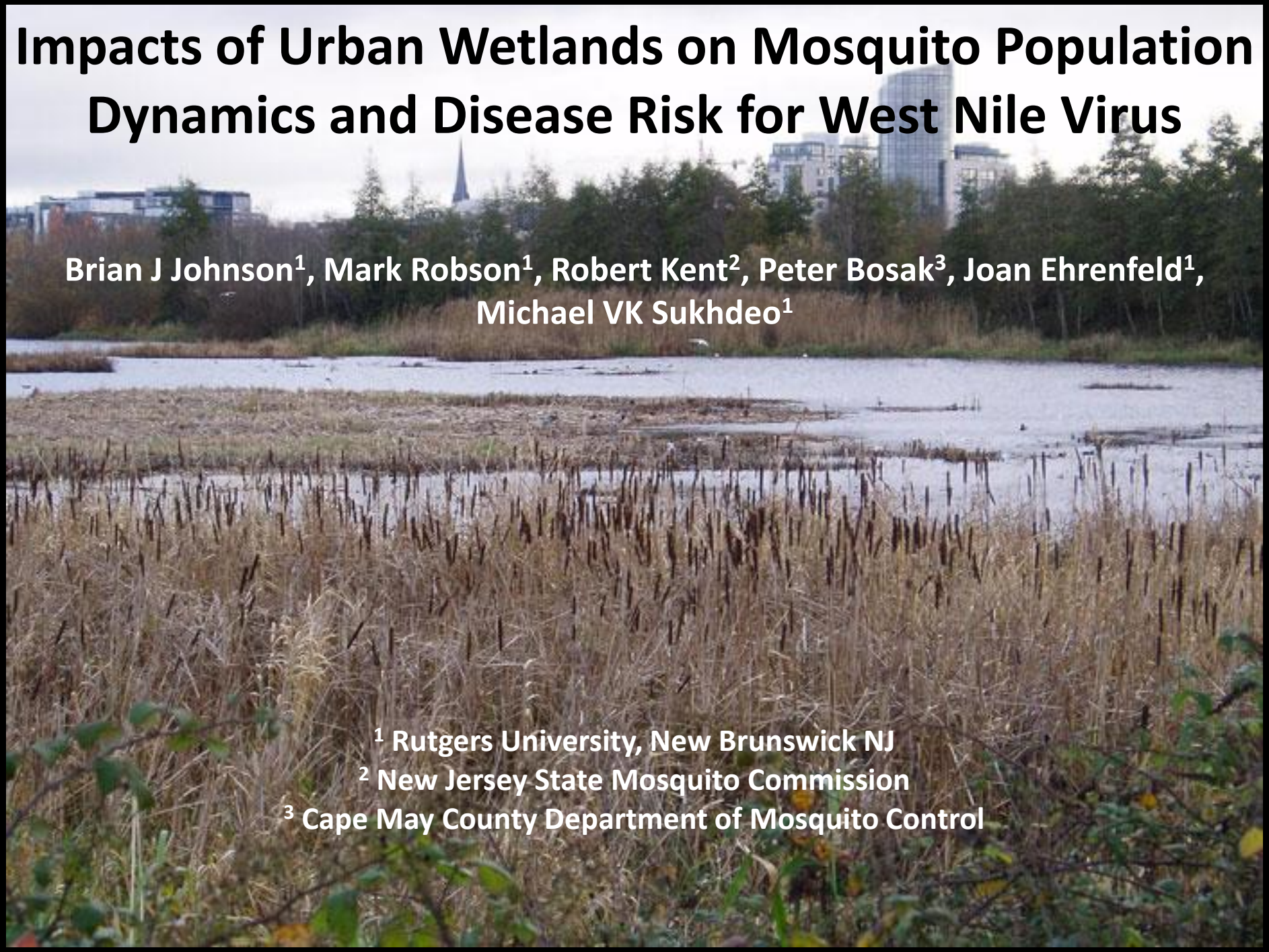
Impacts of Urban Wetlands on Mosquito Population Dynamics and Disease Risk for West Nile Virus



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Association Between West Nile Virus and Urban Wetlands

- Urban wetlands are often that most abundant open-space left within urban landscapes.(Ehrenfeld 2004).

- Wetland areas harbor many species that have tested positive for WNV, especially ***Culex spp***. (CDC,USDA,EPA)

- Outbreak of WNV in NYC in 1999 occurred near wetlands where ornithophilic mosquitoes, migratory birds, and humans were in close contact (Rappole et al. 2000)

- HOWEVER.. the mechanisms behind these associations have never been thoroughly investigated.

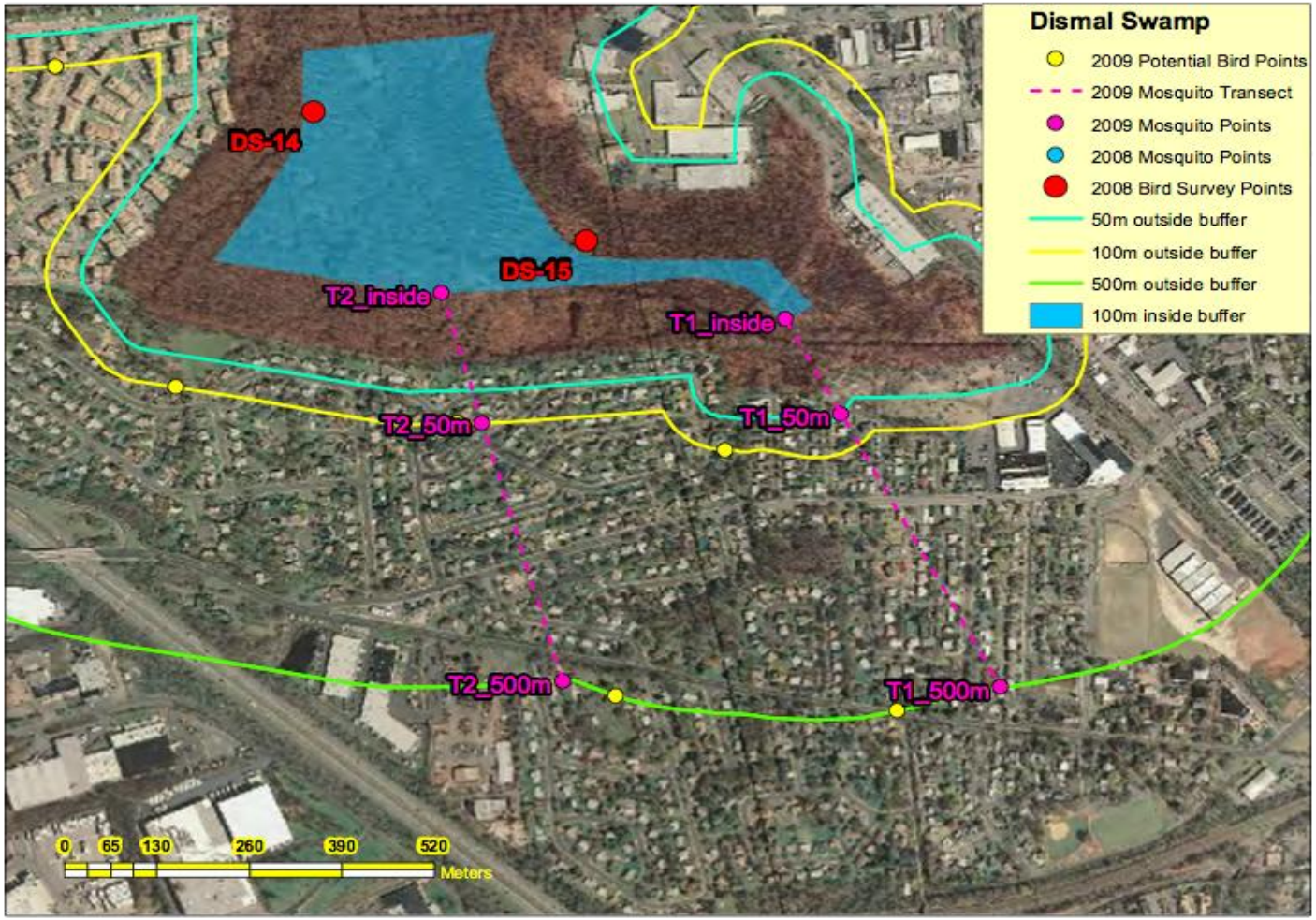
RESEARCH QUESTIONS….

