Climate Change and Infectious Diseases: Focus on Foodborne and Waterborne Diseases

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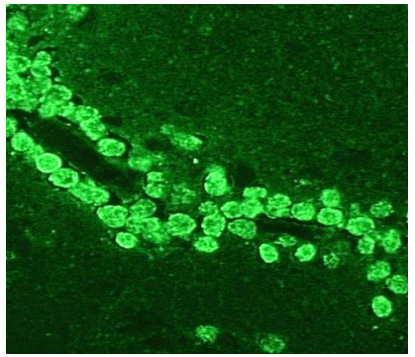


Our **Risk** for
Infectious Diseases
is **Increasing**
because of
Climate Change
CDC

Current Situation

- This period is now the warmest in the history of modern civilization.
- Human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century.
- Researchers around the world have published thousands of studies that document:
  - Surface, atmospheric, and oceanic temperature changes
  - Melting glaciers
  - Diminishing snow cover
  - Shrinking sea ice
  - Rising sea levels
  - Ocean acidification
  - Increasing atmospheric water vapor

Vose, RS, DR Easterling, KE Kunkel, AN LeGrande, MF Wehner, 2017: Temperature changes in the United States.
In: Climate Science Special Report: Fourth National Climate Assessment, Volume I. pp. 185-206, DOI: 10.7930/J0N29V45

What to Expect

- By 2050, annual average temperatures in the U.S. are expected to be about 2.5˚F hotter than they were, on average, from 1976 to 2005.

Vose, RS, DR Easterling, KE Kunkel, AN LeGrande, MF Wehner, 2017: Temperature changes in the United States.
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Anticipated Trends

- Longer and warmer summers
- Shorter and milder winters
- Fewer frost days
- More intense heat waves; less intense cold waves
- More extreme and unpredictable weather events (severe storms like hurricanes, heavy precipitation, severe droughts, flooding)

Vose, RS, DR Easterling, KE Kunkel, AN LeGrande, MF Wehner, 2017: Temperature changesin the United States.
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What does climate change have to do with infectious diseases?

- Changes in climate lead to changes in the environment, which may increase the incidence and distribution of some diseases.
- Climatic variables (temperature and precipitation) impact the replication, interaction, and survival of disease agents in animals, disease vectors, and the environment.
- Climatic disturbances (severe storms and droughts) affect disease occurrence patterns, drive disease outbreaks, and damage critical infrastructure.

Gage KL, Burkot TR, Eisen RJ, Hayes EB. Climate and vectorborne diseases. Am J Prev Med. 2008 Nov;35(5):436-50. http://www.doi.org/10.1016/j.amepre.2008.08.030

Luber, G., et al. 2014: Ch. 9: Human Health. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 220-256

National Infrastructure Advisory Council's Water Sector Resilience: Final Report and Recommendations. July 2016. https://www.cisa.gov/publication/niac-water-sector-resilience-final-report

Many infectious diseases are sensitive to environmental changes

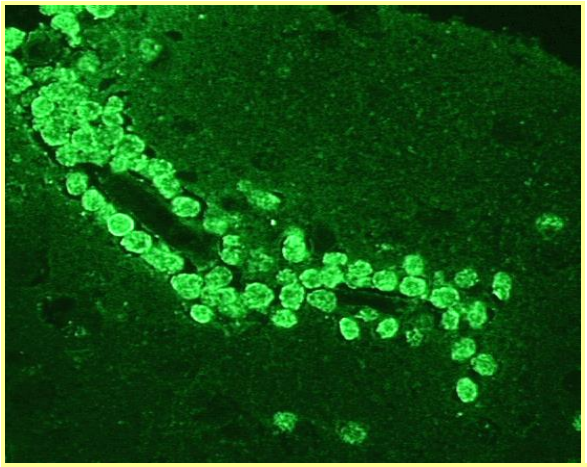
- Zoonotic and vector-borne disease
  - Lyme
  - Dengue
  - West Nile Virus infection
  - Plague
  - Rabies
  - Anthrax
- Foodborne and Waterborne diseases
  - *Cryptosporidium*
  - *Giardia*
  - *Naegleria fowleri*
  - *Salmonella*
  - *Vibrio*
  - Harmful Algal Blooms (HABs)
- Fungal diseases
  - Valley fever (Coccidioidomycosis)
  - Histoplasmosis
  - Blastomycosis
- Soil and dust-associated
- Antibiotic-resistant organisms

Common ways climate-sensitive diseases spread

- Mosquito and tick bites
- Contact with sick or asymptomatic animals
- Inhalation of or contact with mold and other fungi
- Consumption of contaminated food or water
- Contact with contaminated water

