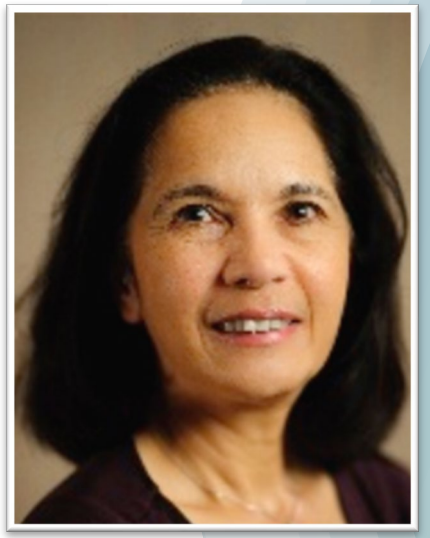
Disease & Invasive Vectors



Dr. Sandra Chang

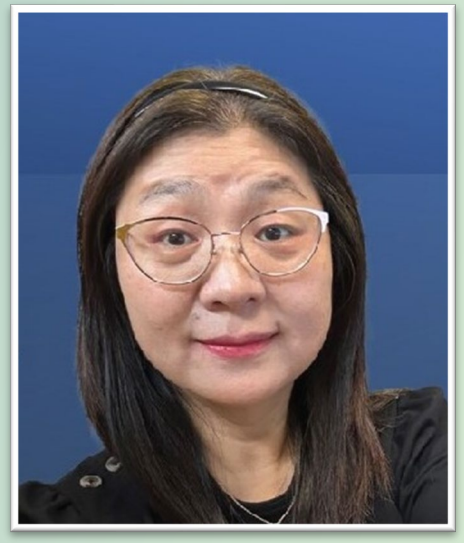
JABSOM

University of Hawaii at Manoa

Dr. Sarah Kemble

Hawaii Department of Health

Disease Outbreak Control Division



Dr. Jeomhee Hasty

Hawaii Department of Health

Vector Control Branch

Lirio Hittle

Climate Policy Strategist

Climate Change & One Health

Sandra P Chang, PhD
Professor of Tropical Medicine
John A Burns School of Medicine, University of Hawaii at Manoa

Presentation Topics

- One Health Overview
- Climate Change and Human Health
  - Lahaina Wildfire Disaster
  - Pandemic Potential of Avian Influenza
- Conclusions

What is One Health?

WHAT DO YOU THINK OF WHEN YOU HEAR THE PHRASE “ONE HEALTH”?

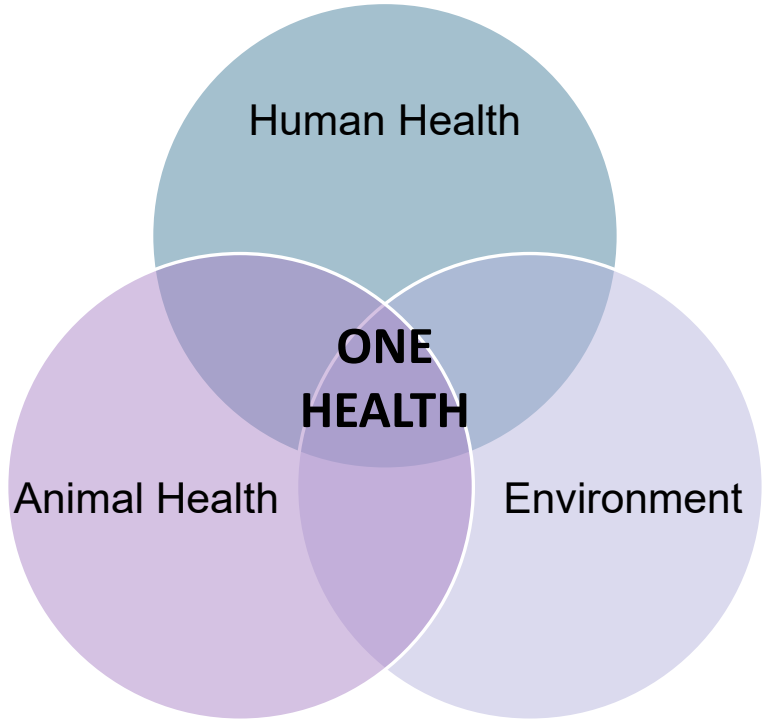
One Health is a **collaborative**, **multisectoral**, and **transdisciplinary** approach

— working at the local, regional, national, and global levels —

with the goal of achieving **optimal health outcomes** recognizing the interconnection between people, animals, plants, and their shared environment.

CDC definition

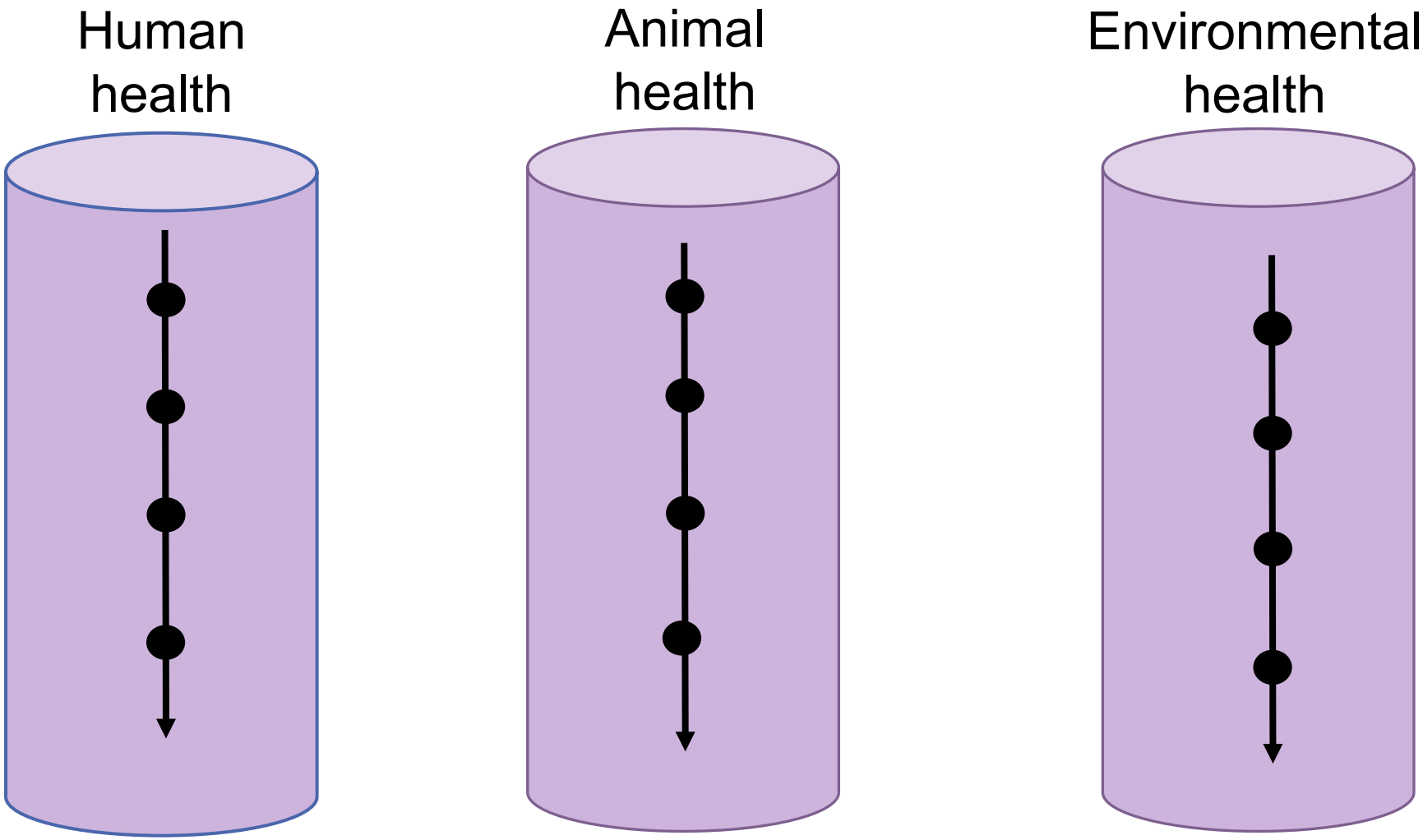
One Health recognizes that the health of people is connected to the health of animals, plants, and the environment.



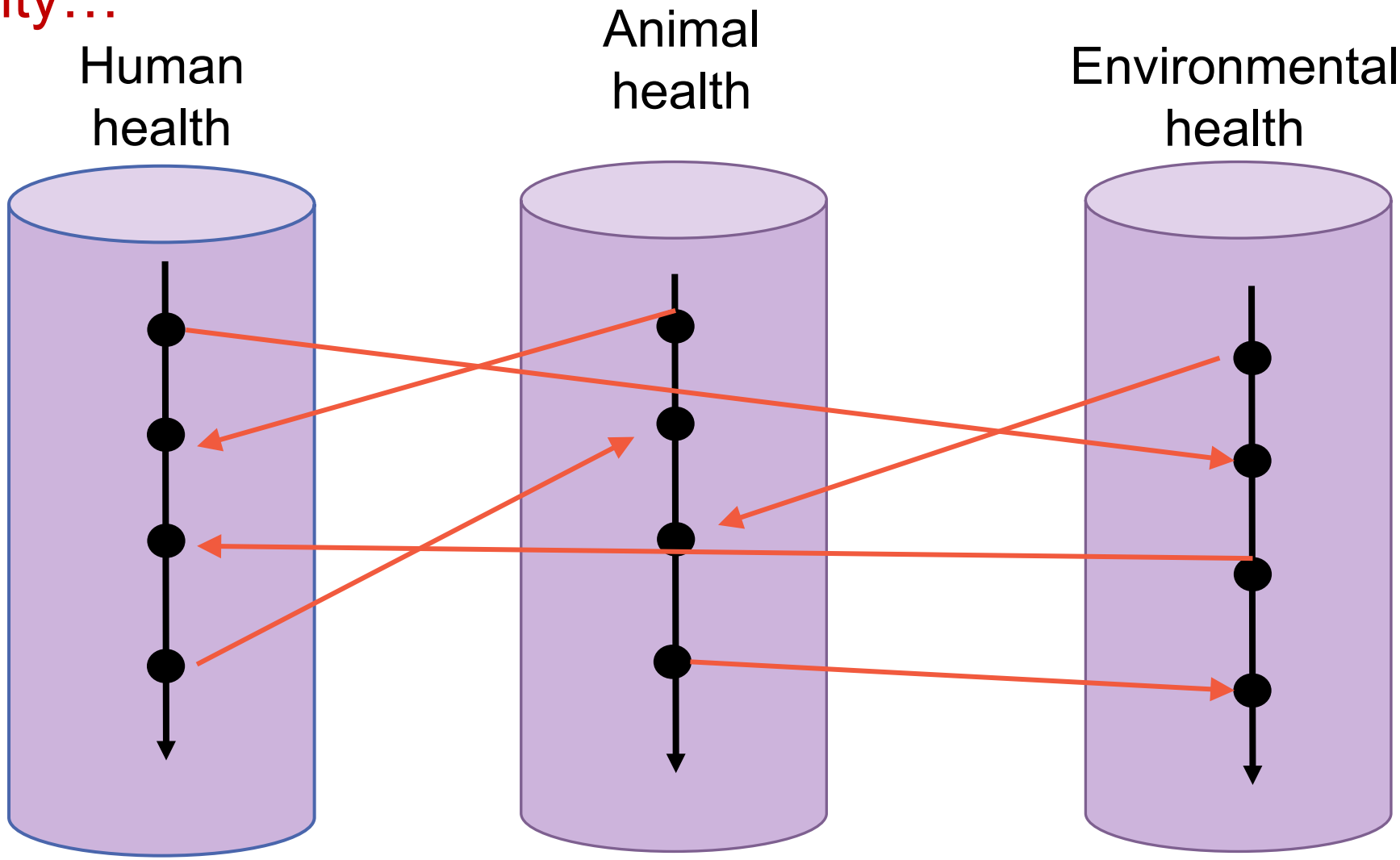
The One Health Triad

These are silos.

These are health silos.

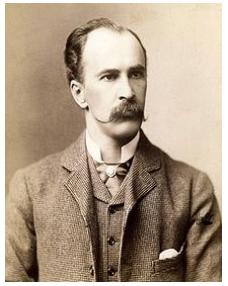


But in reality…



There are interrelationships between human, animal, and environmental health.

Brief History of One Health

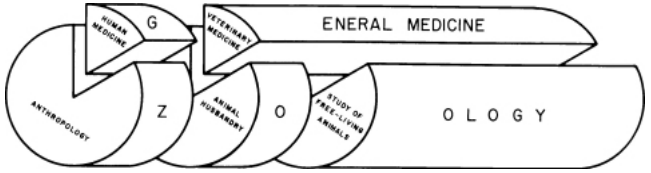


1849 - 1919
William Osler, MD, the Father of Veterinary Pathology

1821-1902
Rudolf Virchow, MD recognizes the link between human and animal health while studying the roundworm, Trichinella spiralis

1947
The Veterinary Public Health Division at CDC is established.

1960s
Calvin Schwabe, DVM, ScD, MPH, coins the term "One Medicine" and calls for a unified approach against zoonoses



2004
The Wildlife Conservation Society publishes the 12 Manhattan Principles

2009
USAID establishes the emerging pandemic threats program

2012
The Global Risk Forum sponsor the first One Health Summit

One Health Now

Food and Agriculture Organization of the United Nations

UN environment programme

World Health Organization

World Organisation for Animal Health
Founded as OIE

Quadripartite Joint Plan of Action

One Health Now

CDC One Health Office

- Established in 2009 within the National Center for Emerging and Zoonotic Infectious Diseases

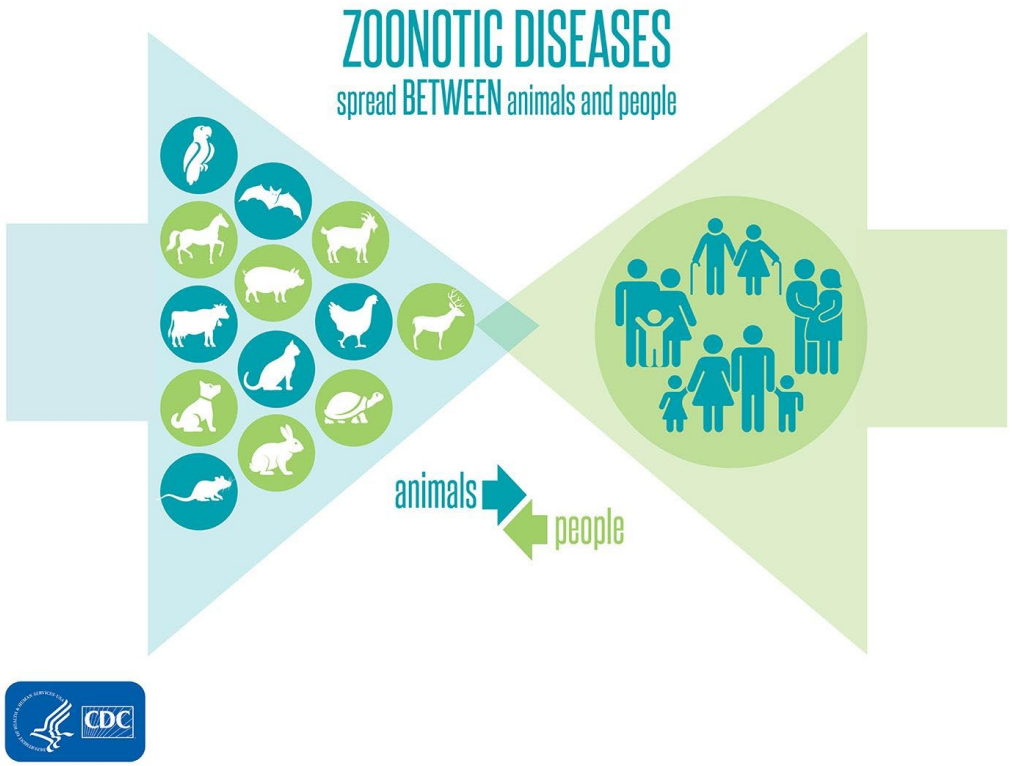
- Program Priorities
  - Zoonotic and emerging infectious diseases
  - Pandemic preparedness and response
  - One Health emergencies at the human-animal-environment interface
  - One Health pan-respiratory disease surveillance
  - Global health security & capacity building
  - Strengthen One Health coordination in US
  - Strategic One Health partnerships
  - Prevent zoonoses shared between people and pets

Zoonotic diseases are an important topic in One Health

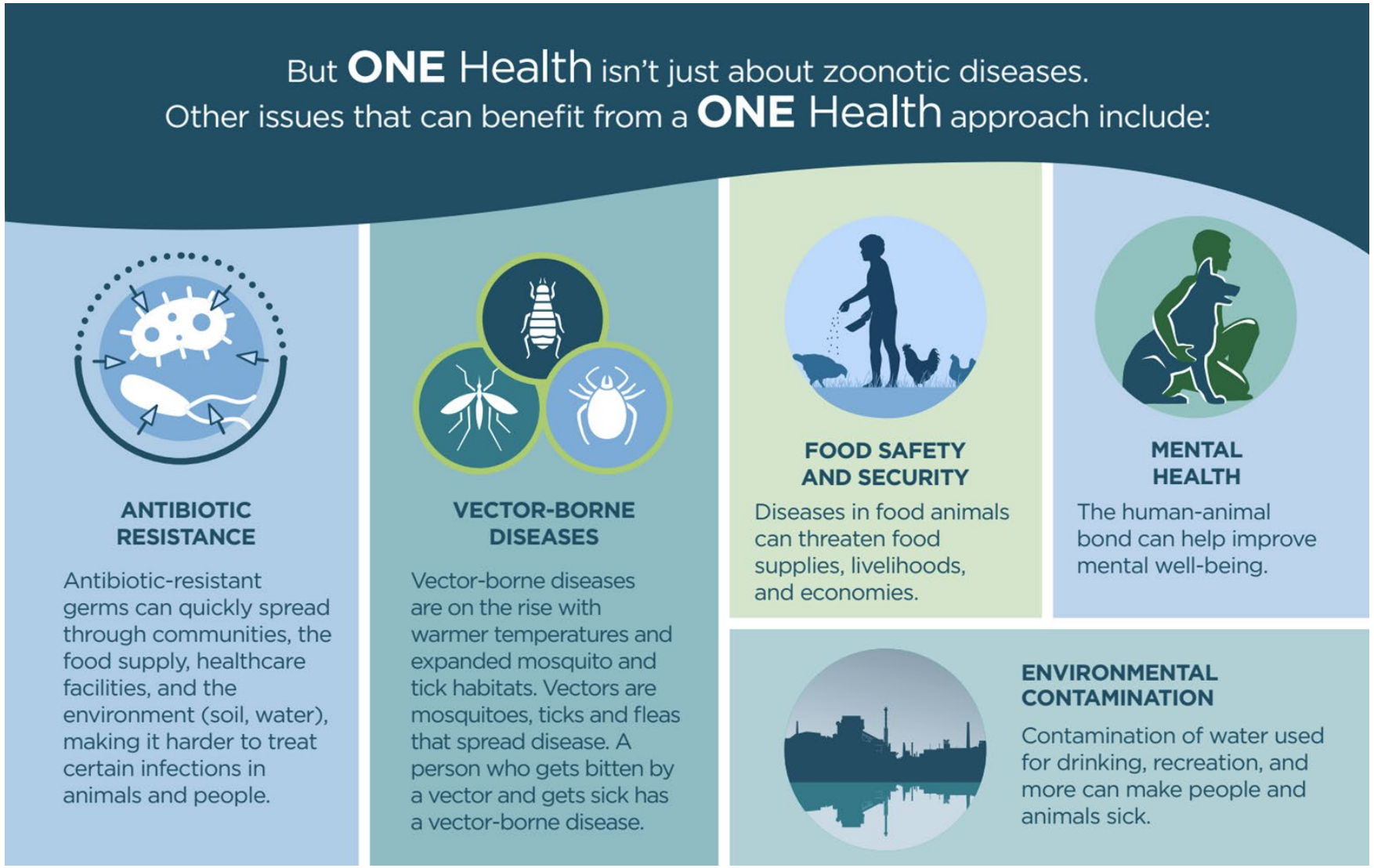
Zoonotic diseases are caused by harmful bacteria, fungi, viruses, or parasites that spread between animals and humans.

