Why GO Mosquito Habitat Mapper?
Because Mosquito Vector Borne Disease!
Mosquito Vector Borne Disease Story

• A disease transmission model for mosquito vector borne diseases

• Disease Guide highlights; a resource guide when telling the story
The elements of the mosquito story . . .

- **Characters:** mosquitoes, humans, viruses, parasites
- **Setting:** everywhere (except Antarctica)
- **Plot:** Unintentional, yet often devastating, events unfold during the species-perpetuating quest by female mosquitoes for certain proteins found in human blood.
- **Conflict:** The female mosquito gets the blood proteins she wants; the humans who donate that blood may get diseases they do not want.
Mosquito-lingo used in the ‘story’

- **Pathogen** — biological agent that causes a disease
- **Vector** — an organism that transmits a disease
- **Arbovirus** — (arthropod-borne virus) general term for any virus transmitted by an Arthropod (such as a mosquito).
- **Parasite** — an organism that lives in or on a host.
Mosquito Vector Borne Disease Story

General Disease Transmission Model

- Source or reservoir
- Mode of transmission
- Susceptible Host

Specific Mosquito Vector Transmission Model

- Pathogen
- Mosquito vectors
- Transmission cycle
- Diseased individual

The principle arboviruses transmitted by mosquito

- Dengue
- Zika
- Chikungunya
- Yellow Fever
- West Nile Fever

AND PLASMODIUM, PATHOGEN FOR MALARIA
There is an ideal climate for both the survival of mosquitoes and for the transmission of pathogens

Transmission Risk
When mosquitoes are likely to spread disease

Percent probability

80%
40%
0%

50°  60°  70°  80°  90°  100°

Degrees Fahrenheit

Aedes aegypti: 50-102 °F; range; peak 73-93 °F
Aedes albopictus: 59-95 degrees °F
Culex: 50-95 °F, peak 82-89 degrees °F

Source: Mordecai et al. 2017

There is an ideal climate for both the survival of mosquitoes and for the transmission of pathogens

<table>
<thead>
<tr>
<th>Mosquito Species</th>
<th>Survival range</th>
<th>Peak rates for lifecycle stages</th>
<th>Optimized Extrinsic Incubation period Selected pathogens</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>A. albopictus</em></td>
<td>59-95°F (15-35 °C)</td>
<td>73-93 °F (23-34 °C)</td>
<td></td>
</tr>
<tr>
<td><em>Culex sp.</em></td>
<td>50-95 °F (10-35 °C)</td>
<td>82-89 °F (28-32 °C)</td>
<td>89 °F (32°C) (West Nile)</td>
</tr>
<tr>
<td><em>A. aegypti</em></td>
<td>50-102 °F (10-39 °C)</td>
<td>73-93 °F (23-34 °C)</td>
<td>95 °F (35°C) (dengue) 97 °F (36 °C) (Zika)</td>
</tr>
</tbody>
</table>
Disease and Climate Change

www.climatecentral.org/gallery/graphics/mosquito-disease-danger-days
Disease and Climate Change

Organisms have their own ecological tolerances - the range of conditions that enable survival, above and below which survival is not possible.

These conditions exist for mosquito vectors of disease.
These conditions also exist for the pathogens of disease.

Our ground level observations using Mosquito Habitat Mapper will help us to trace changes in mosquito populations as an impact of climate change.
This video shows how a viral infection propagates in a mosquito host and then transmits to human. The temperature plays a role in how long it takes for the infection to proceed and then be passed to humans.
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

https://www.npr.org/assets/graphics/2019/03/mosquito-habitat.gif&utm_source=nprnews&utm_medium=app&utm_campaign=storyredirect
How the Zika Virus Enters the Human Population

The virus originates with nonhuman primates in tropical rainforests but can infect humans. Warm, urban environments with standing pools of water attract mosquitoes, and can lead to the virus’s spread.

SYLVATIC CYCLE

Chimpanzees
Monkeys
Baboons

Mosquitoes
Ae. africanus
Ae. furcifer-taylori
Ae. dalzieli

URBAN CYCLE

Human Population

Mosquitoes
Ae. aegypti
Ae. albopictus

It appears that Zika can be transmitted through sexual intercourse, blood transfusion, and in utero.

Sources: CDC, PLOS, Reuters  Credits: David Foster, Laurie Garrett, Doug Halsey, Gabriella Meltzer

https://www.cfr.org/backgrounder/zika-virus
Malaria Transmission Cycle

1st Vector

Initial human host

Liver infection

Blood infection

2nd Vector

Next human host

In utero transmission

Plasmodium sporozoites
Beyond the Bite

Each *Beyond the Bite* contains these elements of the mosquito story:
- Vital Point
- Cause
- Mosquito Vector(s)
- Range
- Transmission
- Incidence (rate or frequency)
- Symptoms
- Treatment
- General Information
- History
- Link to most current CDC disease cases

*Beyond the Bite* for:
- West Nile Virus
- Chikungunya
- Dengue
- Malaria
- Yellow Fever
- Zika
Beyond the Bite: West Nile Virus

Vital Point: Mosquitoes, humans, birds, horses and other animals are all hosts for West Nile virus (WNV) or play a role in the transmission of this virus. Birds are the most common reservoir hosts. Mosquitoes acquire the virus from birds and subsequently then transfer it to humans, horses, and other mammals. Vaccines are available for horses but not yet for humans (Source: WHO).

