Culex quinquefasciatus Production in Combined Sewage Overflows in Atlanta

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Culex spp. larvae

WNV background

- West Nile Virus is a mosquito-borne flavivirus commonly found in Africa, Asia, Europe, Australia, and the Middle East.
- WNV infects humans, birds, mosquitoes, horses and other mammals
- Introduced to the U.S. in the summer of 1999

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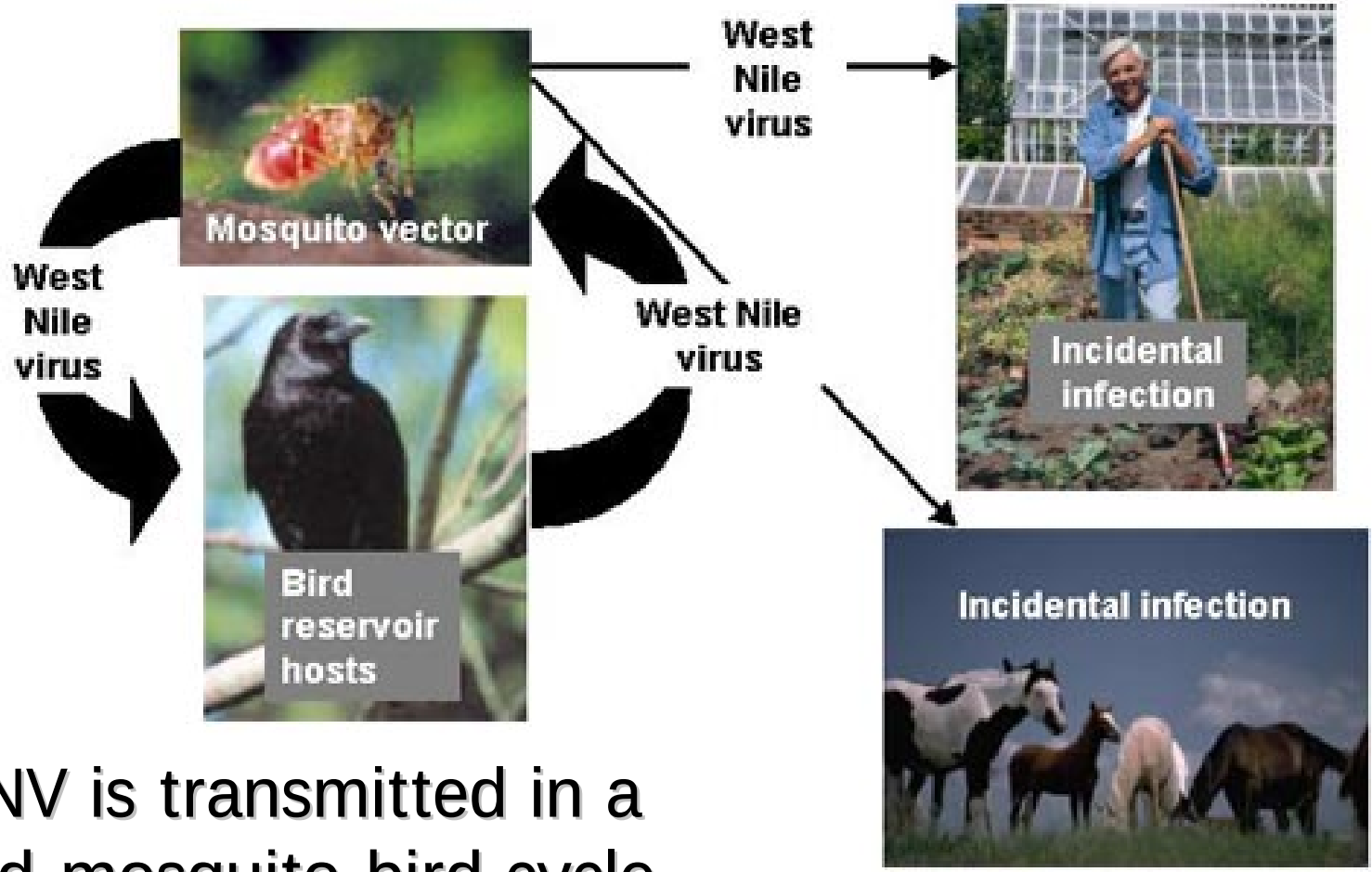
West Nile Virus Transmission Cycle



WNV is transmitted in a bird-mosquito-bird cycle primarily involving *Culex spp.*

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WNV in Georgia

Culex quinquefasciatus

- 2004 -21 human cases of WNV in Georgia- 9 in Fulton Co.
- 2005-20 human cases of WNV in Georgia-9 in Fulton Co.
- In 2005, the Georgia State Health Department found 66 mosquito pools positive for WNV (63 were *C. quinquefasciatus*, 2 *C. restuans*, and one *C. nigrapalpus)*

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In Atlanta, *Culex quinquefasciatus* is found in CSOs

Fulton Co. Department Health & Wellness trapped WNV-pos mosquitoes along the CSOs

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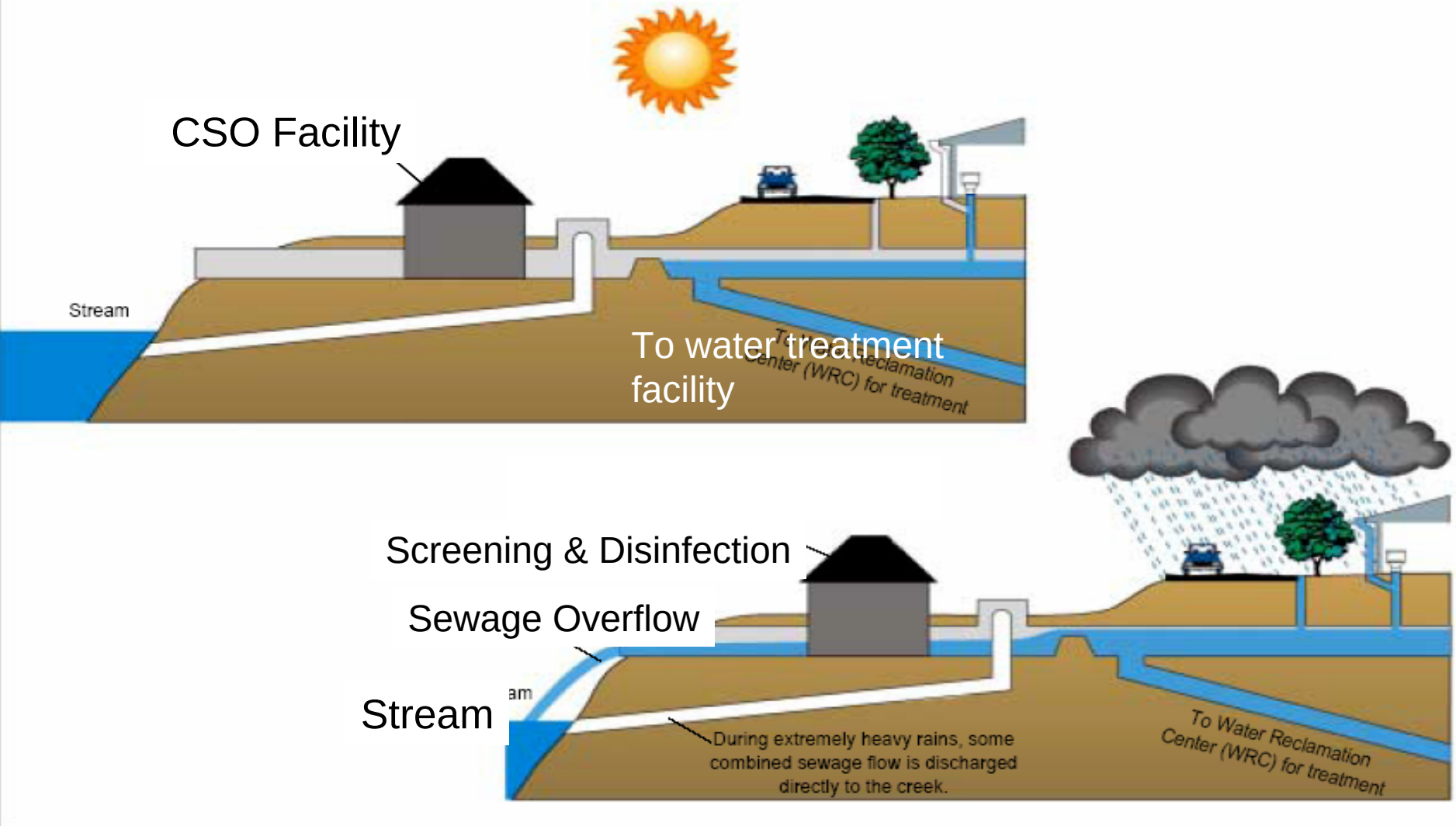
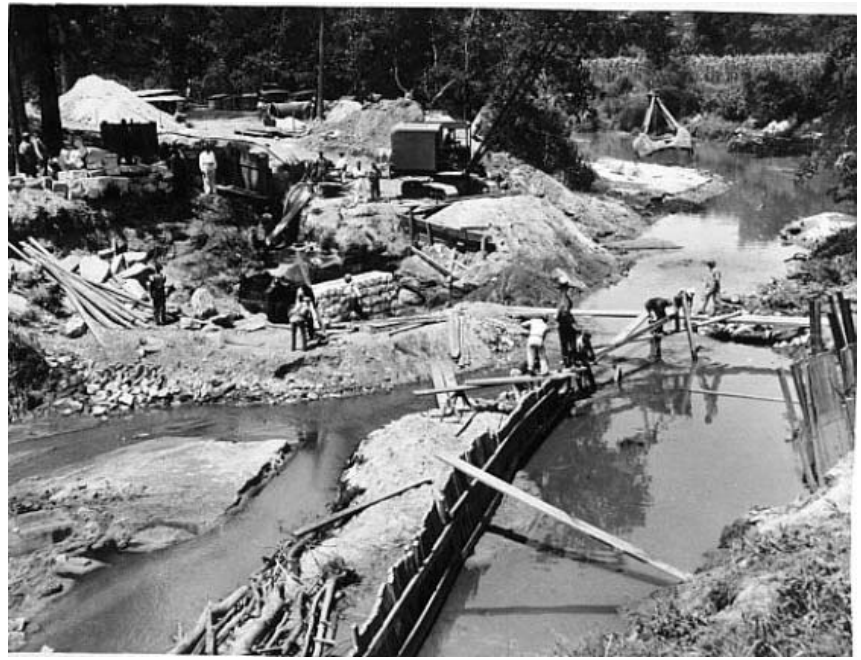
What is a CSO?


