Mosquito Diversity and Seasonality at an Enzootic Eastern Equine Encephalitis Focus in Tennessee

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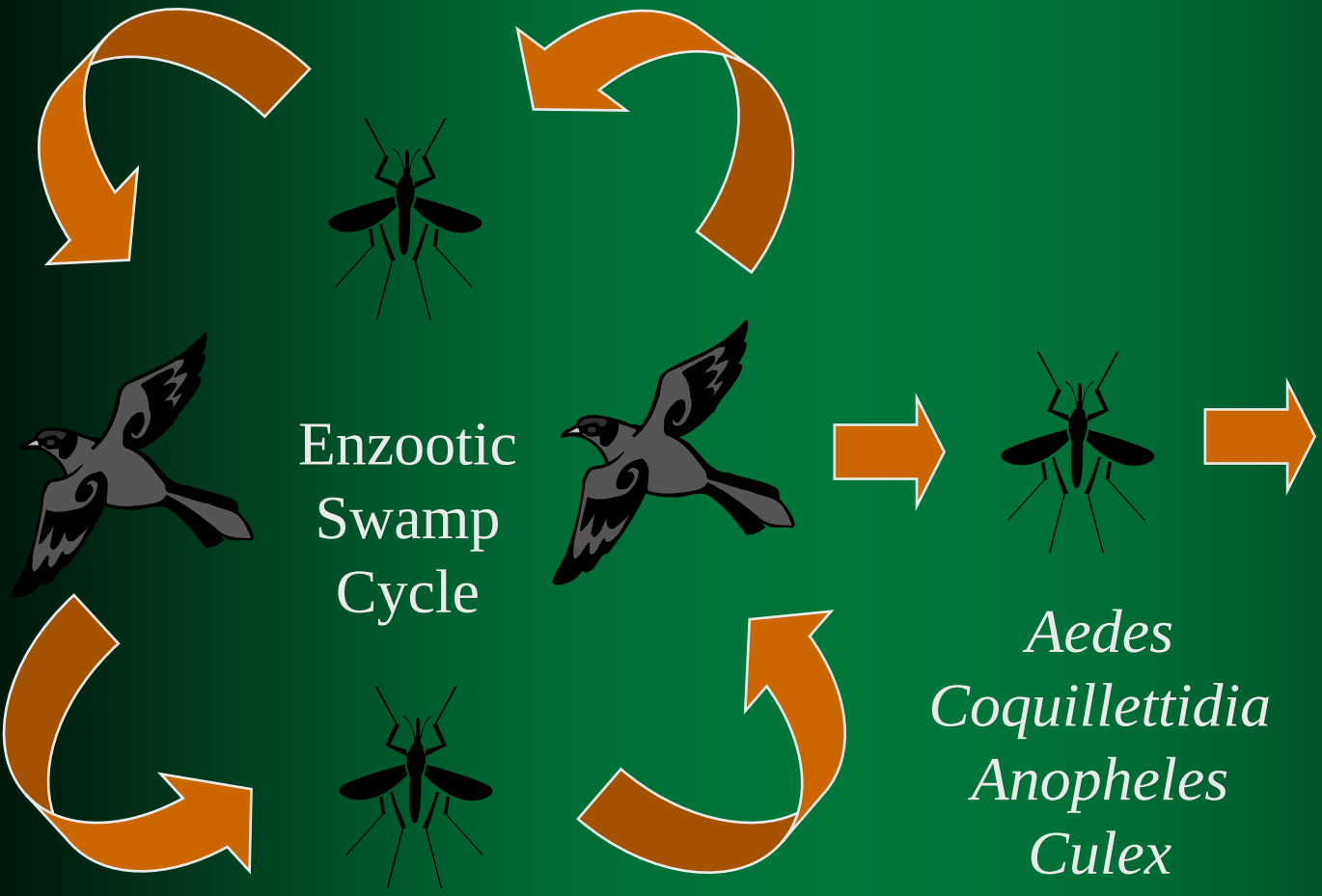
Life Cycle of Eastern Equine Encephalitis



Epidemiology in humans

- Humans*
  - Flu-like illness to encephalitis, coma, and death
  - Case-fatality ~50%
  - Neurologic deficits in ~35% of survivors
  - 4 cases per year in U.S.
  - Largest epidemics in FL, GA, MA, and NJ

***CDC website: one of the most pathogenic mosquito-borne diseases in the US**

Epidemiology in horses

- Horses
  - “Sleeping sickness”, depression, incoordination, circling, head pressing, paralysis, coma and death
  - Case-fatality approaches 90%
  - Preventable
  - Underreported

