

Perspectives on the Mosquitoes of Wisconsin and the Upper Midwest

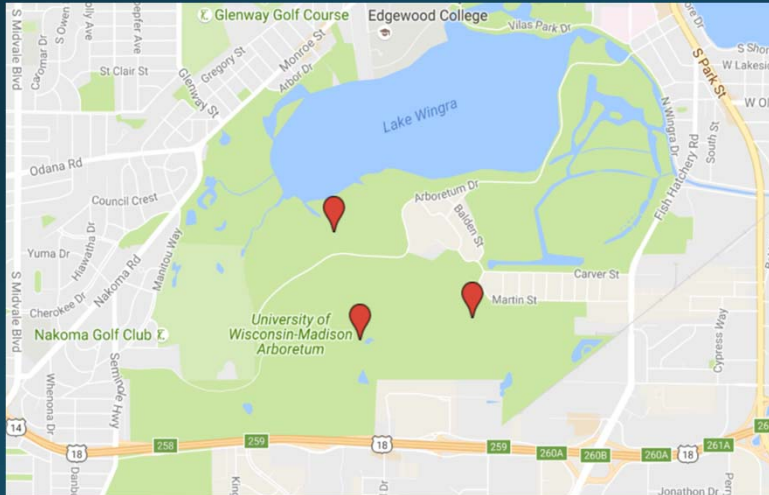
Lyric Bartholomay
Pathobiological Sciences
University of Wisconsin-Madison
Department of Entomology
Iowa State University



Where do we get the data on mossies in the Upper Midwest?

- Universities
 - Land Grant Universities, in particular, with Departments of Entomology and faculty with expertise in Medical Entomology
- State Government
 - Departments of Public Health/Health/Health Services
 - State Medical Entomologist (State of Illinois)
- Mosquito Abatement Districts
 - Tax-based – present in MN, IL, MI – not in IA or WI

For example, biodiversity assessment of the UW-Madison Arboretum 2016-



Biodiversity assessment of the UW-Madison Arboretum 2016-

- Three trapping sites:
 - CDC-light traps baited with CO₂
 - From 4 pm to 9 am (17 hours)
-
- Mosquitoes identified to species:
 - Vouchers deposited in the WIRC



Figure 4. Total number of collected mosquitoes (circle sizes represent percentage of total)



Biodiversity assessment of the UW-Madison Arboretum 2016-

21 species collected:

Aedes cinereus

Aedimorphus vexans vexans

Anopheles (Anopheles) perplexens

Anopheles (Anopheles) punctipennis

Anopheles (Anopheles) quadrimaculatus s.l.

Anopheles (Anopheles) smaragdinus

Coquillettidia (Coquillettidia) perturbans

Culex pipiens

Culex restuans

Culex territans

Culex salinarius

Culiseta (Culiseta) inornata

Hulecoeteomyia japonica japonica

Ochlerotatus (Culicada) canadensis

canadensis

Ochlerotatus (Ochlerotatus) trivittatus

Ochlerotatus punctor

Ochlerotatus sticticus

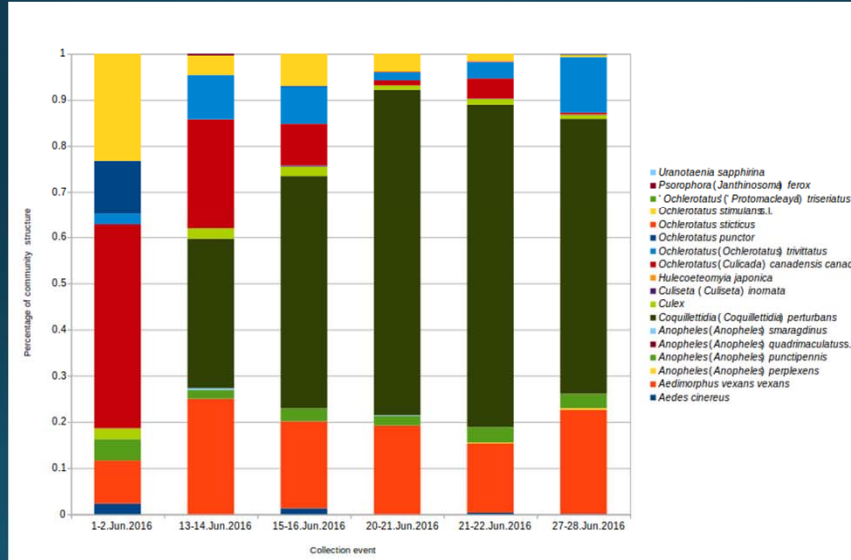
Ochlerotatus stimulans s.l.

'*Ochlerotatus*' ('*Protomacleaya*') *triseriatus*

Psorophora (Janthinosoma) ferox

Uranotaenia sapphirina

Biodiversity assessment of the UW-Madison Arboretum 2016-



A catalog of mosquitoes – WI and IA

- WISCONSIN
 - Museum specimens and published papers reveal
 - 61 species
- IOWA
 - Surveillance data from 1966-present reveal
 - 55 species of mosquito

State-state examples of mosquito surveillance strategies

Wisconsin and Iowa

Arbovirus Surveillance in Wisconsin

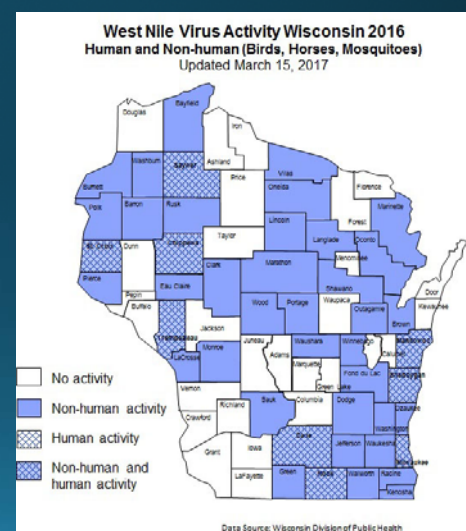
- Partnership between SM Paskewitz laboratory (Department of Entomology, UW-Madison) and WI Department of Health Services

2016 Annual Wisconsin Summary Data
Positive WNV Cases - Updated March 15, 2017

Avian (bird)	59
Equine (horse)	7
Mosquito pools	11
Human confirmed	12
Human probable*	0
Deaths**	2
Hospitalizations	10
Counties reporting WNV activity	45

* Probable cases have presumptive positive laboratory results without confirmatory testing at CDC.

