UNIVERSITY of WEST FLORIDA

A Survey of the Mosquito Population in North Georgia

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Objectives

- Discuss the background for the project, including a description of the host agency, public health significance, and purpose
- Discuss the methodology used for the project and study design
- Discuss the results of the study
- Discuss findings, limitations, benefit to host agency, and areas for future research
- Keep presentation within time parameters
- Questions

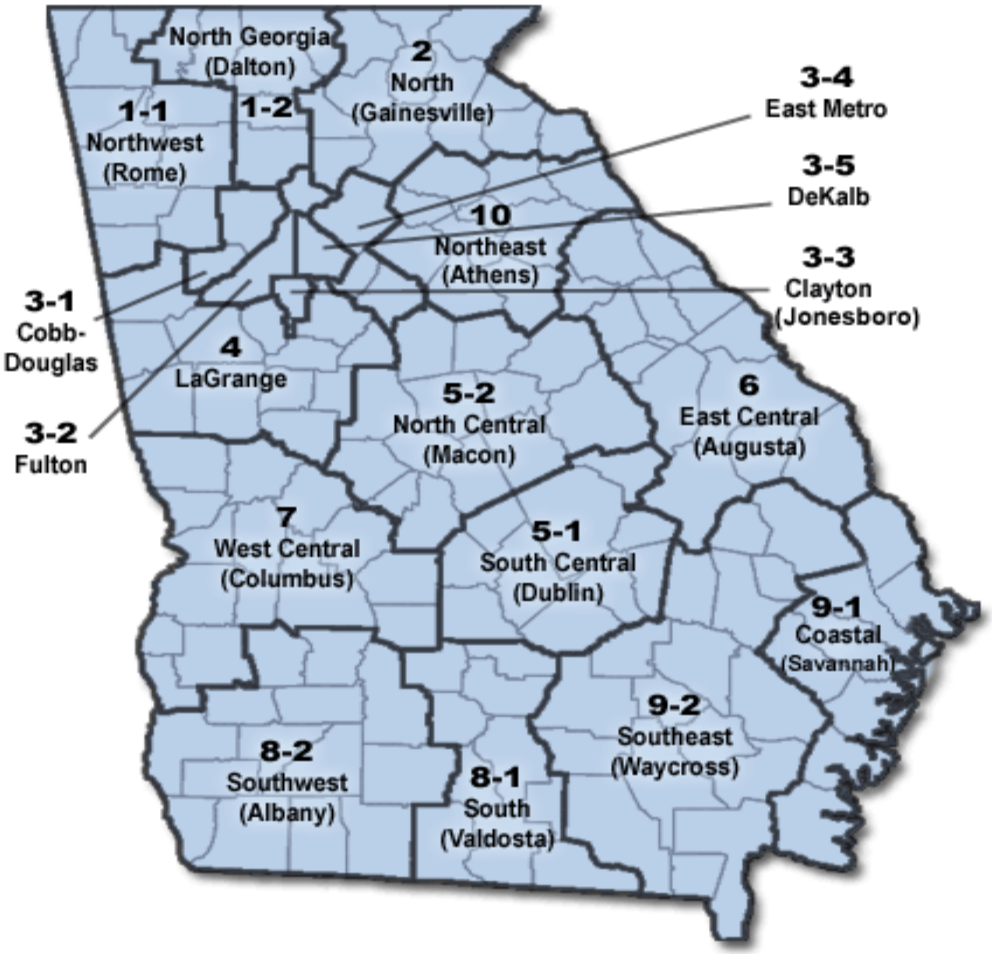
Host Agency

- The North Georgia Health District is a public health agency in the north central part of Georgia.

- Major programs within the agency include Health Clinic Services, Environmental Health, and Emergency Preparedness

North Georgia Health District

Dr. Zachary Taylor, M.D., M.S., Health Director



GA DPH (2016)

- Six counties
- Located between Atlanta, GA and Chattanooga, TN
- Two major interstates
- Mix of urban and rural areas
- Population ~450,000
- Tourism in northern counties
- Various terrain—mountains (Nat'l forest), ridge/valley, piedmont

Environmental Health

Raymond R. King, M.S., District EH Director

- Multiple program responsibilities in host agency (on-site sewage, food service, lead/healthy homes, rabies control, tourist accommodations, pools, body art, emergency response strike teams)
- 16 Environmental Health Specialists in host agency
- Responsible for mosquito surveillance ***(when active)***
- No surveillance since 2004 in agency—sparse overall activity in northern part of state

Background-PH Concern

- Arboviral disease worldwide a major cause of morbidity and mortality (developing countries, southern hemisphere)
- Mosquitoes are primary arthropod vectors
- Mosquito surveillance historically limited--US and Georgia (northern Georgia in particular)
- Emergence and re-emergence of infectious disease
  - Increasing international trade and travel
  - Urbanization –roughly 80% of US population living in urban areas according to Census reports
  - Fluctuations in weather patterns (rain, drought, temperature)
  - Global spread of Zika as example

Background-PH Concern

- Zika virus local transmission a concern as travel-related cases rise in Georgia
- 2015 Census data: Hispanic/Latino population in Whitfield (33.9%), Murray (14.5%), Gilmer (11.5%), and Cherokee (10.1%) counties could be at increased risk for travel-related cases
- West Nile Virus, Eastern Equine Encephalitis, and LaCrosse Encephalitis are currently the three most commonly diagnosed (locally-acquired) mosquito-borne diseases in Georgia (Rustin & Kelly, 2016)
- *Aedes albopictus*, *Culex quinquefasciatis*, and *Culiseta melanura* identified as most common vectors of disease based on limited testing (GA DPH, 2014)

Background

- Eastern Equine Encephalitis
  - No symptoms, flu-like symptoms, encephalitis w/permanent brain damage likely, 33% mortality rate (CDC, 2016c)
- LaCrosse Encephalitis
  - No symptoms, flu-like symptoms, encephalitis w/seizures, paralysis; most severe in those <16 (CDC, 2016b)
- West Nile Virus
  - No symptoms, flu-like symptoms, encephalitis, meningitis (CDC, 2016c)
- Zika Virus
  - No symptoms, mild fever w/rash, myalgia, conjunctivitis **Linked to microcephaly in infants born to infected mothers and Guillain-Barre (sequelae in adults), extended person-person sexual transmission (CDC, 2016d)

Background--Mosquitoes

- Only female mosquitoes take blood meals
- Collection of male mosquitoes in surveillance indicates large population density of species
- Mosquitoes cannot transmit all blood-borne viruses—viral replication must occur for transmission
- Species have different, habitats, feeding patterns, oviposit sites, flight ranges

