



Baked Bacteria, Volatile Viruses & Flooded Fungi: Infectious Diseases in a Changing Climate

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- Nothing to disclose



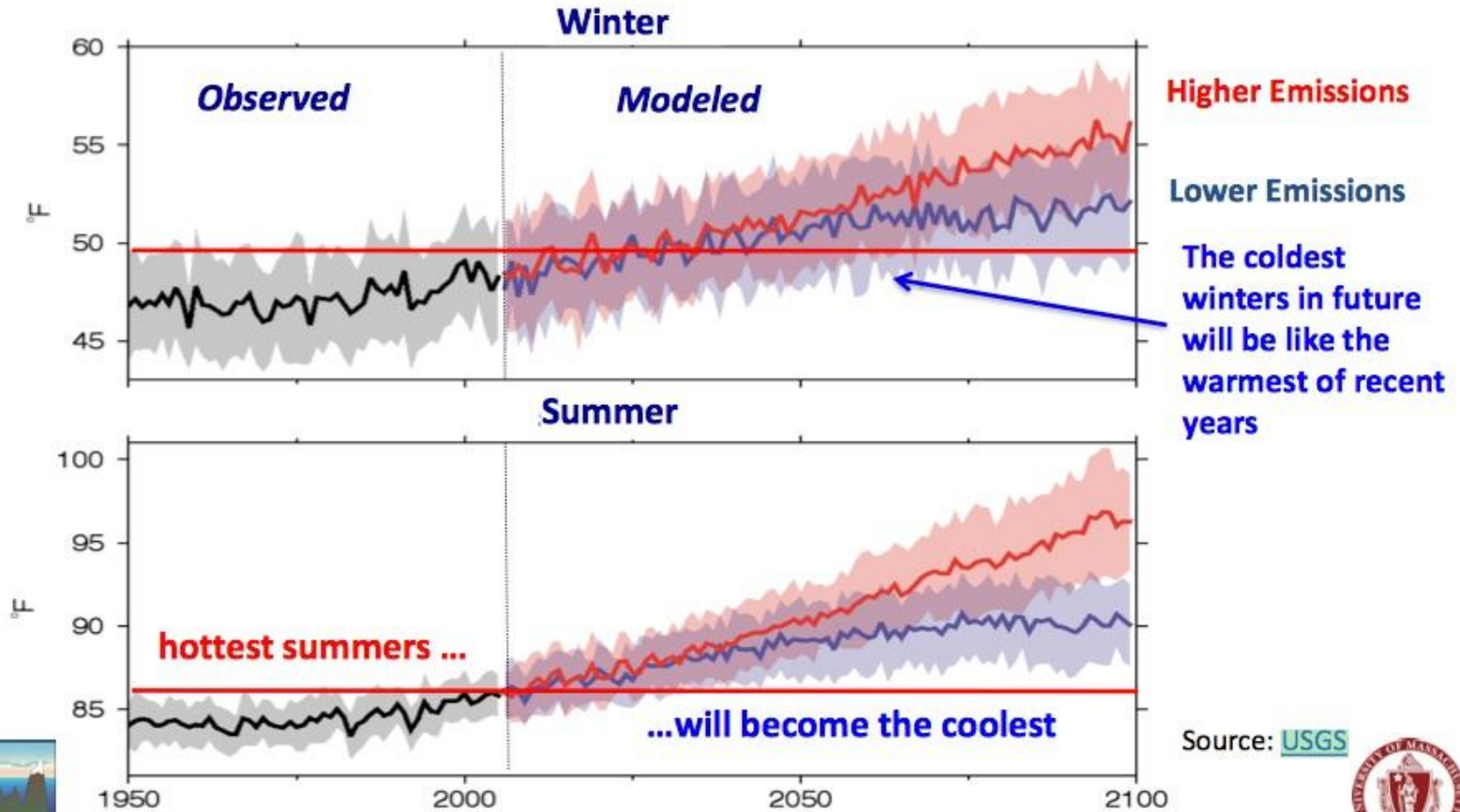
- Understand why and how climate change is relevant to infectious diseases
- Examine examples of the impact climate is already having on infectious diseases
 - Vector-borne diseases
 - Changes in seasonal patterns
 - Disaster-related outbreaks
- Discuss what we can do about the problem



VIRGINIA CLIMATE CHANGE

PROJECTIONS

How warm will Winter and Summer temperatures become?



Source: [USGS](#)

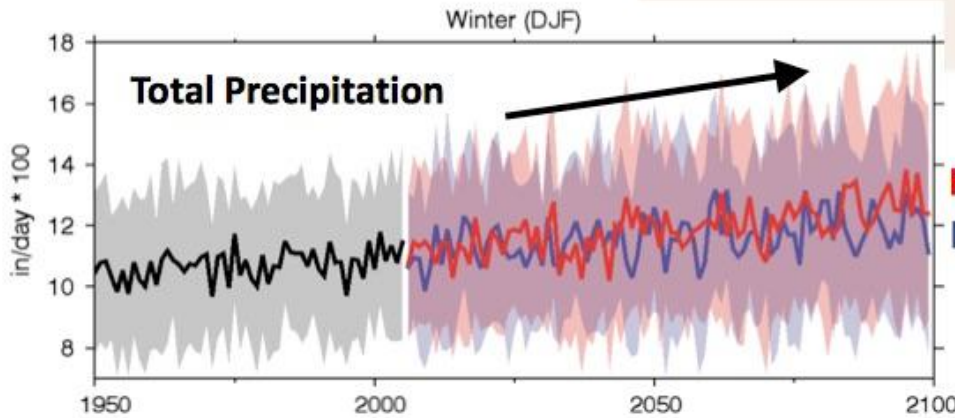




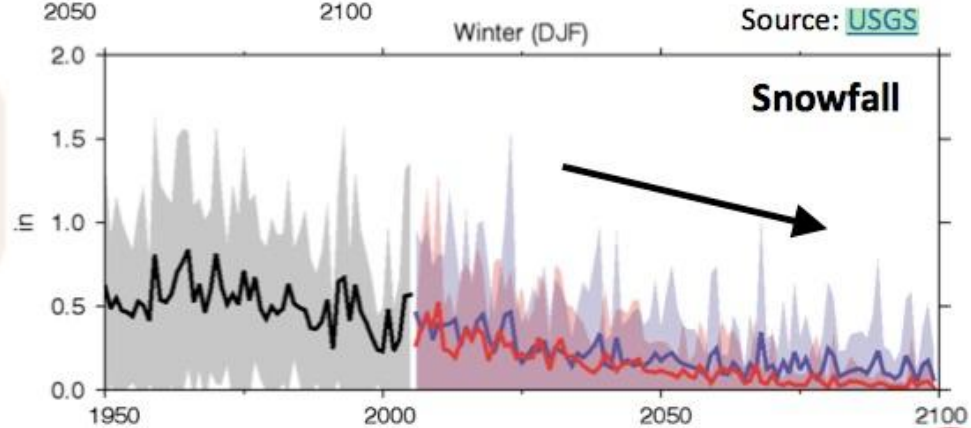
VIRGINIA CLIMATE CHANGE

PROJECTIONS

Winter precipitation is projected to increase through the 21st century.