CSO Facility
Stream
To water treatment facility
Screening & Disinfection
Sewage Overflow
Stream
During extremely heavy rains, some combined sewage flow is discharged directly to the creek.
To Water Reclamation Center (WRC) for treatment

CSOs in Atlanta

- >700 CSOs in hundreds of major cities around the United States, 9 of which are in Atlanta
- Atlanta CSOs completed in 1920's, separate sewers afterwards



Clear Creek

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CSOs are found in densely populated areas of metro Atlanta

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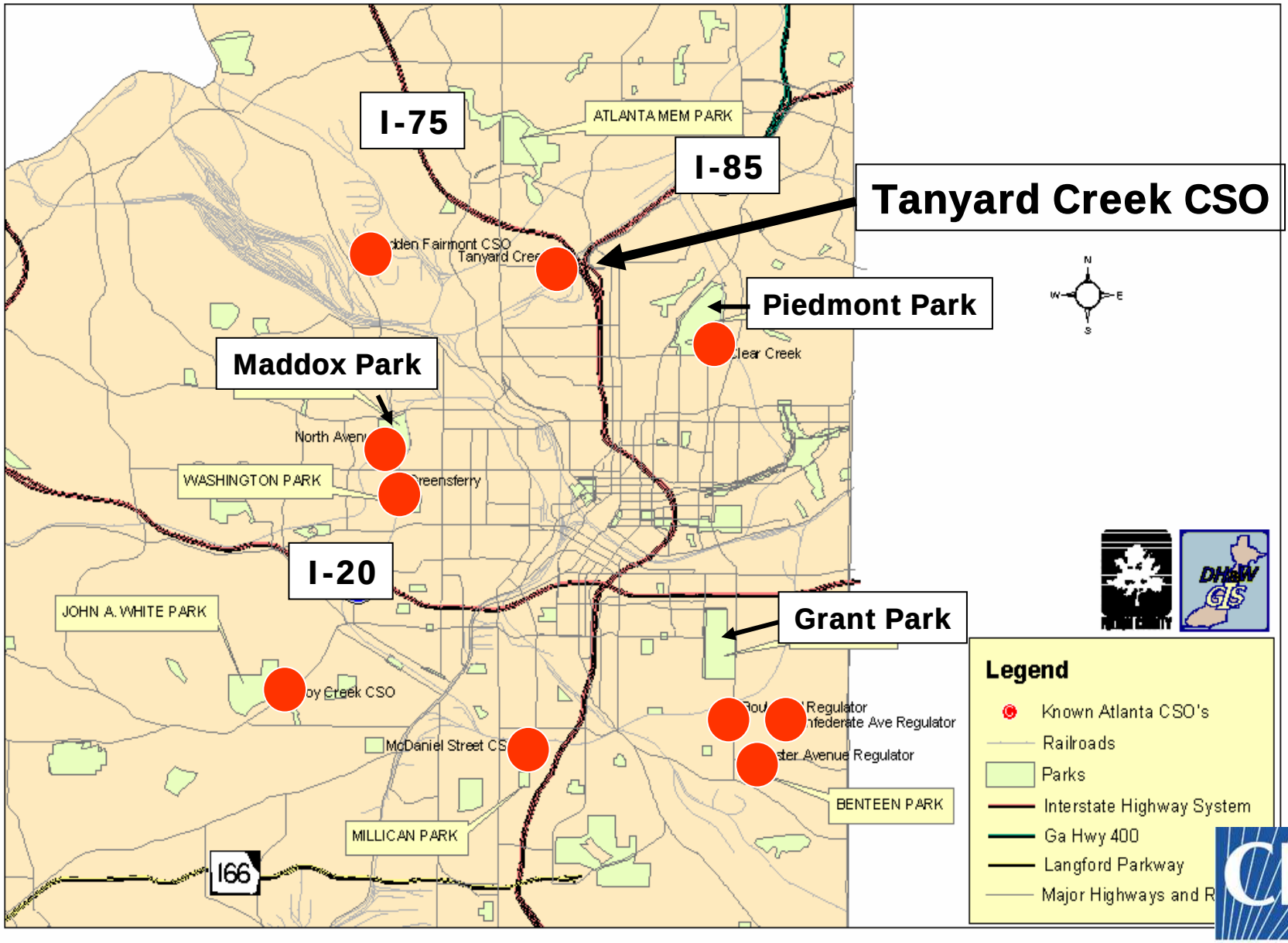
CSO Basins in the City of Atlanta



Goals and Objectives

- To quantify and characterize urban CSO streams for mosquito productivity
- To understand how mosquitoes populations are regulated in CSO streams
- To establish a baseline for evaluation of control options

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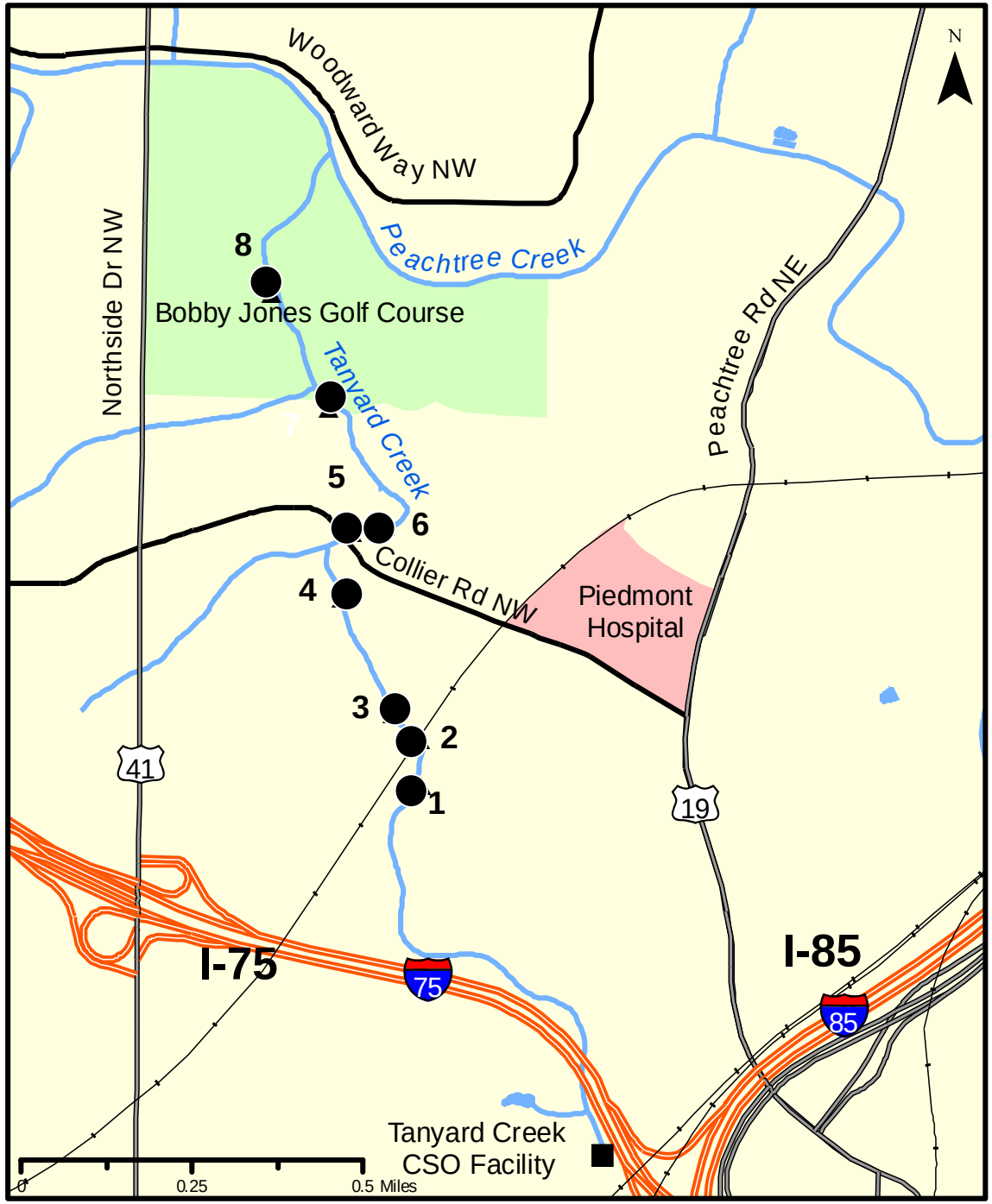
Study design

