



Warming Oceans, Coastal Diseases, and Climate Change Public Health Adaptation

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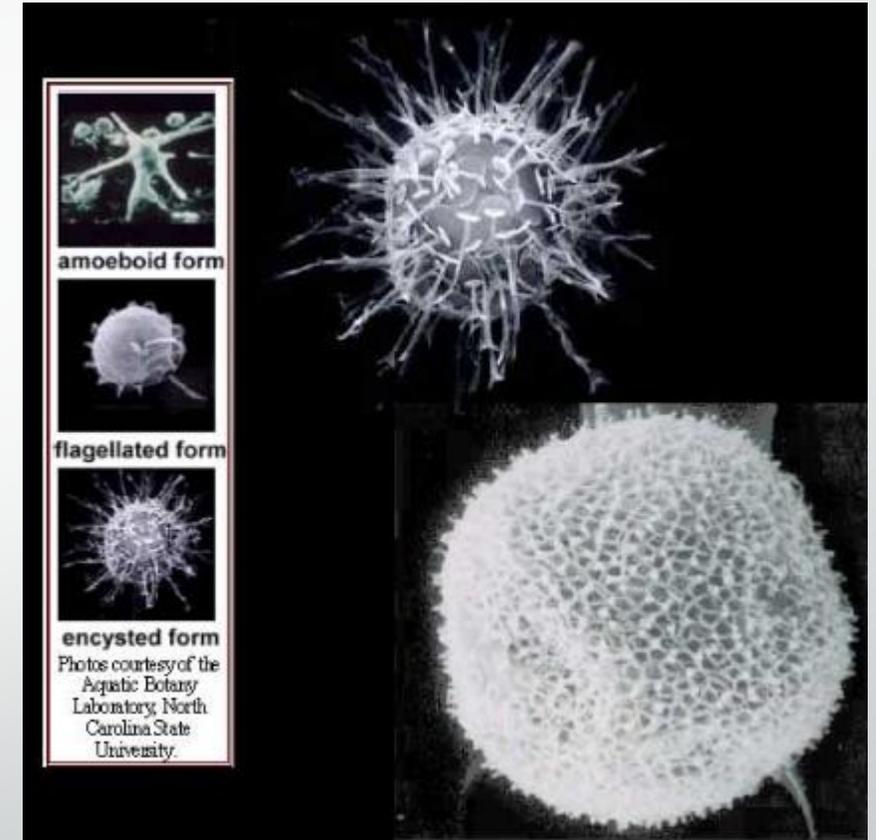
University of Utah S.J. Quinney College of Law

Climate Change, Coasts, and Communities Symposium

Monmouth University ● April 18, 2019

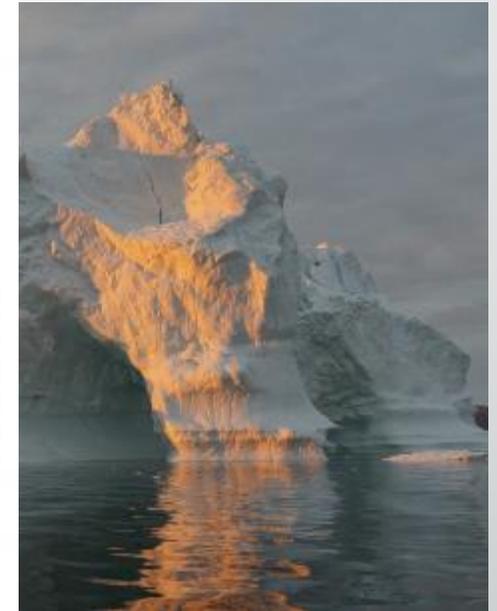
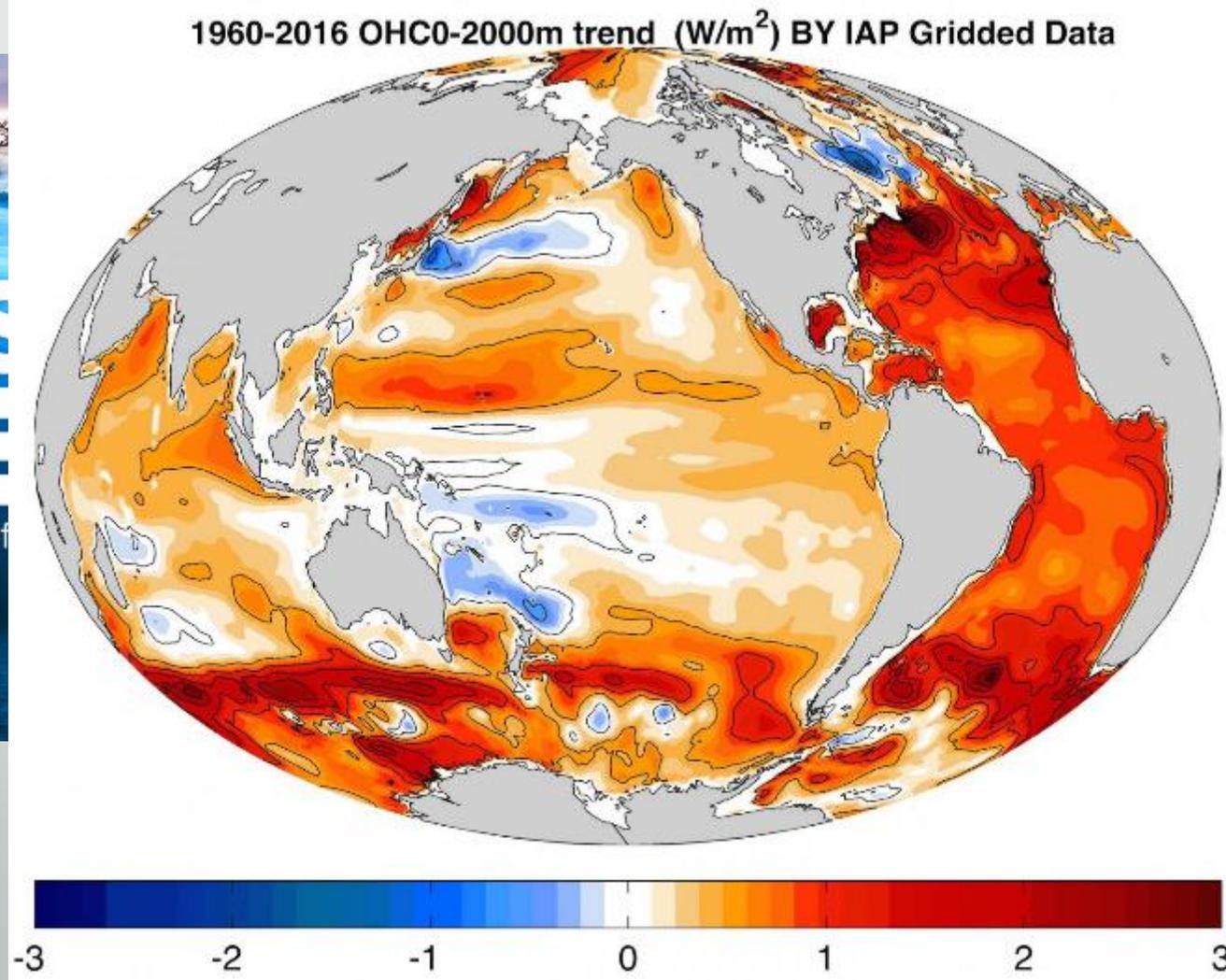
Why Think About Coastal Community Adaptation to Climate Change in Terms of Public Health?

