West Nile Virus and Combined Sewer Overflow streams

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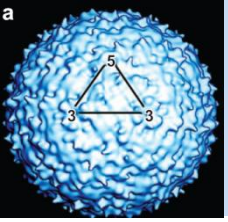
EMORY UNIVERSITY FOGARTY

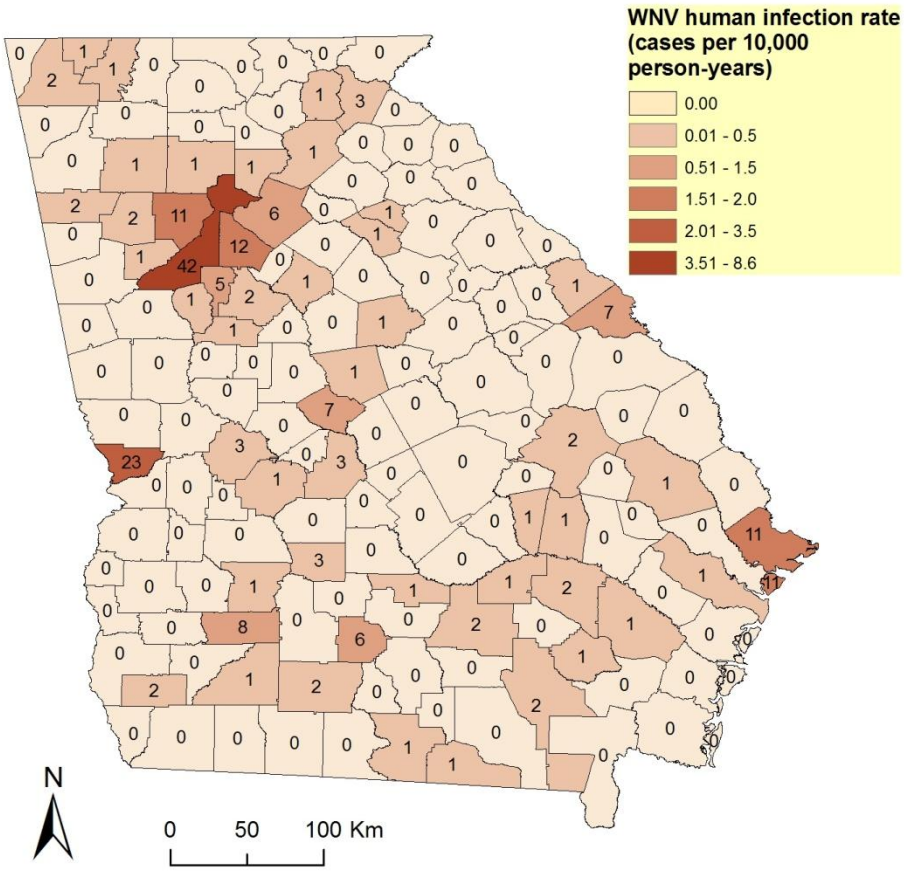
October 20, 2011
34th GMCA meeting

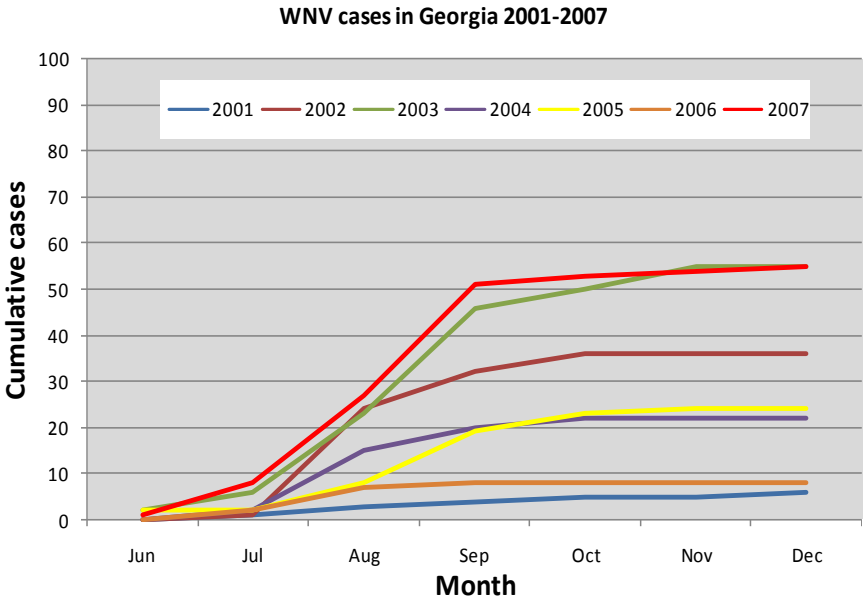


WNV in Georgia

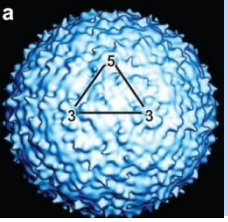
Human cases

- Most of GA human cases in metropolitan Atlanta, Columbus and Savannah.





Factors associated with virus amplification and spillover?



WNV in Georgia

Mosquitoes

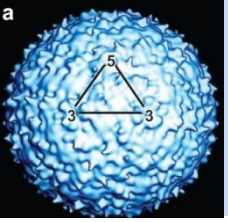
- *Culex quinquefasciatus* the most important Vector. Found in >84% of WNV+ tested pools.

