# Mosquitoborne Viruses in New England: What’s Happening?

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**Massachusetts Department of Public Health**

# Mosquitoborne Arbovirus Diseases Indigenous to the United States (New England)

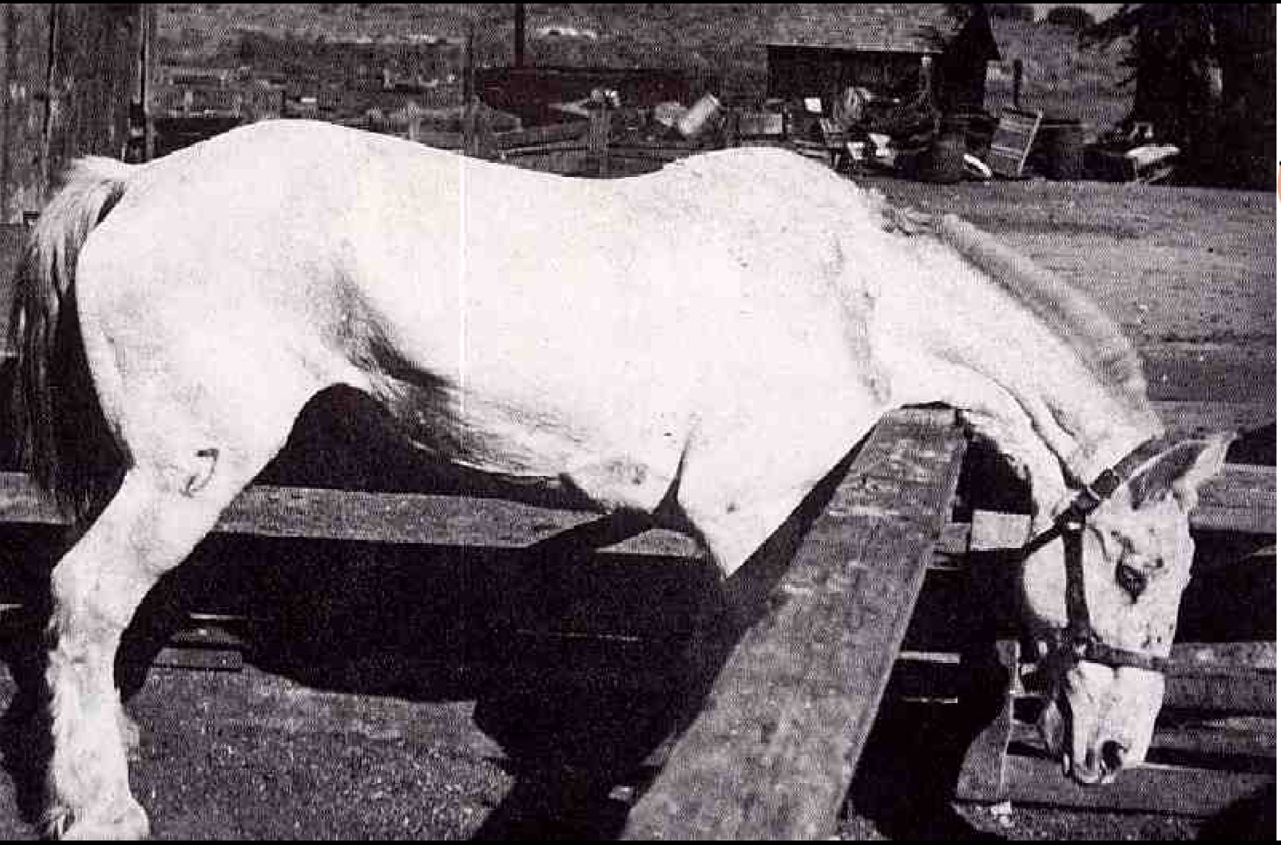
| | Family, Genus | Distribution |
|---|---|---|
| Eastern equine (EEE) | *Togaviridae, Alphavirus* | Eastern U.S. |
| Western equine (WEE) | *Togaviridae, Alphavirus* | Western U.S. |
| St. Louis (SLE) | *Flaviviridae, Flavivirus* | United States |
| La Crosse (LAC) | *Bunyaviridae, Bunyavirus* | Midwest, Eastern, Southern U.S. |
| Venezuelan (VEE) | *Togaviridae, Alphavirus* | United States (rare) |
| West Nile (WNV) | *Flaviviridae, Flavivirus* | United States (since 1999) |
| Jamestown canyon | *Bunyaviridae, Bunyavirus* | United States |

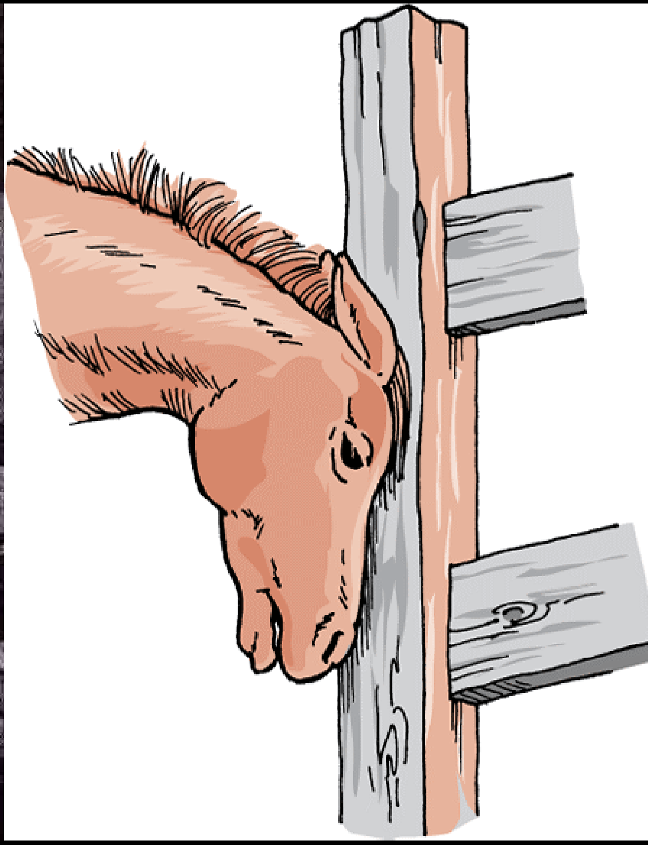
# Mosquitoborne Arbovirus Diseases Potentially Indigenous to the United States or Territories

| | Family, Genus | Distribution |
|---|---|---|
| **Dengue** | ***Flaviviridae, Flavivirus*** | **Puerto Rico, USVI, Guam, Samoa, Florida** |
| **Chikungunya** | ***Togaviridae, Alphavirus*** | **Puerto Rico, USVI, Florida** |
| **Zika** | ***Flaviviridae, Flavivirus*** | **Puerto Rico, USVI, Samoa, Marshall Islands, Florida, Texas** |

# Factors for Vectorborne Diseases

- ❖Reservoir species
- ❖Infectious agent in environment
- ❖Competent vector
- ❖Infected vector
- ❖Susceptible host
- ❖Opportunity for exposure





# Outbreak of Encephalitis in Man Due to the Eastern Virus of Equine Encephalomyelitis*

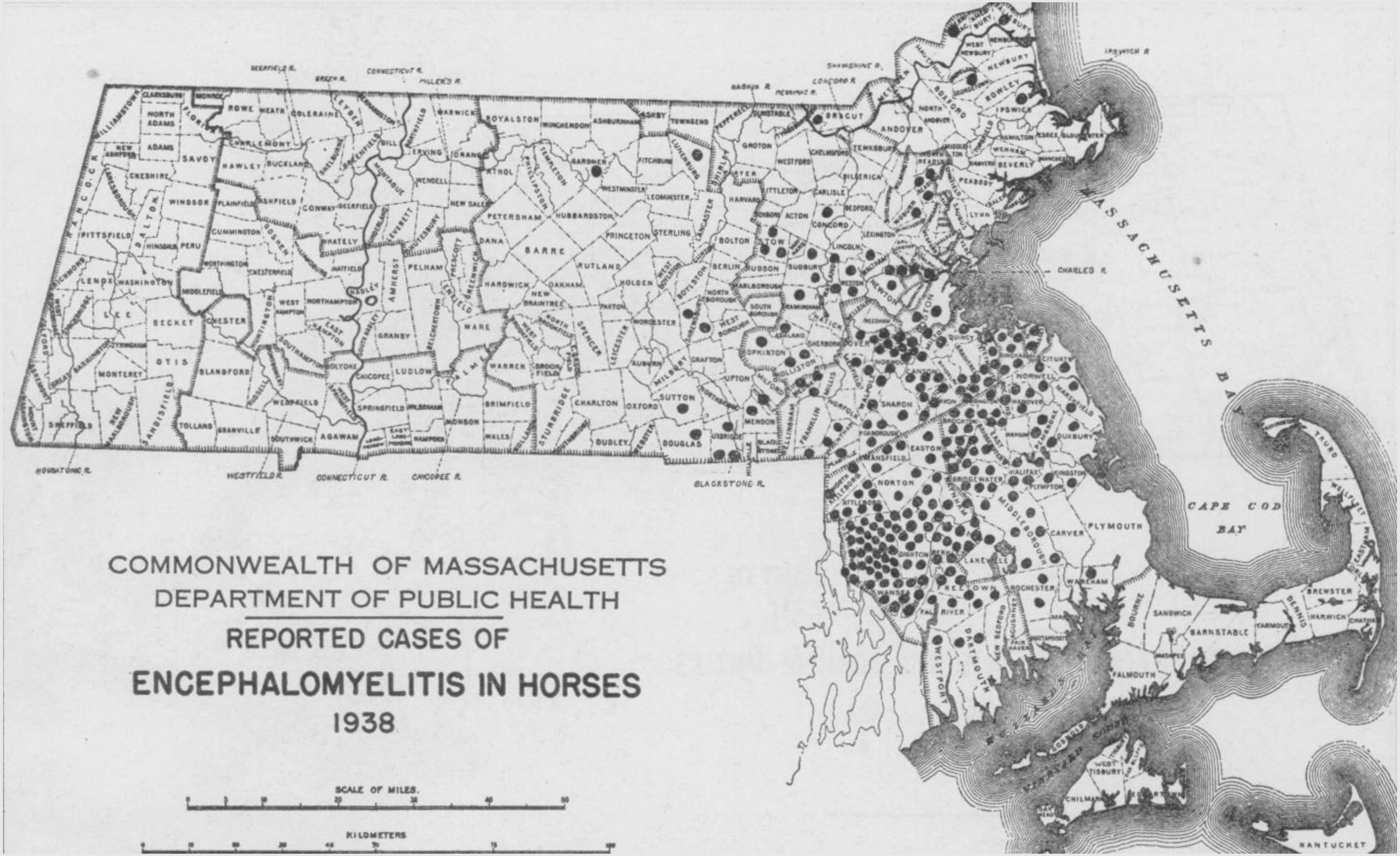
ROY F. FEEMSTER, M.D., Dr.P.H., F.A.P.H.A.

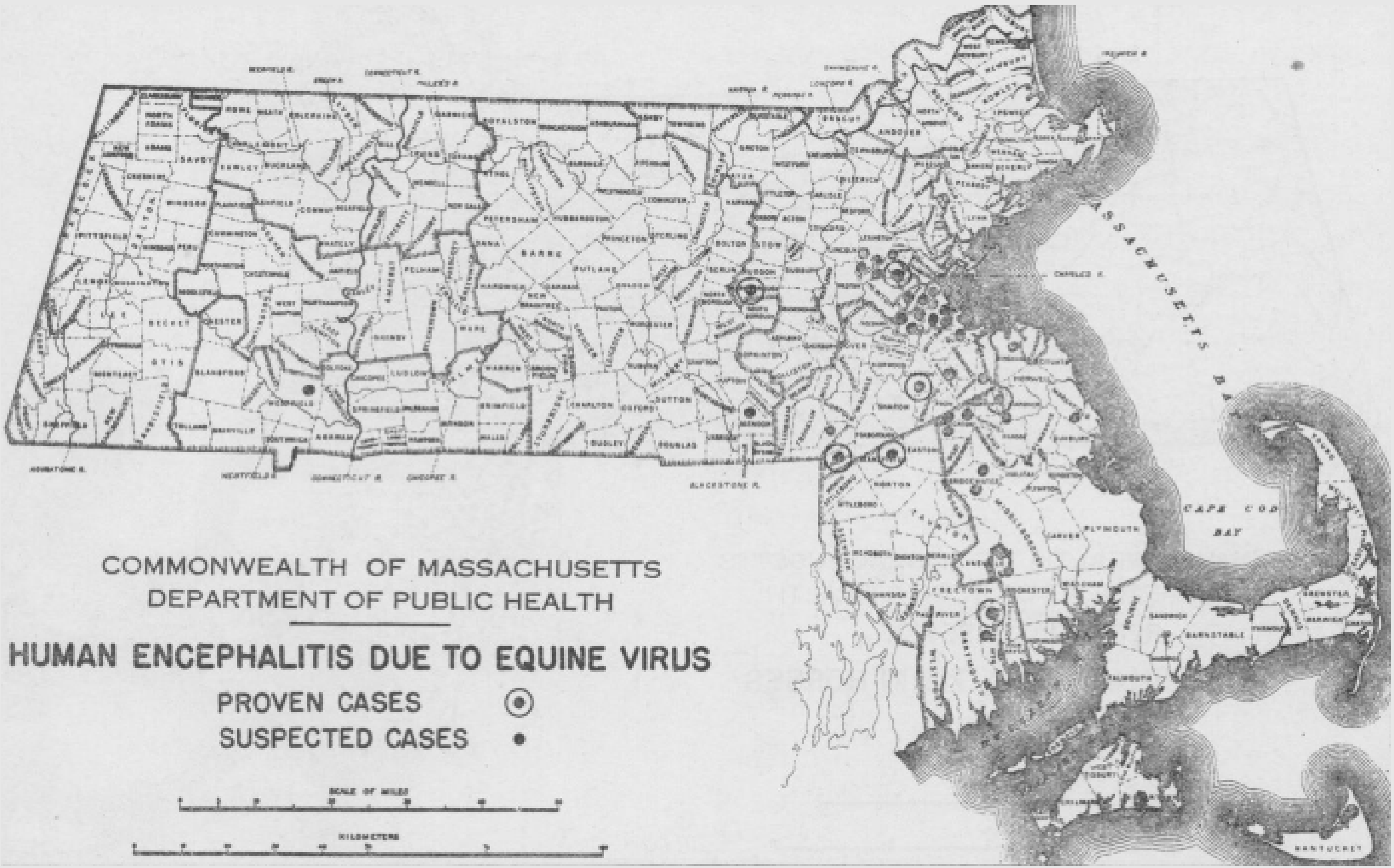
*Director of the Division of Communicable Diseases of the Massachusetts Department of Public Health, Boston, Mass.*

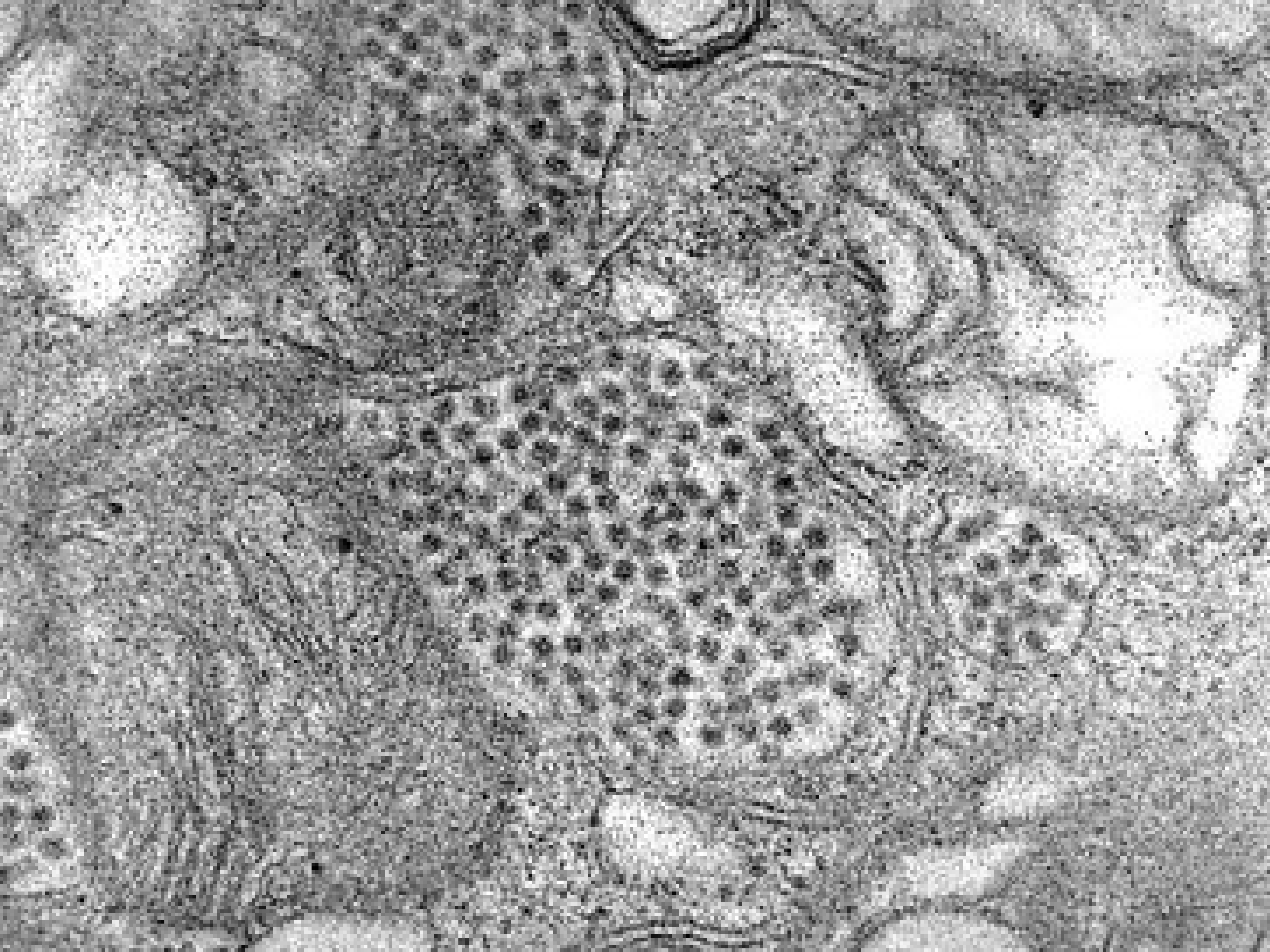
ABOUT the middle of August, 1938, cases of encephalomyelitis in horses were recognized in Massachusetts and it was soon ascertained that an epidemic of considerable proportions existed. On August 12 a child from Brockton died of encephalitis, and when a second child from the same city died on August 30 a rumor spread that the two had been victims of the disease prevalent among horses.

On September 1 the Massachusetts

All five of these cases occurred within 15 miles of each other, the nearest being 20 miles southeast of Boston. An interesting coincidence was that they had occurred in essentially the same area as the equine disease. Because of this fact and also on the chance that this was just the beginning of an outbreak similar to the one at St. Louis, the department arranged for virus studies on any fatal cases that might occur. Over the Labor Day week end


COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC HEALTH
REPORTED CASES OF
ENCEPHALOMYELITIS IN HORSES
1938
MASSACHUSETTS BAY
CAPE COD BAY
SCALE OF MILES.
KILOMETERS
HOUSATONIC R.
WESTFIELD R.
CONNECTICUT R.
CHICOPEE R.
BLACKSTONE R.
CHARLES R.
IPSWICH R.
NANTUCKET


COMMONWEALTH OF MASSACHUSETTS
DEPARTMENT OF PUBLIC HEALTH
HUMAN ENCEPHALITIS DUE TO EQUINE VIRUS
PROVEN CASES
SUSPECTED CASES
CAPE COD
BAY



# Eastern Equine Encephalitis Virus

- ***Alphavirus*** **genus, family** ***Togaviridae***
- **First isolated in 1933**
- **First human case confirmed by isolation from brain tissue in 1938**
- ***Culiseta melanura*** **is primary enzootic vector**
- ***Aedes vexans*****,** ***Ochlerotatus canadensis*** **,** ***Coquillettidia perturbans*** **are putative bridge vectors**
- **Passerine birds are primary amplifying hosts**

# Eastern Equine Encephalitis
# Clinical Course

- Abrupt onset fever, chills, headache, muscle aches, nausea and vomiting
- Progressive disorientation, discoordination
- Seizures, coma
- ~30-50% mortality
- ~80% residual neurological deficits

## Prevalence of Clinical Signs, Symptoms, and Laboratory Abnormalities on Hospitalization among 36 Patients with Eastern Equine Encephalitis.

| Variable | Prevalence (% of Patients) |
|---|---|
| **Symptoms and signs** | |
| Fever | 83 |
| Headache | 75 |
| Nausea and vomiting | 61 |
| Malaise and weakness (nonfocal) | 58 |
| Confusion | 44 |
| Myalgia and arthralgia | 36 |
| Neck stiffness* | 36 |
| Plantar reflex | 29 |
| Chills | 25 |
| Seizures† | 25 |
| Weakness (focal) | 23 |
| Abdominal pain | 22 |
| Respiratory symptoms | 11 |
| Cranial-nerve palsies‡ | 8 |
| Sore throat | 8 |
| Diarrhea | 8 |
| Photophobia | 3 |
| **Laboratory findings§** | |
| Pleocytosis | 97 |
| Elevated protein concentrations in cerebrospinal fluid | 94 |
| Elevated red-cell count in cerebrospinal fluid | 77 |
| Leukocytosis | 69 |
| Hyponatremia | 60 |

1. Fever, headache, other symptoms

2. Confusion, neck stiffness, etc.

Deresiewicz RL et al. N Engl J Med 1997;336:1867-1874.

The NEW ENGLAND JOURNAL of MEDICINE

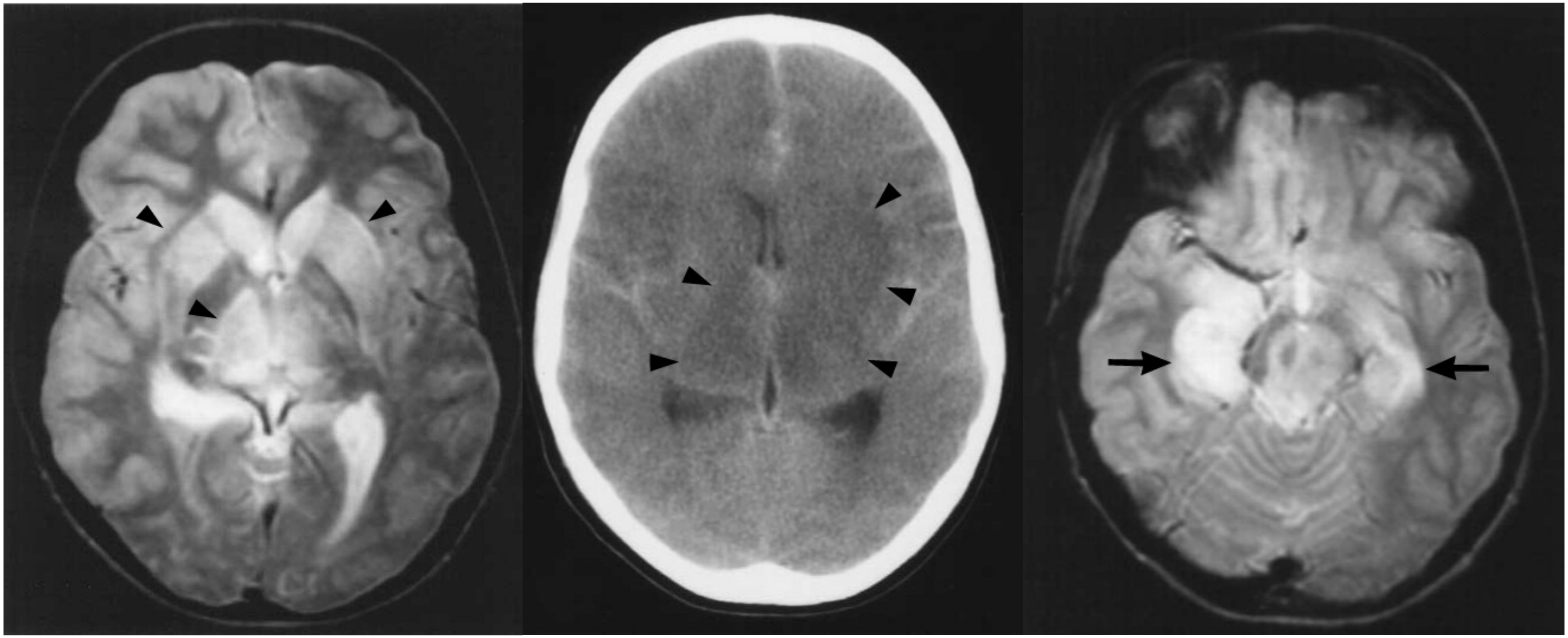
# Results of Neuroradiographic Studies in 32 Patients with Eastern Equine Encephalitis.

| Anatomical Site or Abnormality | CT Scan (N=32) | MRI Scan (N=14) |
|---|---|---|
| | no. with abnormal findings* | |
| Basal ganglia† | 18 | 10 |
| Thalamus | 8 | 10 |
| Brain stem | 3 | 6 |
| Cortex | 4 | 5 |
| Periventricular area (focal lesions) | 0 | 2 |
| Meninges | 2 | 0‡ |
| Hydrocephalus | 1 | 0 |
| Any abnormality | 21 | 13 |

Deresiewicz RL et al. N Engl J Med 1997;336:1867-1874.

The NEW ENGLAND JOURNAL of MEDICINE

# Lesions of the Basal Ganglia and Cortex in a 14-Year-Old Boy Who Died of Eastern Equine Encephalitis.



Deresiewicz RL et al. N Engl J Med 1997;336:1867-1874.

