



Microbial Source Tracking of Bacterial Pollution in the North Fork of the St. Lucie River

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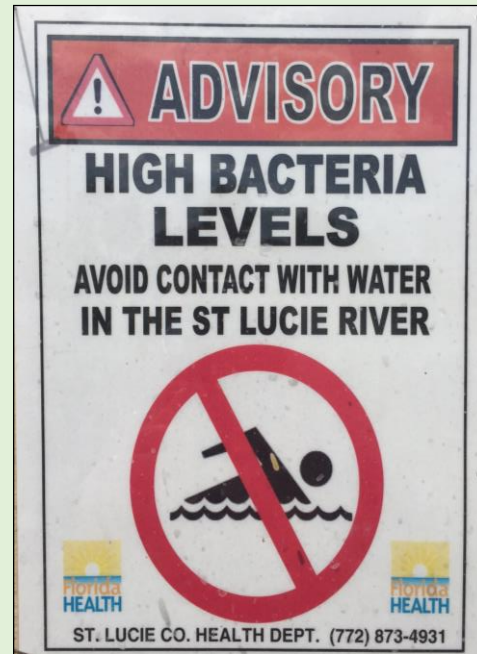
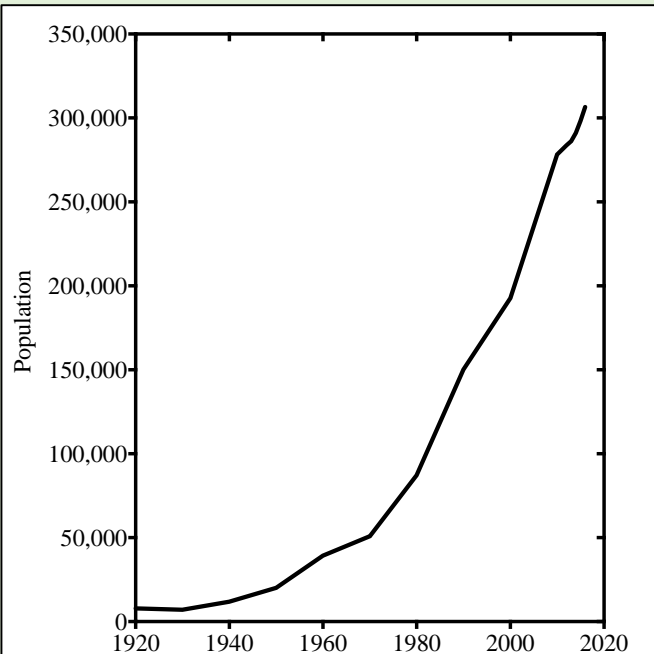
May 21, 2018

HARBOR BRANCH

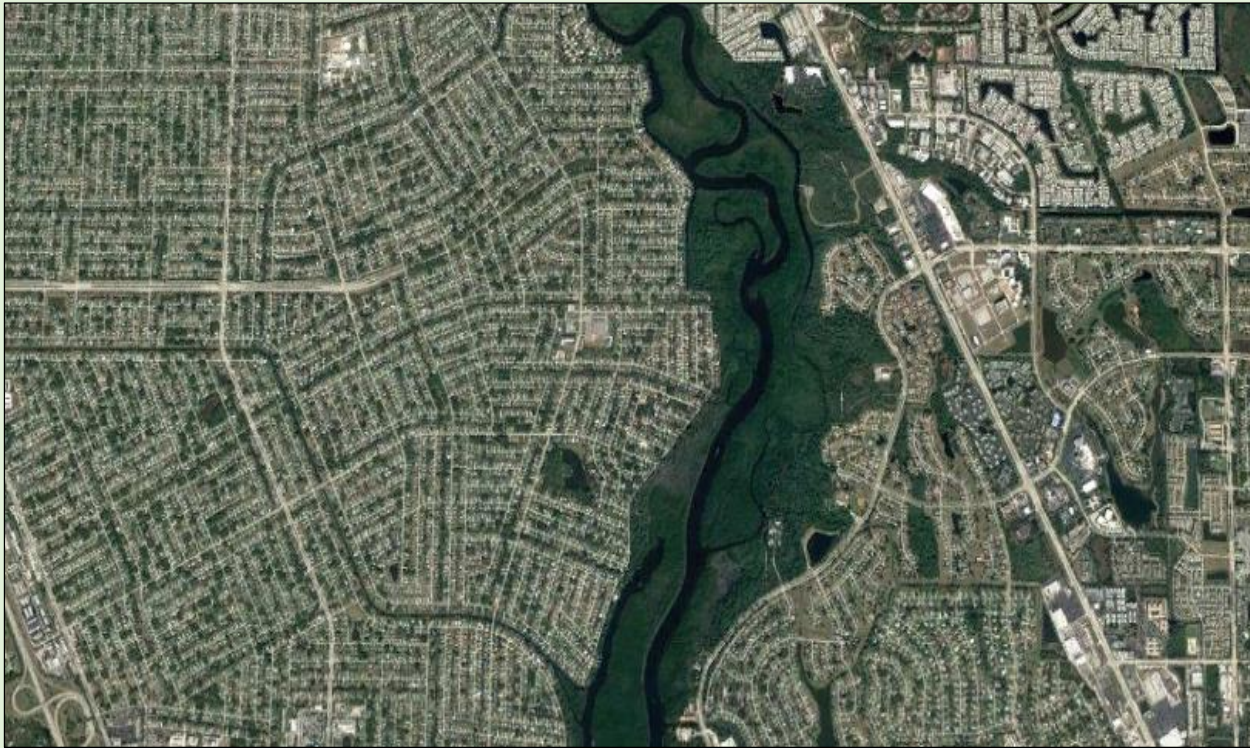
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Urbanization & Water Quality