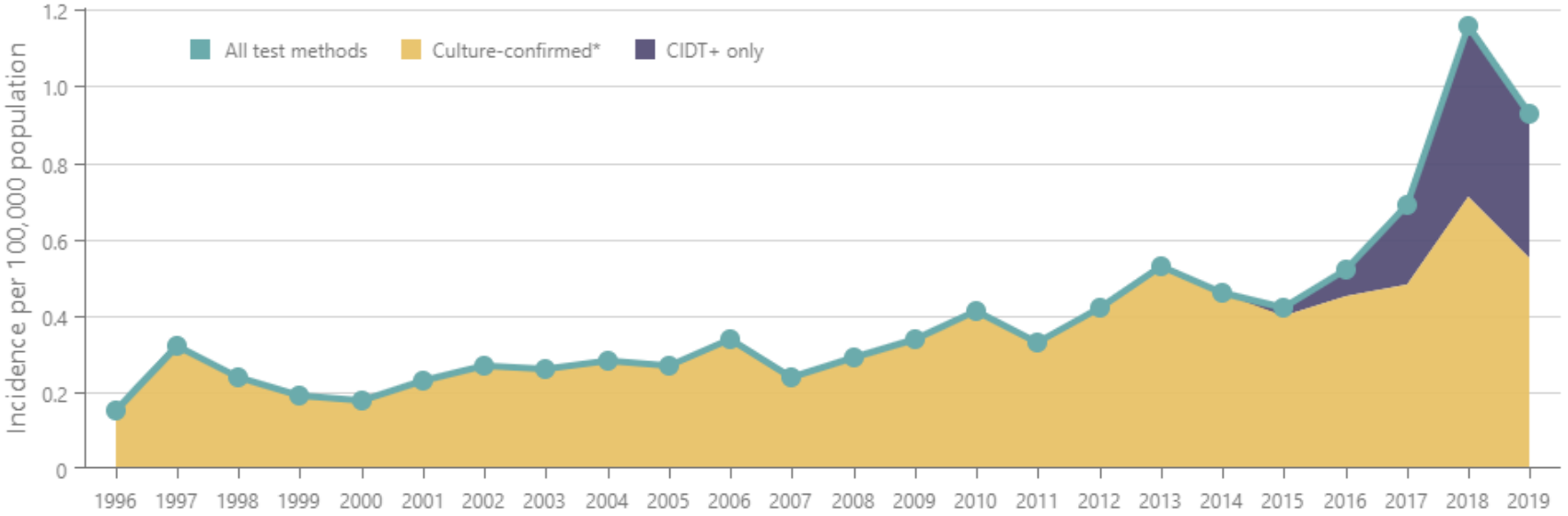
Foodborne, Waterborne and Environmental Climate-related Emerging Threats

- Increased occurrence and expanded geographic distribution of foodborne, waterborne and fungal diseases such as Valley fever, *Vibrio, Salmonella, Giardia, Naegleria fowleri* and the occurrence of harmful algal blooms
- Damage to infrastructure during extreme weather events threatens food and water systems, and creates conditions favorable to pathogen contamination of these systems