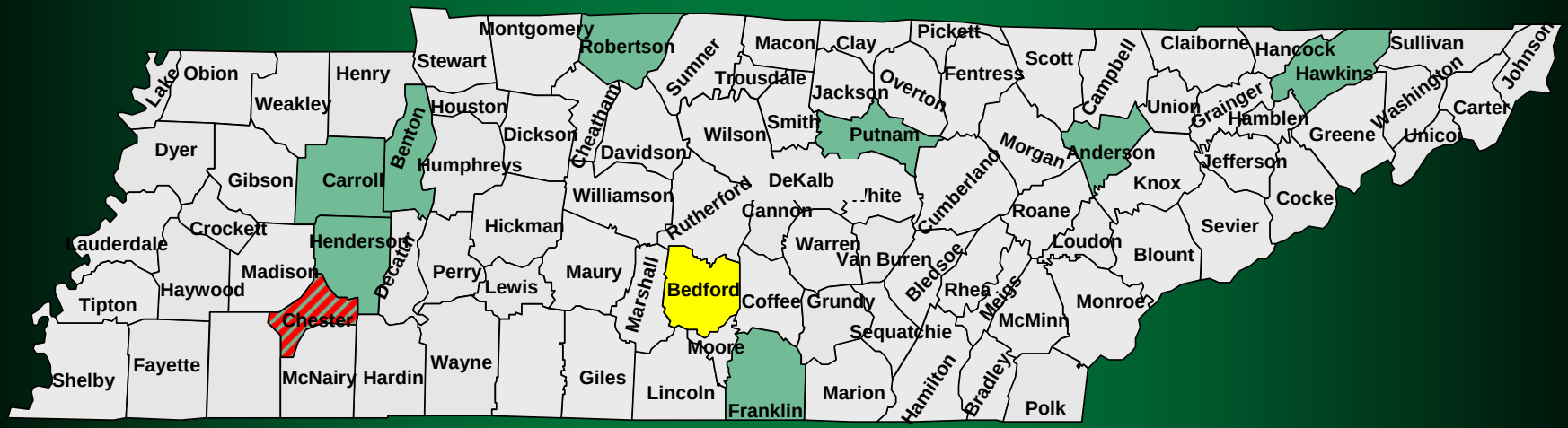
Tennessee

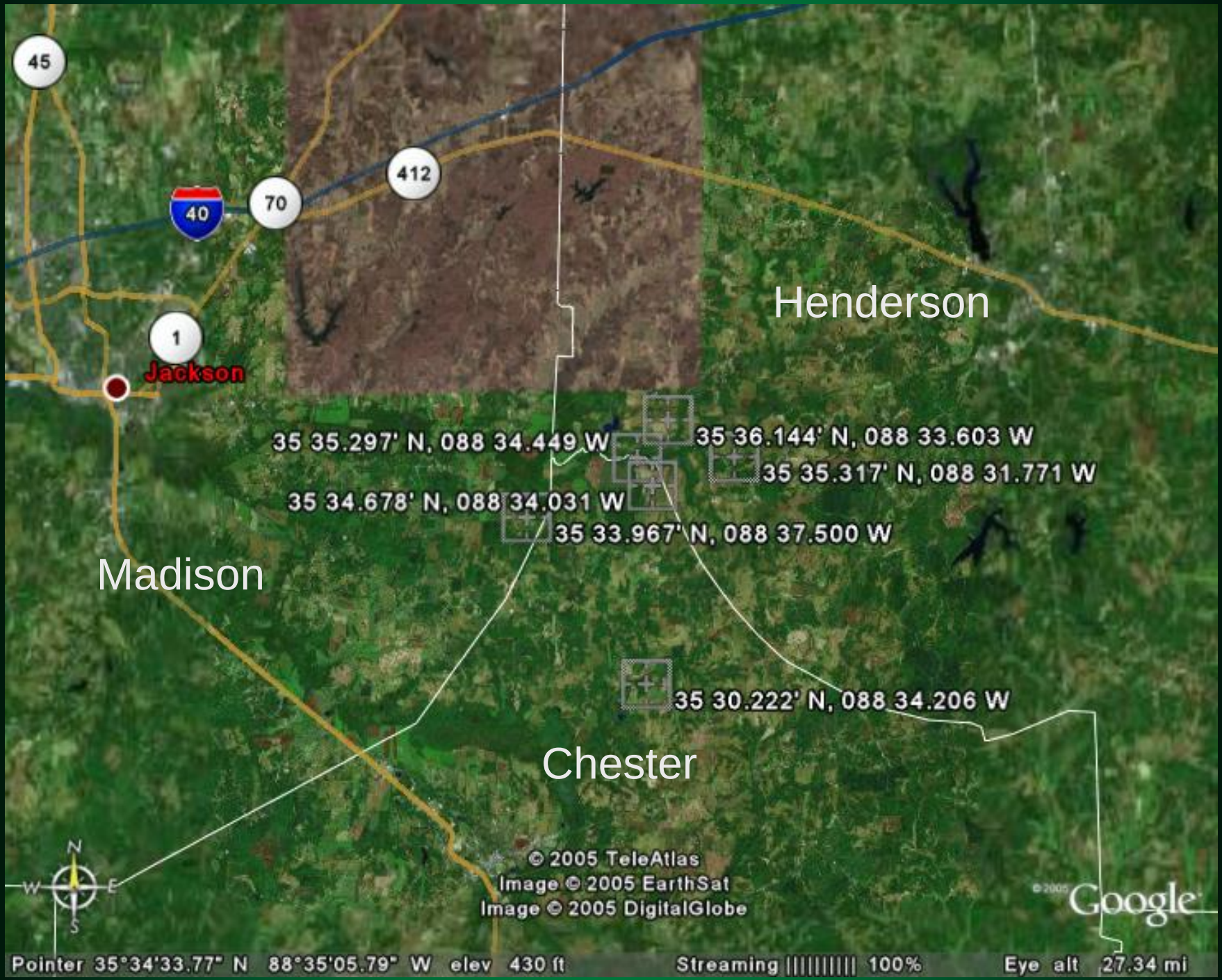
- Positive horse reported in Chester county
- Multiple reports of horse deaths from “sleeping sickness”
- Media release 9/15: “State Veterinarian issues advisory to horse owners”
- Joint Department of Health / Department of Agriculture outbreak investigation: 9/21

