Virginia Arboviral Surveillance 2019

Virginia Mosquito Control Association
Virginia Beach
January 28th 2020

Slides prepared by: Elena Diskin, MPH

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

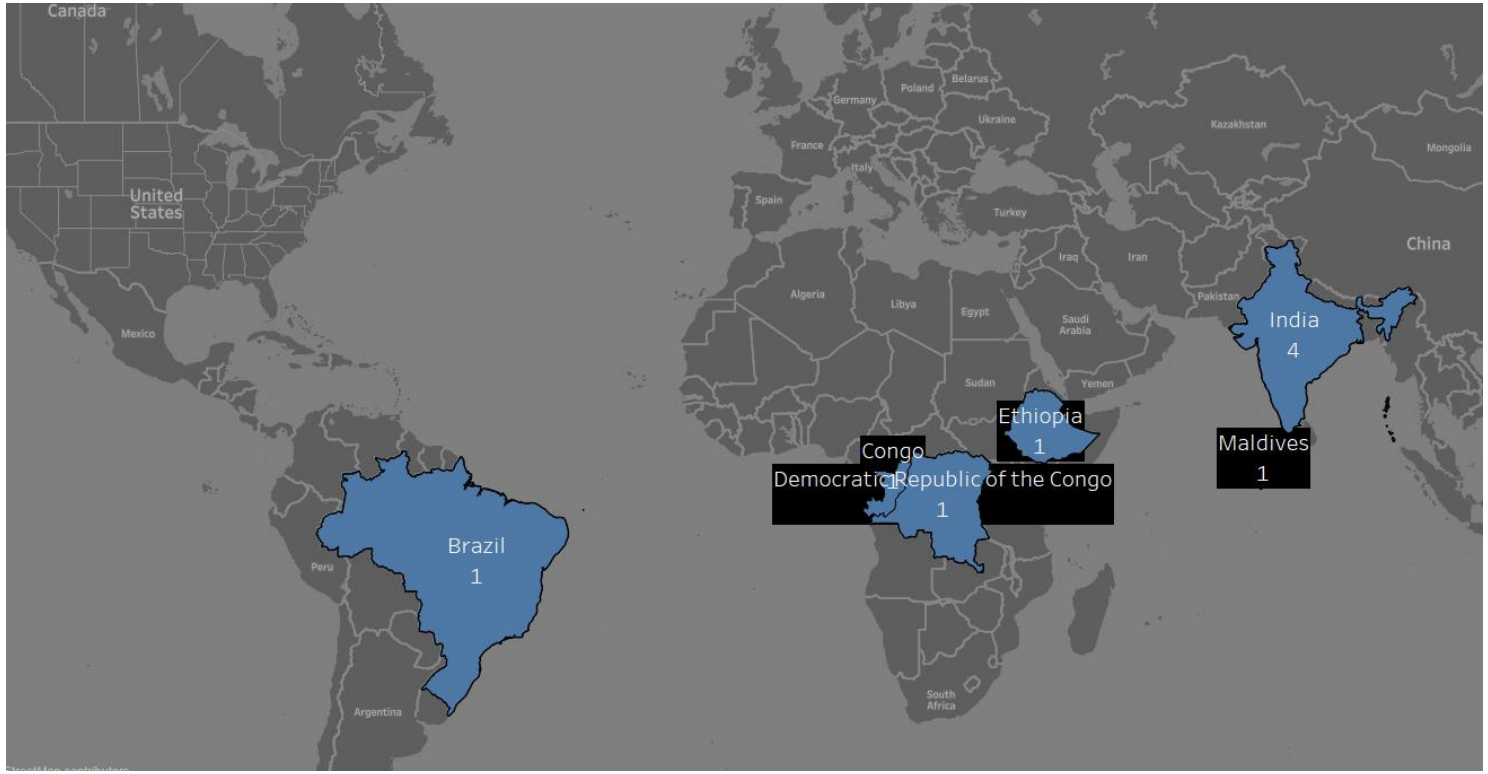
VA Human Infections from Arboviral Diseases

Arboviral Condition	2019	3 yr avg. trend	3 yr avg.	2018	2017	2016
La Crosse virus, neuroinvasive	0	↓	1	2	0	0
West Nile infection, neuroinvasive	4	↓	19	38	12	6
West Nile infection, non-neuroinvasive	2	↓	5	10	1	2
Chikungunya virus diseases	9	↑	5	3	5	6
Dengue virus	19	↑	16	8	12	27
Zika virus, disease	1	↓	39	1	6	109
Grand Total	**62**			**73**	**44**	**172**

Imported Arboviral Disease Cases in VA in 2019

Chikungunya (9 travel-related cases)

- India (4), Brazil (1), Congo (1), DRC (1), Ethiopia (1), Maldives (1)



Imported Arboviral Disease Cases in VA in 2019

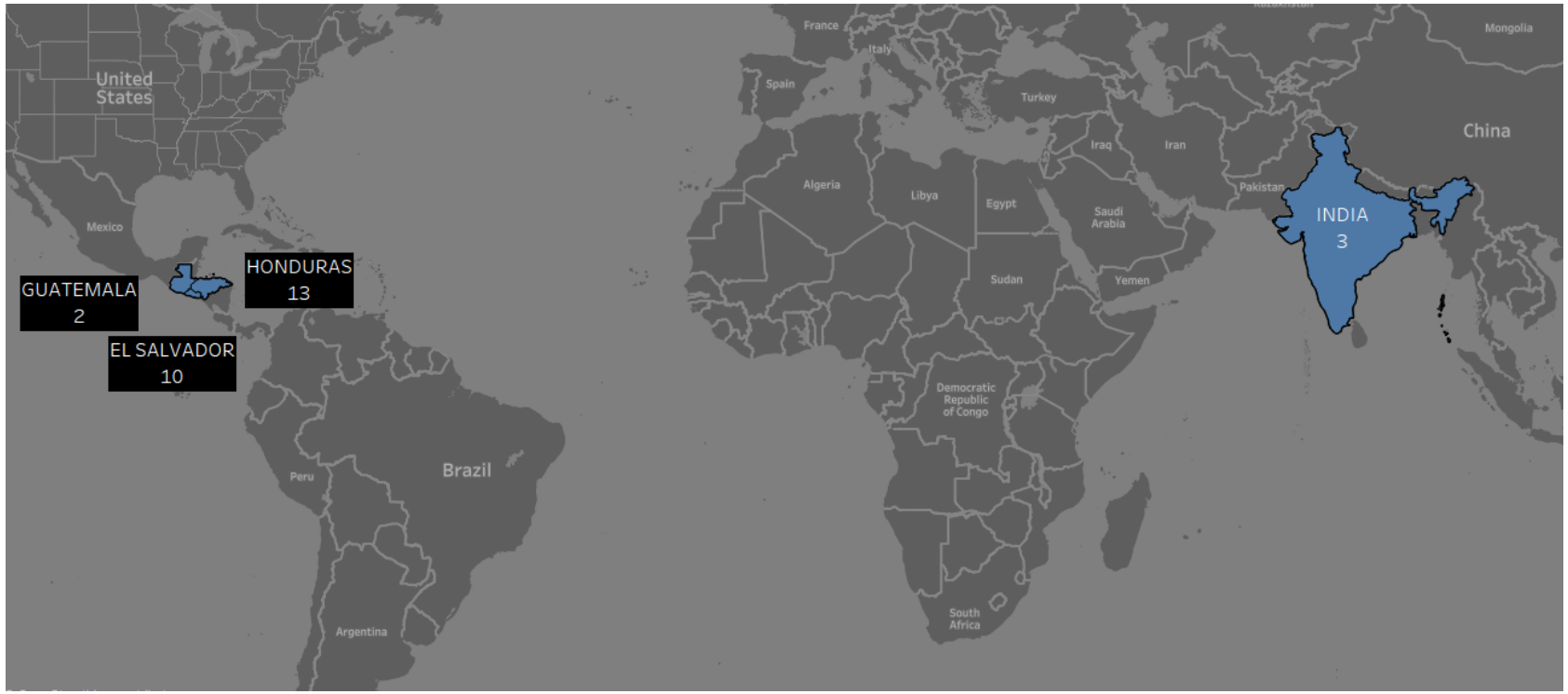
Dengue (19 travel-related cases)

- India (10), Guatemala (2), DR (2), Jamaica (2), Cuba (1), Mexico (1), Nicaragua (1)

Imported Arboviral Disease Cases in VA in 2019

Zika (28 travel-related cases)

- Honduras (13), El Salvador (10), Guatemala (2), India (3)

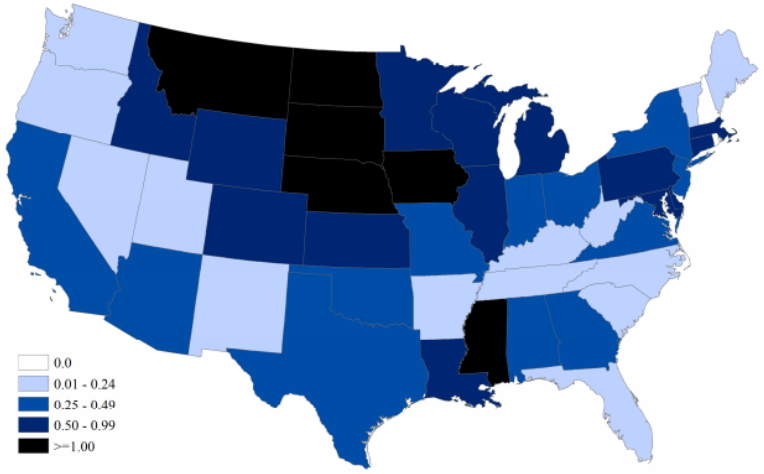


West Nile Virus in US in 2018

As of Jan 8th, 2,544 WNV human cases found in 48 states and DC.

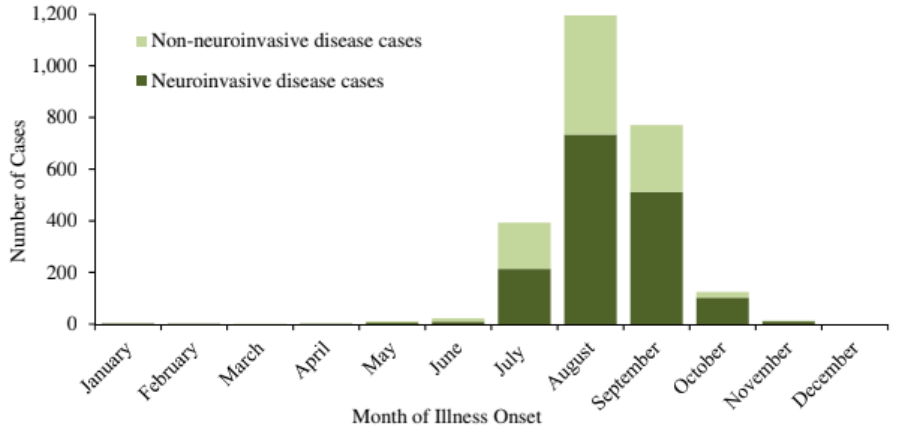
- 447 more WNV cases than 2017, 395 more than 2016
- 63% classified as neuroinvasive (meningitis or encephalitis)
- 37% classified as non-neuroinvasive (febrile illness)
- 357 WNV presumptive viremic donors reported from 35 states
- 137 fatalities (5.3% CFR) reported from 35 states

Figure 3. West Nile virus (WNV) neuroinvasive disease incidence* reported to ArboNET, by state — United States, 2018 (as of January 8, 2019)



*Incidence per 100,000 population

Figure 2. West Nile virus disease cases reported to ArboNET, by month of onset* — United States, 2018 (as of January 8, 2019)



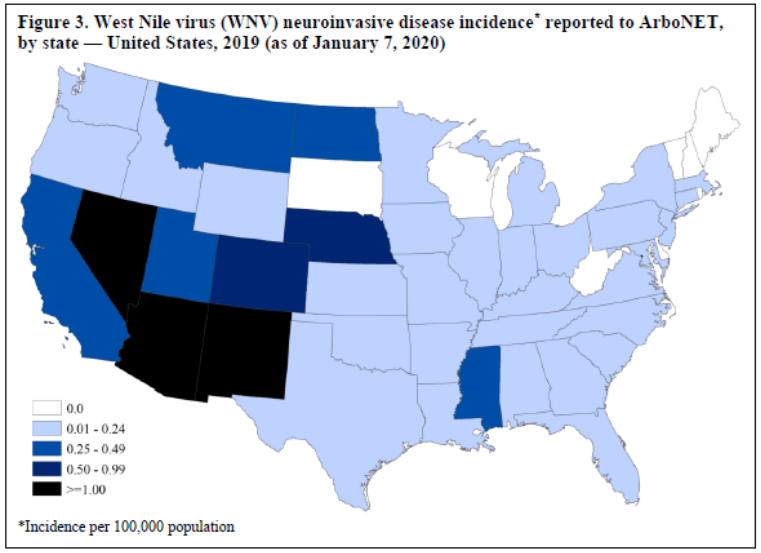
*Cases missing onset date (n=2)

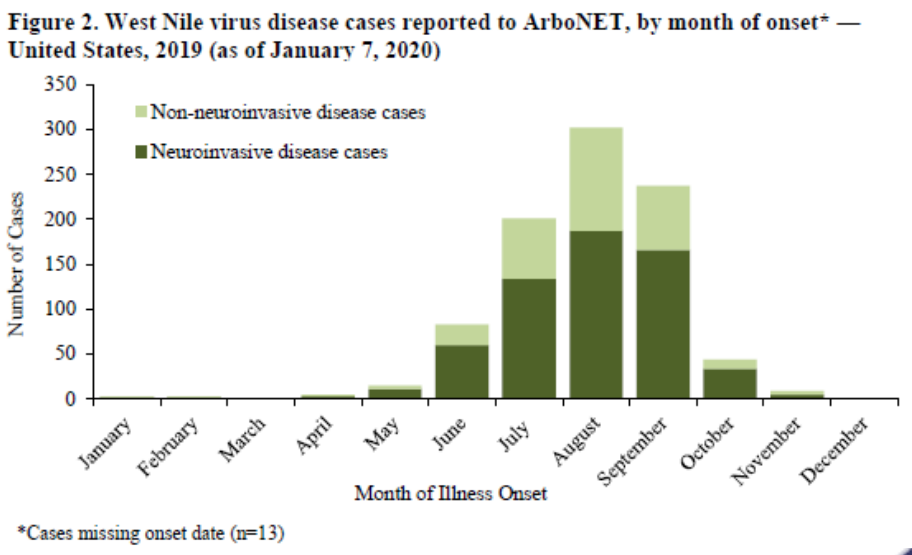
VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

West Nile Virus in US in 2019

As of Jan 7th, 917 WNV human cases found in 43 states and DC.

- Over 60% decrease from 2018 cases
- 66% classified as neuroinvasive (meningitis or encephalitis)
- 34% classified as non-neuroinvasive (febrile illness)
- 100 WNV presumptive viremic donors reported from 23 states
- 51 fatalities (5.5% CFR) reported from 35 states

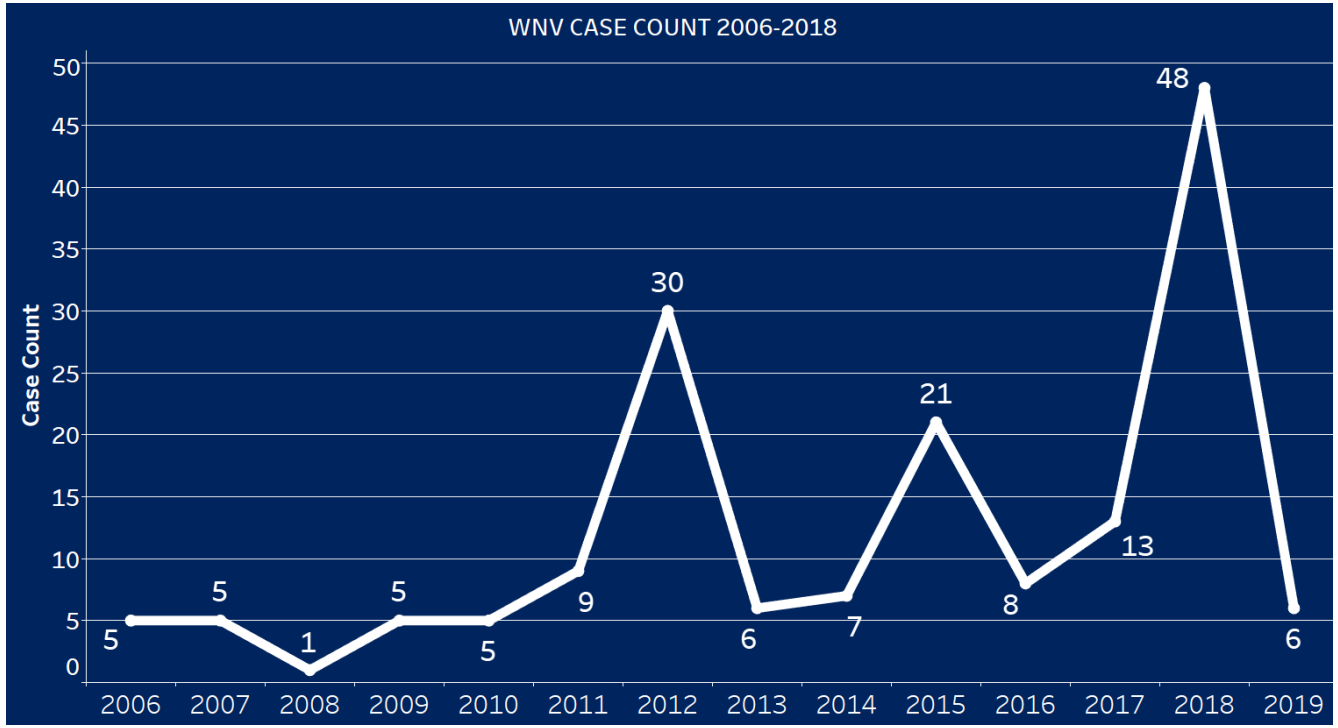




West Nile in VA in 2019

6 WNV human cases in 4 jurisdictions

- 66% (4 cases) neuroinvasive
- 33% (2 cases) non-neuroinvasive
- 1 fatality reported



2018-2019 VA WNV CASES (n=54, 42 neuro & 12 non-neuro)

98% reported fever

65% reported headache

61% reported altered mental status

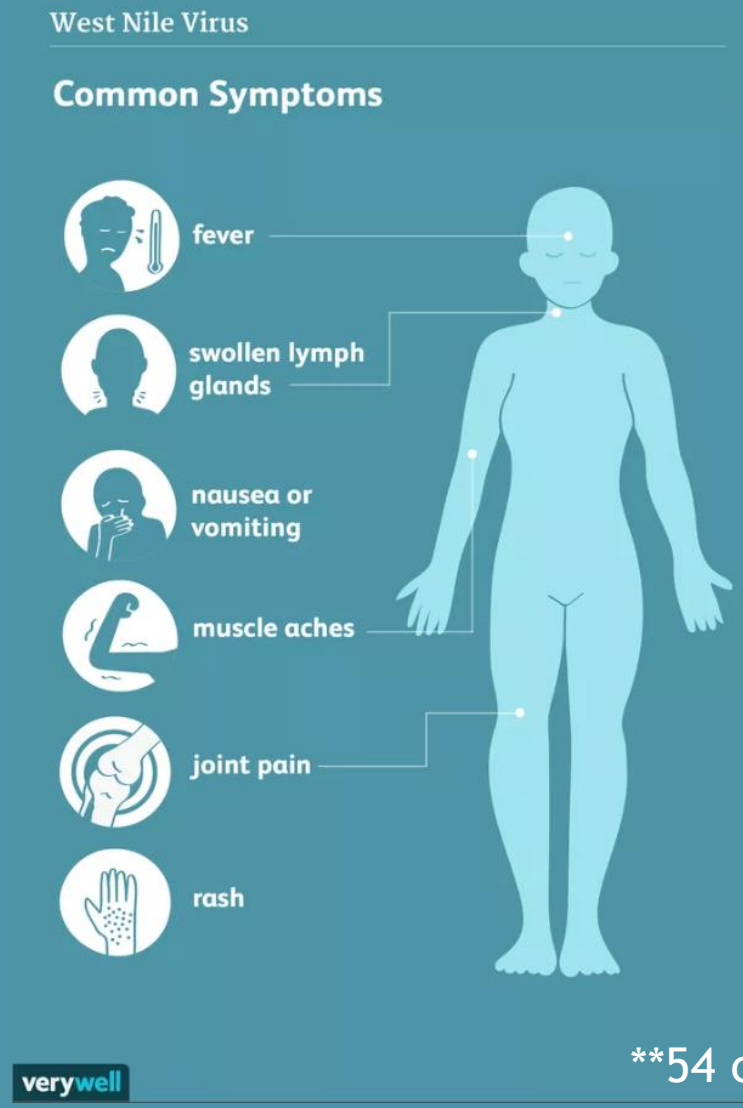
33% reported stiff neck

50% reported nausea/vomiting

48% reported muscle weakness

26% reported arthralgia (joint pain)

30% reported rash



17% (n=9) reported as fatal

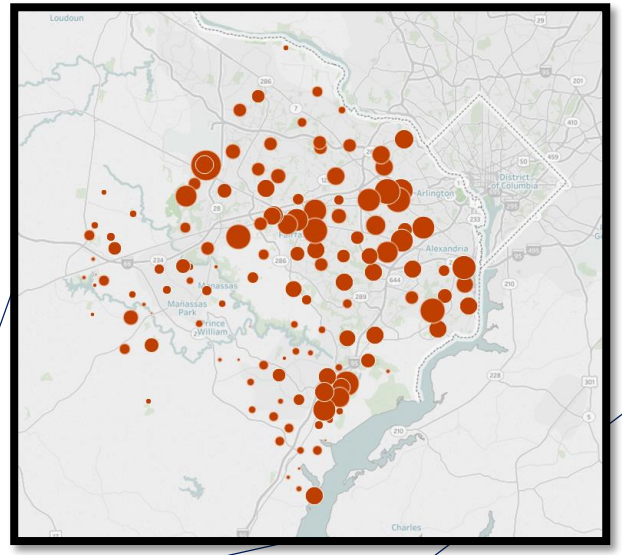
38/54 encephalitis/meningitis

**54 cases total (42 neuro, 12 non-neuro)

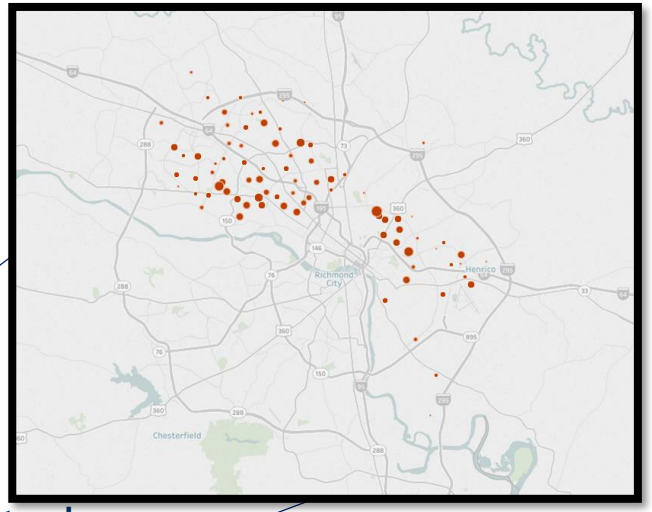
There were **316,021** mosquitoes trapped and tested in **9,166** pools during 2019 surveillance.

