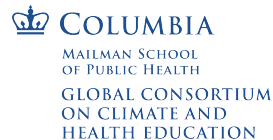


Caribbean Climate and Health Responders Course

Climate Change for the Health Professional – May 11th, 2022
Climate Change - Vector-borne and Zoonotic Disease

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Learning Objectives – Vector-borne and Zoonotic Disease

- a. Explain the environmental processes changing as result of climate change and how they impact the prevalence, incidence, and distribution of vector-borne and zoonotic diseases.
- b. For the following diseases, describe how climate change is influencing their distribution: Leptospirosis, Dengue fever, Chikungunya, Zika. Passing mention of Tick fever, Malaria and West-Nile virus.
- b. Effects of deforestation/bush fires/climate change bringing forest habitat in closer proximity to humans.
- c. Explore what actions health professionals can take to protect patients vulnerable to these diseases
- d. Identify vulnerable populations including: women, outdoor workers, children, immunocompromised, etc
- e. Define steps the health sector can take to become prepared to address shifting geographic burdens of vector-borne disease, including increasing surveillance and early-warning systems

What will I talk about today!

- Start off with some **definitions**
- What are **vector-borne** and **zoonotic** diseases
- The importance of us all following a **One Health** approach

- How Climate Change may affect infectious diseases and pathogens?
- Will Climate Change affect Vector Borne diseases and how? (with examples)
- Will Climate Change affect Zoonotic diseases future pandemics and how?

- What can you as Health Professionals do to protect patients from these diseases?
- How can the health sector become more prepared to address shifting geographic burdens of vector-borne and zoonotic disease?

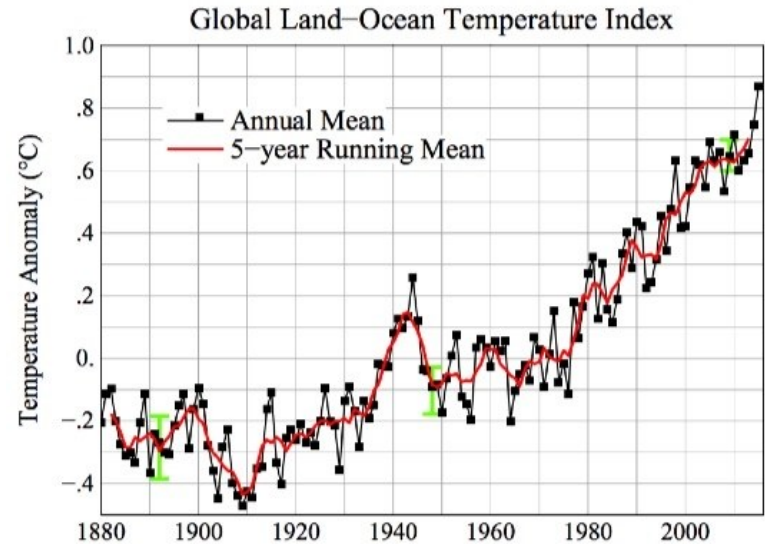
Definitions – to set the scene

Vector-borne diseases are infections transmitted by the bite of infected arthropod species, such as mosquitoes, biting midges, ticks, triatomine bugs, sandflies, and blackflies.

Arthropod vectors are cold-blooded (ectothermic) and thus especially sensitive to climatic factors.

A zoonosis (zoonotic disease or zoonoses -plural) is an infectious disease that is transmitted between species from animals to humans (or from humans to animals).

Global Warming



Major Global and Regional Vector-borne diseases

Disease	Pathogen	Primary vector(s)	Primary non-human reservoir (competent) hosts
Malaria	<i>Plasmodium</i> parasite	<i>Anopheles</i> mosquito	Non-human hosts of minor concern
Dengue*	Flavivirus	<i>Aedes aegypti</i> and <i>Aedes albopictus</i> mosquitoes	Non-human hosts of minor concern
Yellow fever	Flavivirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human primates
Zika	Flavivirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human hosts of minor concern
Chikungunya*	Alphavirus	<i>A. aegypti</i> and <i>A. albopictus</i> mosquitoes	Non-human hosts of minor concern
Lymphatic filariasis*	Various filarial nematodes	A variety of mosquito genera	Non-human hosts of minor concern
Schistosomiasis*	<i>Schistosoma</i> trematode	Snail	Non-human hosts of minor concern
Onchocerciasis*	<i>Onchocerca volvulus</i> nematode	<i>Simulium</i> (black fly)	None
Chagas disease*	<i>Trypanosoma cruzi</i> parasite	Triatomine bug	Mammals
Leishmaniasis*	<i>Leishmania</i> parasite	Sand fly	Rodents, dogs, other mammals
Japanese encephalitis	Flavivirus	<i>Culex</i> mosquitoes	Pigs, birds
African trypanosomiasis*	<i>Trypanosoma brucei</i> parasite	<i>Glossina</i> (tsetse fly)	Wild and domestic animals
Lyme disease	<i>Borrelia</i> spirochete	<i>Ixodes</i> ticks	White-footed mouse and other small mammals, birds
Tick-borne encephalitis	Flavivirus	<i>Ixodes</i> ticks	Small rodents
West Nile fever	Flavivirus	<i>Culex</i> mosquitoes	Birds

Major Global and Regional Zoonotic diseases

Top 8 Zoonotic Diseases of National Concern in the U.S. for One Health Collaboration

1 Zoonotic influenza

2 Salmonellosis

3 West Nile virus

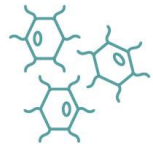
4 Plague

5 Emerging coronaviruses
(SARS, MERS)

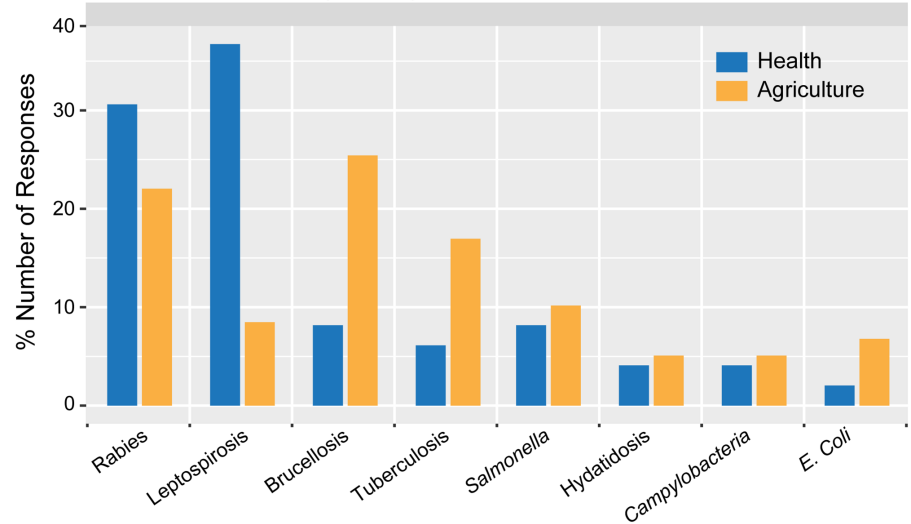
6 Rabies

7 Brucellosis

8 Lyme disease



Ministry Priority Endemic Zoonotic Diseases



ZOOM Poll Question 1:

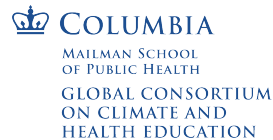
What percentage of new and emerging human diseases are of animal origin?

A) 25%

B) 50%

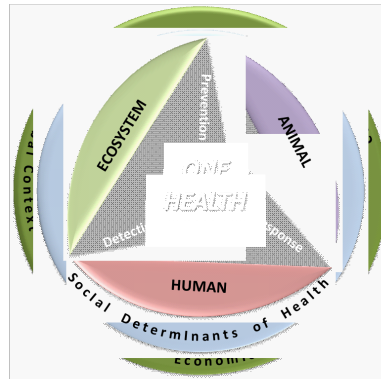
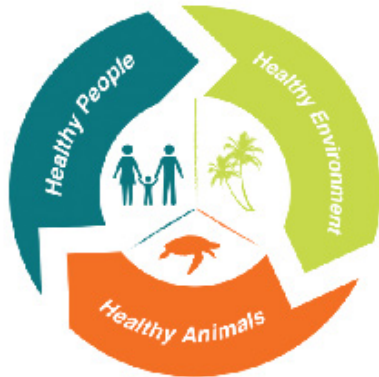
C) 75%