Examples of zoonotic diseases:

- Leptospirosis
- Influenza
- Coronaviruses such as SARS-CoV-2
- Salmonellosis
- Rabies
- Plague



More than 50% of all new or emerging diseases are zoonotic



Other areas include:

Animals as sentinels for environmental contaminants

Biodiversity maintenance

Agricultural production and land use

Plant and soil health

Water safety and security

Occupational health risks

Disease surveillance, prevention, and response

Many of these areas are impacted by climate change.

https://www.cdc.gov/onehealth/pdfs/why-one-health-is-important-P.pdf

Disease Drivers & Priority Sectors

Most common disease threats

- Emerging disease vectors
- Antimicrobial resistance
- Bioterrorism
- *Climate change*

Sectors prioritized for collaboration in One Health:

- Veterinary services
- Wildlife biologists, entomologists
- Transport
- Trade
- Media and communication
- Biosecurity
- Pharmaceutical industry
- Law enforcement, police, immigration
- Environmentalists (geological survey, land planning/development
- Civil society/community
- Risk management (insurance industry)
- Policymakers (federal, state, and local; NGOs)
- Data analysts (disease modeling)

Barriers and Areas of Improvement for One Health implementation in Public Health

Communication/coordination

- Surveillance and early warning systems across sectors
- Coordinated response plans
- Joint public outreach and education
- Identification of cross-sector contact points

Data/sample sharing

- Joint databases for data sharing
- Protocols and frameworks for sample sharing
- Improved testing procedures

Capacity building

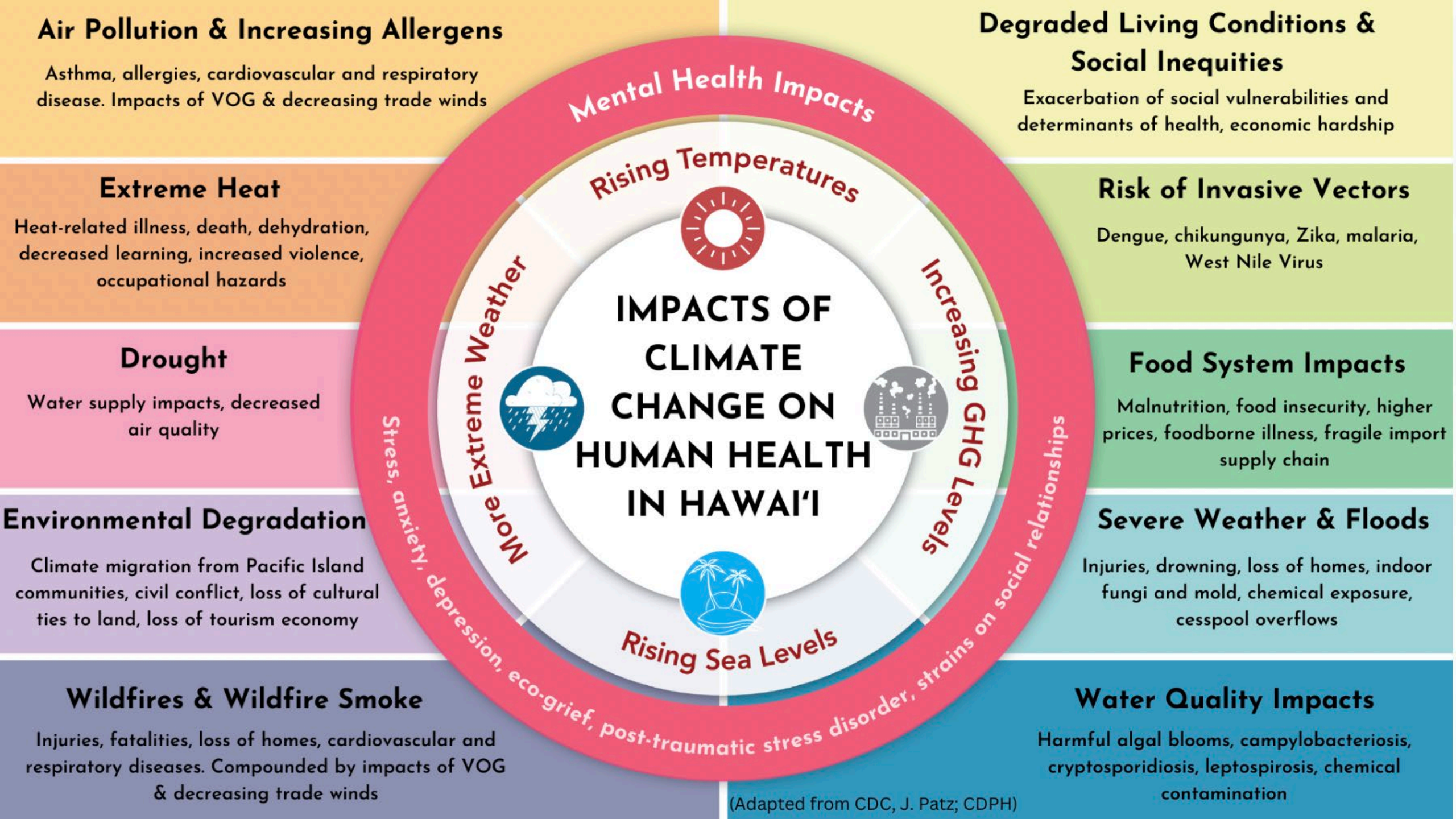
- Local human resources
- Reference laboratories

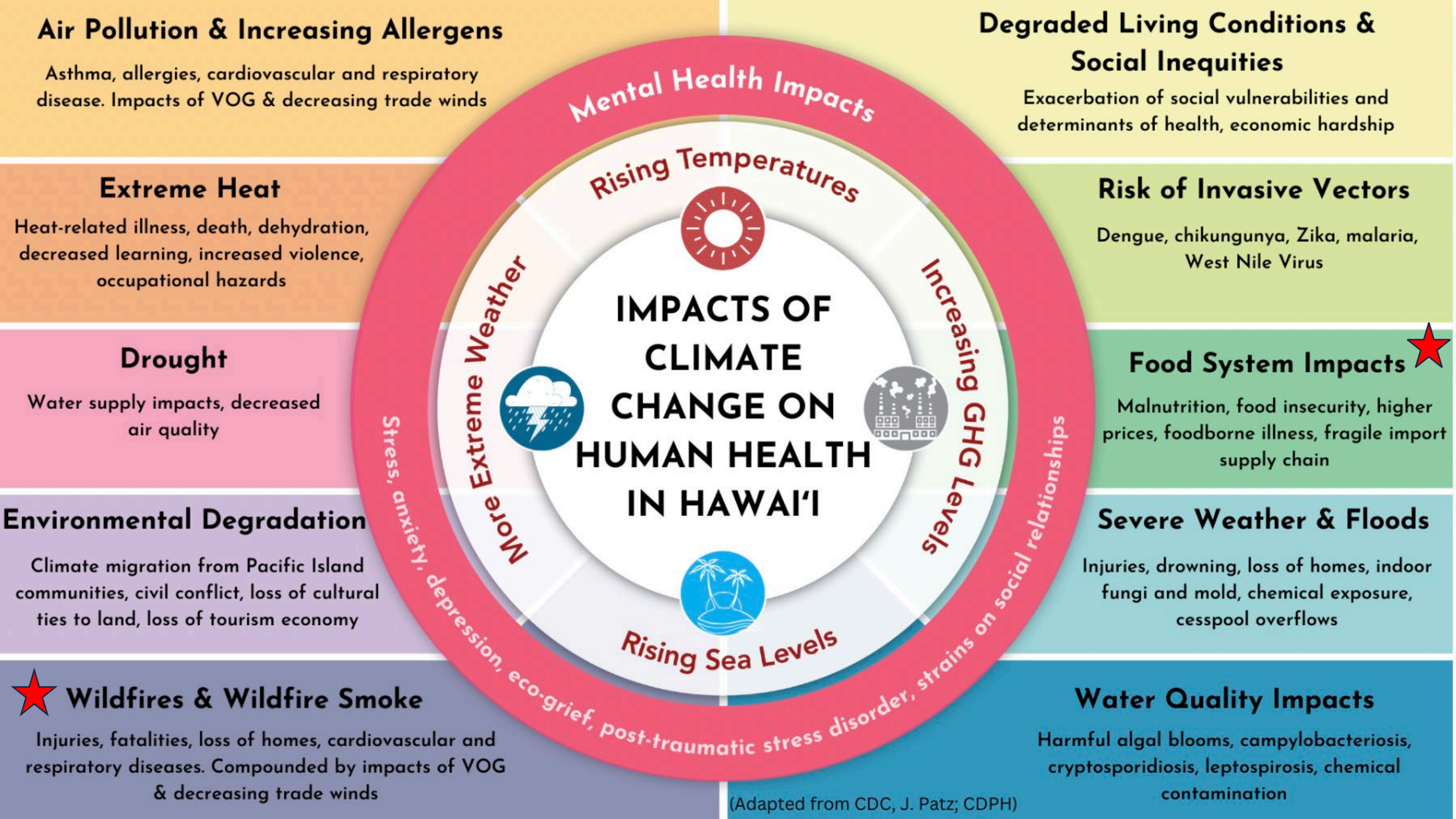
Risk perception

- Recognition of cultural differences
- Overlap of prediction modeling

Other barriers

- Financial responsibility
- Intellectual property
- Career constraints
- Leadership issues


Air Pollution & Increasing Allergens
Asthma, allergies, cardiovascular and respiratory disease. Impacts of VOG & decreasing trade winds
Degraded Living Conditions & Social Inequities
Exacerbation of social vulnerabilities and determinants of health, economic hardship
Extreme Heat
Heat-related illness, death, dehydration, decreased learning, increased violence, occupational hazards
Risk of Invasive Vectors
Dengue, chikungunya, Zika, malaria, West Nile Virus
Drought
Water supply impacts, decreased air quality
Food System Impacts
Malnutrition, food insecurity, higher prices, foodborne illness, fragile import supply chain
Environmental Degradation
Climate migration from Pacific Island communities, civil conflict, loss of cultural ties to land, loss of tourism economy
Severe Weather & Floods
Injuries, drowning, loss of homes, indoor fungi and mold, chemical exposure, cesspool overflows
Wildfires & Wildfire Smoke
Injuries, fatalities, loss of homes, cardiovascular and respiratory diseases. Compounded by impacts of VOG & decreasing trade winds
Water Quality Impacts
Harmful algal blooms, campylobacteriosis, cryptosporidiosis, leptospirosis, chemical contamination
Mental Health Impacts
Rising Temperatures
Increasing GHG Levels
Rising Sea Levels
More Extreme Weather
Stress, anxiety, depression, eco-grief, post-traumatic stress disorder, strains on social relationships
IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN HAWAI'I
(Adapted from CDC, J. Patz; CDPH)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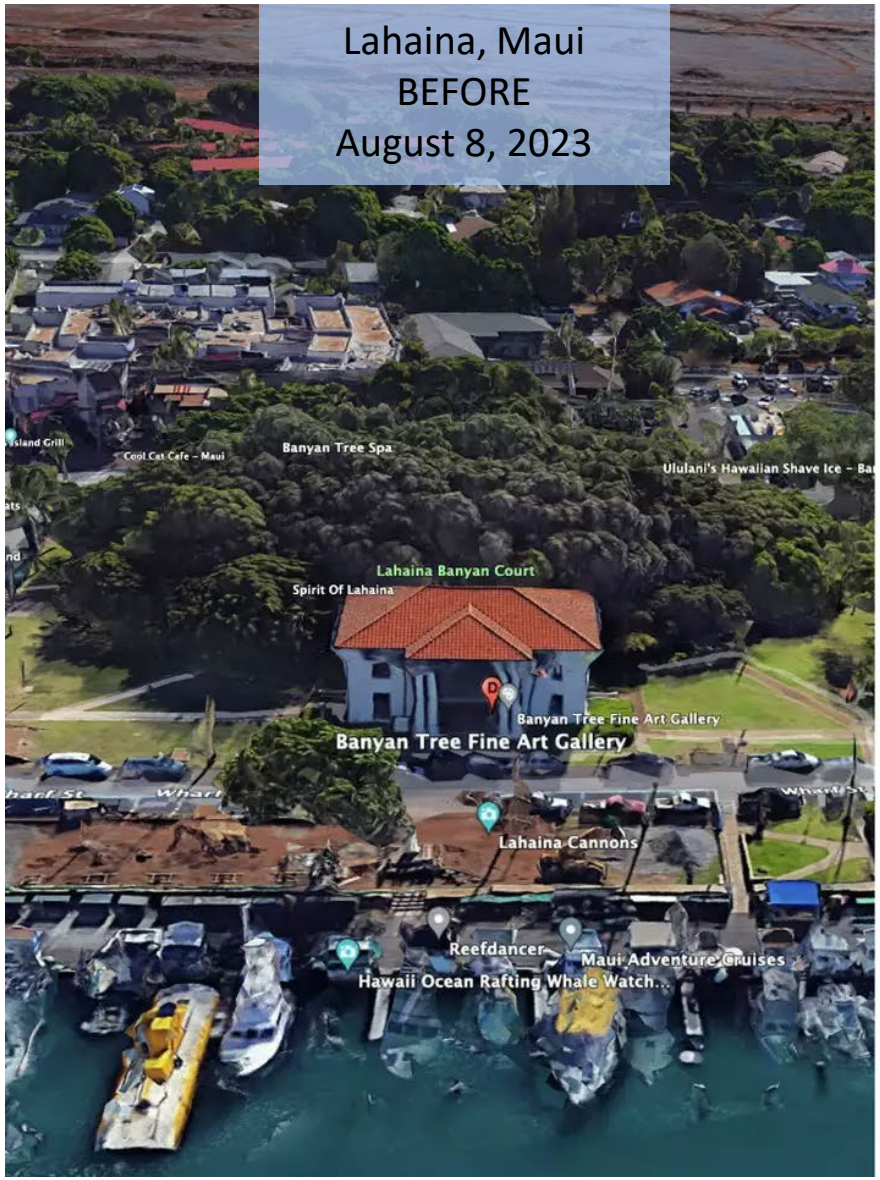
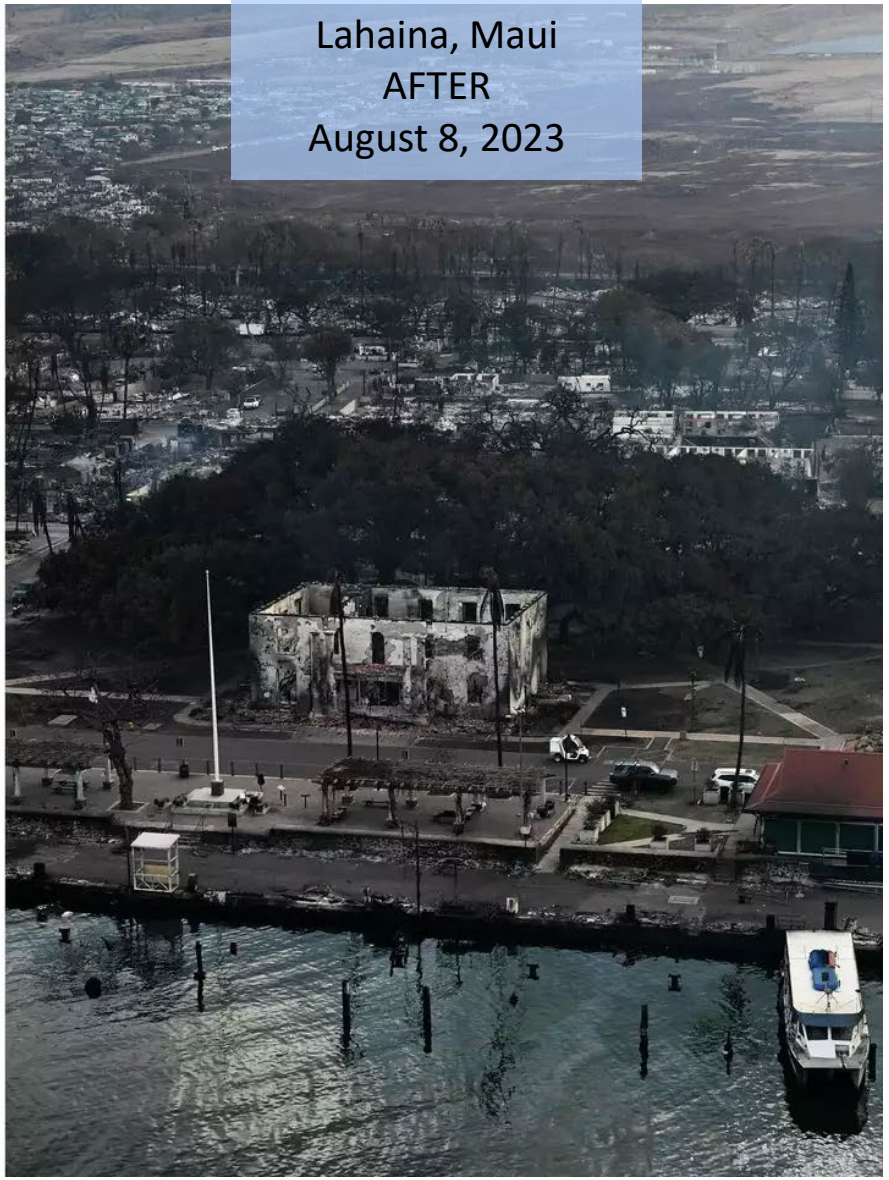
IMPACTS OF CLIMATE CHANGE ON HUMAN HEALTH IN HAWAI'I
(Adapted from CDC, J. Patz; CDPH)

Consequences of Climate Change

- ***Global temperature rise*** – Earth's surface temperature has risen about 2 degrees Fahrenheit since the late 19th century
- ***Warming ocean*** – The top 100 meters show warming of more than 0.6 degrees Fahrenheit
- ***Sea level rise*** – The sea level rose about 8 inches in the last 100 years.
- ***Extreme weather events*** – Record high temperature events, droughts, and intense rainfall events.
- ***Ocean acidification*** – Acidity of the surface ocean waters has increased by about 30%. More CO_2 in the atmosphere, more absorbed into the ocean (soluble form = carbonic acid, H_2CO_3).

Climate change drivers: Severe Drought, Weather Events, and Wildfires





Google Earth Pro / Getty Images

Impact of Lahaina Wildfires

- More than 100 lives lost, over 2,000 homes destroyed, $5.5 billion in damages
- Severe impact on tourism, largest sector of Maui economy
- Loss of employment and increase in homelessness
- Health impacts
  - Respiratory issues, increased cardiovascular disease
  - Mental health impact (Post-traumatic stress disorder (PTSD), depression, anxiety)
  - Poor access to medical care
  - Food insecurity
- Cultural loss due to destruction of historical sites and cultural artifacts
- Environmental toll on impacted land, native forests, soil, coastal marine ecosystems
- 3,000 animals lost or displaced by wildfires

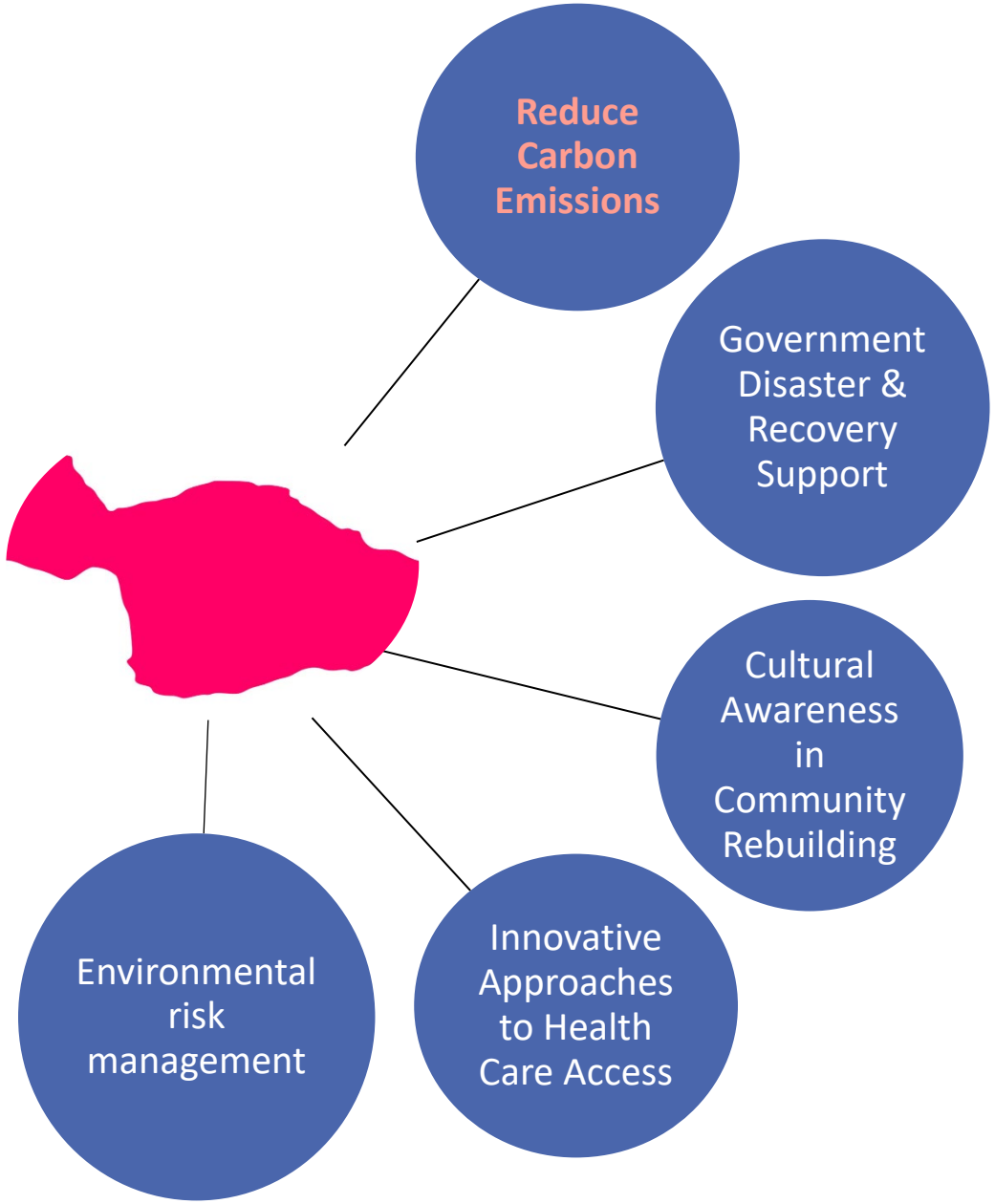
A man mourns after the historic banyan tree was damaged by a blaze on 11 August 2023.

