Water and Human Health

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Goals of Presentation

1. Importance of issue,
2. Need to expand scope of water-based information related to health
3. Useful approaches

Globally

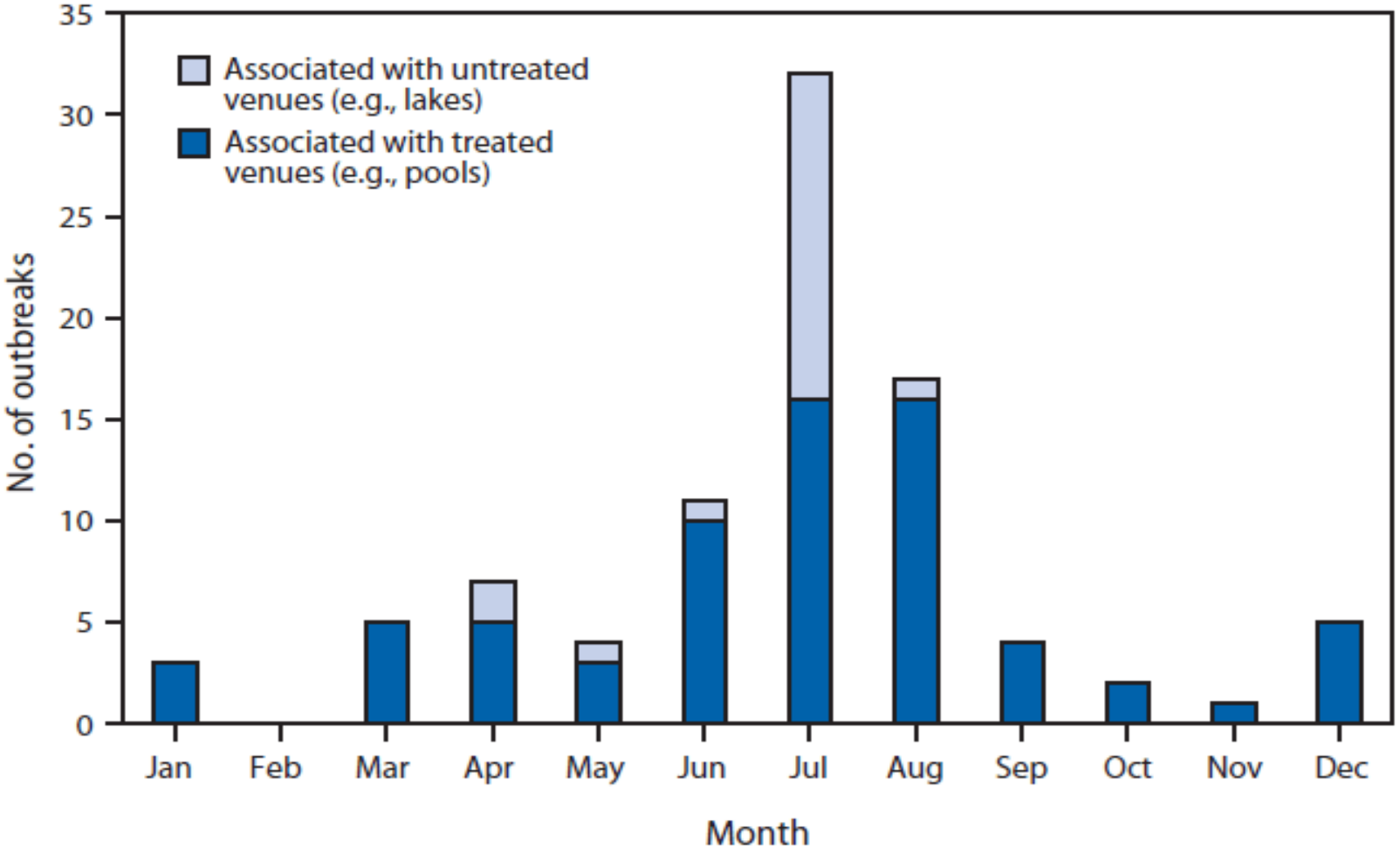
- 1/3 of world's population lives with water stress
- > 1 billion lack access to safe water supplies
- 2.6 billion lack adequate sanitation
- Water-associated infectious diseases kill 3.2 million/yr (6% of all deaths).

United States

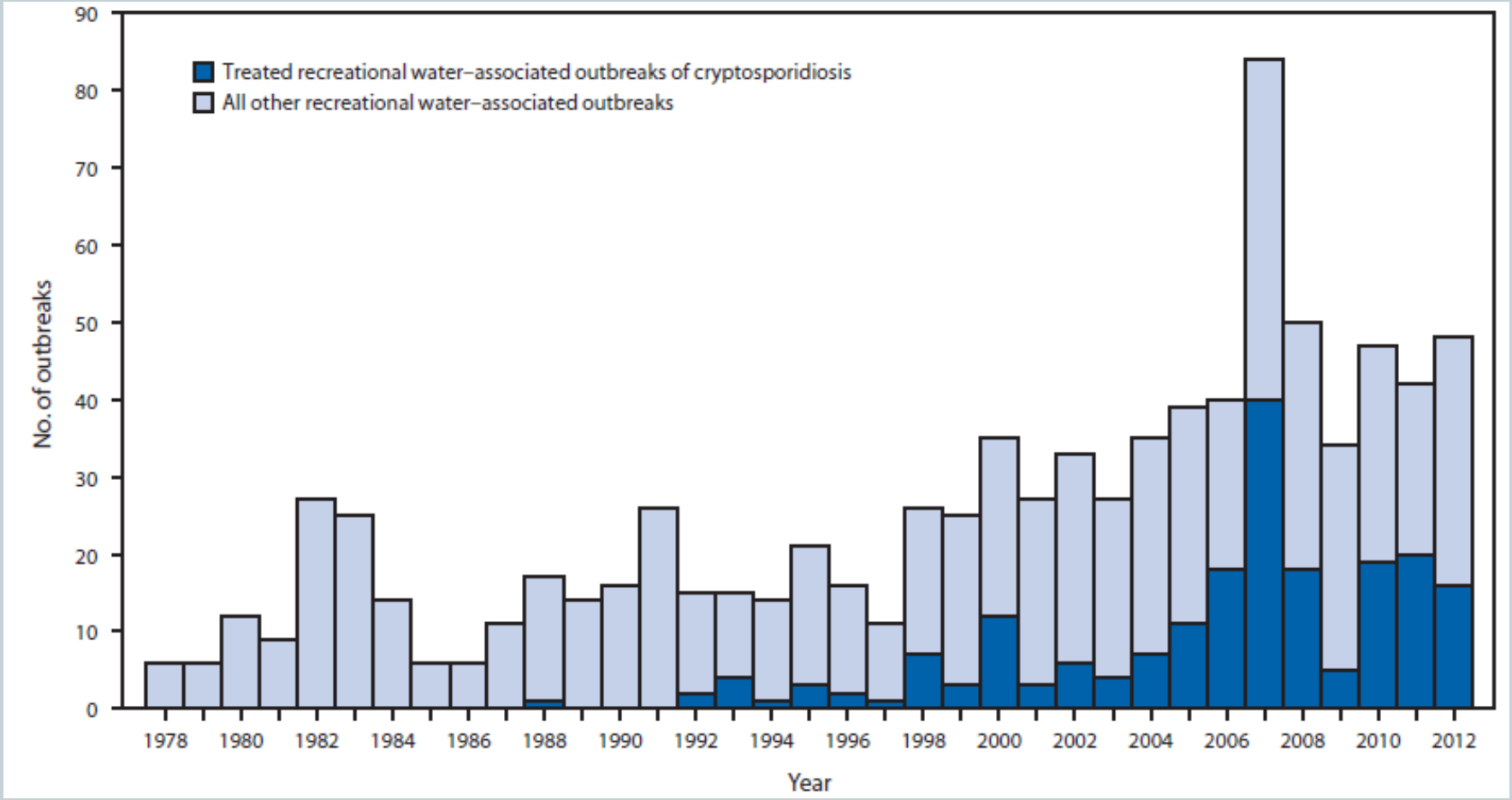
- 4-32 million cases of gastrointestinal illness/yr (in spite of generally safe, drinking water)
- Overall prevalence of water-borne disease is unknown
- Hospital and outpatient costs due to waterborne pathogens 1.8 billion/yr (~100,000 hospitalizations)

- CDC 2016 www.csc.gov/healthy water/burden

Number of outbreaks associated with recreational water, by month — United States, 2011–2012†



Number* of outbreaks associated with recreational water, by year — United States, 1978–2012



http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6424a4.htm?s_cid=mm6424a4_w#Fig1

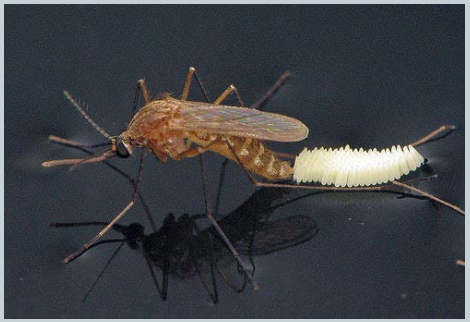
Southern US

- Arboviruses (mosquito-borne illnesses)

Malaria

Anopheles sp.