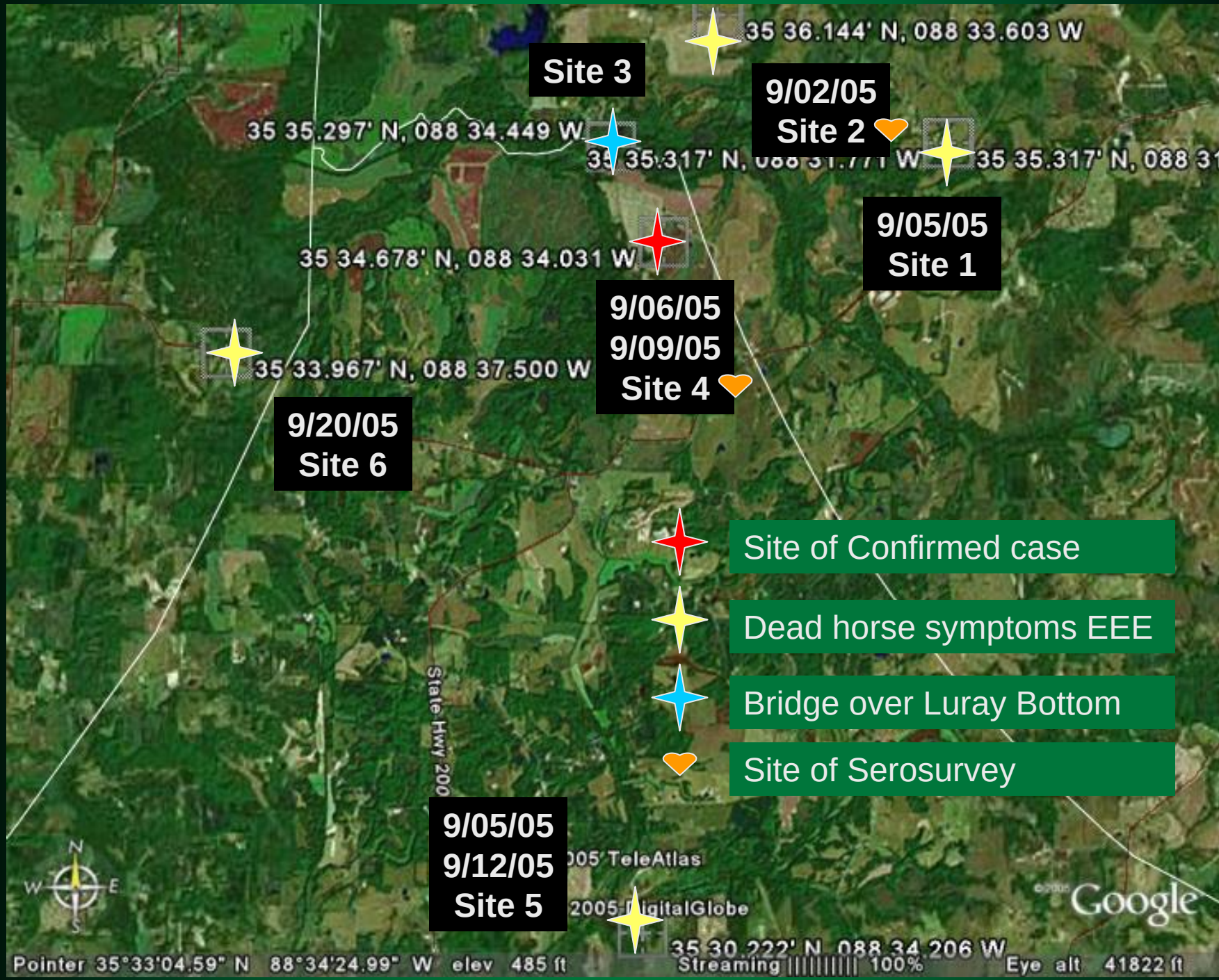
Outbreak Investigation Objectives

- Description of mosquito fauna
- Retrospective description of EEE cases
- Horse antibody isolation

Distribution of EEE horse cases in Tennessee from 2002 to 2005




45
412
40
70
1
Jackson
Henderson
35 35.297' N, 088 34.449 W
35 36.144' N, 088 33.603 W
35 35.317' N, 088 31.771 W
35 34.678' N, 088 34.031 W
35 33.967' N, 088 37.500 W
Madison
35 30.222' N, 088 34.206 W
Chester
© 2005 TeleAtlas
Image © 2005 EarthSat
Image © 2005 DigitalGlobe
Google
Pointer 35°34'33.77" N 88°35'05.79" W elev 430 ft
Streaming 100%
Eye alt 27.34 mi