Laihana, Maui, lost around 25,000 trees in a blaze last year, but this beloved banyan tree is now thriving. Photograph: Lindsey Wasson/AP

Recovery of 151-year old banyan tree in Lahaina one year after Maui wildfires. (The Guardian, AP, 7 Aug 2024)

Recovery from Maui Wildfires

- One Health Aspects of Maui Recovery
  - Climate change mitigation approaches to reduce drought and wildfire emergencies
  - State & federal support for wildfire recovery
    - Debris removal and disposal, provide temporary housing, rebuild schools and infrastructure
    - Provide individual assistance for housing and other needs
    - Crisis counseling and disaster assistance
    - Provide financial support to businesses
  - Community rebuilding approach that takes into consideration the **cultural values** of the Maui community
  - Engagement with community to **build consensus** on Maui redevelopment plan
  - Application of technology and telehealth to improve access to medical care, including mental health care, and social services
  - Environmental and other scientists to assess environmental health risks, impacts of recovery, and risk management to prevent future wildfires



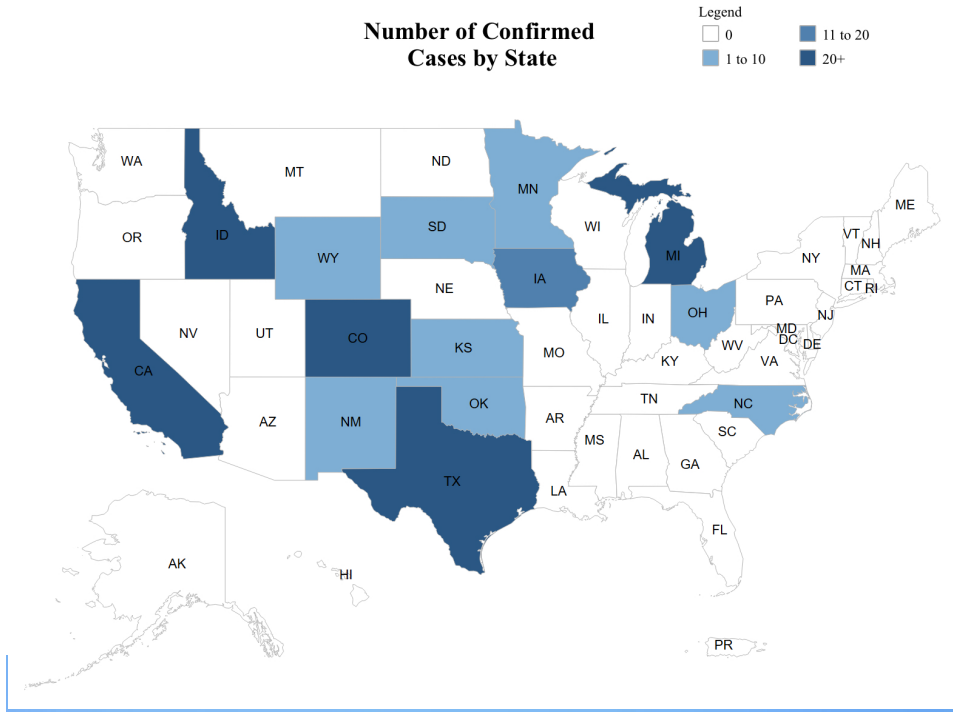
Holliday et al., Hawaii J Health Soc Welf. 2024 Mar;83(3):85-87

Avian Influenza (H5N1 Bird Flu)

Preventing the Next Pandemic

Avian influenza A (H5N1)

- Current US multistate outbreak in dairy cows, poultry and other animals
  - 305 dairy cow herds in 14 states have confirmed H5N1
    - H5N1 has been detected in raw milk but is killed by pasteurization
  - 100 million poultry affected by H5N1 (48 states)
    - 509 commercial flocks
    - 669 backyard flocks
  - 9,715 wild birds detected with H5N1 – probable source of H5N1
- 27 human cases reported in 2024
  - 17 cases associated with exposure to sick dairy cows
  - 9 cases associated with exposure to H5N1-infected poultry
  - No cases to date associated with human-to-human transmission
- CDC surveillance – human health risk low
  - Full genomic sequencing of H5N1 from human cases by CDC
  - So far, viruses maintain genetic characteristics associated with avian virus,
  - Do not have changes associated with increased disease severity or person-to-person transmission in humans

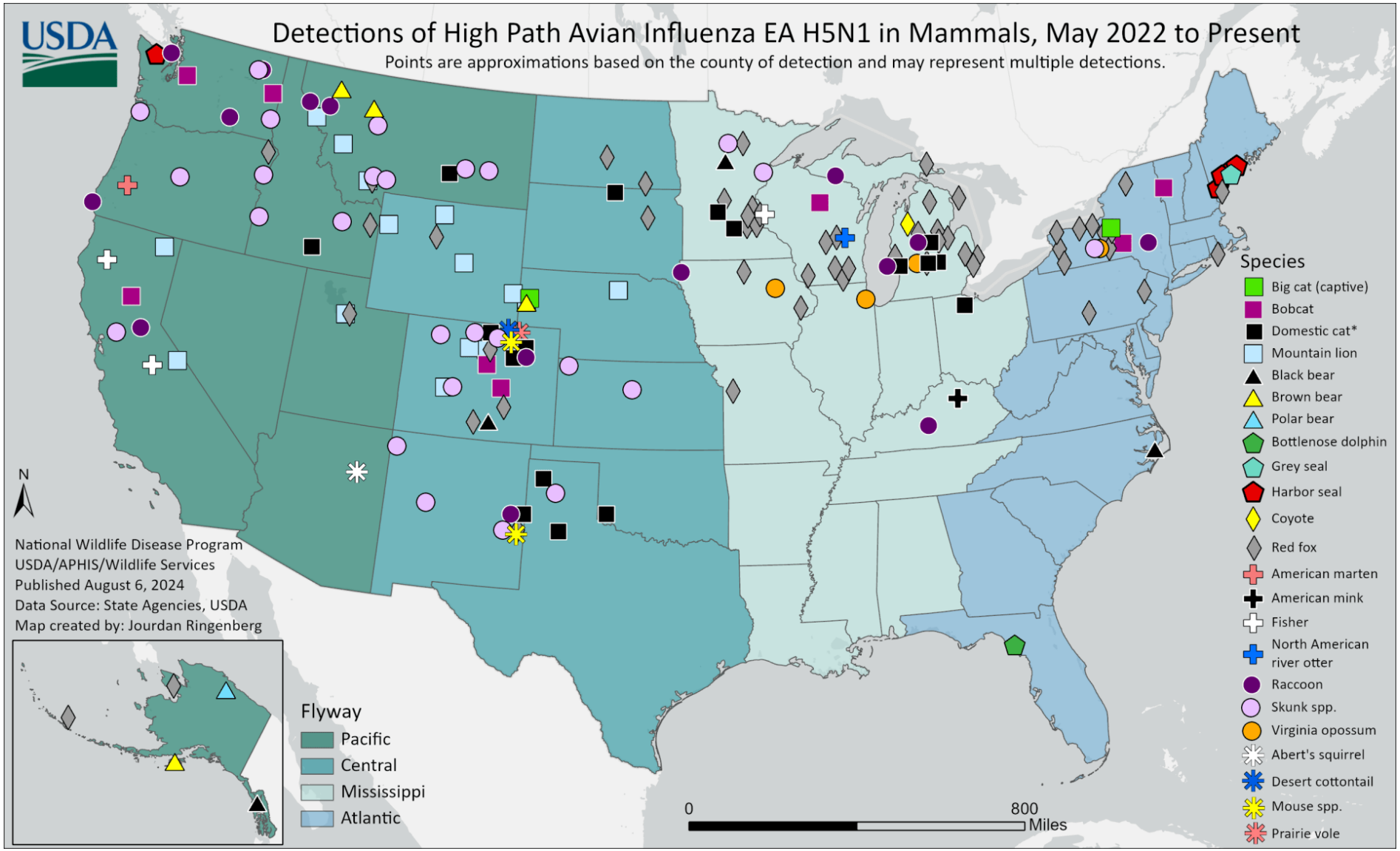


Avian influenza A (H5N1)

- Protection of farmworkers at increased H5N1 risk (CDC)
  - National Center for Farmworker Health
    - Outreach and education on farmworker safety and health
    - Seasonal flu vaccines to livestock, dairy, and poultry workers
      - **Prevent seasonal flu among workers**
      - **Prevent the possibility of emergence of recombinant virus between H5N1 and seasonal flu in farms**
  - Seroprevalence studies among farmworkers in Colorado, Michigan
- USDA
  - Support diary industry to stop spread of H5N1
    - Support biosecurity planning on farms
    - Reimburse costs for H5N1 testing
    - Compensate producers for loss of milk production
- Recommendations for general population
  - Avoid exposures to sick or dead animals
  - Do not drink raw milk; pasteurized milk is safe
  - People with job-related contact with potentially infected animals should take proper precautions

Impact on Animals:

H5N1 infects a wide range of domestic animal and wildlife species



H5N1 Avian Influenza Epidemic

- Avian influenza epidemic endangers multiple species
  - Avian influenza historically associated with migratory birds that cross paths with domestic poultry
  - *Climate change is affecting migration patterns of migratory birds, increasing interactions with other species*
    - 2021 – more than 53 million avian deaths
      - First mass death in cranes in northern Israel
    - Many mammals are also dying of the disease
      - Hundreds of dead or dying sea lions in Peru
- Prevention of an H5N1 or another future pandemic requires a One Health approach leveraging all government, commercial, public health, and community sectors

Summary

- The One Health approach, which recognizes the interconnection between people, animals, plants, and their shared ecosystem, is necessary to address many of today's public health challenges.
- Many of the areas identified as One Health priorities are affected by climate change
- The immediate and long-term responses to a disaster such as the Maui wildfires have required coordination, communication, and collaboration between multiple sectors
- Prevention of the next pandemic will require a One Health approach

climatehealthhawaii.org/

Mission

Research + communicate the human health impacts of climate change

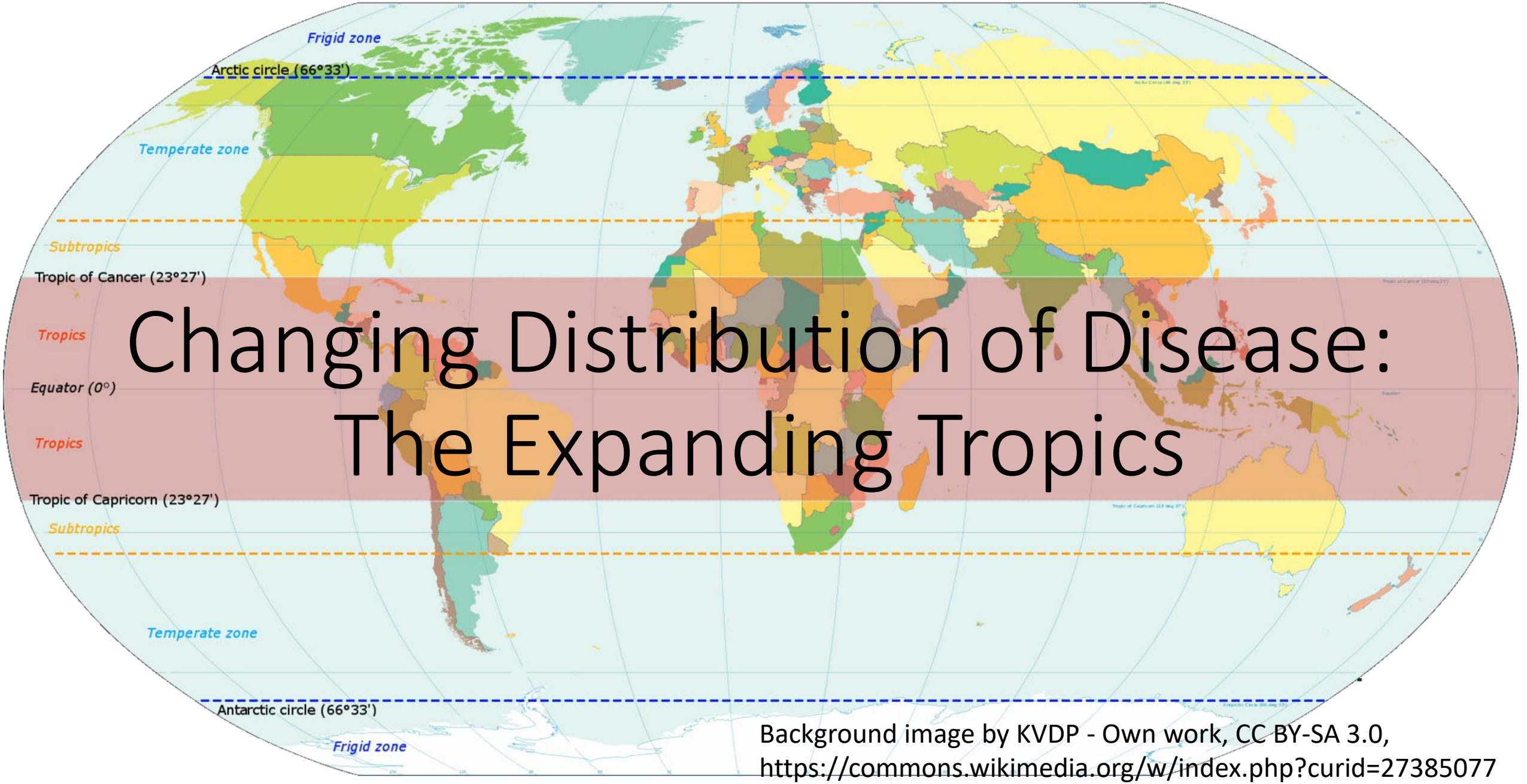
Advocate for policy solutions

Wide range of expertise, backgrounds, and community engagement

Prioritize our most at-risk community members

Climate and Public Health Impacts

Sarah Kemble, MD
Hawaii State Department of Health
Climate Change and Health Conference
October 24, 2024



Changing Distribution of Disease: The Expanding Tropics

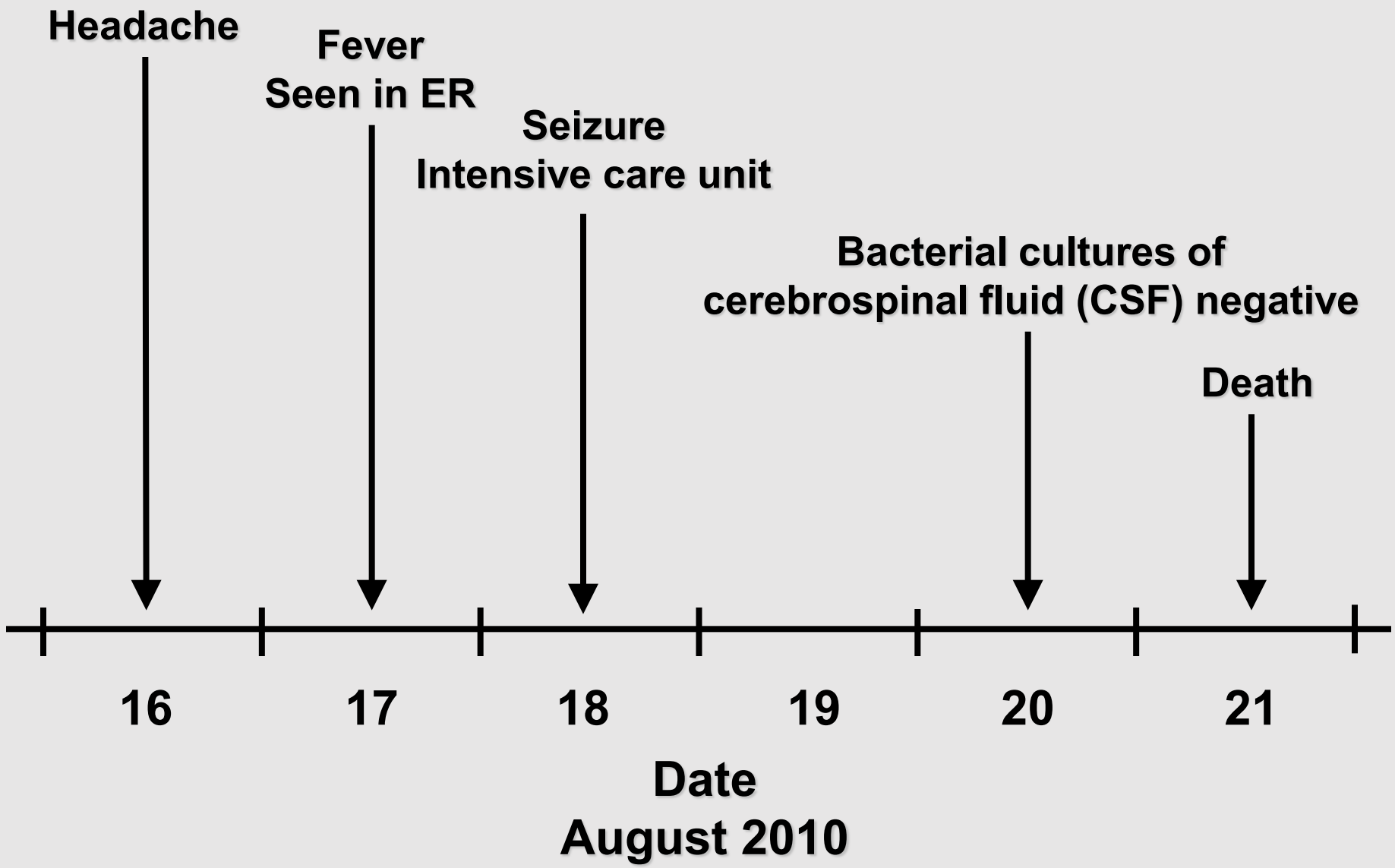
The Changing Geographic Range of Primary Amebic Meningoencephalitis – Minnesota, 2010