Enteric Disease in the Era of Changing Climate: Example of *Vibrio*

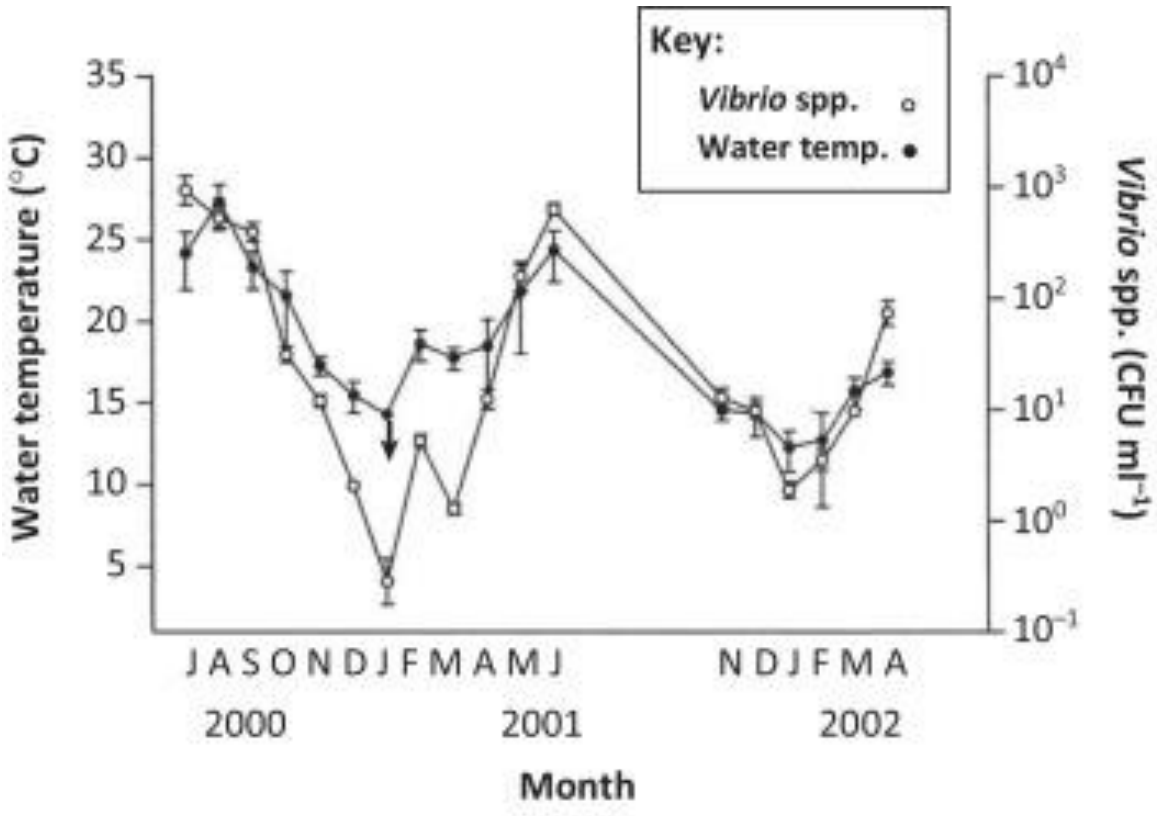
- Infections occur through
  - consumption of raw or undercooked shellfish
  - contact with contaminated water
- Incidence of vibriosis is increasing at a faster rate than other enteric illnesses



Source: FoodNet Fast Pathogen Surveillance Tool (1996-2019)
Culture-confirmed includes infections confirmed by culture only or by reflex culture following a positive CIDT. CIDT includes infections detected using culture-independent methods.

Enteric Disease in the Era of Changing Climate: Example of *Vibrio*

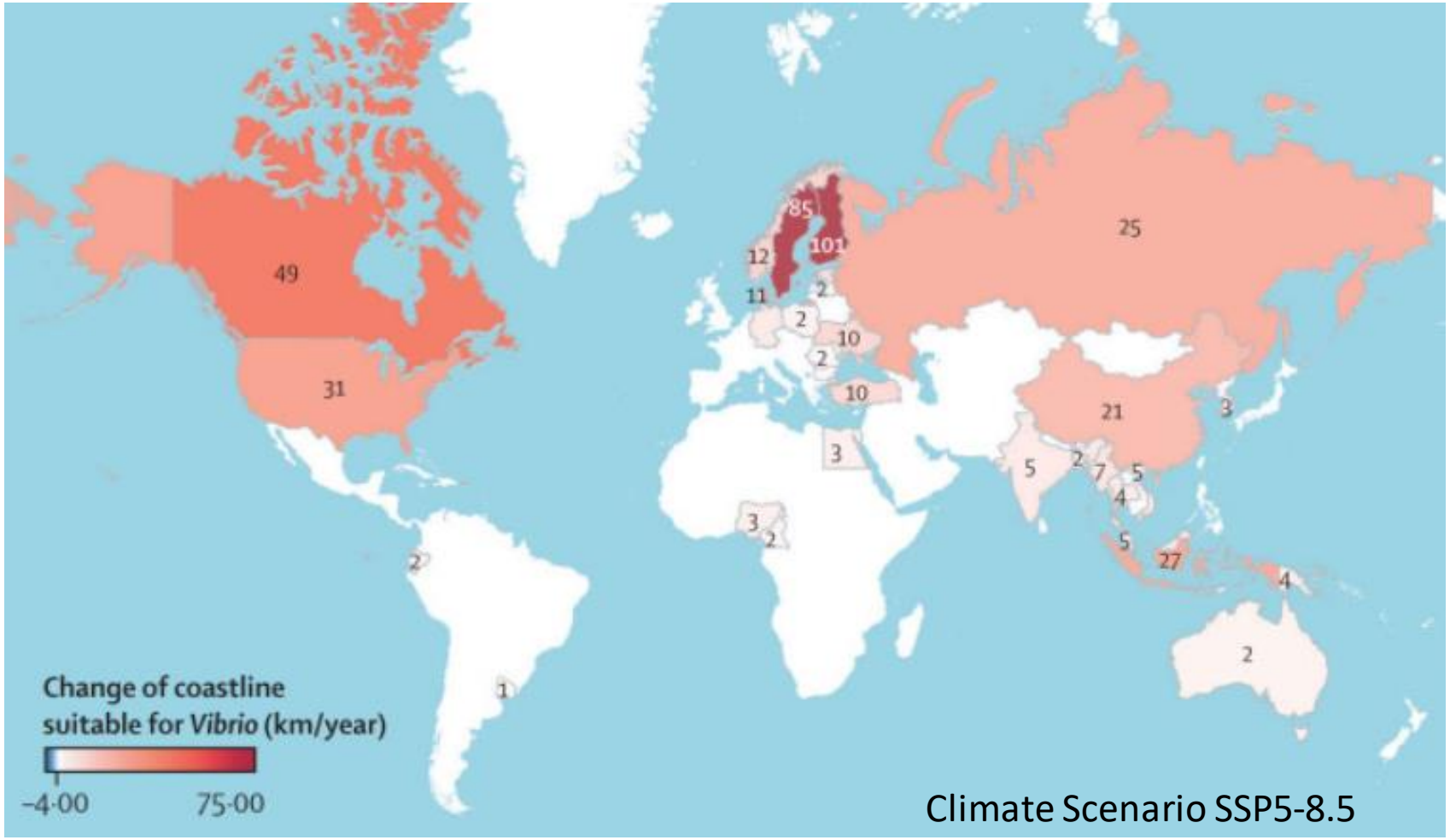
- Climate change will result in a longer '*Vibrio* season', higher *Vibrio* populations in water, and an expansion of *Vibrio* into areas where it was absent or rare
  - *Vibrio* thrive in warmer waters
  - Warming increases the abundance, diversity and distribution of plankton, a reservoir for *Vibrio*
  - Changes to coastal environments, including sea-level rise and altered salinity, will create optimal conditions for *Vibrio*



