



THE UNIVERSITY OF ARIZONA

# Agriculture, Life & Veterinary Sciences & Cooperative Extension

## PESTS & DISASTERS

**Dawn H. Gouge**  
Public Health Entomologist



Natural disasters, catastrophes & climate change

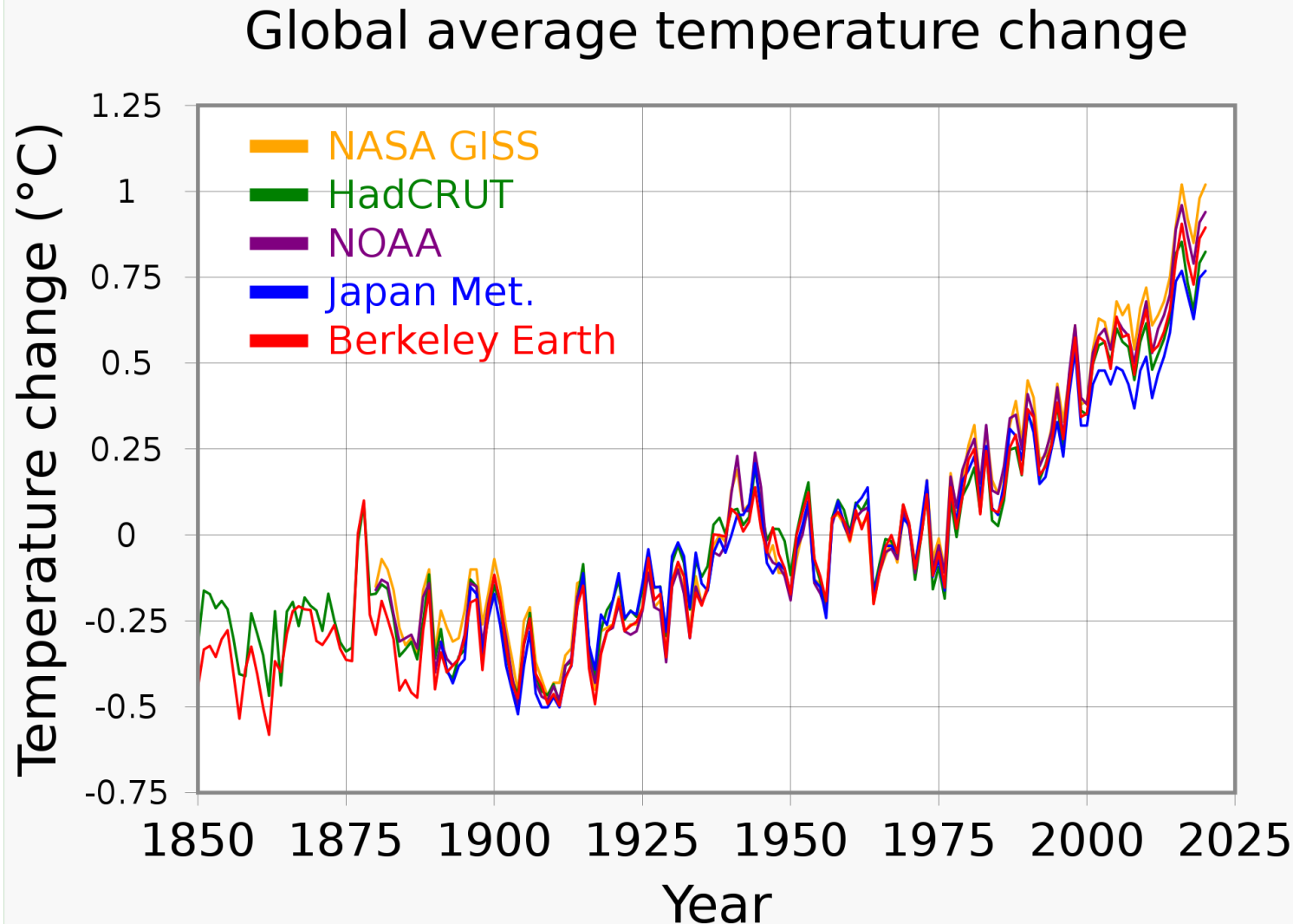


# Global temperature increase



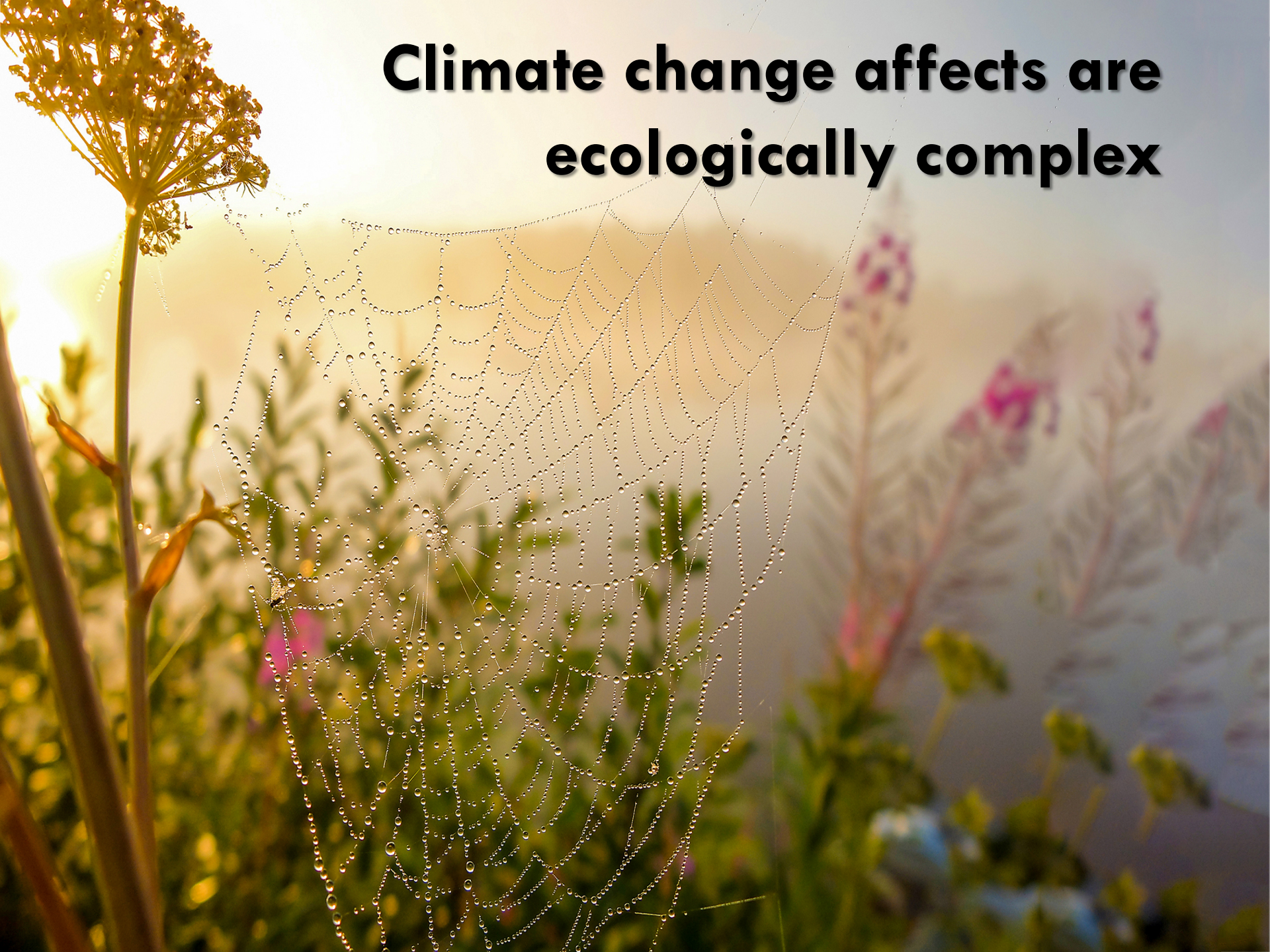
2

Increase  
of  
2.12°F  
since  
1880





**Climate change affects are  
ecologically complex**





# Human activities

4







# Human activities

5







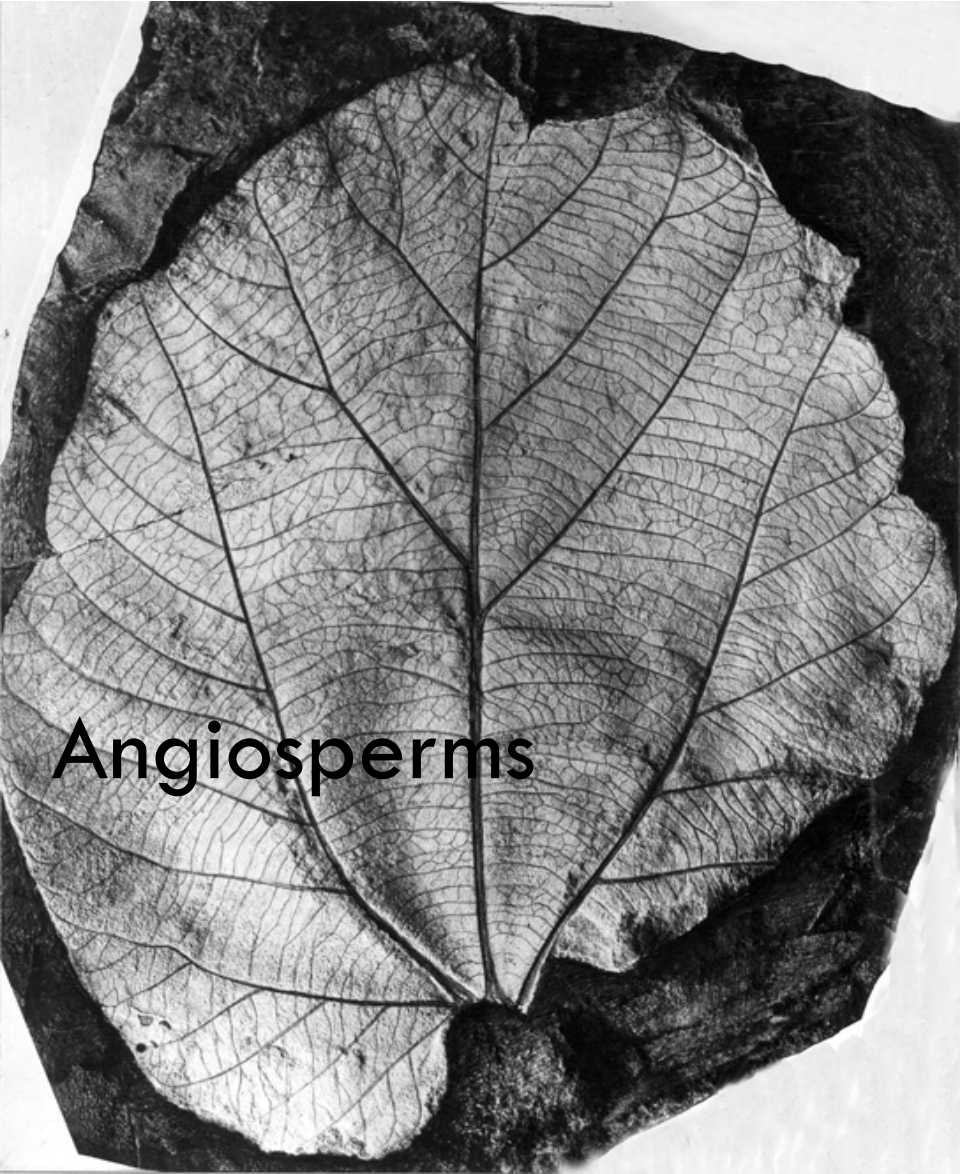






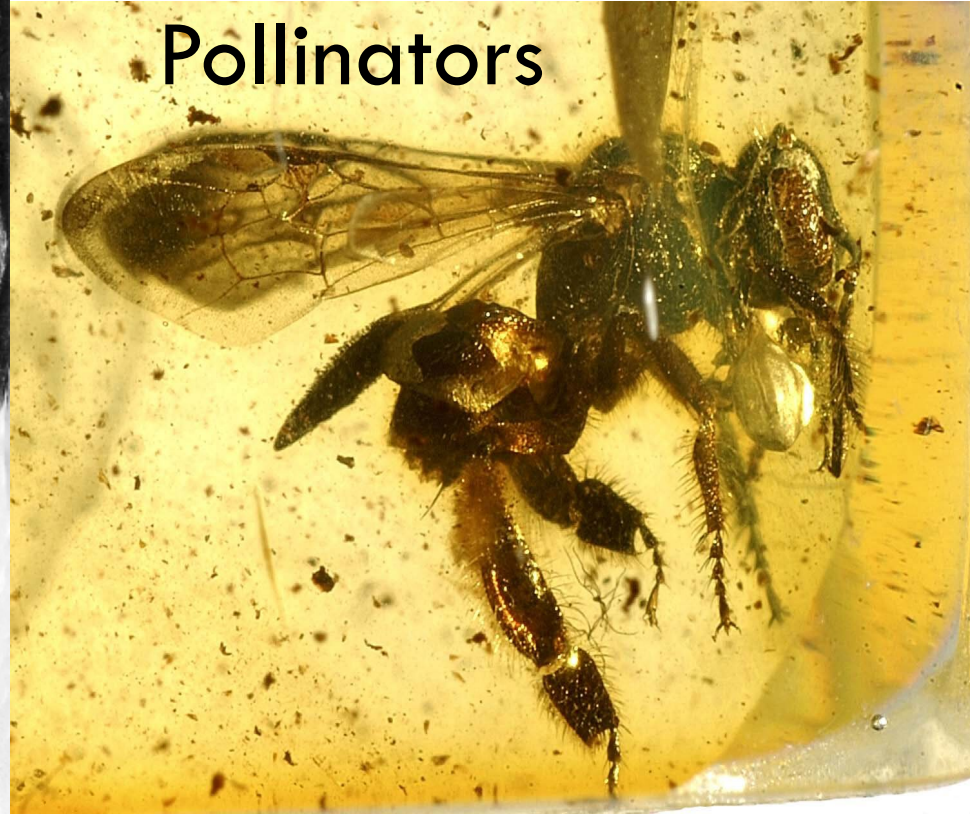


# Cretaceous 140-65 million years ago



Angiosperms

Pollinators







*Melitta leponia*  
A ground-nesting bee that occurs throughout Europe and Asia



*Exaerete smaragdina*  
A cleptoparasitic Orchid bee from South & Mesoamerica



*Lithurgus pullatus*  
A stem-nesting species with wide distribution in southeast Africa



