

# Sentinel Water-Based Organisms as a Measure of Climate Change

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**Great Lakes Beach Conference**

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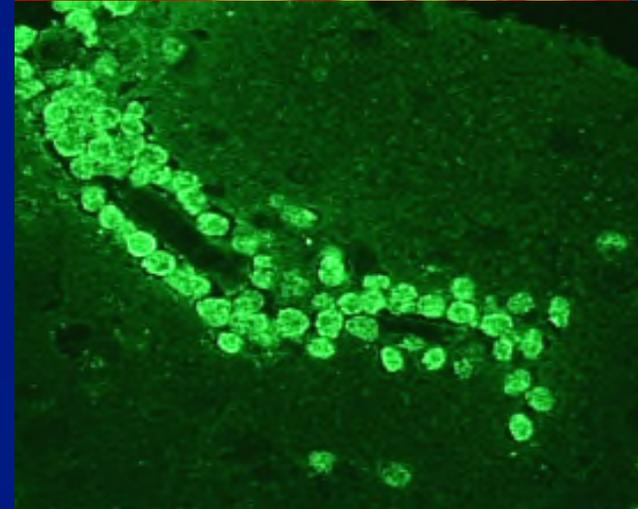
National Center for Environmental and Zoonotic Infectious Diseases

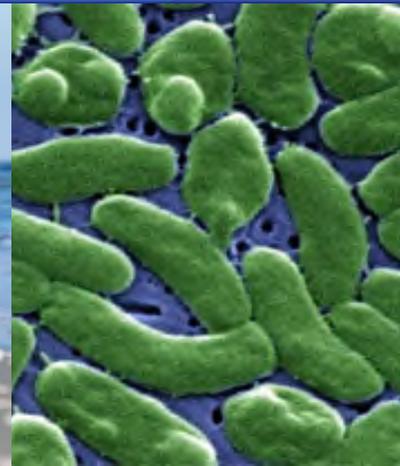
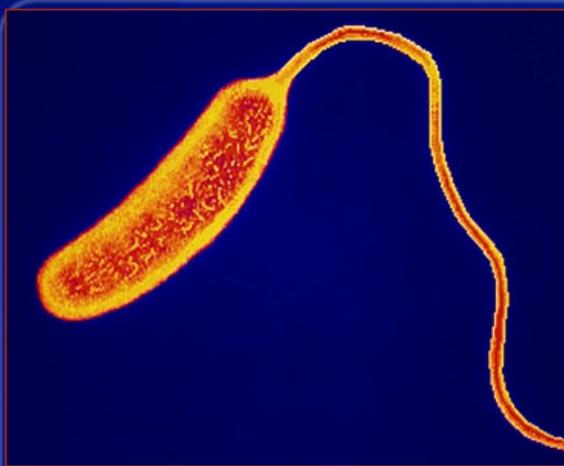
Division of Foodborne, Waterborne, and Environmental Diseases



# Climate Change and Water Impacts

- ❑ Increased or decreased water availability depending on location
  - Water stress for hundreds of millions
- ❑ Extreme weather events
  - Droughts, floods
- ❑ Increased use of recreational water
- ❑ Increased water temperatures
  - Thermophilic organisms to track?





# ***VIBRIO* INFECTIONS**

# Climate Change and Water: Vibriosis



- ❑ Infection with a species from the family *Vibrionaceae*
  - Other than toxigenic *V. cholerae* O1 or O139, which causes cholera
- ❑ First recognized in the 1970s
  - Nationally notifiable disease in U.S. in 2007
- ❑ Characterized by either gastroenteritis, wound infection, or septicemia
- ❑ Marine/estuarine habitat
- ❑ Advantage in warm and low salinity seawater
  - Proliferate >15 °C /59 °F water) and low salinity (<30 ppt NaCl)