Source: Baker-Austin (2017), "Non-Cholera *Vibrios*: The Microbial Barometer of Climate Change"

Trends in Microbiology

Enteric Disease in the Era of Changing Climate: Example of *Vibrio*



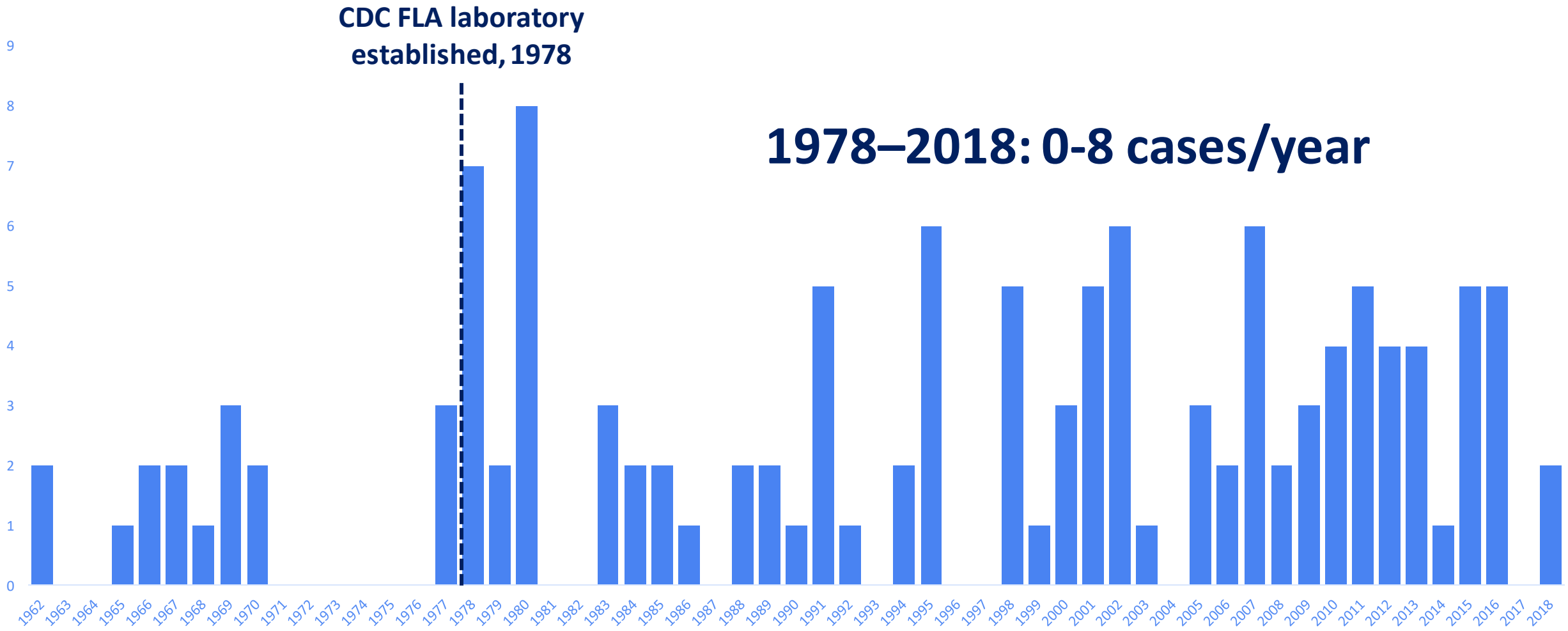
- Coastal areas suitable for *Vibrio* could increase by 38,000 km by 2100
- The "*Vibrio* season" will increase by 1 to 4 months globally
- 1.4 billion people will live in coastal regions suitable for *Vibrio* by 2069