- What are the differences in the mosquito communities moving between urban wetlands and adjacent residential/commercial urban habitats?

- What is the distribution of *Culex spp*. and possible bridge vectors (e.g. *Aedes albopictus* and *Ochlerotatus (Aedes) japonicus*) within each habitat?

- Does disease prevalence change between habitats, and if so, what are the ecological factors causing these differences?

Study System:



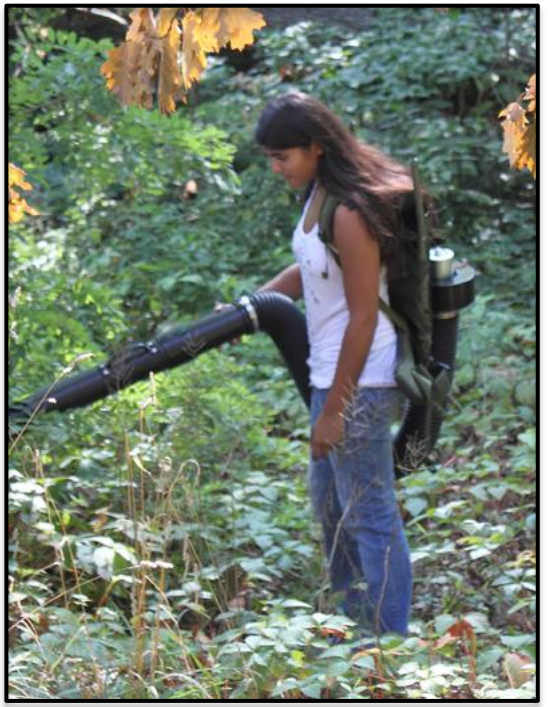
1. Survey local mosquito communities and disease prevalence over short local transects.

1. Transects consisted of a trap site located 100m within urban wetland areas and a second trap site located 500m from the wetlands edge out into adjacent residential/commercial areas. In 2009 a third trap location was located 50m from the wetlands edge.

Surveillance Methods:

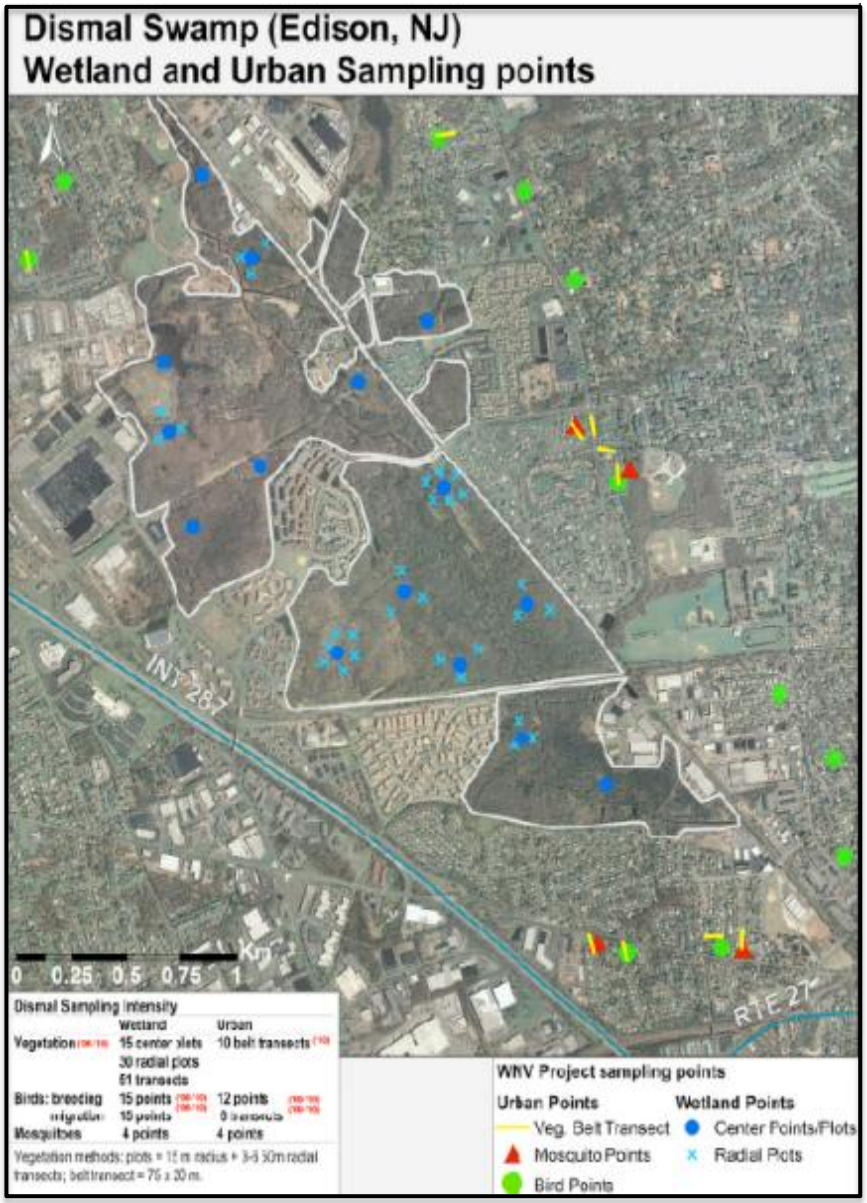
A. CDC Miniature Light traps baited with CO_2

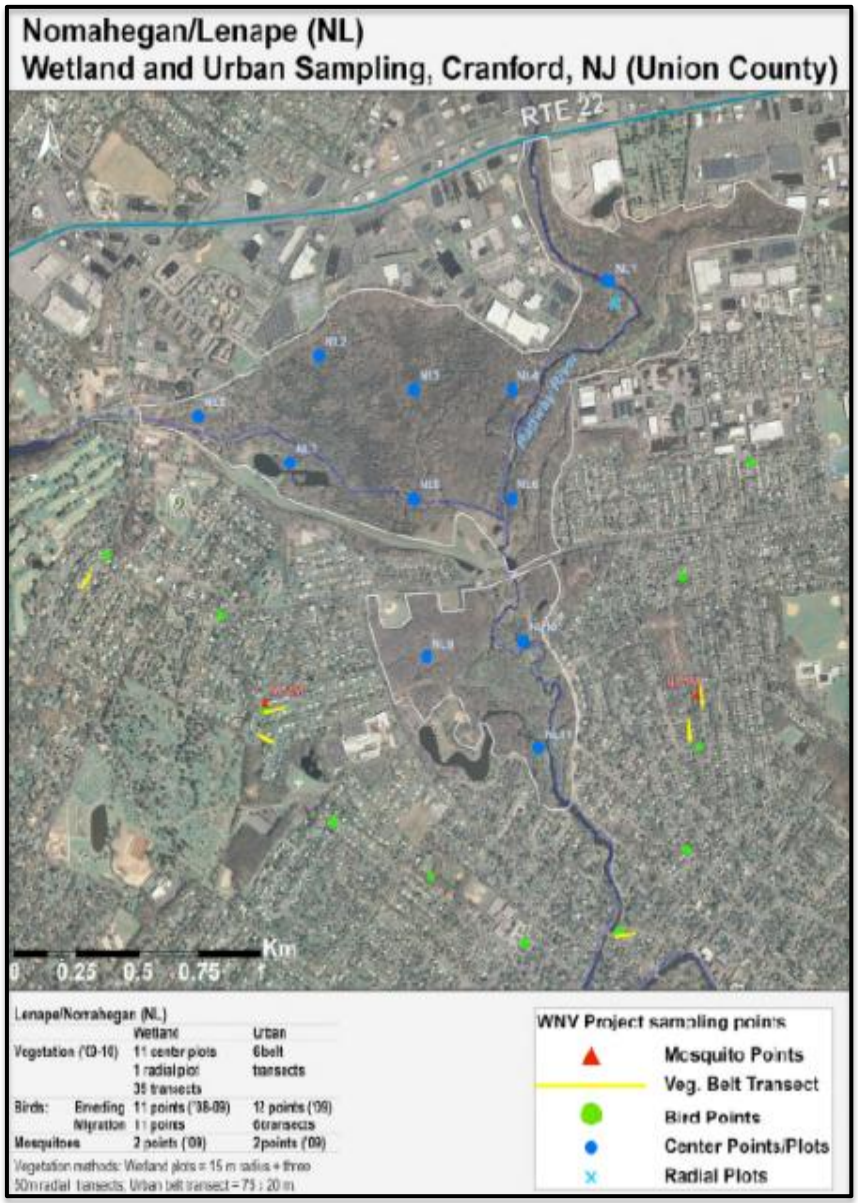
B. CDC Gravid traps baited with a hay infusion