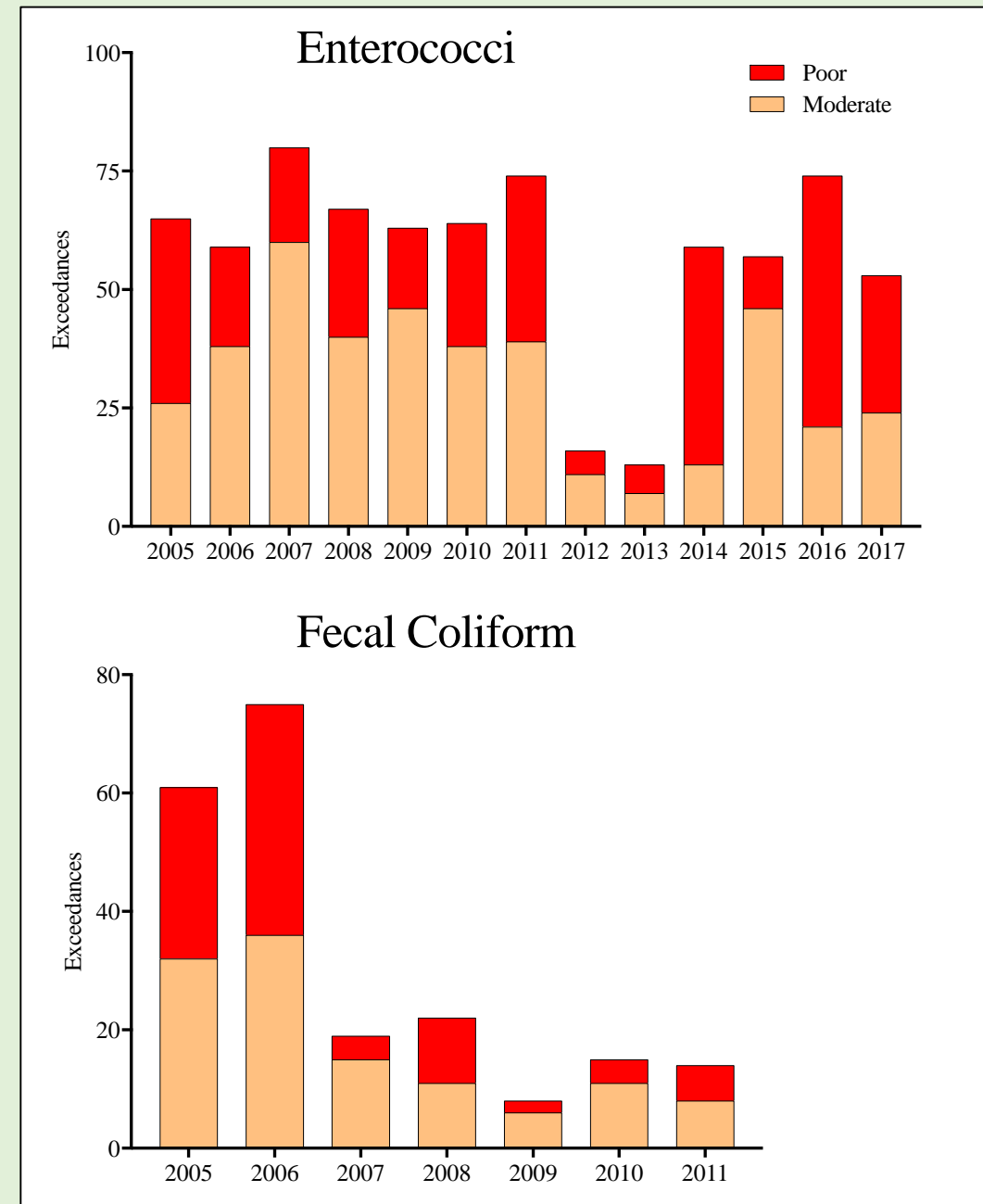
- Global issue
- Complicated, evolving
- There is no single solution
- CPSL- built by GDC, poor infrastructure
- CPSL- proactive in seeking solutions



North Fork Water Quality Issues



- Highly urbanized
- History of bacterial impairment
 - FDEP verified in 2009
- Impaired for dissolved oxygen, nitrogen, & phosphorus