Sarah Kemble, MD

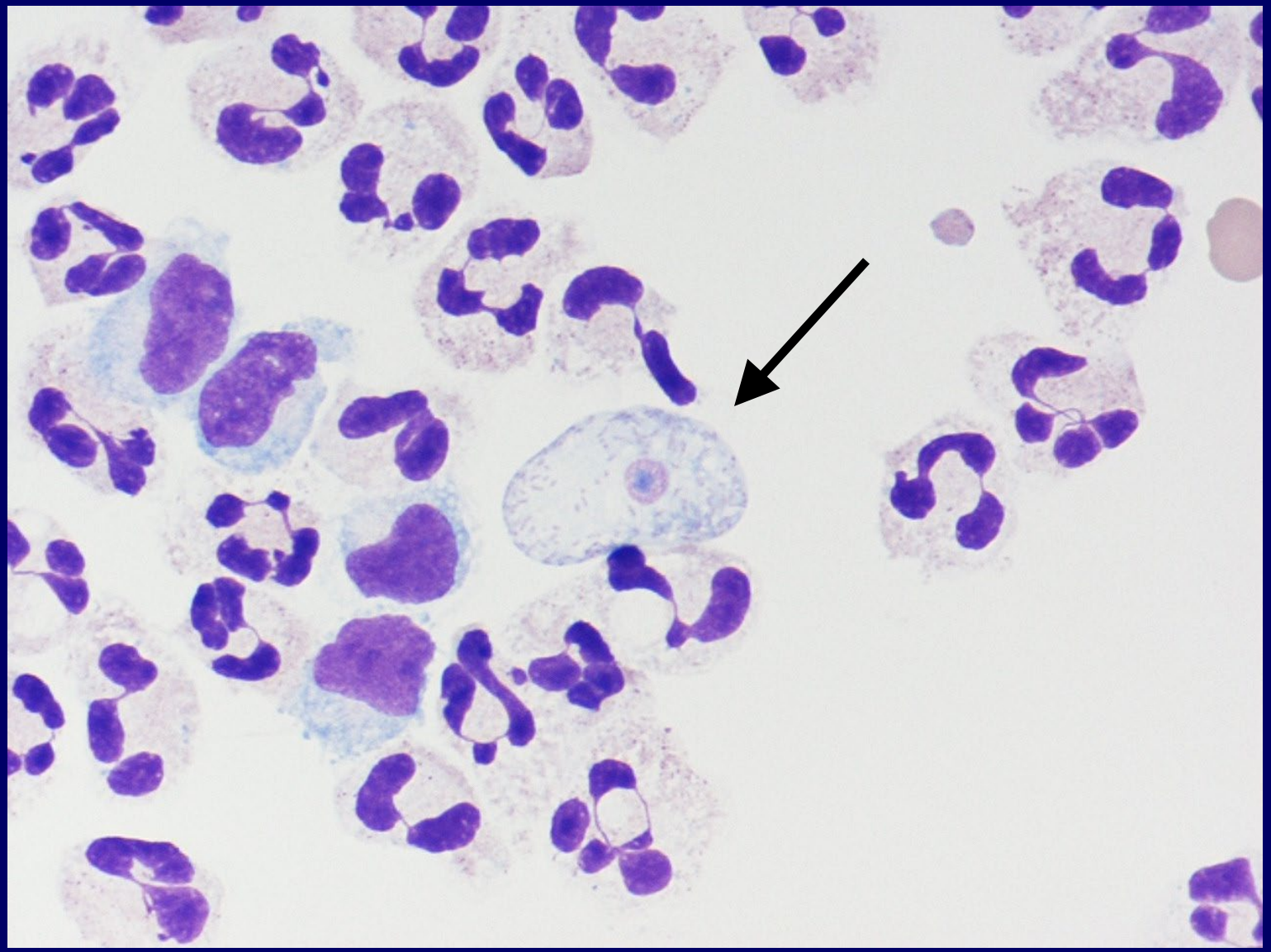
Minnesota Department of Health

EIS Field Assignments Branch

Clinical Course of Illness in 7-Year-Old Girl

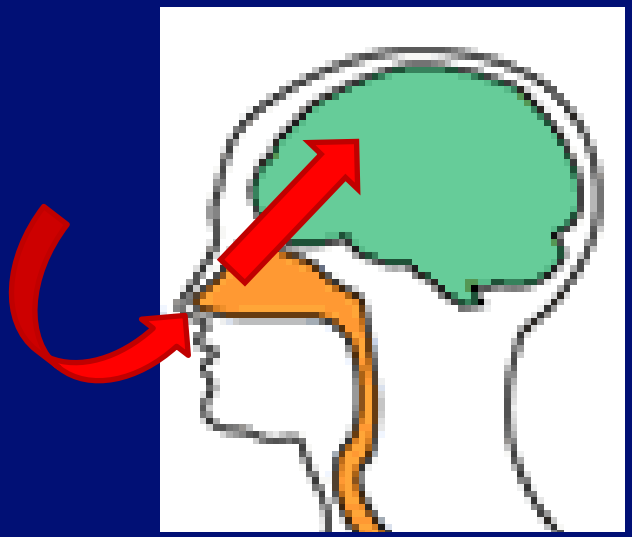


Wright's Stain of CSF from Patient

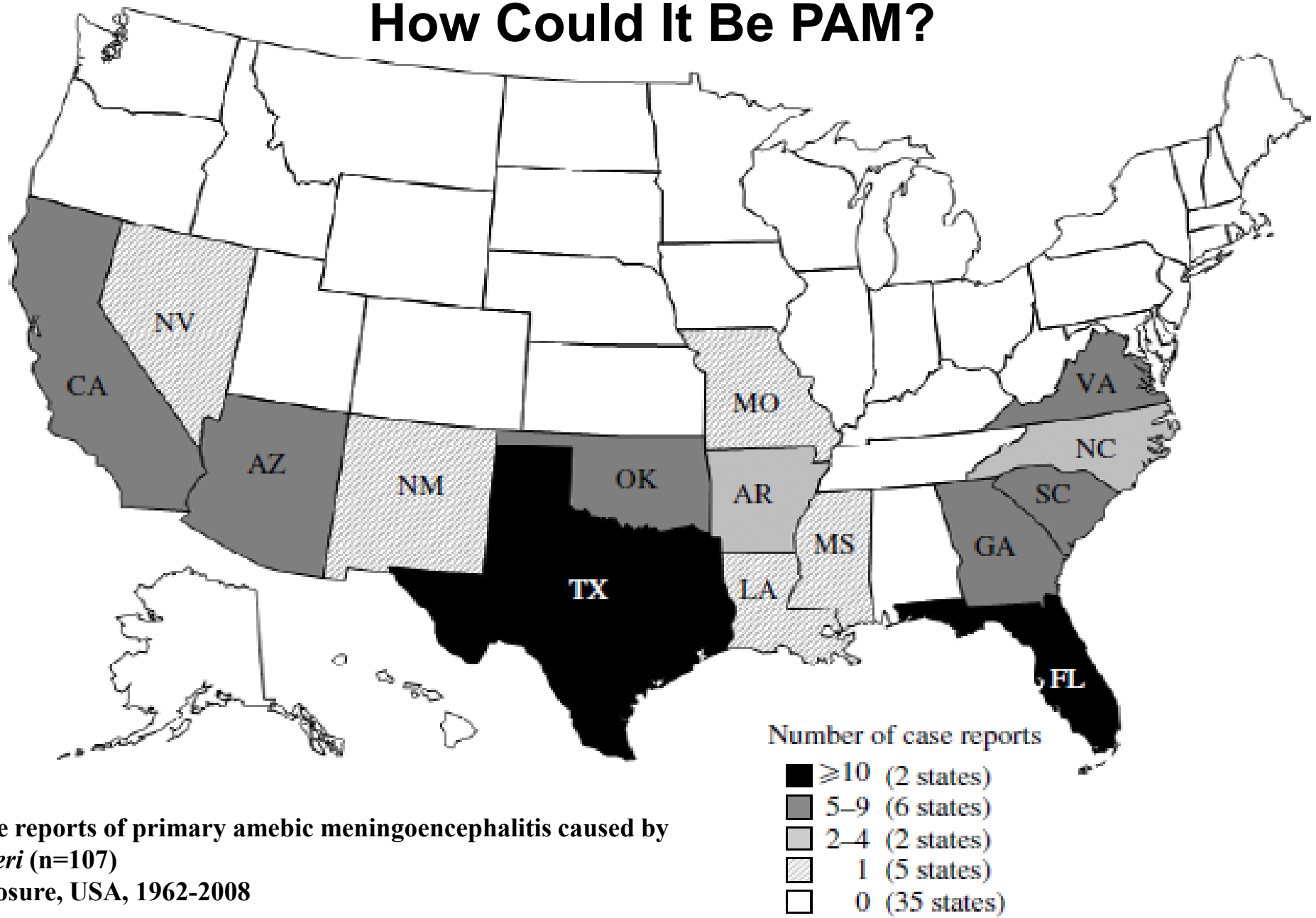


Naegleria fowleri

- Thermophilic, free-living ameba (FLA)
- Fresh water
- Proliferates above 30º C (86º F)
- Introduced into nose during activities in water
- Can migrate up olfactory nerve to brain
- Primary amebic meningoencephalitis (PAM)
- 111 cases in United States 1962–2008
  - 1 survived

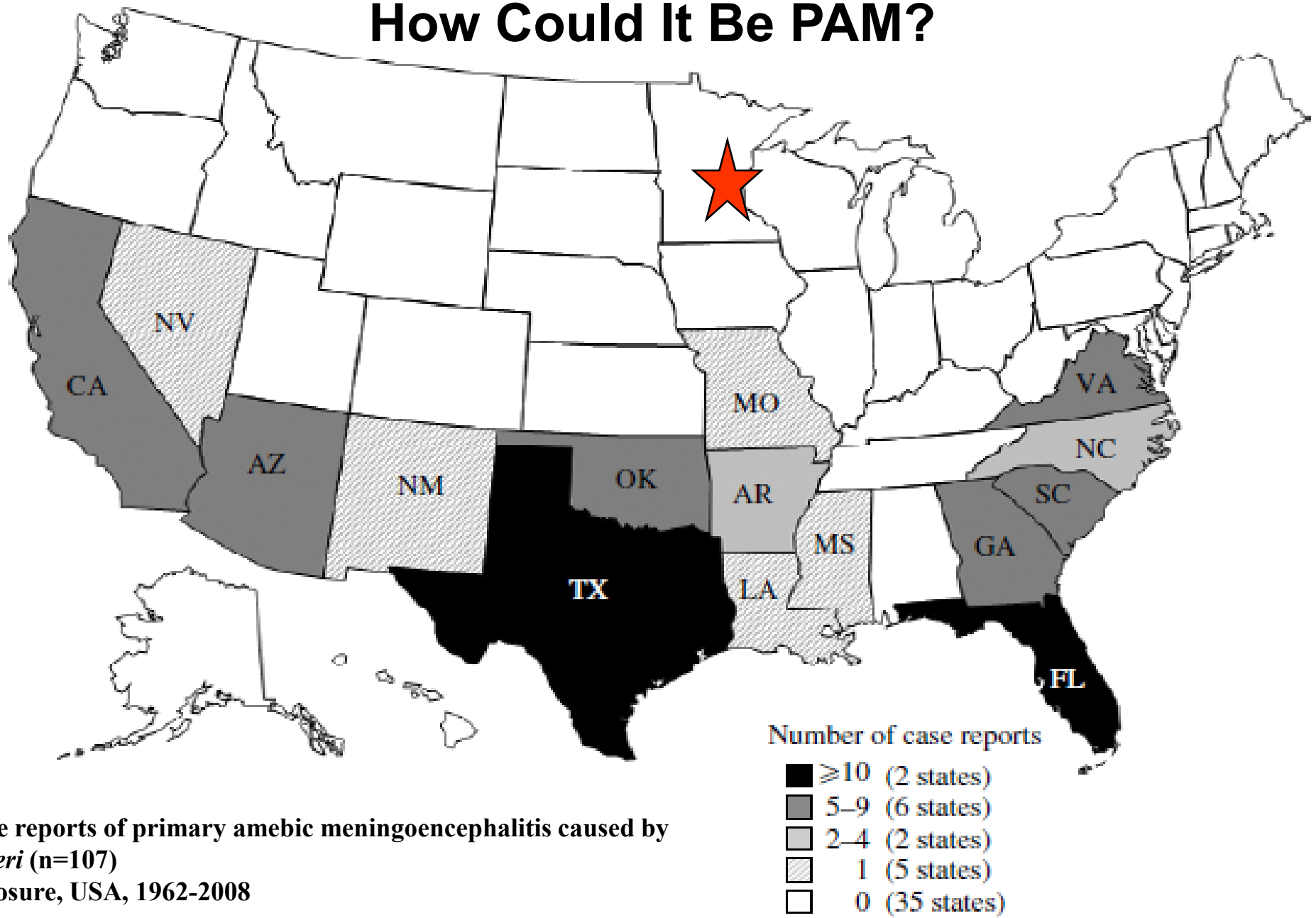


How Could It Be PAM?



Number of case reports of primary amebic meningoencephalitis caused by *Naegleria fowleri* (n=107) by state of exposure, USA, 1962-2008

How Could It Be PAM?

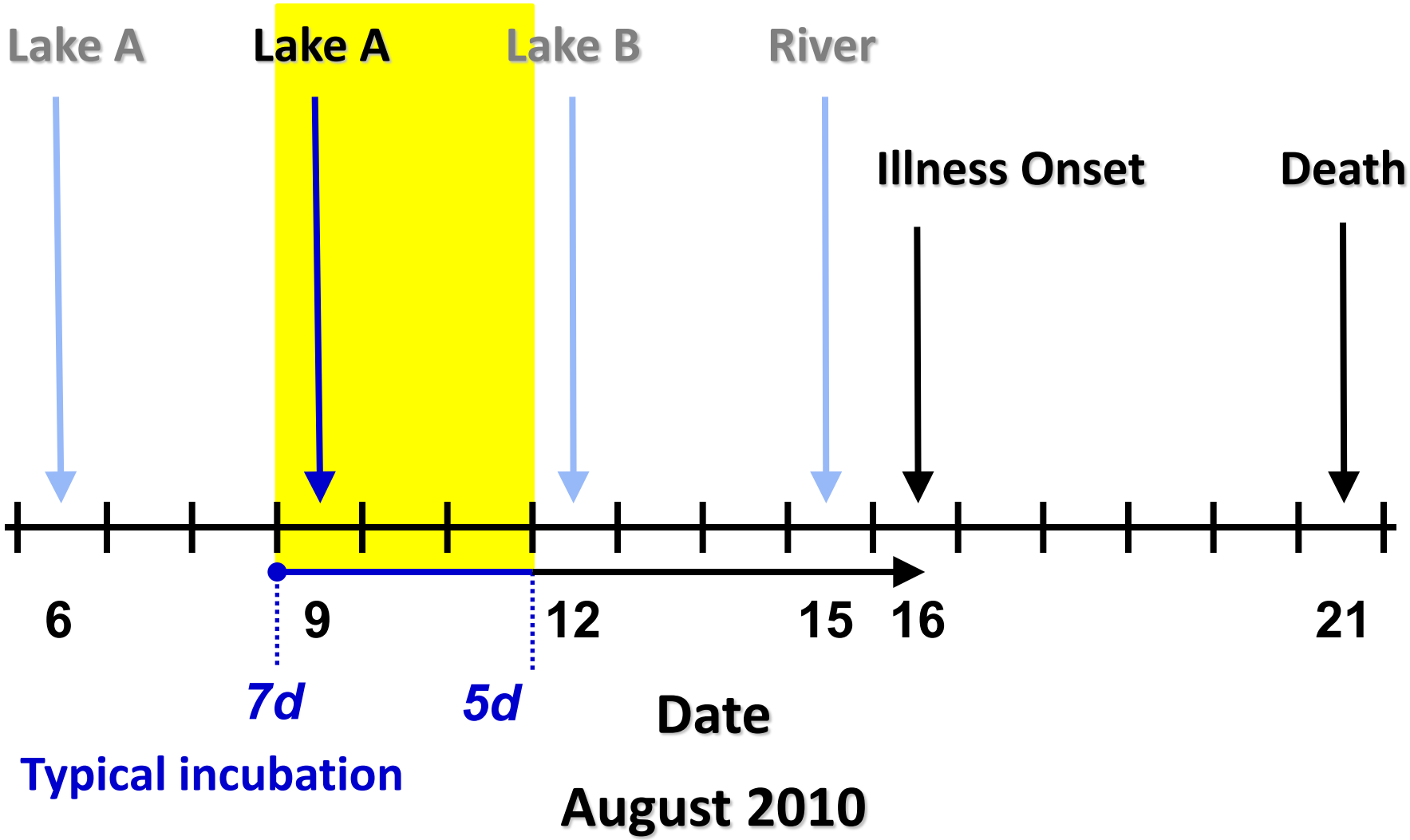


Number of case reports of primary amebic meningoencephalitis caused by *Naegleria fowleri* (n=107) by state of exposure, USA, 1962-2008

Patient History

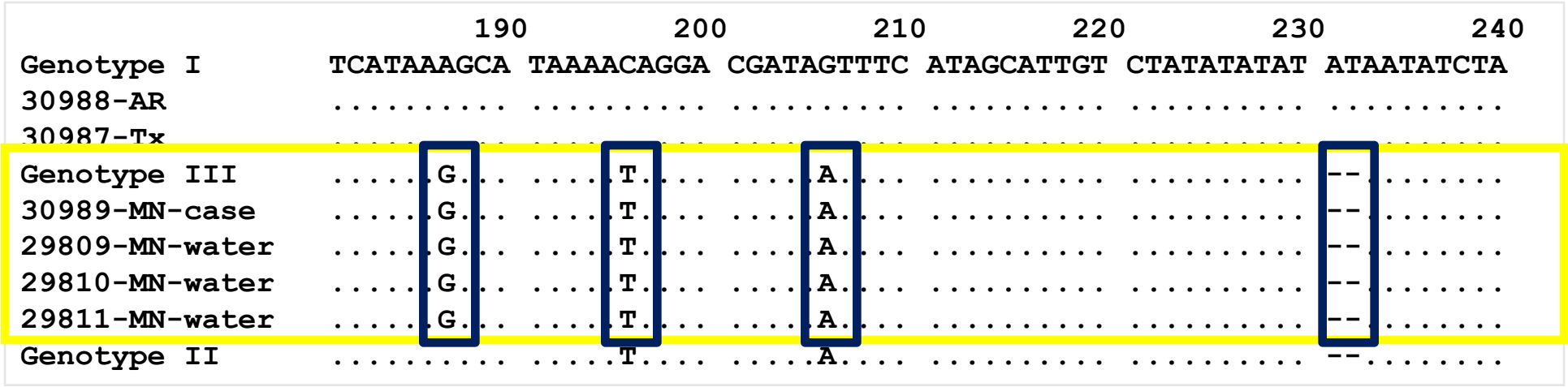
- Previously healthy 7-year-old
- No travel outside Minnesota in month prior to illness
- Frequent swimming outings for several hours
  - Practiced handstands underwater
  - Parents reported water very warm

Timeline of Swimming Exposures and Illness



Lake A
Organic Matter and Algal Bloom

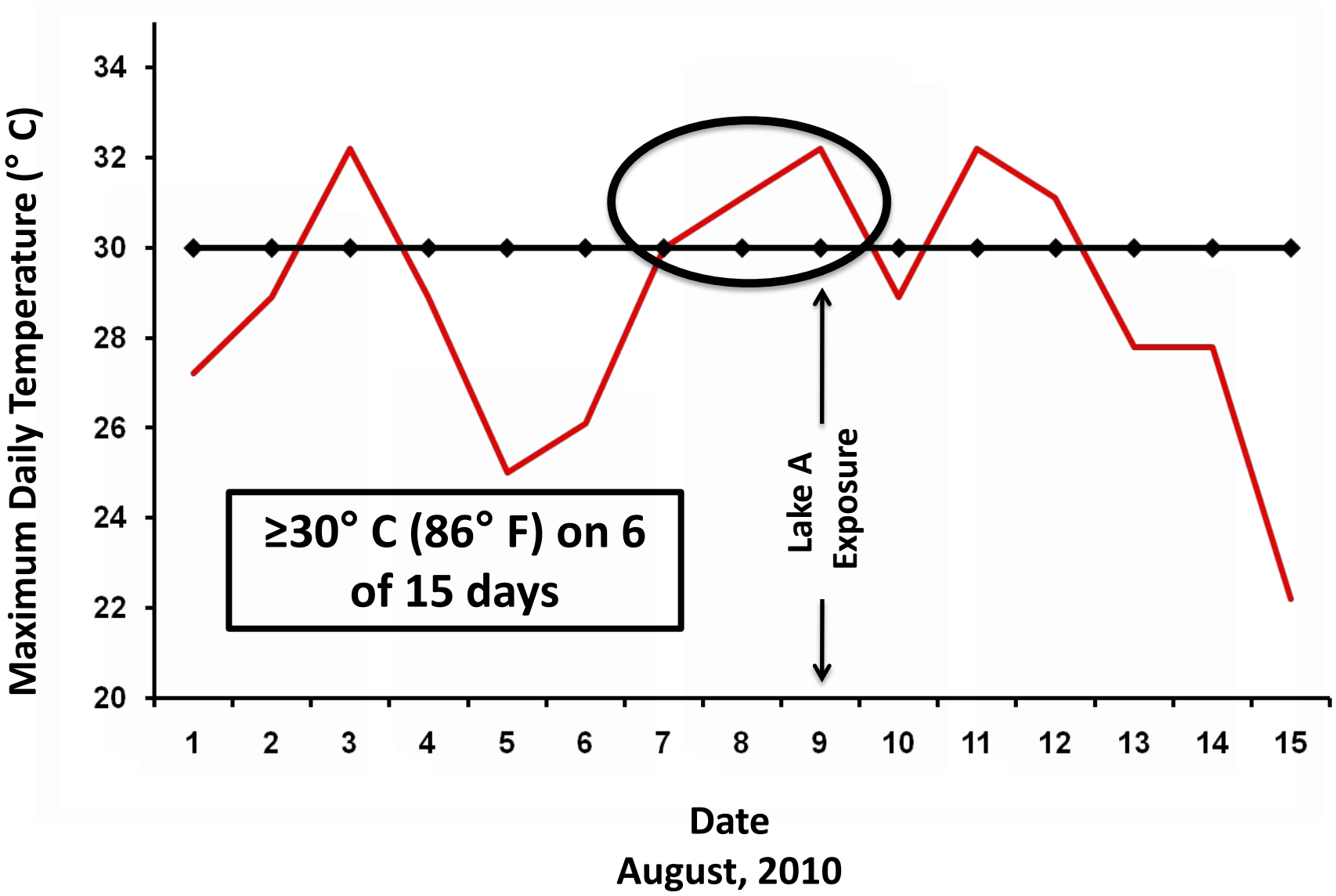
Genotyping of *N. fowleri* in Minnesota Case Patient and Water Samples