Common urban habitats for *Cx quinquefasciatus*:

* unmanaged residential pools and containers
* catch basins
* **Combined Sewer Systems (CSS)**

Mosquito Surveillance (positive pools)		
14-Sep-07		
2007	EEE*	0
	Hart Park	0
	Flanders	93
	WNV*	64
5-Sep-06		
2006	EEE*	0
	Flanders	24
	WNV*	51
	Highlands J	0
6-Sep-05		
2005	EEE*	8
	Flanders	100
	WNV*	31
	Highlands J	6
8-Sep-04		
2004	EEE*	2
	Flanders	56
	WNV*	100
	Highlands J	0

Source: R. Kelly

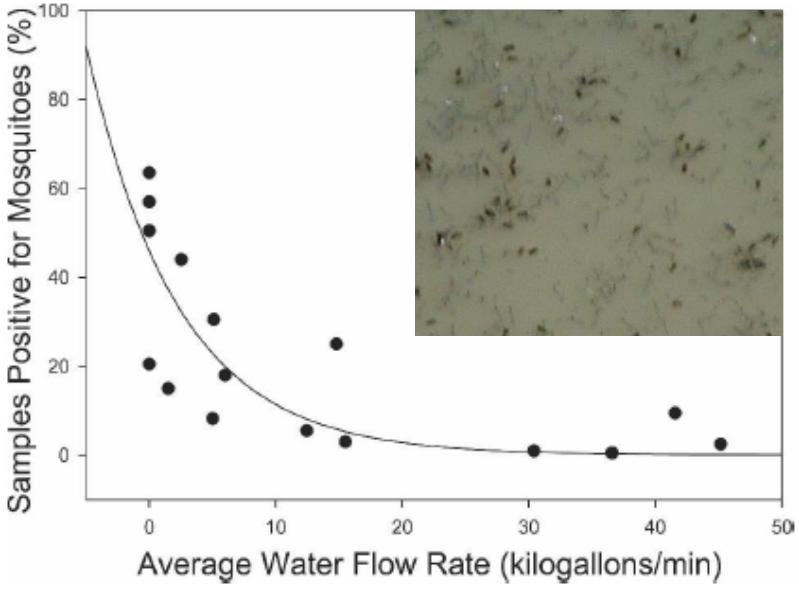


CSOs and Mosquitoes

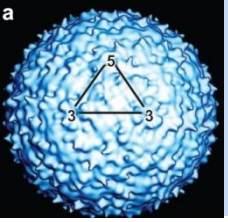
Am. J. Trop. Med. Hyg., 77(3), 2007, pp. 478–484

Combined Sewage Overflows (CSO) Are Major Urban Breeding Sites for *Culex quinquefasciatus* in Atlanta, Georgia

Lisa M. Calhoun, Melissa Avery, LeeAnn Jones, Karina Gunarto, Raymond King, Jacquelin Roberts, and Thomas R. Burkot*
Division of Parasitic Diseases, Centers for Disease Control and Prevention, Atlanta, Georgia



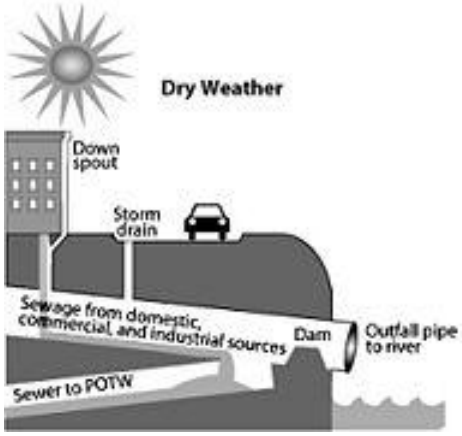
Does the high mosquito productivity translates in a higher WNV transmission risk?

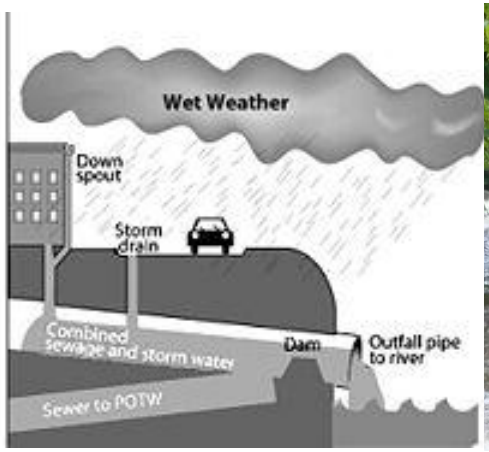


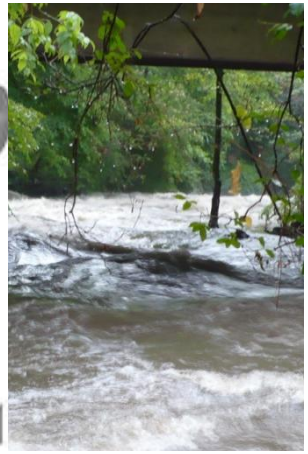
Combined Sewer Systems

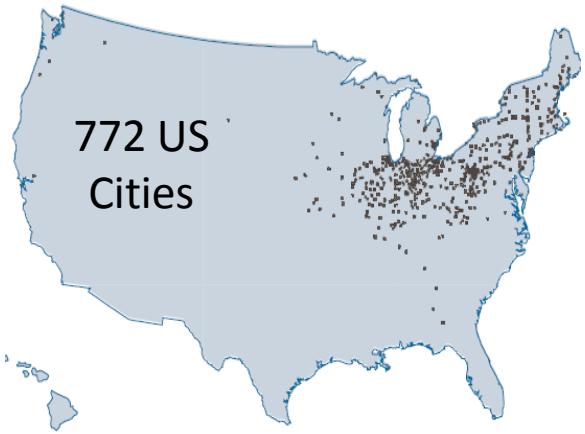
Designed to carry both sewage and storm water.

