# Using Systems Science to Optimize Health Security Coalitions & Networks

## Applications with the National Health Security Preparedness Index

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# Health security requires collective actions across many activities and sectors

- Surveillance
- Environmental monitoring
- Laboratory testing
- Communication systems
- Response planning
- Incident management
- Emergency response
- Surge capacity
- Management & distribution of countermeasures
- Continuity of healthcare delivery
- Community engagement
- Workforce protection
- Volunteer management
- Education & training
- Drills & exercises
- Information exchange
- Evacuation & relocation
- Infrastructure resiliency
- Protections for vulnerable populations

# Why a Health Security Index?

**Track national progress in health security as a shared responsibility across sectors**

- Raise public awareness
- Identify strengths and vulnerabilities
- Detect gains and losses
- Encourage coordination & collaboration
- Facilitate planning & policy development
- Support benchmarking & quality improvement
- Stimulate research & innovation

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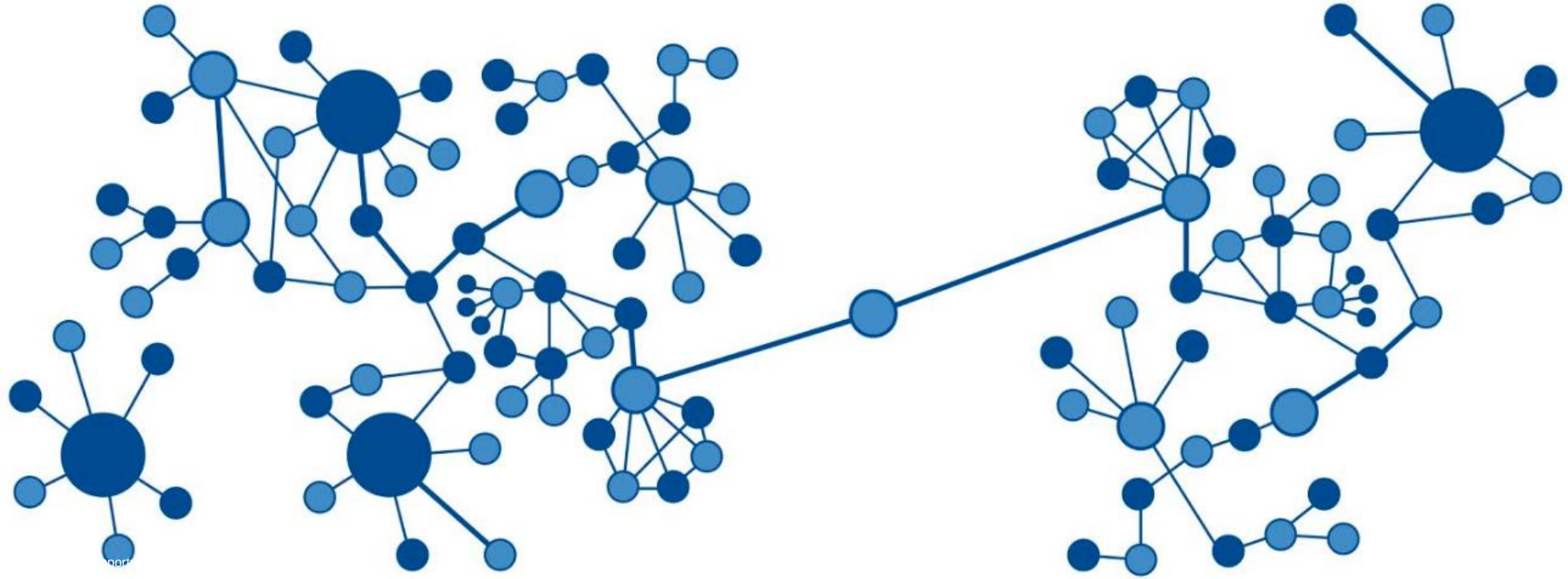
# Networks as Force Multipliers

- Enhance coordination
- Accelerate information flow
- Acquire new ideas
- Spread innovations
- Build resilience

- Density
- Centralization



# Key questions to explore with the Index

- How do health security levels vary across states and change over time?
- What roles do networks and coalitions play in shaping the dynamics of health security?
  - Healthcare Coalitions
  - Other community networks
- How can we strengthen coalitions & networks to improve overall health security?

# Measurement: National Health Security Index

- **139 individual measures**

Weighted average

- **19 subdomains**

Weighted average

- **6 domains**

Weighted average

- **State overall values**

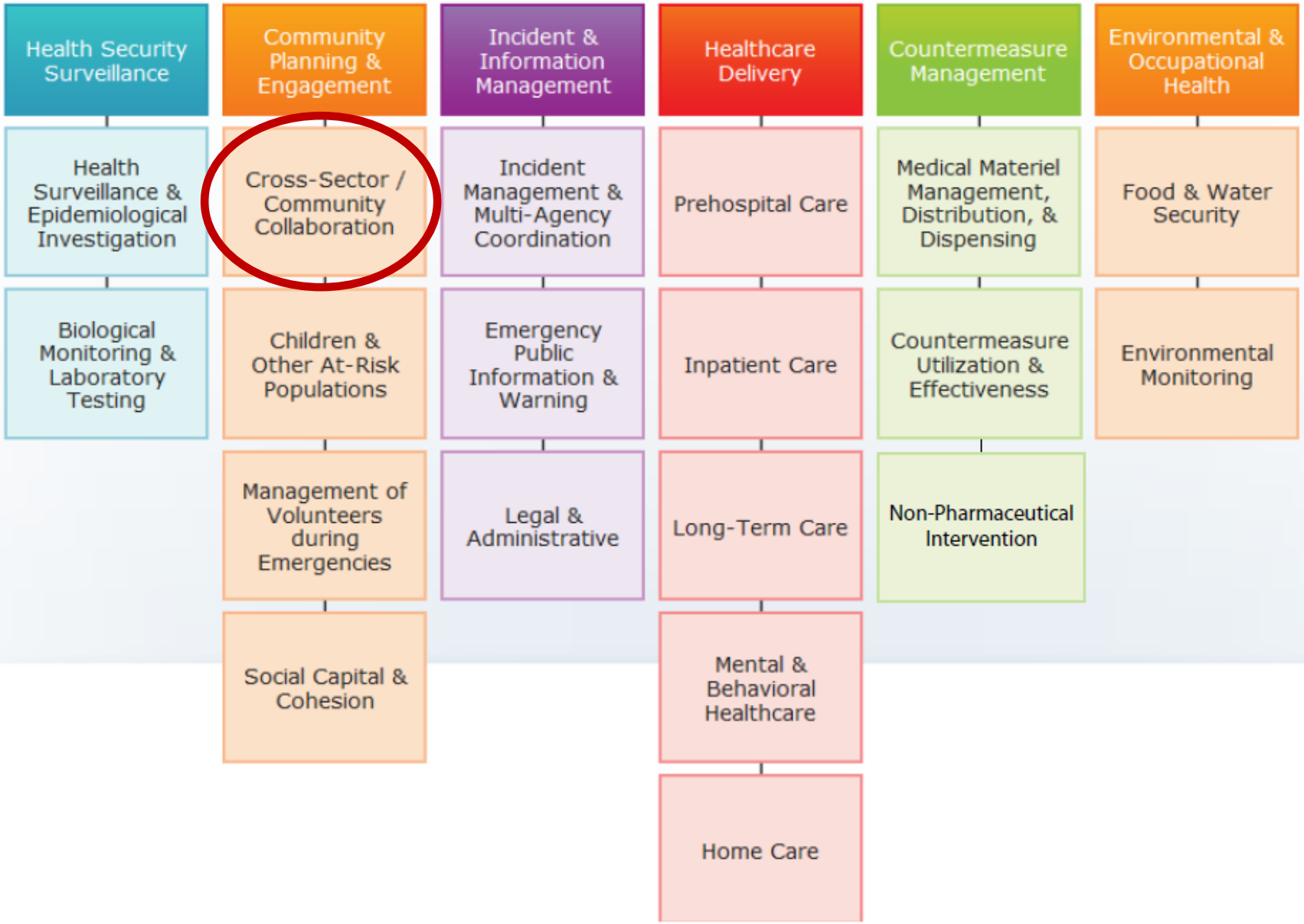
Unweighted average

- **National overall values**

- Normalized to 0-10 scale using min-max scaling to preserve distributions
- Imputations based on multivariate longitudinal models
- Empirical weights based on Delphi expert panels
- Bootstrapped confidence intervals reflect sampling and measurement error
- Annual estimates for 2013-2016

| Reliability by Domain | Alpha |
|---|---|
| Health security surveillance | 0.712 |
| Community planning & engagement | 0.631 |
| Incident & information management | 0.734 |
| Healthcare delivery | 0.596 |
| Countermeasure management | 0.654 |
| Environmental/occupational health | 0.749 |

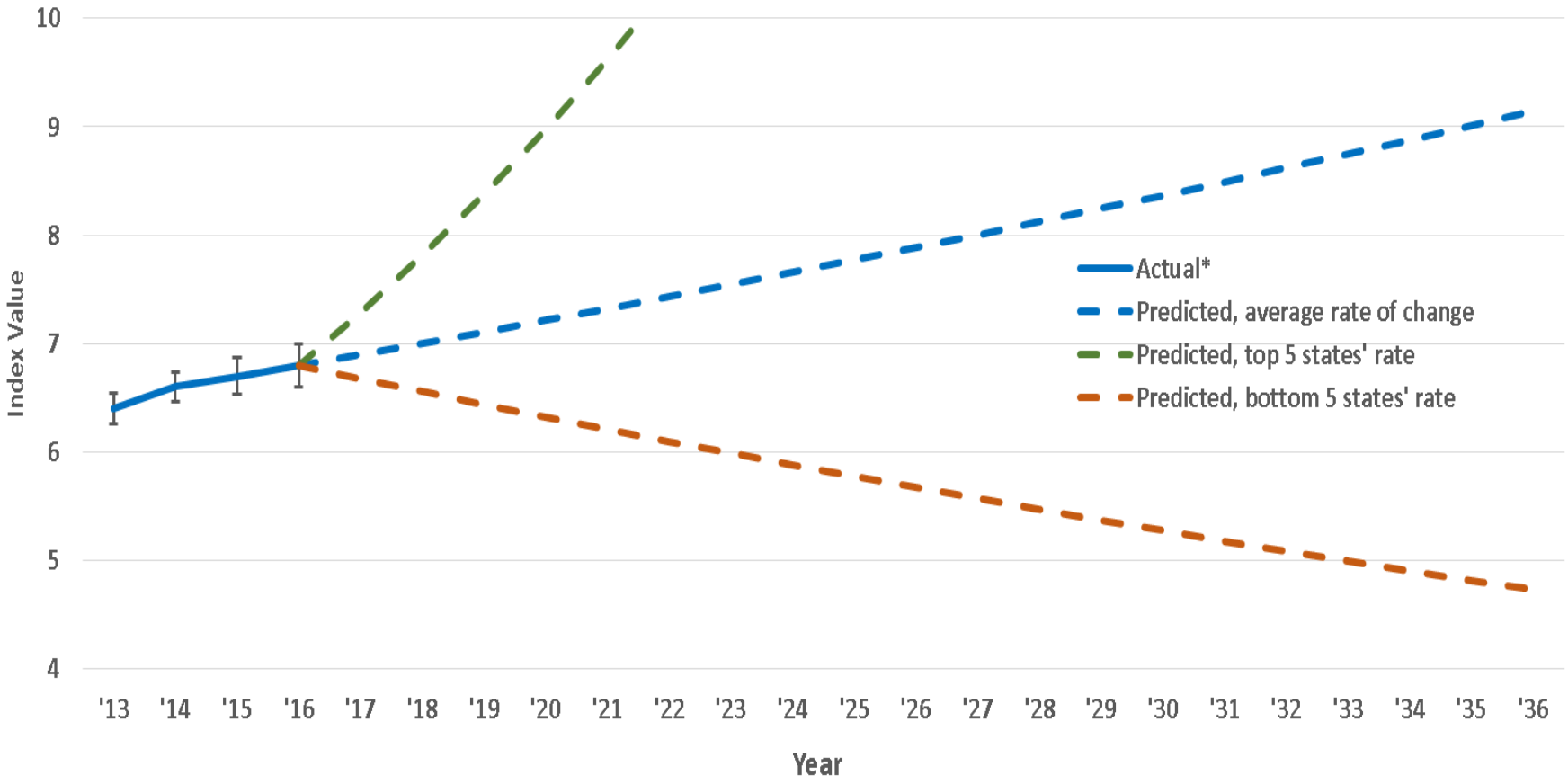
# Index measurement domains & subdomains



# Two Index measures capture network attributes

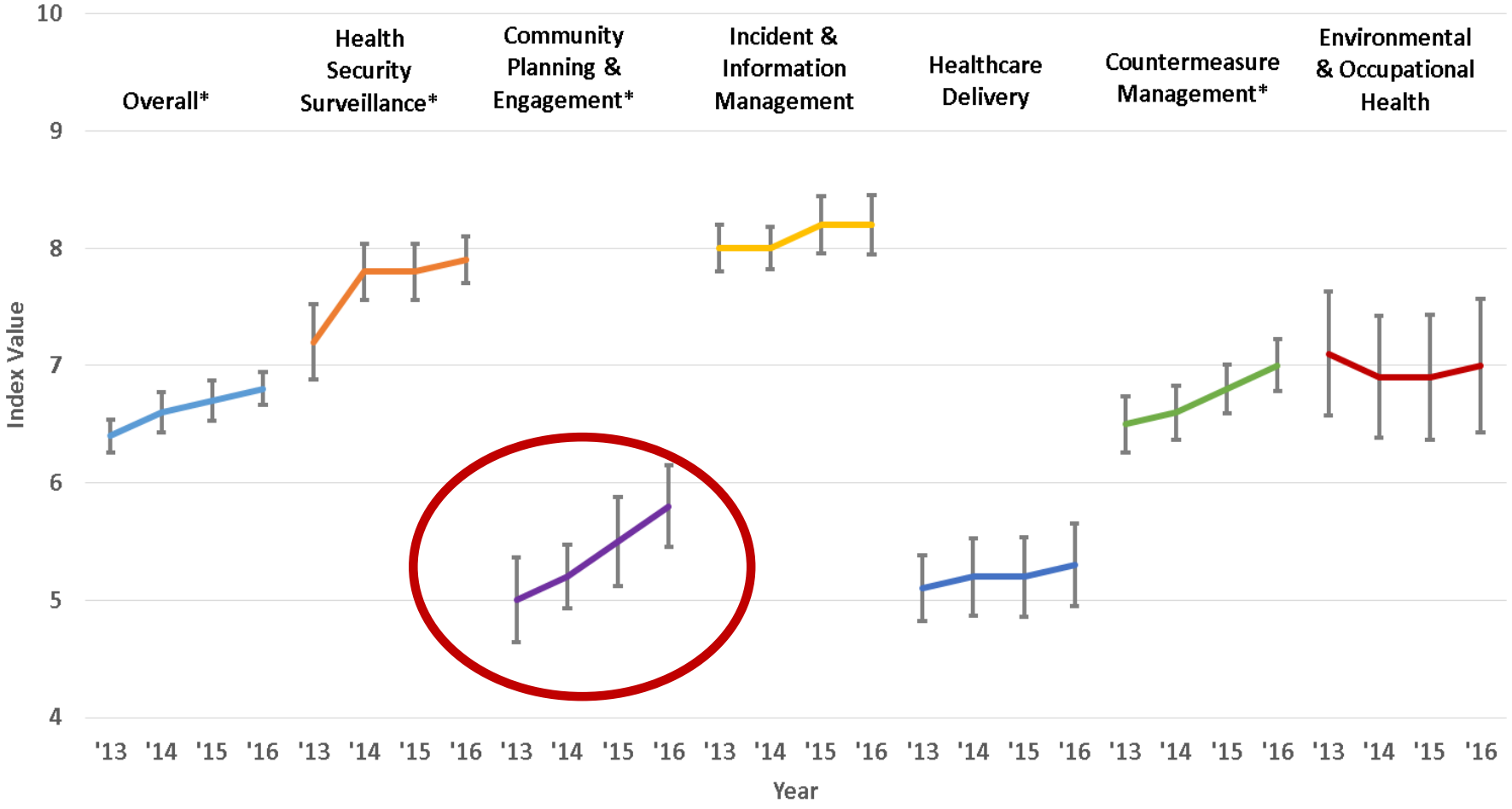
- Healthcare Coalition Membership Penetration
  - Local public health agencies
  - Local emergency management agencies
  - Hospitals
  - EMS agencies
- Comprehensiveness of Local Public Health Networks (Public Health System Capital)
  - Density
  - Centrality

