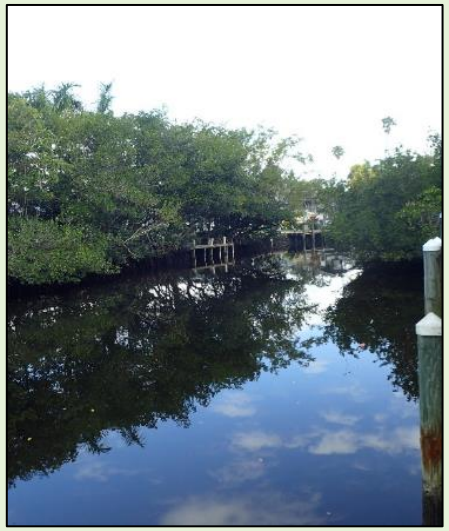
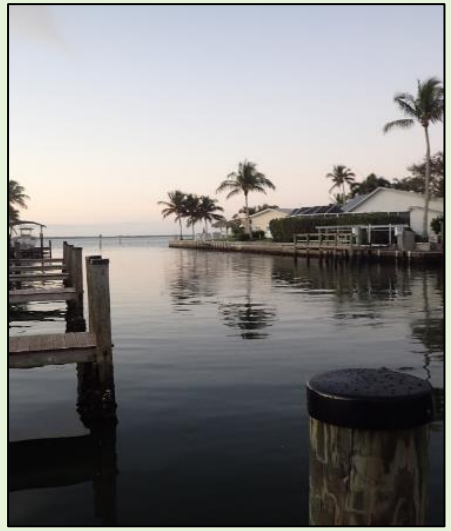
Total Immersion: What's in Lee County Waterways?

Microbial Source Tracking in Lee County Waterways

Presenters

Lisa Kreiger, M.S., PMP, Lee County

Rachel Brewton, M.S., HBOI-FAU

Kevin Tyre, M.S., Geosyntec Consultants (formerly with HBOI-FAU)

Principal Investigator - Dr. Brian LaPointe, HBOI-FAU

June 16, 2022

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Project Team

Project Sponsor

Consultant

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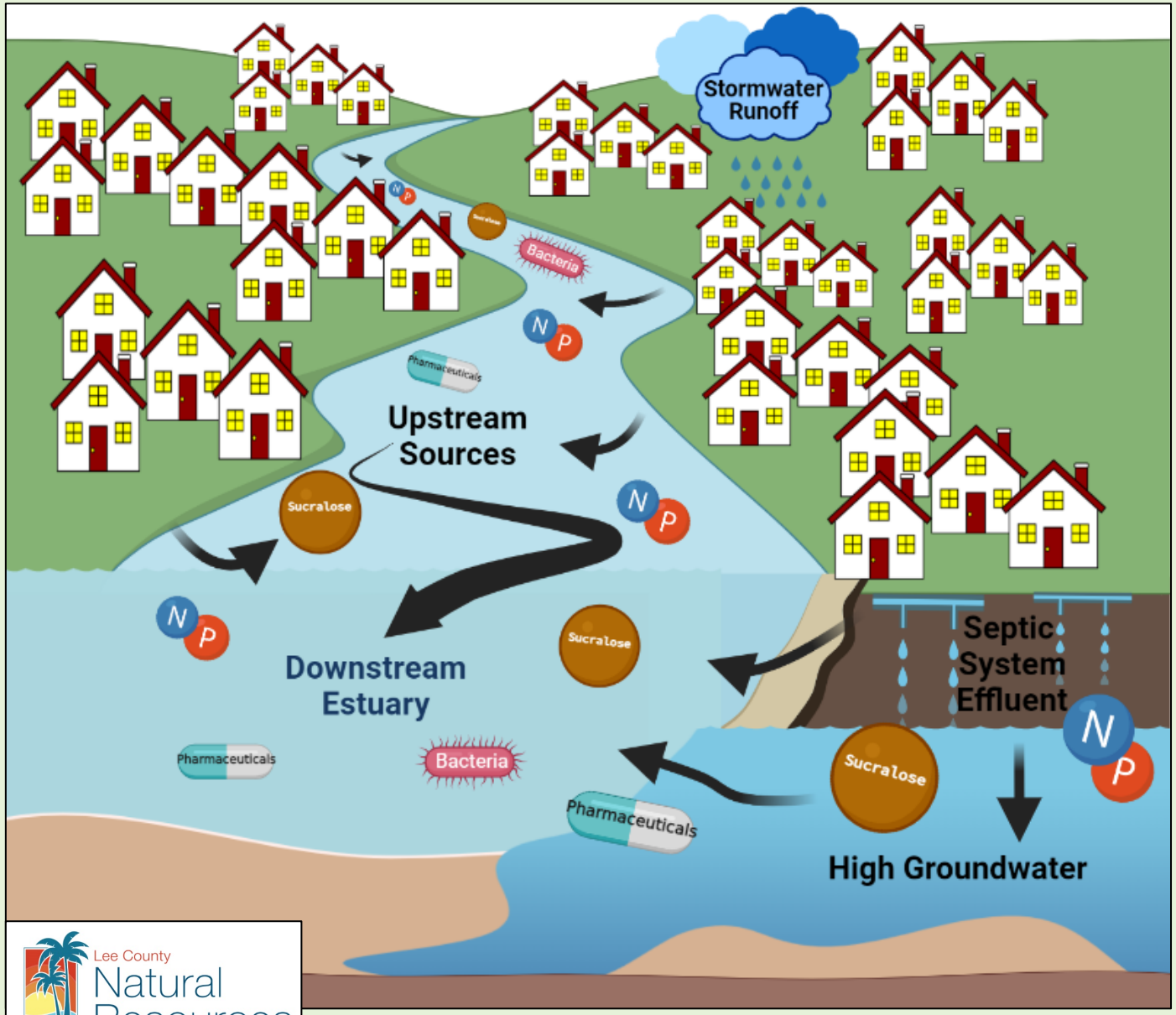
Urban Water Quality Degradation



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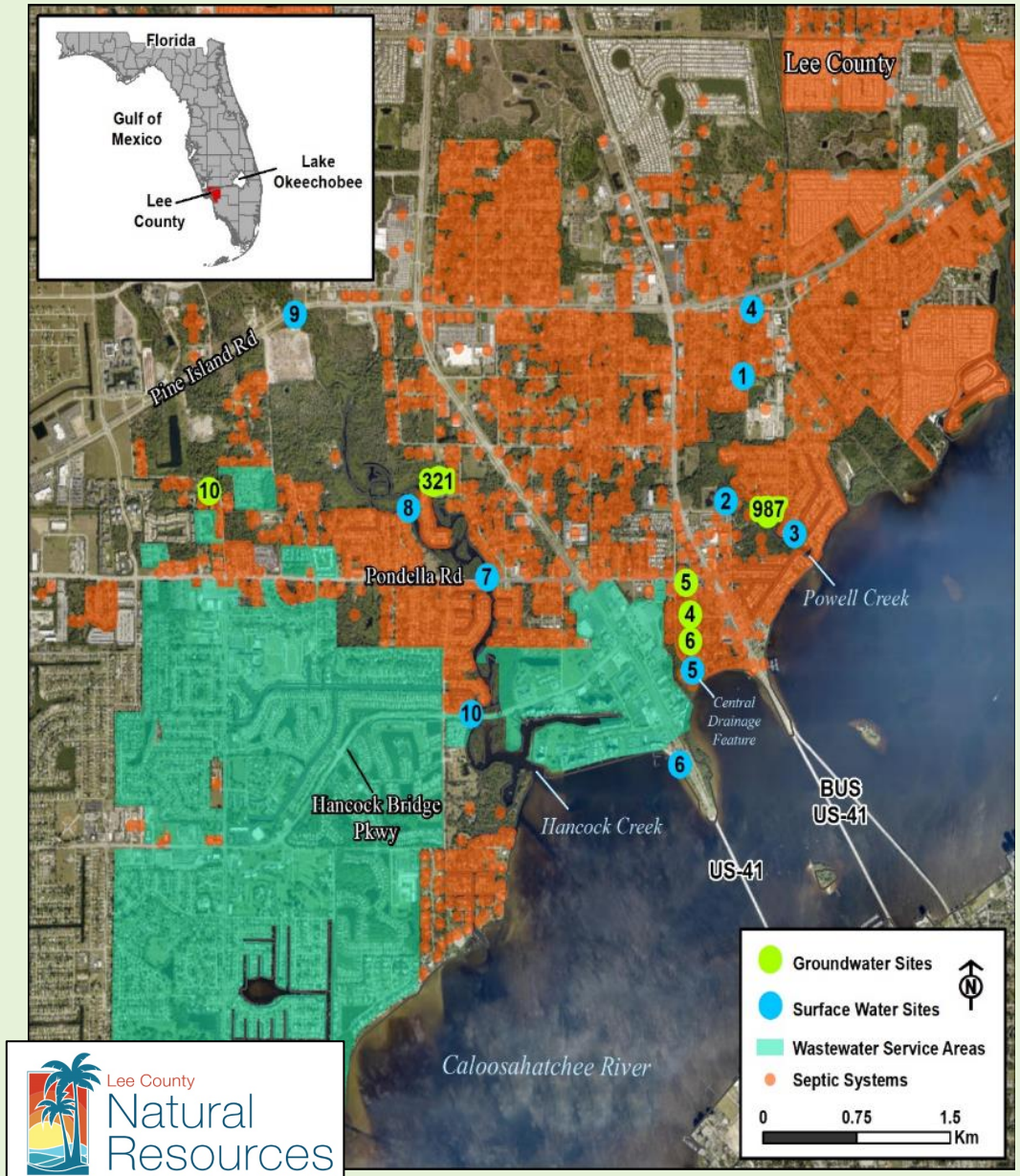
North Fort Myers Nutrient & Bacteria Study 2017-2020



- High water tables in NFM = septic systems can't function
- Groundwater & surface water were influenced by human waste
  - High fecal indicator bacteria, ammonium, nitrate, sucralose, pharmaceuticals, & $\delta^{15}N$
- Conclusion: Evidence of human waste throughout NFM, so decreased reliance on septic systems may improve water quality

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Where else might there be human waste contamination in unincorporated Lee County?