C. Backpack Aspirators

Large Study Sites (≥ 125ha)



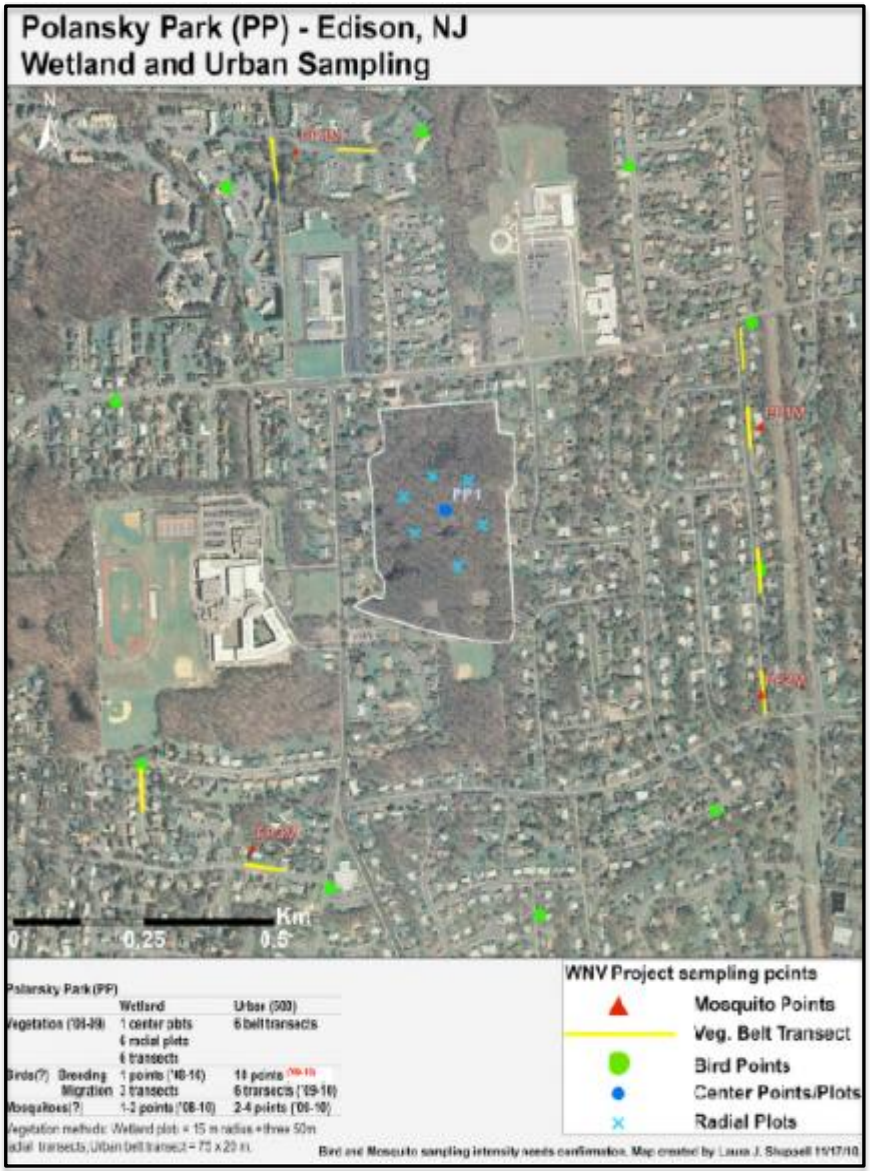


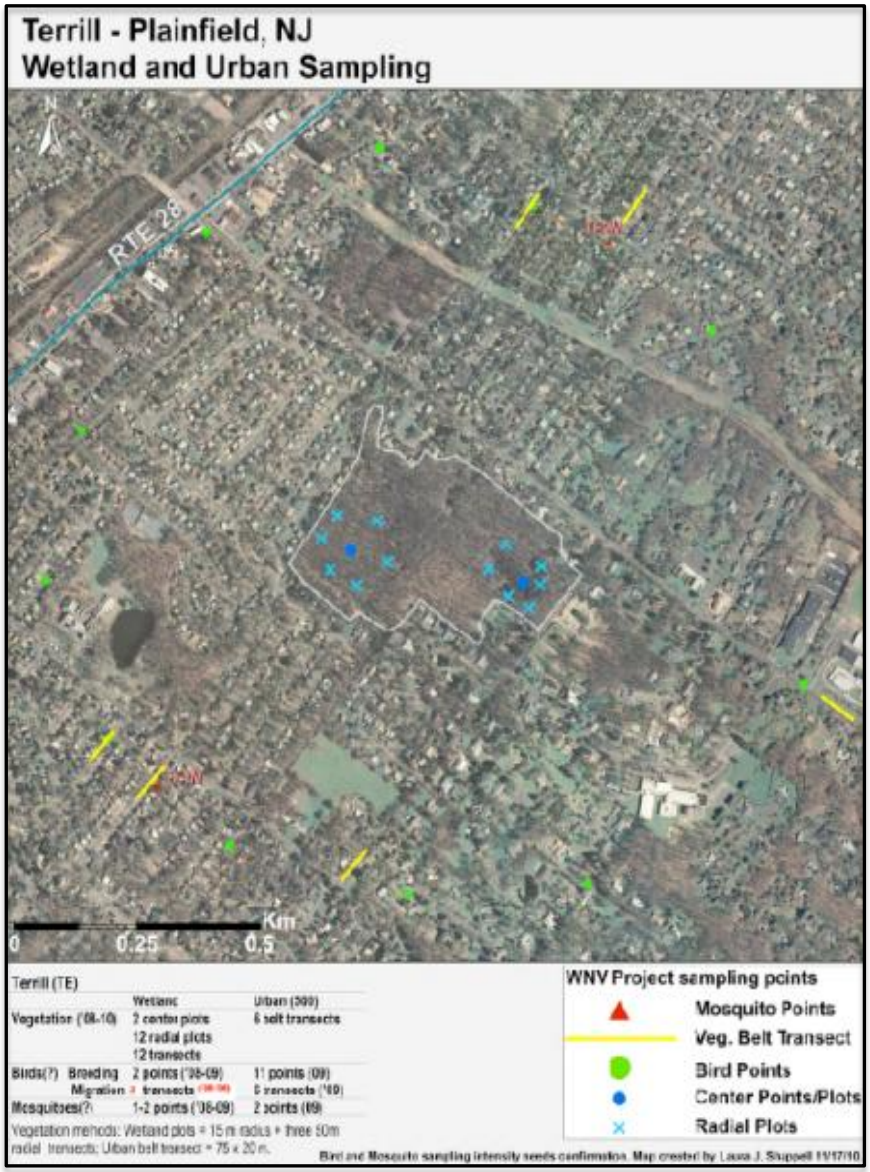
Maps courtesy of Laura Shappell

Medium Study Sites (15-35ha)

Maps courtesy of Laura Shappell

Small Study Sites (≤15 ha)