CDC (2014)--*Aedes albopictus*

Background--Georgia

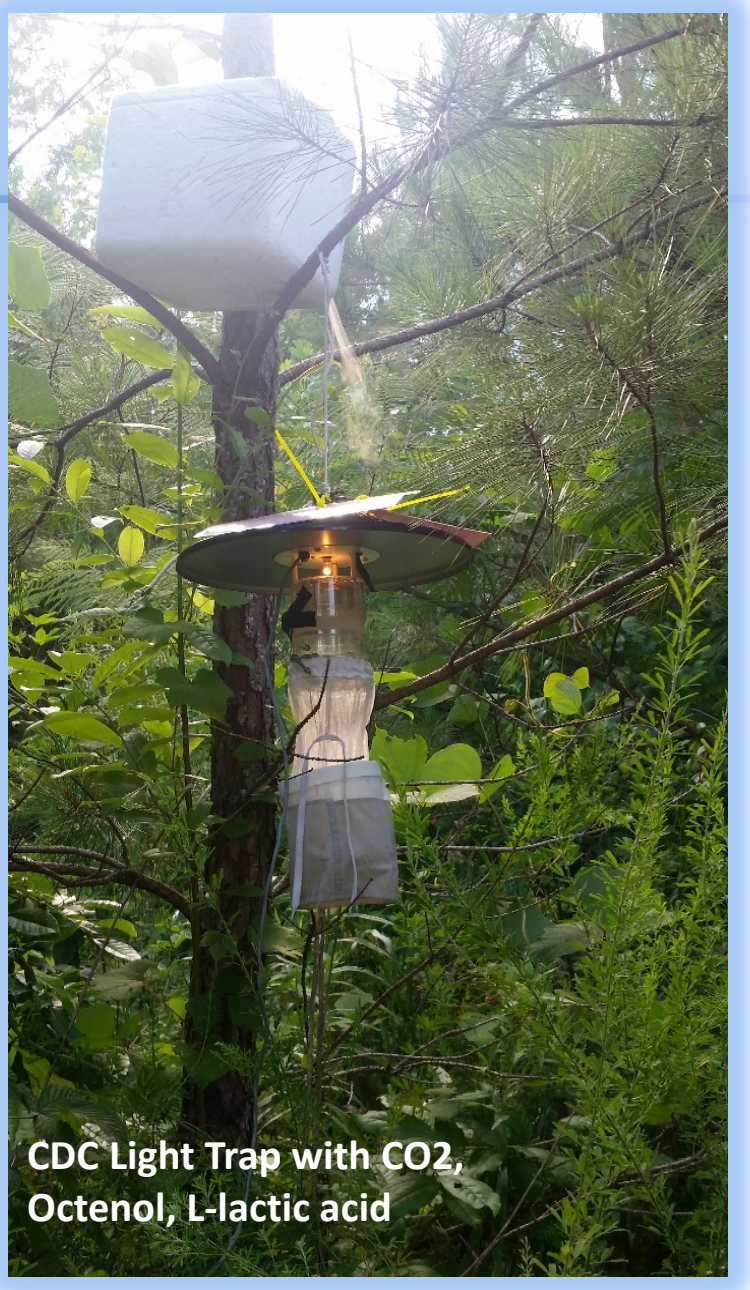
- **Georgia Mosquito Surveillance (GA DPH, 2014)**
  - **2001**: Introduction of WNV in Georgia (6 cases, 1 death)
  - **2003**: Most robust year for surveillance, 60 out of 159 counties (including some in NGHD); viral testing of birds and mosquitoes
  - **2012**: Budget cuts suspended viral testing of mosquitoes through state public health lab (117 WNV cases reported—WNV now endemic)
  - **2014**: Only 6 of 159 counties doing surveillance (southern portions and some Atlanta area)
  - **2016**: January-October: 96 cases of travel-related Zika (GA DPH, 2016)

Purpose

- The purpose of this study was to assess the distribution of mosquito species of human risk in the North Georgia Health District by
  - 1) Evaluating and analyzing historical mosquito surveillance data—historical data does not include all counties
  - 2) Conducting new mosquito surveillance to **include all counties** and analyzing the results of the new data.

Methods

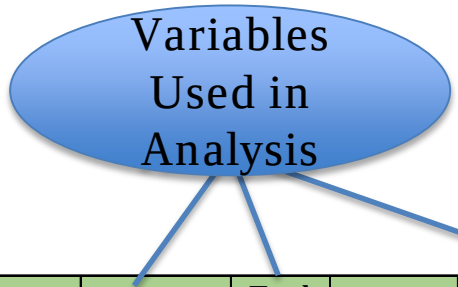
- Descriptive Study of Mosquito Species in the Host Agency
- 2 Data Sets:
  - 1) Historical data (limited) from surveillance activities in 2003,2004, 2011 in host agency
  - 2) New surveillance performed between June and September 2016



CDC Light Trap with CO2, Octenol, L-lactic acid

Gravid Trap

Methods



Collection Date	VIAL ID	Address	City	Zip Code	Latitude (Y)	Longitude (X)	County	District	Species	Total per Pool	Trap Type	Blood Fed?	Risk
6/8/2016	A01	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD 1-2	*Ae. albopictu*	3	Light	no	yes
6/8/2016	A01	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD 1-2	*Ae. albopictu*	1	Light	no	yes
6/13/2016	A03	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD 1-2	*Ae. albopictu*	6	Light	no	yes
6/13/2016	A03	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD 1-2	*An. punctipe*	3	Light	no	no
6/13/2016	A03	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD 1-2	*An. quadrim*	2	Light	no	no
6/13/2016	A03	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD	*Ur. sapphiri*	2	Light	no	no
6/13/2016	A03	1130 Bluffs	Canton	30114	34.26801	-84.4715	Cherokee	NGHD	*Wy. smithii*	3	Light	no	no
6/17/2016	A04	243 Orchard	Jasper	30143	34.43542	-84.4781	Pickens	NGHD	*Ae. albopictu*	1	Gravid	no	yes
6/17/2016	A04	243 Orchard	Jasper	30143	34.43542	-84.4781	Pickens	NGHD	*Cx. erraticus*	2	Gravid	no	yes
6/18/2016	A05	16054 Morg	Morganton	30560	34.84435	-84.2028	Fannin	NGHD	*Ae. albopictu*	3	Light	no	yes
6/18/2016	A05	16054 Morg	Morganton	30560	34.84435	-84.2028	Fannin	NGHD	*Ae. vexans*	4	Light	no	yes
6/18/2016	A05	16054 Morg	Morganton	30560	34.84435	-84.2028	Fannin	NGHD	*An. punctipe*	1	Light	no	no
6/19/2016	A06	243 Orchard	Jasper	30143	34.43542	-84.4781	Pickens	NGHD	*Ae. vexans*	1	Light	no	yes
6/19/2016	A06	243 Orchard	Jasper	30143	34.43542	-84.4781	Pickens	NGHD	*An. punctipe*	6	Light	no	no
6/21/2016	A07	180 McClur	Canton	30114	34.22594	-84.4966	Cherokee	NGHD	*An. punctipe*	56	Light	no	no
6/22/2016	A07	180 McClur	Canton	30114	34.22594	-84.4966	Cherokee	NGHD	*An. punctipe*	3	Light	no	no
6/22/2016	A07	180 McClur	Canton	30114	34.22594	-84.4966	Cherokee	NGHD	*Cx. restuans*	1	Light	no	yes
6/22/2016	A08	340 Cherok	Canton	30114	34.23183	-84.4844	Cherokee	NGHD	*An. punctipe*	5	Light	no	no
6/22/2016	A08	340 Cherok	Canton	30114	34.23183	-84.4844	Cherokee	NGHD	*Cx. nigripalp*	9	Light	no	yes