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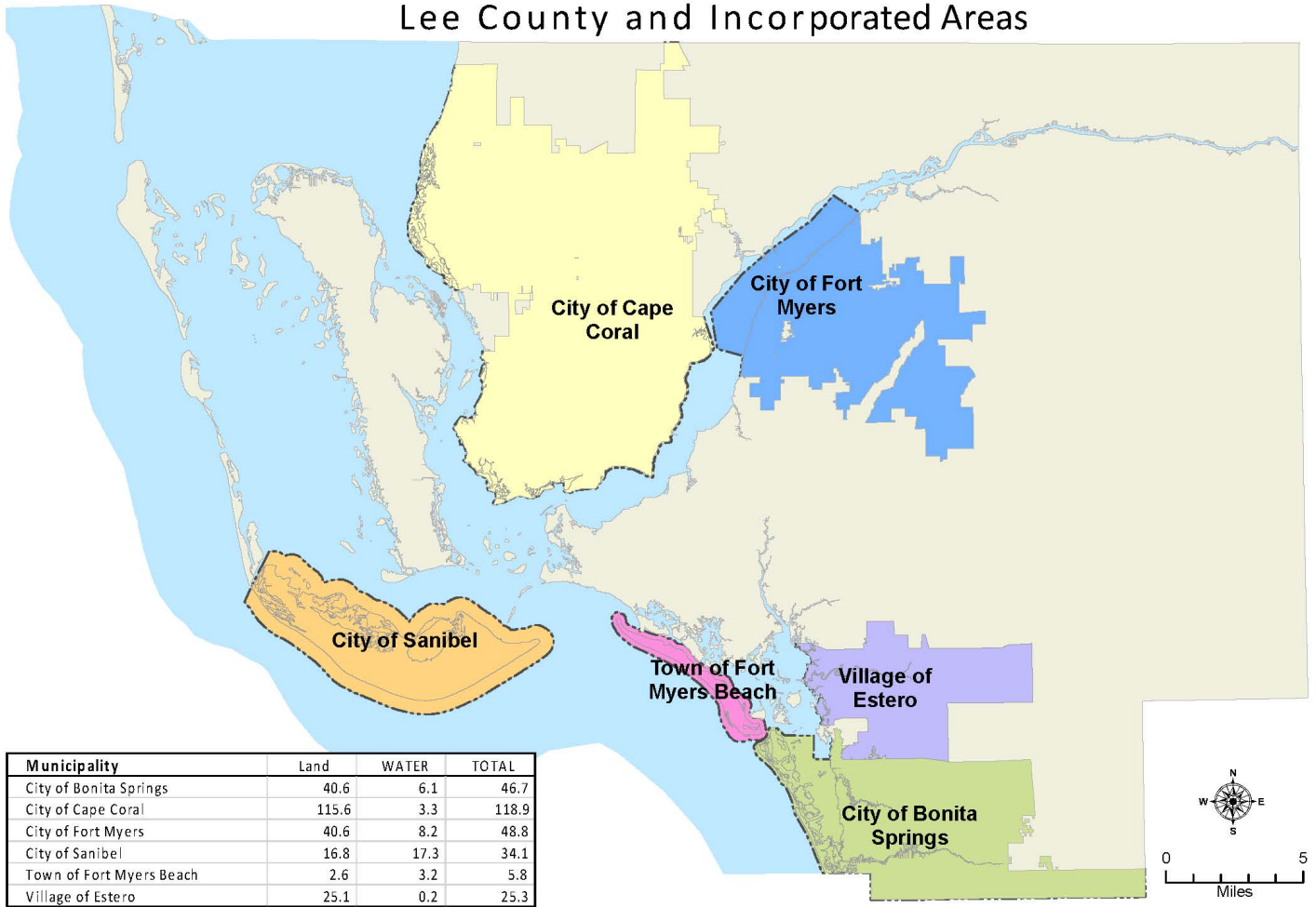
Lee County and Incorporated Areas



Municipality	Land	WATER	TOTAL
City of Bonita Springs	40.6	6.1	46.7
City of Cape Coral	115.6	3.3	118.9
City of Fort Myers	40.6	8.2	48.8
City of Sanibel	16.8	17.3	34.1
Town of Fort Myers Beach	2.6	3.2	5.8
Village of Estero	25.1	0.2	25.3
Total incorporated area (sq mi)	241.3	38.3	279.6
Unincorporated Lee	572.1	360.8	932.9
Total area in Lee County (sq mi)	**813.4**	**399.1**	**1212.5**

Prepared by Lee County, August 24, 2020

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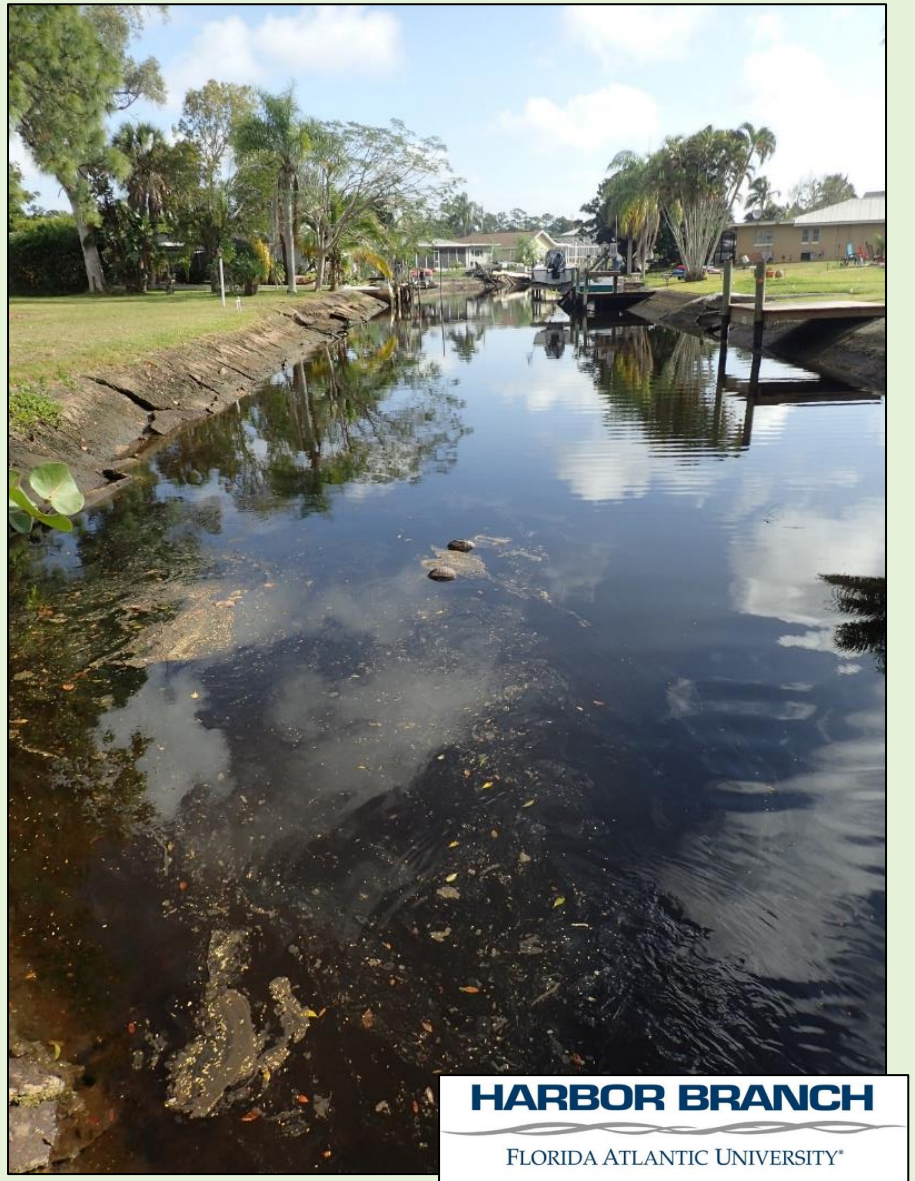
Purpose and Design

1. Identify areas where human waste may be a contributing factor to waters impaired for nutrients &/or bacteria (areas with septic tanks along impaired waterways)
2. Sample discrete neighborhood outfall locations to ascertain distinct sources
3. Identify neighborhoods that might benefit from replacement of septic systems with central sewer or other alternatives



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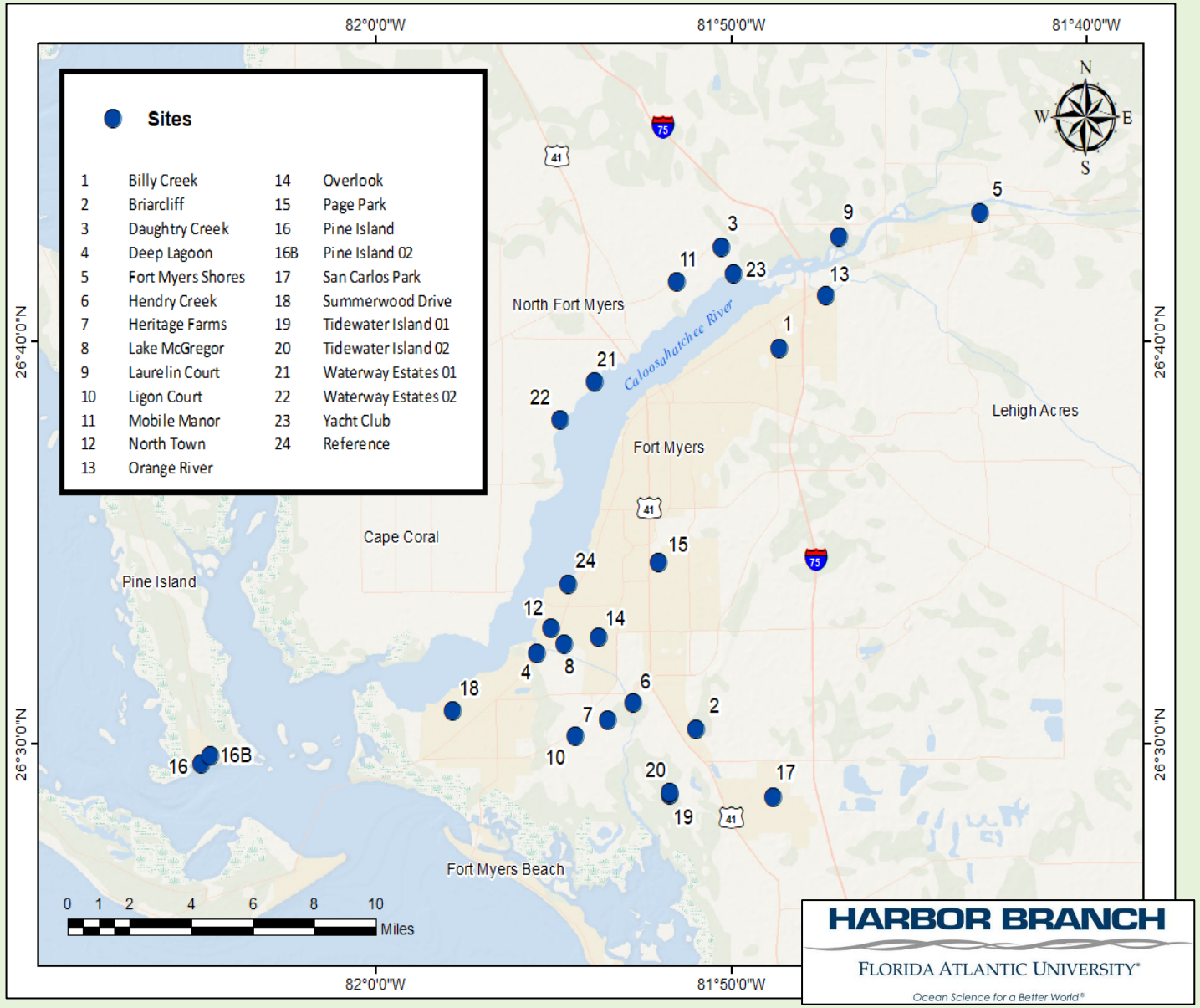
Methods

