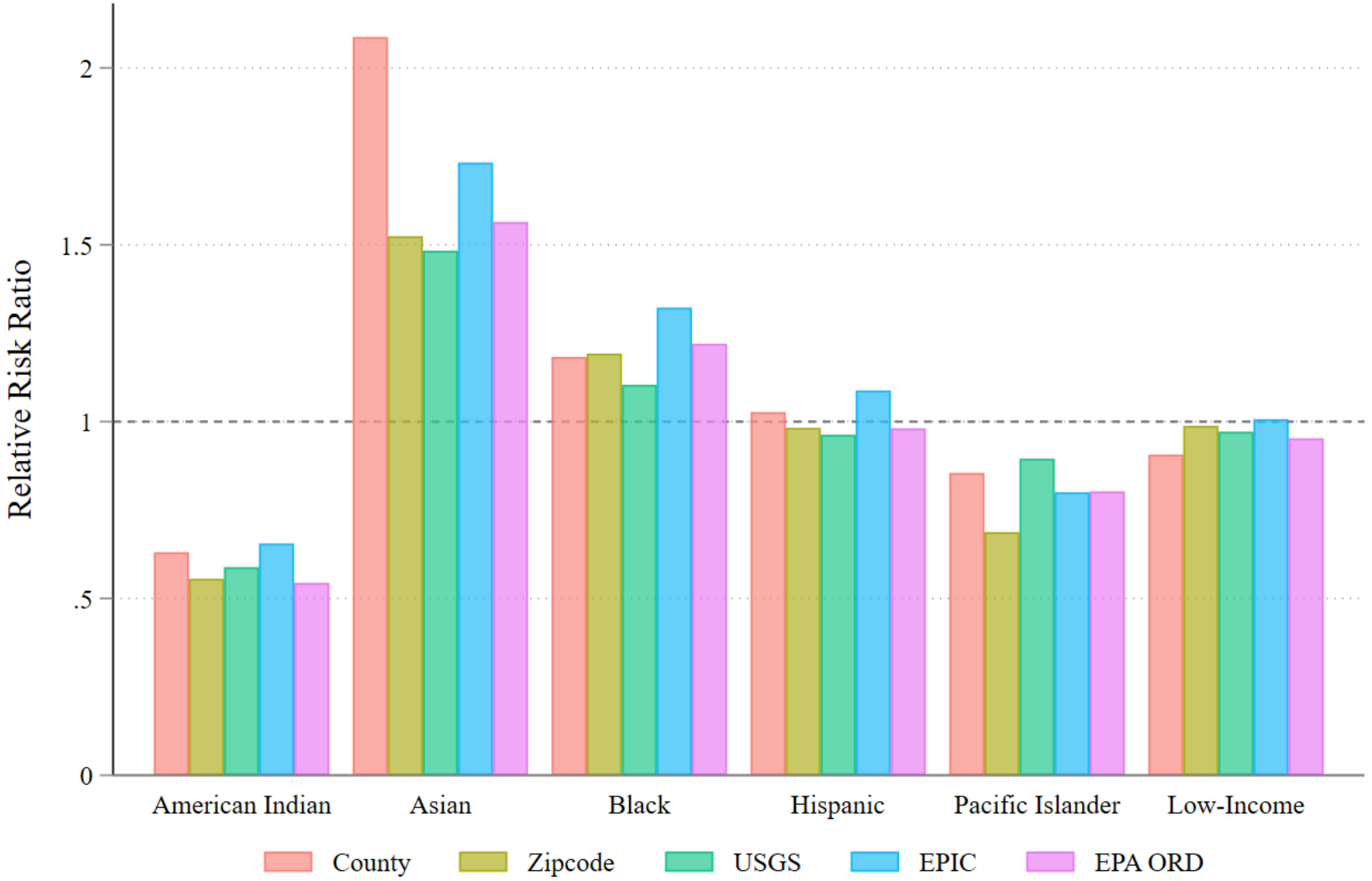


# Health-based SDWA Violations

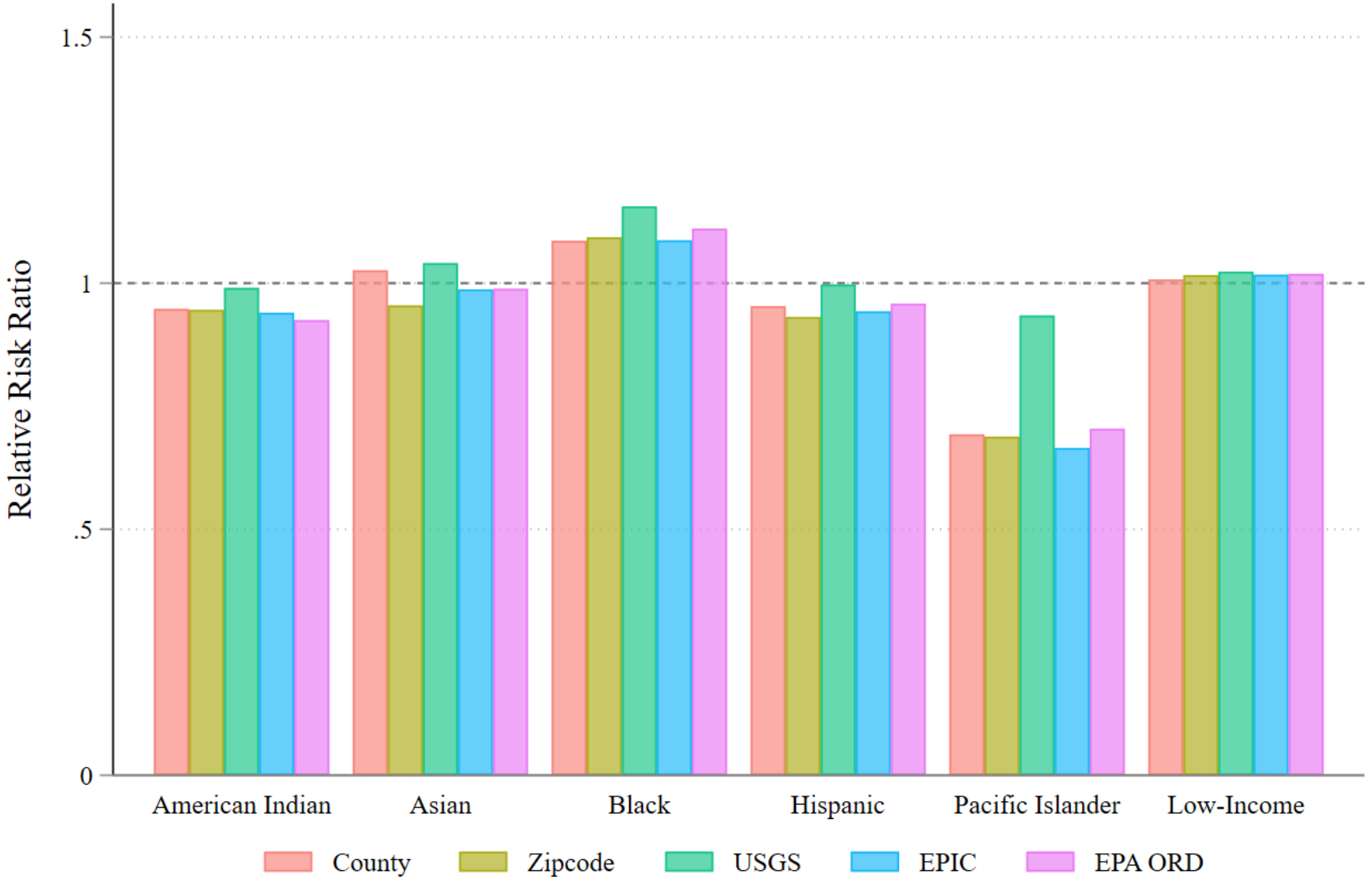



Notes: The comparison group for each relative risk ratio is non-Hispanic White individuals except for the low-income ratio, where the reference category is all individuals with income above twice the federal poverty limit.