Excel spreadsheet format used in data reporting of historical and 2016 surveillance activities

Methods

- Identification of species and classification as risk or non-risk to humans (Risk species: species associated with human arboviral disease transmission in region)
- Simpson and Shannon Indices (ecological science) used to assess species richness and biodiversity
- Risk and non-risk groups analyzed separately (historical and 2016 data also analyzed separately)
- Shapiro-Wilk ($p < .05$) tests of normality used for statistical significance

Results

- Shannon and Simpson diversity measures indicated moderate diversity/species evenness among risk and non-risk groups in both data sets (not measures of significance, no extreme values)

Mosquito Collection from NGHD

CDC (2014)

Results

- Shapiro-Wilk ($p < .05$)
  - Results not significant ($p > .05$) for ***distribution of species*** between risk and non-risk groups in both historical and 2016 data. Normal distribution of species
  - Results significant ($p < .05$) for ***distribution of mosquitoes*** within risk and non-risk species in both historical and 2016 data. Distribution of mosquitoes within species is skewed

Results

Table 1. Summary of Statistical Measures Used to Assess Mosquito Populations of the North Georgia Health District

Statistical Measures	Historical Data		2016 Data	
	Risk Sp.	**Non-Risk Sp.**	**Risk Sp.**	**Non-Risk Sp.**
Number of Species	**6**	**5**	**14**	**11**
Total Mosquitoes	**1170**	**39**	**943**	**760**
Shannon Index[1]	.887	.974	1.59	1.58
Shannon's Equitability[2]	.495	.605	.603	.635
Simpson Index[3]	.530	.476	.341	.261
Shapiro-Wilk[4] Species Comparison Between Risk and Non-Risk Group	.987, *df* = 5, *p* = .967	.982, *df* = 6, *p* = .961	.922, *df* = 14, *p* = .232	.944, *df* = 11, *p* = .567
Shapiro-Wilk[4] Mosquito Comparison Within Risk and Non-Risk Groups	.757, *df* = 5, ***p* = .035**	.787, *df* = 6, ***p* = .045**	.516, *df* = 14, ***p* = .000**	.709 *df* = 11, ***p* = .001**

Notes: 1) **Shannon Index**: 0 = no diversity; 5 = infinite diversity 2) **Shannon's Equitability**: 0 = no diversity; 1 = maximum evenness/diversity; 3) **Simpson Index**: 0 = infinite diversity ; 1 = no diversity
4) **Shapiro-Wilk**: Significant at p < .05 level and rejection of null hypothesis

Discussion

- 31 species identified between historical and 2016 collections
- No significant difference in numbers of species identified as human risk vs non-risk
- Dominant mosquito species within groups

Results

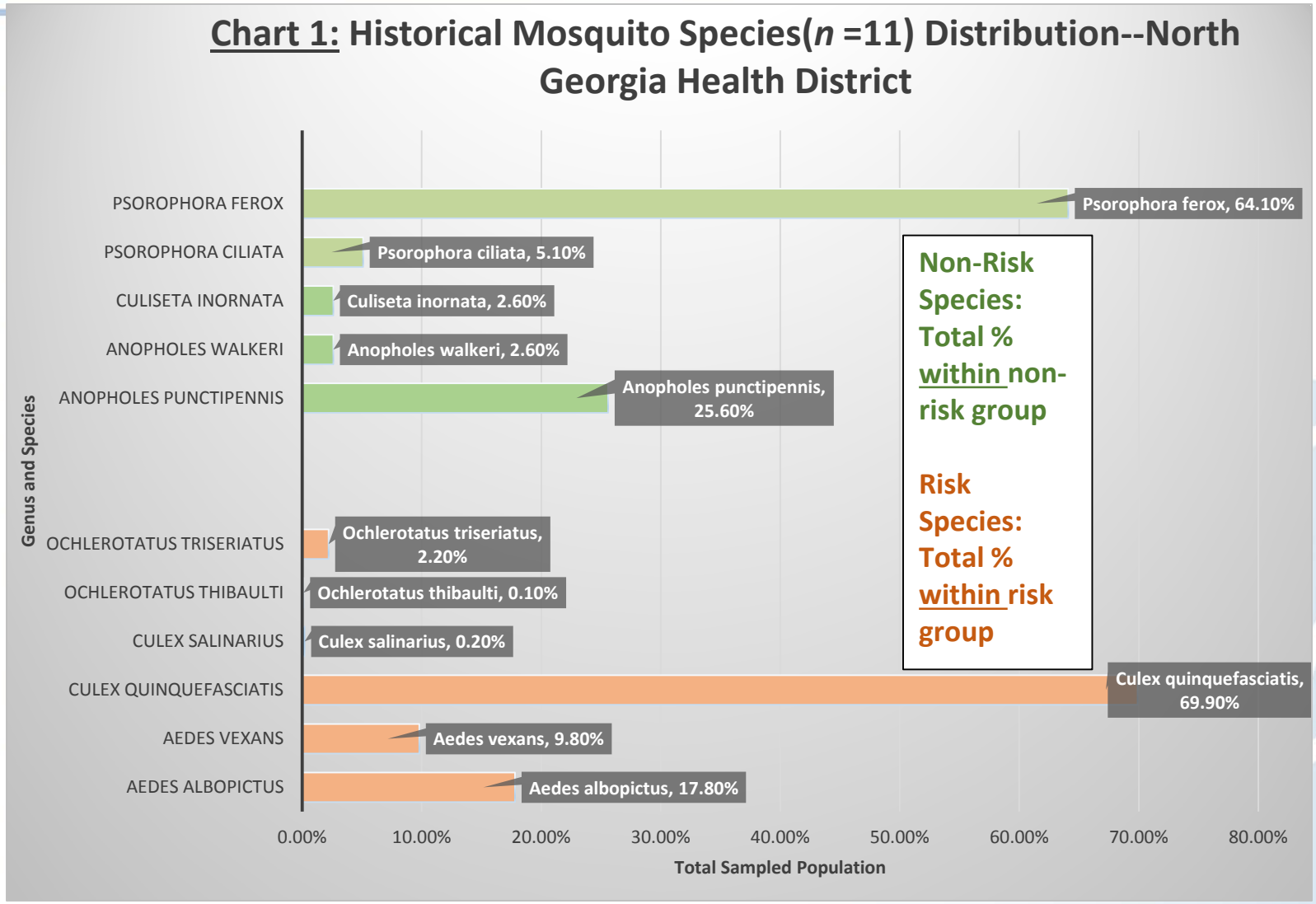


Chart 1: Historical Mosquito Species(n =11) Distribution--North Georgia Health District
Genus and Species
PSOROPHORA FEROX
PSOROPHORA CILIATA
CULISETA INORNATA
ANOPHOLES WALKERI
ANOPHOLES PUNCTIPENNIS
OCHLEROTATUS TRISERIATUS
OCHLEROTATUS THIBAULTI
CULEX SALINARIUS
CULEX QUINQUEFASCIATIS
AEDES VEXANS
AEDES ALBOPICTUS
Psorophora ferox, 64.10%
Psorophora ciliata, 5.10%
Culiseta inornata, 2.60%
Anopholes walkeri, 2.60%
Anopholes punctipennis, 25.60%
Ochlerotatus triseriatus, 2.20%
Ochlerotatus thibaulti, 0.10%
Culex salinarius, 0.20%
Culex quinquefasciatis, 69.90%
Aedes vexans, 9.80%
Aedes albopictus, 17.80%
Non-Risk Species: Total % within non-risk group
Risk Species: Total % within risk group
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
70.00%
80.00%
Total Sampled Population