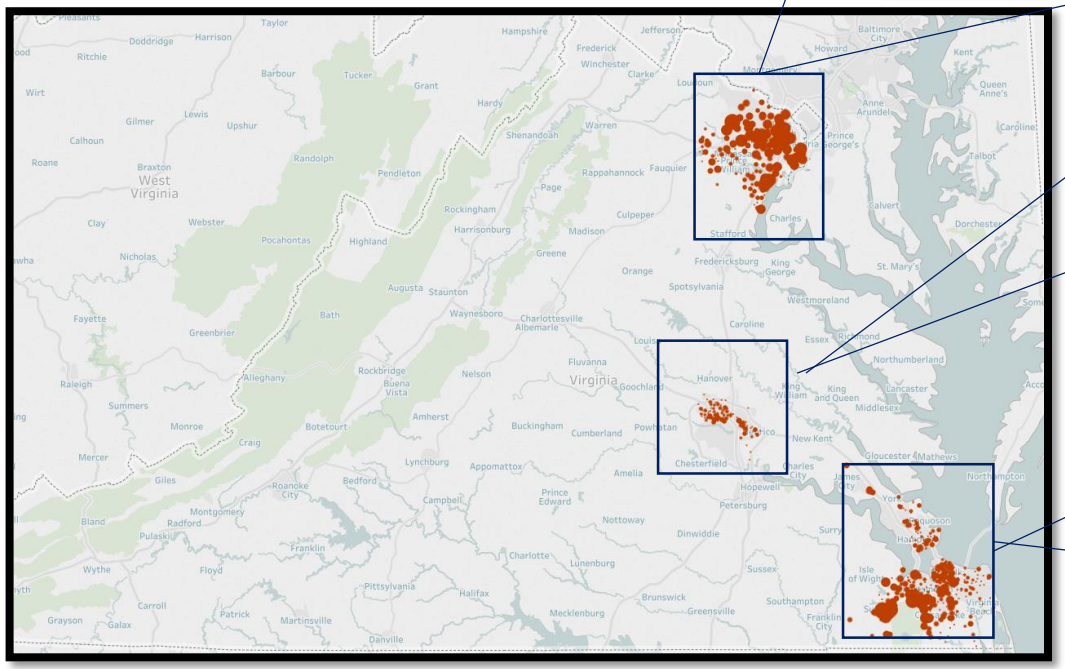
448 mosquitoes
3,042 mosquitoes
9,970 mosquitoes

NOVA

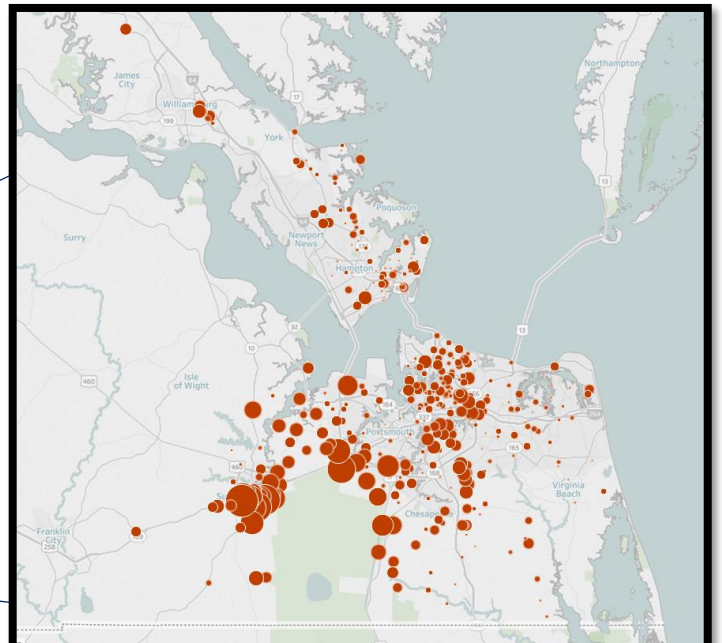


Central

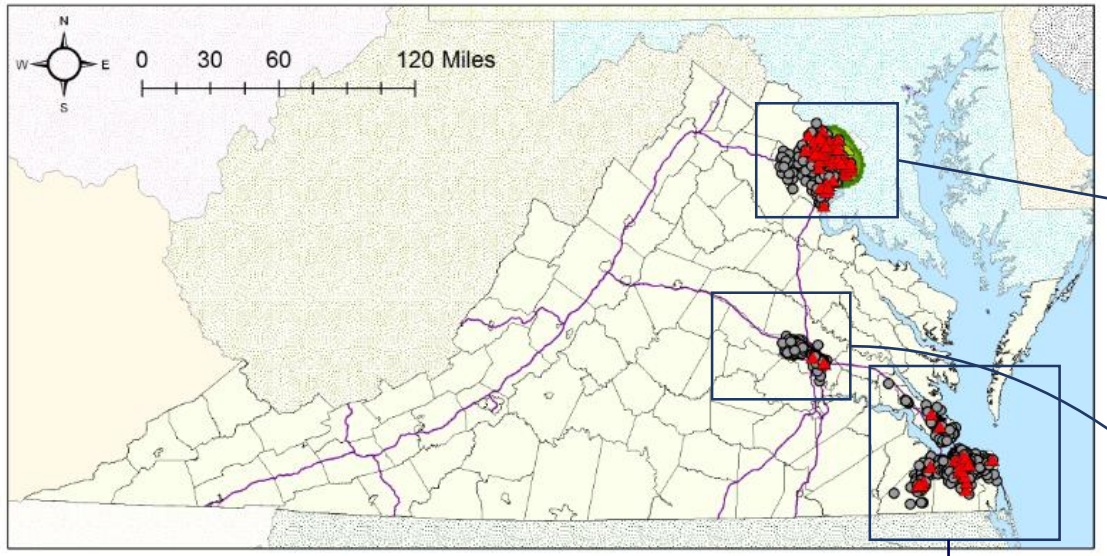


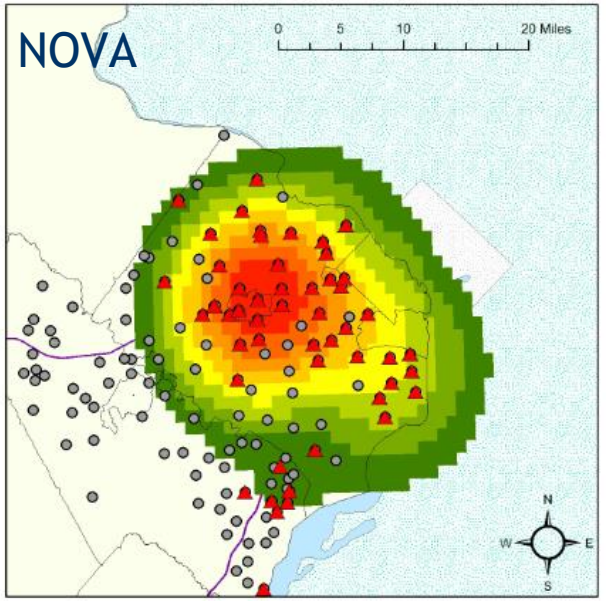


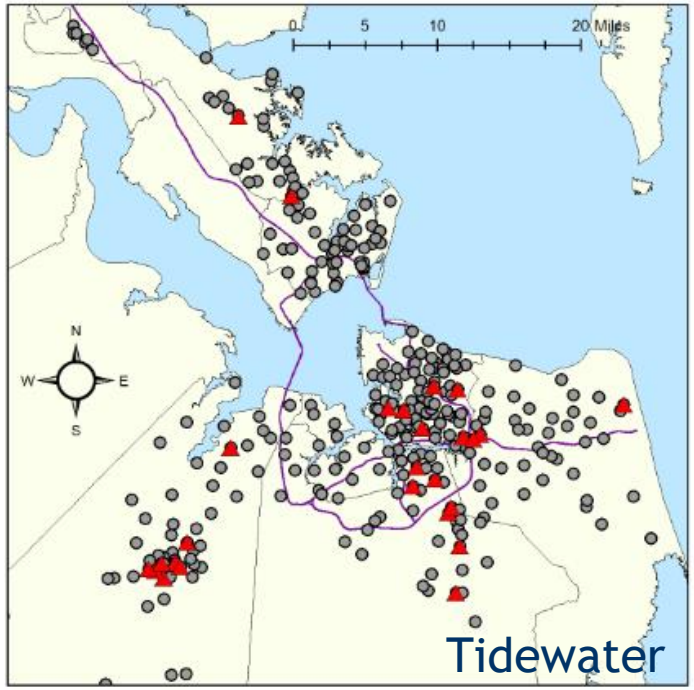
Tidewater

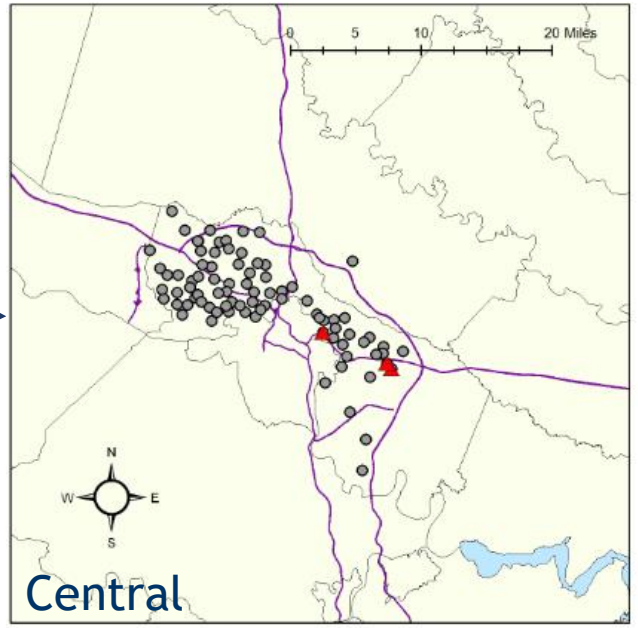


Of 8,501 pools, 1.99% (n=169 pools) were WNV positive.







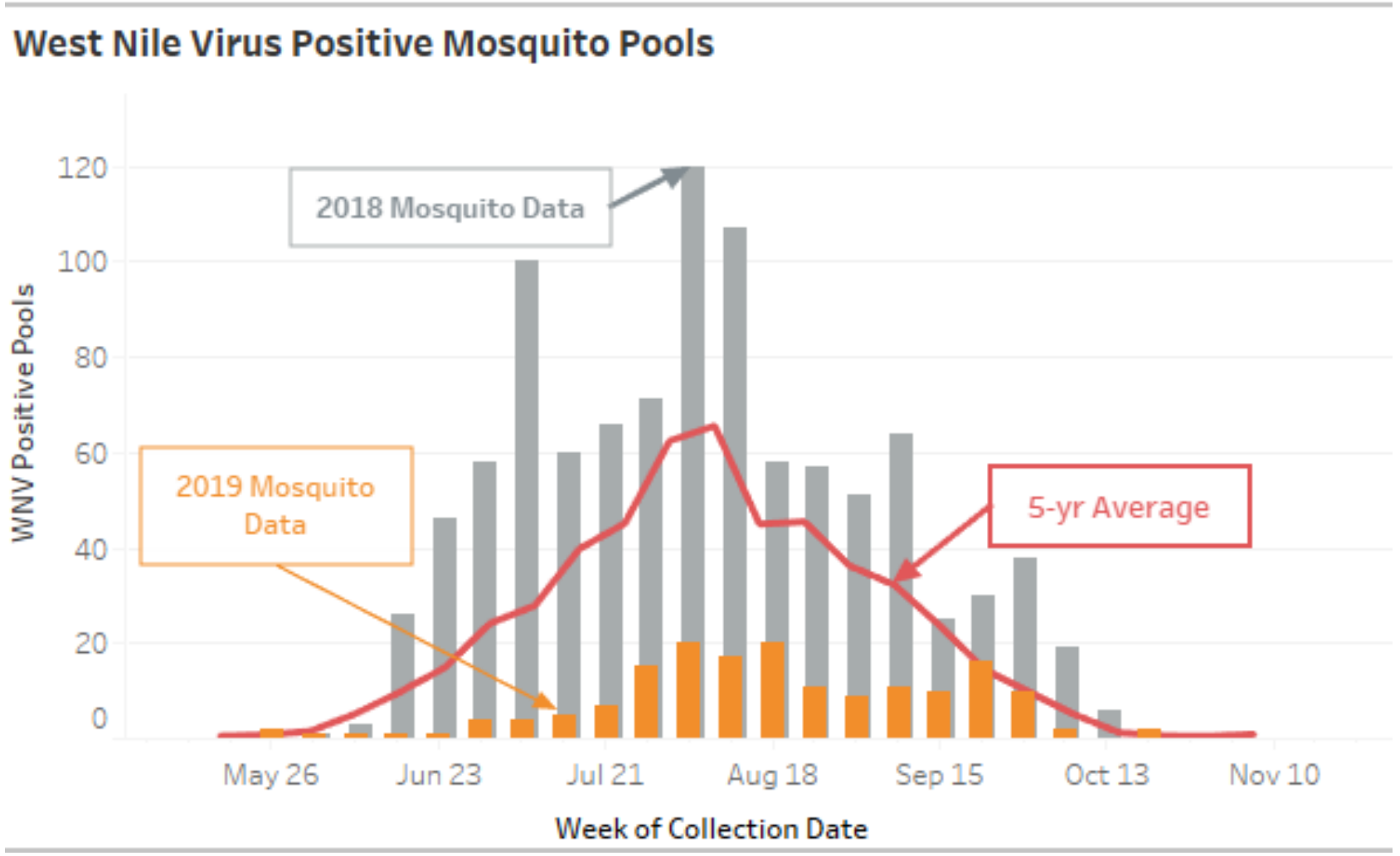


WNV Testing Mosquito Pool Sites

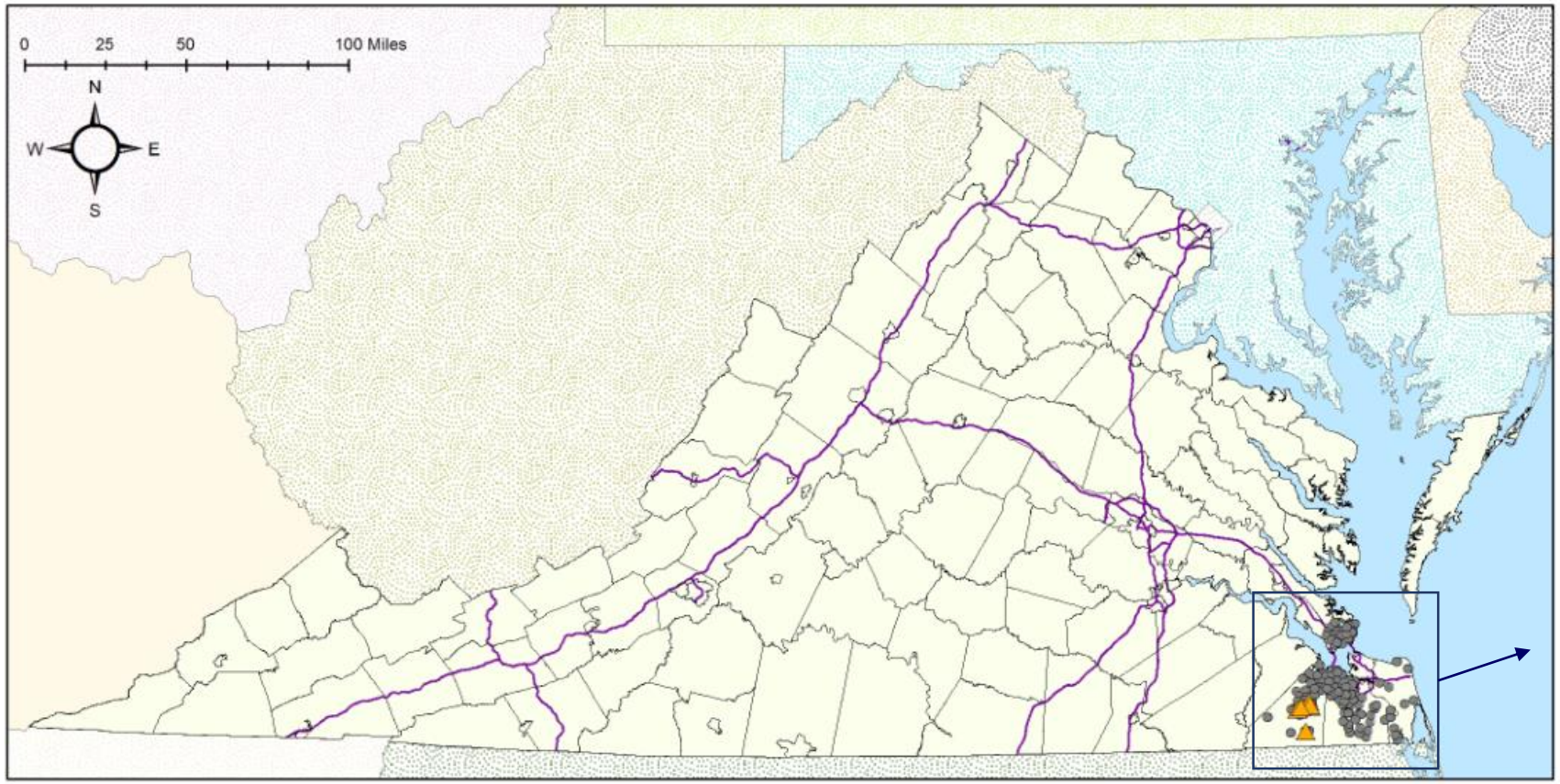
- WNV Pos
- WNV Neg

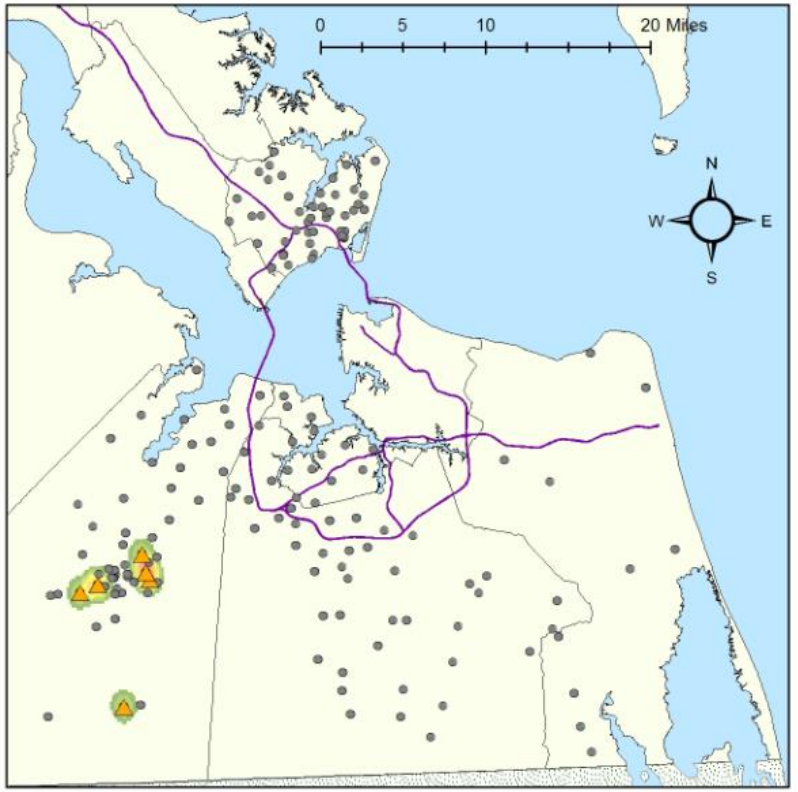
Maps by: James Broyhill

Of 8,501 pools, 1.99% (n=169 pools) were WNV positive.



Of 2,051 pools, 0.39% (n=8 pools) were EEE positive.

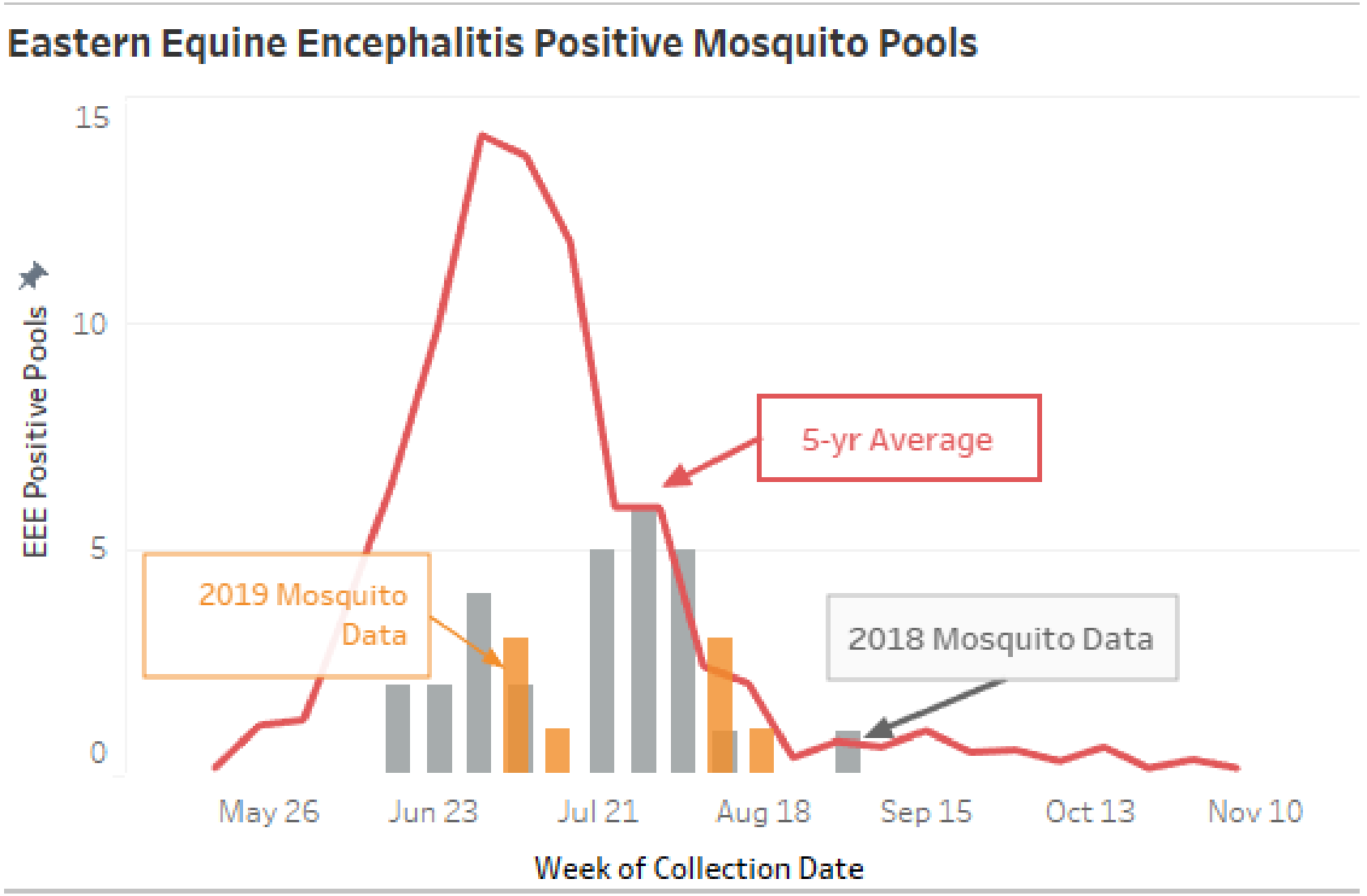


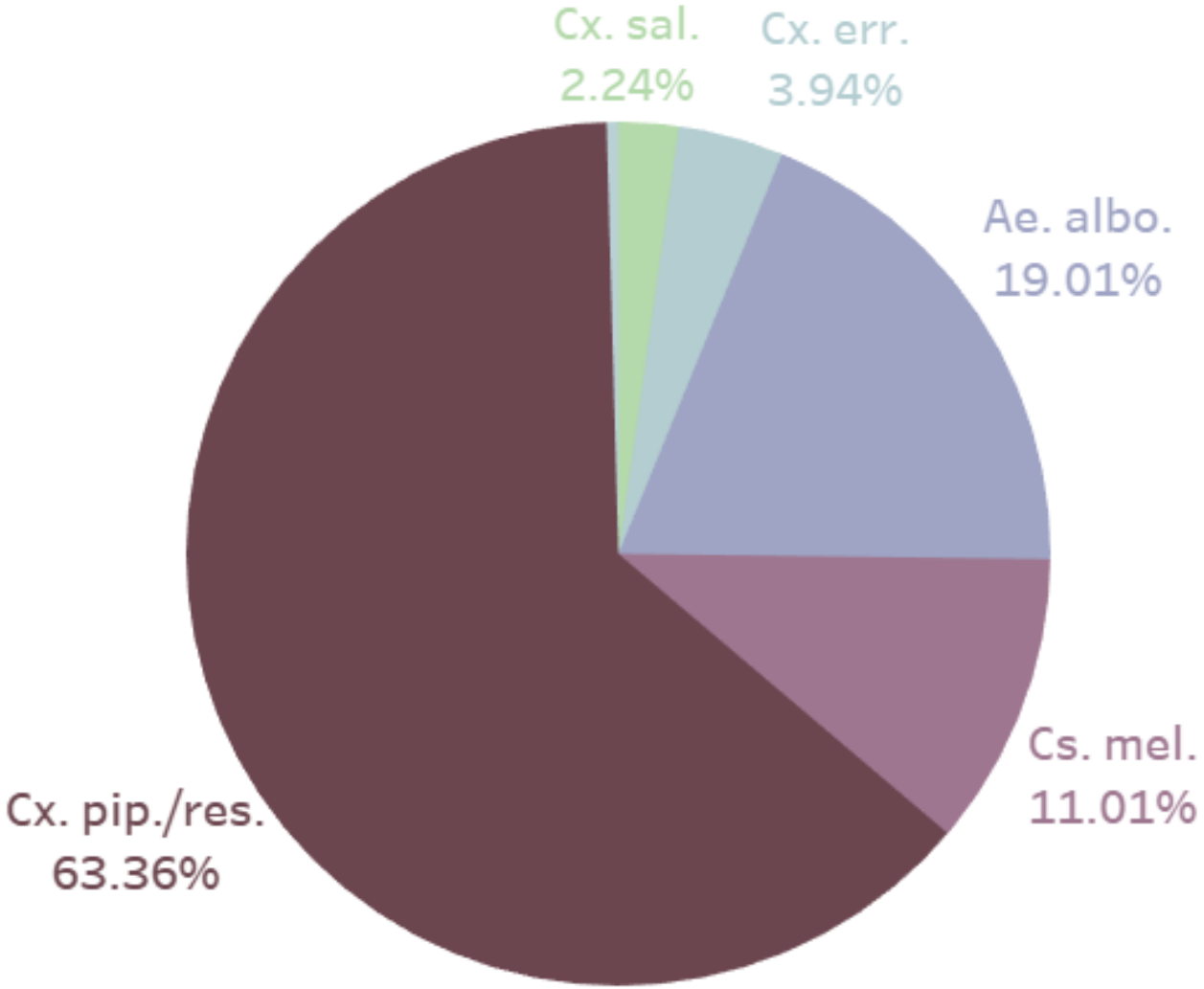


Tidewater

Maps by: James Broyhill

Of 2,051 pools, 0.39% (n=8 pools) were EEE positive.