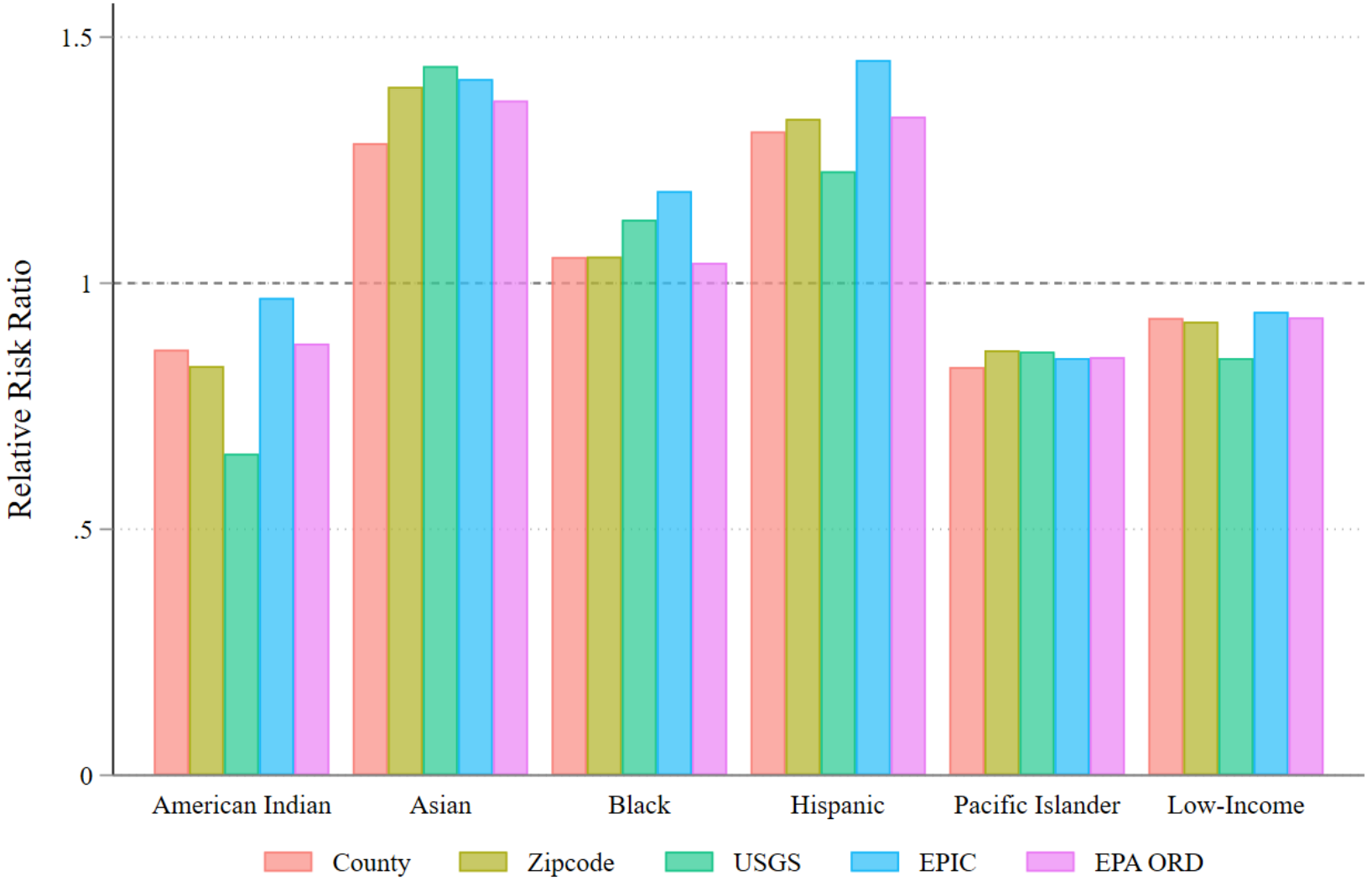
# Lead Action Level Exceedances



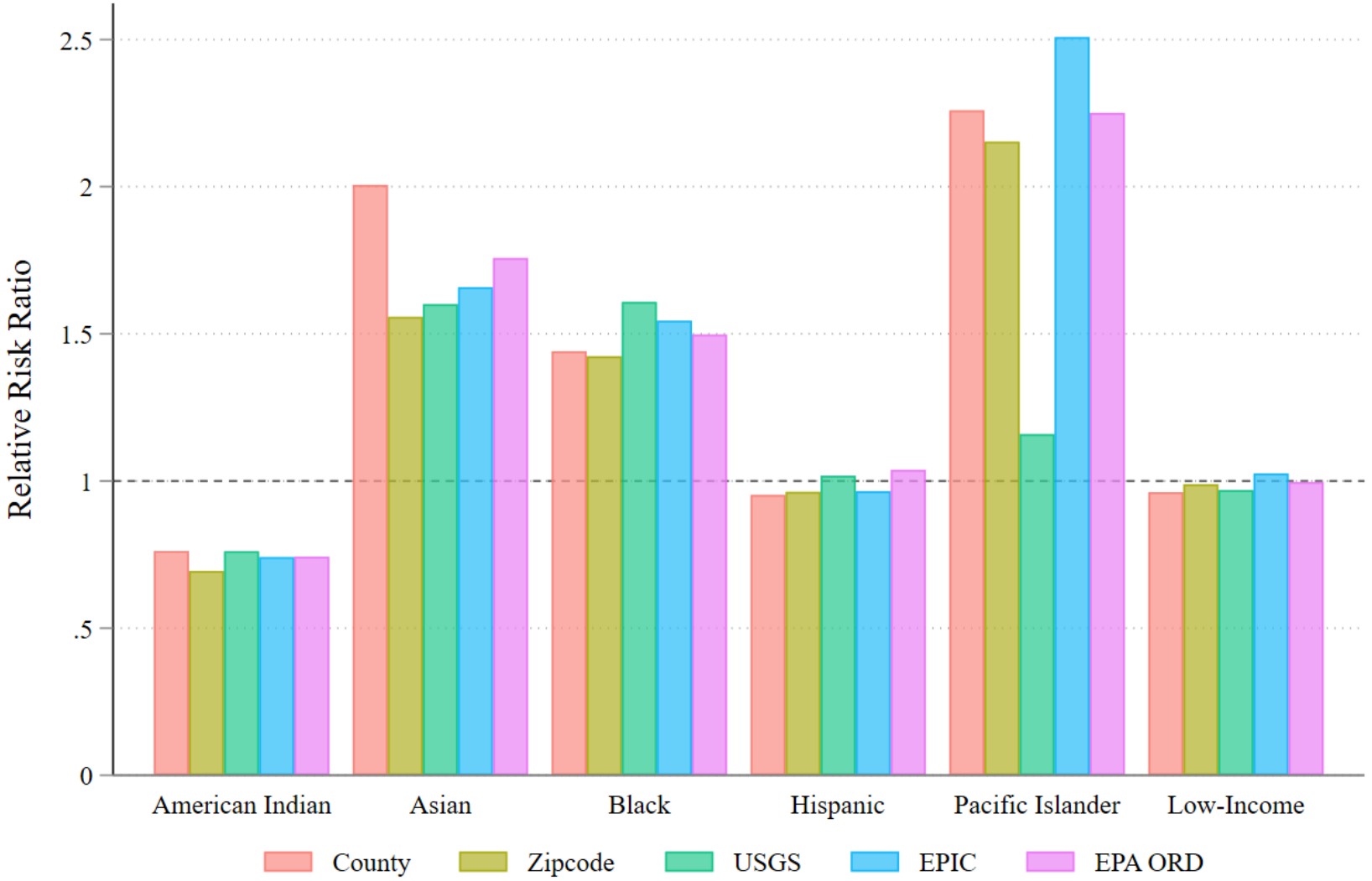
# Disinfection Byproduct Concentrations



# Count of Unique PFAS Detected



# Total Coliform Detection Share



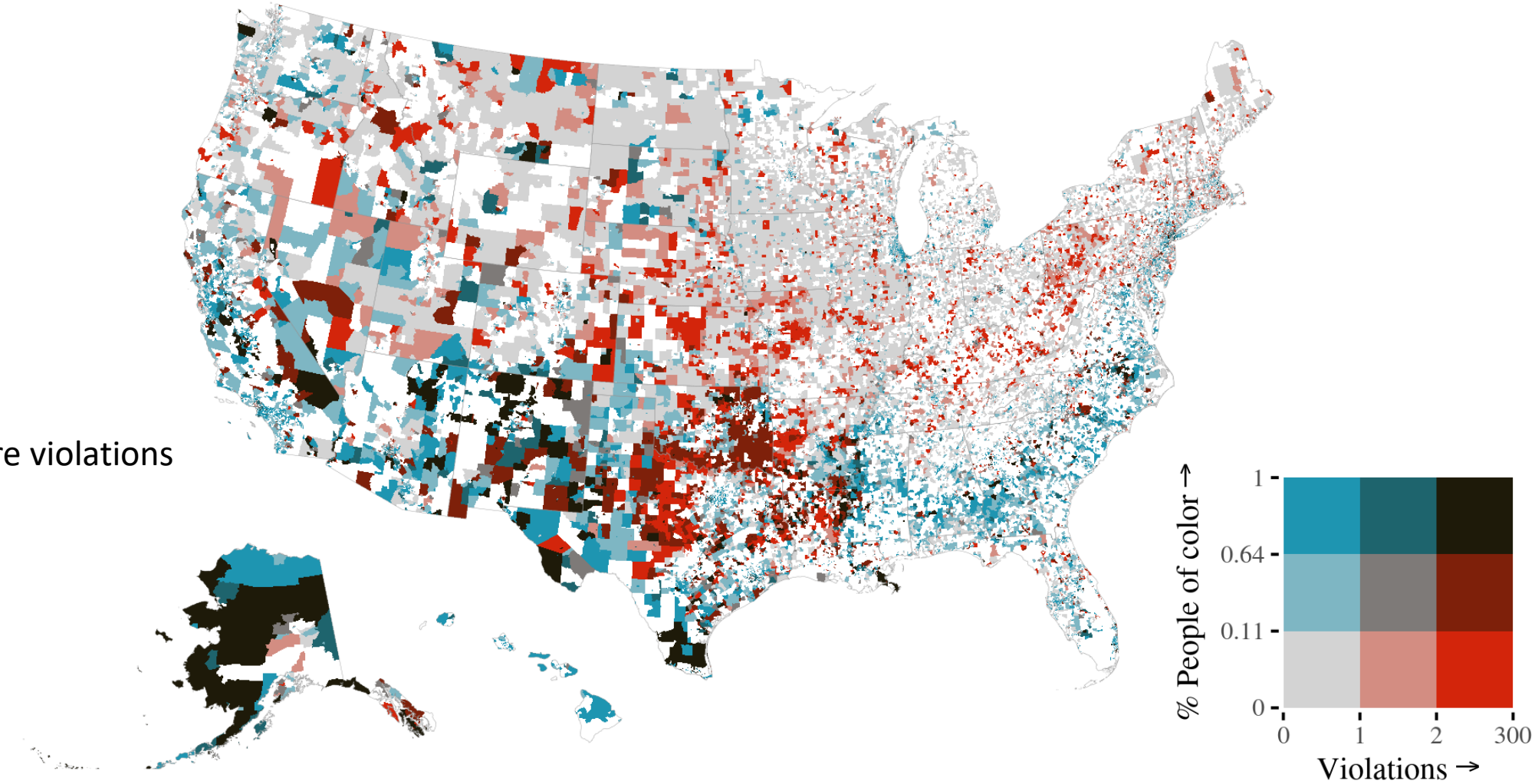
# Mapping Drinking Water Quality

Produce bivariate