Due to increasing temperatures, there will be more rain and less snow.



Projected changes in rainfall in summer are uncertain.

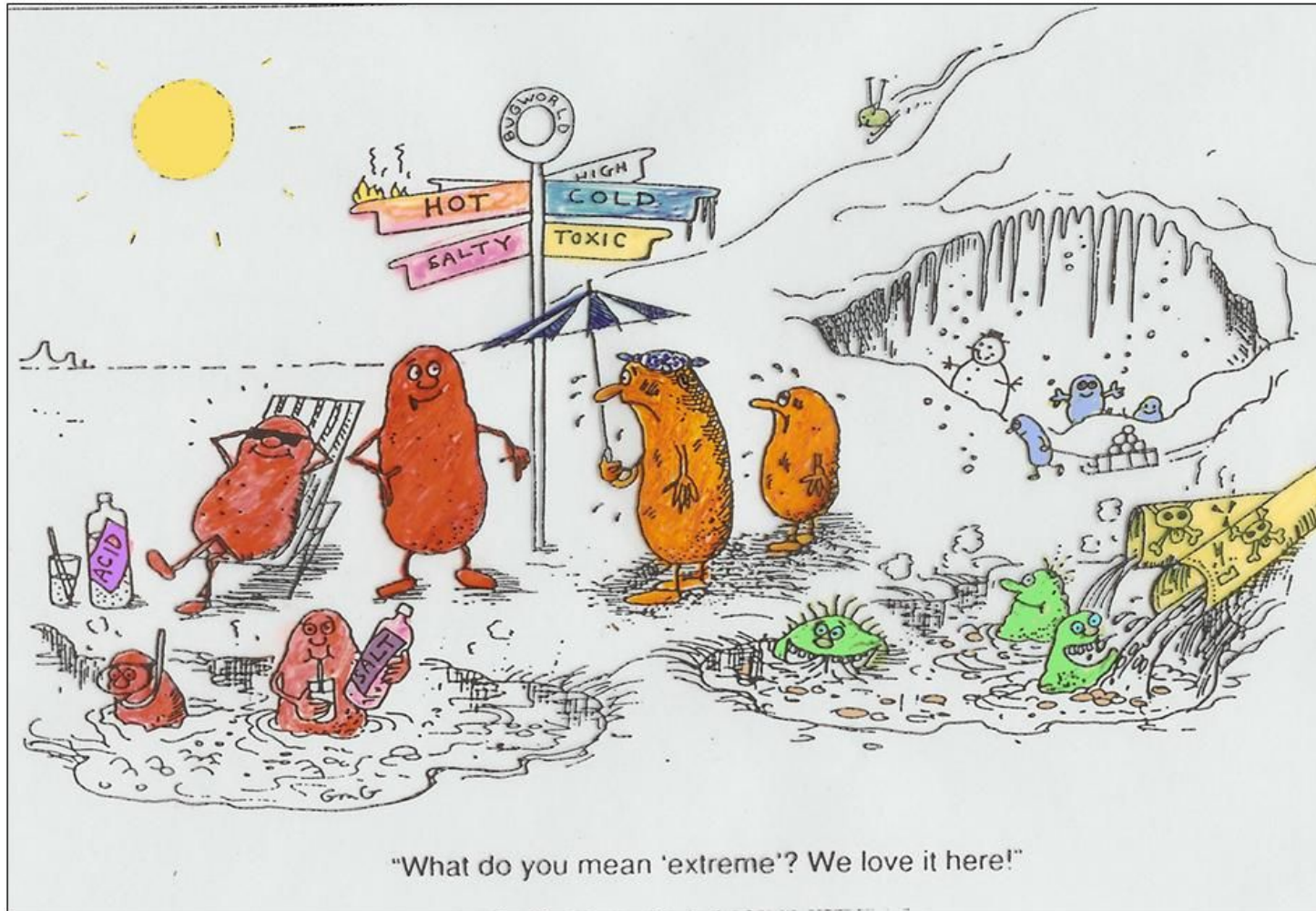




- Bacteria and viruses live on and infect us.
- Why would the temperature and rainfall and environment outside affect them?
- Anyway, some bacteria like extreme environments!