*Melitturga oraniensis*  
A rare bee from the Mediterranean



*Systropha krigei*  
A pollen specialist that only visits flowers of Morning Glory



*Ctenocolletes nigricans*  
One of only 21 species in the family, this bee occurs in remote Australia

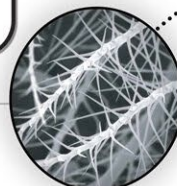
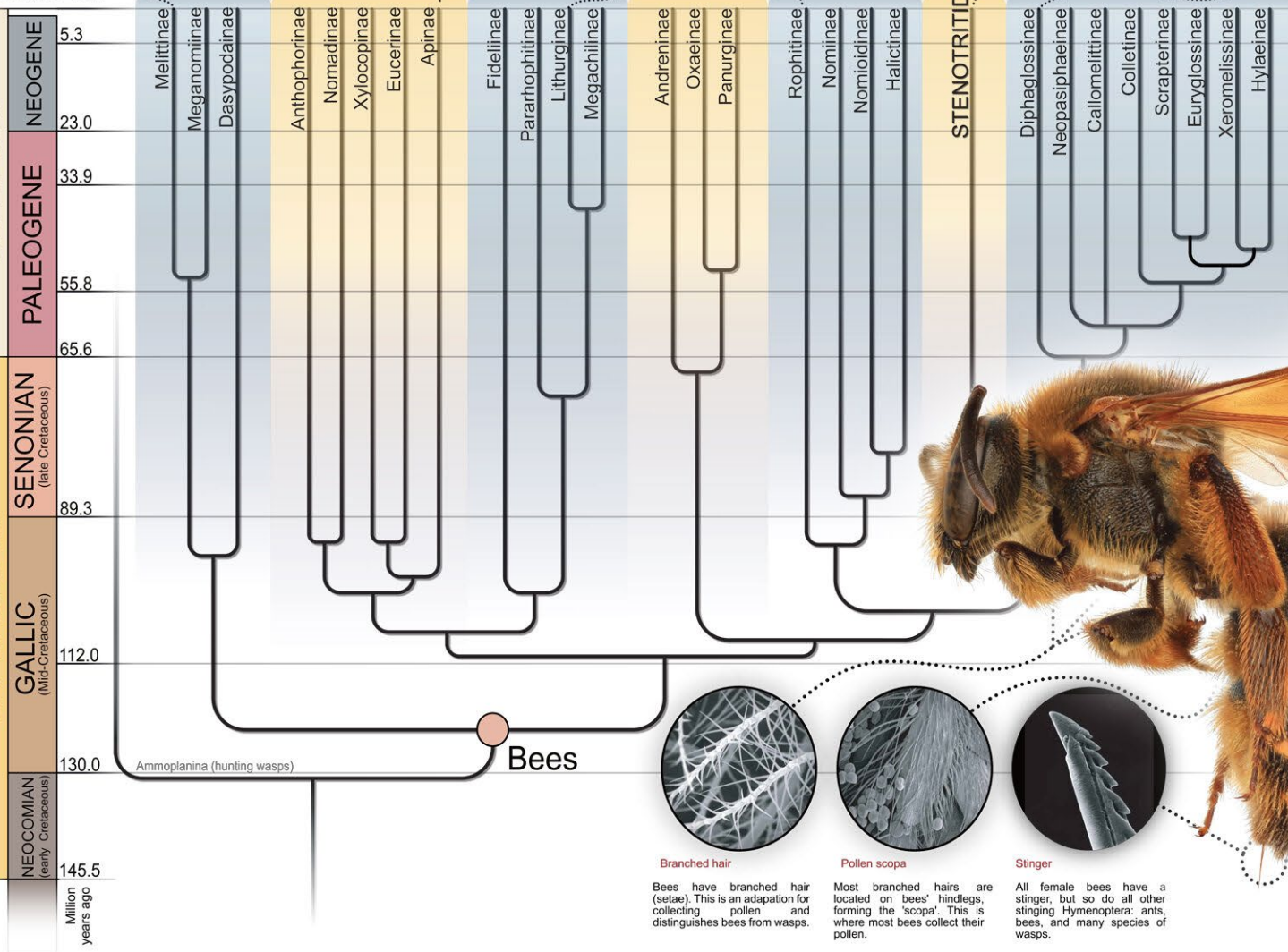


*Caupolicana yarrowi*  
A crepuscular bee from the Southwestern US

today - modern Earth

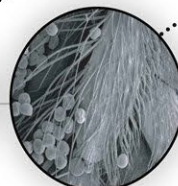
CENOZOIC

CRETACEOUS



Branched hair

Bees have branched hairs (setae). This is an adaptation for collecting pollen and distinguishes bees from wasps.



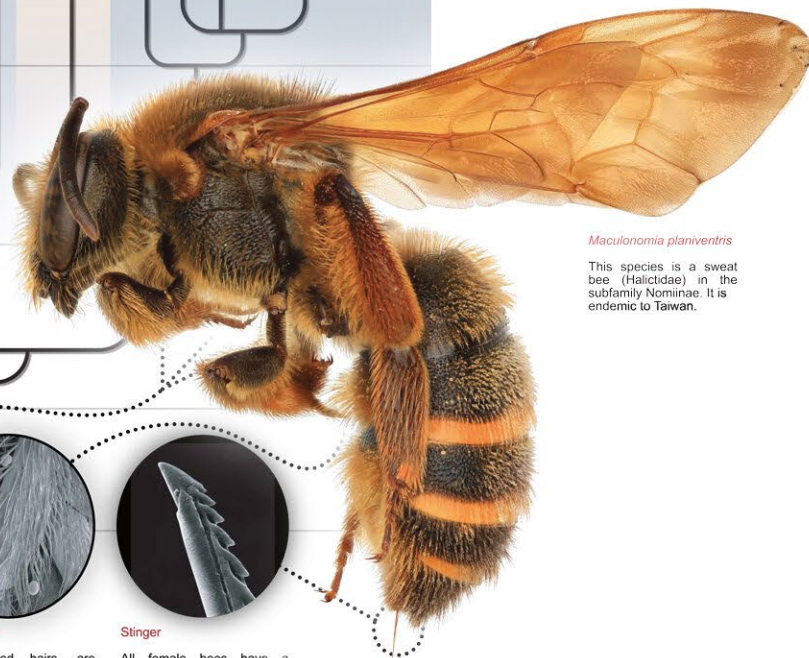
Pollen scoop

Most branched hairs are located on bees' hindlegs, forming the 'scoop'. This is where most bees collect their pollen.



Stinger

All female bees have a stinger, but so do all other stinging Hymenoptera: ants, bees, and many species of wasps.