When flow exceeds the maximum capacity of the sewer systems, it <u>overflows</u> directly into bodies of water with minor treatment.









Atlanta: 7 CSO facilities located in close proximity to residential, commercial and recreational sites.

Research VOLUME 118 | NUMBER 10 | October 2010 • ehp ENVIRONMENTAL HEALTH PERSPECTIVES OPEN ACCESS

The Risk of West Nile Virus Infection Is Associated with Combined Sewer Overflow Streams in Urban Atlanta, Georgia, USA

Gonzalo M. Vazquez-Prokopec,[1] Jodi L. Vanden Eng,[2] Rosmarie Kelly,[3] Daniel G. Mead,[4] Priti Kolhe,[5] James Howgate,[5] Uriel Kitron,[1,6] and Thomas R. Burkot[2]

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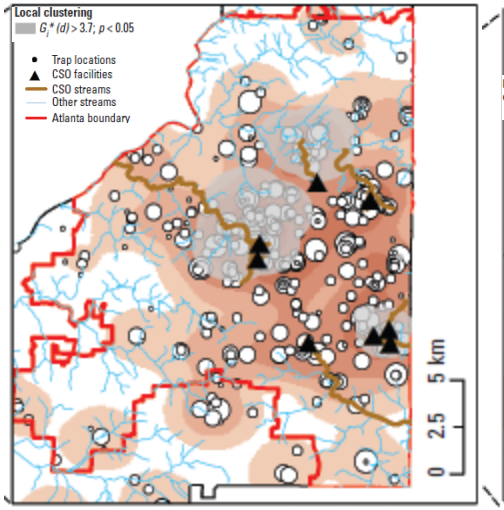
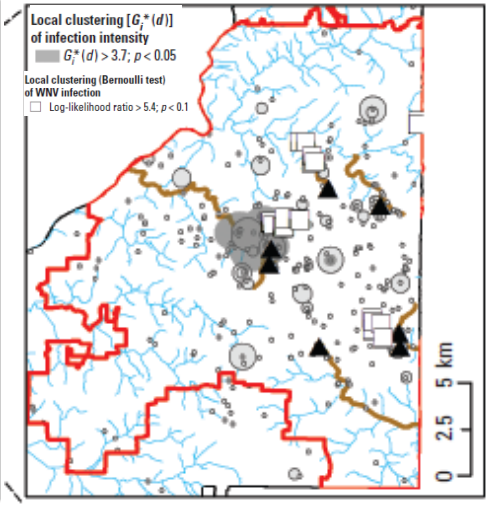
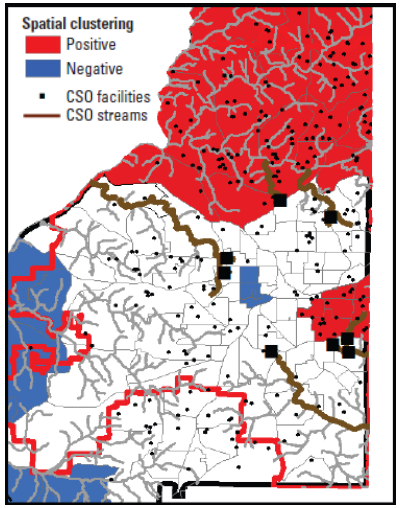
Cx. quinquefasciatus **abundance**



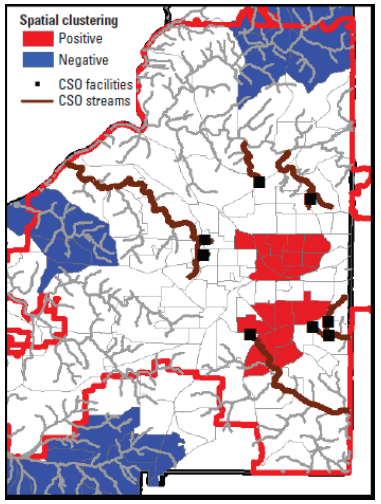
WNV infection in ***Cx. quinquefasciatus***



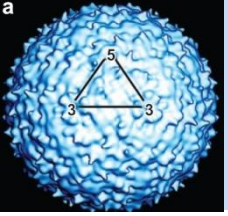
WNV infection in dead corvids



WNV infection in humans



WNV infection in mosquitoes, birds and humans clustered in close proximity to CSO streams.



Risk factors of WNV infection

Response variable, model[b]	Distance to CSO (m)	Distance to catch basin (m)	Tree cover range (%)	Mean tree cover (%)	Residential use: Low (%)	Residential use: Medium (%)	Residential use: High (%)	Wetland (%)	Forest (%)	Barren land (%)	Elevation (m)	Constant	AIC	ΔAIC	ω_i[c]
WNV infection in *Cx. quinquefasciatus*															
1	−6.9E−4*	—	—	—	—	—	—	—	—	—	—	−1.26*	406.2	0.0	0.559
2	−7.5E−4*	2.4E−4	—	—	—	—	—	—	—	—	—	−1.28*	407.83	1.63	0.247
3	—	—	0.04*	0.04	—	—	—	—	—	—	—	−3.70	408.8	2.6	0.152
4	—	—	—	—	1.40	−4.44	0.04	−3.33	3.33	22.19	−0.03	−1.88	412.15	5.95	0.029
5	−2.1E−5	1.3E−4	0.04	1.31	−1.23	1.55	6.51	6.95	−4.07	21.23	−0.01	−4.03	413.9	7.7	0.012
6		3.5E−4	—	—	—	—	—	—	—	—	—	−1.51*	419.67	13.47	0.001
$\Sigma\omega_i$	0.81	0.0	0.152	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0				