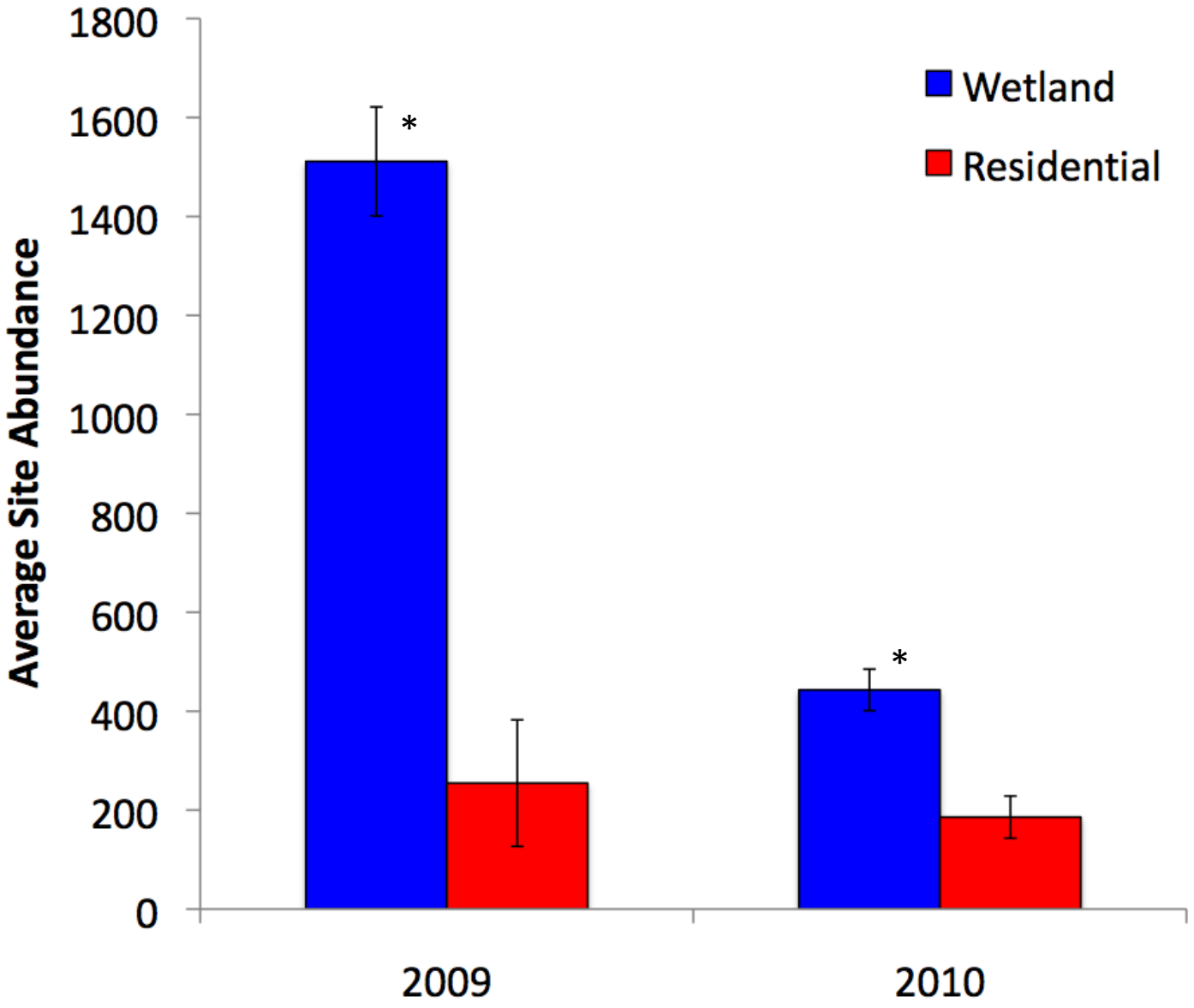




Maps courtesy of Laura Shappell

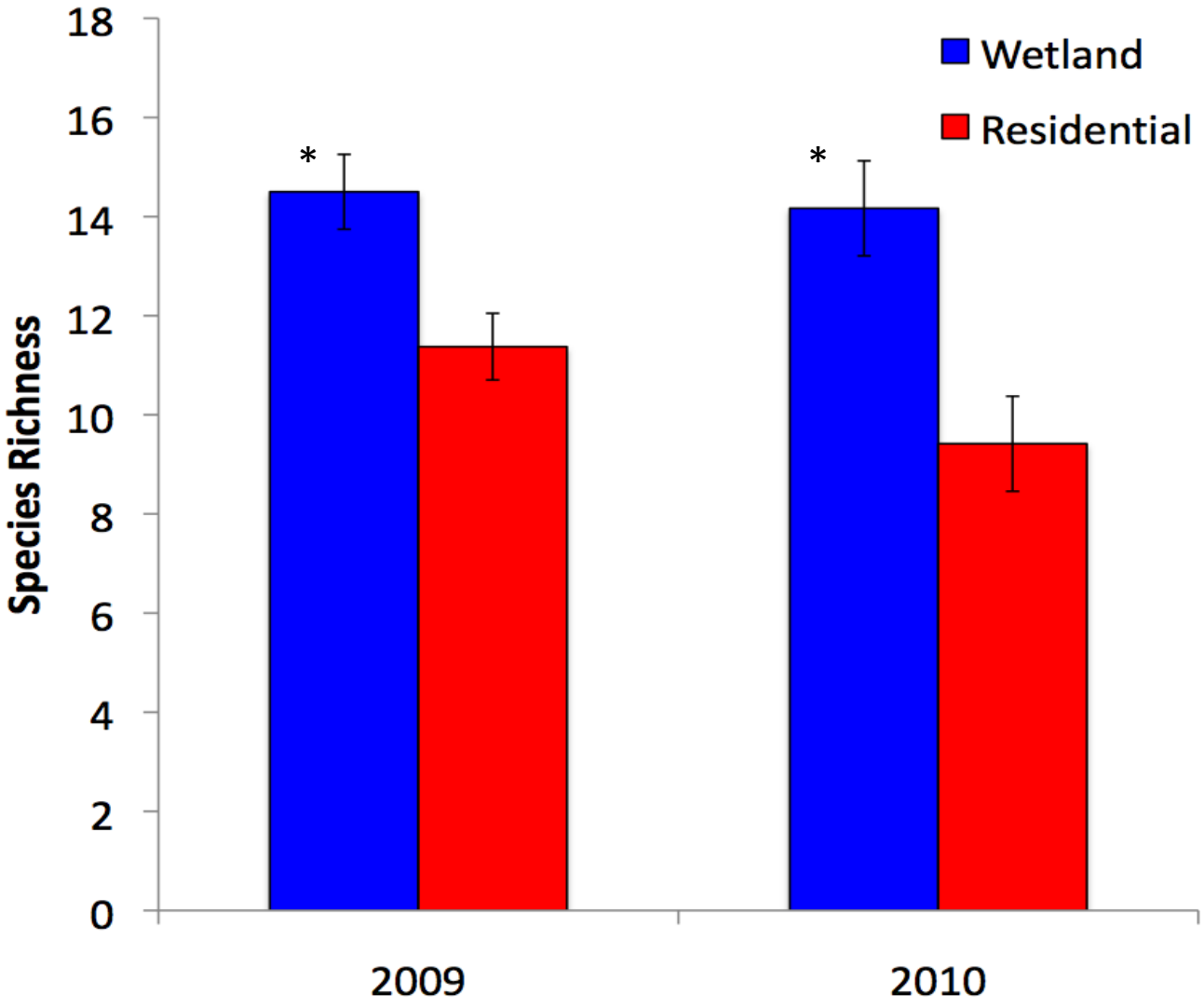
How Did Habitat Type Impact Local Mosquito Populations and West Nile Virus?