- Many uncertainties surround climate change's impacts on the sea, especially sea level rise.
- MOREOVER, the time scales involved are often longer than those typical in planning efforts.
- A public health focus is politically salient, addresses real human needs, and can help to identify practical "no regrets" steps that may benefit adaptation efforts more generally.



Pfiesteria

The Three Impacts of Climate Change on the Ocean Most Relevant to Changing Disease Burdens

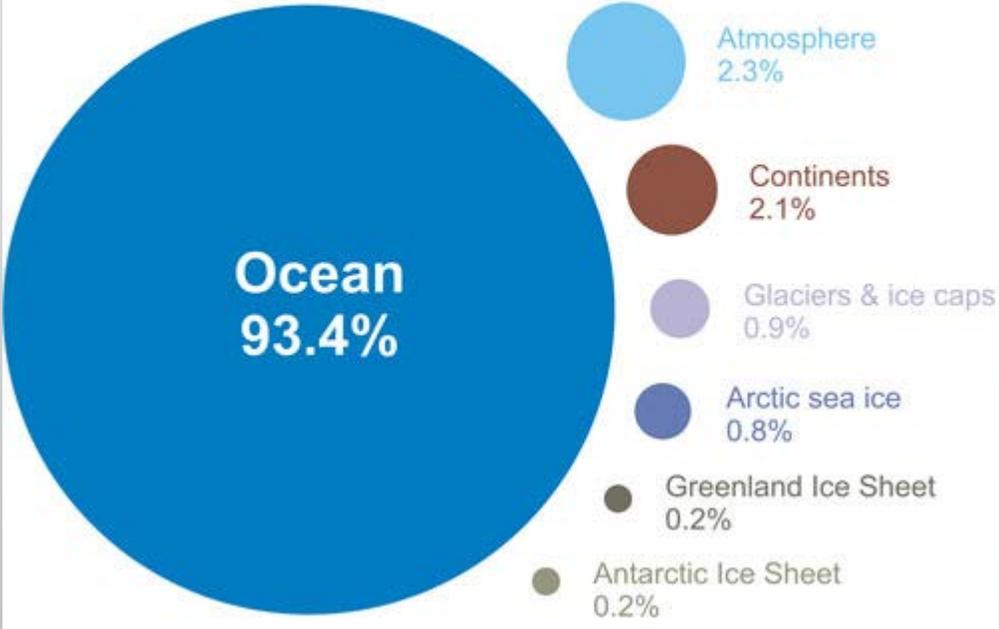




1. Ocean Warming

The Ocean as a Heat Sink

Where is global warming going?



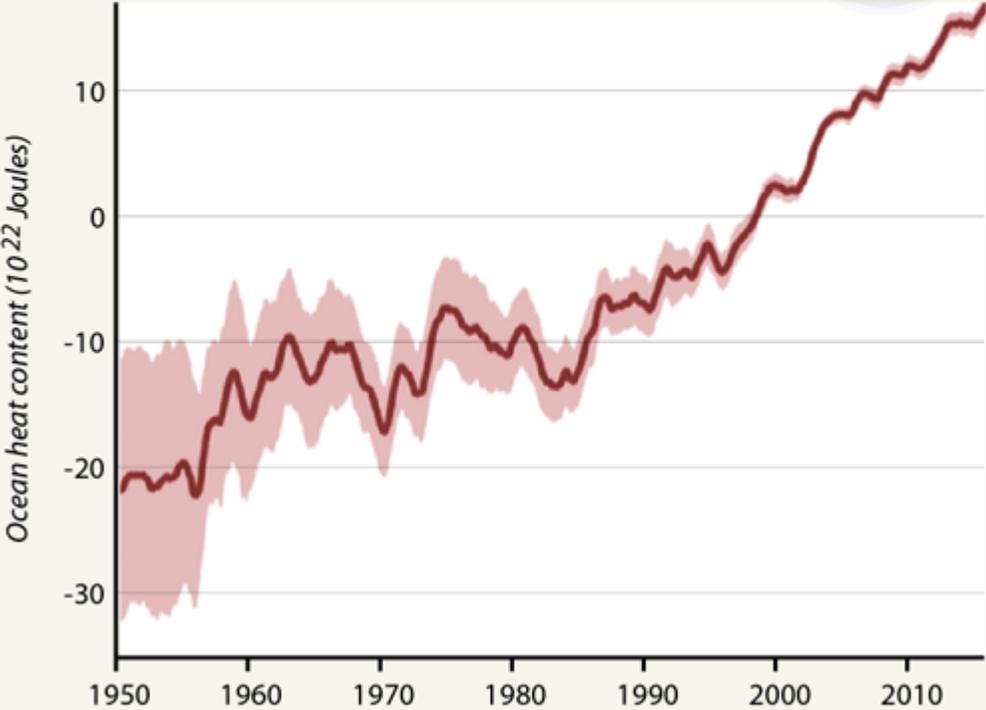
World's Oceans Warming at Faster Rate

The rate at which oceans have warmed has nearly doubled since 1992, compared to previous decades, according to a study by U.S. and Chinese scientists that created a record of ocean warming between 1960-2015.

OCEAN HEAT

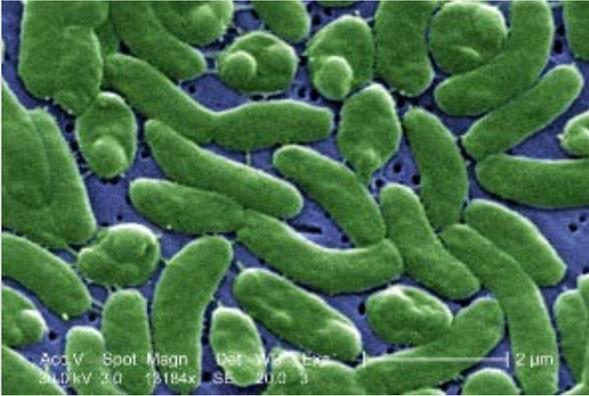
Surface to 2,000 meters deep, 1950-2015

Change in heat content Uncertainty estimates



What's Loving the Heat? *Vibrios!*

Vibrio vulnificus



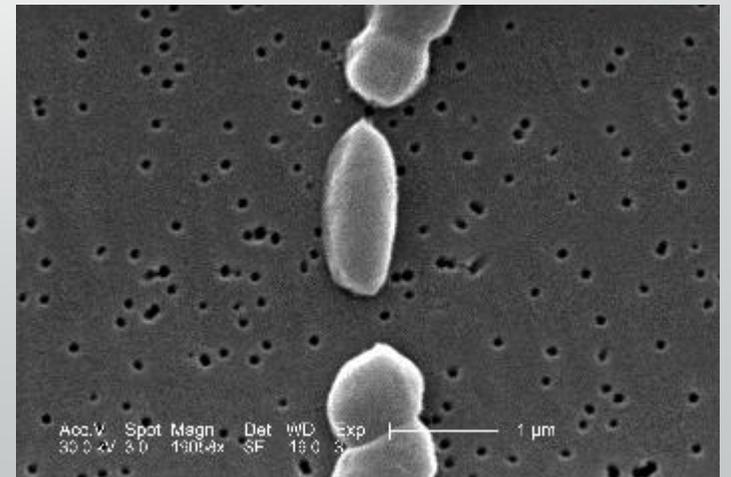
Photos courtesy of the *New England Journal of Medicine*