- 25 surface water sites
  - Caloosahatchee River Estuary
  - Freshwater Creeks
  - Drainage Canals
  - Ditches
- Sampled 8 times 01/20 - 01/21
- Samples analyzed for:
  - ✓Nutrients (N & P)
  - ✓Fecal indicator bacteria
  - ✓Chemical tracers
  - ✓Molecular tracer: HF183
  - ✓Nitrate stable isotopes



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Nutrient Pollution

- Excess **nitrogen** (N) & **phosphorus** (P)
  - Water quality degradation
  - Harmful algal blooms
  - Depletes dissolved oxygen
  - Fish kills
  - Habitat loss

- FDEP water quality standards
  - **Total nitrogen** < 1.54 mg/L
  - **Total phosphorus** < 0.12 mg/L

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Nitrogen Results

- 4 sites (16%) **exceeded** FDEP total nitrogen standard (> 1.54 mg/L)
- 15 sites (60%) had **high ammonium** (> 0.06 mg/L)
- 5 sites (20%) had **very high ammonium**!! (> 0.20 mg/L)
- 1 site had **high** nitrate (>0.21 mg/L)

North Shore Park
12/07/2021

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Site #	Site Name
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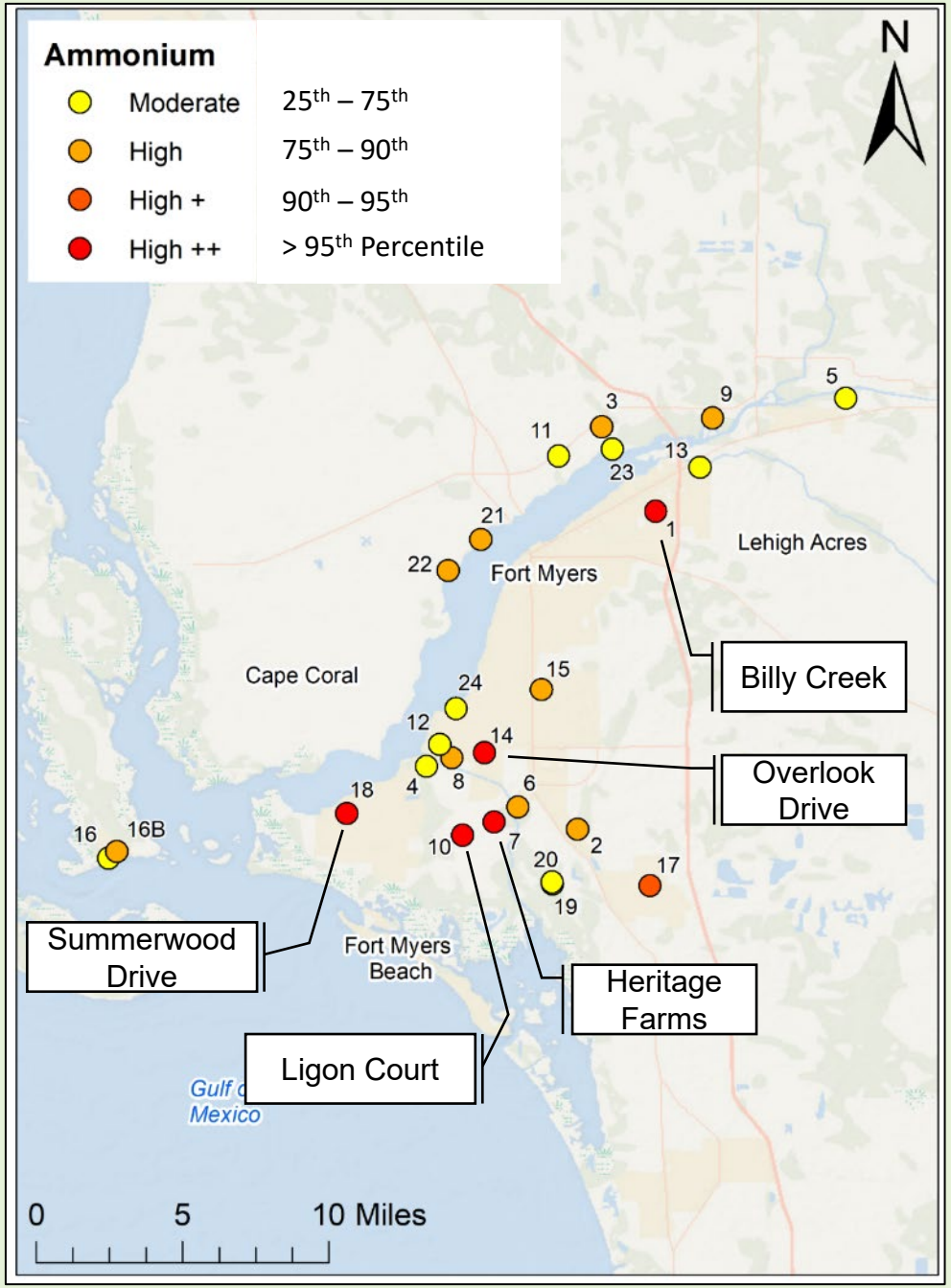

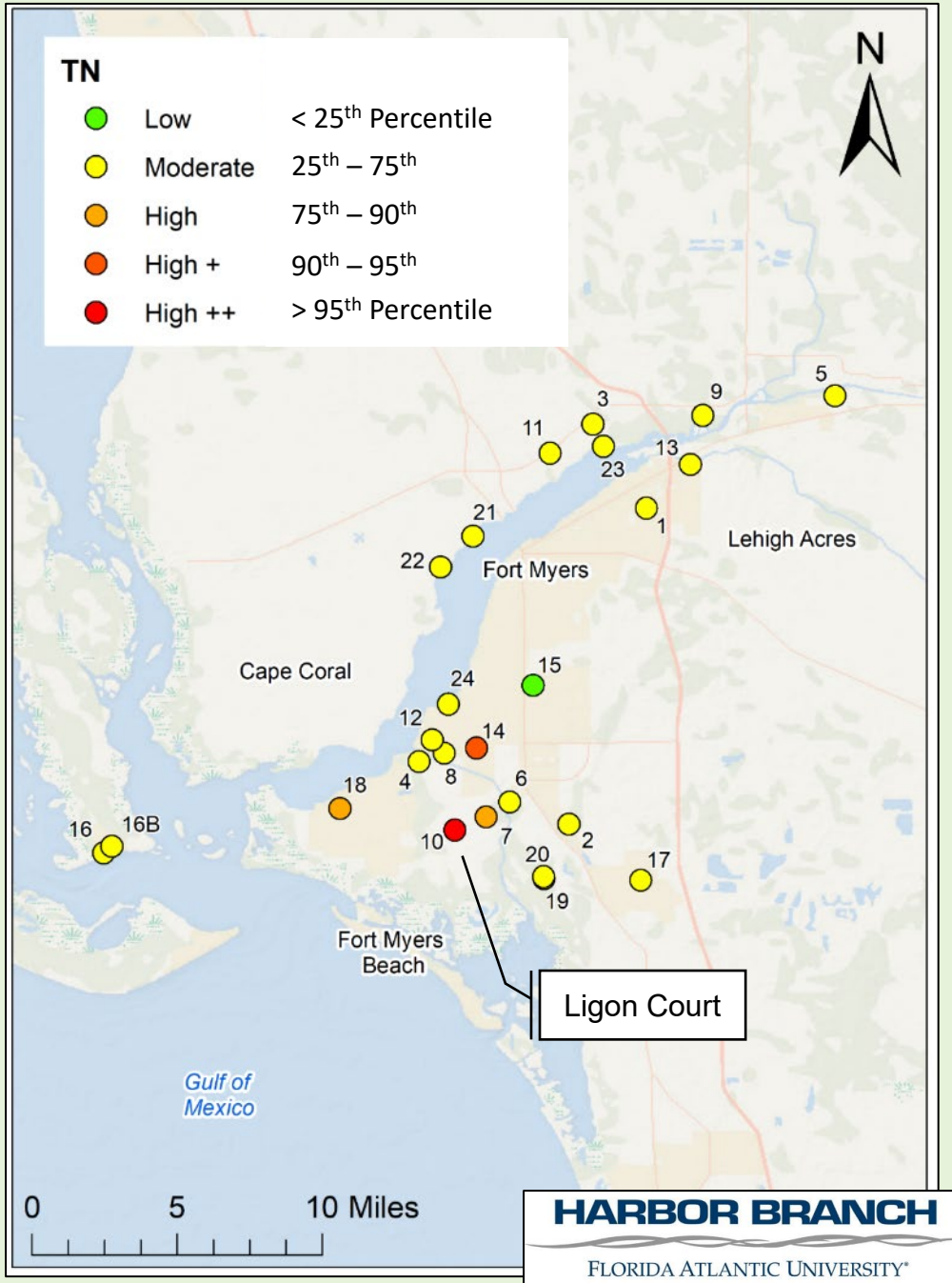

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Phosphorus Results

- 9 sites (36%) **exceeded** FDEP total phosphorus standard (> 0.12 mg/L)
- 9 sites (36%) had **high** soluble reactive phosphorus (> 0.08 mg/L)