Overall Mosquito Abundances Within Each Habitat



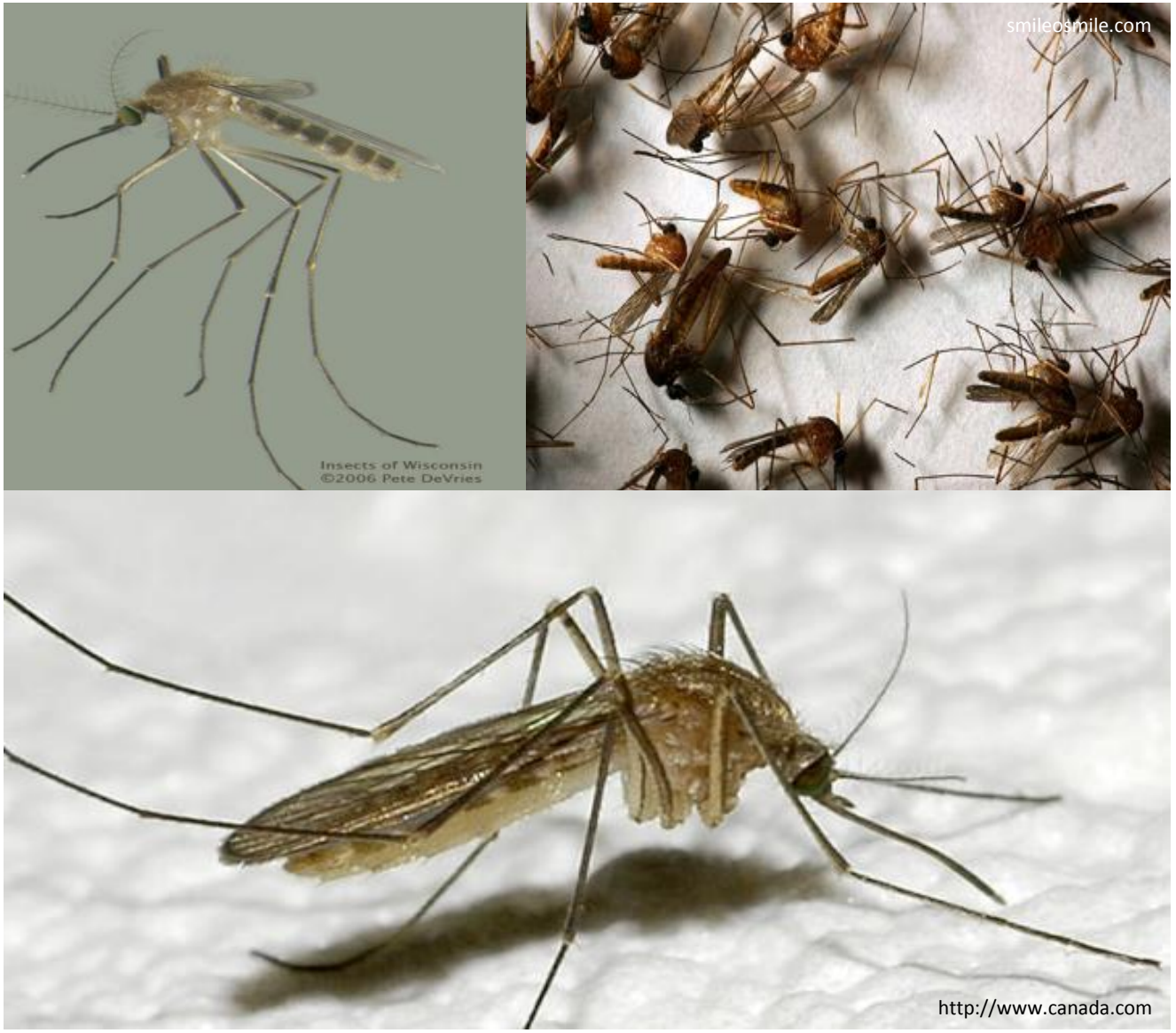
* P<0.05; Wetland vs. Residential

Mosquito Species Richness within Each Habitat

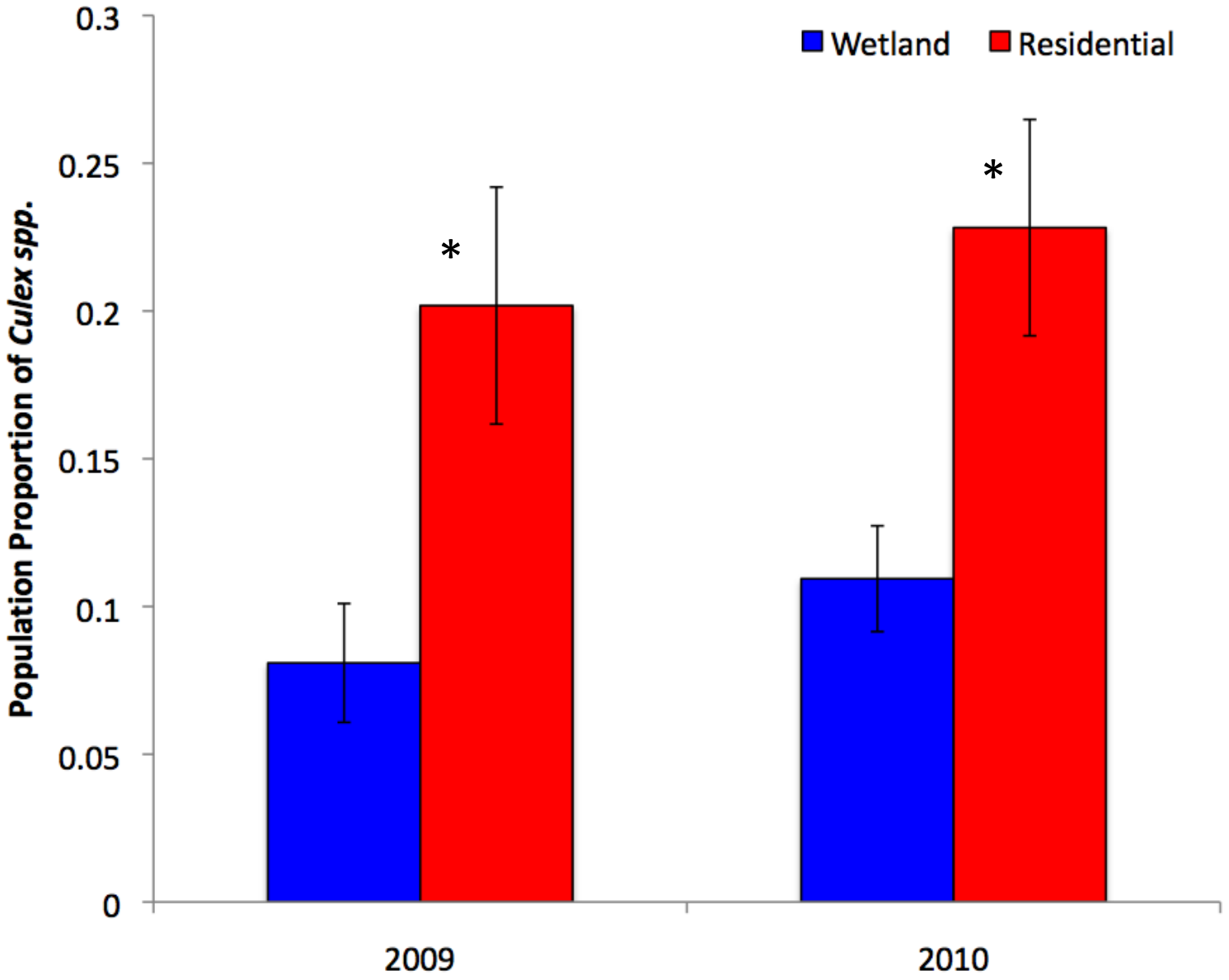


* P <0.05; Wetland vs. Residential

What is the distribution of *Culex spp.* (*e.g. Culex pipiens* and *Culex restuans*), which are the main vector species for WNV in the Northeast, within each habitat?