D) 90%

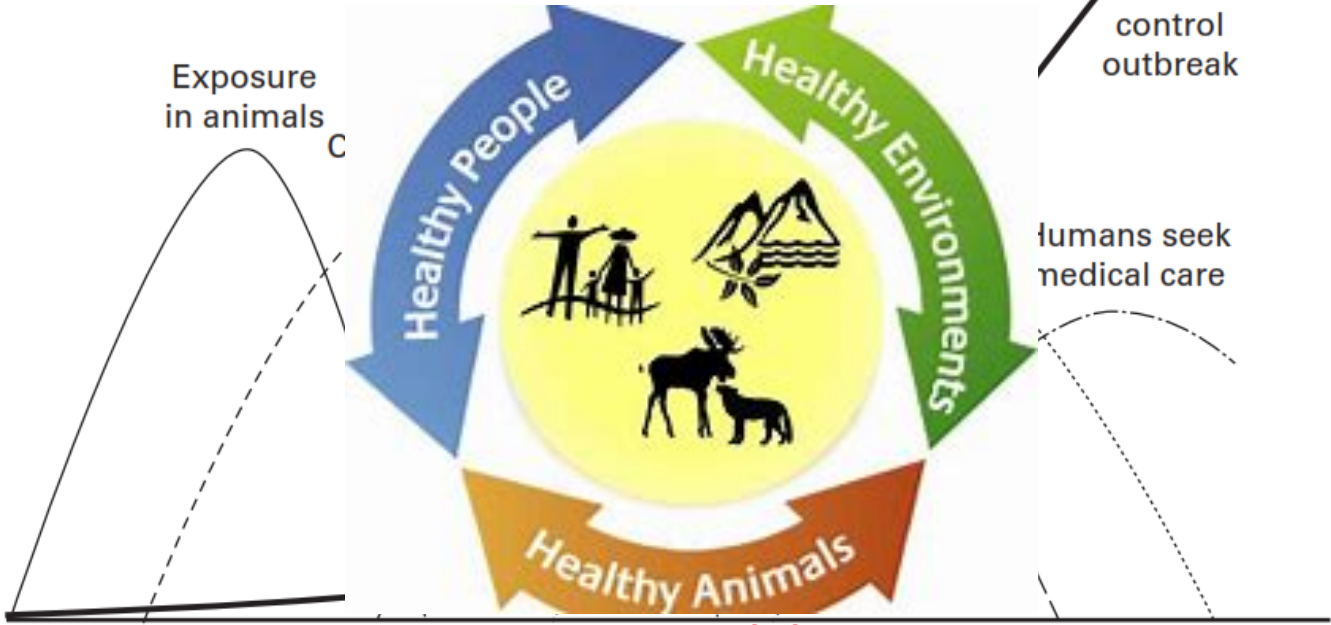


Vector-borne / Zoonotic Diseases and One Health

- Most vectors feed on a wide range of hosts – transmit many zoonoses.
- Many pathogens are 'reservoired' in wildlife, and spill over into livestock or people.
- Hosts can be
 - Amplification: viraemia high enough to infect vectors
 - Dead-end: viraemia not high enough to infect vectors
- Humans are dead-end hosts for several major VBDs – preventing transmission in animals can protect humans



BIG lesson we need to learn

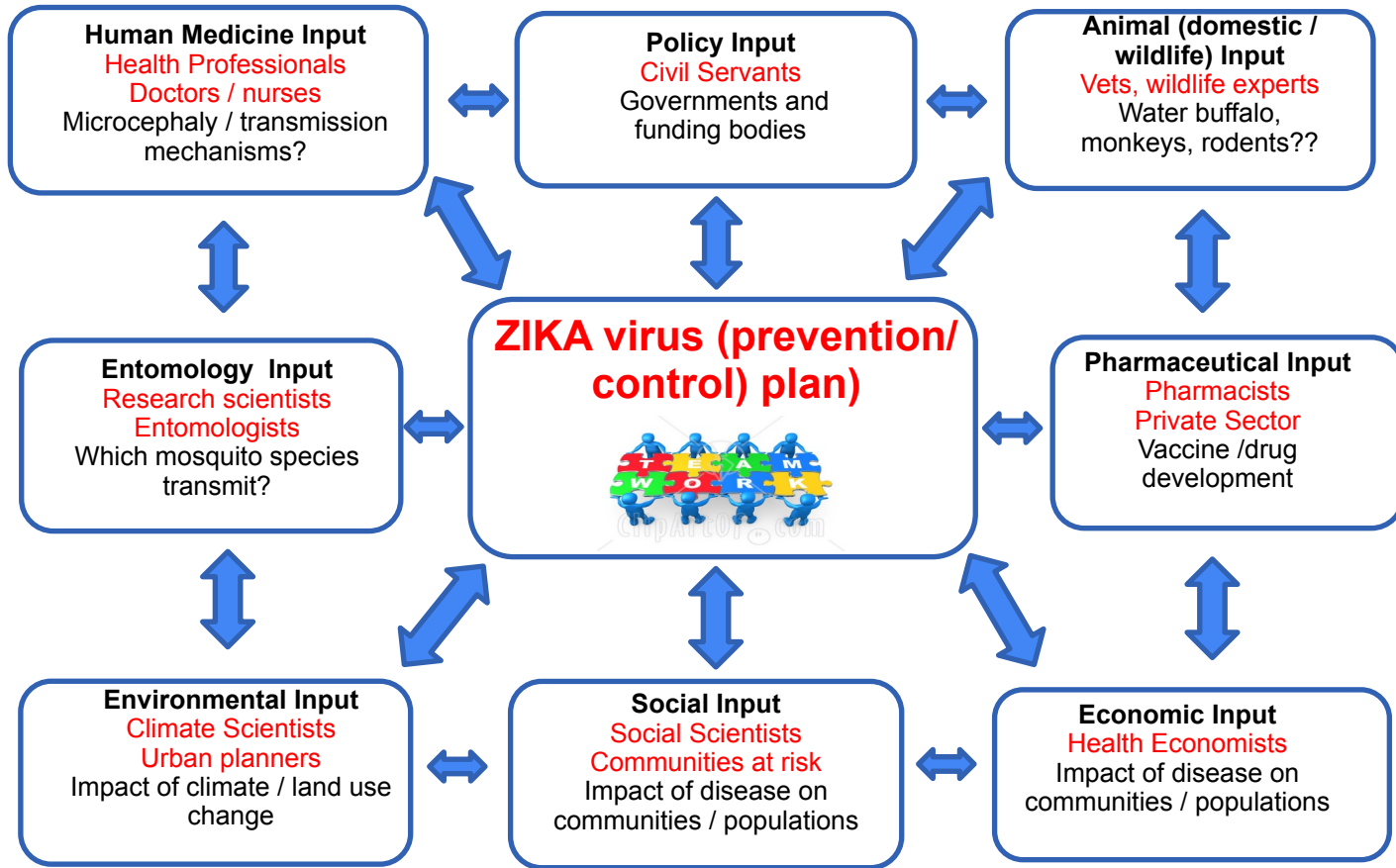


One Health

World Bank (2012)

Source: Adapted from IOM (2009)

A “One Health” approach to ZIKA



How climate affects infectious disease

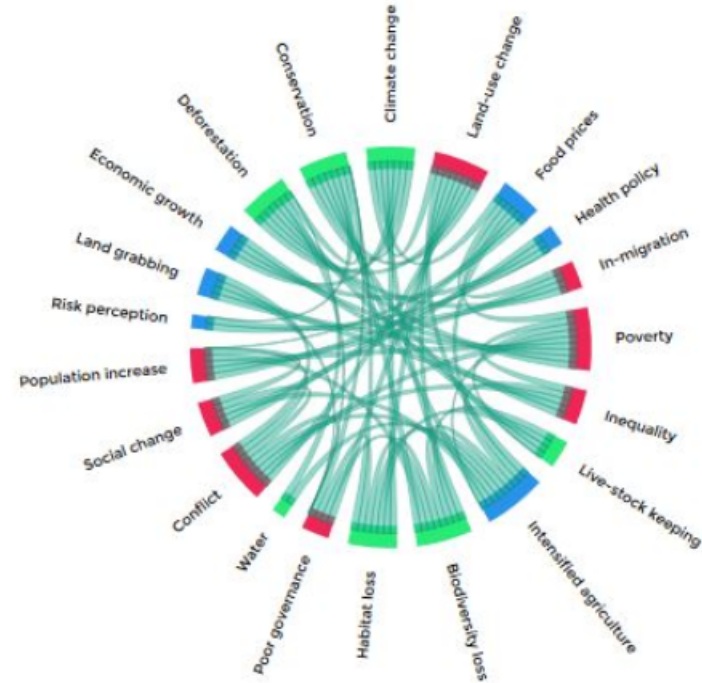
- Climate may affect:
 - Spatial distribution of outbreaks: *where?*
 - Timing of disease outbreaks: *when?*
 - Frequency of disease outbreaks: *how often?*
 - Intensity or severity of outbreaks: *how bad?*
- Via effects on
 - Pathogens: *if free-living or outside of host*
 - Hosts: *eg, immunity*
 - Vectors: *eg mosquitoes, ticks etc*
 - Dynamics: *eg contact rates*
 - Indirect effects: *effects on other disease drivers*

Climate Change and Pathogens

- To get from one host to another, many pathogens spend time in the environment, exposed to the weather.
- Climate affects pathogen development time and survival.
- Longer 'seasons' may increase the number of cycles.
- Milder winters may increase/decrease between-season pathogen survival.
- Climate change may affect disease seasonality.
- Climate change may affect dispersal - aerosols

There are many Drivers of Disease.....