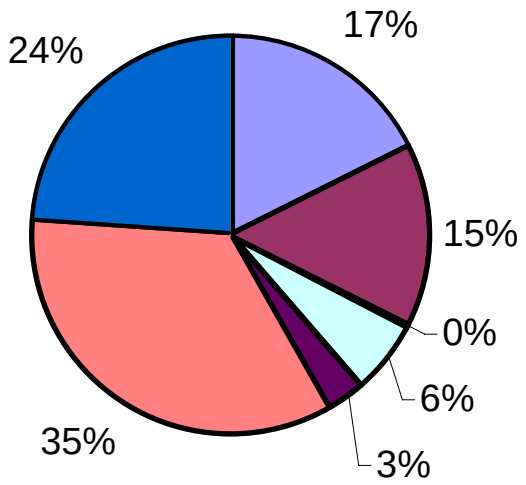

35 36.144' N, 088 33.603 W
Site 3
9/02/05
Site 2
35 35.297' N, 088 34.449 W
35 35.317' N, 088 31.771 W
35 35.317' N, 088 31
9/05/05
Site 1
35 34.678' N, 088 34.031 W
9/06/05
9/09/05
Site 4
35 33.967' N, 088 37.500 W
9/20/05
Site 6
Site of Confirmed case
Dead horse symptoms EEE
Bridge over Luray Bottom
Site of Serosurvey
State Hwy 200
9/05/05
9/12/05
Site 5
005 TeleAtlas
2005 DigitalGlobe
Google
35 30.222' N, 088 34.206 W
Pointer 35°33'04.59" N 88°34'24.99" W elev 485 ft
Streaming 100%
Eye alt 41822 ft

Species Diversity

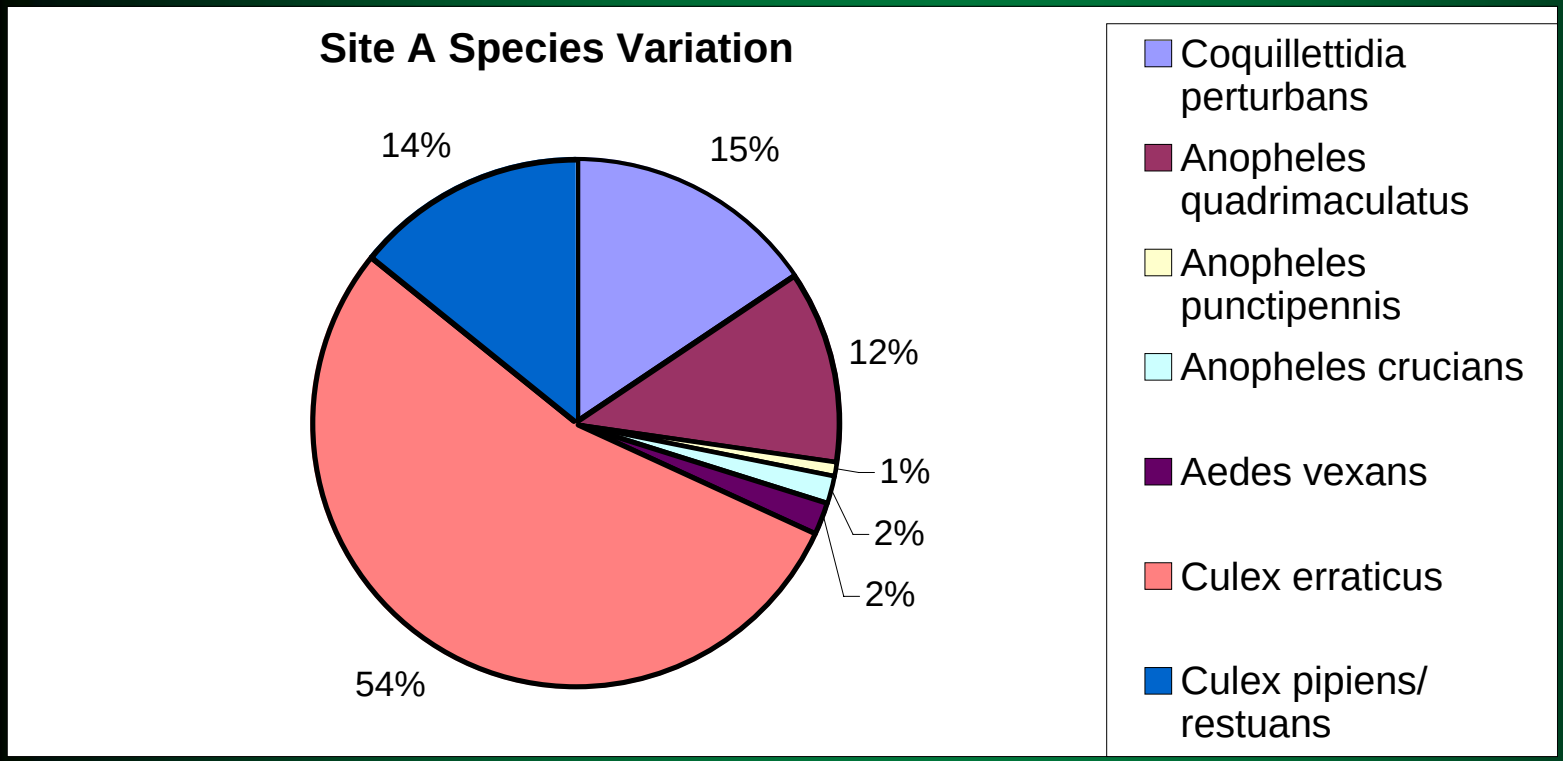
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Total
Cx. restuans/pipiens	73	91	3	113	1	7	288
Cx. erraticus	12	11	21	137	5	51	237
Cq. perturbans	0	22	0	149	2	2	175
An. quadrimaculatus	3	57	1	34	11	15	121
Ae. vexans	0	19	0	9	4	0	32
An. punctipennis	0	2	0	4	0	3	9
Cx. territans	0	0	0	0	0	1	1
Oc. dupreei	19	0	0	0	0	4	23
Oc. fulvus pallens	0	0	0	2	0	6	8
Ps. ferox	4	0	0	0	0	0	4
Oc. trivittatus	1	0	0	0	2	0	3
Oc. triseriatus	0	0	0	2	0	0	2
Ps. howardi	0	1	0	0	0	1	2
Ps. ciliata	0	0	0	1	0	0	1