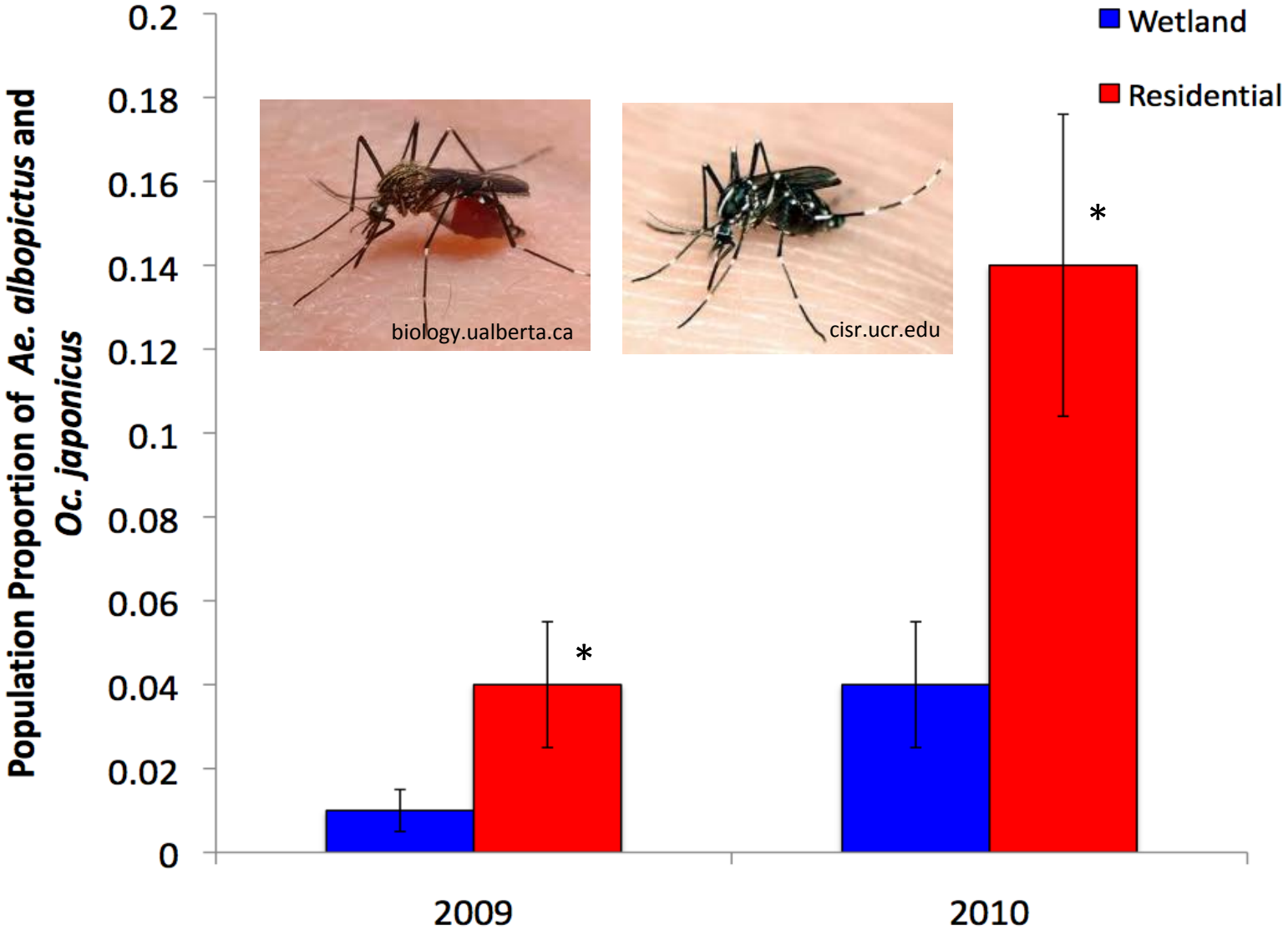


Community presence of *Culex spp*. within each habitat



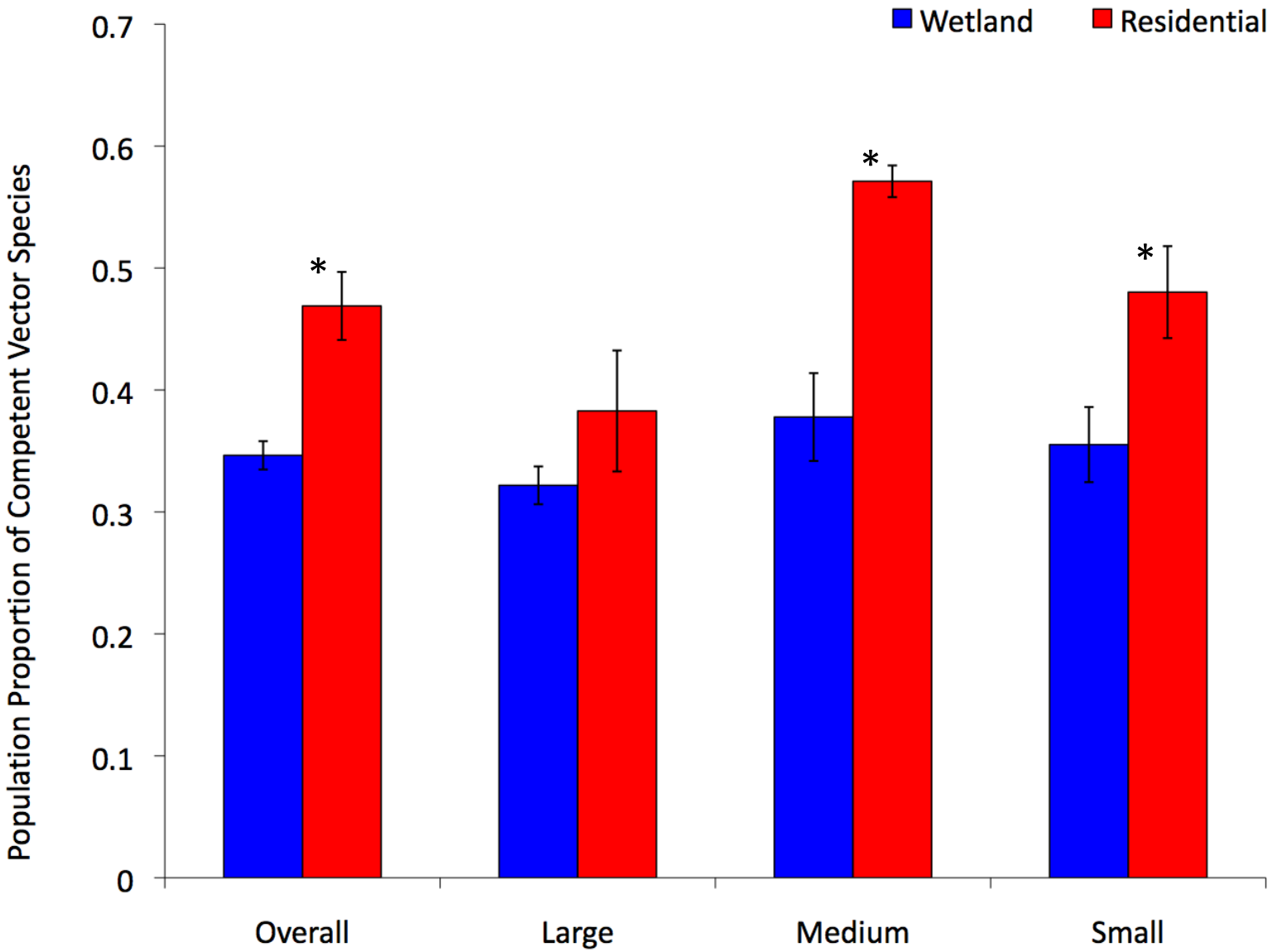
* P <0.05; Residential vs. Wetland

Community Presence of *Aedes albopictus* and *Ochlerotatus japonicus*



* P<0.05; Wetland vs. Residential

Community Presence of *Culex spp.*, *Aedes albopictus*, and *Ochlerotatus japonicus* for Each Wetland Size Classification