Results

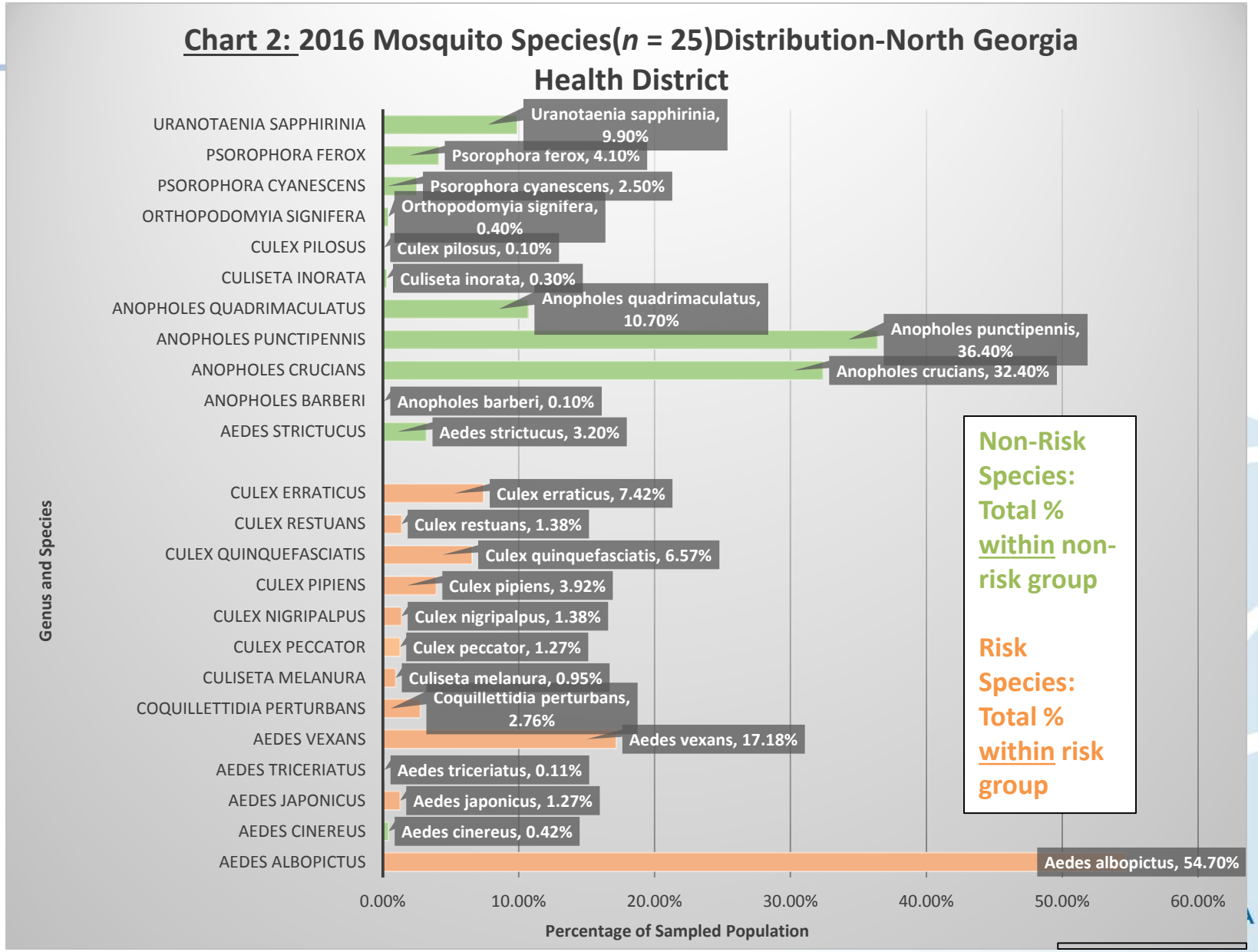


Chart 2: 2016 Mosquito Species(n = 25)Distribution-North Georgia Health District
URANOTAENIA SAPPHIRINIA
PSOROPHORA FEROX
PSOROPHORA CYANESCENS
ORTHOPODOMYIA SIGNIFERA
CULEX PILOSUS
CULISETA INORATA
ANOPHOLES QUADRIMACULATUS
ANOPHOLES PUNCTIPENNIS
ANOPHOLES CRUCIANS
ANOPHOLES BARBERI
AEDES STRICTUCUS
CULEX ERRATICUS
CULEX RESTUANS
CULEX QUINQUEFASCIATIS
CULEX PIPIENS
CULEX NIGRIPALPUS
CULEX PECCATOR
CULISETA MELANURA
COQUILLETTIDIA PERTURBANS
AEDES VEXANS
AEDES TRICERIATUS
AEDES JAPONICUS
AEDES CINEREUS
AEDES ALBOPICTUS
Uranotaenia sapphirinia, 9.90%
Psorophora ferox, 4.10%
Psorophora cyanescens, 2.50%
Orthopodomyia signifera, 0.40%
Culex pilosus, 0.10%
Culiseta inorata, 0.30%
Anopholes quadrimaculatus, 10.70%
Anopholes punctipennis, 36.40%
Anopholes crucians, 32.40%
Anopholes barberi, 0.10%
Aedes strictucus, 3.20%
Culex erraticus, 7.42%
Culex restuans, 1.38%
Culex quinquefasciatis, 6.57%
Culex pipiens, 3.92%
Culex nigripalpus, 1.38%
Culex peccator, 1.27%
Culiseta melanura, 0.95%
Coquillettidia perturbans, 2.76%
Aedes vexans, 17.18%
Aedes triceriatus, 0.11%
Aedes japonicus, 1.27%
Aedes cinereus, 0.42%
Aedes albopictus, 54.70%
Genus and Species
0.00%
10.00%
20.00%
30.00%
40.00%
50.00%
60.00%
Percentage of Sampled Population
Non-Risk Species: Total % within non-risk group
Risk Species: Total % within risk group

Discussion—Historical Data Major Findings

- *Culex quinquefasciatis*, *aka* southern house mosquito, most prevalent species in historical totals accounting for 67.7% of total
  - Historical surveillance performed in response to West Nile virus cases rather than for general studies
  - *Cx. quinquefasciatis* thought to be primary WNV vector, viral testing of mosquitoes
  - Locations may have been sampled repeatedly where mosquito was found
- *Aedes albopictus* accounted for 17.2% of historical totals

