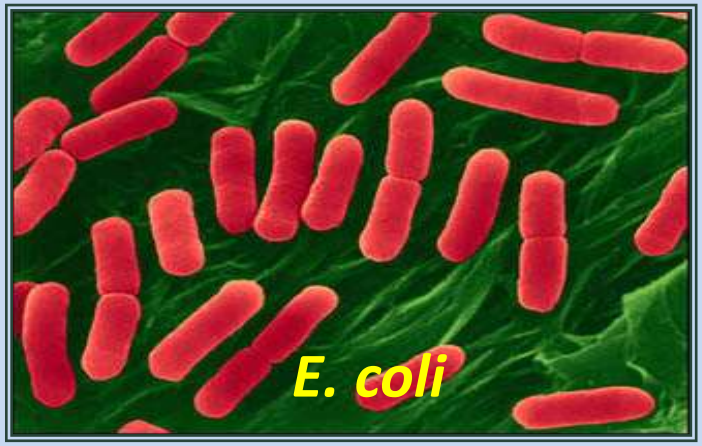
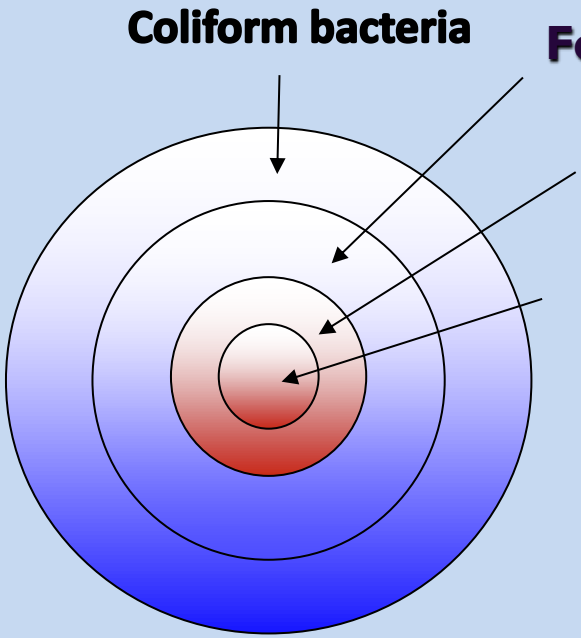
Swim at Your Own Risk?
Richard Whitman, MS, PhD