- Map CSO with GPS to determine actual length and characterize different habitats
- Longitudinal collections at 8 sites in Tanyard Creek
- Quantify mosquito stages by weekly dipping (25 random dips in each area with description of environment for each dip)
- Collected pupae brought back to lab to rear and identify adult mosquito

Locations of Study Sites in Tanyand Creek



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Examples of habitats

Mosquitoes Species in CSOs
(Identified from emerged pupae)

Month	No. Pupae	Species *C quinq*	*C restuans*	other
June	66	58%	42%	
July	56	79%	21%	
August	79	85%	15%	
Sept	54	87%	6%	7%
Oct	53	100%		
Nov	17	29%	65%	6%

- Found *Culex nigrapalpus* as well as one *Anopheles punctipennis* in addition to *C. restuans* and *C. quinquefasiciatus*

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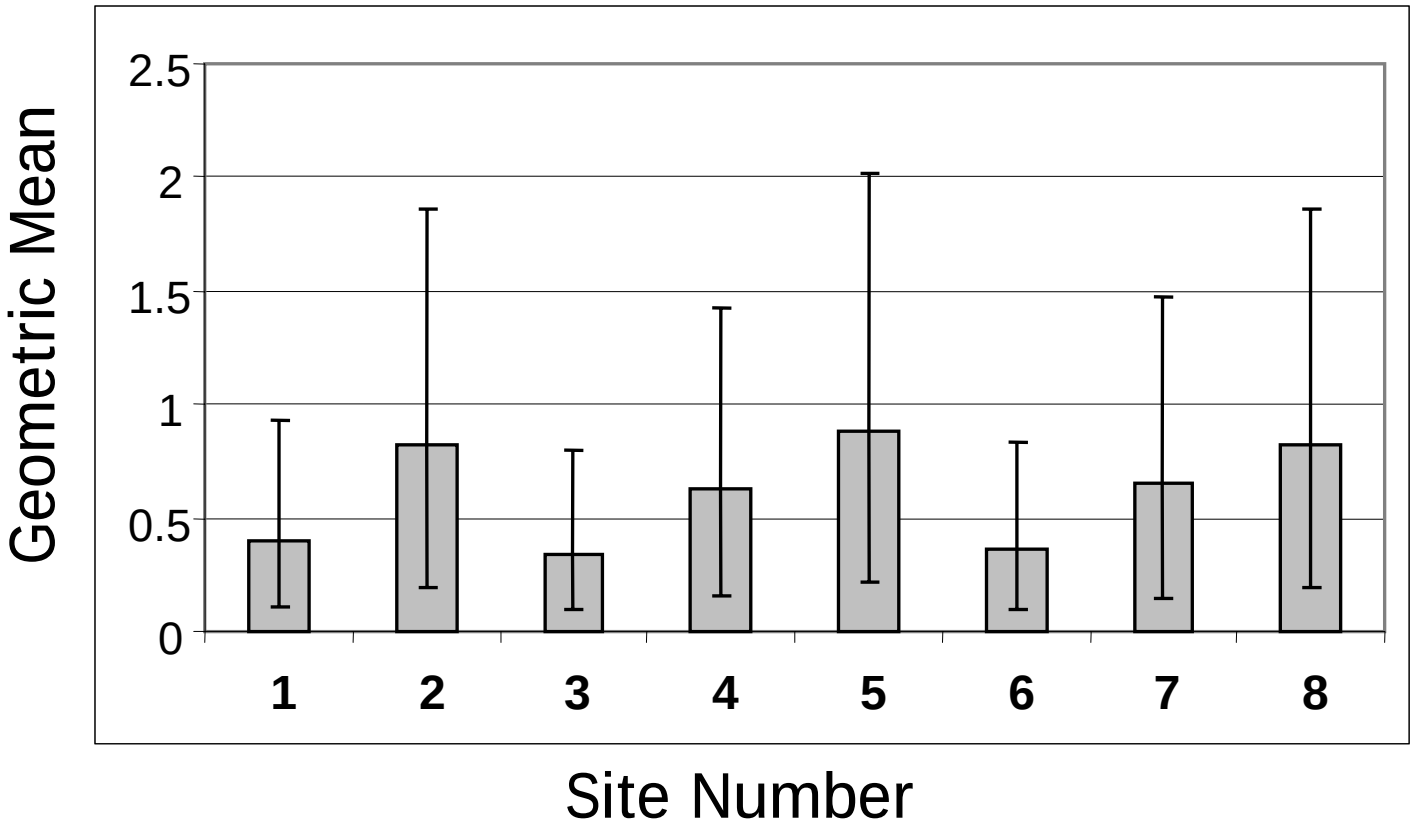
Differences in geometric mean per dip among the 8 sites for all mosquito stages (egg rafts, larvae and pupae)



Significant differences in density among sites (e.g., site 3 was significantly less productive overall than sites 2, 5, 7 and 8)

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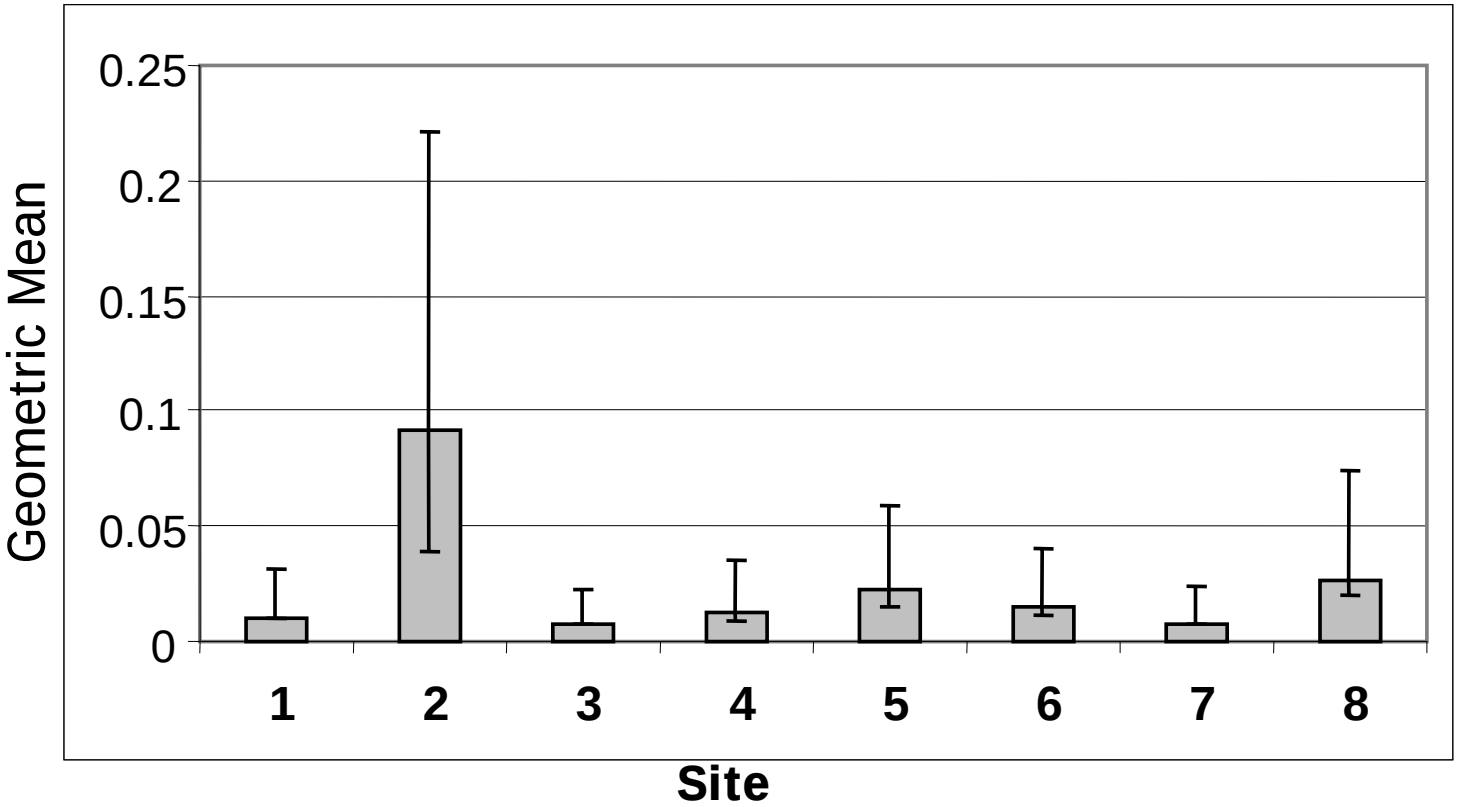
Egg Raft differences among sites