West Nile



Culex quinquefasciatus

Zika

Aedes aegypti

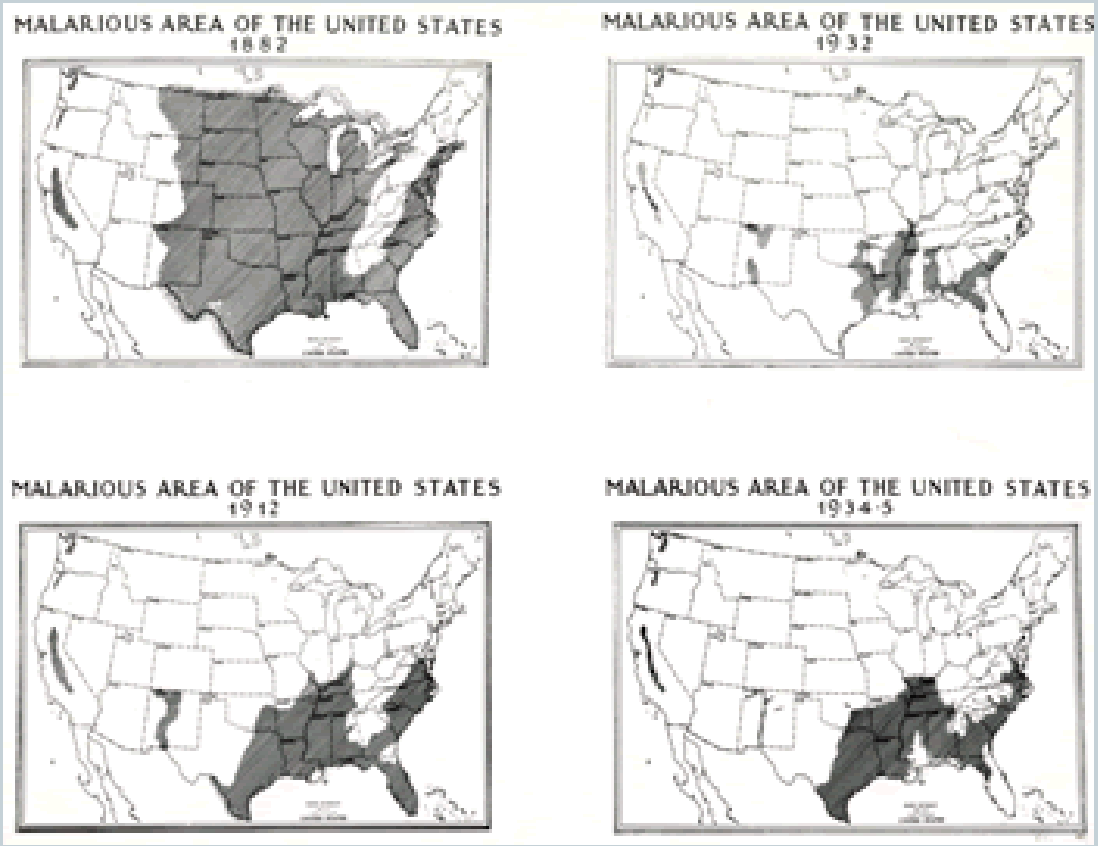
Arbovirus Infection

Offers advantages in terms of epidemiology.