** The deaths are included among the confirmed and probable cases.

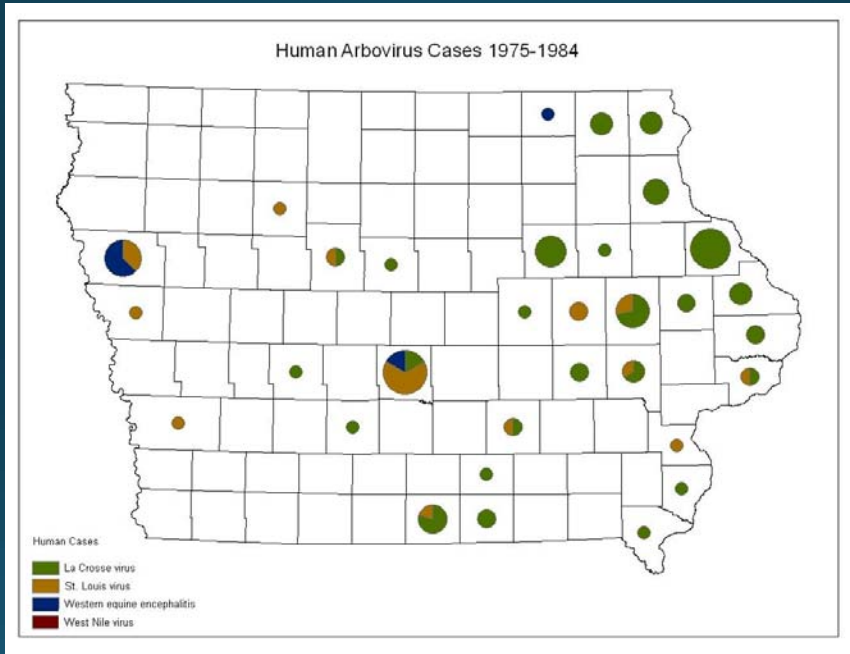
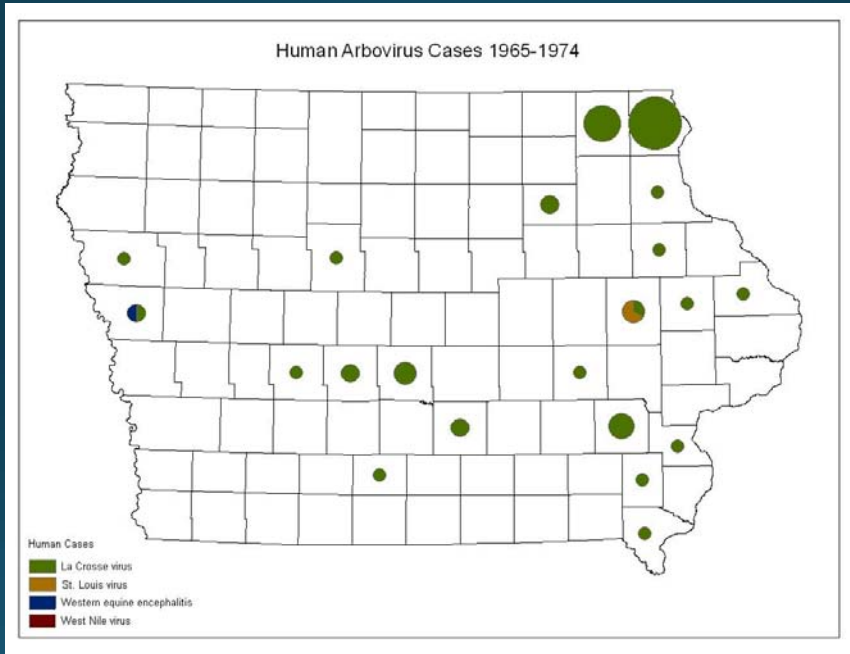


