Global Climate Change and what History tells us about the Risk of New Pathogens being introduced into the United States

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Opinions, interpretations, conclusions, and recommendations are those of the author and are not necessarily endorsed by the U.S. Army.

“Climate change creates new risks, particularly in the United States, for human exposure to vector-borne diseases.”

taken from: Climate Nexus

Climate Change will:

- Allow for geographic expansion of vector mosquitos

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- Allow for geographic expansion of vector mosquitos
- Allow for the expansion of "Tropical" diseases into North America and Europe

Cause for Alarm?

Zika
Chikungunya
Dengue
Yellow fever
Malaria

Vector-borne pathogens have a long history in the U.S.

What can we learn from it?

Very Recent History

Zika	2014
Chikungunya	2013
West Nile	1999

Recent History

1998

Diseases caused by arthropod-borne pathogens of concern in the U.S.

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St. Louis encephalitis
Eastern equine encephalitis
La Crosse encephalitis
Lyme disease
Rocky Mountain spotted fever

Forgotten History

Diseases caused by arthropod-borne pathogens that were once common in the U.S.

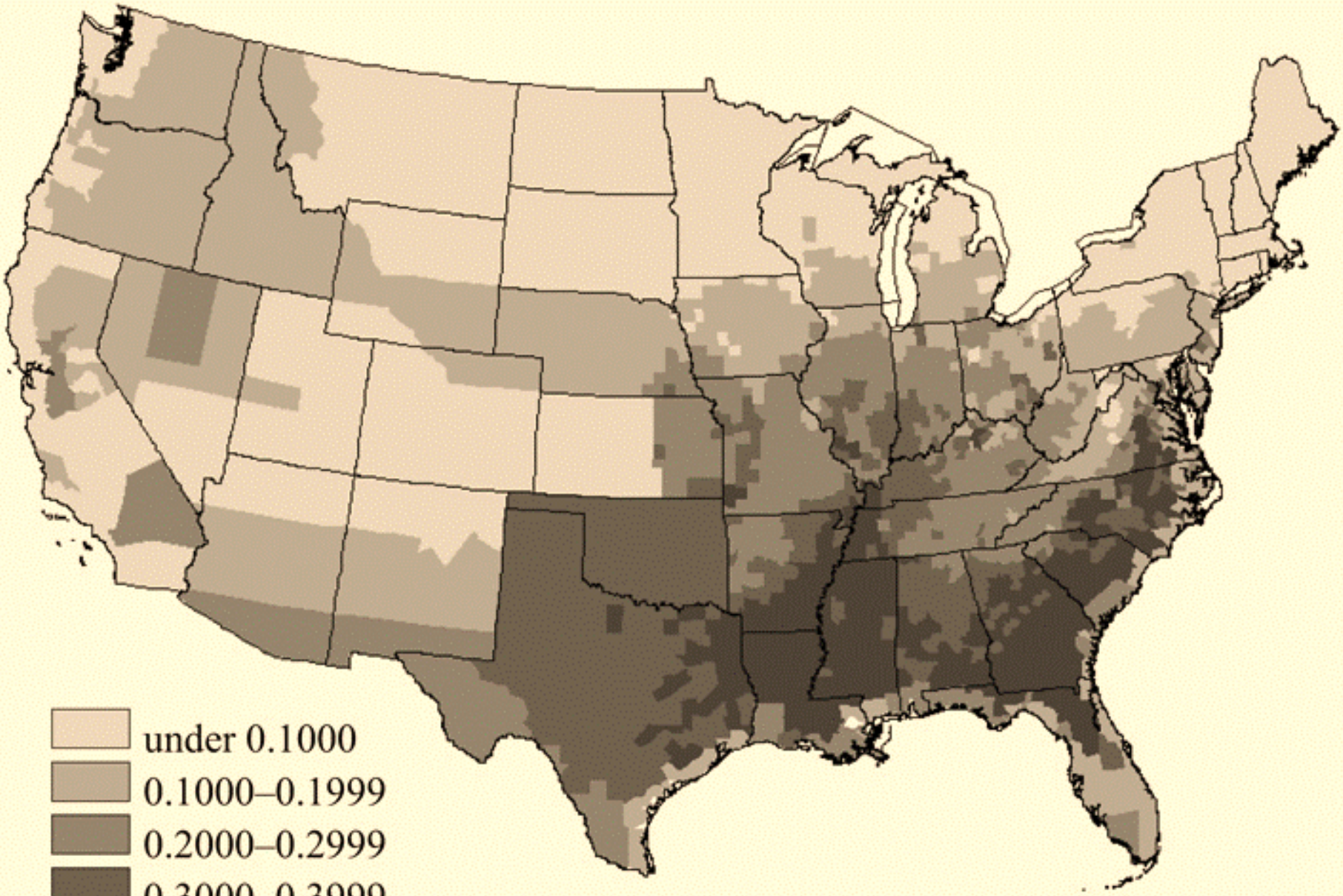
Dengue
Malaria
Yellow fever

DENGUE IN THE U.S.

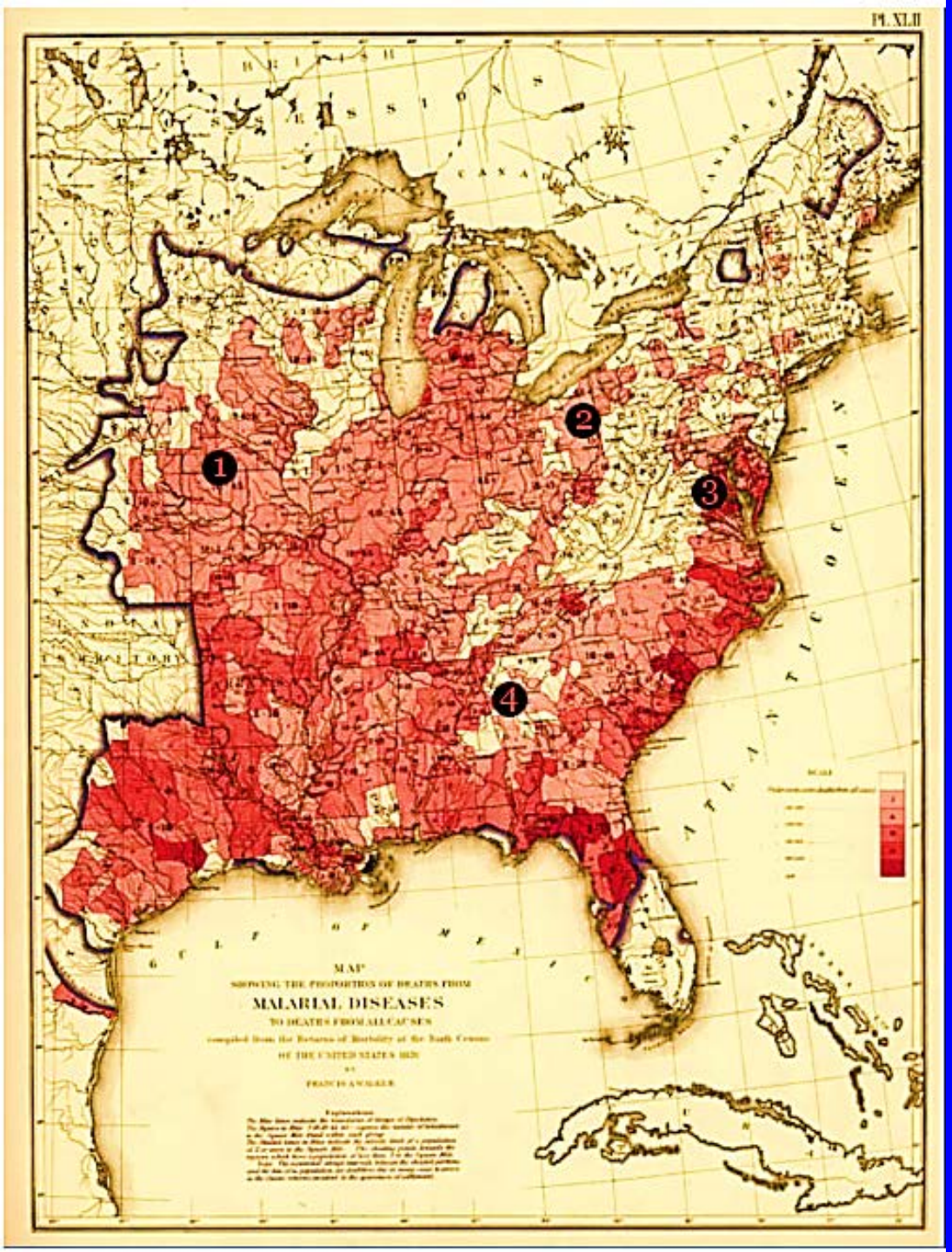
1780 Philadelphia "Bilious fever"