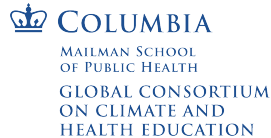
- The causes of emergence of 335 human diseases from 1940-2004 were classified into twelve categories (Jones et al., Nature, 2008).
- land use changes (36/335)
- agricultural industry changes (31/335)
- antimicrobial agent use
- international travel and commerce
- human demography and behaviour
- human susceptibility to infection
- medical industry change
- war and famine
- food industry changes
- breakdown of public health
- bushmeat
- **climate and weather (10/335)**
 - 6 = non-cholera Vibrio bacteria
 - 1 = fungal infection
 - 3 = mosquito-borne viruses.



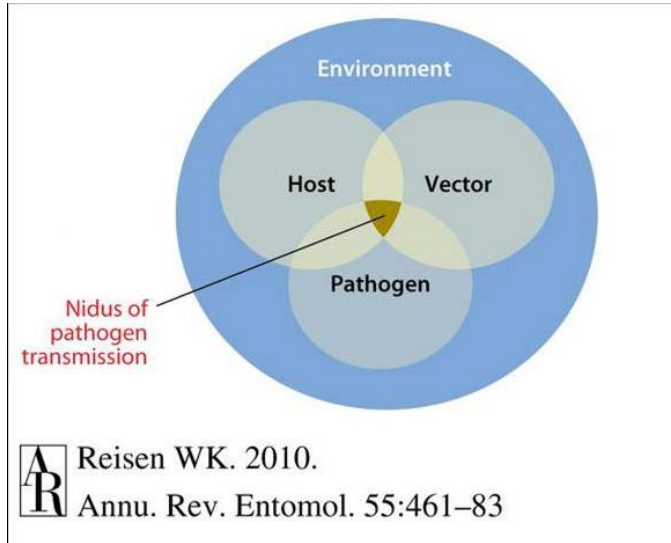
ZOOM Poll Question 2:

Climate change will:

- A) increase the incidence and geographical spread of all vector-borne diseases
- B) increase the incidence and geographical spread of some vector-borne disease, but some will reduce and may disappear completely
- C) Increase the incidence of vector-borne disease, but not the geographical spread
- D) not significantly affect the incidence and geographical spread of vector-borne diseases



Will Climate Change affect Vector-borne diseases?



- Changes in temperature and precipitation affect the environment in which the VBDs are transmitted.
- These environments may become more or less favourable to the vectors and to disease transmission.
- Vectors move will more favourable conditions

Examples:

- Leishmaniasis, transmitted by sand flies which are moving from south to north in Europe and from north to south in Argentina.
- In Canada and the USA, heatwaves are causing the northward displacement of ticks responsible for Lyme disease

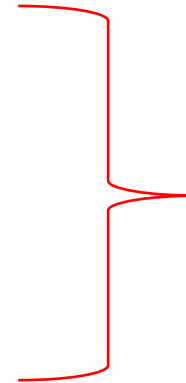
Will Climate Change affect Vector-borne diseases?

- Climate change will affect vector distributions, population sizes and seasonality
- Higher temperatures will affect vector competence, and vectorial capacity
- Climate change may affect vector dispersal
 - Vectors move to more favourable conditions
- Extreme weather events (El Niño) may favour some vector-borne disease
 - Flooding / Drought – increased opportunities for vector breeding



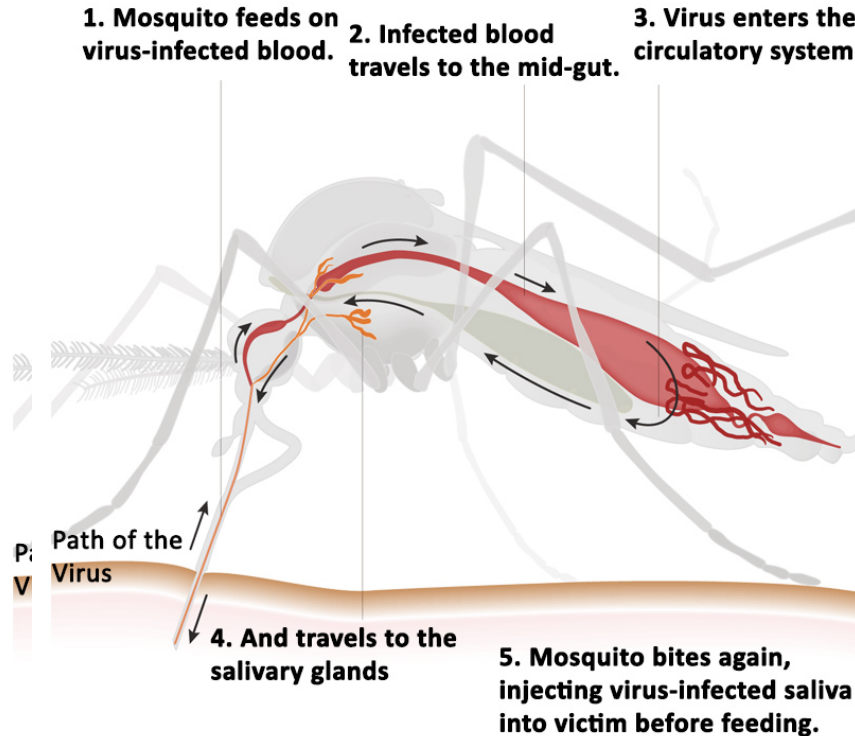
Vector-borne disease risk depends on:

- Vector competence = “susceptibility”
- Distribution and abundance (relative to hosts)
- Ability to transmit a pathogen
 - Vectorial capacity

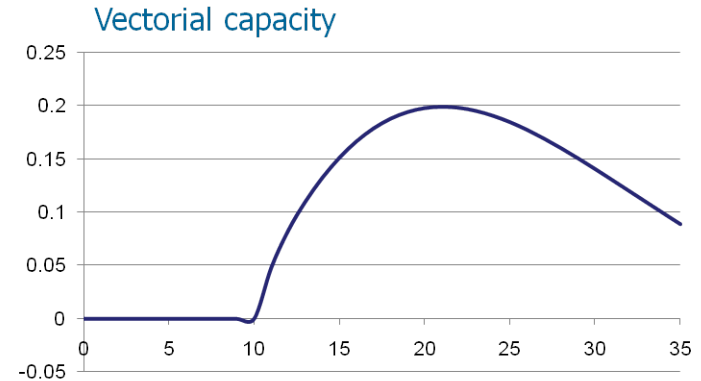


CLIMATE

Pathway to infection



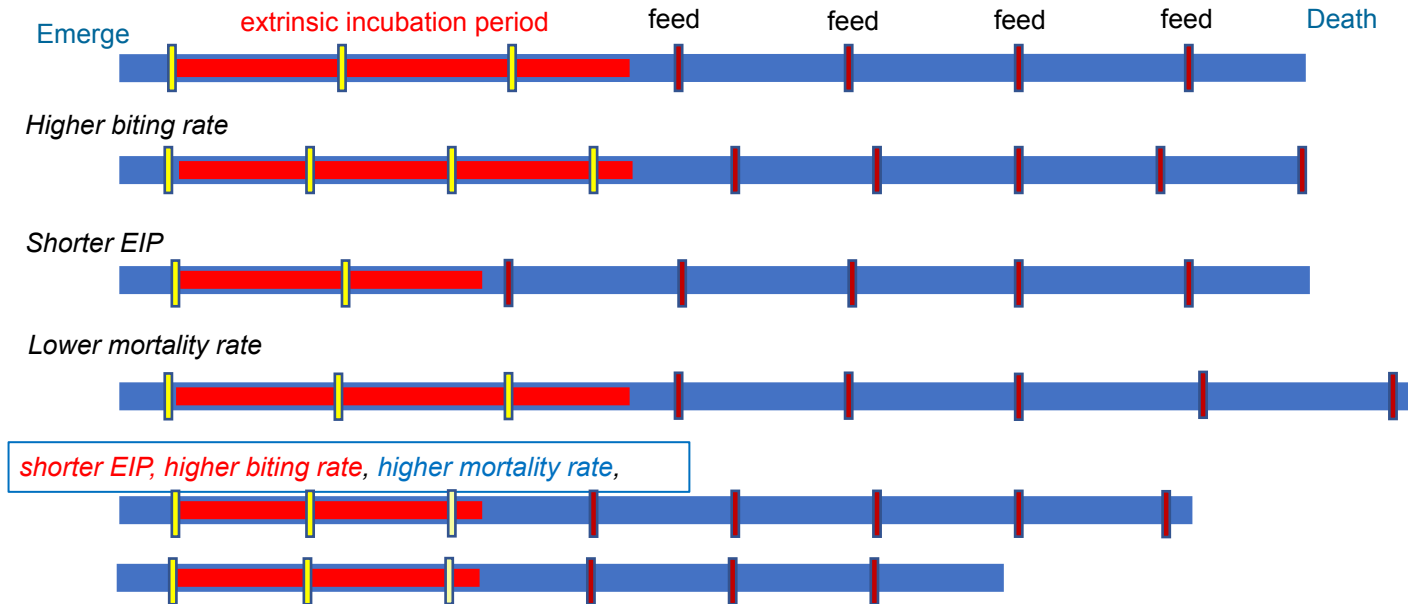
Time from taking bloodmeal to becoming infectious called **Extrinsic Incubation Period**