# Steady but slow progress



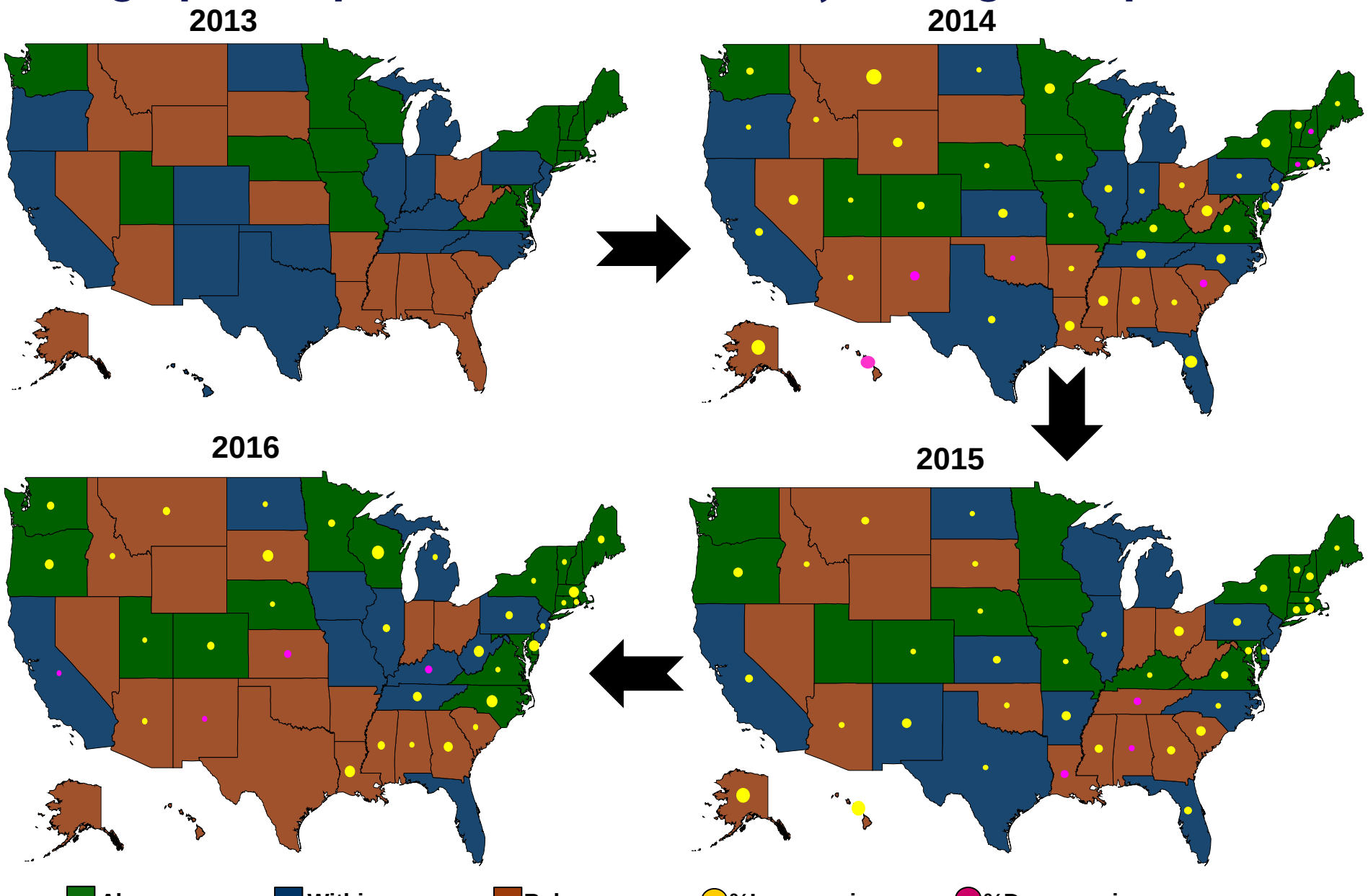

*statistically significant change

# The U.S. improved in most domains during 2013-16, except healthcare delivery and environmental health

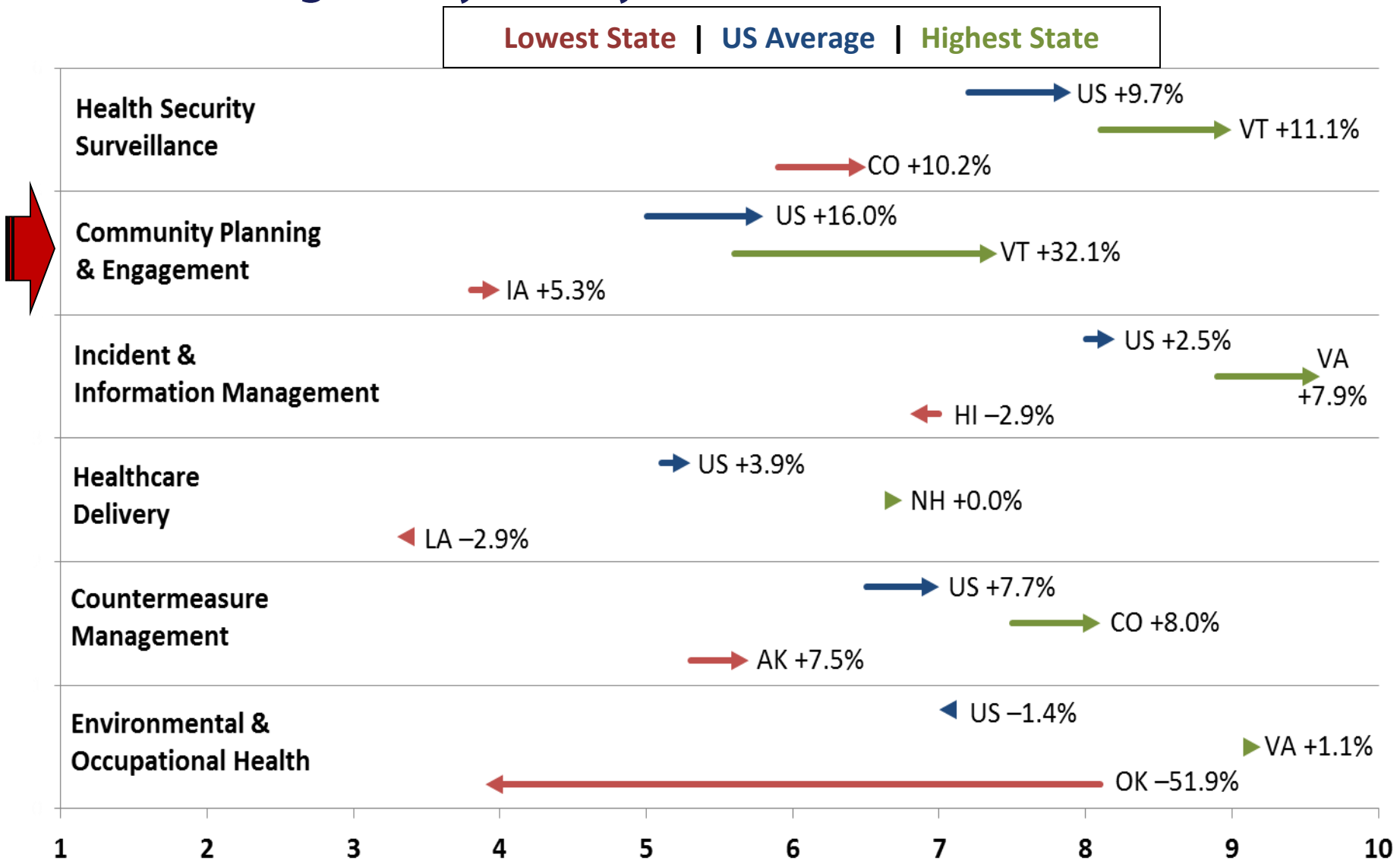



*statistically significant change

# Geographic disparities in health security are large and persistent



# Changes vary widely across states and domains




Index Values in 2013 and 2016

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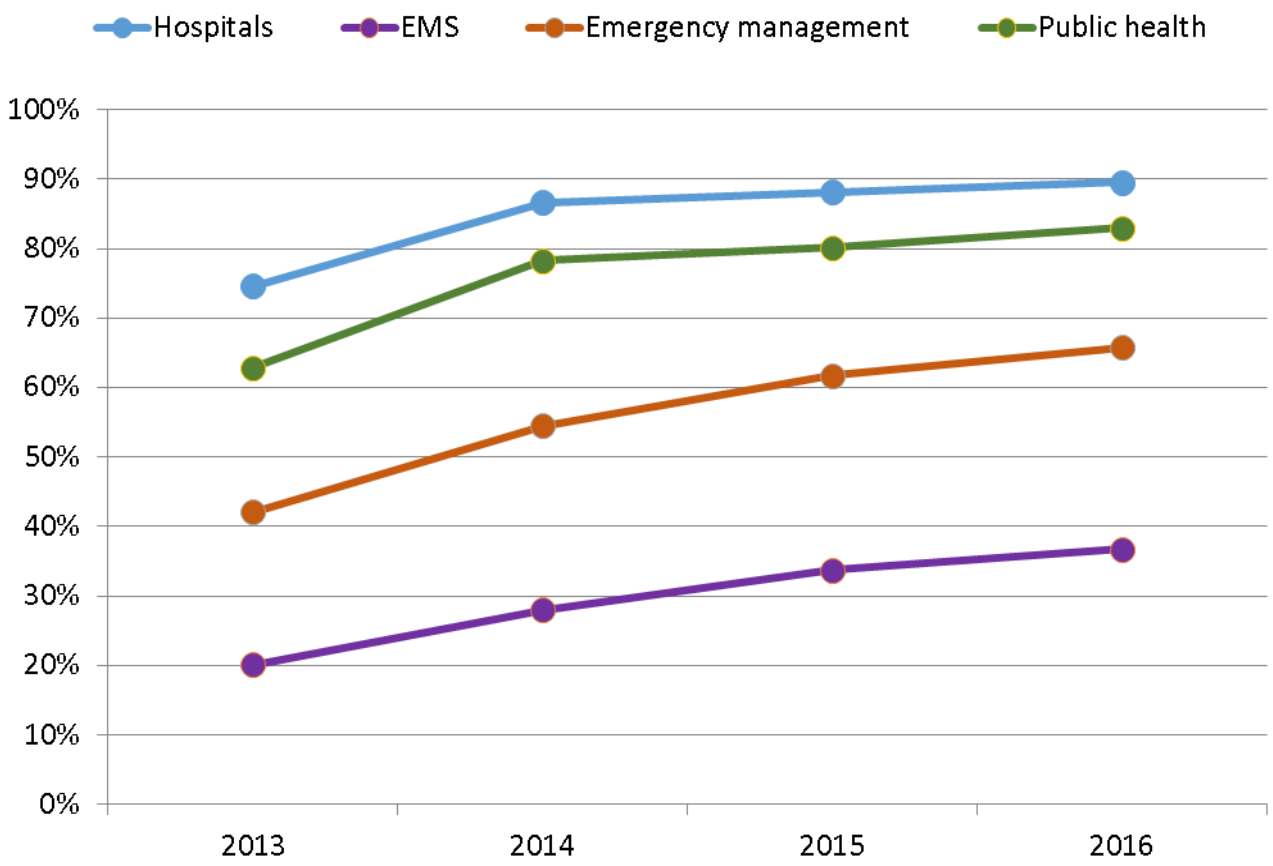
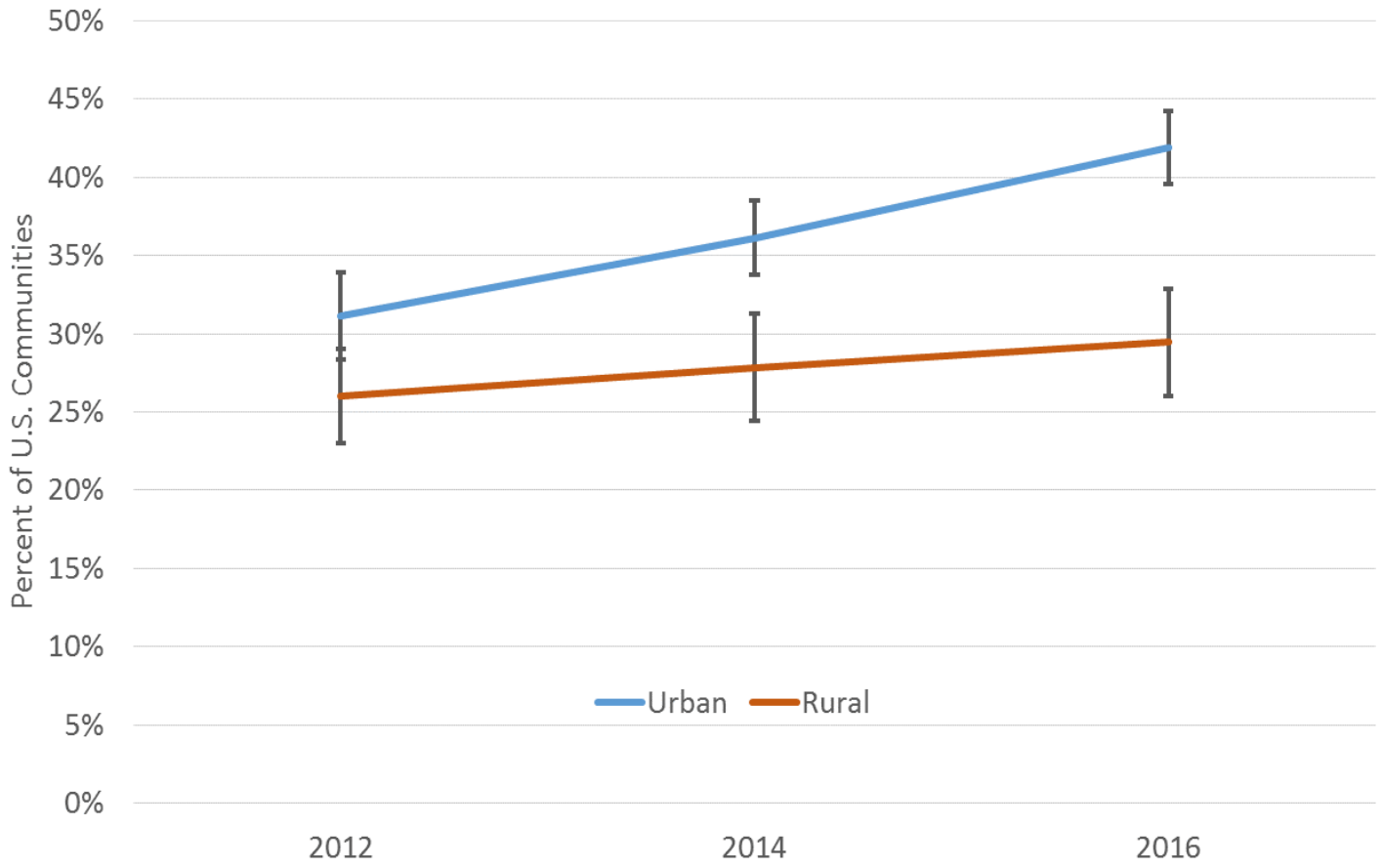
# Network drivers: density & penetration

## Participation in Healthcare Preparedness Coalitions



# Network drivers: density & centrality

## Communities with Strong Multi-Sector Networks (Comprehensive Public Health System Capital)

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*statistically significant difference

# Unpacking public health system capital

## One of RWJF's Culture of Health National Metrics

- ***Broad scope*** of public health activities
- ***Dense network*** of multi-sector relationships
- ***Central actors*** to coordinate actions

**Access to public health**

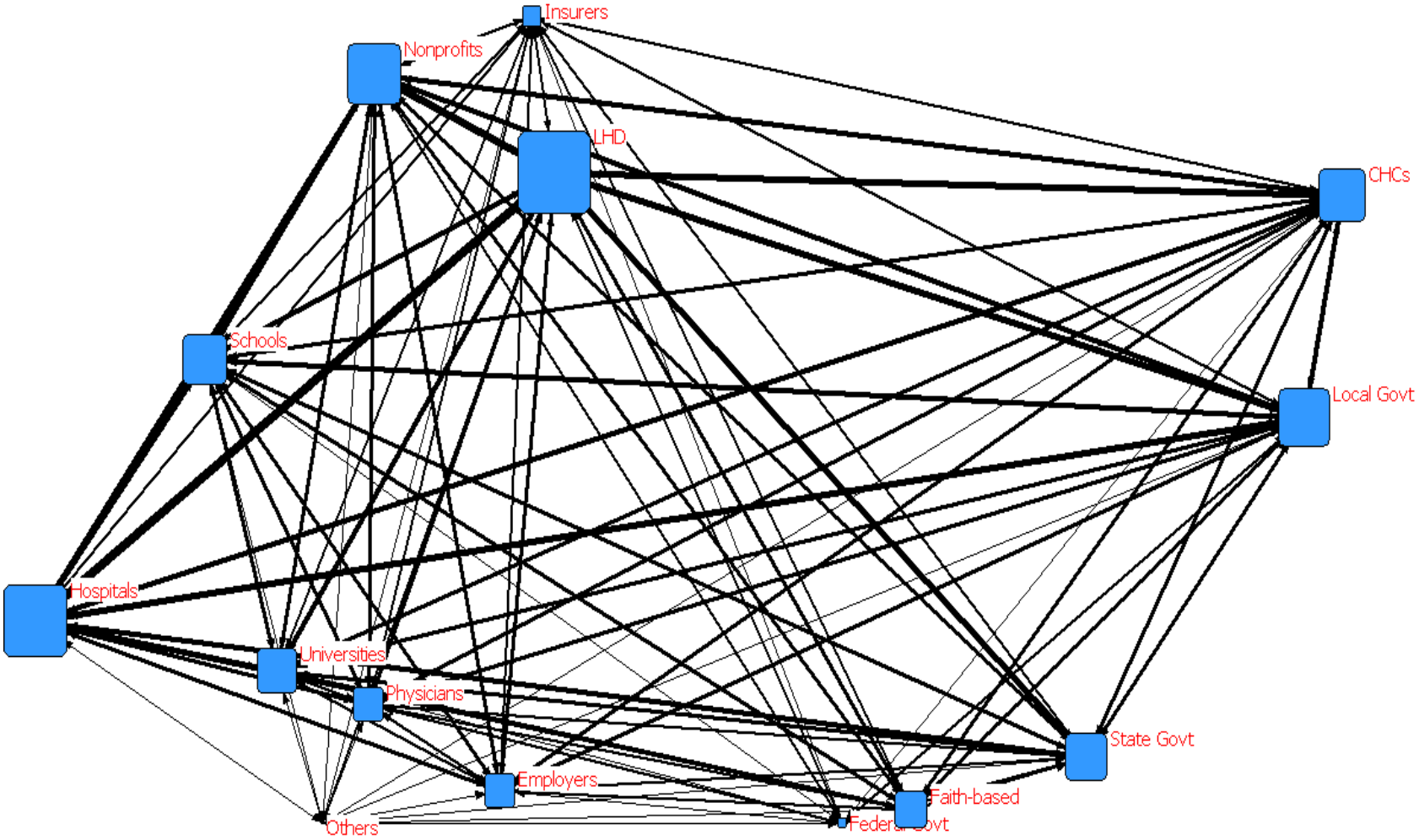
Overall, 47.2 percent of the population is covered by a comprehensive public health system. Individuals are more likely to have access if they are non-White (51.5 percent vs. 45.5 percent White) or live in a metropolitan area (48.7 percent vs. 34.1 percent in nonmetropolitan areas).

47.2%

of population served by a comprehensive public health system

http://www.cultureofhealth.org/en/integrated-systems/access.html

# Mapping public health system capital




**Node size = degree centrality**

**Line size = % activities jointly contributed (tie strength)**

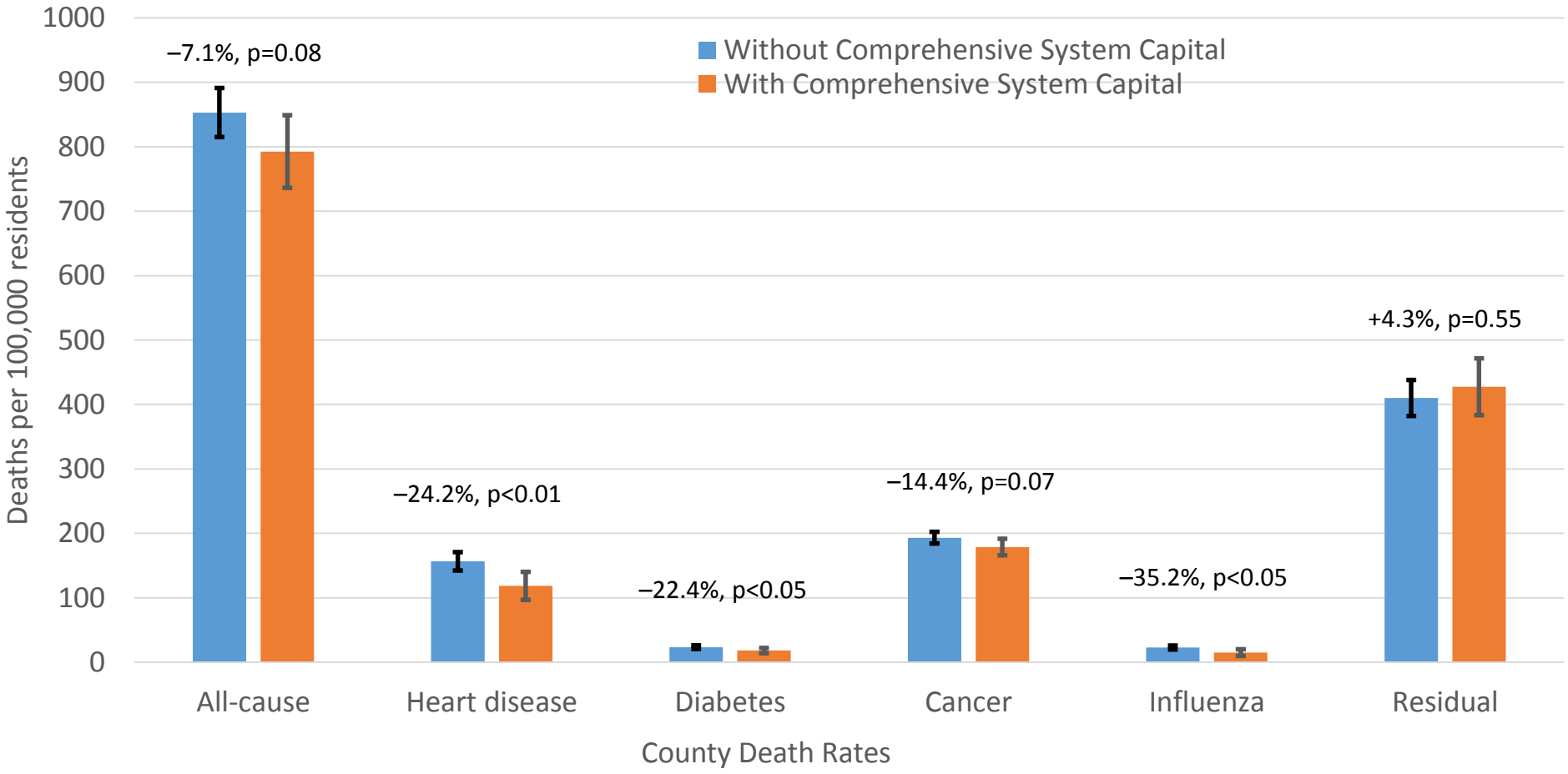
Mays GP et al. Understanding the organization of public health delivery systems: an empirical typology. *Milbank Q.* 2010;88(1):81–111.