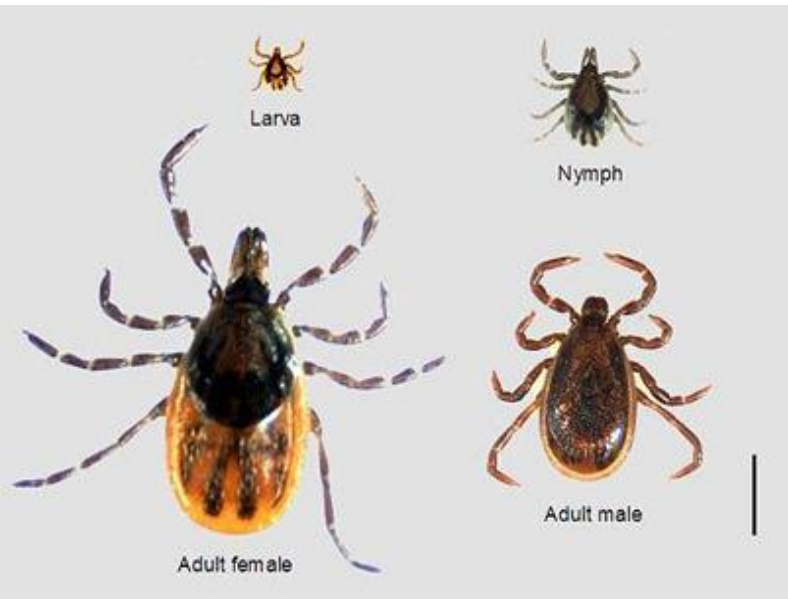


CLIMATE CHANGE, SHMIMATE SHMANGE





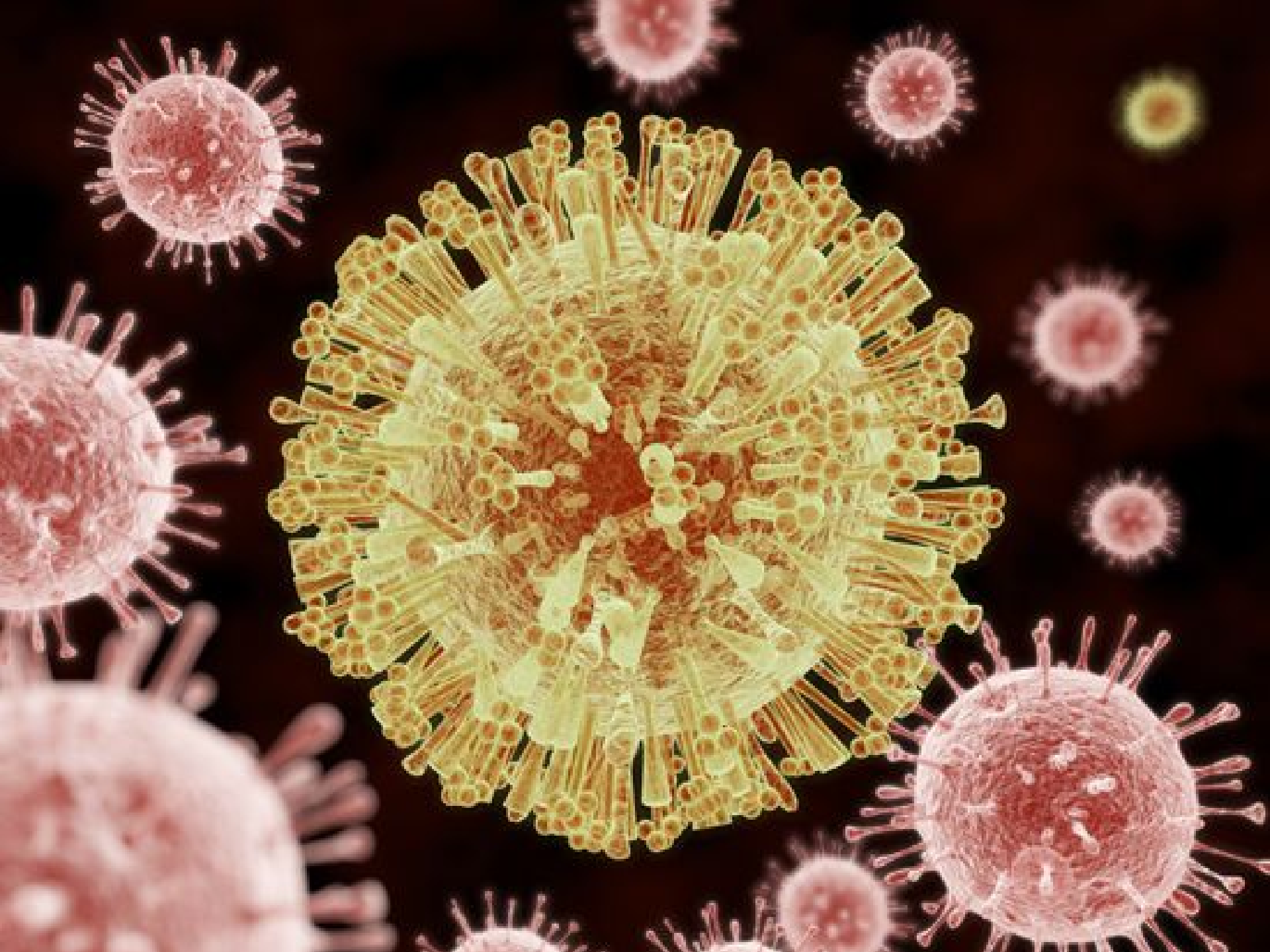
NOT JUST BUGS & US





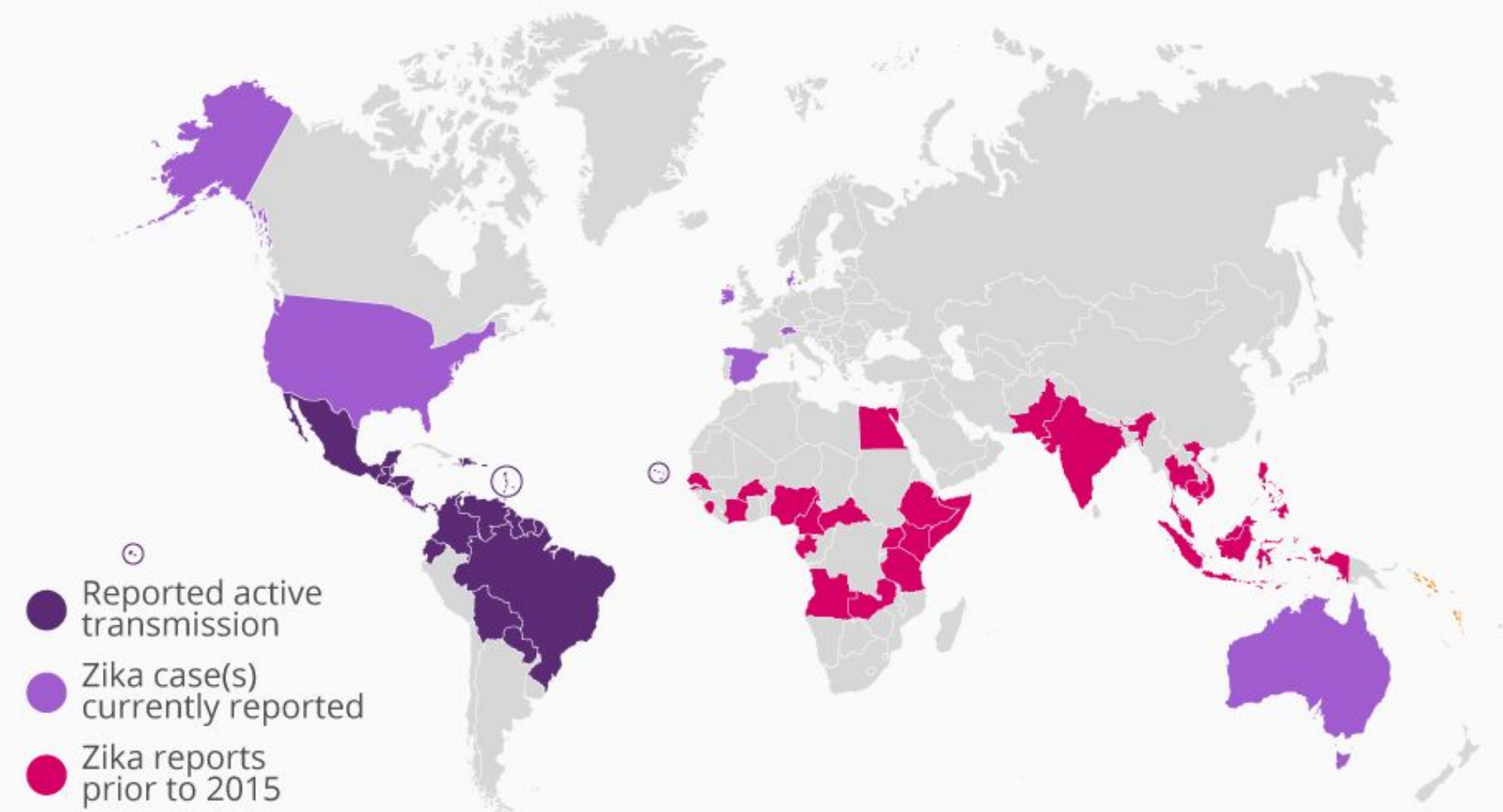
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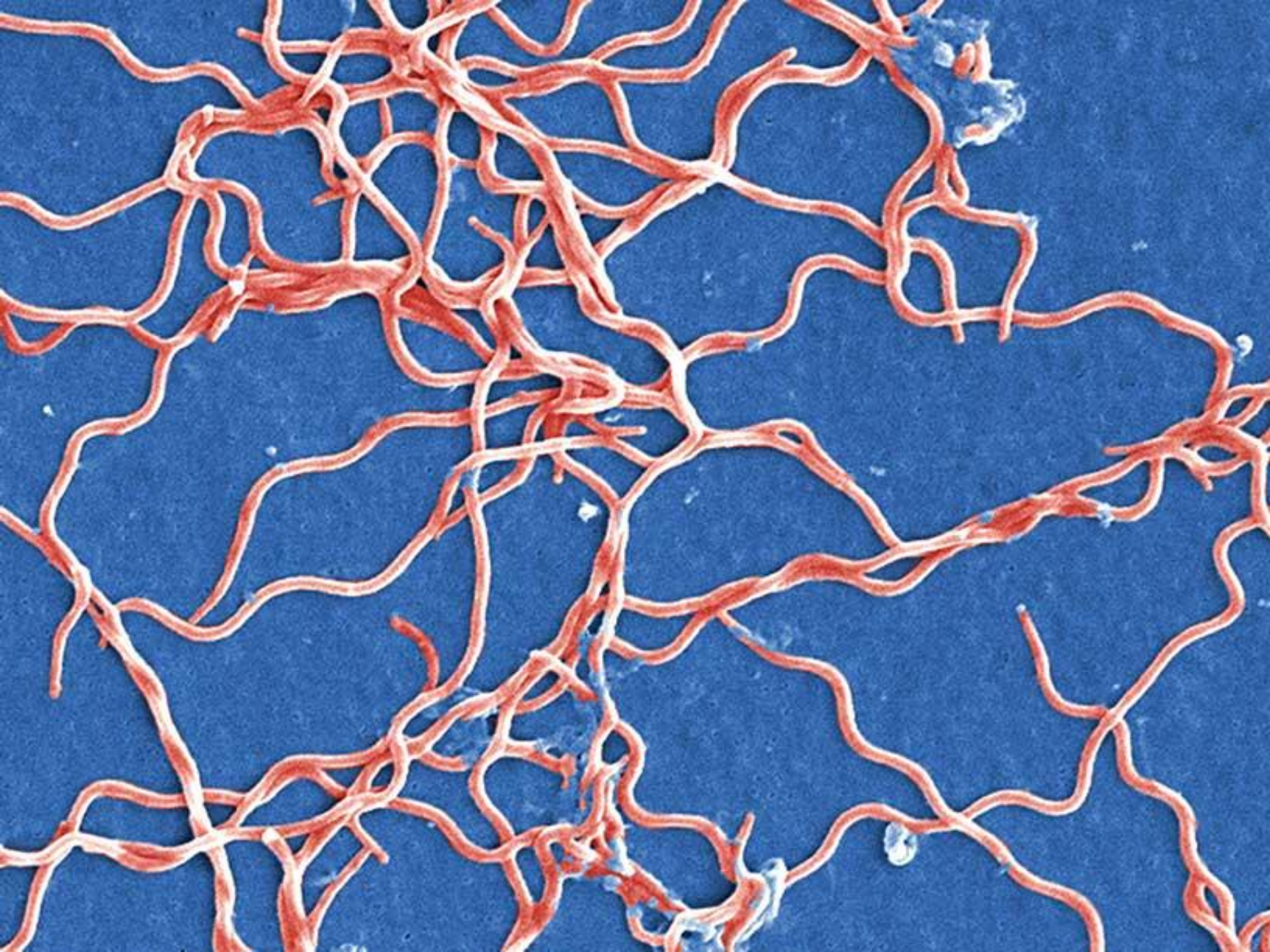
Vector-borne infections