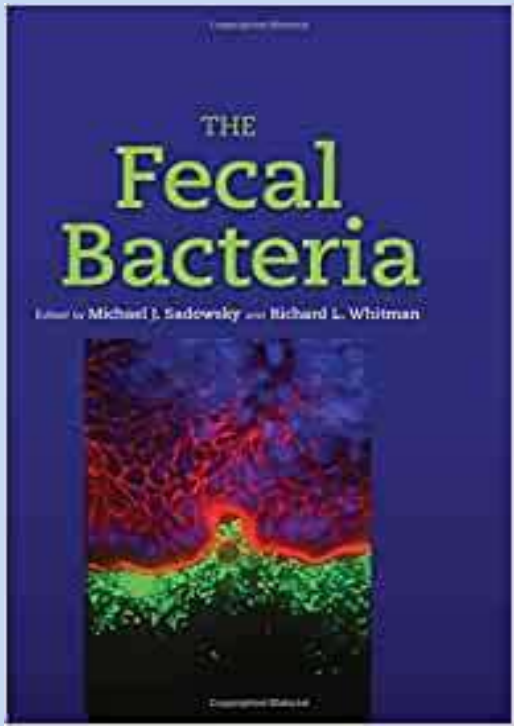
Port Charlotte Beach
April 3, 2021

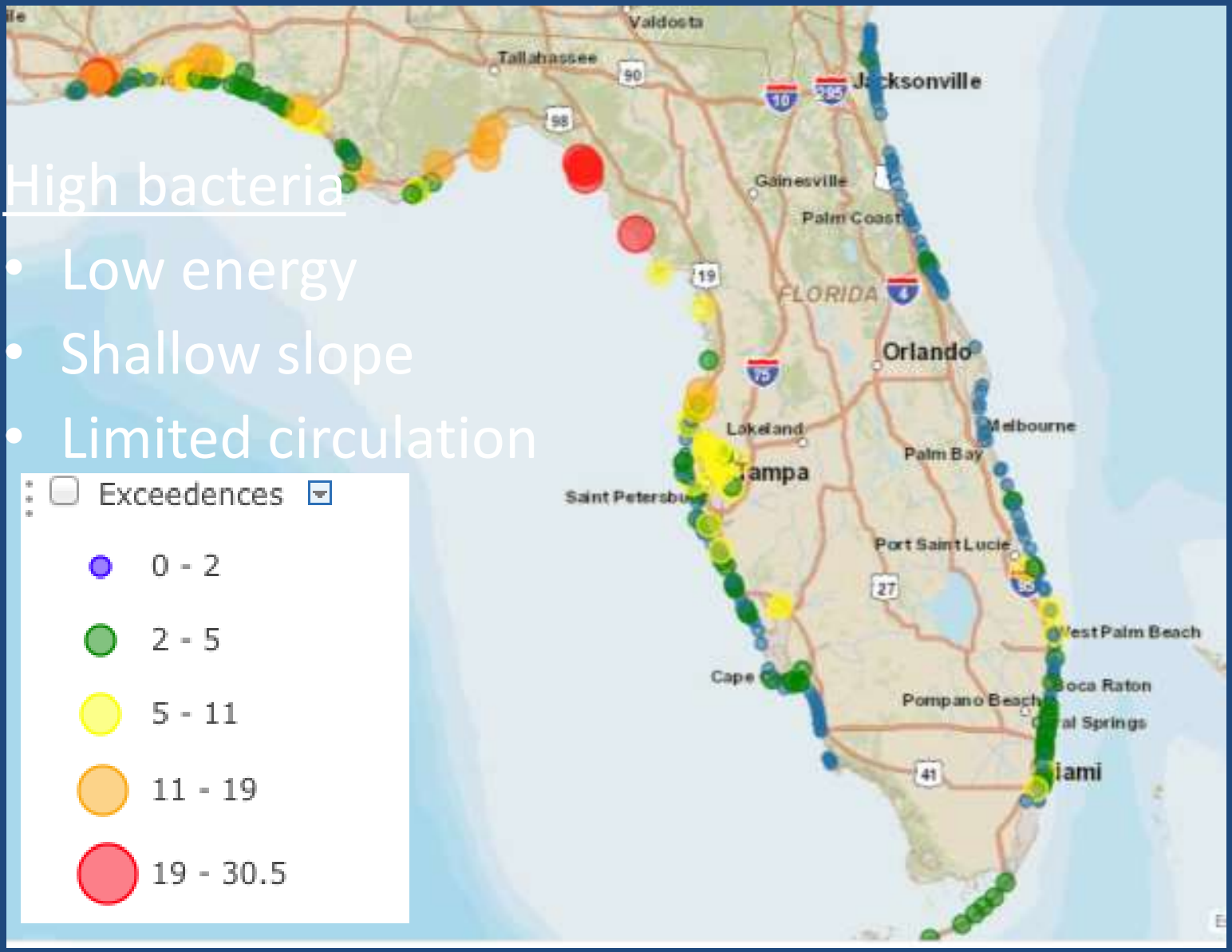
0.17 miles

Fecal Indicator Bacteria (FIB)









Study of 316 Beaches in Florida.
Enterococci Data from 2000 to 2013 (n~160,000)

Beaches: An Ecosystem Service

Ecosystem Dis-service

Blue-green ‘algae’

State Florida and US EPA Swimming Criteria

Good 0-35 enterococci per 100 ml

Moderate 36-70 enterococci per 100 ml

Poor = >71 enterococci per 100 ml

CRITERIA ELEMENTS	**Recommendation 1** Estimated Illness Rate 36/1,000		**Recommendation 2** Estimated Illness Rate 32/1,000	
Indicator	GM (cfu/100 mL)	STV (cfu/100 mL)	GM (cfu/100 mL)	STV (cfu/100 mL)
Enterococci (marine & fresh)	35	130	30	110
E. coli (fresh)	126	410	100	320

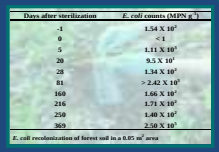
Examining Nonpoint Sources of FIB in Coastal Areas: A Beachshed Approach

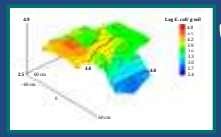
A Conceptual Diagram of *E. coli* Within and Between Stream and Beach Watersheds

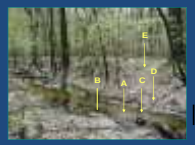
Whitman et al. 1989 to 2012

Stream | **Lake**

Bacterial inputs from animal defecation, storm runoff, and human activities may be deposited to riparian soils and stream sediments, where they may colonize and persist.