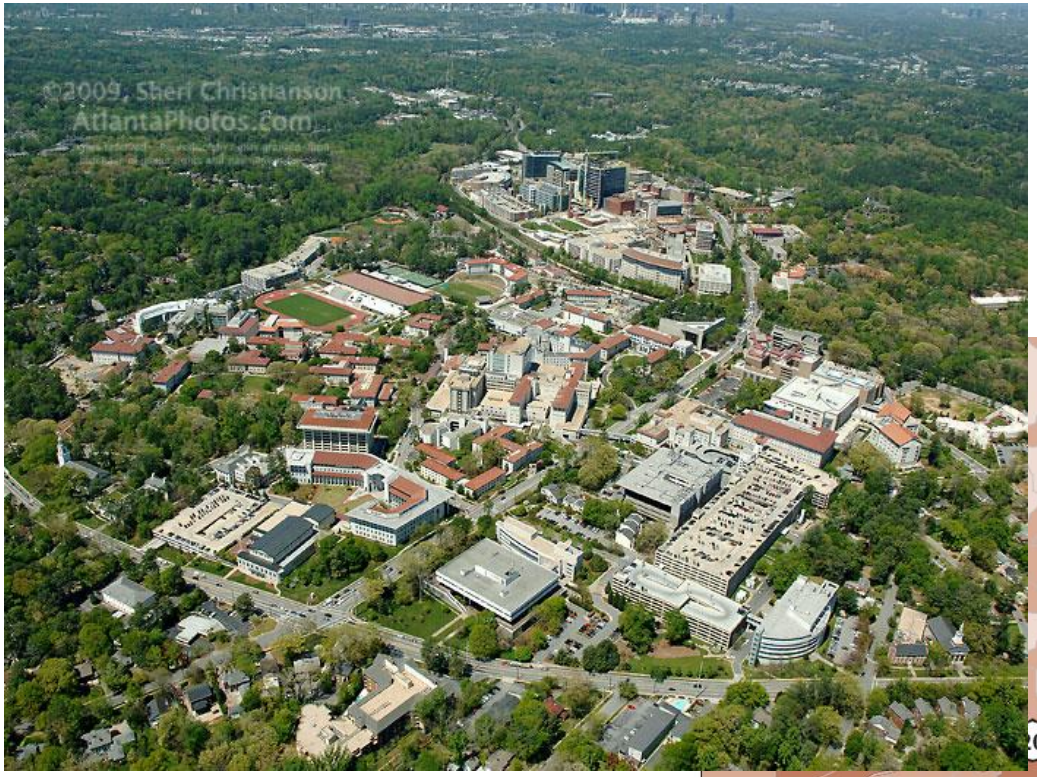
Mosquitoes: Distance to CSO, followed by Tree cover range

Response variable	Model[b]	Mean distance to CSO (m)	Mean distance to catch basin (m)	Mean tree cover (%)	Mean elevation (m)	2000 U.S. Census: Percent houses 1950s–1960s	2000 U.S. Census: Median household income (U.S. dollars)	No. dead corvids	Constant	AIC	ΔAIC	ω_i[c]
Human WNV incidence												
1		−6E−5**	—	−0.0018	—	0.0276*	−1E−5*	−0.0362	3.60*	309.0	0.0	0.817
2		−6E−5**	5E−5	−0.0012	−0.0018	0.0287*	−2E−5*	−0.032	4.13*	313.1	4.1	0.105
3		−8E−5*	3E−5	—	—	—	—	−0.117*	2.65*	314.8	5.8	0.04
4		—	—	—	—	0.0381*	−2E−5*	—	3.58*	316.8	7.8	0.02
5		—	—	−0.020*	−0.0035	—	—	—	3.75*	316.9	7.9	0.02
$\Sigma\omega_i$		0.97	0.0	0.02	0.0	0.94	0.92	0.04				
WNV-positive corvid death ratio												
1		−6E−4*	—	0.194*	—	0.1095	1.0E−5*	—	4.26*	707.0	0	0.913
2		−6E−4*	2E−5	0.215*	−0.0159	0.1023	−6.0E−5	—	10.46*	711.7	4.7	0.09
3		—	—	—	—	0.186*	1.4E−4*	—	1.19	728.2	21.2	0.00
4		—	—	0.172*	−0.0017	—	—	—	4.83	728.4	21.4	0.00
5		−3E−4	−1E−5	—	—	—	—	—	11.61*	739.9	32.9	0.00
$\Sigma\omega_i$		1.0	0.0	1.0	0.0	0.0	0.91					

Humans: Distance to CSO and housing age, followed by median income.