Benjamin Rush and the first description of a major dengue outbreak

MALARIA IN THE U.S.



ESTIMATED MALARIA RISK OF U.S. COUNTIES IN THE 1850s
Hong. 2007. J Econ Hist. 67: 1001–1035



US Malaria Deaths 1870

Urban, L. 2010. US Malaria Deaths 1870, The Scientist

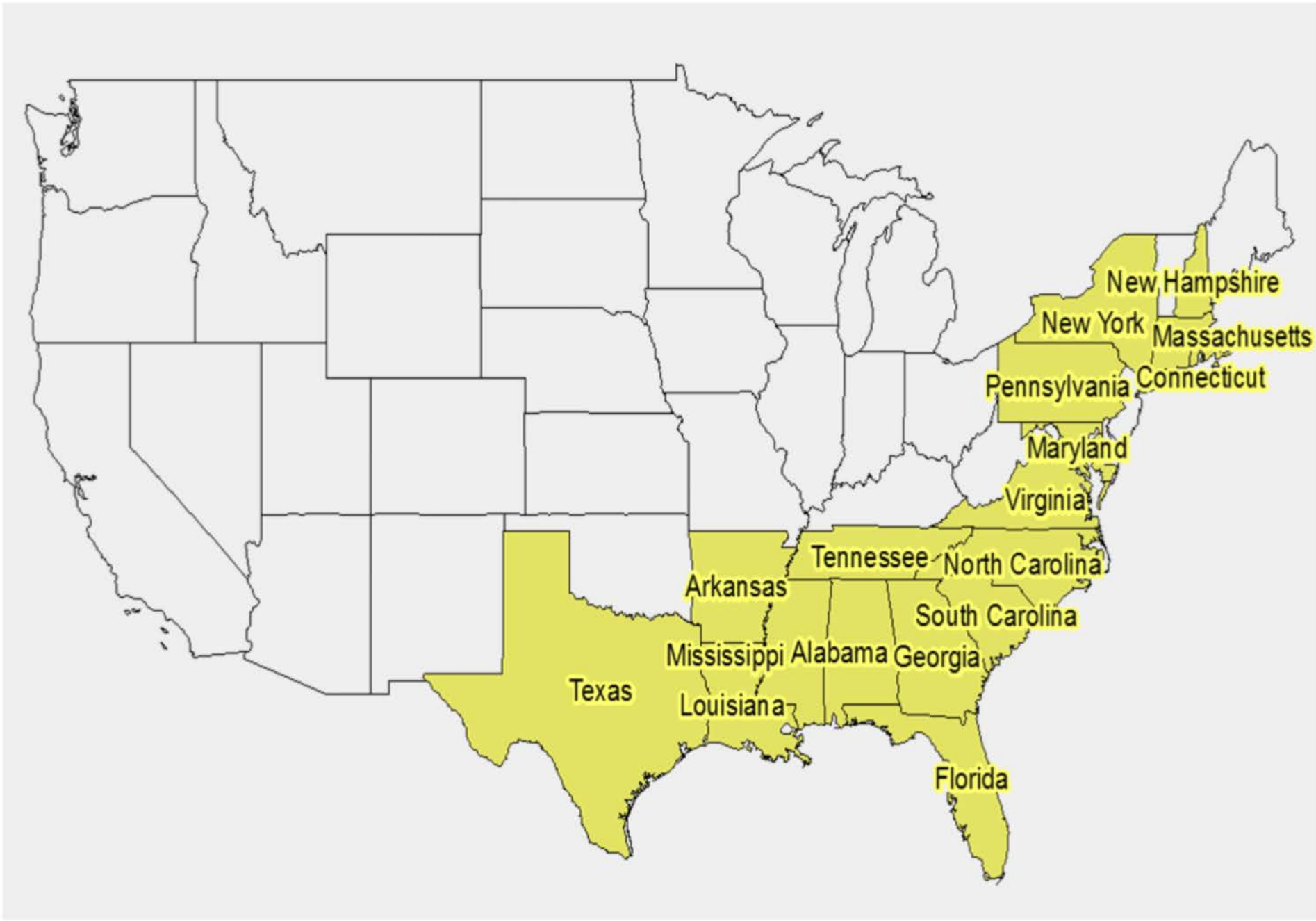
MALARIA CASES IN THE U.S.