CDC Light Traps

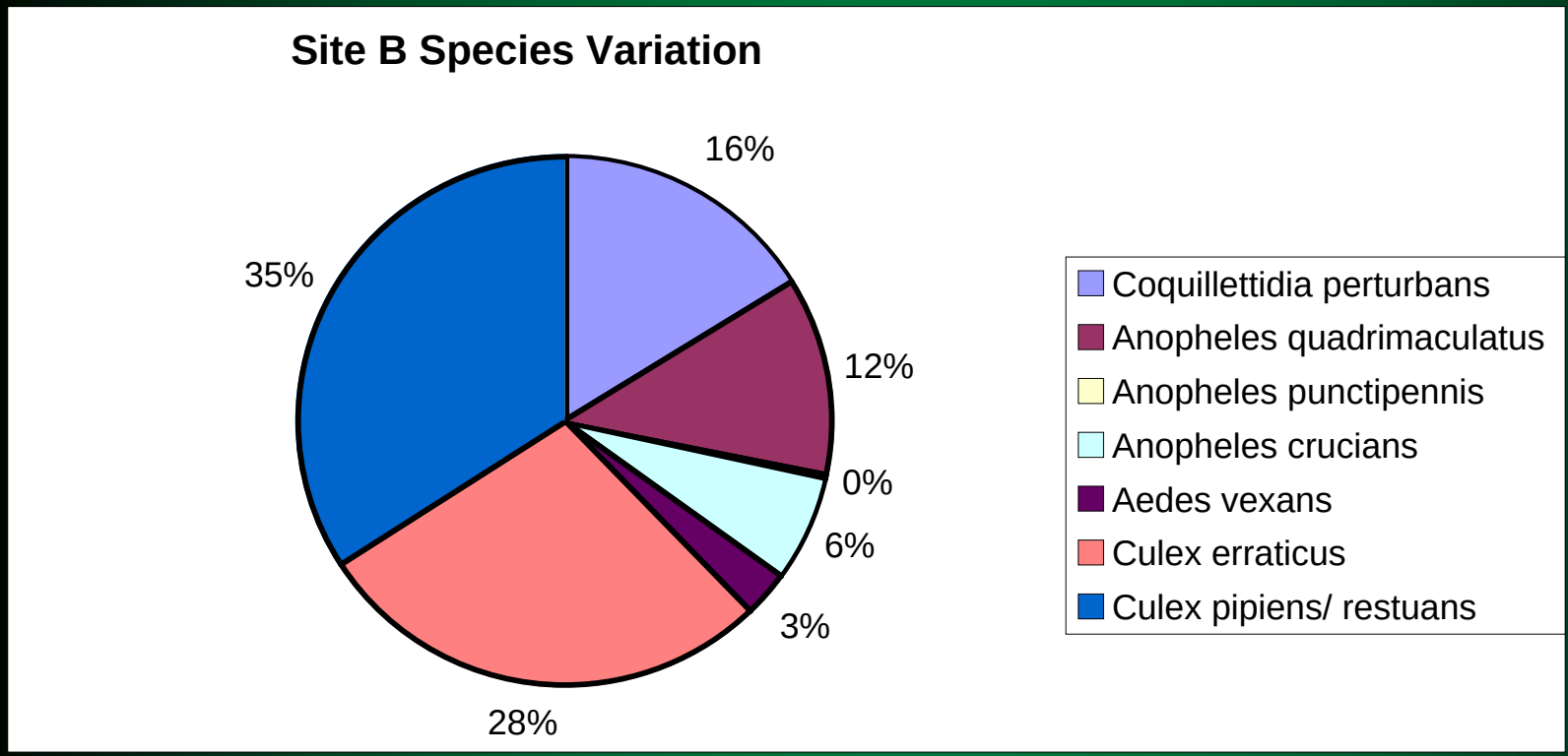
Overall Species Variation



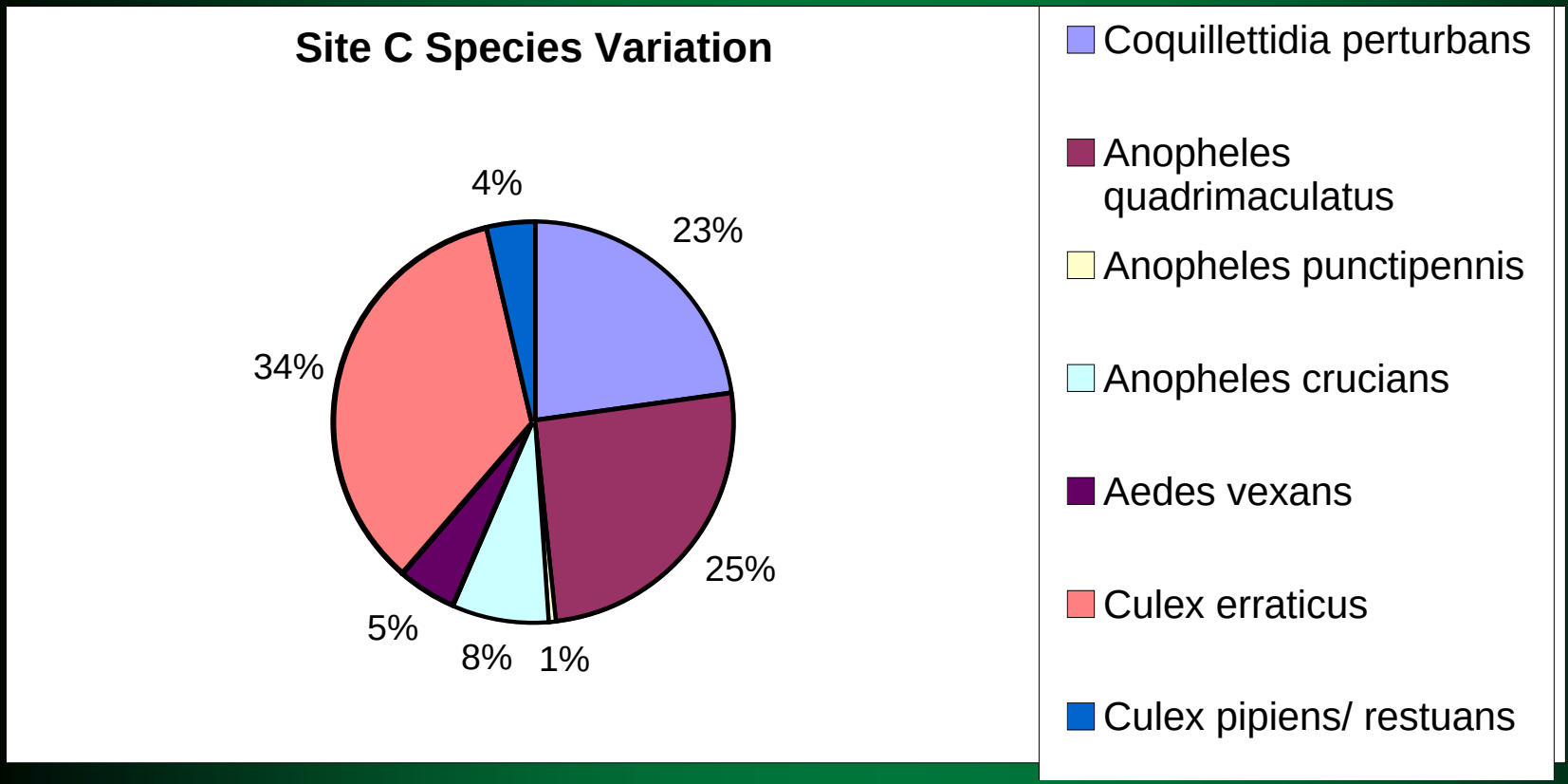
- Coquillettidia perturbans
- Anopheles quadrimaculatus
- Anopheles punctipennis
- Anopheles crucians
- Aedes vexans
- Culex erraticus
- Culex pipiens/ restuans