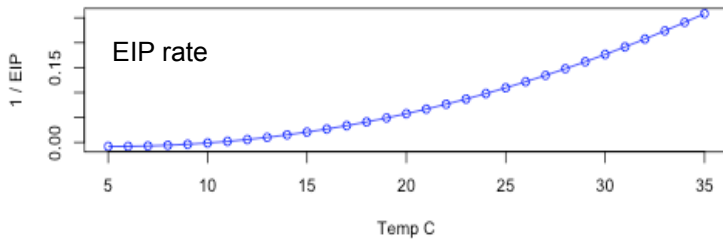
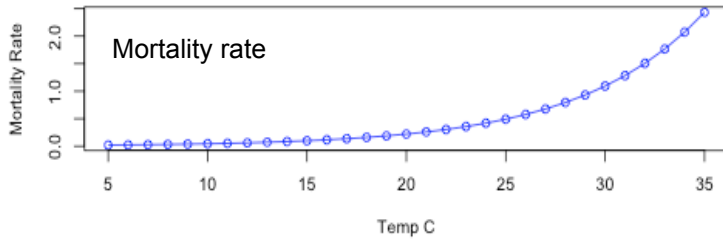
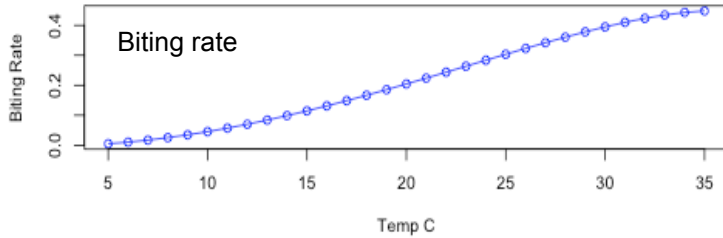
For example, dengue viruses will develop in mosquitoes and be transmitted only if exposed to temperatures within the range of 20 to 25°C

Pathogen transmission

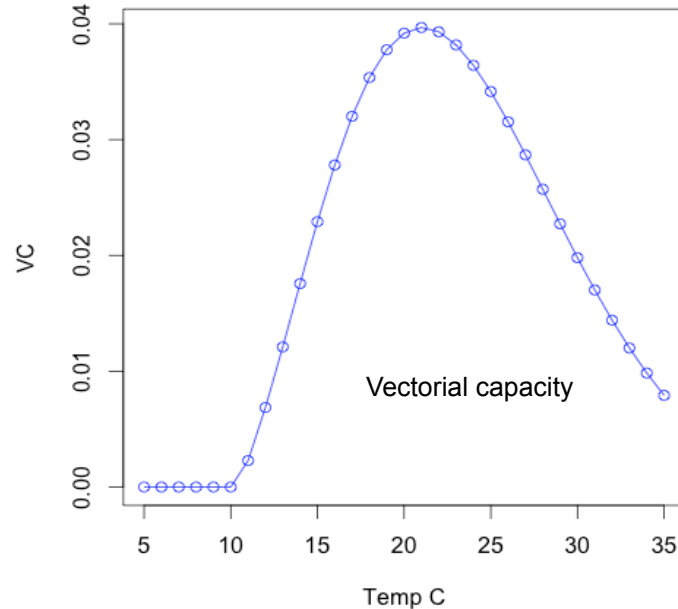
- Ability to transmit pathogen is determined by
 - How many feeds a vector takes (on average) in the time between becoming infectious (after EIP) and death



Pathogen transmission and temperature



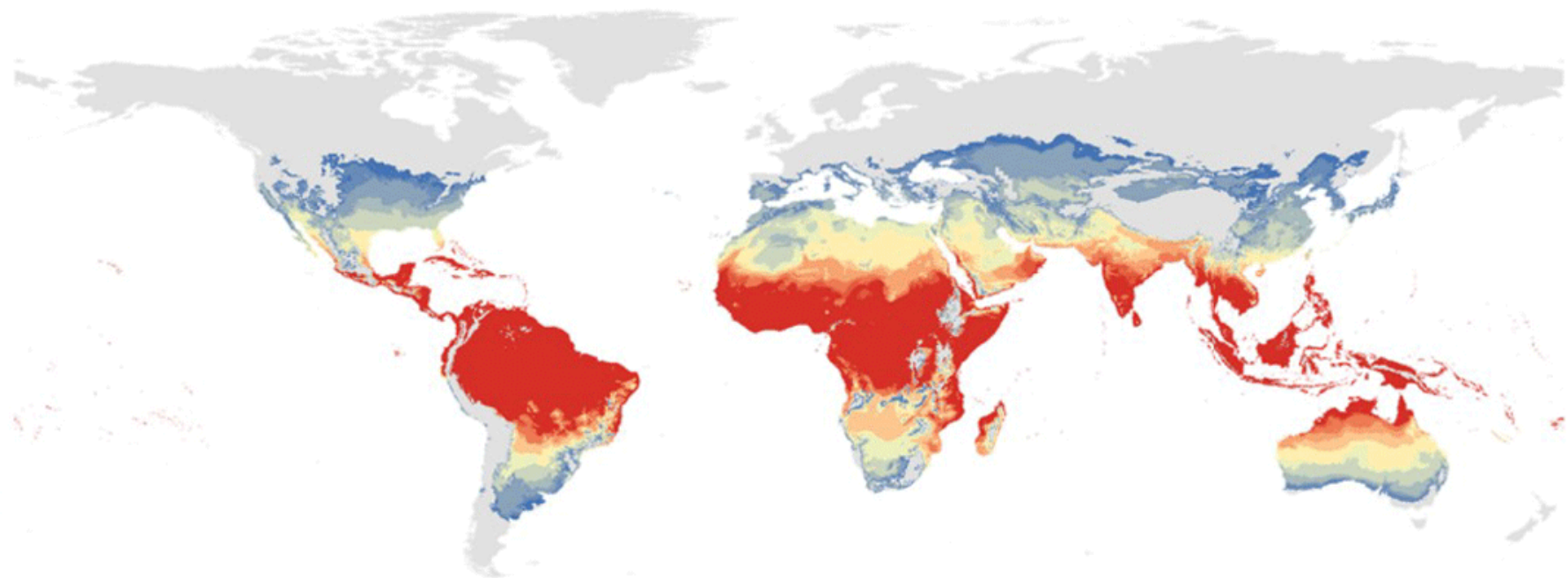
These combine to give an optimum temperature for virus transmission....



2019

Mosquito Habitat: Current & Projected

THIS PROJECTION IS BASED ON A WORST-CASE SCENARIO
WITH THE IMPACT OF CLIMATE CHANGE UNMITIGATED.



Number of months per year when disease transmission by *Aedes aegypti* mosquito is possible

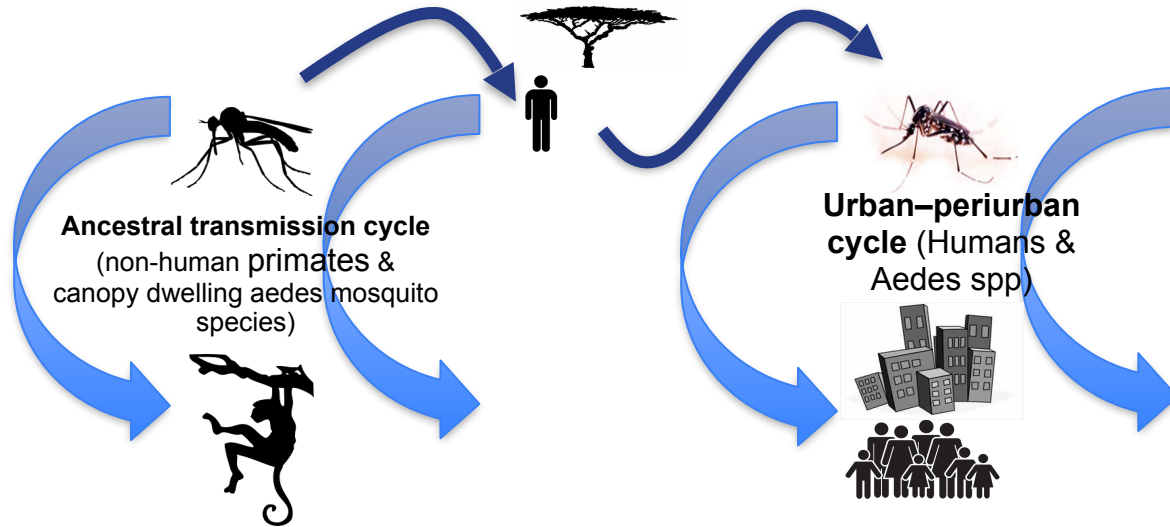


Zika Virus



Zika Virus

Spillover into human population and **adaptation** to anthropophilic *Aedes* mosquito spp.