During the Civil War there were 1,316,000 reported cases of malaria in just the Union troops!

YELLOW FEVER IN THE U.S.

YELLOW FEVER DEATHS IN THE U.S.

Location	Deaths
Boston	175
New York	4,809
Philadelphia	8,164
Baltimore	3,848
Entire U.S.	>100,000


New Hampshire
New York
Massachusetts
Pennsylvania
Connecticut
Maryland
Virginia
Tennessee
North Carolina
Arkansas
South Carolina
Mississippi
Alabama
Georgia
Texas
Louisiana
Florida

YELLOW FEVER DEATHS IN EUROPE

Location	Deaths	outbreak year
Barcelona	>20,000	1821
Rest of Spain	>40,000	1741,1803,1819
Lisbon	>5,000	1857
Gibraltar	>7,000	1804,1813
Southhampton	10	1866

Why were these diseases so common?

and

Why did they essentially disappear?

WHAT DO

MALARIA

DENGUE

CHIKUNGUNYA

ZIKA

HAVE IN COMMON?

ANTHROPONOSES

BASIC TRANSMISSION CYCLE TYPES

ANTHROPONOSIS

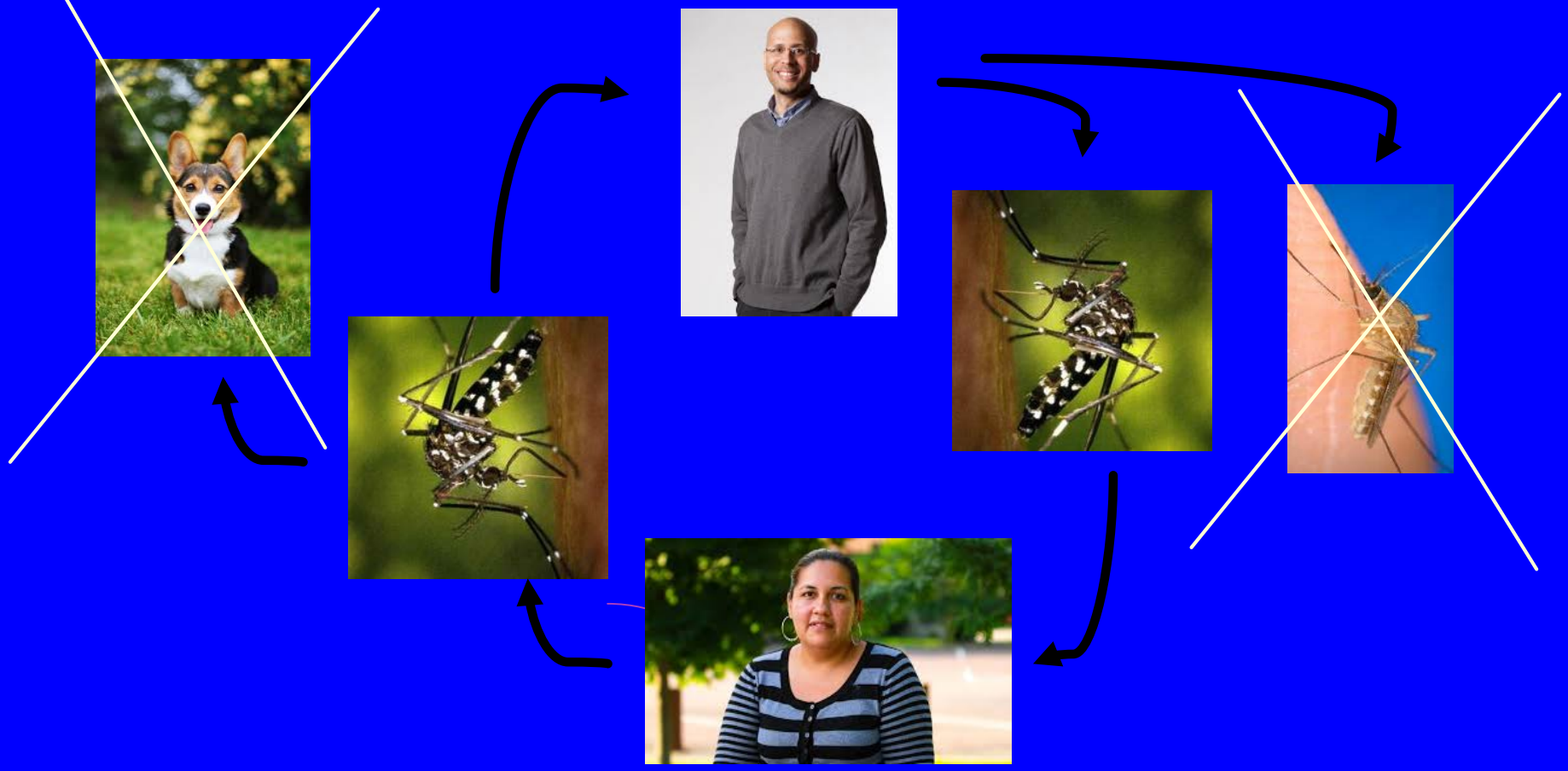
VS

ZOONOSIS

ANTHROPONOSIS

DISEASES WHERE THE SOURCE IS AN INFECTIOUS HUMAN

ANTHROPONOSIS



Dengue, chikungunya, Zika, malaria

ANTHROPONOSIS

MALARIA

DENGUE

CHIKUNGUNYA

WUCHERERIAN FILARIASIS

ZIKA

ANTHROPONOSIS

REQUIRES HUMANS.