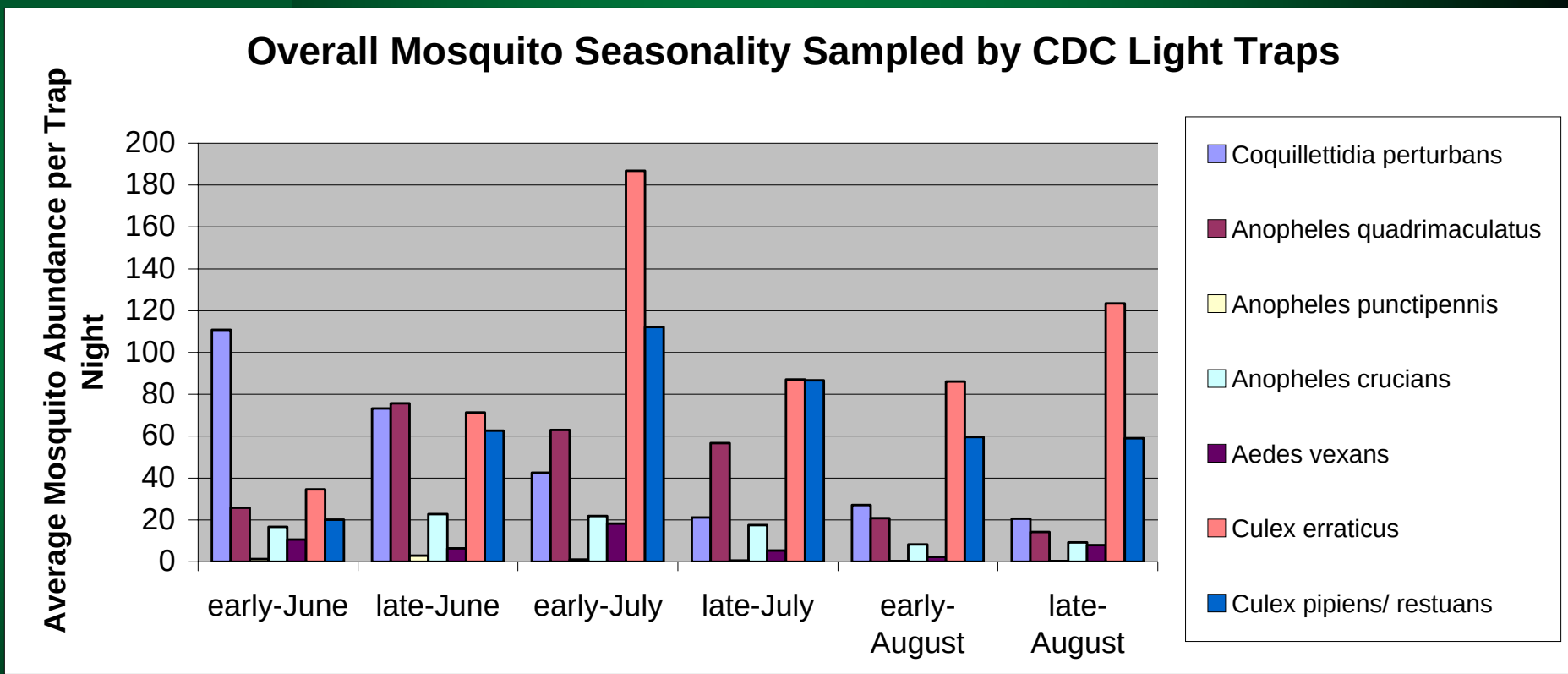
Early successional bottomland hardwood forest and emergent marsh heavily impacted by beaver activities.



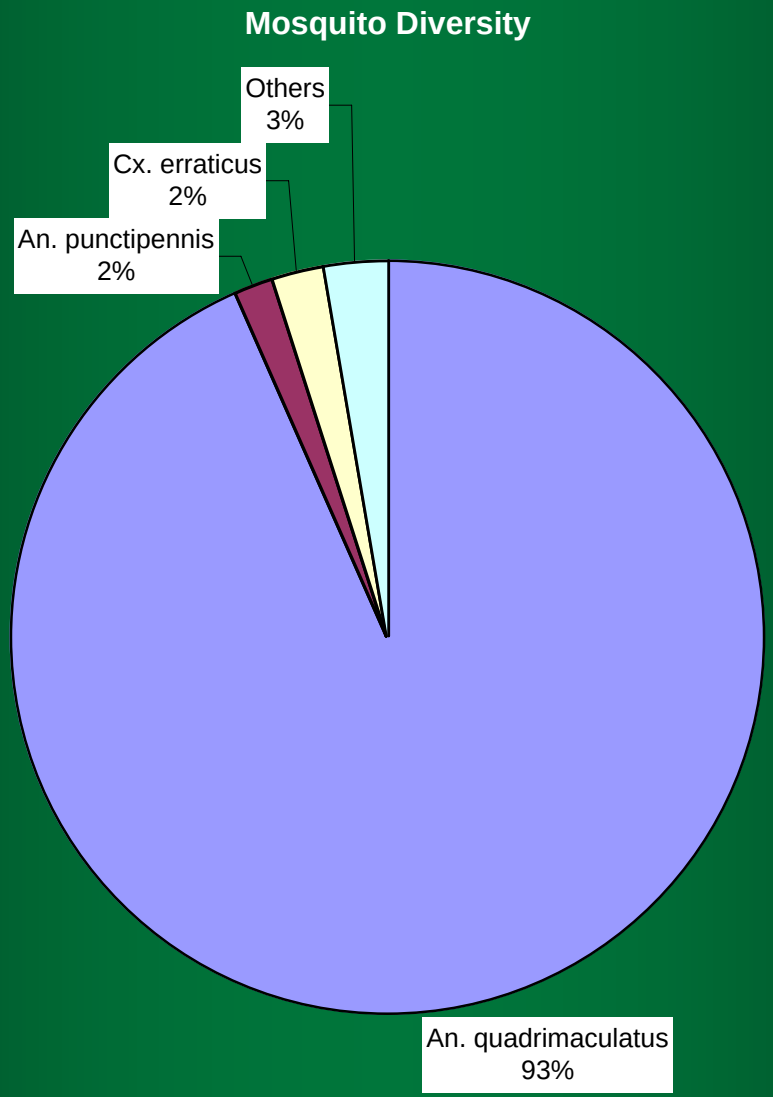
Forested wetland, emergent marsh, and early successional shrub-forest wetland.



Bottomland hardwood forest disturbed by logging.