Vibrio parahaemolyticus



Vibrio parahaemolyticus



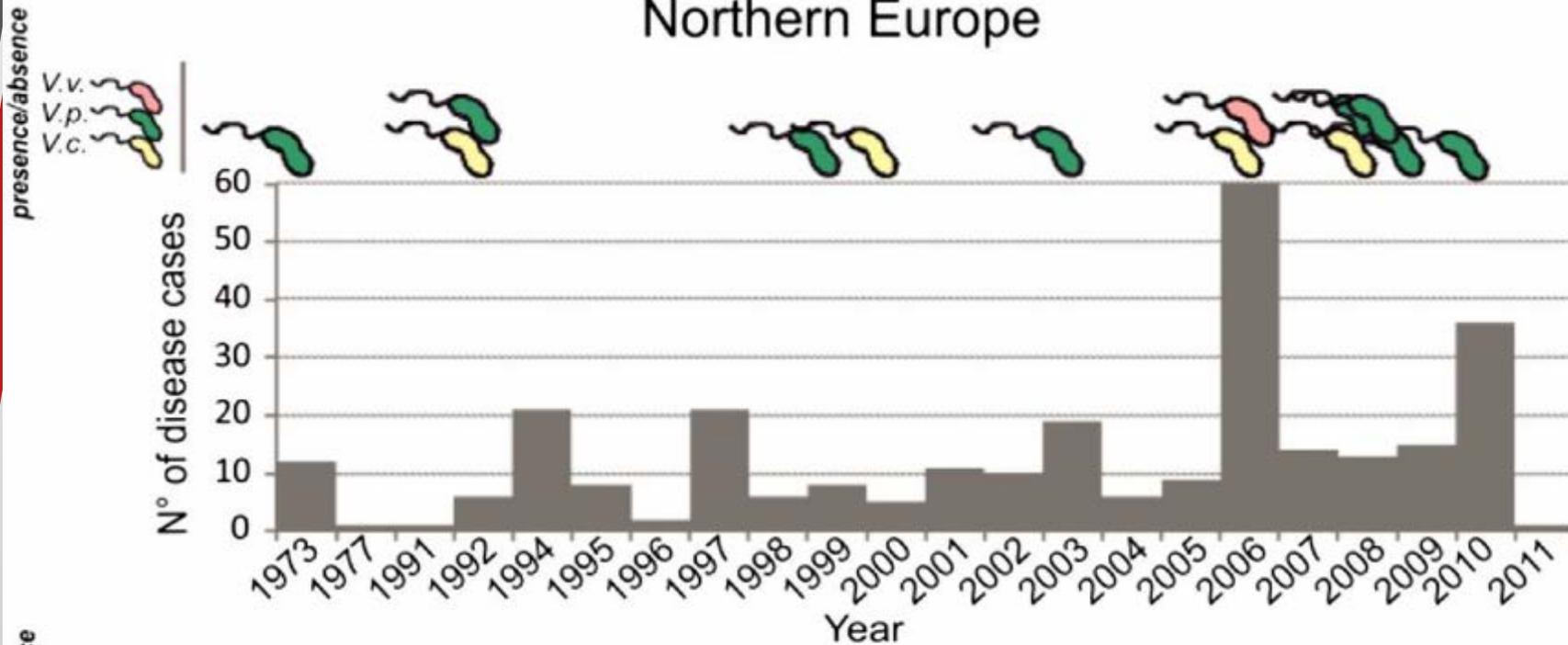
And of course . . .