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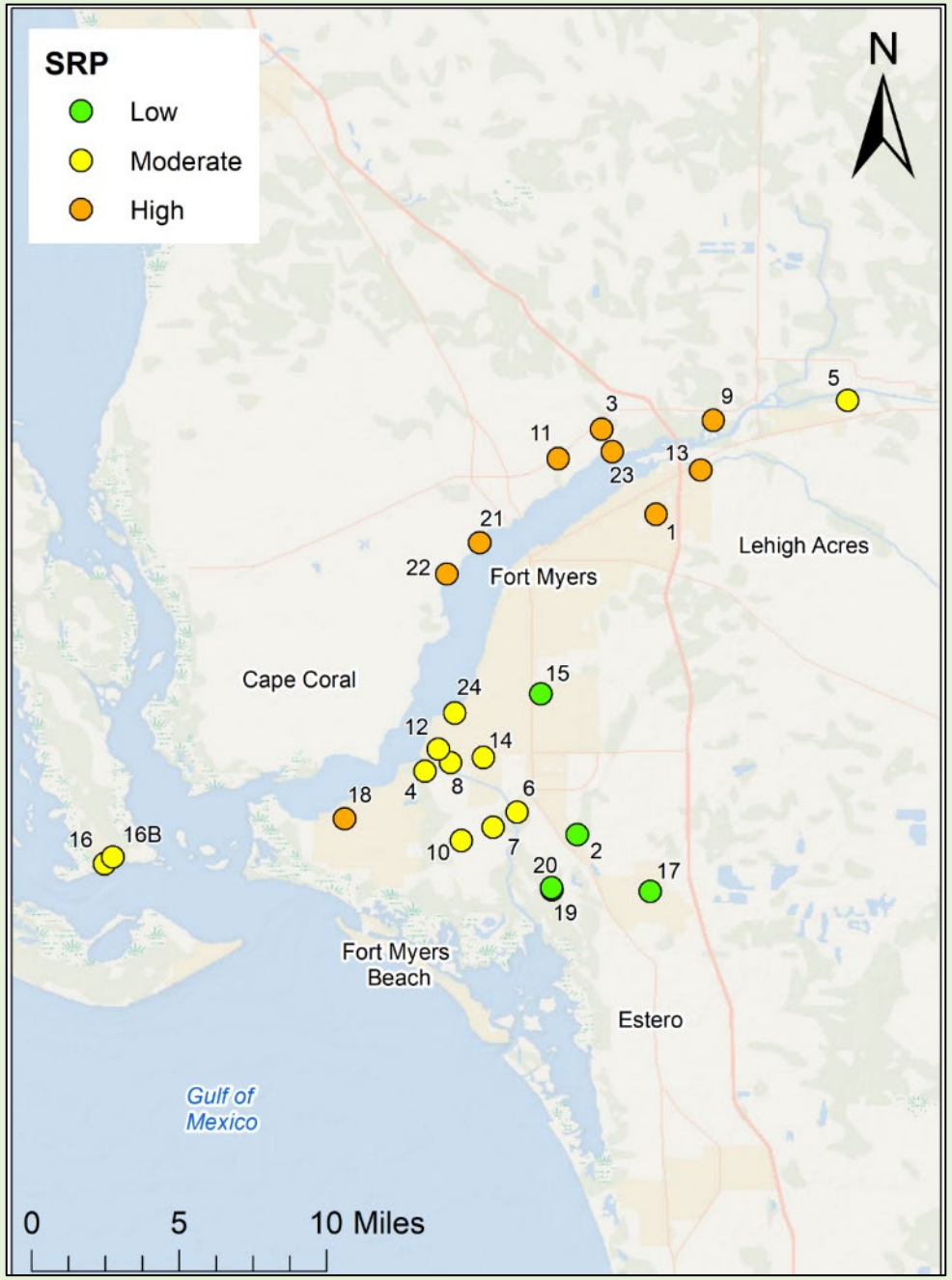

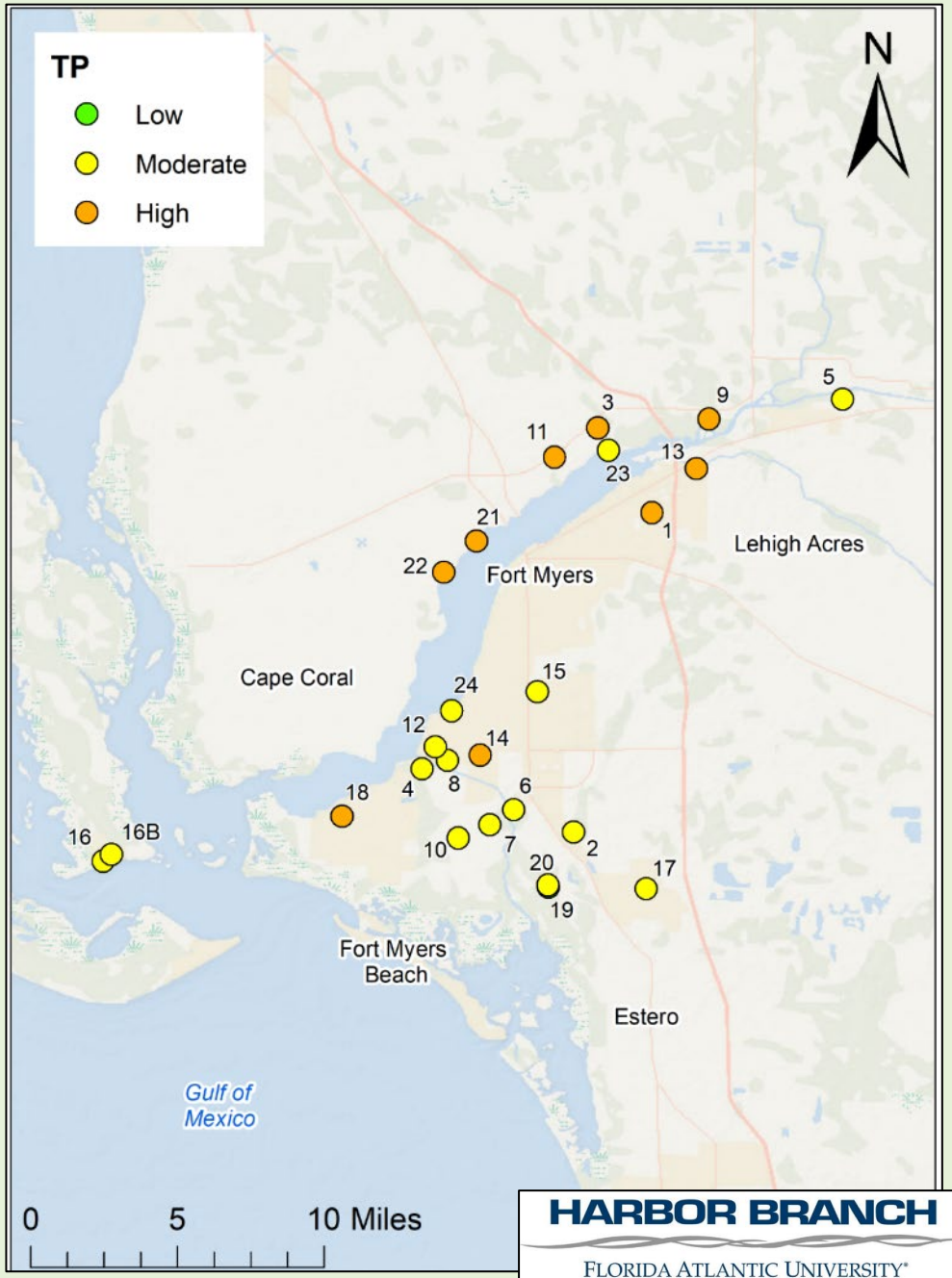

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Fecal Indicator Bacteria

- Enterococci & *E. coli* gauge human health risk from fecal pathogens
- Enterococci > 130 MPN/100mL = health hazard (EPA, 2012)
- *E. coli* > 410 MPN/100mL = health hazard (EPA, 2012)

EPA. (2012). Recreational water quality criteria. Health and Ecological Criteria Division OoSaT, 42.

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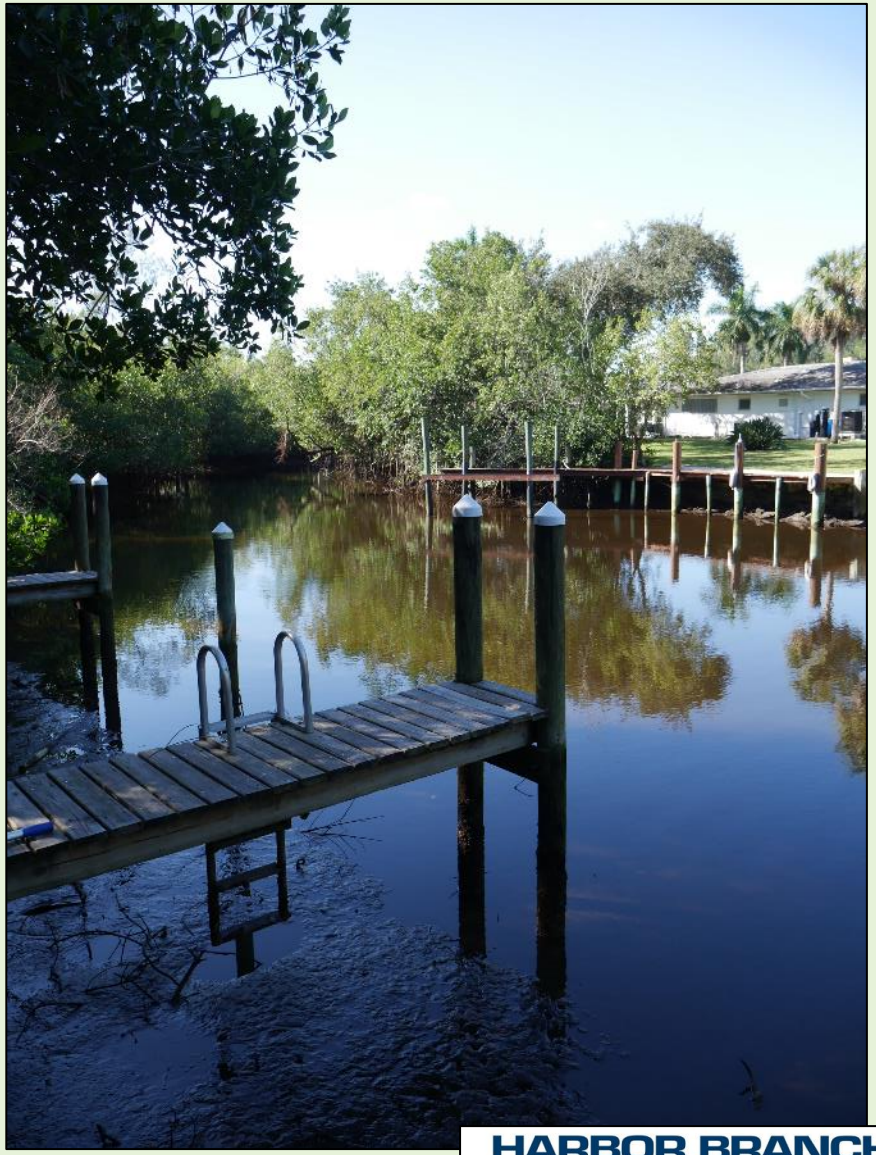
Enterococci Results