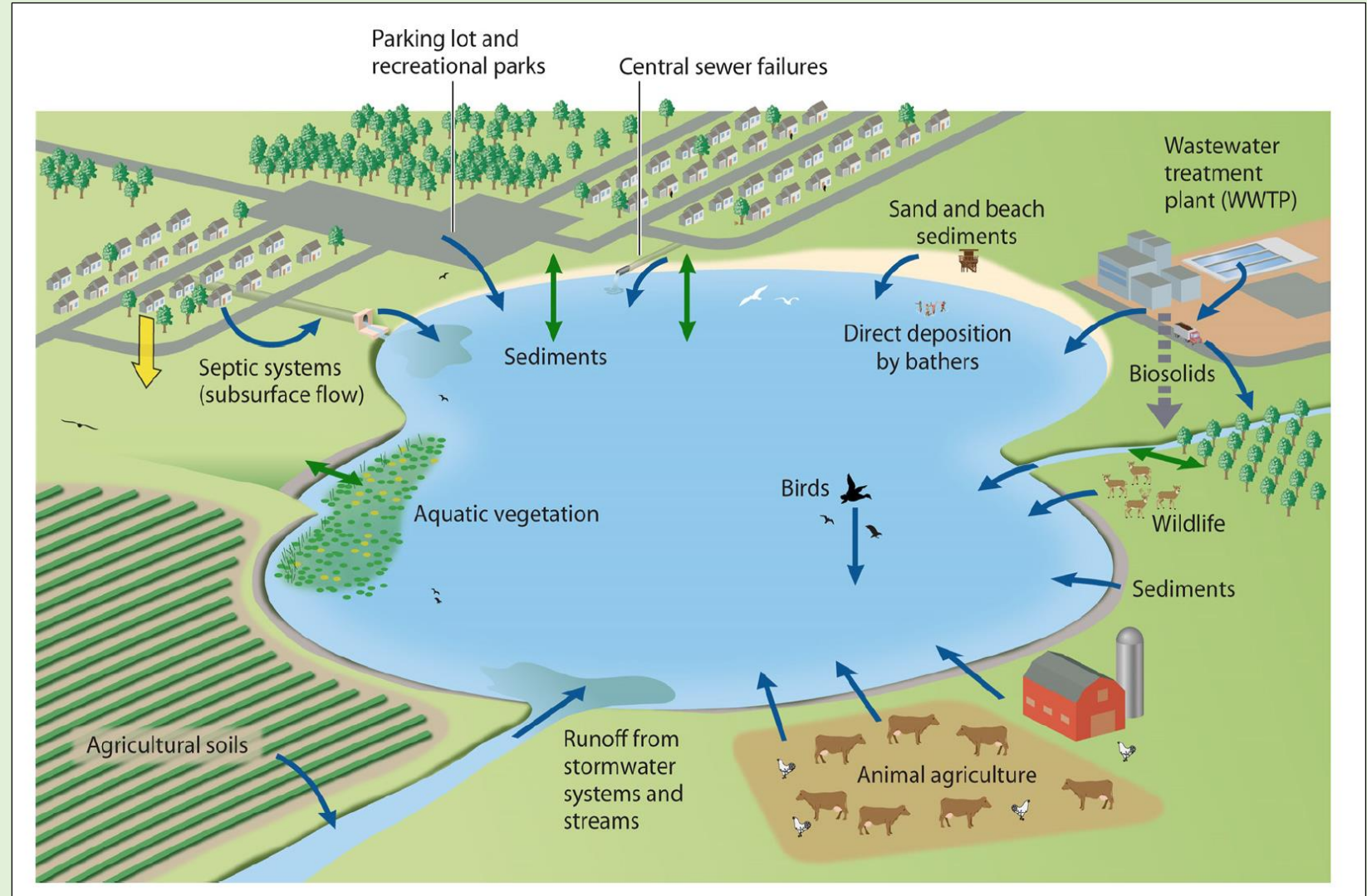
Sources of Enteric Bacteria

➤ Point source

- Wastewater treatment plant discharge

➤ Non-point source

- Septic systems
- Leaking sewer pipes
- Sewage overflows
- Urban runoff
- Pet waste
- Livestock
- Agriculture
- Wildlife
- Aquatic vegetation