- There were significant variations in the production of all life stages for each of the 8 sites
- Site 2 produced significantly more egg rafts than that of the other 7 sites

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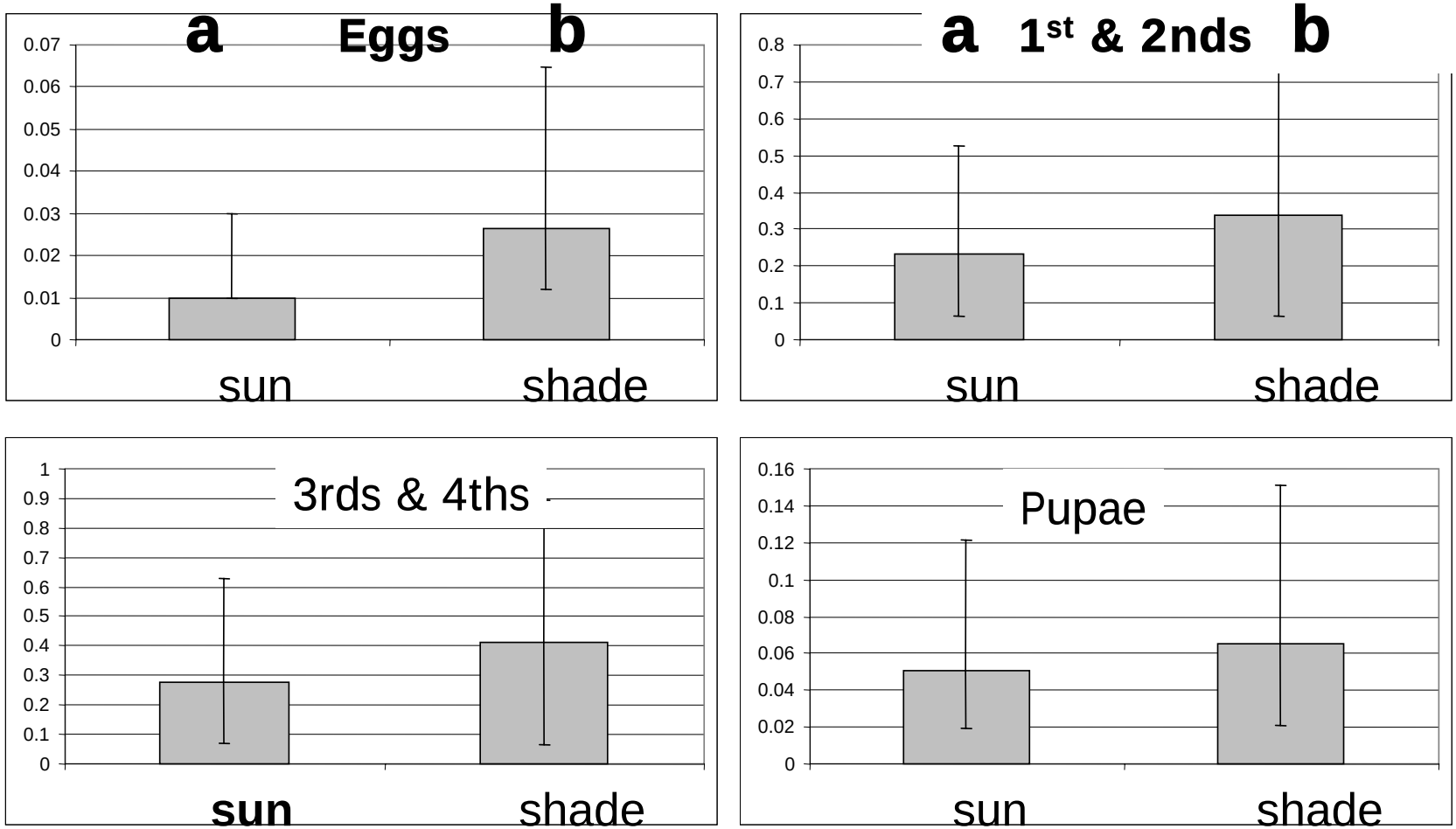
Lighting conditions



Egg rafts and early stage larval production found at significantly higher densities in shady locations than sunlit areas

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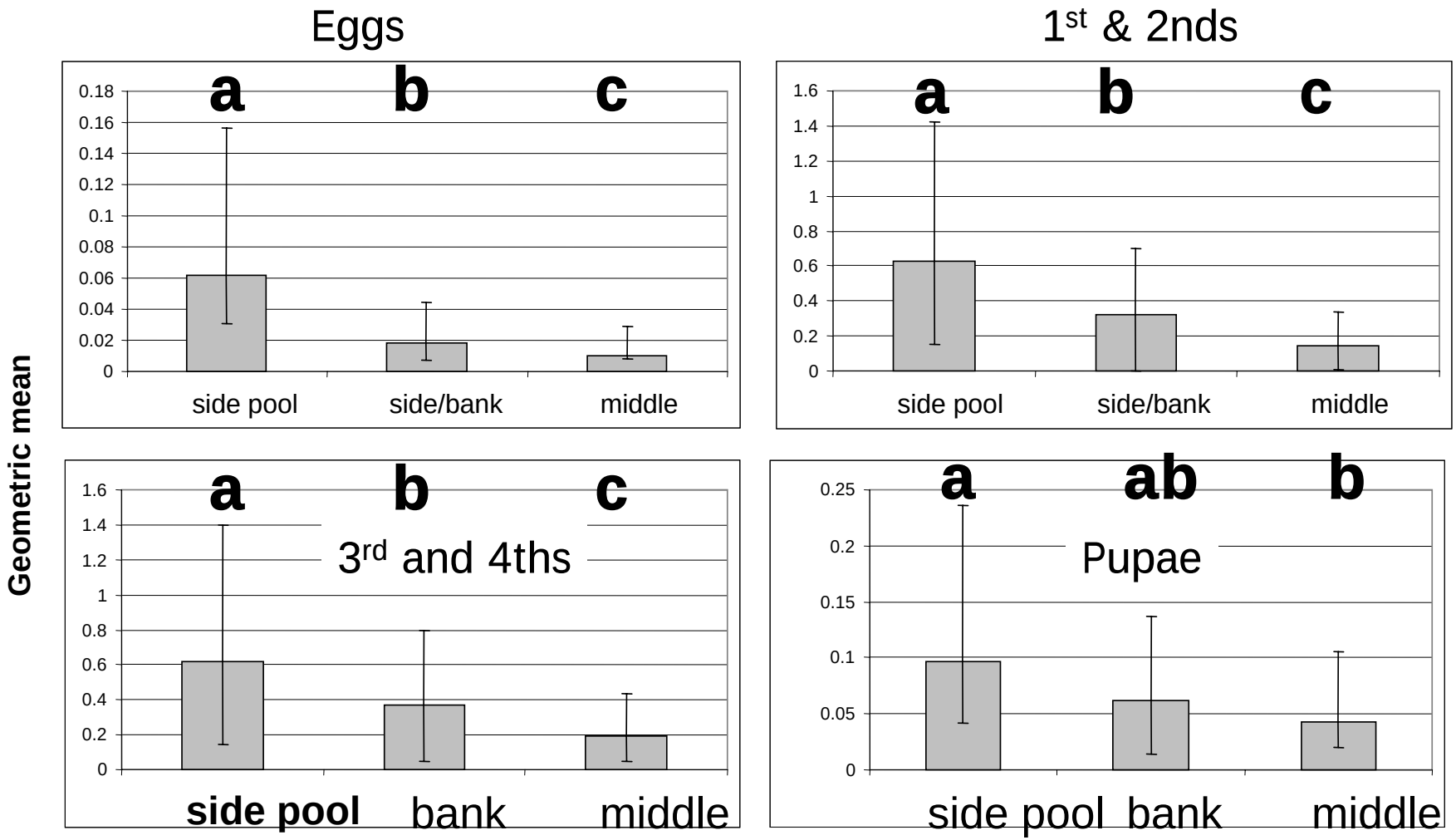
Immature Abundance in Tanyard Creek



- Highest densities in side pools, followed by the edge of the creek and finally the center of the creek.