- 16 sites (64%) **exceeded** FDEP standard (> 130 MPN/100mL)
- 9 sites (36%) had **very high enterococci** (> 770 MPN/100mL)
- Enterococci **correlated** with ammonium ($r = 0.48$, $p < 0.001$)



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E. coli Results

- 13 sites (52%) **exceeded** FDEP standard (> 410 MPN/100mL)
- 4 sites (16%) had **very high** *E. coli* (> 775 MPN/100mL)
- *E. coli* **correlated** with ammonium (r = 0.18 , p = 0.01)

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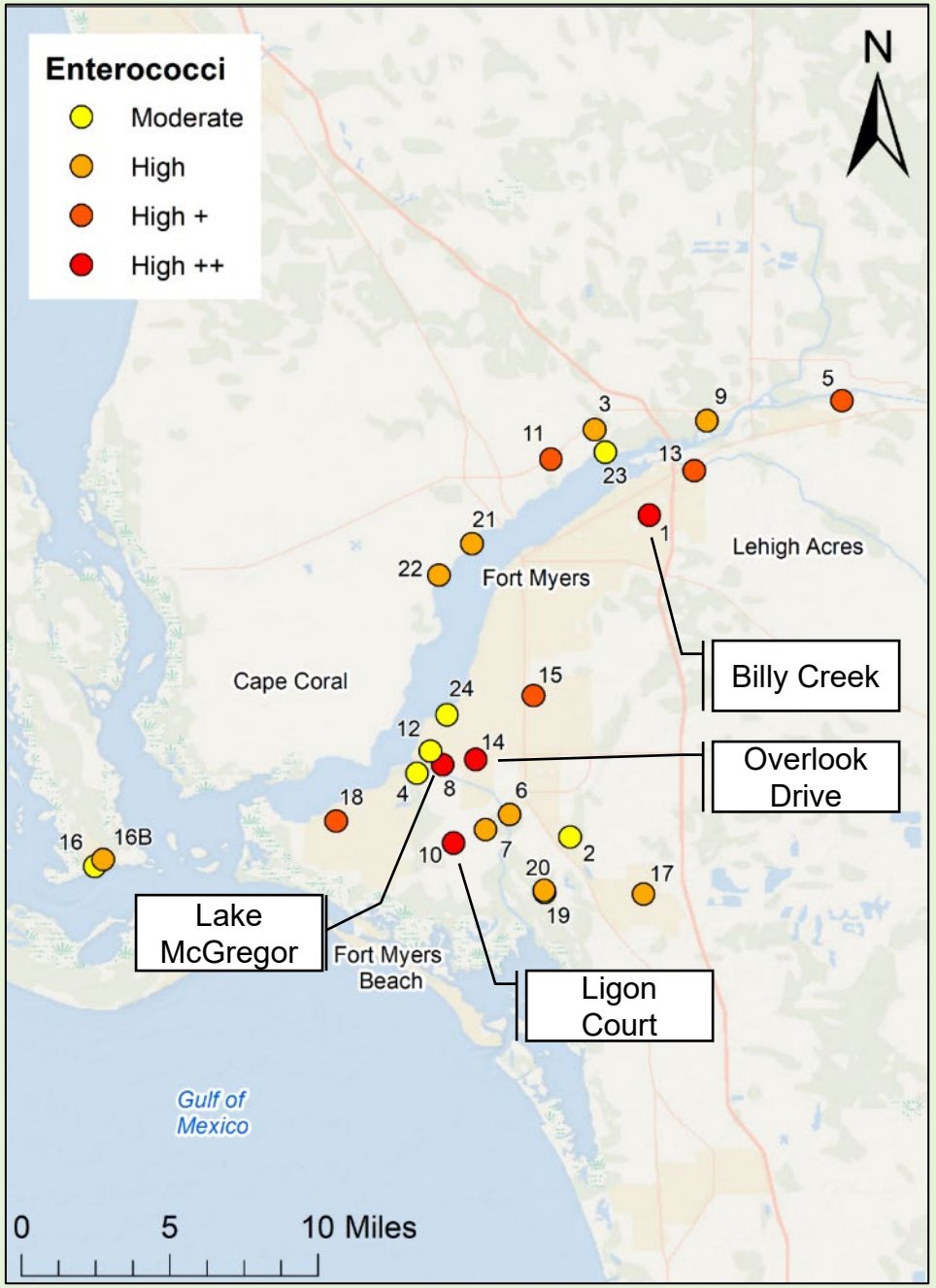

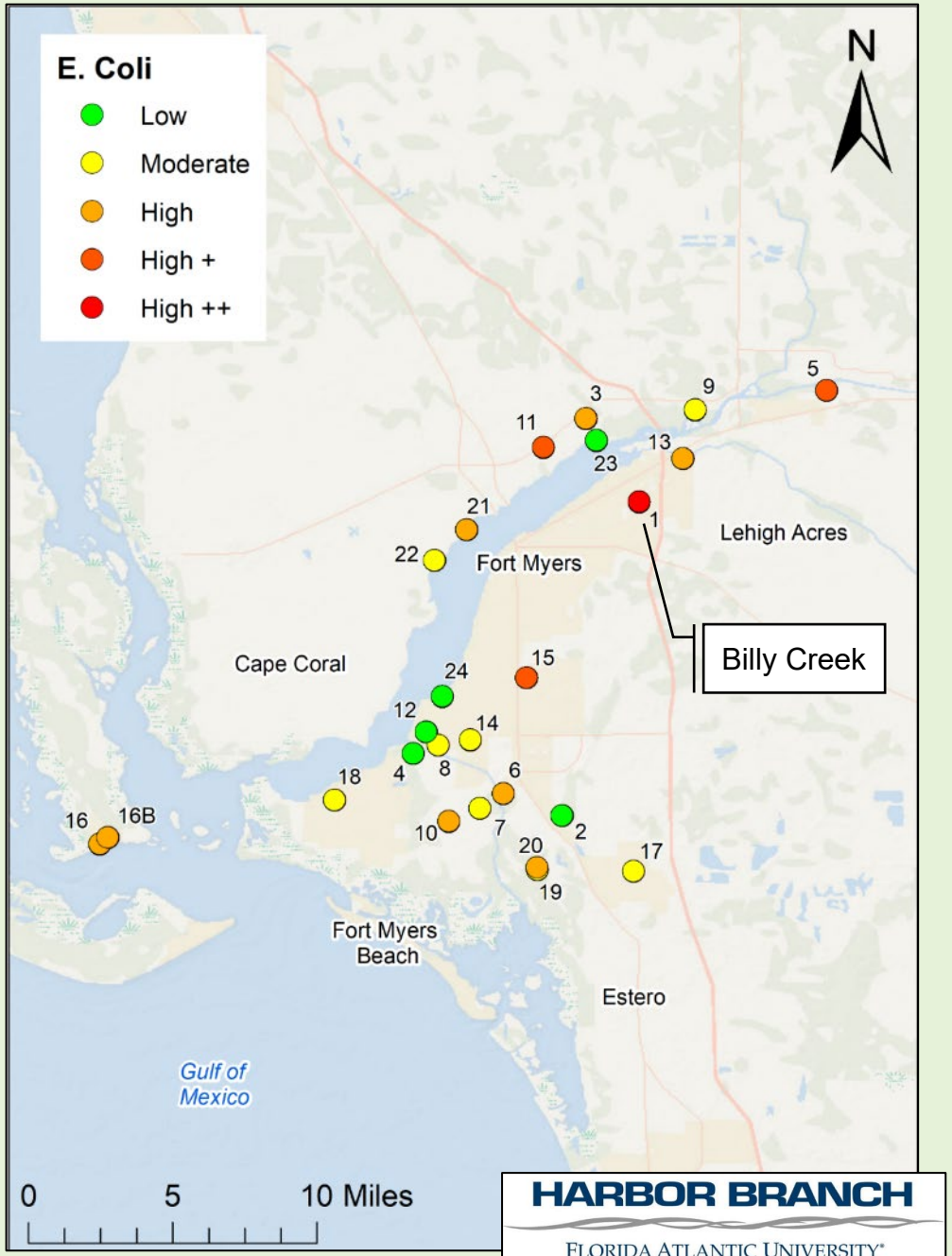

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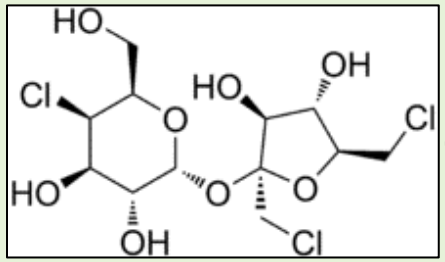
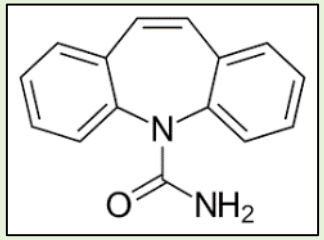
Chemical Tracers of Human Waste

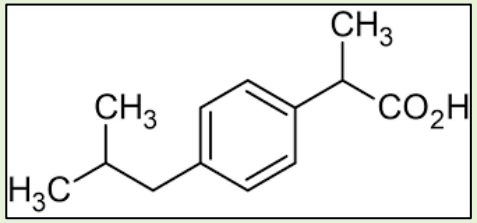
- Artificial Sweetener
  - **Sucralose** – not removed in wastewater treatment, persists in the environment



- Pharmaceuticals
  - **Carbamazepine** – partially removed in wastewater treatment