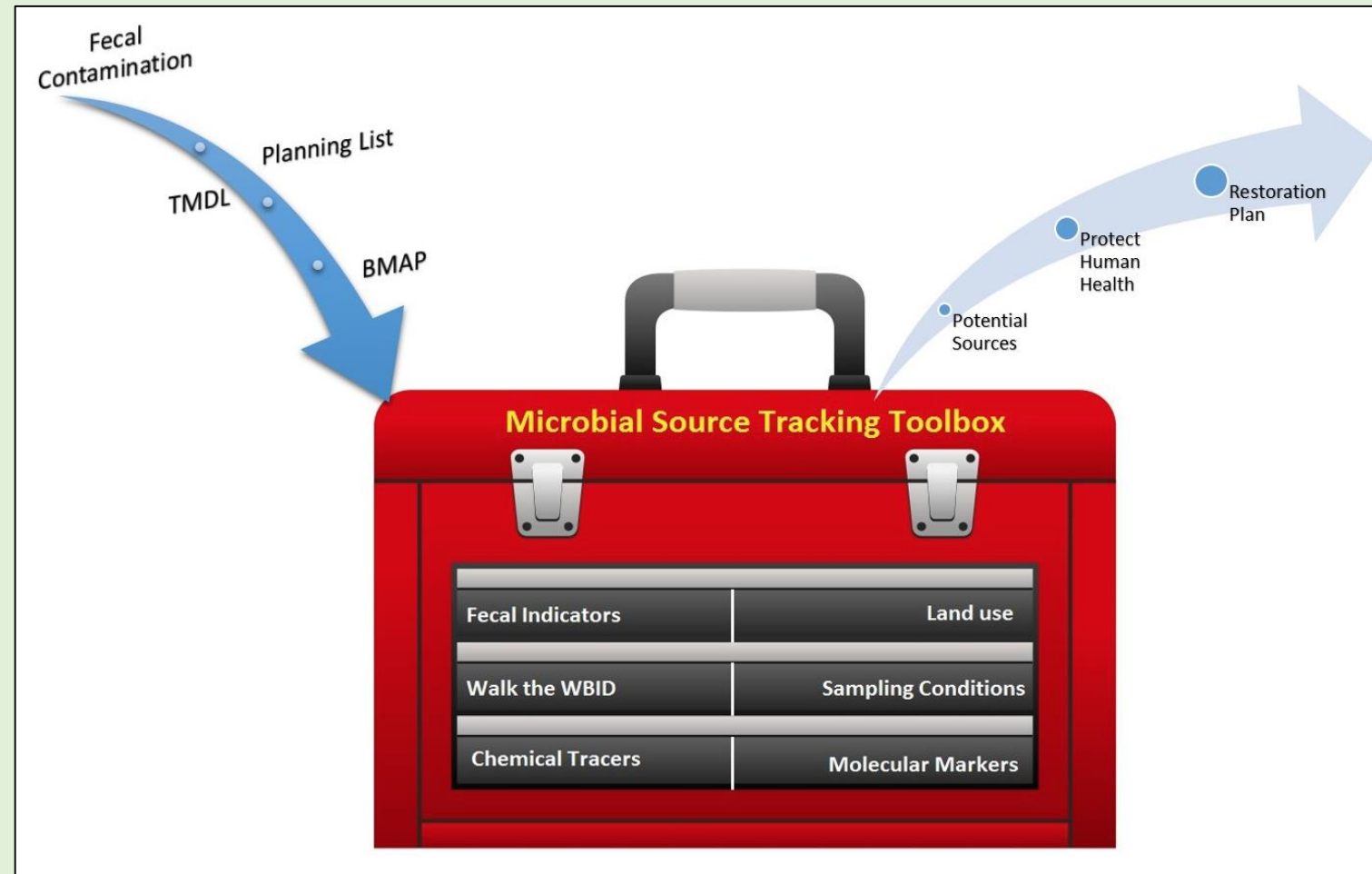
Microbial Source Tracking Study

- Collaborative effort
 - Port St. Lucie, St. Lucie County, & FDEP
 - Harbor Branch analytical assistance

Multi-prong approach:

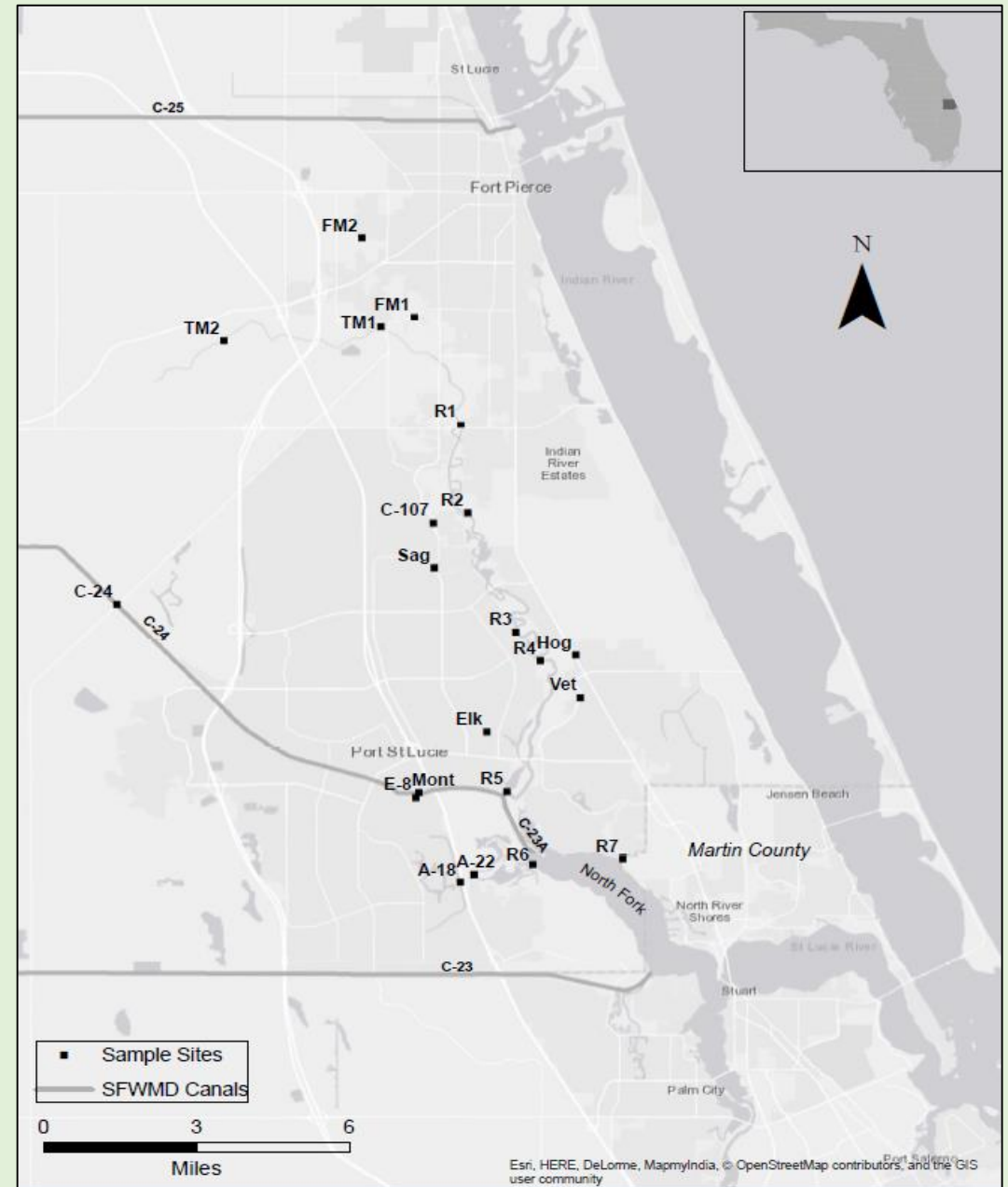
- Molecular markers
 - Gull2 (avian)
 - HF183 (human)
- Chemical markers
 - Sucralose (conservative)
 - Acetaminophen (labile)
 - Pesticides
 - Herbicides
- Bacteria concentrations
- Reactive nutrients