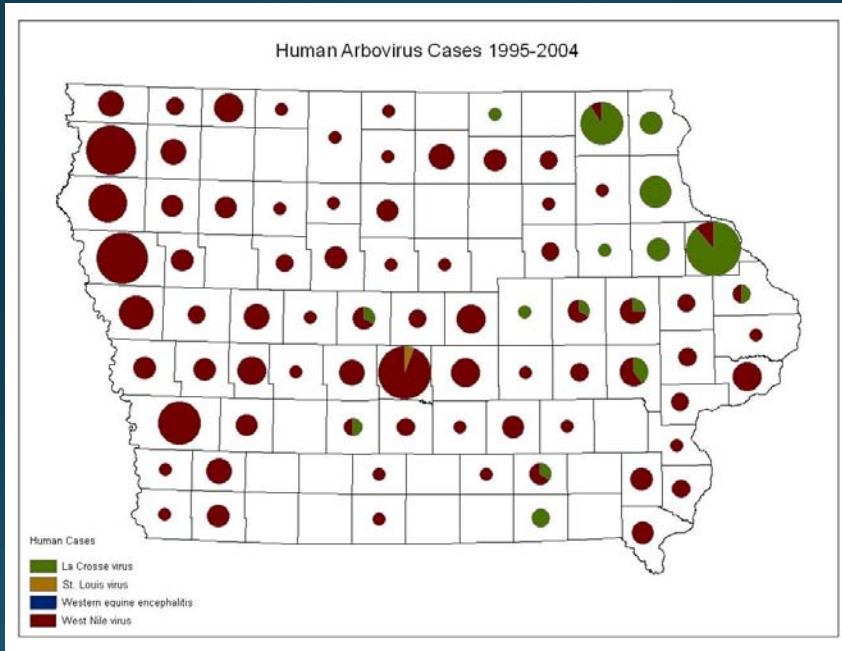
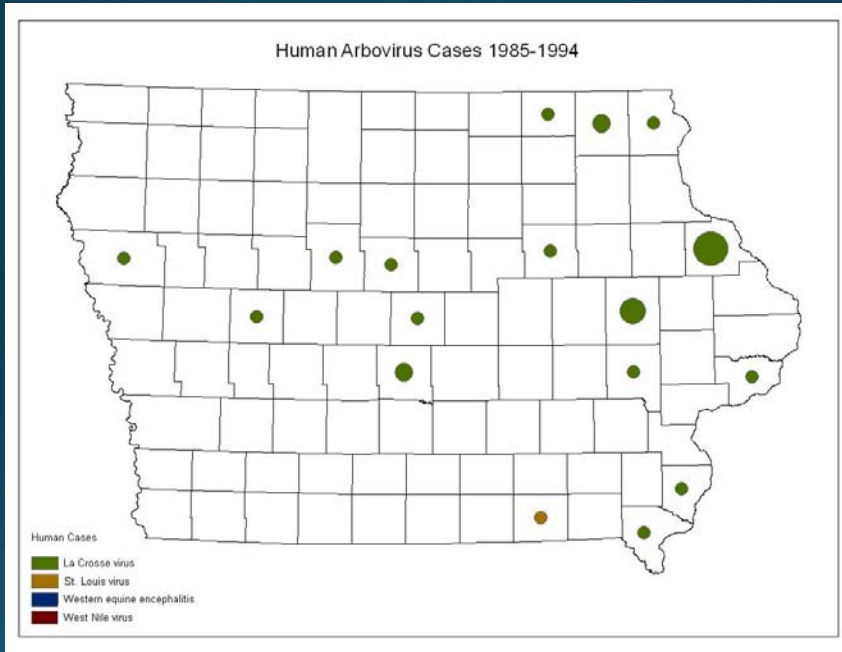
Arbovirus Surveillance in Iowa

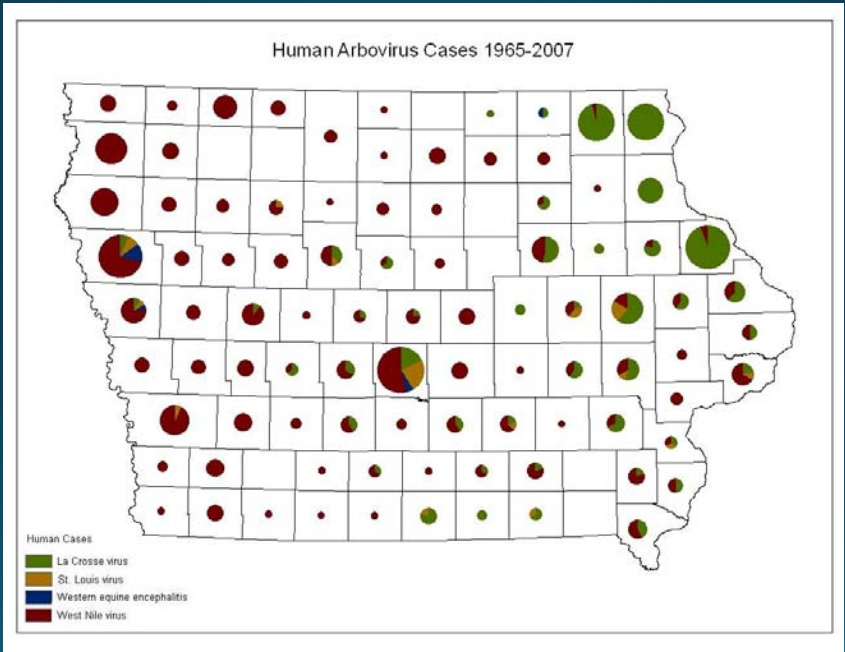
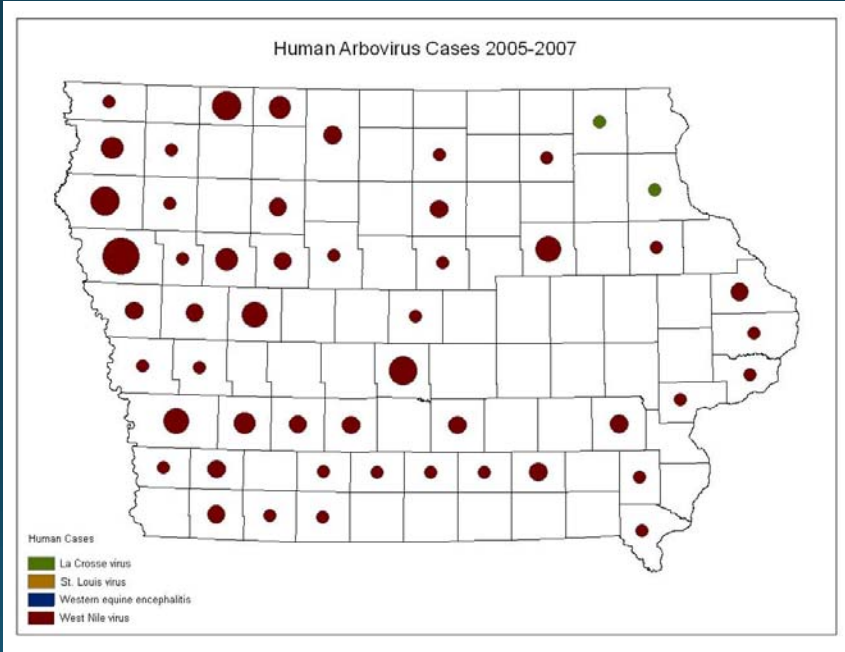
- Initiated in 1966
 - Wong et al. (1970) Arbovirus encephalitis surveillance in Iowa. *Health Lab Sci* 7(3): 117-123.
 - Operated continuously in the absence of consistent tax-based support
 - Shoulders of giants
 - College of Agriculture and Life Sciences, ISU
 - Agricultural Experiment Station
 - Iowa Department of Public Health
 - Centers for Disease Control
- Has involved:
 - Sentinel program for vertebrate exposure

Arbovirus Surveillance in Iowa

- Comprehensive approach. . .
 - Epidemiologic investigations
 - Case follow-up and reporting
 - Data from 1966-2007 show sweeping arbovirus epidemics over time







Arbovirus Surveillance in Iowa

- Comprehensive approach. .
 - Trapping and processing mosquitoes
 - Species composition, abundance, seasonal distribution
 - Virus isolation or identification
 - Sentinel program for vertebrate exposure

Trapping. . .