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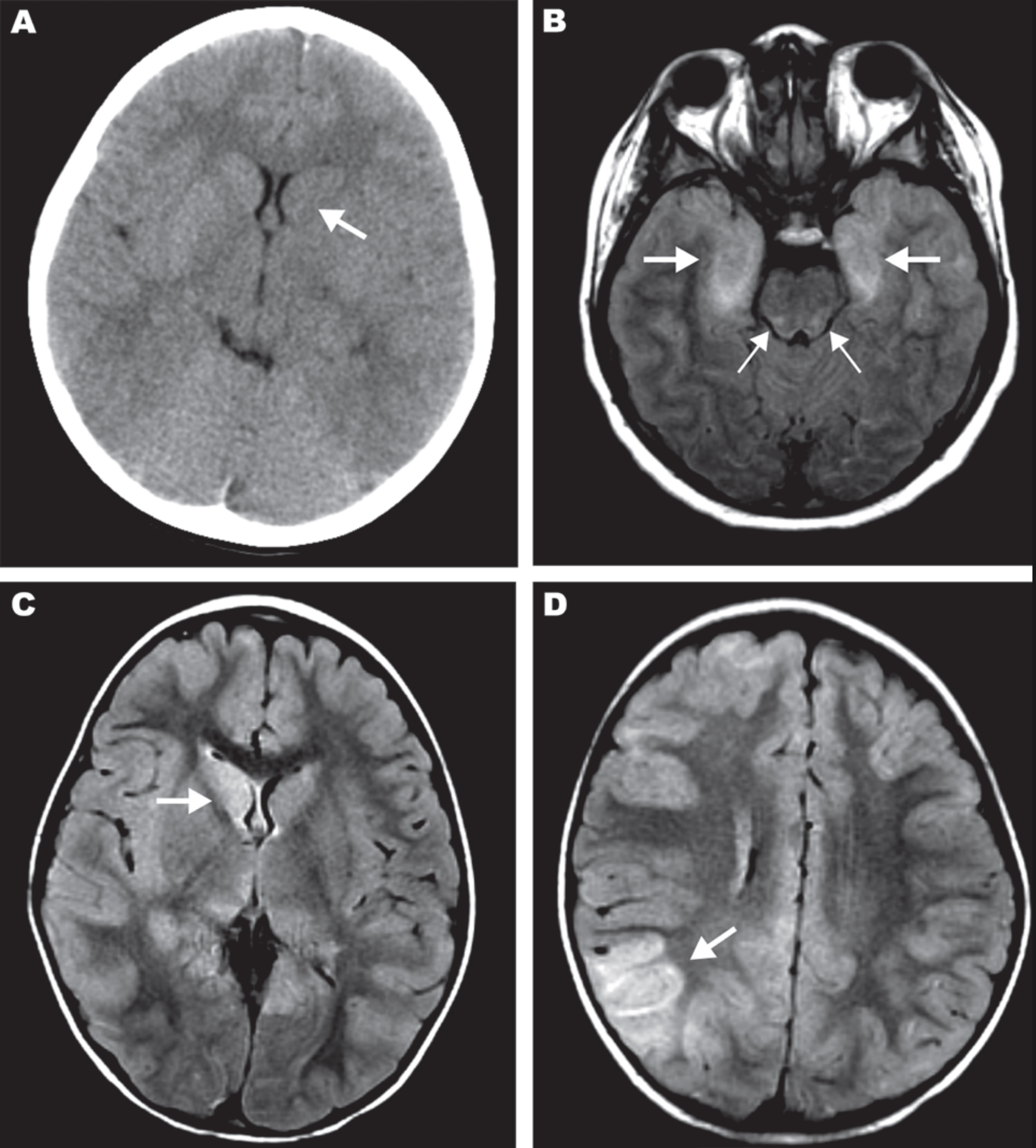
# Clinical signs and symptoms at the time of hospital admission for 14 children with EEE, Massachusetts and New Hampshire, 1970–2010

**Silverman, et al. EID 2013; 19: 194-201.**

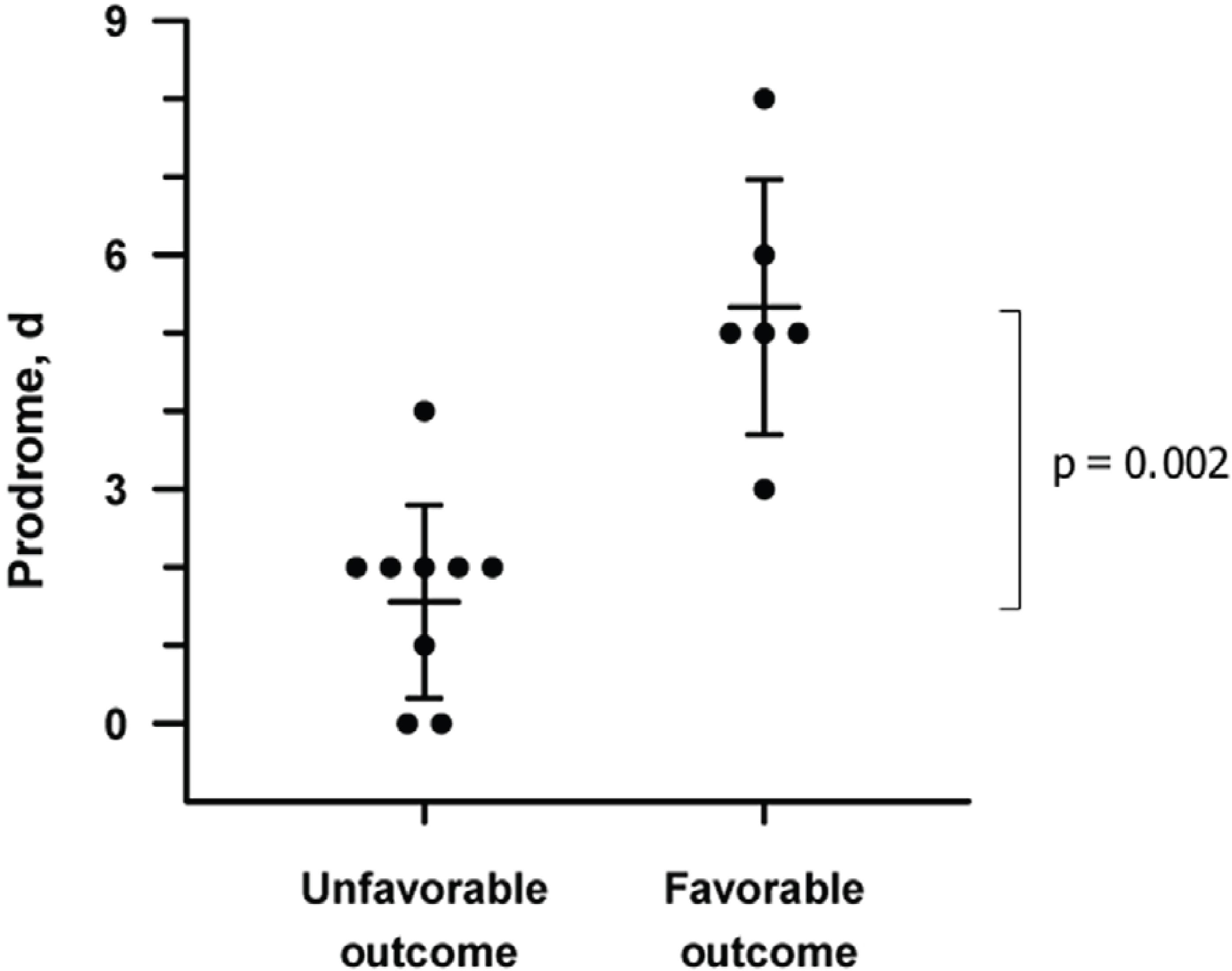
| Sign or symptom | No. (%) patients |
|---|---|
| Fever | 14 (100) |
| Seizure | 10 (71) |
| Headache | 9 (64) |
| Neck stiffness | 9 (64) |
| Nausea/vomiting | 9 (64) |
| Myalgia/arthralgia | 4 (29) |
| Plantar reflex | 4 (29) |
| Photophobia | 4 (29) |
| Sore throat | 2 (14) |
| Cranial nerve palsy | 1 (7) |
| Abdominal pain | 1 (7) |
| Diarrhea | 0 |




**Magnetic resonance images (MRIs) and computed tomography (CT) neuroradiographs showing lesions in brains of 3 children with eastern equine encephalitis.**
**Silverman, et al. EID 2013; 19: 194-201.**

# Association of Length of Prodrome with Clinical Outcome in Children with Eastern Equine Encephalitis

**Silverman, et al. EID 2013; 19: 194-201.**

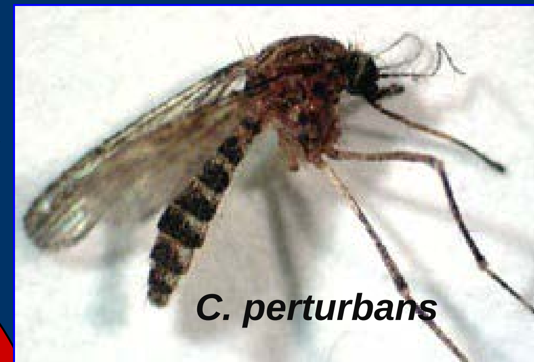


# Eastern Equine Encephalitis in Massachusetts

| | |
|---|---|
| 1831 | Epidemic of brain disease in horses in Massachusetts |
| 1931 | Differentiated from other equine encephalitides |
| 1933 | Virus isolated |
| 1933-36 | Birds implicated as reservoir of virus |
| 1938 | Outbreak of “brain disease” in horses in Massachusetts (~ 300 cases) |
| 1938-39 | Outbreak of human EEE in Massachusetts (35 cases) |
| 1947 | Louisiana and Texas outbreaks |
| 1955-56 | Second Massachusetts outbreak (16 cases), aerial spraying, DDT |
| 1957 | Taunton Field Station of the USPHS |
| 1969 | Taunton Field Station closed, State Laboratory continues surveillance |
| 1973 | Equine vaccine |
| 1973-75 | Outbreak (7 cases), aerial spraying, malathion |
| 1982-84 | Outbreak (10 cases) |
| 1990 | Outbreak (3 cases), aerial spraying, malathion |
| 2004-06 | Outbreak (13 cases), aerial spraying, sumithrin |
| 2010 | Record mosquito EEE isolations (2 cases), aerial spraying, sumithrin |
| 2012 | Record mosquito EEE isolations (7 cases), aerial spraying, sumithrin |
| 2014 -18 | Virtually no EEE activity, no human cases |
| 2019 | Record mosquito EEE isolations (12 cases), aerial spraying, sumithrin |

# EEE Transmission Cycle

Passerine Birds serve as reservoirs for the virus. Examples include: Red-winged Blackbirds, Blue Jays, and Chickadees





**Potential Bridge Vectors**


Main amplification vector in the EEE cycle

?

**Animals and people serve as dead-end host and are unable to pass the virus on**

Adapted from: PC Matton, W Andrews,

Bristol County Mosquito Control Project

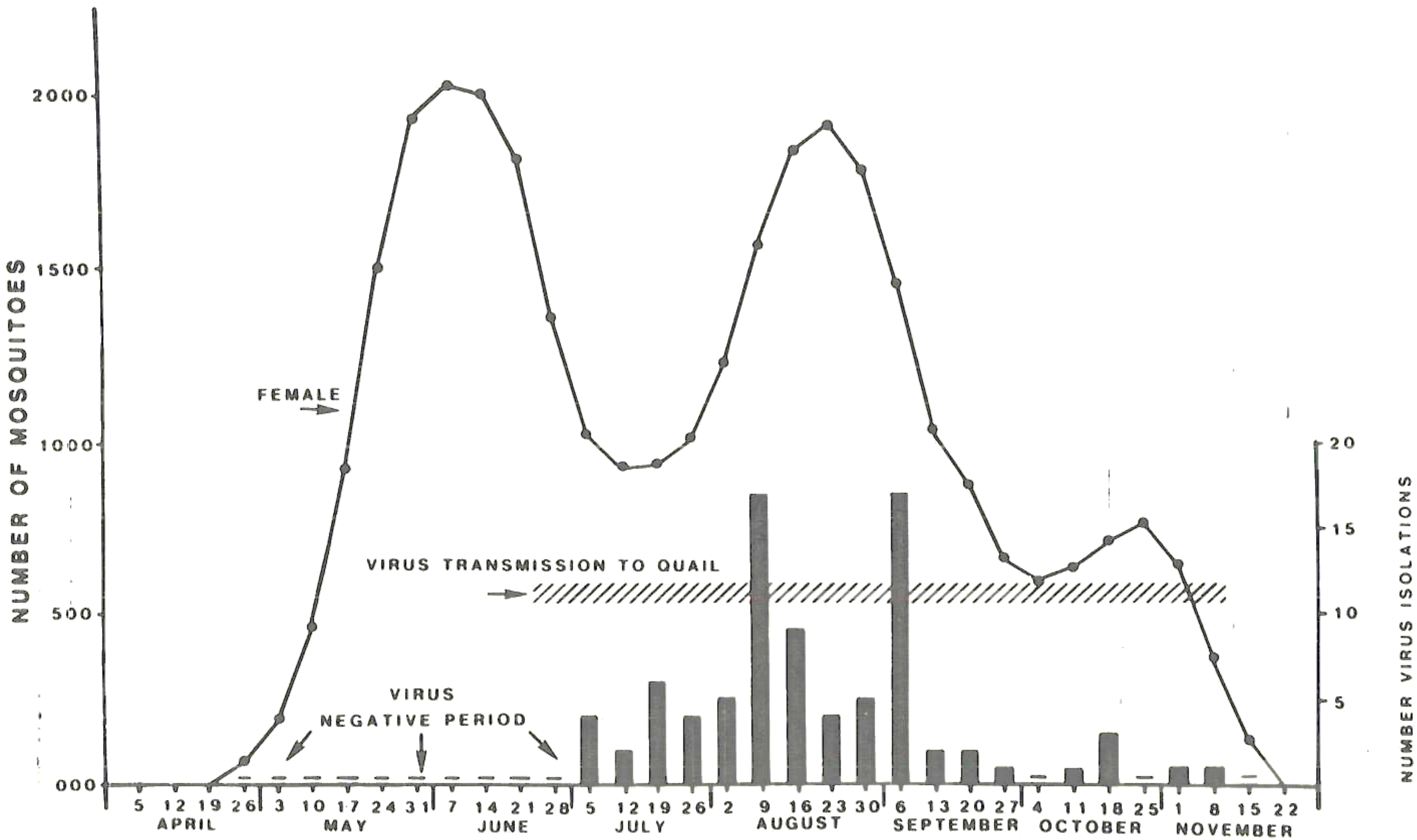



FIG. 2. Seasonal pattern and frequency of EEE virus isolations from ♀ *Culiseta melanura* and transmission to Bobwhite quail, Pocomoke Cypress Swamp, Maryland, 1982.

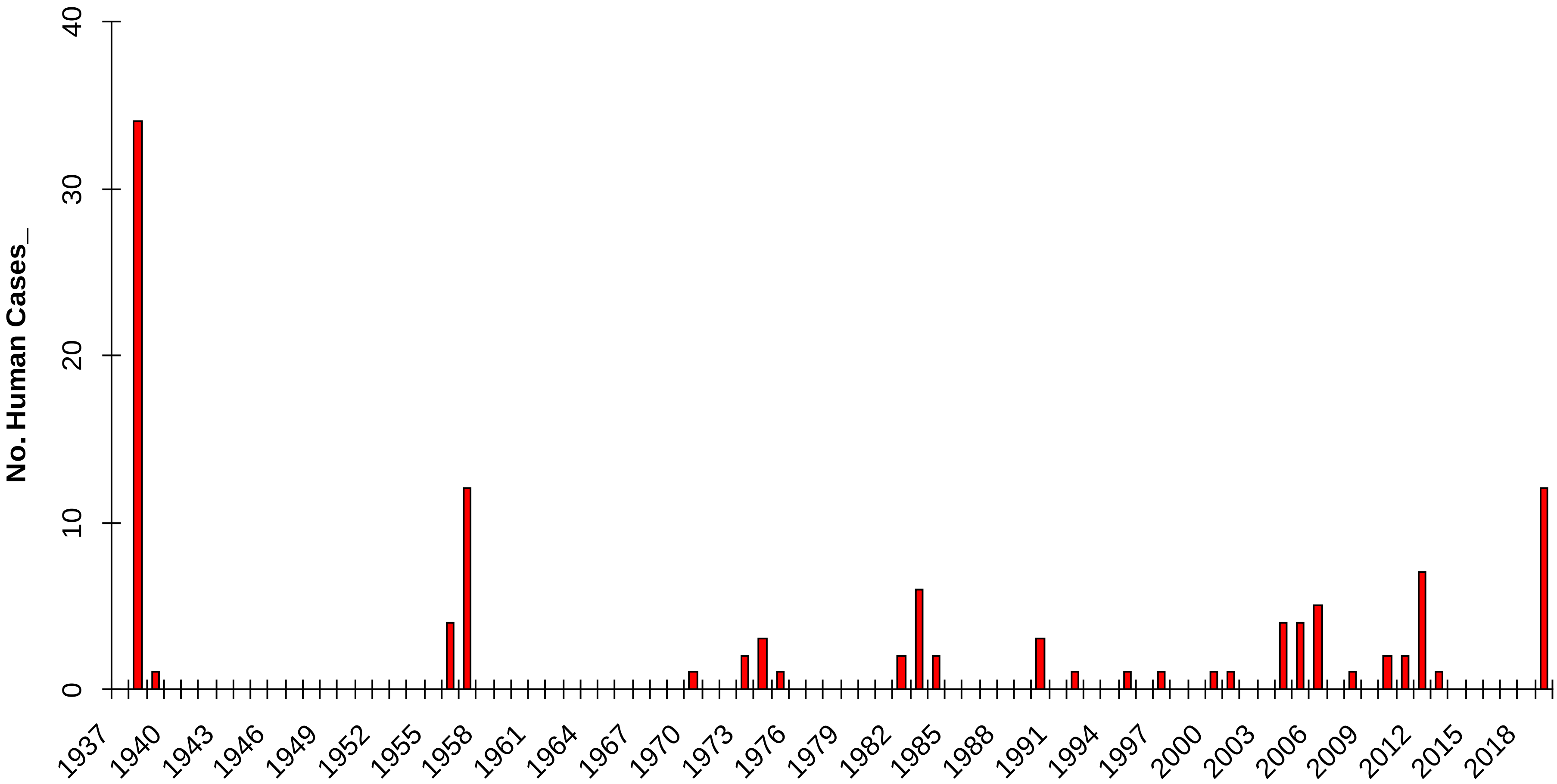
**Watts, et al. J Med Entomol 1982; 24:91-98**

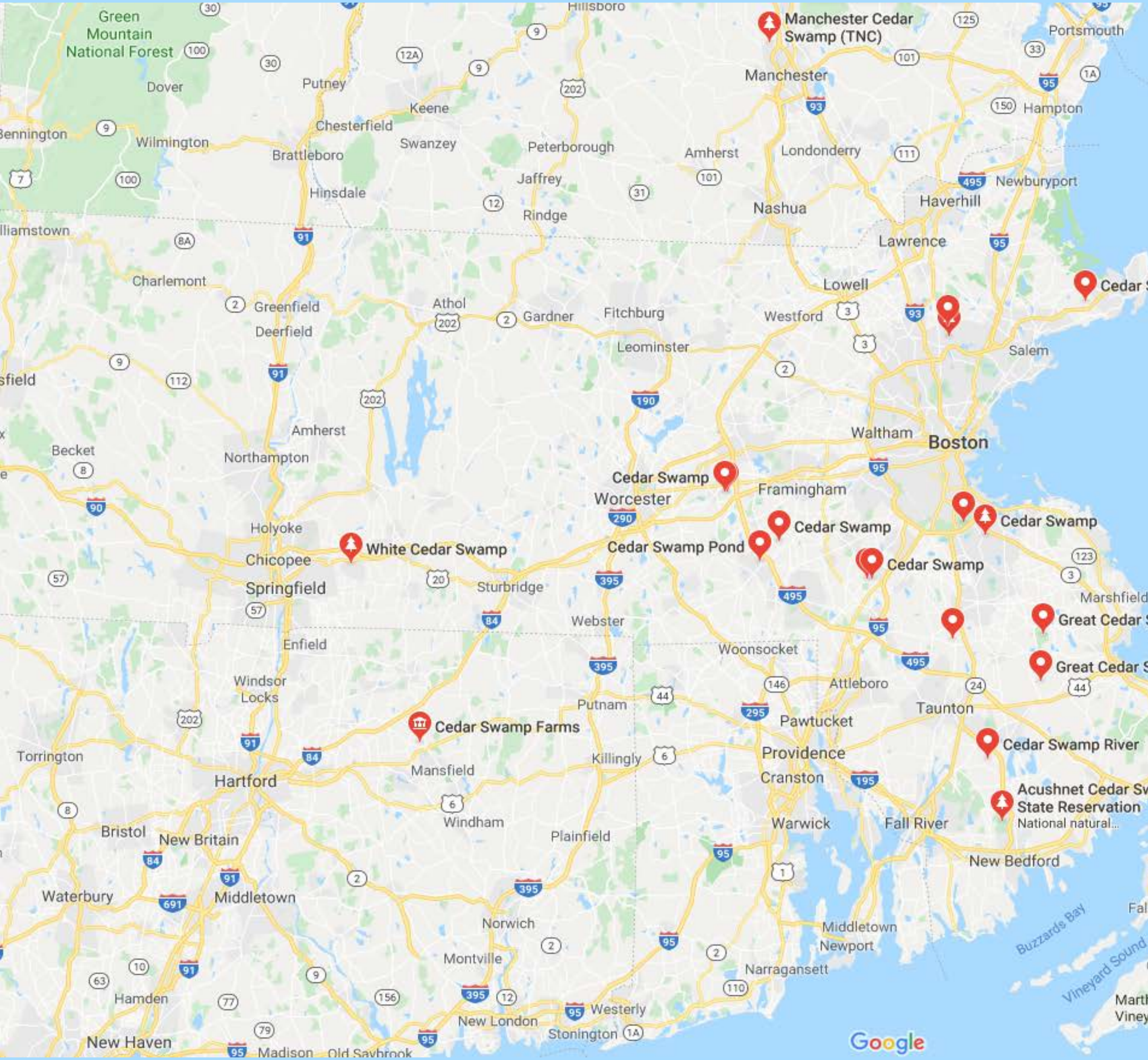
# The Distribution of *Culiseta melanura*

**Map by C. Roxanne Connelly, University of Florida.**

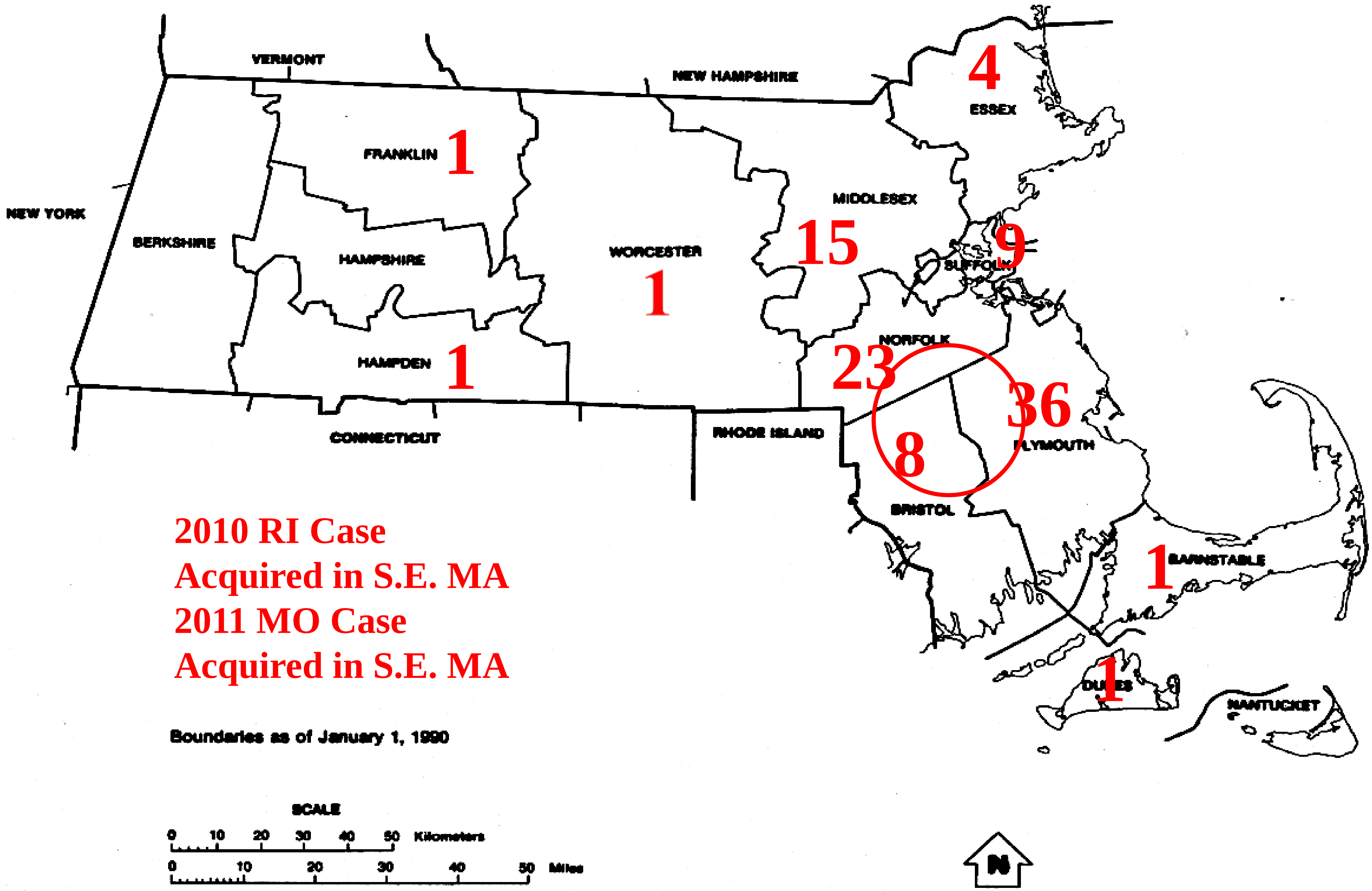
| Human Cases of EEE in Massachusetts | | | |
|---|---|---|---|
| | Cases | Deaths | Mortality (%) |
| 1938-39 | 35 | 25 | 71 |
| 1955-56 | 16 | 9 | 56 |
| 1970 | 1 | 0 | |
| 1973-75 | 6 | 4 | 41 |
| 1982-84 | 10 | 3 | |
| 1990 | 3 | 1 | |
| 1992-1997 | 3 | 1 | |
| 2000 | 1 | 0 | 38 |
| 2001 | 1 | 0 | |
| 2004-2006 | 13 | 6 | |
| 2008 | 1 | 1 | |
| 2010 | 2 | 0 | |
| 2011 | 2 | 1 | |
| 2012 | 7 | 3 | 46 |
| 2013 | 1 | 1 | |
| 2014-2018 | 0 | 0 | |
| 2019 | 12 | 4 | 33 |
| TOTAL | 114 | 59 | 52 |