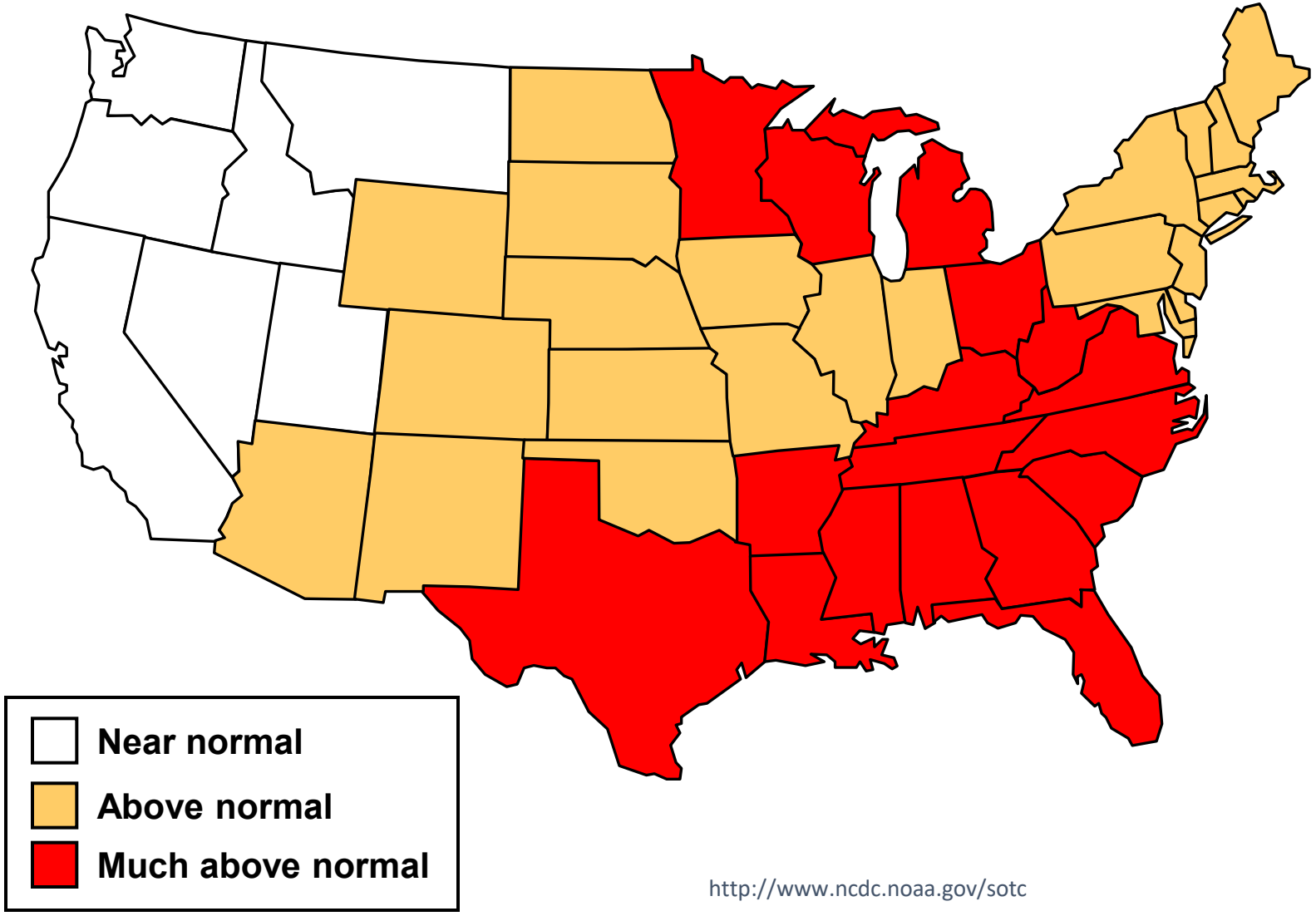
Why is *N. fowleri* Causing Illness in Minnesota?

- Ambient temperature data from weather station near Lake A
- Historic temperature data for Minnesota

Daily Maximum Air Temperature near Lake A Prior to Illness Onset, August 1-15, 2010



Minnesota's Temperature was "Much Above Normal" in August 2010



http://www.ncdc.noaa.gov/sotc

Conclusions

- *N. fowleri* is in Minnesota and has caused disease
- Northernmost PAM case in United States by 550 miles
- Warmer temperatures could have resulted in northward expansion of PAM cases

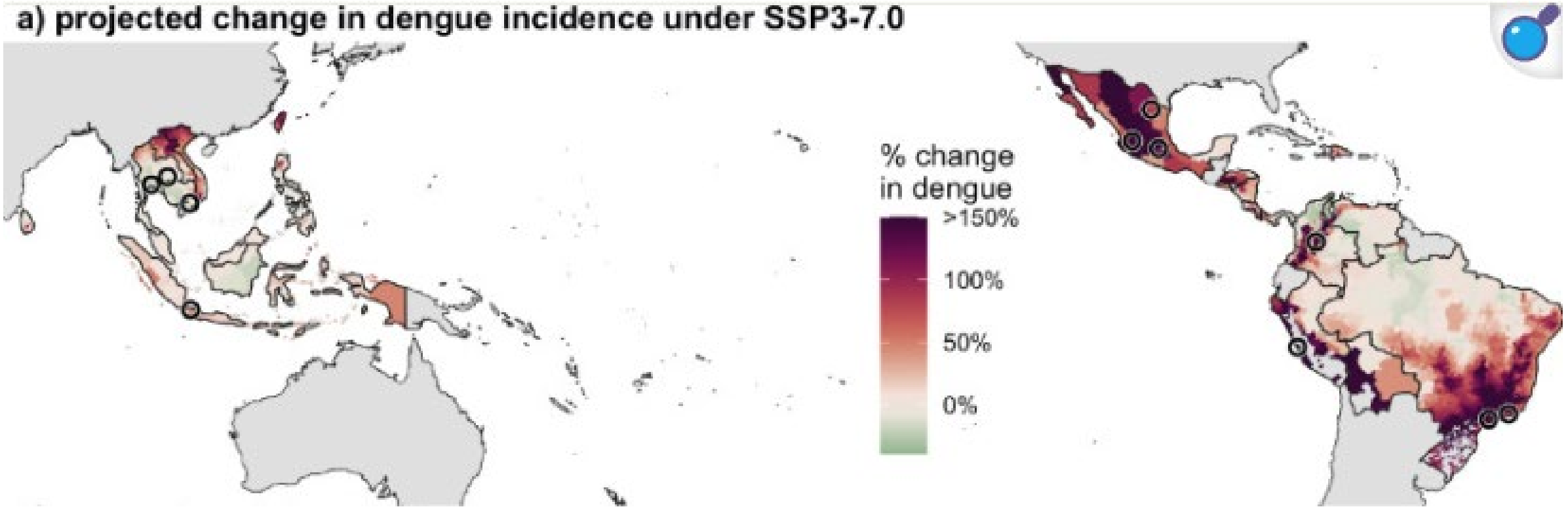
Dengue reaching record numbers worldwide

According to the CDC,

- In 2024, over 11 million cases of dengue have been reported in North, Central, and South America and the Caribbean
- Outbreaks in areas where dengue is common has increased the number of cases in travelers to those areas and may result in small outbreaks in the continental United States

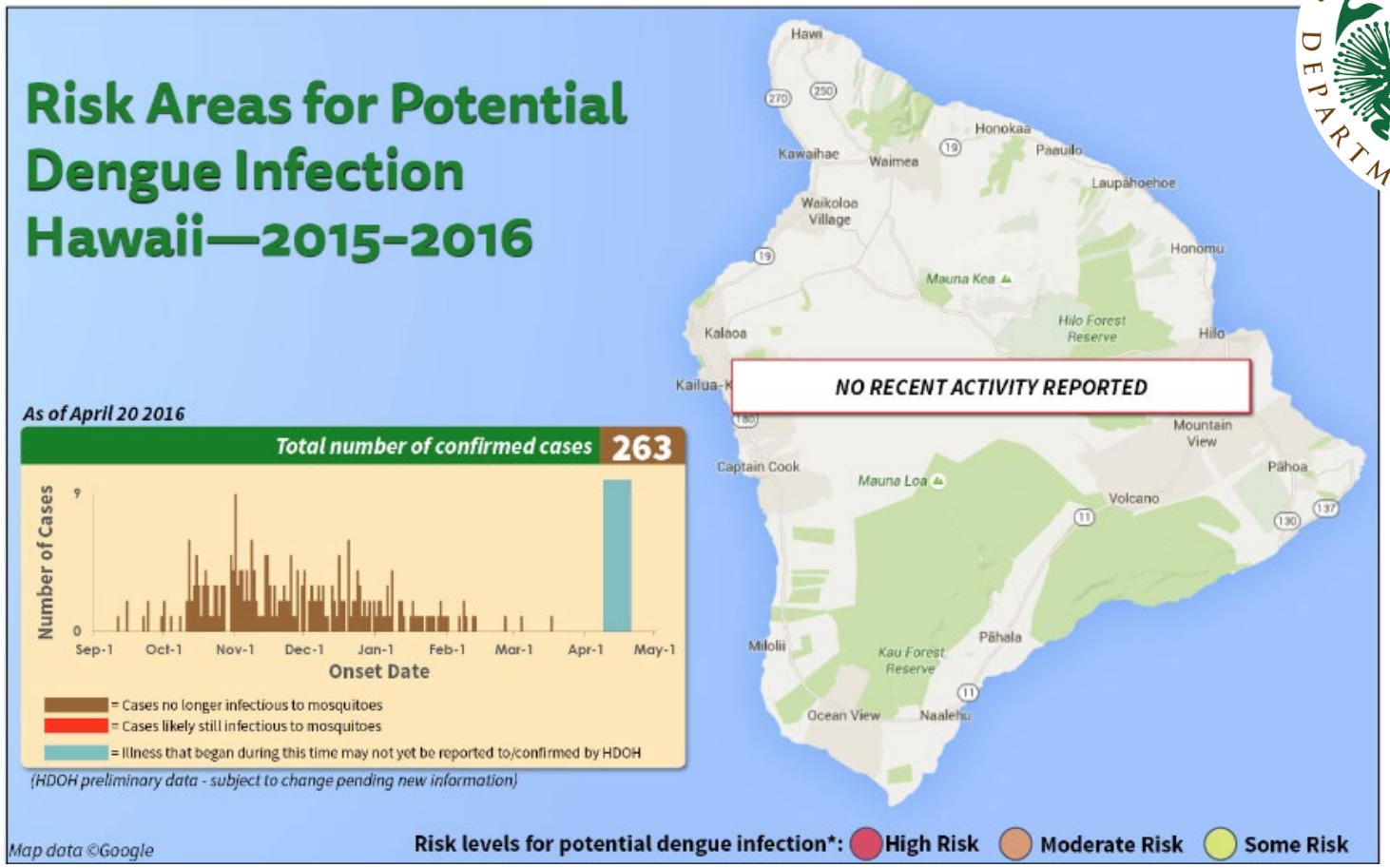
Climate warming is expanding dengue burden in the Americas and Asia (preprint)

Figure 5: Estimated impacts from climate change for 2040–2059 are widespread and largest in more temperate regions, but few places will become too warm.



Childs ML, Lyberger K, Harris M, Burke M, Mordecai EA. Climate warming is expanding dengue burden in the Americas and Asia. medRxiv [Preprint]. 2024 Jan 9:2024.01.08.24301015. doi: 10.1101/2024.01.08.24301015. PMID: 38260629; PMCID: PMC10802639.

Last local dengue outbreak: Hawaii island, 2015–2016



Will we see more dengue outbreaks in the US?

HEALTH

LA is seeing cases of dengue, the range of which may be growing due to climate change

OCTOBER 22, 2024 · 6:10 PM ET

HEARD ON ALL THINGS CONSIDERED

By Alejandra Borunda

- 8 locally acquired dengue virus cases reported in Baldwin Park (LA County) this fall
- Panorama City and El Monte have each seen one and two cases respectively
- First confirmed case in LAC was reported September 9, 2024
- Locally acquired dengue previously confirmed in Long Beach and Pasadena in fall 2023

The Threat From the North

Photo: Courtesy of HBO.

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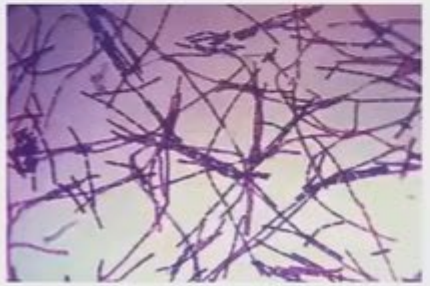
ANTHRAX IN SIBERIA

Anders Koch, MD, PhD, MPH
Professor (adjunct)
University of Greenland, Nuuk, Greenland
&
Senior consultant
Statens Serum Institut & Rigshospitalet University Hospital
Copenhagen, Denmark

Presented by Dr. Jay Butler

- Spore forming bacterium
- Early 20th Century
  - 40.000-60.000 animal cases annually
  - 10.000-20.000 human cases
  - 25% mortality
- 1941
  - Last know outbreak of Anthrax in Siberia
- 2011
  - Russian researchers warn of re-emergence of Anthrax in Yakutia due to warming of grounds with >200 burial grounds of cattle died of Anthrax
- Summer 2016
  - Heatwave in Yamal tundra
  - Outbreak of Anthrax due to thawing of a reindeer carcass died 75 years ago
  - 72 Yamal nomads sick, 1 boy and >2.300 reindeer died



IDWeek
OCT. 16 – 19, 2024 | LOS ANGELES, CA

1918 SPANISH FLU VIRUS IN ALASKAN SOIL

Anders Koch, MD, PhD, MPH
Professor (adjunct)
University of Greenland, Nuuk, Greenland
&
Senior consultant
Statens Serum Institut & Rigshospitalet University Hospital
Copenhagen, Denmark

Presented by Dr. Jay Butler

Brevig, Alaska

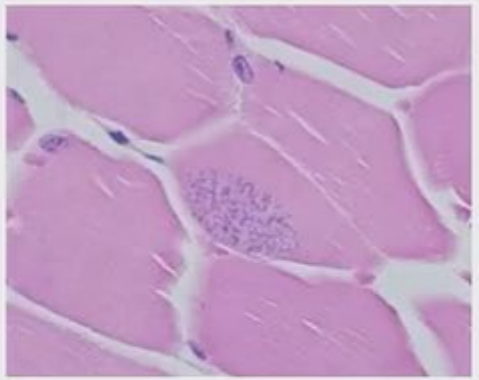
Are polar bears more exposed to terrestrial pathogens?

Emily Jenkins,
PhD, DVM, BSc Hon
University of Saskatchewan

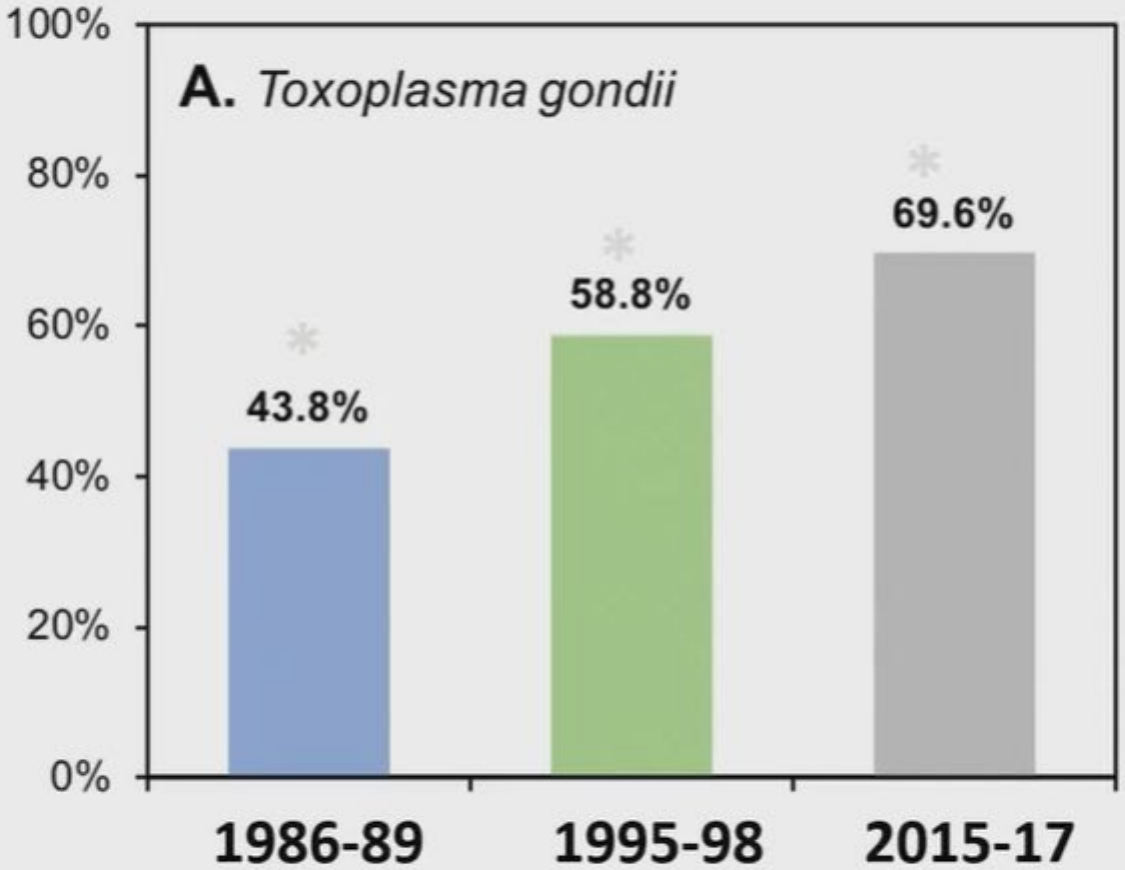
IDWeek™
OCT. 16 – 19, 2024 | LOS ANGELES, CA

Antibodies to *Toxoplasma gondii* in archived polar bear sera

IDWeek
OCT. 16 – 19, 2024 | LOS ANGELES, CA



Emily Jenkins,
PhD, DVM, BSc Hon
University of Saskatchewan



*significant difference at $p<0.05$

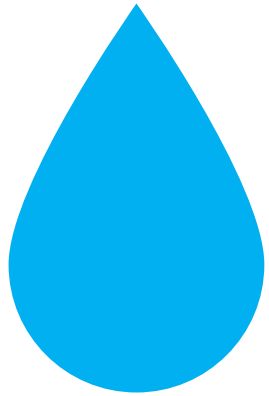
Overall prevalence 56%

https://doi.org/10.1111/gcb.1553

Dr Dr Adrian Hernandez Ortiz

Wetter summers correlated with higher seroprevalence
More terrestrial run-off of oocysts into fresh and marine water?
Higher prevalence in prey species exposed through oocysts?

Water Is Life



SCIENCE ENVIRONMENT

As Salem Frets About Toxic Algae, Should The Rest Of Oregon?

By Erin Ross (OPB)

Portland, Ore. June 7, 2018 3:30 a.m.

0:00 / 4:16

Detroit Lake in Detroit, Oregon, Saturday, March 18, 2017. Detroit Lake flows downstream into Salem's drinking water intake.

Bradley W. Parks / OPB

For the second time in two weeks,

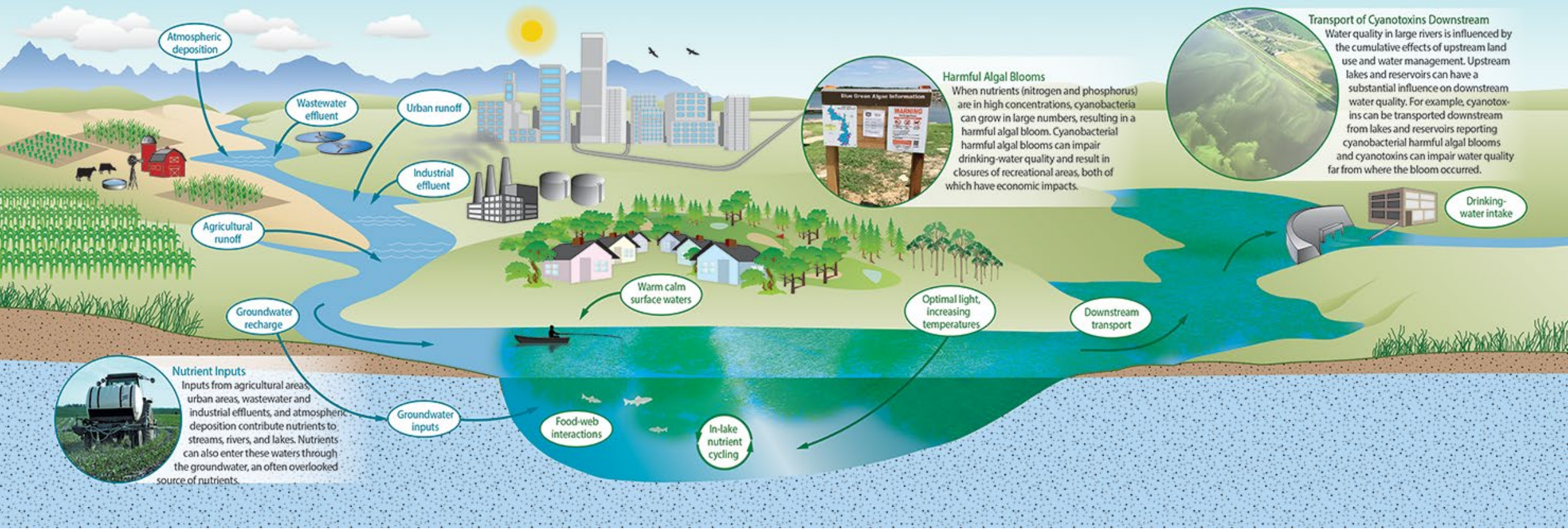
Salem is under a drinking water advisory

, and there's very little the city can do about it.