national and state maps at the Census block group level:

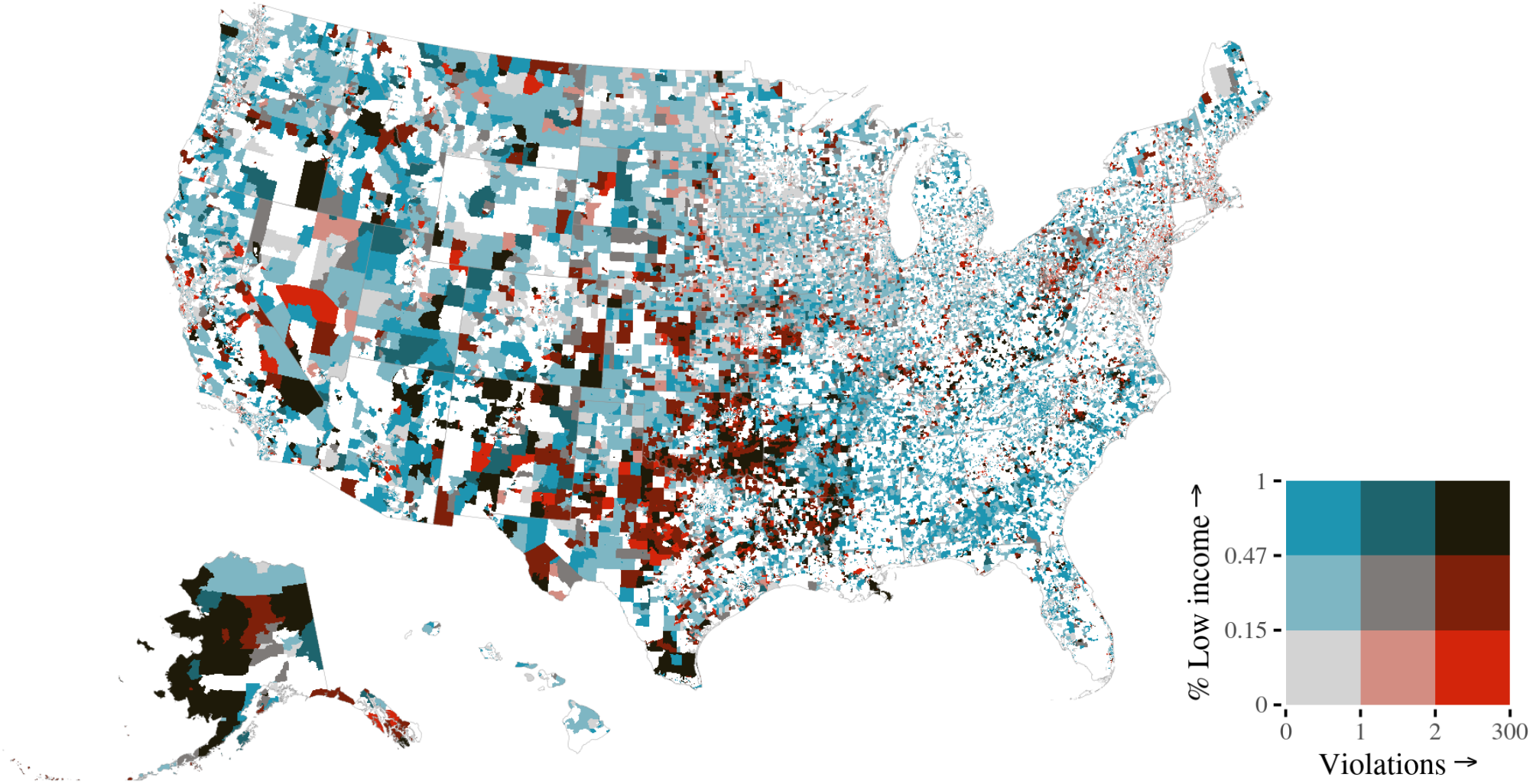
- Highlights patterns in drinking water quality across a wide geographic region
- Illustrates disparities with respect to race and income across indicators
- Helps to identify hotspots of environmental justice concern

