PBS LearningMedia

Buzz: Climate Change Prolongs Mosquito Season
Background Essay

Climate change is increasing the number of days with temperatures around 80°F and high humidity, the ideal environment for mosquito breeding. With prolonged breeding conditions, mosquitoes can breed more frequently, increasing the opportunities to transmit disease. Not only are temperatures reaching 80°F more frequently, they are reaching or going above 86°F more frequently as well. This is even worse news for mosquito borne disease transmission.

At 86°F mosquito activity increases in several life stages. First, mosquito larvae develop faster at warmer temperatures. Because the larvae are developing faster, the generation length decreases and more generations can reproduce in the same time period. Once the larvae become adults, the adults digest blood faster and feed on blood more often in warmer temperatures. The more often the adult mosquitoes feed on humans, the more opportunities there are for disease transmission. Finally, in temperatures around 86°F the disease vectors incubate faster. It can be difficult to determine how the concentration of disease vectors affects the likelihood of transmission. But, for at least some mosquito borne diseases, like malaria, the higher the concentration of disease vectors the more likely a mosquito is to transmit the disease to anyone it bites.

Humidity also increases the life span and activity of adult mosquitos. Increased humidity keeps the mosquitoes active and feeding on humans for longer. Humidity relates more specifically to breeding because mosquito larvae hatch in stagnant water. While most mosquitoes lay their eggs in still bodies of water, some lay their eggs in dry conditions and the eggs only hatch when rained upon. In either case, humidity helps contribute to the stagnant water the larvae need. The larvae also form pupae in stagnant water. Only when the adult mosquitoes emerge from the pupae do mosquitoes become land based.

Seventy-six percent of major U.S. cities had an increase in the number of days with these mosquito breeding conditions between 1980 and 2016. Mosquito season has increased by half a month or more in many regions. This ecological change impacts human welfare beyond the itchiness of mosquito bites. Two mosquito-borne diseases became public health concerns in the U.S. during the early part of the 21st century: West Nile virus and Zika. West Nile virus first appeared in the summer of 1999 in New York. Over the next decade it spread throughout the country. In 2015 a Zika outbreak began in Brazil and travelers brought it back to the U.S. In 2016 the first cases of mosquitoes transmitting Zika in the US occurred. Most people who are infected with either virus do not develop symptoms. As of 2017 there were no vaccines for either virus.

Zika is a serious health concern because a pregnant woman can transmit the virus to her fetus. This can cause microcephaly, a birth defect in which an infant's head is smaller than expected. Patients with microcephaly from Zika infection have decreased brain tissue and other birth defects. Mosquitoes are infected with the Zika virus from direct feeding on humans with Zika. They can then transmit the virus to other humans they bite. As of 2016 the only transmission from mosquito to human in the continental US was in southern Florida and Brownsville, Texas. There were cases where mosquitoes transmitted Zika from an infected individuals in Florida and Texas to other individuals in that region.

West Nile virus is a serious health concern because a small percentage of individuals infected with the virus develop serious neurological illnesses. Those severe cases can lead to coma or paralysis, and can even be lethal. Mosquitoes are infected with the West Nile virus from feeding on birds with West Nile virus. They can then transmit the virus to humans they bite.

Globally, climate change may also bring mosquito borne diseases to new locations. As with Zika, most mosquito borne diseases originate in tropical climates. Some can only be transmitted under tropical conditions. Climate change is starting to create tropical conditions in previously temperate zones. This could bring tropical mosquito borne diseases, like malaria from Africa and dengue from Latin America and Asia, to more temperate regions like Europe.

PBS LearningMedia

Buzz: Climate Change Prolongs Mosquito Season
Discussion Questions

These discussion questions are designed to be used in conjunction with the information in the background essay and in the interactive.

Comprehension Questions

- How does a prolonged mosquito season relate to climate change? Why do you think mosquito season is getting longer.
- Look at a sampling of cities. Was mosquito season prolonged in every city? Which cities had the longest mosquito seasons?

Critical Thinking Questions

- What other effects could climate change have on organisms' breeding seasons? What criteria might determine the effects of climate change on different organisms' breeding patterns? How does the longer mosquito season affect the mosquitoes' ecosystem?
- Could mosquito season increase indefinitely? How might even higher temperatures affect mosquito breeding?
- Why are mosquitoes an important organism to focus on? How are mosquitoes related to human health and welfare?

Buzz: Climate Change Prolongs Mosquito Season

Pick ten cities from the dropdown menu in the interactive and fill in the table below with the mosquito days for those cities.

City	Mosquito Days - Then	Mosquito Days - Now	Mosquito Days Change

Calculate the change in the number of mosquito days by subtracting **Mosquito Days – Then** from **Mosquito Days – Now**. Record the result in the Mosquito Days Change column.

Follow your teacher's instructions to create a bar chart of the change in the number of mosquito days for each city.

Analysis

1. Was there a trend in how the number of mosquito days changed?

2. Compare your cities to a map of the climate zones in the United States.
   a. Do the cities that have the greatest change have similar climates?

   b. If yes, how might those climates contribute to a longer mosquito season?

3. Why did you create a bar chart rather than a line graph?

4. Data presentation:
   a. What years were used to calculate the **Mosquito Days – Then**?

   b. What years were used to calculate the **Mosquito Days – Now**? You may need to increase the zoom in order to read the source information in the lower left corner.

   c. Do the two values include the same number of years?

   d. If not how might that affect the comparison?

PBS LearningMedia

Buzz: Climate Change Prolongs Mosquito Season
Teaching Tips

- Breaking down climate change into simple concepts that students can relate to is challenging. This interactive focuses on climate change's impact on something all students can relate to. The lesson can be introduced by seeing if students remember in what months they've received the most mosquito bites.

- The handout Buzz: Climate Change Prolongs Mosquito Season (/asset/cc17-doc-mosquito) allows students to rigorously explore the data from the interactive. The handout can be customized for specific cities, rather than allowing students to select their own. If there is not access to an individual computer for each student, the handout can be used for a group activity. Increase the rows in the table and allow each student to select a city. Students can use excel or other graphing software to create a bar chart, or they can draw a bar chart on a separate sheet of paper.

- The resource Major Climate Zones in the United States | QUEST (/resource/205662cd-43c5-476c-9d04-c25559da64af/major-climate-zones-in-the-united-states/#.WMHY6vLzN-g)
can be used to compare the increase of mosquito season to climate. Or use a map of the U.S. and help the students assign typical weather conditions to the different cities.

- The interactive was created as part of the Climate Central article below. The article can be used to select cities that experienced the greatest change. Or read the article with the class as an extension activity and compare the students' analysis to the article. Questions three and four in the handout can be expanded by examining the line graph of months in mosquito season vs. calendar year in the article.

The interactive is generously provided by Climate Central. More information can be found at More Mosquito Days Increasing Zika Risk in U.S. (http://www.climatecentral.org/news/more-mosquito-days-increasing-zika-risk-in-us-20553)

Vocabulary

Climate Change – the large-scale, long-term shift of earth's weather patterns and average temperatures, particularly from the mid to late 20th century onwards. This change results from greenhouse gas emissions from human activity.
Larvae – immature, active insect, like a caterpillar.
Mosquito Season – the period of time when weather conditions allow mosquitos to breed.
Vaccine – a preventative measure against disease. A preparation of non-active microorganisms that stimulate antibody production, providing immunity.
Virus – infective agent that consists of a nucleic acid genome and a protein coat. A tiny particle that causes disease, like the flu or chicken pox.