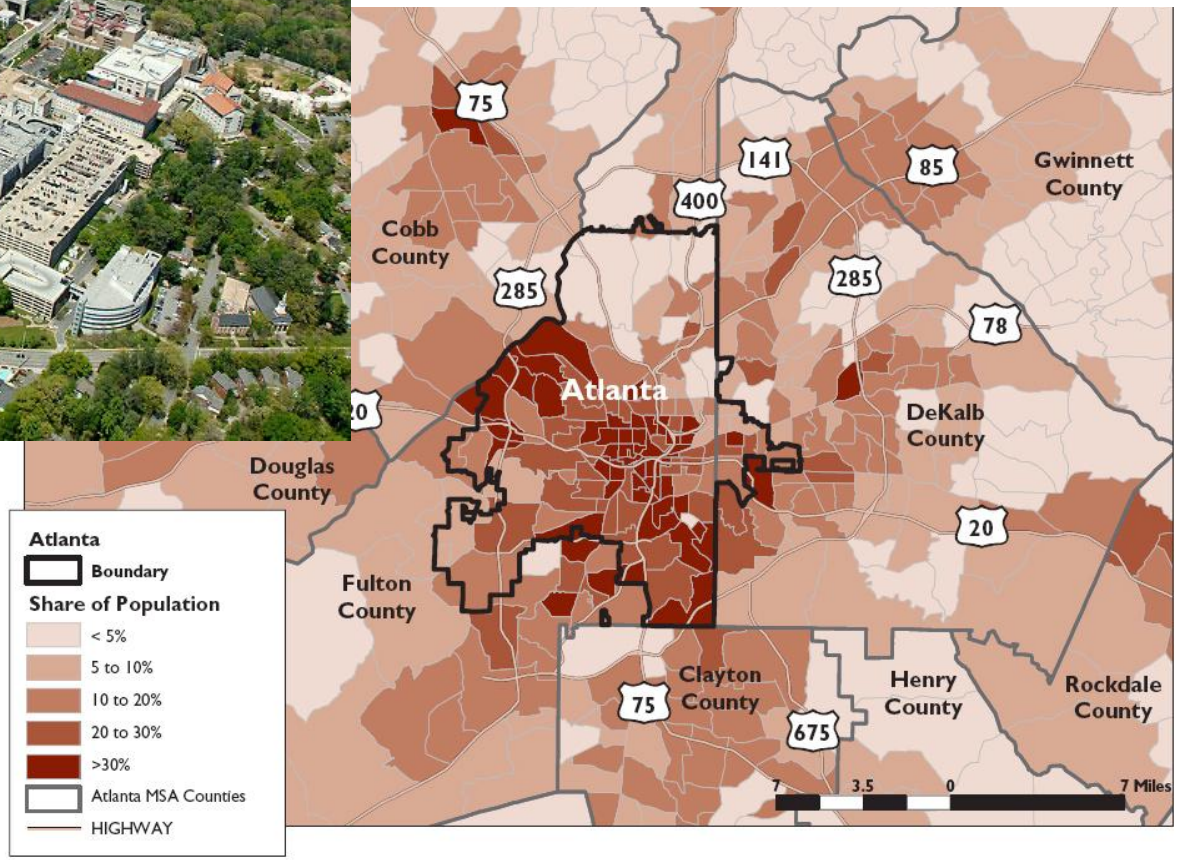
Birds: Distance to CSO and mean tree cover, followed by Median income.

Urban context of WNV transmission



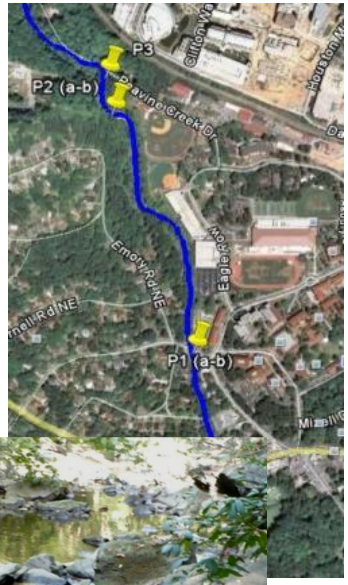
Atlanta is an urban woodland.

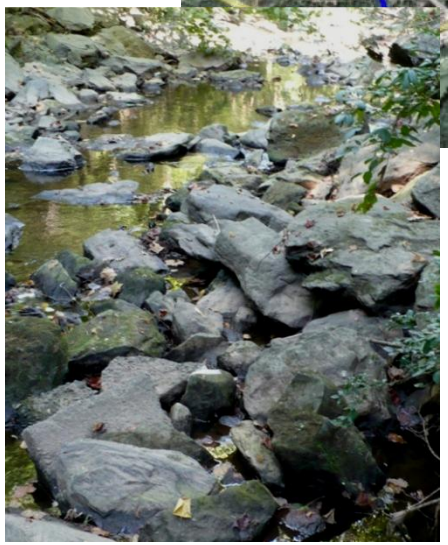
Share of persons living in poverty, 2000



With contrasting socio-economics and high poverty rates

Observational, laboratory, and semi-natural experiments



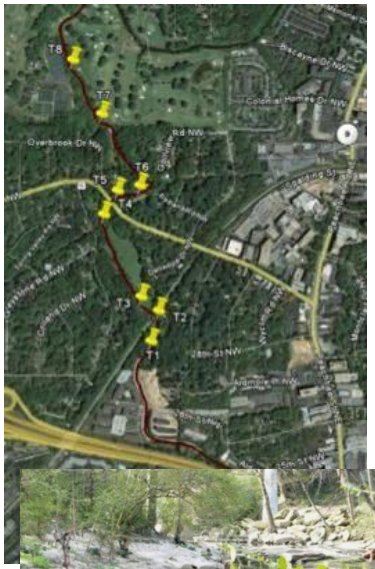


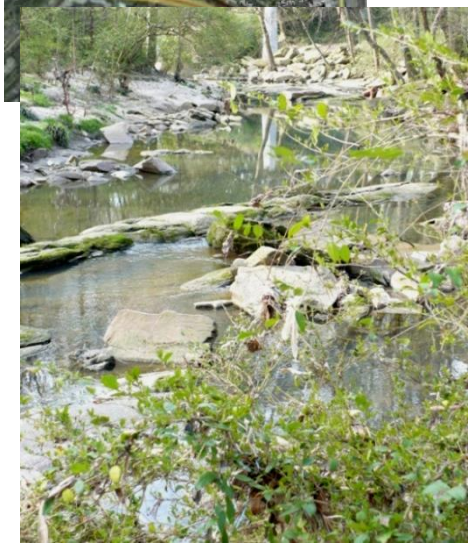
Peavine creek
Non-CSO

The role of CSO in mosquito population dynamics.