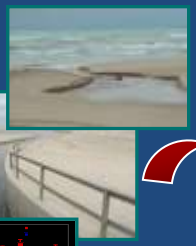


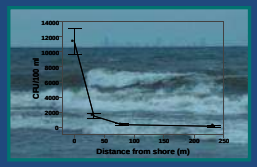


Stream Water-A
Stream Sand-B
Margin Sand-C
Sand (1 m from margin)-D
Soil (4 m from margin)-E

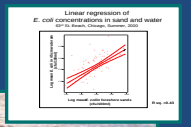
Once in the stream system, bacteria are in continual or episodic flux between exposed water and the submerged sediment, shore, and groundwater interface.

Stream to Lake

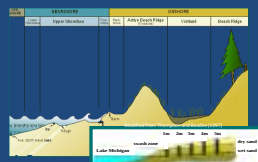


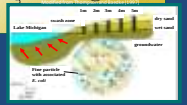


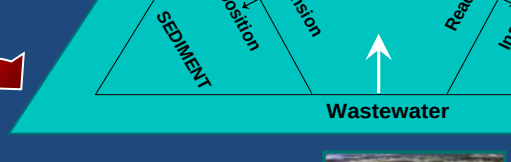
Nearshore energy (waves and currents) defines importation and exportation.



Sand harbors *E. coli* where it may persist and grow, making foreshore sand a potential sink or source to beach water.



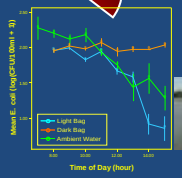


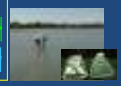


Future Challenge: Define Fluxes and Budgets

Animal and human waste and bacteria-laden plants can be integrated into foreshore sand. Resuspension can occur through wave action and runoff.

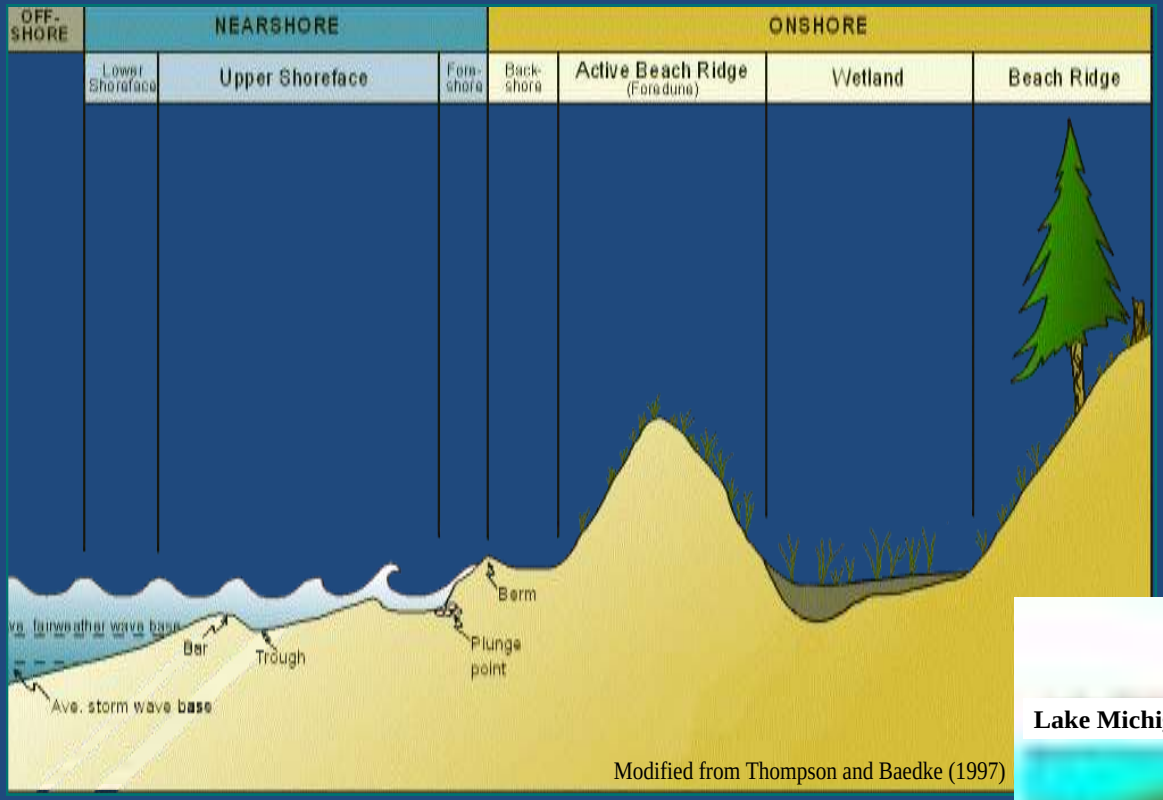
Sunlight inactivates *E. coli*; recovery and net increase from importation may cause diurnal, seasonal, daily and even hourly variation.