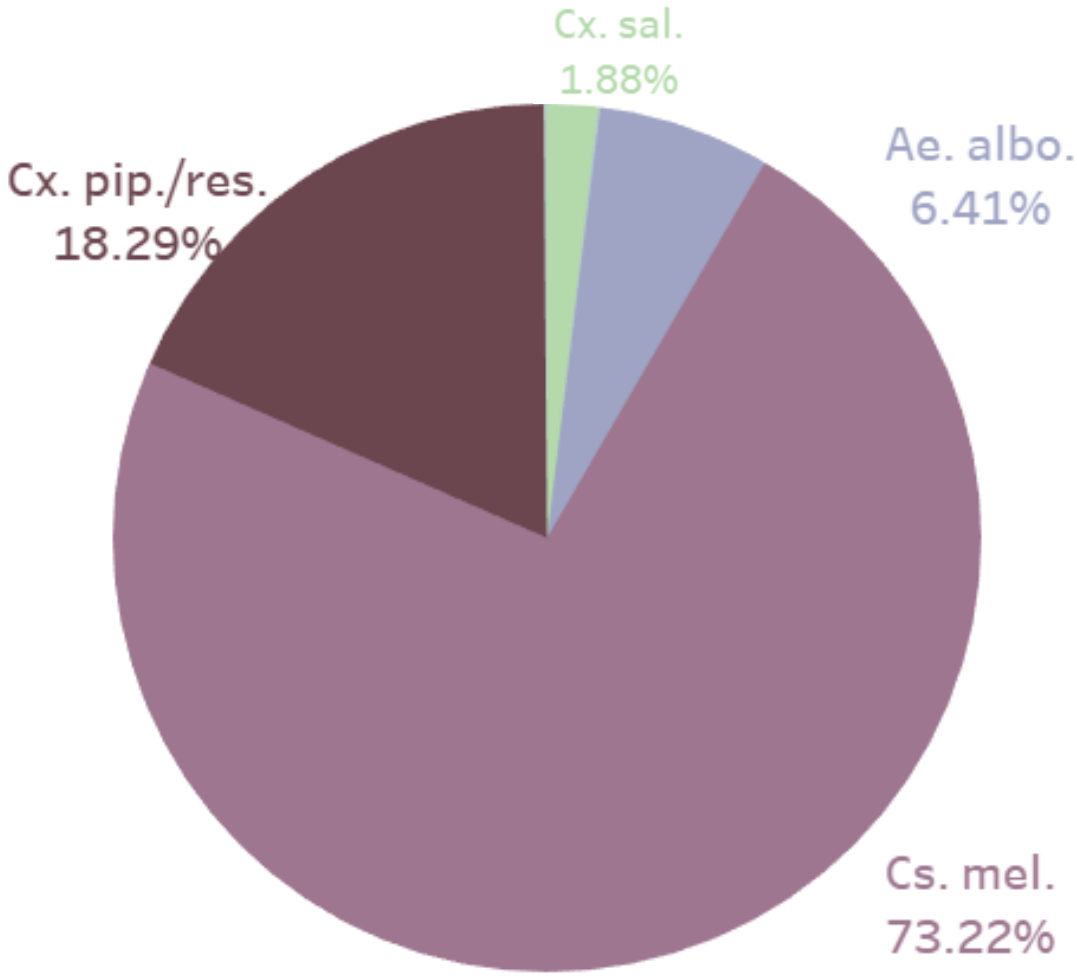




MOSQUITO SPECIES TESTED FOR WNV (2019, n=8,501 pools)

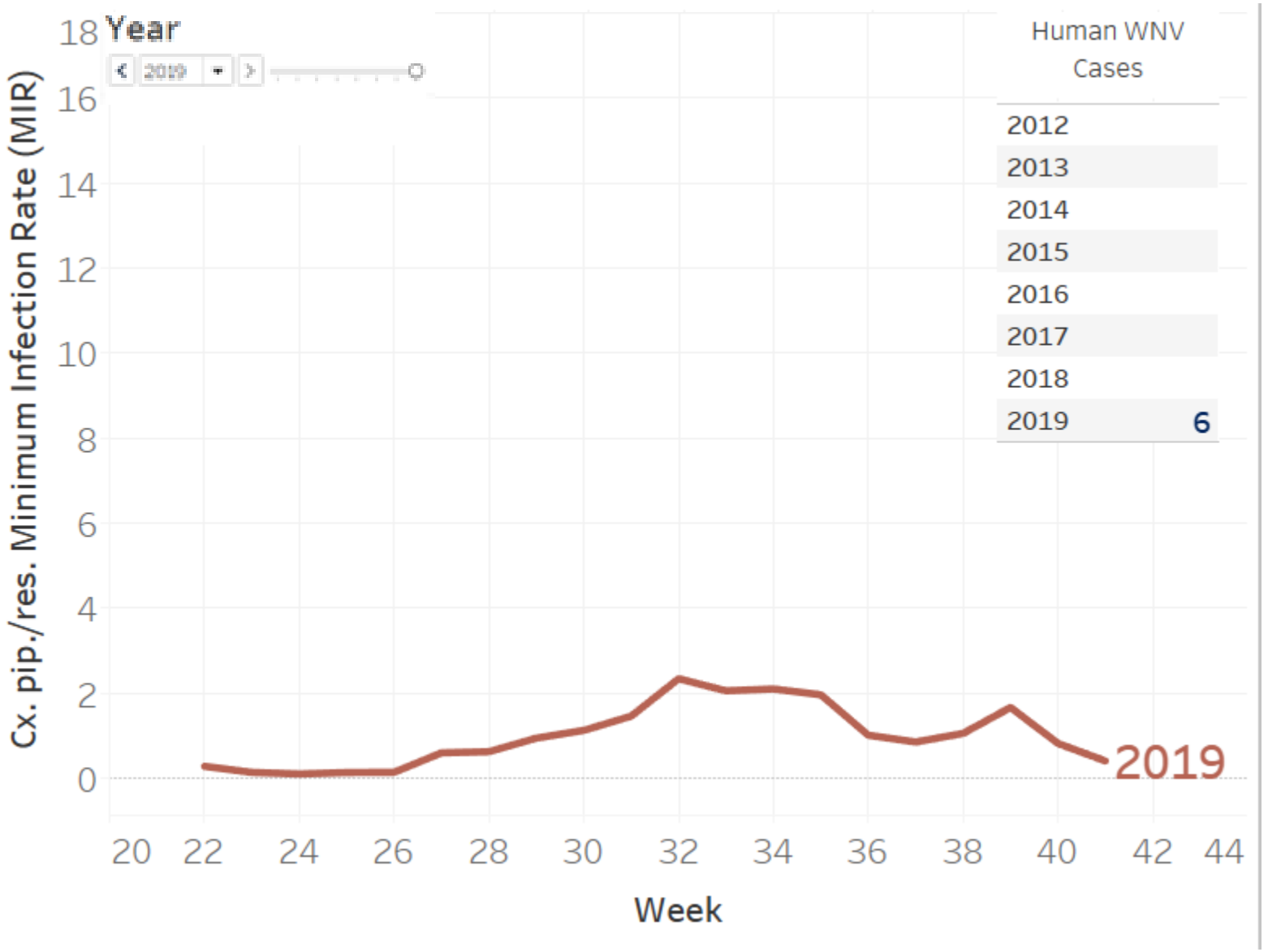
165 *Cx. pip./res.* pools WNV+

4 *Cs. mel.* pools WNV+

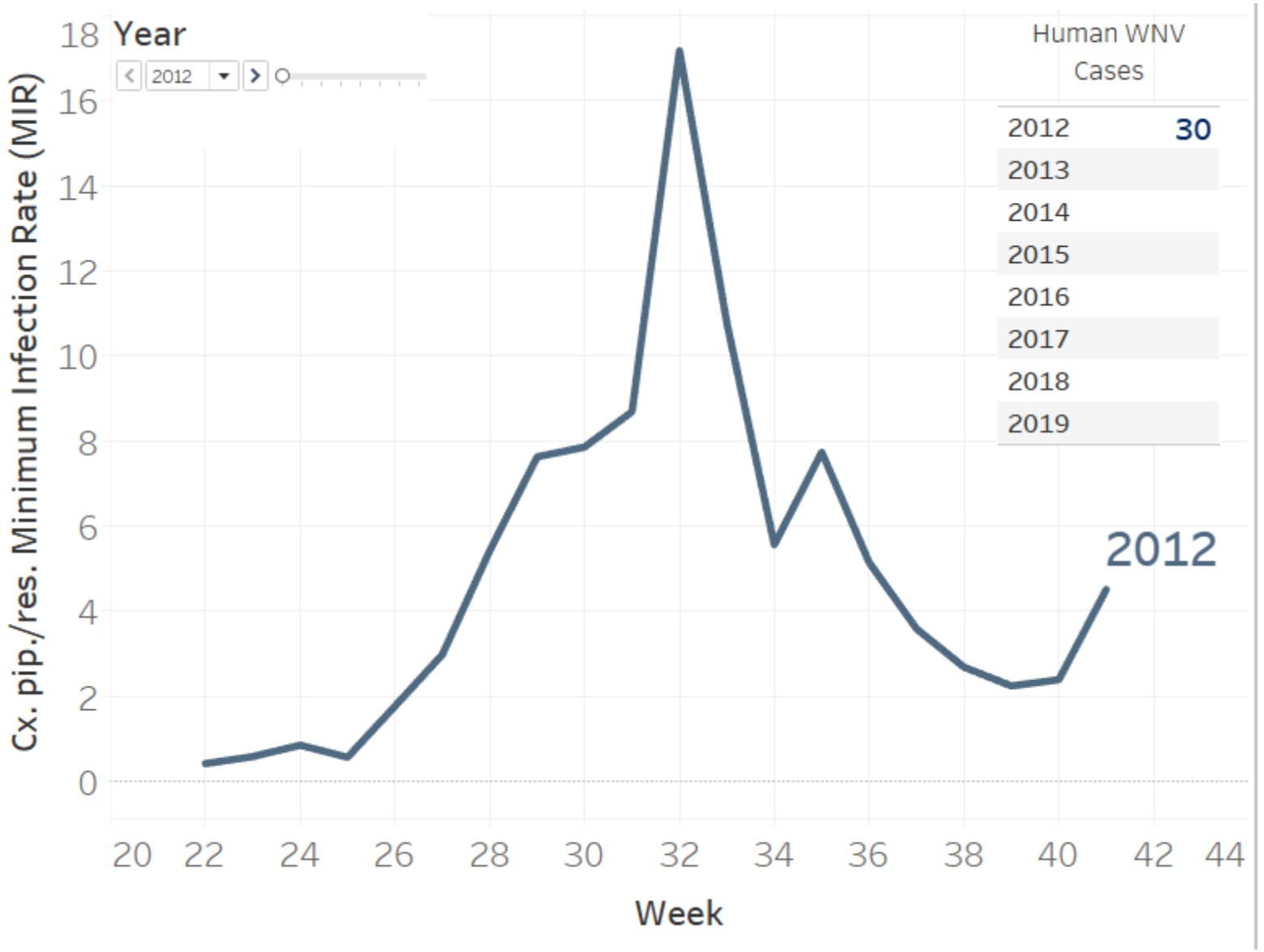


MOSQUITO SPECIES TESTED FOR EEE (2019, n=2,051 pools)

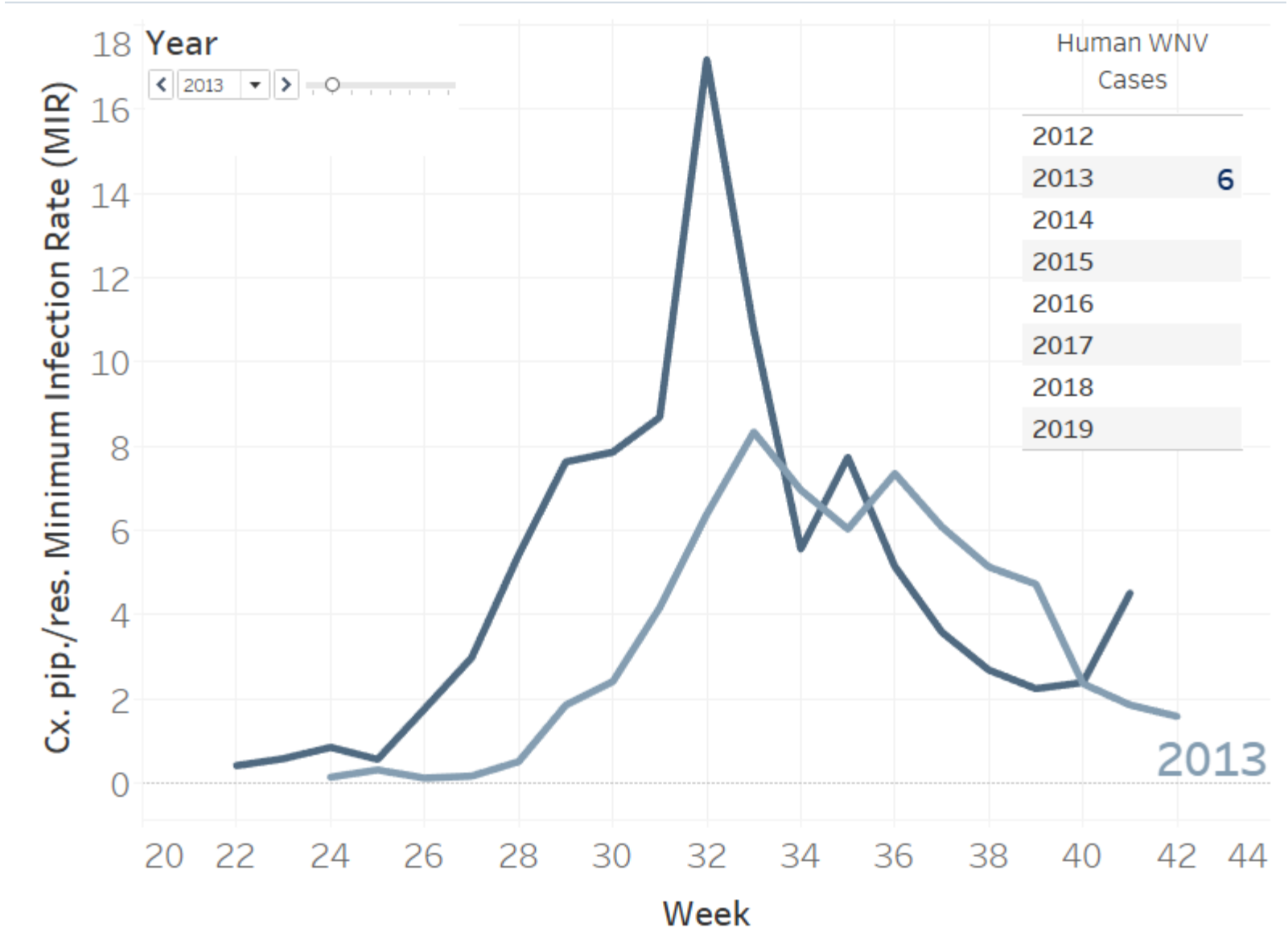
8 *Cs. mel.* pools WNV+



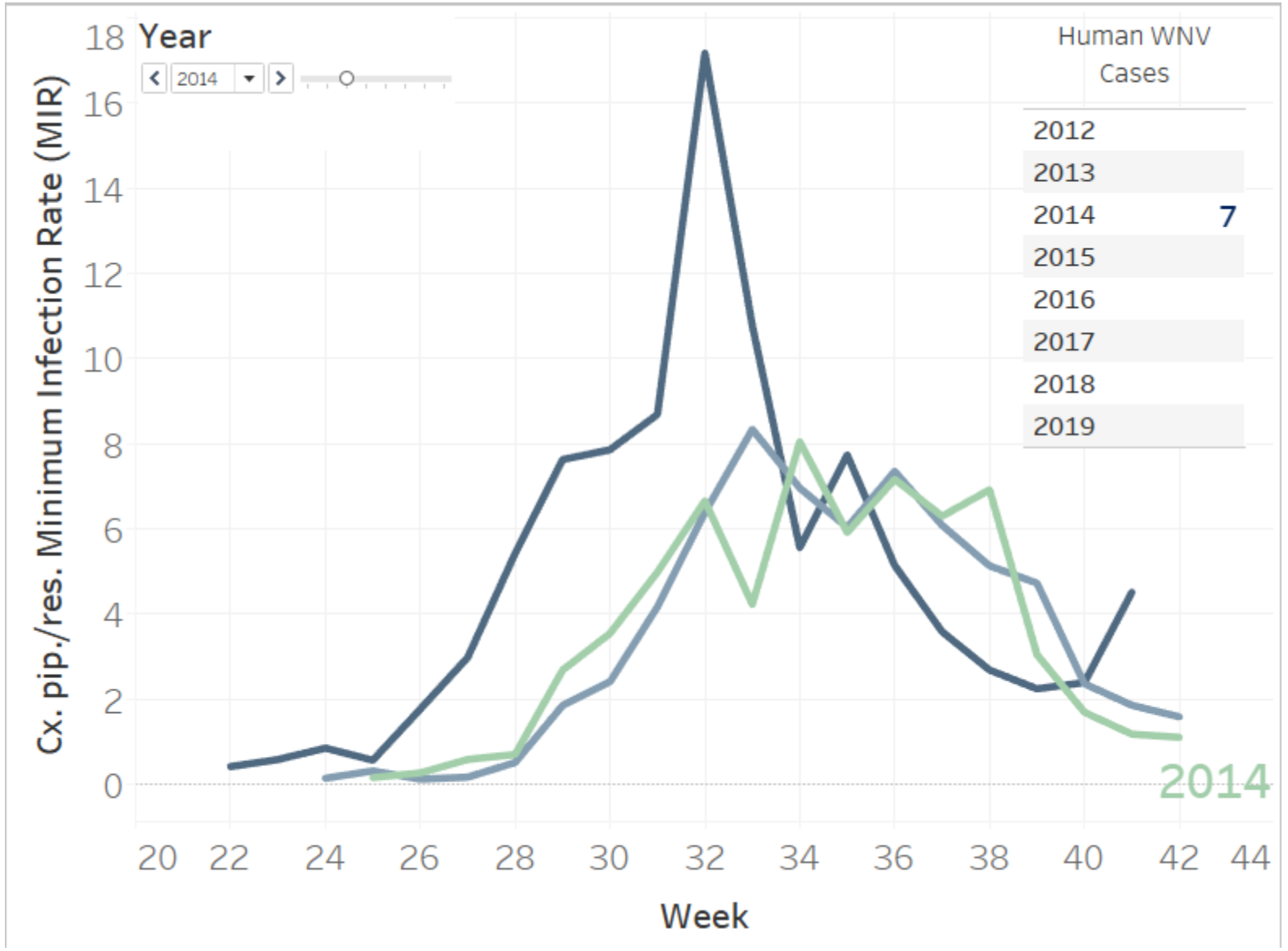
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



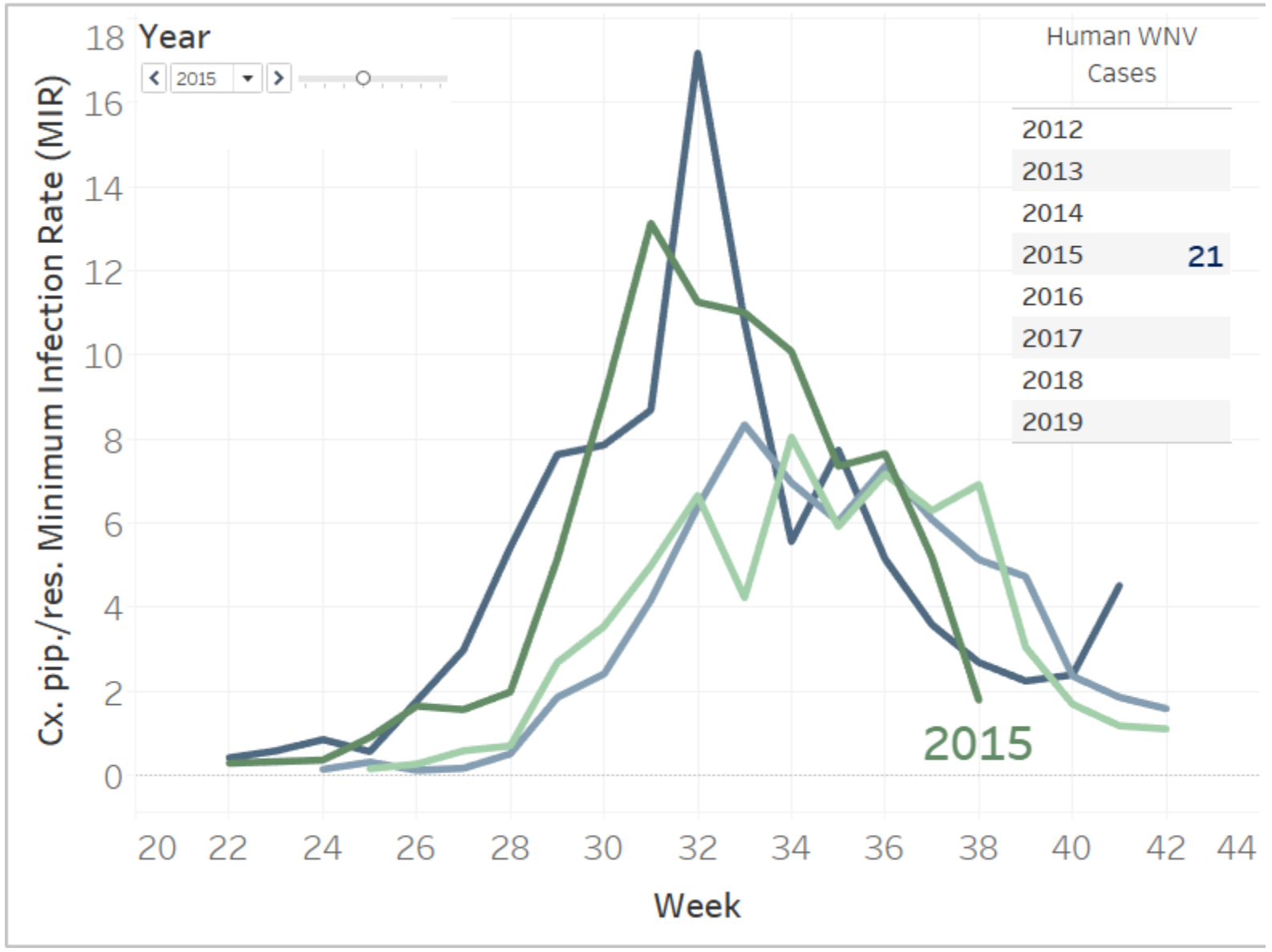
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