Test results released Wednesday from water collected four days prior found an algae-produced toxin was present at levels deemed unsafe for certain groups to drink. It's left city and state residents asking how it happened and wondering if it will happen elsewhere.

The toxins in the water are caused by a harmful algal bloom in Detroit Lake, a reservoir on the Santiam River that provides Salem with drinking water. These blooms sometimes cover an infected lake with a bright, turquoise scum that produces a dangerous toxin.

Harmful Algal Blooms (HABs)



- Harmful algal blooms (HABs) produce cyanotoxins which pose health risks to humans and animals
- Boiling does not destroy cyanotoxins and may increase toxin levels (by killing off algae which release more toxins)
- Prevent HABs by reducing use of fertilizers and phosphate-based detergents, reducing runoff from lawns, gardens and agricultural/industrial sources, and increasing aquatic plant diversity

Left: Severino Urubio of Hilo, Hawaii snaps photos of Kealia Pond's pink water at Kealia Pond National Wildlife Refuge in Kihei, Hawaii on Wednesday, Nov. 8, 2023. Officials in Hawaii are investigating why the pond turned pink, but there are some indications that drought may be to blame. (Matthew Thayer/The Maui News via AP)

Go Deeper

basic research

By —
Audrey McAvoy, Associated Press

Hawaiian refuge pond's unusual pink glow may be linked to drought

Science Nov 10, 2023 11:34 AM EDT

A pond in Hawaii has turned so bubble-gum pink it could be from the set of "Barbie," but

Bugs Gone Wild

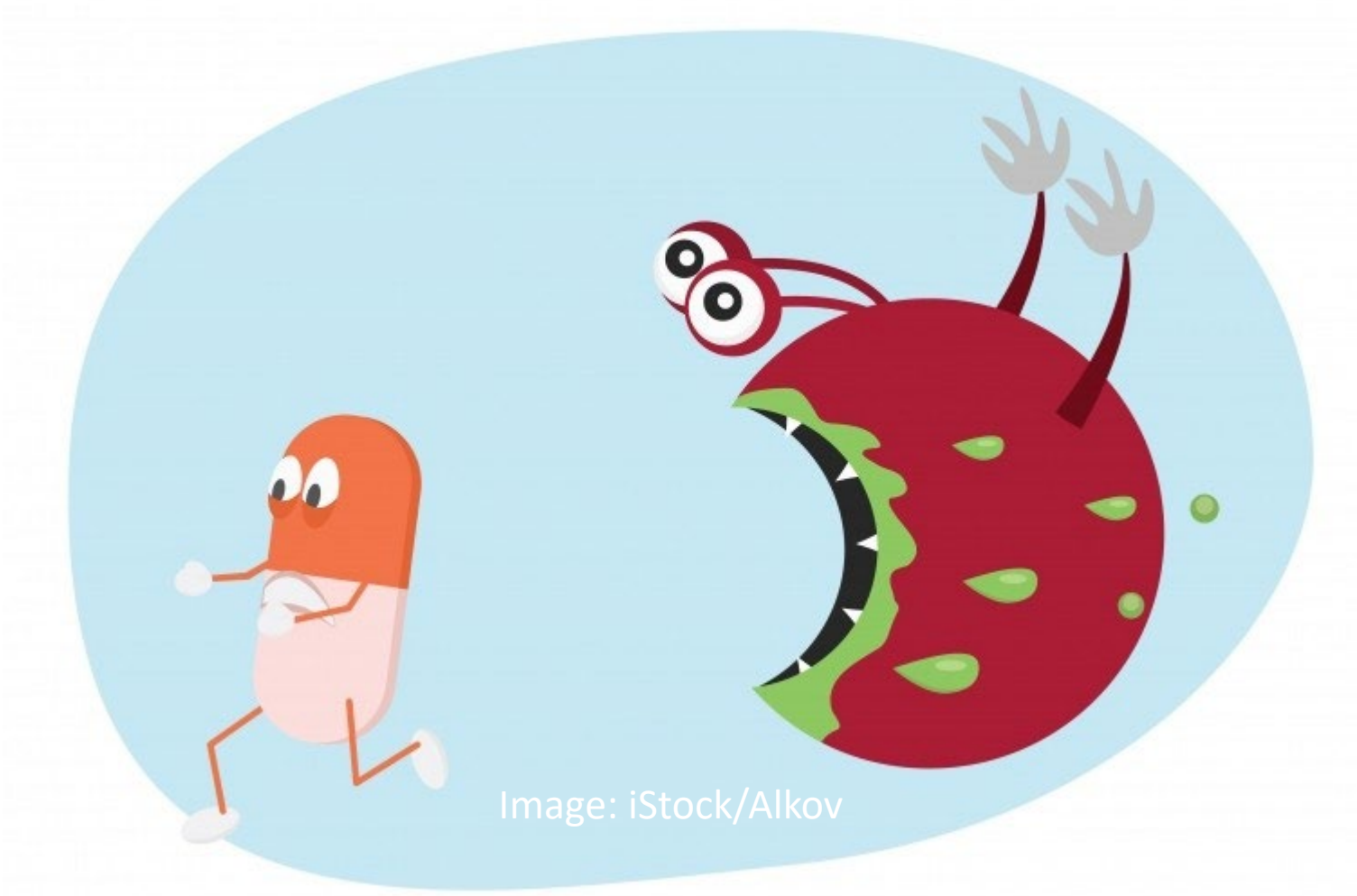


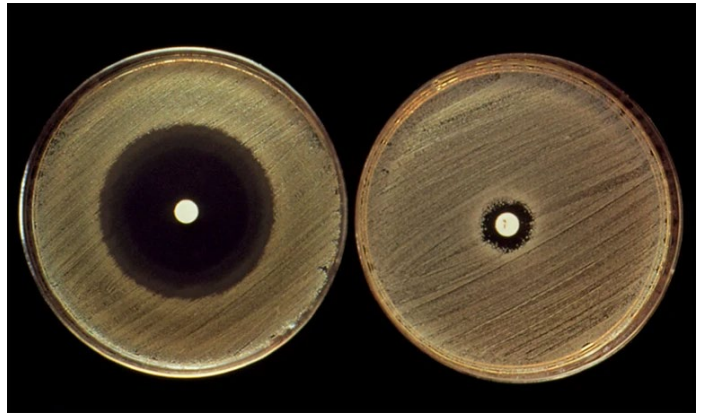
Image: iStock/Alkov

NEWS FEATURE | 08 January 2024

Antibiotic resistance is a growing threat — is climate change making it worse?

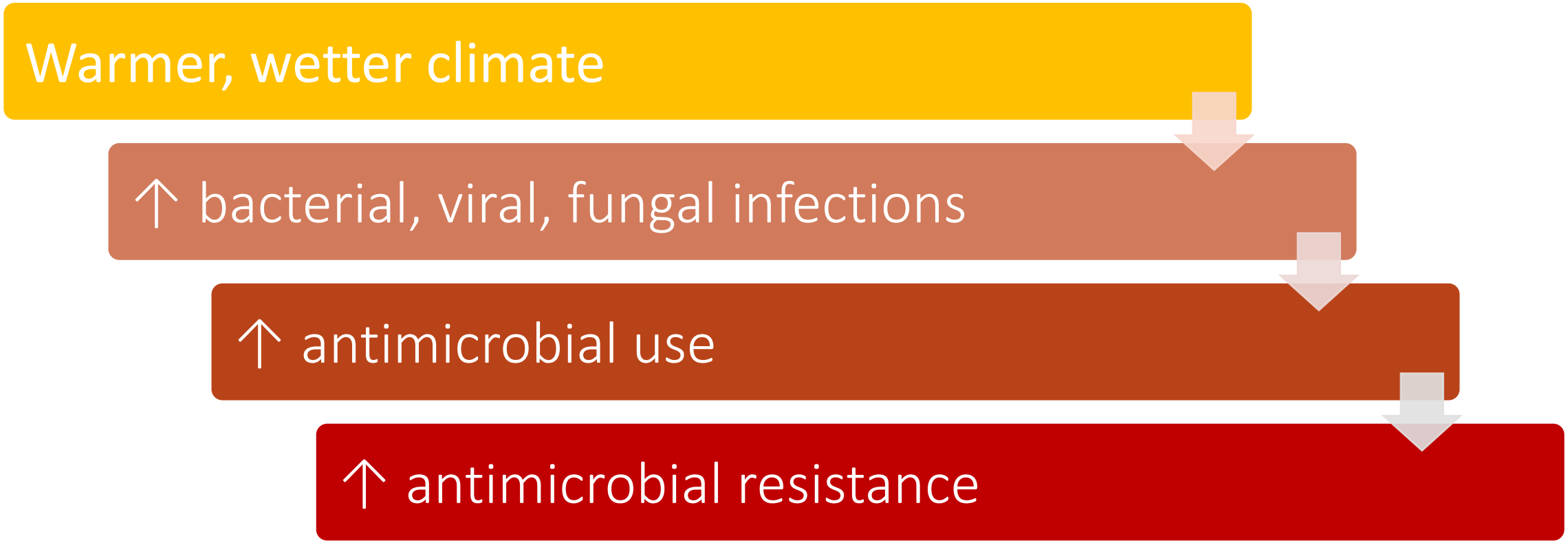
Researchers are studying how extreme weather and rising temperatures can encourage the spread of drug-resistant infections.

By Carissa Wong



https://www.nature.com/articles/d41586-023-04077-0

How climate change relates to antimicrobial resistance



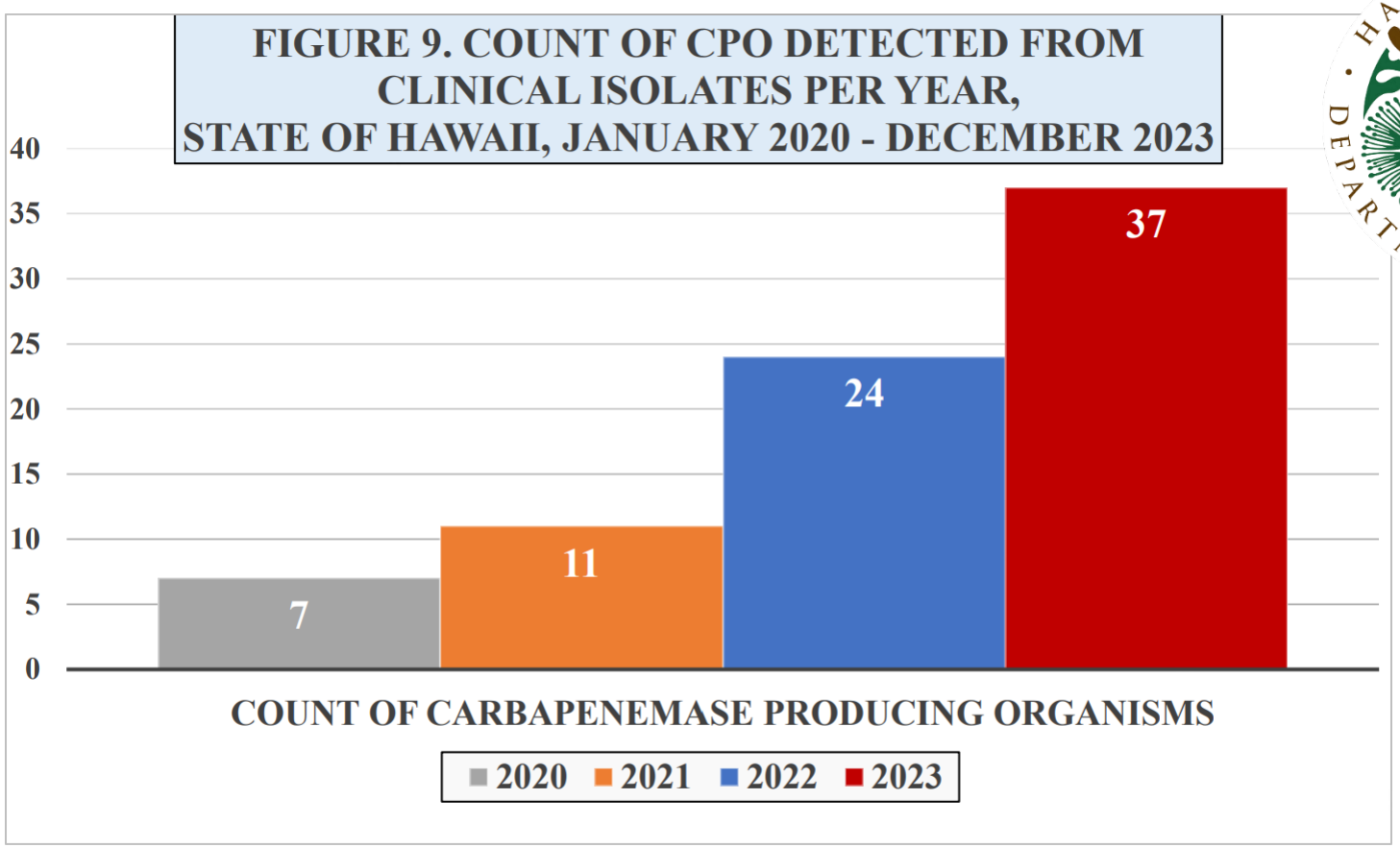
How climate change relates to antimicrobial resistance

For every 1°C increase in average air temperature, there was a 14% increase in the proportion of samples containing *K. pneumoniae* that were resistant to a type of antibiotic called carbapenems. **These drugs are usually reserved for treating bacteria that are resistant to all other antibiotics.**

https://www.nature.com/articles/d41586-023-04077-0

Li W, Liu C, Ho HC, Shi L, Zeng Y, Yang X, Huang Q, Pei Y, Huang C, Yang L. Association between antibiotic resistance and increasing ambient temperature in China: An ecological study with nationwide panel data. Lancet Reg Health West Pac. 2022 Nov 14;30:100628. doi: 10.1016/j.lanwpc.2022.100628. PMID: 36406382; PMCID: PMC9672962.

Increasing antimicrobial resistance in Hawaii



HDOH/DOCD Antimicrobial Resistance Surveillance Report

Conclusions

- Climate impacts on human and animal health are diverse
- Expanding range of tropical diseases and naturally “archived” arctic pathogens are both potential sources of new public health problems
- Precious resources like drinking water can also be compromised by climate change
- In the “bugs vs. drugs” race, climate change tips the balance in favor of microbial evolution, enabling disease-causing microbes to “escape” our most powerful antibiotics

What actions can we take to protect the health of the public?

Model climate-mediated disease impacts to most effectively target resources for disease prevention and mitigation

Work proactively to protect drinking water sources from climate-related impacts

Invest now to accelerate new antimicrobial drug development and promote stewardship

Continue to advocate for policies that mitigate climate change

Vector-Borne Disease & Invasive Vectors

Jeomhee Hasty Ph.D.

Entomologist

Hawaii DOH, Vector Control Branch

Vector-borne diseases are infections that are transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes, ticks, and fleas.

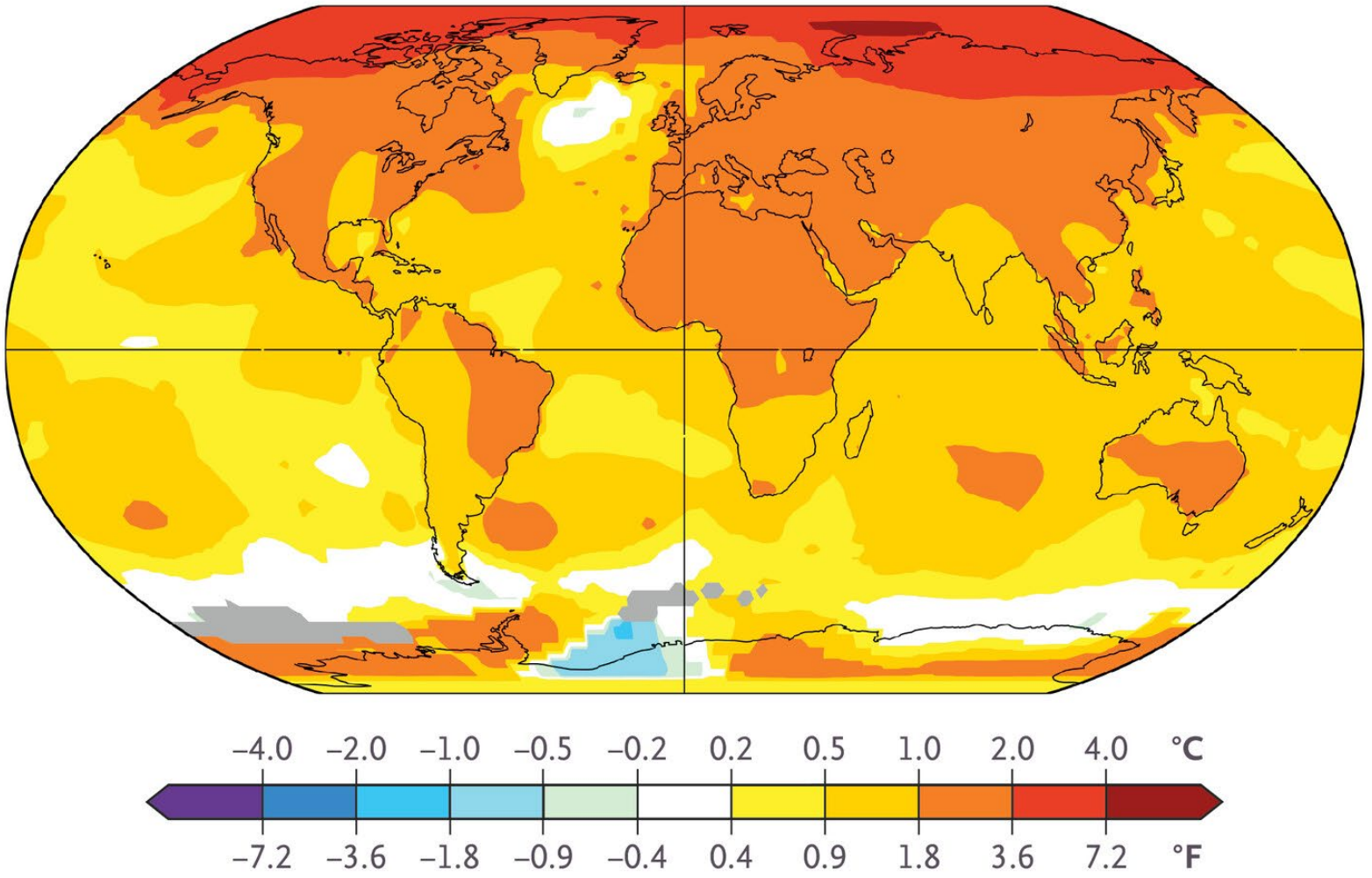
Dengue
West Nile virus
Yellow fever
Chikungunya
Zika virus
Malaria
Japanese Encephalitis
Lyme Disease
Rocky Mountain Spotted Fever
Leishmaniasis
Oropouche
Plague

Mosquitoes, *Aedes*
Mosquitoes, *Culex*
Mosquitoes, *Aedes*
Mosquitoes, Aedes
Mosquitoes, Aedes
Mosquitoes, *Anopheles*
Mosquitoes, *Culex*
Ticks
Ticks
Sand Flies
Biting midge
Fleas

A disease **vector** is any living agent that carries and transmits an infectious pathogen such as a parasite or microbe, to another living organism.