# Health-based violations and % POC

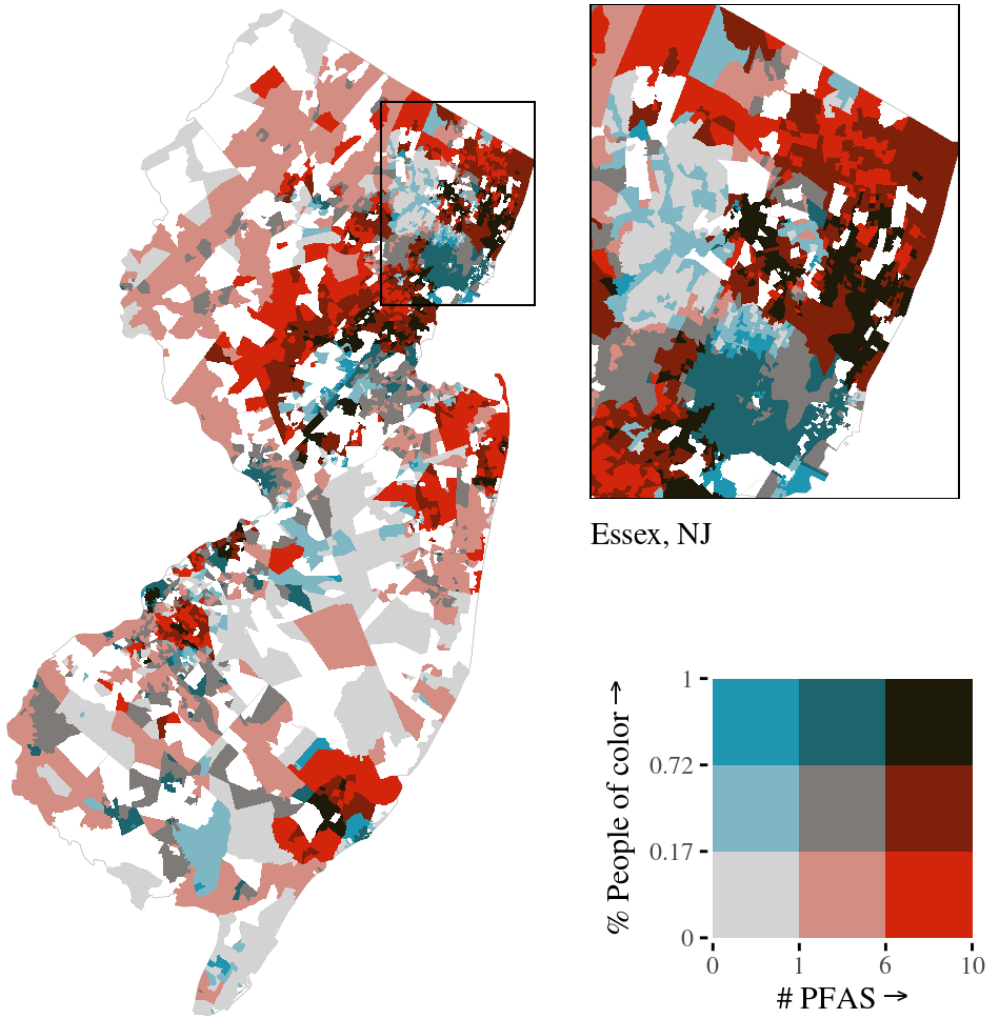
Darker red = more violations
& higher % POC



