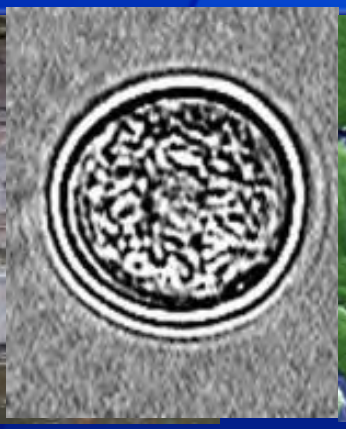



Sentinel Water-Based Organisms as a Measure of Climate Change

Michael J. Beach, PhD

Waterborne Disease Prevention Branch

Great Lakes Beach Conference

Traverse City, MI

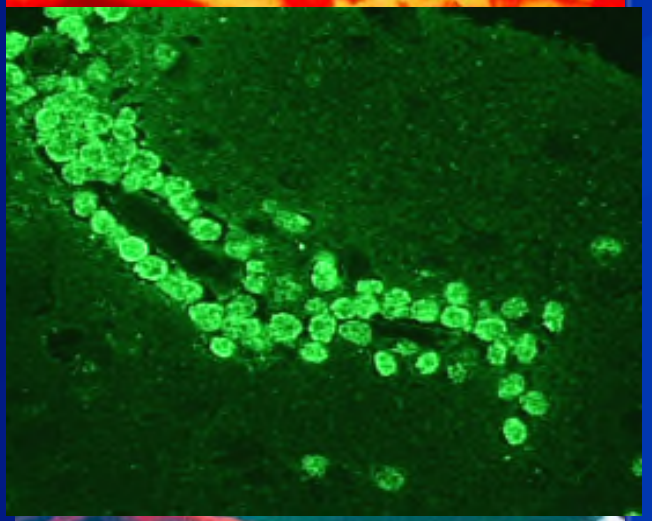
October 29, 2015

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?



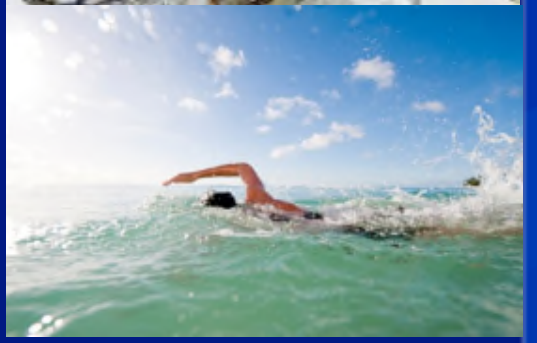



VIBRIO INFECTIONS

Climate Change and Water: Vibriosis

- Infection with a species from the family *Vibrionaceae*
  - *O*ther 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)