Discussion-2016 Data Major Findings

- *Aedes albopictus* most prevalent species in 2016 total collection (30.3%) and of risk group (54.7%)
  - Indicates a rise in prevalence from historical *Ae. albopictus* totals (17.2%)
  - Comparable to 2014 state totals (40.6%)

- *Culex quinquefasciatis* (3.6%) of 2016 collection and (6.8%) of 2016 risk group
  - Much lower than historical total (67.7%)
  - Lower than 2014 state reported (29.1%)
    - 2016 drought conditions could be a factor

Discussion—*Aedes albopictus*

- *Aedes albopictus* ("Asian Tiger") mosquito is a concern of the host agency for potential local Zika virus transmission as travel-related cases continue
- Thought to be a competent vector of Zika virus, second to *Aedes aegypti* for US transmission
- *Aedes aegypti* not found during surveillance activities in host agency (*Ae. albopictus* is superior competitor)

Discussion-Limitations

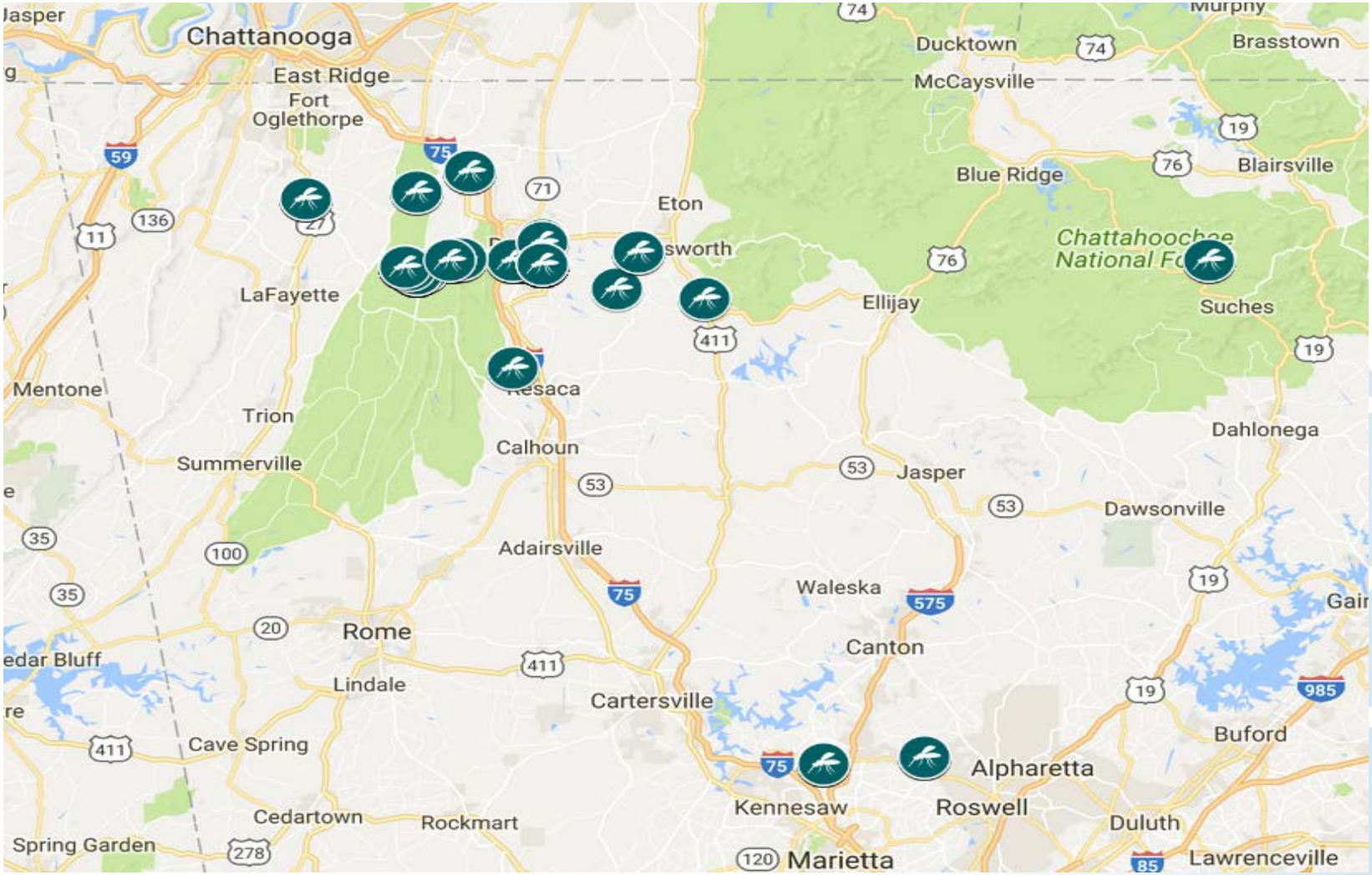
- Site selection not random which may have biased results (property access, travel, urban areas)
- Differences in historical and 2016 data made comparisons difficult (purpose of collection, mosquito ID, missing info)
- Only 2 trap types used; octenol & lactic acid used
- Drought conditions in 2016