Source: Trinanes, J and Martinez-Hurtaza, J. (2021), "Future scenarios of risk of Vibrio infections in a warming planet: a global mapping study" Lancet Planet Health 2021; 5: e426–35

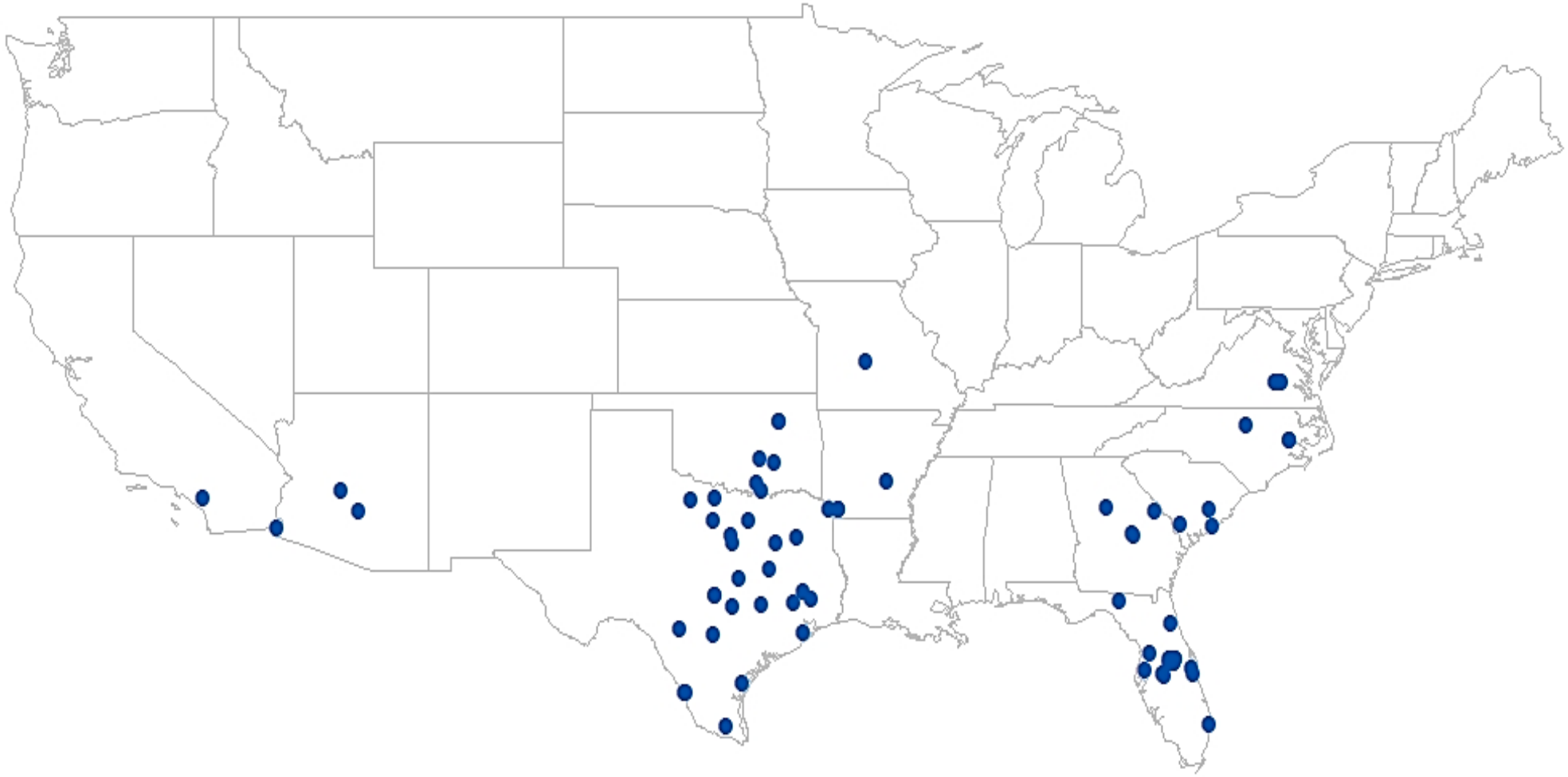
What's the Issue: *Naegleria fowleri*

- Thermophilic (heat-loving) ameba that thrives in warm freshwater