- Transmission factors are well established
- Clearly documented human cases

Malaria

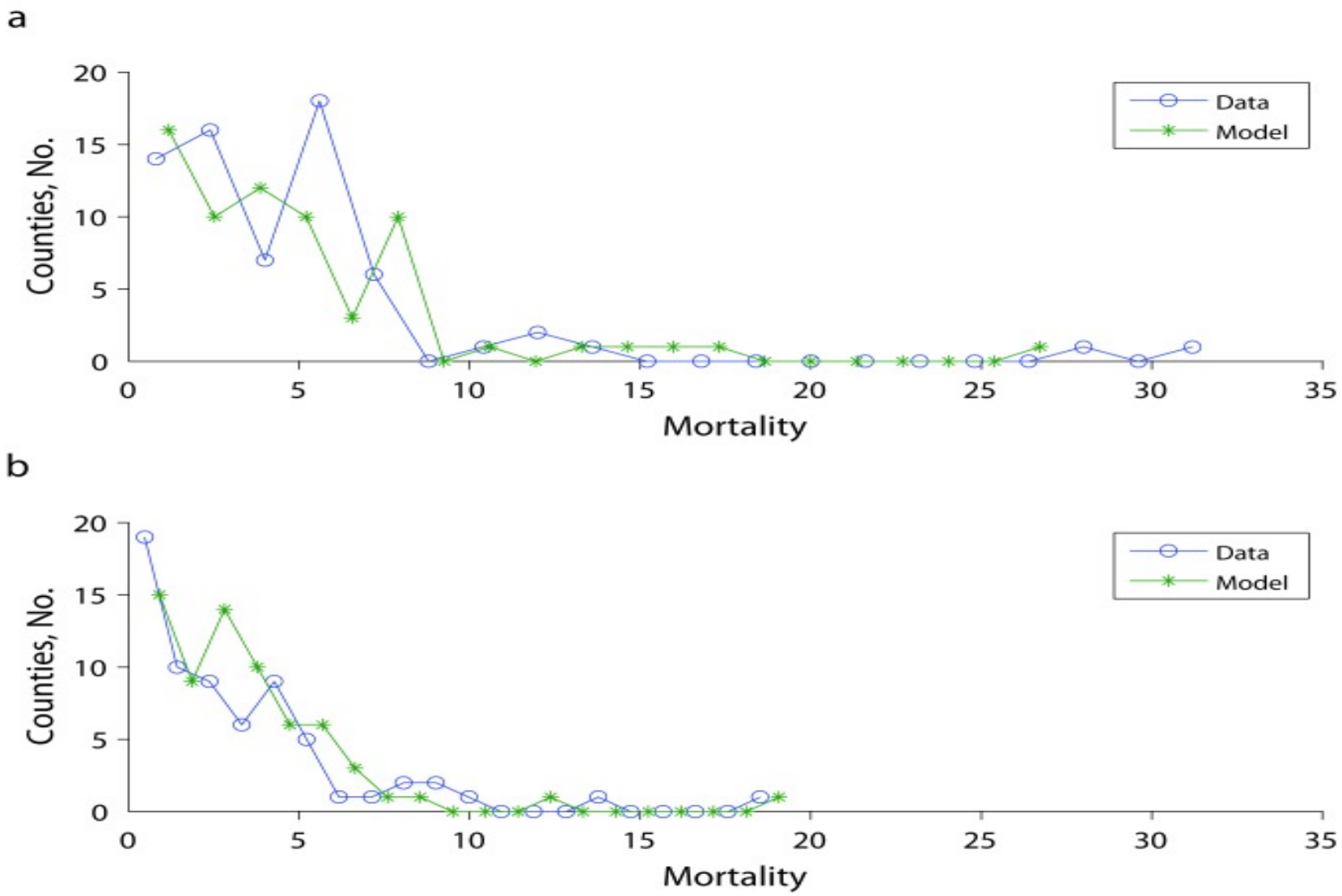
- Common in southern US prior to 1945



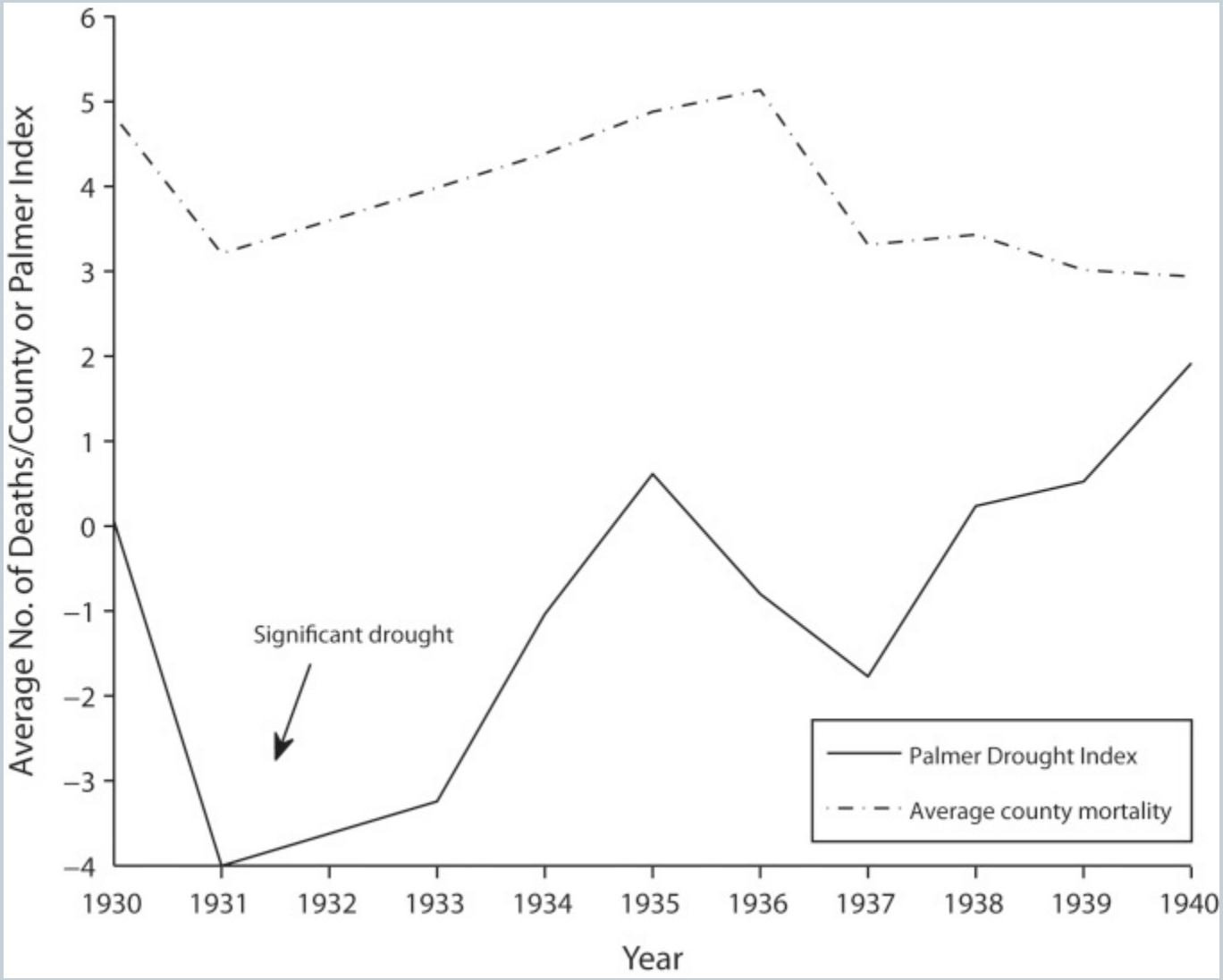
Distribution of malaria in the United States, 1882-1935.

http://www.cdc.gov/malaria/about/history/elimination_us.html

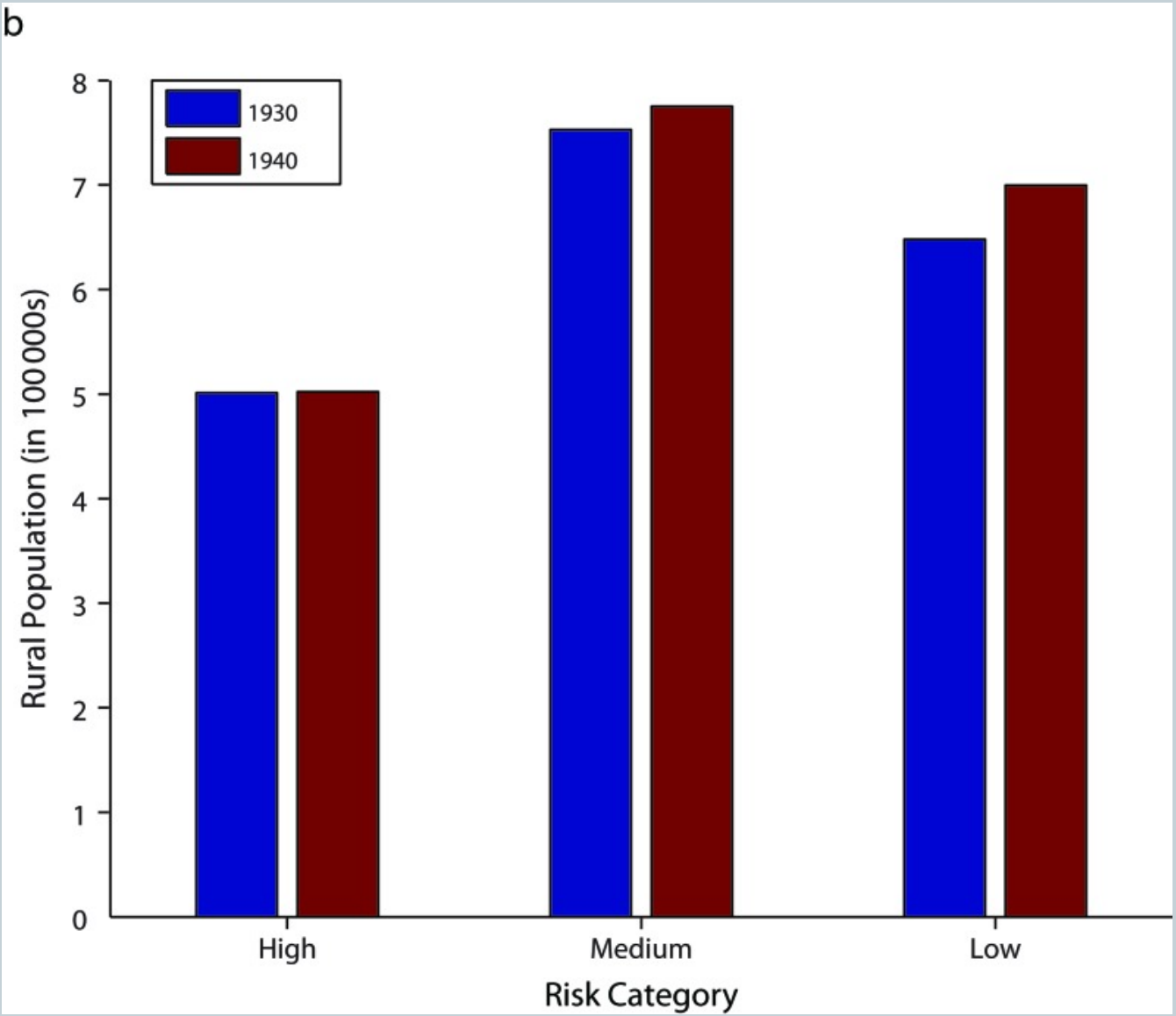
Distribution of mortality rates across all counties of Alabama in (a) 1930 and (b) 1940.