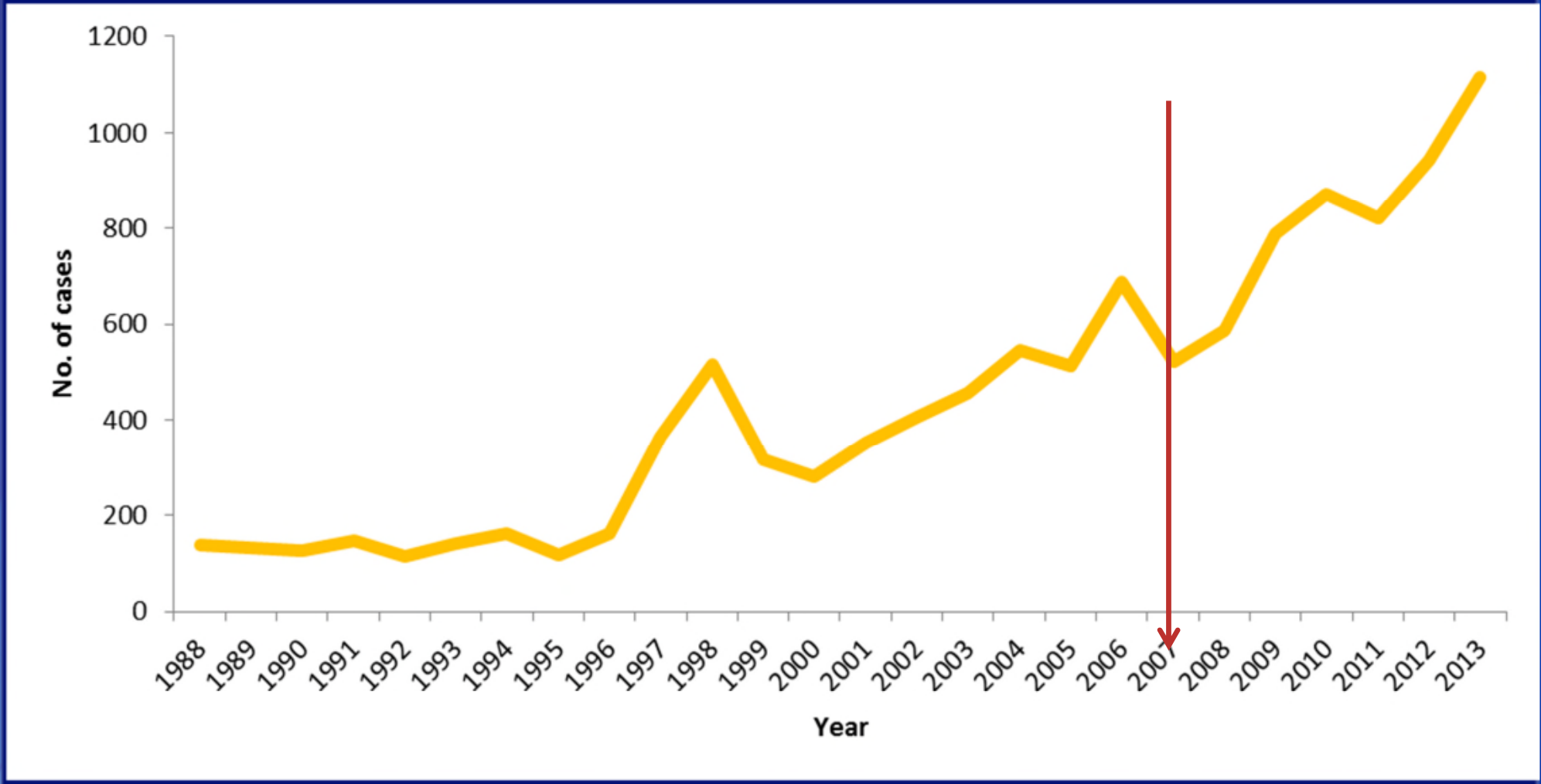
Climate Change and Water: Vibriosis



- 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

Scallan, E., et al., Emerg Infect Dis, 2011. 17(1): 7-15.

Reports Are Increasing Reported Vibriosis Infections, 1988-2013



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

Photography credit: California Department of Public Health, Kai Schumann

- 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

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

Photography credit: (L-R)Wisconsin Department of Health Services, Lorrie Backer (image height modified)

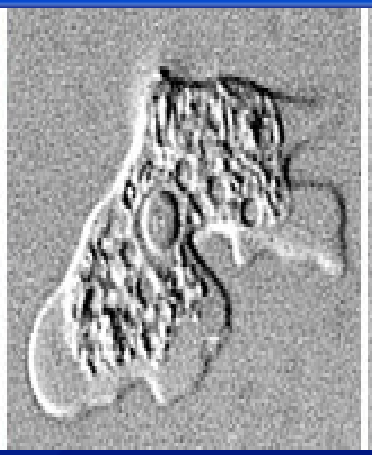
U.S Harmful Algal Bloom-Associated Outbreaks

- 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

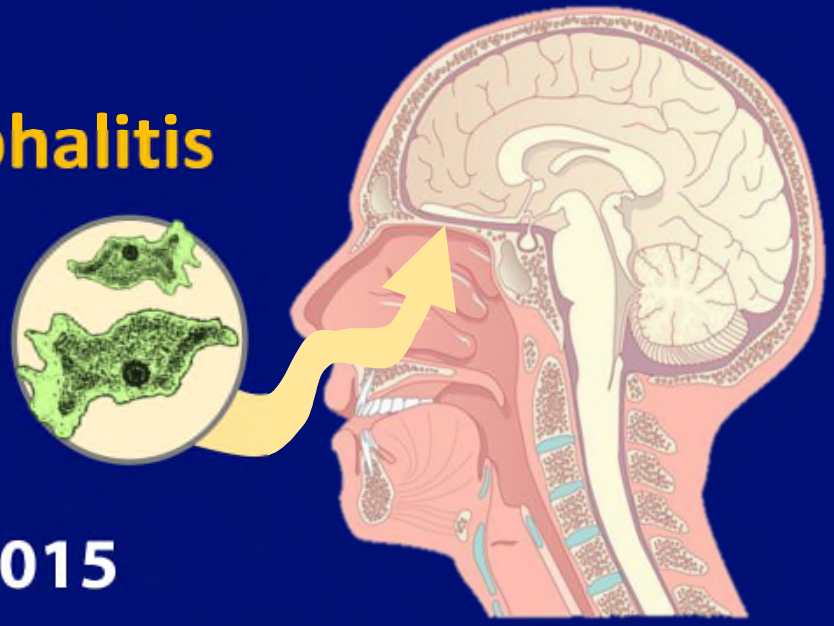
Hilborn ED et al. MMWR 2014;63(1):11–5.