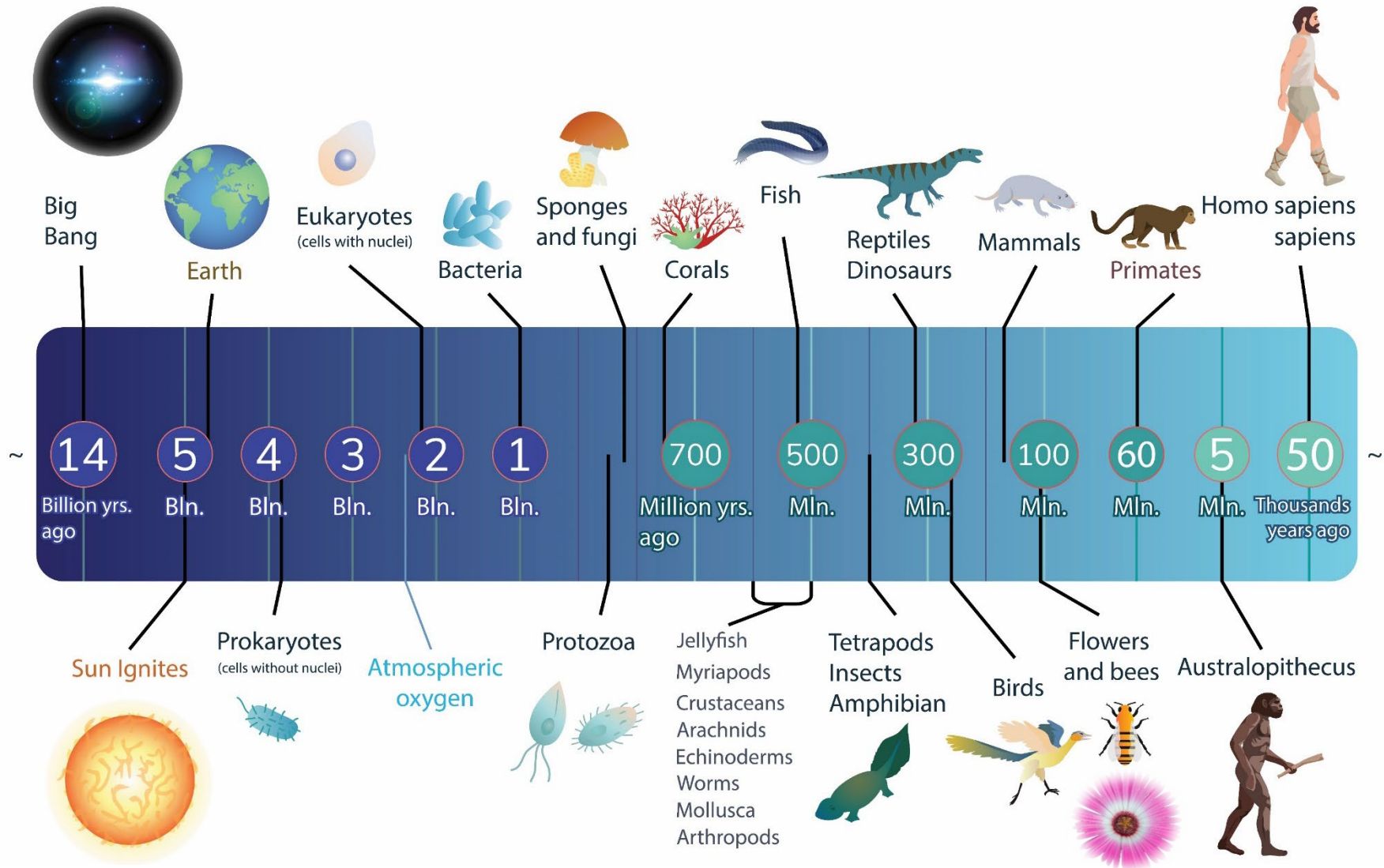


*Maculonoma planiventris*

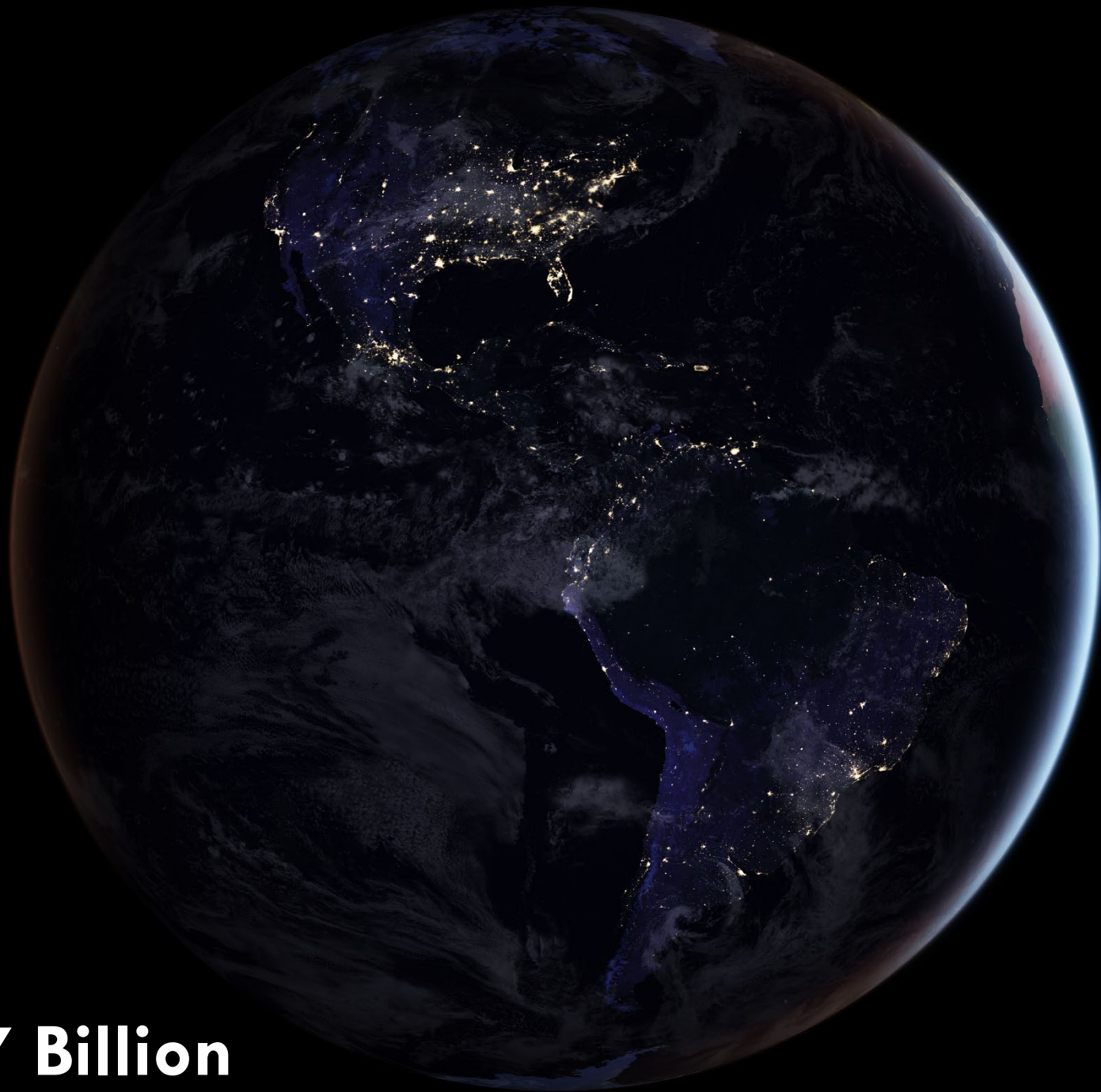
This species is a sweat bee (Halictidae) in the subfamily Nominae. It is endemic to Taiwan.

# Pollinating insects and angiosperms

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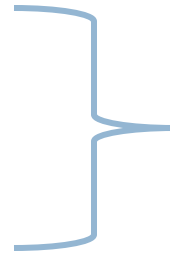




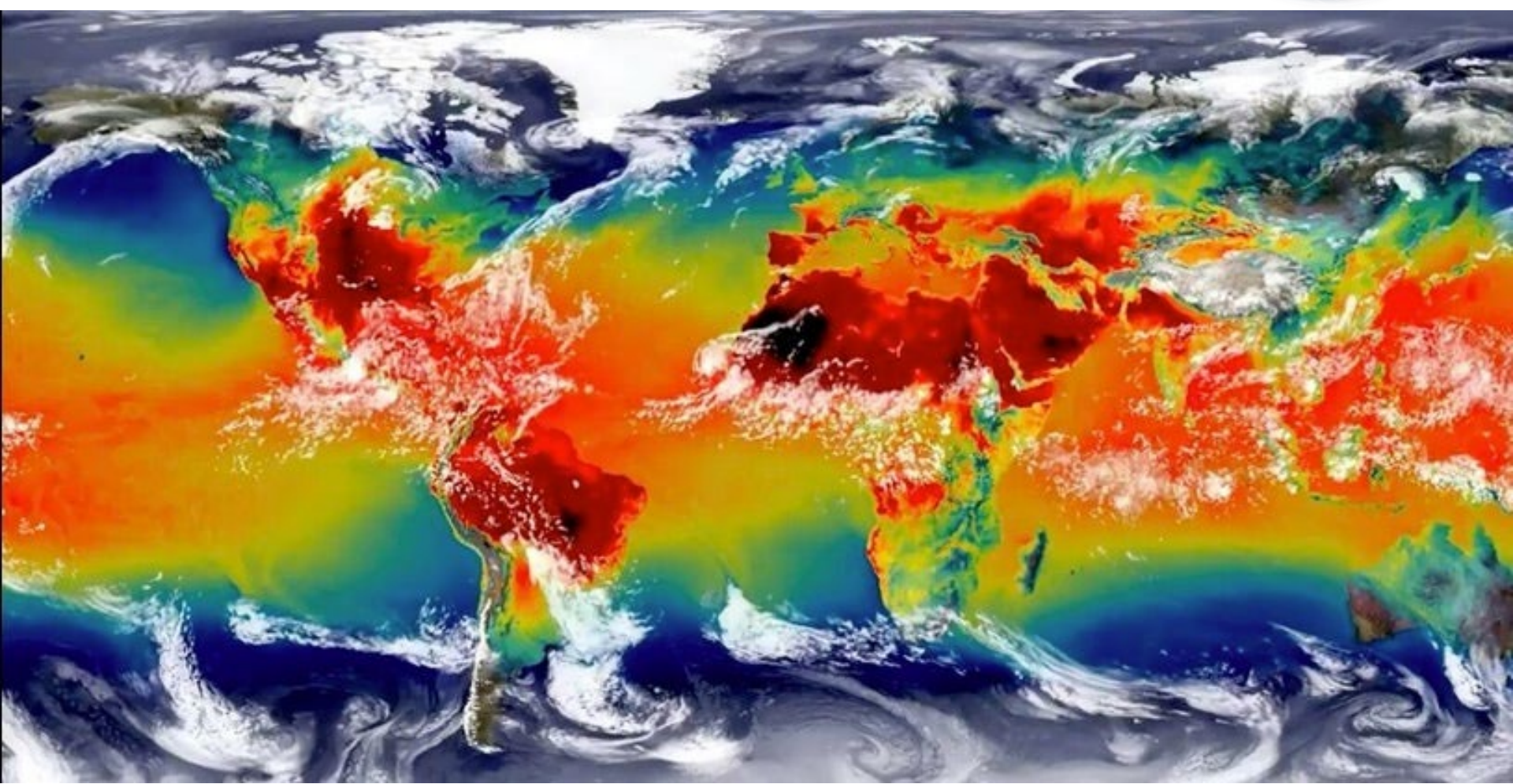


**7.87 Billion**

**Natural causes**  
**Human causes**



**Climate  
change**

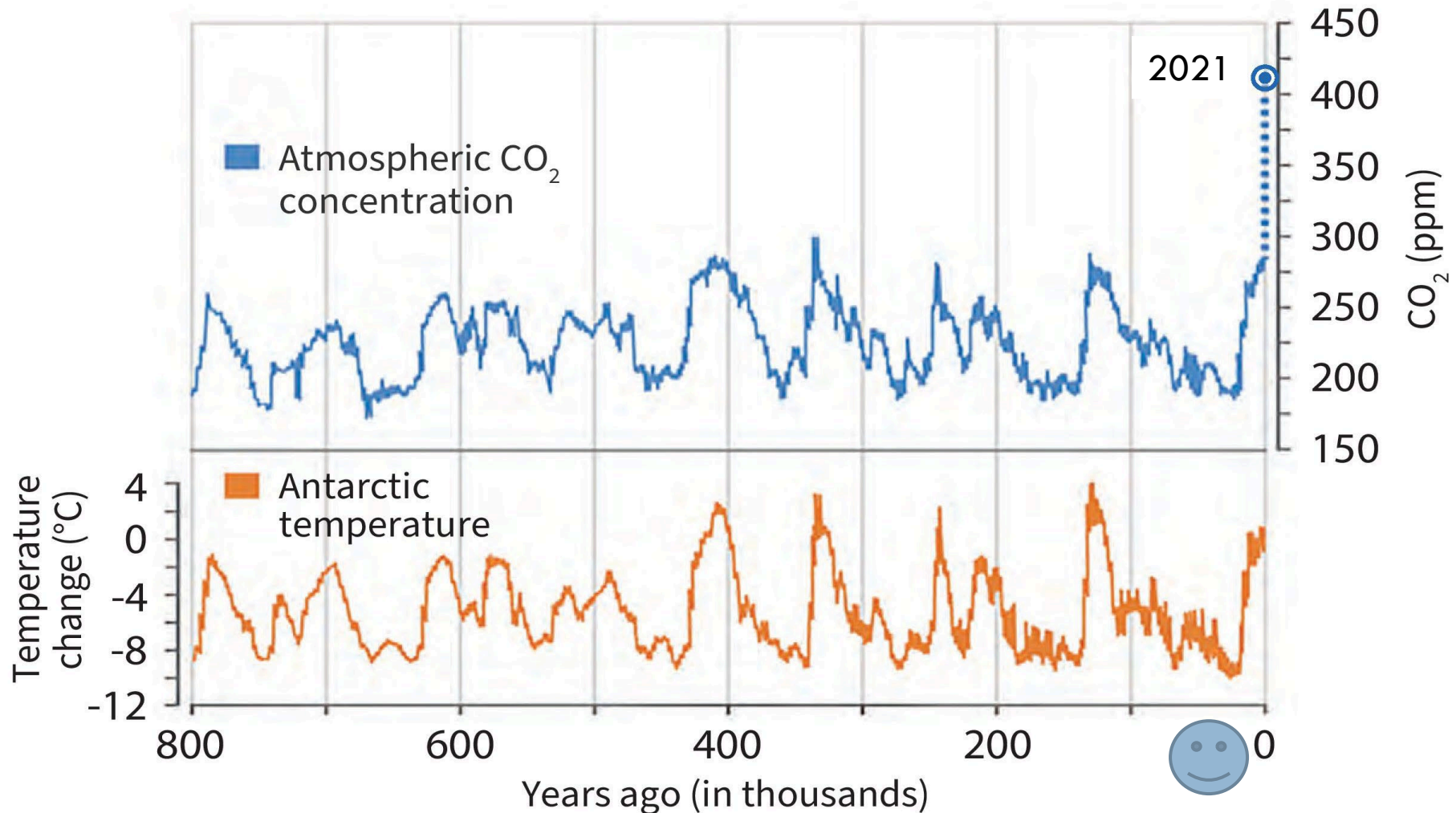




# Change

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Adapted from figure by Jeremy Shakun,  
data from Lüthi et al., 2008 and Jouzel et al., 2007.