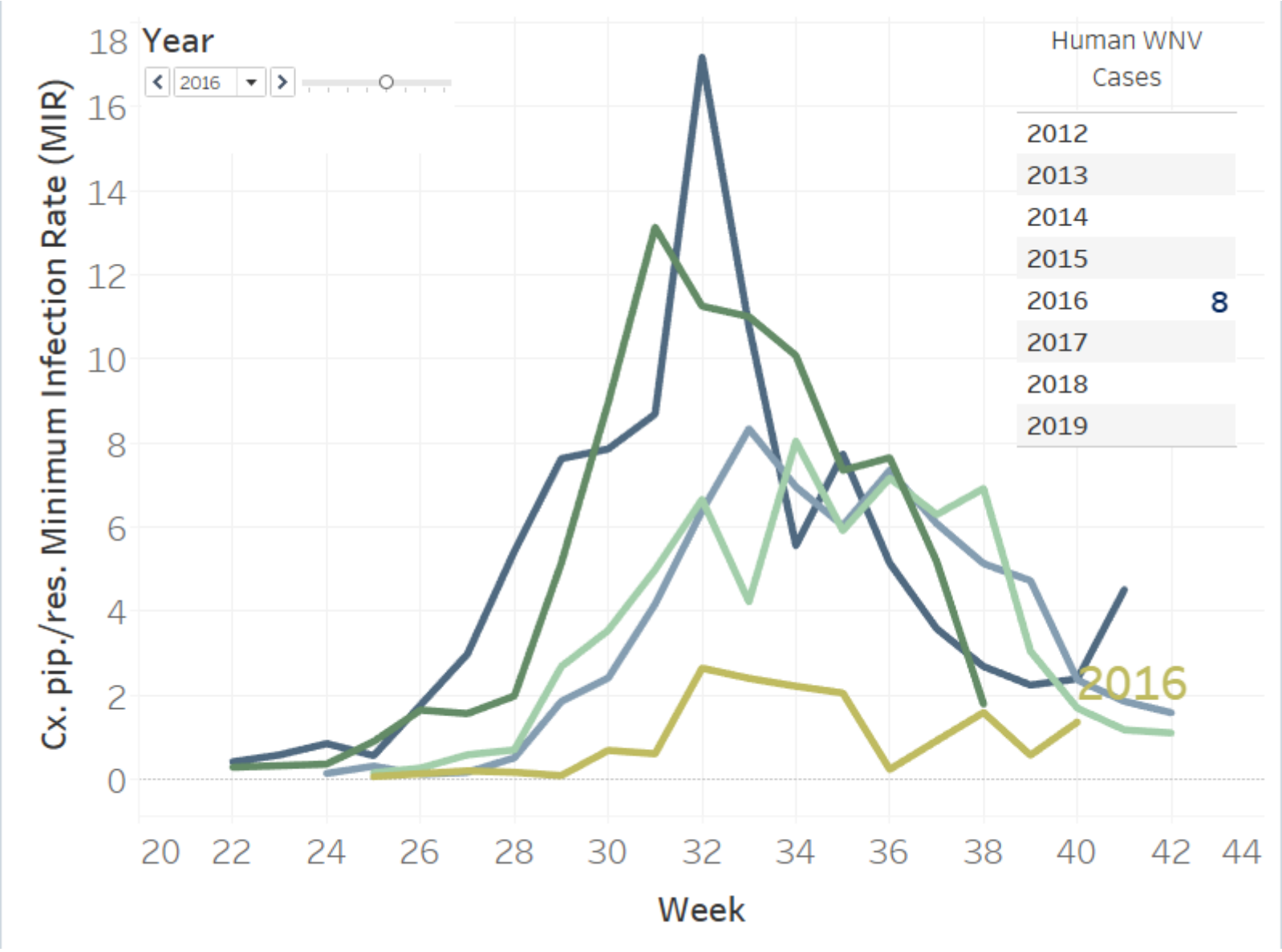
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



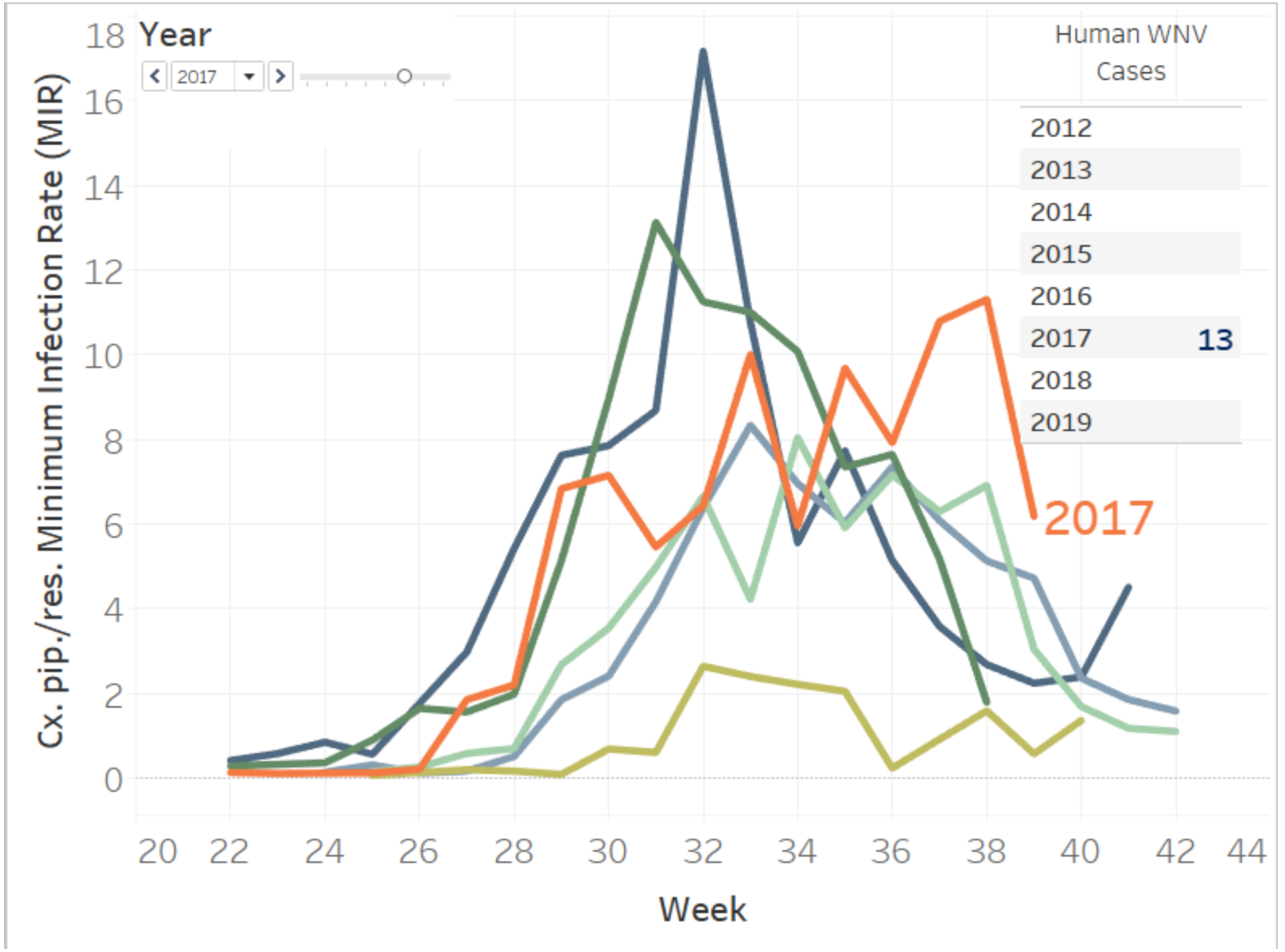
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



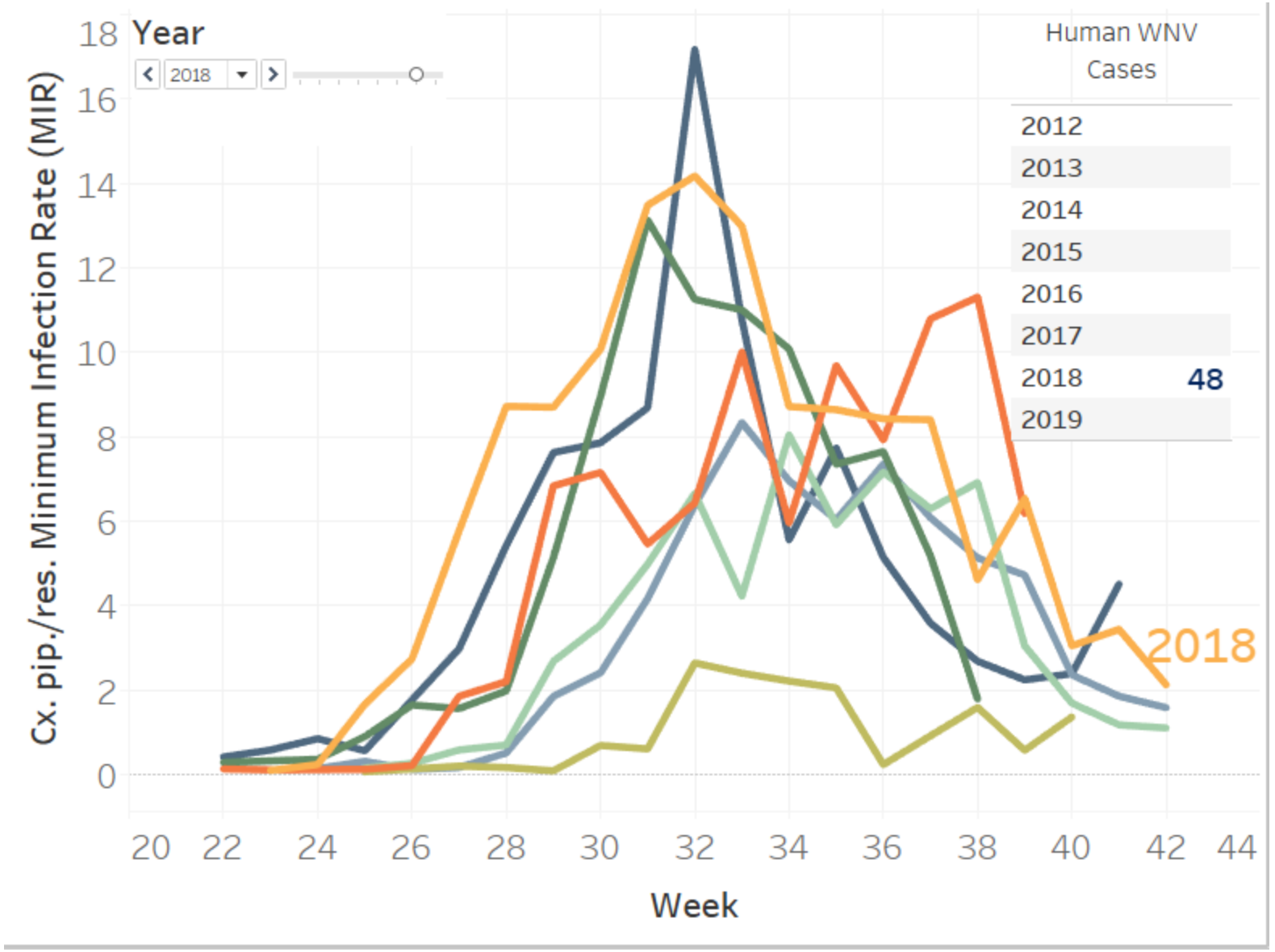
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



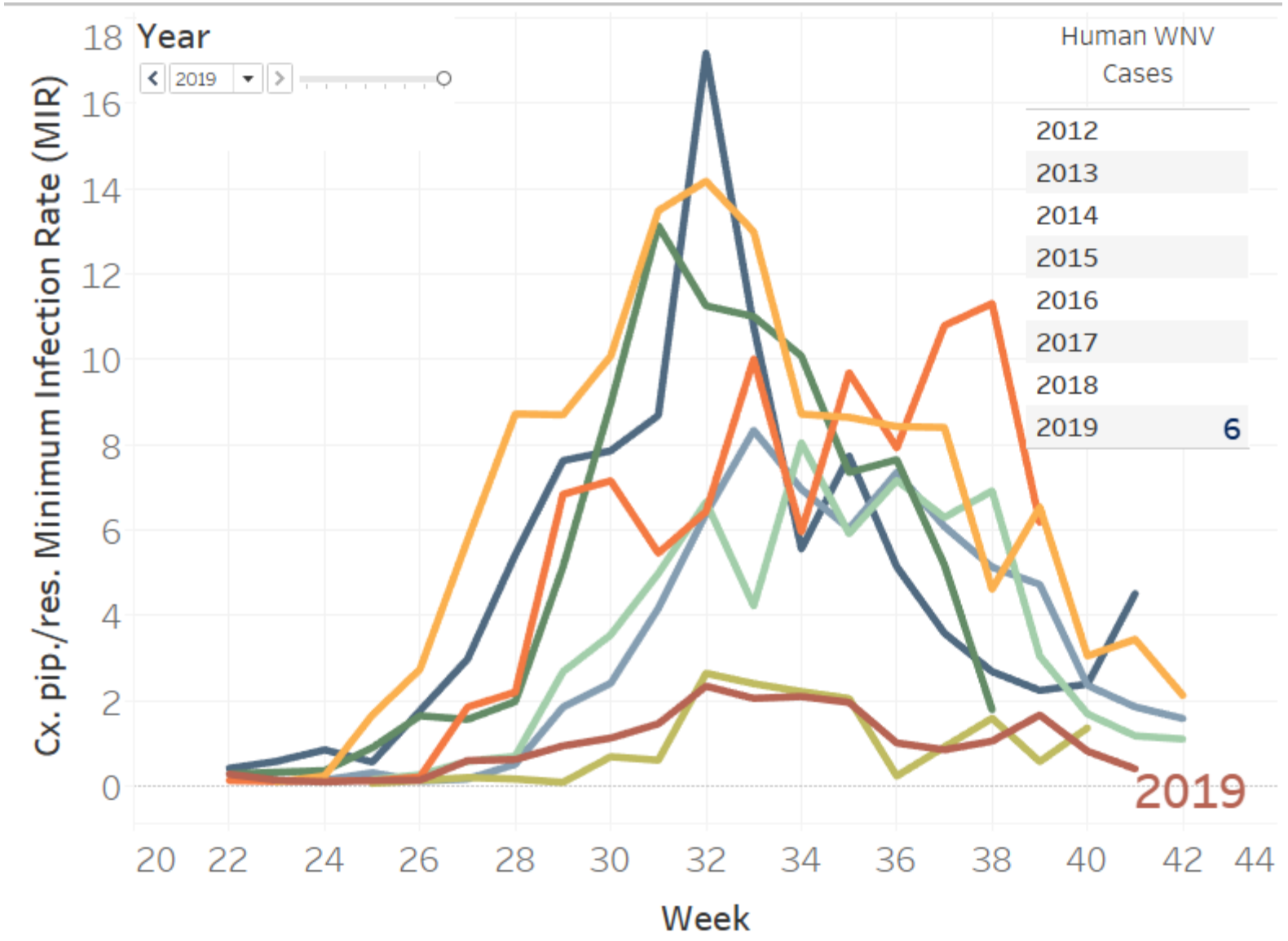
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC

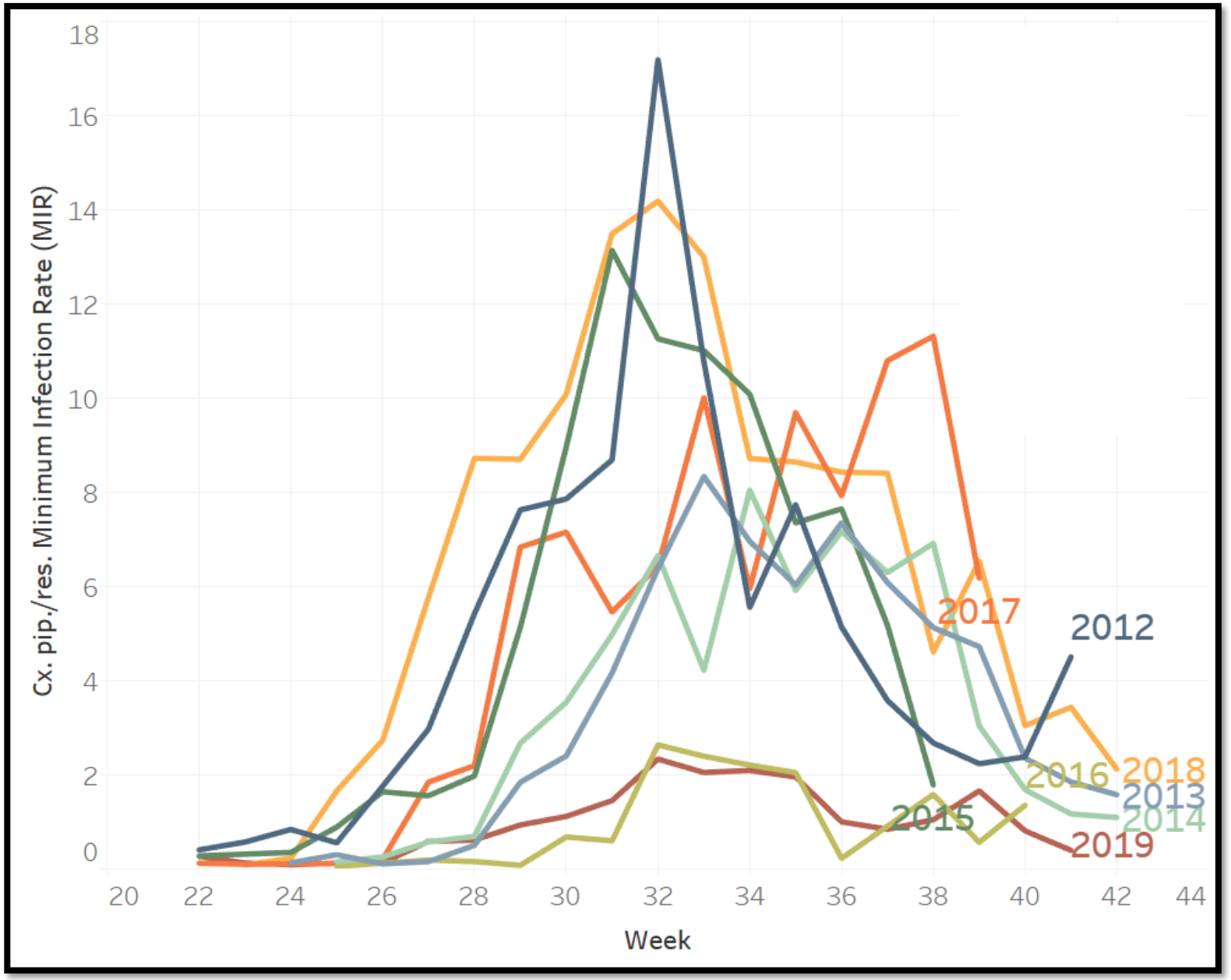


Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC



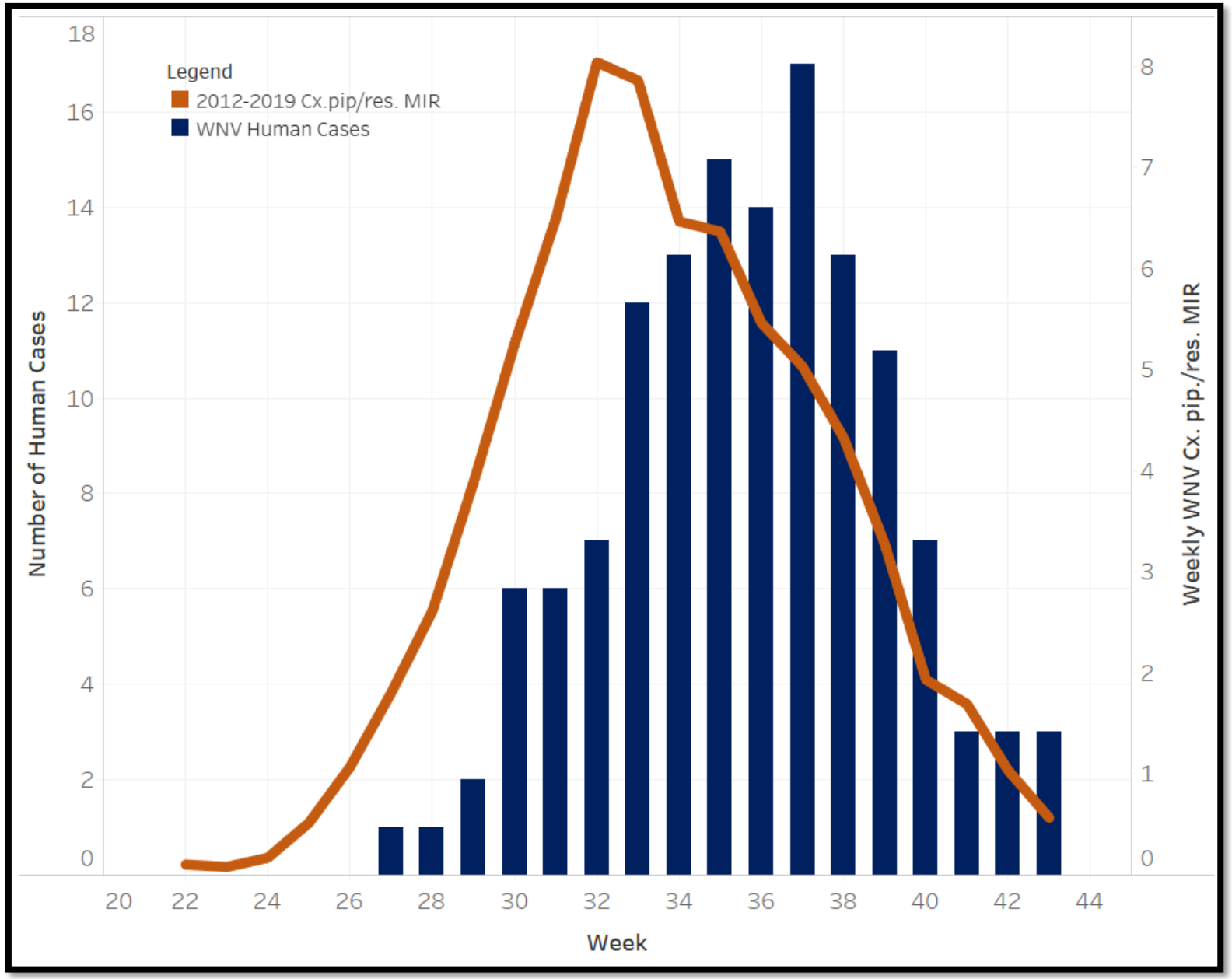
Minimum Infection Rate: ([number of positive pools / total specimens tested] x 1000), with the data representing a single species or species group collected over a time period and geographic area relevant to the goals of the surveillance program.- CDC