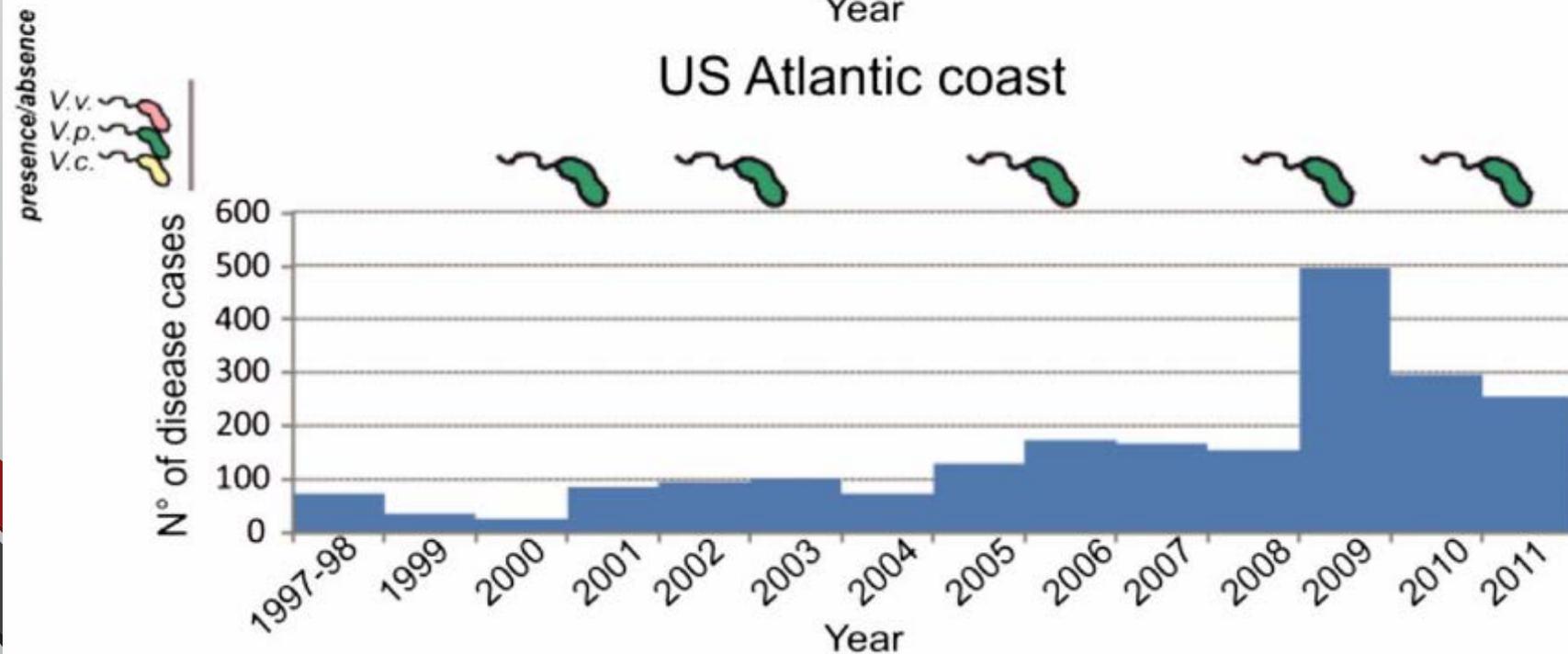
Vibrio cholerae



Northern Europe

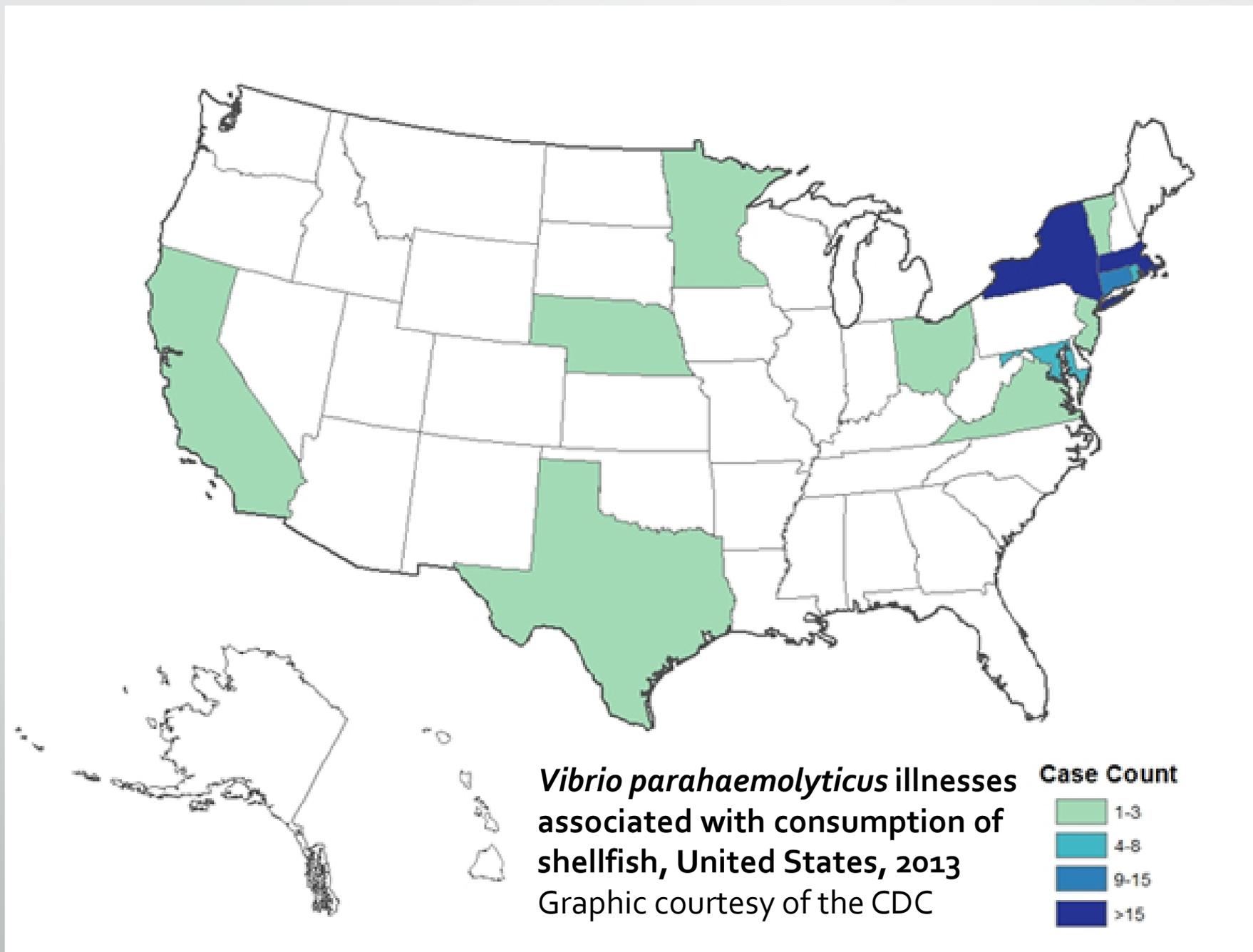


US Atlantic coast

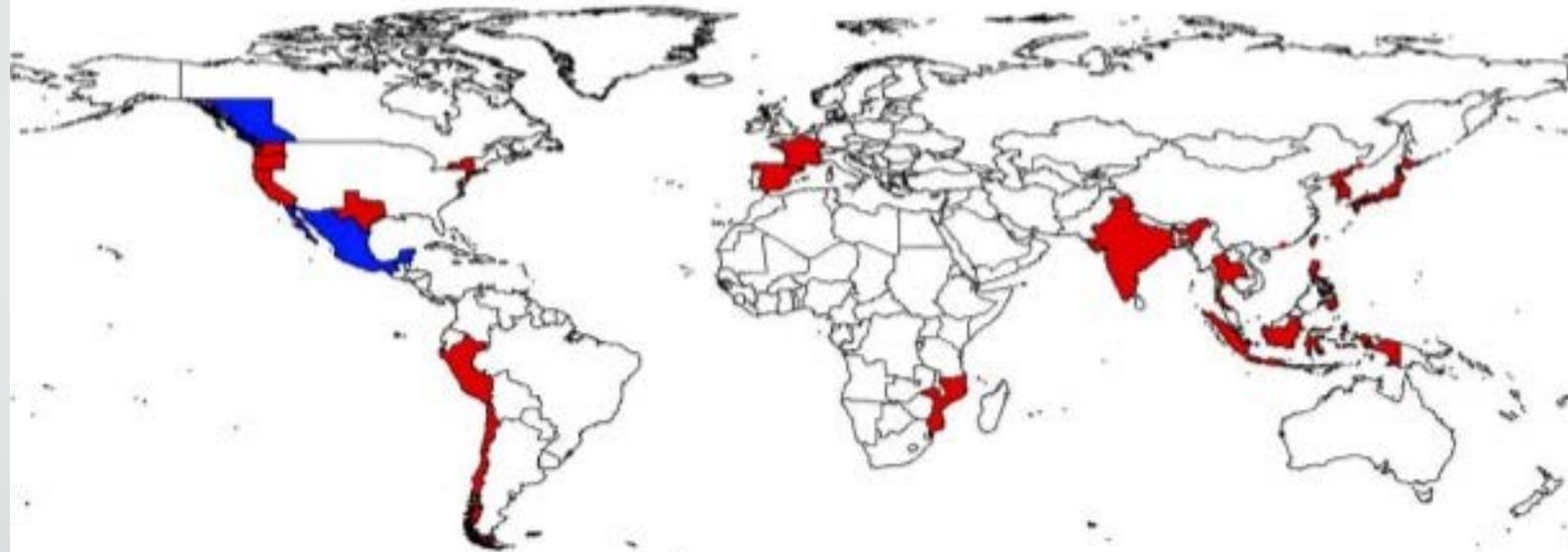


Vibrio Disease along the Atlantic Ocean

SOURCE: Vezulli et al.,
PNAS 2016,
<https://doi.org/10.1073/pnas.1609157113>



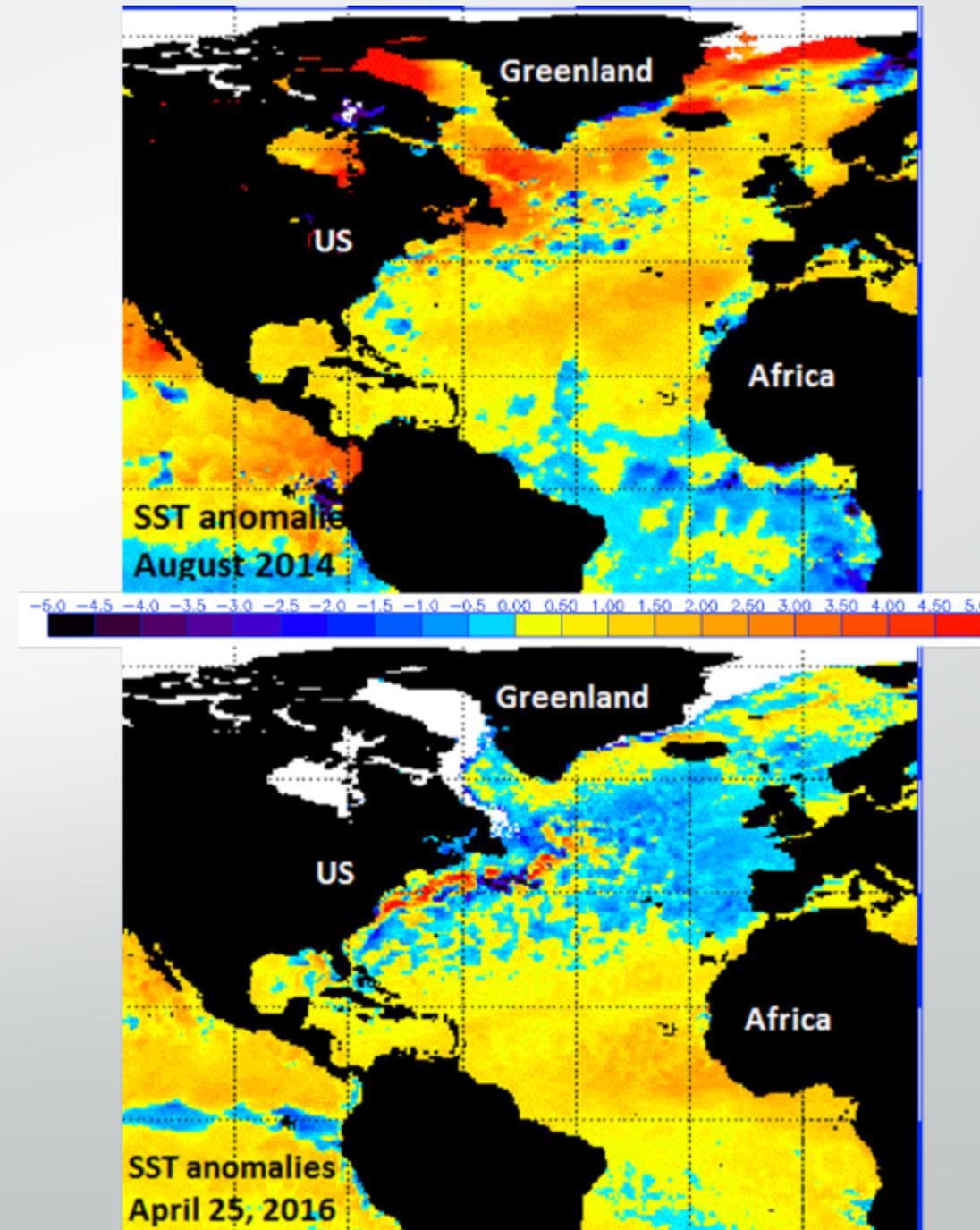