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 ameba, *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 ameba
  - 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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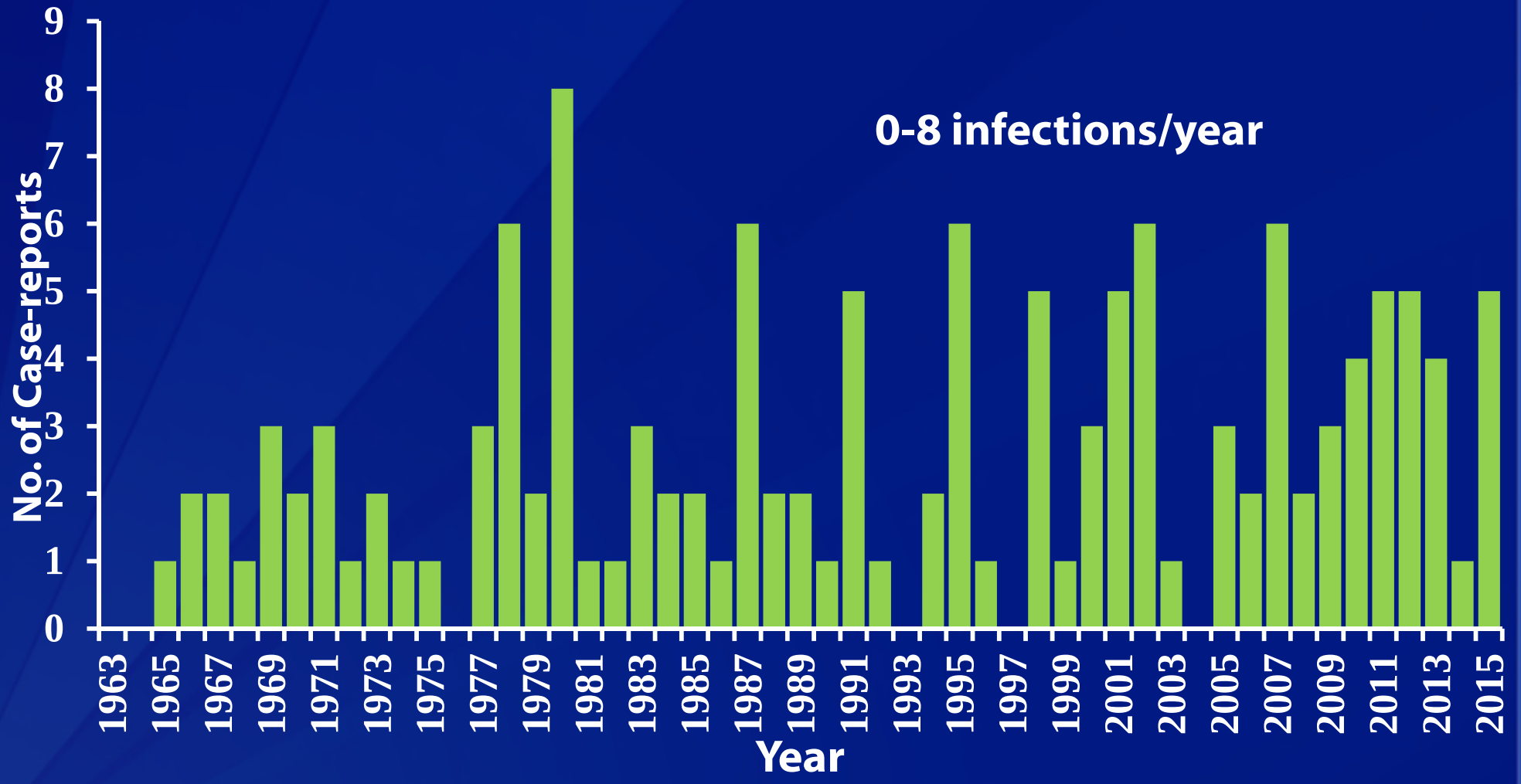
- State/Local Public Health Partners
- EPA

Questions?
More Information: Healthy Water Website
www.cdc.gov/healthywater;
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."

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



N=138; Year of exposure unknown for one case