Arbovirus Surveillance – Sentinel Chickens

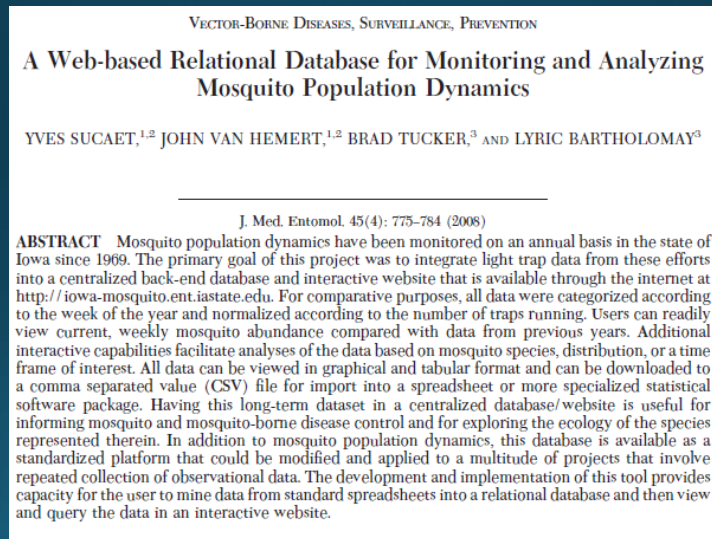


- Flocks cared for by local Public and Environmental Health agencies
- Chicken bled once/week and serum tested for arbovirus antibodies

The invaluable nature of a long-term mosquito surveillance program and dataset

Richness, diversity, abundance, phenology of mosquito species

Decades of Mosquito Presence and Abundance Data



<http://www.iowa-mosquito.net>

IOWA STATE UNIVERSITY
Department of Entomology
Lyric Bartholomay

ISU Entomology > Lyric Bartholomay > Iowa-Mosquito.net

Browse
County
Location
Year
species
Analyze
Get started
Summary

species abundance [Browse alphabetically](#) - [Browse hierarchically](#) - [Seasonal](#)

Please note that the colored bars are log-scaled.

Aedes vexans	2281446
Culex pipiens group	446843
Aedes trivittatus	172380
Culex tarsalis	71420
Anopheles punctipennis	60438
Culiseta inornata	22382

Aedes sollicitans
Aedes spencerei
Aedes sticticus
Aedes stimulans
Aedes triseriatus
Aedes trivittatus
Aedes vexans

mosquito.ent.iastate.edu/browse_species_.php
Sucaet, VanHemert, Tucker and Bartholomay (2008) *J Med Entomol*

Journal of the American Mosquito Control Association, 30(2):119–121, 2014
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SCIENTIFIC NOTE

A TAXONOMIC CHECKLIST OF THE MOSQUITOES OF IOWA

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ABSTRACT. The last published report of the mosquito species composition present in the state of Iowa was published in 1969 and included 43 species in 8 genera. Since that time, reassessment of specimens in the Iowa State Insect Collection and annual mosquito surveillance efforts have yielded 12 new species records, bringing the total to 55 species in 8 genera. In addition to providing an updated taxonomic checklist for the state of Iowa, abundance information is provided for each species using specimen counts from New Jersey light trapping events that span 45 years.

¹ Each species is listed alphabetically according to genus and has been assigned an abundance rating based on total specimens collected by New Jersey light trapping (NJLTs) events that took place between 1969 and 2013, with the following delineations: extremely abundant (>1,000,000), very abundant (100,000–999,999), abundant (10,000–99,999), common (1,000–9,999), uncommon (100–999), rare (10–99), very rare (1–9), and extremely rare (never collected by NJLTs, only by other traps).

Vector status – Genus *Aedes*

Table 1. Mosquitoes of Iowa according to genus, collection frequency, and whether or not specimens have been collected annually since 1st capture in New Jersey light trapping events from 1969 to 2013.¹