THUS:

- REDUCTION IN MOSQUITO (VECTOR) POPULATIONS CAN INHIBIT TRANSMISSION

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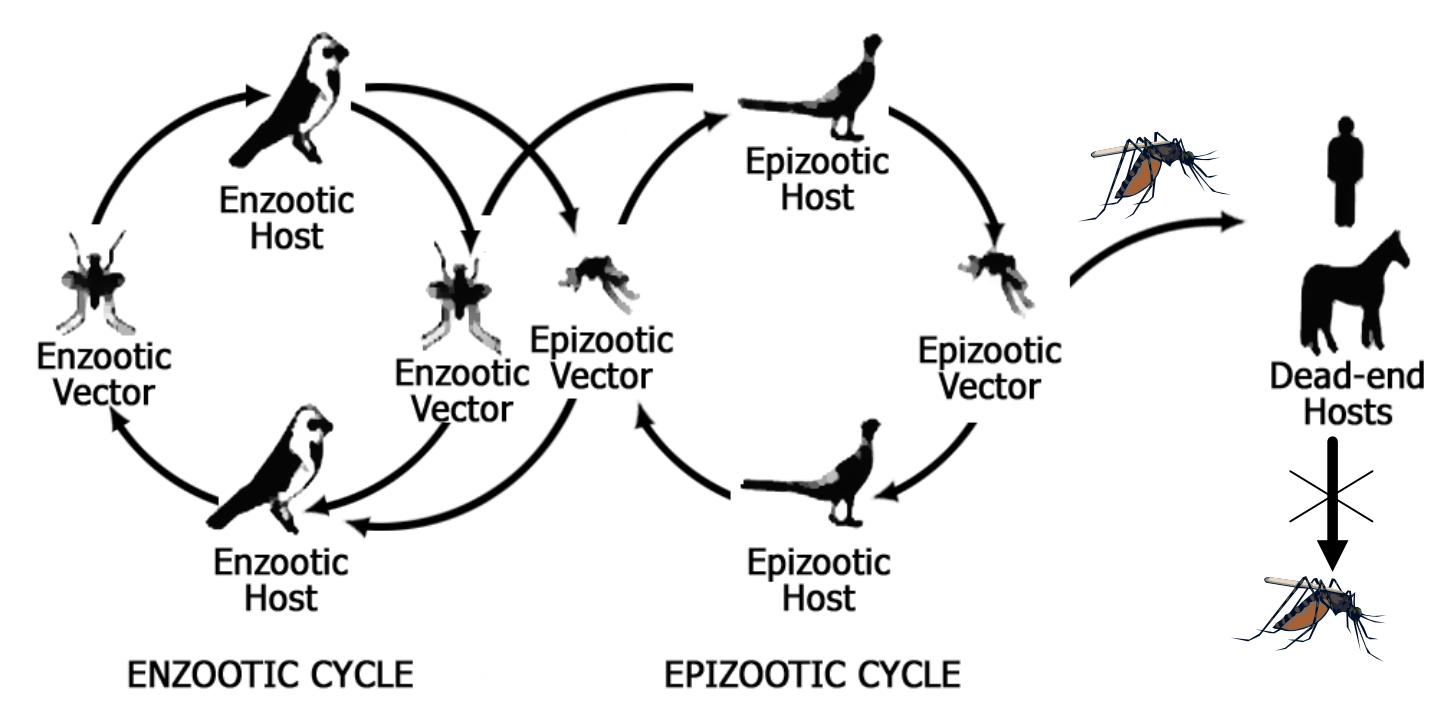
- **REDUCTION IN MOSQUITO-HUMAN CONTACT CAN INHIBIT TRANSMISSION**

ZOONOSIS

DISEASES WHERE THE SOURCE IS AN INFECTIOUS ANIMAL

ZOONOSIS



EASTERN EQUINE ENCEPHALITIS

ZOONOSES

WEST NILE (BIRDS)

EASTERN EQUINE ENCEPHALITIS (BIRDS)

ST. LOUIS ENCEPHALITIS (BIRDS)

RIFT VALLEY FEVER (DOMESTIC UNGULATES)

VENEZUELAN EQUINE ENCEPHALITIS (HORSES)

JAPANESE ENCEPHALITIS (BIRDS, PIGS)

LA CROSSE ENCEPHALITIS (SQUIRRELS, CHIPMUNKS)

Back to RECENT HISTORY

CHIKUNGUNYA

2013

Chikungunya cases by year in the U.S.