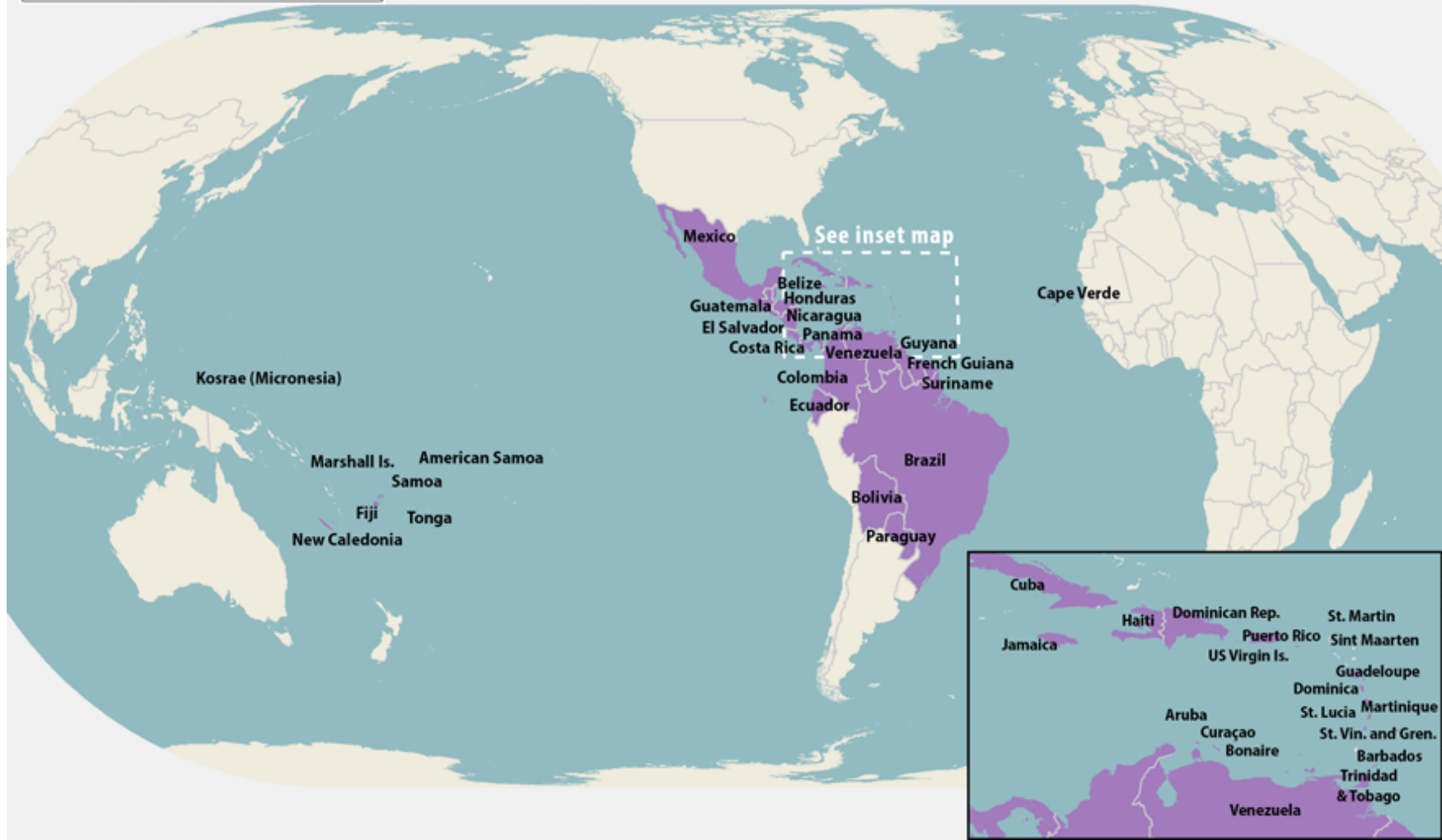


- 1st isolated in 1947 from sentinel rhesus monkey from Ziika Forest, Uganda.
- Animal reservoir still to be confirmed; likely to include non-human primates.