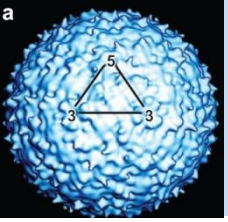
Oviposition preference
Fitness and behavior
Density dependence

CDC insectary



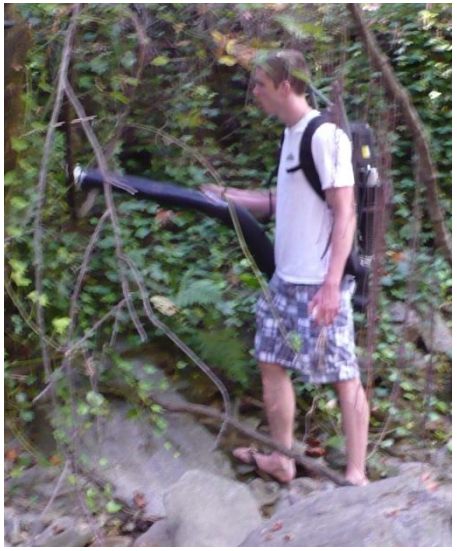


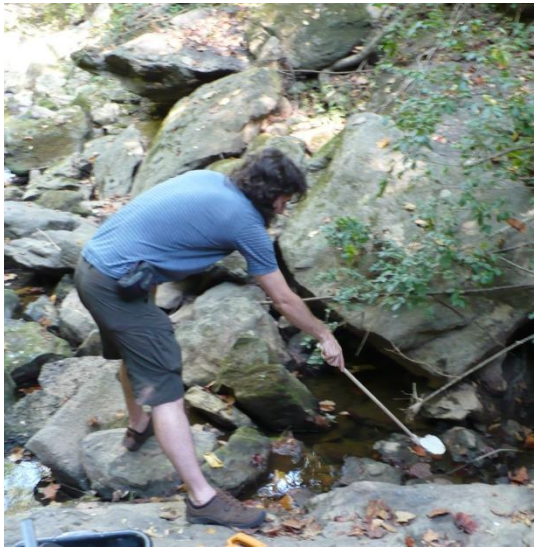
Tanyard creek
CSO



Field research

Weekly mosquito monitoring by dipping (immatures), light traps, gravid traps and Prokopack aspirators (adults).