Global spread of pandemic strain of *V. parahaemolyticus*



- Areas where outbreak of *V. parahaemolyticus* has occurred or presence in the environment has been reported but the pandemic statuses of the strains are not clear
- Areas or countries where the pandemic *V. parahaemolyticus* clone has spread

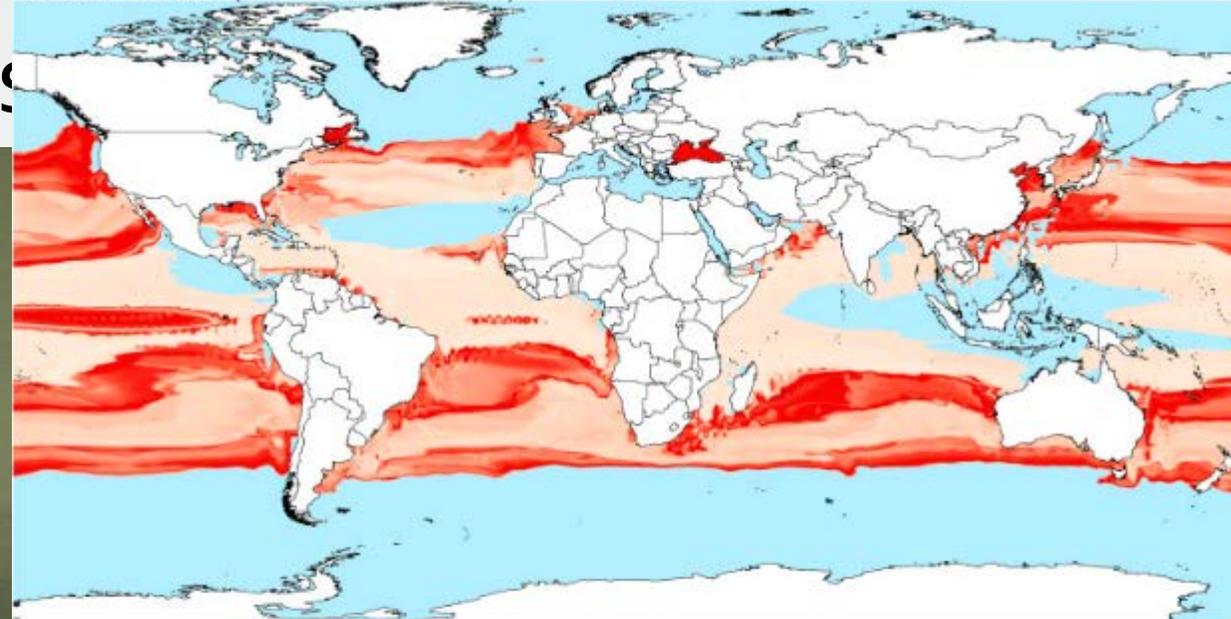
Map courtesy of the
World Health Organization