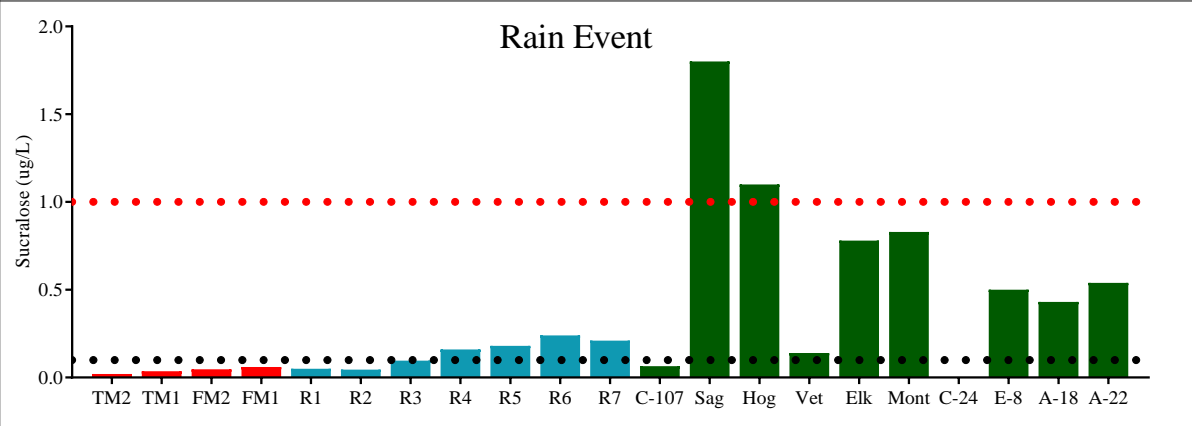
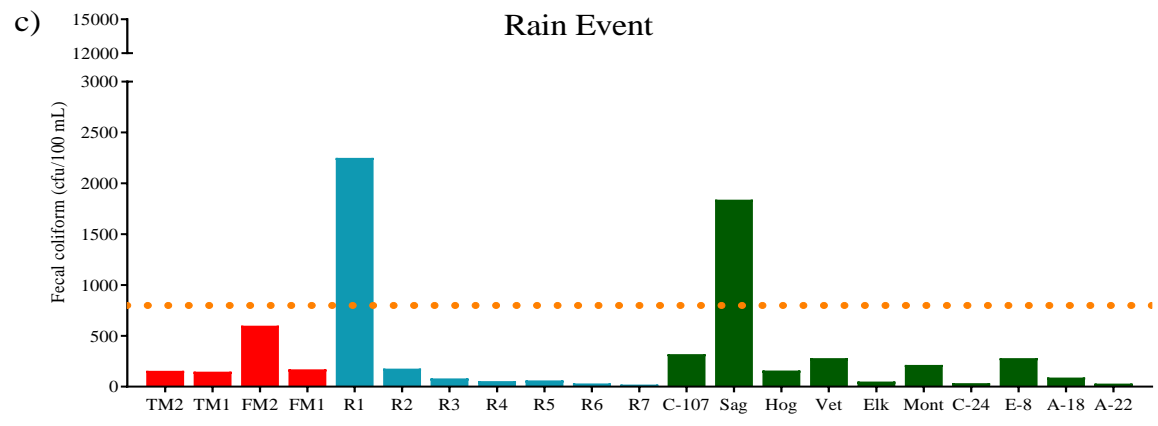
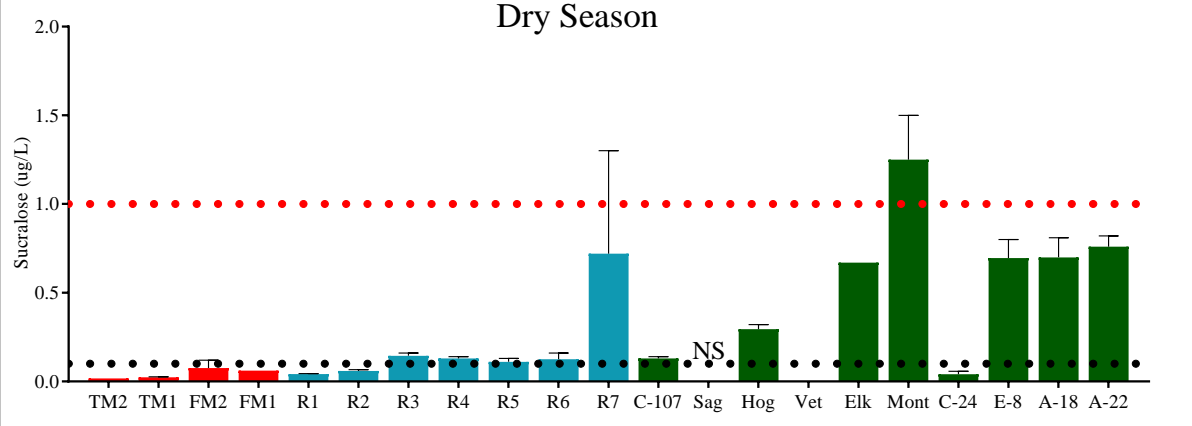