Average Surface Air Temperature Change in the Past 50 Years

2011–2021 as compared with baseline mean temperatures from 1956–1976



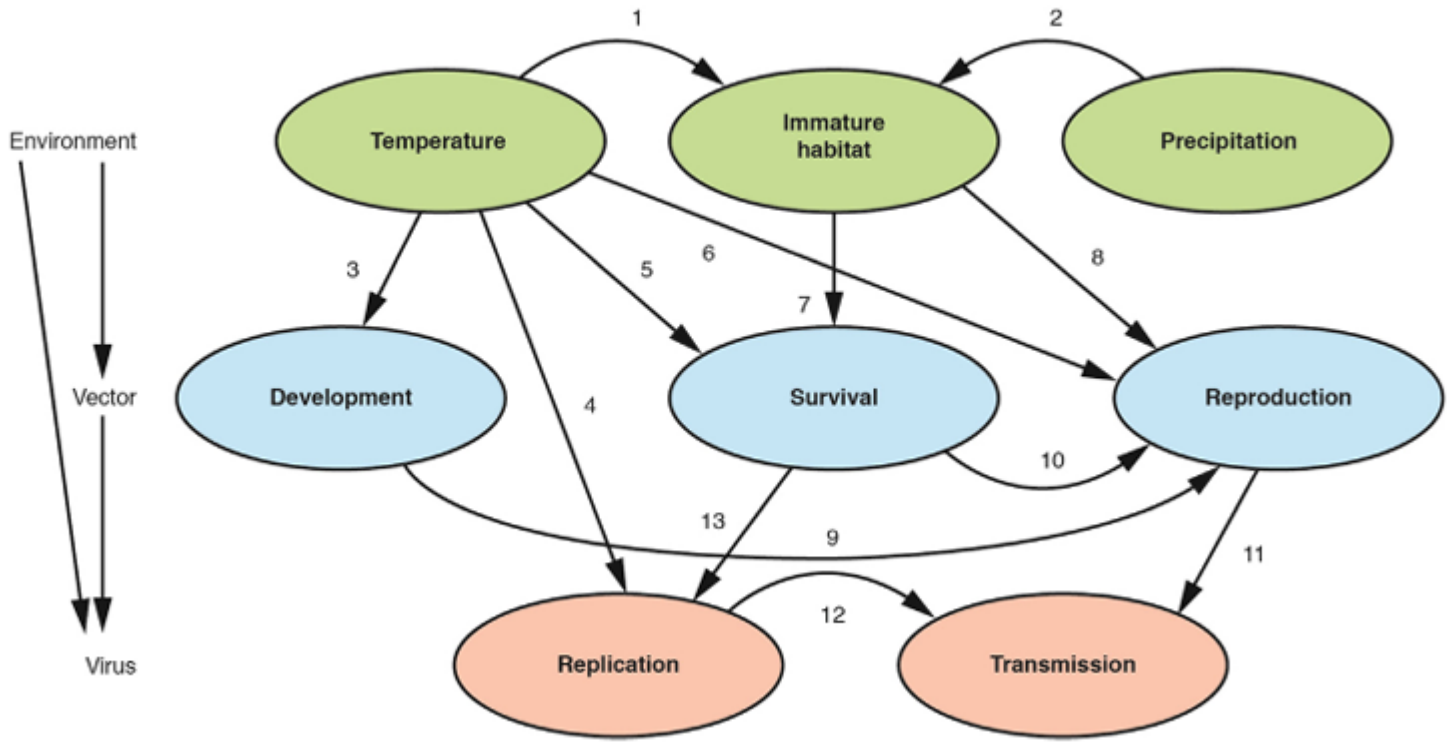
https://www.ipcc.ch/report/ar6/wg2/

Vectors (Arthropods)

- Unlike mammals, many insects (Arthropods) are ectotherms, which means they are unable to regulate their own body temperature.
- Because they are so dependent on external conditions, they may respond to climate change more acutely than other animals.

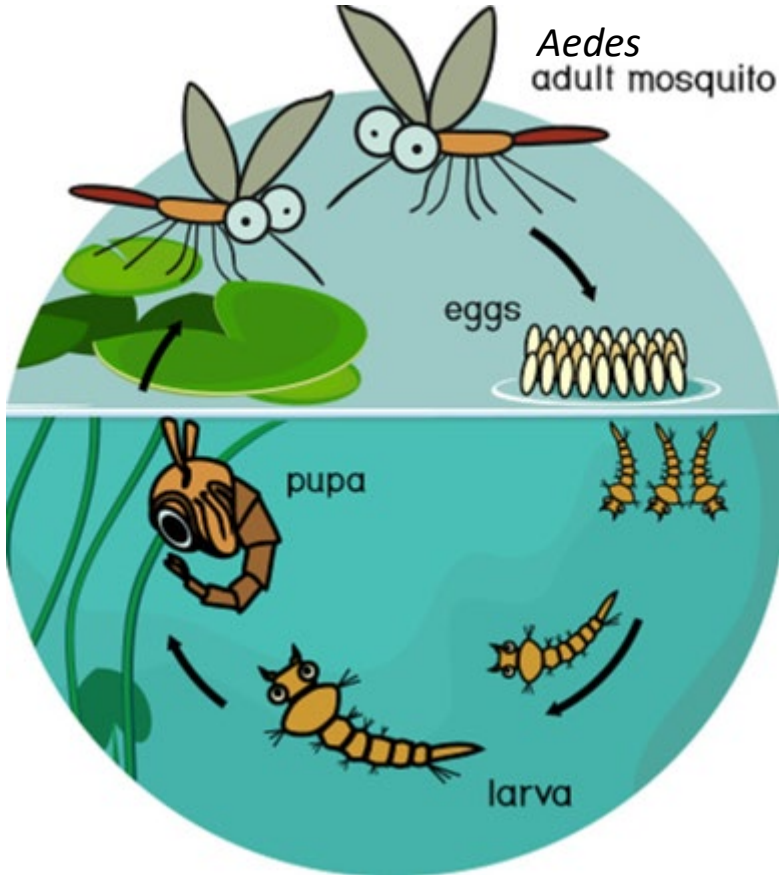
Factors in the emergence and resurgence of vector-borne disease

Attributing changes in the distribution and frequency of vectors and diseases to climate change is challenging because other factors, including land-use changes, the abundance of reservoir hosts, and control measures, also contribute to these changes.

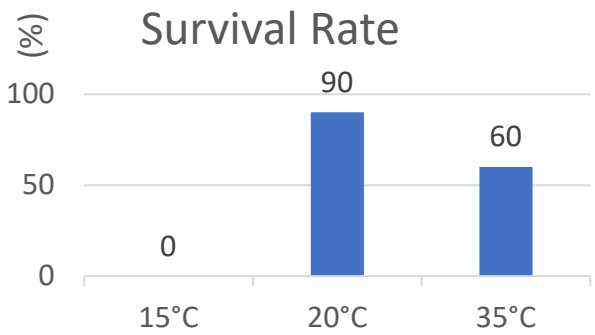


Climate change (Temperature) and Vectors

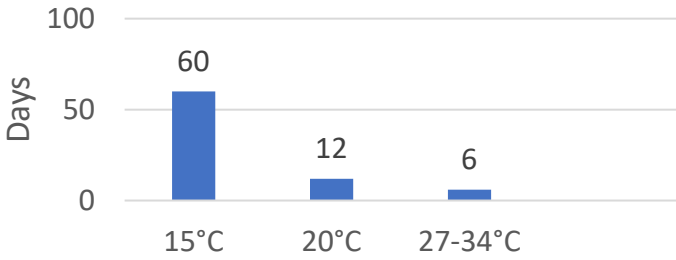
‘Warmer is better’ for vectors in general, the relationships between temperature and vector survival, abundance and feeding behavior are often complex.



Survival Rate



Time of Development



The percentage of mosquitoes that complete a blood meal within 30 minutes after a host is made available plateaus at about 50% between 22 °C and 28 °C and then declines to almost 0% at 33 °C. Blood meal will directly impact the reproductivity. https://www.scirp.org/journal/paperinformation?paperid=57094

Climate change (Precipitation) and Vectors

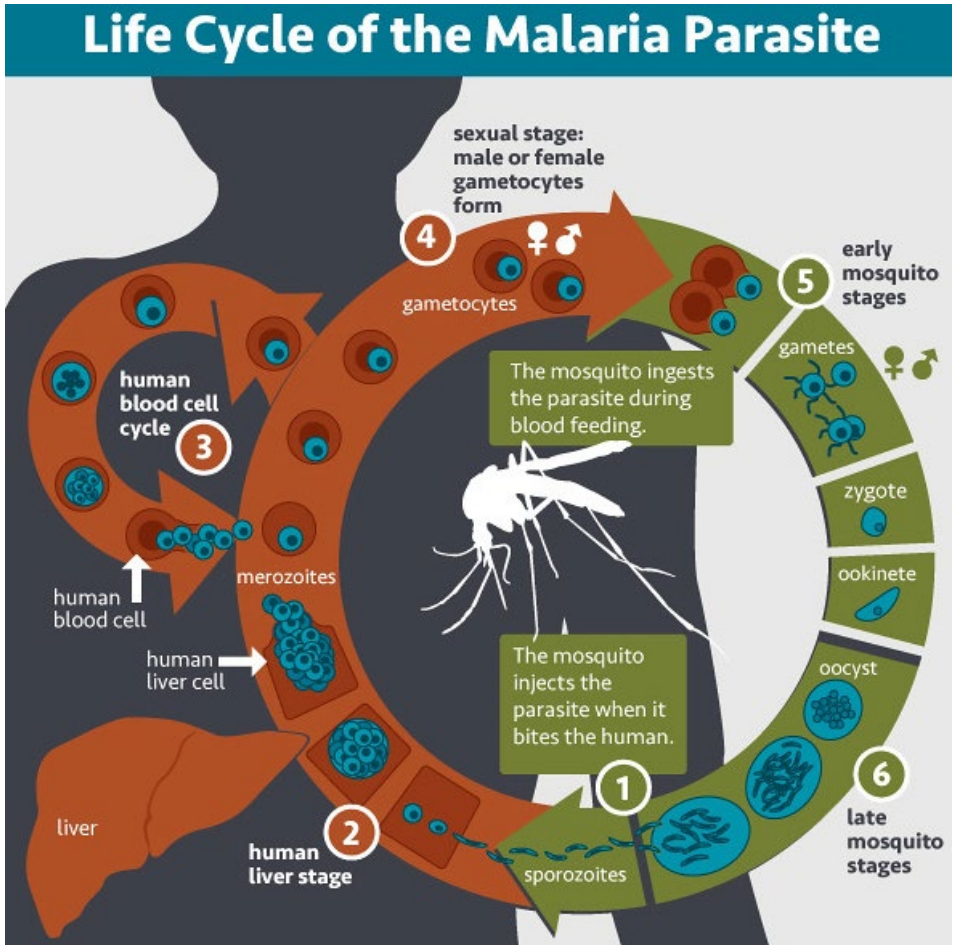
Mosquitoes need pools of standing water to breed and develop, but too much rainfall can wash away the developing mosquitoes.
The role of rainfall is less clearcut than temperature

Drought conditions have been associated with increased WNV activity in California.

- Prevents the “washing out” of underground mosquito populations in urban wastewater systems or other water sources
- May force birds and mosquitoes into closer proximity as both seek out limited sources of water, especially in urban areas, resulting in virus amplification

Climate change (Temperature) and Pathogen

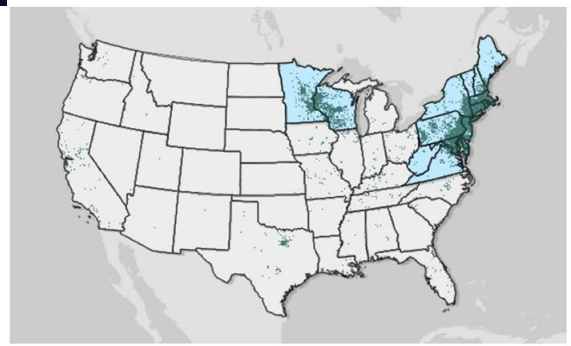
Optimal temperatures for efficient malaria transmission are between 25°C and 27°C.
Malaria parasite development is not possible at temperatures below 16°C and temperatures above 40°C have adverse effects on mosquito population turnover.



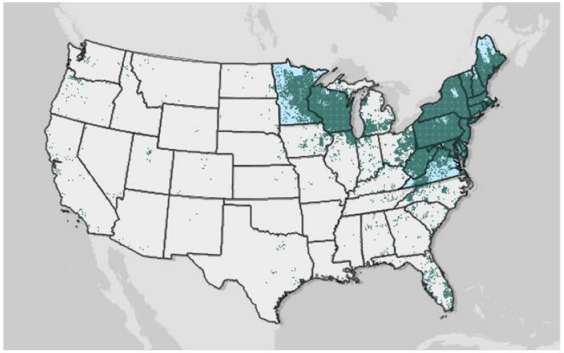
Plasmodium falciparum (causes severe malaria)

At temperatures below 20°C (68°F), it cannot complete its growth cycle in the Anopheles mosquito. Therefore, it cannot spread in these areas.

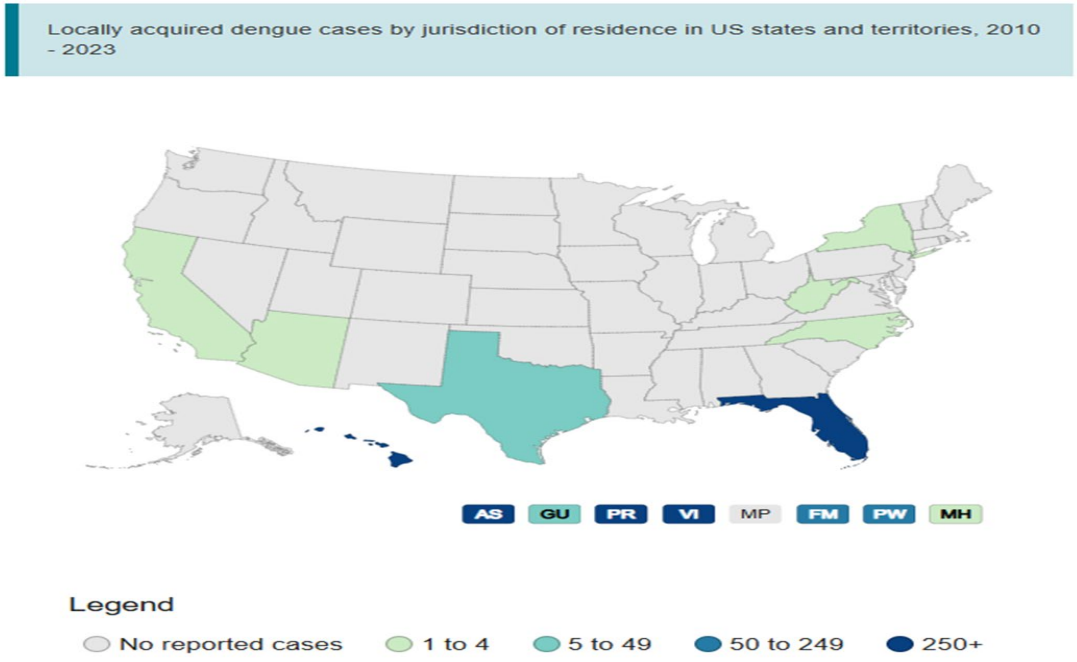
What changes we observe in the Vector Borne Disease occurrence in the United State