Average number of malaria deaths for each year per county and Palmer Drought Index.

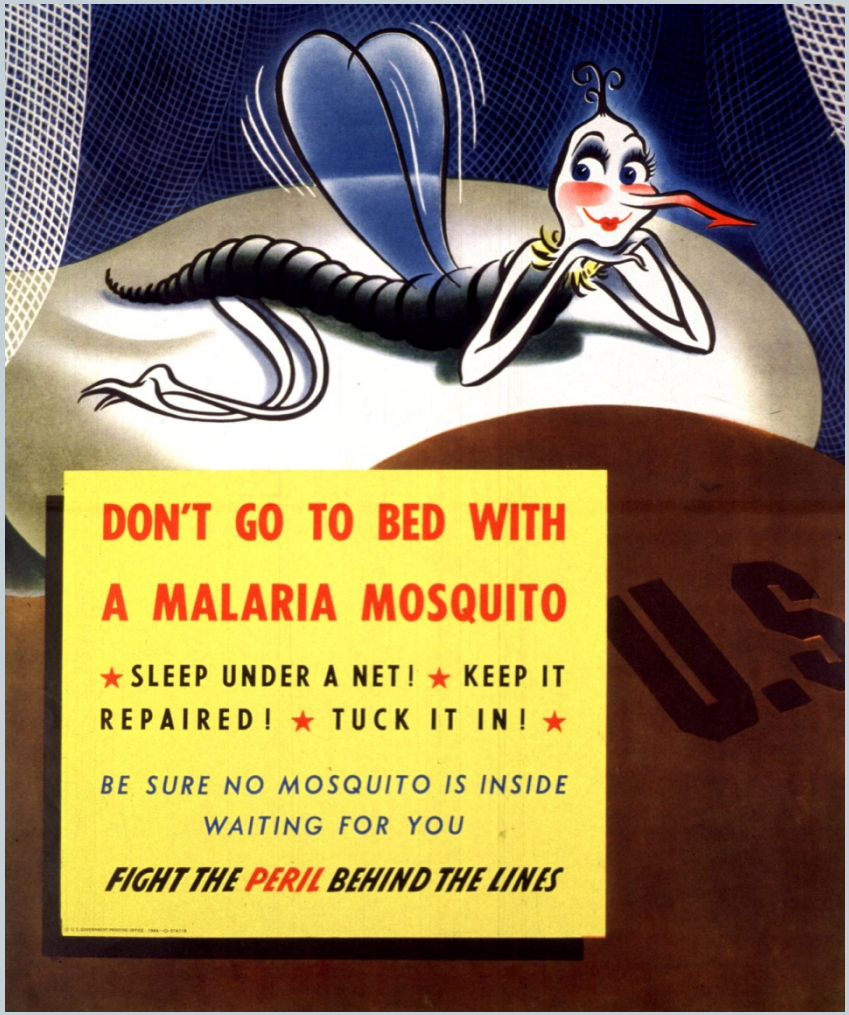


Estimated population in the 3 risk categories for malaria mortality in Alabama in 1930 and 1940 for (b) the rural population



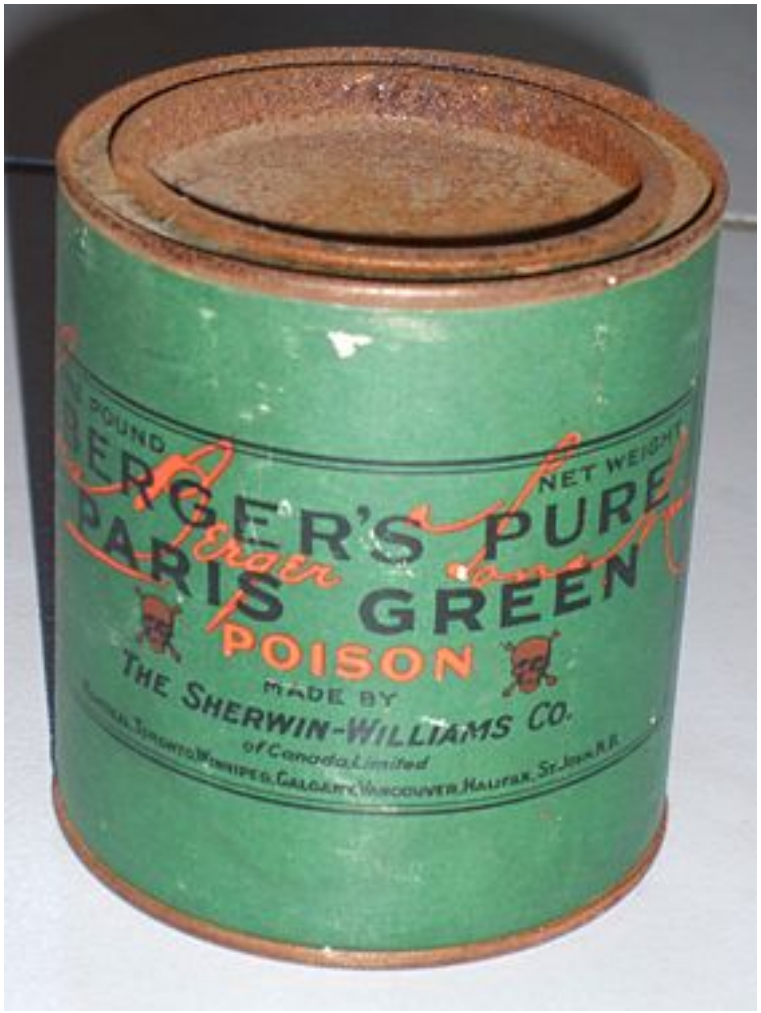
Spraying insecticide into Southern swamp