# Organizational contributions to system capital, 1998-2016

| Type of Organization | % of Recommended Activities Contributed 1998 | 2016 | Percent Change |
|---|---|---|---|
| Local public health agencies | 60.7% | 67.5% | 11.1% |
| Other local government agencies | 31.8% | 33.2% | 4.4% |
| State public health agencies | 46.0% | 34.3% | -25.4% |
| Other state government agencies | 17.2% | 12.3% | -28.8% |
| Federal government agencies | 7.0% | 7.2% | 3.7% |
| Hospitals | 37.3% | 46.6% | 24.7% |
| Physician practices | 20.2% | 18.0% | -10.6% |
| Community health centers | 12.4% | 29.0% | 134.6% |
| Health insurers | 8.6% | 10.6% | 23.0% |
| Employers/businesses | 16.9% | 15.3% | -9.6% |
| Schools | 30.7% | 25.2% | -17.9% |
| Universities/colleges | 15.6% | 22.6% | 44.7% |
| Faith-based organizations | 19.2% | 17.5% | -9.1% |
| Other nonprofit organizations | 31.9% | 32.5% | 2.0% |
| Other | 8.5% | 5.2% | -38.4% |

# Health effects attributable to system capital

## Impact of Comprehensive Systems on Mortality, 1998-2014

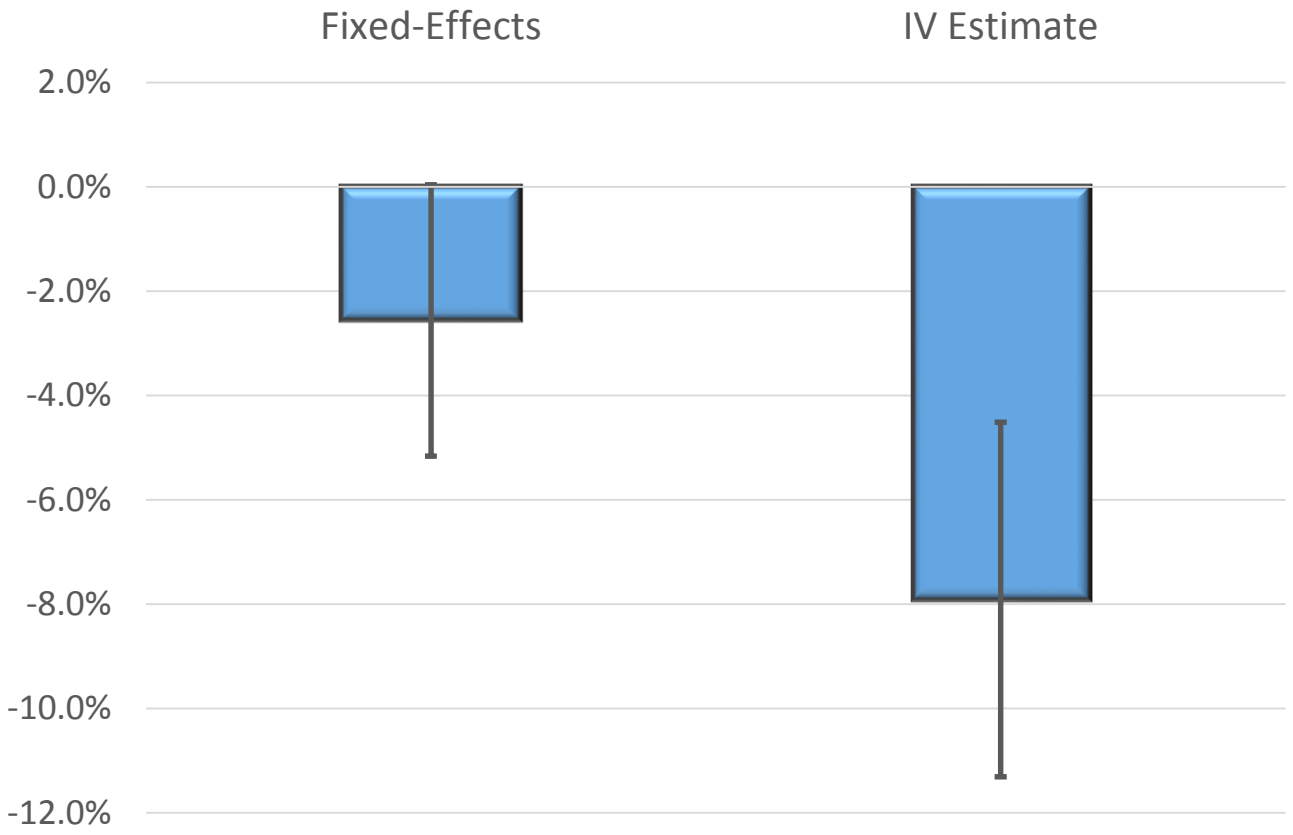



**Fixed-effects instrumental variables estimates controlling for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years**

Mays GP et al. *Health Affairs* 2016

# Economic effects attributable to system capital

## Impact of Comprehensive Systems on Medical Spending (Medicare) 1998-2014

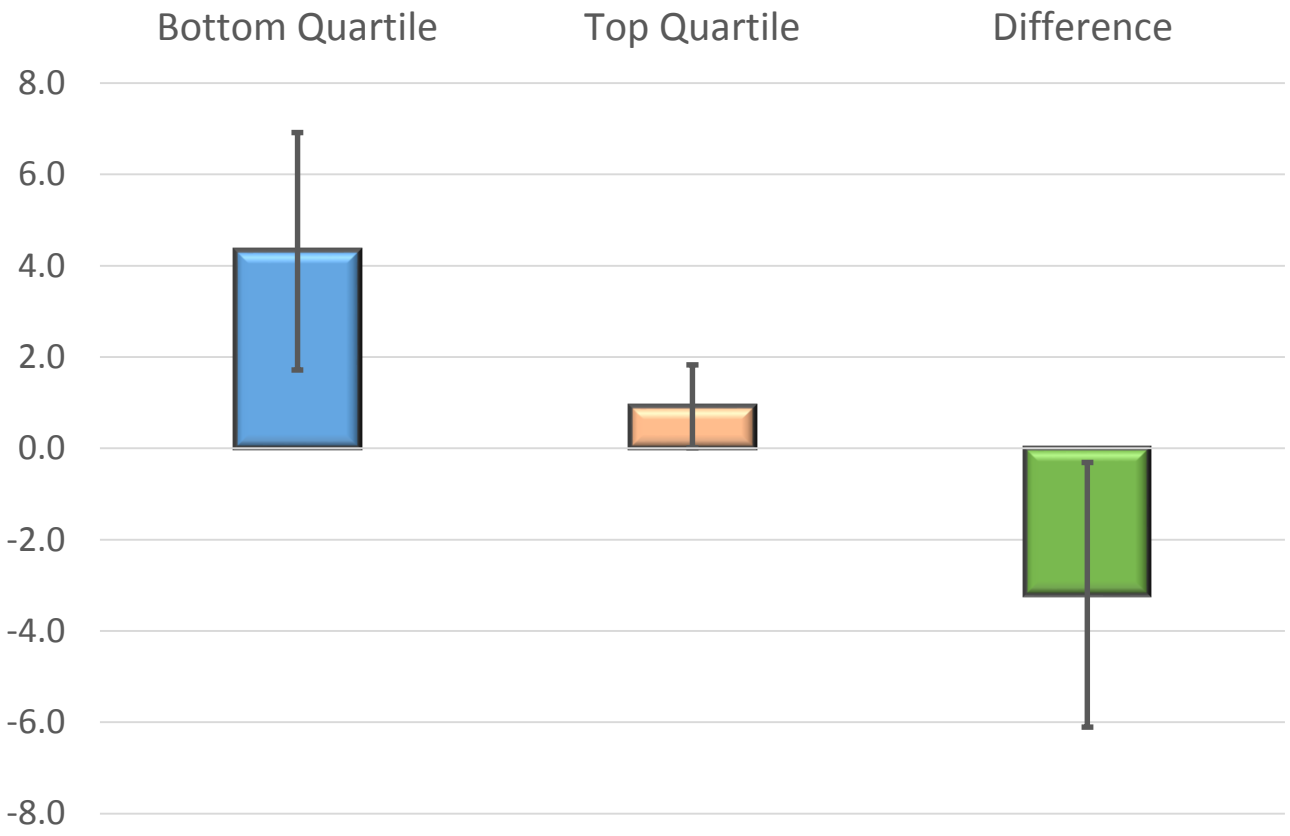



**Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years. Vertical lines are 95% confidence intervals**

Mays GP et al. *Health Services Research* 2017

# Economic effects attributable to system capital

## Impact of Comprehensive Systems on Life Expectancy by Income (Chetty), 2001-2014




**Models also control for racial composition, unemployment, health insurance coverage, educational attainment, age composition, and state and year fixed effects. N=1019 community-years. Vertical lines are 95% confidence intervals**

# Conclusions & Implications

- Health security driven in part by the strength of networks:
  - Healthcare Coalitions
  - Multi-sector public health systems
- Network strength varies widely across communities & changes over time
- Networks have large health & economic implications for their communities

# Conclusions and implications

- Large health gains in places with strong system capital
- Larger gains for low-income populations
- Comprehensive systems do more than just plan: prioritize, invest, evaluate, repeat (crowd-sourcing)
- Equity and opportunity: more than half of communities currently lack comprehensive system capital
- ACA incentives and resources may help:
  - Hospital community benefit
  - Value-based health care payments
  - Insurer and employer incentives
- Sustainability and resiliency are not automatic

# Caveats and cautions

- Imperfect measures & latent constructs
- Timing and accuracy of underlying data sources
- Unobserved within-state heterogeneity
- Short panel
- Observational, not causal, estimates

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Special appreciation to Index collaborators at CDC, ASPR, ASTHO, APHL, NACCHO, RAND, members of the Model Design and Analytic Methodology Workgroup, and the Stakeholder Engagement and Communications Workgroup.
Visit or join an Index workgroup at http://nhspi.org/get-involved/

# For More Information

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# Using Systems Science to Optimize Health Security Coalitions and Networks: Being Strategic with the Index

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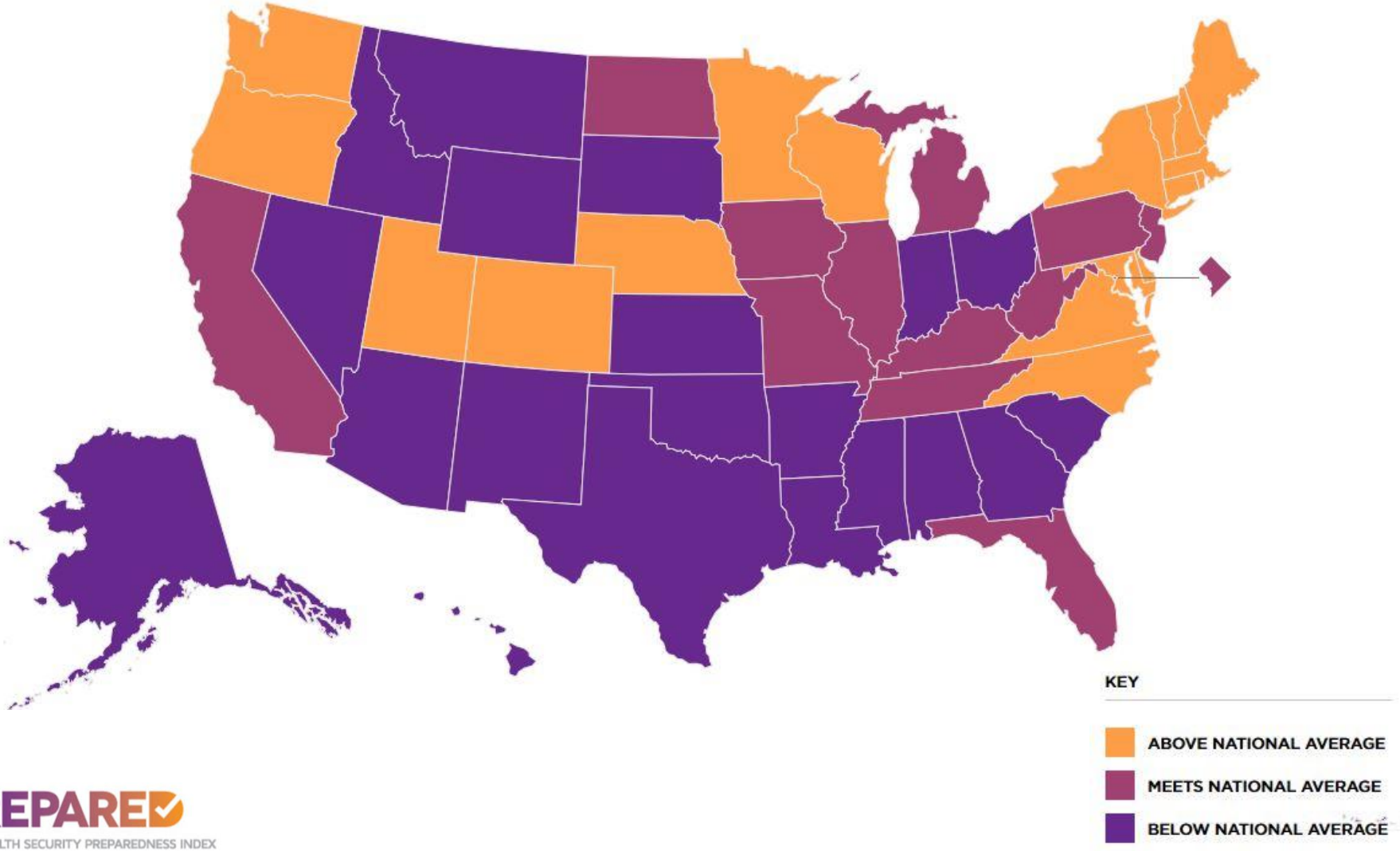
# The 2017 Release of the Index

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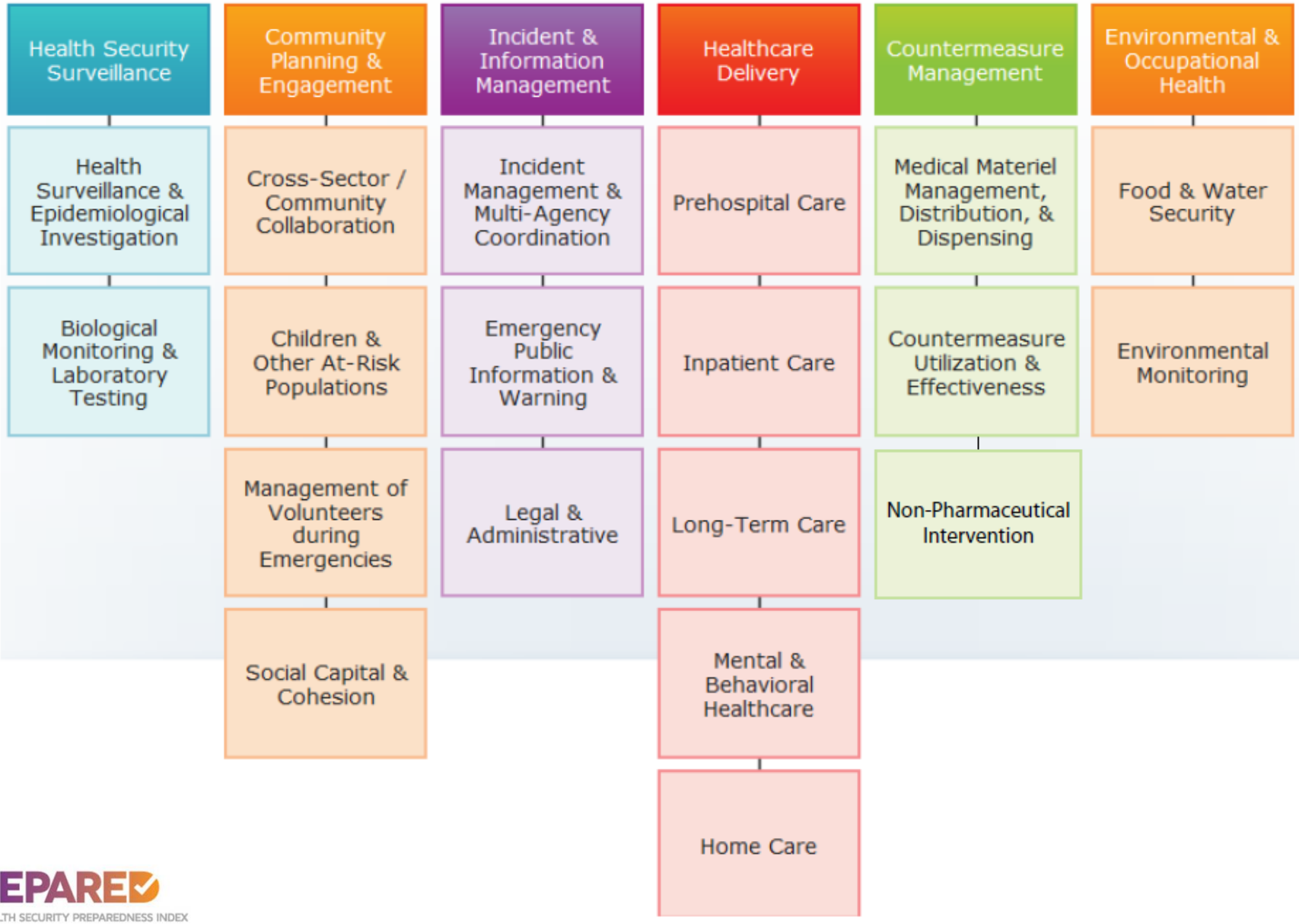
# What the Index measures

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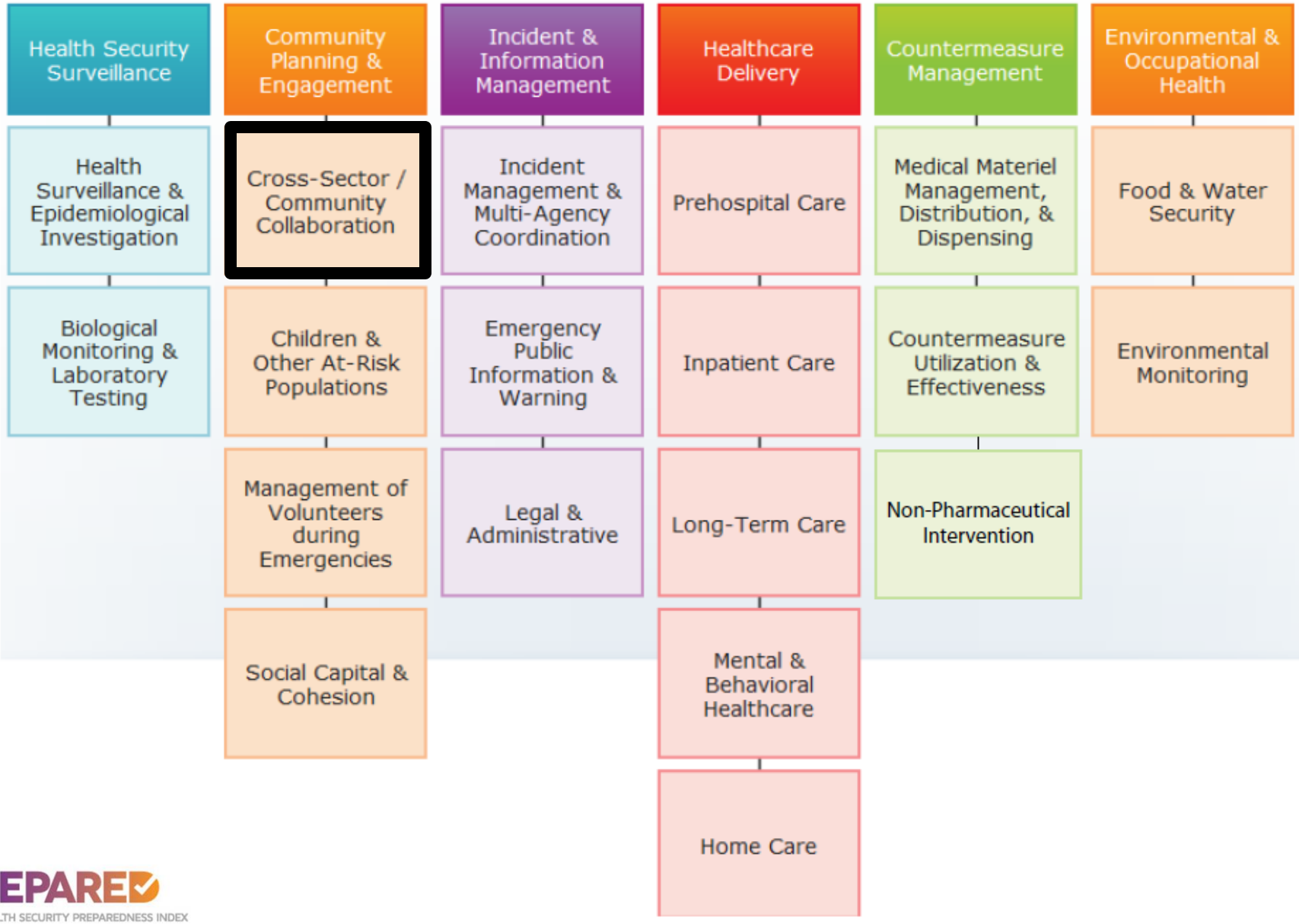
# What the Index measures

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# Cross Sector Community Collaboration

- The coordination necessary to engage community-based organizations and social networks through collaboration among agencies primarily responsible for providing direct health-related services; partners include public health, healthcare, business, education, and emergency management in addition to federal and nonfederal entities necessary to facilitate an effective and efficient return to routine delivery of services.