- Causes a mostly fatal infection called primary amebic meningoencephalitis (PAM)
- Exposure most common through swimming in lakes, ponds, streams
- Most cases occur in summer months
- Geographic range previously limited to southern states, in last decade, have seen cases in northern states

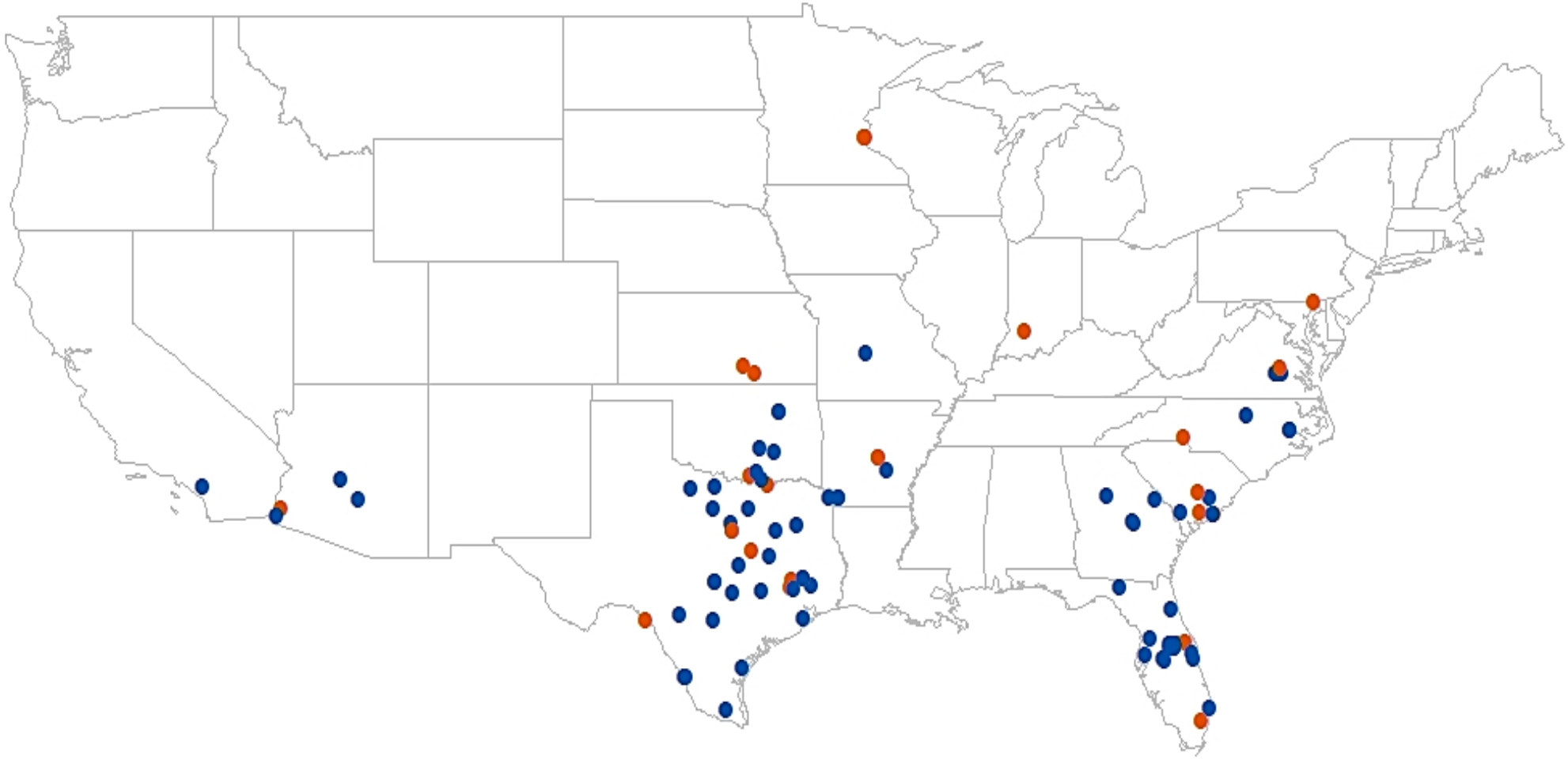
The incidence of PAM in the United States does not appear to be increasing.