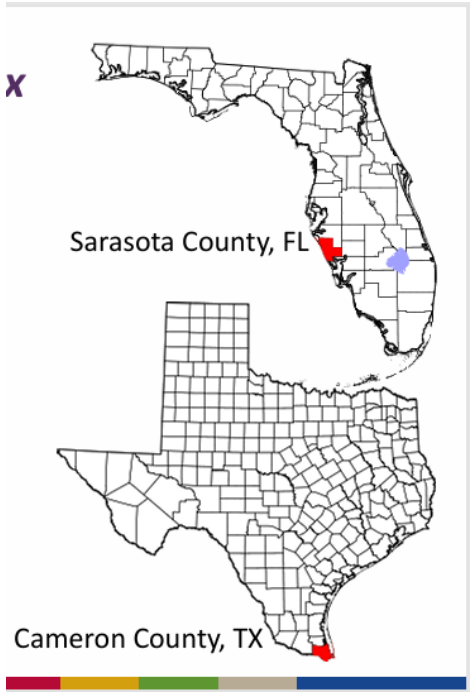


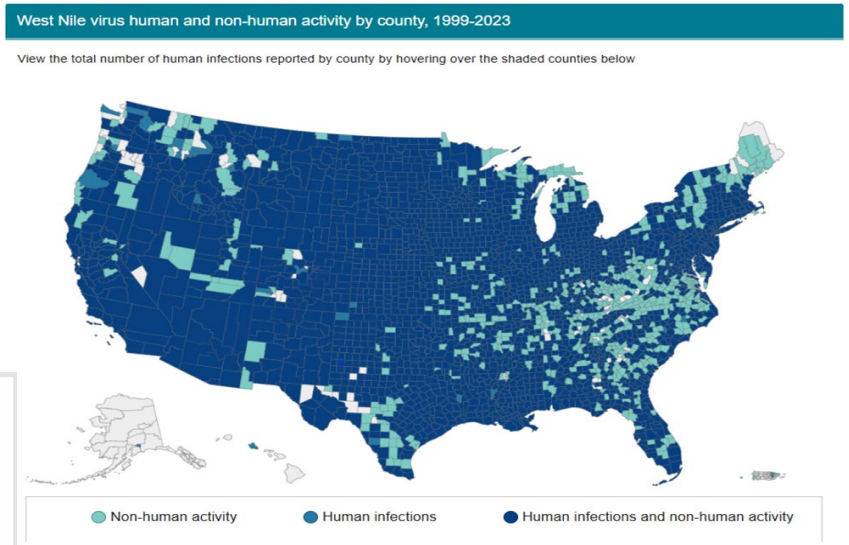
2001



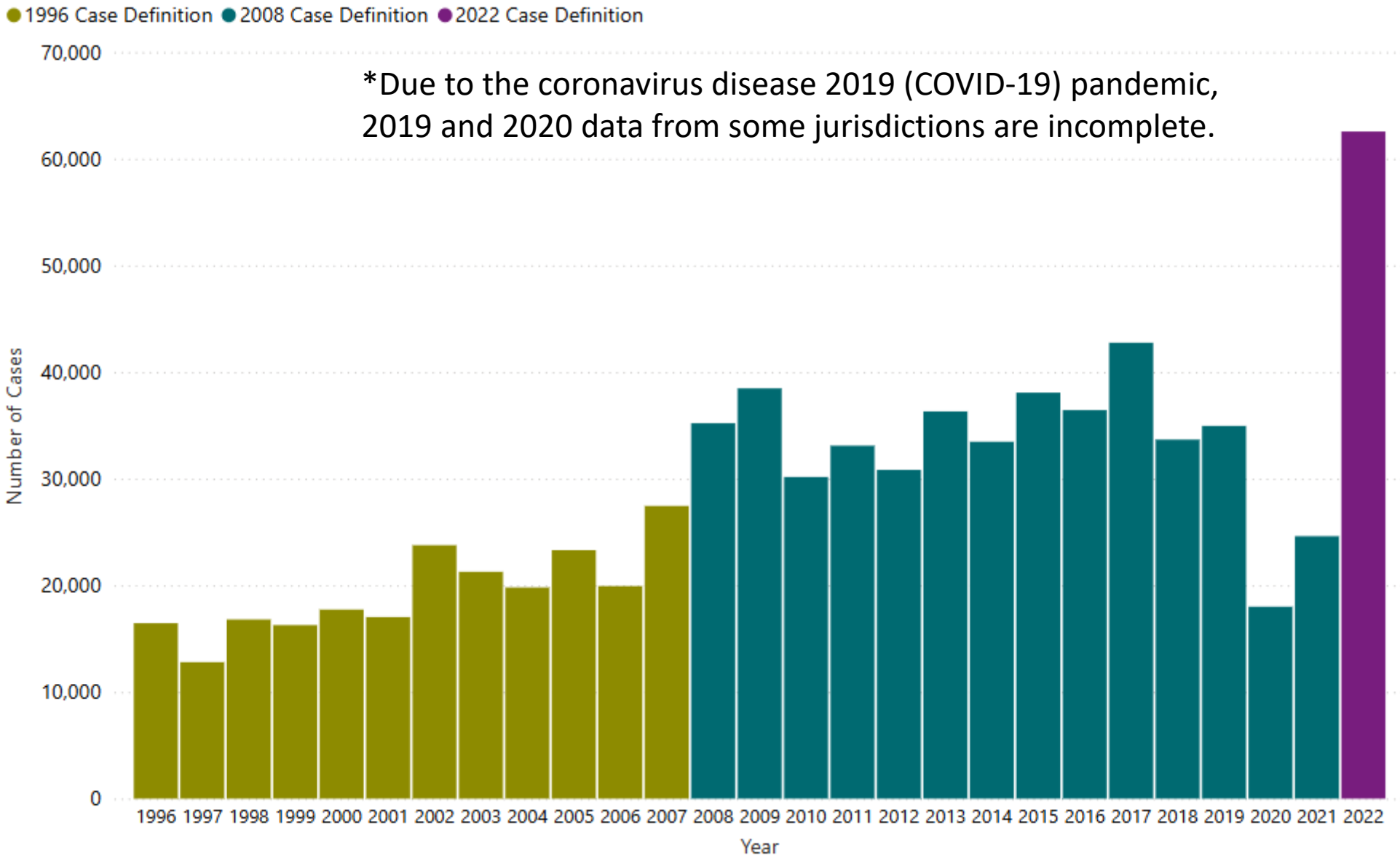
2022



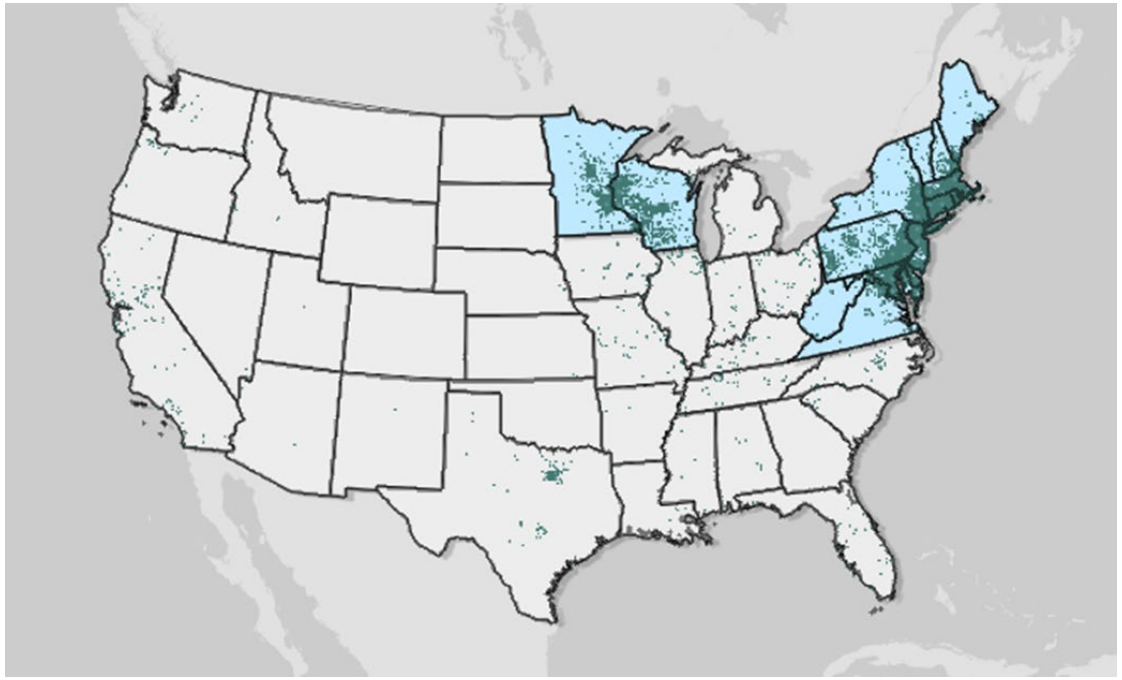




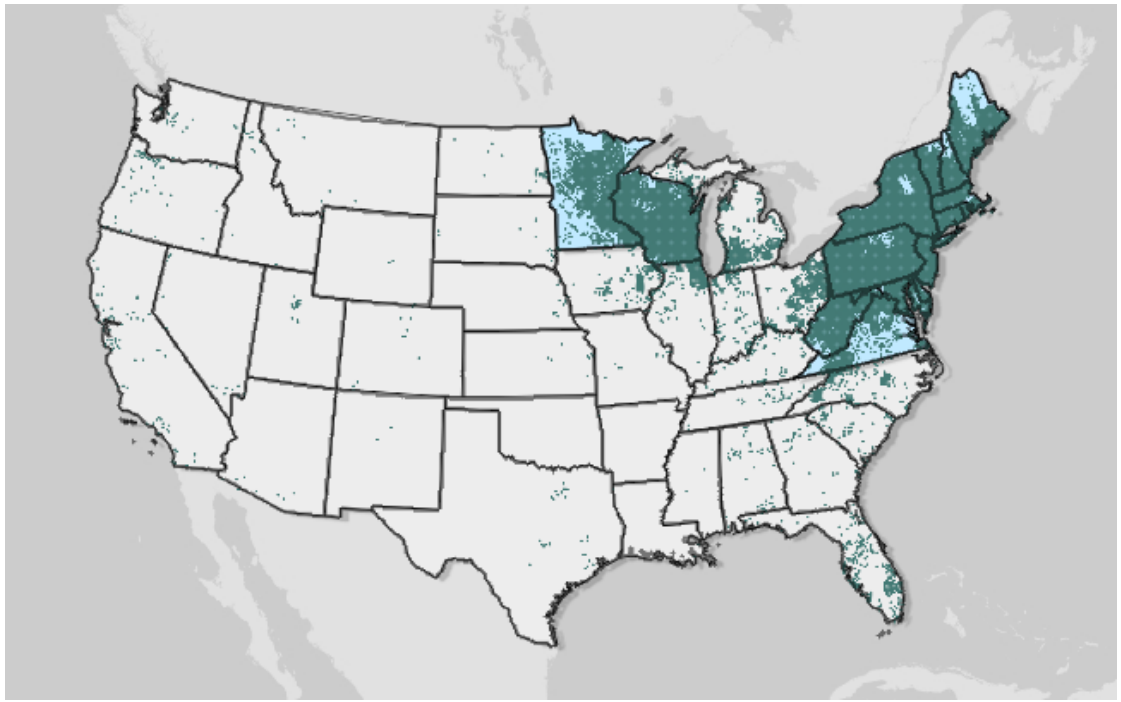
Lyme Disease – Total Reported Cases by Year, United States



*These data were reported according to different Lyme disease case definitions. Only major case definition changes are denoted.

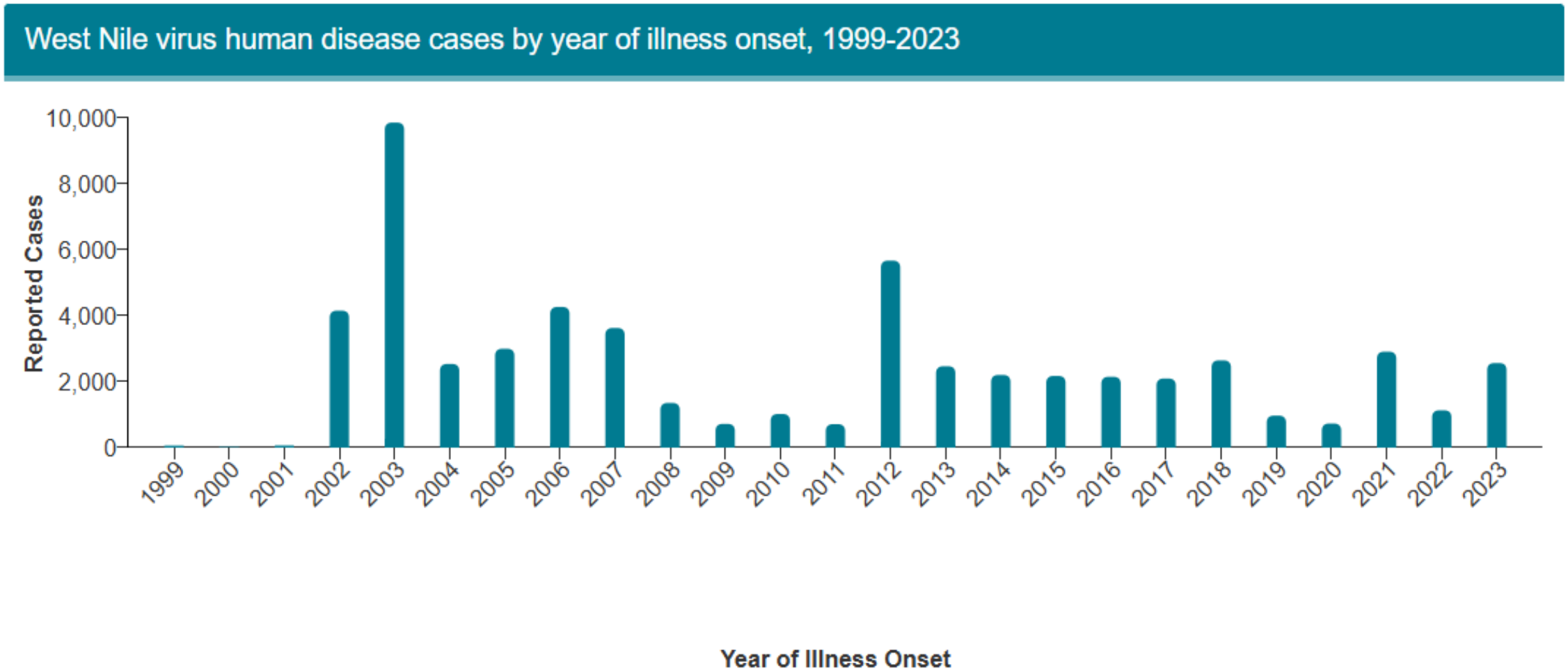


2001



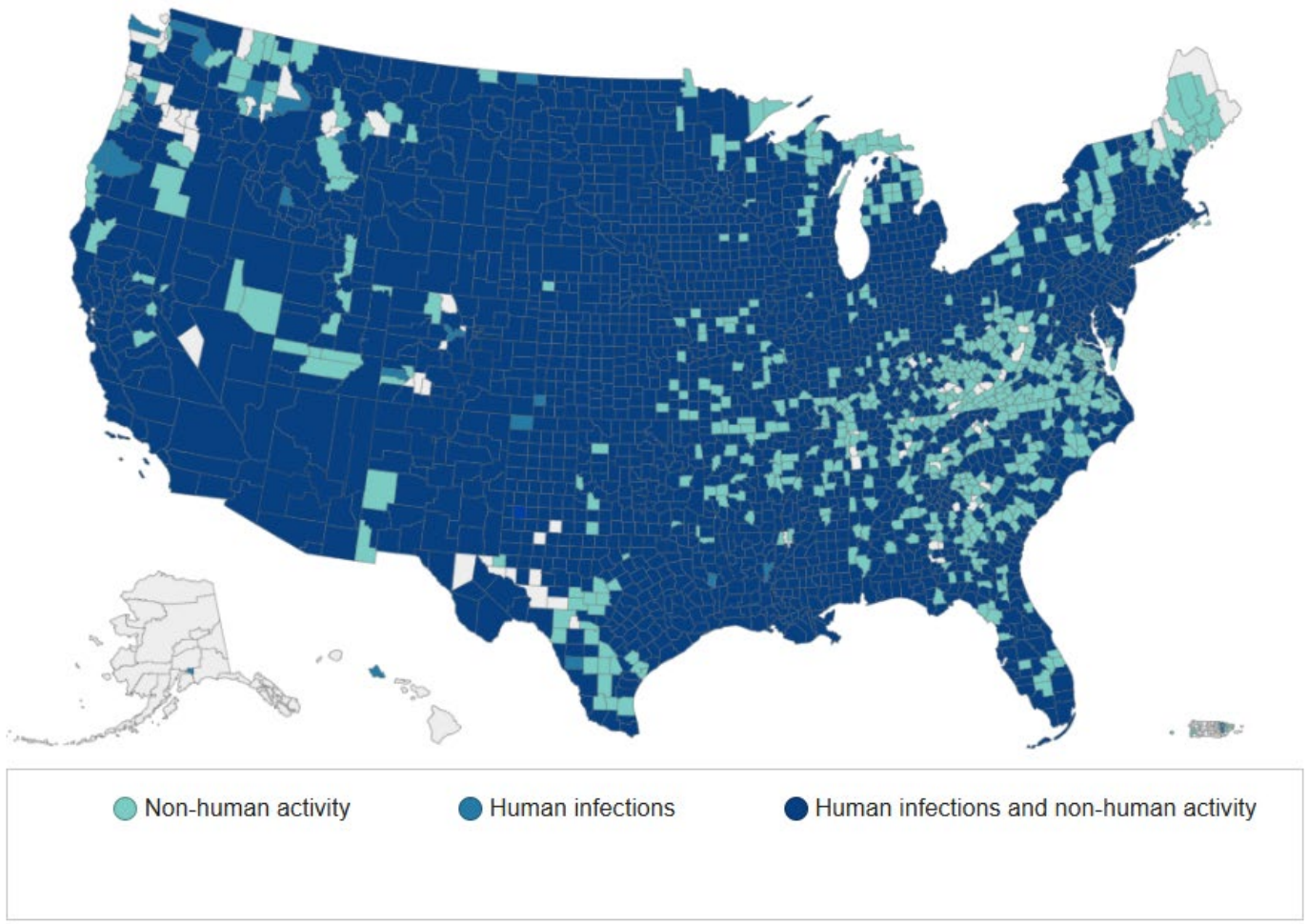
2022

Cumulative data for 1999-2023



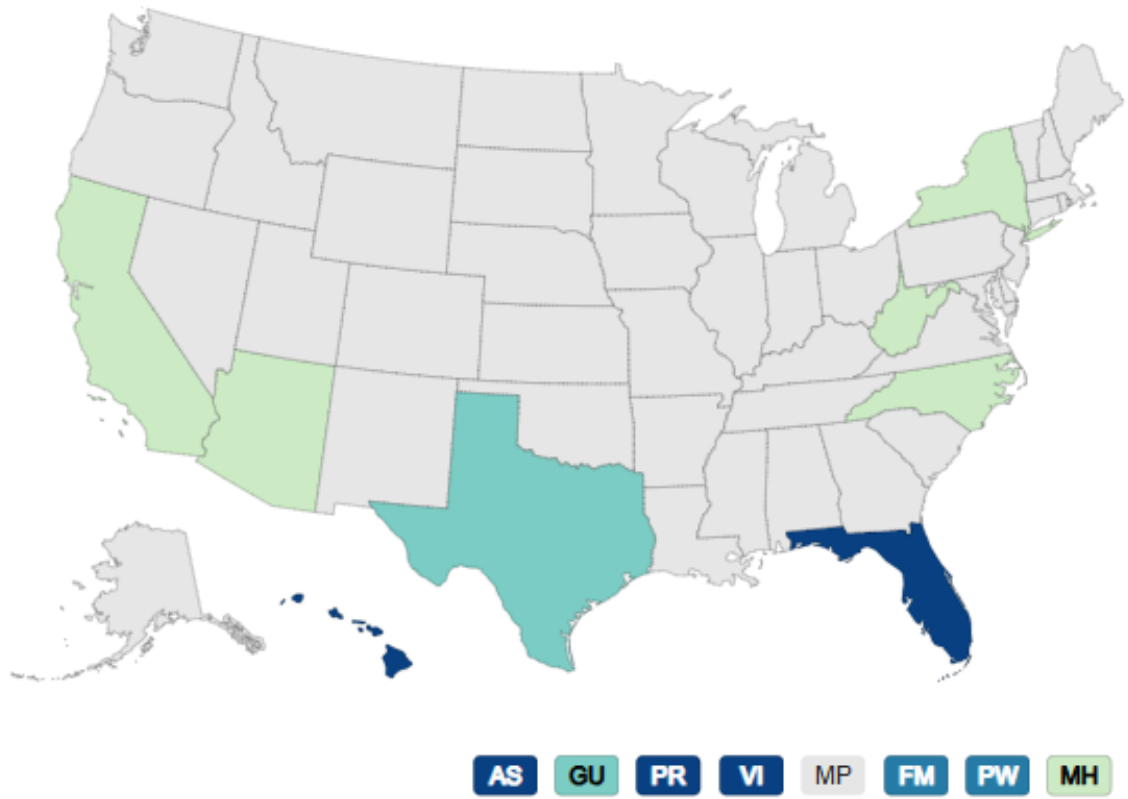
West Nile virus human and non-human activity by county, 1999-2023

View the total number of human infections reported by county by hovering over the shaded counties below



About this map:
Non-human activity: *Indicates that veterinary disease cases or infections in mosquitoes, birds, or sentinel animals have been reported to CDC.*
Human infections: *Indicates that human disease cases or infections in blood donors have been reported to CDC.*
Human infections and non-human activity: *Indicates that both human infections and non-human infections have been reported to CDC.*

Locally acquired dengue cases by jurisdiction of residence in US states and territories, 2010 - 2023



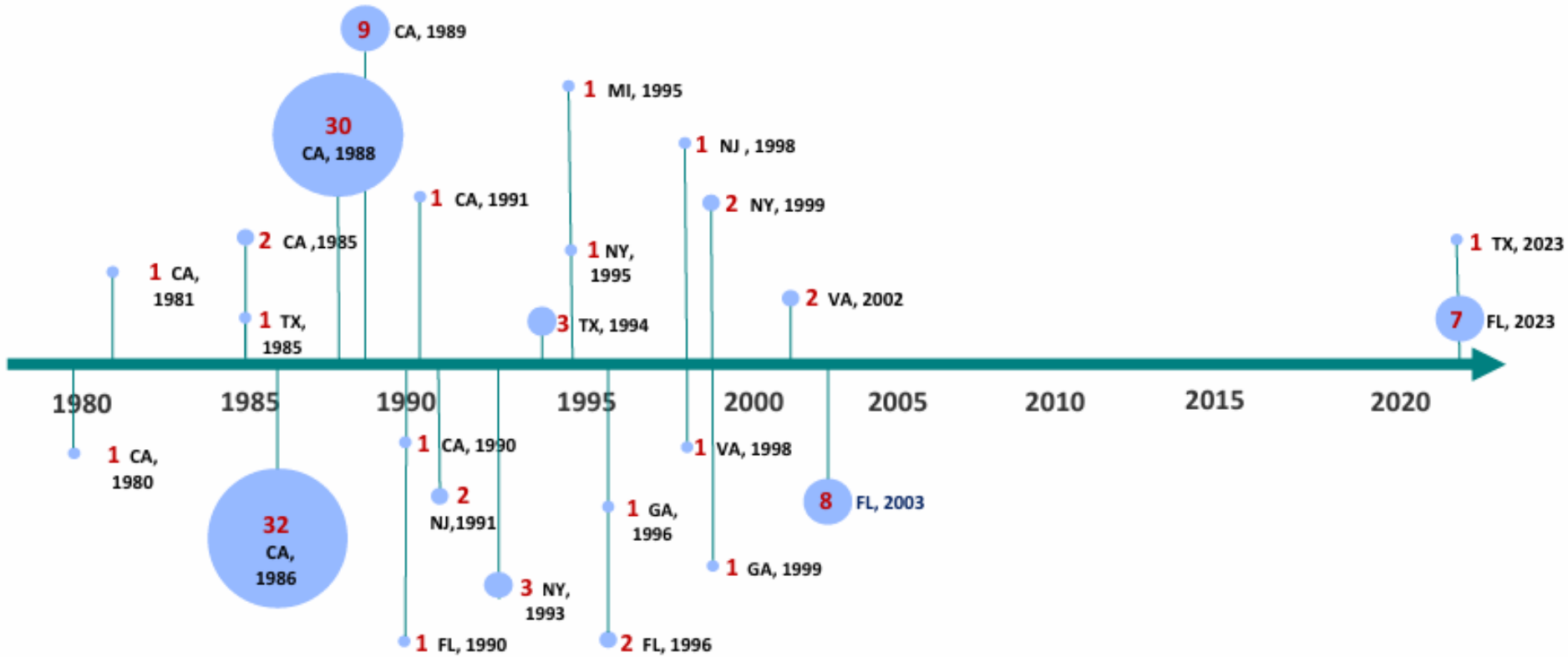
Locally Acquired Mosquito-transmitted Malaria in the United States

8 Locally acquired *Plasmodium vivax* malaria in Florida and Texas, 2023

- Mosquito-transmitted *P. vivax:*
  - Sarasota County, FL: 7 individuals
  - Cameron County, TX: 1 individual

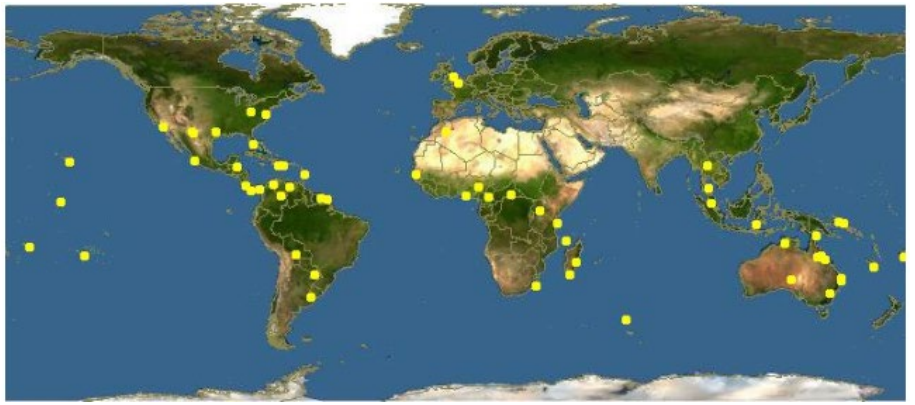
- No recent international travel identified

Timeline of Locally Acquired Malaria, U.S.: 1980–2023



At least 28 events from 1980–2003

Invasive Vector concerns in Hawaii



All vectors and vector-borne diseases are invasive in Hawaii.

Aedes aegypti mosquitoes are only found on the Big Island of Hawaii. Interisland transportation can facilitate their spread and accelerate the public health risk in the State.

Anopheles mosquitoes capable of transmitting malaria ("vectors") exist in the U.S. Thus, there is a constant risk that malaria transmission can resume in the U.S.

- An. quadrimaculatus
- An. freeborni

Figure 2. Known distribution of *Anopheles quadrimaculatus* Say.

Invasive Vectors in Hawaii

BROWN DOG TICK *Rhipicephalus sanguineus*
WHERE FOUND Worldwide.
TRANSMITS *Rickettsia rickettsii* (Rocky Mountain spotted fever). Primary vector for *R. rickettsii* transmission in the southwestern United States and along the U.S.-Mexico border.
COMMENTS Dogs are the primary host for the brown dog tick in each of its life stages, but the tick may also bite humans or other mammals.

No tick-borne disease was reported and issued in Hawaii, but recently, brown dog ticks, which are present in Hawaii, have been listed as vectors of Rocky Mountain Spotted Fever. Therefore, Hawaii is increasing biosecurity over invasive tick-borne diseases and vector ticks.

No Chagas disease has been reported in Hawaii yet. However, the CDC recognizes 11 kissing bug species as Chagas disease vectors, and one of the cousin species of Triatoma is present in Hawaii.

Several imported cases of the Oropouche virus have been confirmed in Florida, and maybe other states. A midge (probably not in Hawaii) is cited as an important vector. Mosquitoes present in Hawaii can play a role in urban areas where many people are carrying the virus.

Climate change and Host (Human)