# Human EEE Cases Massachusetts 1938-2019

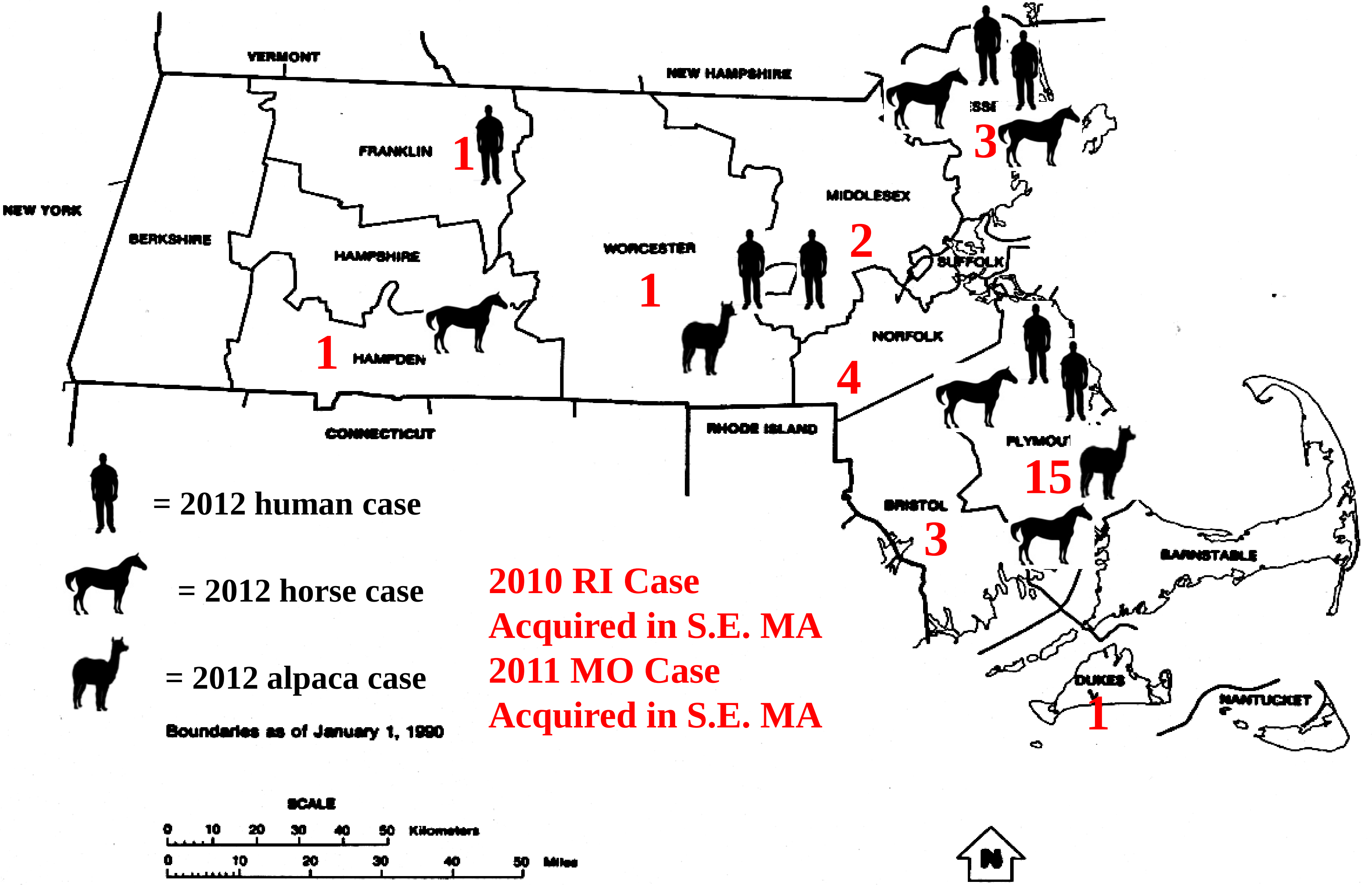



Manchester Cedar Swamp (TNC)
Cedar Swamp
Cedar Swamp
Cedar Swamp
Cedar Swamp Pond
Cedar Swamp
Cedar Swamp
White Cedar Swamp
Great Cedar Swamp
Great Cedar Swamp
White Cedar Swamp Trail
Cedar Swamp Farms
Cedar Swamp River
Acushnet Cedar Swamp State Reservation
National natural...
Green Mountain National Forest
Manchester
Portsmouth
Hampton
Newburyport
Haverhill
Lawrence
Lowell
Nashua
Keene
Brattleboro
Salem
Boston
Waltham
Framingham
Worcester
Fitchburg
Leominster
Springfield
Chicopee
Holyoke
Northampton
Amherst
Greenfield
Sturbridge
Webster
Woonsocket
Attleboro
Taunton
Marshfield
Pawtucket
Providence
Cranston
Warwick
Fall River
New Bedford
Hartford
New Britain
Middletown
Waterbury
New Haven
Norwich
New London
Westerly
Newport
Narragansett
Falmouth
Oak Bluffs
Martha's Vineyard
Barnstable
Dennis
Chatham
Orleans
Provincetown
Cape Cod Bay
Buzzards Bay
Vineyard Sound
Google

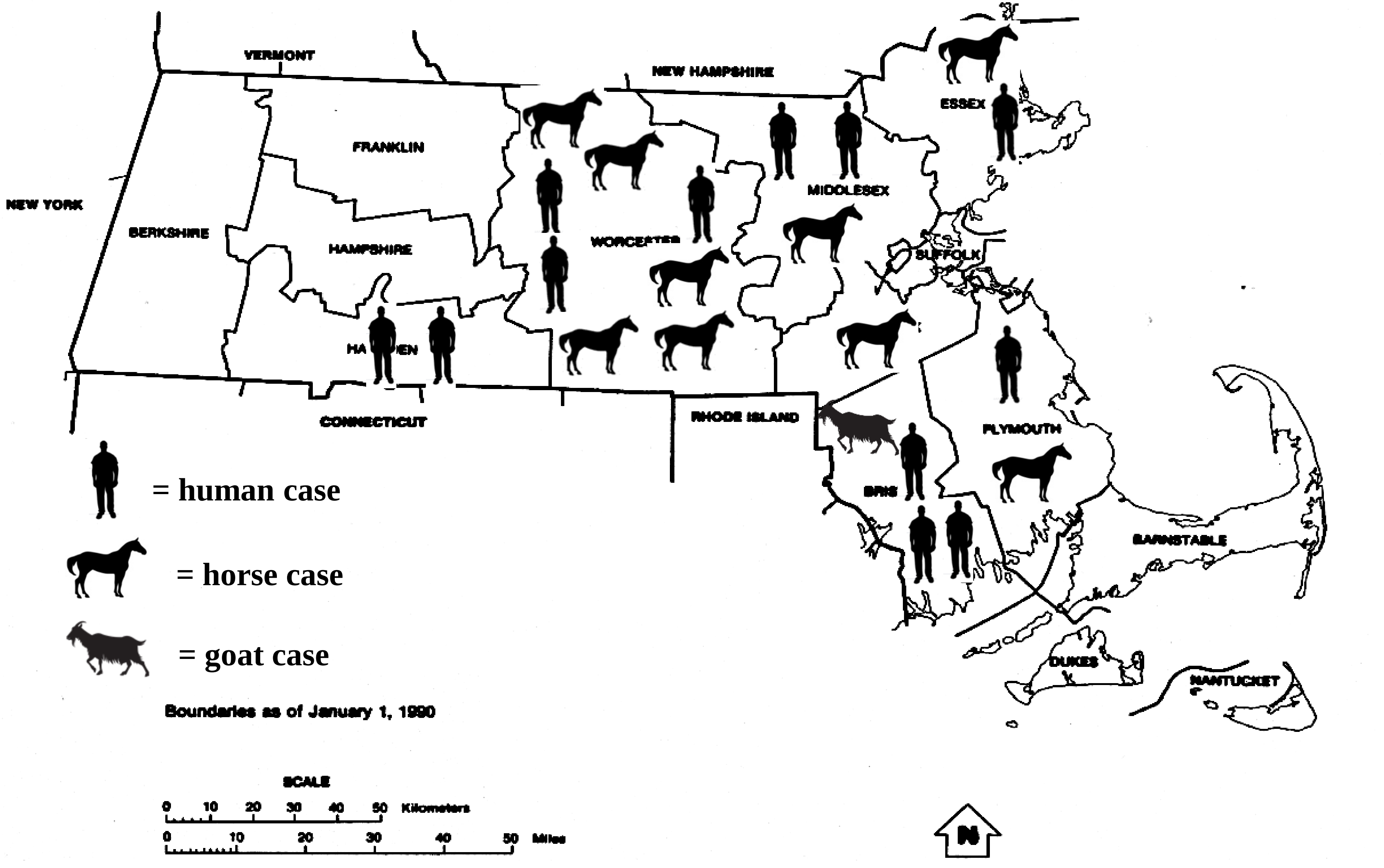
# Human EEE Cases by County of Residence, 1938-2013



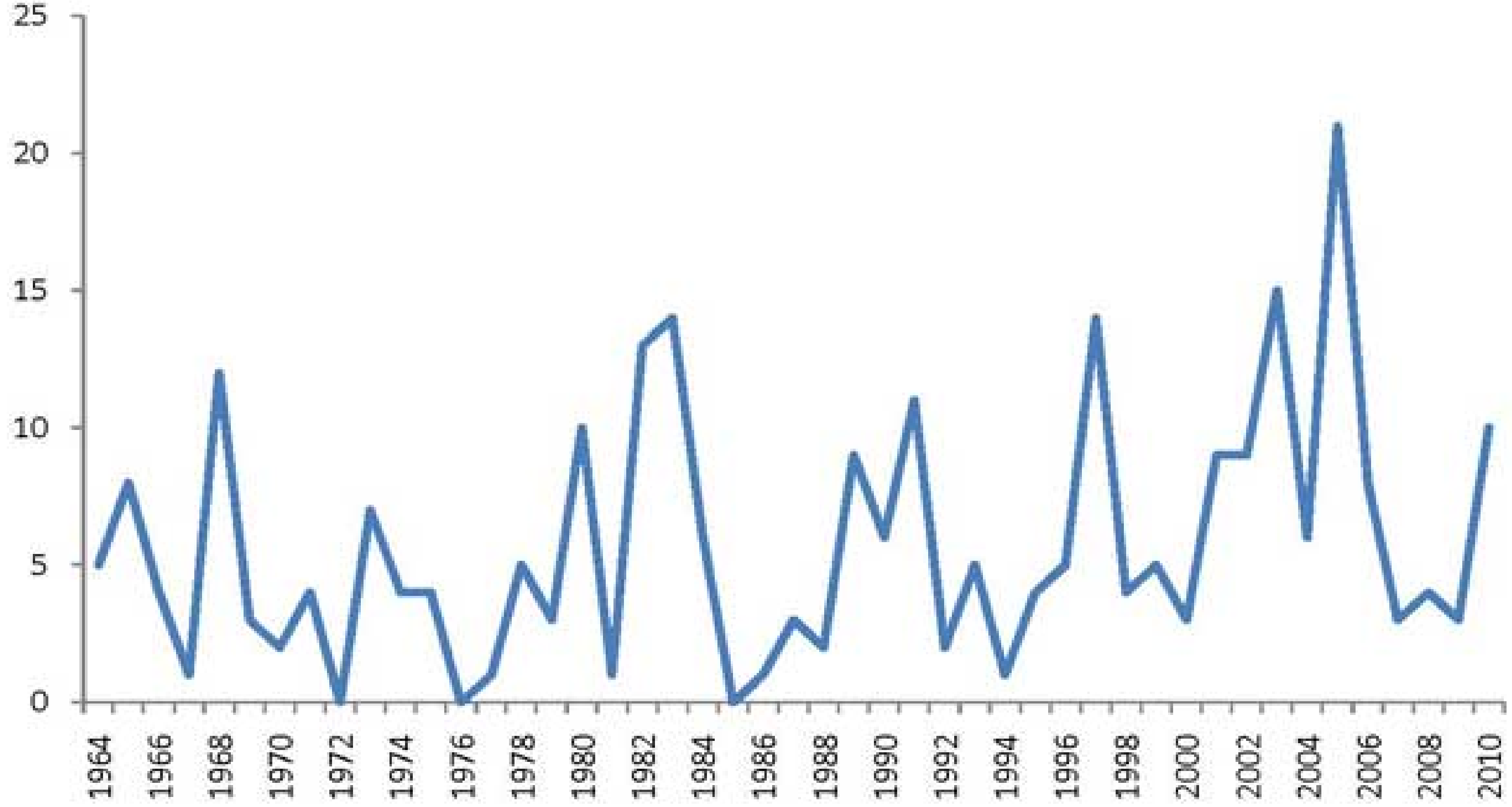
# EEE Cases by County of Residence, 1990-2012



# EEE Cases by County of Residence, 2019

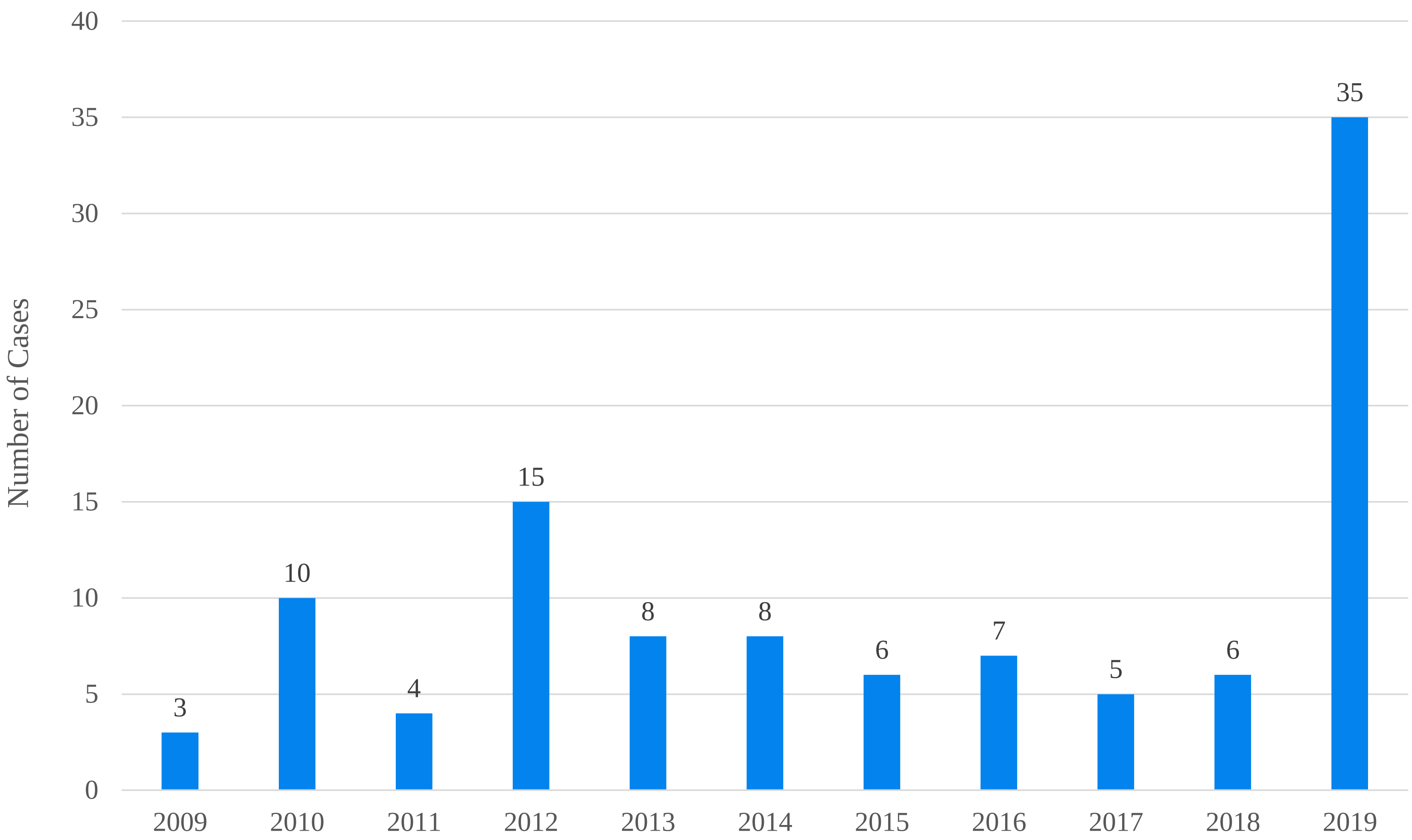


# Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported in the U.S. by Year, 1964-2010 (CDC)



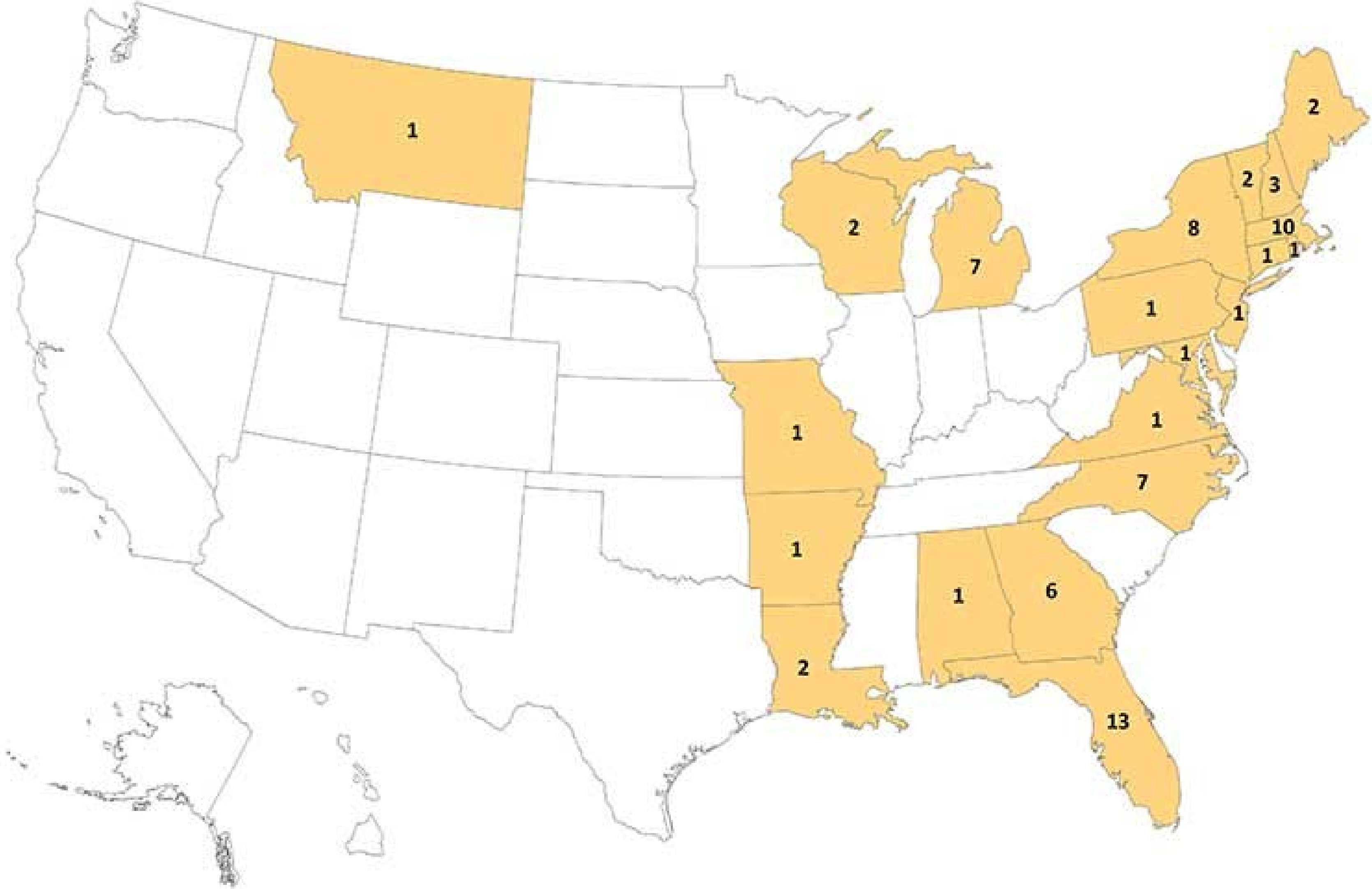

CDC

# Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported by Year, U.S., 2009–2019



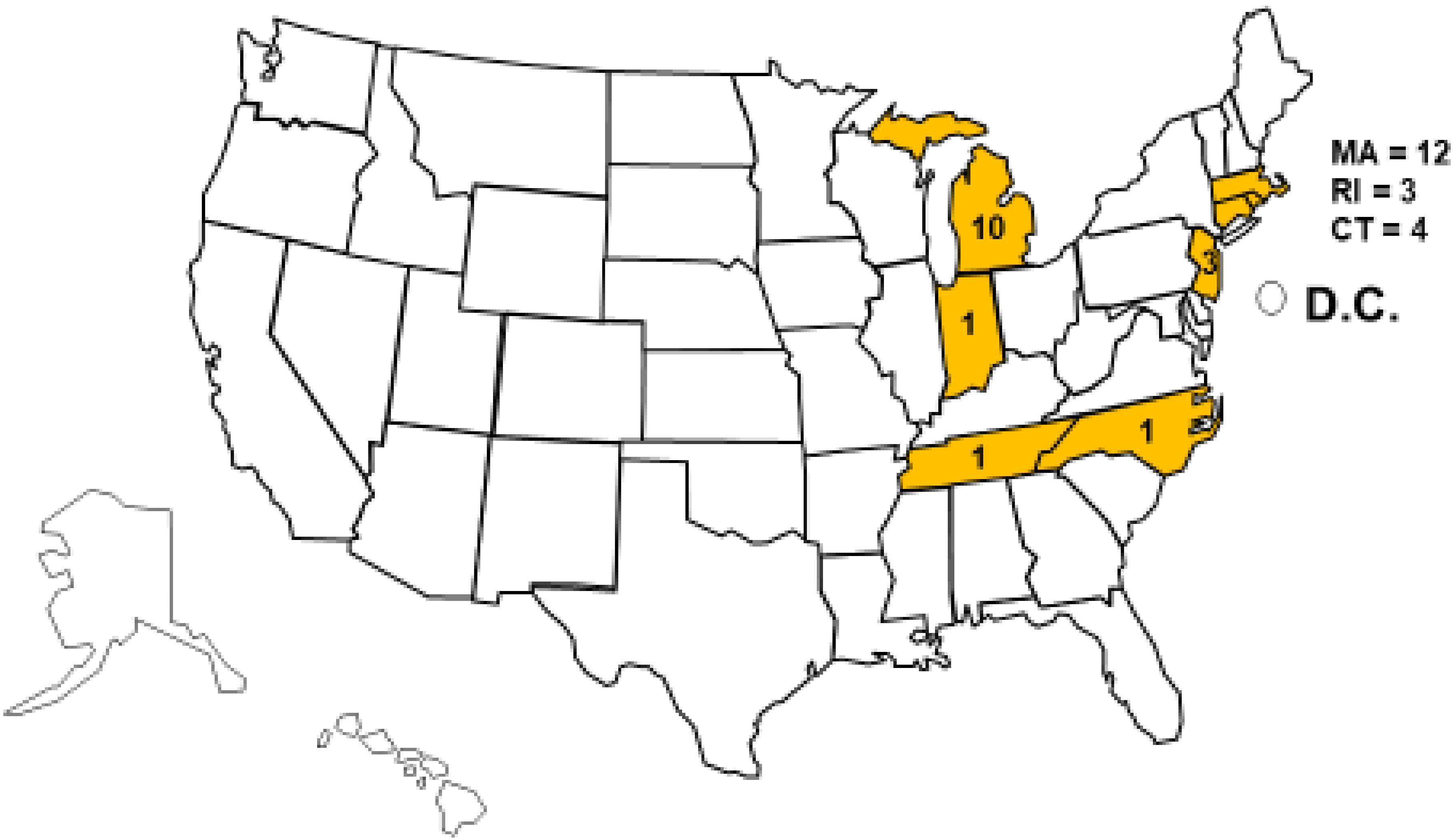
# Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported by State, 1964-2010

# Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported by State, 2009-2018

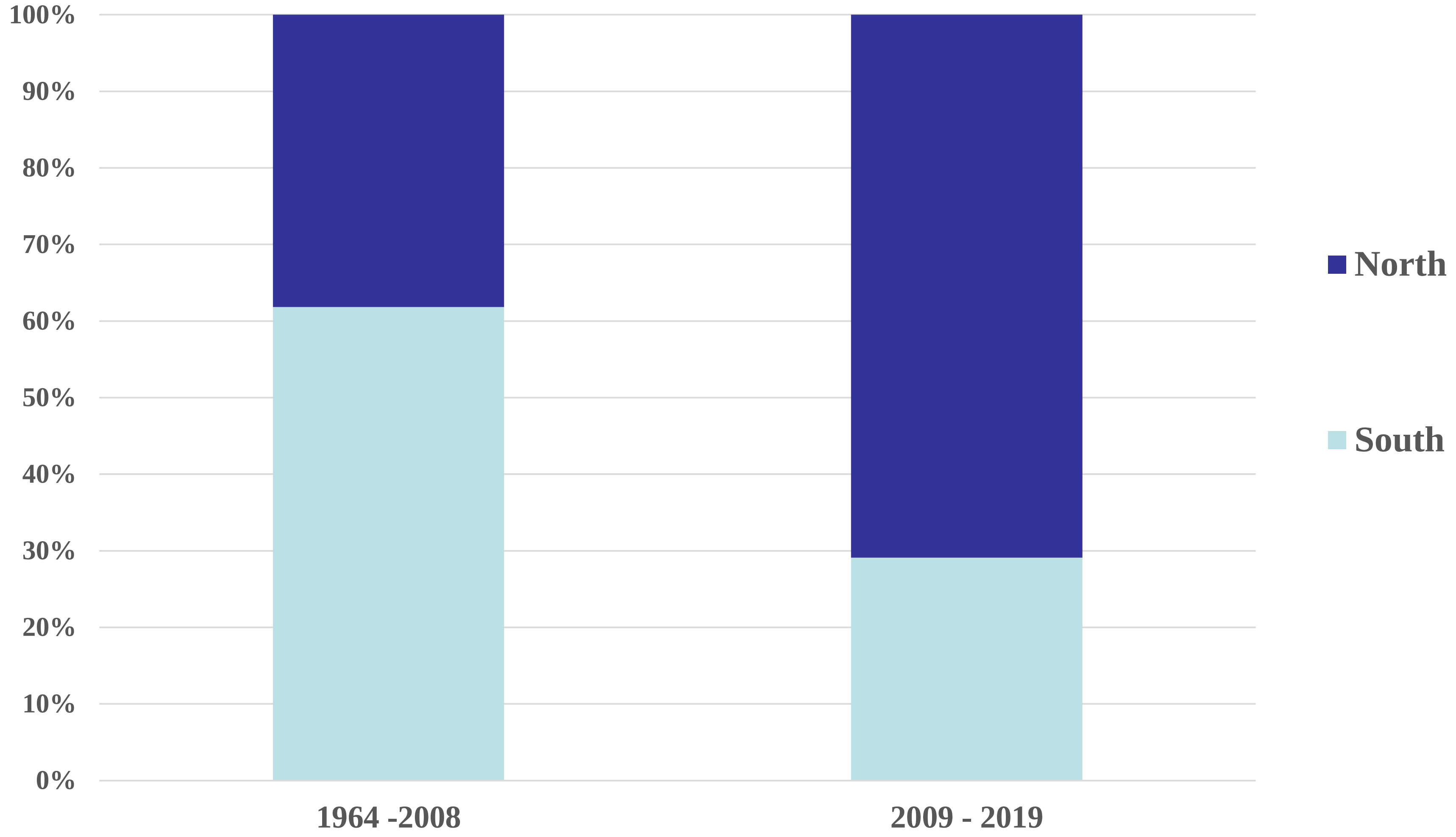


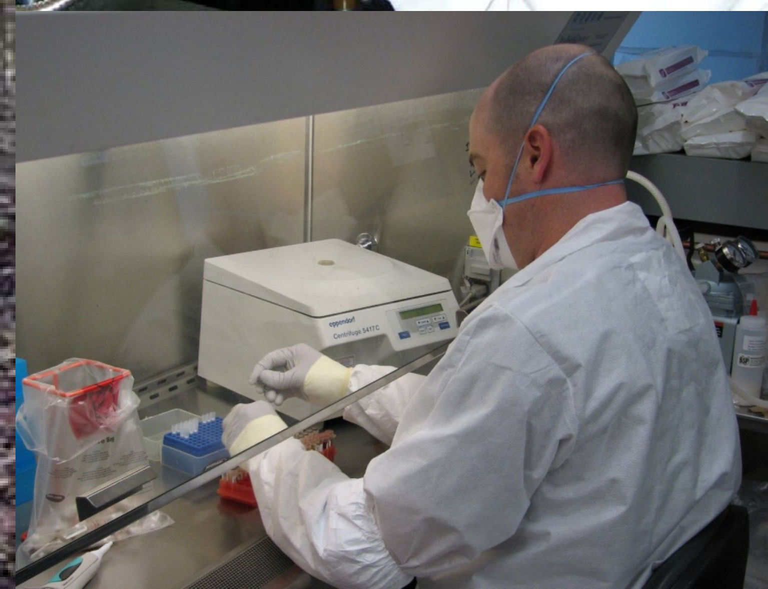

CDC

# Eastern Equine Encephalitis Virus Neuroinvasive Disease Cases Reported by State, 2019

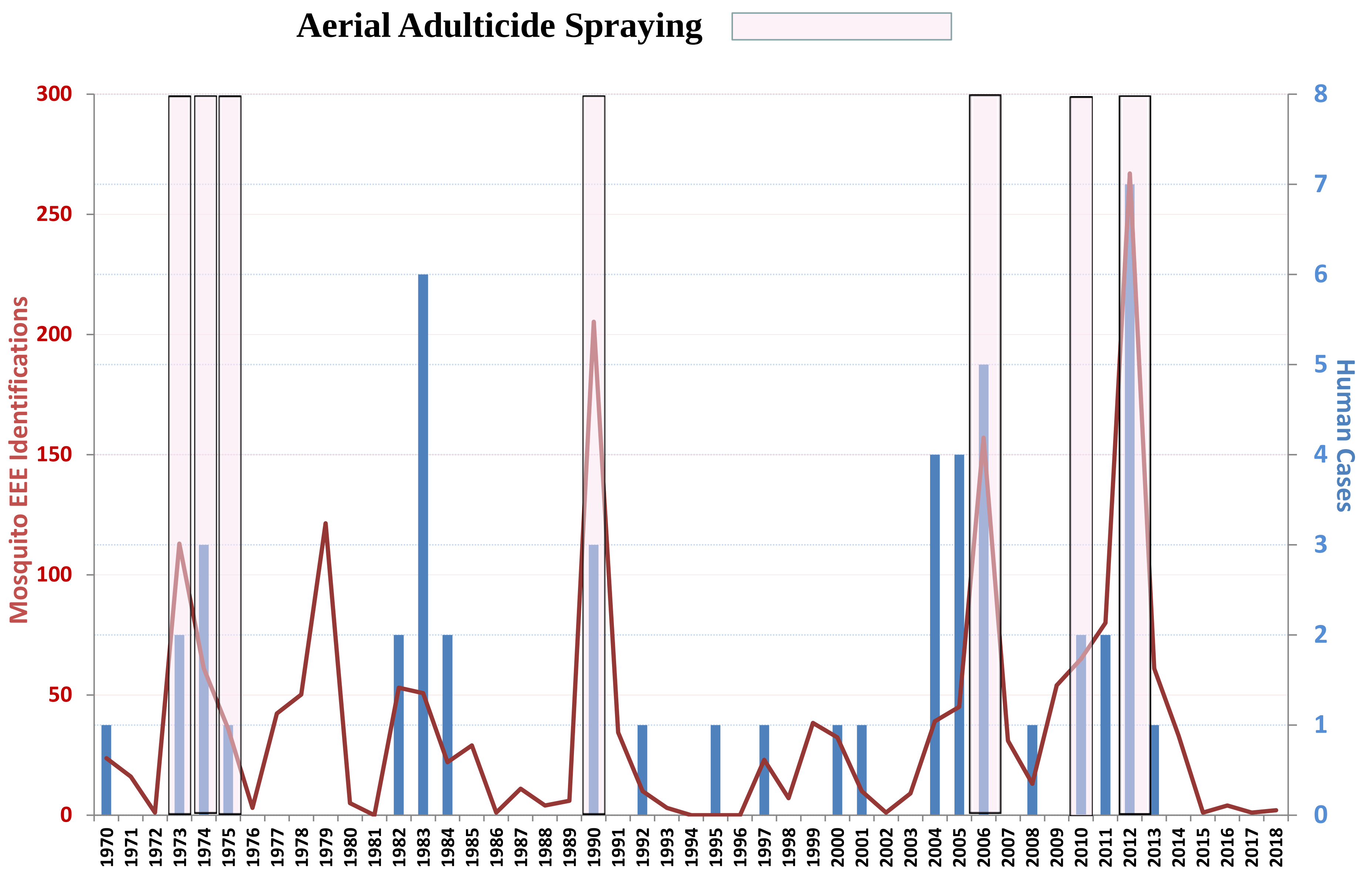


# Proportions of Reported Human EEE Cases in the U.S. Above and Below the 37th Parallel

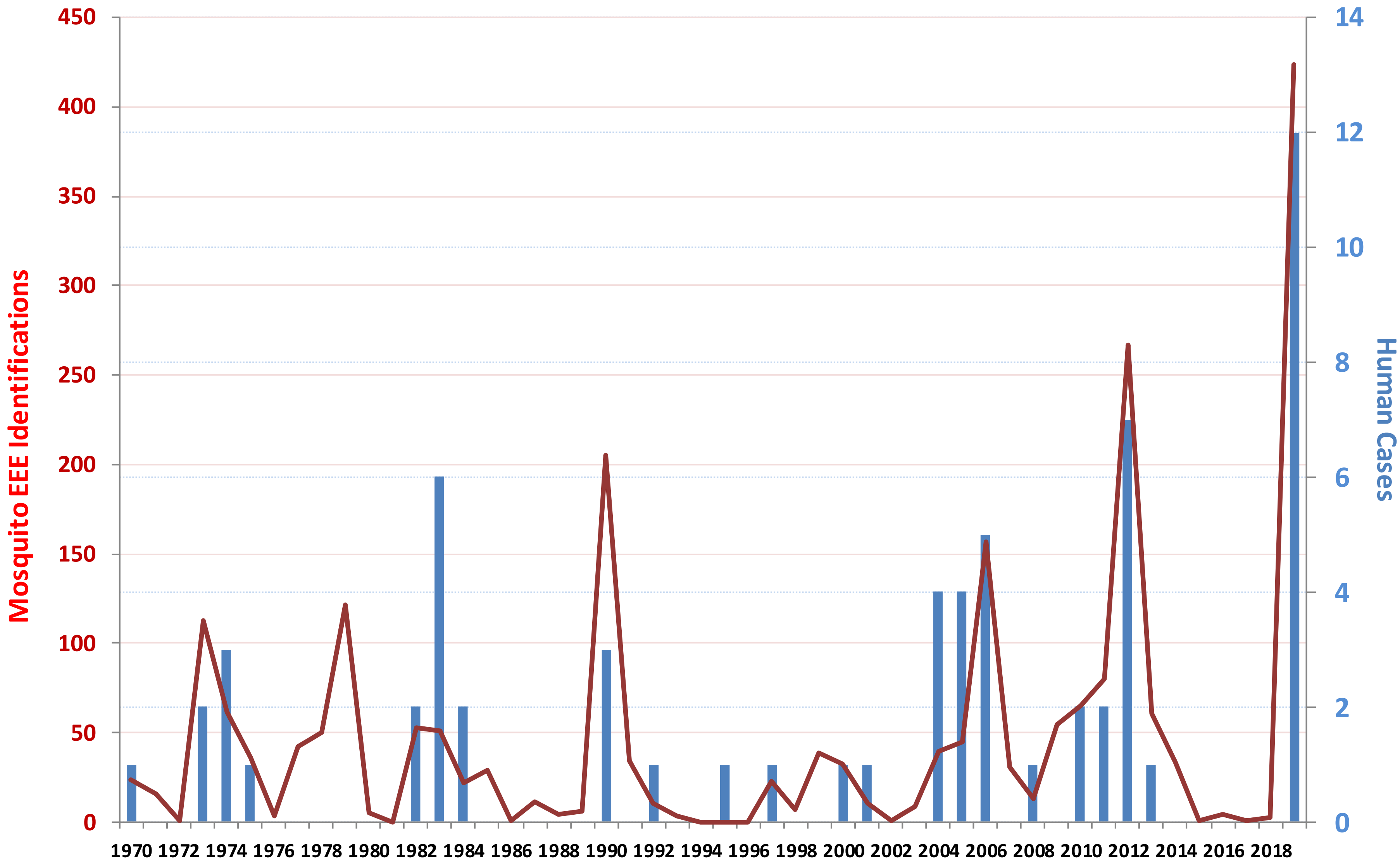


# Massachusetts 1970-2018
# Human EEE and EEEV Mosquito Isolates



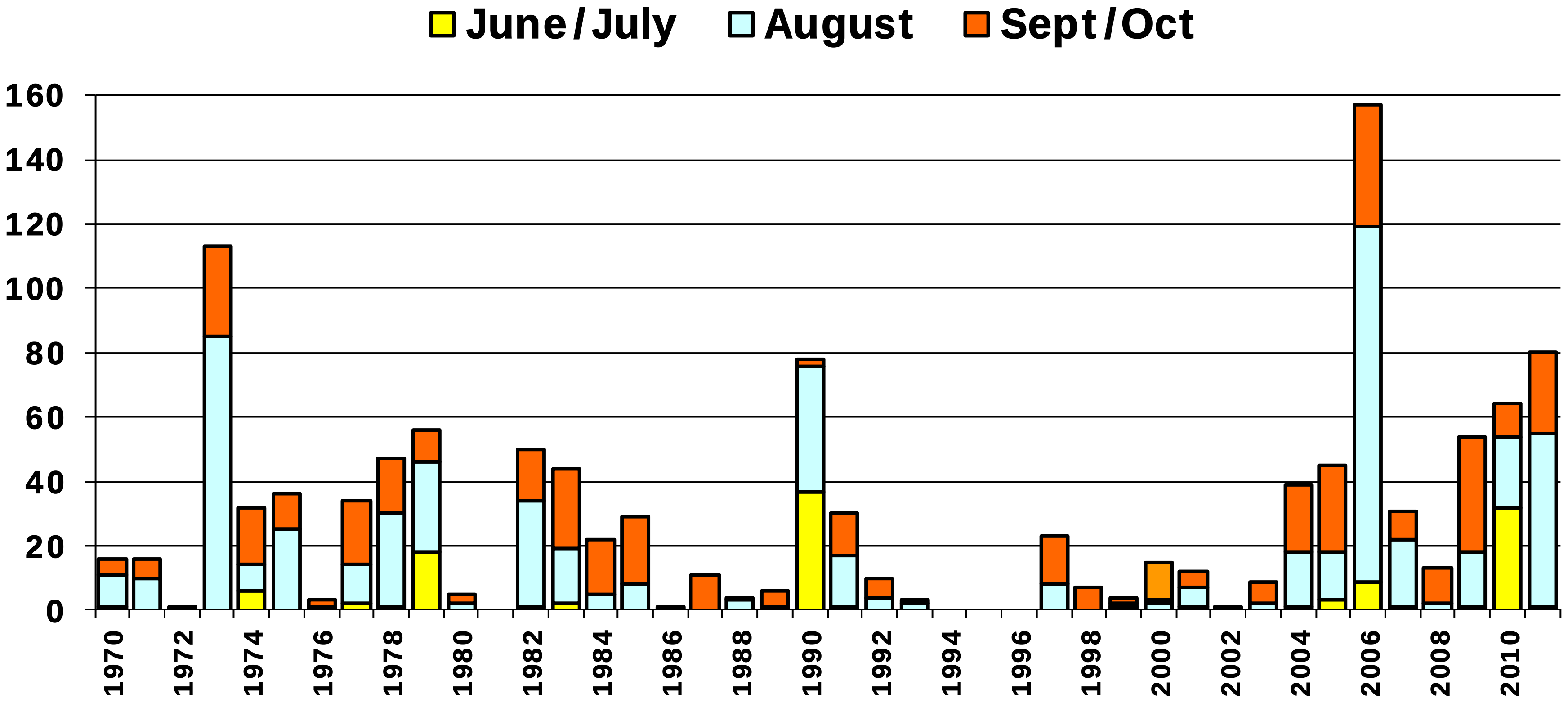
# Massachusetts 1970-2019
# Human EEE and EEEV Mosquito Isolates



# Risk Assessment Criteria for EEE in Massachusetts

- **<u>Pre-Season</u>**
  - **Significant EEE activity the previous year**
  - **Groundwater levels above normal, heavy rainfall**
  - **Mild winter with insulating snow cover**
- **<u>Early Season</u>**
  - **Exceptionally wet spring**
  - **Above average *Cs. melanura* densities**
  - **EEE virus isolations in June or early July**
- **<u>In Season</u>**
  - **Numerous mosquito pools EEEV positive (30-50)**
  - **High minimum infection rates in *Cs. melanura* (> 2:1000)**
  - **Early appearance of disease in horses or humans**
  - **Any human case, particularly before late August**