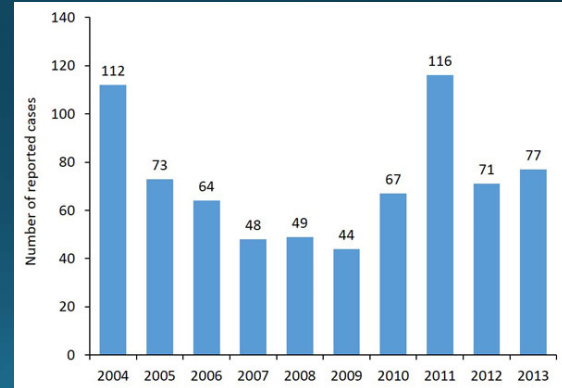
	Species	Collection frequency	Annual
Genus <i>Aedes</i> Meigen			
1	<i>Aedes (Aedes) cinereus</i> Meigen	Rare	–
2	<i>Ae. (Aedimorphus) vexans</i> (Meigen)	Extremely abundant	+
3	<i>Ae. (Finlaya) japonicus japonicus</i> (Theobald)	Common	+
4	<i>Ae. (Ochlerotatus) atropalpus</i> (Coquillett)	Rare	–
5	<i>Ae. (Och.) aurifer</i> (Coquillett)	Very rare	–
6	<i>Ae. (Och.) campestris</i> (Dyar and Knab)	Rare	–
7	<i>Ae. (Och.) canadensis canadensis</i> (Theobald)	Uncommon	+
8	<i>Ae. (Och.) dorsalis</i> (Meigen)	Common	+
9	<i>Ae. (Och.) dupreei</i> (Coquillett)	Very rare	–
10	<i>Ae. (Och.) fitchii</i> (Felt & Young)	Extremely rare	–
11	<i>Ae. (Och.) flavescens</i> (Müller)	Very rare	–
12	<i>Ae. (Och.) implicatus</i> (Vockeroth)	Extremely rare	–
13	<i>Ae. (Och.) nigromaculis</i> (Ludlow)	Common	+
14	<i>Ae. (Och.) punctator</i> (Kirby)	Very rare	–
15	<i>Ae. (Och.) riparius</i> (Dyar and Knab)	Extremely rare	–
16	<i>Ae. (Och.) sollicitans</i> (Walker)	Common	+
17	<i>Ae. (Och.) spencerii spencerii</i> (Theobald)	Rare	–
18	<i>Ae. (Och.) sticticus</i> (Meigen)	Abundant	+
19	<i>Ae. (Och.) stimulans</i> (Walker)	Uncommon	–
20	<i>Ae. (Och.) trivittatus</i> (Coquillett)	Abundant	+
21	<i>Ae. (Protomacleaya) hendersoni</i> (Cockerell)	Uncommon	+
22	<i>Ae. (Pro.) triseriatus</i> (Say)	Common	+
23	<i>Ae. (Stegomyia) albopictus</i> (Skuse)	Very rare	–

Vector status – *Aedes triseriatus*



Aedes triseriatus – the Eastern tree hole mosquito

La Crosse virus neuroinvasive disease cases reported by year, 2004–2013



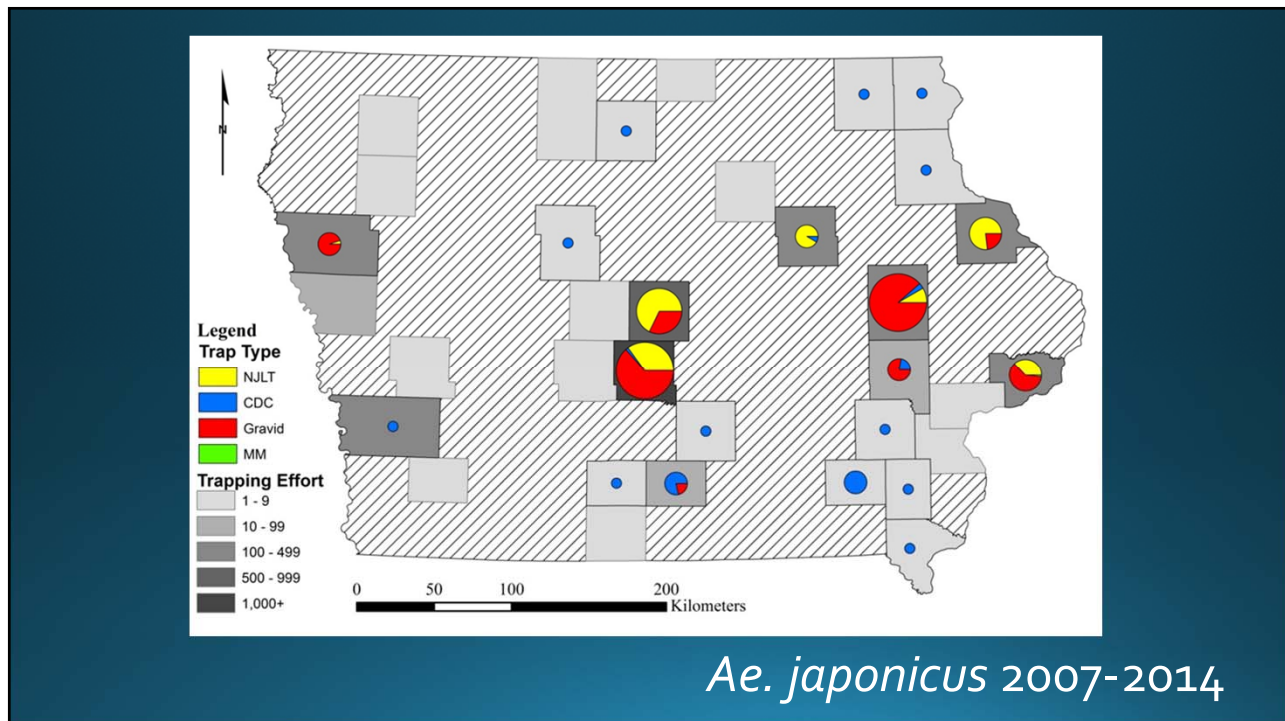
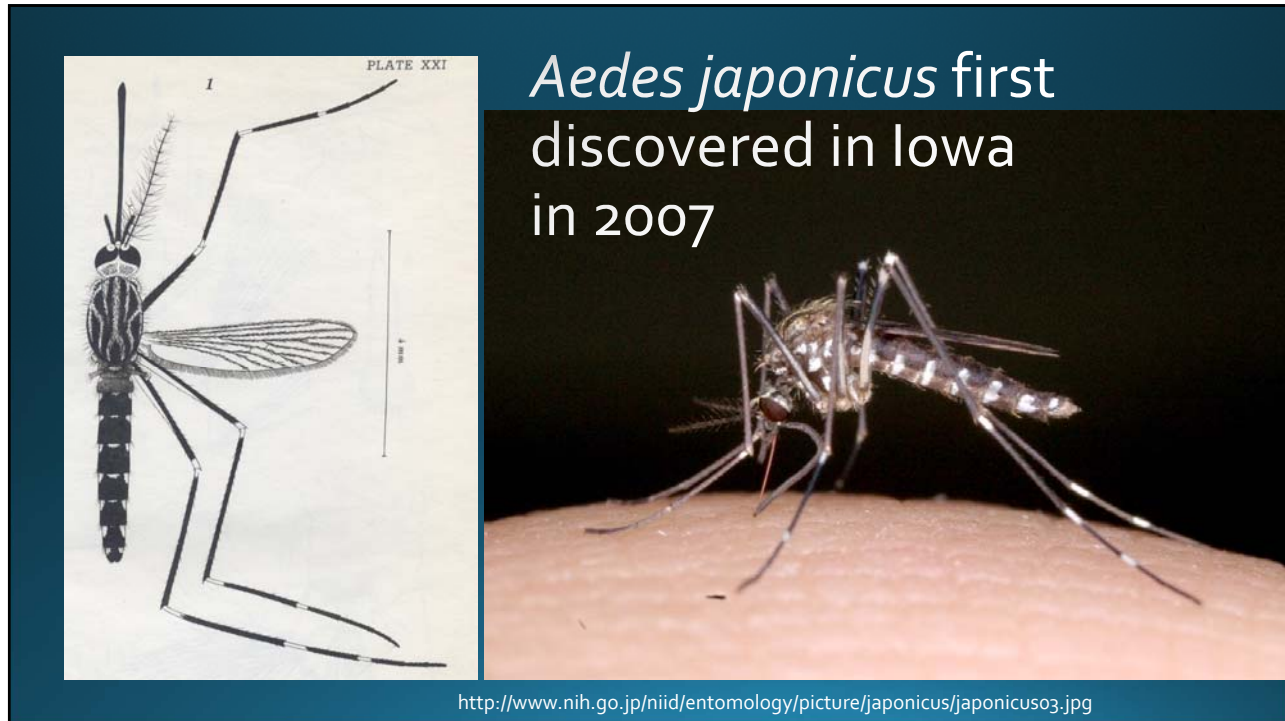
LaCrosse Encephalitis & LACV