WWII propaganda re: malaria



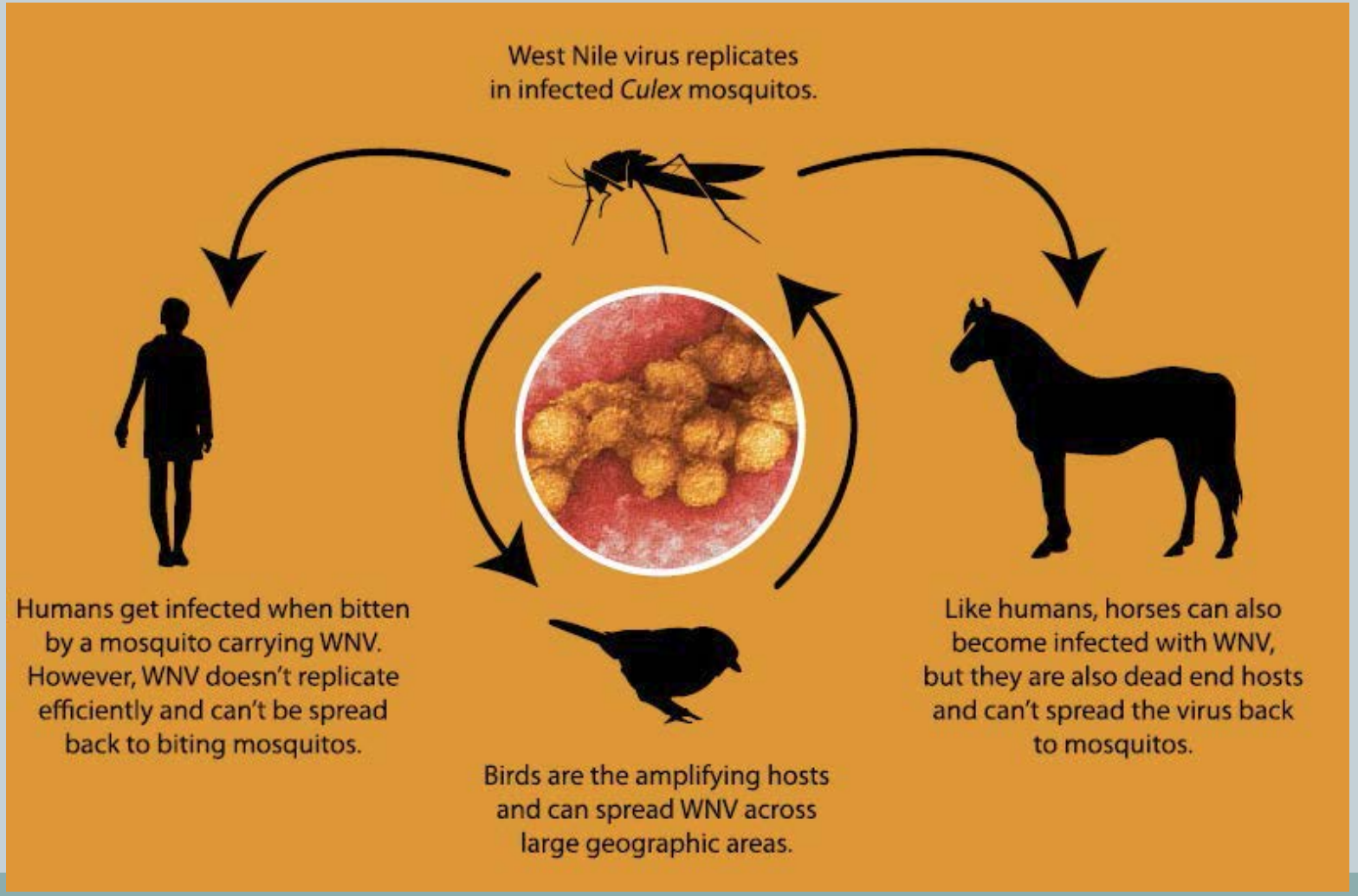
Drainage activities, Virginia, 1920's

Paris Green insecticide used in Southern swamps



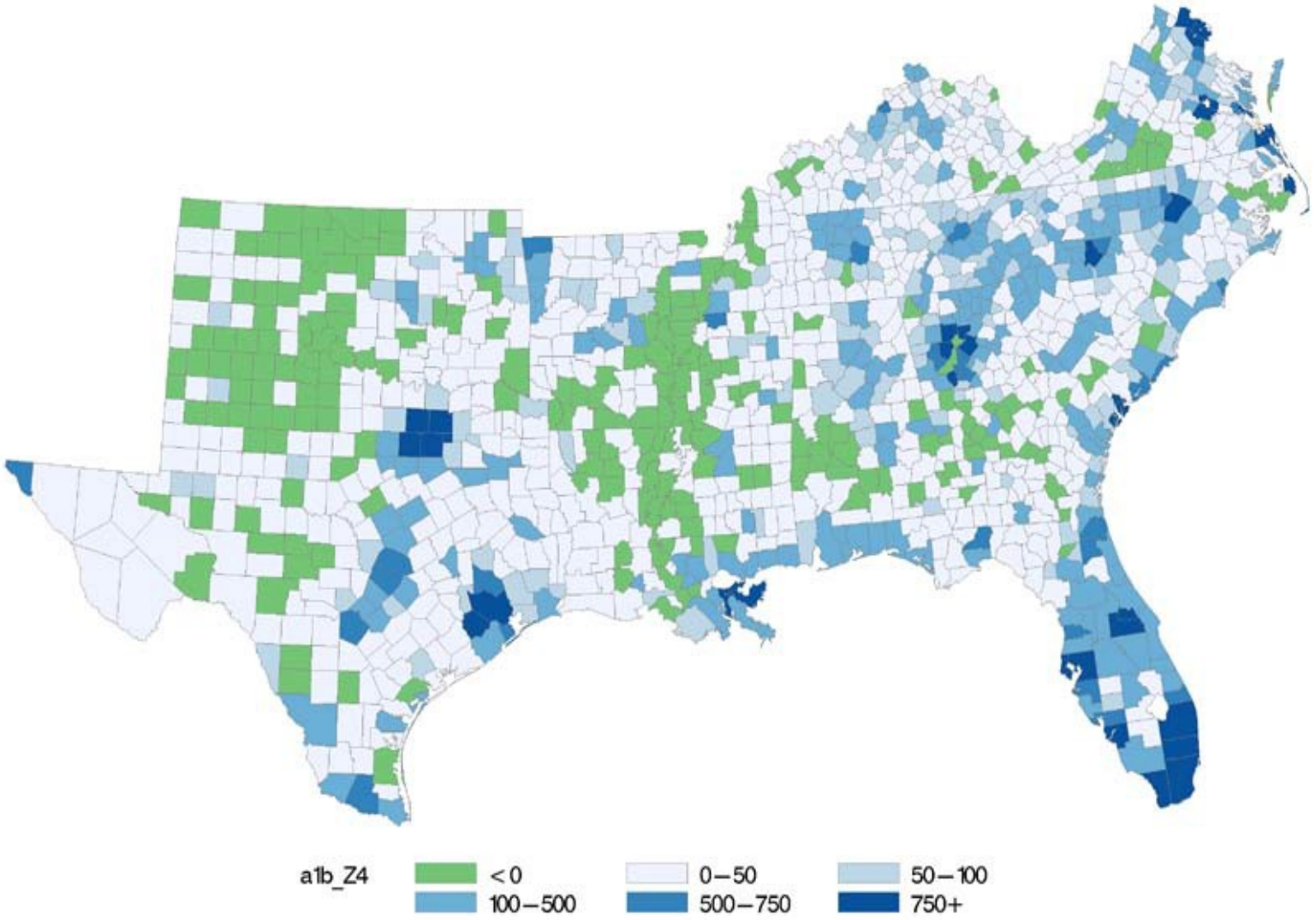
Influence of Land Use Conversions on Incidence of West Nile Virus near Atlanta, GA

West Nile Virus



Greene and Reid, AAM 2013

WNV is related to land use changes.



Projection of population change (change in people per square mile)-counties in green have forecasted population losses. (www.rsr.fs.usda.gov/futures/)

Loss of hydrologic stability and polluted urban waters

Combined stormwater –sewer overflow

Credit: Alan Cressler

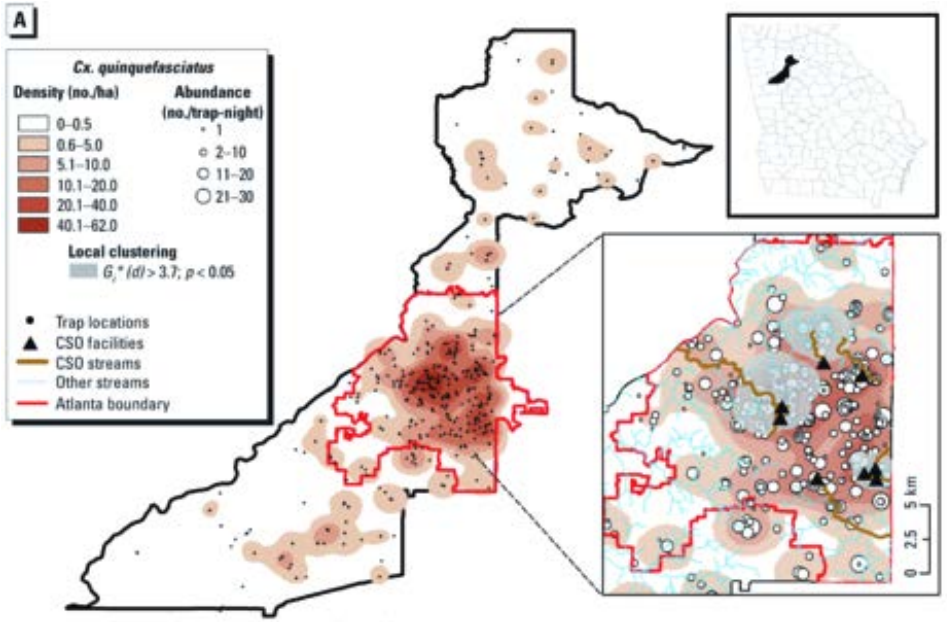
http://water.usgs.gov/edu/urbansew.html

West Nile Virus – Related Factors

- Habitat factors
  - Forest characteristics
  - Urban hydrology
  - Corvid habitat (reservoir)
  - Socioeconomics