# 6 Measures in this Subdomain

- **M87** - Is the state-level health department accredited by the Public Health Accreditation Board (PHAB)?
- **M501** - Percent of population served by a comprehensive public healthsystem (scope of services and inter-organizational connectedness)

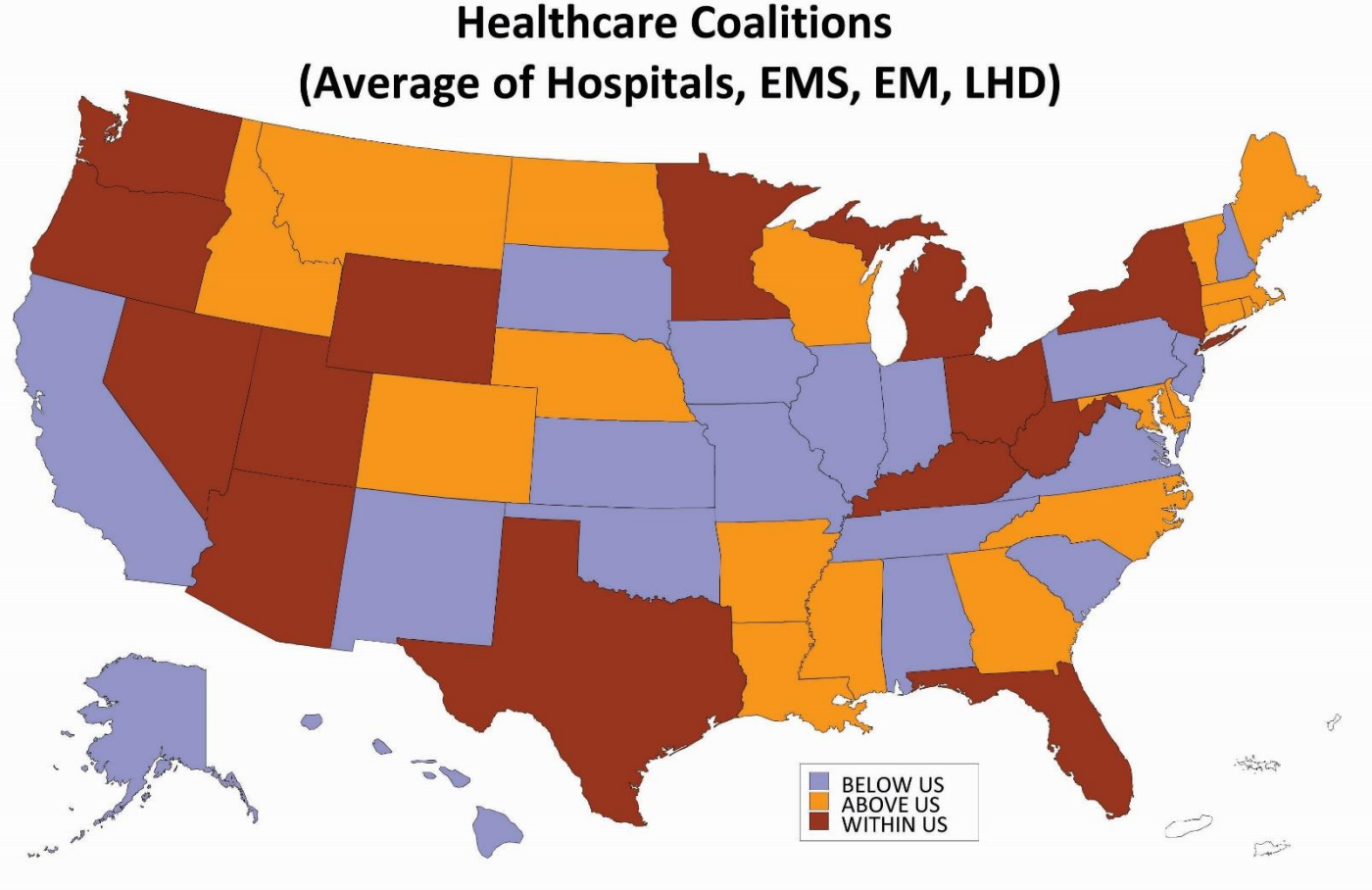
# 6 Measures, continued

- **M9031** - Percentage of hospitals that participate in Health Care Coalitions
- **M9032** - Percentage of emergency medical service agencies that participate in Health Care Coalitions
- **M9033** - Percentage of emergency management agencies that participate in Health Care Coalitions
- **M9034** - Percentage of local health departments that participate in Health Care Coalitions

# Distribution of State (and DC) Results

| Variable | Label | Minimum | Mean | Maximum |
|---|---|---|---|---|
| M9031 | Hospitals | 47% | 90% | 100% |
| M9032 | EMS | 0% | 37% | 100% |
| M9033 | EM | 0% | 66% | 100% |
| M9034 | LHD | 0% | 83% | 100% |
| Grand Mean | Overall | 26% | 69% | 100% |

# Coalitions

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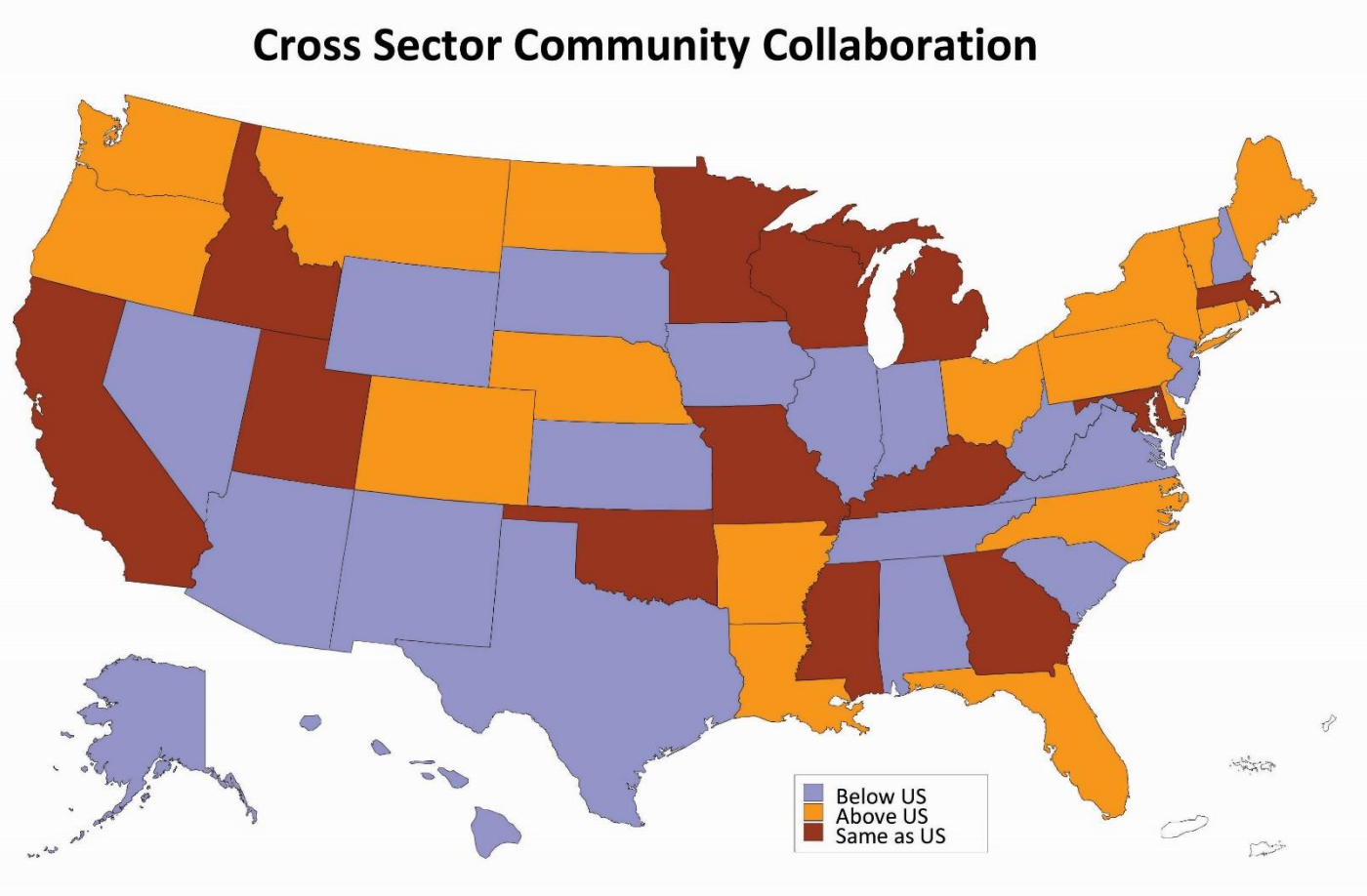
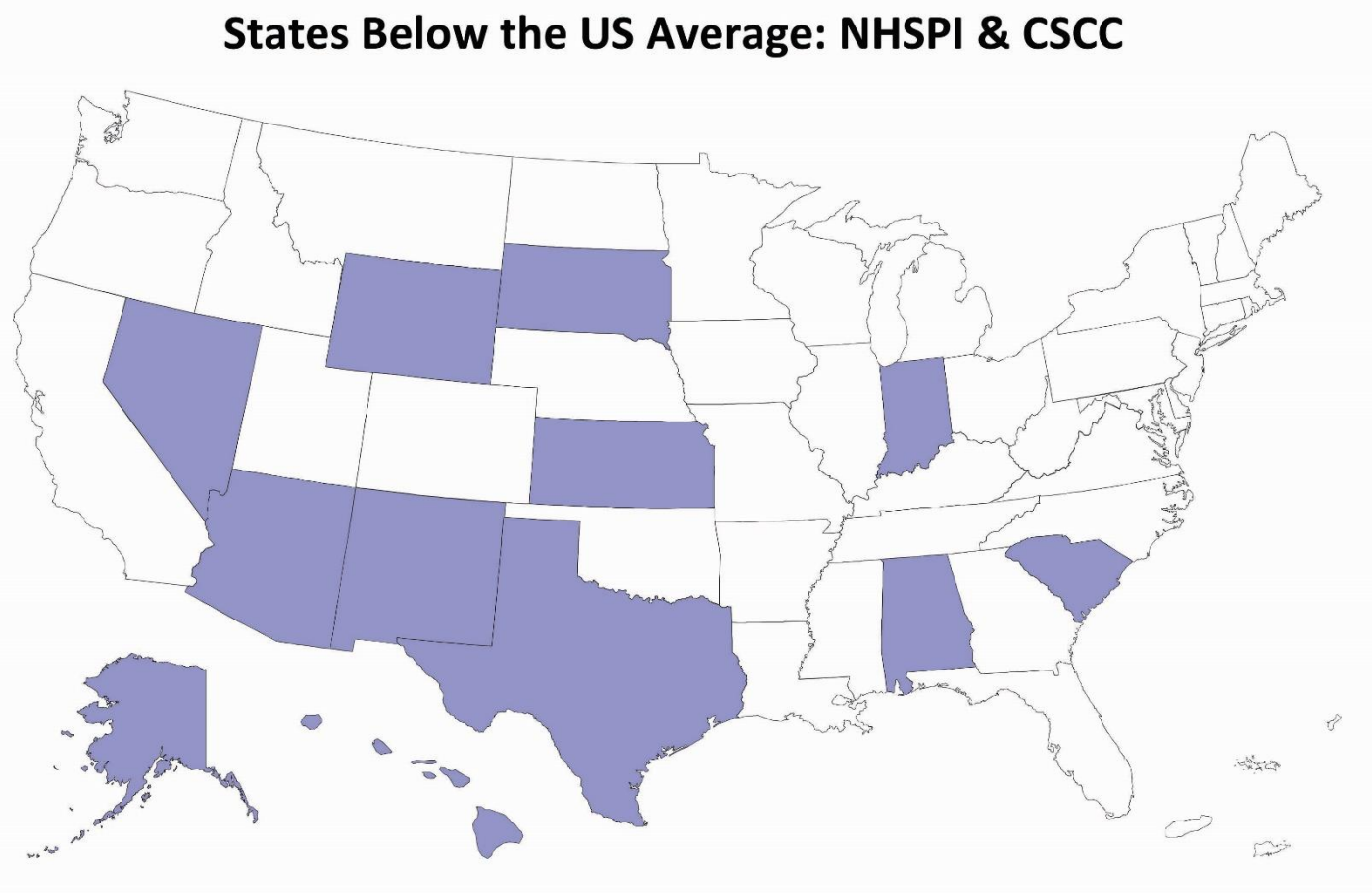
# CSCC Subdomain Index Results



# Which states are low on the Index & low on the CSCC Subdomain?



# Being Efficient & Strategic

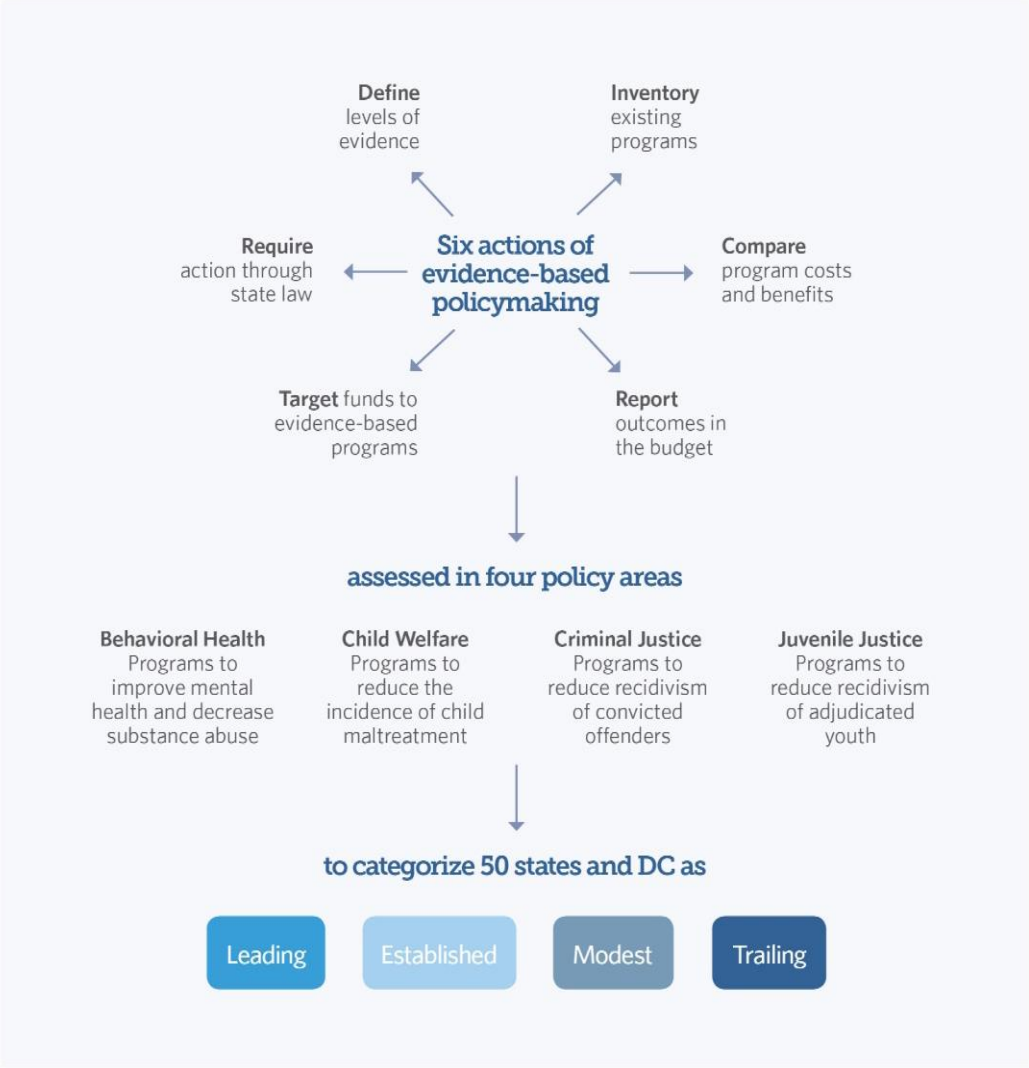
- Should we focus our efforts on these 12 states?
- Maybe, but we can be more strategic by combining these results with other factors that affect health preparedness, such as…
  - Culture of evidence-based planning
  - CDC Social Vulnerability Index
  - Level of Social Capital

# Evidence-Based Planning

- *How States Engage in Evidence-Based Policymaking: A National Assessment*
  - The Pew Charitable Trusts & MacArthur Foundation, January 2017