- A leading cause of infectious pediatric encephalitis
- Most often seen in Midwestern and Mid-Atlantic states
- Prior to WNV, most commonly reported arbovirus in U.S.
- Long-term consequences of infection
 - Seizures
 - Learning disabilities
 - Cognitive defects



Boy dies from LaCrosse encephalitis

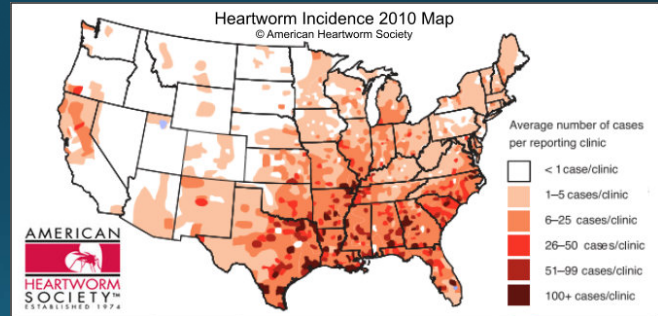
Fifteen-year-old Christopher Doyle died Aug. 11 2006 from LaCrosse encephalitis. He died just 10 days before he was to start his freshman year at North Side High School. Fort Wayne, IN.



Vector status – *Aedes trivittatus*



Aedes trivittatus



Vector status – *Aedes vexans*???

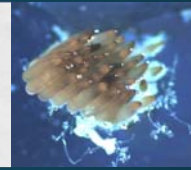


Aedes vexans

Vector status – Genus *Culex*

Genus *Culex* Linnaeus

31	<i>Culex (Culex) pipiens</i> Linnaeus	Very abundant	+
32	<i>Cx. (Cux.) quinquefasciatus</i> Say	Very rare	-
33	<i>Cx. (Cux.) restuans</i> Theobald	Very abundant	+
34	<i>Cx. (Cux.) salinarius</i> Coquillett	Abundant	+
35	<i>Cx. (Cux.) tarsalis</i> Coquillett	Abundant	+
36	<i>Cx. (Melanoconion) erraticus</i> (Dyar and Knab)	Uncommon	+
37	<i>Cx. (Neoculex) territans</i> Walker	Common	+



Culex pipiens– the Northern house mosquito



Culex tarsalis

Vector status – *Culex tarsalis* - Iowa

Genus *Culex* Linnaeus

31	<i>Culex (Culex) pipiens</i> Linnaeus	Very abundant	+
32	<i>Cx. (Cux.) quinquefasciatus</i> Say	Very rare	-
33	<i>Cx. (Cux.) restuans</i> Theobald	Very abundant	+
34	<i>Cx. (Cux.) salinarius</i> Coquillett	Abundant	+
35	<i>Cx. (Cux.) tarsalis</i> Coquillett	Abundant	+
36	<i>Cx. (Melanoconion) erraticus</i> (Dyar and Knab)	Uncommon	+
37	<i>Cx. (Neoculex) territans</i> Walker	Common	+



Culex tarsalis

Abstract

Background: West Nile virus (WNV) emerged as a threat to public and veterinary health in the

Landscape, demographic, entomological, and climatic associations with human disease incidence of West Nile virus in the state of Iowa, USA

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Brad J Tucker³ and Lyric C Bartholomay³



¹Center, Geography Department, University of Northern Iowa, Cedar Falls, IA, USA
²Department of Entomology, Iowa State University, Ames, IA, USA

WNV disease incidence had significantly lower landscape variables showing differences included stream channels, presence of irrigation, and presence of animal enclosures. Differences in the annual means of precipitations, dew point, and temperature in the year of WNV disease incidence and the prior year, were analyzed for each parameter. However, the differences

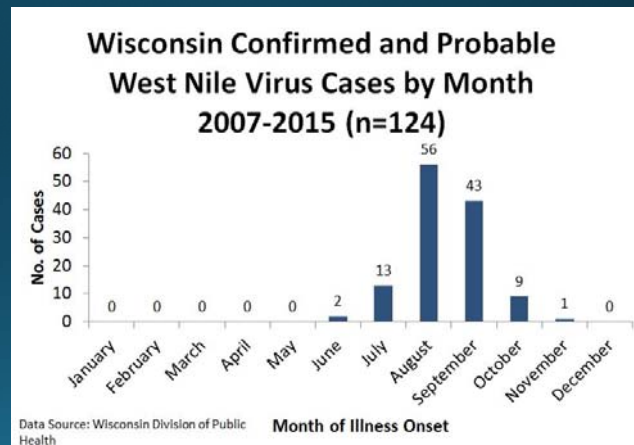
in WNV disease incidence by census block groups in Iowa were analyzed for landscape and climatic associations. Our results indicate that

multiple ecological WNV transmission dynamics are most likely taking place in Iowa. In 2003 and 2006, drier conditions were associated with WNV disease incidence. In a significant novel finding, rural agricultural settings were shown to be strongly associated with human WNV disease incidence in Iowa.