# Climate Change and Water: Vibriosis

## ❑ Risk factors

- Consumption of raw or undercooked shellfish
- Wound exposure to seawater

## ❑ ~1000 cases reported/year

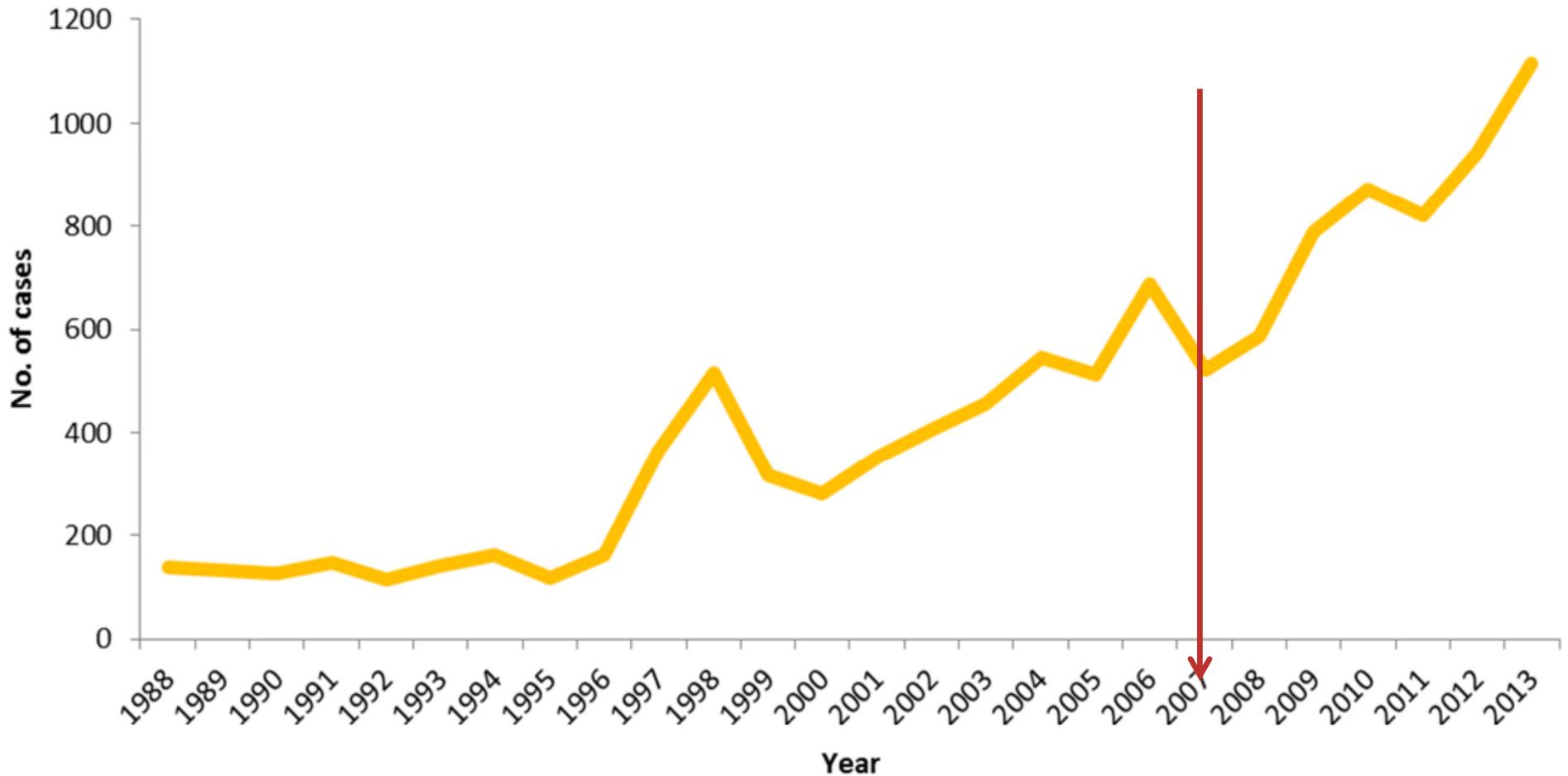
## ❑ Estimated annual impact in U.S.