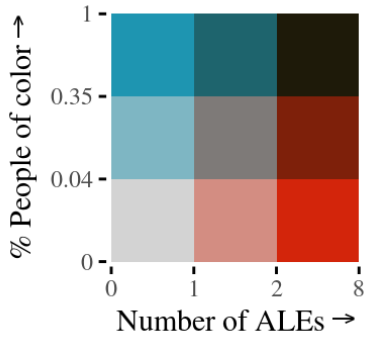
# HB violations and % Low income

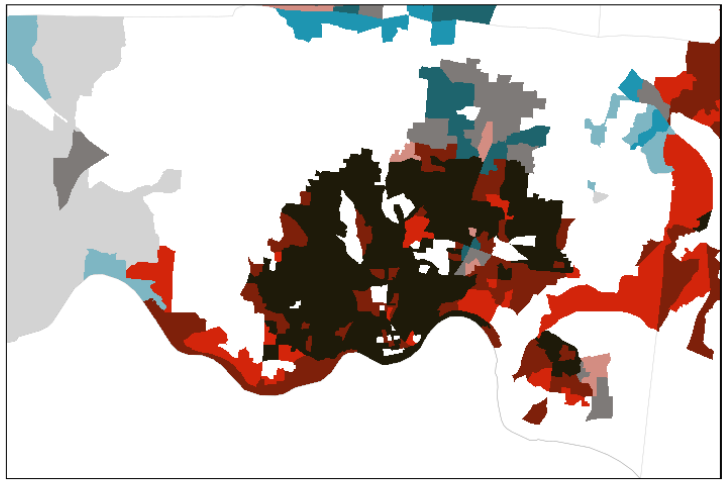


# New Jersey: PFAS detected

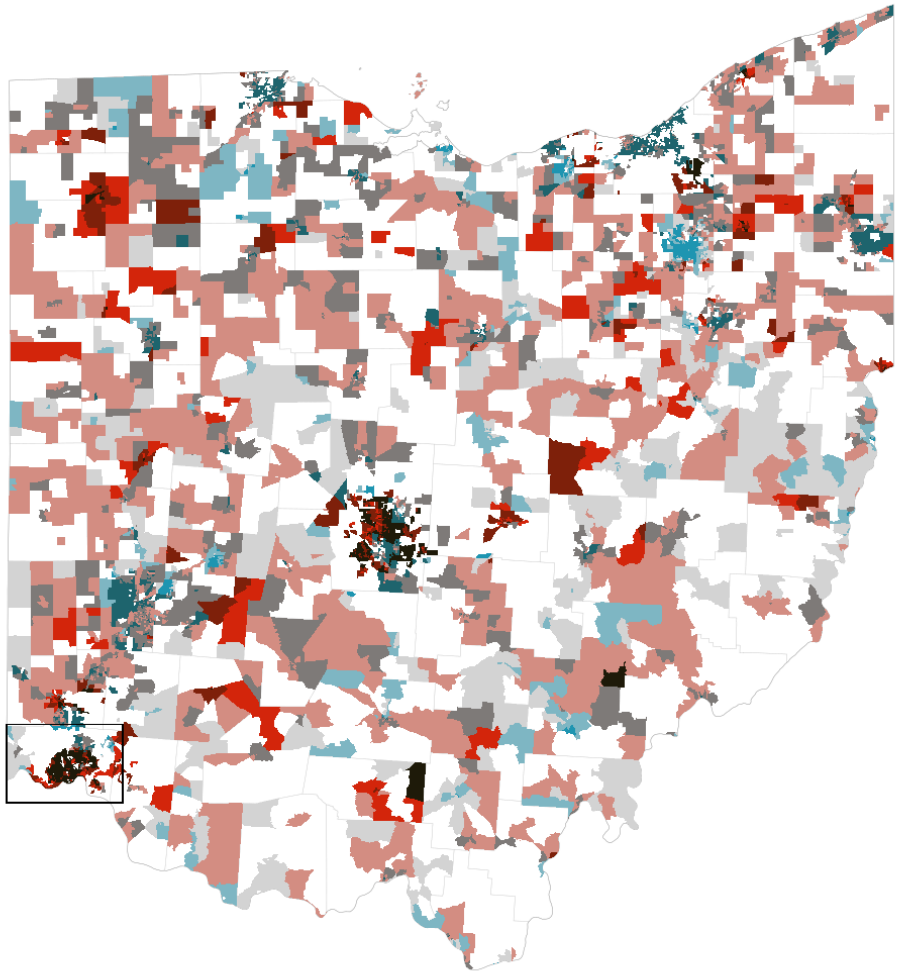


# Ohio: Lead Action Level Exceedances

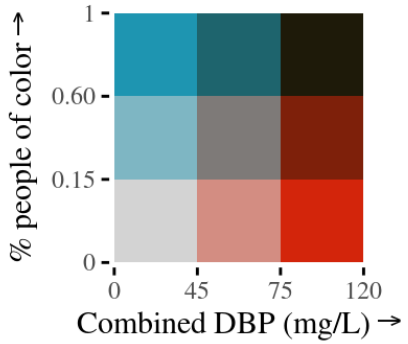


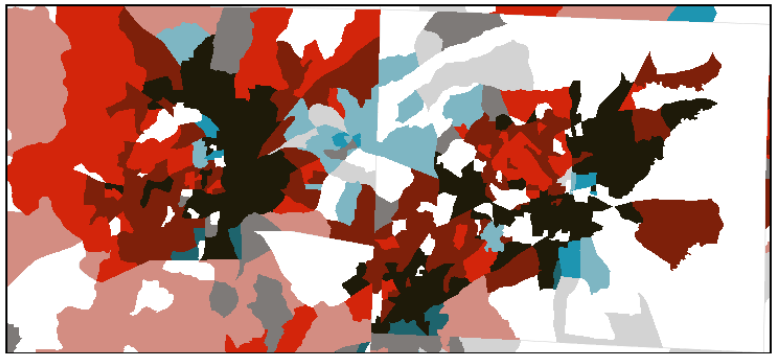



Hamilton County, OH

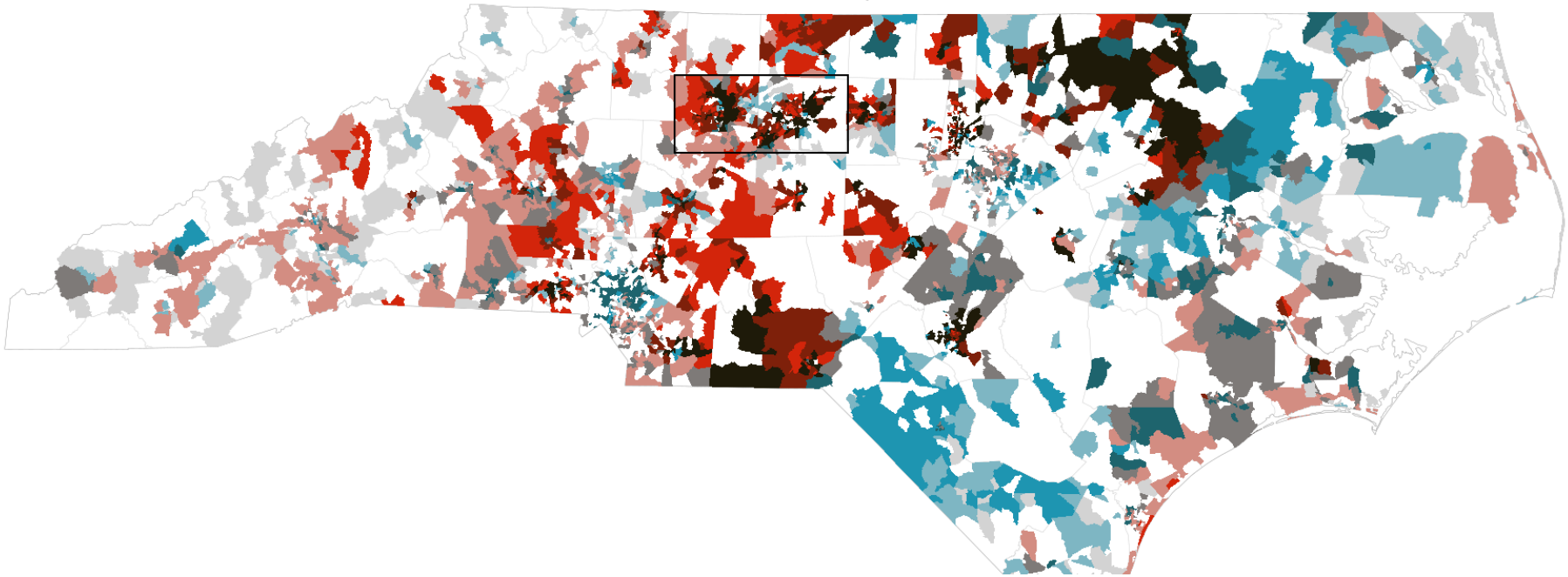


# North Carolina : DBP



Forsyth, NC



# Thank you for listening.

Questions/comments?

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# Appendix Slides

# Computing Indicators by Demographic Group

For each drinking water indicator *i* and service area boundary representation, we compute the **average population-weighted drinking water indicator** for group *j*:

$$Indicator_{ij} = \frac{\sum_{k \in PWS}^{K} PopulationShare_{ijk} * PopulationServed_{ijk} * Indicator_{ijk}}{Total\ Population\ Served_j}$$

- $PopulationShare_{ijk}$ variables are determined using areal apportionment over the service area boundary representation and multiplied by the population served according to SDWIS, $PopulationServed_{ijk}$.
- The total population per system remains constant while the total population of each demographic group varies across service area boundary representations.

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# Constructing Relative Risk Metrics

We then construct **relative risk ratios** that compare the relative exposure for an EJ population group of concern *u* to the exposure of a comparison group *v*.

$$Relative\ Risk_i = \frac{Indicator_{iu}}{Indicator_{iv}}$$

Two general type of comparisons:

- Compare minority populations to non-Hispanic white individuals.
- Compare individuals with income below twice the federal poverty limit to those with incomes above twice the federal poverty limit.

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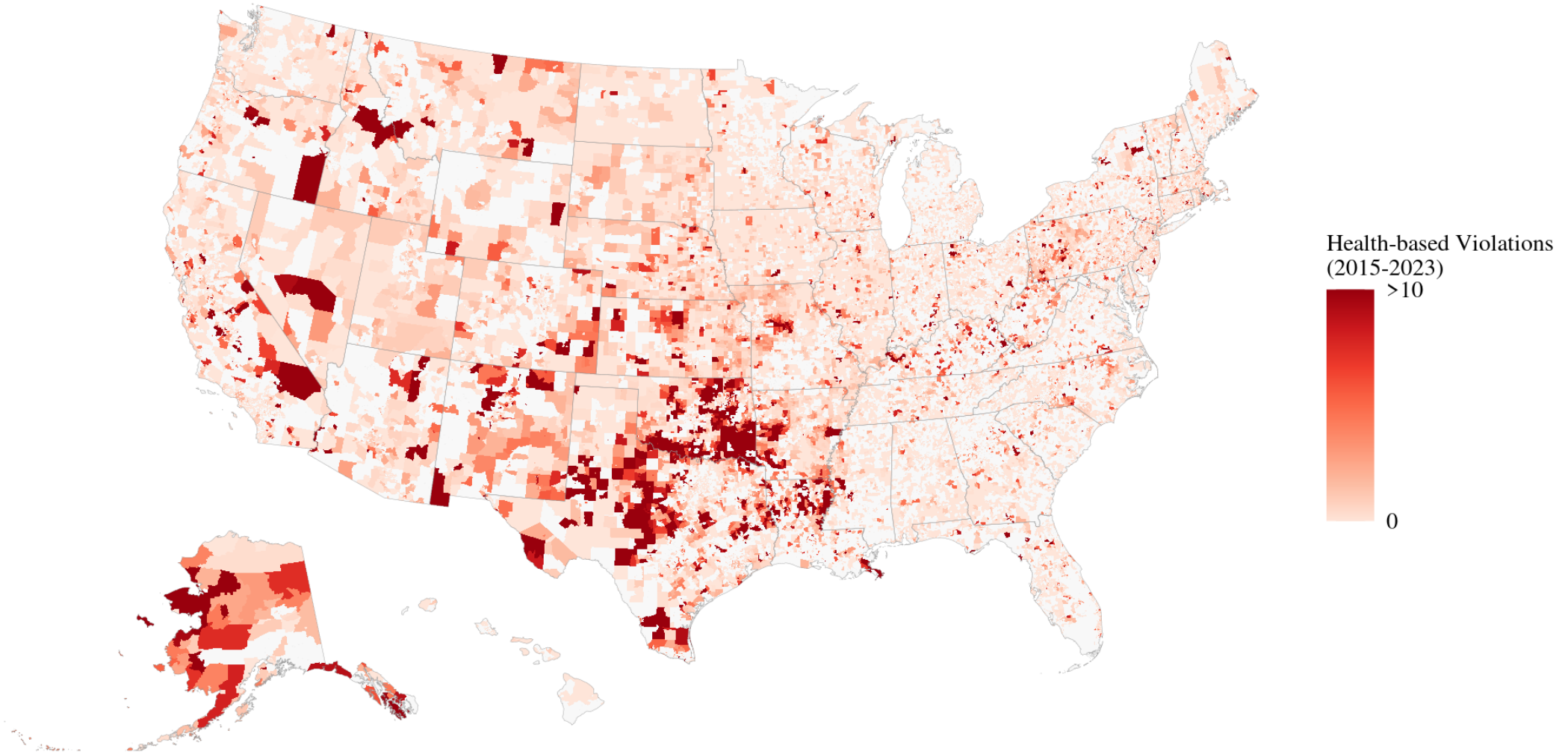
# Health-based SDWA Violations