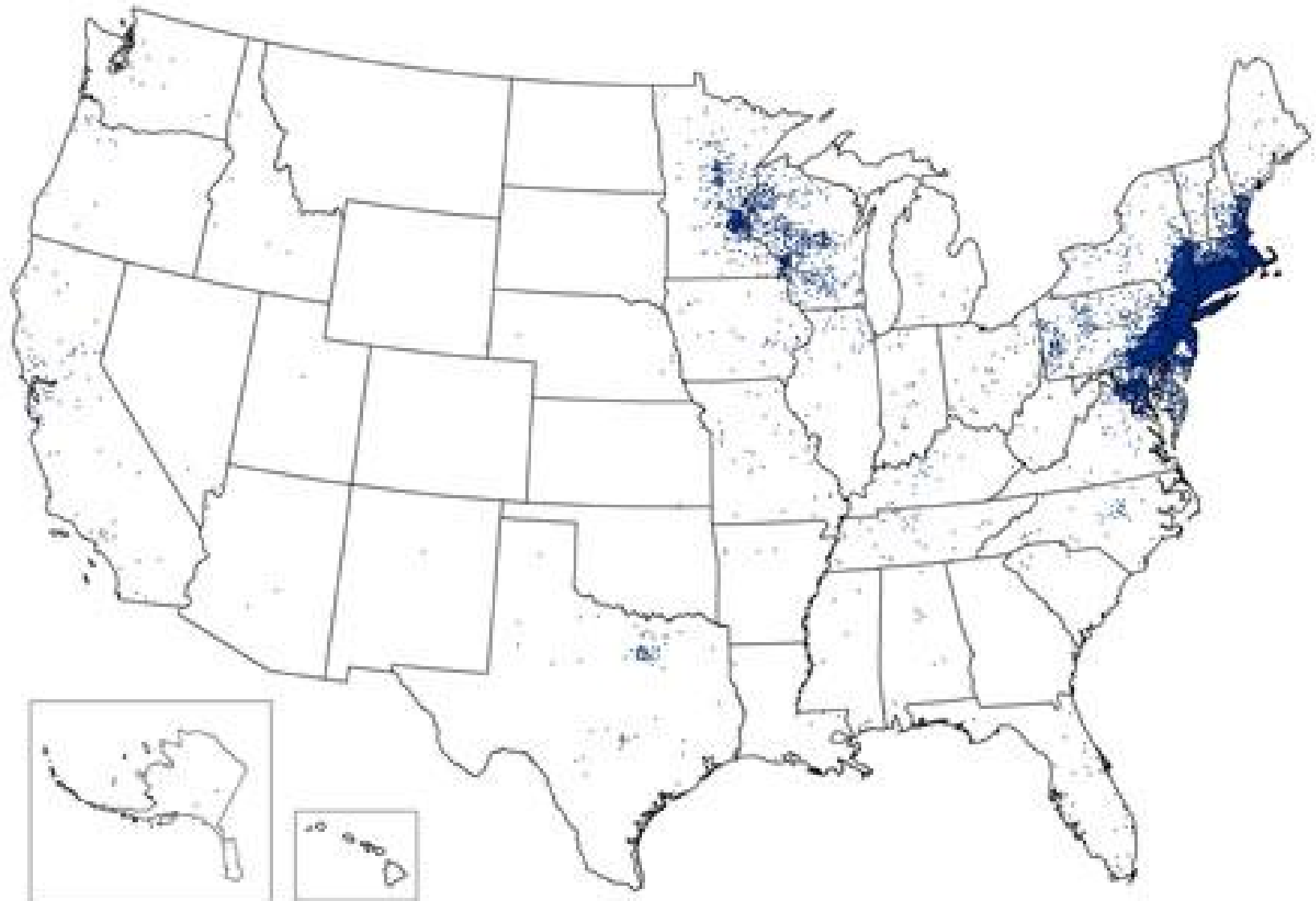
The Spread Of The Zika Virus

Countries and territories with active Zika virus transmission* and reported cases