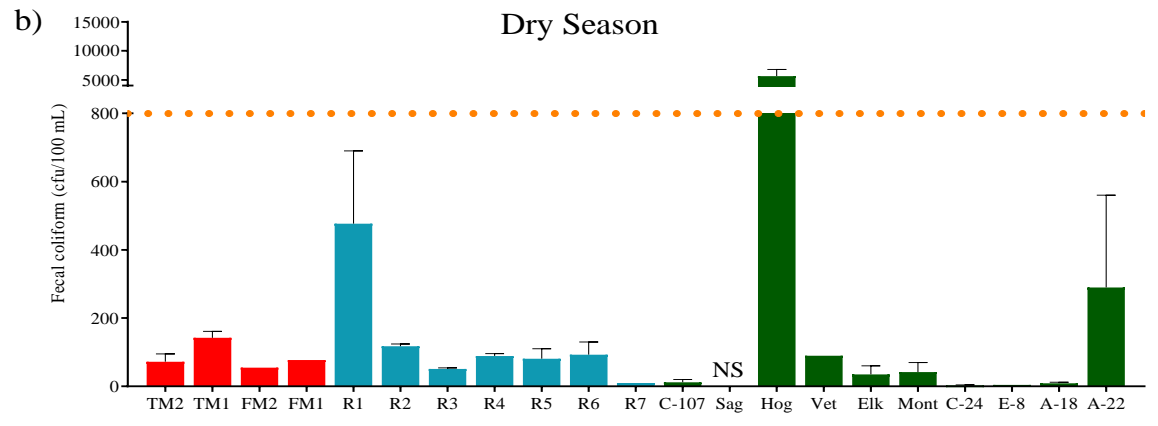
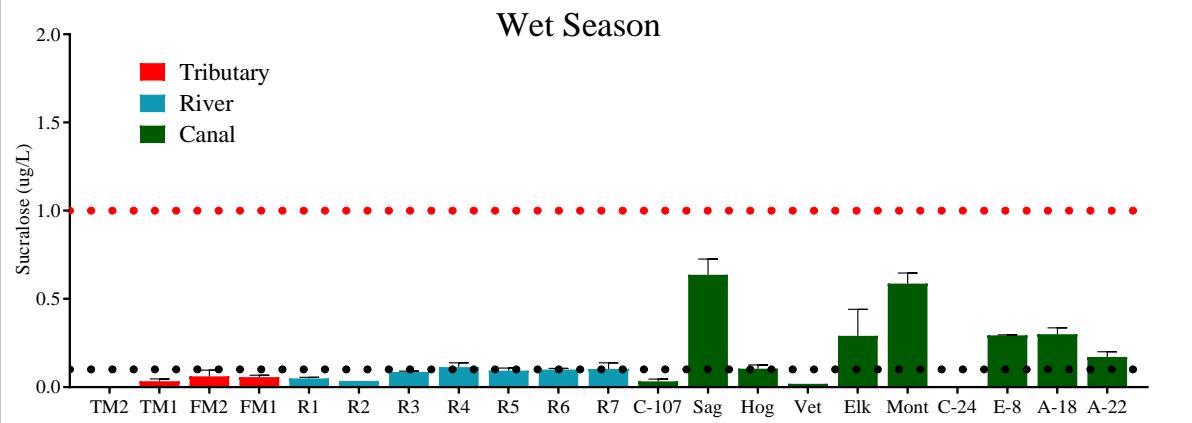
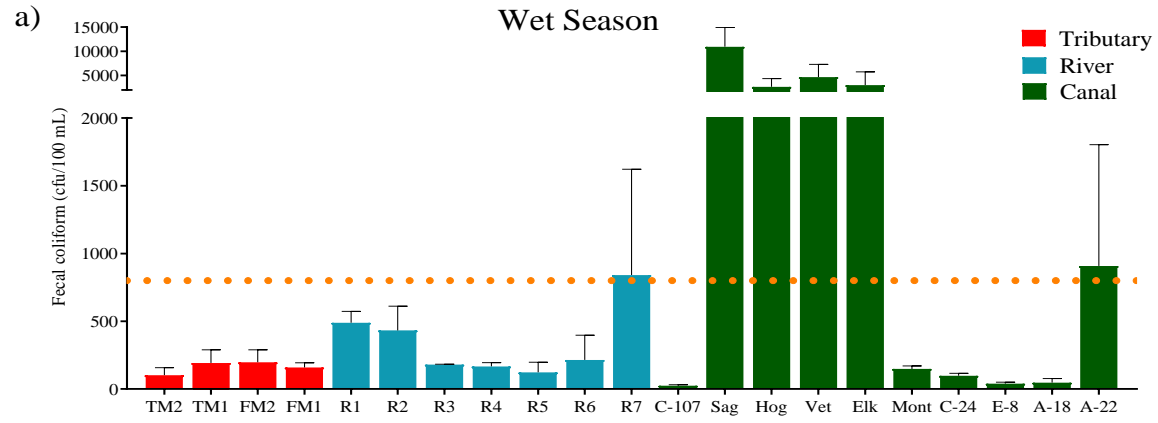
FDEP'S MST "Toolbox Approach"