Vibrio Infestations and Sea Surface Temperature

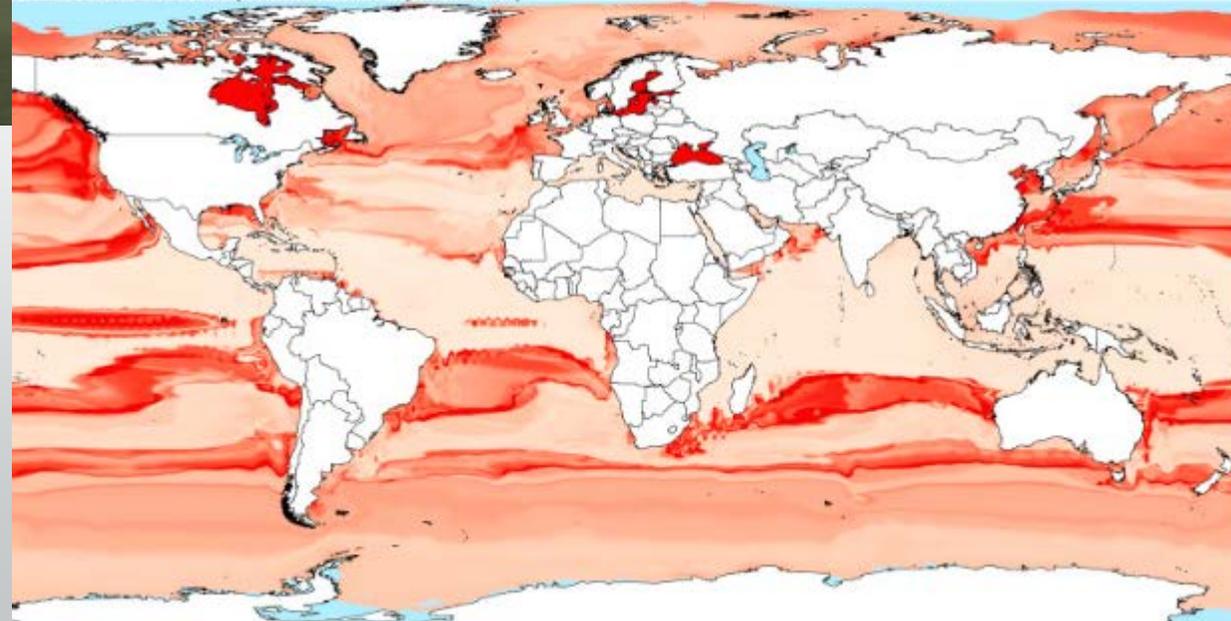


Cholera's

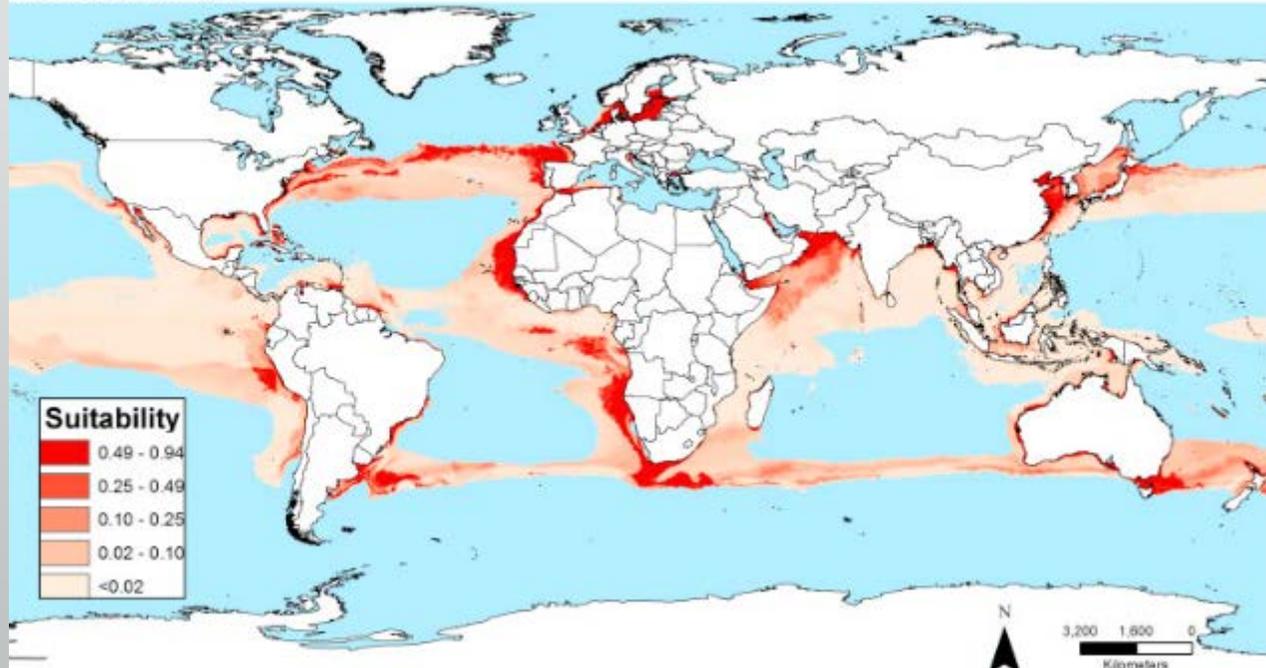
Future climate (model transference)



Future climate (model extrapolation)



Current climate



Copepod Carrying Cholera Bacteria

Image courtesy of the
National Science Foundation

Escobar et al., *Acta Tropica* 2015,
<https://doi.org/10.1016/j.actatropica.2015.05.028>