Weekly Cx. pip./res. MIR 2012-2019

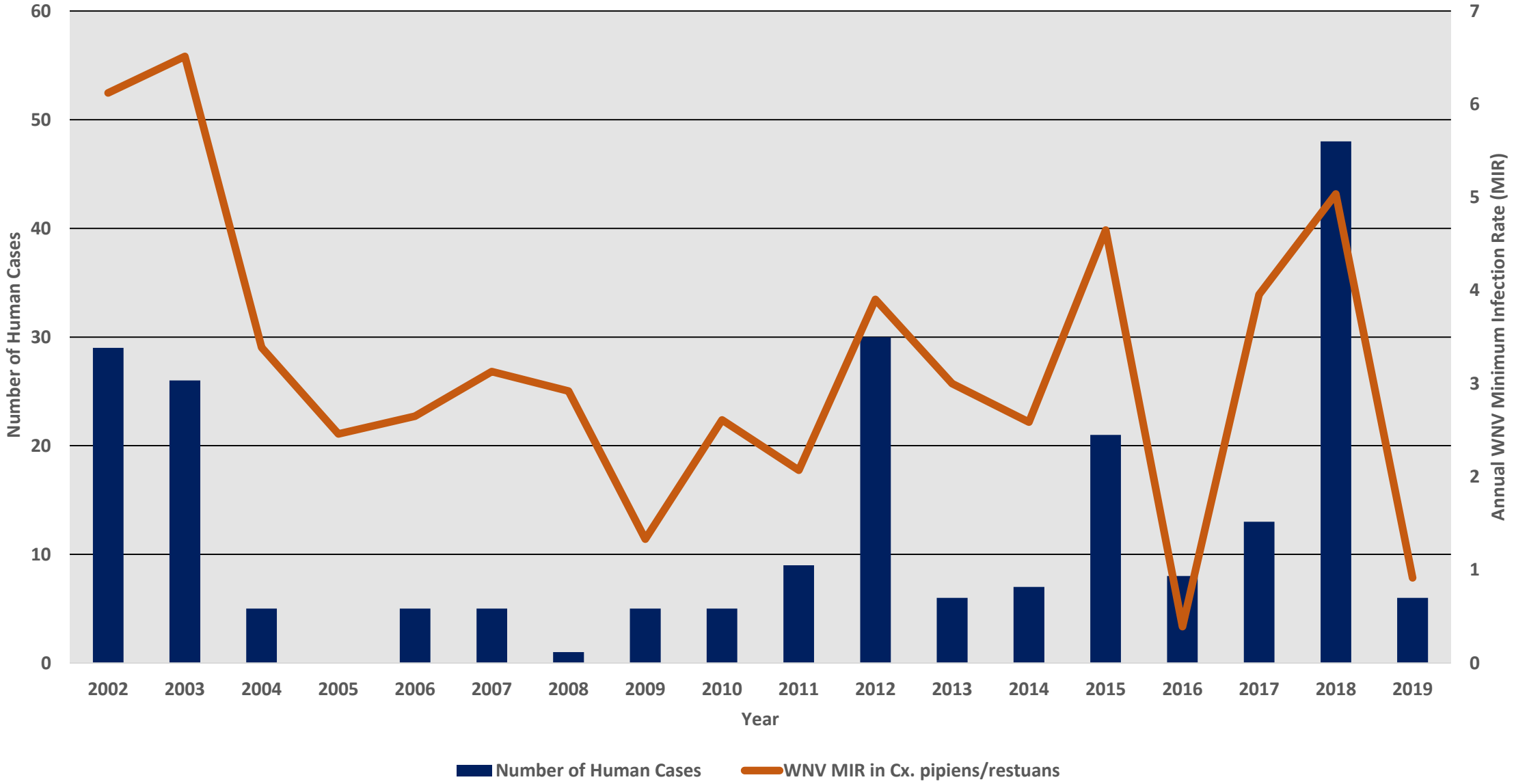


Year	Human Cases
2012	30
2013	6
2014	7
2015	21
2016	8
2017	13
2018	48
2019	6

Weekly Cx. pip./res. MIR 2012-2019

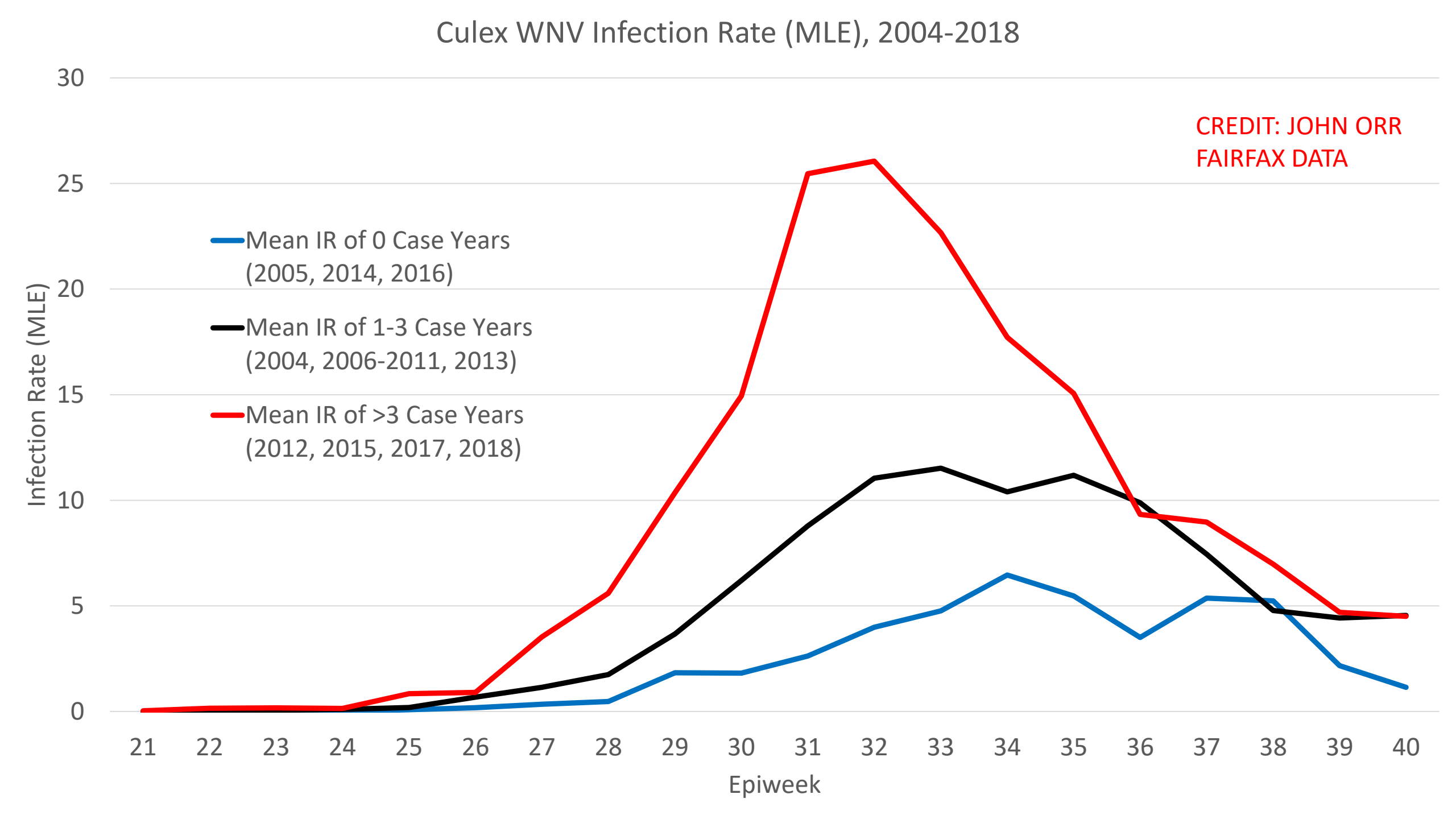


Influence of *Cx. pipiens/restuans* annual WNV minimum infection rate (MIR) on the count human WNV cases in VA.

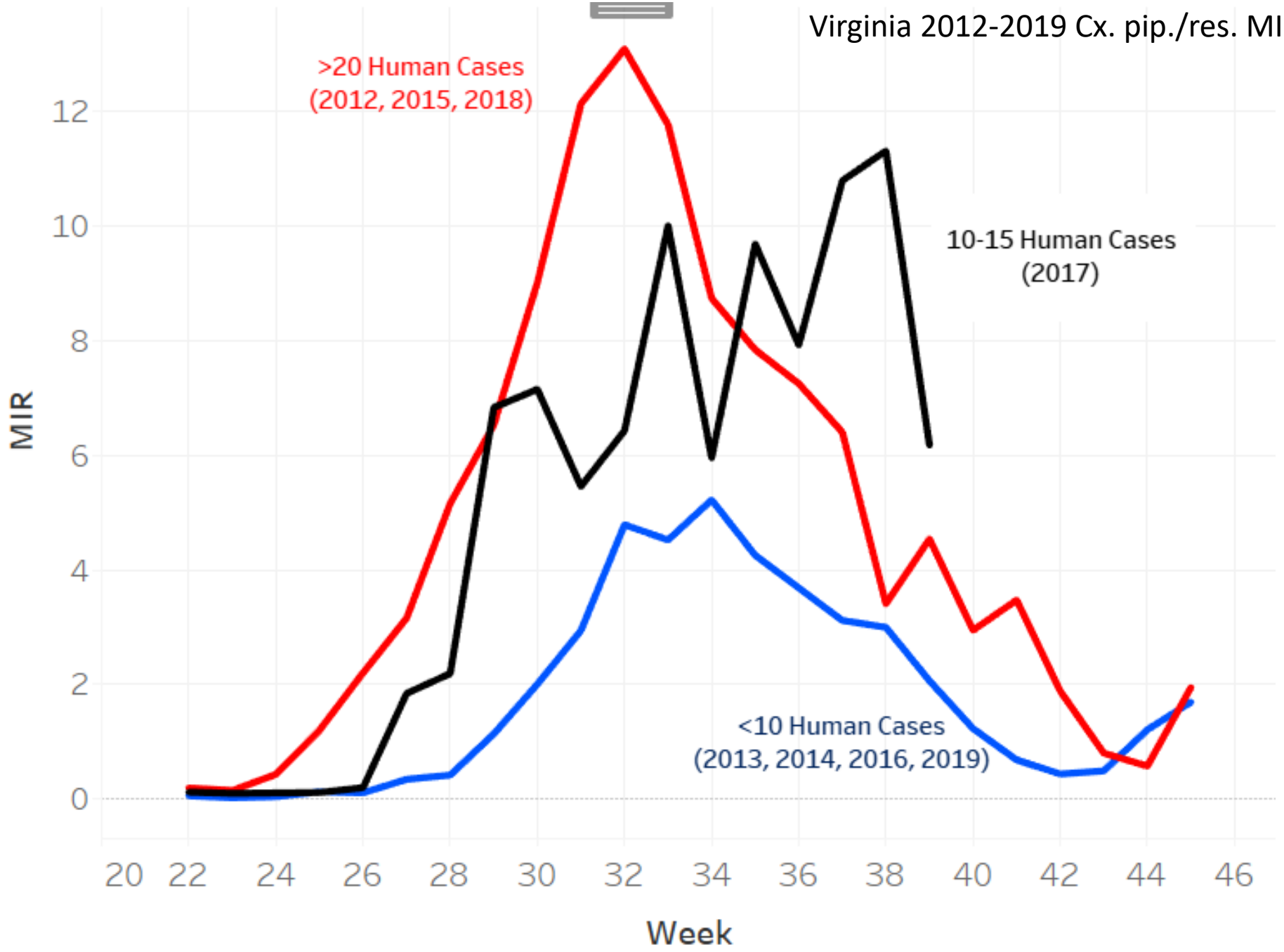


Linking Mosquito and Human WNV Data

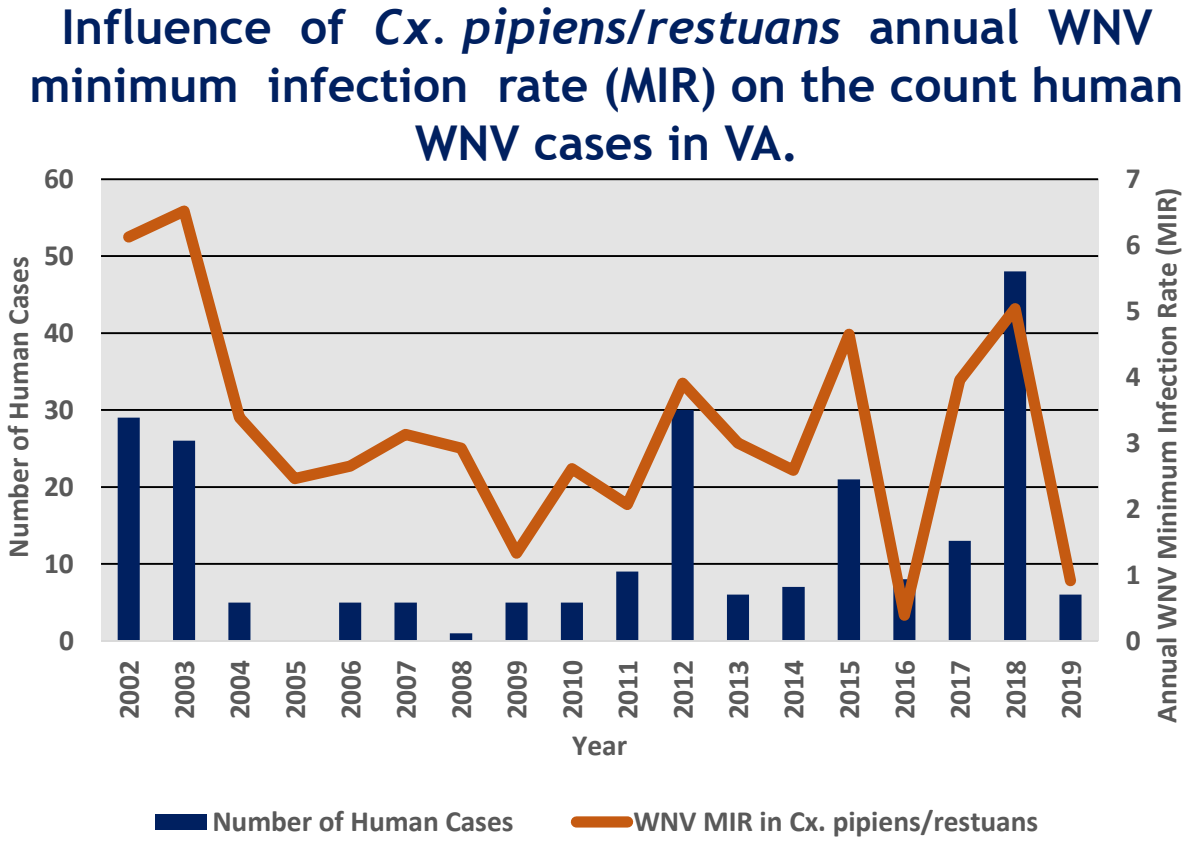
"Holy grail of WNV mosquito surveillance"~John Orr


Culex WNV Infection Rate (MLE), 2004-2018
CREDIT: JOHN ORR
FAIRFAX DATA
Mean IR of 0 Case Years
(2005, 2014, 2016)
Mean IR of 1-3 Case Years
(2004, 2006-2011, 2013)
Mean IR of >3 Case Years
(2012, 2015, 2017, 2018)
Infection Rate (MLE)
0
5
10
15
20
25
30
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
Epiweek

Virginia 2012-2019 Cx. pip./res. MIR



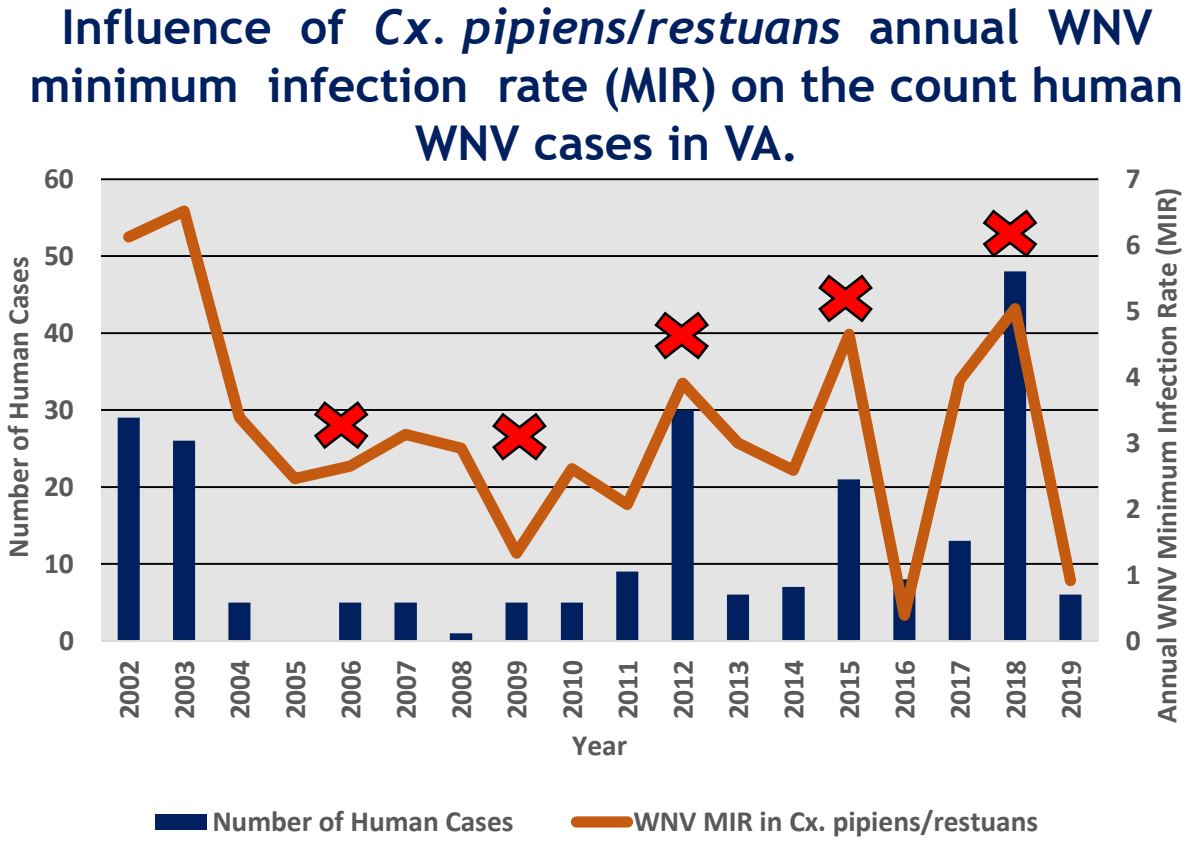
Birds?



https://www.allaboutbirds.org/guide/American_Robin/overview

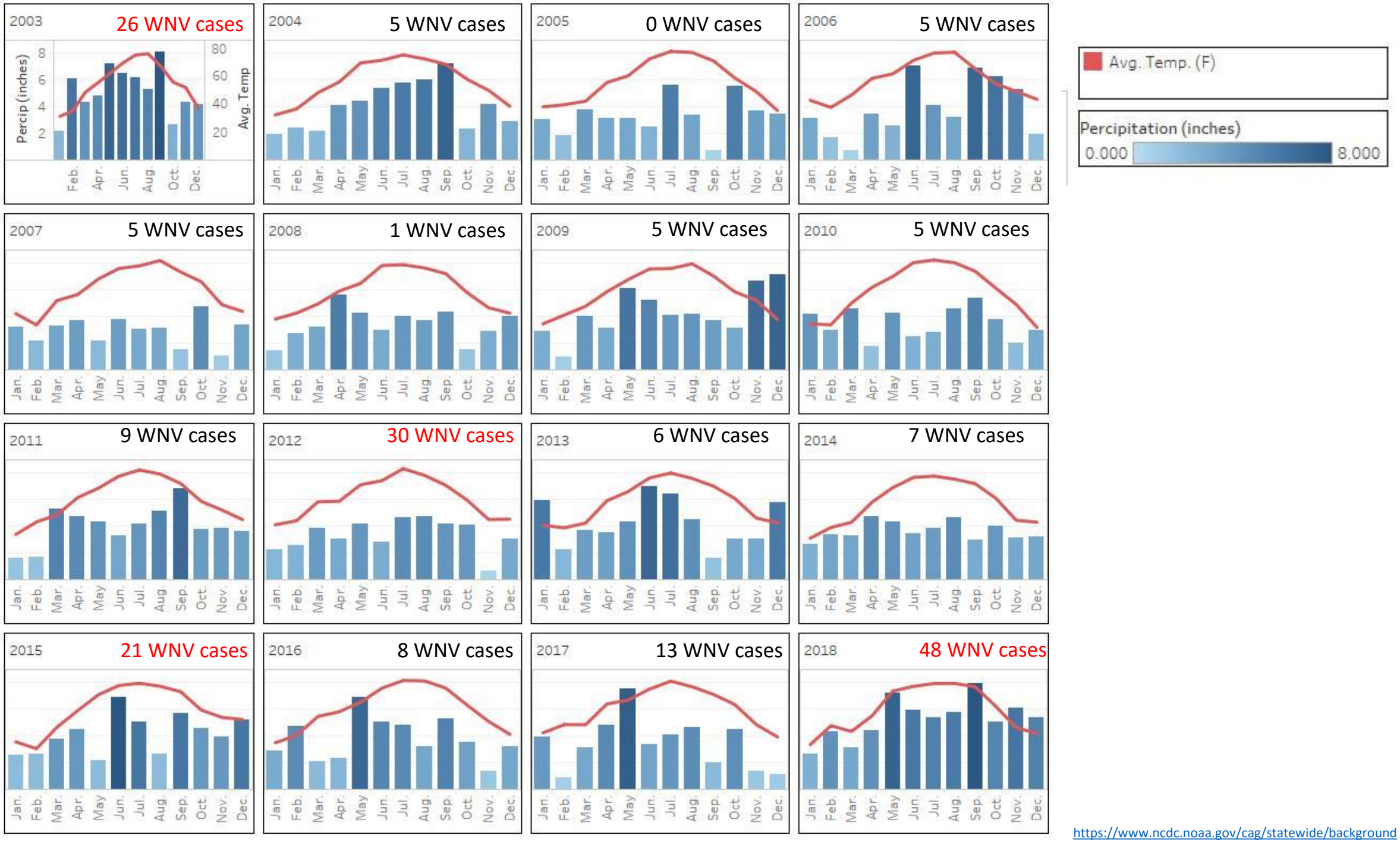
https://www.birdnote.org/show/how-long-does-robin-live

“An American Robin can produce three successful broods in one year. On average, though, only 40 percent of nests successfully produce young. Only 25 percent of those fledged young survive to November. From that point on, about half of the robins alive in any year will make it to the next. Despite the fact that a lucky robin can live to be 14 years old, the entire population turns over on average every six years.”



https://www.allaboutbirds.org/guide/American_Robin/overview

https://www.birdnote.org/show/how-long-does-robin-live



https://www.ncdc.noaa.gov/cag/statewide/background

Increased transmissibility of Emergent Genotypes of West Nile virus in New York State

Sean M. Bialosuknia[1], Alan P. Dupuis II[1], Yi Tan[2], Steven D. Zink[1], Cheri A. Koetzner[1], Joseph G. Maffei[1], Rebecca A. Halpin[3], Emmi Muller[3], Mark Novatny[3], Meghan Shilts[2, 3], Nadia B. Fedorova[3], Paolo Amedeo[3], Suman R. Das [2], Brett Pickett[3], Jennifer C. Owen[4], Hannah Landwerlen[4], Laura D. Kramer[1,5] and Alexander T. Ciota[1,5]

[1]The Arbovirus Laboratory, Wadsworth Center, New York State Department of Health, Slingerlands, NY, United States of America

[2] Department of Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, USA.