Notes: Map portrays total health-based violations from 2015-2023. Violation totals are averaged across all water systems serving any given census block group.

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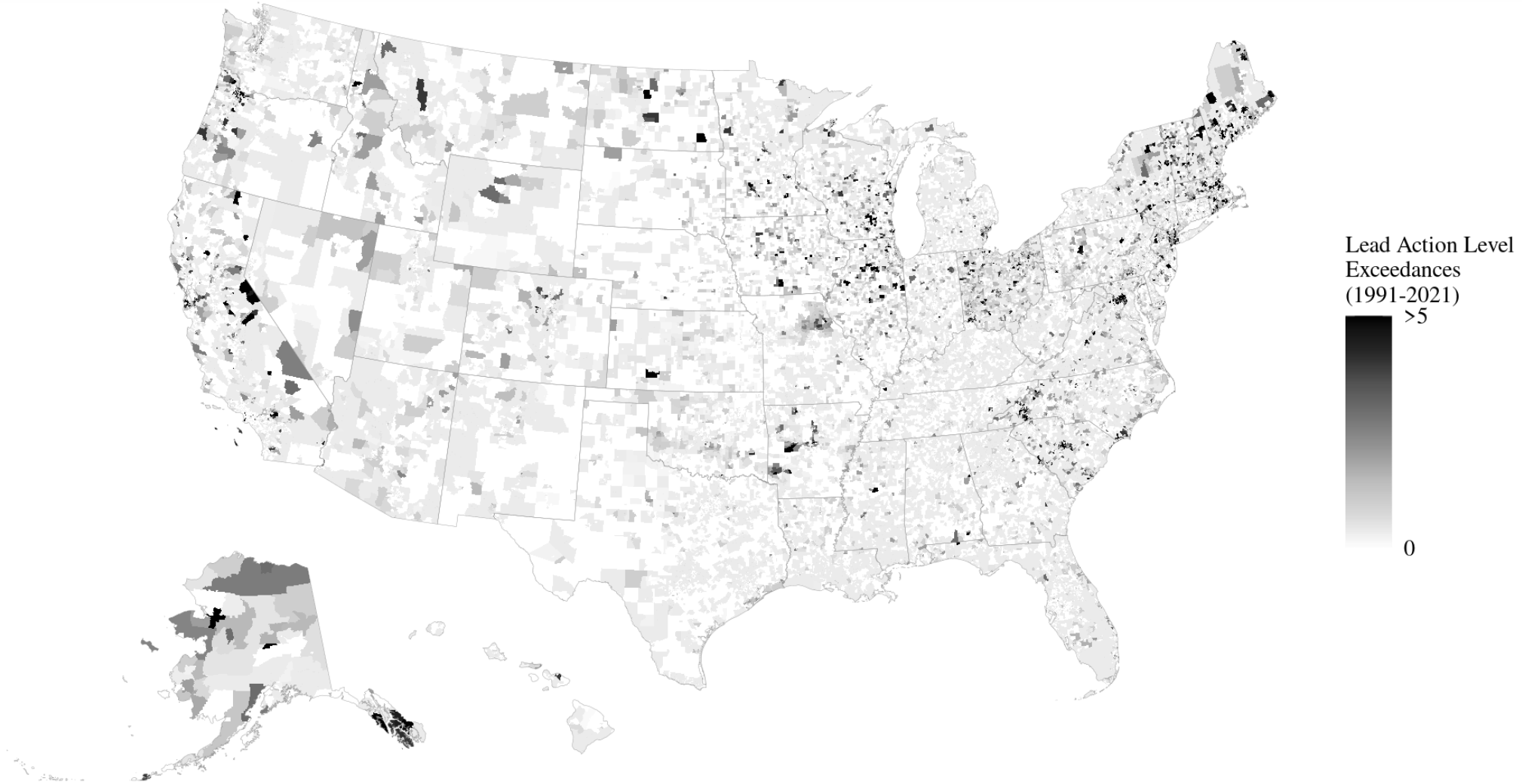
# Lead Action Level Exceedances




Notes: Map portrays all lead action level exceedances from 1991 to 2023 at the census block group level.

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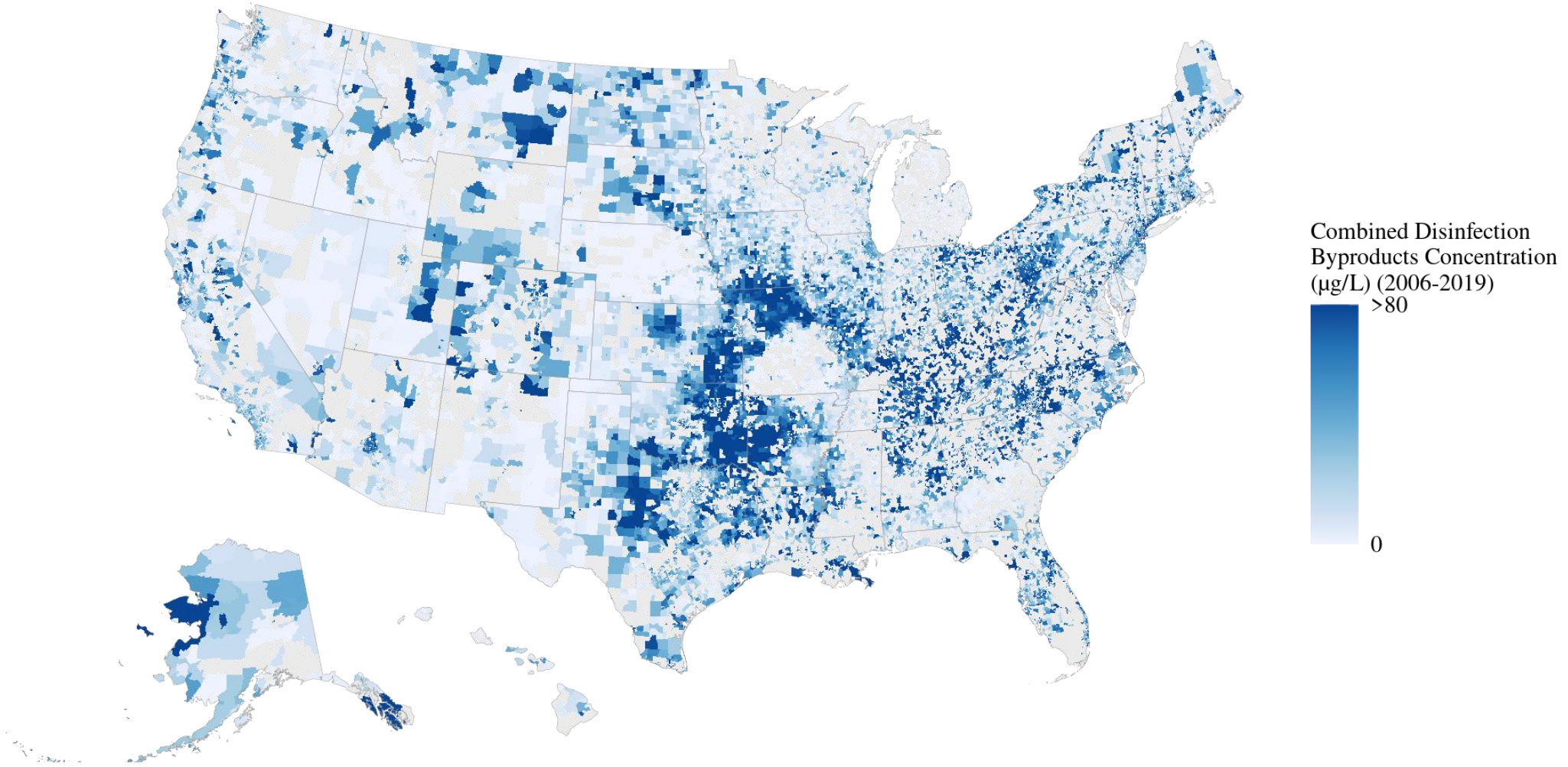
# Disinfection Byproduct Concentrations