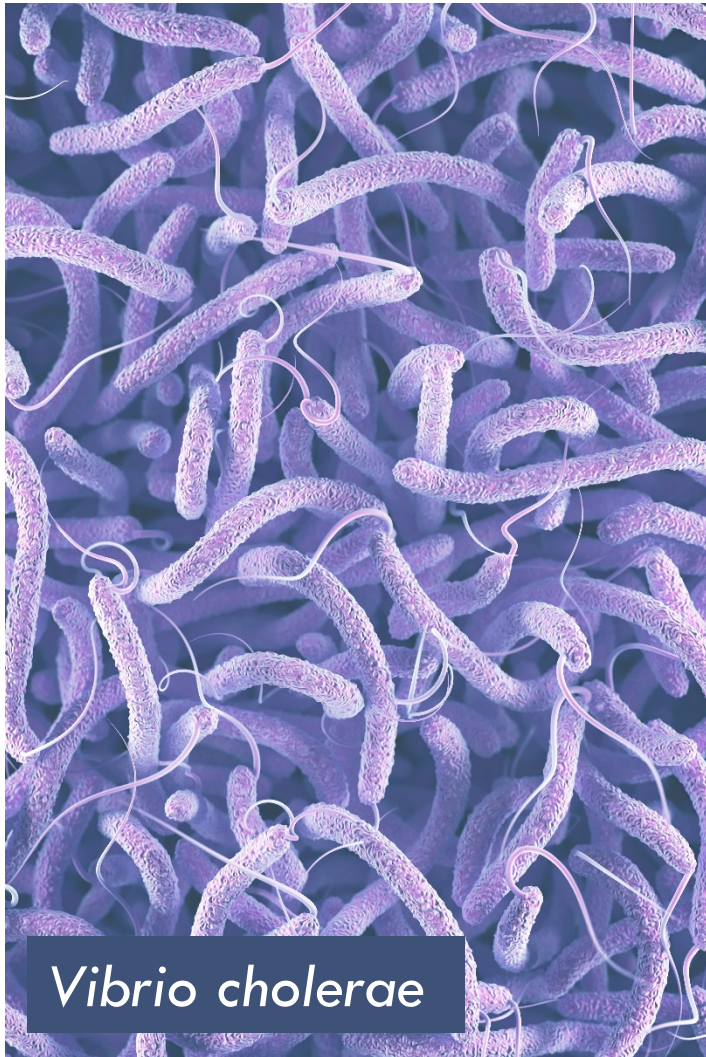




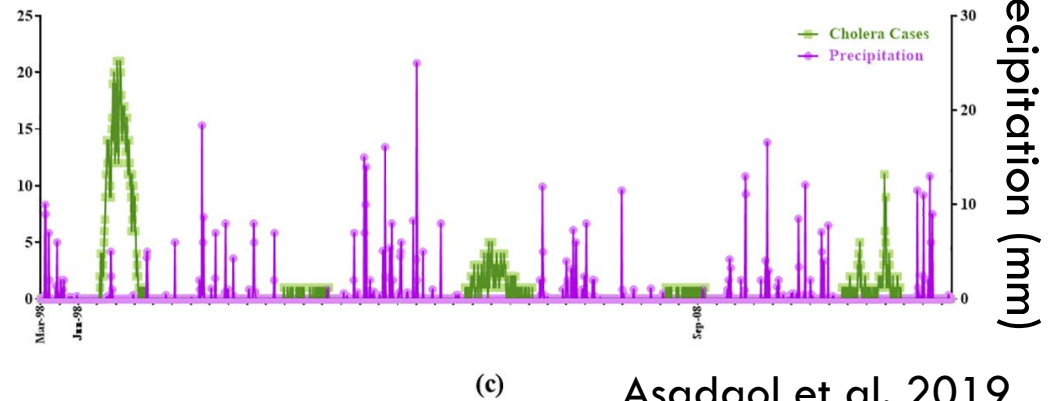
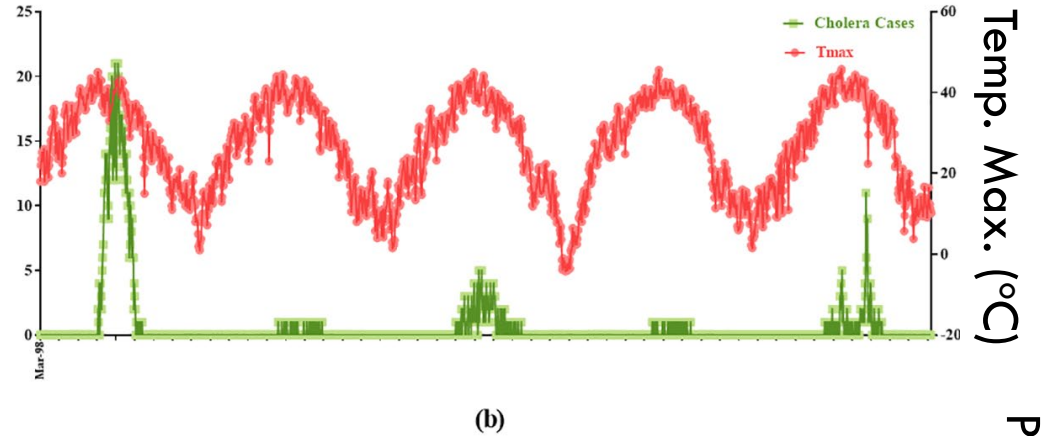
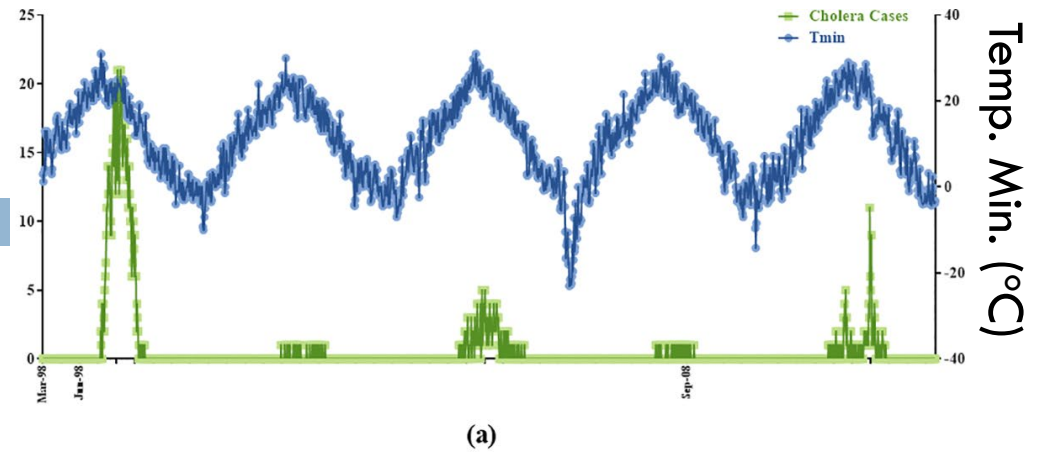


# Climate and Disease

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Number of cholera cases



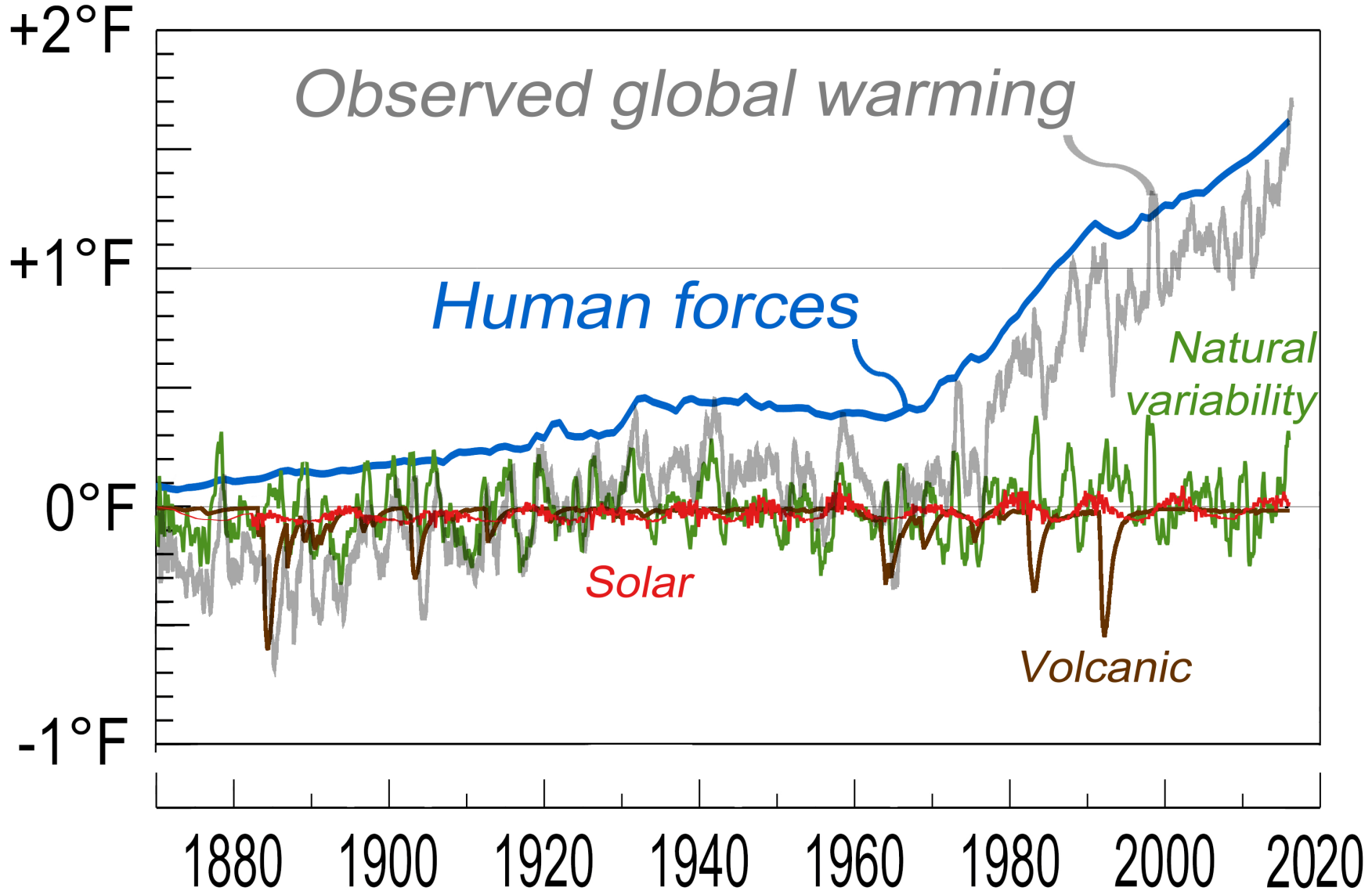
Asadgol et al. 2019



# Accelerating change

Adapted from USGCRP 2017

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# Biodiversity - living variation, including genes, species and ecosystems

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# Climate resilient sites - ecological diversity & degree of human modification

The Nature Conservancy



*Indigenous Lands: This analysis was conducted throughout the continental United States using publicly available data and academic resources. However, the results have not yet been reviewed by members of the sovereign indigenous nations of the U.S. For more information or to request access to the data on these lands please contact [escience@tnc.org](mailto:escience@tnc.org).*

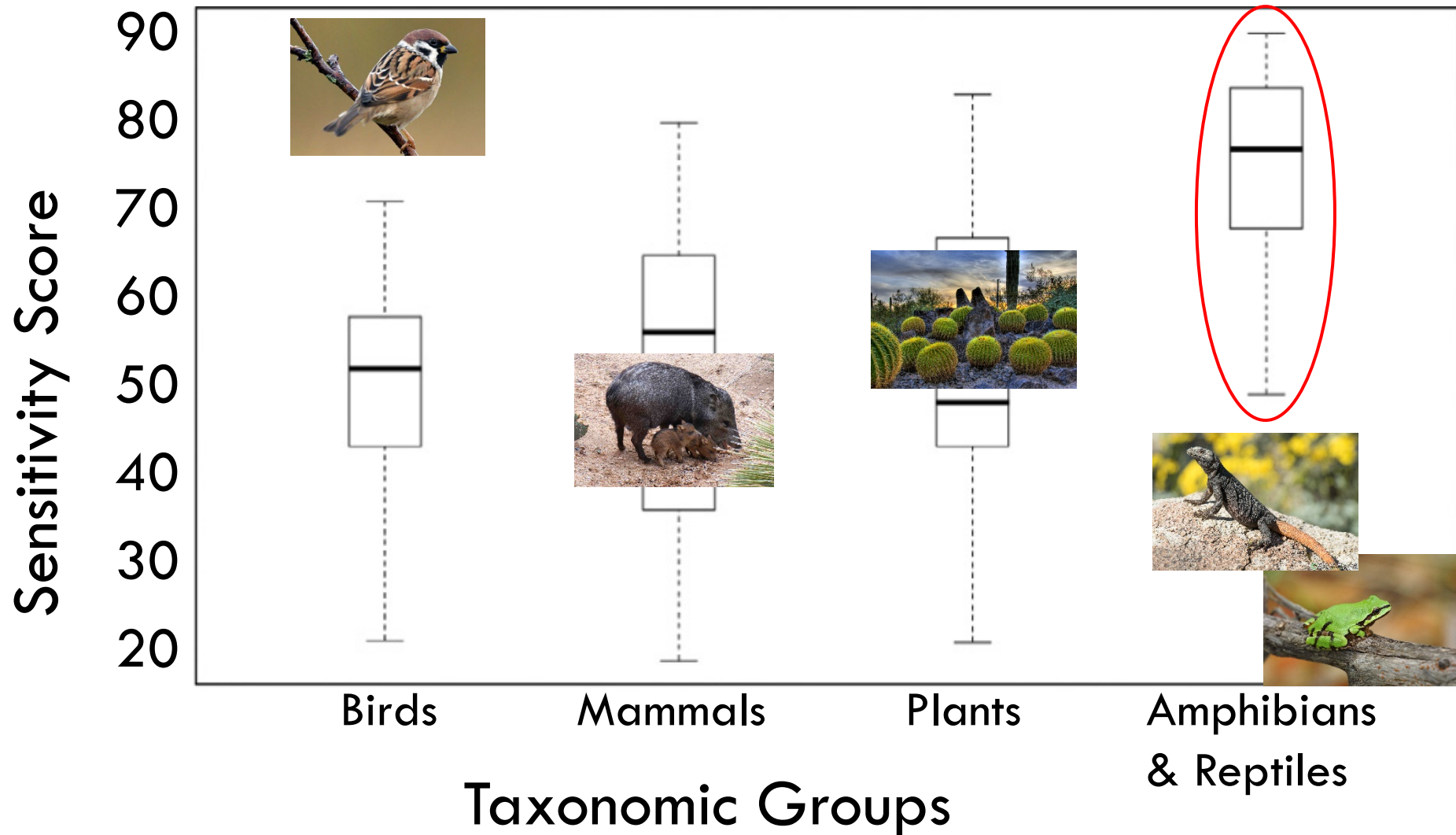




# Some things are more sensitive than others

Case et al. 2015

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# Sensitivity to climate change

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- Resource generalist or specialist,
- Physiology,
- Dependence on sensitive habitats,
- Dependence on disturbance regimes,
- Life-history,
- Natural dispersal,
- Ecological relationships,
- Interacting stressors,
- Geographic range,
- Population dynamics.