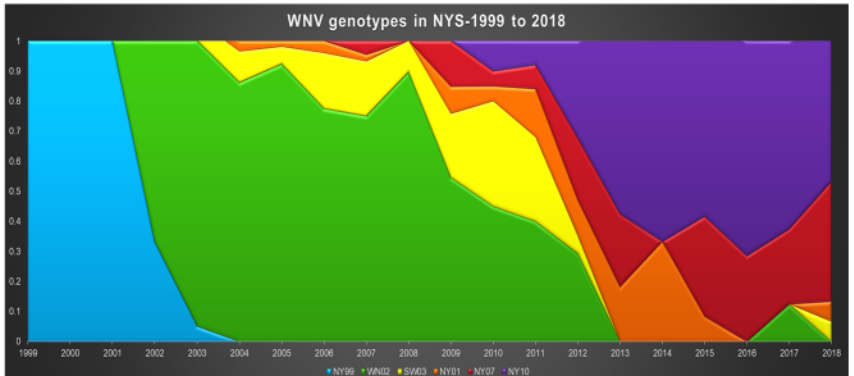
[3]J. Craig Venter Institute, Rockville, Maryland, USA.

[4] Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI USA.

[5]Department of Biomedical Sciences, State University of New York at Albany School of Public Health, Albany, NY, United States of America

HIGHLIGHTS

- **Phylogenetic and selection analyses of over 1200 full-genome WNV sequences, focusing on ~500 newly sequenced NYS WNV isolates from 1999-2018**
- **Identified 13 positions in the WNV genome under positive selection in the US, including 7 in NYS**
- **Novel genotypes with shared, positively selected sites have emerged in NYS over the last decade: NY07 and NY10**
- **Genotype displacement was concurrent with increased WNV activity from 2010-18**
- **NY10 strains are more infectious and transmissible by *Cx. pipiens* and American robins, supporting the hypothesis that adaptive evolution drove WNV displacement and contributed to increased WNV activity**

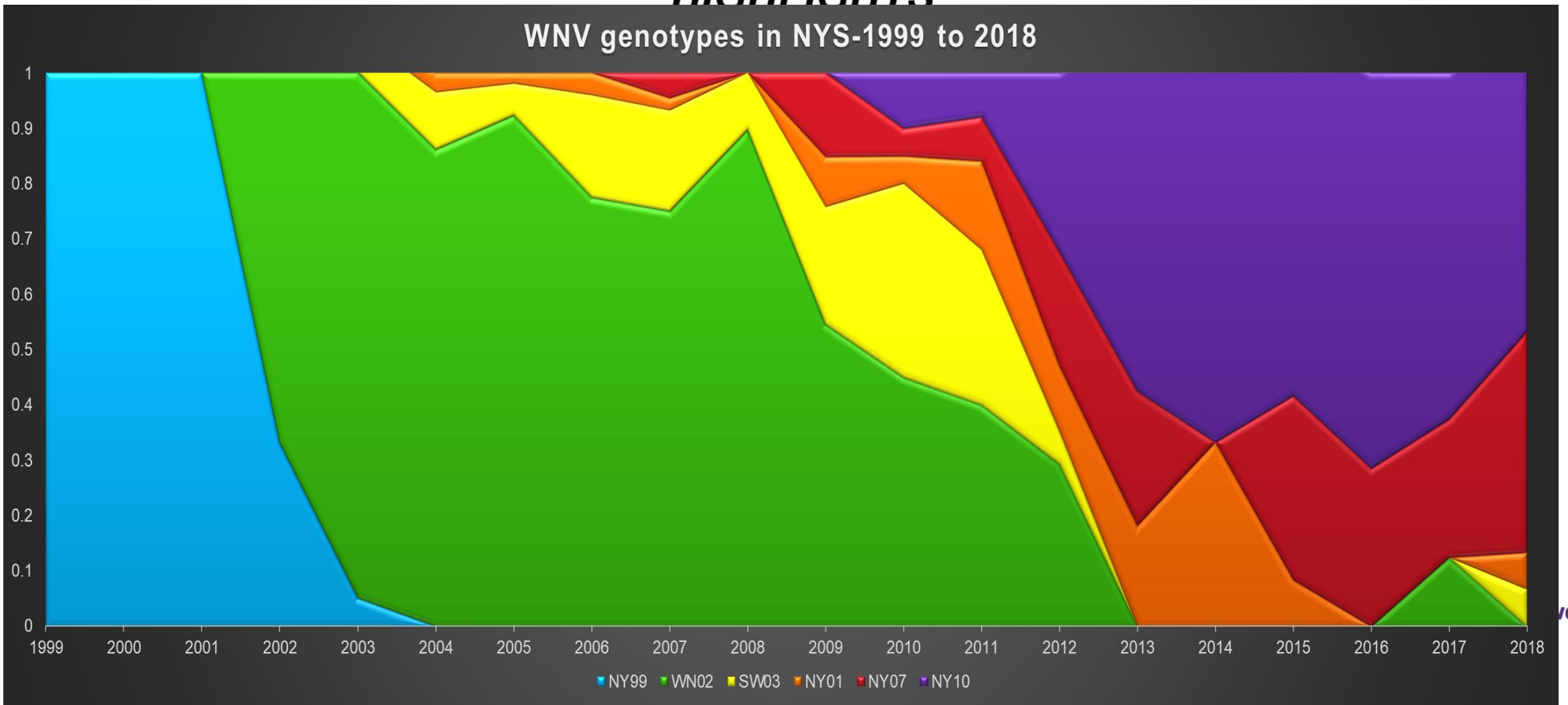


Increased transmissibility of Emergent Genotypes of West Nile virus in New York State

Sean M. Bialosuknia[1], Alan P. Dupuis II[1], Yi Tan[2], Steven D. Zink[1], Cheri A. Koetzner[1], Joseph G. Maffei[1], Rebecca A. Halpin[3], Emmi Muller[3], Mark Novatny[3], Meghan Shilts[2, 3], Nadia B. Fedorova[3], Paolo Amedeo[3], Suman R. Das [2], Brett Pickett[3], Jennifer C. Owen[4], Hannah Landwerlen[4], Laura D. Kramer[1,5] and Alexander T. Ciota[1,5]

NY99 WN02 SW03 NY01 NY07 NY10

HIGHLIGHTS



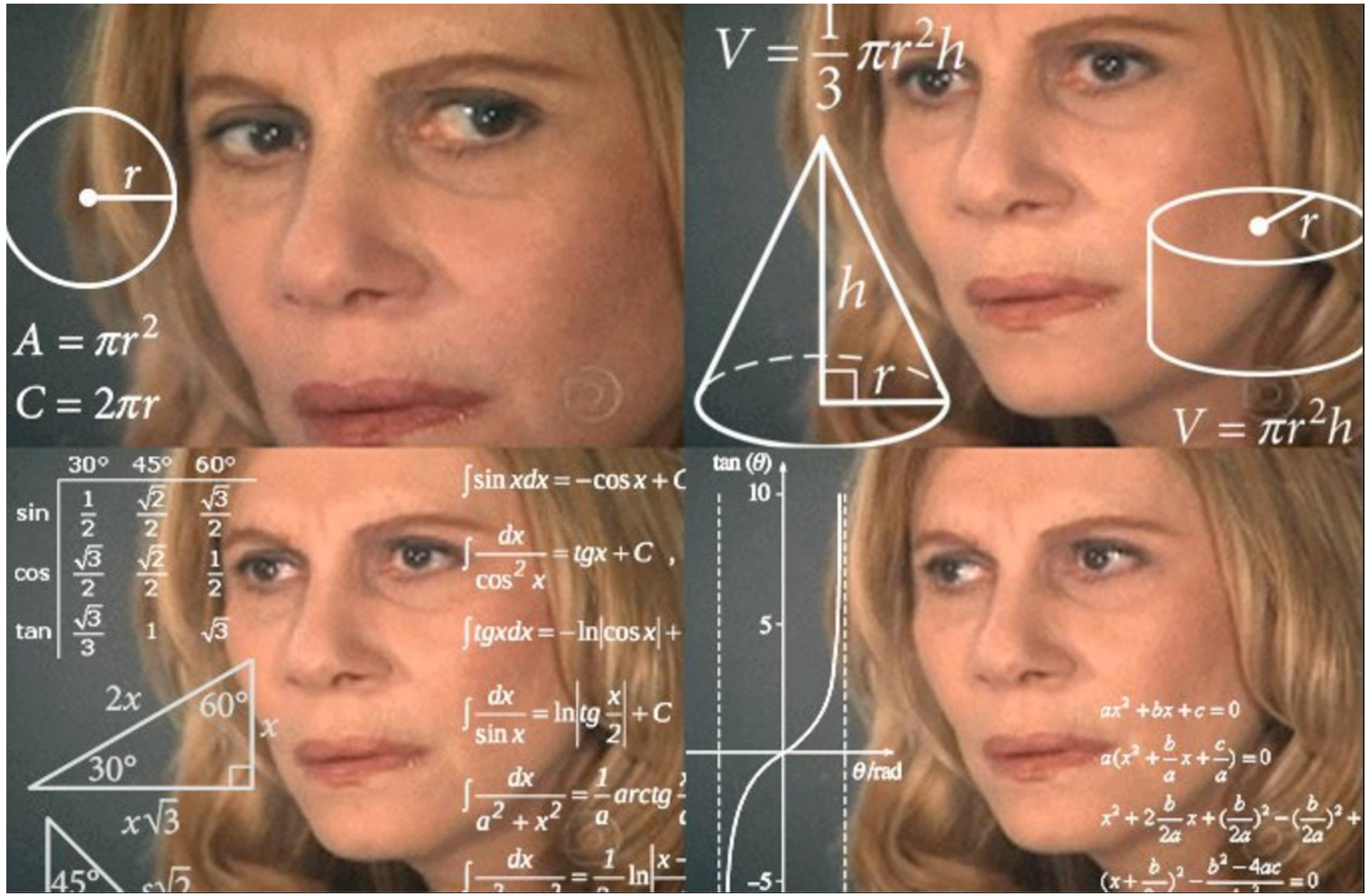
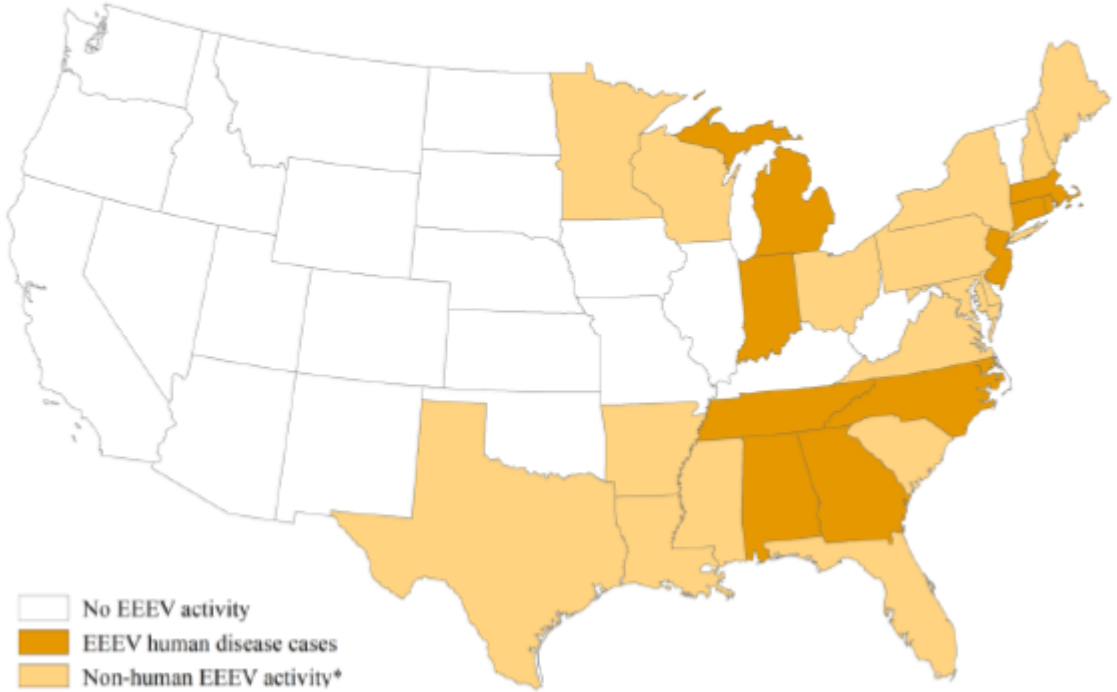

r
$A = \pi r^2$
$C = 2\pi r$
$V = \frac{1}{3}\pi r^2 h$
h
r
r
$V = \pi r^2 h$
30° 45° 60°
sin $\frac{1}{2}$ $\frac{\sqrt{2}}{2}$ $\frac{\sqrt{3}}{2}$
cos $\frac{\sqrt{3}}{2}$ $\frac{\sqrt{2}}{2}$ $\frac{1}{2}$
tan $\frac{\sqrt{3}}{3}$ 1 $\sqrt{3}$
2x
60°
x
30°
$x\sqrt{3}$
45°
$\int \sin x dx = -\cos x + C$
$\int \frac{dx}{\cos^2 x} = tgx + C$,
$\int tgx dx = -\ln|\cos x| +$
$\int \frac{dx}{\sin x} = \ln\left|tg\frac{x}{2}\right| + C$
$\int \frac{dx}{a^2 + x^2} = \frac{1}{a} arctg$
$\int \frac{dx}{} = \frac{1}{} \ln|x -$
tan (θ)
10
5
-5
θ/rad
$ax^2 + bx + c = 0$
$a(x^2 + \frac{b}{a}x + \frac{c}{a}) = 0$
$x^2 + 2\frac{b}{2a}x + (\frac{b}{2a})^2 - (\frac{b}{2a})^2 +$
$(x + \frac{b}{}) - \frac{b^2 - 4ac}{} = 0$

Figure 4. Eastern equine encephalitis virus (EEEV) activity reported to ArboNET, by state — United States, 2019 (as of January 7, 2020)



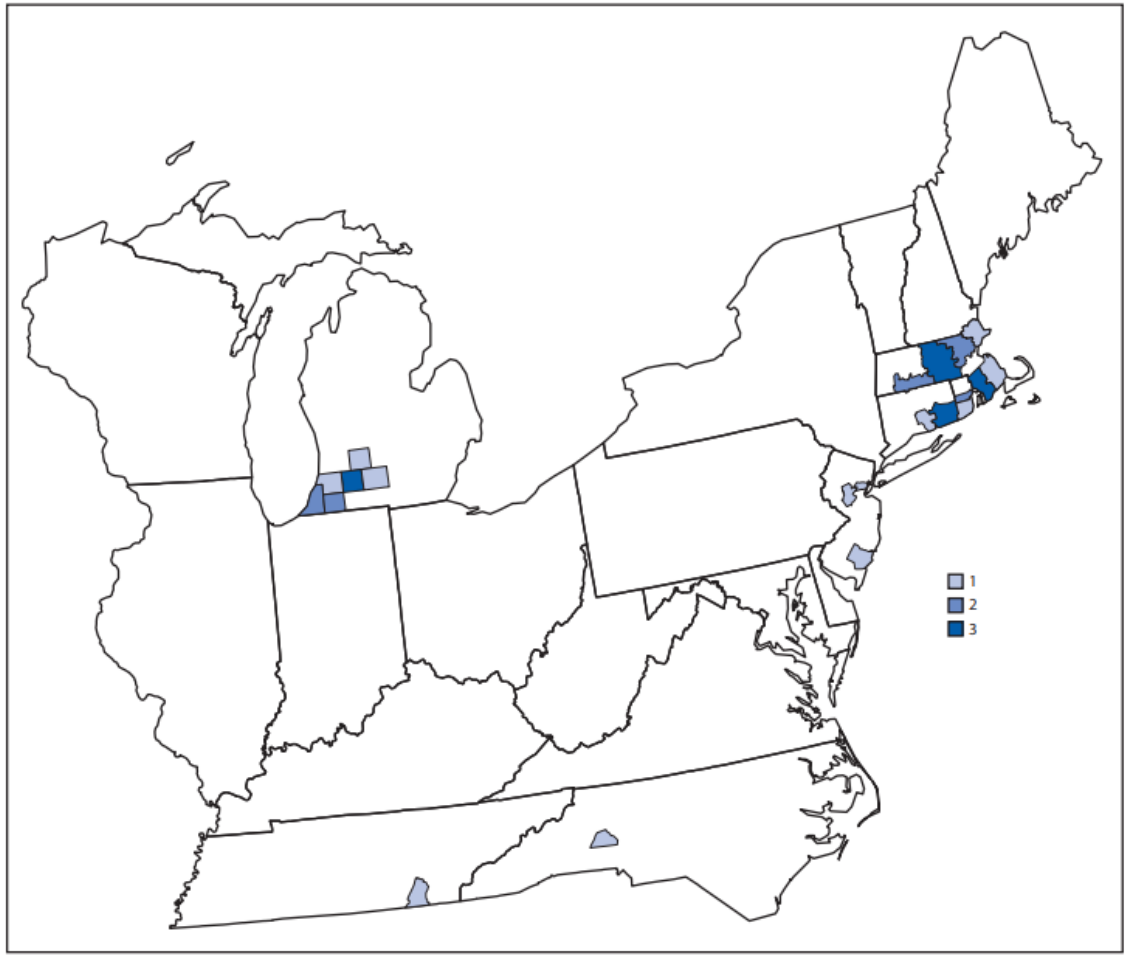
*EEEV veterinary disease cases, or infections in mosquitoes, birds, or sentinel animals

Table 2. Eastern equine encephalitis virus human disease cases reported to ArboNET, United States, 2019

State	Neuroinvasive disease cases	Non-neuroinvasive disease cases	Total cases*	Deaths
Alabama	1	0	1	1
Connecticut	4	0	4	3
Georgia	1	0	1	0
Indiana	1	0	1	1
Massachusetts	12	0	12	3
Michigan	10	0	10	6
New Jersey	4	0	4	0
North Carolina	1	0	1	0
Rhode Island	3	0	3	1
Tennessee	1	0	1	0
Totals	**38**	**0**	**38**	**15**

*Includes confirmed and probable cases.

FIGURE. Number of reported cases of Eastern equine encephalitis virus disease (N = 34), by county of residence — United States, 2019*

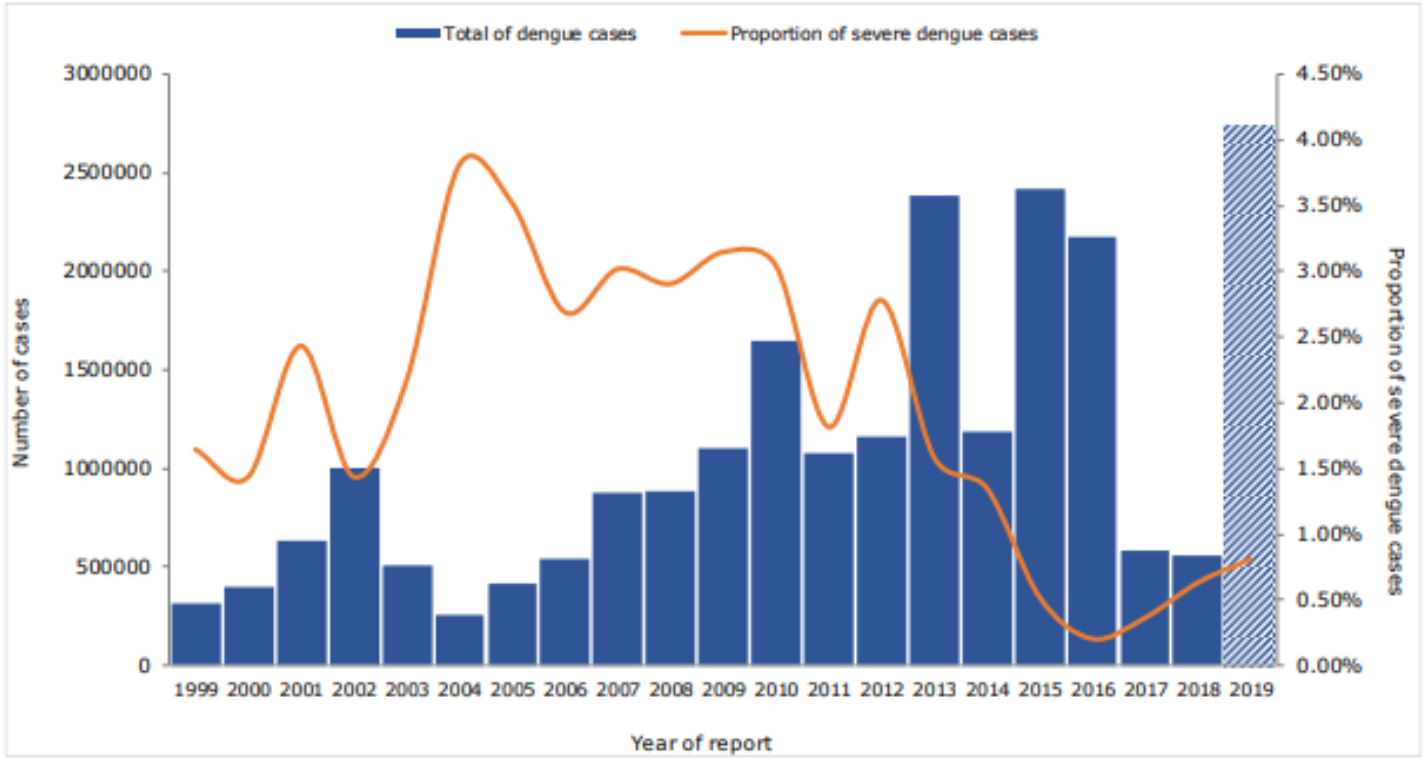


Lindsey N. et al. Multistate Outbreak of Eastern Equine Encephalitis Virus-United States, 2019 (2020) MMWR

Dengue

"Rapid unplanned urbanization, changing land use patterns and increased international travel and trade have brought people into more frequent contact with vectors; climate and other environmental changes have added to their spread."- PAHO

Figure 1. Distribution of reported dengue cases and proportion of severe dengue cases, by year of report. Region of the Americas, 1999-2019 (up to EW 42 of 2019).



Source: Data entered into the Health Information Platform for the Americas (PLISA, PAHO / WHO) by the Ministries and Institutes of Health of the countries and territories of the Region.

PAHO Epidemiological Update 11/11/2019

Accomplishments/Reminders

- Mosquito Monthly Report (http://www.vdh.virginia.gov/environmental-epidemiology/bugs-human-health-statistics/)
- Mosquito data is available on ArboNET for current year
- Attending TRAST, NMMM
- No mosquito testing at DCLS for 2020
- Enter IR data to MosquitoNET PLZ
- NEVBD CoE Newsletter interest

Questions?