Sample Sites and Study Period

- Tributary: 2 sites in Tenmile Creek & Fivemile Creek
- River: 7 sites within the main stem of the North Fork
- Canal: 10 sites draining into the main stem
- Wet Season 2016- MST only
- Dry Season 2017- MST & nutrients
- Rain Event July 19, 2017- MST & nutrients
- Wet Season 2017- nutrients only

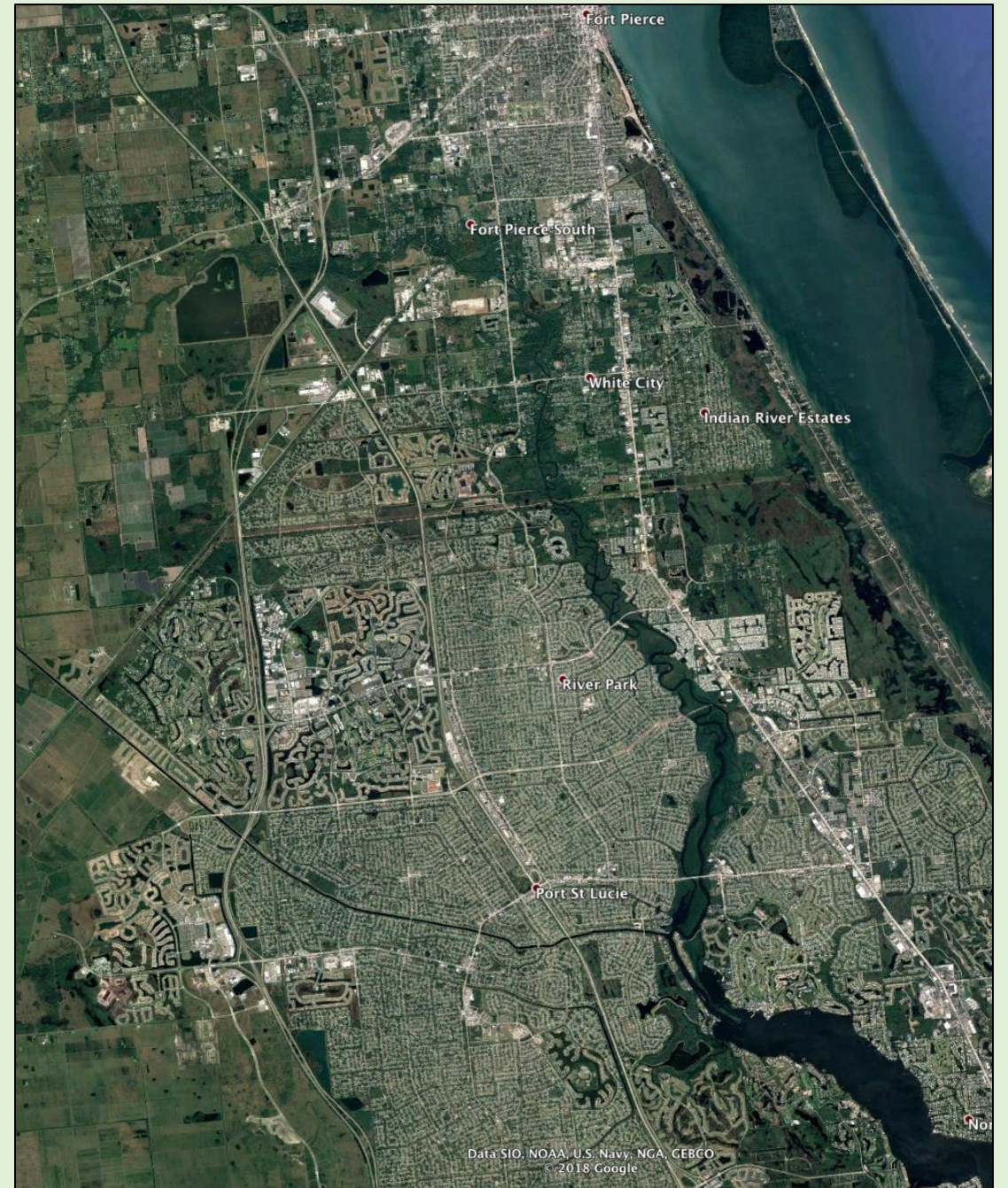




Type	Site	GULL2	HF183	Fecal coliforms	<i>Escherichia coli</i>	Enterococci	Sucralose	Acetaminophen	Carbamazepine	Diuron	Fenuron	Fluridone	Imidacloprid	Ammonium	Nitrate + Nitrite	DIN	SRP
Tributary	Tenmile 2 - upstream	-				NA			-								
	Tenmile 1 - downstream	-	-			NA					-						
	Fivemile 2 - upstream	-	-			NA					-						
	Fivemile 1 - downstream	-	-			NA					-						
River	R1 - upstream				NA						-						
	R2	-	-		NA						-						
	R3	-	-		NA			-			-						
	R4	-	-		NA						-						
	R5	-	-		NA						-						
	R6	-	-		NA			-									
	R7 - downstream	-	-		NA												
Canal	C-107	-	-			NA			-								
	Sagamore	-				NA											
	Hogpen Slough	-	-			NA					-						
	Vet Memorial	-	-			NA			-								
	Elkcam	-	-			NA											
	Monterrey	-	-			NA		-									
	C-24	-	-			NA		-	-		-						
	E-8	-	-			NA		-									
	Horseshoe A-18	-	-			NA		-									
	Southbend/Horseshoe A-22	-	-			NA											
Legend	Low	1,700-9,999	71-9,999	<400	<126	<35	0.01-0.09	0.004-0.009	0.0004-0.0099	0.0008-0.0099	0.008-0.0099	0.0004-0.009	0.0008-0.009	<0.02	<0.02	<0.04	<0.005
	Moderate	10,000-99,999	10,000-99,999	400-799	126-409	35-129	0.1-0.99	0.01-0.049	0.01-0.99	0.01-0.99	0.01-0.99	0.01-0.99	0.01-0.99	0.02-0.06	0.02-0.06	0.04-0.13	0.005-0.01
	Significant	≥ 100,000	≥ 100,000	≥ 800	≥ 410	≥ 130	≥1.0	≥0.05	≥1.0	≥1	≥1	≥1	≥1	≥0.07	≥0.07	≥0.14	≥0.02
	Parameter Units	TSC/100mL	GEU/100mL	cfu/100mL	MPN/100mL	cfu/100mL & MPN/100mL	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L

Summary

- High fecal bacteria at many sites
- Widespread wastewater tracers in both septic system dominated & sewerred areas
- Seasonal variation reflects the impact of rainfall & water table changes
 - Higher nutrient concentrations & fecal bacteria
 - Highest nitrogen @ tributary sites & canals with septic systems



Summary