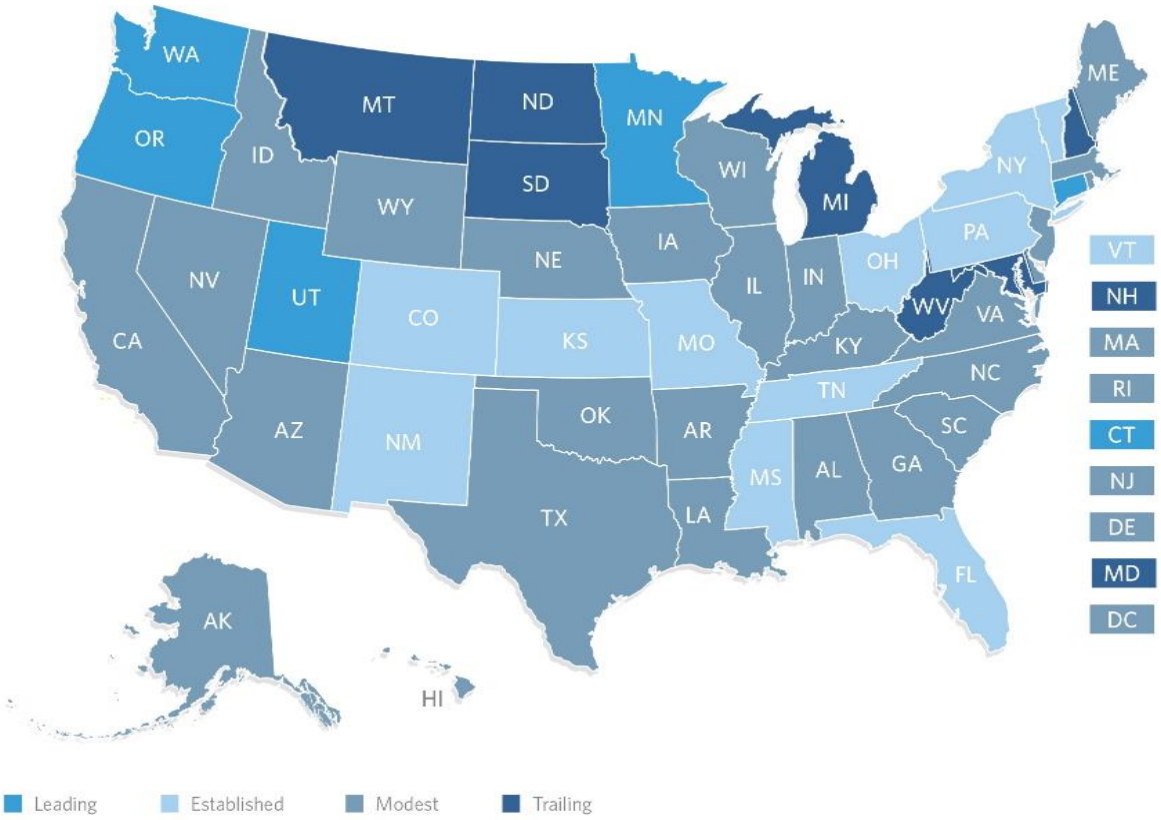
Figure 2

## Assessing Evidence-Based Policymaking in the States



Map 1

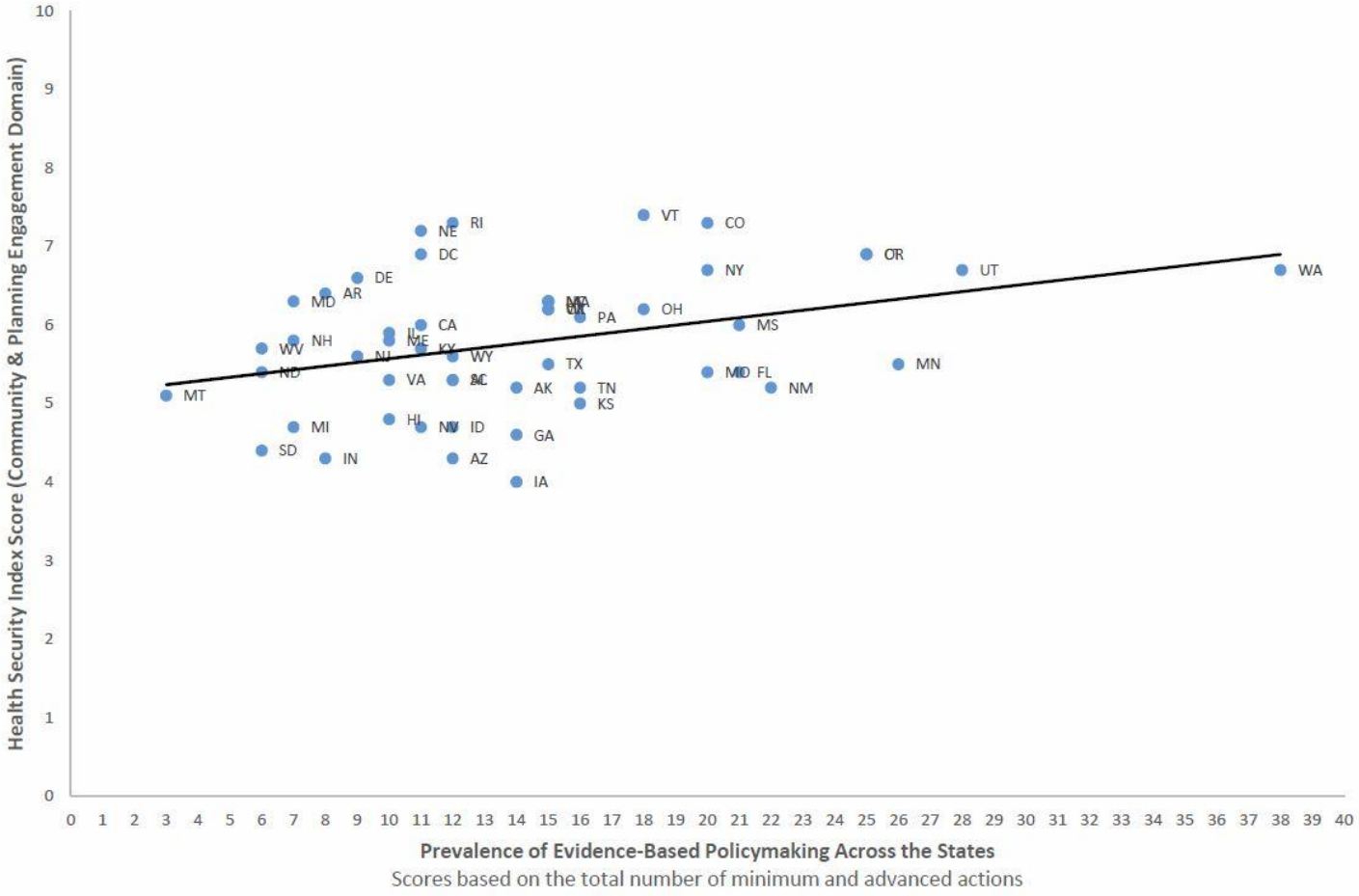
## Most States Show Modest Levels of Evidence-Based Policymaking




Source: Pew analysis of statutes, administrative codes, executive orders, and state documents

# CPE Domain by EBP

FIGURE 1—Health Security Index Score in the Community Planning & Engagement (CPE) Domain by the Use of Evidence-Based Policymaking in a State

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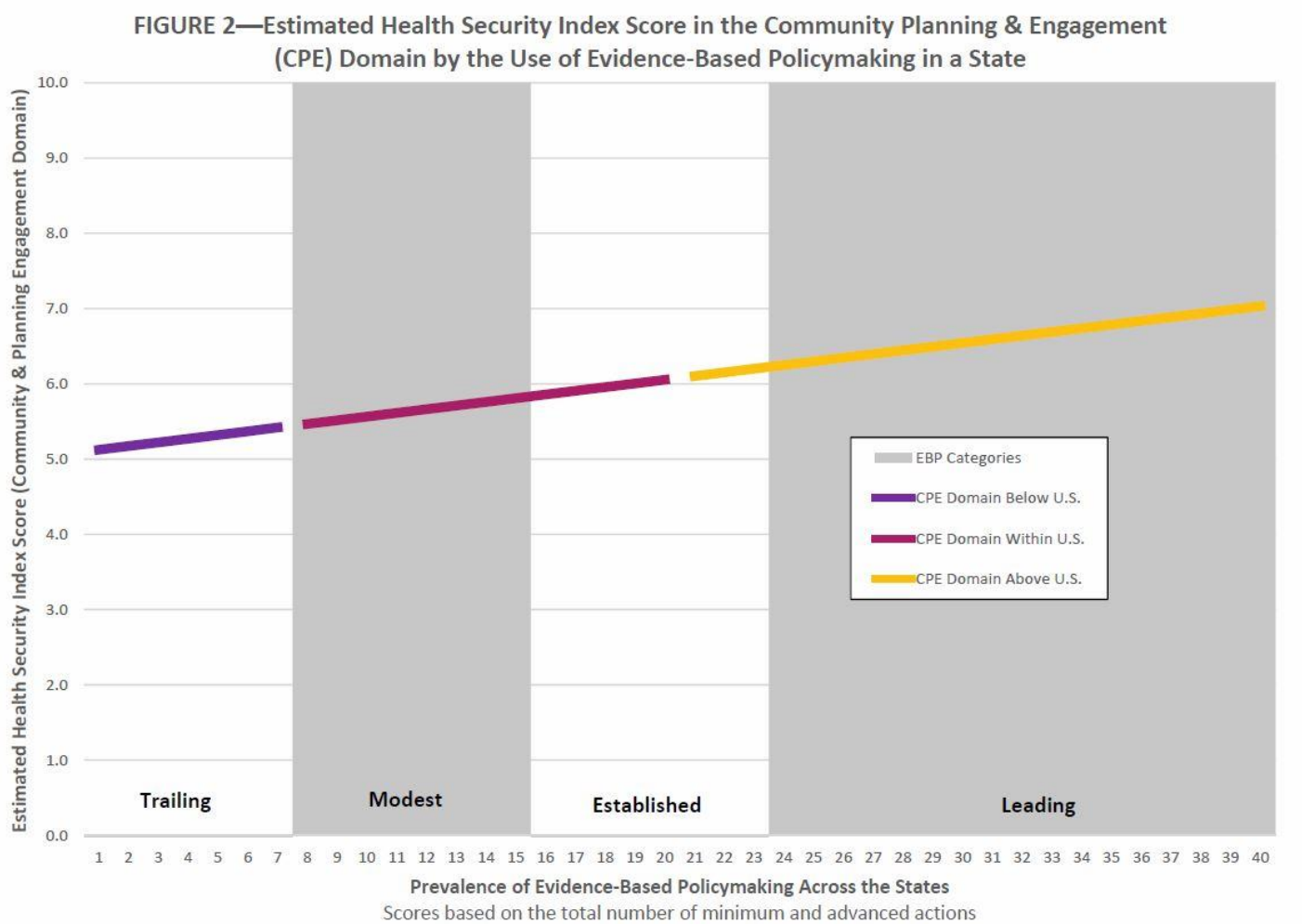
# Planning Matters

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*Note: Statistically significant while holding per capita income, state fiscal health, and disaster experience constant*

# CDC Social Vulnerability Index

- What is Social Vulnerability?

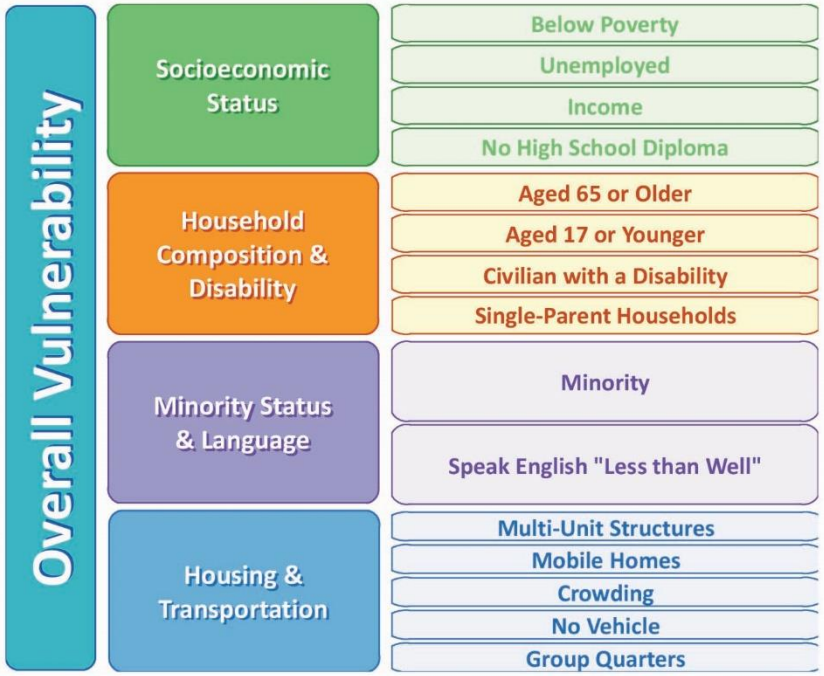
  "Every community must prepare for and respond to hazardous events, whether a natural disaster like a tornado or a disease outbreak, or an anthropogenic event such as a harmful chemical spill. The degree to which a community exhibits certain social conditions, including high poverty, low percentage of vehicle access, or crowded households, may affect that community's ability to prevent human suffering and financial loss in the event of disaster. These factors describe a community's social vulnerability." (Source: CDC)

# CDC Social Vulnerability Index

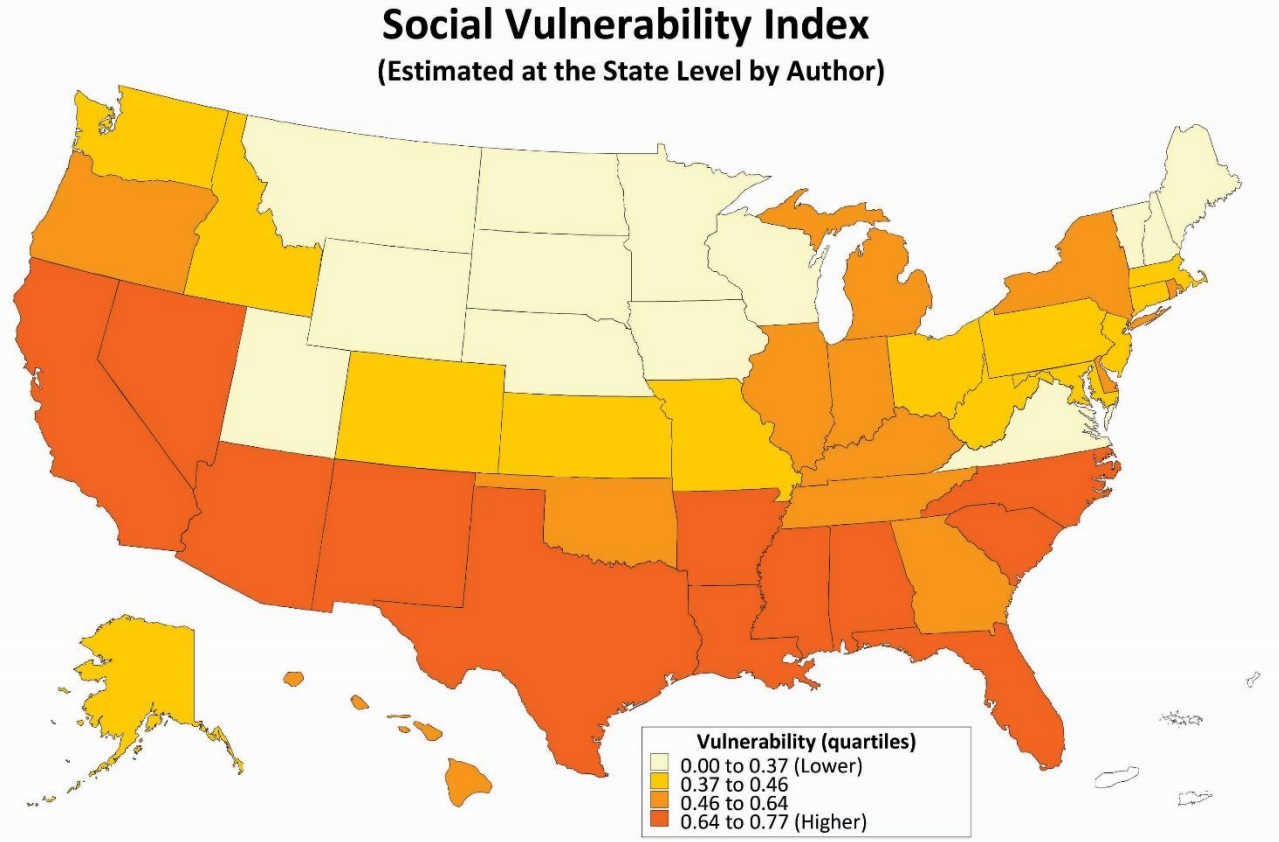
***Methods***

*Variables Used*

American Community Survey (ACS), 2010-2014 (5-year) data for the following estimates:



# Estimated State-Level Social Vulnerability Index




*Note: The CDC Social Vulnerability Index is estimated at the county level. The author has "population-weighted" these county-level estimates to generate state-level values.*

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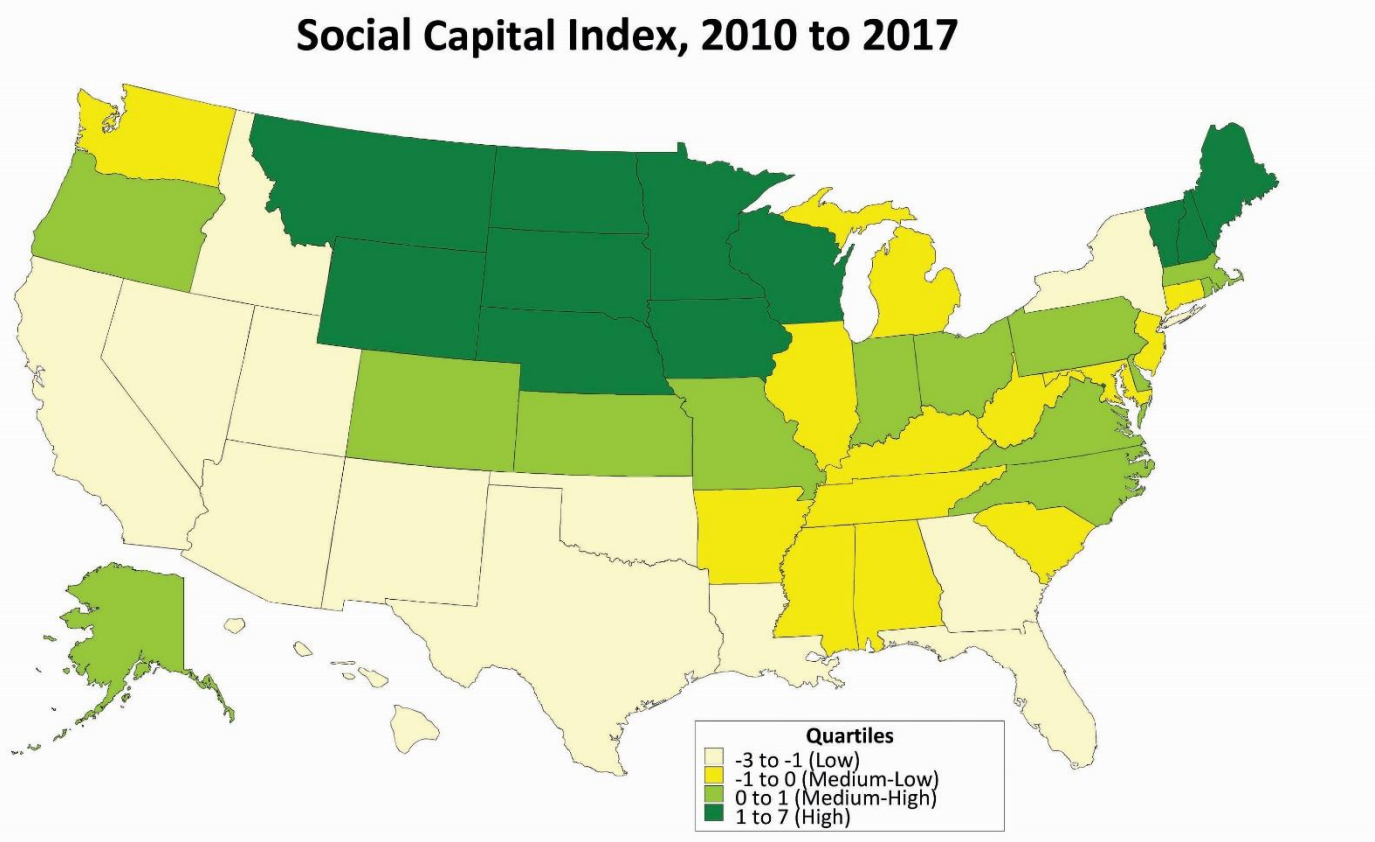
# Social Capital Index