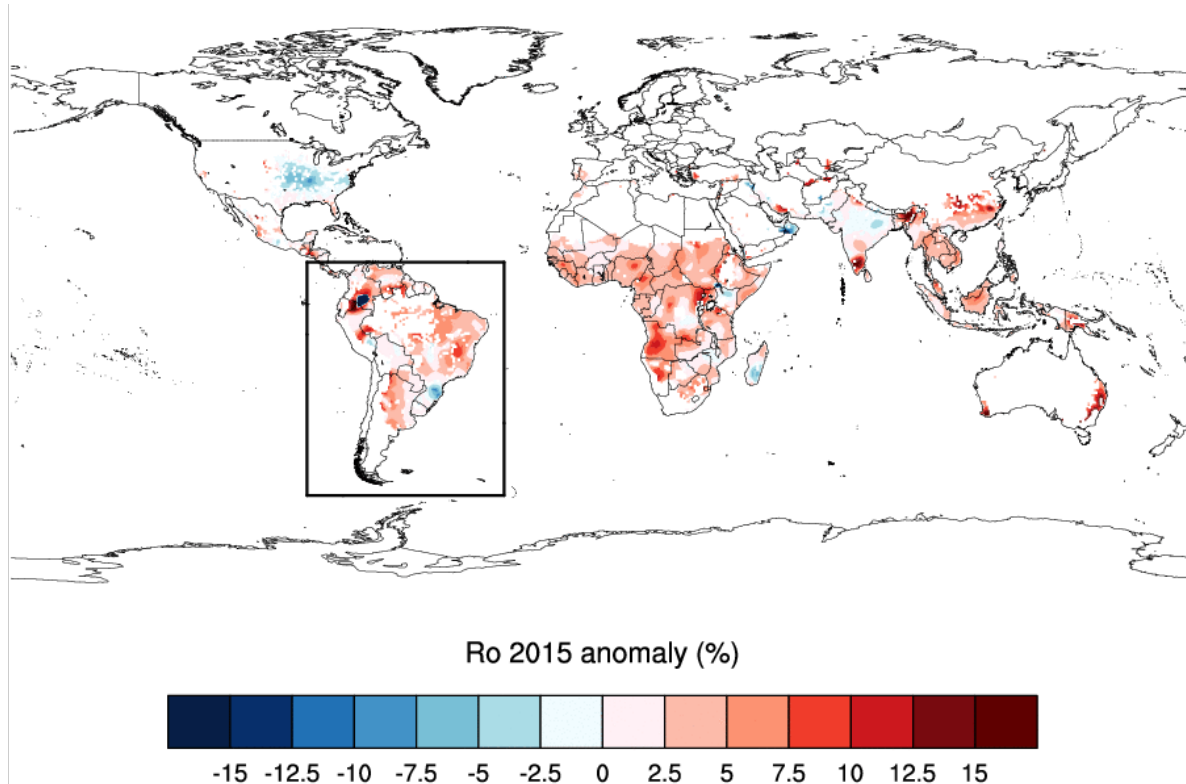
Global SPREAD of Zika



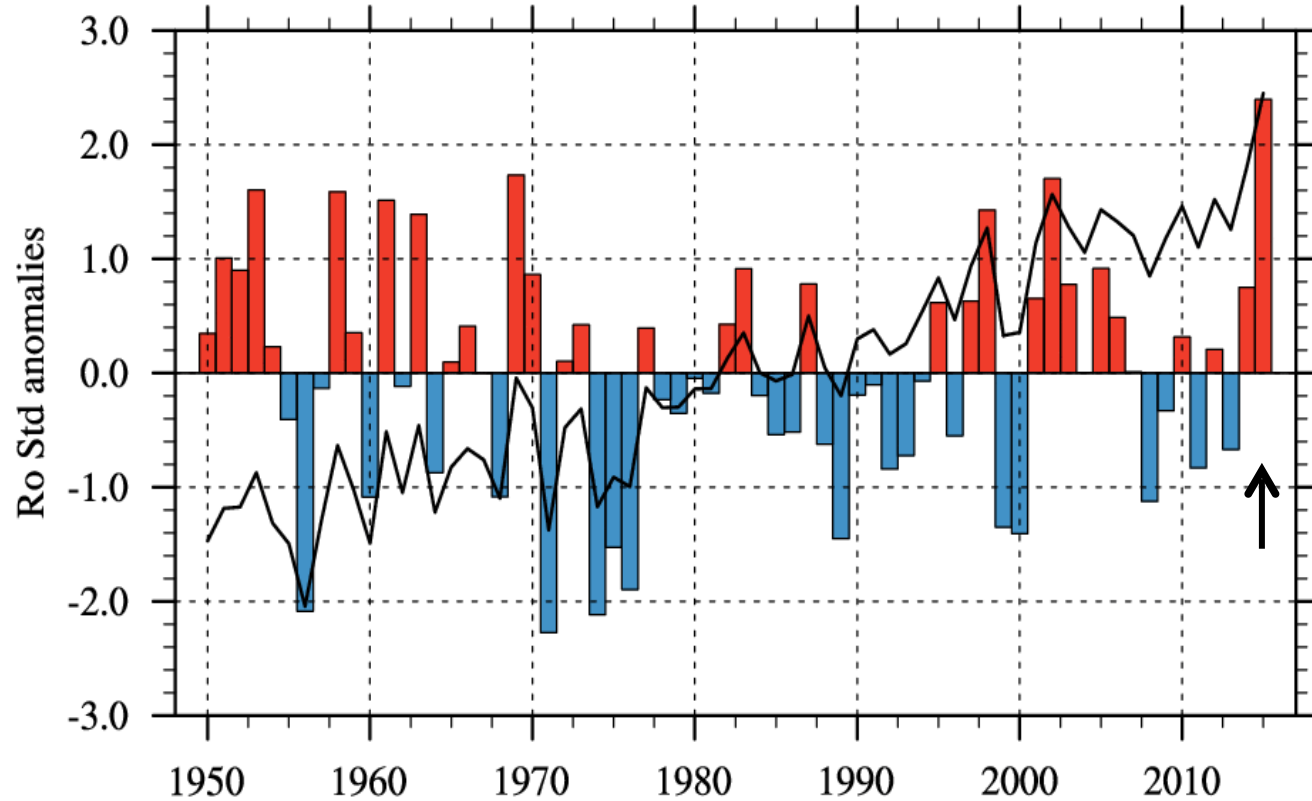
Reported active transmission



Zika virus - Annual anomaly in risk: 2015

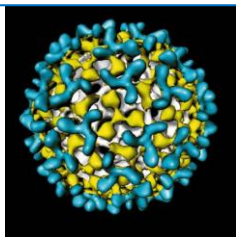


Zika virus - Annual anomaly in risk: 2015



Bluetongue

VIRUS



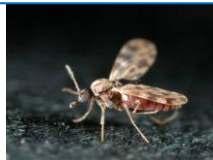
Reoviridae: Orbivirus, 24 serotypes

RUMINANT



Infectious to all ruminants; severe disease in sheep & some deer

VECTORS



C. imicola
AFRICA, ASIA,
S. EUROPE



C. obsoletus
EUROPE



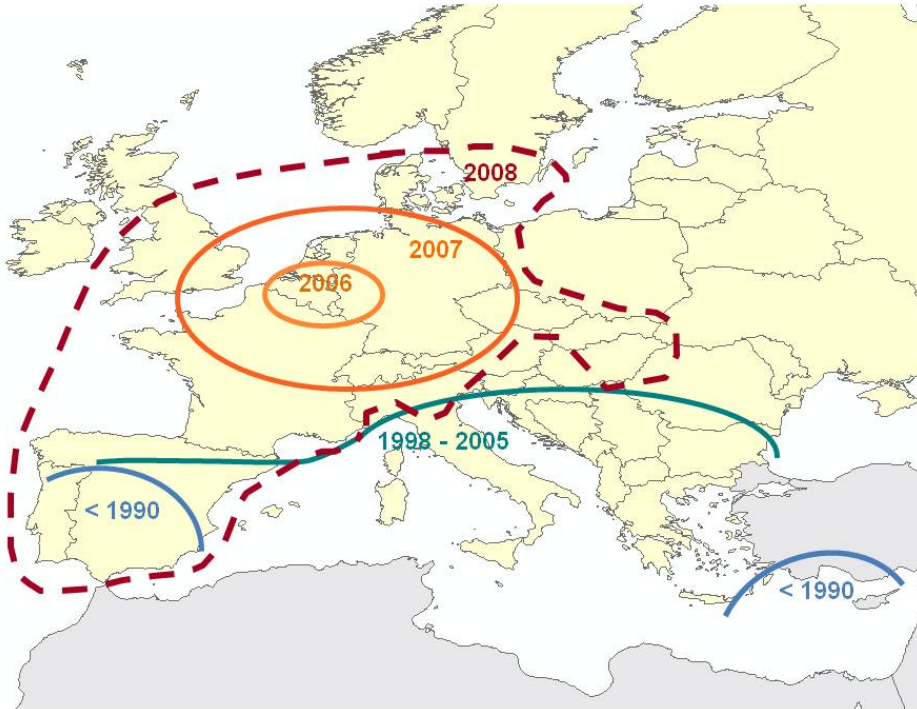
C. sonorensis
N. AMERICA

Culicoides biting midges
Highly seasonal
Very abundant
Long range dispersal
Transmit >50 viruses

Northward movement of bluetongue in Europe

Changes in European climate that have allowed:

1. increased virus persistence during winter,
2. the northward expansion of *Culicoides imicola*, the main bluetongue virus vector, and, beyond this vector's range,
3. transmission by indigenous European *Culicoides* species - thereby expanding the risk of transmission over larger geographical regions.



Review > Nat Rev Microbiol. 2005 Feb;3(2):171-81. doi: 10.1038/nrmicro1090.

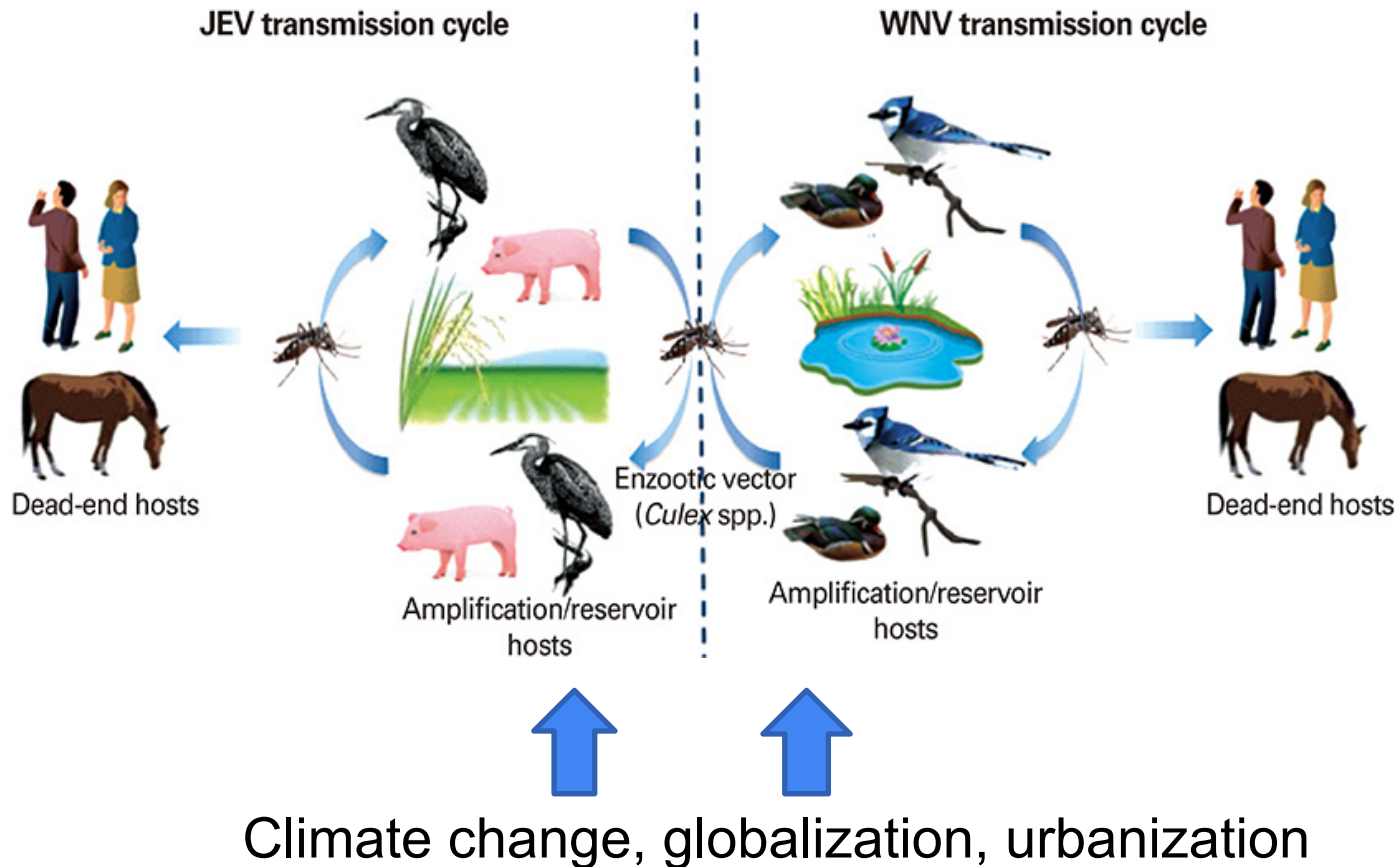
Climate change and the recent emergence of bluetongue in Europe

Bethan V Purse¹, Philip S Mellor, David J Rogers, Alan R Samuel, Peter P C Mertens, Matthew Baylis

Affiliations + expand

PMID: 15685226 DOI: 10.1038/nrmicro1090

One Health: Humans, animals and the environment



Summary – Climate Change and vector-borne diseases

- Climate change is and will continue to affect the incidence and distribution of vector-borne diseases – some will increase and some decrease depending on geography
- Climate variability is an important cause of VBD outbreaks
- Climate change is enabling vectors to spread, and increasing their vectorial capacity.
- Other drivers including global travel, trade and ‘human’ factors are also hugely important
- Consequently, we are seeing vectors spread in the Americas transmitting new diseases
- Other vector-borne disease lie in wait – WNV, JEV, Oropouche.....