MANY THANKS TO:

- West Nile Virus Northern VA Managers Meeting
- TRAST
- VMCA
- Chesapeake Mosquito Control
- Fairfax County Dept. of Health- Vector Borne Diseases Program
- Hampton Mosquito Control
- Henrico County Mosquito Control
- Norfolk Dept. of Health Vector Control
- Suffolk Mosquito Control
- Virginia Beach Mosquito Control
- Portsmouth Mosquito Control
- York County Mosquito Control
- Prince William County Vector Control
- The Virginia Division of Consolidated Laboratory Services (DCLS)
- Fairfax County Dept. of Health Laboratory
- The Virginia Dept. of Agriculture and Consumer Services (VDACS) Veterinary Laboratories
- Alex Ciota & New York Health Dept. Wadsworth Lab
- VDH- Vector-borne Team
- VDH- Regional and District Epidemiology Staff

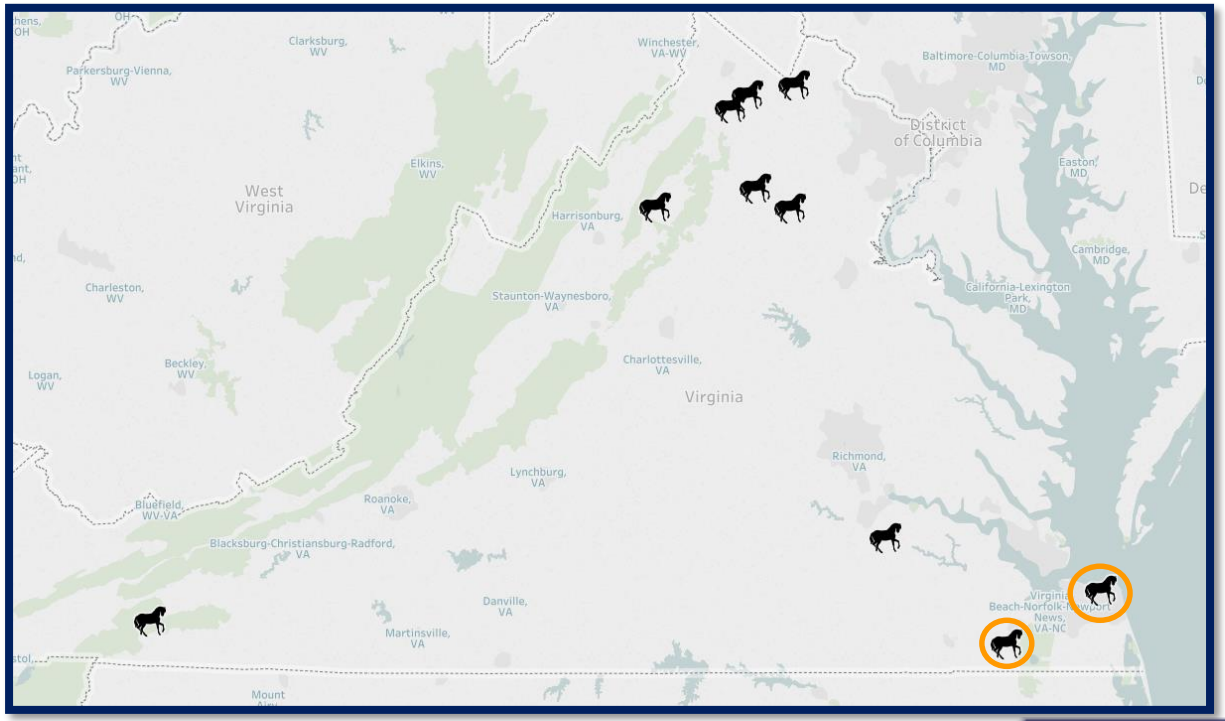
Veterinary Arboviral in VA in 2018

8 reported WNV equine cases

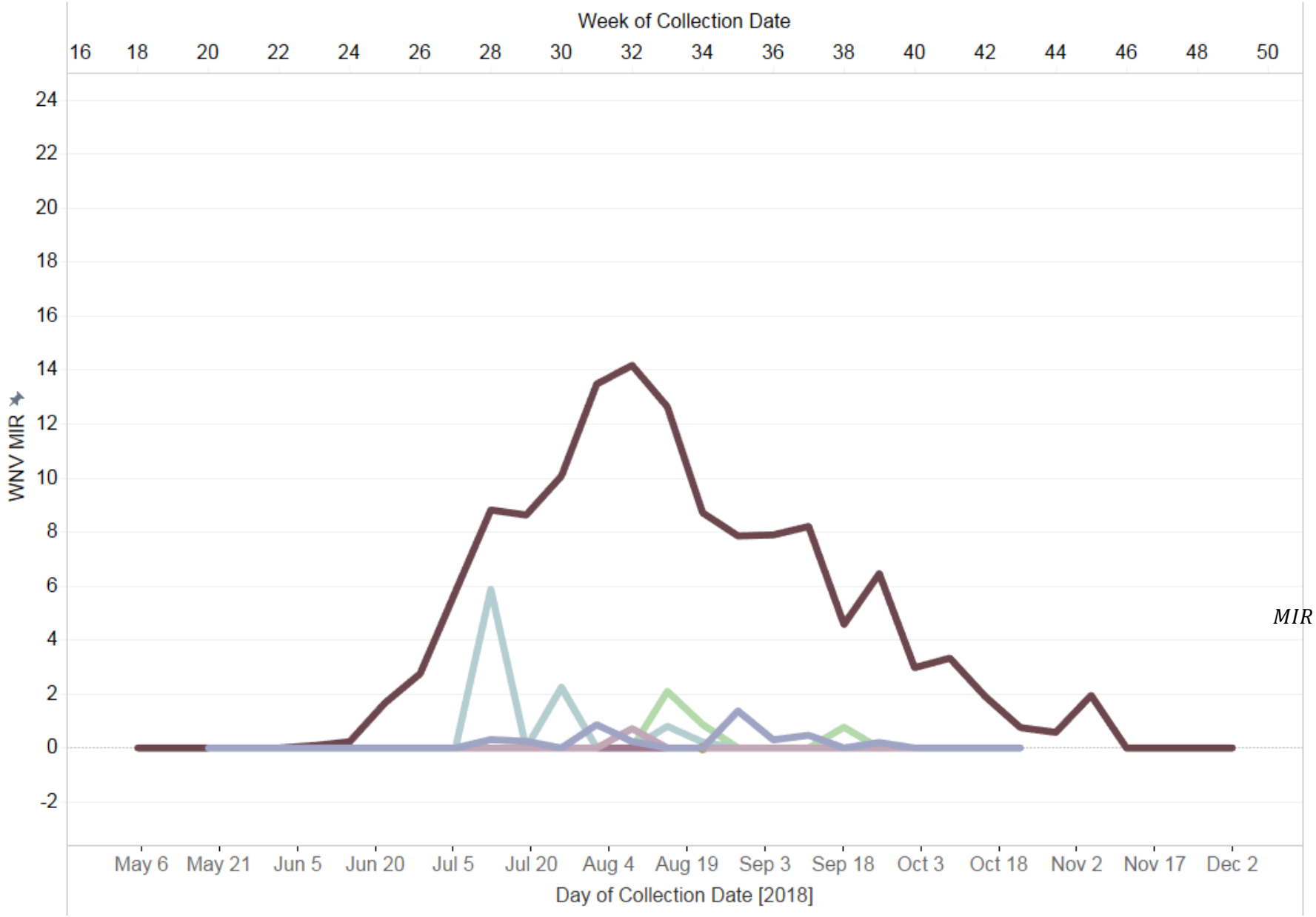
- Fauquier, Warren, Prince George, Page, Loudoun, Rappahannock, Smyth, Clarke

2 reported EEE equine cases

- Suffolk, Virginia Beach



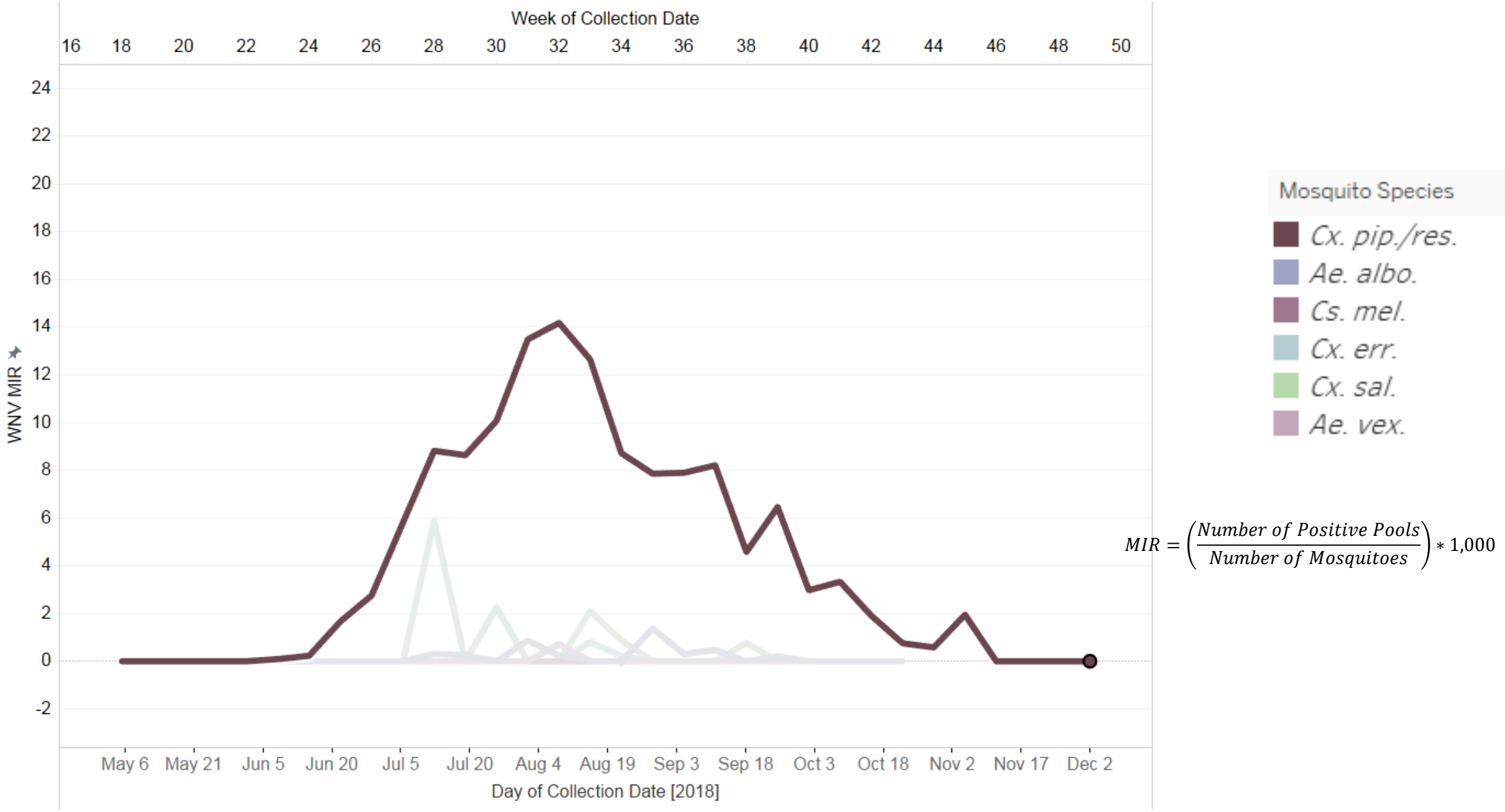
Time series species-specific WNV MIR from May 1-Dec 4.



$$MIR = \left(\frac{Number\ of\ Positive\ Pools}{Number\ of\ Mosquitoes}\right) * 1{,}000$$

*Only includes fully identified mosquito species with ≥1,000 mosquitoes trapped/tested (excludes Ae. tris., Ae. jap., Ae. atl., Cq. per., Cx. spp.)

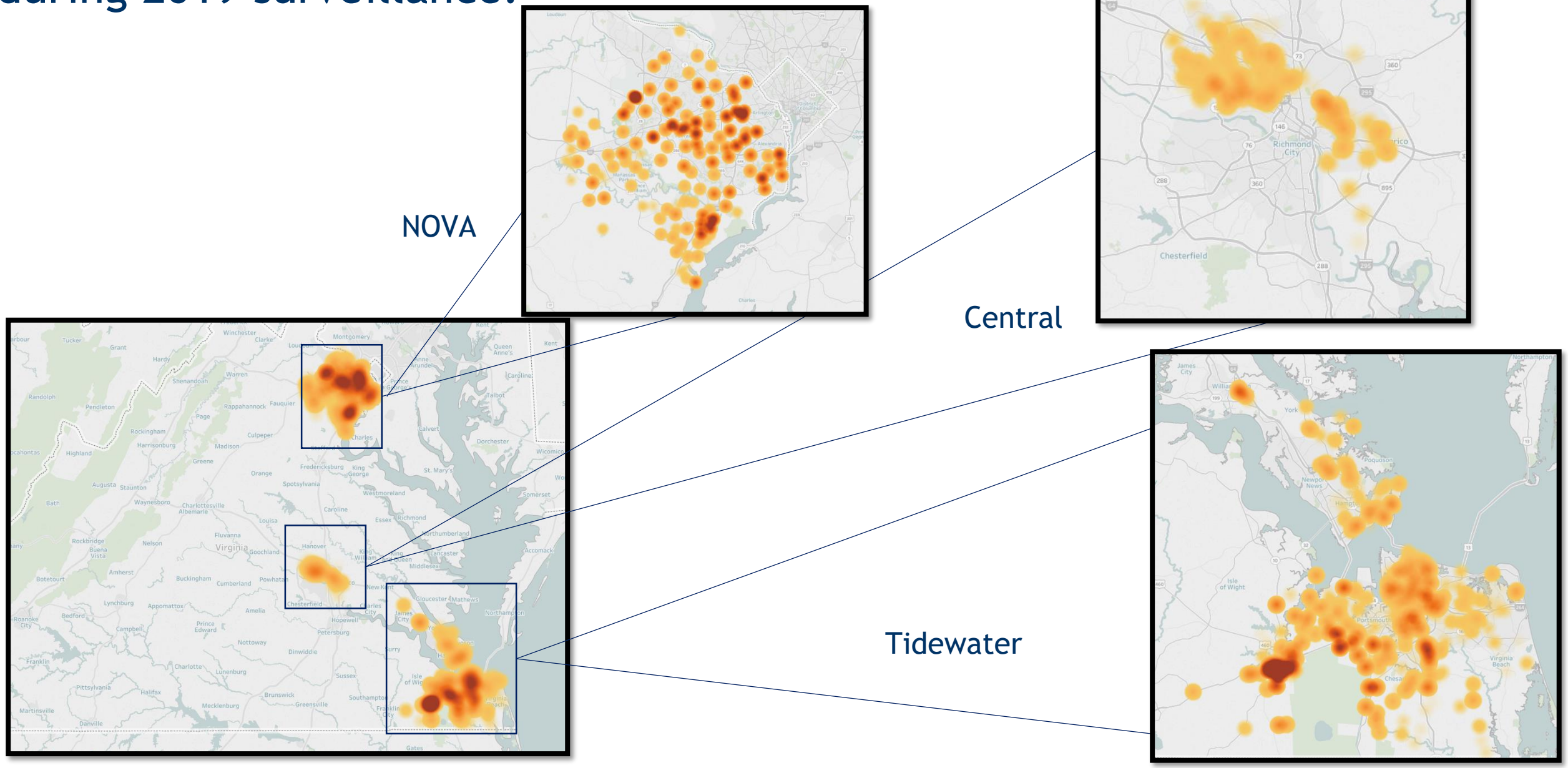
Cx. pip./res. WNV MIR peaked at 14.18 MIR during week 32 (Aug 5th-12th).



$$MIR = \left(\frac{Number\ of\ Positive\ Pools}{Number\ of\ Mosquitoes}\right) * 1{,}000$$

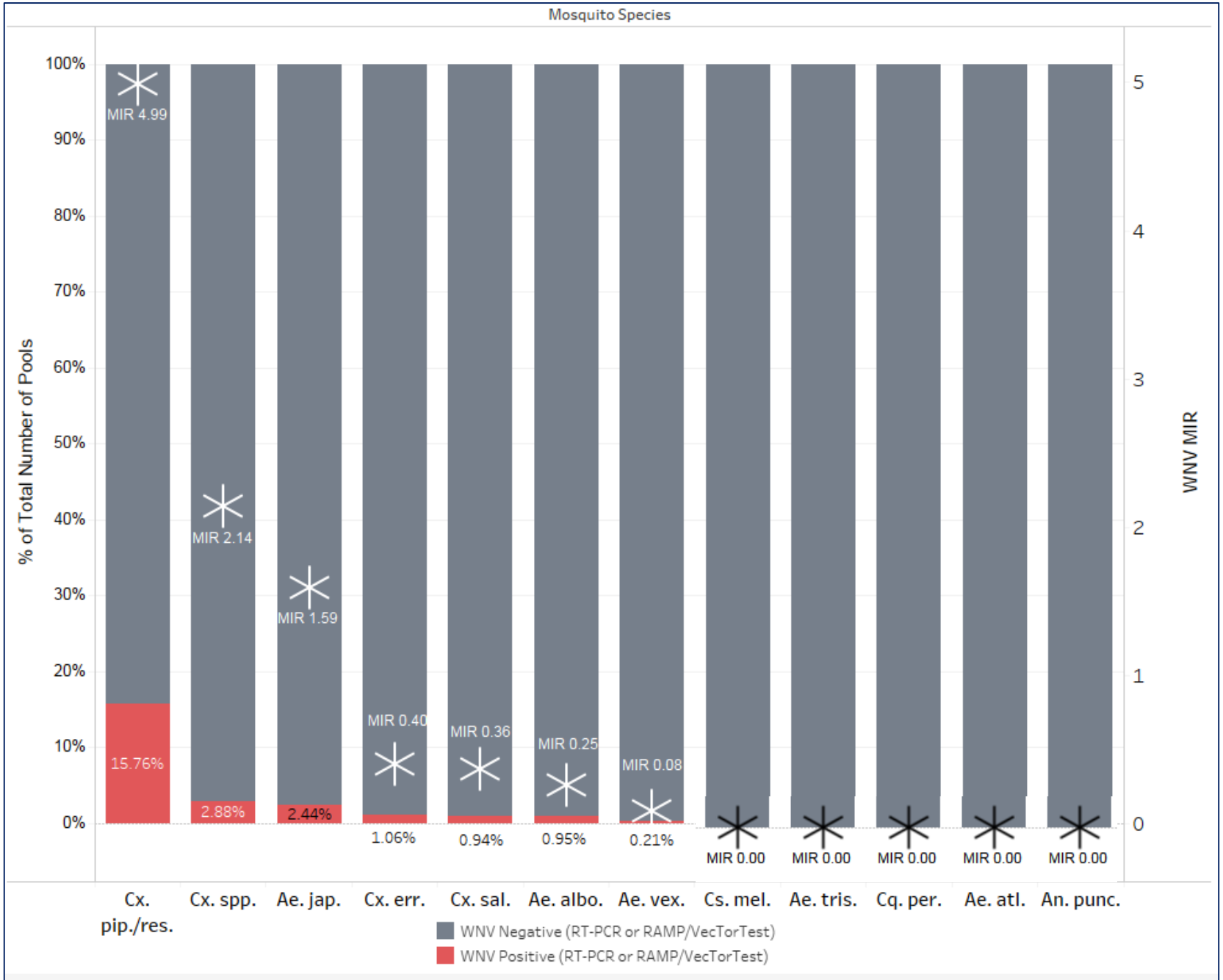
*Only includes fully identified mosquito species with ≥1,000 mosquitoes trapped/tested (excludes Ae. tris., Ae. jap., Ae. atl., Cq. per., Cx. spp.)

There were **316,021** mosquitoes trapped and tested in **9,166** pools during 2019 surveillance.



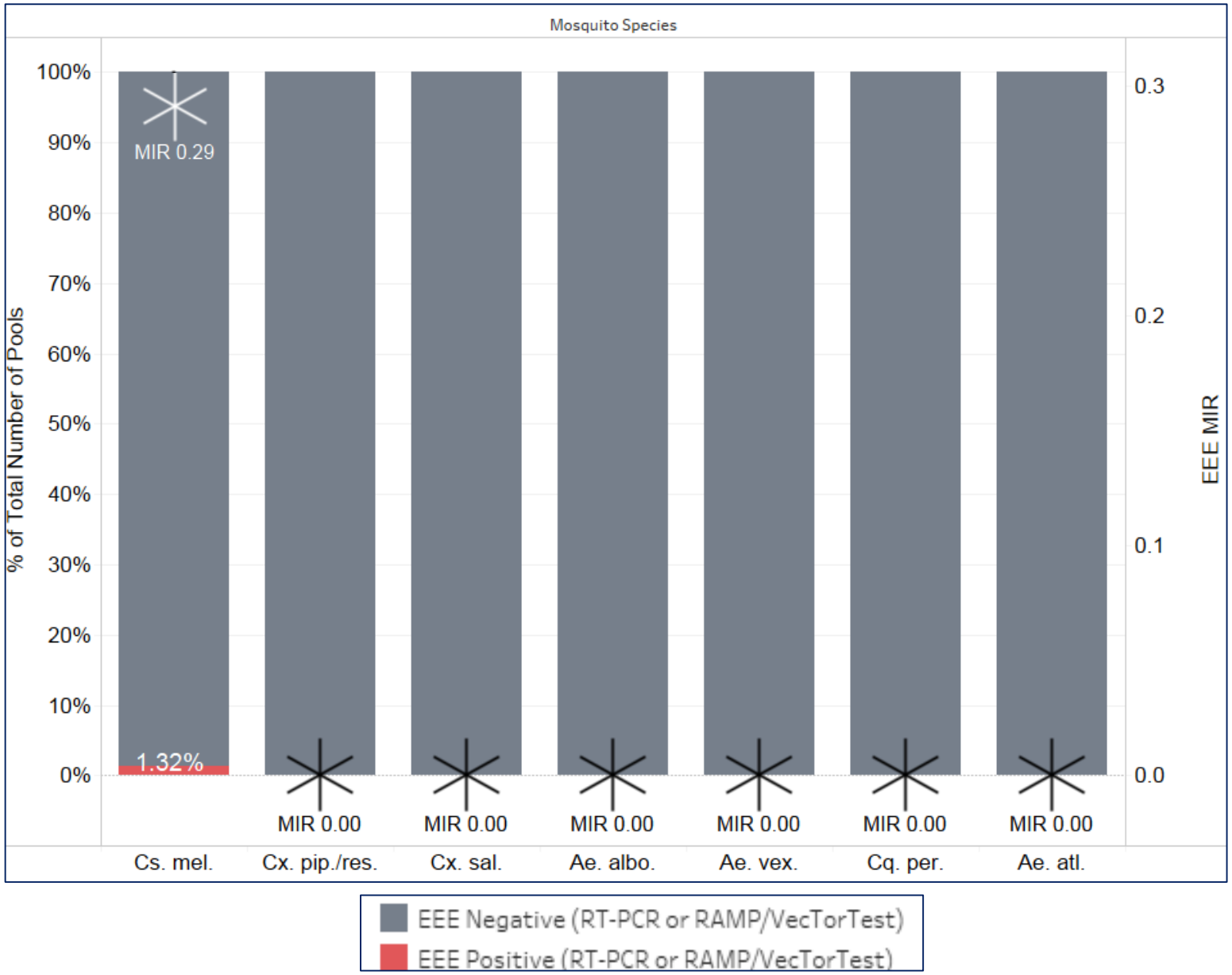
16% of *Cx. pip./res.* pools were WNV positive for a species-specific 4.99 WNV MIR.

Mosquito Species	Number of Mosquitoes Tested	Number of Pools Tested	WNV Positive Pools
Cx. pip./res.	191,173	6,047	953
Ae. albo.	83,372	2,210	21
Cx. spp.	8,892	659	19
Cx. err.	20,051	754	8
Cx. sal.	16,620	641	6
Ae. jap.	628	41	1
Ae. vex.	12,231	484	1
Ae. atl.	97	2	0
Ae. tris.	666	44	0
An. punc.	39	1	0
Cq. per.	378	9	0
Cs. mel.	59,179	1,316	0
Grand Total	393,326	12,208	1,009



1% of *Cs. mel.* pools were EEE positive for a species-specific 0.29 EEE MIR.