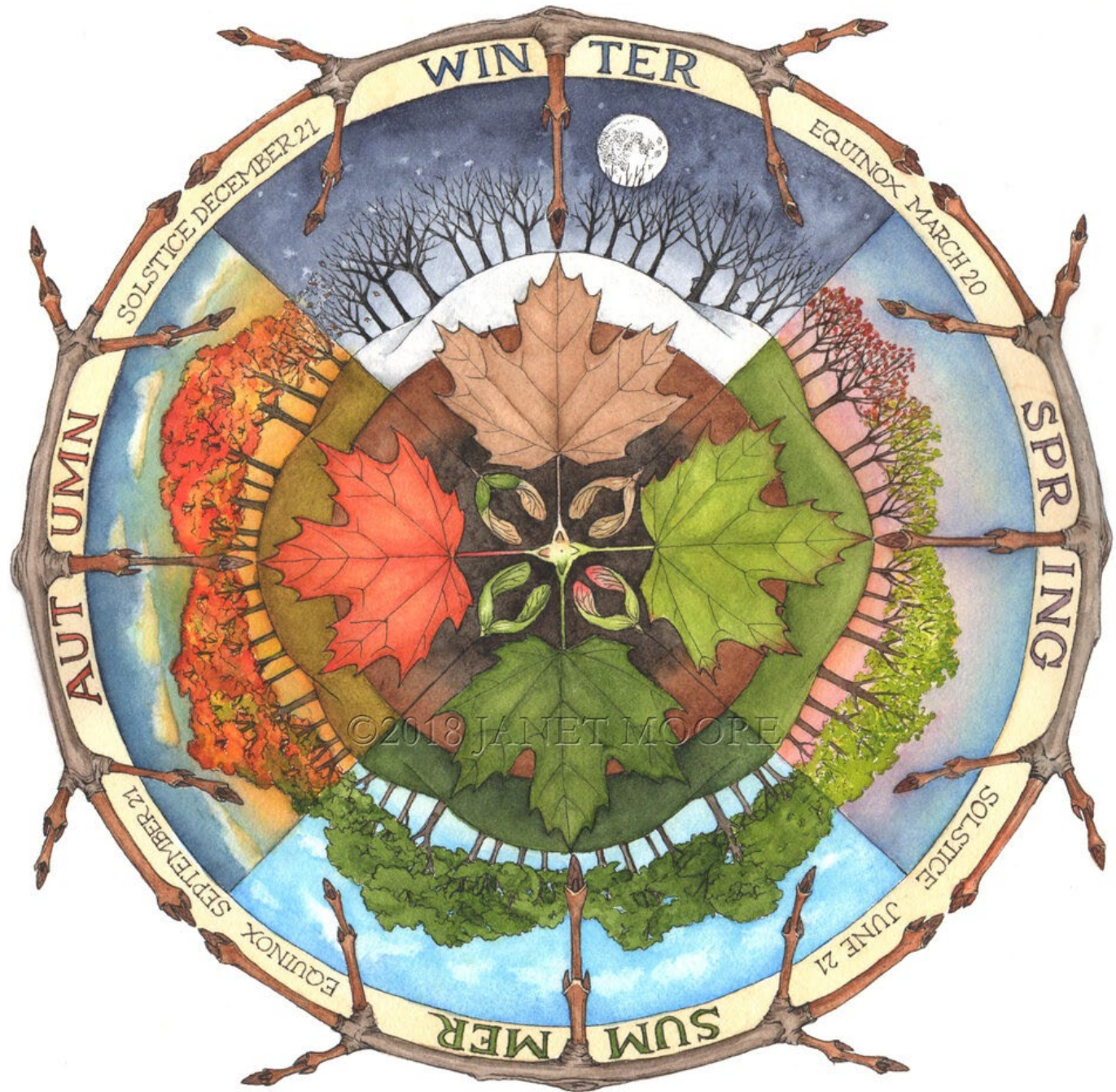
*Melissodes* ?





# Phenology

- study of cyclic and seasonal natural phenomena in relation to climate and plant and animal life







# Plant–pollinator interactions

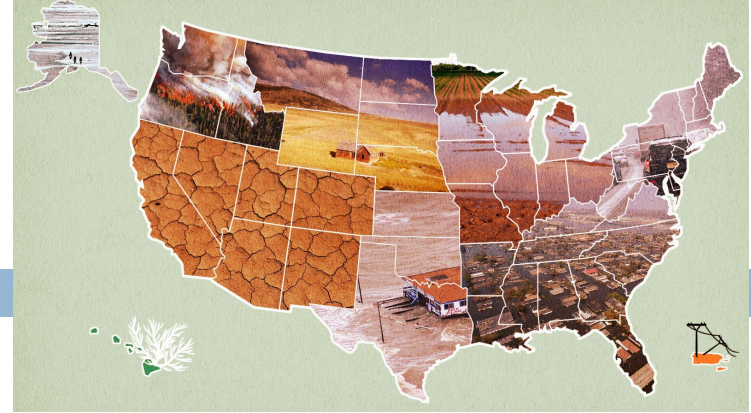
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# Global climate change effects

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## □ Northeast:

□ Increasing heat waves, heavy downpours, and sea level



Hemlock woolly adelgid

□ Declining protective infrastructure, agricultural yields, and fisheries





# Global climate change effects

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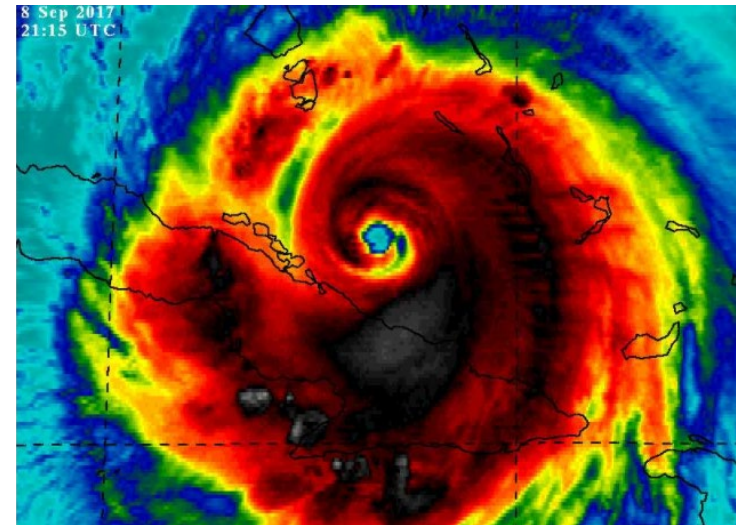


## □ Southeast:

- Increasing extreme heat, storms, sea levels
- Widespread threats to the region's economy, environment, negative health



- Declining reliable energy, agricultural yields, and water availability





# New Orleans increasing mosquito populations

25

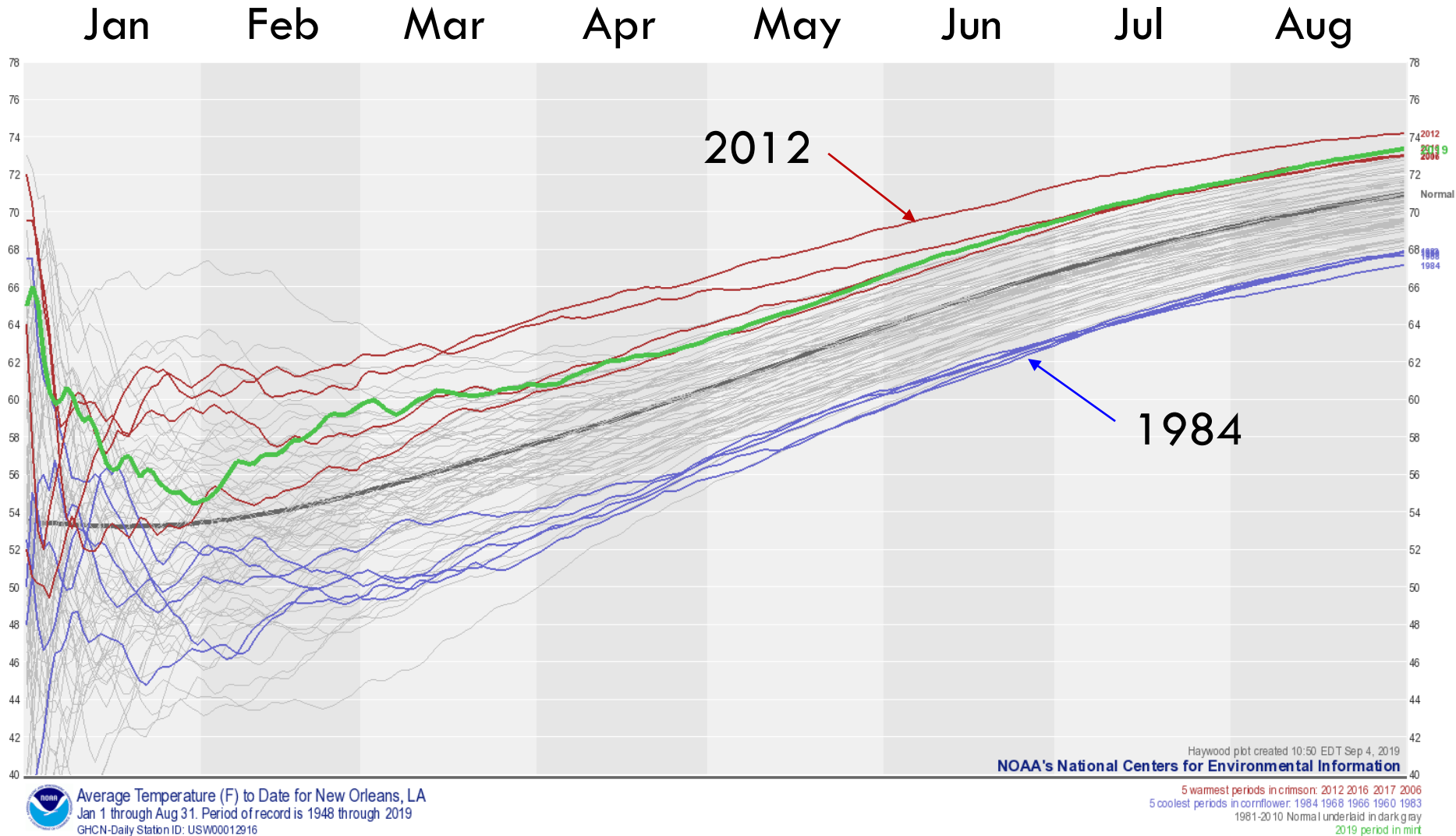




# Average temperature Jan-June 2012

## 5.2°F warmer than average

26





# Global climate change effects

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## □ Midwest:

- Increasing extreme heat, heavy rain and flooding
- Increased crop disease, pests, toxic algal blooms in freshwater
- Declining protective infrastructure, health, agricultural yields, forestry, reliable transportation, air and water quality





# Global climate change effects

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## □ Northern Great Plains:

- Increasing heat, shorter warmer winters
- Declining mountain snow, decreasing rain
- Declining water availability, loss of forest land
- Increasing forest fires



Mountain pine beetle



# Global climate change effects

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## □ Southern Great Plains:

- Increasing heat waves, tornadoes, drought, ice storms, hail, flooding, hurricanes
- Longer and hotter summers - year-round pests
- Declining aquifer reserves & water availability, human health, crop yields
- Increasing sea-level

*Aedes aegypti*





# Global climate disaster

30



## □ Alaska:

- Increasing ocean acidification, wildfires, coastal flooding, drought
- Increasing yellowjacket wasps & spruce beetle



- Decreasing permafrost
- Declining shellfish, marine life, spruce forest







# Global climate disaster

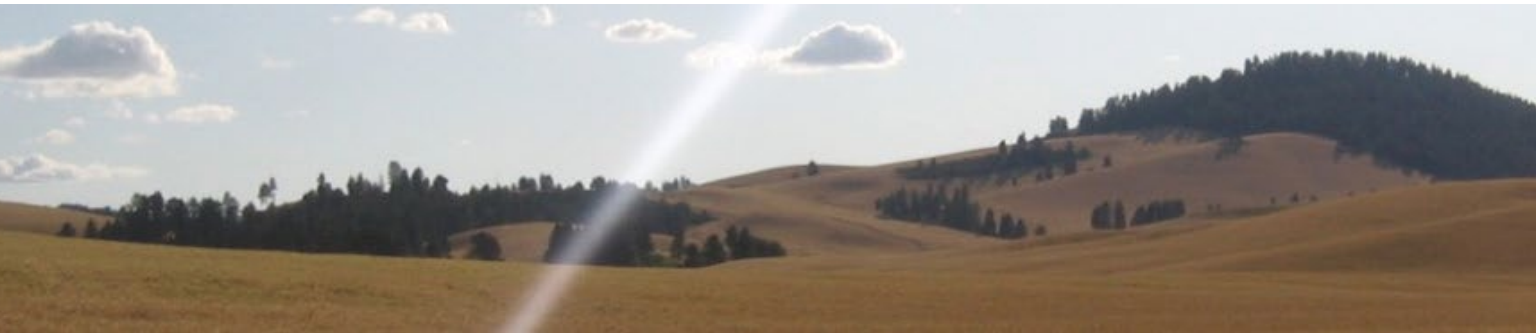
32

## □ Pacific northwest:

- Changes in the timing of streamflow
- Increasing winter temperature, rain, wildfire, insect outbreaks, sea level, erosion, inundation, ocean acidity, tree diseases & die-off
- Declining water supplies for farmers, salmon, protective infrastructure



Douglas-fir beetle galleries



# Global climate disaster

33

## □ Hawaii & Pacific Islands:

- Increasing sea levels, ocean acidification, drought, flooding, extreme temperatures, algal blooms, erratic rainfall
- Increasing invasive species – decreasing biosecurity
- Decreasing water availability & human health
- Declining nesting seabirds, turtles, seals, fish and coastal plants



Invasive nettle caterpillar





# Southwestern U.S.

34

- Increasing heat, drought, insect outbreaks, wildfires, flooding, erosion of coastal areas
- Declining water availability
- Negative human health, economy, and quality of life impacts



# Hottest years on record and “fastest warming” cities

35

- 1) Las Vegas, NV has risen  $5.76^{\circ}\text{F}$
- 2) El Paso, TX has risen  $4.74^{\circ}\text{F}$
- 3) Tucson, AZ has risen  $4.48^{\circ}\text{F}$
- 4) Phoenix, AZ has risen  $4.35^{\circ}\text{F}$





# Phoenix 2020

36

- 130 days  $> 100^{\circ}\text{F}$
- 53 days  $> 110^{\circ}\text{F}$
- July 2020
- 14 days  $> 115^{\circ}\text{F}$

**hottest  
month  
ever**









# Climate and human disease

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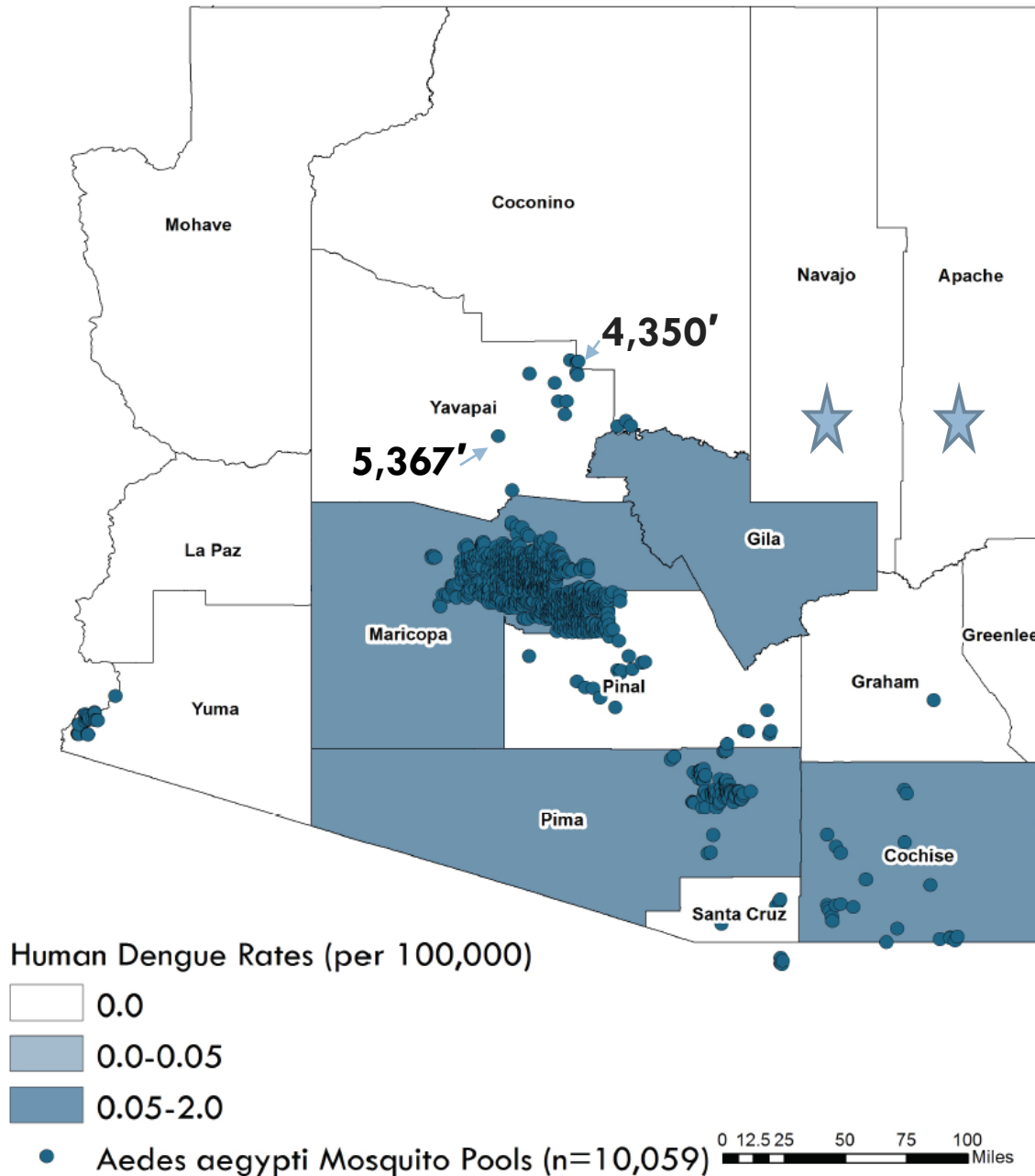


# Climate-sensitive arthropod vector changes

39

- Spatial distributions, seasonal cycles – disease incidence





\* Traps set in the same location at different times are displayed only once in the map.

**No *Aedes aegypti* over 5,500 feet elevation?**



# *Aedes aegypti*

41



## □ Yellow fever mosquito

- Zika, dengue, chikungunya, yellow fever viruses (sick - **humans** & other primates)
- Sensitive to freezing





# Ticks and tick-borne diseases are inherently climate-sensitive due to the sensitivity of tick lifecycles to climate

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- Survival of individual ticks,
- Duration of development and host-seeking activity

*Amblyomma  
maculatum*

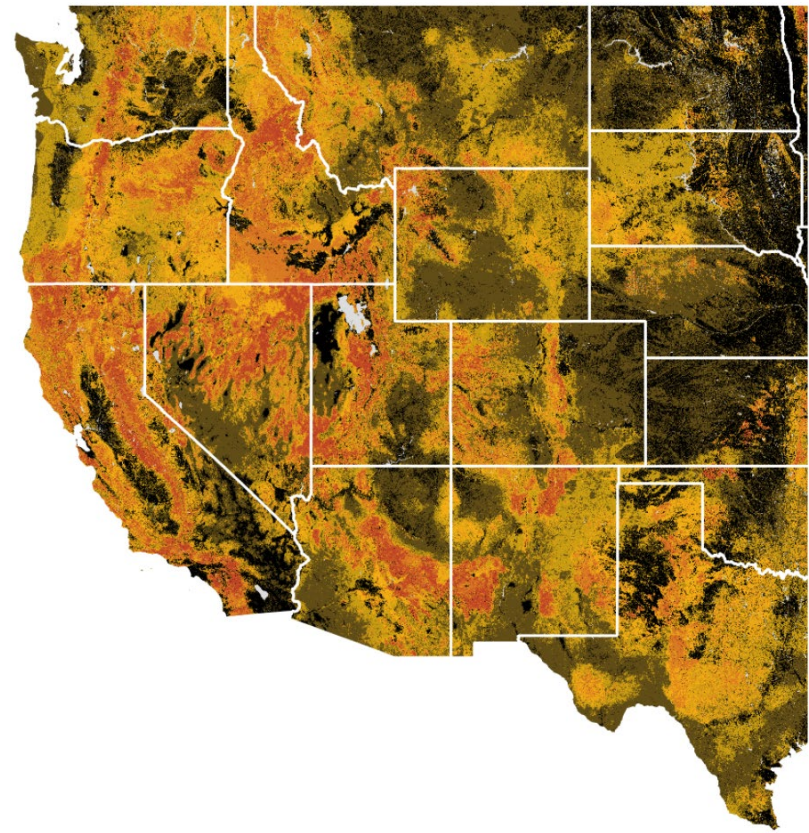
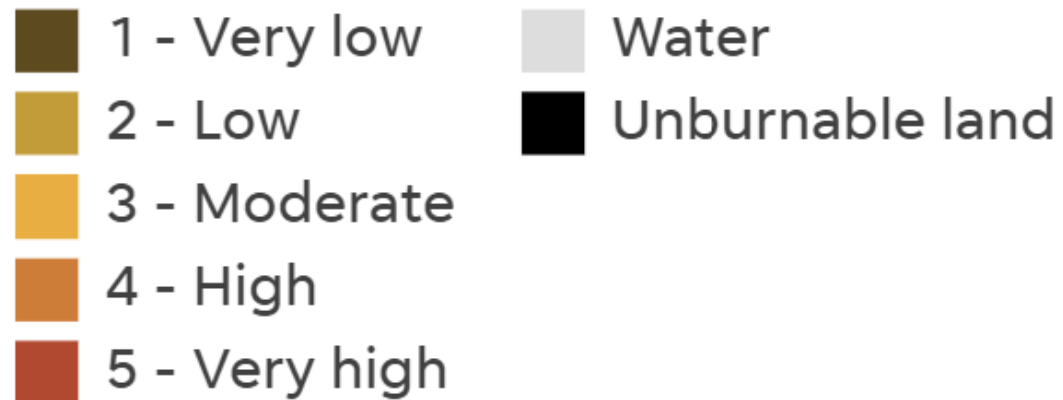


# Disasters in the West

43

- Increasing incidence of:
  - thunderstorms,
  - flash floods,
  - drought,
  - dust storms
  - **wildfire**

## Wildfire hazard potential rating

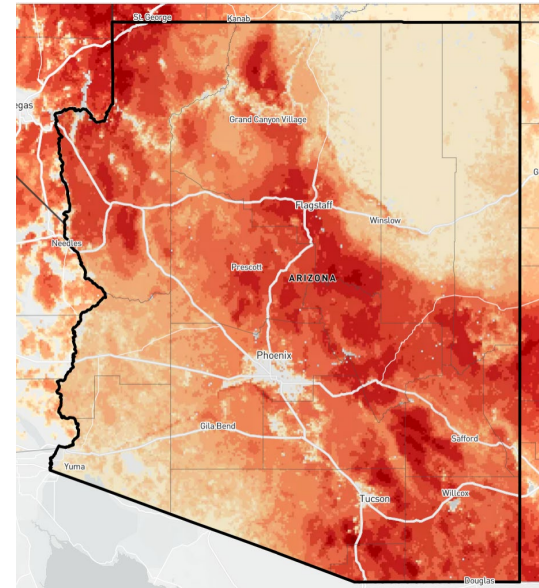




# Arizona risk of wildfire 2019

44

- Arizona Department of Forestry and Fire Management did a wildfire risk assessment of more than 500 communities
- 42% high risk
- 44% moderate risk



- <https://wildfirerisk.org/explore/2/04/>



# Wildfire & bark beetles

45

- Do fires cause bark beetle outbreaks?
- Do bark beetle outbreaks cause fire?