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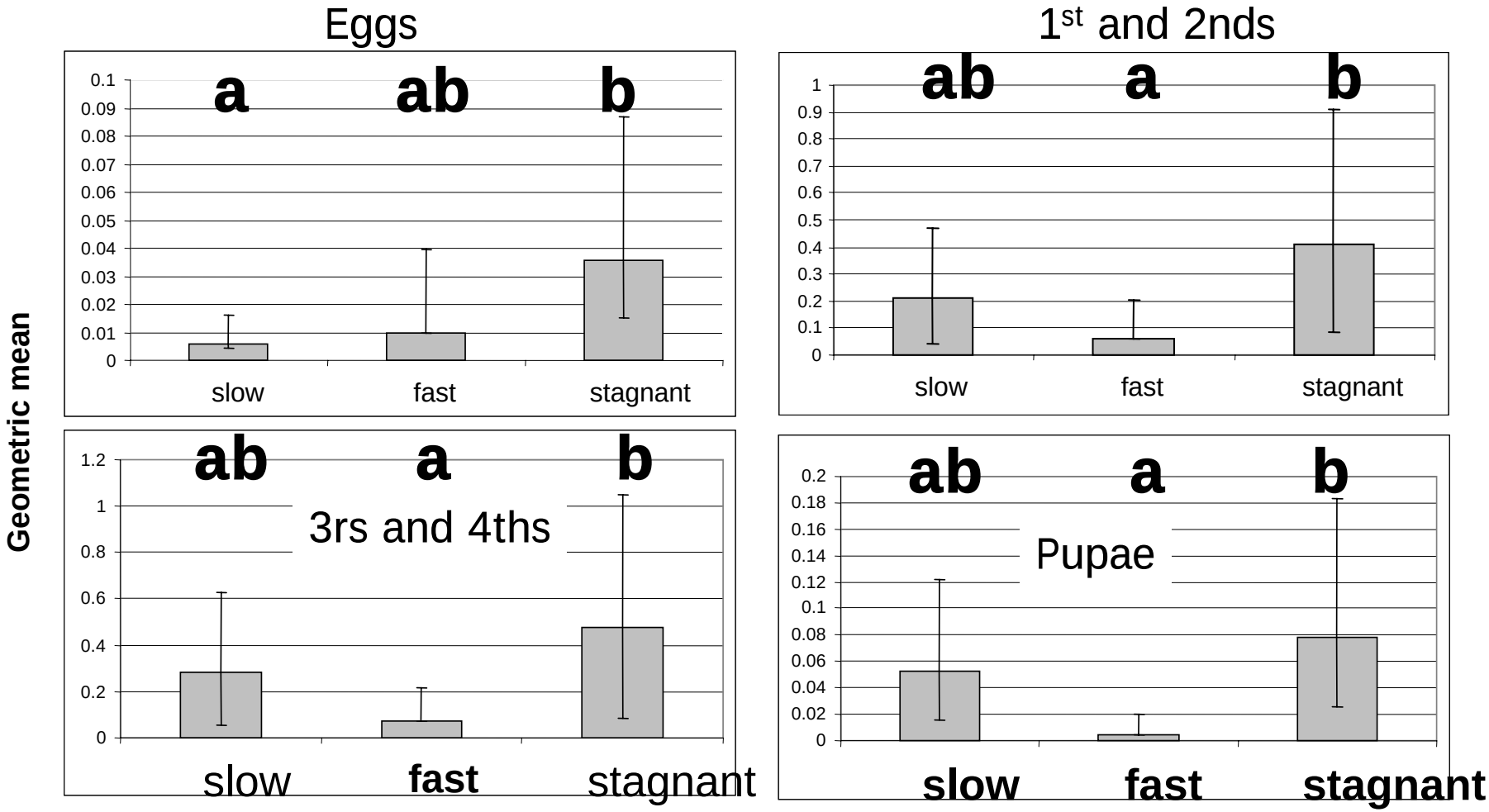
Rate of Water Flow



Stagnant water was much preferred over slowly moving or quickly moving water

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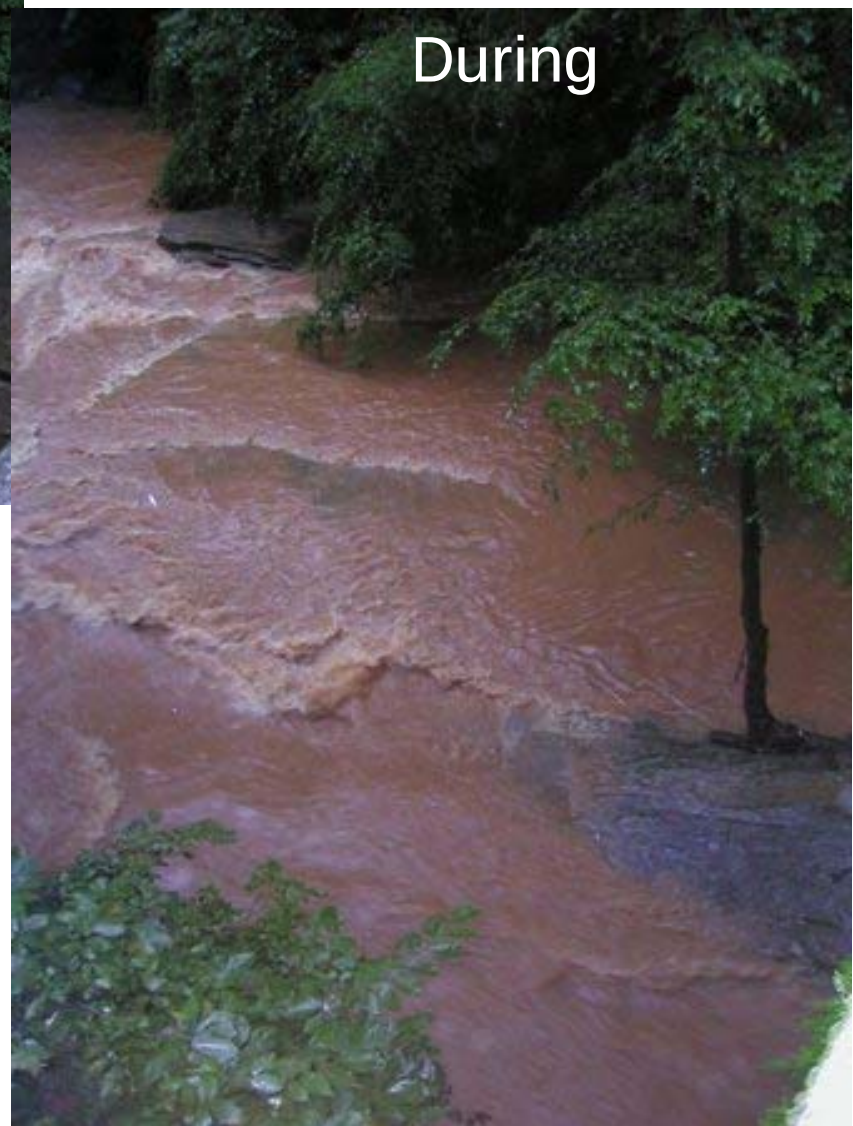
Events!