Vector status – *Culex pipiens* - Wisconsin



Culex pipiens – the Northern house mosquito



Vector status – Genus *Anopheles*

Genus <i>Anopheles</i> Meigen		
24	<i>Anopheles (Anopheles) barberi</i> Coquillett	Rare +
25	<i>An. (Ano.) crucians</i> Wiedemann	Extremely rare -
26	<i>An. (Ano.) earlei</i> Vargas	Extremely rare -
27	<i>An. (Ano.) punctipennis</i> (Say)	Abundant +
28	<i>An. (Ano.) quadrimaculatus</i> Say	Common +
29	<i>An. (Ano.) walkeri</i> Theobald	Common +



Anopheles quadrimaculatus



Anopheles punctipennis

CDC Home Search Health Topics A-Z

MMWR
Weekly
June 09, 2009 / 49(22);455-8

Persons using assistive technology might not be able to fully access information in this file. For assistance, please send e-mail to: mmwrq@cdc.gov. Type 508 Accommodation and the title of the report in the subject line of e-mail.

Probable Locally Acquired Mosquito-Transmitted *Plasmodium vivax* Infection --- Suffolk County, New York, 1999

In the United States, malaria transmission was eliminated in the 1940s, and malaria eradication was certified in 1970 (1). Since then, 60 small localized outbreaks of probable mosquito-transmitted malaria have been reported to CDC (2-6). Before 1995, the number of imported malaria cases reported to the Suffolk County (New York) Department of Health Services ranged from zero to eight per year. Since 1995, seven to 17 cases per year have been reported. In all of these cases, a history of residing in or traveling to an area with endemic malaria outside the United States was confirmed. This report describes the investigation of two cases of *Plasmodium vivax* malaria that occurred in Suffolk County in August 1999; the patients had no history of travel outside of the United States.

Article in press – AJTMH - as of 4/25/2017!

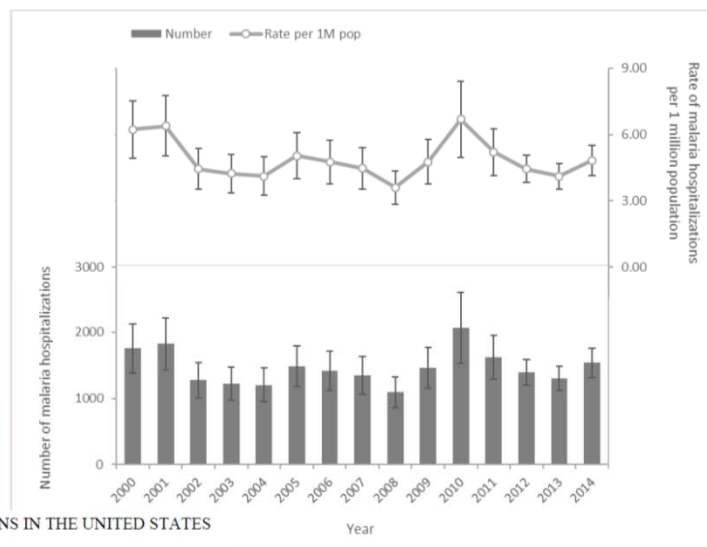
MALARIA HOSPITALIZATIONS IN THE UNITED STATES

Malaria-Related Hospitalizations in the United States, 2000–2014

Diana Khuu,^{1,2} Mark L. Eberhard,³ Benjamin N. Bristow,¹ Marjan Javanbakht,¹ Lawrence R. Ash,¹ Shira C. Shafir,^{1,4} and Frank J. Sorvillo^{1*}

* estimates based on weighted frequencies.

Figure 1

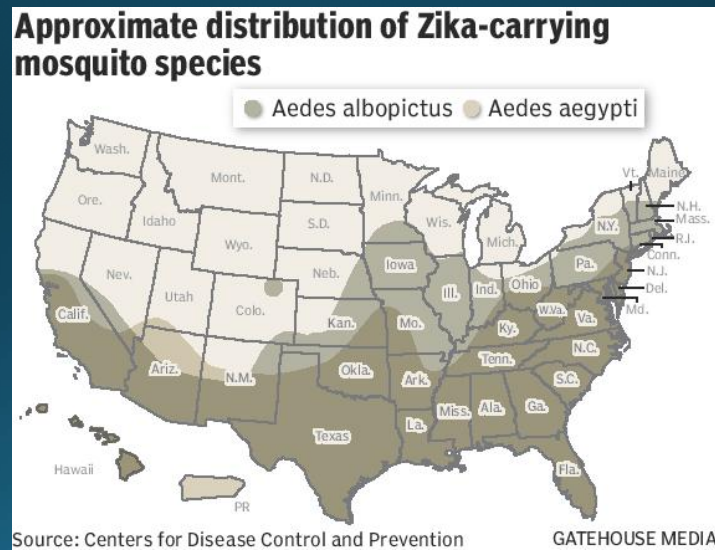


Vector Capacity examples/summary. . .