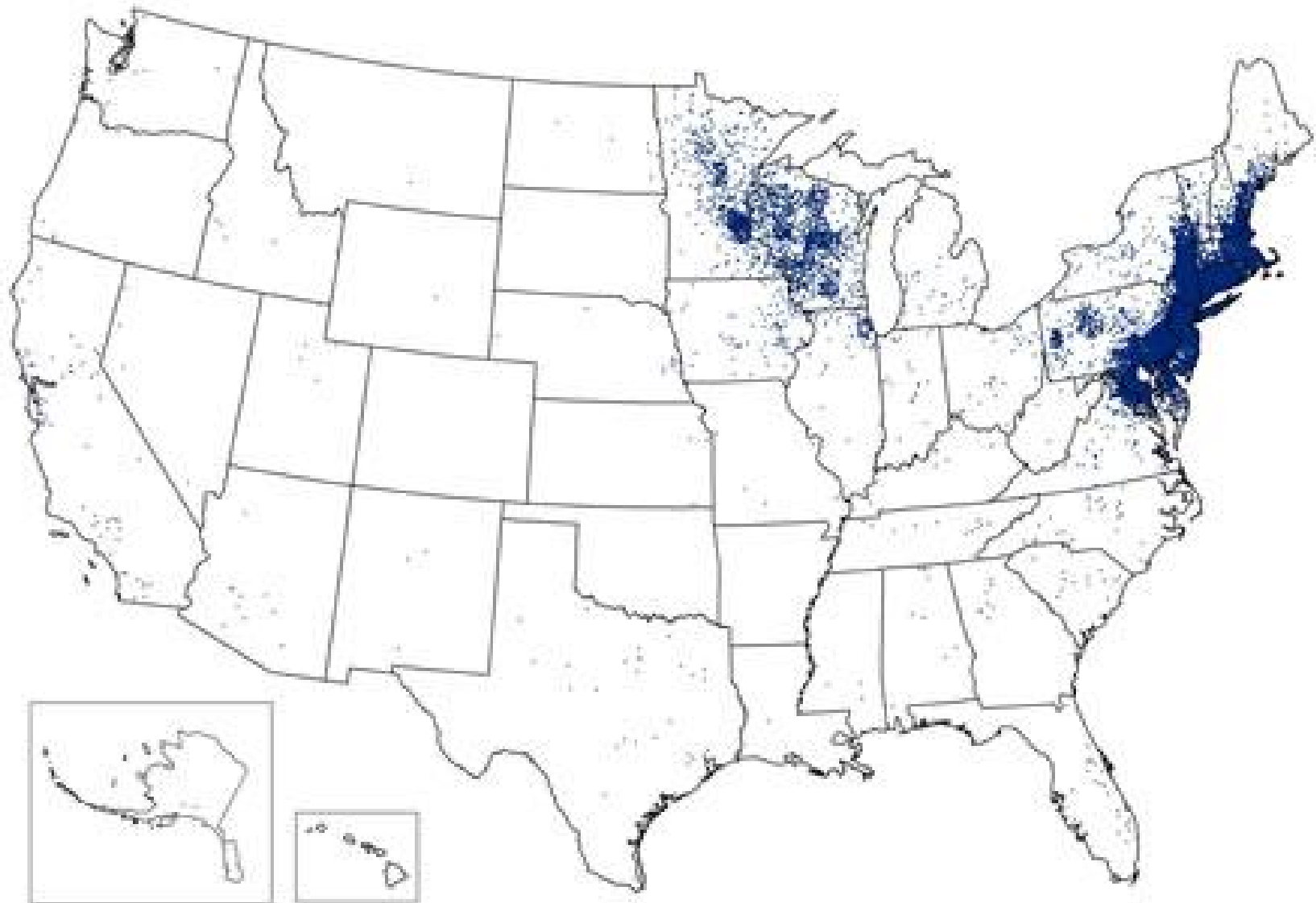


Reported Cases of Lyme Disease -- United States, 2001



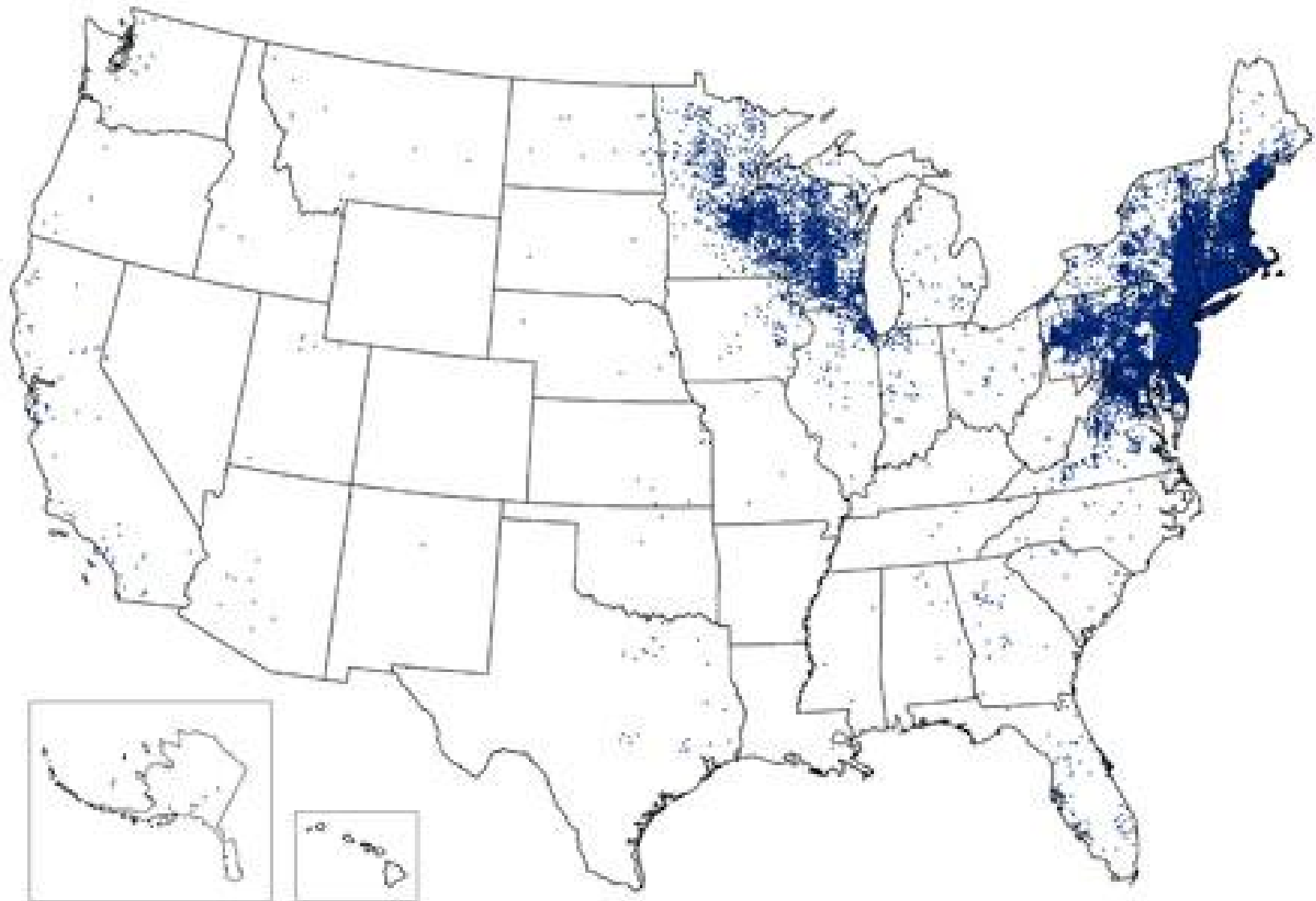
1 dot placed randomly within county of residence for each reported case