Cause: West Nile virus is caused by a flavivirus, a genus of viruses found in arthropods (primarily ticks and mosquitoes) and hosted by humans and other animals, such as birds and horses.

Mosquito Vector(s): Over 65 species of Culex mosquitoes have been shown to be infected by West Nile virus. Some of the common species with competence for both infection and transmission of West Nile virus include C. tarsalis, C. pipens, C. quinquefasciatus, C. stigmatosoma, C. thriambus, and C. nigripalpus.

Range: Currently, WNV has a pandemic distribution, including all of Africa, and parts of Europe, Middle East, West Asia, and Australia. Since its introduction in 1999 into North America, the virus has spread and become widely established from Canada through the U.S. to Central and South America.

Transmission: Birds are the natural hosts of the virus. Mosquitoes acquire the virus when they extract blood from infected birds. The virus eventually infiltrates the mosquito’s salivary glands; then it is released into a human during a mosquito bite, completing the bird to mosquito to human transmission. Culex mosquitoes tend to bite from dusk to dawn.

Incidence (rate or frequency): WNV is the leading cause of domestically acquired mosquito-borne disease in the United States. In 2012 the U.S. had its first WNV epidemic which killed 286 people. Today it is the mosquito-borne disease of most concern for those living the United States. In 2018 case numbers were unusually high in Nebraska, California, North Dakota, Illinois, and South Dakota while in Europe, the number of cases exceed the total from the previous seven years combined. People over the age of 50 are at higher risk for serious illness.

Symptoms: The viral incubation period is usually 3–14 days. Diagnosis is difficult with eight out of ten victims (80%) showing no symptoms. If present, those symptoms include fever, headache, body ache, joint pains, vomiting, diarrhea, and rash. One in 150 will develop severe encephalitis (inflammation of the brain), and/or meningitis (inflammation of the membranes surrounding the brain/spinal cord). Effects on the brain and spinal cord may be permanent; one out of ten affected neurologically will die.

Treatment: There is neither a vaccine nor a specific treatment for WNV. Over-the-counter medicines can be used to relieve some symptoms. Hospitalization is required when the brain and/or spinal cord are affected (infected).

General Information: The disease derives from the West Nile District in Uganda. Outbreaks often occur along major migratory routes of birds with several species of birds carrying the virus. Some birds, such as crows and jays, can die from WNV. Reporting dead birds and having them examined for WNV is one way to check for the presence of WNV in the environment. West Nile virus can also infect horses and other mammals. Humans, horses and other mammals are considered “dead-end” hosts – none of them can develop high enough levels of the virus in their blood for mosquitoes to pick up during a bite. Birds are called an “amplifier” host – they develop levels of the virus high enough for mosquitoes to acquire and transfer.

History: WNV was first discovered in 1937 in the blood of a woman from the West Nile District of Uganda. The virus was identified in birds in the Nile delta regions in 1953. The mode of arrival into the U.S. in 1999 is still unresolved; however, West Nile virus may have come from an infected bird or by an infected mosquito brought in through shipping ports.
Human WNV disease cases, 2019. (CDC). Screenshot of an interactive map, retrieved from

https://wwwn.cdc.gov/arbonet/Maps/ADB_Diseases_Map/index.html
Transmission Cycle
West Nile Virus (WNV)

Bird Migration/Travel Helps Spread/Distribute West Nile Virus

Horses and Other Animals Dead-End Victims

Birds Viremia/Virus Amplification

Adult Female Mosquito

Larval Development Cycle in Water

- Virus From Migrated Birds to Local Mosquitoes
- Local Mosquitoes to Non-Infected Local Birds
- The Virus Replicates in Mosquitoes and Exponentially in Some Birds, Making Virus Transmissibility Easier
- The Viremia is Less in Dead-End Victims, Resulting in Their Exclusion From the WNV Transmission Cycle
Mosquito Resource Library

Tutorials

**MHM Infographic**

A step-by-step infographic on the use of the GLOBE Observer Mosquito Habitat Mapper tool.

- Static PDF Infographic
- Interactive ePub file (requires ePub reader)
- Full Screen, Interactive Infographic

**Step-by-Step Mosquito Habitat Mapper Tutorial**

Step-by-step illustrated guide to collecting specimens and observations with the GLOBE Observer Mosquito Habitat Mapper.
In the toolkit . . .

In Summary

We recommend:

1. watch the entire 40-minute video from which sections were taken for this presentation (http://bit.ly/2SyucmM).
2. Download and use the MHM to document breeding habitats and to reduce the chance of breeding habitats (observer.globe.gov).
3. visit GLOBE Observer Mosquito Habitat Toolkit at observer.globe.gov to download the disease guides and additional resources.
At our next Citizen Science Webinar,
Dr. Lisa Gardiner

August 21, 2pm ET
Our next Education Webinar

Around the World with Mission Mosquito
August 7 @ 8pm ET


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Thank you

Dr. Rusty Low (rusty_low@strategies.org)
Liz Burck (liz_burck@strategies.org)
Cassie Soeffing (cassie_Soeffing@strategies.org)