- 80,000 infections
- 500 hospitalizations
- 100 deaths



# Reports Are Increasing Reported Vibriosis Infections, 1988-2013

Nationally  
notifiable



Newton, A et al., CDC COVIS Surveillance System, N=11,341

## Changing Geographic Range



- ❑ ***Vibrio parahaemolyticus* in Alaskan waters, 1000 km farther north than previously reported (2004)**
  - Water temperatures had increased 0.21°C per year since 1997
- ❑ **Movement up east coast to Chesapeake Bay**
- ❑ **Infections in Northern Europe (1994, 1997, 2003, 2006)**
  - Coincides with unusual temperature peaks in Baltic Sea
- ❑ ***Vibrio* wound infections following Hurricane Katrina**
- ❑ ***Vibrio* occurrence may track with El Nino events**

McLaughlin JB. N Engl J Med. 2005;353(14):1463-70

Baker-Austin C, Environ Microbiol Rep. 2010;2(1):7-18

CDC. MMWR Morb Mortal Wkly Rep. 2005;54(37):928-31.

Martinez-Urtaza J, Epidemiol. 2008;19(6):829-37



# **NUTRIENTS, TEMPERATURE, AND HARMFUL ALGAL BLOOMS**

# Marine HABs

- ❑ **U.S. states on Atlantic and Pacific oceans**
- ❑ **Respiratory illness (brevetoxins)**
- ❑ **Foodborne illness**
  - **NORS data, 2009-2013**
    - **Mostly foodborne**
    - **58 foodborne outbreaks, 209 illnesses,  
30 hospitalizations**



Photography credit: California  
Department of Public Health,  
Kai Schumann

# Freshwater HABs

- ❑ **Cyanobacteria (“blue-green algae” or “cyanoHAB”)**
  - **World Health Organization has provisional guidelines for drinking water and recreational water exposures**
  - **No U.S. federal guidelines, criteria, standards, or regulations in drinking water or ambient recreational water**
  - **Toxins: microcystin, anatoxin-a, cylindrospermopsin, saxitoxin**
  - **Cases of illness are difficult to confirm in the absence of clinical diagnostic tests and rapid water sample tests**

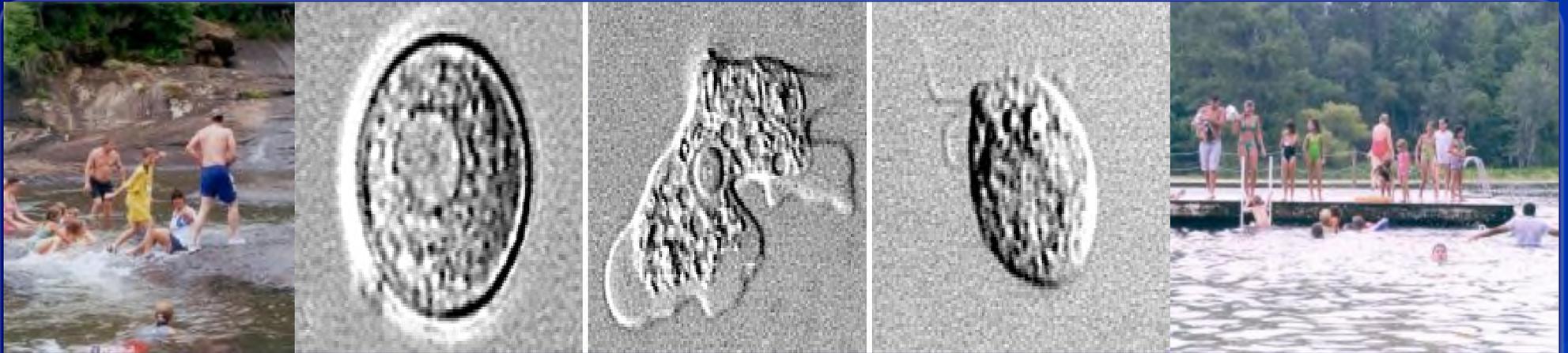


# U.S Harmful Algal Bloom-Associated Outbreaks

- ❑ Prior to 2009: 5 outbreaks reported (2 marine, 3 freshwater)
- ❑ 2010-2011: 11 freshwater outbreaks in NY, OH, WA
- ❑ 2013: Toledo, OH is first US city reportedly exceeding WHO values for microcystin in finished drinking water
- ❑ Increasing in frequency, intensity, and duration in all aquatic environments on a global scale
  - Role of climate change?
- ❑ Impacted by increasing phosphorus, nitrogen levels
- ❑ Issues with testing, monitoring in humans, environment
- ❑ Piloting national surveillance system