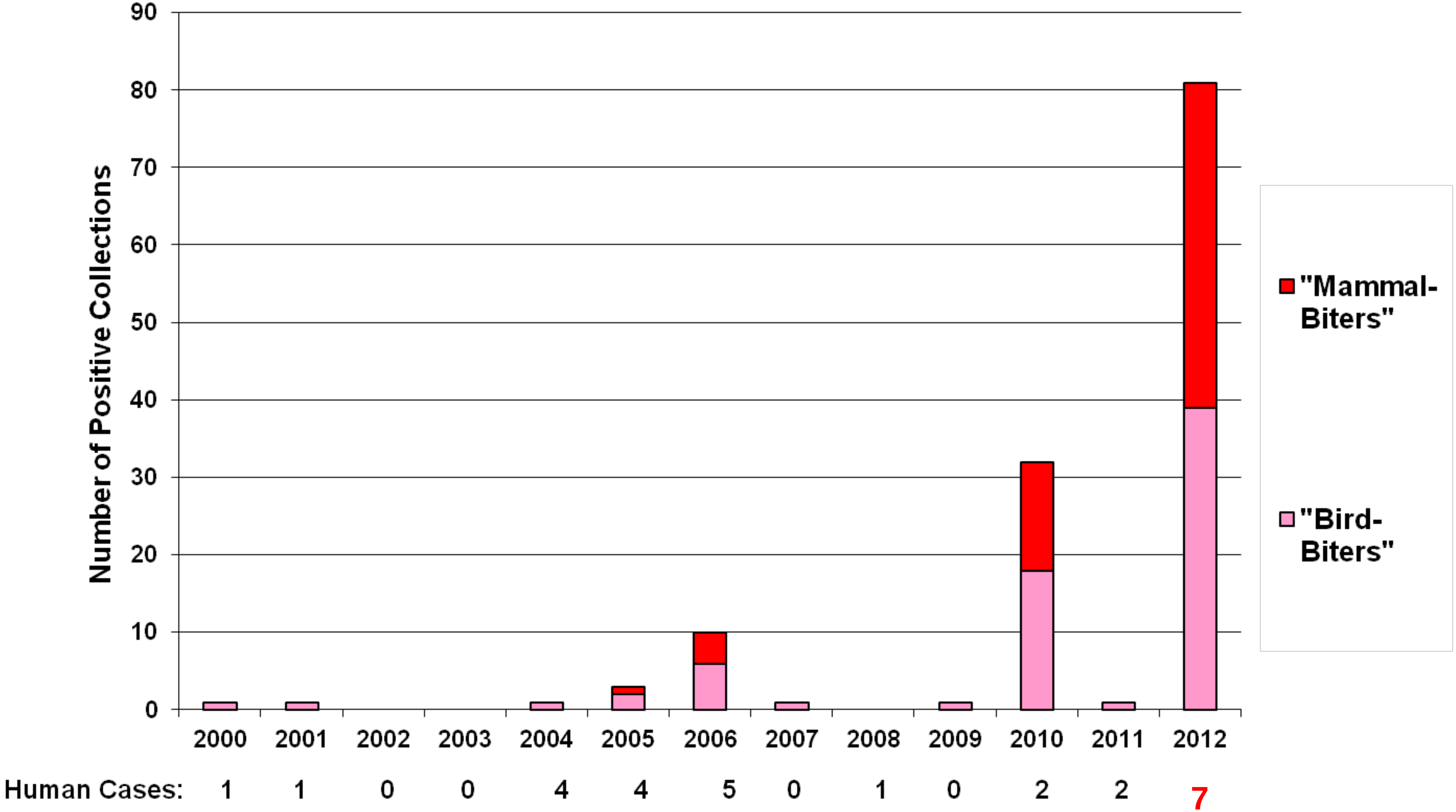
# Timing of EEE Positive Mosquitoes

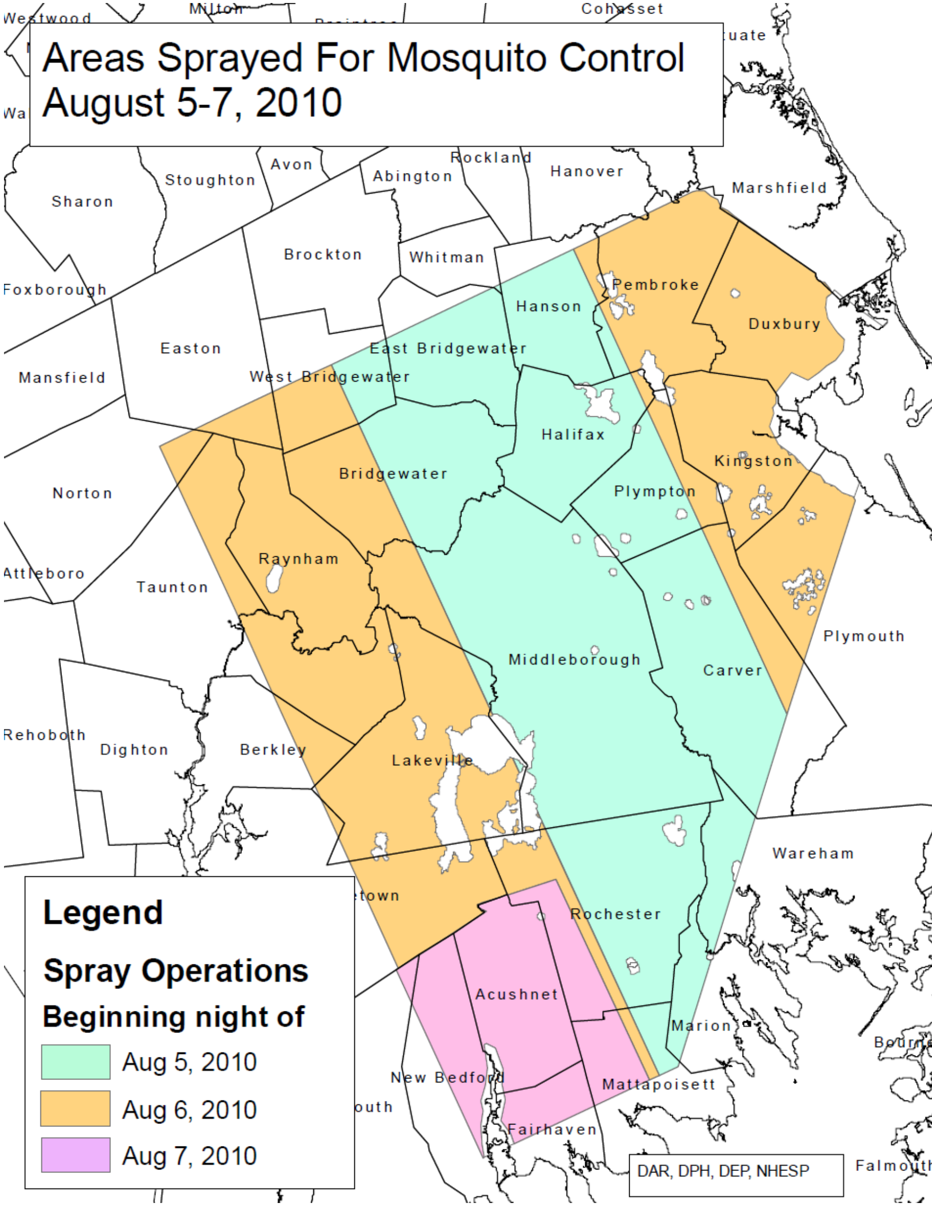


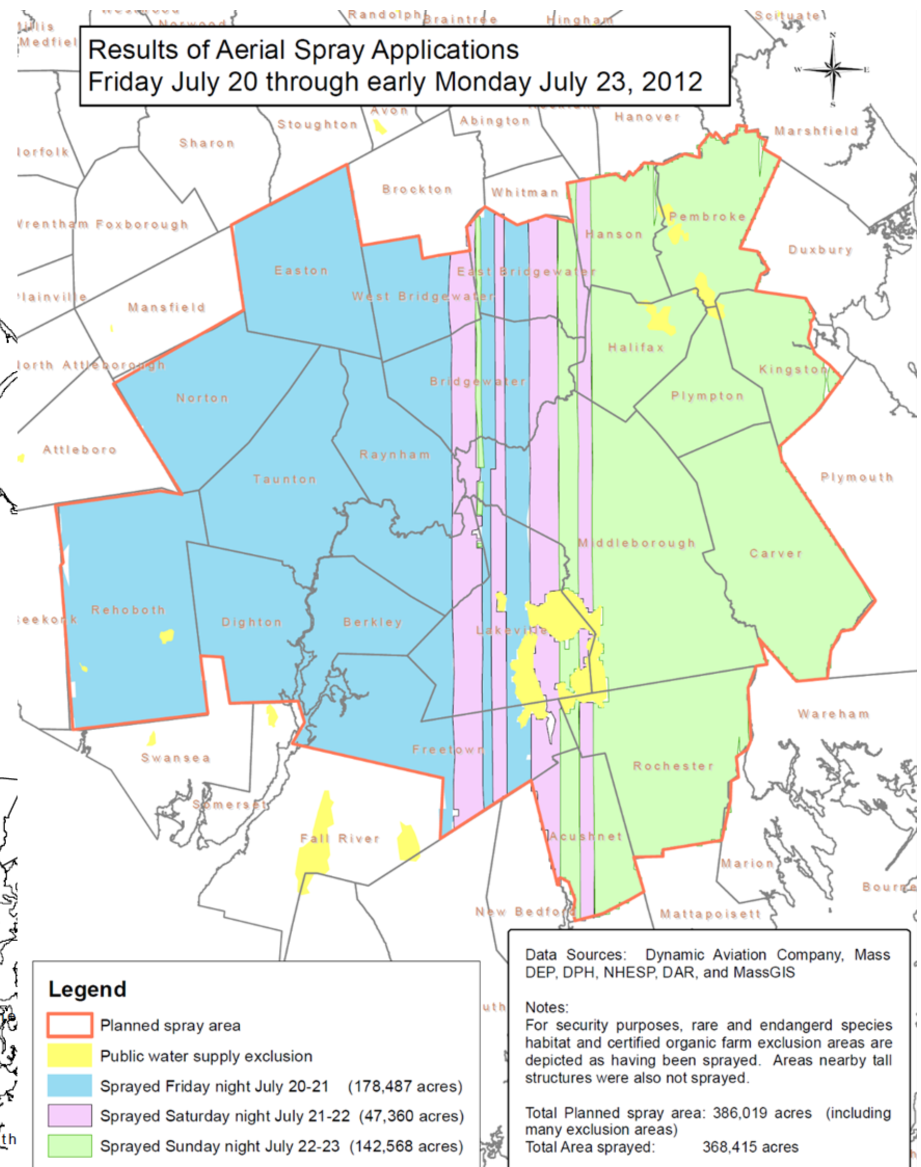
## Key to Color Coding on Risk Maps

| Risk | What it Means | What You Should Do |
|---|---|---|
| Remote | Multiple cases of human disease caused by EEE or WNV are considered highly unlikely at this time.<br><br>No human, animal or mosquito infections have been identified in the area so far this year. | • Repair screens<br>• Dump standing water twice weekly |
| Low | Multiple cases of human disease caused by EEE or WNV are considered unlikely at this time.<br><br>Infected mosquitoes have been found in the area this year, but no human or animal infections. | • Repair screens<br>• Dump standing water twice weekly<br>• **Wear mosquito repellent when outdoors during peak mosquito hours (from dusk to dawn)**<br>• **Wear long sleeves and long pants when outdoors during peak mosquito hours (from dusk to dawn)**<br>• **Use mosquito netting on baby carriages and playpens outdoors**<br>• **Arrange neighborhood cleanups to get rid of mosquito breeding sites** |
| Moderate | Multiple cases of human disease caused by EEE or WNV are considered moderately likely at this time.<br><br>There have been multiple infected mosquitoes this year in addition to human or animal cases last year. | • Repair screens<br>• Dump standing water twice weekly<br>• Wear mosquito repellent when outdoors during peak mosquito hours (from dusk to dawn)<br>• Wear long sleeves and long pants when outdoors during peak mosquito hours (from dusk to dawn)<br>• Use mosquito netting on baby carriages and playpens outdoors<br>• Arrange neighborhood cleanups to get rid of mosquito breeding sites<br>• **Be aware of stagnant water on private property (e.g. unused swimming pools) and consult the local board of health.** |
| High | Multiple cases of human disease are considered very likely at this time.<br><br>There have been infected mosquitoes repeatedly in the area or a human or animal case in the area this year. | • Repair screens<br>• Dump standing water twice weekly<br>• Wear mosquito repellent when outdoors during peak mosquito hours (from dusk to dawn)<br>• Wear long sleeves and long pants when outdoors during peak mosquito hours (from dusk to dawn)<br>• Use mosquito netting on baby carriages and playpens outdoors<br>• Arrange neighborhood cleanups to get rid of mosquito breeding sites<br>• Be aware of stagnant water on private property (e.g. unused swimming pools) and consult the local board of health.<br>• **Avoid outside areas with obvious mosquito activity**<br>• **Adjust outdoor activity to avoid peak mosquito hours (from dusk to dawn)**<br>• **Avoid overnight camping near freshwater swamps where EEE activity is likely** |
| Critical | **Multiple cases of human disease are extremely likely at this time.**<br><br>There has been more than one human and/or animal case of disease or rapid escalation of indications of risk in the area this year. | • Repair screens<br>• Dump standing water twice weekly<br>• Wear mosquito repellent when outdoors during peak mosquito hours (from dusk to dawn)<br>• Wear long sleeves and long pants when outdoors during peak mosquito hours (from dusk to dawn)<br>• Use mosquito netting on baby carriages and playpens outdoors<br>• Arrange neighborhood cleanups to get rid of mosquito breeding sites<br>• Be aware of stagnant water on private property (e.g. unused swimming pools) and consult the local board of health.<br>• Avoid outside areas with obvious mosquito activity<br>• Adjust outdoor activity to avoid peak mosquito hours (from dusk to dawn)<br>• Avoid overnight camping near freshwater swamps where EEE activity is likely<br>• **Consider cancelling or rescheduling outdoor gatherings, organized sporting events, etc. during peak mosquito hours** |

# EEE Identifications in July by"Bird-Biting" and "Mammal-Biting" Mosquito Species




Areas Sprayed For Mosquito Control
August 5-7, 2010
Legend
Spray Operations
Beginning night of
Aug 5, 2010
Aug 6, 2010
Aug 7, 2010
DAR, DPH, DEP, NHESP
Westwood
Milton
Cohasset
Sharon
Stoughton
Avon
Abington
Rockland
Hanover
Marshfield
Brockton
Whitman
Foxborough
Hanson
Pembroke
Duxbury
Easton
East Bridgewater
Mansfield
West Bridgewater
Halifax
Kingston
Bridgewater
Plympton
Norton
Raynham
Attleboro
Taunton
Plymouth
Middleborough
Carver
Rehoboth
Dighton
Berkley
Lakeville
Wareham
Rochester
Acushnet
Marion
Bourne
New Bedford
Mattapoisett
Fairhaven
Falmouth


Results of Aerial Spray Applications
Friday July 20 through early Monday July 23, 2012
Legend
Planned spray area
Public water supply exclusion
Sprayed Friday night July 20-21 (178,487 acres)
Sprayed Saturday night July 21-22 (47,360 acres)
Sprayed Sunday night July 22-23 (142,568 acres)
Data Sources: Dynamic Aviation Company, Mass DEP, DPH, NHESP, DAR, and MassGIS
Notes:
For security purposes, rare and endangerd species habitat and certified organic farm exclusion areas are depicted as having been sprayed. Areas nearby tall structures were also not sprayed.
Total Planned spray area: 386,019 acres (including many exclusion areas)
Total Area sprayed: 368,415 acres
Randolph
Braintree
Hingham
Scituate
Stoughton
Abington
Hanover
Marshfield
Sharon
Brockton
Whitman
Pembroke
Hanson
Duxbury
Foxborough
Easton
West Bridgewater
East Bridgewater
Mansfield
Halifax
Kingston
Bridgewater
Plympton
Norton
Attleboro
Raynham
Taunton
Plymouth
Middleborough
Carver
Rehoboth
Dighton
Berkley
Lakeville
Wareham
Swansea
Freetown
Rochester
Somerset
Fall River
Acushnet
Marion
Bourne
New Bedford
Mattapoisett

# Preliminary Control Efficacy
# Aerial Application, August 5-7, 2010

| | **Estimated Percent Mosquito Reduction** |
|---|---|
| **Overall** | **77 - 87** |
| ***Culiseta melanura*** | **39 - 96** |
| ***Coquillatidia perturbans*** | **87 - 89** |

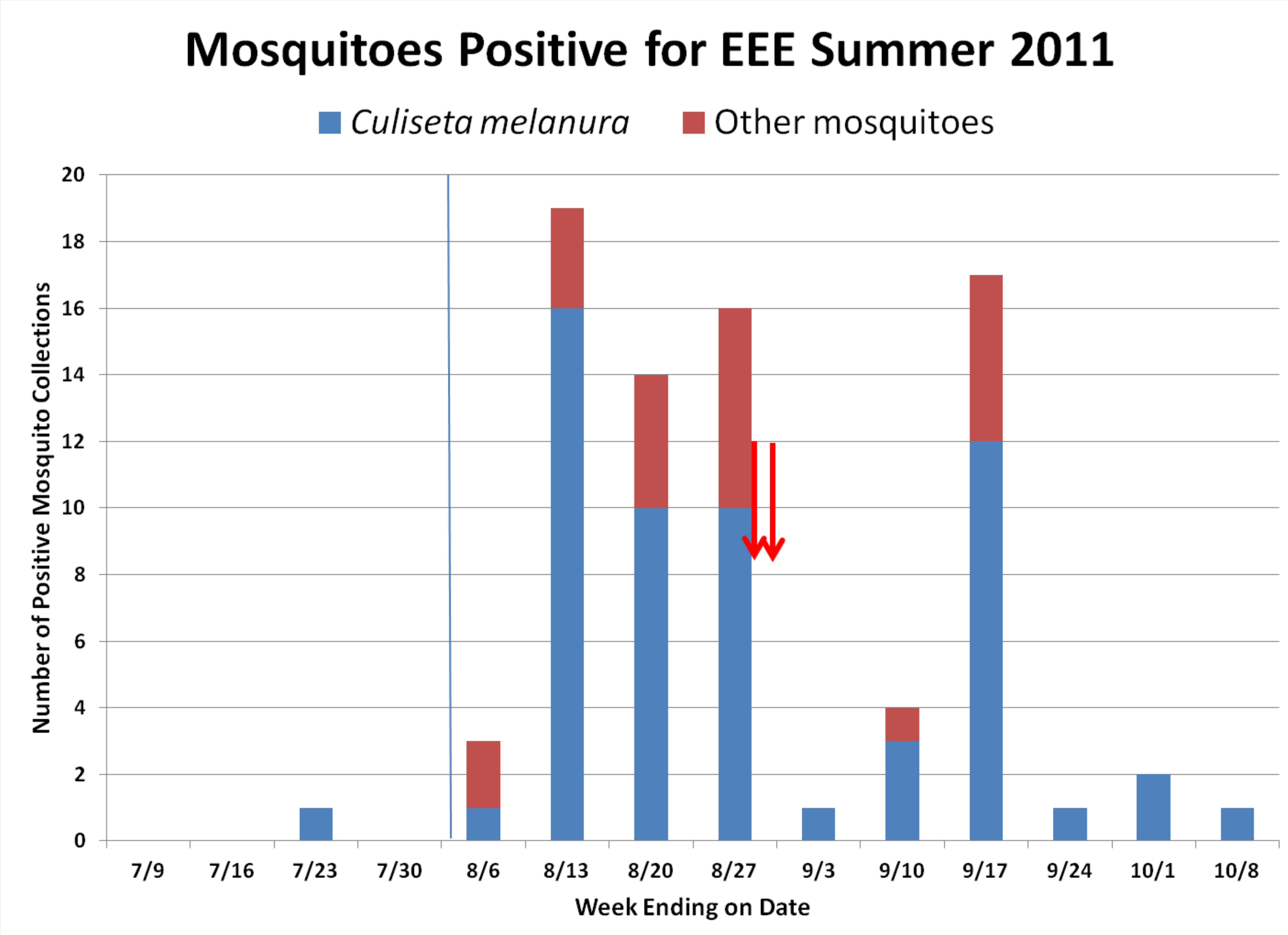
**Mosquito EEE Infection Rate**

**Before spray:** **25.1/1,000 pools**

**Since spray:** **13.5/1,000 pools**

# Estimated Efficacy Rates of Aerial Adulticide Application July 20-22, 2012

| | 2012 |
|---|---|
| **Overall Mosquito Population Reduction** | **42-81%** |
| **Bird-biting Mosquito Population Reduction (primarily *C. melanura*)** | **36-80%** |
| **Mammal-biting Mosquito Population Reduction (primarily *C. perturbans* and *O. canadensis*)** | **14-84%** |


Mosquitoes Positive for EEE Summer 2011
Culiseta melanura
Other mosquitoes
Number of Positive Mosquito Collections
0
2
4
6
8
10
12
14
16
18
20
7/9
7/16
7/23
7/30
8/6
8/13
8/20
8/27
9/3
9/10
9/17
9/24
10/1
10/8
Week Ending on Date

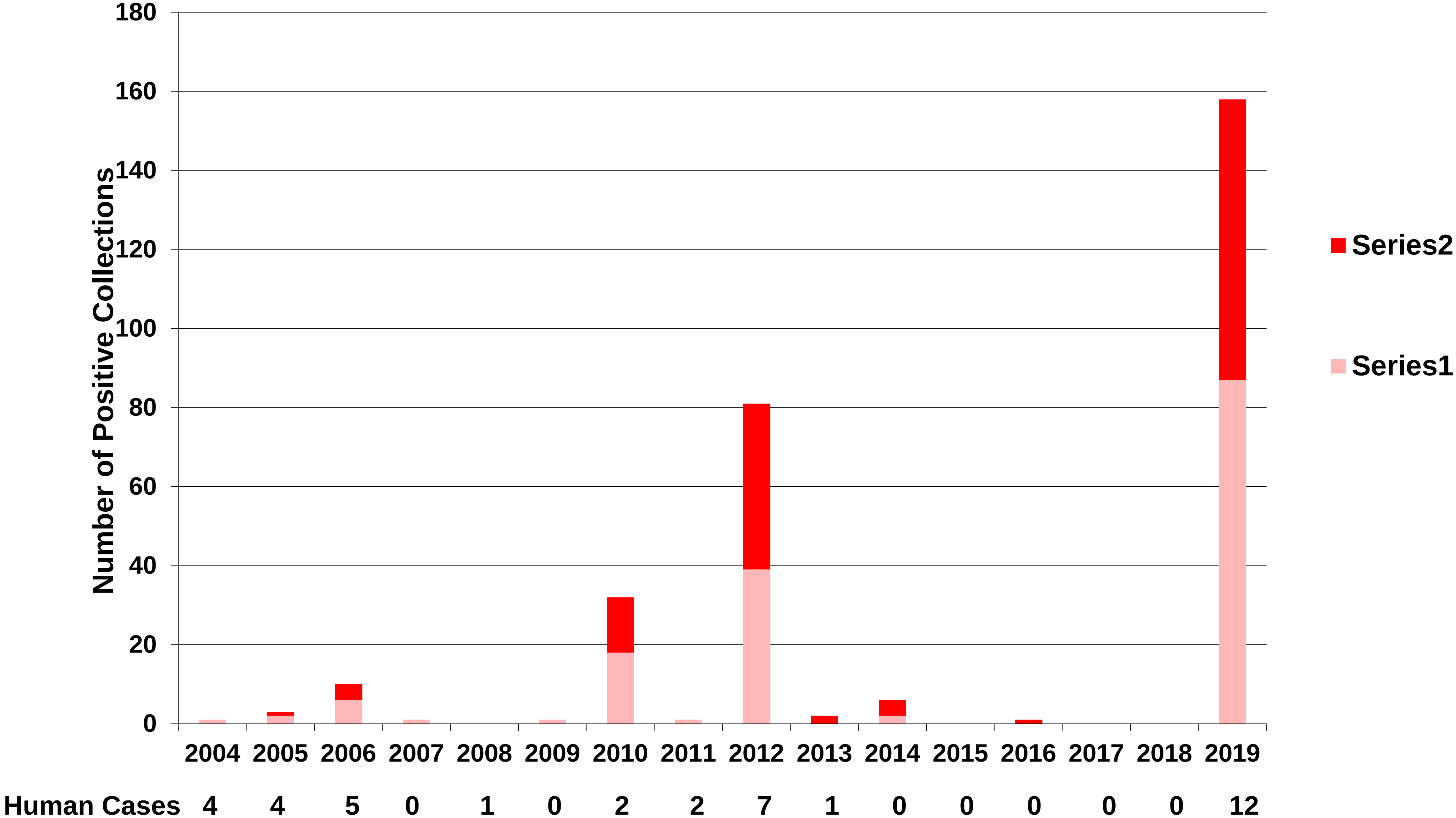
# Massachusetts EEE Expert Panel 2011-2012

Experts in the fields of

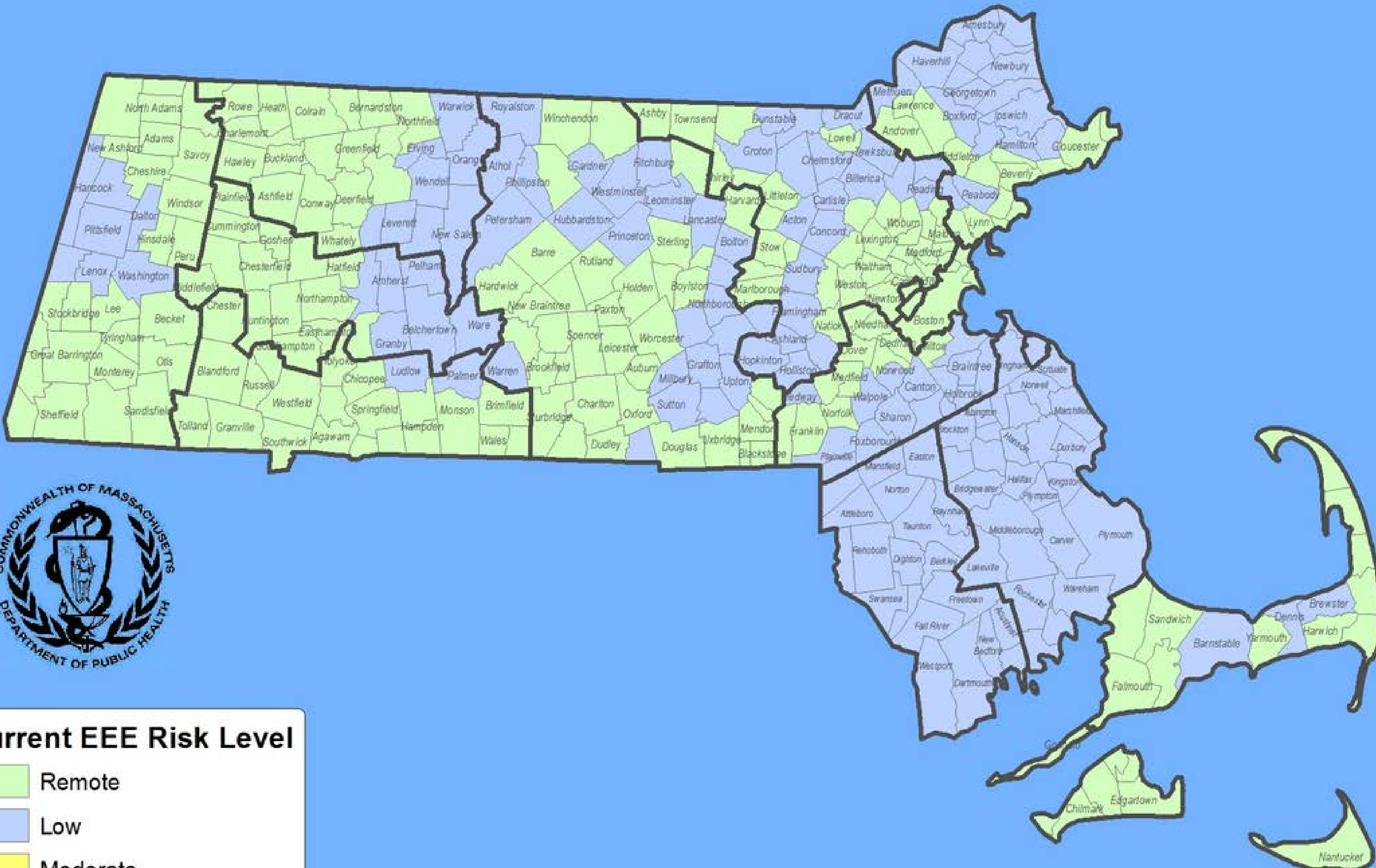
- mosquito control
- toxicology,
- ecology,
- climate change,
- public health
- infectious disease were invited to participate.

Panelists were chosen specifically because they were not already involved in the Massachusetts arbovirus surveillance and mosquito control processes, and could be expected to provide fresh perspectives.

# EEE Identifications in July by"Bird-Biting" and "Mammal-Biting" Mosquito Species



# Massachusetts EEE Risk Categories



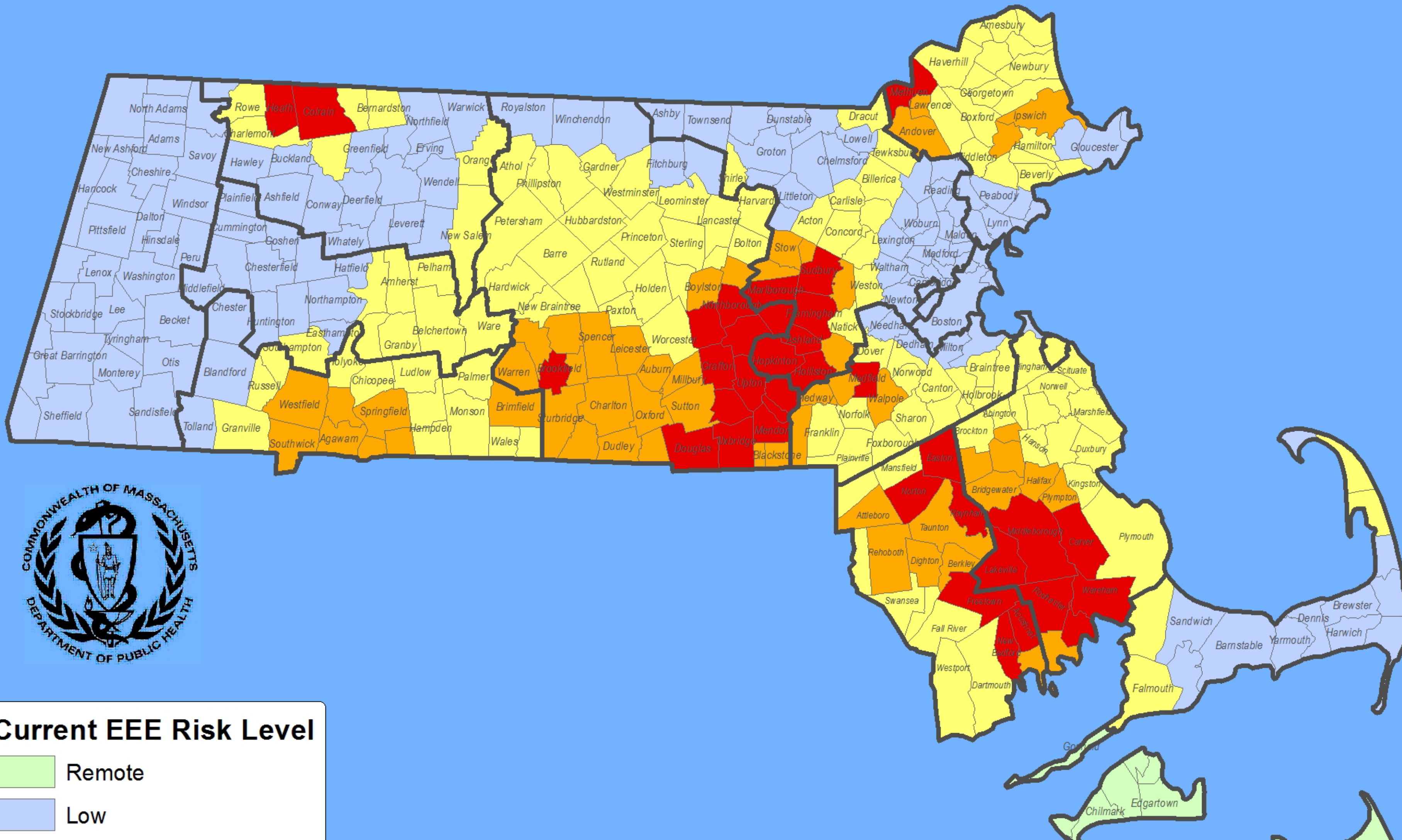

## Current EEE Risk Level

- Remote
- Low
- Moderate
- High
- Critical

## Current Risk Levels – as of October 09, 2018

Massachusetts State Public Health Laboratory
Arbovirus Surveillance Program

# Massachusetts EEE Risk Categories

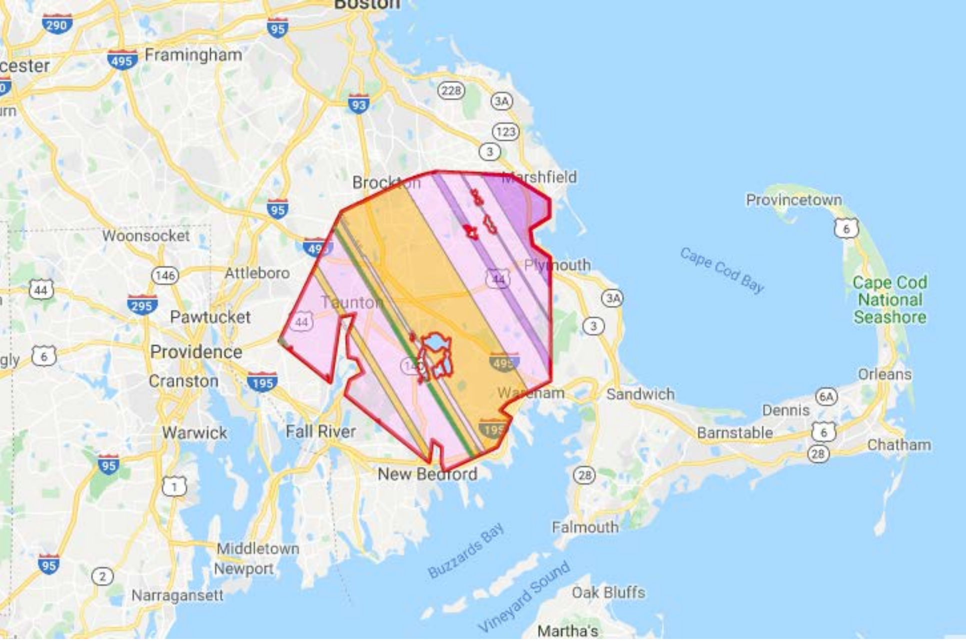



**Current EEE Risk Level**

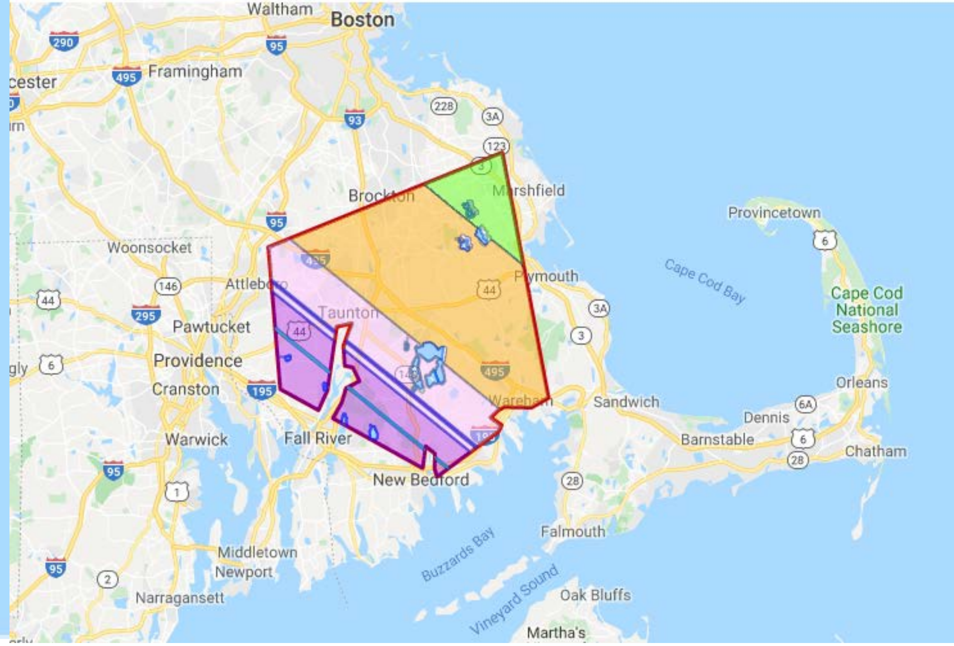
- Remote
- Low
- Moderate
- High
- Critical