Reported Cases of Lyme Disease -- United States, 2006



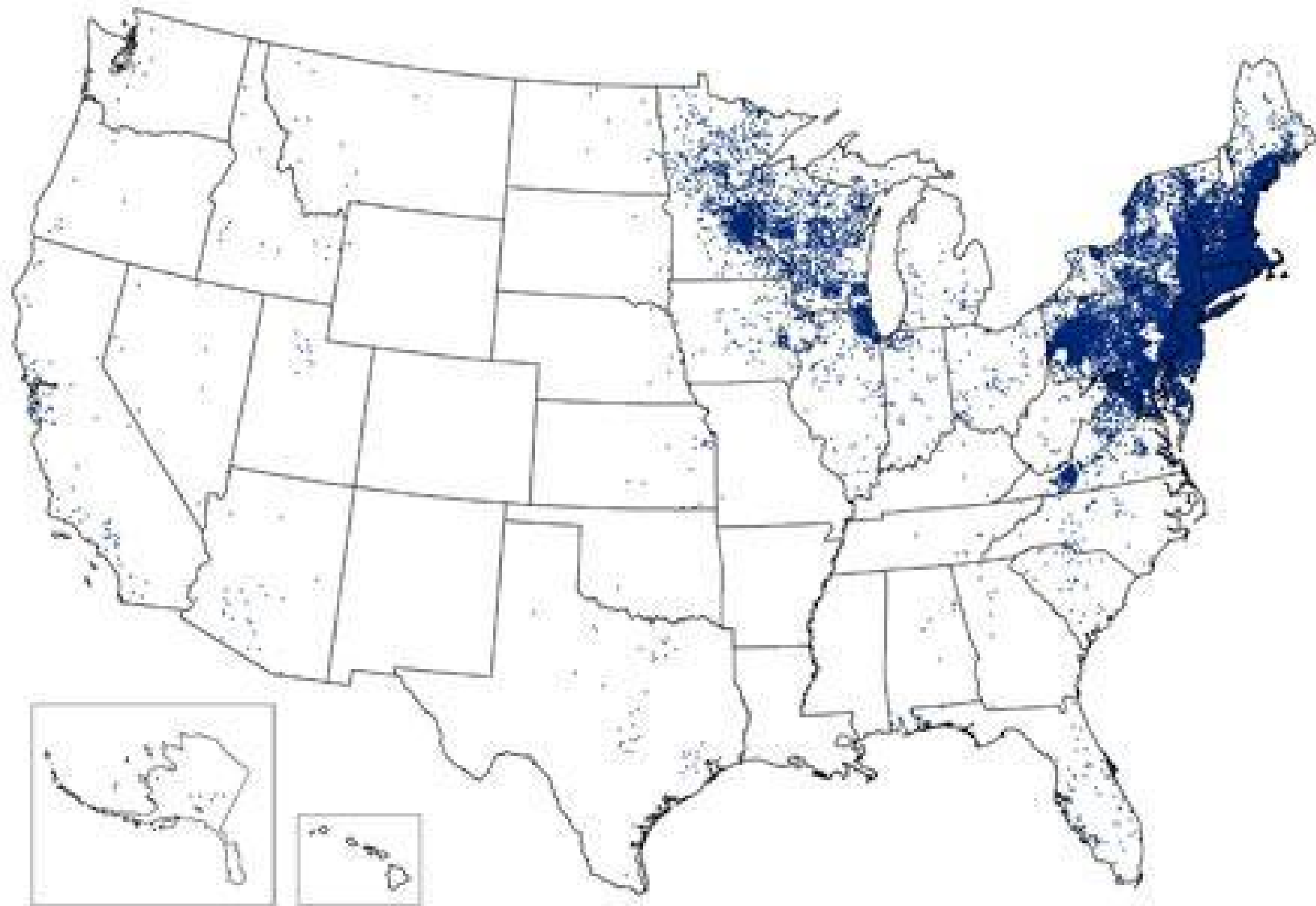
1 dot placed randomly within county of residence for each reported case