Benefits to Host Agency

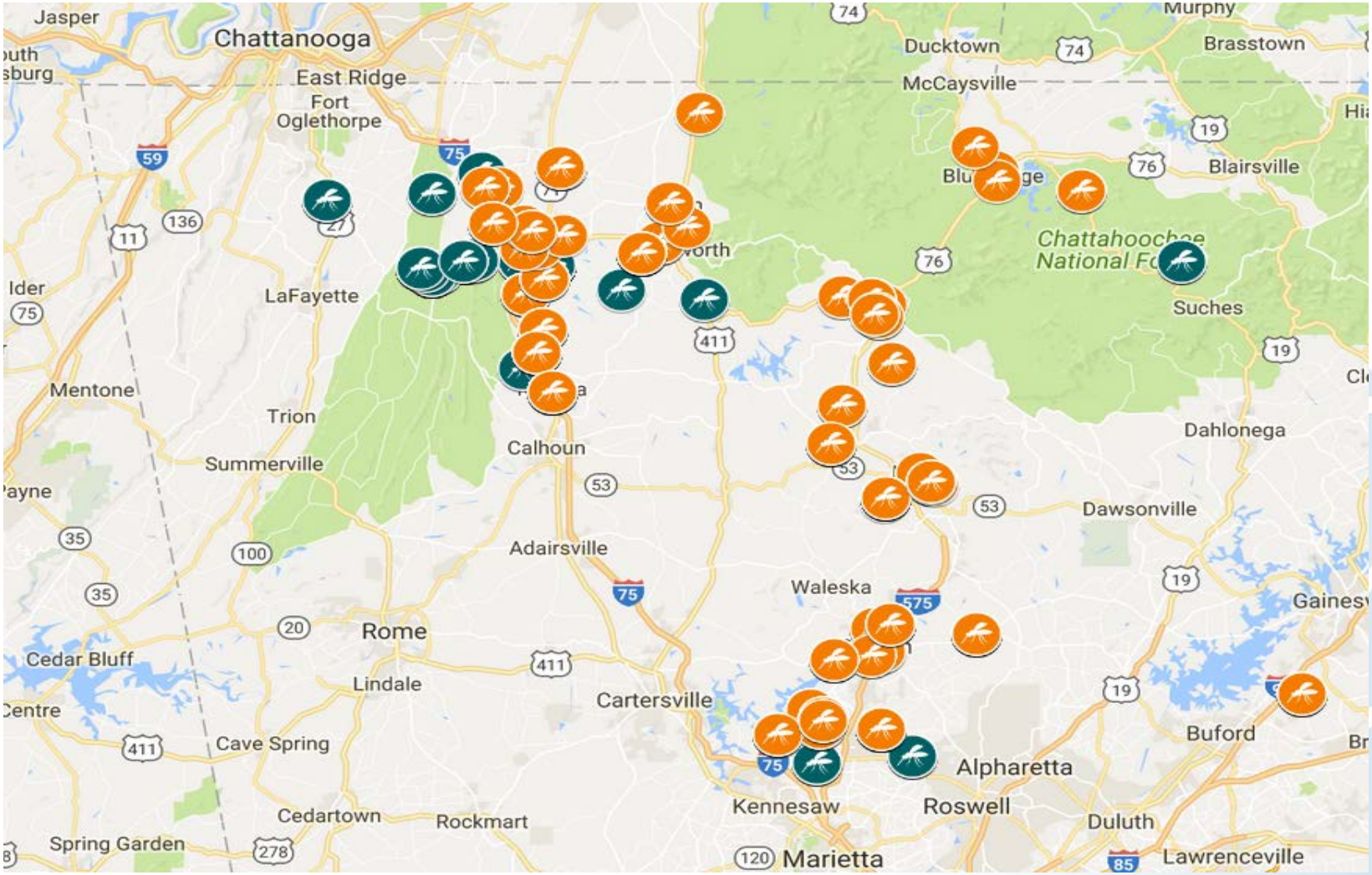
North Georgia Health District

- Improved baseline knowledge of mosquito species in area helps direct limited funding (habitats, behavior, insecticide use)
- Included all district counties in the surveillance
- Surveillance logistics improved (dry ice, specimen preservation, trap placement)
- Data also shared with Georgia DPH
- Contribution to state-wide Zika preparedness efforts
- State/Federal Grant (CDC 485) awarded to district in August 2016 for public education (billboards, flyers, etc...), surveillance equipment

Historical (2003, 2004, 2011) Collection Sites (*n*= 25)



June-Sept 2016 Collection Sites(n=53)--- 78 sites total w/hist.



Billboard—Hwy 411

Educational Flyers—English and Spanish

Respuesta de los CDC al **zika**

ZIKA PARA MUJERES EMBARAZADAS QUE NO VIVEN EN UN ÁREA CON ZIKA

Los CDC comprenden que las mujeres embarazadas pueden estar preocupadas y tener dudas en cuanto a la infección por el virus del Zika durante el embarazo. Obtenga más información sobre las pruebas de detección del virus del Zika en mujeres embarazadas y qué puede suceder si padece esta enfermedad durante el embarazo.

Cómo se propaga el zika.

Una mujer embarazada que no vive en un área afectada por el zika puede infectarse con el virus a través de la picadura de un mosquito mientras esté de visita en un área en que la enfermedad se propaga a través de los mosquitos. También puede contraer el zika si tiene relaciones sexuales con una pareja infectada. Para obtener más información sobre la transmisión del zika, visite www.cdc.gov/zika/transmission.

Lo que los CDC saben acerca del virus del Zika y el embarazo.

- El virus del Zika puede transmitirse de la madre al feto durante el embarazo o en el momento próximo al parto.
- El virus del Zika puede causar defectos de nacimiento y se ha asociado a otros problemas en bebés.

Lo que los CDC aún desconocen acerca del virus del Zika y el embarazo, y están investigando de forma inmediata para revelarlo.

- Desconocemos si una mujer se infecta durante el embarazo
- Qué probabilidades hay de que el virus la afecte o afecte su embarazo.
- Qué probabilidades hay de que el virus pase al feto.
- Qué probabilidades hay de que el feto, si se infecta, tenga defectos de nacimiento.
- En qué momento del embarazo la infección puede dañar al feto.

www.cdc.gov/zika

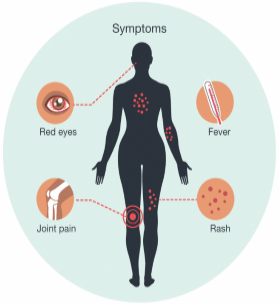
North Georgia Health District

U.S. Department of Health and Human Services
Centers for Disease Control and Prevention

CDC's Response to **Zika**

How can a pregnant woman find out if she has Zika?

- If a pregnant woman gets infected with Zika, the virus will be in her blood and urine for up to two weeks. If she gets sick with a fever, joint pain, rash, or red eyes, doctors or other healthcare providers can test small amounts of her blood and urine and test them for Zika virus.
- If she never feels sick, or if more than two weeks have gone by since possible exposure to Zika (through travel or sexual contact with an infected partner), doctors can order a different test to look for evidence of Zika infection.



What do the test results mean?

What happens if samples from a pregnant woman test positive?

If a woman has a positive test result for Zika during pregnancy, it signals to her doctor or other healthcare provider to watch her pregnancy more closely, meaning the provider might do more ultrasounds or other tests to check the growth and development of her fetus and check for any signs of Zika virus infection. CDC recommends steps for doctors or other healthcare providers to help care for pregnant women.

What happens if a pregnant woman's test results are inconclusive (not positive or negative)?

Sometimes, if the tests aren't clearly positive or negative, the results are considered inconclusive. If the test results are inconclusive, her doctor may follow the CDC recommendations for a positive test result, meaning he or she might do more ultrasounds or other tests to monitor your pregnancy.

What happens if a pregnant woman tests negative?

If she tests negative, her doctor may check the growth and development of the fetus during an ultrasound and check for any signs of Zika virus infection. If there are no signs of Zika virus infection, routine prenatal care is recommended. If her doctor sees signs of Zika virus infection during an ultrasound, then the doctor may do additional tests.