Warm Water Also Promotes Harmful Algal Blooms

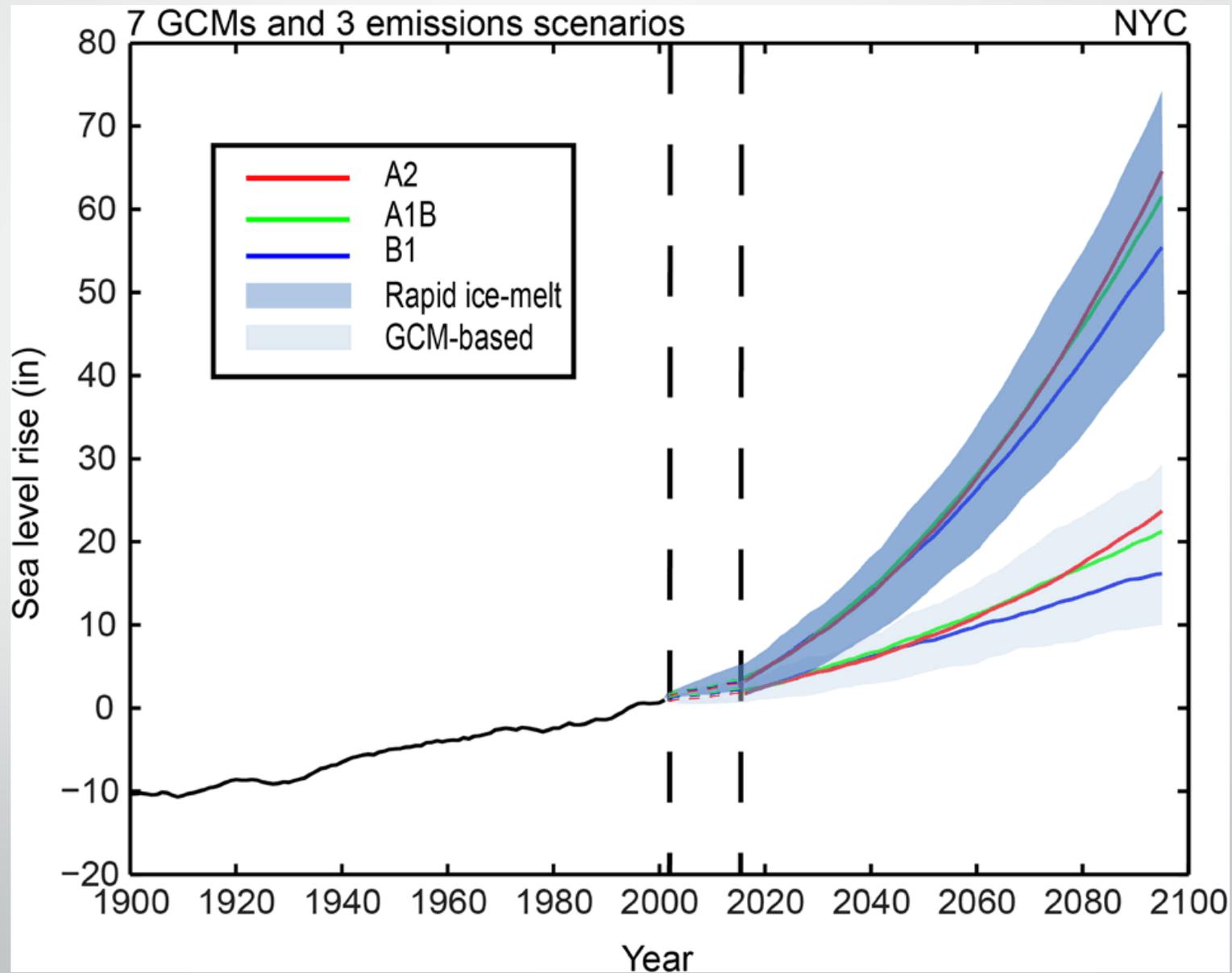




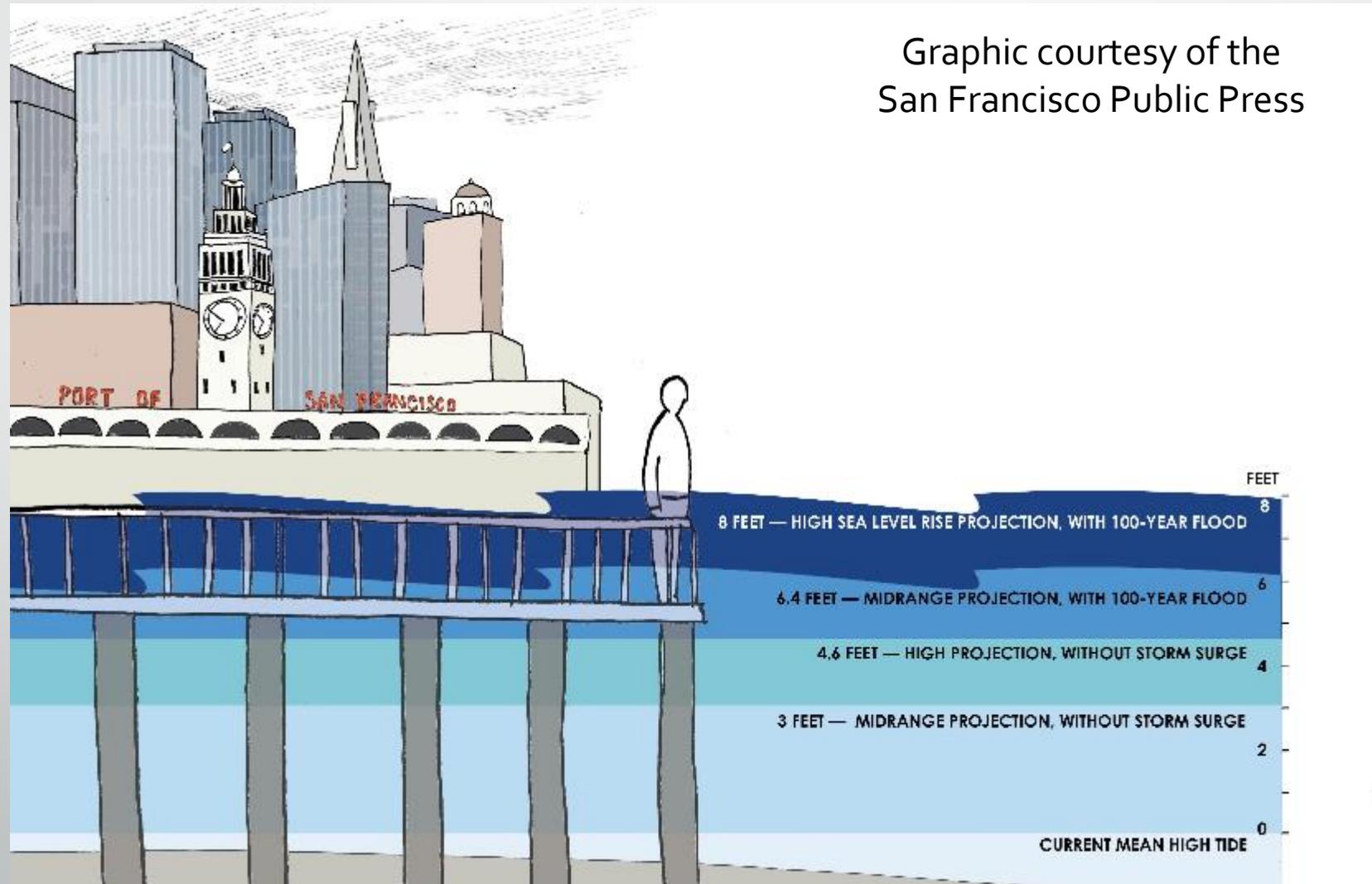
2. Sea Level Rise

So, How Much?

Sea Level Rise Projections to 2100 based on 7 Global Circulation Models (GCMs) and 3 emissions scenarios.
Graphic courtesy of NASA.



What We Normally Worry About in Connection with Sea Level Rise



But Inundated Coasts Tend to Increase Mosquito Habitat





Anopheles

- | | | | |
|---------------------------|---------------------------|---|----------------------|
| ○ No vector | ○ funestus and arabiensis | ○ melas | ○ pulcherrimus |
| ○ albimanus | ○ barbirostris | ○ funestus, arabiensis and gambiae s.s. | ○ messeae |
| ○ annularis | ○ culicifacies | ○ funestus and gambiae s.s. | ○ minimus |
| ○ anthropophagus | ○ dirus | ○ gambiae s.s. | ○ multicolor |
| ○ arabiensis | ○ farauti | ○ gambiae s.s. and funestus | ○ nunez-tovari |
| ○ arabiensis and funestus | ○ flavirostris | ○ labranchiae | ○ punctulatus group |
| ○ aquasalis | ○ fluviatilis | ○ maculatus | ○ pharoensis |
| ○ atroparvus | ○ freeborni | ○ darlingi and marajoara | ○ pseudopunctipennis |
| | | | ○ superpictus |

DeSouza et al., "The Impact of Climate Change on the Geographic Scope of Diseases" (2012), DOI: 10.5772/50646