- *The Production of Social Capital in US counties*
  - Rupasingha, A., Goetz, S. J., & Freshwater, D. (2006, with updates). The production of social capital in US counties. Journal of Socio-Economics, 35, 83–101.
- Factors include voter turnout, community-based organizations (10), Census response rates, number of nonprofits

# Estimated State-Level Social Capital



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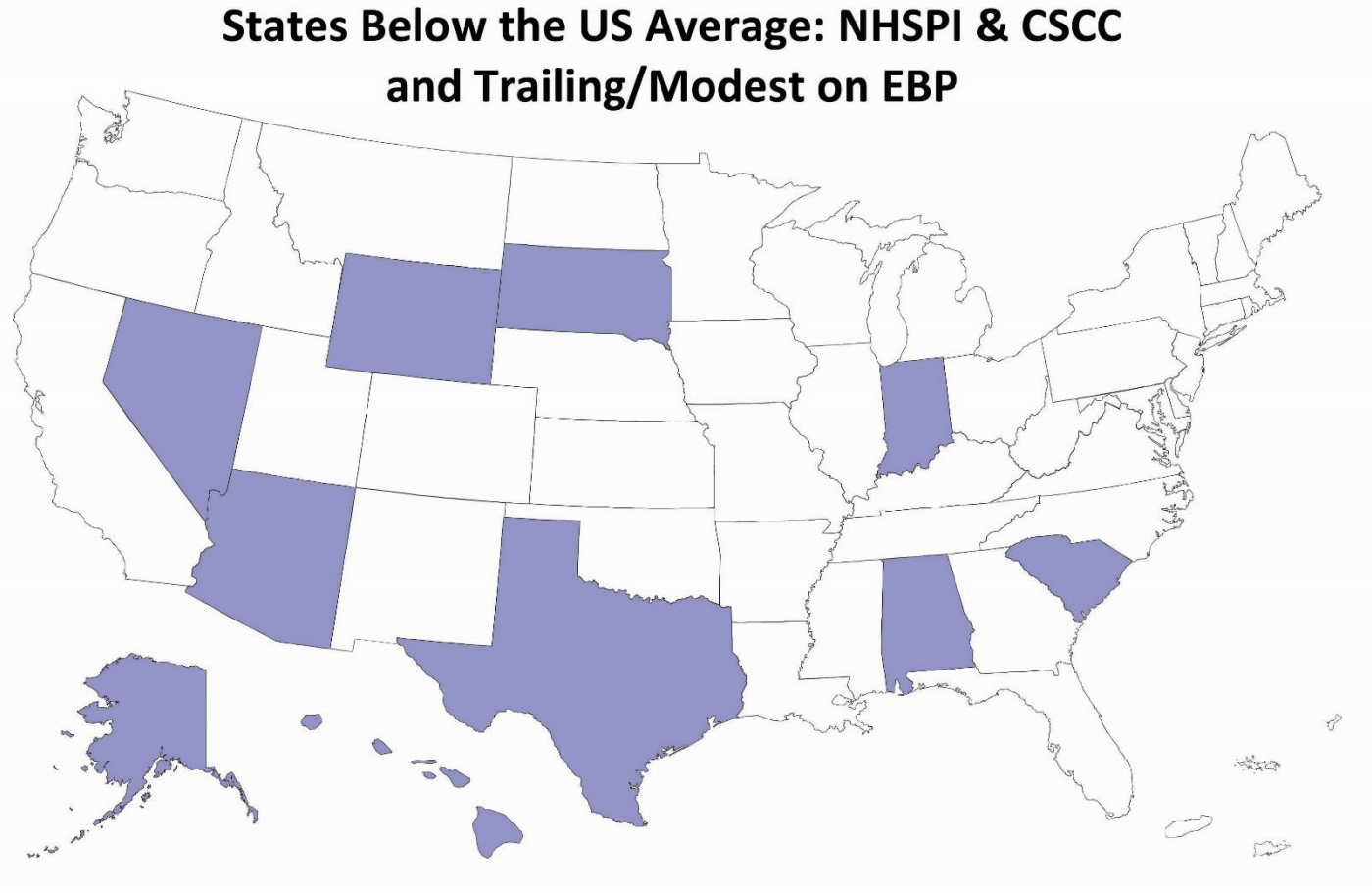
# Low-Low by EBP

| | | Evidence-Based Planning | | | |
|---|---|---|---|---|---|
| | | Trailing or Modest | Established | Leading | Total |
| NHSPI & CSCC subdomain | Not Low-Low | 25 | 9 | 5 | 39 |
| | Low on Both | **10** | 2 | 0 | 12 |
| | Total | 35 | 11 | 5 | 51 |

# Evidence-Based Planning

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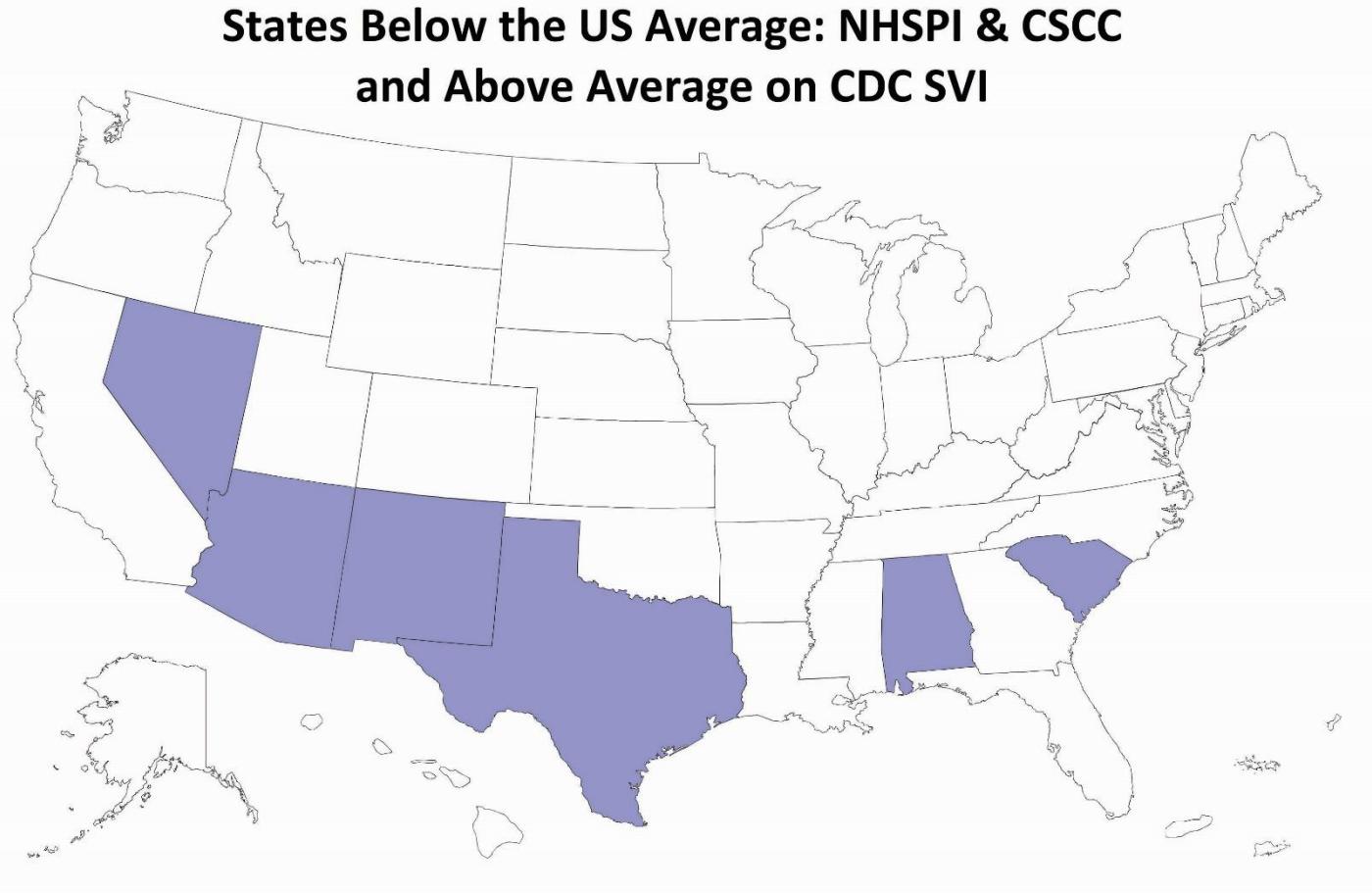
# Low-Low by Social Vulnerability

| | | CDC Social Vulnerability Index | | | |
|---|---|---|---|---|---|
| | | Above US | Below US | Within US | Total |
| NHSPI & CSCC subdomain | Not Low-Low | 13 | 15 | 11 | 39 |
| | Low on Both | **6** | 4 | 2 | 12 |
| | Total | 19 | 19 | 13 | 51 |

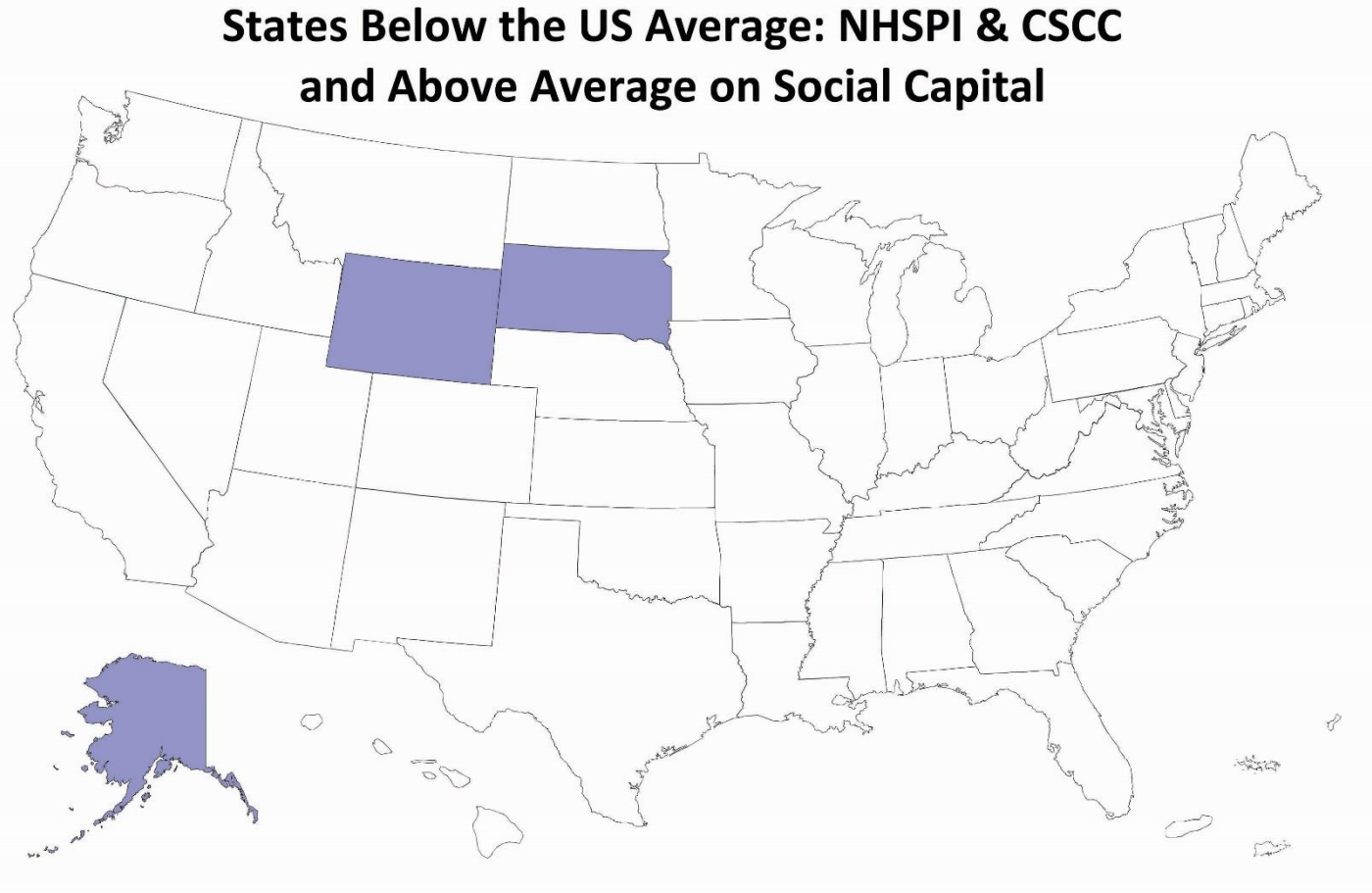
# Social Vulnerability



# Low-Low by Social Capital

| | | Social Capital Index | | | |
|---|---|---|---|---|---|
| | | Above US | Below US | Within US | Total |
| NHSPI & CSCC subdomain | Not Low-Low | 11 | 14 | 14 | 39 |
| | Low on Both | **3** | 5 | 4 | 12 |
| | Total | 14 | 19 | 18 | 51 |

# High Social Capital



# Overview

| Coalitions (low %) | Low NHSPI, Low CSCC (low-low) | LowLow + EBP (T/M) | LowLow + SVI (high) | LowLow + Social Capital (high) |
|---|---|---|---|---|
| AK | AK | AK | | AK |
| AL | AL | AL | AL | |
| | AZ | AZ | AZ | |
| CA | | | | |
| HI | HI | HI | | |
| IA | | | | |
| IL | | | | |
| IN | IN | IN | | |
| KS | KS | | | |
| MO | | | | |
| NH | | | | |
| NM | NM | | NM | |
| NJ | | | | |
| | NV | NV | NV | |
| OK | | | | |
| PA | | | | |
| SC | SC | SC | SC | |
| SD | SD | SD | | SD |
| TN | | | | |
| | TX | TX | TX | |
| VA | | | | |
| | WY | WY | | WY |
| 18 | 12 | 10 | 6 | 3 |

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# Conclusions

- The Index can be used as a tool to plan strategically
  - Where is planning capacity lower?
  - Which states are socially vulnerability?
  - Where is fertile ground for success?
- User can introduce additional dimensions
- Can be used at all levels of government

# For more information

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# Using the Index to Assess and Address Climate-Related Vulnerabilities and Resources

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**National Healthcare Coalition Preparedness Conference**

San Diego, CA

30 November 2017

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# Presenter Disclosure

The following personal financial relationships with commercial interests relevant to this presentation existed during the past 12 months:

**No relationships to disclose**.

- Outdoor air quality
- Surface and ground water quality
- Toxic substances and hazardous wastes
- Homes and communities
- Infrastructure and surveillance
- Global environmental health

# Impact of Climate Change on Human Health

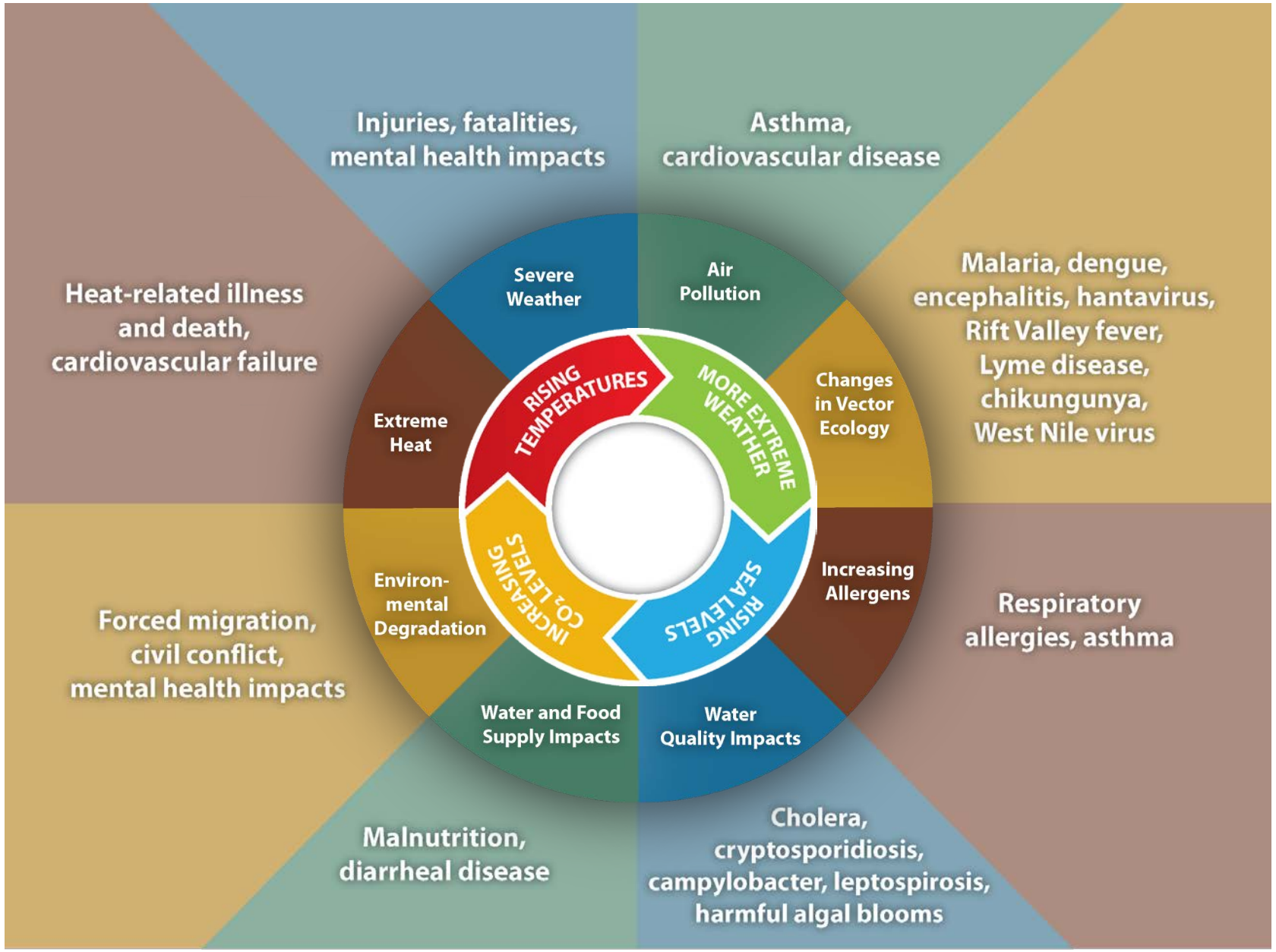


Image Courtesy CDC: https://www.cdc.gov/climateandhealth/effects/default.htm

# Overview: Index Environmental & Occupational Health Domain


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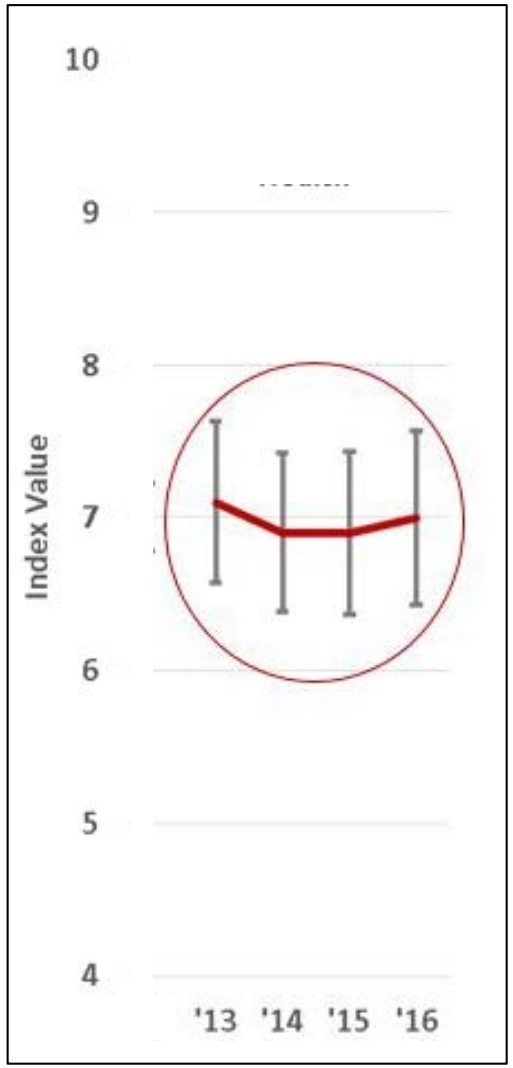
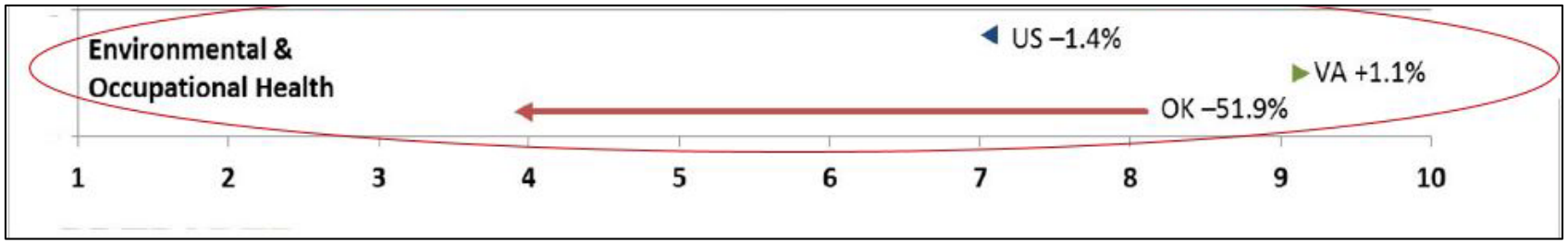
# Trends in Environmental & Occupational Health Protections