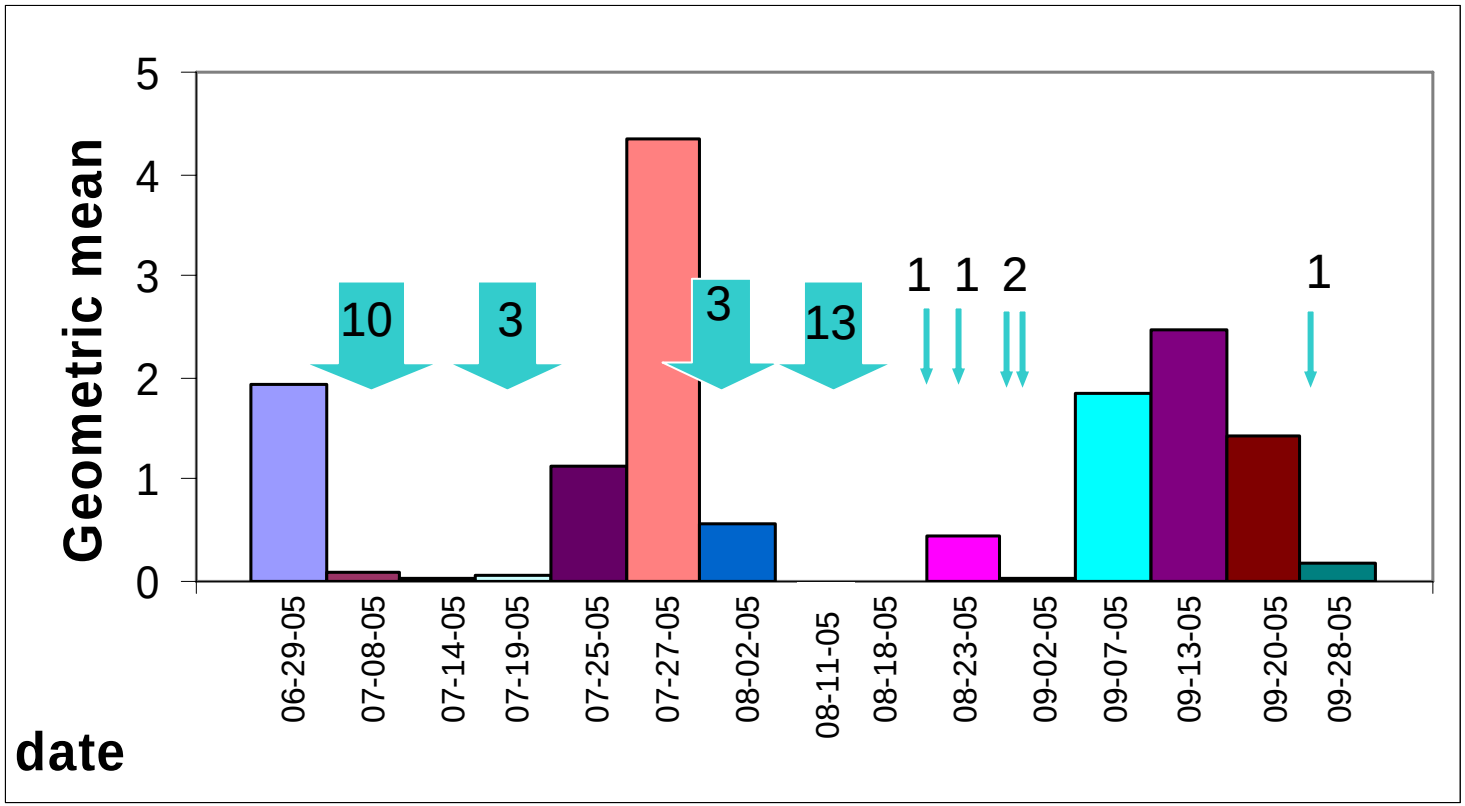
Site 5

2005:567 events from the 7 CSOs & 2 regulators

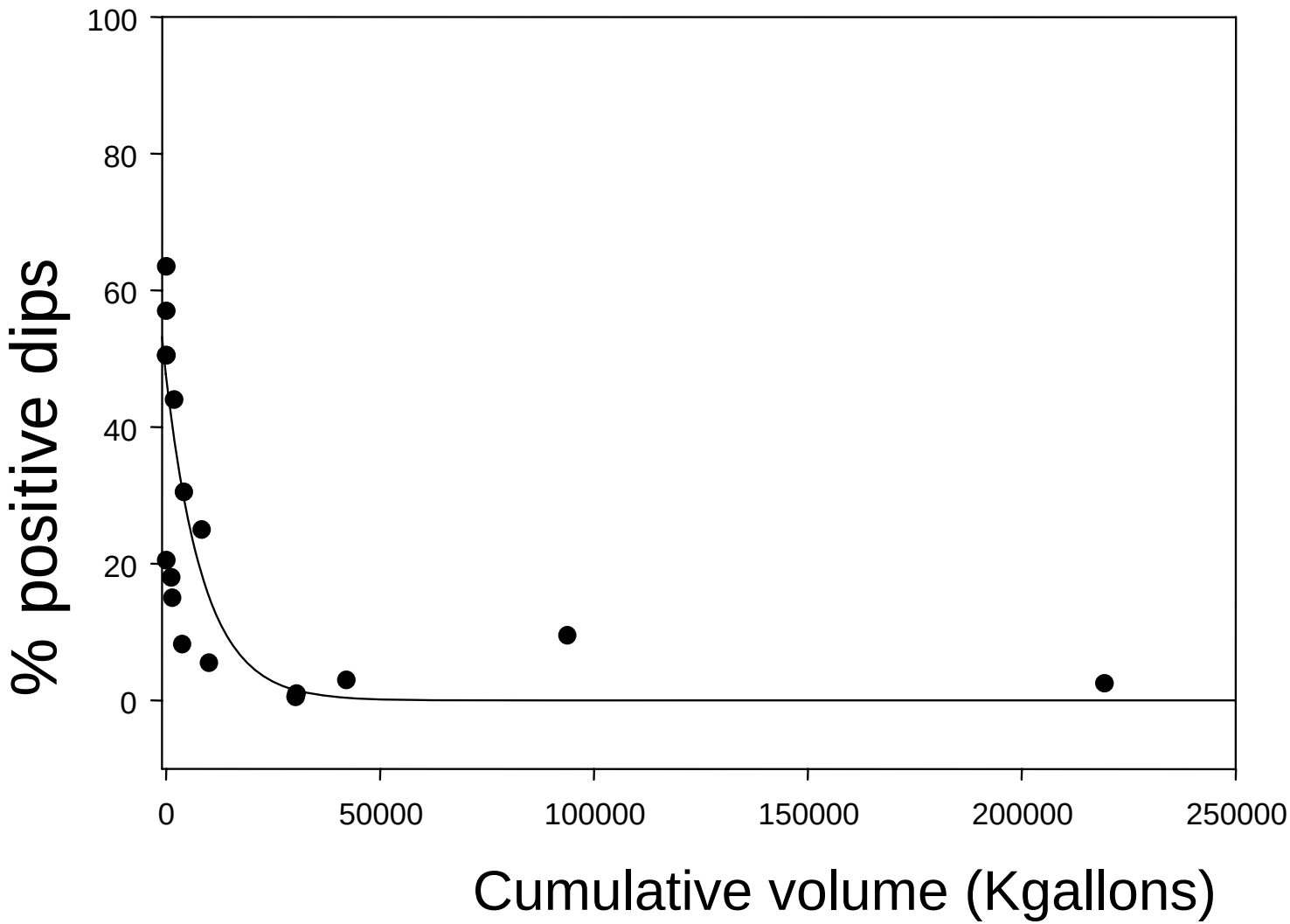
Tanyard Creek, discharges on 64 of the 166 days of the study

Events ranged from 104kgal in 36 min to 173m gal in 28 hrs

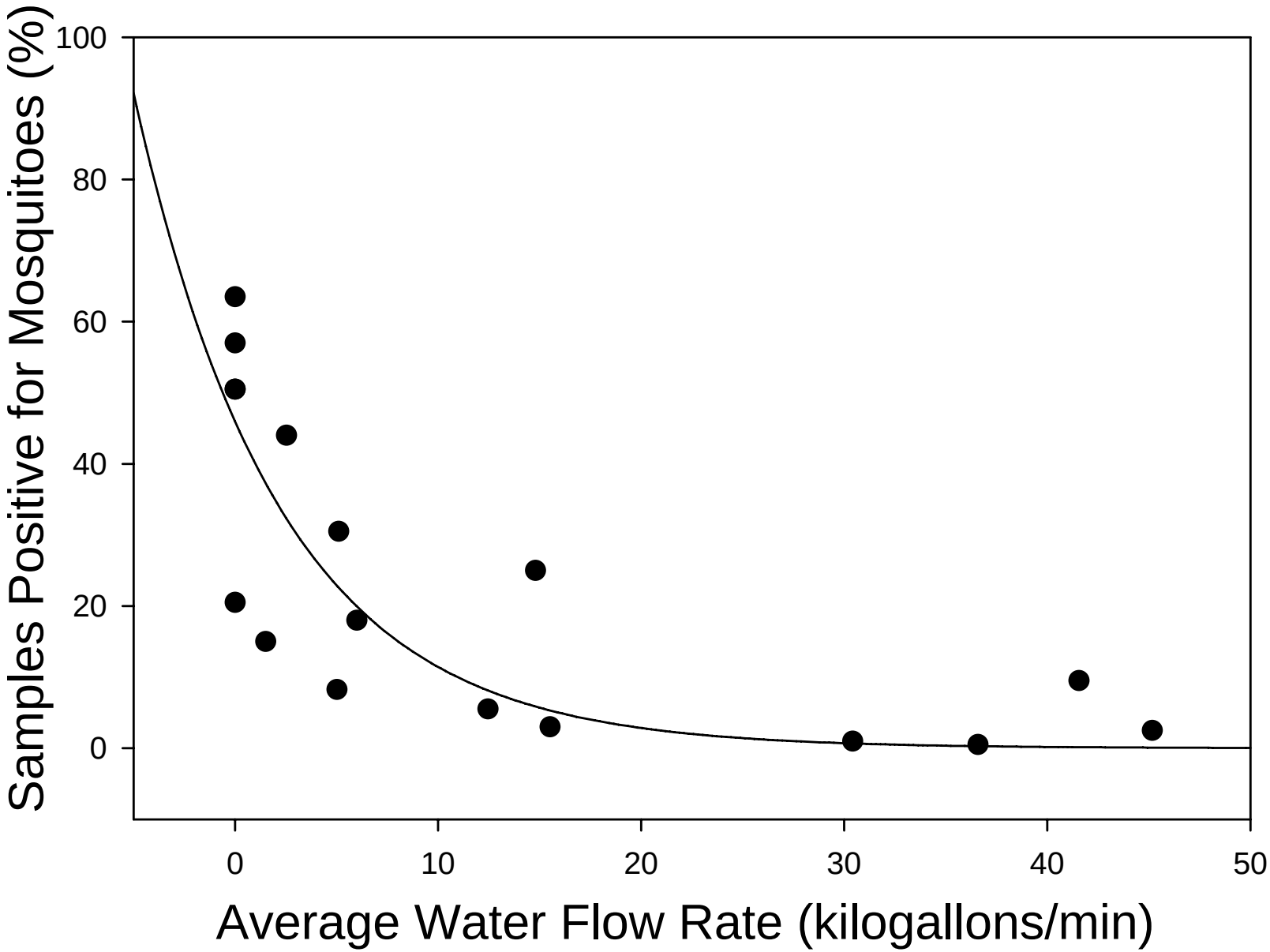
Impact of CSO Events on Mosquito Productivity