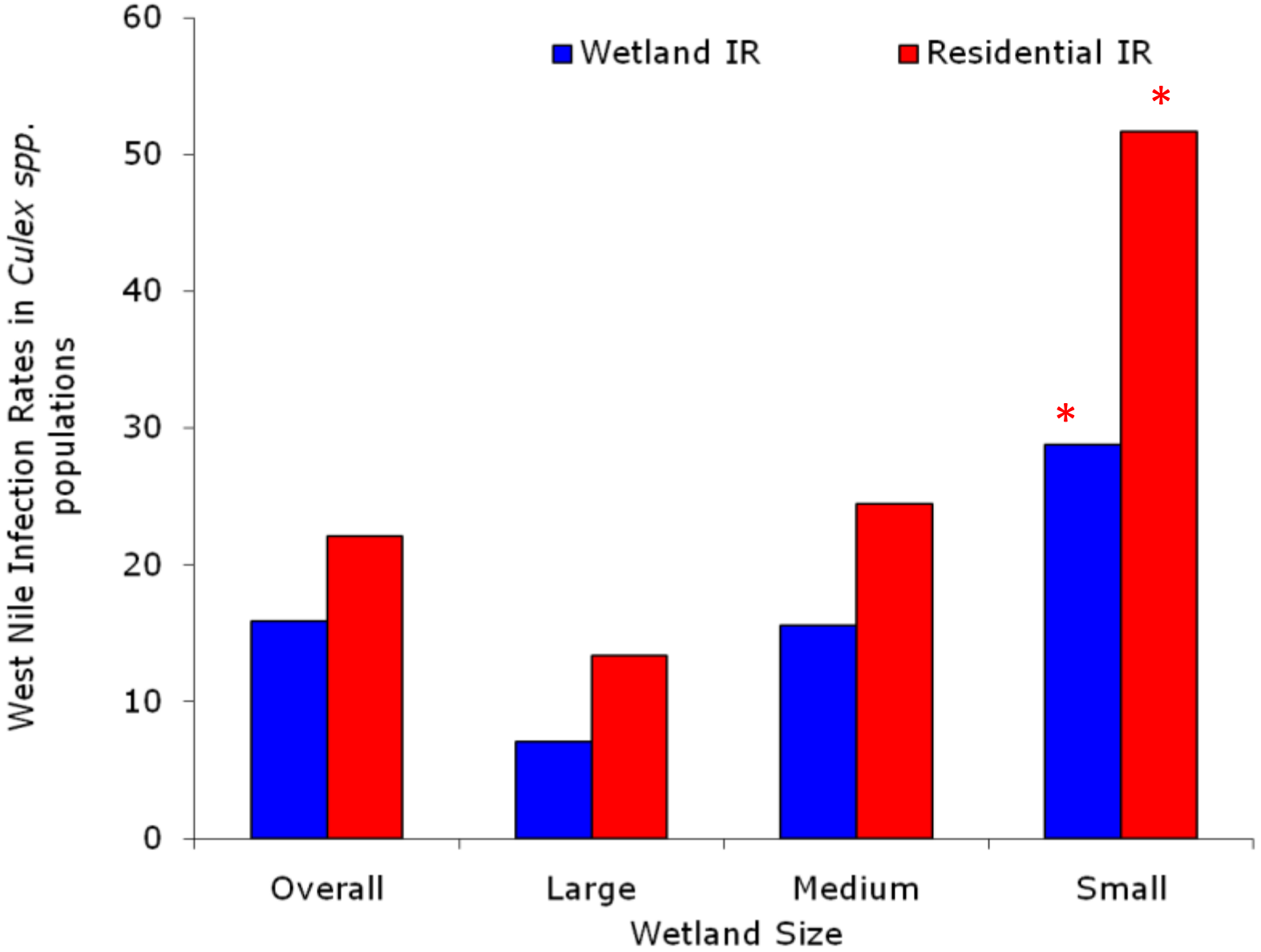


* P<0.05; Wetland vs. Residential

West Nile Virus Testing

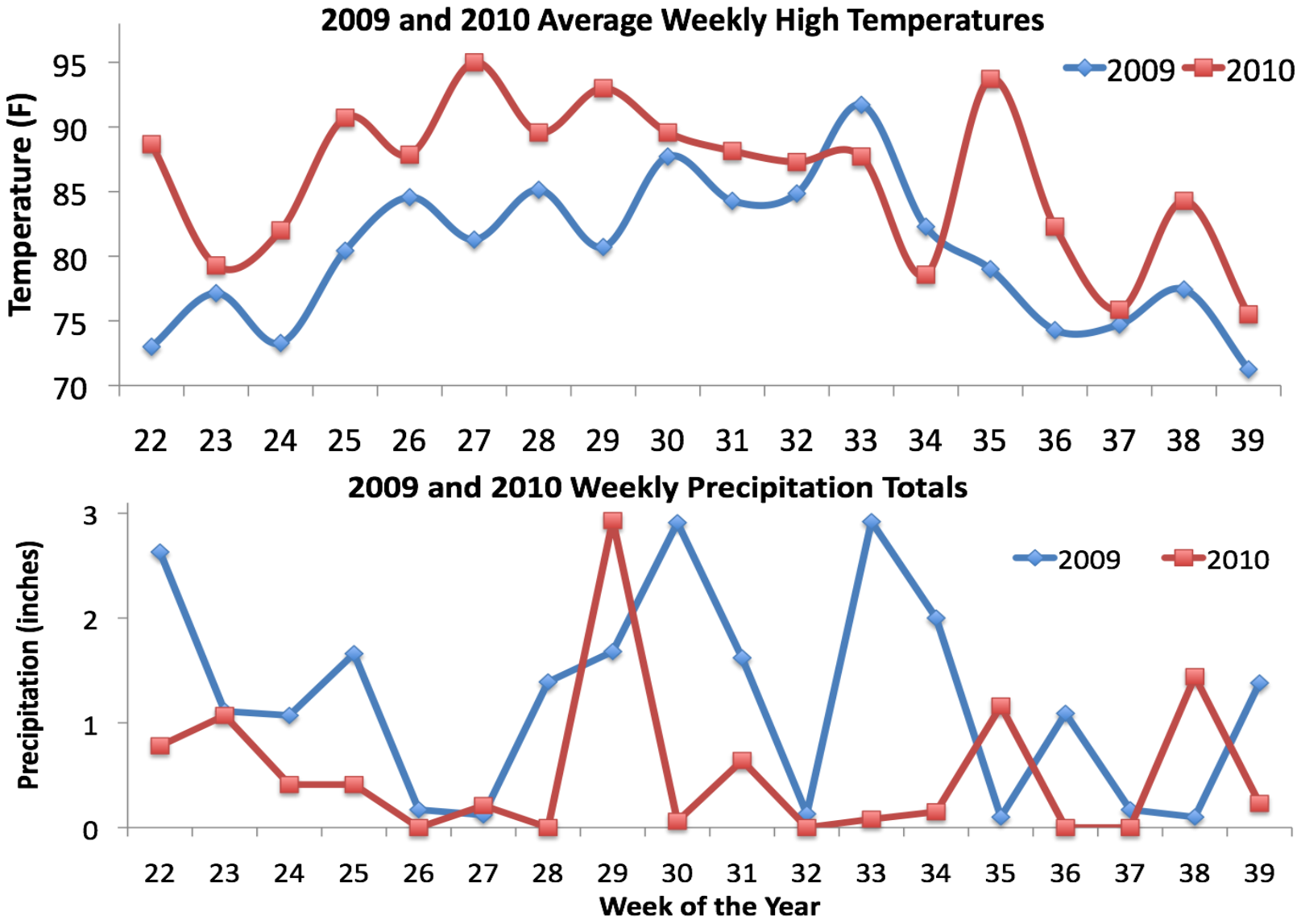
- *Culex spp.* from light and gravid trap collections from both habitats were sorted into pools of up to 50 mosquitoes
    - Collections were originally frozen at -20 C then transferred into -80 C freezer for storage
- In 2009 pools were tested for WNV using VecTest (Microgenics Corporation, CA)
    - WNV antigen panel assay
- In 2010 pools were tested for WNV using real-time reverse transcription polymerase chain reaction (RT-PCR) methods.
    - Cape May County Dept. of Mosquito Control (Cape May, NJ)
        - Special thanks to Robert Kent, Dr. Mark Robson, Dr. Peter Bosak, and Karen Hedstrom
- Infection Rates Calculated using PooledInfRate 3.0 add-in for Microsoft Excel(Biggerstaff 2006)