  - **Ibuprofen** – near-complete removal in wastewater treatment
    - Best chemical indicator of untreated human waste



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Artificial Sweetener Results

- 16 sites (64%) had **high sucralose** (> 380 ng/L)
- 4 sites (16%) had **very high sucralose** (> 1,100 ng/L)
- Sucralose **correlated** with ammonium ($r = 0.31$, $p < 0.001$)
- Sucralose **not correlated** with fecal indicator bacteria ($p > 0.1$)

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Pharmaceutical Tracer Results

- 8 sites (32%) had **high** carbamazepine (> 0.8 ng/L)
- 4 sites (16%) had **very high** carbamazepine (> 3.4 ng/L)
- 1 site (4%) had **high** ibuprofen (> 20 ng/L)

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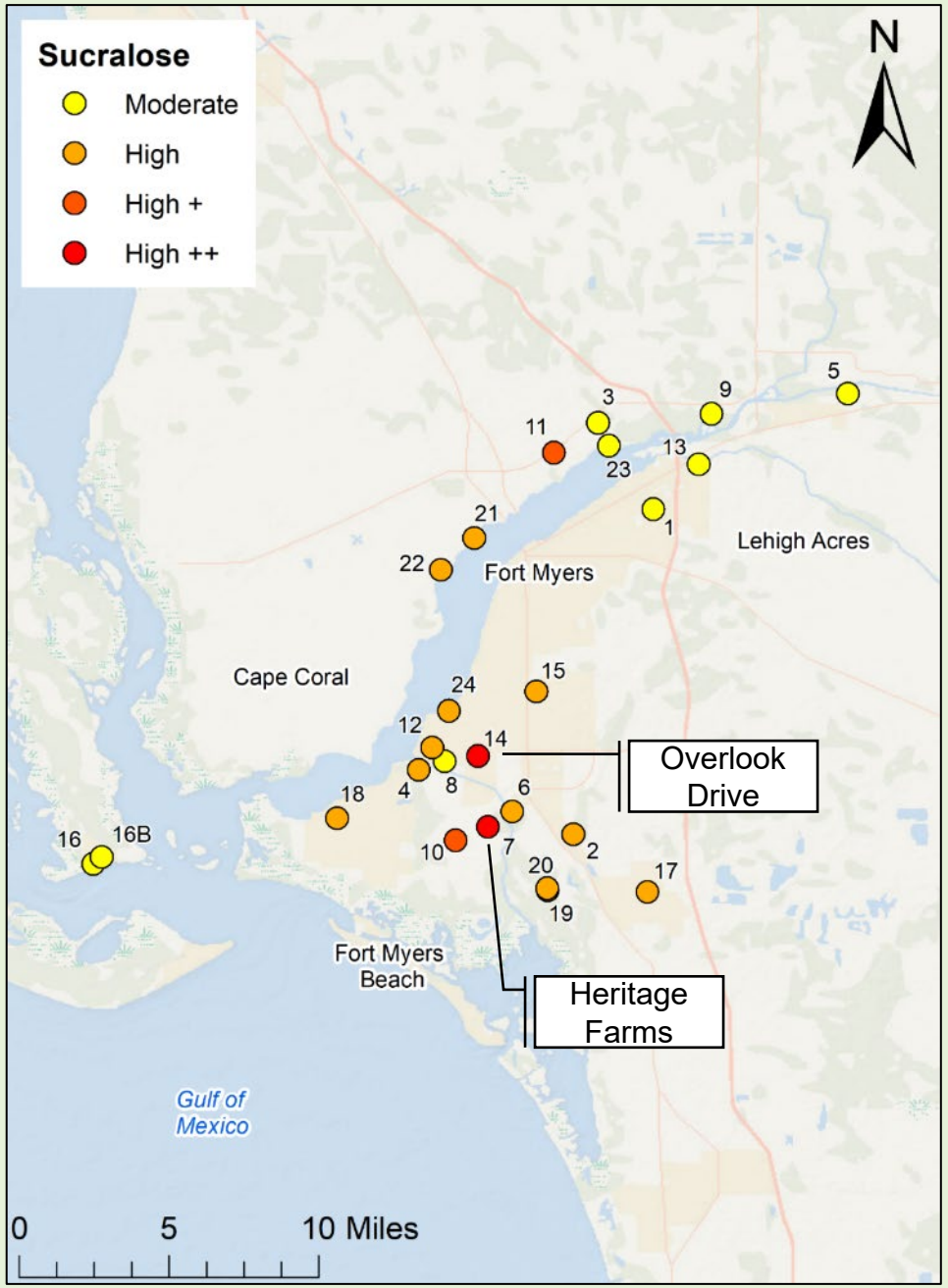

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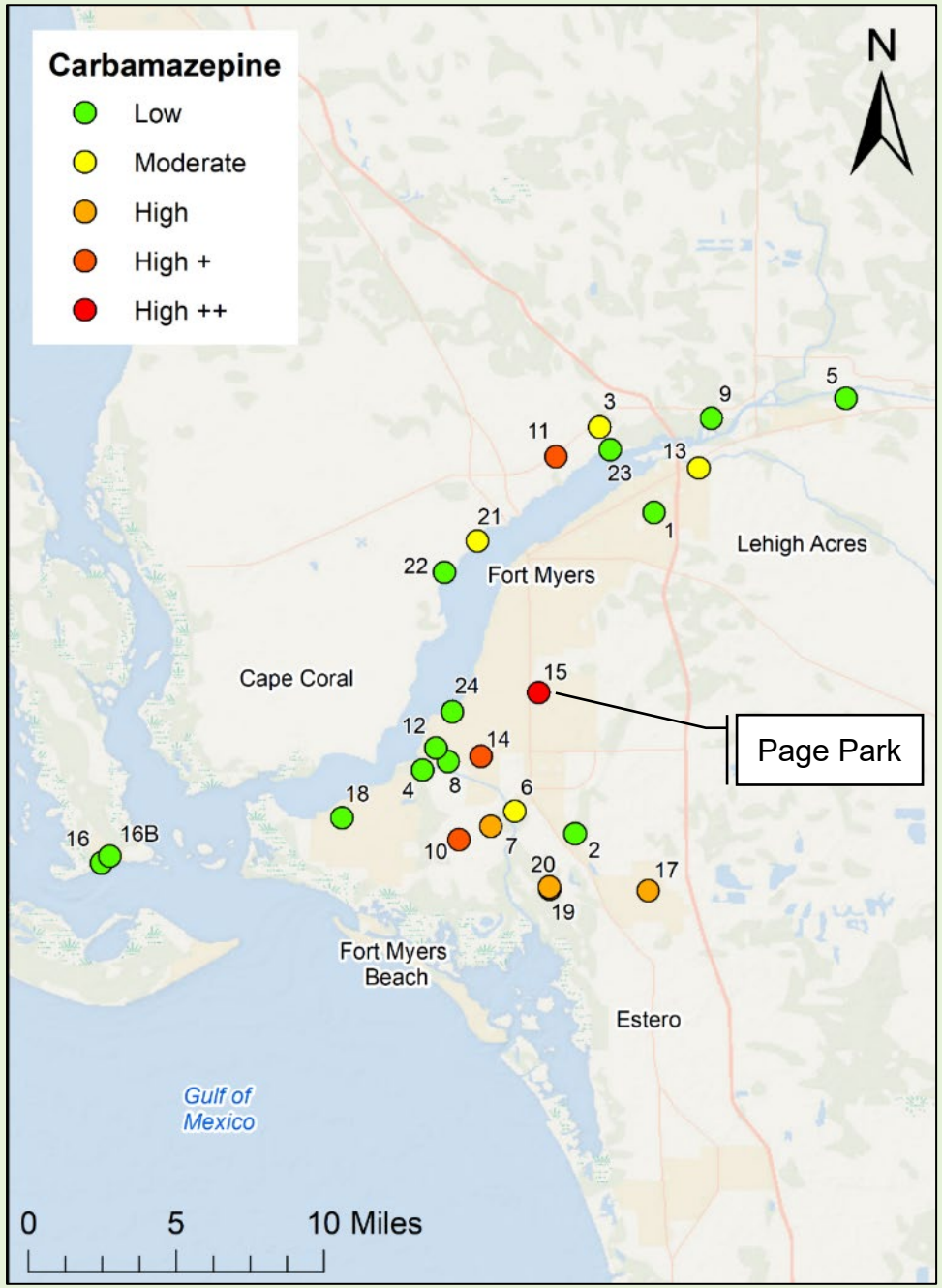