Association of mosquito prevalence and cumulative volume water released 1 to 5 days prior to mosquito collection

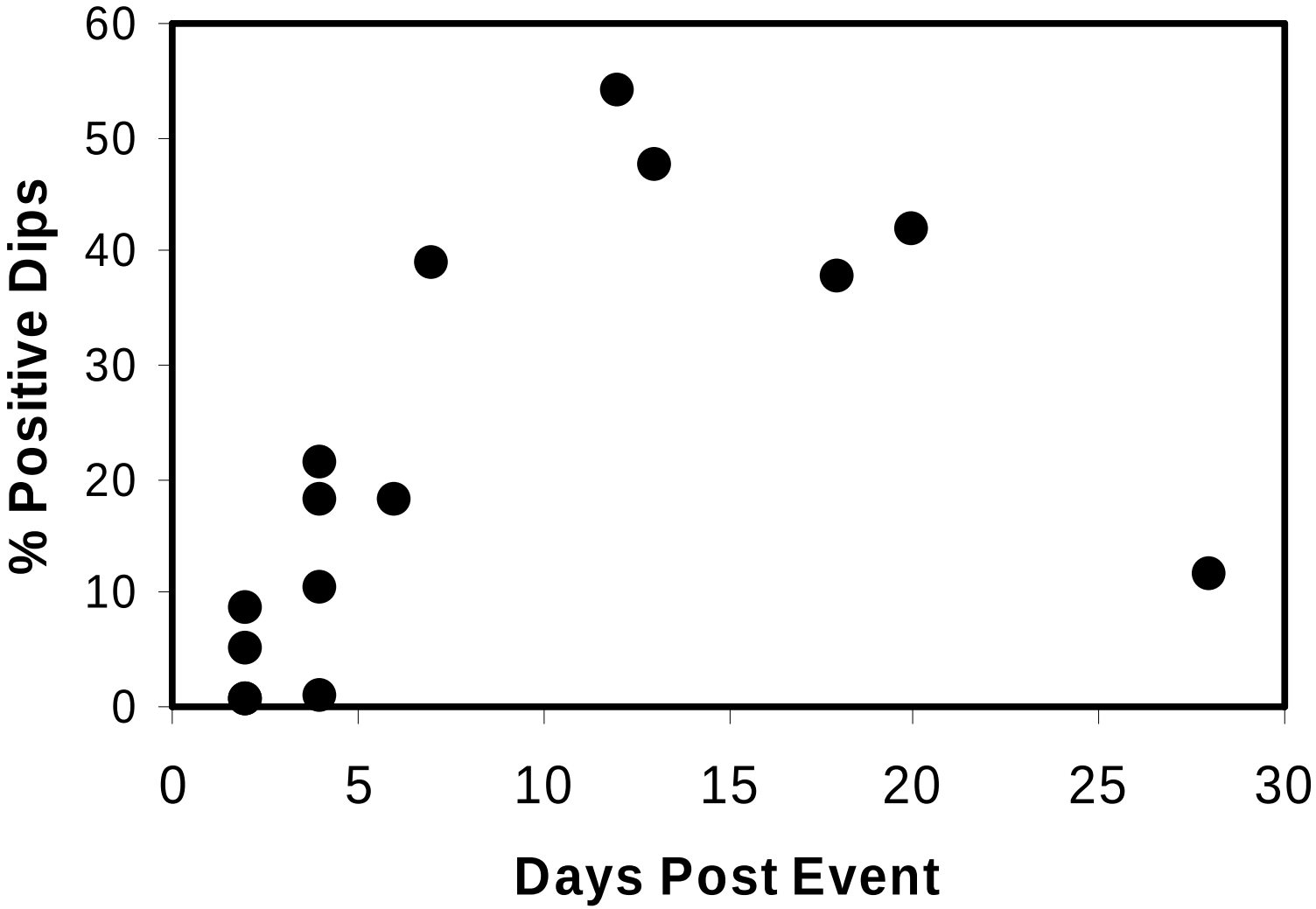


Impact of Event Flow Rates on Mosquito Populations



A few mosquitoes could still be found immediately after events

Mosquito Population Rebound After Events



Significant increases within 5-10 days

MONDAY, NOV. 14, 2005
★★★★★

The Atlanta Journal-Constitution
Metro

West Nile may have sewer link

Most Fulton cases are near 1 overflow facility

By PATRICIA GUTHRIE
pguthrie@ajc.com

Fulton County officials say residents of northwest Atlanta neighborhoods with aging sewage overflow systems may be at greater risk of contracting West Nile virus.

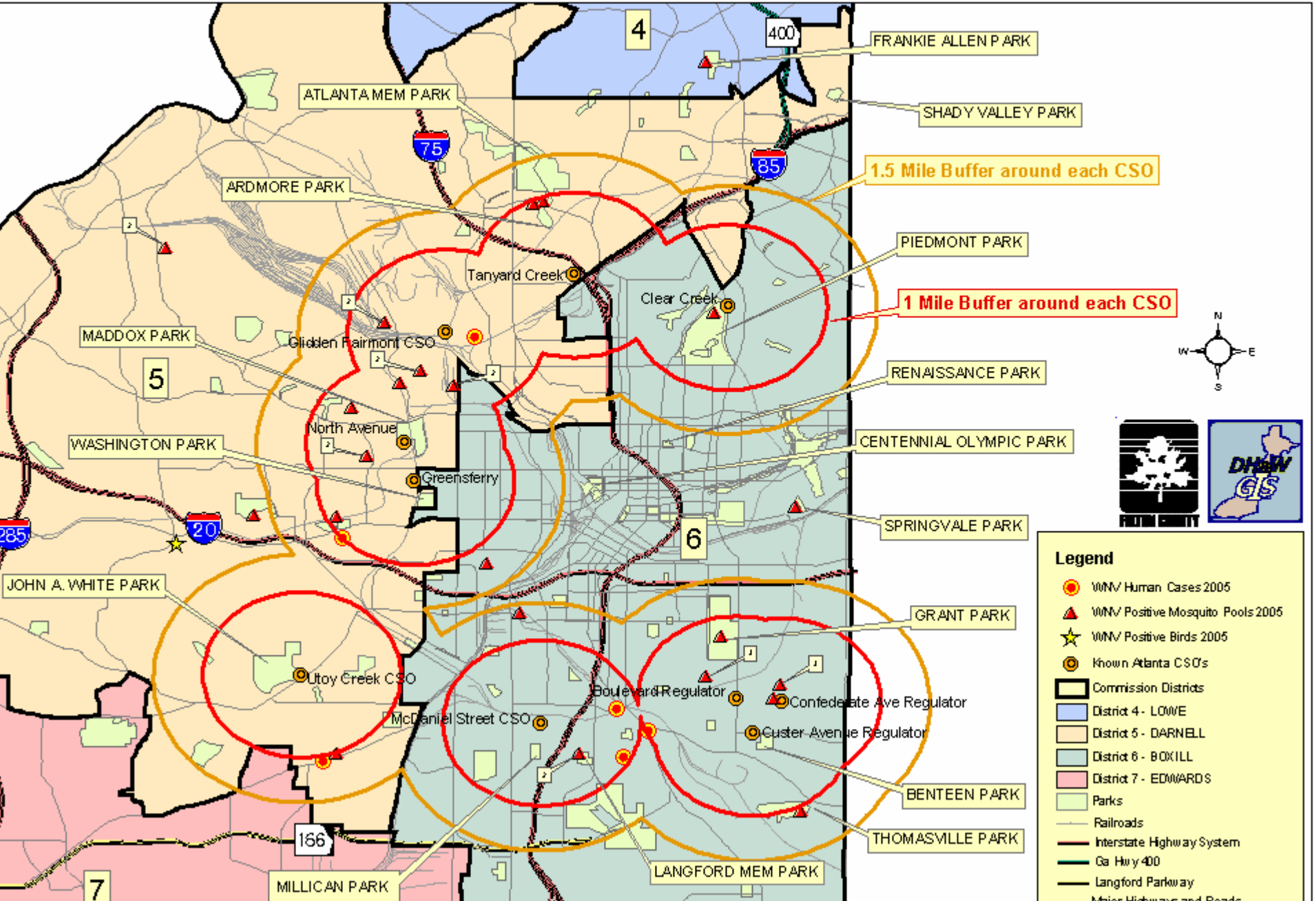
Of eight Fulton residents infected with the virus in the past several months, seven lived within one mile of a combined sewer overflow facility or of the of Fulton County's Division of Population Health. "We don't know where the mosquitoes came from."

Run by the city of Atlanta, small wastewater facilities are scattered throughout older city neighborhoods. During heavy rainfall, they treat and release a mix of rainwater and sewage that can't be handled by the city's sewer system alone.