Reported Cases of Lyme Disease -- United States, 2011



1 dot placed randomly within county of residence for each confirmed case

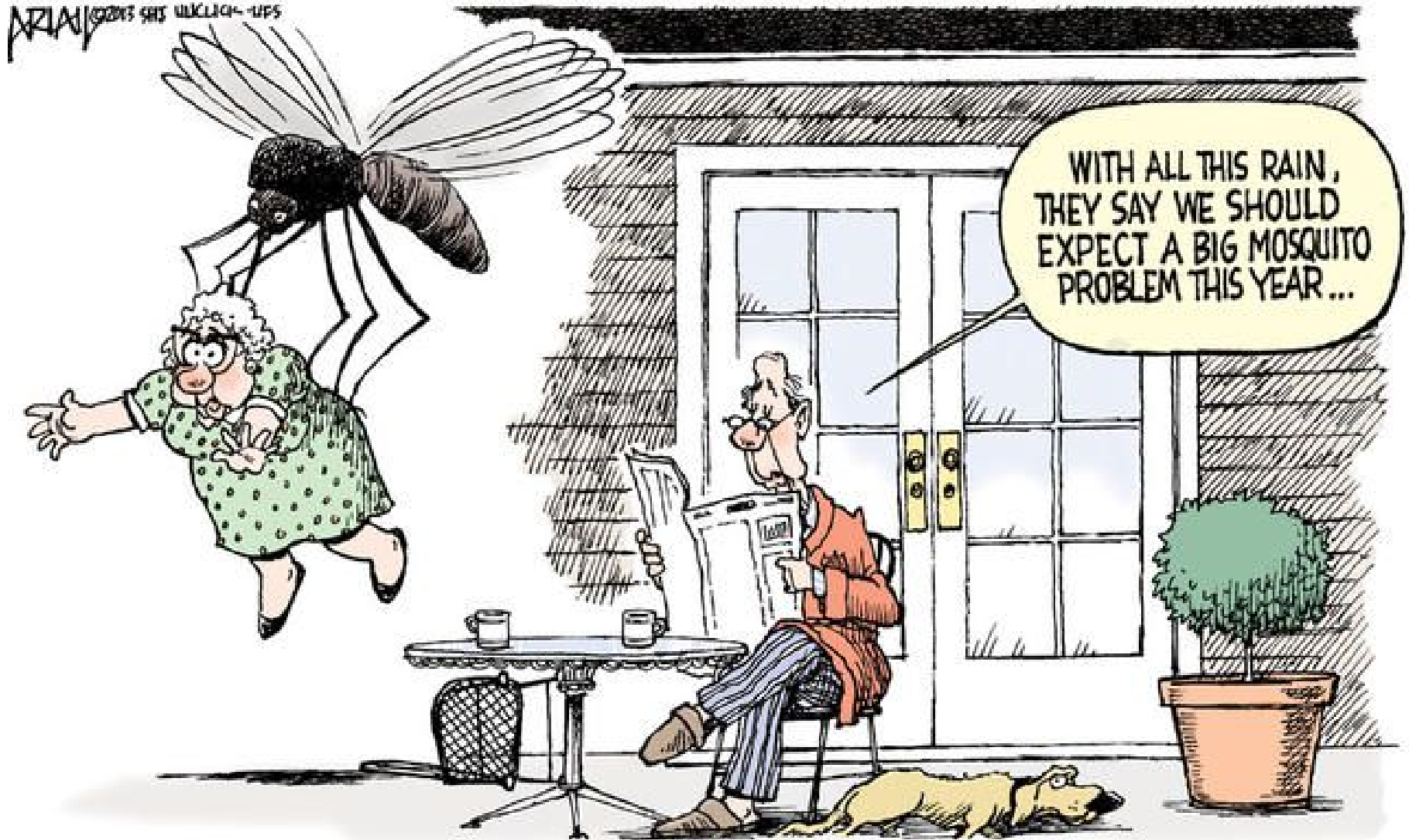
Reported Cases of Lyme Disease -- United States, 2013



1 dot placed randomly within county of residence for each confirmed case



- Zika is spreading
- Lyme is spreading
- But are we certain this is due to climate change? And if so how?





Climate Change and Range Expansion of the Asian Tiger Mosquito (*Aedes albopictus*) in Northeastern USA: Implications for Public Health Practitioners

Ilia Rochlin , Dominick V. Ninivaggi, Michael L. Hutchinson, Ary Farajollahi

- Correctly modeled and predicted current known *Aedes albopictus* range based on past→present climate data
 - Also predicted future range expansion based on future climate predictions
- Profound future implications for disease



- *Aedes aegypti* is a highly efficient vector for:
 - Dengue Fever
 - Yellow Fever
 - Chikungunya
 - Zika Virus
- *Aedes albopictus* is a less efficient but **still capable** vector for:
 - Dengue Fever
 - Yellow Fever
 - Chikungunya
 - Zika Virus



Aedes aegypti and *Aedes albopictus* Mosquitoes: Geographic Distribution in the United States



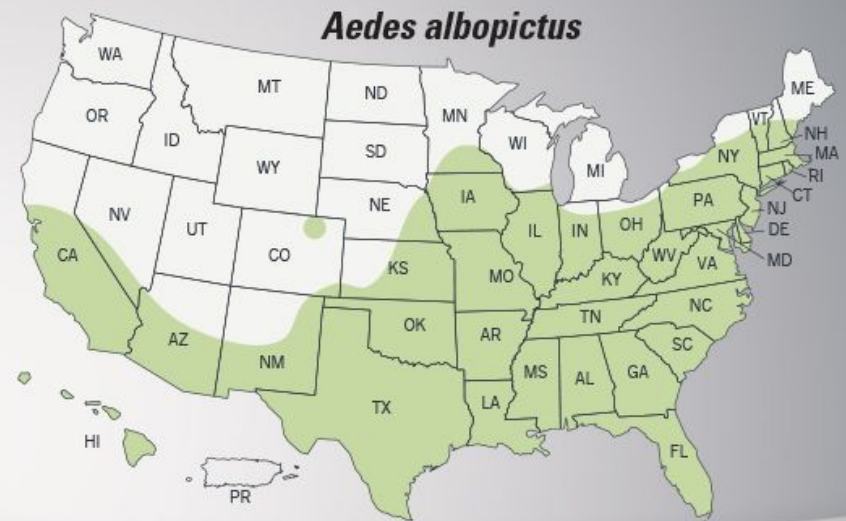
Aedes aegypti



Aedes albopictus



Estimated range of *Aedes aegypti* and *Aedes albopictus* in the United States, 2016*



***Aedes aegypti* mosquitoes are more likely to spread viruses like Zika, dengue, chikungunya than other types of mosquitoes such as *Aedes albopictus* mosquitoes.**

- These maps show CDC's best estimate of the potential range of *Aedes aegypti* and *Aedes albopictus* in the United States.
- These maps include areas where mosquitoes are or have been previously found.
- Shaded areas on the maps do not necessarily mean that there are infected mosquitoes in that area.

*Maps have been updated from a variety of sources. These maps represent CDC's best estimate of the potential range of *Aedes aegypti* and *Aedes albopictus* in the United States. Maps are not meant to represent risk for spread of disease.

SOURCE: Zika: Vector Surveillance and Control. www.cdc.gov/zika/vector/index.html



IT'S HAPPENED BEFORE...



Figure 4. Malaria in the United States and Canada in 1862. The dark shaded areas are regions where the disease was probably endemic. Modified from Faust [98], Stewart [100], and Williams [188].



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...AND IT CAN AGAIN...HERE...