West Nile Virus Infection Rates within each Habitat



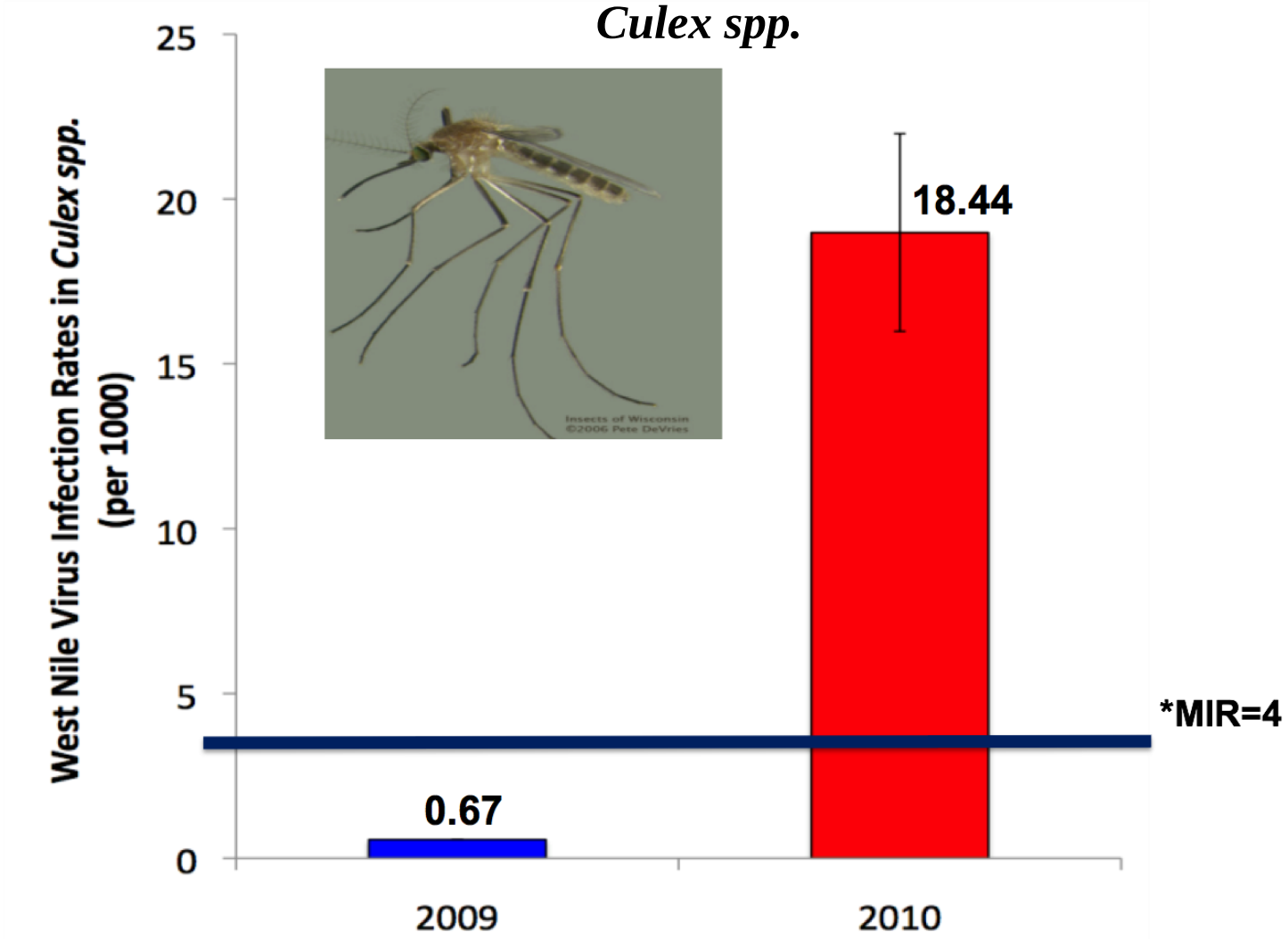
* P <0.05; Small Wetland, Residential vs. Large Wetland, Residential

Seasonal Influences of Temperature and Precipitation on the Prevalence of West Nile Virus



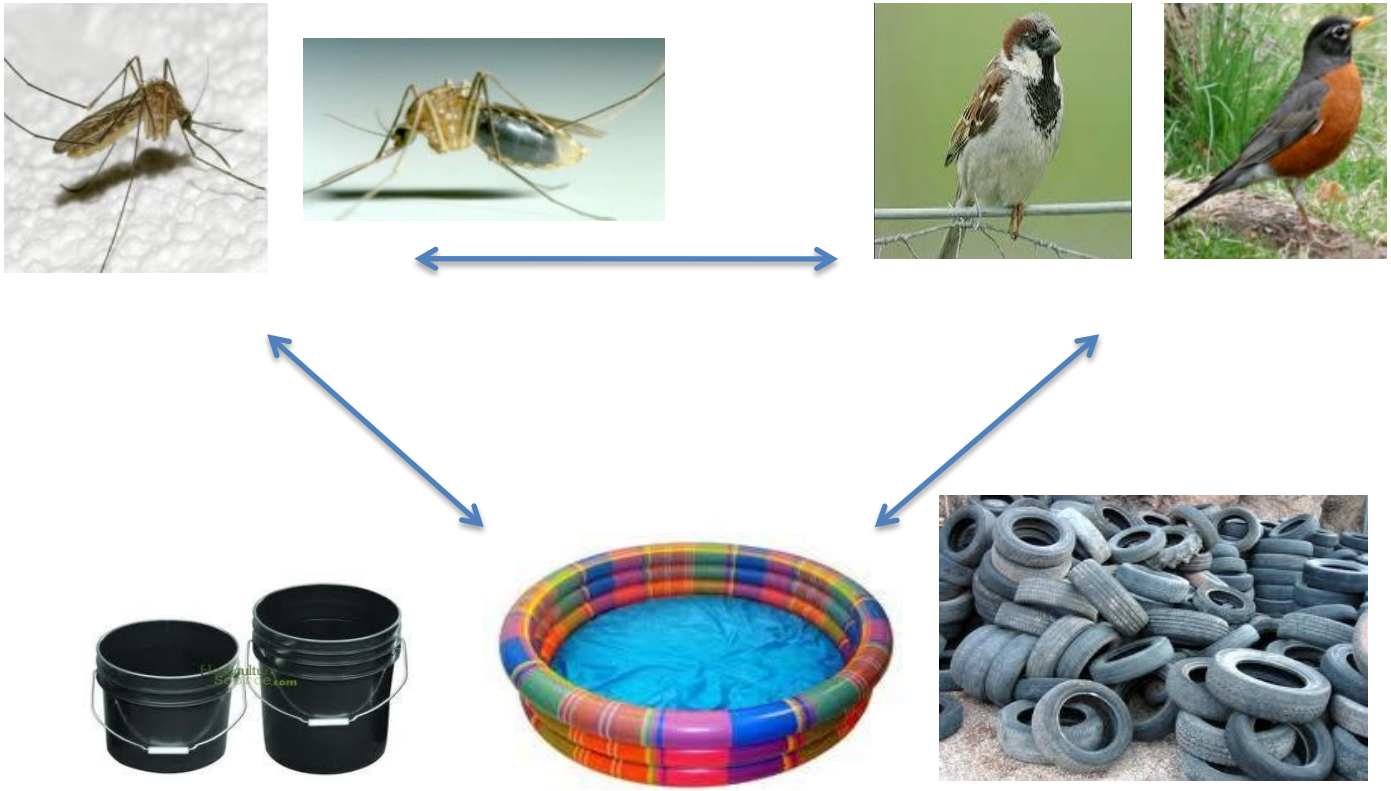
- Overall, the 2010 season was a much hotter and drier year than 2009, which significantly impacted yearly WNV infection rates.

Yearly West Nile Virus Infection Rates in *Culex spp.*



- The hot and dry conditions of the 2010 season resulted in substantial increases in WNV infection rates within *Culex spp.* populations compared to 2009.

* MIR ≥ 4 indicates epidemic levels of transmission in local vector and avian host populations



- One hypothesis as to why drought conditions increase viral transmission is that hot and dry conditions cause an aggregation of avian host species (e.g. American robin and House Sparrow) around remnant patches of water, many of which would be container habitats.

- These container habitats also happen to be suitable breeding habitats for *Culex spp.* and possible WNV bridge vector species (e.g. *Ae. albopictus* and *Oc. japonicus*).

- The aggregation of competent avian host and vector species created by these conditions subsequently increases the contact rate between vector and host species, and ultimately increases the transmission of WNV.

Conclusions…

- Residential areas contain a stronger community presence of competent enzootic and bridge vector species compared to their wetland counterparts.

- WNV was more prevalent within residential *Culex spp*. populations compared to wetland populations.

- The size of a wetland patch can be an important predictor for WNV.
  - Large wetland batches buffer disease better than small and medium sized wetlands.

- Seasonal variations in temperature and precipitation can be important predictors for WNV, especially drought conditions.

- Overall, these results prove that Disease Risk for WNV is greatest within residential areas and not urban wetland areas.

Acknowledgements

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