Notes: Each concentration metric represents the total across four trihalomethanes and five haloacetic acids from 2006-2019. Data source: Six Year Review 3 and Six Year Review 4.

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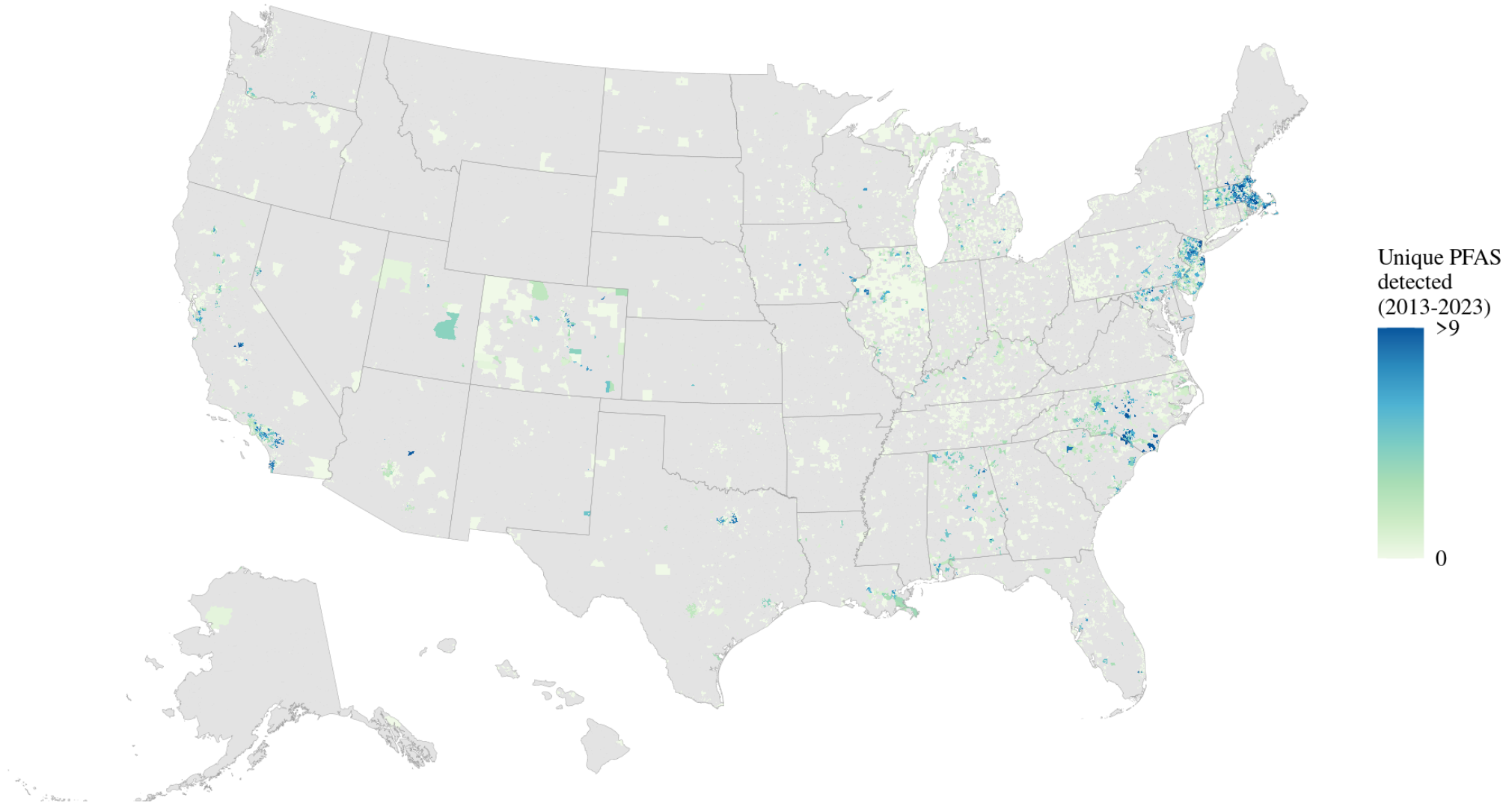
# Count of Unique PFAS Detected




Notes: Data sources include UCMR3, UCMR5, and PFAS Analytic Tools. Gray regions have no samples.

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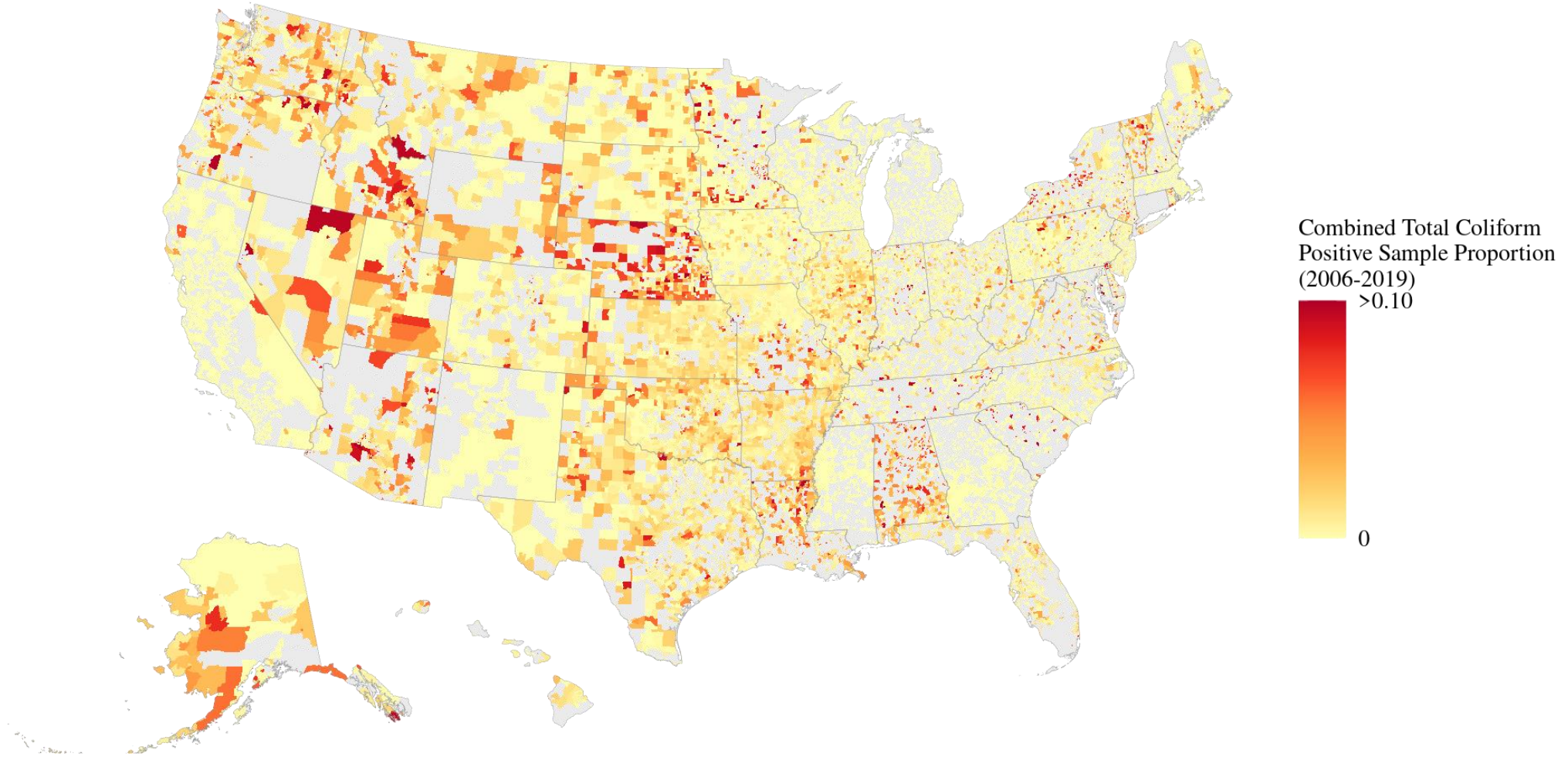
# Total Coliform Detection Share