- More than 40% of states have experienced declines in EOH protections since the first Index release in 2013
- 17% of top-tier states in overall health security are below the national average in EOH protections
- More than 1/3 of top-tier states in overall health security have experienced declines in EOH protections since the first Index release
- By 2016, the top EOH state reflected EOH protections 2.4X higher than its lowest-scoring counterpart

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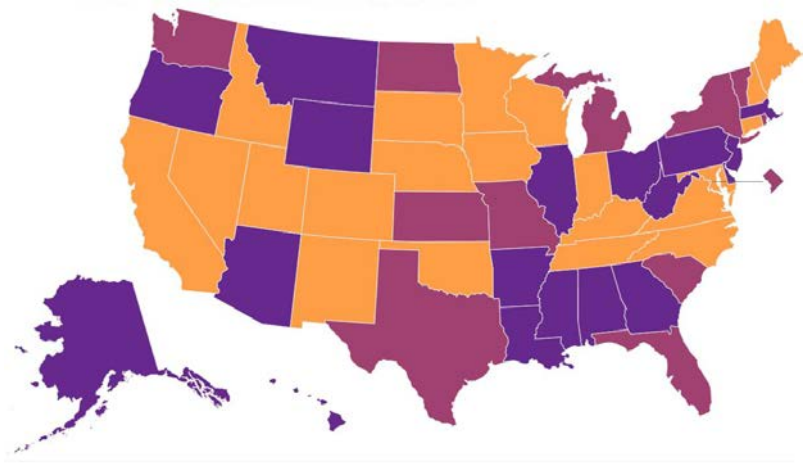
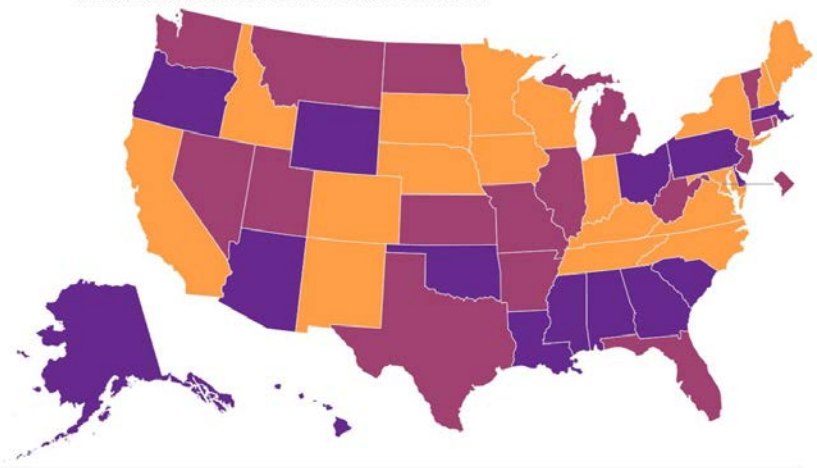
# Trends in EOH Protections: Geographic Disparities

2013



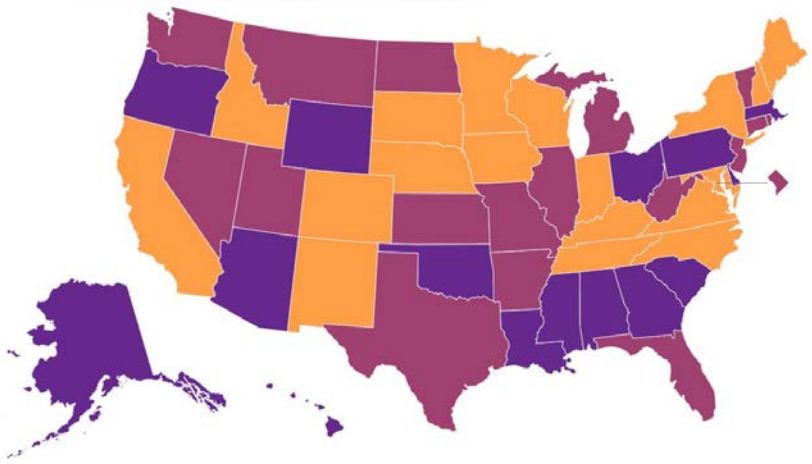
2014



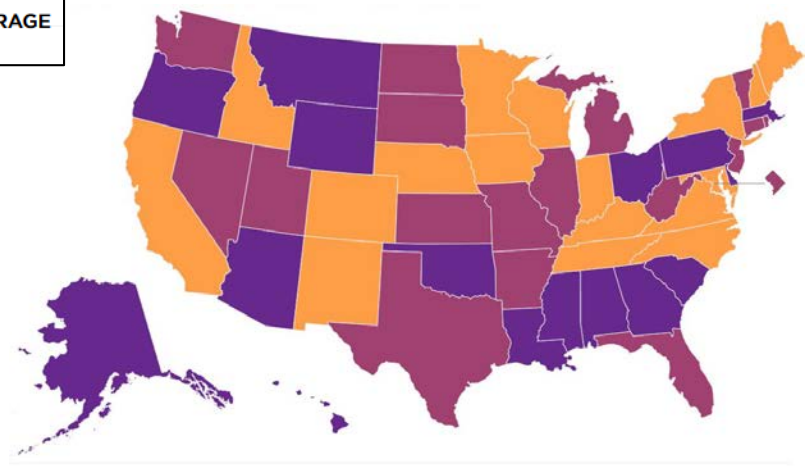
KEY

- ABOVE NATIONAL AVERAGE
- MEETS NATIONAL AVERAGE
- BELOW NATIONAL AVERAGE

2015



2016



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# Environmental & Occupational Health Domain Measures

**FWS: FOOD WATER SECURITY** | EM: ENVIRONMENTAL MONITORING

**The sufficient availability, access, use, and protection of safe and clean food and water resources to support human well-being and health.**

| MEASURE | MEASURE DESCRIPTION |
|---|---|
| **m275_dw** | Does your laboratory provide or assure testing for the following environmental matrices (Drinking water)? |
| **m275_pww** | Does your laboratory provide or assure testing for the following environmental matrices (Private well water)? |
| **m275_rec** | Does your laboratory provide or assure testing for the following environmental matrices (Recreational water)? |
| **m275_sur** | Does your laboratory provide or assure testing for the following environmental matrices (Surface water)? |
| **m275_ust** | Does your laboratory provide or assure testing for the following environmental matrices (Underground storage tanks)? |
| **m275_wst** | Does your laboratory provide or assure testing for the following environmental matrices (Waste water)? |
| **m276** | For which of the following organisms or their toxins does your state public health laboratory provide or assure testing for food and or water samples to assist with foodborne disease outbreak investigations: Bacillus cereus, Brucella sp., Campylobacter sp., Clostridium botulinum, Clostridium perfringens, Cryptosporidium sp., Cyclospora cayetanensis, Listeria monocytogenes, norovirus, Salmonella, Shigella, Staphylococcus aureus, STEC non-O157, STEC O157, Vibrio sp., Yersinia enterocolitica. The state's value is equal to the percentage of these tests performed. |
| **m195** | Percent of population in the state whose community water systems meet all applicable health-based standards through approaches that include effective treatment and source water protection |

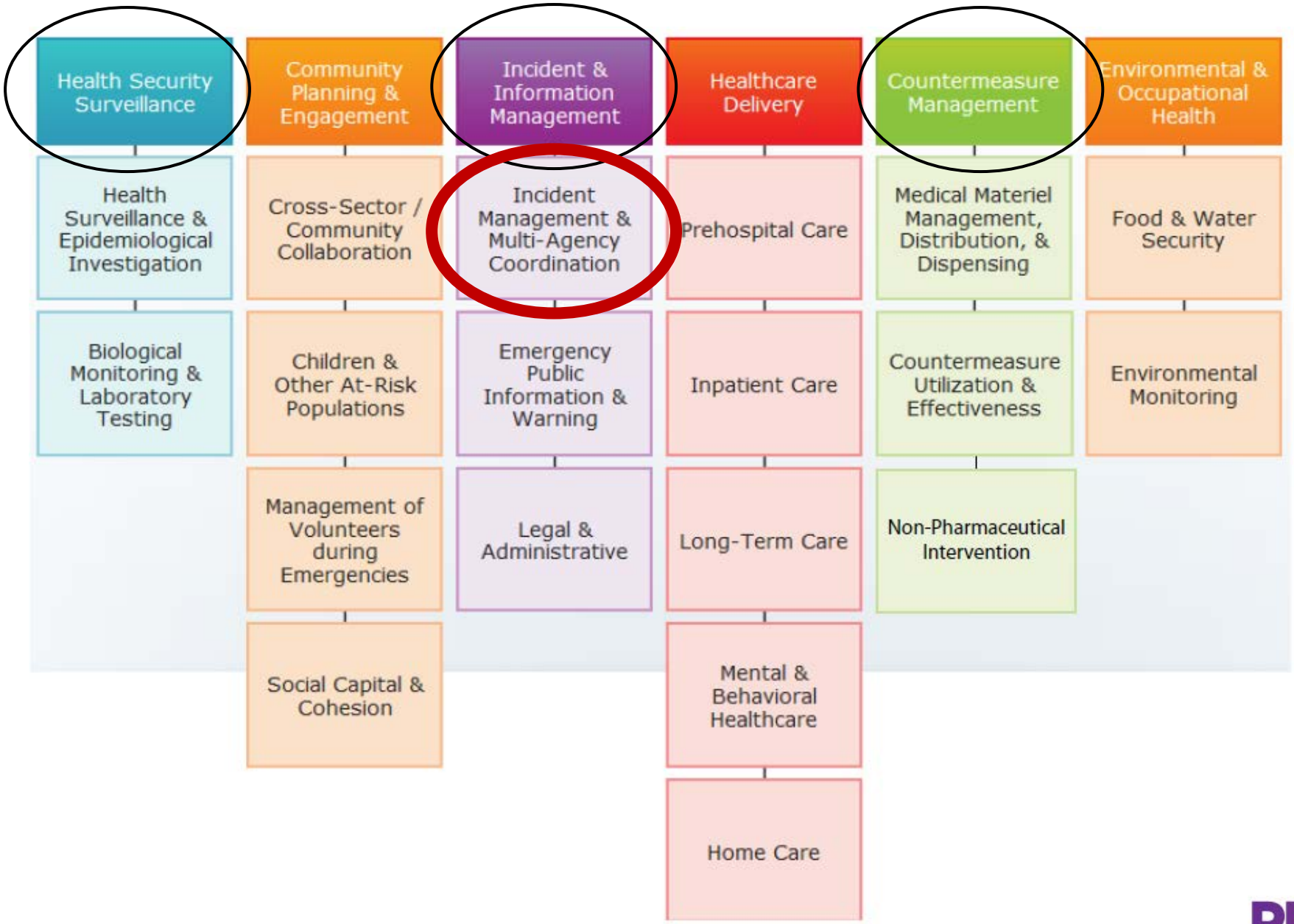
# Environmental & Occupational Health Domain Measures

FWS: FOOD WATER SECURITY | EM: ENVIRONMENTAL MONITORING

**The systematic collection and continuous or frequent standardized measurement and observation of: environmental specimens (air, water, land/soil, and plants) analyzing the presence of an indicator, exposure, or response (warning and control), including monitoring the environment for vectors of disease to give information about the environment to assess past and current status and predict future trends**

| MEASURE | MEASURE DESCRIPTION | SOURCE |
|---|---|---|
| m202 | Does your state public health laboratory provide or assure testing for air? | |
| m257_aiha | Does the American Industrial Hygiene Association (AIHA) provide certification or accreditation of your state public health laboratory? | |
| m257_epa | Does the U.S. Environmental Protection Agency (EPA) provide certification or accreditation of your state public health laboratory? | |
| m257_nelac | Does the National Environmental Laboratory Accreditation Conference (NELAC) provide certification or accreditation of your state public health laboratory? | |
| m197 | Does your state public health laboratory provide or assure testing for radiologic agents in environmental samples? | |
| m196 | Does your state public health laboratory provide or assure testing for environmental samples in the event of suspected chemical terrorism? | |
| m272 | Does your state public health laboratory test for contaminants in environmental samples: asbestos, explosives, gross alpha and gross beta, inorganic compounds (e.g., nitrates), metals, microbial, lead, persistent organic pollutants, pesticides (including organophosphates), pharmaceuticals, radon, or volatile organic compounds? The state's value is equal to the percentage of these tests performed. | |
| m273 | Does your state public health laboratory provide or assure testing for hazardous waste? | |
| m274 | State participates in the National Plant Diagnostic Network (NPDN) | |
| m904 | Number of Environmental Scientists and Specialists, including Health per 100,000 population | |