**Sometimes**







# Fires sometimes increase bark beetle populations by weakening trees

46

1. Must be undamaged inner bark
2. Fires occur when beetles can infest trees
3. There are beetles close by
4. Post-fire weather is conducive
5. Beetle and tree specifics

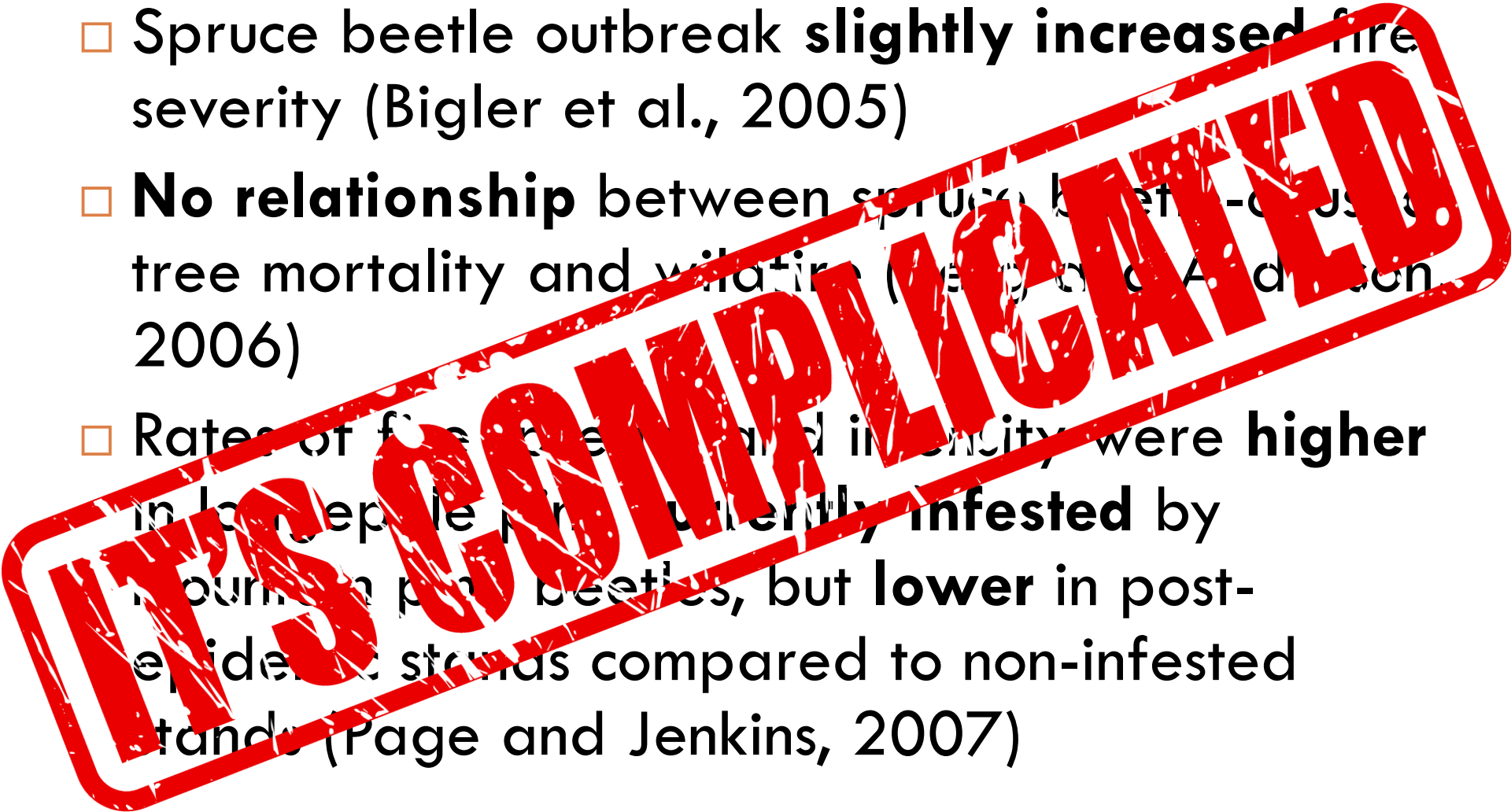




# Bark beetle outbreaks sometimes increase the chance of future fires

47

- Spruce beetle outbreak **slightly increased** fire severity (Bigler et al., 2005)
- **No relationship** between spruce beetle-caused tree mortality and wildfire (Page and Addison, 2006)
- Rates of fire occurrence and intensity were **higher** in large-scale previously infested by mountain pine beetles, but **lower** in post-epidemic stands compared to non-infested stands (Page and Jenkins, 2007)







# Southwestern U.S. – bark beetle damage

48



*lps* spp.

Lake Mead



# A story about too much water



# New Orleans 2005

50

- Powerful winds of hurricane Katrina caused Lake Pontchartrain to flood over 80% of the city, claiming 1,833 lives



# Hurricane Katrina 2005

51

- Interaction of natural forces and failure of storm and flood protection structures in New Orleans





# Hurricane Katrina & Rita 2005

52

- 26 days later Hurricane Rita

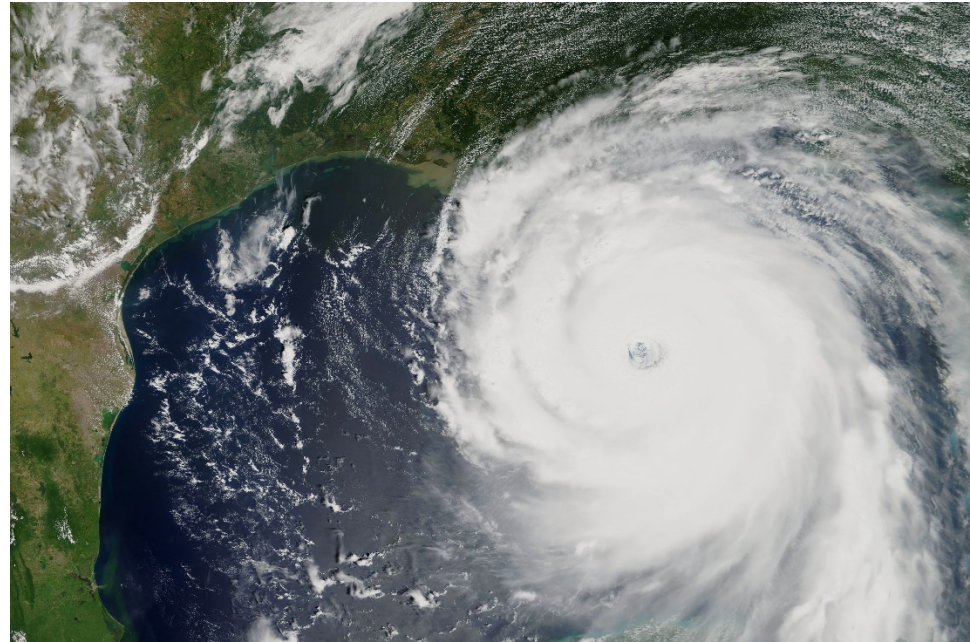




# Response

53

- ❑ Delayed medical aid
- ❑ 40% residents spent 24 hours “on the street”
- ❑ 35% residents were trapped in homes
- ❑ 48 hours critical-needs assessments





# What happens to people during a disaster?

54

- ❑ Loss of life
- ❑ Disconnected
- ❑ Stranded
- ❑ **Displaced**
- ❑ Can not access emergency services
- ❑ Can not access necessities – water, food, shelter
- ❑ Injuries and illness
- ❑ **Congregate** where resources exist - water, food, shelter, each other



# What happens to pests during a disaster?

55



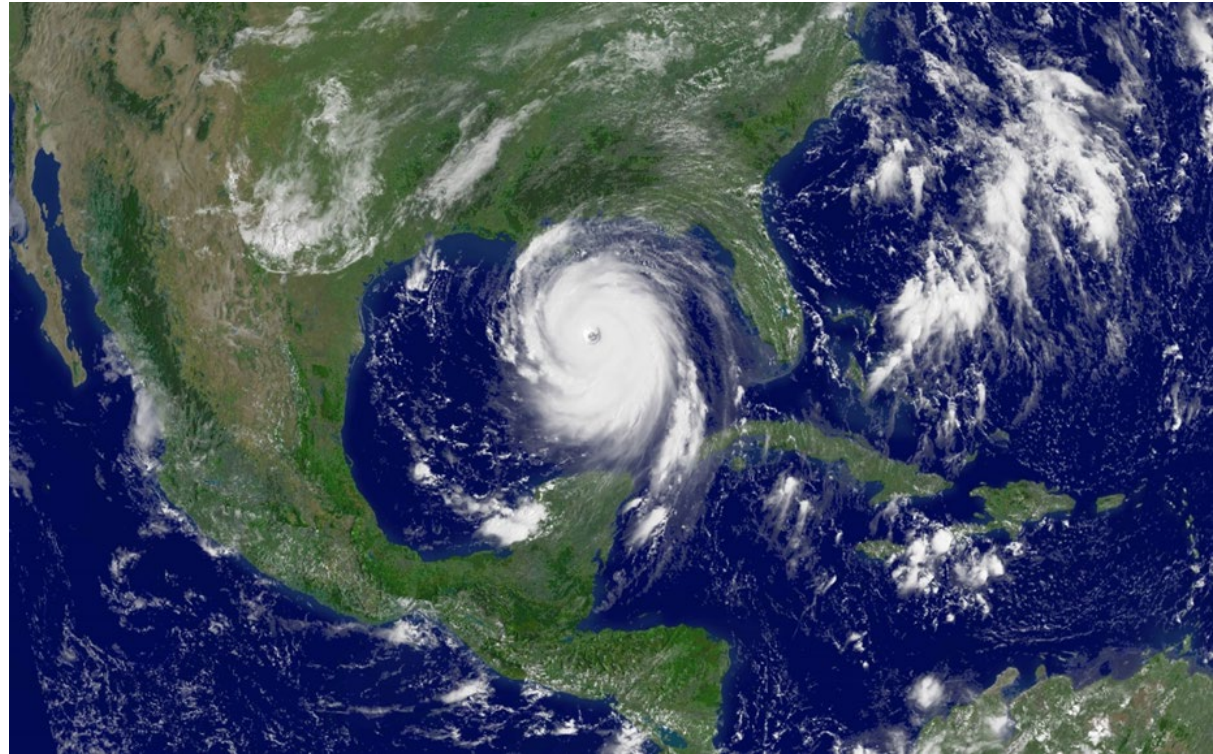




# Unfounded concerns

57

- Exposure to dead bodies is not automatically a disease risk
- Mosquitoes do not feed on dead bodies