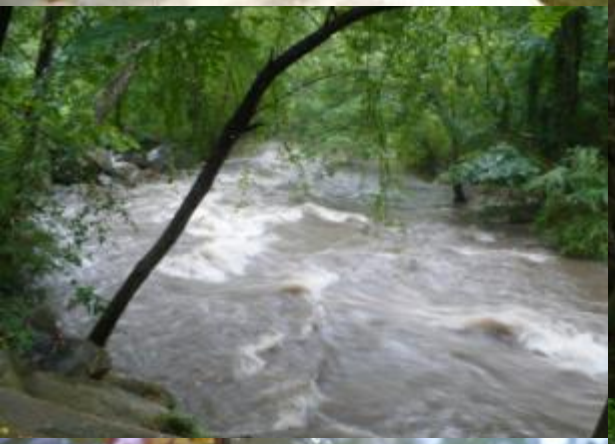




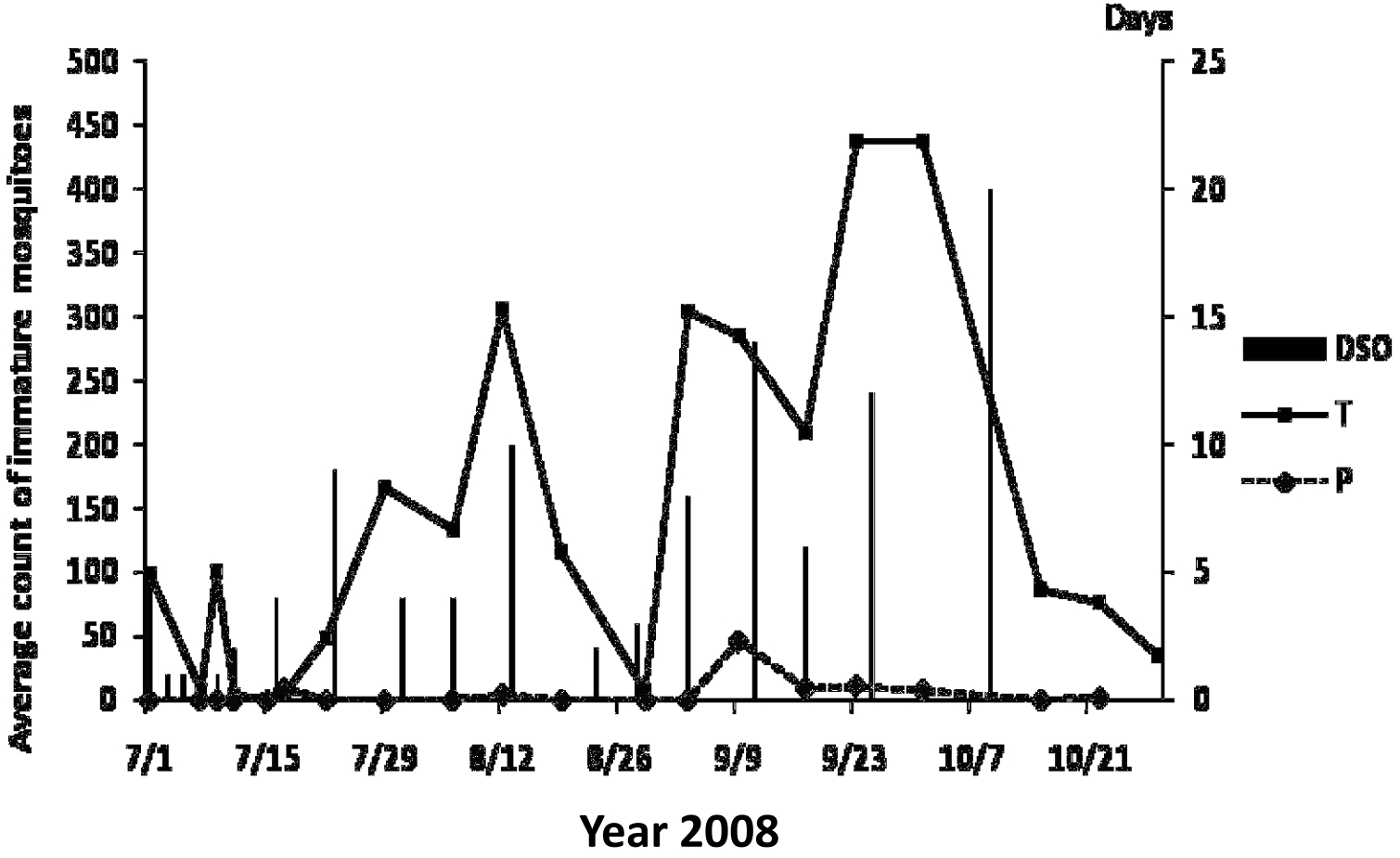
Weekly evaluation of water quality (Dissolved Oxygen, Ph, Temperature, Chlorine, Ammonia, Nitrates, Phosphates, Fecal coliforms and *E. coli*).

WNV and blood meal analysis of adult mosquitoes at UGA (Mead's Lab).


Tanyard Creek
WARNING
DO NOT PLAY, SWIM OR FISH IN CREEK
This is an urban creek
and is subject to sewag overflows
and runoff contaminants.
To report foul odor or
unusual discoloration:
Call 404-659-6757
To find out how you can help local
governments clean up &
protect urban creeks:
Call 404-330-6980

