Vector Hazard Report: 
Zika Virus in Puerto Rico, August 2016

Vector distributions, taxonomic characters and bionomics

All material in this brief is provided for your information only and may not be construed as medical advice or instruction. No action or inaction should be taken based solely on the contents of this information; instead, readers should consult appropriate health professionals on any matter relating to their health and well-being.
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The first locally transmitted case of Zika virus in Puerto Rico was reported on December 31, 2015. According to the CDC, as of August 10, 2016 there have been 6,475 locally transmitted cases of Zika reported from 77 of Puerto Rico’s 78 districts. Since the outbreak began 2 deaths have been attributed to Zika virus in Puerto Rico. Travelers to Puerto Rico are advised to remain alert and practice enhanced precautions due to the ongoing outbreak.

Historically, other arbovirus outbreaks reported from Puerto Rico have an increased number of cases in the late summer and fall (August to September), which are the hottest and wettest months of the year in PR (Sharp et al. 2010, Sharp et al. 2014).

In Puerto Rico, the primary vector of Zika virus is *Aedes aegypti* (yellow fever mosquito). Although a competent vector of other arboviruses like dengue and chikungunya, *Aedes albopictus* (Asian Tiger Mosquito) is considered a suspected vector of Zika virus as well. Of these two mosquito species, *Ae. aegypti* is more closely associated with man, preferring to lay eggs in human containers near human dwellings making it a much more effective vector of disease.

A number of studies have attempted to classify larval breeding sites of *Aedes aegypti*, the primary vector of Zika virus in Puerto Rico. Of these studies, the breeding sites listed below are identified as the most productive for *Ae. aegypti* larvae. (Barrera et al. 2006a, Barrera et al. 2006b, Barrera et al. 2011)

- Buckets (small and large)
- Barrels
- Water Meters
- Plant pots
- Plastic covers containing water
- Tires
- Plastic pools

There is evidence that the most productive larval habitats in PR are human containers that are not managed by humans, whether they be trash or other unattended objects around homes (Barrera et al. 2011).

Municipality of residence of persons with confirmed and presumptive Zika virus infection (n = 4,986) — Puerto Rico, November 1, 2015–July 7, 2016. (596 additional cases were reported in persons with unknown municipality of residence) Source: CDC 8/10/2016

http://www.cdc.gov/mmwr/volumes/65/wr/mm6530e1.htm?s_cid=mm6530e1_w

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Aedes aegypti and Aedes albopictus, the primary vectors of dengue, chikungunya & Zika viruses, are originally of African and Asian origin, respectively. The spread of these two species around the world in the past 50 years is well documented and facilitated by a unique life trait: their eggs can survive desiccation. This trait allows eggs laid by these species to travel undetected in receptacles like used tires, or lucky bamboo plants, which are distributed throughout the world. When these receptacles are wetted (e.g. by rain), the larva emerge and grow to adults in their new environment. In temperate or tropical environments conditions are highly suitable for populations to quickly become established, as these mosquitoes have done in Brazil and nearly every other country in North, Central and South America.

Compounding this problem is that these mosquito species are capable of ovarian viral transmission – meaning that if the mother is infected with a virus, she can potentially pass it on to her offspring through her eggs. Each female mosquito lays 100-120 eggs, every 4-5 days (c.4-8 times in her life time of 1-3 months), and if she is infected, all her offspring emerge ready to infect the first person they bite.

Reducing exposure of infected people to mosquitoes

Reducing the exposure of infected people to mosquitoes requires the widespread availability of rapid diagnostic tests, effective treatment and most importantly, containment of the patients. Given that there is currently no vaccine or effective treatment for Zika virus, reducing the opportunity for mosquitoes to bite infected people is critical in slowing the continued spread of the disease.

Further guidance on protecting yourself from the Zika Virus:  
CDC Guidance on Zika Virus  
CDC Dengue and Chikungunya in Our Backyard: Preventing Aedes Mosquito-Borne Diseases  
CDC Preventing Aedes Mosquito-Borne Disease  
CDC DEET Factsheet  
WHO Zika Virus Background  
WHO Microcephaly/Zika virus  
U.S. EPA Controlling Mosquitoes at the Larval Stage

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Aedes (Stg.) aegypti (Linnaeus, 1762)

**Bionomics:**
In association with man, *Ae. aegypti* will use any and all natural and artificial containers as larval breeding sites. Away from urban areas the species tends to favor pools in river beds, tree stumps, tree holes and natural containers. Females are primarily day biters and readily enter buildings to feed. They have also been taken in lesser numbers at night (Christophers 1960).

**Medical Importance:**
Primary vector of Yellow Fever, Dengue Fever, Chikungunya Virus and Zika Virus (Christophers 1960).

**Identification Keys:**
[WRBU Mosquito Catalog Species Page](#)

**Distribution:**

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Taxonomic Characters:
Aedes (Stg.) aegypti (Linnaeus, 1762)

Images also found at wrbu.si.edu
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Taxonomic Characters: *Aedes (Stg.) aegypti* (Linnaeus, 1762)

- **Ae. aegypti** Foreleg
- **Ae. aegypti** Midleg
- **Ae. aegypti** Hind leg
- **Ae. aegypti** Hind tarsi
- **Ae. aegypti** Wing: dorsal view
- **Ae. aegypti** Abdomen: dorsal view
- **Ae. aegypti** Wing: lateral view

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Aedes (Stg.) albopictus (Skuse, 1894)

Bionomics:
Larval *Ae. albopictus* are found in natural containers, including tree holes, bamboo stumps, coconut shells, rock holes, palm fronds, and leaf axils. They are also found in all varieties of artificial containers and will breed indoors. Females readily bite man (Huang 1972).