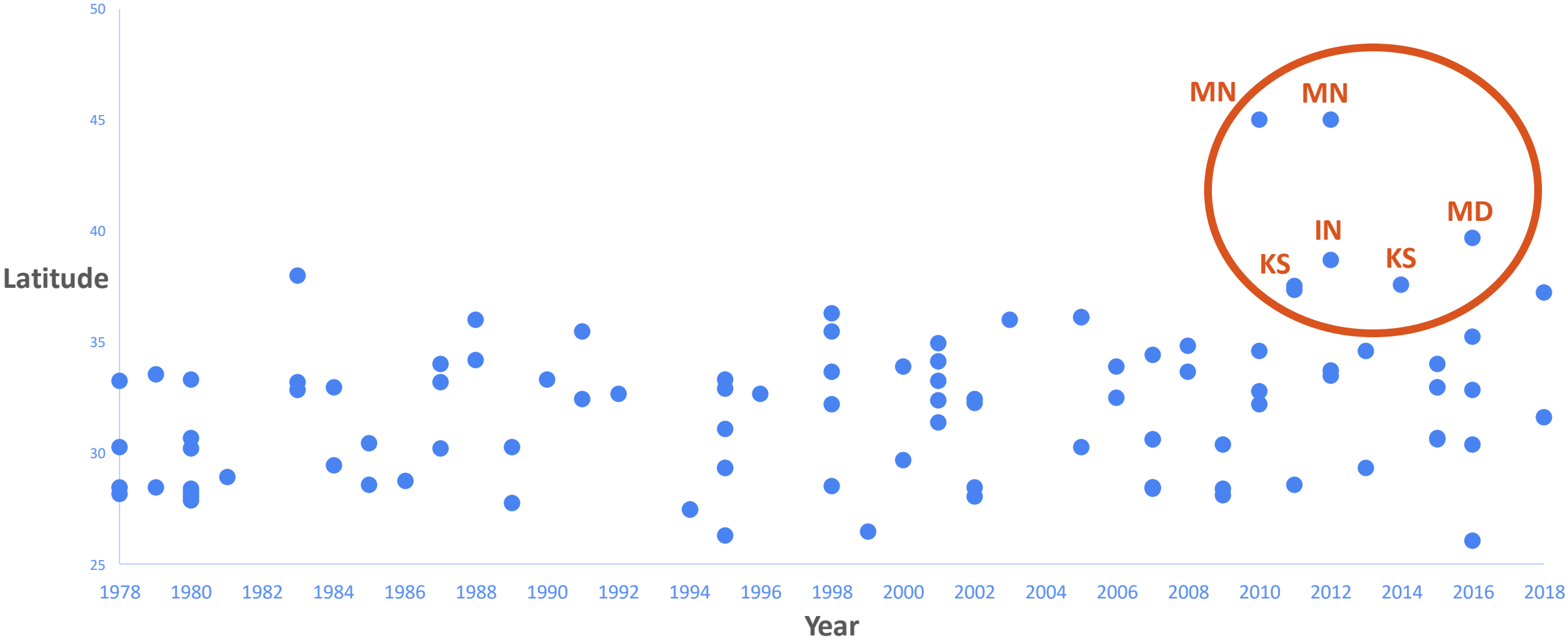
However, when we compare cases before 2010…



…to cases after 2010, the geographic distribution appears to be moving north.



The majority of northern cases have occurred in recent years.



U.S. Water and Wastewater Systems

- Aging water and wastewater infrastructure
  - **Plants, distribution systems, source water protection, water development**
  - **Most systems in U.S. long overdue for replacement**
    - **Estimated $500 billion to replace**
    - **~240,000 annual water main breaks**
    - **Leaks, breaks, low pressure events open systems to contamination and health effects**
- Cuts in funding and personnel for drinking water programs in public health departments

Mass. Water Resources Authority

What is the impact of extreme weather events?