## Current Risk Levels – as of October 10, 2019

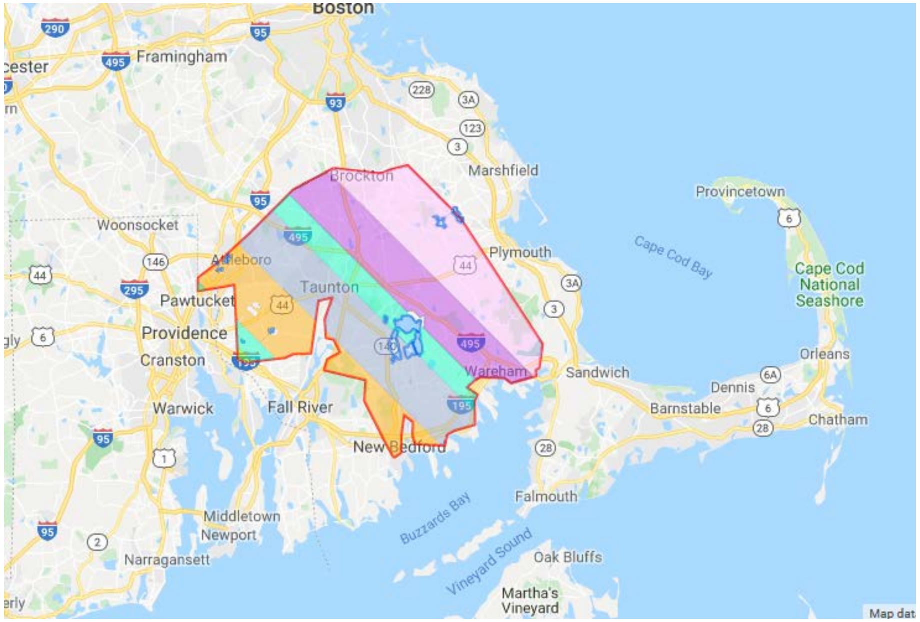
*Massachusetts State Public Health Laboratory*
*Arbovirus Surveillance Program*



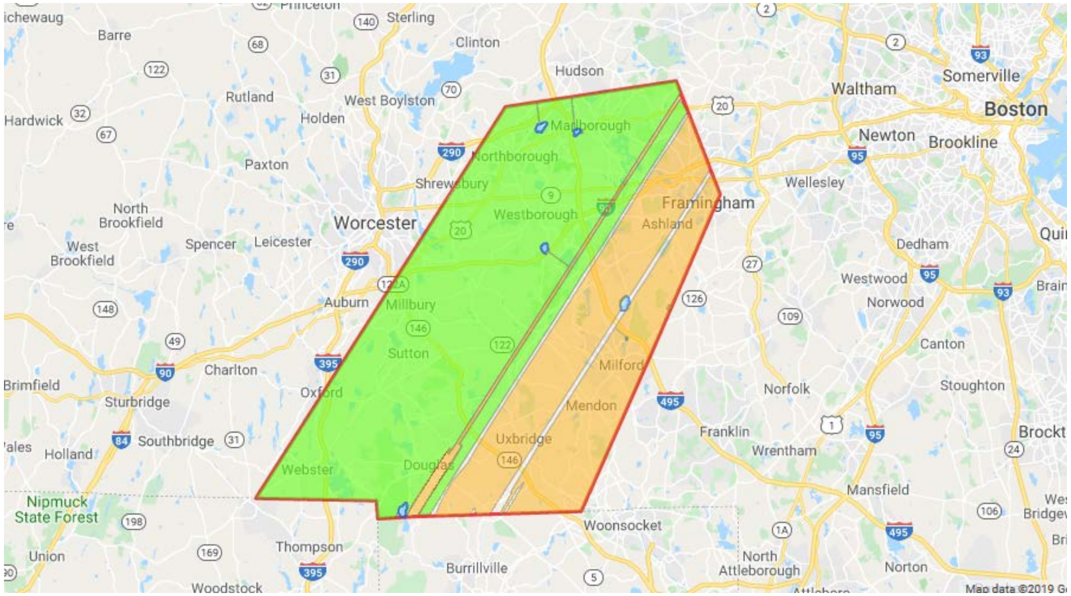

August 8-12, 2019



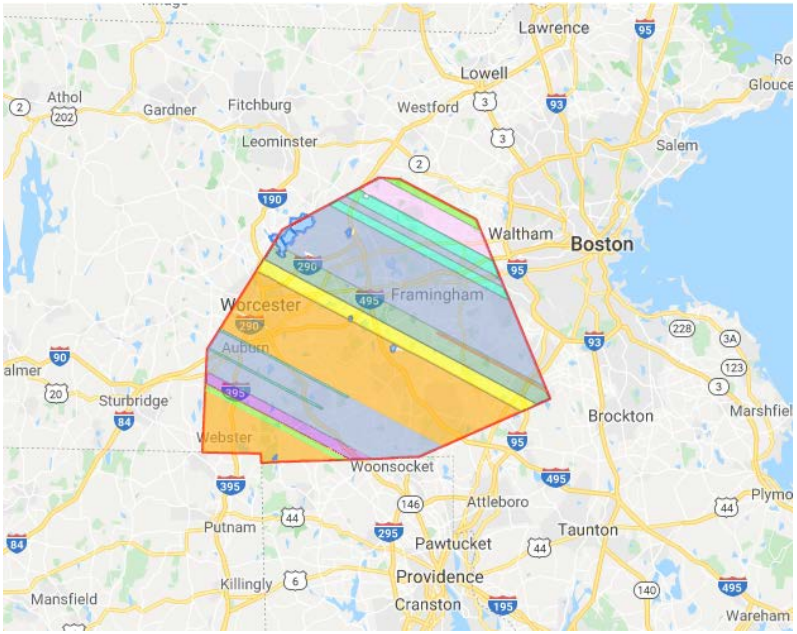

August 21-25, 2019



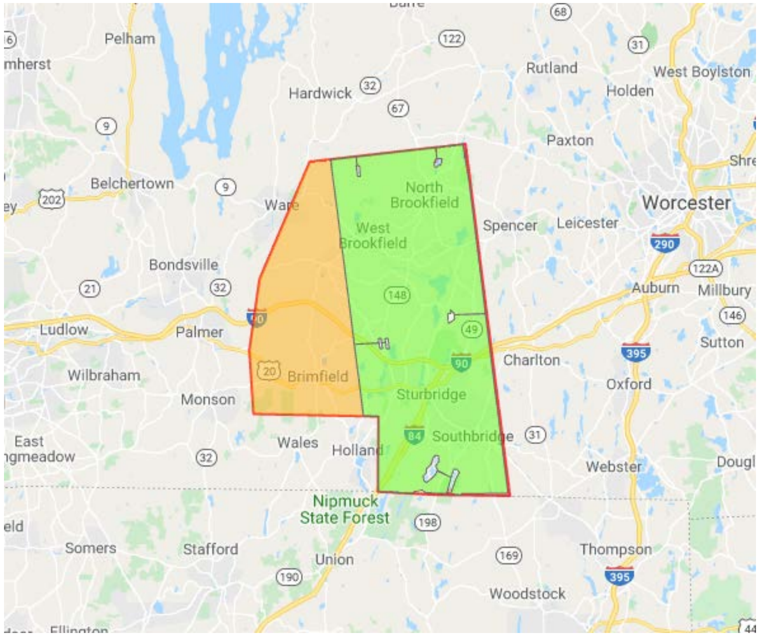

September 18-24, 2019




August 26-27, 2019




September 10-18, 2019




September 16-17, 2019


PRICE $3.00
THE NEW YORKER
APRIL 17, 2000

# West Nile Virus

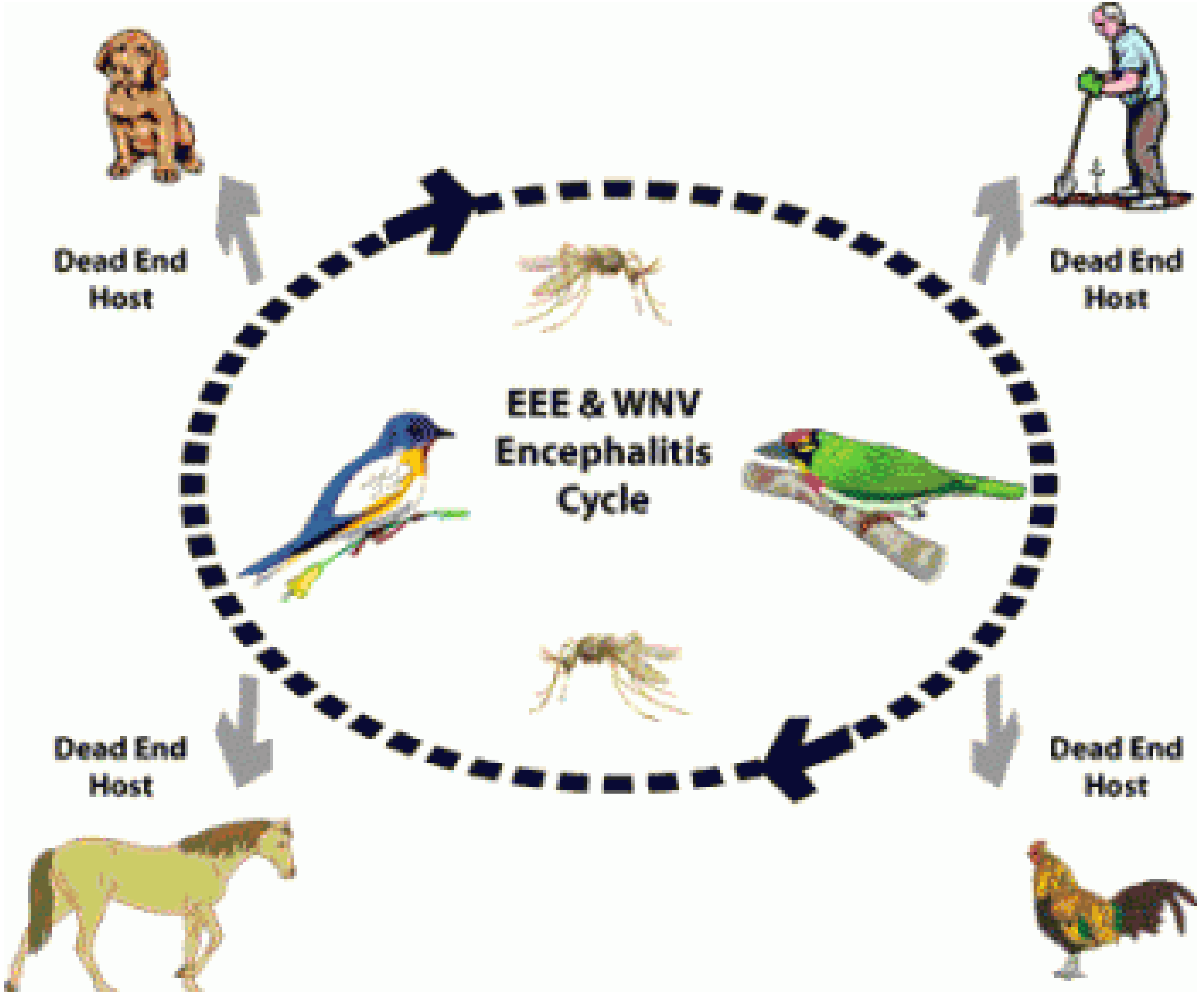
- Isolated from woman with fever, West Nile region, Northern Province, Uganda, 1937
- First epidemic described: Israel, 1950
- Multiple strains, widely endemic - Middle East, Africa, Asia, Europe, Australia, and North America
- Broad range of hosts: birds, mammals
- Human infection common in endemic areas
- First appearance in North America, Summer of 1999
  - 62 confirmed and probable cases, 7 deaths
  - Serosurveys suggest widespread, unrecognized, human infection
  - Severe disease and deaths in birds and horses

# West Nile Virus Infection
# Human Disease

- **Incubation period 5 to 15 days**
- **Headache, sore throat, fatigue, myalgia, arthralgia, fever (moderate to high), conjunctivitis, lymphadenopathy**
- **Rash (roseolar) more common than with other flaviviruses**
- **Muscle weakness, often profound**
- **Aseptic meningitis, encephalitis, meningoencephalitis**
- **Myocarditis, hepatitis, pancreatitis**
- **Mild and sub-clinical infection very common, age-related severity**

# WNV Encephalitis/Infection and Clinical/Sub-Clinical Ratios

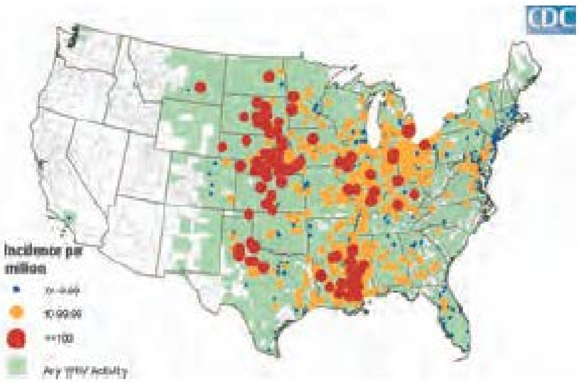
| Area | Year(s) | Encephalitis/ Infection | Clinical/ Sub-Clinical |
|---|---|---|---|
| Israel | 1950s | 1:100 | - |
| Romania | 1996 | 1:331 | - |
| Czechland | 1997 | - | 1:1.6 |
| NYC | 1999 | 1:139 | 1:4.8 |
| Staten Island | 2000 | 1:157 | |
| Suffolk Co., NY | 2000 | 1:>121 | |


Dead End
Host
Dead End
Host
EEE & WNV
Encephalitis
Cycle
Dead End
Host
Dead End
Host

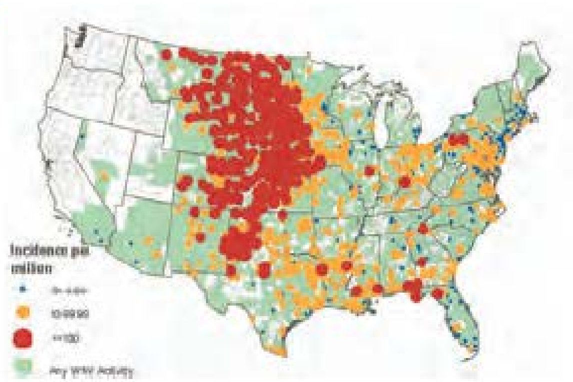

1999


2000

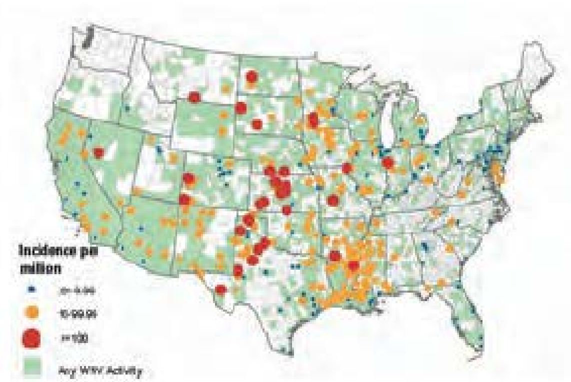

2001



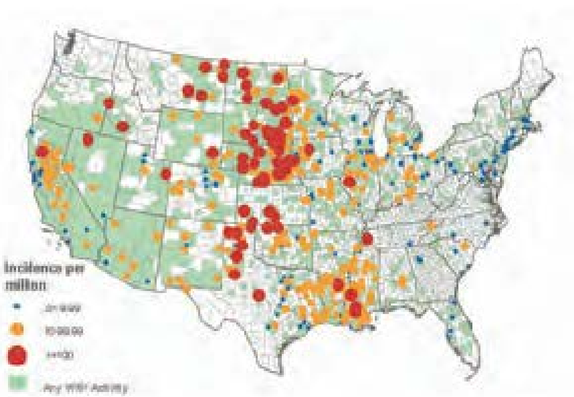

2002



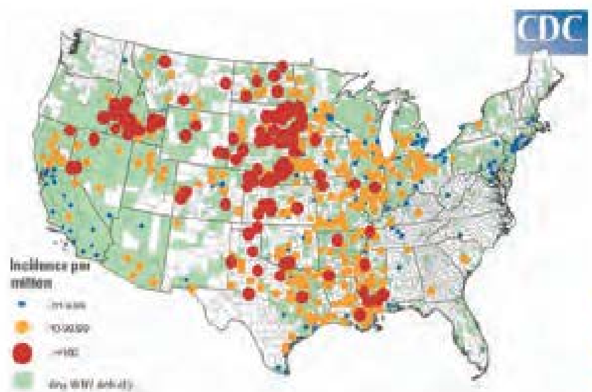

2003



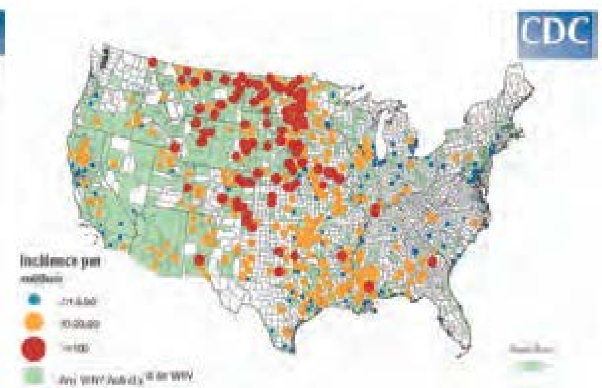

2004



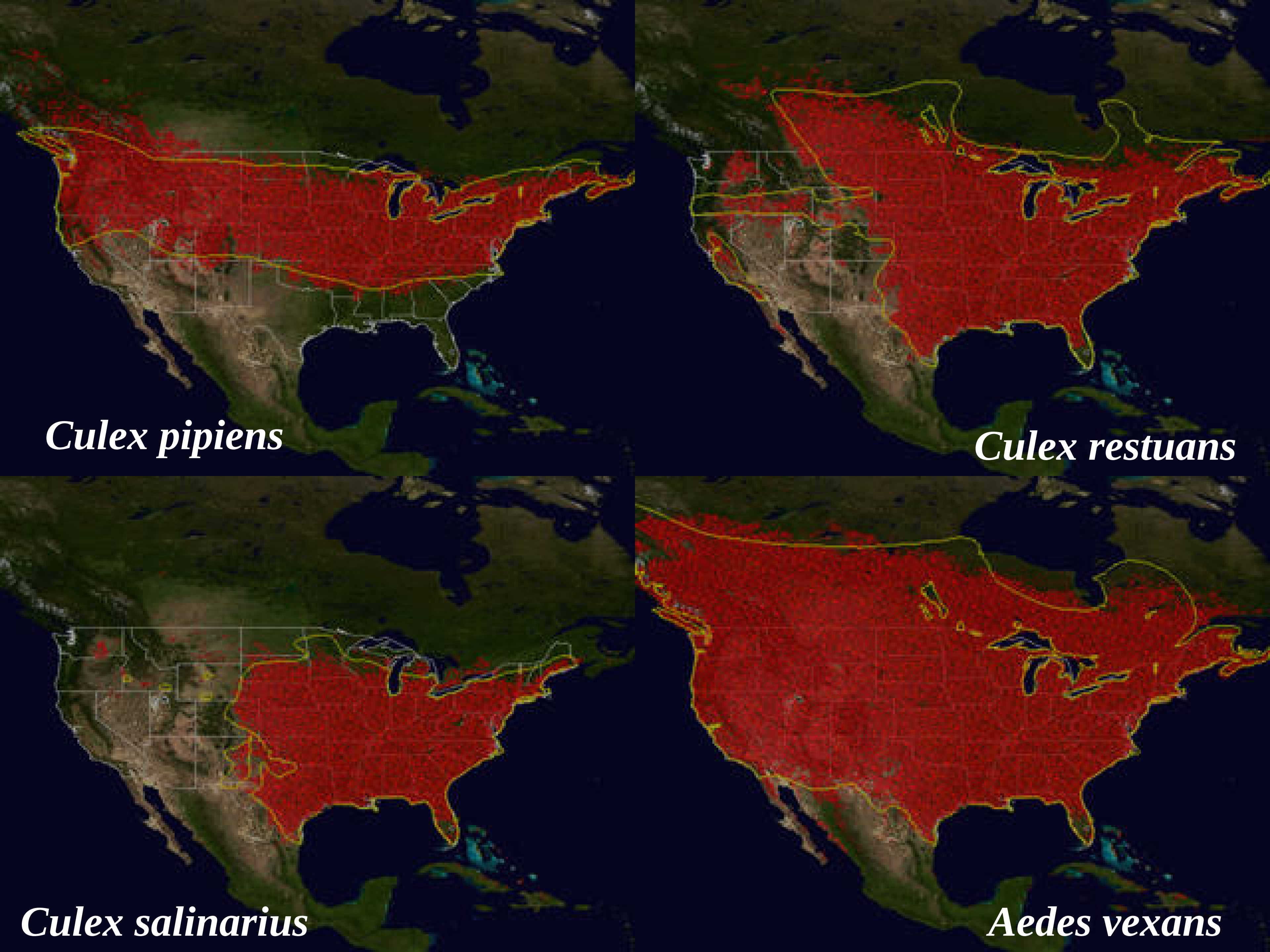

2005




2006




2007

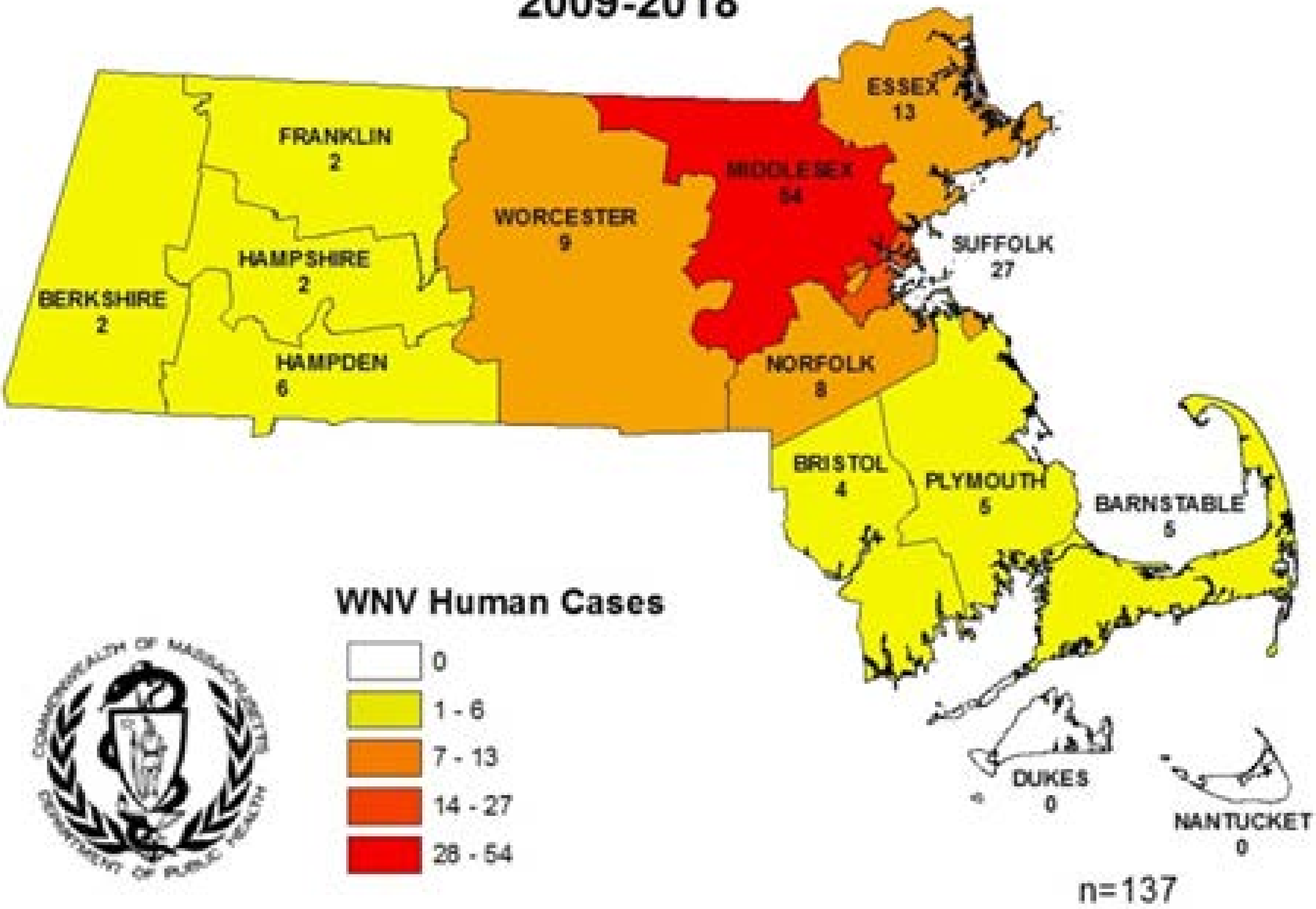


Culex pipiens
Culex restuans
Culex salinarius
Aedes vexans

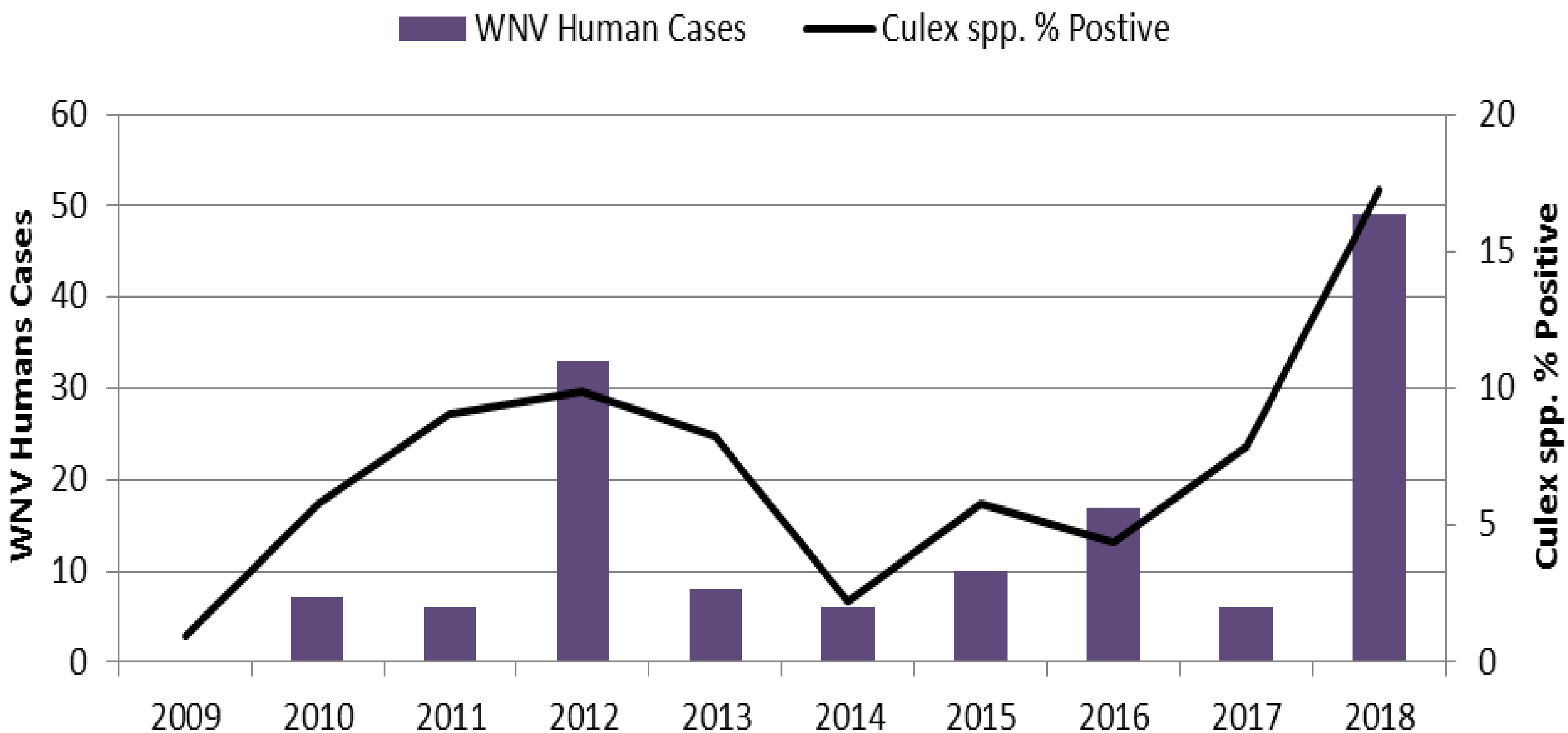
# West Nile Virus Activity, Massachusetts, 2000-2018

