Climate Change: Its Potential Effect on Mosquitoes and Disease in Michigan

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The evidence for climate change is all around us. Rising sea levels, warmer temperatures, declining arctic sea ice, retreating glaciers, warming oceans, and an increase in severe weather events provide clear evidence that climate change and global warming are occurring at an unprecedented rate. Although arguments continue over the affect that human activities have on climate change, most scientists agree that the earth's climate is changing at rates and in patterns that are not normal. In North America alone, climate changes have included fewer cold days and nights, more frequent heat waves and warm spells, more intense precipitation events, total rainfall and hurricanes, and increases in areas affected by drought. These climate changes will directly impact the mosquito population in Michigan and increase the incidence of mosquito-borne diseases. (Andreadis, Theodore, 1)

Michigan has over 60 species of mosquitoes within its borders. These mosquitoes typically fall into three main types: permanent water mosquitoes, floodwater mosquitoes, and artificial container/tree hole mosquitoes. Each type of mosquito requires some form of standing water source to breed and mature. Climate change promises to bring these water sources. Permanent water mosquitoes in Michigan reside in permanent habitats, such as swamps, ponds, sewage ponds, and ditches. Flood water mosquitoes are found in habitats that are flooded temporarily due to heavy rainfall, snow melts, and after summer storms. The flood water mosquitoes are able to use these short-term breeding sites to lay their desiccation-resistant eggs that can remain viable up to 7 years after being laid.

Artificial container or tree hole mosquitoes make use of natural tree holes, as well as discarded tires, rain buckets or anything that might hold water. (Sternberg, Laura, 1)

As climate warms and precipitation events become more intense and frequent, standing water sources will undoubtedly increase in number, making for optimal breeding sights and increased mosquito populations. Conversely, hotter summers and milder winters would seemingly decrease the availability of standing water sources, and result in a decrease in the population. Research suggests, however, that lower rainfall amounts and drought conditions may in fact serve to create improved mosquito breeding habitat by causing rivers to dry into "pools," actually increasing the mosquito population. Finally, decreased rainfall will undoubtedly increase the need for water storage, likely increasing the population of container-breeding mosquitoes. Any way you look at it, climate change will increase the mosquito population in Michigan. But how will this affect the transmission of mosquito-borne diseases in Michigan and what precautions should Michiganders take to protect their selves? (Andreadis, Theodore, 3)

Mosquitoes have a four-stage life cycle that begins with the egg, hatches into the larva, develops into the pupa, and finally matures into the adult or imago stage. This life cycle can last anywhere from two to four weeks, depending on the type of mosquito. The first half of the mosquito's life cycle requires a water source. Thus, increased precipitation and warmer climates caused by climate change will increase the mosquito population in Michigan. However, the bigger concern rests with the second half of the mosquito's life cycle—the adult stage. Although this stage lasts only one to two weeks, it is during this stage that the adult mosquitoes feed and mate. Because female mosquitoes require iron (in the form of blood) to produce eggs, they become dependent

on blood from humans, birds, mammals, reptiles or amphibians to reproduce. As insect vectors, it is the female mosquitoes need for blood that creates the largest risk and danger for transmission of disease. (Reitz, Diedre, 4)

According to researcher Theodore Andreadis from the Department of Entomology and Center for Vector Biology and Zoonotic Diseases, there are four principal characteristics of vector mosquito populations that relate to the transmission of disease. First, the geographic and temporal distribution of mosquitoes will increase the incidence of mosquito-born diseases by bringing more tropical mosquito vectors into contact with more of the human population and extending the seasons during which mosquitoes are able to transfer disease. In short, more tropical mosquitoes will migrate into warmer climates and expand their geographic range, the seasons during which they can transmit diseases will be longer in duration, and more people and animals will be at risk. (Andreadis, Theodore, 2)