- The Vector
  - Culex sp. mosquitoes
    - Mosquito habitat
    - Nutrients in water

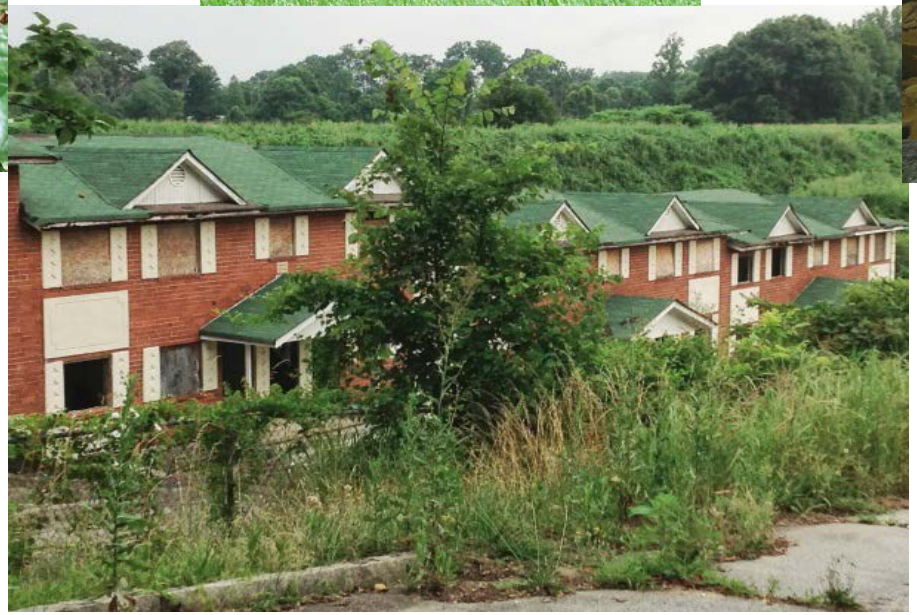
Polluted CSO water and WNV



Abundance (mosquitoes/trap-night), density distribution (mosquitoes/ha), and local spatial clustering of *Cx. quinquefasciatus* abundance, 2001–2007.

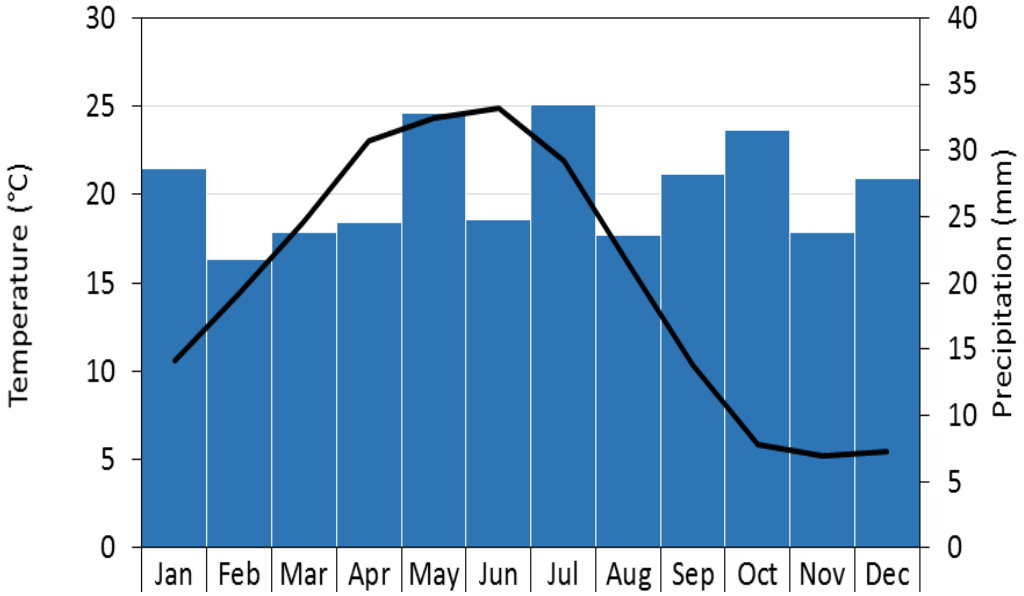
Vazquez-Prokopec GM, Vanden Eng JL, Kelly R, Mead DG, Kolhe P, et al. 2010 The Risk of West Nile Virus Infection Is Associated with Combined Sewer Overflow Streams in Urban Atlanta, Georgia, USA. Environ Health Perspect 118(10): doi:10.1289/ehp.1001939