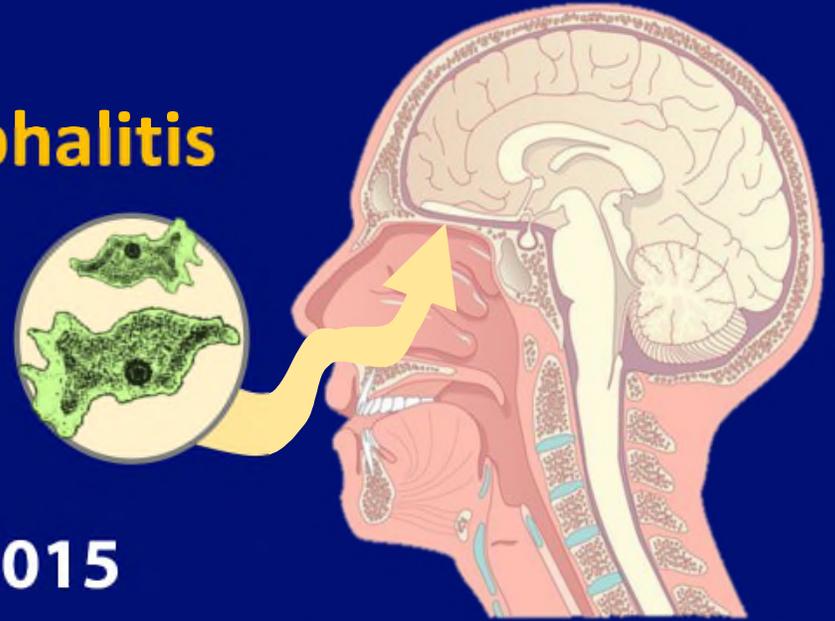
<http://www.cdc.gov/healthywater/surveillance/rec-water-surveillance-reports.html>

Hilborn ED et al. MMWR 2014;63(1):11–5.



**AMEBIC INFECTIONS:  
SHIFTING DISTRIBUTION, EMERGING  
TRANSMISSION MODES**

## Primary Amebic Meningoencephalitis (PAM)



- Rare and serious brain infection
  - 138 cases in U.S. from 1962-2015
    - Most diagnostics come through CDC
  - Fatal: only 3 known US survivors
  - Acute disease: exposure to death in ~10 days
- Caused by free-living amoeba, *Naegleria fowleri*
- Most infections associated with swimming in lakes, rivers
  - Water containing *Naegleria* goes up nose to brain
- All infections in southern tier states in US until 2010

## Organism: *Naegleria fowleri*



- ❑ **Distributed globally**
- ❑ **Potential for being a climate-sensitive pathogen as water temperatures rise globally**
  - **Thermophilic free-living amoeba**
  - **Lives in temperatures up to 115°F (46°C)**
- **CDC has been tracking infections since 1962**



## **Changing Geographic Range of PAM: 2010-2013**

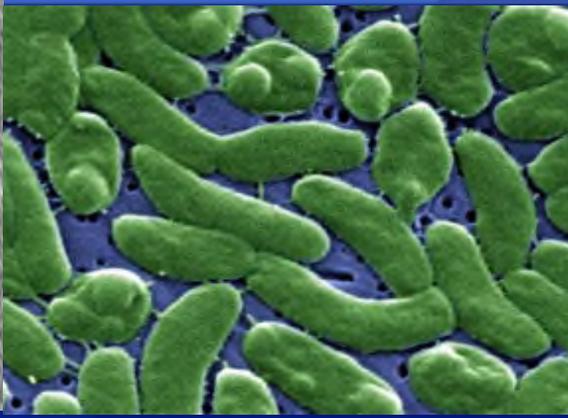
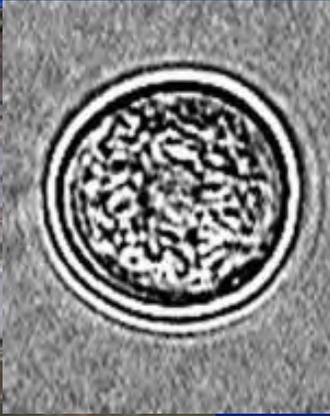