Year	Total cases	Local cases	Location
2014	2,811	12	FL-12
2015	896	1	TX-1
2016	248	0	
2017	114	0	

CDC: chikungunya

CHIKUNGUNYA

Aedes albopictus

versus

Aedes aegypti

CHIKUNGUNYA

Aedes albopictus

AND THE

A226V MUTATION

Ae. albopictus vs *Ae. aegypti*

Ae. albopictus	Inf. rate	*Ae. aegypti*	Inf. rate
GENTILLY	47	ROCKEFELLER	15
OAHU	39	LAS VIRTUDES	14
MADAGASCAR	39	GENTILLY	9
SABAH	38	FOSTER	4
SAO PAULO	32	DAKAR	4
OKINAWA	32	REX	2
ZAMA	28	THAILAND	0
POLK	22		
HOUSTON	20		
TAIWAN	16		

Turell et al. 1992. J. Med. Entomol. 29:49-53

DENGUE, ZIKA, YELLOW FEVER, AND CHIKUNGUNYA HAVE ESSENTIALLY THE SAME LIFE CYCLE

Aedes aegypti or *Ae. albopictus*

and

humans

Zika cases by year in the U.S.

Year	Total cases	Local cases	Location
2015	61	0	
2016	5,102	224	FL-218,TX-6
2017	407	4	FL-2,TX-2

CDC: Zika

WHAT IS THE RISK OF A NEW PATHOGEN BEING IMPORTED TO THE U.S.?