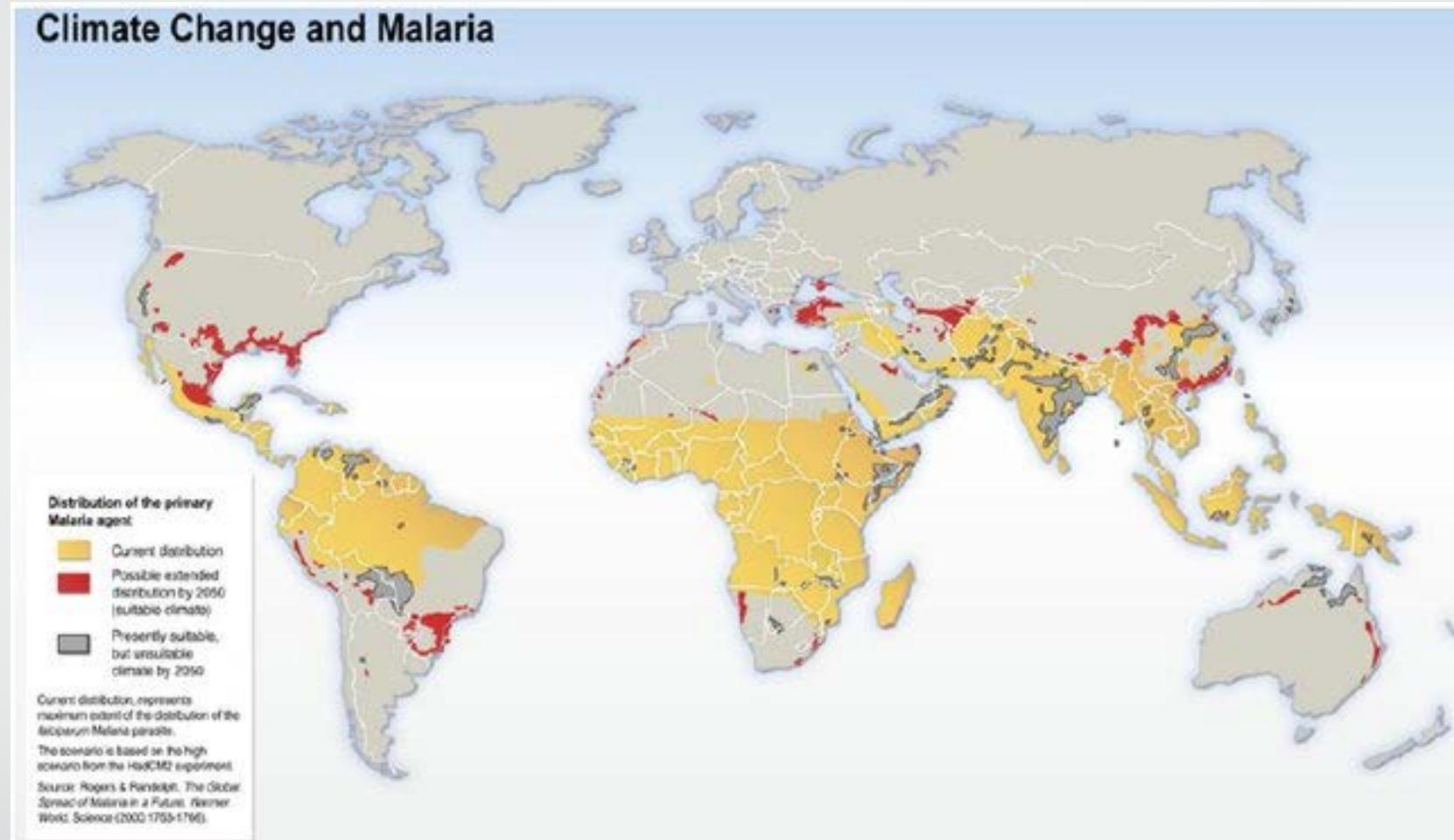
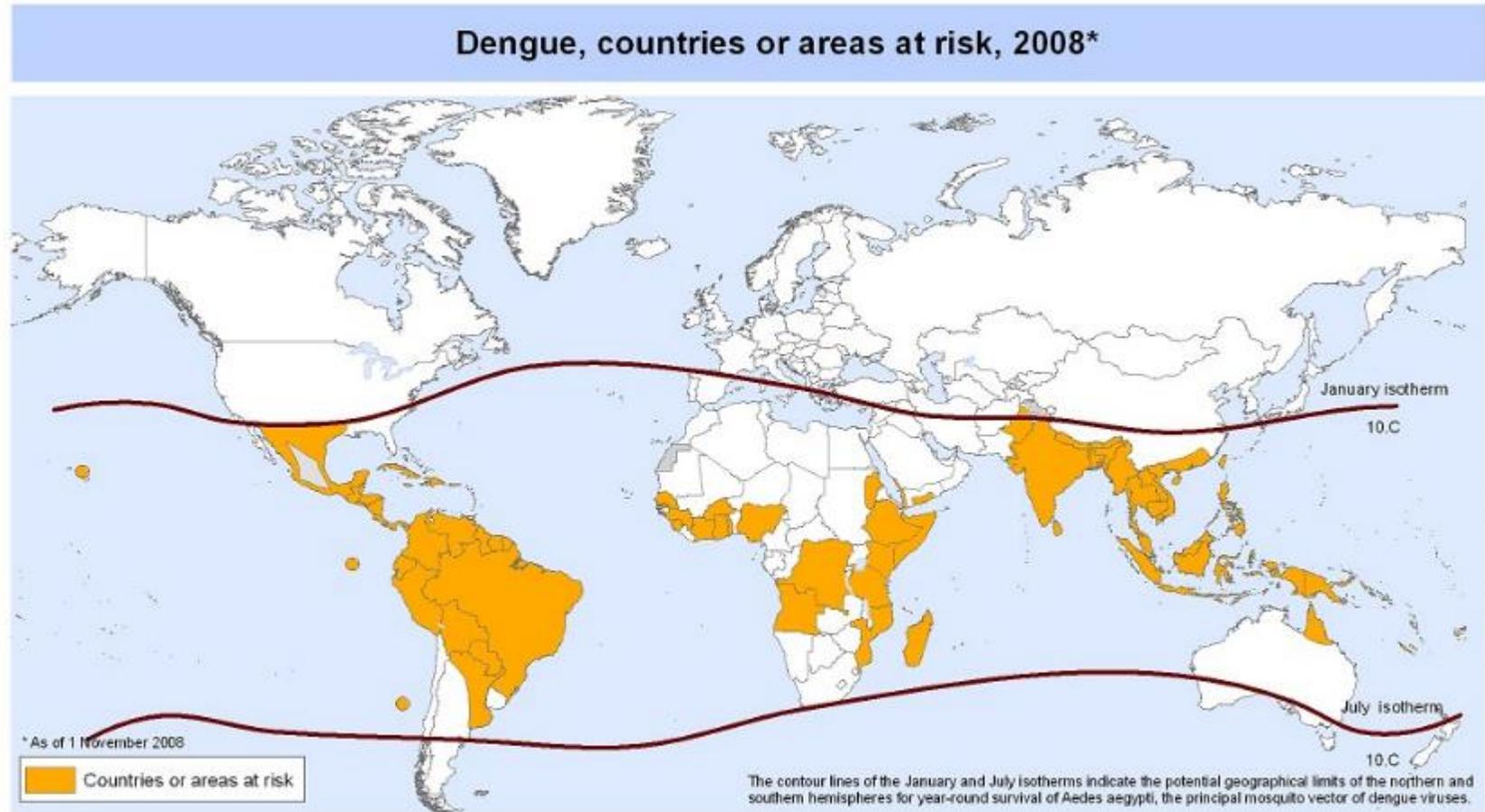


Figure 1. Climate change and malaria, scenario for 2050 (UNEP/GRID 2005). With climate conditions changing in the future, due to increased concentrations of carbon dioxide in the atmosphere, conditions for pests also change. The primary malaria agent, the falciparum malaria parasite, will be able to spread into new areas, as displayed in this map, by 2050 using the Hadley CM2 high scenario. Other areas, not displayed in the map, will be uninhabitable by the parasite.

Dengue Fever



The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

Data Source: World Health Organization
Map Production: Public Health Information
and Geographic Information Systems (GIS)
World Health Organization



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Dengue in Florida



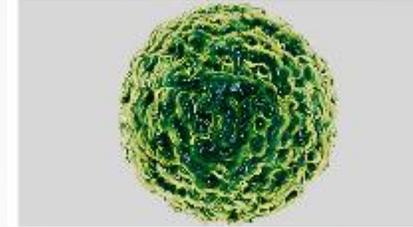
Dengue Cases in Florida, 2013
Graphic courtesy of Health News Florida

Also, Sea Level Rise and Storm Surge Mean More Sewage Contamination of the Coast

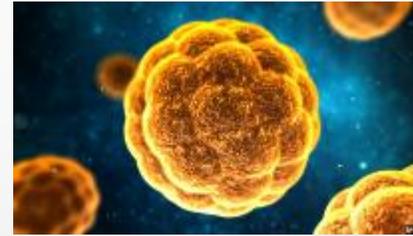


**Hurricane Michael Makes Landfall in Florida,
October 2018**

Photograph courtesy of CNN



Norovirus



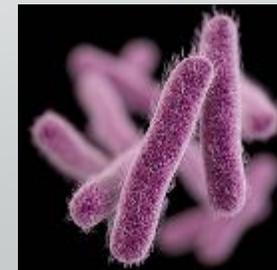
Hepatitis A



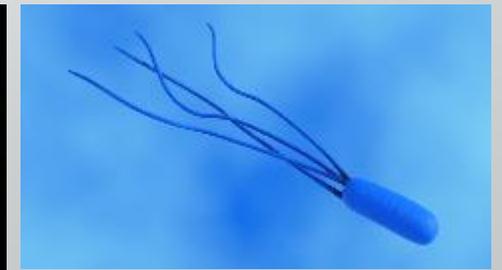
Cryptosporidium



Giardia



Shigella



E. coli



3. Ice Melting

It Sounds Like Science Fiction, But . . .



“The Zombie Diseases of Climate Change,” *The Atlantic*,
November 6, 2017



Anthrax Spores



So What Does a Public Health Perspective Suggest for Coastal Adaptation?

- Public health officials need to be part of the coastal adaptation discussion.
- Adaptation planning should include future disease risk and appropriate training for medical personnel so that they can recognize the new or returning diseases when they show up.
- Mosquito control programs may need to be started or expanded as part of sea level rise adaptation.
- Harmful algal blooms provide a significant reason to get serious about nutrient pollution control.
- Sewage exposure from storm surge suggests the need for new building codes for the coast.