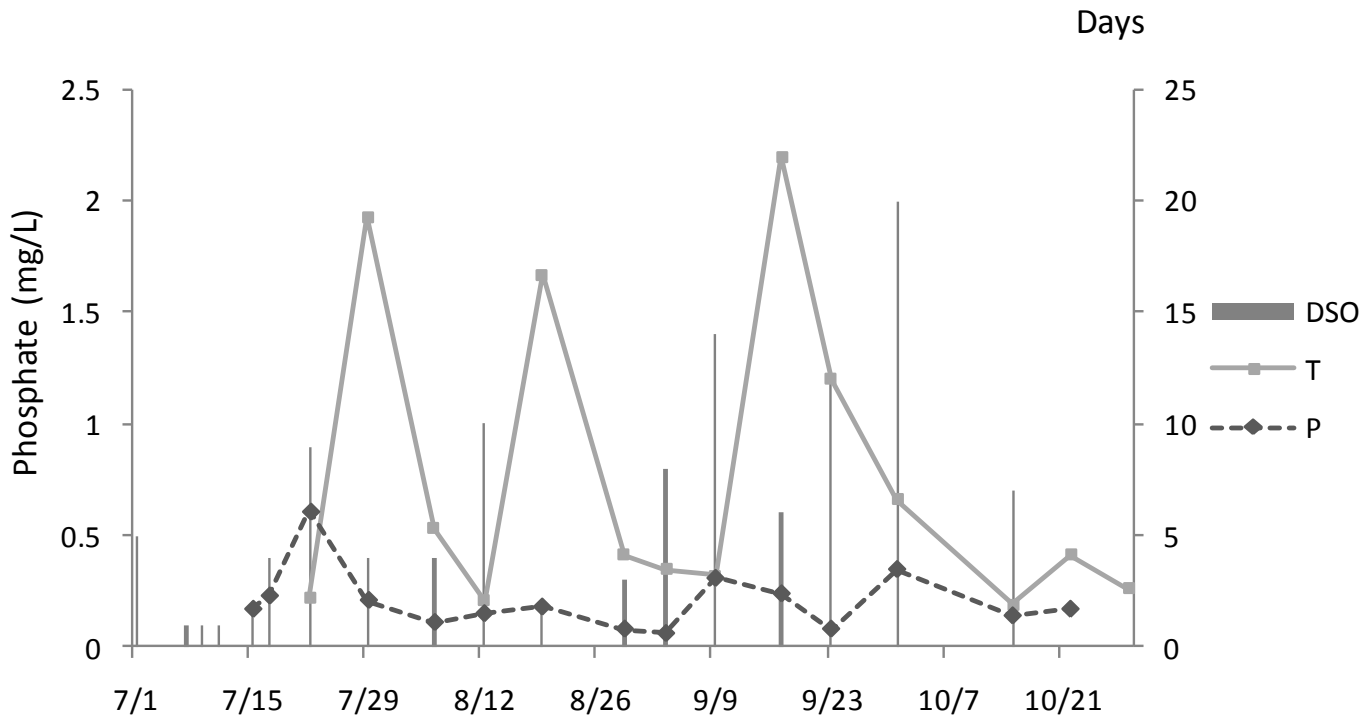


Monitoring CSO (T) and non-CSO (P) streams



Jabbarzadeh et al. in preparation

Water quality and vector productivity



Cx quinquefasciatus

Ammonia and Phosphate

Dissolved oxygen

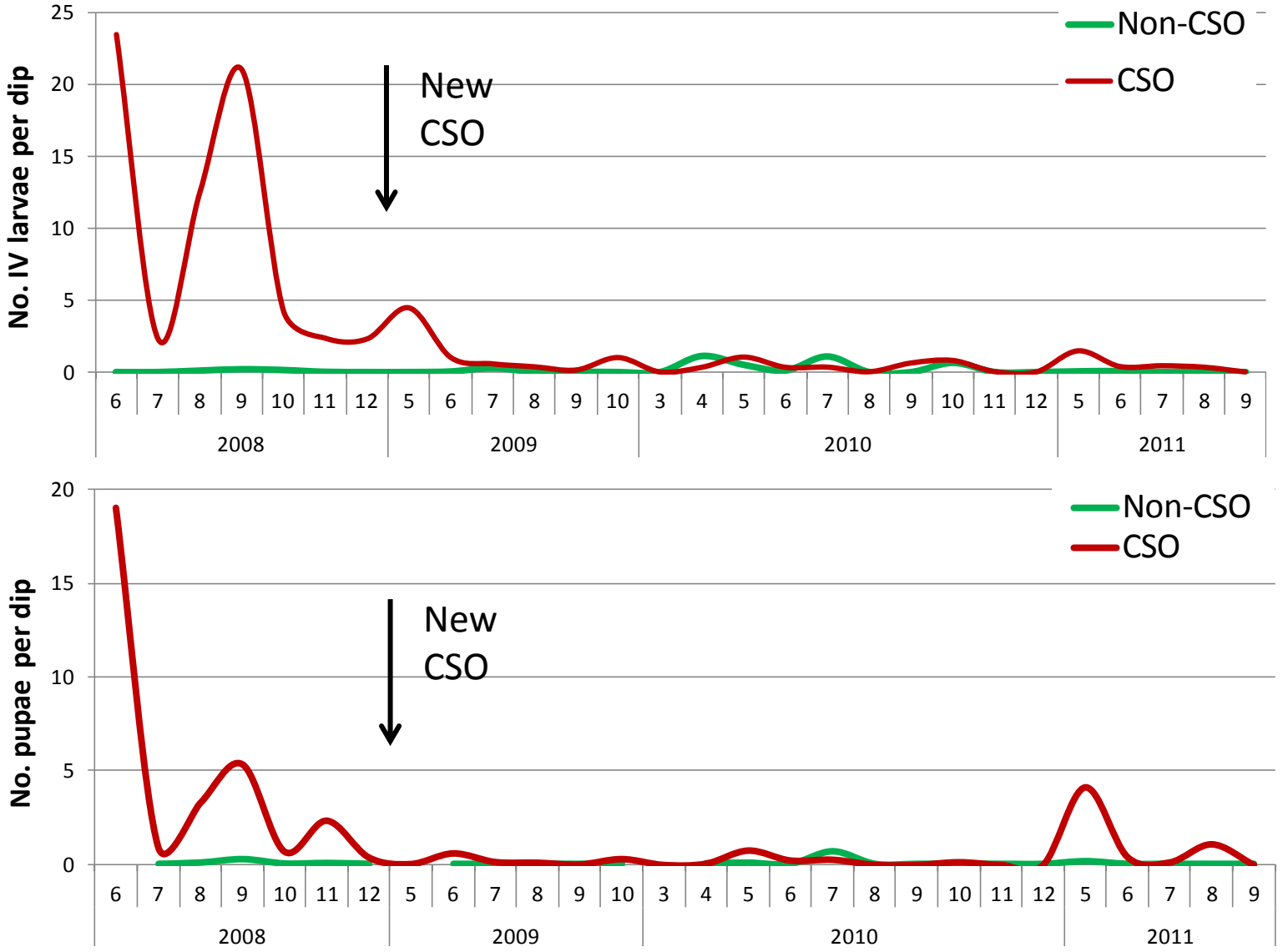
Jabbarzadeh et al. in preparation

New CSO and wastewater management: 2008 - present

- New tunnels to divert water to treatment facilities
- Large reservoirs for temporary water storage
- Goals:
  - Separate CSO from runoff waters
  - Delay CSO events.

Impacts on *Cx. quinquefasciatus* population dynamics?

Temporal trends in mosquito productivity



Vazquez-Prokopec et al. in preparation

Urbanization and WNV

- CSO increase nitrogen in natural streams
- Reduces stream diversity (less predators)
- Increases bacterial counts
- Increases *Culex sp*. mosquito abundance.
- Abundant bird populations in riparian forests.
- Susceptible human population
- **Perfect for WNV amplification & spillover.**
- **Changes in wastewater management had a negative impact on mosquito productivity**

Where is WNV now amplified?

Thank you!

Collaborators

Rosmarie Kelly – Georgia Division of Public Health

Thomas Burkot - CDC

Gonzalo Vazquez-Prokopec, Luis Chaves, Rebecca Levine, Nelle Couret, Uriel Kitron – Emory

Danny Mead – UGA

Contributors

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Daniel Kitron – Druid Hills High School

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