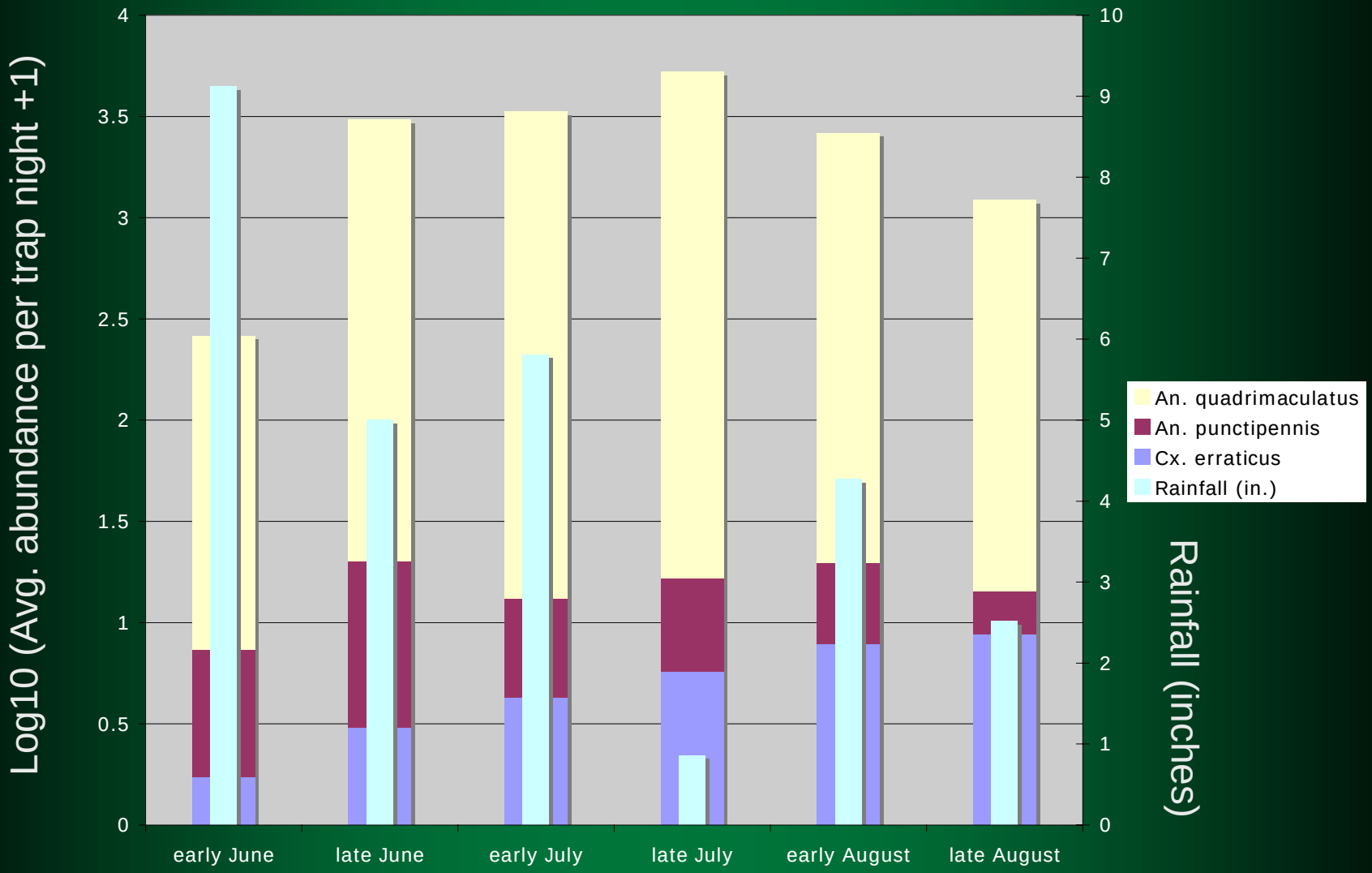

Overall Mosquito Seasonality Sampled by CDC Light Traps
Average Mosquito Abundance per Trap Night
200
180
160
140
120
100
80
60
40
20
0
early-June
late-June
early-July
late-July
early-August
late-August
Coquillettidia perturbans
Anopheles quadrimaculatus
Anopheles punctipennis
Anopheles crucians
Aedes vexans
Culex erraticus
Culex pipiens/ restuans

Resting box and aspirator



Total: 24871
Females: 11176
Males: 13984
Blood fed: 2190

Resting box collections



Conclusions

- This study represents the 1st characterization of an EEE enzootic focus in Tennessee
- Our initial equine serosurvey suggests a 66% (n=3) mortality rate on one farm
- 50% of the mosquito fauna collected are potential vectors
- Species most abundant in the beginning of the season that are ornithophagic may be involved in EEEv amplification in avian hosts, while those most abundant at the end of the summer that are both ornithophagic and mammalophagic may be bridge vectors.

Conclusions

- Most human and horse cases occur in coastal states where *Cs. melanura* serves as an efficient enzootic vector.
- At inland sites, *Cx. erraticus* may take over the role of *Cs. melanura* in amplification of EEEv in bird populations.
- Inland transmission cycle of EEEv may be similar to EEEv cycles in South America where *Cs. melanura* is not present and *Culex* of subgenus Melanoconion are involved in low level EEEv transmission.
- Reasons for low level transmission in Tennessee
  - Paucity of human population
  - Horse vaccinations
  - Low *Cs. melanura* population replaced by *Cx. erraticus*, possibly a less efficient vector.

Future work

- Speciate collections from September
- Testing of samples for EEEv and WNv
- Testing blood meals for host identification
- Vector competence of *Cx. erraticus*
- Avian serosurvey

Acknowledgments

- Tennessee Department of Agriculture
- University of Tennessee Agricultural Extension
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- Union University
- Tennessee Department of Health