ANTHROPONOSIS

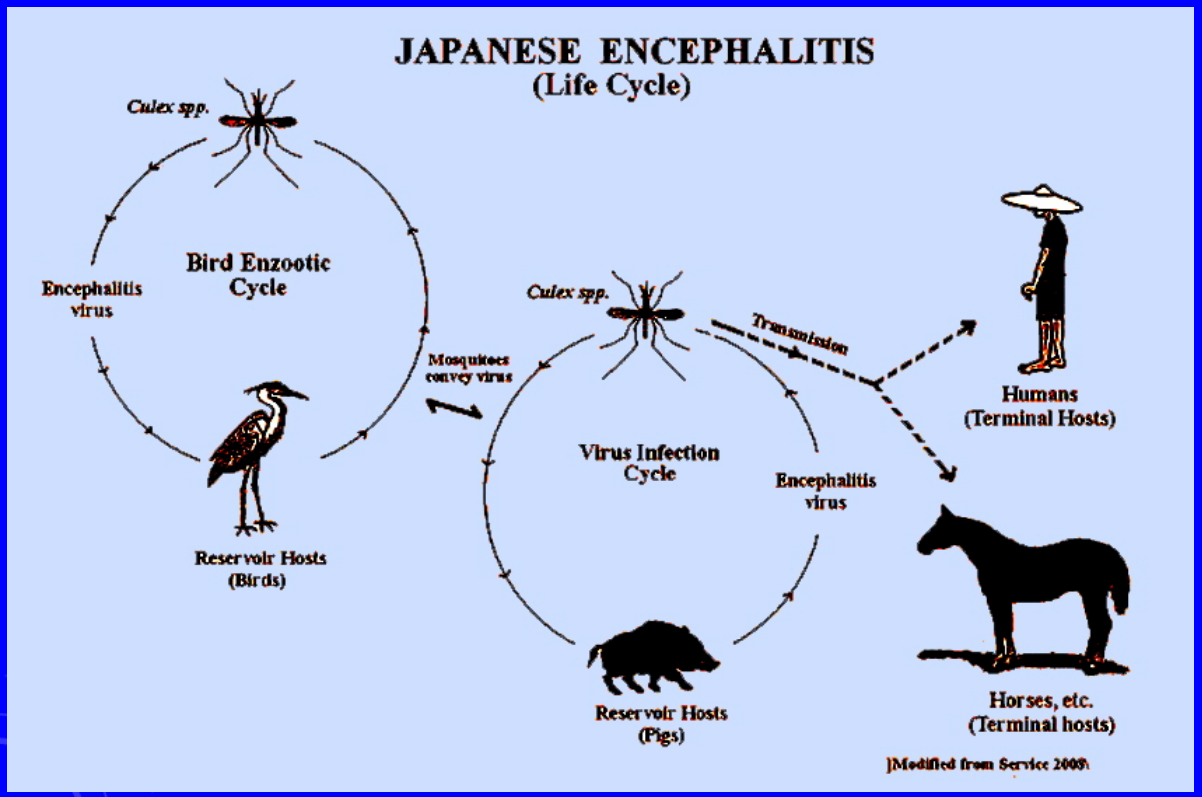
VS

ZOONOSIS

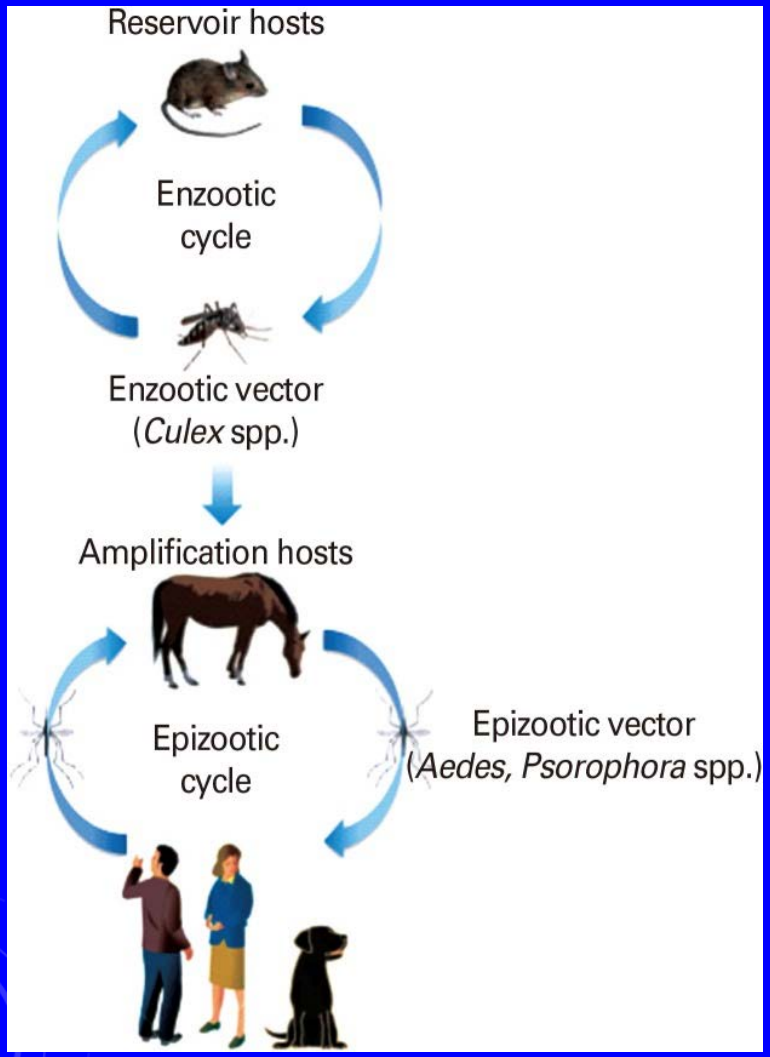
WHICH OTHER VIRUSES ARE OF PARTICULAR CONCERN?

Rift Valley fever

Japanese encephalitis



Venezuelan equine encephalitis



and what needs to be done?

Restore and improve our mosquito control programs

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2. Public education

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3. Basic knowledge on which mosquitoes should be prioritized for control

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4. Better diagnostics

QUESTIONS?