Second, changes in the population density of the mosquito vector will increase the frequency of contact with humans. As mentioned earlier, increased precipitation will increase the number and quality of larva breeding sites, while lower rainfall amounts and drought conditions will decrease the flow of rivers resulting in the creation of "pools" and the need for increased water storage. Andreadis suggests that, "population density could arise due to increased overwintering survival as a result of warmer temperatures, a shortening of larval development times, more frequent feeding by adults, quicker digestion of blood meals, and increased adult survival at higher latitudes." (Andreadis, Theodore, 2)

The third characteristic that Andreadis notes is the prevalence of infection by "Zoonotic Pathogens." This essentially means that mosquitoes may be able to transmit disease-causing agents to humans from other animals. If a female mosquito "bites" a cow that has been infected with mad cow disease, for example, this disease is now part of the transmission cycle. Currently, 75% of emerging infectious diseases affecting humans are diseases that originate from animals. (Andreadis, Theodore, 3)

Finally, Andreadis notes that climate change will increase the "pathogen load" in surface water by increasing the number of bacteria or viruses that are capable of causing disease. Reproduction, replication, and growth in the vector mosquito will be affected as temperatures increase and the incubation period of pathogens decrease. Because pathogens inside the mosquito mature faster in heat, the transmission efficiency will increase and enhance the spread of disease. (Andreadis, Theodore, 3)

Currently in Michigan there are seven known mosquito-borne diseases: West Nile Virus, Eastern Equine Encephalitis, Jamestown Canyon Virus, LaCrosse Encephalitis, St. Louis Encephalitis, Dog Heartworm, and Malaria. The health effects of these various diseases range from mild illness such as a fever, headache and body aches, to serious disease and death. The very young and elderly are particularly vulnerable to mosquito-borne disease and have a higher fatality rate. Many of these mosquito-borne diseases are on the rise. For instance, in 2002, Michigan reported over 500 human cases from 23 counties with 41 deaths. By 2012, health officials were reporting a record 2,118 cases, with 92 deaths. This was the highest number of cases reported to the Center for Disease Control since West Nile was first detected in the United States. According to Angela Minicuci, public information officer for the Michigan Department of Community

Health, "this is the highest number of cases that Michigan has seen since 2002, when West Nile virus appeared in the state." (Sternberg, Laura. 1)

For many, the mosquito represents the most deadly insect on earth. Its ability to transmit diseases that often result in sickness, death, and economic loss is hard to comprehend. With climate change and global warming, it is imperative that scientists, politicians, and health officials recognize the likelihood that climate change will increase the mosquito population in Michigan, and thus impact the transmission of many mosquito-borne diseases. It is imperative that we are prepared to monitor and respond to mosquito-borne disease threats. Early detection and intervention will save lives, maximize the use of resources, and improve the health of people and communities.

BIBLIOGRAPHY

2010, January 9. Climate Change Linked to Global Spread of Mosquitoes and Mosquito Borne Diseases. Retrieved October 16, 2013 from http://www.mosquitotraps.com/climate-change-linked-to-global-spread-of-mosquito-born.

2013. Michigan Mosquito Control Association. Mosquitoes of Michigan-Their Biology and Control. Retrieved on October 28, 2012 from http://www.mimosq.org/mosquito biology/mosquitobiology,htm.

Andreadis, Theodore G. (2012, July 15). Global Climate Change and Mosquito-borne Diseases. Retrieved October 16, 2013 from **http://www.nmca.org/2012andreadisabstract.htm**.

Reitz, Diedre F. West Nile Virus and Abrupt Climate Change. Retrieved October 16, 2013 from https://sites.google.com/site/acchumanhealthwestnile/home/fg/w-nile-mosquitoes-climate .

Sternberg, Laura. (2012, September 6). Detroit Free Press. Mosquitoes in Michigan: Information and Strategy. Retrieved on October 28, 2013 from http://detroit.about.com/od/summerindetroit/a/Michigan_Mosquitoes.htm