Notes: Each detection share metric represents sampling conducted from 2006-2019. Data source: Six Year Review 3 and Six Year Review 4.

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# Relative Risks by Boundary Type

| | County | Zip code | USGS | EPIC | EPA ORD |
|---|---|---|---|---|---|
| **Health-based Violations (2015-2022)** | | | | | |
| People of Color & Non-Hispanic White | 0.98 | 1.04 | 1.04 | 1.07 | 1.09 |
| Below & Above 2X Poverty Level | 1.16 | 1.19 | 1.24 | 1.27 | 1.29 |
| **Lead Action Level Exceedances (1991-2021)** | | | | | |
| People of Color & Non-Hispanic White | 1.24 | 1.13 | 1.09 | 1.25 | 1.14 |
| Below & Above 2X Poverty Level | 0.91 | 0.99 | 0.97 | 1.01 | 0.95 |
| **PFAS Detected (2013-2023)** | | | | | |
| People of Color & Non-Hispanic White | 1.20 | 1.22 | 1.20 | 1.33 | 1.22 |
| Below & Above 2X Poverty Level | 0.93 | 0.92 | 0.85 | 0.94 | 0.93 |
| **TTHM & HAA5 Concentrations (2006-2019)** | | | | | |
| People of Color & Non-Hispanic White | 1.01 | 0.99 | 1.06 | 1.00 | 1.01 |
| Below & Above 2X Poverty Level | 1.01 | 1.02 | 1.02 | 1.02 | 1.02 |
| **Total Coliform Detection Share (2006-2019)** | | | | | |
| People of Color & Non-Hispanic White | 1.28 | 1.22 | 1.31 | 1.28 | 1.30 |
| Below & Above 2X Poverty Level | 0.96 | 0.99 | 0.97 | 1.03 | 1.00 |
| PWS Observations | 45,934 | 16,394 | 18,806 | 45,372 | 42,300 |
| Population Served | 308m | 283m | 269m | 313m | 307m |

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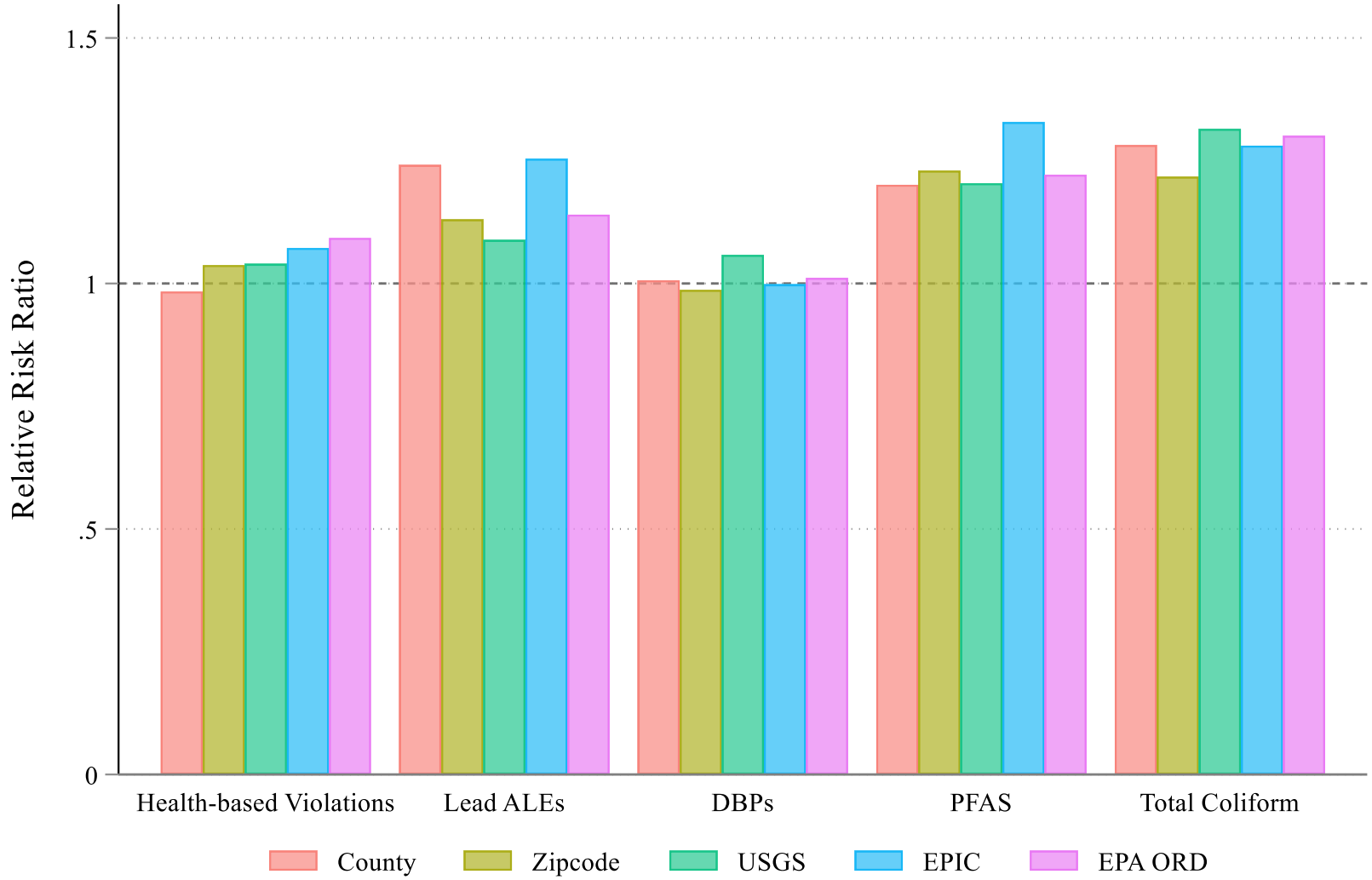
# Relative Risk by Race/Ethnicity

All relative risks ratios compare People of Color to non-Hispanic White populations.

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# Next Steps

Some possible next steps with the study:

- Explore reasons why different service area boundaries can lead to different conclusions.
- Additional measures related to income and affordability concerns.
- Additional indicators of drinking water quality.