Will Climate Change affect Zoonotic diseases?

'Potentially devastating': Climate crisis may fuel future pandemics

'Zoonotic spillovers' expected to rise with at least 15,000 instances of viruses leaping between species over next 50 years



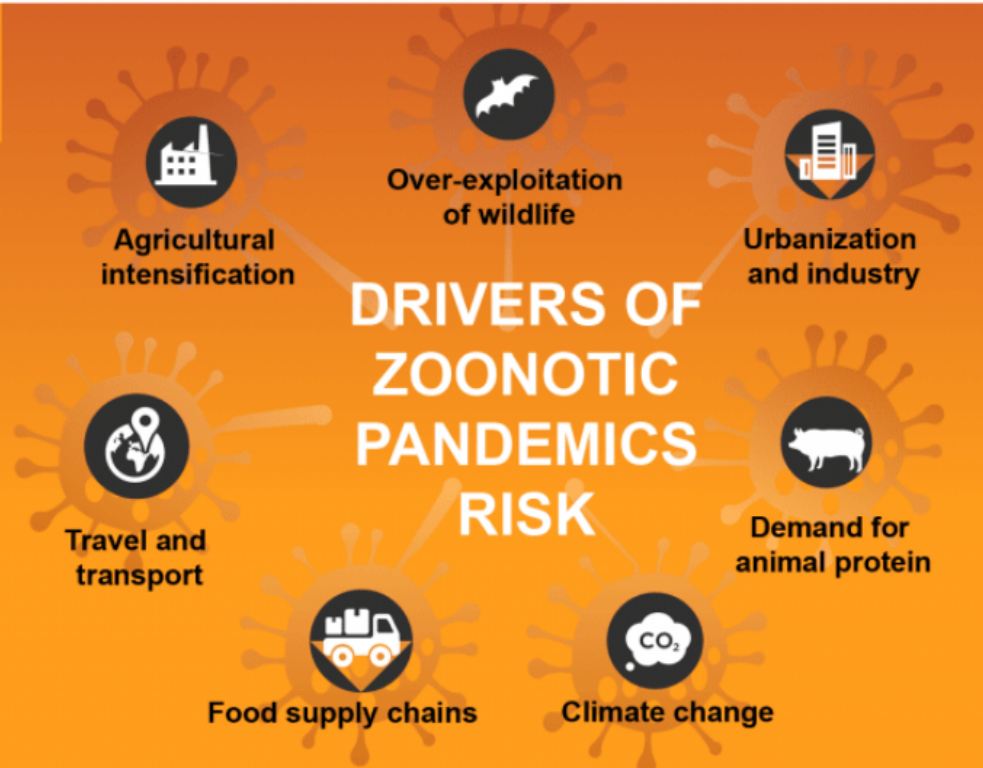
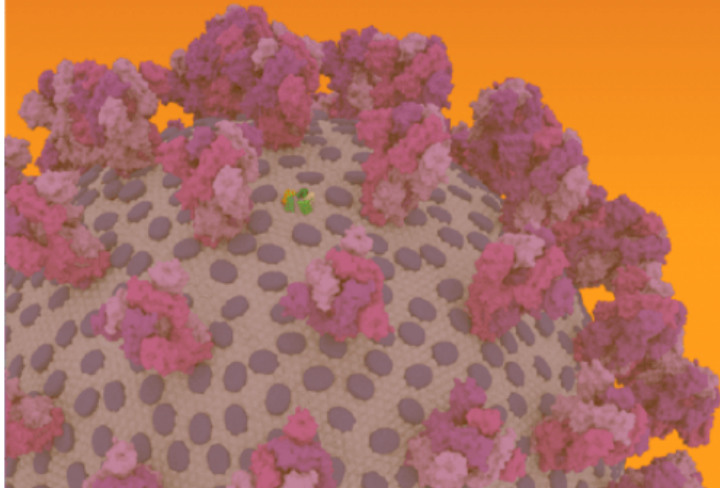
As the planet heats up, many animal species will be forced to move into new areas to find suitable conditions.

They will bring their parasites and pathogens with them, causing them to spread between species that haven't interacted before.

This will heighten the risk of "zoonotic spillover", where viruses transfer from animals to people, potentially triggering another pandemic of the magnitude of Covid-19 – or worse

PREVENTING THE NEXT PANDEMIC

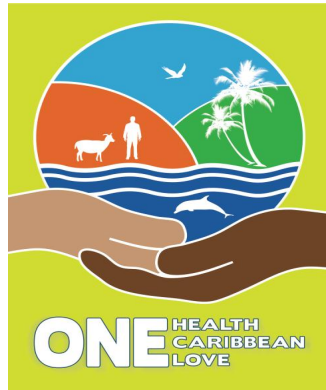
Zoonotic diseases and how to break the chain of transmission

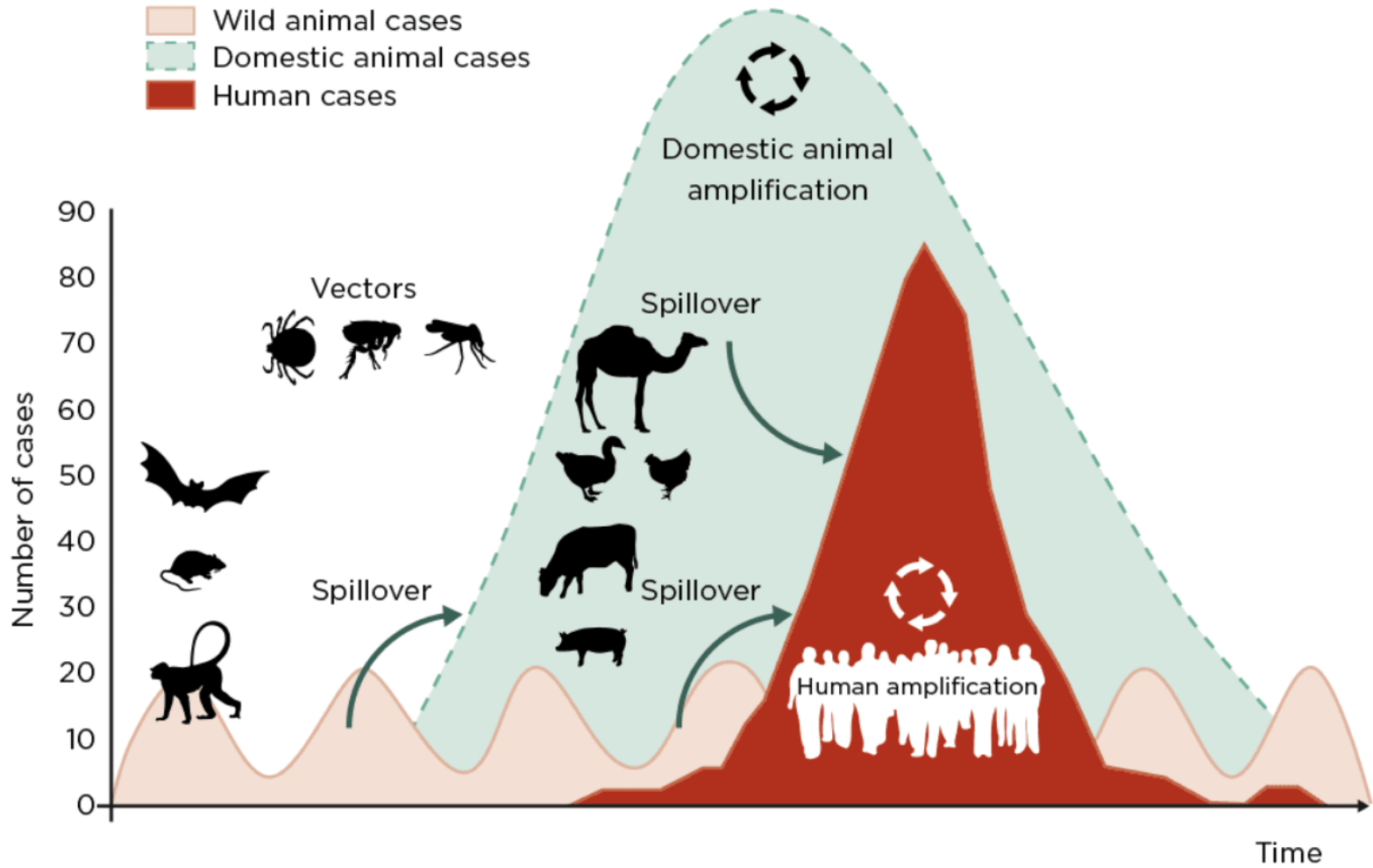


The emergence of zoonotic diseases

- Most human pathogens have come through animals
- Animals often maintain pathogens in the environment – wildlife
- Animals are involved in the spread of the pathogens to humans
- Environmental factors are linked to the spread of many pathogens

Need to follow a multidisciplinary “One Health” approach





Why is the situation getting worse?