| | Birds | Mosquitoes | Horses | Humans |
|---|---|---|---|---|
| 2000 | 448 | 4 | 1 | 0 |
| 2001 | 1104 (46%) | 25 (0.39%) | 45 | 3 |
| 2002 | 575 (67%) | 68 (1.10%) | 2 | 25 |
| 2003 | 429 (72%) | 48 (0.80%) | 8 | 19 |
| 2004 | 8 (9%) | 15 (0.19%) | 0 | 0 |
| 2005 | 83 (27%) | 99 (1.22%) | 0 | 6 |
| 2006 | 57 (18%) | 43 (0.50%) | 0 | 3 |
| 2007 | 43 (19%) | 65 (0.43%) | 0 | 6 |
| 2008 | 63 (45%) | 135 (2.95%) | 0 | 1 |
| 2009 | - | 26 (0.76%) | 1 | 0 |
| 2010 | - | 121 (3.4%) | 1 | 7 |
| 2011 | - | 275 (6.0%) | 1 | 6 |
| 2012 | - | 307 (4.5%) | 2 | 33 |
| 2013 | - | 335 (5.5%) | 2 | 8 |
| 2014 | - | 56 (1.1%) | 0 | 6 |
| 2015 | - | 164 (3.6%) | 0 | 9 |
| 2016 | - | 189 (2.9%) | 0 | 16 |
| 2017 | | 290 (5.3%) | 0 | 6 |
| 2018 | | 579 (9.8%) | 2 | 49 |

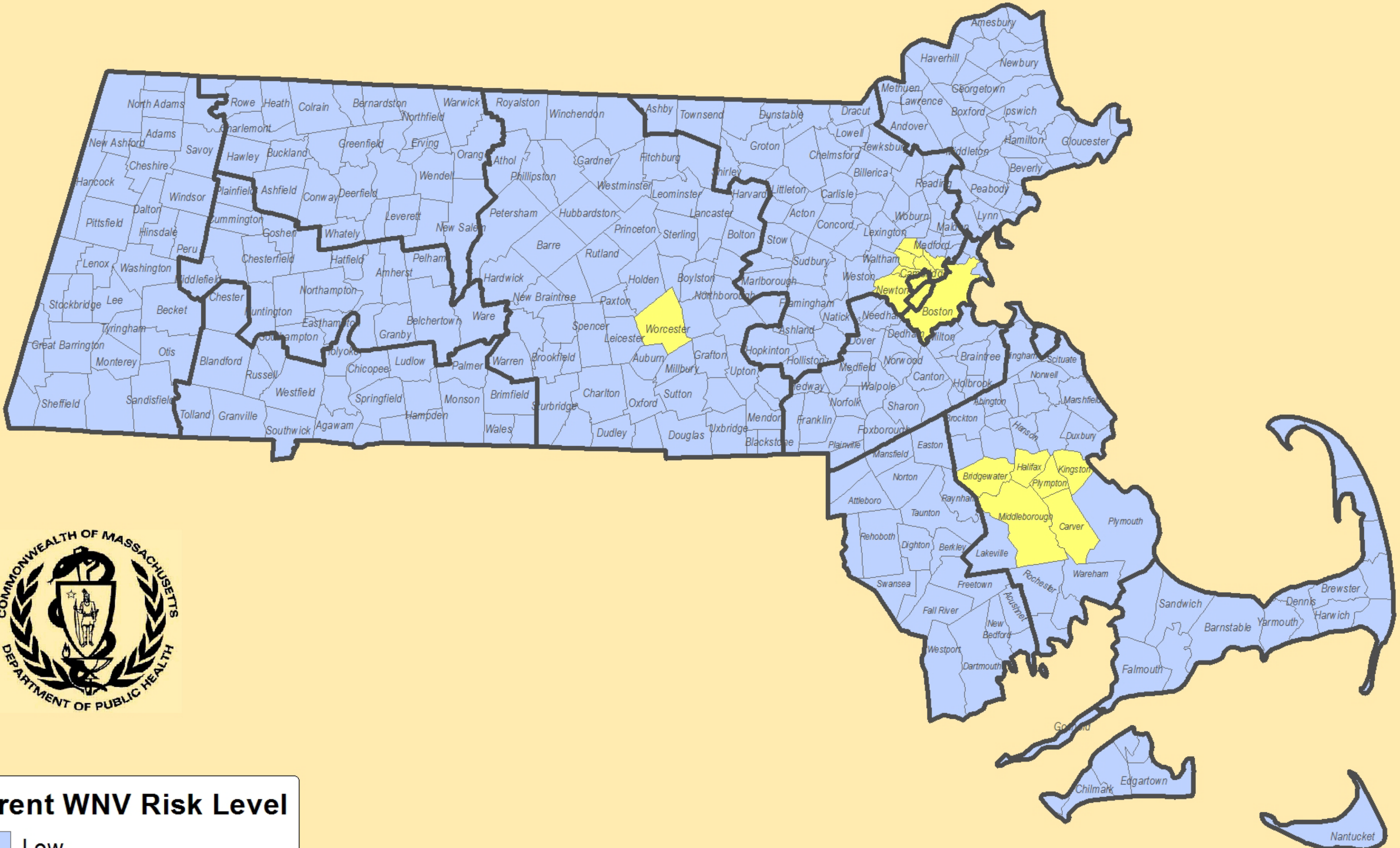
# WNV Human Cases in Massachusetts 2009-2018



**Confirmed WNV Human Cases and the percentage of *Culex spp.* Mosquito Samples Positive for WNV in Massachusetts by Year: 2009-2018**



# Massachusetts WNV Risk Categories




**Current WNV Risk Level**

- Low
- Moderate
- High
- Critical

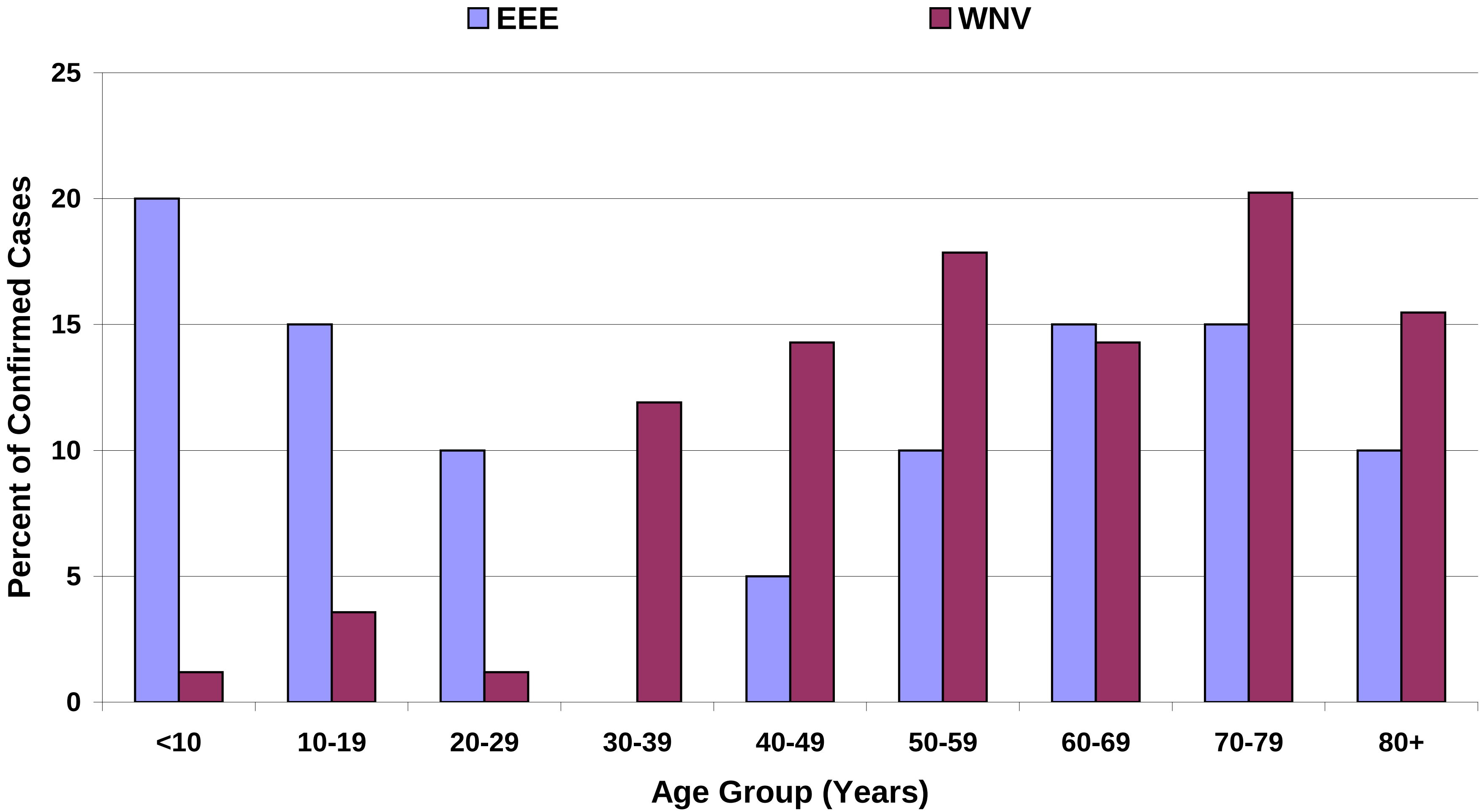
## Current Risk Levels – as of October 10, 2019

*Massachusetts State Public Health Laboratory*
*Arbovirus Surveillance Program*

# West Nile Virus
# Laboratory Confirmation

- WNV isolation (virus identified by IFA, neutralization, RT-PCR or sequencing)
- RT-PCR using multiple primers
- Captured WNV antigen
- IgM by capture EIA
- IgG by EIA, HI or neutralization test
- Identification of WNV antigen or genome in tissue

# Percent of Human WNV and EEE Cases in Massachusetts, 2001-2012, by Age Group



# Jamestown Canyon Virus

- California serogroup orthobunyavirus
- First identified in *Culiseta* species in Colorado
- Related to Inkoo virus in Northern Europe
- Found in mosquitoes in Connecticut for many years, widely distributed in U.S.
- Natural cycle presumably similar to EEE, with deer as a reservoir host
- Human seroprevalence of 4-10% in New England
- Clinical illness non-specific ranging from “summer virus” to encephalitis
  - Identified patients with clinical illness tend to be older than patients with LaCrosse virus infection
- 1-2 cases per year confirmed in Massachusetts

# Seroprevalence of Jamestown Canyon Virus among Humans, Nova Scotia, Canada, 2012

## Patriquin G, et al. EID 2018; 24: 118-121

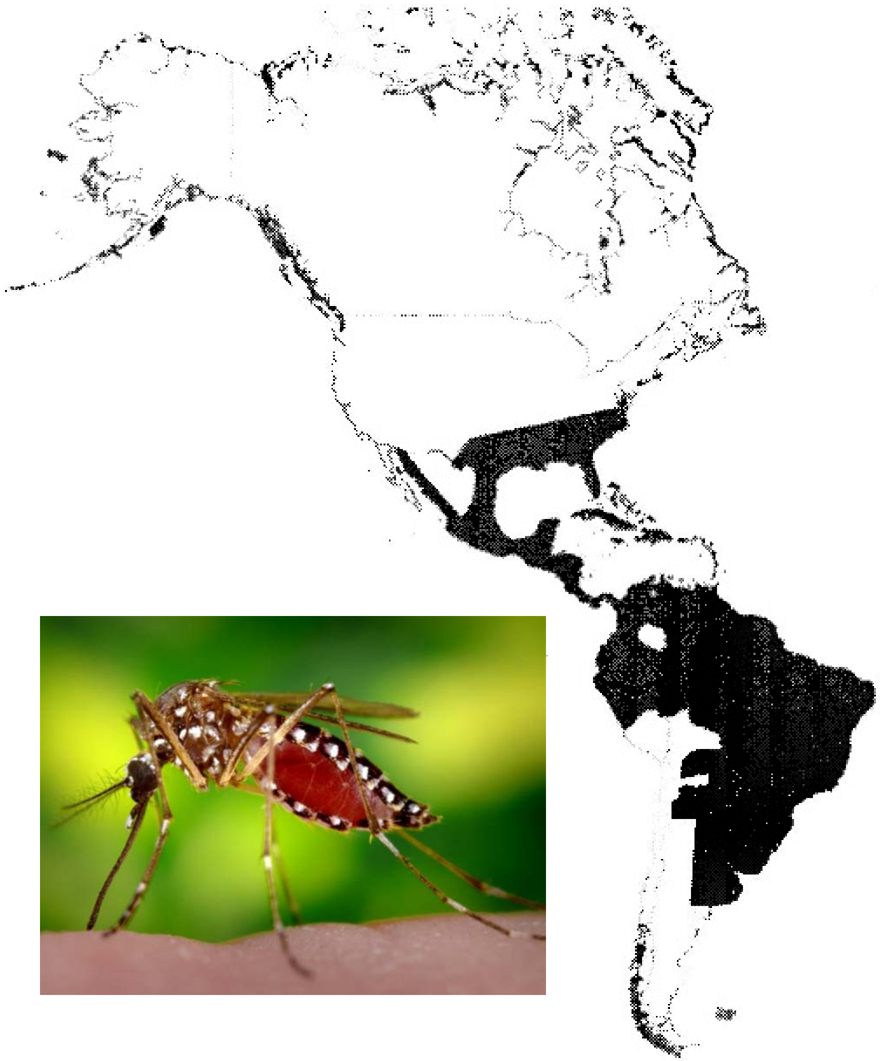
| Characteristic | No. tested | No. (%) positive | Adjusted proportion (95% CI) | p value* |
|---|---|---|---|---|
| Sex | | | | 0.013 |
| M | 151 | 51 (33.8) | 26.8 (19.9–35.0) | |
| F | 150 | 30 (20.0) | 14.4 (9.3–21.5) | |
| Age group, y | | | | 0.024 |
| 10–19 | 43 | 6 (14.0) | 10.8 (4.0–25.8) | |
| 20–29 | 54 | 13 (24.1) | 20.4 (11.0–34.5) | |
| 30–39 | 52 | 12 (23.1) | 14.1 (6.9–26.7) | |
| 40–49 | 60 | 15 (25.0) | 20.4 (1.6–33.3) | |
| 50–59 | 61 | 21 (34.4) | 27.8 (17.1–41.7) | |
| 60–64 | 31 | 14 (45.2) | 33.0 (17.7–53.0) | |
| District Health Authority | | | | 0.004 |
| 1 | 81 | 39 (48.2) | 48.2† (37.4–59.1) | |
| 2–8 | 115 | 26 (22.6) | 22.6† (15.8–31.4) | |
| 9 | 105 | 16 (15.2) | 15.2† (9.5–23.5) | |
| Total no. | 301 | 81 (26.9) | 20.6 (16.0–25.9) | |

*Pearson $\chi^2$ for test by DHA; corrected Pearson $\chi^2$ for test by sex; logistic regression test for trend by age group.
†Adjustment was unnecessary for estimates made by the DHA because weighting was done by this authority.

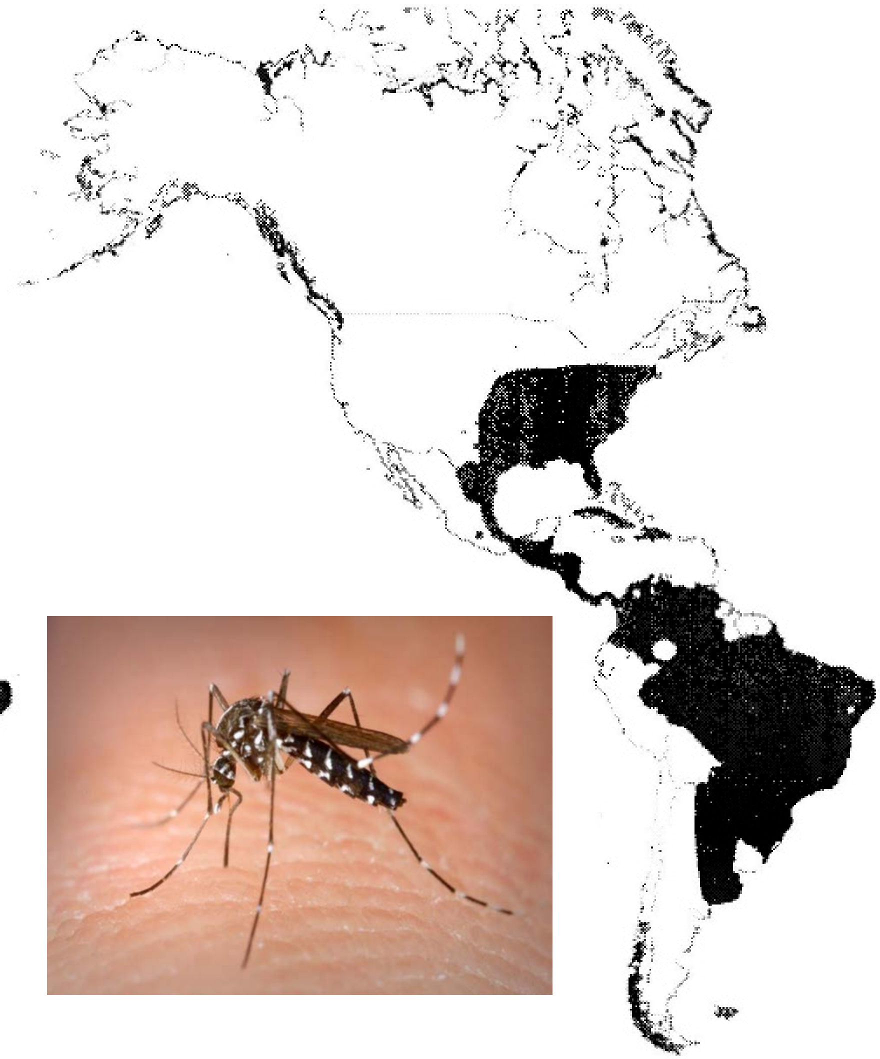

Image by: ISAAC KASAMANI/AFP

| Interpretation of results of antibody testing for suspected Zika virus infection - United States, 2016 | | | |
|---|---|---|---|
| **Zika virus and dengue virus IgM ELISA** | **Zika virus PRNT** | **Dengue virus PRNT** | **Interpretation** |
| Positive or equivocal (either assay) | ≥10 | <10 | Recent Zika virus infection† |
| Positive or equivocal (either assay) | <10 | ≥10 | Recent dengue virus infection† |
| Positive or equivocal (either assay) | ≥10 | ≥10 | Recent flavivirus infection; specific virus cannot be identified† |
| Any result (either or both assays) | <10 | <10 | No evidence of Zika virus or dengue virus infection |
| Inconclusive in one assay AND inconclusive or negative in the other | ≥10 | <10 | Evidence of Zika virus infection; timing cannot be determined§ |
| Inconclusive in one assay AND inconclusive or negative in the other | <10 | ≥10 | Evidence of dengue virus infection; timing cannot be determined§ |
| Inconclusive in one assay AND inconclusive or negative in the other | ≥10 | ≥10 | Evidence of flavivirus infection; specific virus and timing cannot be determined§ |