- **First 2 cases in MN**
  - **600 miles farther north than previous case in MO**
  - **During long, unusual heat spell**
- **First 2 cases reported in KS**
- **First case in VA reported since 1969**
- **First case in IN**

## ***Naegleria fowleri* : Changing Transmission Routes Since 2011**

- **First documented infections from nasal irrigation**
  - **Neti pots (Louisiana, 2011)**
  - **Ritual ablutions (U.S. Virgin Islands, 2012)**
- **First death associated with colonization of a treated drinking water supply and colonization of a U.S. public water system (Louisiana, 2013)**
  - **Testing shows other LA water systems colonized (2014-15)**
- **First death associated with overland piping of water in high temperatures followed by household/recreational use (private water system, CA, 2015)**





**CONCLUSIONS**

## **Conclusions: Water and Climate Change**

- ❑ Geographic ranges of pathogens shifting northward in marine and fresh water**
- ❑ Some indicators show increasing numbers**
- ❑ Changing transmission routes for *Naegleria***
- ❑ Drinking water systems and premise plumbing can also be impacted by warmer temperatures**
- ❑ Underscores need to continue tracking multiple markers of water-related impact of climate change**
  - Trends, emerging issues, alerts**
  - Data supports taking action**

# Acknowledgments

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- ❑ **EPA**

# Questions?

## More Information: Healthy Water Website

[www.cdc.gov/healthywater](http://www.cdc.gov/healthywater);  
[healthywater@cdc.gov](mailto:healthywater@cdc.gov)

"The findings and conclusions in this presentation have not been formally disseminated by CDC and should not be construed to represent any agency determination or policy."

Healthy Water

For Specific Groups

- Public
- Public Health & Medical Professionals
- Aquatics, Water Utilities, & Other Water-related Industries
- Outbreak Response
- Drinking Water Advisories

Publications, Data, & Statistics

Healthy Swimming Resources

- Health Promotion Materials
- Newsroom, Features, & Observances
- Training & Education
- CDC at Work: Healthy Water
- Policy & Recommendations
- Index of Water-related Topics

Swim Healthy. Swim Safely. Rec. Water Illness and Injury Prevention Week

A-Z Index of Water-related Topics

With its many uses for drinking, recreation, sanitation, hygiene, and industry, water is our most precious global resource. Clean and safe drinking water is critical to sustain human life and without it waterborne illness can be a serious problem. Water, which is necessary for recreational water activities like swimming, also helps promote healthy living. Often, water's vital role is most apparent during an emergency or disaster. Answers to your water-related questions can be found within our healthy water pages, below.

Healthy Water Topics

- Drinking Water
  - Public Water Systems, Private Water Systems, Water Fluoridation, Camping, Hiking, Travel...
- Global Water, Sanitation, & Hygiene (WASH)
  - Community Systems, Household Treatment & Storage, Sanitation and Hygiene, Travelers' Health
- Water-related Emergencies & Outbreaks
  - Safe water, Wastewater, Hygiene, Public Health Toolkits...
- Healthy Swimming / Recreational Water
  - Pools and Spas, Oceans/Lakes/Rivers, Injury and Skin Cancer, Recreational Water Illnesses...
- Other Uses of Water
  - Agricultural, Industrial, Medical...
- Water-related Hygiene
  - Handwashing, Body washing, Facial Cleanliness, Hygiene Etiquette...