- Terrestrial herbicides & pesticides = surficial urban runoff
 - Pet waste, lawn clippings, fertilizers, etc. = bacteria & nutrients
 - Seasonal residents may add variation between seasons
- Aquatic herbicide, fluridone
 - Macrophyte control may affect water quality
 - Increased nutrient & bacterial concentrations from decay



Conclusions

- Hot spots with high flow, fecal bacteria abundance, chemical or molecular source tracers, & nutrient concentrations should be closely monitored at Sagamore, Hogpen, Elkcam, Veteran's Memorial, & Monterrey



Recommendations for Future Monitoring

- Coupled groundwater & surface water monitoring of aqueous nitrogen isotopes & sucralose
 - Martin County, Loxahatchee River District, Charlotte County, Lee County
 - Interactions of septic systems & surface water
 - Tracing studies to determine the rate of transport into surface waters
- Using stable isotopes of macrophytes, particulate organic matter, & sediment to identify nutrient sources
- These data would help qualify for BMAP nutrient reduction credits



Recommendations for Source Identification

- Investigate reclaimed water & Class AA biosolids as potential sources of dissolved nutrients & wastewater tracers
- Study the effects of aquatic plant control methods
 - Quantify the impact of decaying water lettuce on nutrients & bacteria



Recommendations for Long-term Monitoring

- A long-term water quality monitoring program using dissolved nutrients, stable isotopes, & source tracers
- Gauge water quality changes as a result of:
 - Septic-to-sewer programs
 - Stormwater treatment
 - Other infrastructure improvements



Image: TC Palm

Recommendations for Improved Infrastructure

- CPSL has an ambitious septic-to-sewer program already in place
 - Focus on hotspots at Sagamore, Hogpen, Elkcam, & Monterrey, as well as other septic systems close to waterways
- Stormwater improvements continued & expanded
- Ongoing water quality research & monitoring
 - Evaluate infrastructure improvements
 - Ensure management actions achieve environmental goals



Acknowledgments

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Questions?

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