- Potential infrastructure failures of drinking/ wastewater treatment
- Sewer overflows
  - **>1 trillion gal of sewage & storm water discharged annually**
- Agricultural runoff
- Water quality
  - **Surface & ground water contamination w/ pathogens, chemicals, nutrients**
- Extreme rainfall events
  - **Increased waterborne disease outbreaks**
  - **Wound infections, leptospirosis**

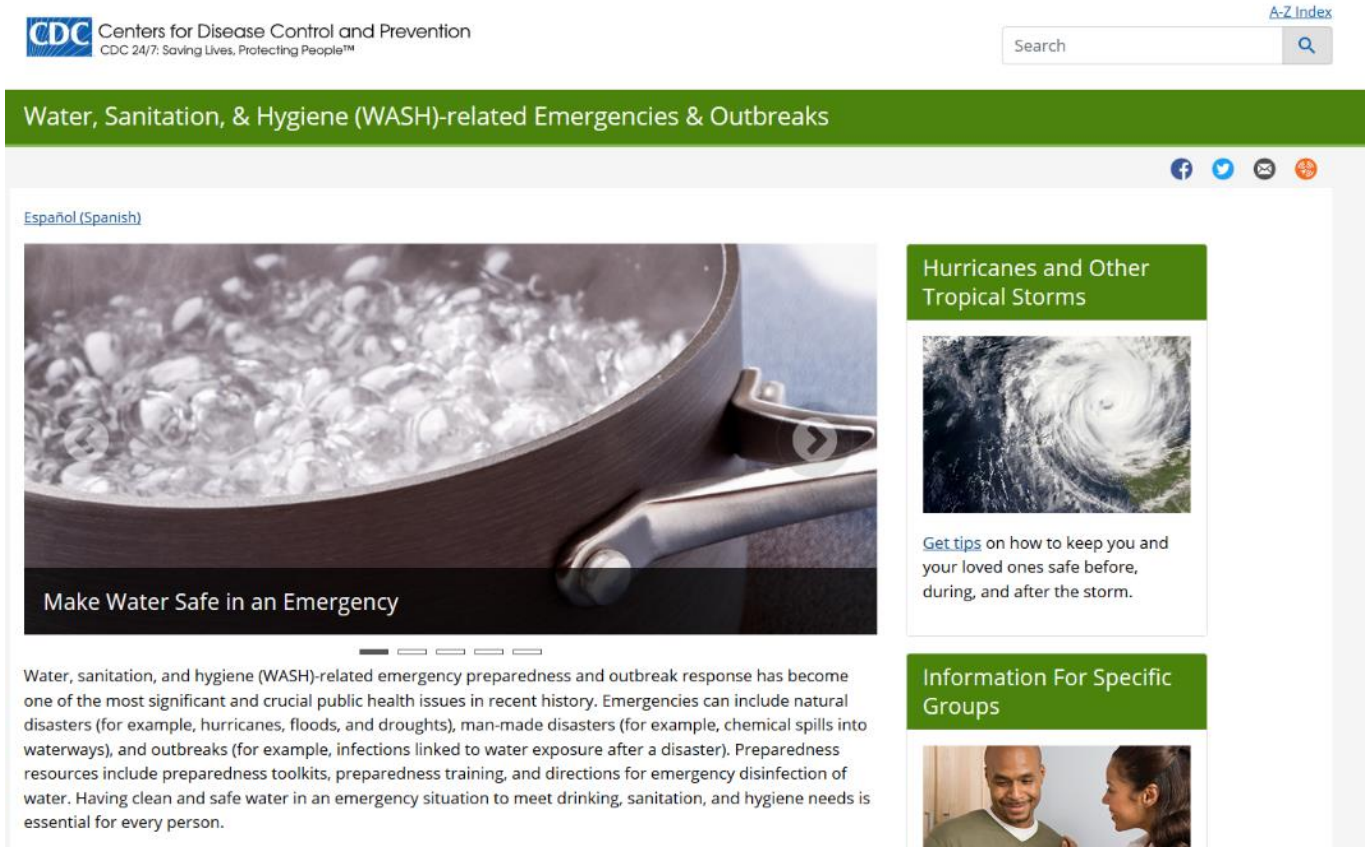
Curriero *et al*. AJPH 2001;91:1194-1199; Levy, et al. Environ. Sci. Technol. 2016

Strategies for Combatting Impact of Climate Change on Climate-Sensitive Infectious Diseases

- Invest in disease surveillance systems
  - improve timeliness, geographic information and interoperability
- Maintain a strong national public health system and workforce so we can quickly detect and respond to new diseases as they expand to new areas of the U.S.
- Develop new tools to help us analyze and interpret the data we collect and predict where threats are most likely to occur
- Identify disproportionately affected communities and provide tools to prepare for and respond to infectious disease threats
- Invest in research, environmental data collection, and disease/climate modeling efforts

Thank you!

www.cdc.gov/healthywater/emergency
www.cdc.gov/climateandhealth
https://www.cdc.gov/ncezid/what-we-do/climate-change-and-infectious-diseases/index.html



For more information, contact CDC
1-800-CDC-INFO (232-4636)
TTY: 1-888-232-6348 www.cdc.gov