Top 5 Causes of Drinking and Recreational Water Outbreaks

- Giardia intestinalis
- Shigella
- Norovirus
- Hepatitis A
- Copper

Top 5 Causes - Drinking Water Outbreaks \*

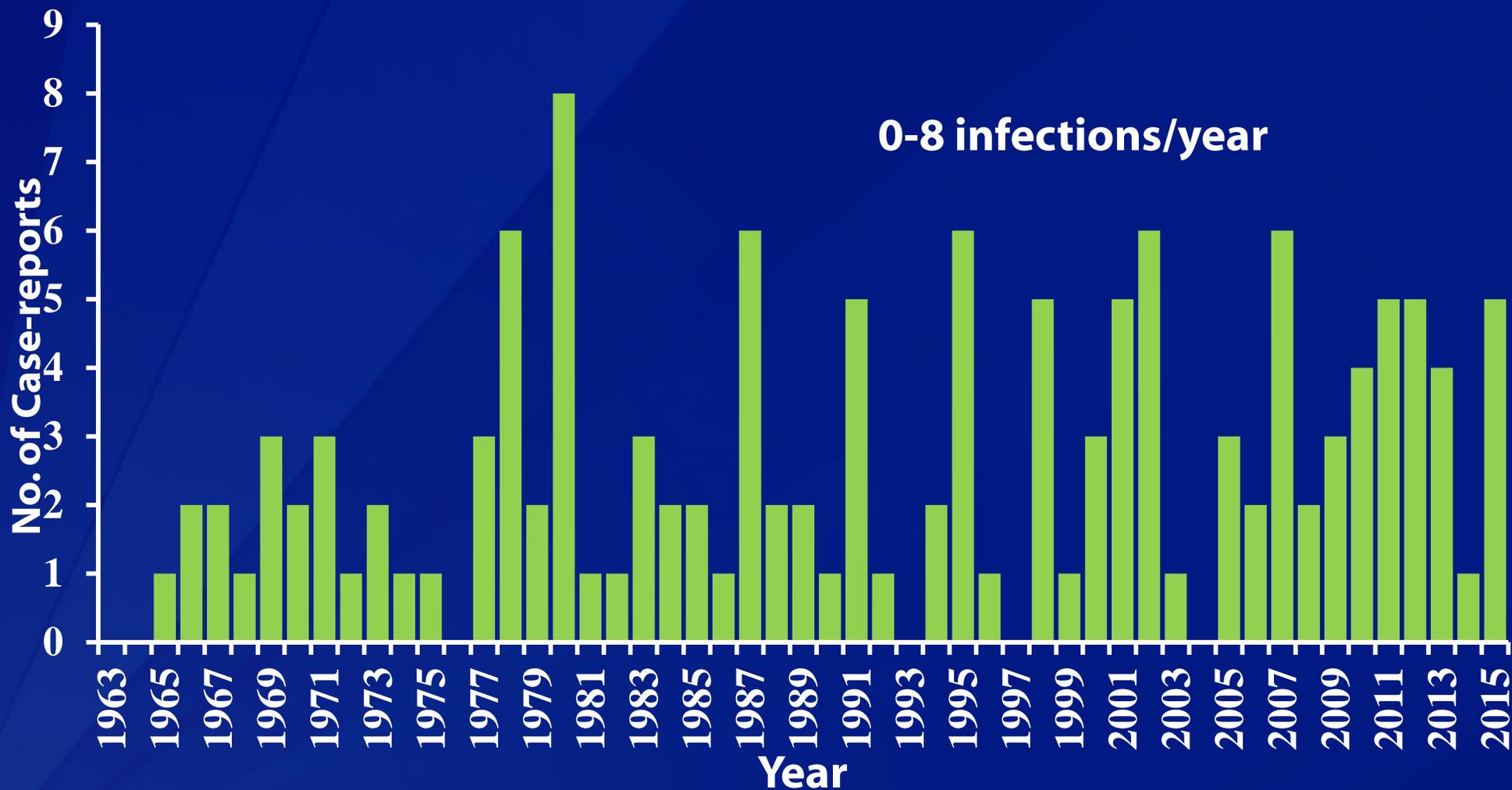
- Pseudomonas
- Cryptosporidium
- Shigella
- Legionella
- Norovirus/Calicivirus

For a complete listing of water-related surveillance data, see CDC's Surveillance Summaries for Waterborne Diseases and Outbreaks

\* Based on tracking of waterborne outbreaks from 1971-2009. Outbreak reporting is dependent on detection, investigation, and reporting of the outbreak. This assumes health effects to be measured and these health effects to be linked to water exposure. However, many waterborne (i.e., many diarrheal) or drinking water may not cause easily recognizable outbreaks because they require a long illness exposure period. As a result, they would not be part of waterborne disease outbreak reporting or part of these Top 5 lists.



# Number of Case-reports of Primary Amebic Meningoencephalitis , by Year: United States, 1962–2015



N=138; Year of exposure unknown for one case