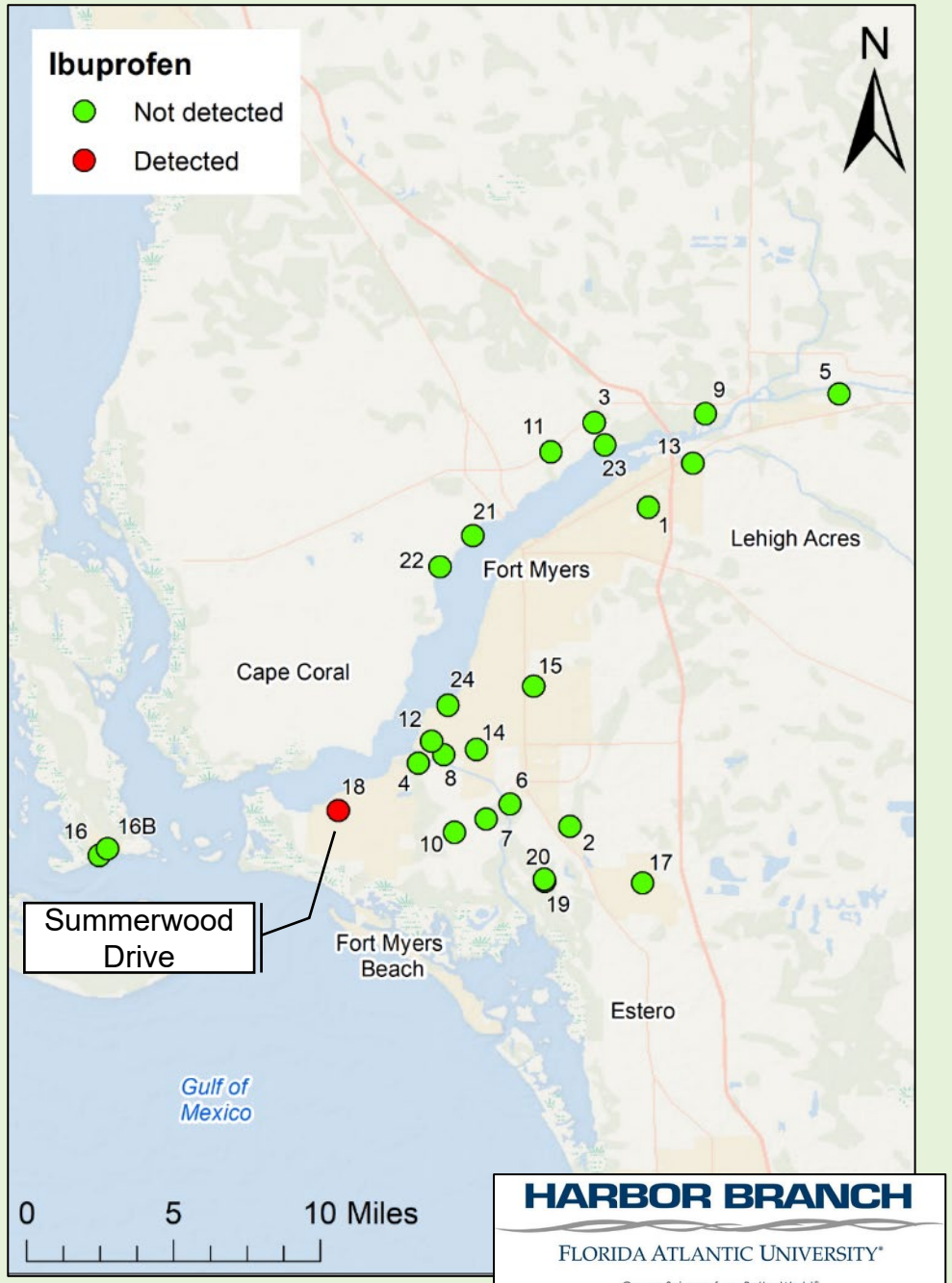

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Molecular Tracer of Human Waste

- **Bacteroides HF183** = Reliable indicator of human fecal pollution
- Half-life < 8 days in the environment
- Wastewater treatment reduces HF183 compared to raw sewage
- Concentrations exceeding 525 copies/100mL = health hazard (Boehm and Soller, 2020)

Boehm, A. B., & Soller, J. A. (2020). Refined ambient water quality thresholds for human-associated fecal indicator HF183 for recreational waters with and without co-occurring gull fecal contamination. Microbial Risk Analysis, 16, 100139.

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HF183 Results

- HF183 **detected in 50% of samples** and at least once at 22 sites (88%)
- 4 sites (16%) had **high** HF183 (>525 copies/100mL)
- 3 sites (12%) had **very high** HF183 (>1,400 copies/100mL)
- HF183 **correlated** with *E. coli* ($r = 0.29$, $p < 0.001$)
- HF183 **correlated** with enterococci ($r = 0.32$, $p < 0.001$)
- HF183 **correlated** with ammonium ($r = 0.24$, $p < 0.001$)

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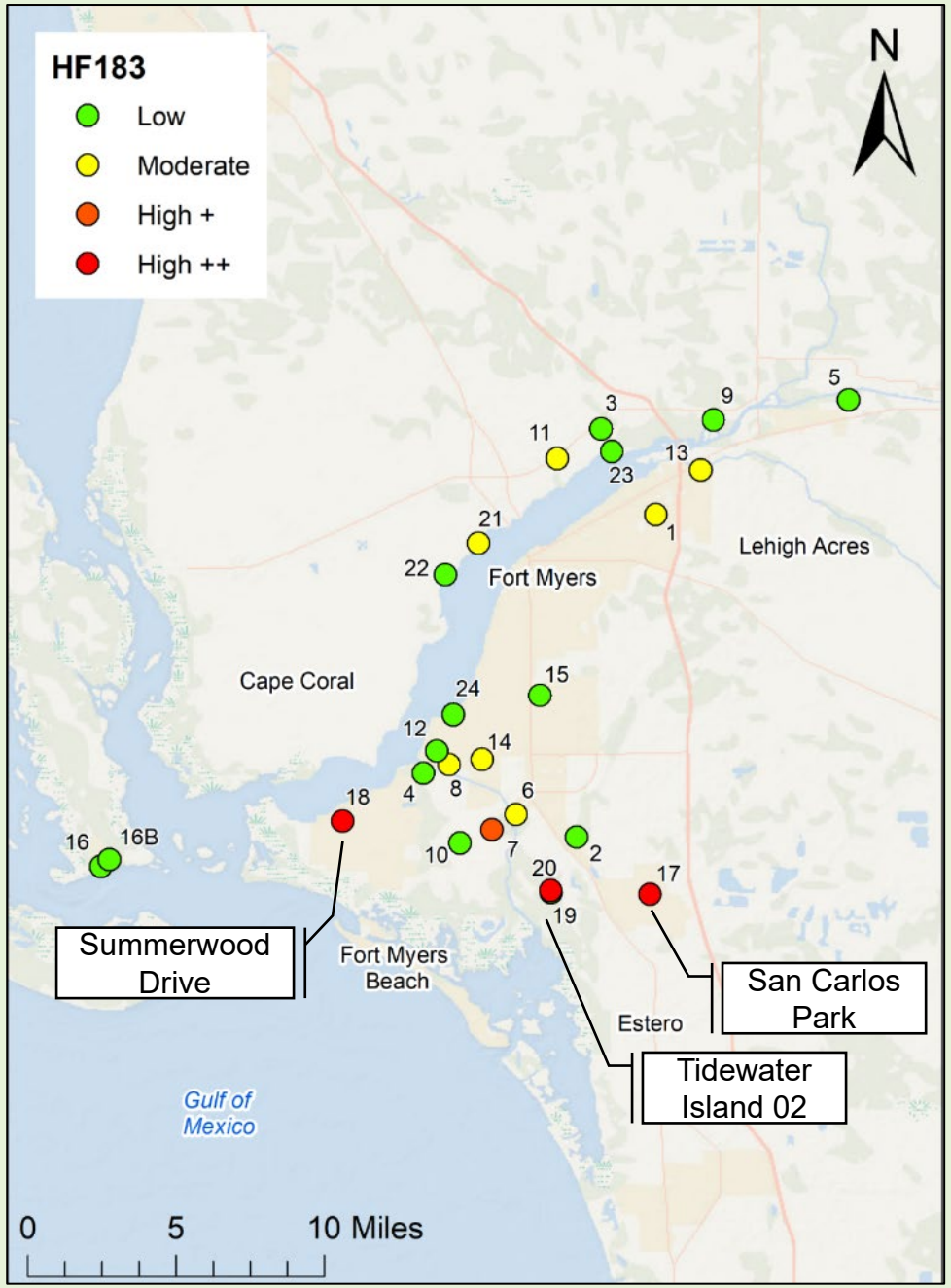

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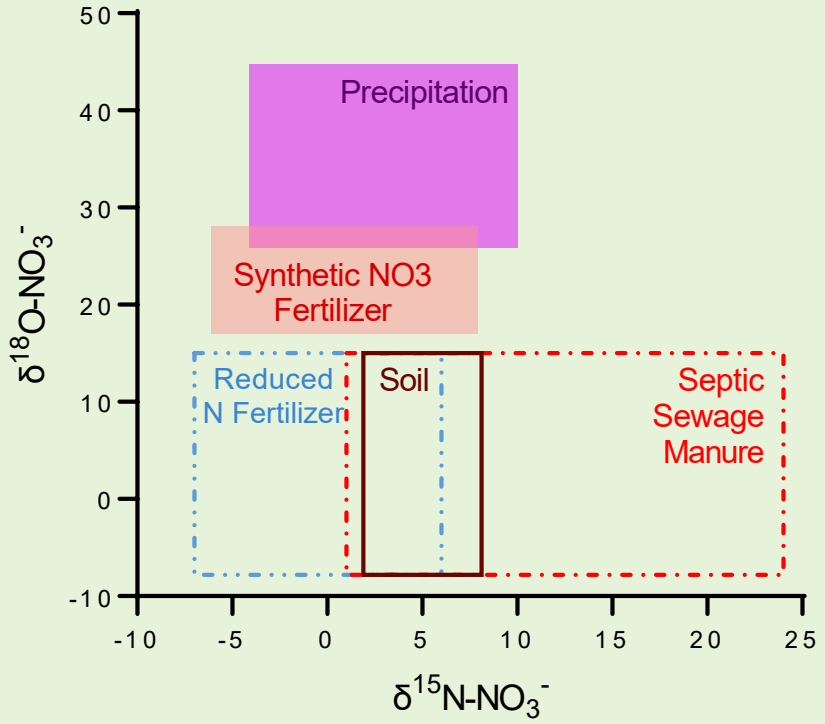
Dual Isotope Method

- $\delta^{15}N\text{-}NO_3^-$ & $\delta^{18}O\text{-}NO_3^-$ can discriminate between nitrate sources
- Can **only** be done when nitrate is high enough



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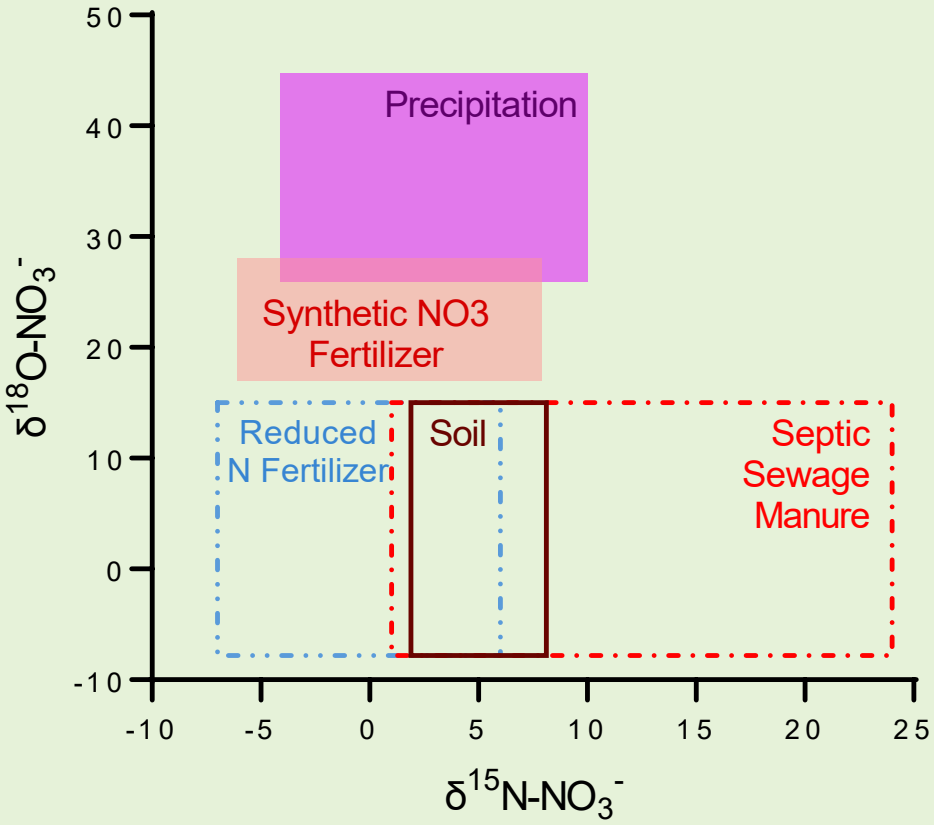
Nitrate Stable Isotope Results