# But.....

59

- ❑ Disasters can soon expose people to disease-carrying pests

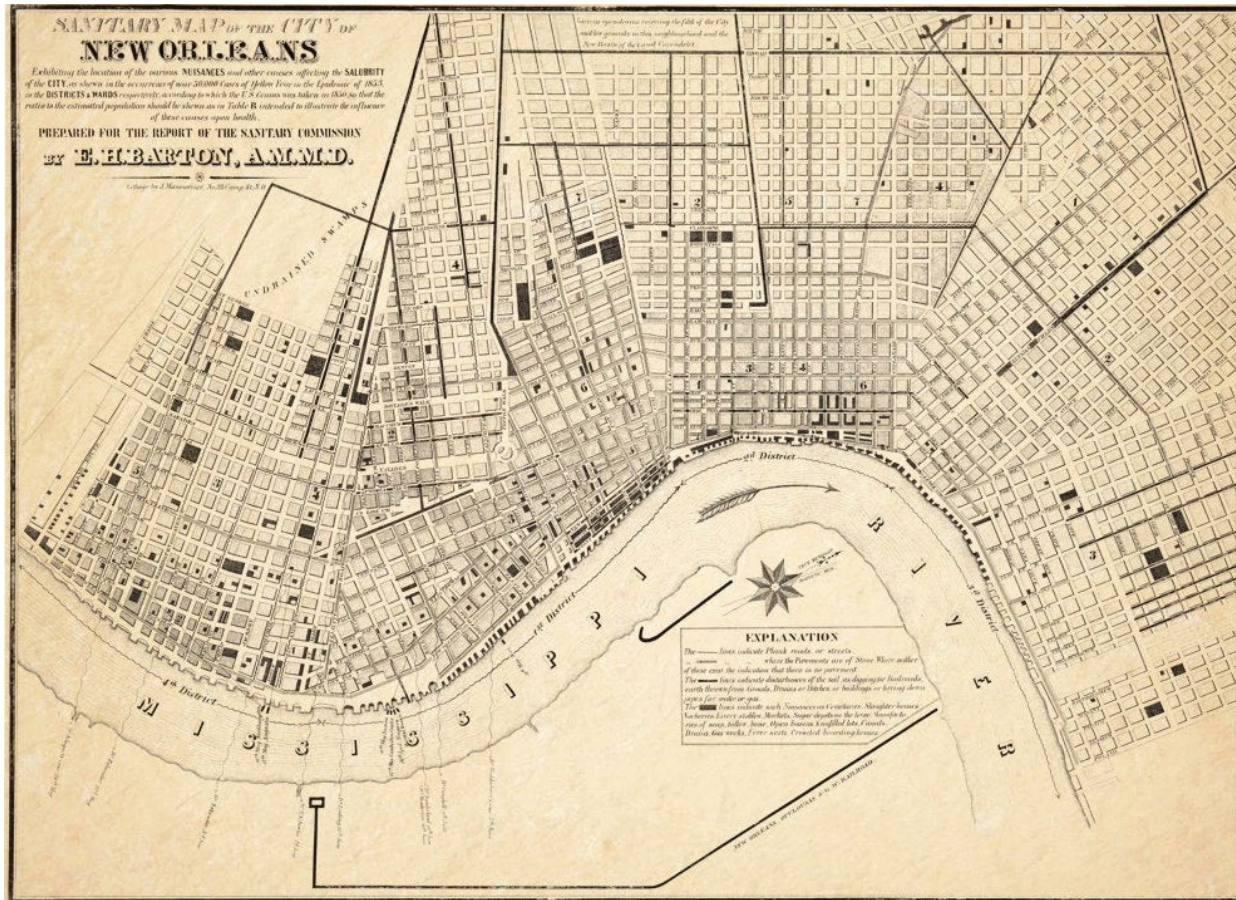




# Historic *Aedes aegypti* presence in New Orleans

60

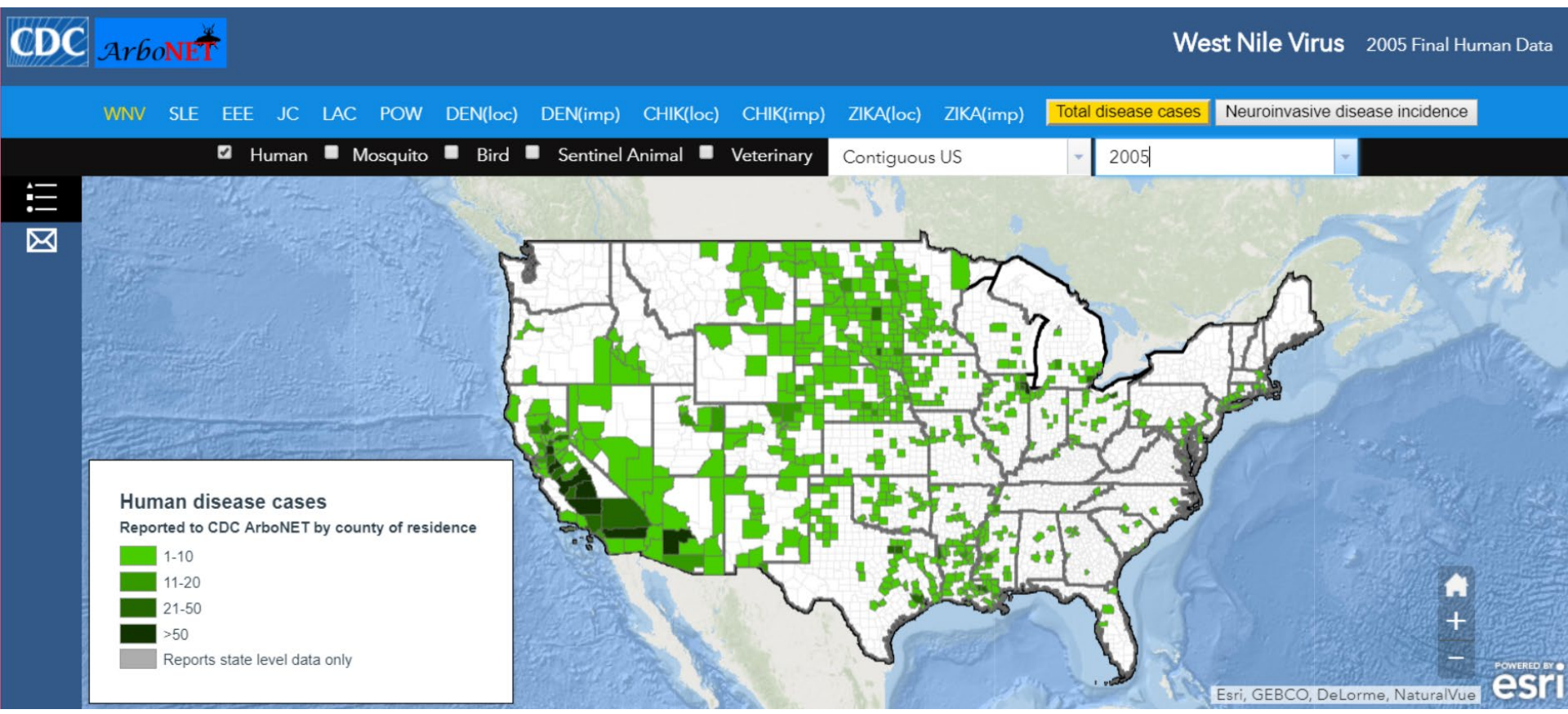
- Historical yellow fever outbreaks
- 1905 – last yellow fever epidemic in U.S.
- Dengue
- Chikungunya
- Zika



# West Nile virus

61

- Documented in New York 1999
- Spread across the country by 2005



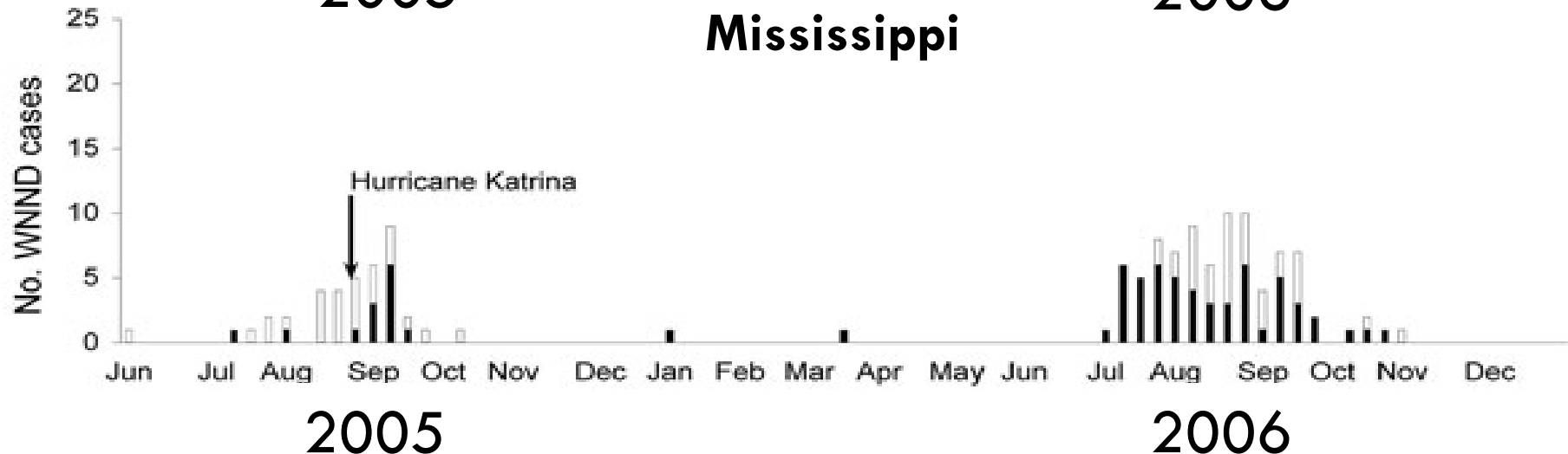
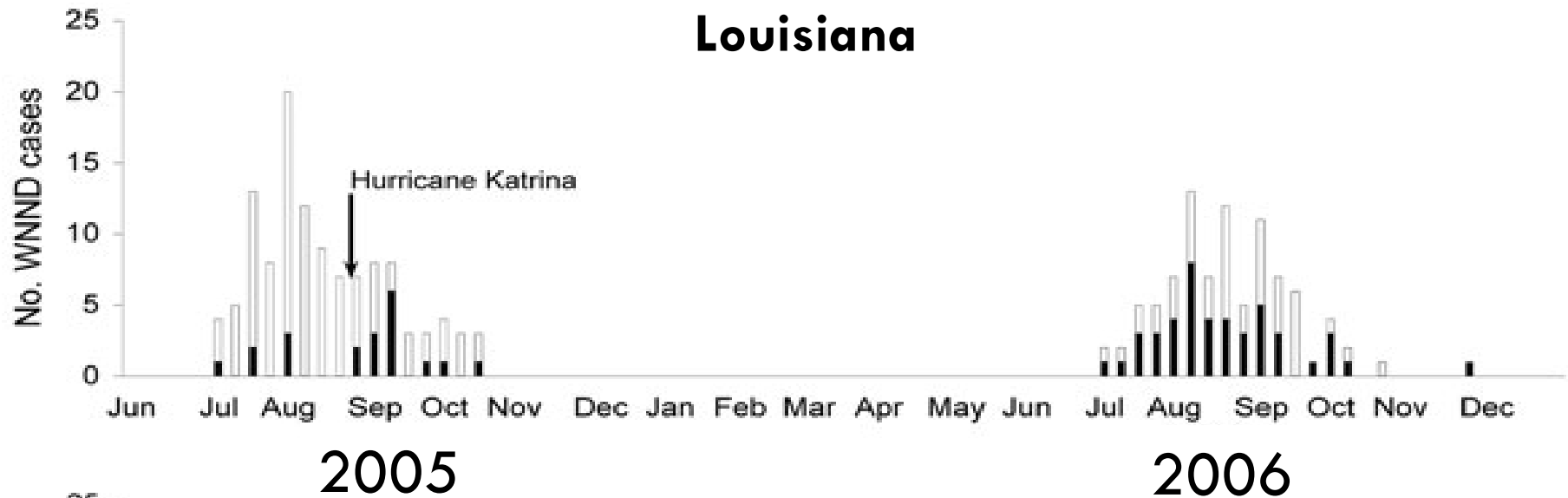




# West Nile neuroinvasive disease after Katrina

## Hurricane-affected parishes and counties – black bars

62



# Actual documented pest outbreaks

63

- ❑ **Mosquitoes – WNV – WN Fever & WN Neuroinvasive Disease**
- ❑ Filth flies
- ❑ Head lice, body lice, bed bugs, scabies
- ❑ Rodents (leptospirosis risk)







# Before the Swarm – guidelines for the emergency management of mosquito-borne disease outbreaks

64

- ☐ Use the best science and data
- ☐ Have a response plan for a Mosquito-Borne Epidemic Emergency
  - ☐ Inform citizens
  - ☐ Involve others
  - ☐ Plan ahead

# During the 'anthropause'







# Frog in pot

66

Is this us?



# Call to action

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Climate change is a global health emergency that threatens to deepen global health inequities, destroy communities, cultures and environmental stability.





# Thank you

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# Resources

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Calculate your Carbon Footprint <https://www3.epa.gov/carbon-footprint-calculator/>

Climate news <https://www.climate.gov/news-features>

Water Resources Dashboard <https://www.climate.gov/news-features/decision-makers-toolbox/water-resources-dashboard>

Climate and Health <https://www.cdc.gov/climateandhealth/BRACE.htm>

## Ten Tips:

- Eat more plant-based food.
- Bike, carpool, reduce your road miles, trade in gas guzzlers.
- Recycle responsibly.
- Buy energy efficient appliances and lightbulbs.
- Reduce water use (xeriscape, etc).
- Use solar power.
- Install programable thermostats at home.
- Investigate the consumables you buy.
- Keep up to date with the issues and communicate your stance to political leaders.
- Join a group.