Medical Importance:
Vector of dengue and yellow fever in the wild. Under laboratory conditions: bird malarias, Eastern and Western equine encephalitis, West Nile, Zika, Chikungunya and Japanese encephalitis viruses (Huang 1972).

Identification Keys:
[Rueda, Leopoldo M. 2004. Pictorial keys for the identification of mosquitoes (Diptera: Culicidae) associated with dengue virus transmission. Walter Reed Army Institute of Research Washington DC Department of Entomology.](#)


Distribution:
Taxonomic Characters:
*Aedes (Stg.) albopictus* (Skuse, 1894)

Images also found at wrbu.si.edu
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Taxonomic Characters: *Aedes (Stg.) albopictus* (Skuse, 1894)

* Ae. albopictus Foreleg
* Ae. albopictus Midleg
* Ae. albopictus Hind leg
* Ae. albopictus Hind tarsi
* Ae. albopictus Wing: dorsal view
* Ae. albopictus Abdomen: dorsal view
* Ae. albopictus Abdomen: lateral view

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Rainfall
This map shows the accumulated rainfall for the past month. Updated monthly.
- NASA Earth Observations

Consistent Above and Below Average Precipitation
Areas with consistent above average monthly rainfall over the past 3 months may indicate increased mosquito breeding sites which may lead to increased mosquito-borne disease transmission. Areas with consistent below average rainfall may also indicate increased water storage or ponding which can provide additional habitat for mosquito species that lay eggs in human containers, protected micro environments, or long lasting pools. Updated monthly. - NASA Earth Observations.

Drought Breaking Rain
Areas receiving above average rainfall for the past month and below average rainfall for the previous 12 months. Drought breaking rain may indicate recent suitable conditions for vectors and diseases in a stressed environment or human population. Updated monthly. - WorldClim, Giovanni online data system NASA GES DISC, Tropical Rainfall Measuring Mission (TRMM).

Temperature anomaly
This map shows where earth’s temperatures were warmer or cooler in the daytime for the past month than the average temperatures for the same month from 2001-2010. Updated monthly.
- NASA Earth Observations

Land Surface Temperature
This map shows the temperature of the earth’s lands during the daytime. Updated monthly.
- NASA Earth Observations

National Oceanic and Atmospheric Administration (NOAA)
Get current weather conditions, hazards, forecasts and radar updated daily. - NOAA

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Month of Maximum Precipitation and Temperature: Puerto Rico

Month of maximum precipitation compiled from the 50 year average of the WorldClim dataset.

Month of maximum temperature compiled from the 50 year average of the WorldClim dataset.

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Geographic Distribution: *Ae. aegypti*

VectorMap data points for *Ae. aegypti*, Global. 21,768 records as of August 2016.

Boosted regression tree model of habitat suitability for *Ae. aegypti*, Puerto Rico. Kraemer et al. 2015

Boosted regression tree model of habitat suitability for *Ae. aegypti*, Global. Kraemer et al. 2015
Geographic Distribution: *Ae. albopictus*

VectorMap data points for *Ae. albopictus*, Global. 37,426 records as of August 2016.

*Boosted regression tree model of habitat suitability for Ae. albopictus, Puerto Rico. Kraemer et al. 2015*

*Boosted regression tree model of habitat suitability for Ae. albopictus, Global. Kraemer et al. 2015*

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Habitat Suitability and Human Population: Aedes aegypti

Methods:
Zonal statistics/histogram analyses of buffered collection locations against the LandScan (2011) population density raster (Ispop2011) showed that despite the high frequency of pixels of 51-100 people/sq km, the majority of Ae. albopictus and Ae. aegypti positive locations occurred in the categories 101-500 and 501-2500 people/sq km. Aedes aegypti appears more often than Ae. albopictus in denser human habitats but as these are of such low frequency considering the whole they were discounted for the purposed of these figures. Therefore we created a polygon of the population raster for density 101-2500 then converted this to points (Data Management Tools>Features>Feature to point). This was necessary because some polygons are not counted when trying to extract elements of the population raster. Then we used Spatial analyst tools>Extraction>Extract by Mask to reveal instances where both conditions (>50% chance of the vector species and 101-2500 people) occurred.

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Habitat Suitability and Human Population: Aedes albopictus

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Insecticide Resistance testing of Aedes aegypti in Puerto Rico:

Results of CDC Bottle Assay Tests on Aedes aegypti mosquitoes in Puerto Rico, February 2016 to present. Testing conducted in 23 of the 78 districts of Puerto Rico. Resistance was found in other insecticides as well, full results can be found here:

Additional References for Insecticide Resistance by Zika Virus Vectors:


Macoris, Maria de Lourdes G., et al. 2012. Resistance of Aedes aegypti from the state of São Paulo, Brazil, to organophosphates insecticides. Memórias do Instituto Oswaldo Cruz 98.5: 703-708


References


5. Kraemer, Moritz et al. 2015. The global distribution of the arbovirus vectors Aedes aegypti and Ae. albopictus. ELife: 4:e08347. DOI: 10.7554/eLife.08347


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The Walter Reed Biosystematics Unit is part of the Walter Reed Army Institute of Research and is based at the Smithsonian Institution Museum Support Center. To access taxonomic keys, the Systematic Catalog of Culicidae or to learn more about WRBU visit wrbu.si.edu.

VectorMap is only as good as the data you provide. If you have collection records, models or pathogen testing results please contact the VectorMap team to learn how to contribute data at mosquitomap@si.edu.

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