- 3 sites had **high values** (>7‰) – human waste
- 16 sites had intermediate values (2 to 7‰) – mixed
- 6 sites had low values (<2 ‰) – fertilizer



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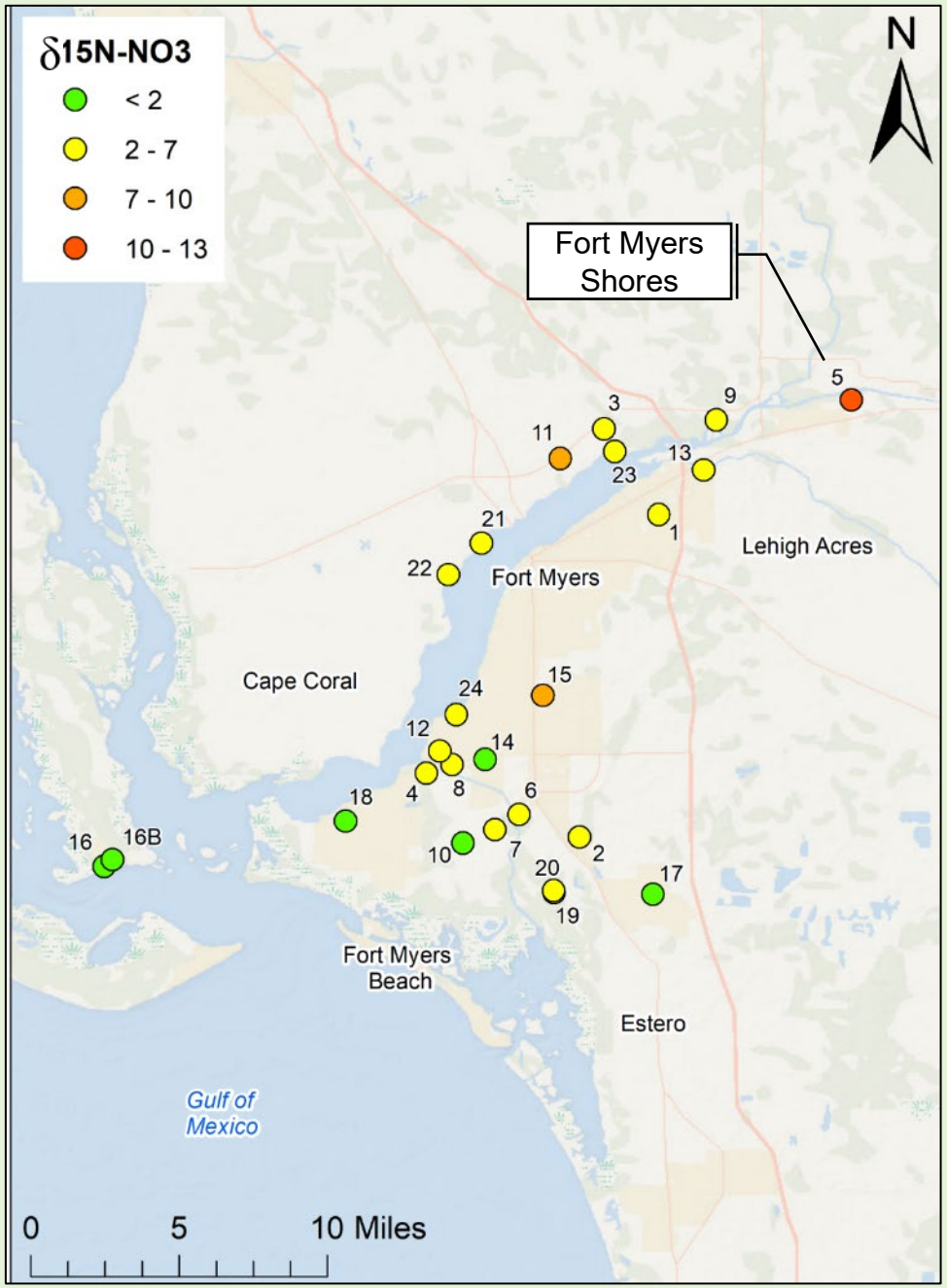

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Site Specific Summaries

All data were compiled &
holistically evaluated for each site

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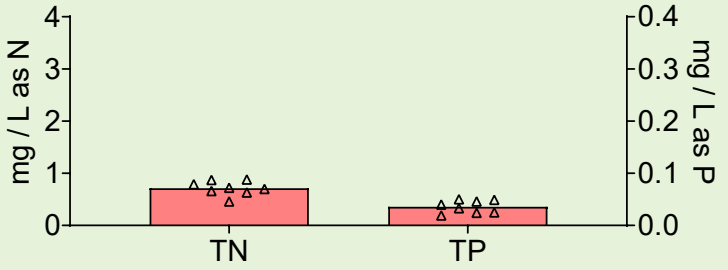
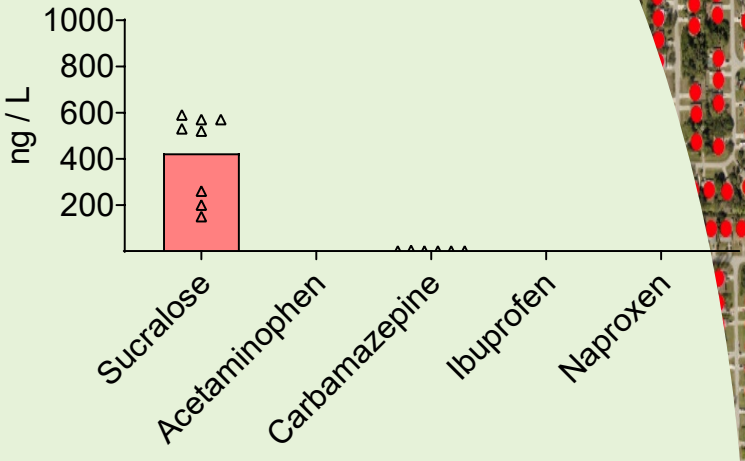
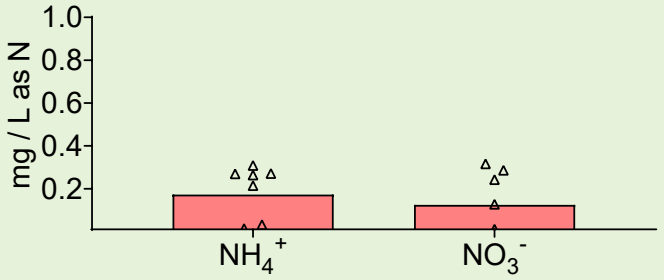
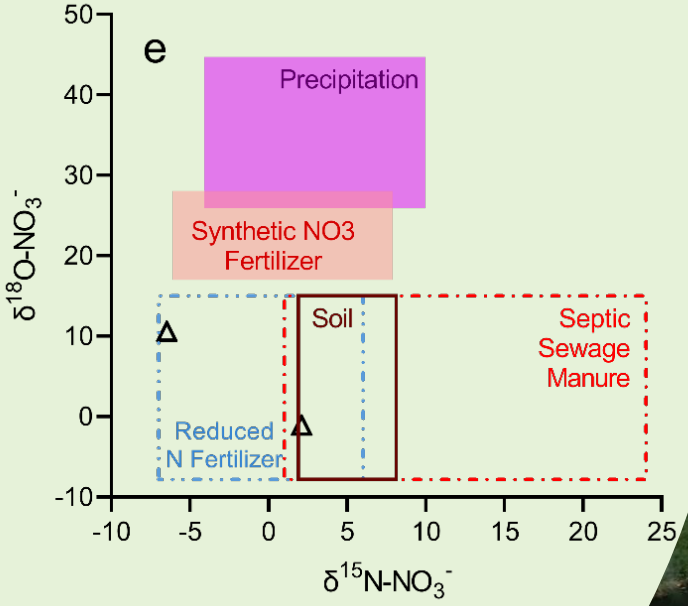
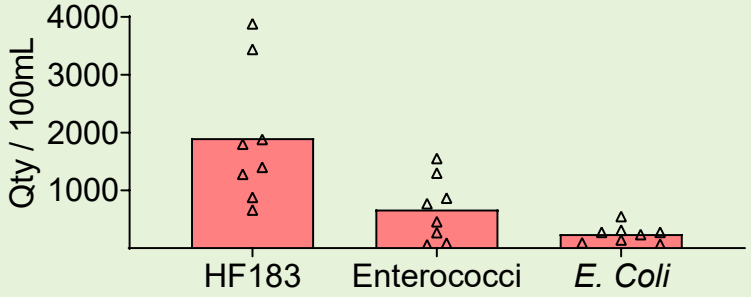
San Carlos Park











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Research Conclusions

- Multiple lines of evidence show some level of human waste contamination at every site
  - Severity highly variable
  - Few seasonal effects observed

- Sites with high tidal flushing have confounding factors

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Management Considerations

- Sites with persistent contamination may benefit from infrastructure improvements
- Management options are costly. A solid, defensible scientific understanding is necessary to create effective management strategies.
- Lee County planned this research in coordination with HBOI-FAU to fill information gaps
- The deeper understanding gained from this research can guide the County, and the results will be integrated into the Countywide Wastewater Management Plan

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Questions?

Lisa Kreiger
Lee County
lkreiger@leegov.com

Rachel Brewton
HBOI-FAU
brewtonr@fau.edu

Kevin Tyre
Geosyntec Consultants
kevin.tyre@geosyntec.com

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