Deforestation



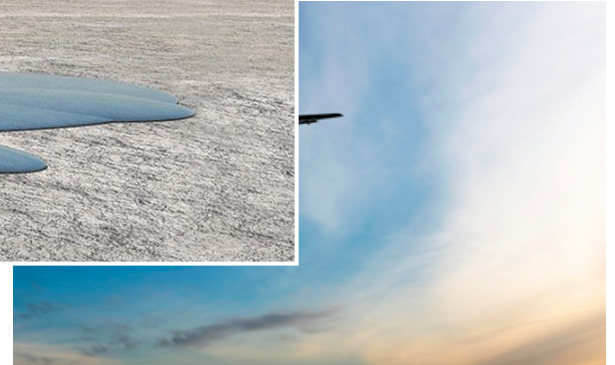
Meats / Eating habits



High-density human populations
unplanned urbanisation



Modern agricultural practices



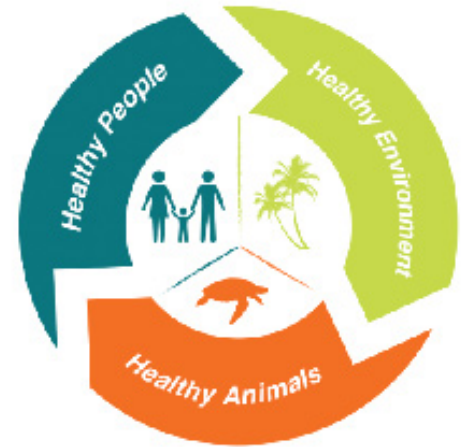
Rapid global transport networks

Key take home messages!

- Domestic animals / wildlife play an important role in spreading viruses to humans
- However - there is a single species responsible for this – humans
- Recent pandemics are a direct consequence of human activity
- We must not blame wildlife – need to change our habits and customs
- We MUST learn from our experiences or worse will happen..... **Not if – WHEN**
- We need to follow a One Health approach as everything is connected!
- **Stop Climate Change!**

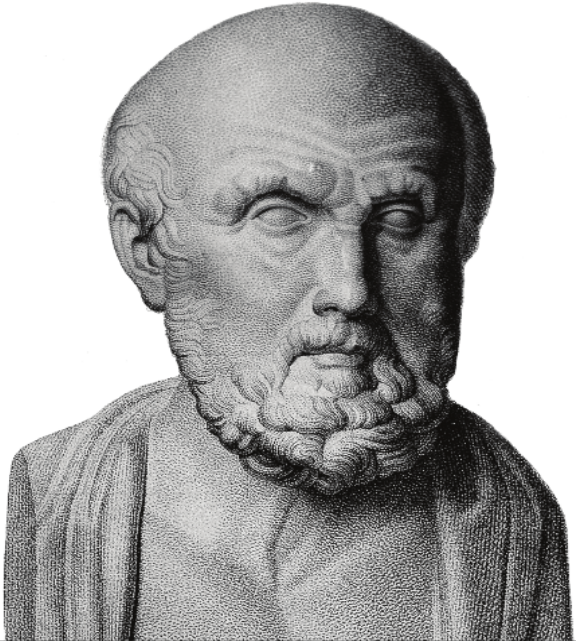
Halt destruction of nature or suffer even worse pandemics, say world's top scientists

Exclusive: only one species is responsible for coronavirus - humans - say world's leading wildlife experts



What actions can you as health professionals take to protect you patients vulnerable to these diseases?

Think “One Health” in your day-day work!
Take a One Health / Climate Change and Health History



“

It is better to know what sort of person has a disease than what sort of disease a person has.



”

Hippocrates


Knowing when and where your patients are at risk
Identify vulnerable patients including: women, outdoor workers, farmers, slaughter house workers, children, adolescents, immunocompromised, etc

What are the Health Implications for March - May 2022?







Respiratory Illness

- 
 The short term drought and associated increase in dust, as well as, potential soot and smoke from bushfires may contribute to higher concentrations of airborne particulate matter. This could result in an increase in **acute respiratory illnesses**.
- 
 There may be an increase in symptoms in persons with chronic respiratory conditions such as **asthma**, and in persons prone to **allergic rhinitis** due to more frequent episodes of Saharan dust incursions into the Caribbean, as well as due to local dust being suspended in the air when the ground surface is dry.
- 
 This may be offset by a decrease in allergic reactions to fungal spores from mold at least until the end of April. By contrast, increasing humidity across the region from May onwards could cause dampness in some poorly ventilated residences and offices resulting in the growth of mold. This could be particularly so in the Guianas. In the Caribbean islands, increased allergens in the atmosphere may occur from plant materials (e.g. pollen) driven by increased wind speeds and reduced washing out by rain. These factors may also trigger increased incidences of **upper respiratory tract symptoms**.
- 
 Where episodes of flooding may occur, there is an increased risk of **ear, nose, and throat infections** from contaminated water across the region, particularly in April and May.

Gastrointestinal Illness

- 
 Drought conditions may increase concentrations of water pollutants. Additionally, a drop in water pressure in the pipes of water supply systems may result in cross-contamination and reduced access to water by consumers. Alternative use of unsafe sources of water, in turn may

Vector-Borne Illness

- 
 Increased rainfall and the more frequent occurrence of stagnant water from flooding towards May, particularly in the Guianas, may create more breeding sites for the *Aedes aegypti* and *Aedes albopictus* mosquitoes which are the vectors of diseases such as **Dengue, Chikungunya, Zika and Yellow Fever**. These diseases remain a perennial concern for Caribbean territories.
- 
 With drought evolving in a few locations, particularly east of Hispaniola and with recurrent dry spells across the region in this period, there may be increased use of containers for water storage.
- 
 At the household level, careful attention should be given to the management of water storage containers. This includes mosquito proofing water tanks, barrels, drums and buckets.
- 
 The focus should be on public education and awareness on source reduction and personal protection. If fogging operations are considered by the Ministry, advice from the local meteorological services on temperature, wind speed, humidity, etc. should be sought.
- 
 Access useful materials on mosquito control measures here: (<https://www.paho.org/en/campaigns/caribbeanmosquito-awareness-week-2020>); Join the fight against mosquito-borne disease in the Caribbean: <https://www.carpha.org/What-We-Do/PublicHealth/Dengue> and <http://missionmosquito.carpha.org/>
- 
 Flooding may increase the risk of **Leptospirosis** due to displacement of rodent vectors from their usual habitats into houses, increasing the risk of contamination of flood waters, household surfaces and food-stores with rodent



CA
This Bull
Caribbe
incler
combina
weather
manager

What

Managing the risk of disease emergence:

Critical points going forward.

Where should we concentrate our time and effort?

1. Increase awareness of what is out there – surveillance
2. Legislation to protect our wildlife and reduce spill-over
3. Assess the risk of introduction (legal and illegal trade)
4. Consider how to reduce supply and demand for wildlife and wildlife meat – how?
4. Promote harmonization – take a regional approach
5. Promote an interdisciplinary ‘One Health’ approach

What can our health sectors do to become better prepared to address shifting geographic burdens of vector-borne and zoonotic disease?

Need to pair viral surveillance and discovery efforts with biodiversity surveys tracking species' range shifts, especially in regions that harbour the most zoonoses and are experiencing rapid warming

We need to invest in primary pandemic prevention, namely habitat conservation, strictly regulating wildlife trade, and improved livestock biosecurity. Stop wet markets.

Design and develop a climate-driven spatio-temporal modelling framework that provides early warning of the increased risk of mosquito-borne diseases, for evidence-based decision making in the area of vector surveillance and control.

More data needed to inform the models.....



Caribbean Resilience
and Prosperity Through
ONE HEALTH

Editors:
Chris Oura
Adana Mahase-Gibson
Craig Stephen

Thanks for
Listening!



Thanks to Prof Matthew Baylis
University of Liverpool, UK for help
with slides used in this presentation

[http://www.cwhc-rcsf.ca/docs/
technical_reports/
Caribbean_Resilience.pdf](http://www.cwhc-rcsf.ca/docs/technical_reports/Caribbean_Resilience.pdf)

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