- Data from the EPA:
 - (still climate change pages on their site...for now...)
- Lyme Disease is listed as one of their indicators of climate change's impact on human health
 - Incidence doubled from 1990-2014 (4→8/100,000)—national data
 - In NE, where more endemic, Maine, Vermont, NH had *increases* of 80-100 cases/100,000
 - The disease is moving north with the warmer climate



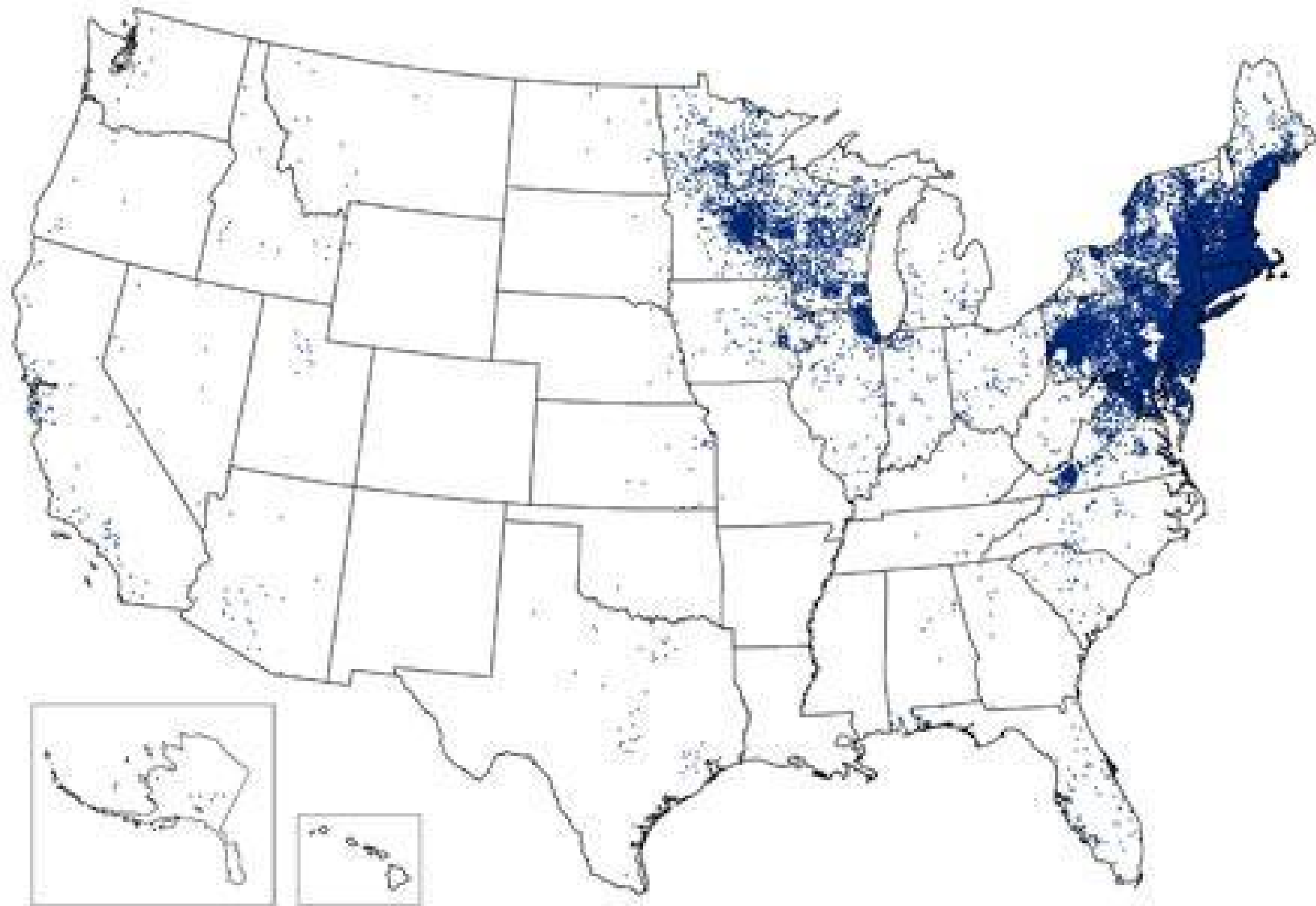
- One study showed rate of rise of Lyme cases significantly increased with increasingly northern latitude (Tuite et al. CMAJ Open, 2013)
 - The areas being warmed proportionately more by climate change are being more affected by Lyme
 - Controlled for multiple other factors—none significant
- 2009: 128 cases reported → 2015: 700 (>400%)
- Numbers are still small...for now...

Reported Cases of Lyme Disease -- United States, 2001



1 dot placed randomly within county of residence for each reported case

Reported Cases of Lyme Disease -- United States, 2013



1 dot placed randomly within county of residence for each confirmed case



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Seasonal infections



- Not just moving geographically, but also temporally.
- Lyme season is classically April/May-October
 - The ticks hibernate during cold weather and emerge in spring.
- In past 5 years on Long Island, local Lyme incident cases have expanded into November, December, and this past year, January.



- In the literature on this topic, most admit changes in seasonal diseases may be **difficult to predict** (Greer et al. CMAJ, 2008; WHO website).
- Cold-weather diseases (influenza, RSV) may be attenuated by milder winters
 - Increased migration into now milder areas, increasing population, could counteract this also
- Others (enteroviruses) with summer patterns, may become year-round



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Natural disasters



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NATURAL DISASTERS





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NATURAL DISASTERS



MARK WILSON/GETTY IMAGES



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NATURAL DISASTERS





- Hurricanes and flash floods may cause increases in infectious disease outbreaks through multiple ways:
 - Bring salt water organisms into water and food supply
 - Bring fresh water or soil organisms in as above
 - Sewage contamination due to overloaded sewers and storm drains, loss of power/pumps
 - Displaced animal vectors (rats)



- Salt water organisms
 - Vibrio—diarrheal illness, infected wounds
 - Aeromonas—bacteremia, infected wounds
 - Mycobacterium marinum—infected wounds
- Fresh water and soil organisms
 - Botulism—paralysis, death
 - Aeromonas
 - Pseudomonas
 - Amebiasis—diarrhea, anemia
 - Giardia—diarrhea
 - Legionella—pneumonia, death



- No access to clean water/sewage contamination
 - All of the above, especially Giardia, Amebiasis, Vibrio
 - Cryptosporidium
 - E coli (all forms including EHEC, HUS)--dysentery, shock
 - Shigella/Salmonella—dysentery, bacteremia
 - Typhoid—fever, bacteremia, death
 - Cholera (not unheard of)
 - Hepatitis A/E—liver disease
 - Norovirus—diarrhea



- Displaced animals—rats & other rodents in particular:
 - Plague
 - Hantavirus
 - Typhus
 - Salmonella
 - Rabies



Infectious Disease Issues Associated with Hurricane Katrina (HK)

Joe Posid

Centers for Disease Control and Prevention

- 6 cases of cholera
- 17 cases of other Vibrio (5 deaths)
- Norovirus
- E coli
- Salmonella

Flu & pneumonia (overcrowding of evacuees)



What can I do?



WHAT CAN YOU DO?

- Aside from drive a hybrid or electric, get solar panels, recycle, etc...
- Familiarize yourself with new and emerging infections like Lyme, Zika, Dengue, etc.
 - If you haven't seen them, you will
- Expect the usual suspects, but at unsuspected times
 - If it looks like Coxsackie virus in February, it still could be



WHAT CAN YOU DO?

- Consider patients post-flood, post-tornado, post-hurricane:
- Are they evacuees? Are they overcrowded?
- Do they have clean water? If not they should boil water if they can.
 - Or use portable pump filter or iodine—think like you would for travel medicine
- Consider odd organisms—legionella pneumonia, vibrio cellulitis, etc.
- Call your local ID Doc!



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THANK YOU

Questions?