Mosquito breeding sites, corvids, and poverty

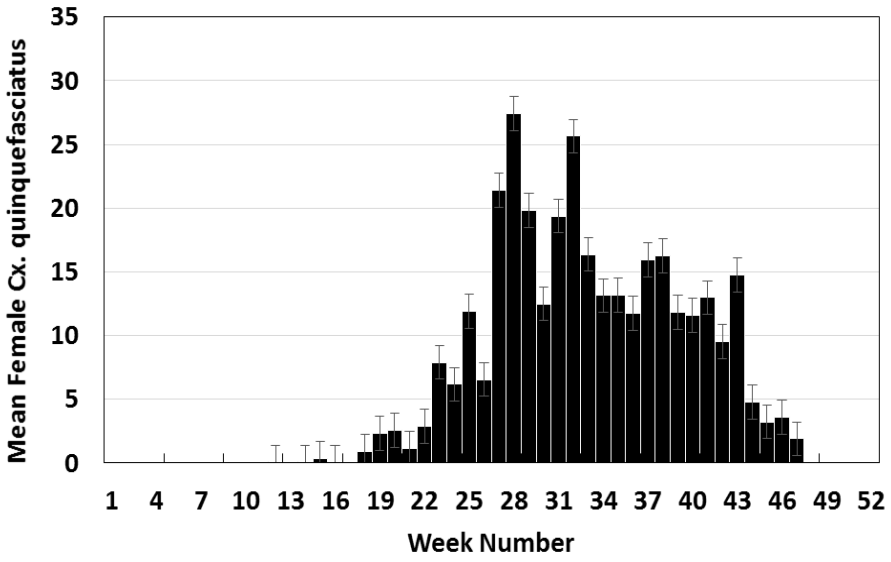


Vector Index (VI) = average WNV positive mosquitoes collected per trap night

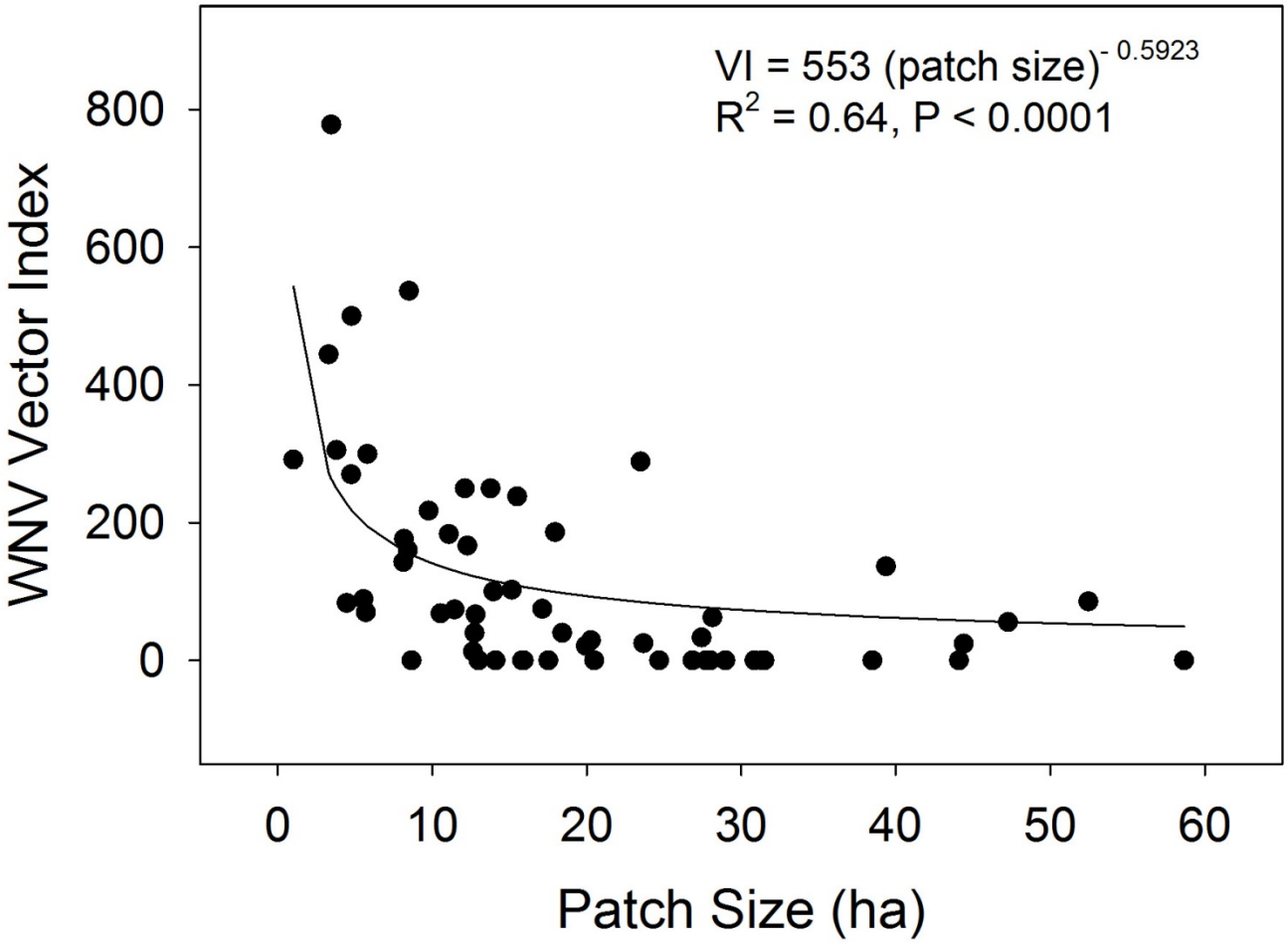
Average weekly climate data



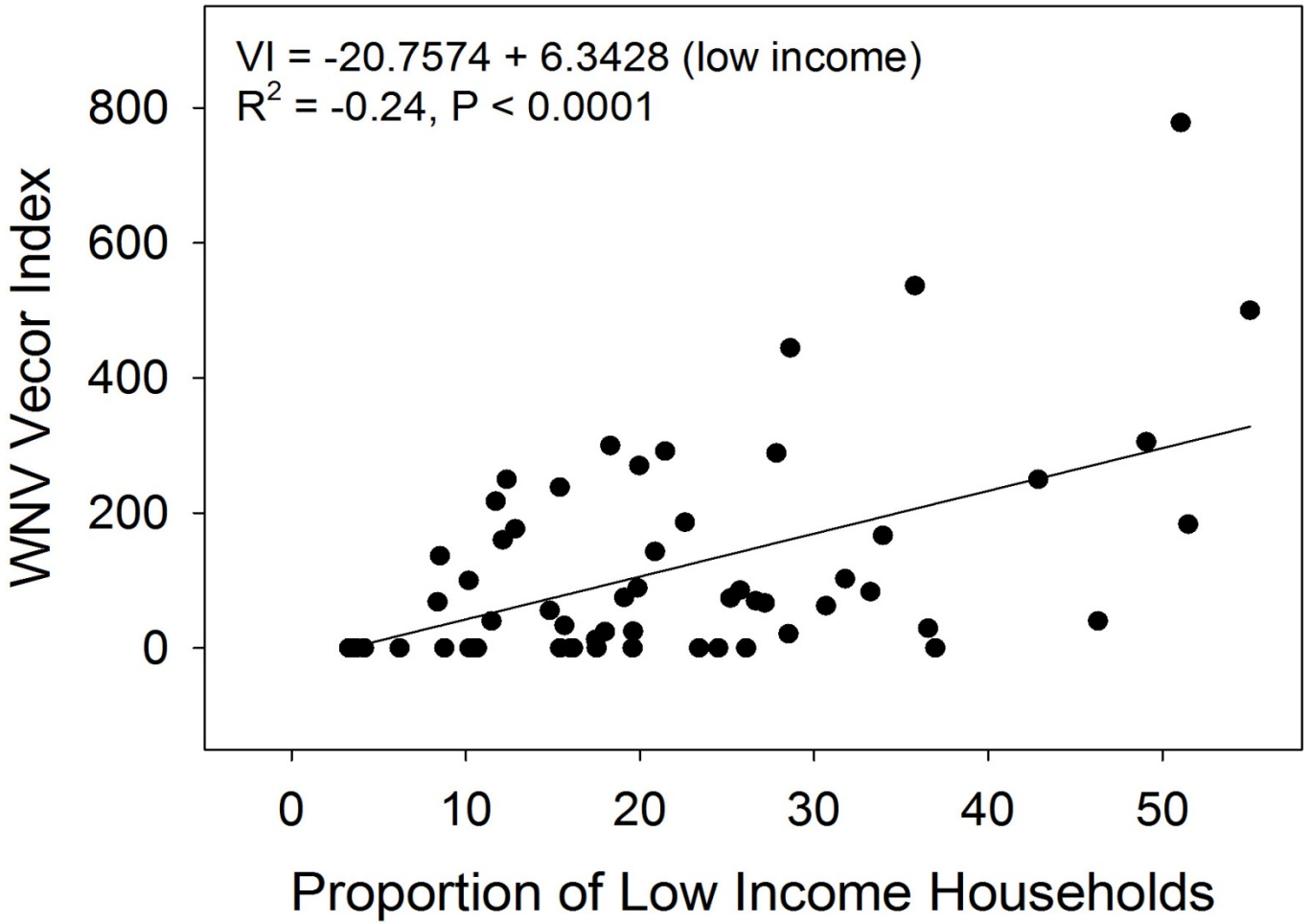
Average weekly mosquito abundance data over the period 2002 to 2009 for the central north of GA