"We are an environmental dumping ground, and we have

Fulton County Department of Health and Wellness

City of Atlanta Combined Sewer Overflows and Positive West Nile Virus Activity for 2005

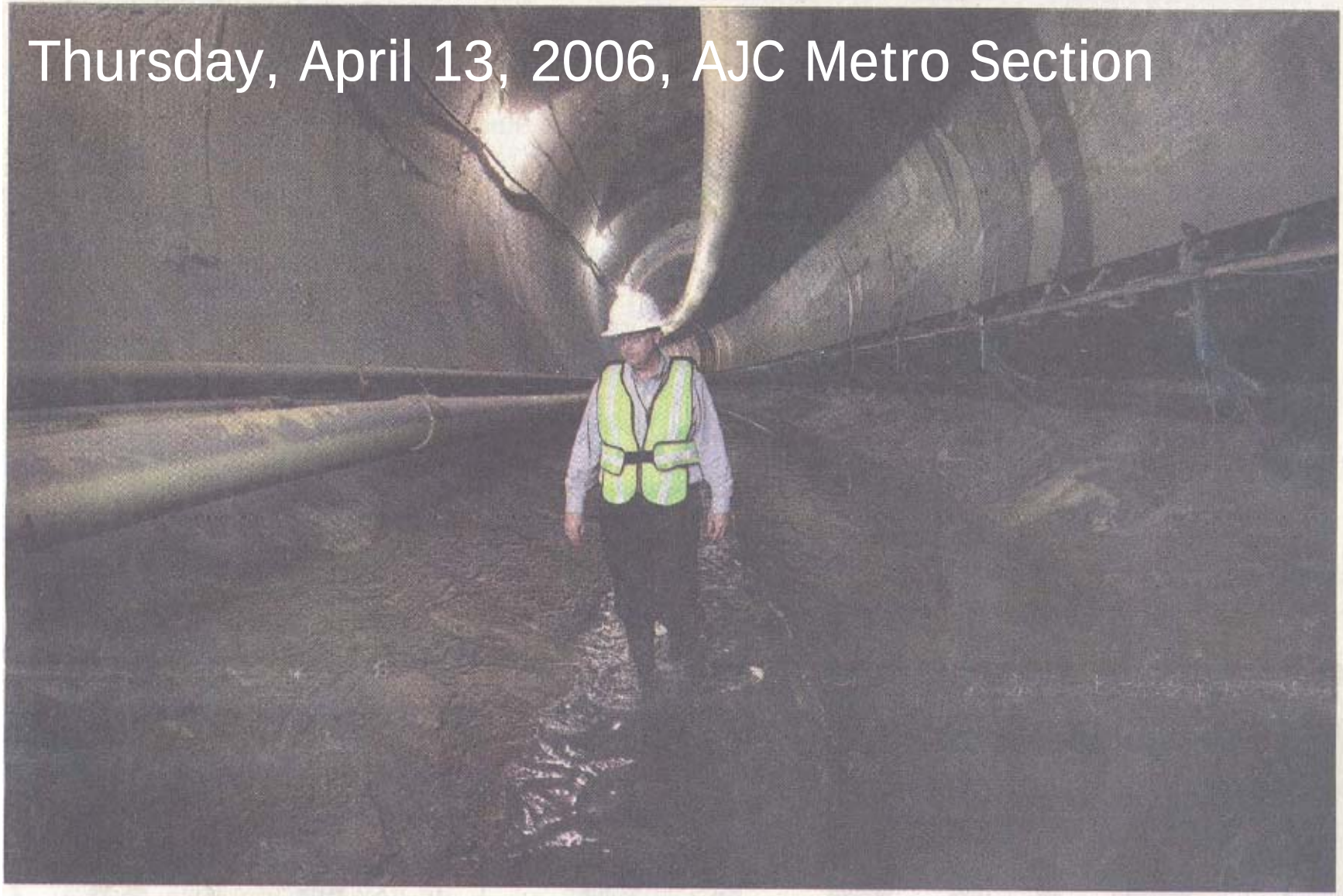


CSO remediation:

1999, Atlanta found in violation of the Clean Water Act and the GA Water Quality Control Act for polluting the Chattahoochee River ($3.2 m fine)

2007 will complete an underground reservoir system to hold excess effluent until treatment ($3.9 b)

Thursday, April 13, 2006, AJC Metro Section



Photos by BEN GRAY / Staff

Rob Hunter, commissioner of Atlanta's Department of Watershed Management, walks through the Clear Creek combined sewer overflow tunnel Wednesday on a tour of the site with media. He and his team are blunt about the disruptions ahead for Atlantans.

Your street may be next

Conclusions

Mosquitoes found in the CSO:

Not just *Culex quinquefasciatus*

- *Culex quinquefasciatus* and *C restuans* were the dominant species early
- *Culex quinquefasciatus* increased in abundance during the summer
- Small number of *C nigripalpus* also found as well as one *Anopheles punctipennis*

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Larvae and pupae were found

In virtually in all habitats, but
Significant variations in density among areas
Highest densities found in:

Side pools>banks of creek>middle
Stagnant water>>slow>>fast
Shade>sunny locations

Flooding (“events”) significantly reduce but do not eliminate mosquitoes in CSO

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Next Steps:

- More quantitative assessment (Jim McNally)
- Building on our understanding of mosquito productivity to evaluate interventions (Jim McNally)
- Evaluating the relationship between CSO location and isolation of WNV and *Culex* trap densities (Fulton County and CDC)

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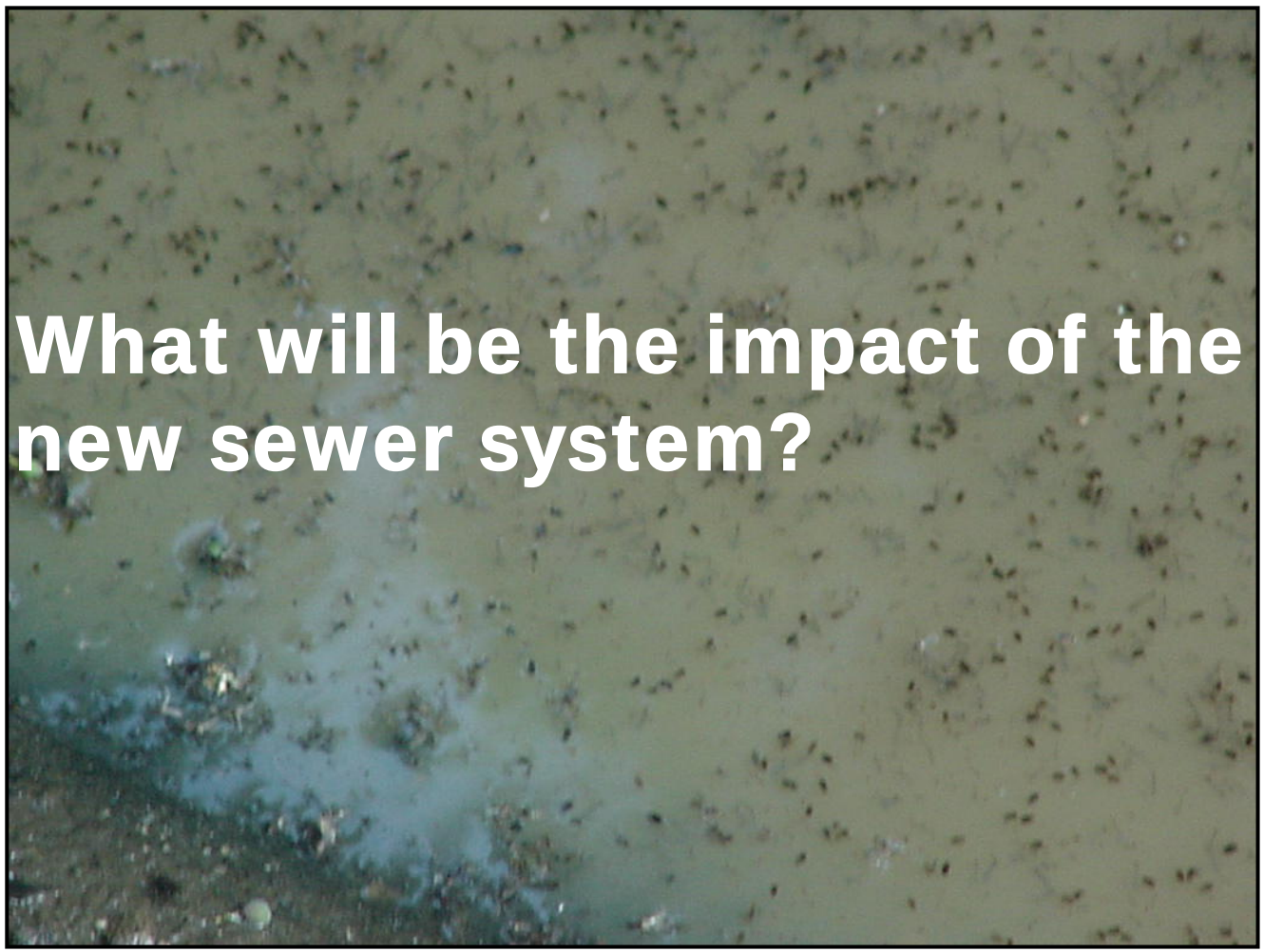
Conclusion: CSOs have the potential to generate explosive numbers of *Culex quinquefasciatus*



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City of Atlanta: John Shimmin, CSO Manager

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