Mosquito Species	Number of Mosquitoes Tested	Number of Pools Tested	EEE Binary
Cs. mel.	96,252	2,125	28
Cx. pip./res.	8,517	371	0
Cx. sal.	2,022	46	0
Ae. albo.	989	24	0
Cq. per.	378	9	0
Ae. atl.	97	2	0
Ae. vex.	52	1	0
Grand Total	108,307	2,578	28



Ongoing Projects at VDH

✓ Complete
• In progress
‼ Goal

New Arboviral page in statewide disease surveillance system

- Better data collection

Arboviral Investigation Guidelines- Mosquito Control Communication Toolkit

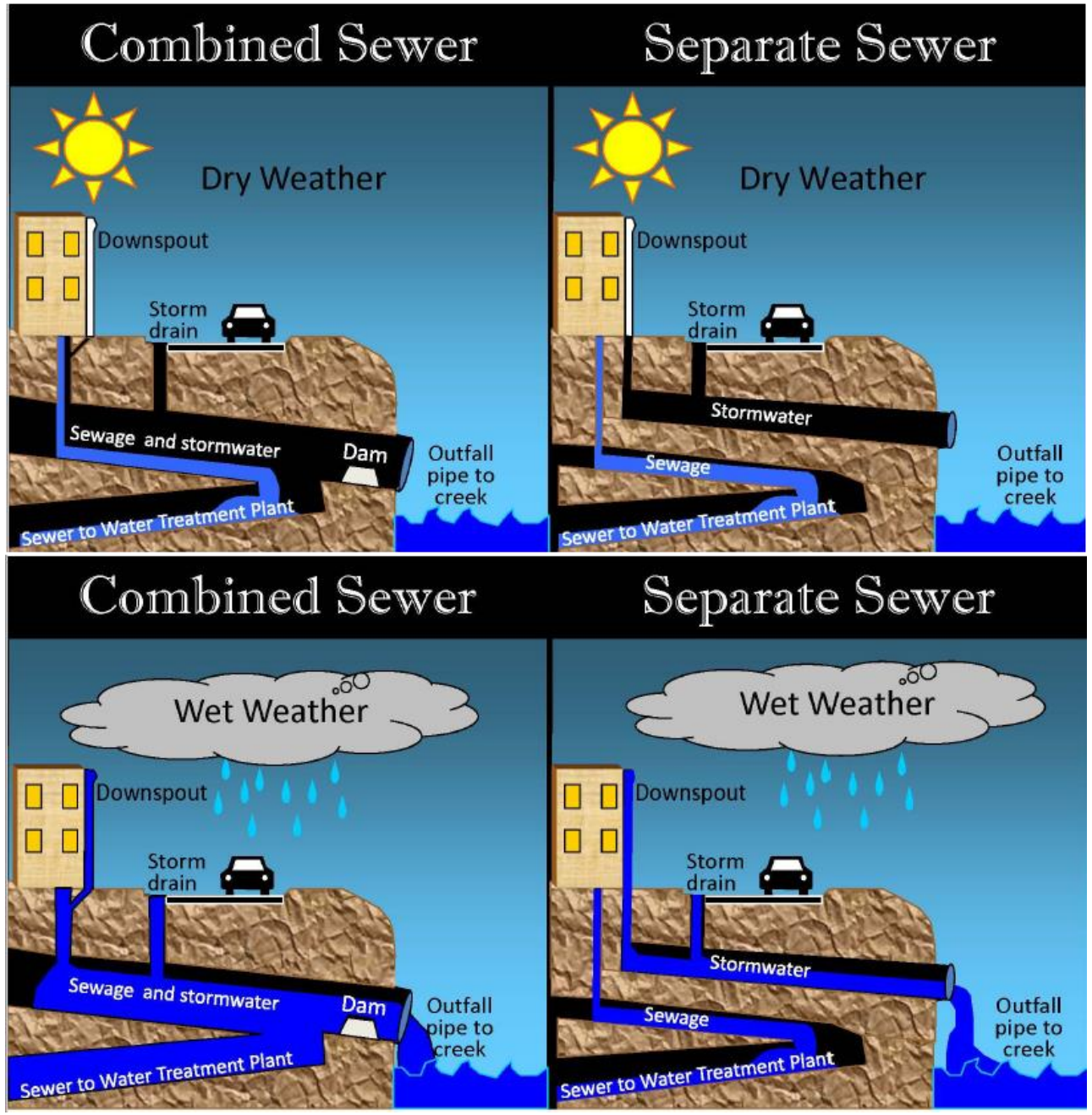
- Provide contact list and protocol for those in jurisdictions with MC
- LHD should notify MCD on positive WNV IgM

New mosquito surveillance data collection system

- Dropbox sheets

Monthly mosquito surveillance and arboviral disease report on VDH website

- Build public facing interactive and PDF report


Combined Sewer
Separate Sewer
Dry Weather
Downspout
Storm drain
Sewage and stormwater
Dam
Outfall pipe to creek
Sewer to Water Treatment Plant
Dry Weather
Downspout
Storm drain
Stormwater
Sewage
Outfall pipe to creek
Sewer to Water Treatment Plant
Combined Sewer
Separate Sewer
Wet Weather
Downspout
Storm drain
Sewage and stormwater
Dam
Outfall pipe to creek
Sewer to Water Treatment Plant
Wet Weather
Downspout
Storm drain
Stormwater
Sewage
Outfall pipe to creek
Sewer to Water Treatment Plant

NEVBD Pesticide Resistance Monitoring Program

- The Northeast Regional Center for Excellence in Vector Borne Diseases (NEVBD) is initiating a pesticide resistance monitoring program for the 2019 field season
  - *A specimen submission system will be available, whereby live mosquitoes can be sent directly to Cornell University for resistance testing*
  - *Kits for mosquito collection and pesticide resistance testing will be available*
  - *We will provide education for conducting pesticide resistance testing*

- If you are interesting in participating in our program please visit the NEVBD website: neregionalvectorcenter.com/resistance
  - *The site is still under development, but please include your contact information and we will notify you of program developments*

If you have questions about the program please contact James Burtis
jb766@cornell.edu

Cornell CALS
College of Agriculture and Life Sciences

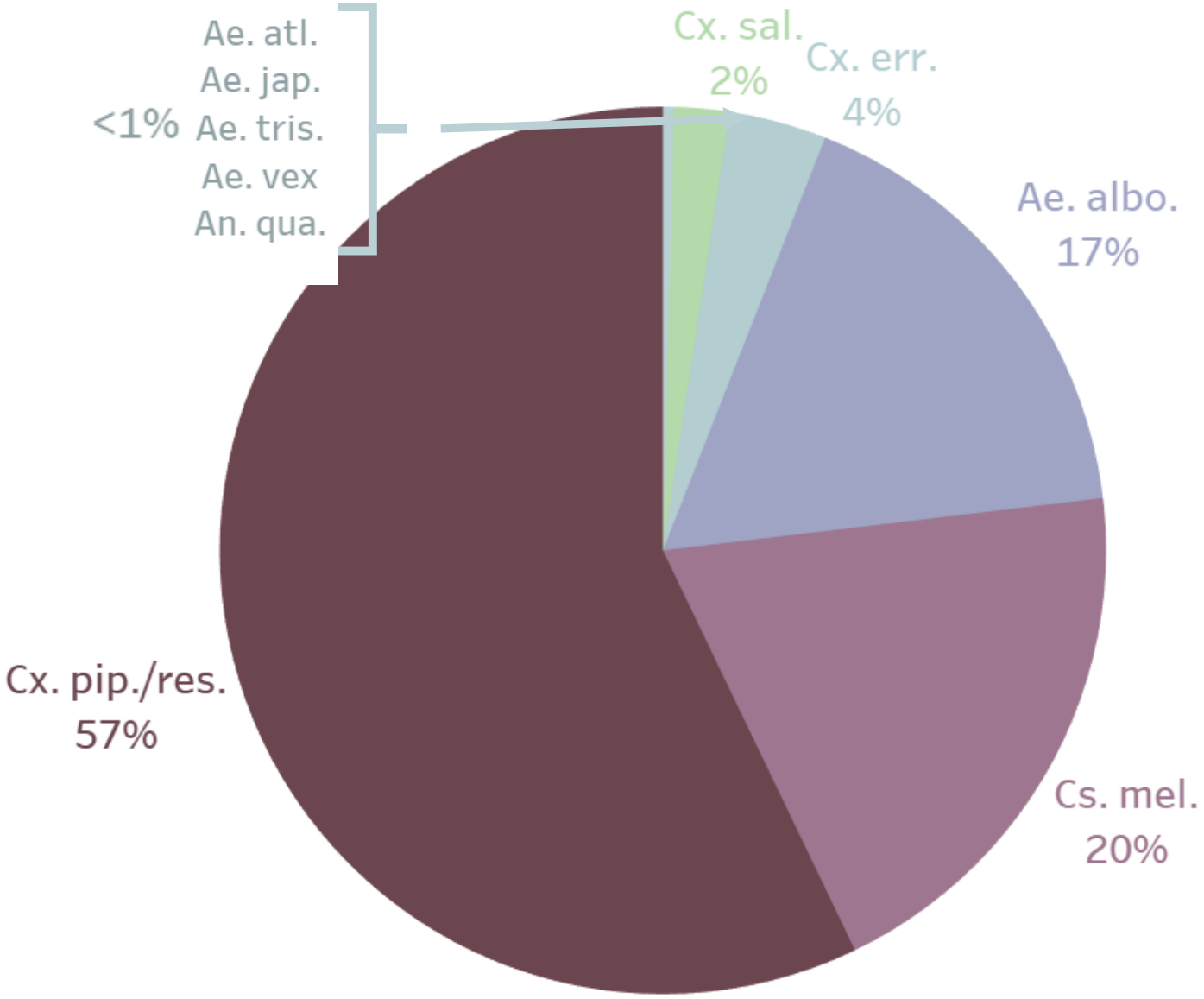
2017

Mosquito Species Tested for WNV	Number of Mosqitoes Tested	Number of Pools Tested	WNV Positive Pools	WNV MIR
Cx. pipiens/restuans	**201,641**	**5,810**	**744**	**3.690**
Cs. melanura	**141,913**	**2,005**	**5**	**0.035**
Ae. albopictus	**67,905**	**1,814**	**8**	**0.118**
Cx. erraticus	**21,459**	**674**	**3**	**0.140**
Cx. salinarius	**13,103**	**429**	**8**	**0.611**
Ae. vexans	**8,976**	**323**	**3**	**0.334**
Cx. spp.	**5,477**	**413**	**17**	**3.104**
Ae. japonicus	432	29		
Ae. triseriatus	346	25		
An. quadrimaculatus	319	9		
Cq. perturbans	79	2		
An. crucians	41	1		
An. punctipennis	28	1		
Grand Total	**461,719**	**11,535**	**788**	

2018

Mosquito Species	*Number of Mosquitoes Tested*	*Number of Pools Tested*	*WNV Positive Pools*
Cx. pip./res.	*191,173*	*6,047*	*953*
Ae. albo.	*83,372*	*2,210*	*21*
Cs. mel.	*59,179*	*1,316*	*0*
Cx. err.	*20,051*	*754*	*8*
Cx. sal.	*16,620*	*641*	*6*
Ae. vex.	*12,231*	*484*	*1*
Cx. spp.	*8,892*	*659*	*19*
Ae. tris.	*666*	*44*	*0*
Ae. jap.	*628*	*41*	*1*
Cq. per.	*378*	*9*	*0*
Ae. atl.	*97*	*2*	*0*
An. punc.	*39*	*1*	*0*
Grand Total	*393,326*	*12,208*	*1,009*

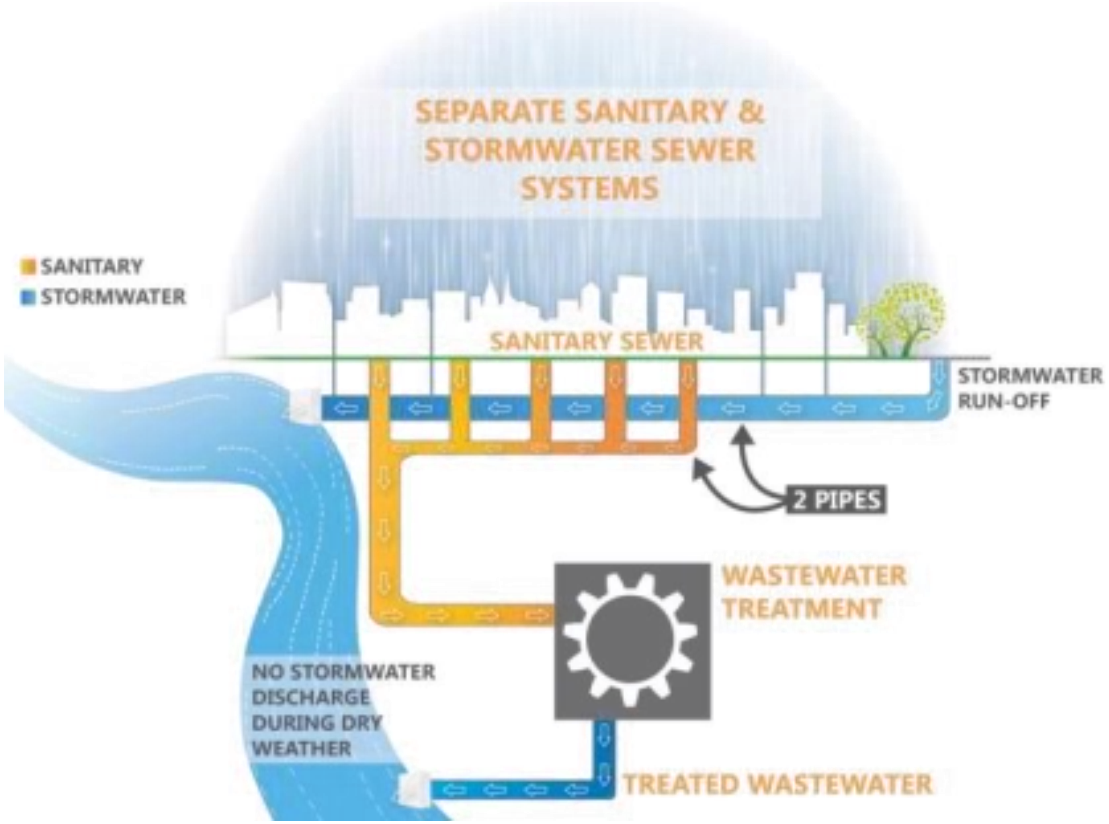
Culex pipiens/restuans, *Aedes albopictus*, & *Culiseta melanura* accounted for 94% of all tested mosquitoes.

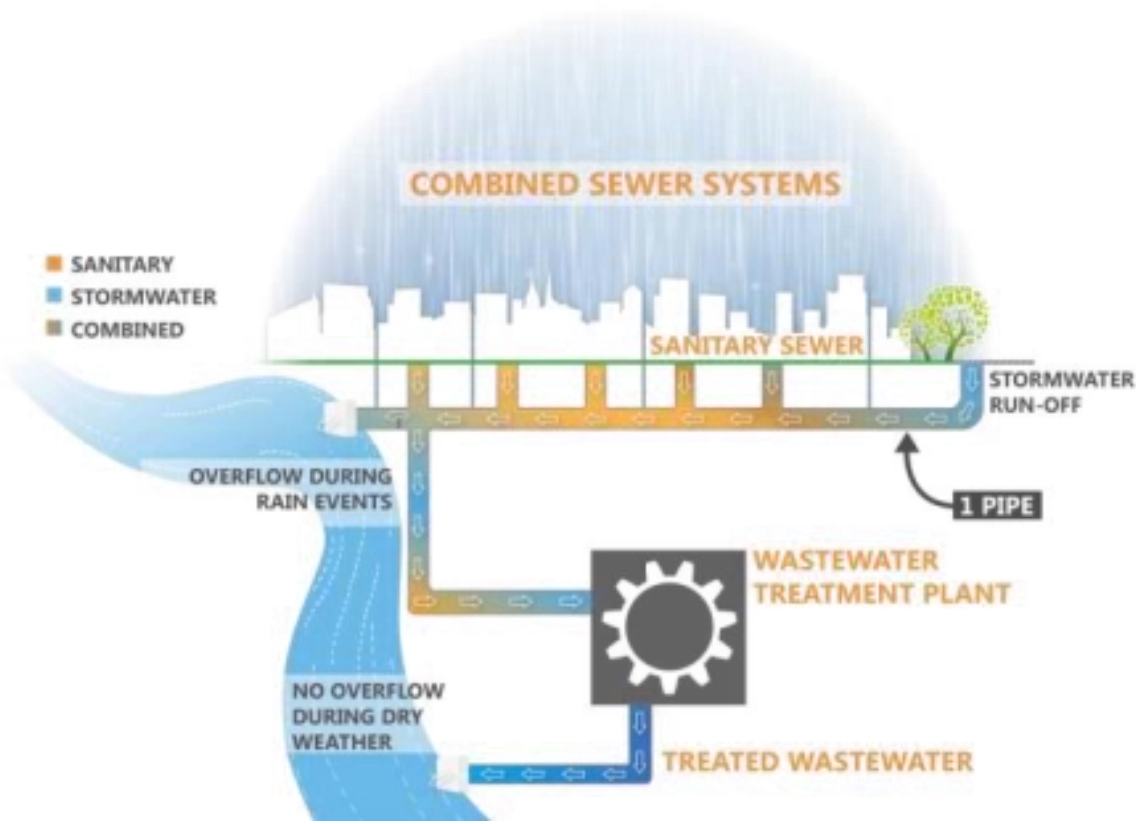


WNV+ Pools
-165 *Cx. pip./res.*
-4 *Cs. mel.*

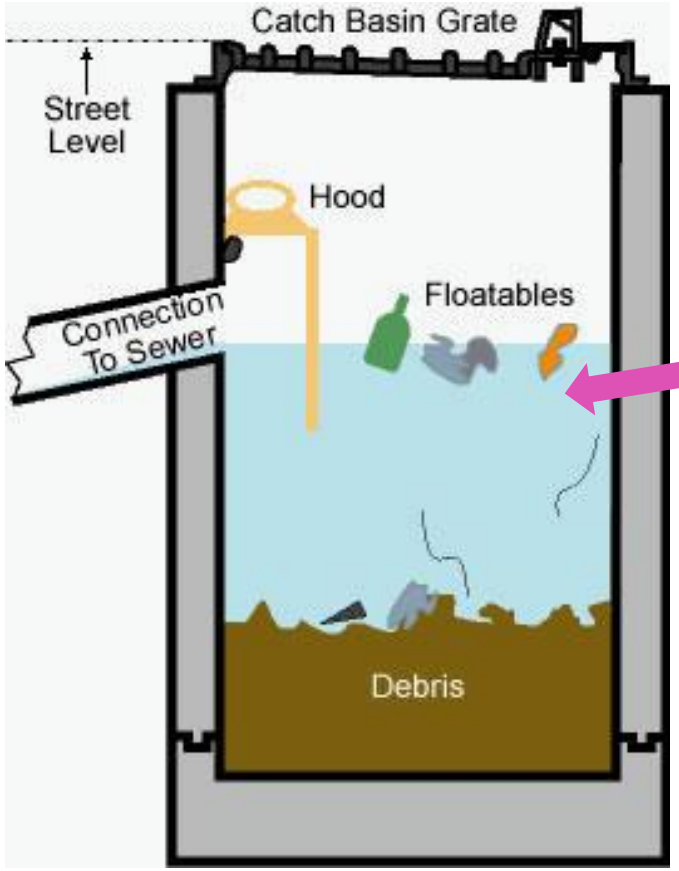
EEE+ Pools
-8 Cs. Mel.

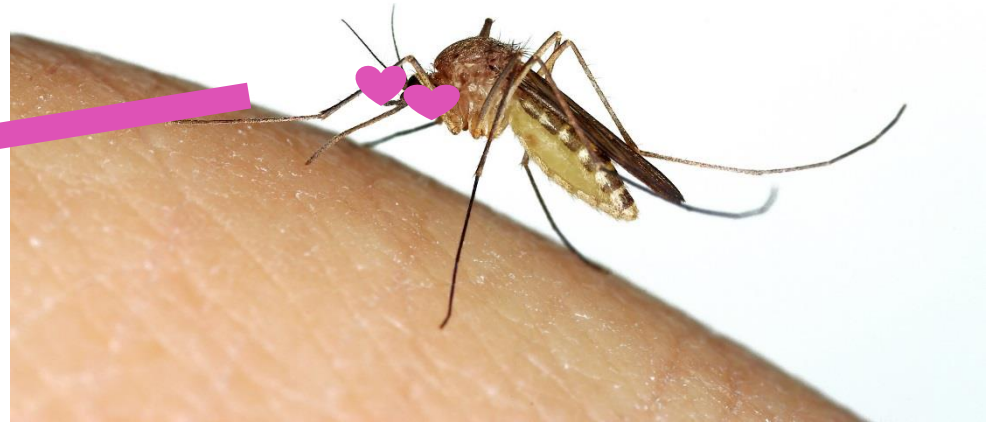
Combined Sewage Systems?

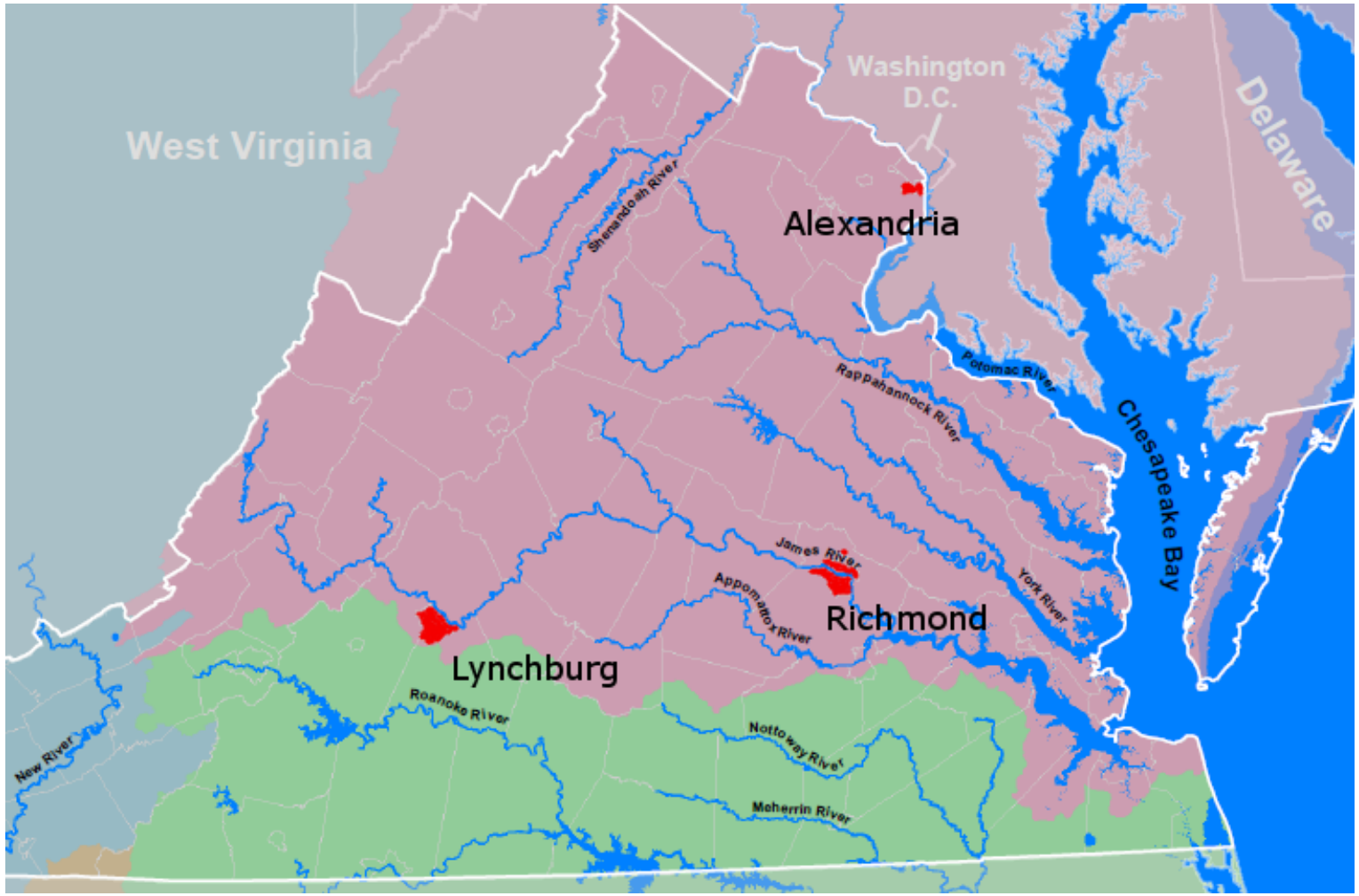




http://www.virginiaplaces.org/waste/cso.html


Catch Basin Grate
Street Level
Hood
Floatables
Connection To Sewer
Debris





http://www.virginiaplaces.org/waste/cso.html