North Georgia Health District

www.cdc.gov/zika

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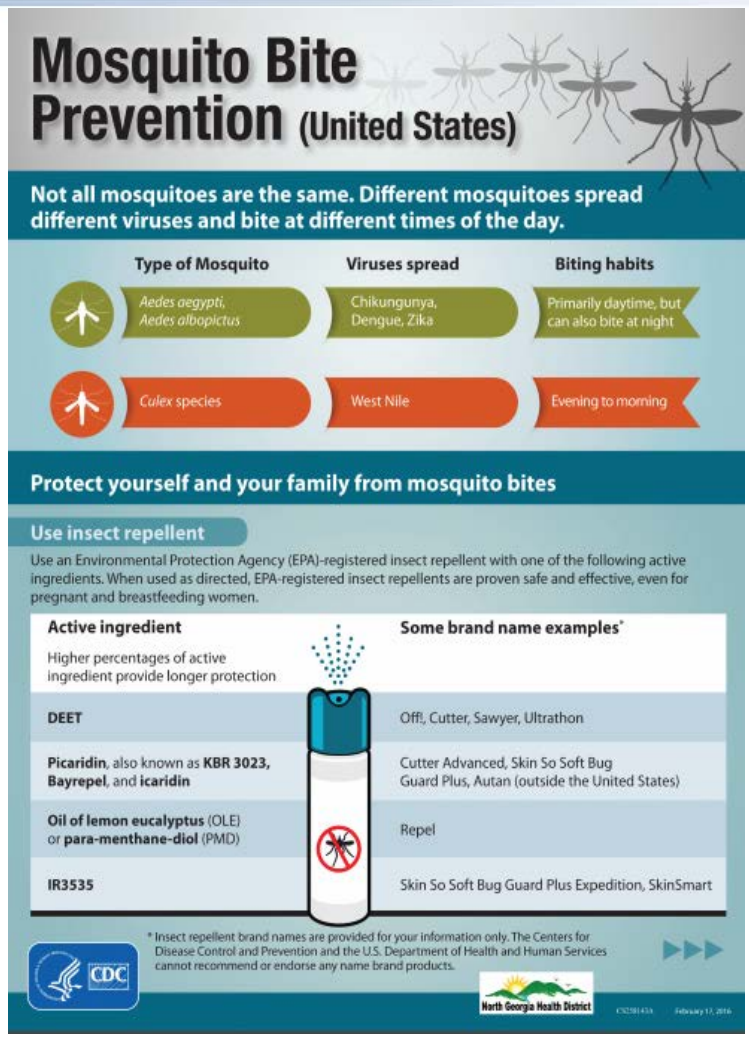
Educational Flyers –English & Spanish



Mosquito Bite Prevention (United States)

Not all mosquitoes are the same. Different mosquitoes spread different viruses and bite at different times of the day.

Type of Mosquito	Viruses spread	Biting habits
Aedes aegypti, *Aedes albopictus*	Chikungunya, Dengue, Zika	Primarily daytime, but can also bite at night
Culex species	West Nile	Evening to morning

Protect yourself and your family from mosquito bites

Use insect repellent

Use an Environmental Protection Agency (EPA)-registered insect repellent with one of the following active ingredients. When used as directed, EPA-registered insect repellents are proven safe and effective, even for pregnant and breastfeeding women.

Active ingredient Higher percentages of active ingredient provide longer protection	Some brand name examples*
DEET	Off!, Cutter, Sawyer, Ultrathon
Picaridin, also known as **KBR 3023, Bayrepel**, and **icaridin**	Cutter Advanced, Skin So Soft Bug Guard Plus, Autan (outside the United States)
Oil of lemon eucalyptus (OLE) or **para-menthane-diol** (PMD)	Repel
IR3535	Skin So Soft Bug Guard Plus Expedition, SkinSmart

* Insect repellent brand names are provided for your information only. The Centers for Disease Control and Prevention and the U.S. Department of Health and Human Services cannot recommend or endorse any name brand products.

CDC

North Georgia Health District

- Vuelva a aplicar el repelente de insectos cada cierta cantidad de horas, dependiendo del producto y la concentración del ingrediente activo que haya elegido.
  - No ponga repelente en la piel debajo de la ropa.
  - Si también usa un filtro solar, apliquelo primero y luego el repelente de insectos.

Repelentes de insectos naturales (repelentes no registrados en la EPA)

- Se desconoce la eficacia de los repelentes de insectos no registrados en la EPA, incluida la de algunos repelentes naturales.
- Para protegerse contra enfermedades como chikunguña, dengue y zika, los CDC y la EPA recomiendan usar un repelente de insectos registrado en la EPA.
- Cuando se usan de acuerdo con las instrucciones, se ha comprobado que los repelentes de insectos registrados en la EPA son seguros y eficaces.
- Para más información, visite: www2.epa.gov/insect-repellents

Si tiene un bebé o niño

- Siempre siga las instrucciones en la etiqueta del producto al aplicar repelente de insectos a los niños.
- No utilice repelente de insectos en bebés menores de dos meses.
- Vista a su hijo con ropa que le cubra los brazos y las piernas, o…
- Cubra la cuna, el coche y el portabebés con un mosquitero.
- No aplique repelente de insectos en las manos, los ojos, la boca, o la piel irritada o cortada de un niño.
  - Adultos: Rocíen el repelente de insectos en sus manos y luego apliquenlo en la cara del niño.
- No use productos que contengan aceite de eucalipto de limón (OLE) o para-mentano-diol (PMD) en niños menores de 3 años.

Trate la ropa y el equipo

- Trate con permetrina los artículos como botas, pantalones, calcetines y tiendas de campaña o compre ropa y equipo ya tratados con permetrina.
  - La ropa tratada con permetrina lo protegerá luego de varias lavadas. Lea la información del producto para saber cuánto tiempo durará la protección.
  - Si usted va a aplicar el tratamiento, siga las instrucciones del producto.
  - No use productos con permetrina directamente sobre la piel.

Mantenga su hogar libre de mosquitos

Use una malla o tela metálica en las puertas y ventanas. Repare los huecos que tenga la malla o tela metálica para mantener los mosquitos afuera.

- Use el aire acondicionado si está disponible.
- Evite que los mosquitos pongan huevos en agua acumulada.
  - Una vez a la semana, vacíe y restriegue, dé vuelta, cubra o bote los recipientes que acumulen agua, tales como neumáticos, baldes, floreros, macetas, juguetes, piscinas, baños para pájaros, tiestos o contenedores de basura. Revise dentro y fuera de su hogar.

www.cdc.gov/features/StopMosquitoes

North Georgia Health Distri

CDC, 2014—Aedes albopictus

Future Research/Suggestions

- Compare species diversity of settings (urban vs rural), terrain (mountain vs valley) and trap types (light vs gravid)
- Establish standardized surveillance protocol (random selection, frequency, uniform reporting)
- Examine vector species that are risks to other mammals (i.e. horses, dogs)

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  - Ms. Leauna Stone
  - Dr. Enid Sisskin
  - Dr. Denice Curtis
  - Dr. Justice Mbizo