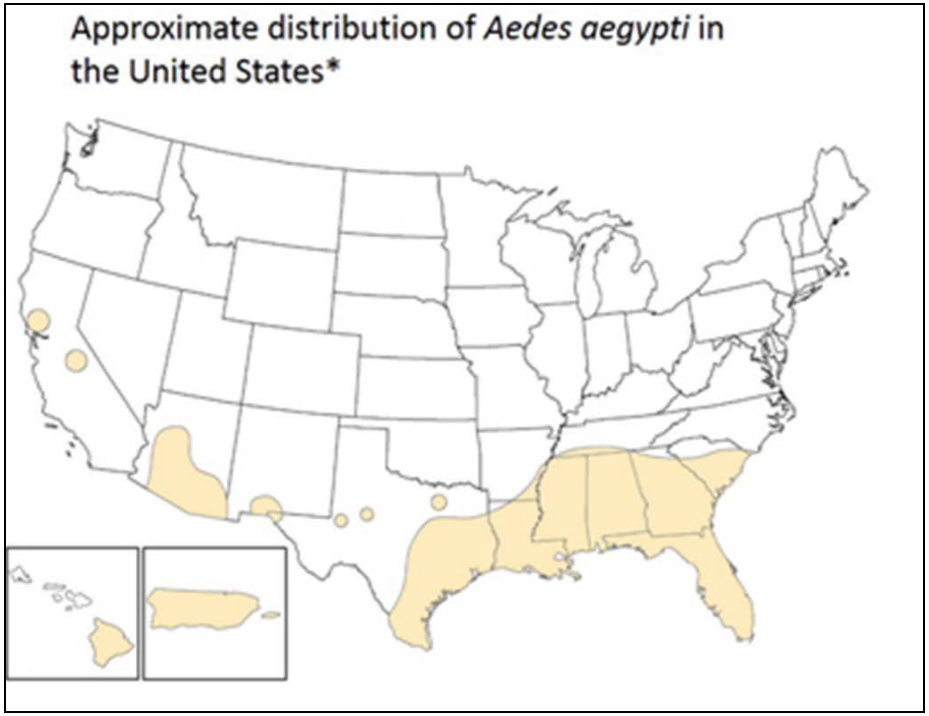
*Aedes aegypti*

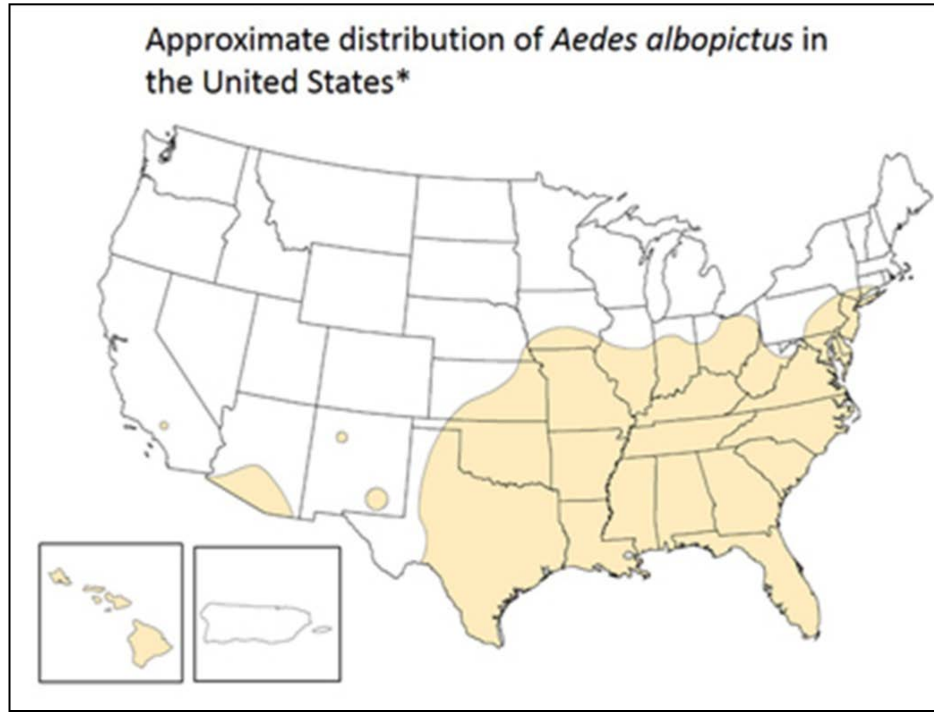


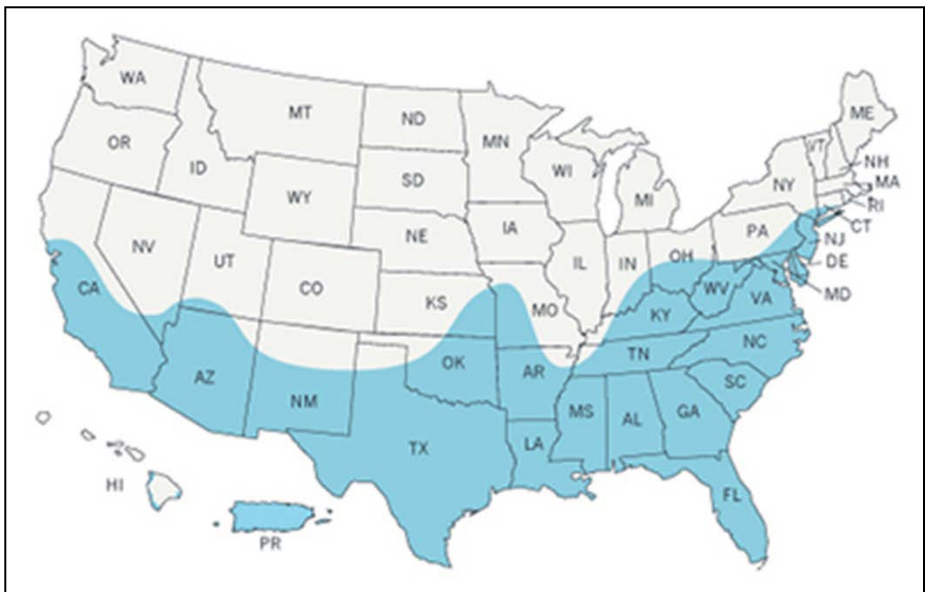
*Aedes albopictus*



**Peterson LR, Epstein JS. Tansfusion 2014; 54:1911-1915.**


Approximate distribution of *Aedes aegypti* in the United States*


Approximate distribution of *Aedes albopictus* in the United States*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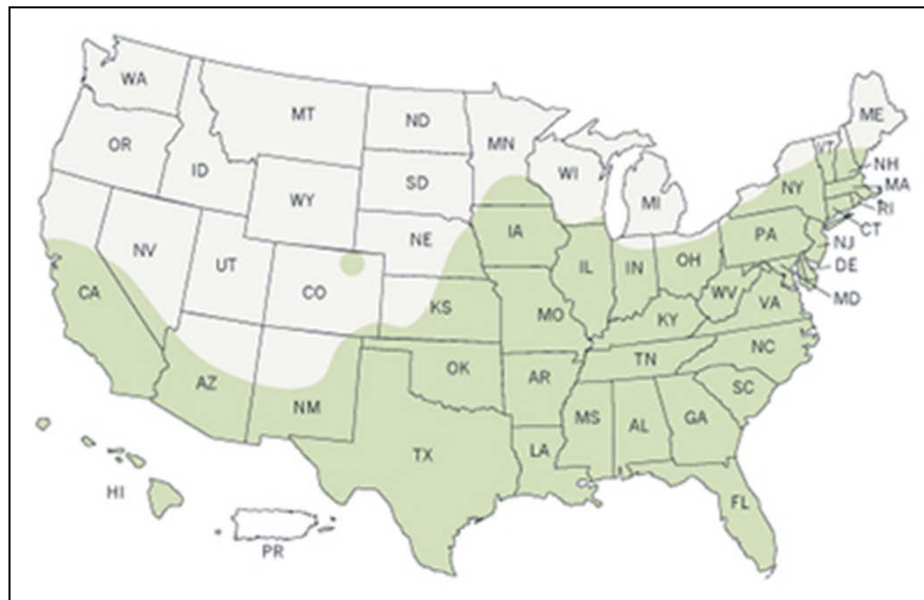
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CDC


CENTRAL MASSACHUSETTS
MOSQUITO CONTROL PROJECT
MOSQUITO
OVITRAP

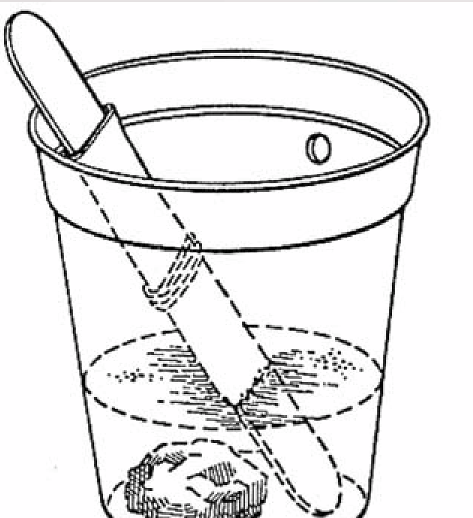
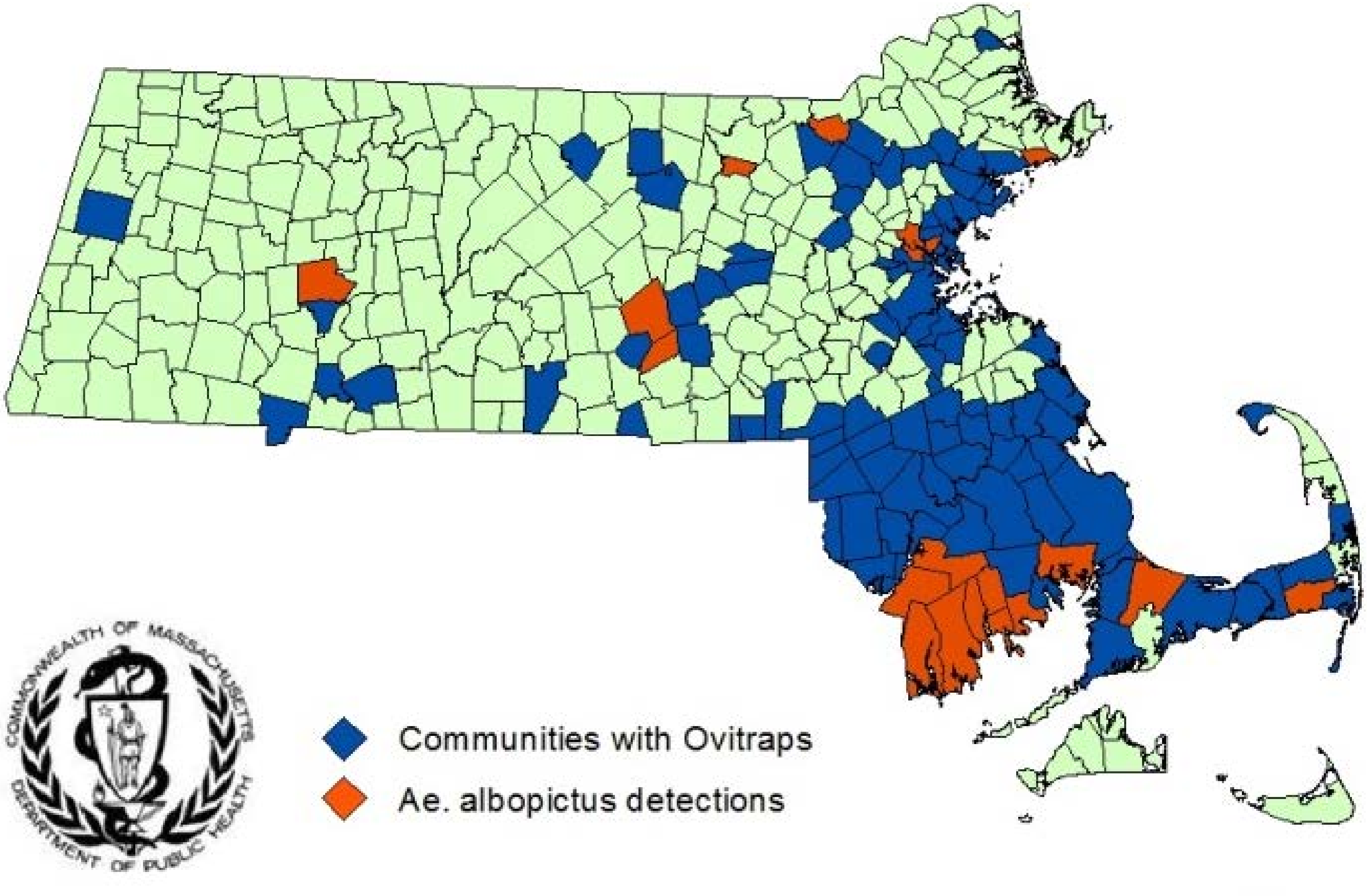
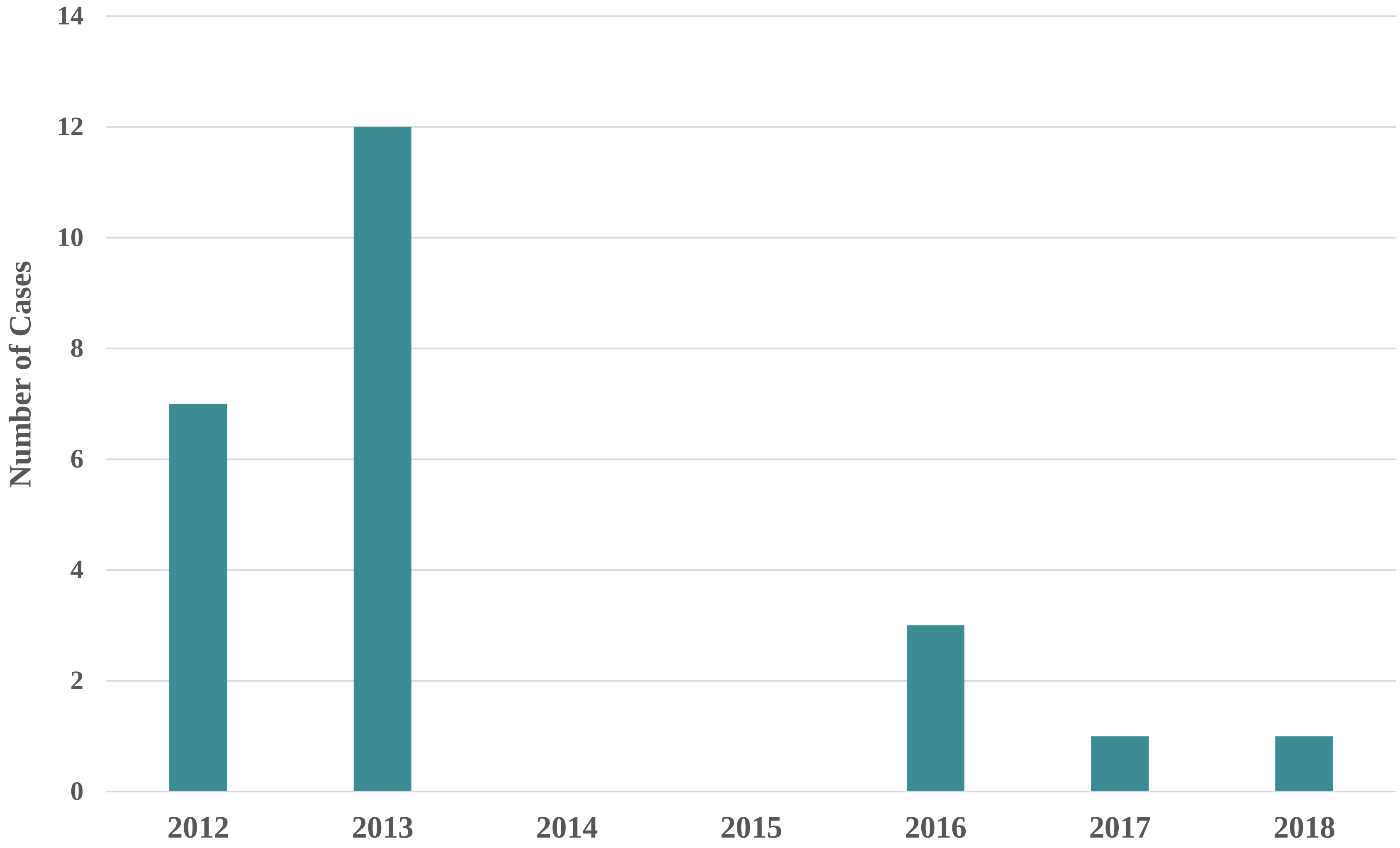


Figure 1

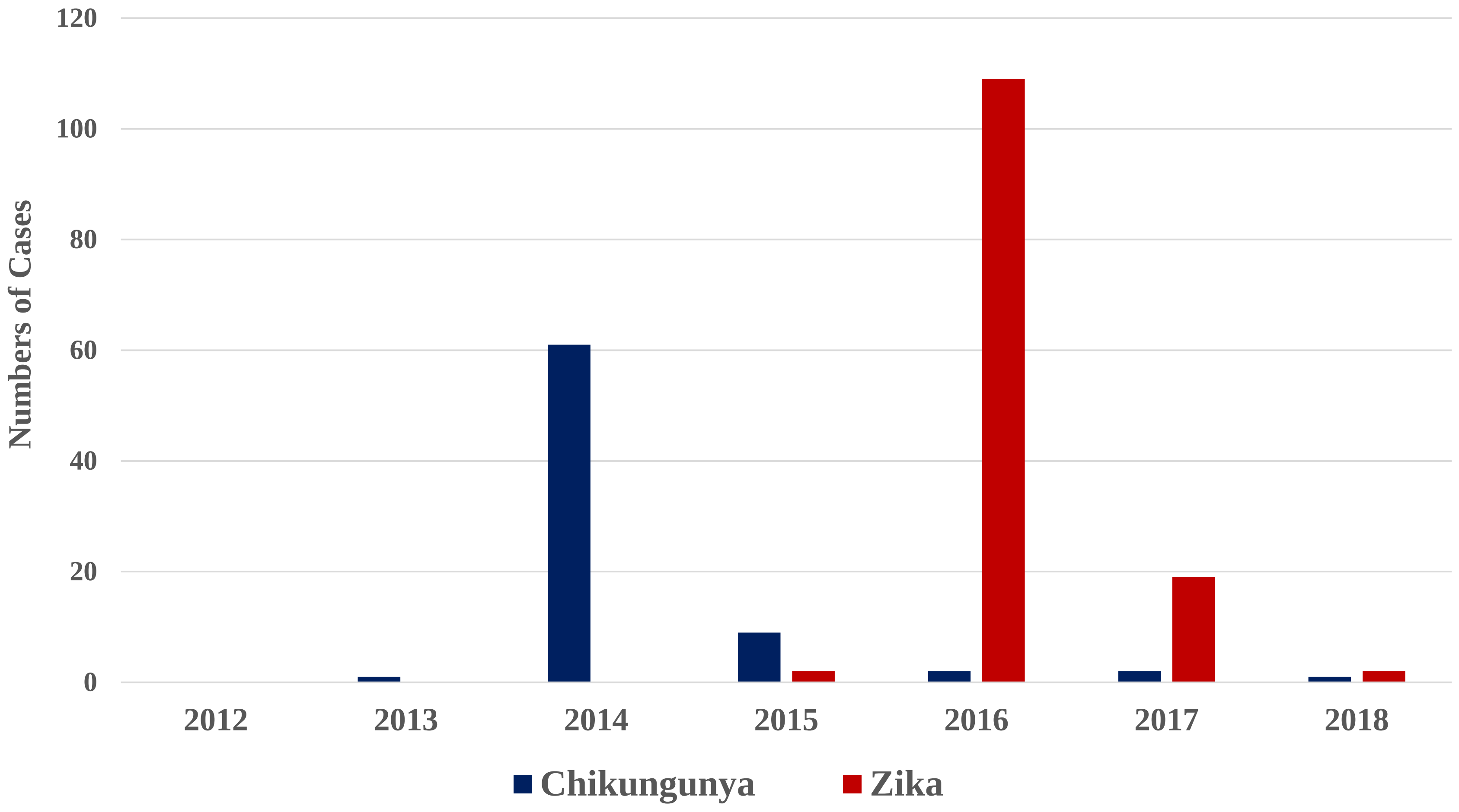
## *Massachusetts Aedes albopictus Ovitrap Effort*
## *2009-2018*



# Confirmed Cases of Dengue Reported in Massachusetts Residents

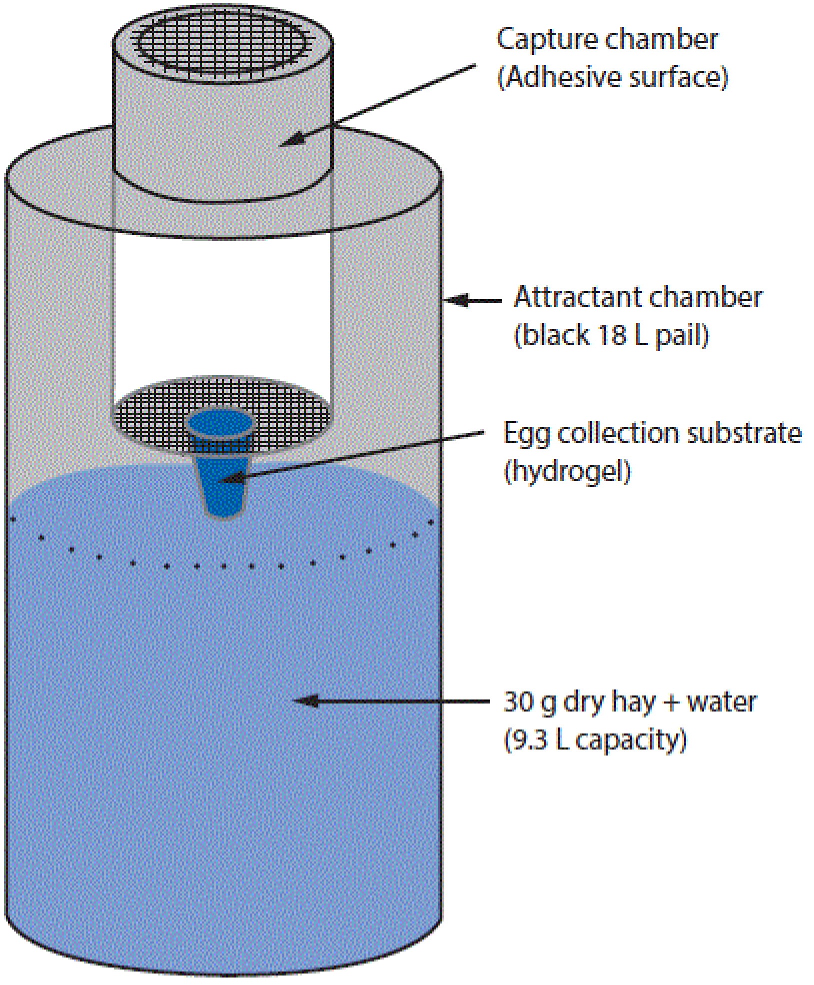


# Confirmed Cases of Chikungunya and Zika Virus Infection Reported in Massachusetts Residents



| Transmission of Eastern Equine Encephalitis (EEE) Virus, West Nile Virus (WNV) and Zika Virus – Vectors and Vector Characteristics | | | |
|---|---|---|---|
| | **EEE** | **WNV** | **Zika, Dengue, Chikungunya** |
| **Virus host reservoir** | **Birds** | **Birds** | **Humans** |
| **Amplifying vector(s)** | | | |
| **Primary species** | ***Culiseta melanura*** | ***Culex* species** | ***1. Aedes aegypti*<br>*2. A. albopictus*** |
| **Breeding habitat** | **White cedar/red maple swamp** | **Puddles and containers, dirty water** | **Containers** |
| **Transmitting vector(s) for humans** | | | |
| **Primary species** | ***Coquillettidia perturbans*, *Aedes vexans*, other bridge mosquitoes** | ***Culex* species** | ***1. Aedes aegypti*<br>*2. A. albopictus*** |
| **Primary host** | **Mammals and birds** | **Birds** | **1. Humans<br>2. Mammals** |
| **Breeding habitat** | **Cattail swamps, flood plain** | **Puddles and containers, dirty water** | **Containers** |
| **Habitat of adults** | **Rural** | **Tree canopy, ubiquitous** | **Peridomestic** |
| **Biting habits** | **Dawn/dusk, outdoors; one host meal** | **Dawn/dusk, outdoors; one host meal** | **All day, indoor/outdoor; multiple host meal** |

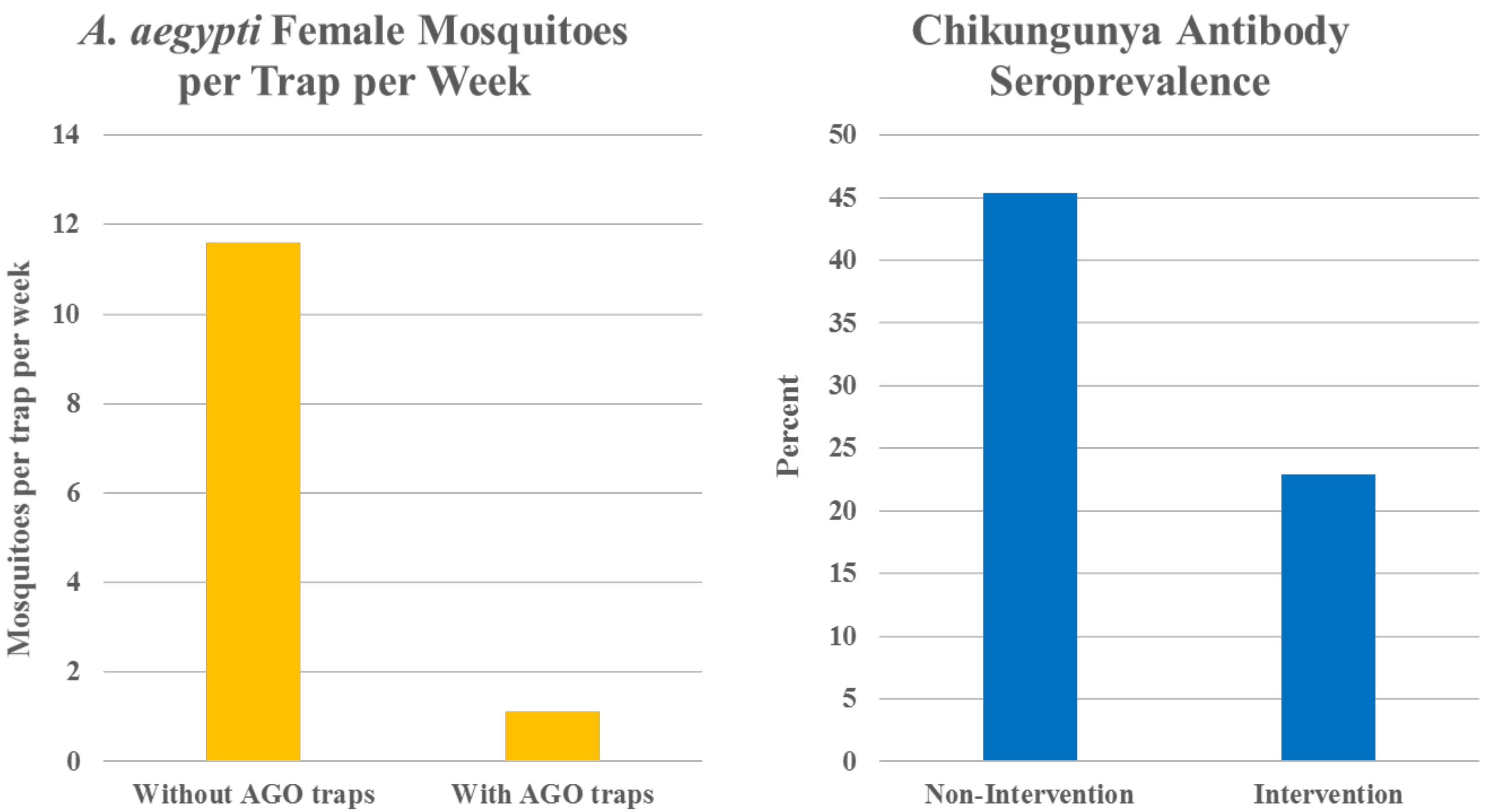
# Diagram of an Autocidal Gravid Ovitrap used to attract and capture female *Aedes aegypti* mosquitoes




**Mackay AJ, Amador M, Barrera R. An improved autocidal gravid ovitrap for the control and surveillance of Aedes aegypti. Parasit Vectors 2013;6:225.**

# Reduced Incidence of Chikungunya Virus Infection in Communities with Ongoing *Aedes Aegypti* Mosquito Trap Intervention Studies - Salinas and Guayama, Puerto Rico, November 2015 - February 2016

**MMWR, May 13, 2016 / 65(18)**



# Prevention

- Reduce mosquito exposure
  - Window and door screens
  - Mosquito netting
  - Staying indoors at peak mosquito times
- Reduce mosquito bites
  - Clothing
  - Repellents
    - DEET
    - Picaridin
    - Oil of lemon eucalyptus
    - Permethrin
- Reduce mosquitoes
  - Reduce standing water
  - Mosquito control
    - Reducing breeding environment
    - Larviciding
    - Adulticiding