# Additional EOH-Relevant Measures

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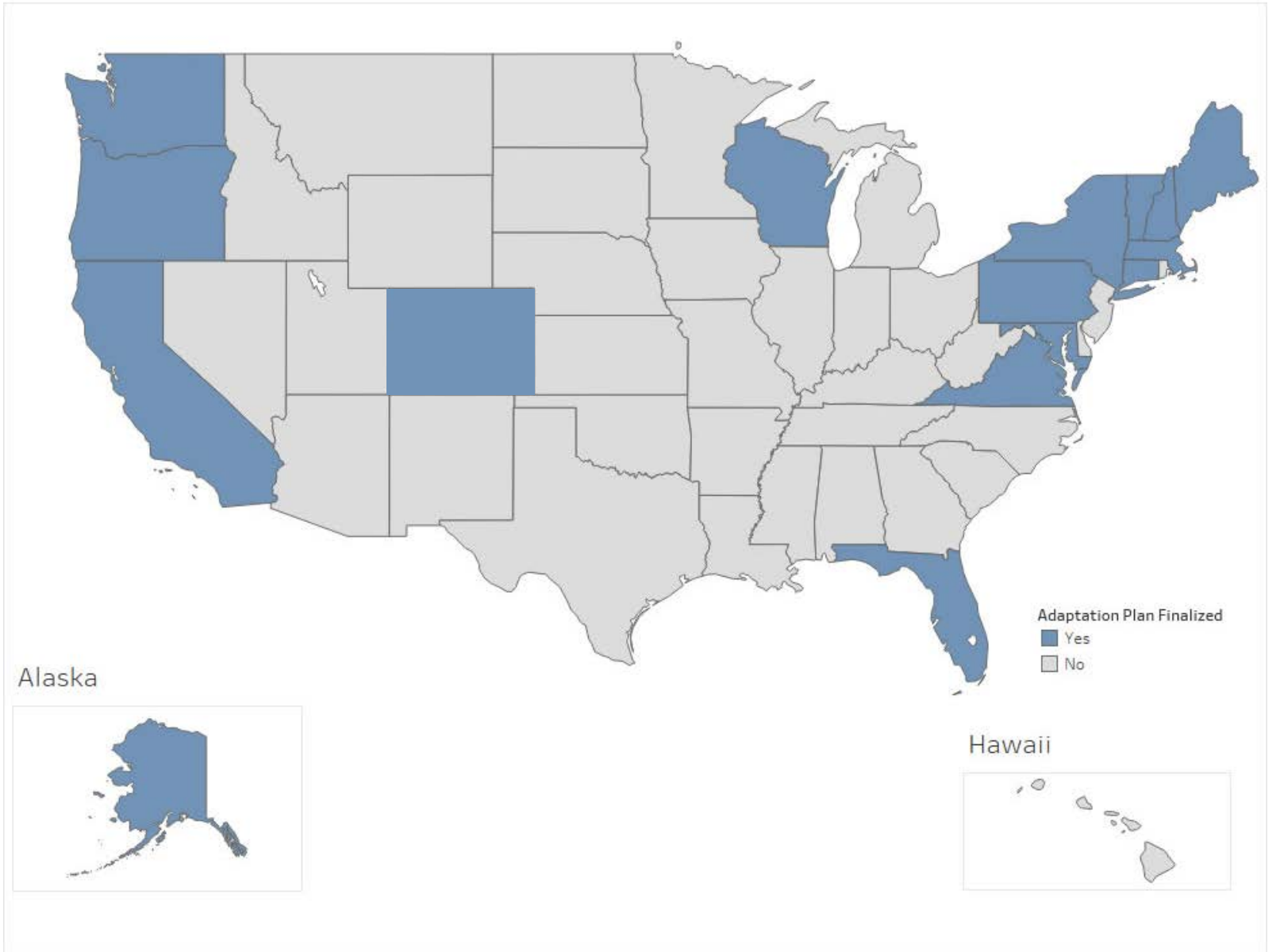
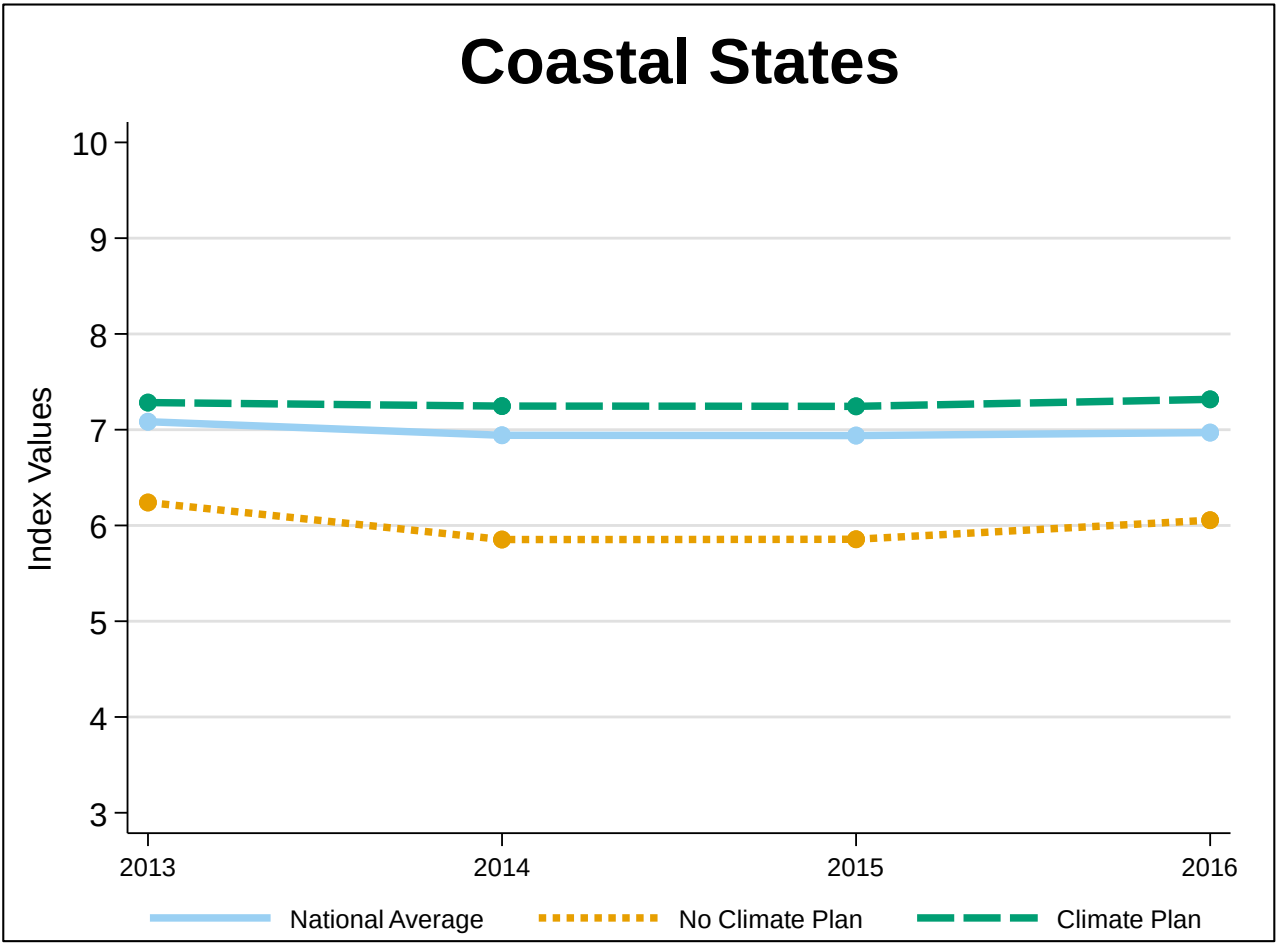
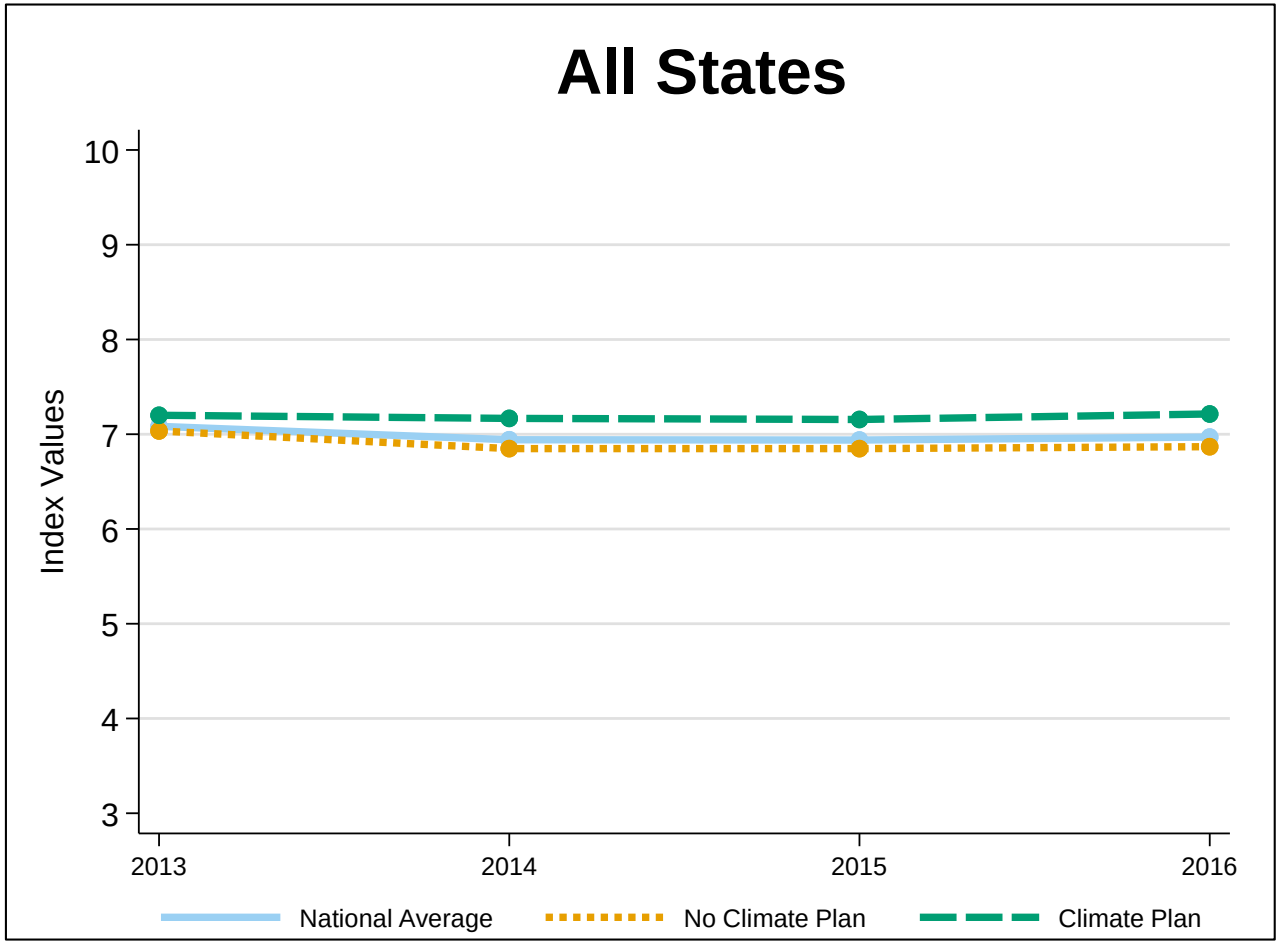
# Finalized State Climate Adaptation Plans



# Environmental and Occupational Health Domain



# Why?

| m334 | Does state have a climate change adaptation plan? |
|---|---|

| | |
|---|---|
| **Measure Name** | M334 |
| **Measure Source** | Center for Climate and Energy Solutions (C2ES), State and Local Climate Adaptation |
| **Data date(s)** | 2014 - 2016 |
| **Limitations** | The measure is an indicator of state planning for climate change; however, it only indicates if a state has a plan. The quality of the plan is not evaluated. The degree to which the plan is being implemented is also not evaluated. |

# 15 Heterogeneous State Climate Adaptation Plans

- Timelines
  - Plan finalization dates range from 2008 to 2016
  - 75% of coastal states had finalized plans before the first non-coastal state plan was finalized in 2011
  - Only 1 new plan since the first Index release in 2013
- Length: from 12 pages to >400
- Leadership
  - Most authored by governor-appointed commissions/task forces/steering committees
  - All steering committees included representation from state and/or local departments of environmental protection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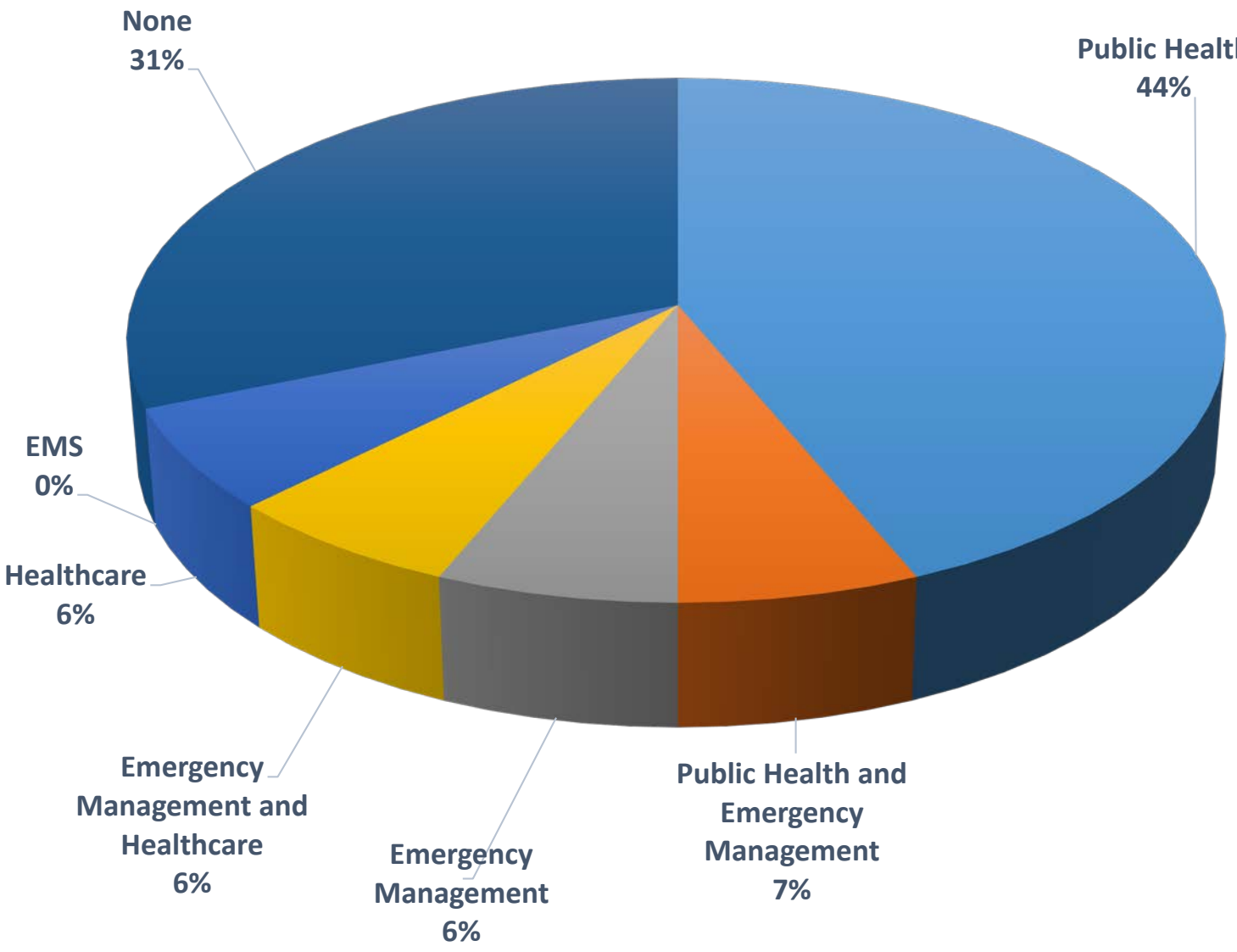
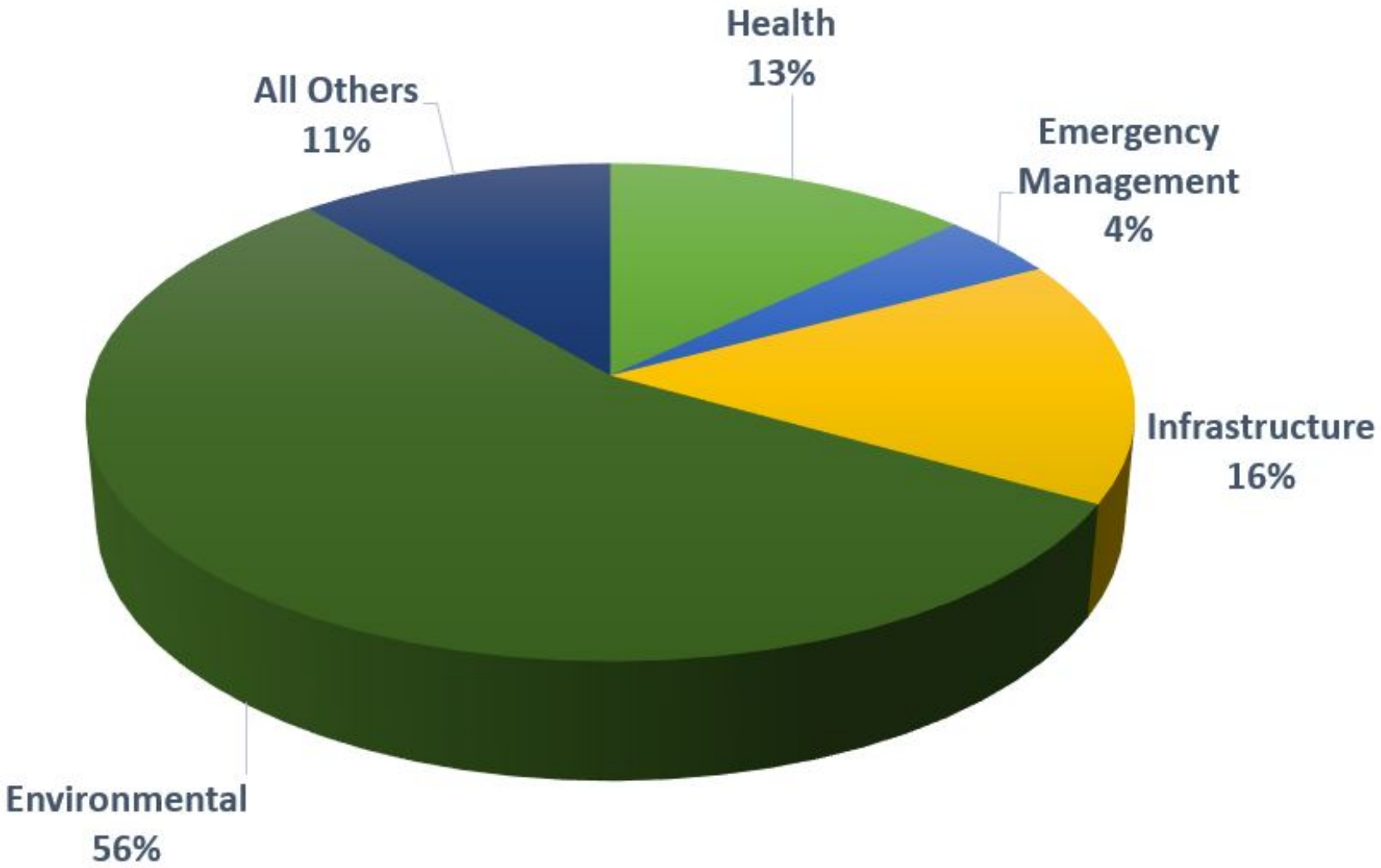
# Adaptation Planning Steering Committee Membership by Sector (All States)



# Adaptation Goals by Sector (All States)



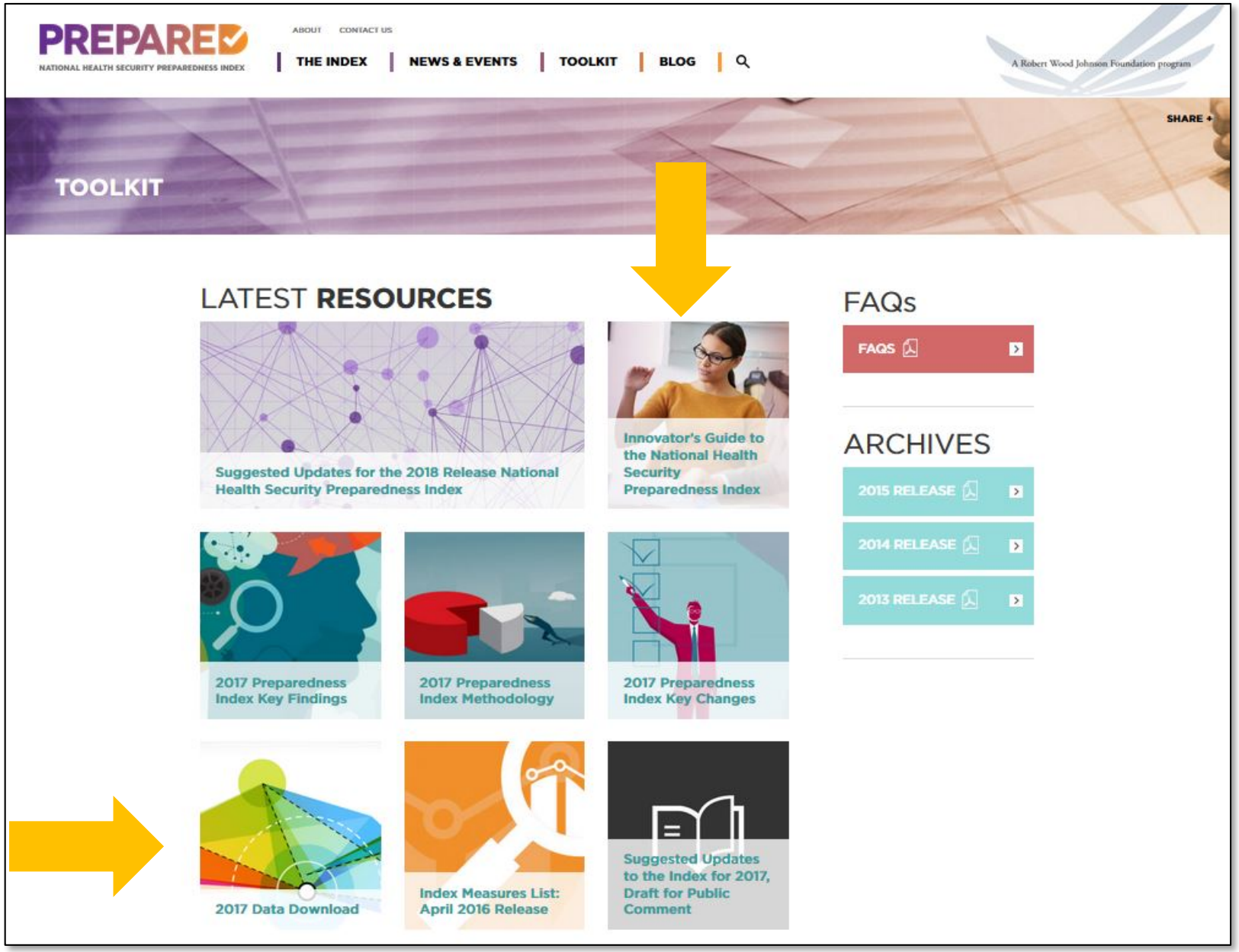
# Common Themes: Adaptation Goals

- Health Goals
  - Extreme Heat
  - Other Extreme Weather Health Hazards
  - Surveillance (Food, Water, Air)
  - Water Quantity and Quality
  - Vector Control
  - Smoke Emergencies
  - Vulnerable Populations
  - Preparedness Planning

- Emergency Management Goals
  - Early Warning Systems
  - Information Sharing
  - Emergency Response Planning

- Index findings can:
  - Point to gaps in protections at domain, subdomain, and measure levels
  - Be triangulated with other data to:
    - Prioritize areas for improvement
    - Examine potential drivers and contributors to gaps
    - Seek and learn from benchmarks
    - Identify and convene stakeholders
    - Develop and implement strategies for improvement
  - Track progress over time in target areas
- Including coalition partners in collaborative planning for climate adaptation and similar long-range strategic initiatives can help identify relevant protections to strengthen preparedness and health security

# Accessing Index Data



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