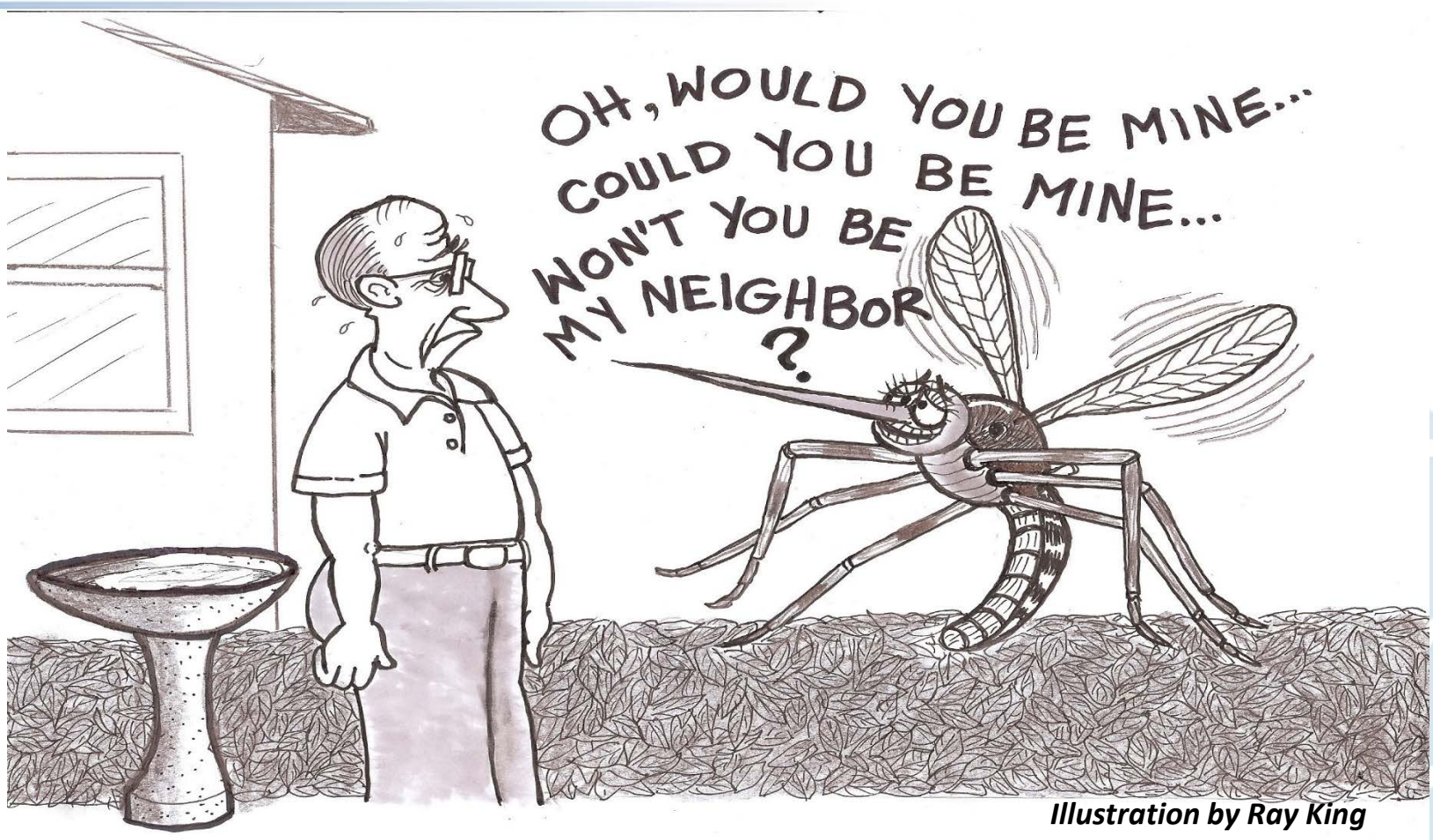

Illustration by Ray King

Questions??

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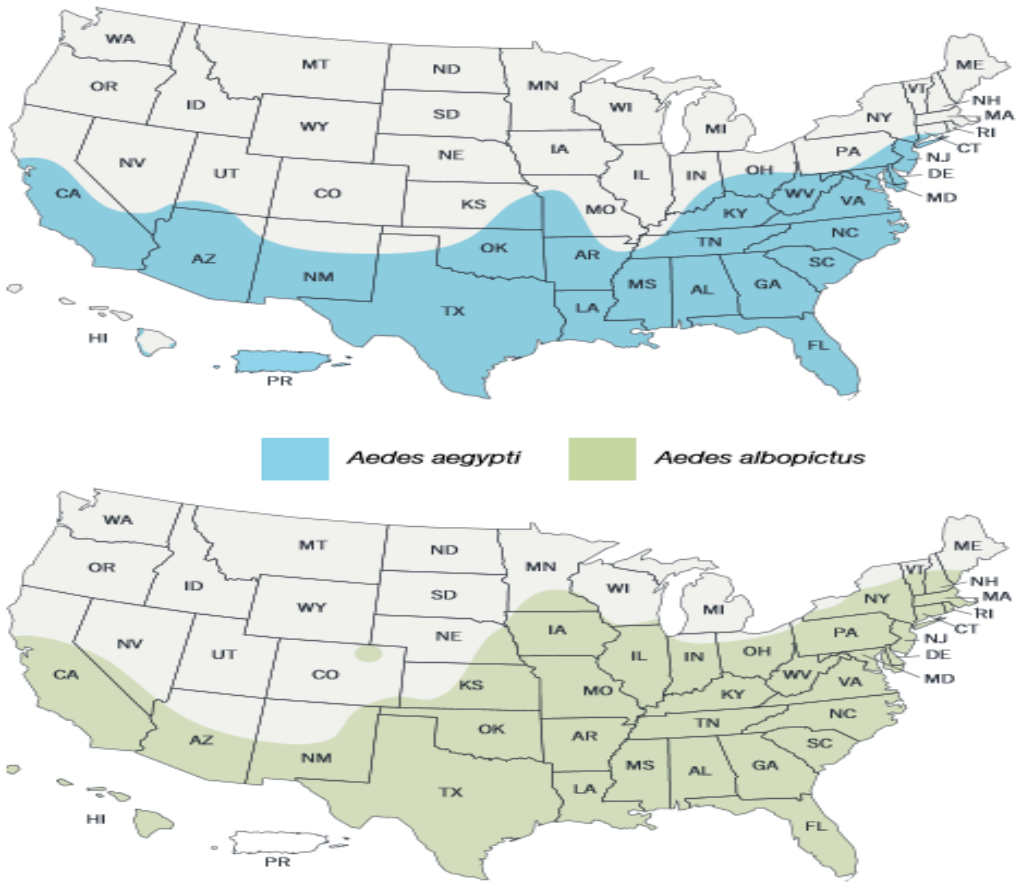
ESTIMATED range of *Aedes albopictus* and *Aedes aegypti* in the United States, 2016*



Aedes aegypti mosquitoes are more likely to spread viruses like Zika, dengue, chikungunya and other viruses than other types of mosquitoes such as _Aedes albopictus_ mosquitoes.

These maps DO NOT show

- Exact locations or numbers of mosquitoes living in an area
- Risk or likelihood that these mosquitoes will spread viruses

These maps show

- CDC's best estimate of the potential range of *Aedes aegypti* and *Aedes albopictus* in the United States
- Areas where mosquitoes are or have been previously found

* Maps have been updated from a variety of sources. These maps represent CDC's best estimate of the potential range of *Aedes aegypti* and *Aedes albopictus* in the United States. Maps are not meant to represent risk for spread of disease.

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