Relationship between average urban forest patch size and West Nile Virus



Relationship between low income households and West Nile VI

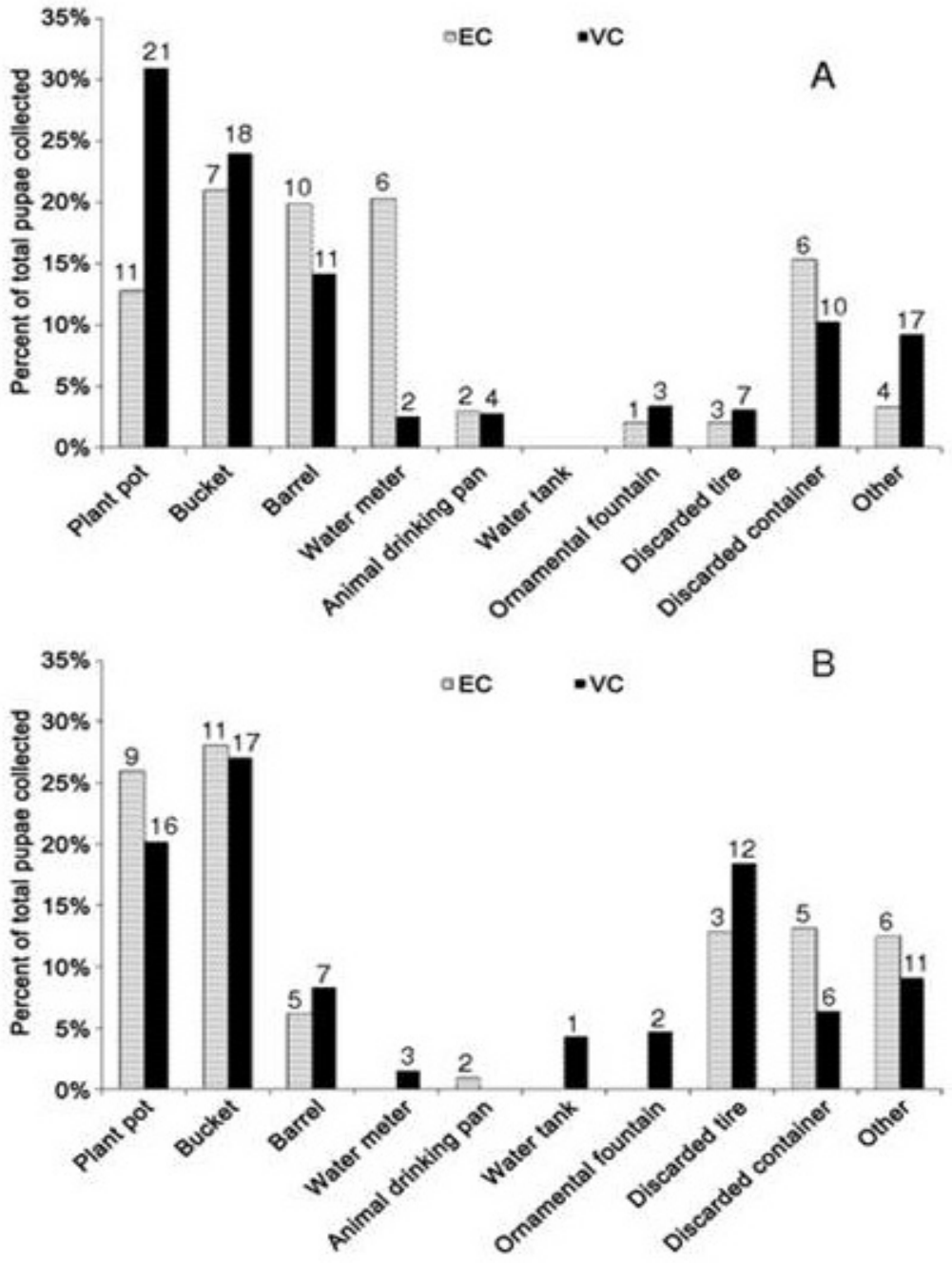


Variable	Correlation with VI (R)	P>F
Area of patch	-0.50	> 0.0001
Percent pine	-0.65	>0.0001
Percent impervious surface	0.37	0.0030
Percent low income	0.51	>0.0001
# houses (pre1960)	0.68	0.0001
Average weekly soil moisture summer 2009	0.40	0.0020
4 week moving average soil moisture summer 2009	0.37	0.0044
4 week moving average soil moisture spring 2009	0.33	0.0094
Average weekly soil moisture summer 2010	0.35	0.0087
Average weekly soil moisture winter 2011	0.39	0.0059
Average weekly soil moisture fall 2011	0.35	0.0087
4 week moving average soil moisture winter 2011	0.36	0.0059

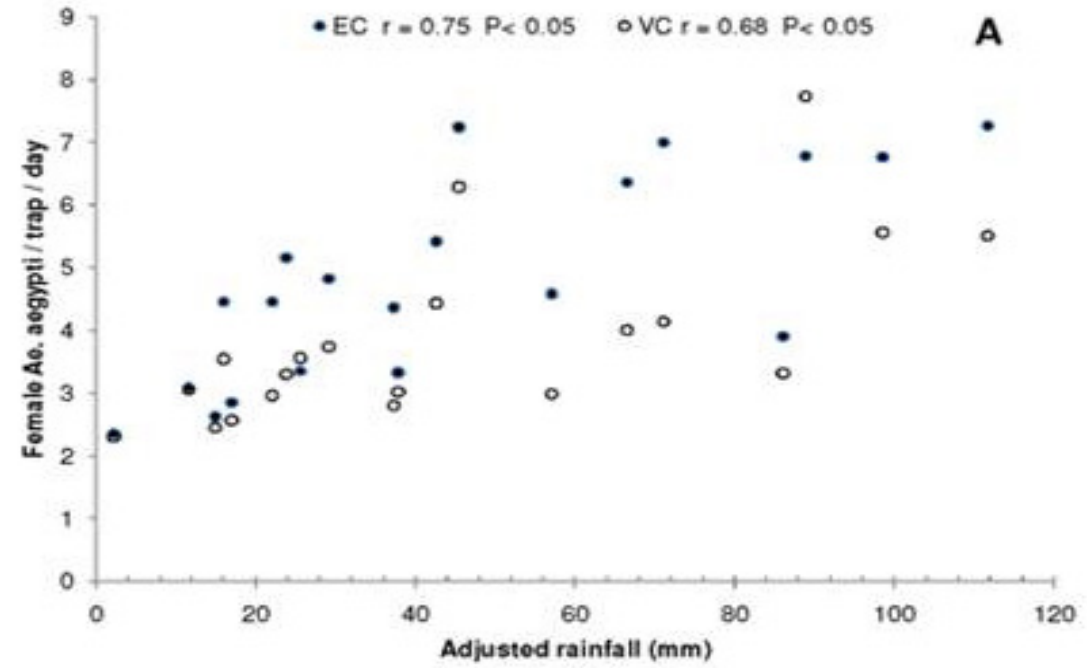
Zika Virus

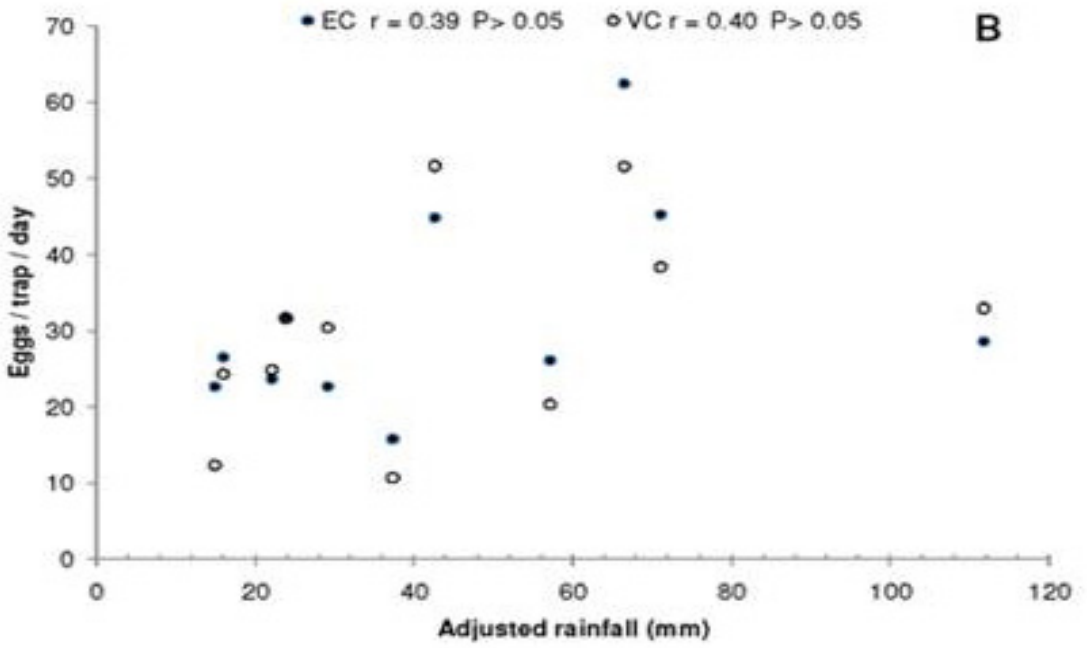
- Associated factors:
  - Open containers in yards
  - Discarded tires
  - Tree cavities
  - Sexually transmitted

Aedes aegypti pupae per type of container



Relationships between mosquitoes and rainfall





Climate Change and Arbovirus Risk?

- Depends on:
  - Effects on mosquito biology
  - Host population
  - Larvae habitat (including predation)
  - Socioeconomics
  - Land-use/ land-cover
  - Etc.

Closing Thoughts

- water x health interactions are critical
- developing an understanding requires different approach
- carefully designed, ‘real’ interdisciplinary approaches allow progress to be made


I'VE GOT ONE TO ADD TO THE LIST.
NEGATIVE EFFECTS OF CLIMATE CHANGE
Mike Keefe the DENVER POST 8-4-11