Mosquito spp.	Pathogens
<i>Aedes triseriatus</i>	LACV, WNV
<i>Ae. trivittatus</i>	<i>D. immitis</i>
<i>Ae. japonicus</i>	WNV, SLEV, LACV, EEEV
<i>Anopheles quadrimaculatus</i> and <i>An. punctipennis</i>	Human malaria, JCV?
<i>Culex pipiens</i>	WNV, SLEV
<i>Cx. tarsalis</i>	WNV, SLEV, WEEV

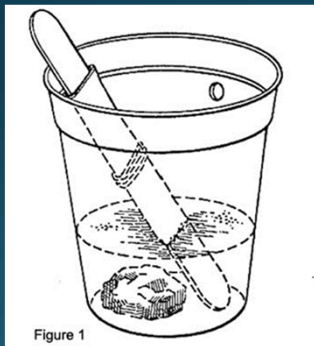
New and emerging infections:
Zika

What is the threat in the Upper Midwest?



Public Health Entomology @ UW-Madison: protecting communities from Zika

- Surveillance for the vectors
- Reduce mosquito population



After 1 week:

- Check for eggs on sticks
- Dump out water to eliminate any mosquito larvae
- Replace water
- Replace stick (only if eggs are present)



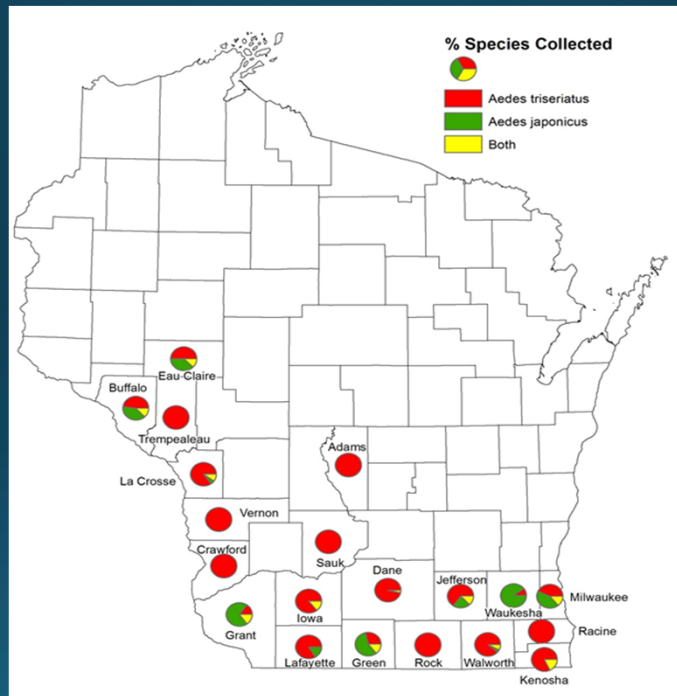
Eggs of *Aedes albopictus* on the egg sticks



Might be a lot or a few
Like small grains of dirt
Will mostly stay attached to stick

Send it in if you aren't sure
If no eggs are seen, leave the stick
and just replace the water

Results



45

Will be on the lookout for invasion/establishment!

TABLE 1 Twentieth century invasions by container-inhabiting mosquitoes into the United States

Species	Regions		Transport	Date	Key reference
	Donor	Recipient			
<i>Aedes albopictus</i>	Japan	Texas	Tires	1985	77
<i>Aedes atropalpus</i>	Eastern United States	Illinois, Indiana, Nebraska, Ohio	Tires	1970–1980	12
<i>Aedes bahamensis</i>	Bahamas	South Florida	Tires	1986	145
<i>Aedes japonicus</i>	Japan	Connecticut, New Jersey, New York	Tires	1998	149
<i>Aedes togoi</i>	Asia	Pacific NW	Ships	1940–1950	11
<i>Culex biscoyensis</i>	Caribbean (?) ^a	South Florida	Bromeliads	?	142
<i>Toxorhynchites brevipalpis</i>	E. Africa	Hawaii	Biocontrol	1950s	194
<i>Toxorhynchites amboinensis</i>	Pacific region	Hawaii	Biocontrol	1950s	194
<i>Wyeomyia mitchellii</i>	Caribbean or Florida	Hawaii	Bromeliads	1970s	183

^aIt remains unclear whether this recently described species (223) was introduced in exotic bromeliads to south Florida or is, rather, an indigenous species that had previously escaped recognition despite intensive mosquito collecting in the state.

Lounibos, LP (2002) Invasions by Insect Vectors of Human Disease. Ann Rev Entomol 47:233–266.

From a state-centric to a regional approach

Midwest Regional Center of Excellence for Vector-Borne Disease

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MCE-VBD

- University of Wisconsin-Madison
- Iowa State University
- Michigan State University
- University of Illinois
- Loyola University
- Minnesota Department of Health
- Departments of Public Health
 - Iowa
 - Illinois
 - Michigan
 - Minnesota
 - Wisconsin
- Advisory Boards
 - Scientific
 - Public Health

MCE-VBD

Training

Communities of Practice

Applied Research

MCE-VBD Training

Certificate in Public Health Entomology

Internships for undergraduates - field work experiences

Workshops and Training events for current practitioners

MCE-VBD Training

Certificate in Public Health Entomology

Offered to trainees at any level – BS, MS, MPH, MD, DVM, current PH

Granted by the MCE-VBD; Advisory Board oversight

Competencies/experiences:

- Course in Public Health/Medical Entomology/VBD
- Vector Identification – Surveillance – IR monitoring
- Pesticide applicator licensure
- Field experience

MCE-VBD Communities of Practice in Public Health

- Paid interns to work with Public Health
- Annual Conference
- Shared surveillance data
- Public Health Advisory Board

MCE-VBD Communities of Practice in Public Health

- Survey of current vector control providers and practices
- Insecticide resistance surveillance and training
- Enhanced vector surveillance
- Design for sustainability

MCE-VBD Research and Innovation

Predictive modeling
Efficacy of Mosquito Control
Integrated Tick Management Approach
Novel Insecticide/Acaricide/Repellent Development

MCE-VBD Research and Innovation

Optimization of mosquito trapping
Development of rapid and inexpensive diagnostics
Human/vector interactions and exposure risks
Emerging pathogens

Perspectives on the Mosquitoes of Wisconsin and the Upper Midwest

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