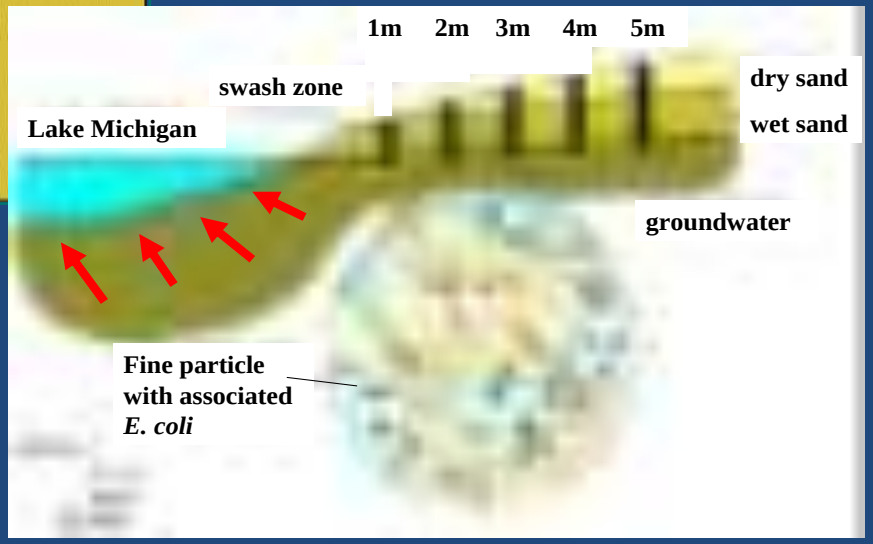


Whitman, R. L., M. B. Nevers, and M. N. Byappanahalli Examination of the Watershed-Wide Distribution of *Escherichia coli* along Southern Lake Michigan: an Integrated Approach. Applied and Environmental Microbiology. 72(11), 7301-7310.

Local Non-Point Sources



Bacteria can be integrated into foreshore sand from human, animal waste and decomposing vegetation



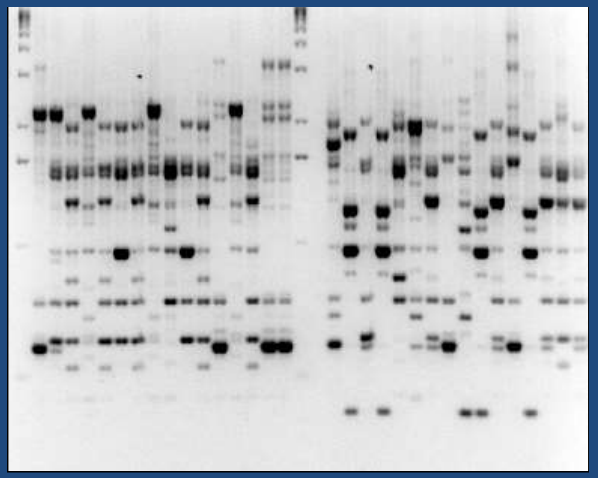
Sand harbors *E. coli* where it may persist and grow, making foreshore sand a potential sink or source to beach water.

Non-point Sources

FIB sources influence the risk of exposure to swimming-related illnesses (e.g., gastroenteritis)

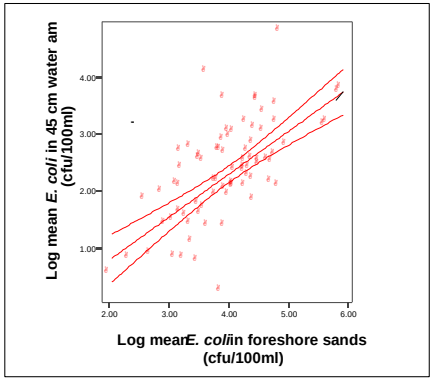
E. coli source	Relative risk
• Human feces/sewage	High
• Non-human (e.g., animal feces)	Moderate
• Environmental (e.g., plants, sand, wildlife, runoff)	poorly studied

Source identification: critical to management and remediation



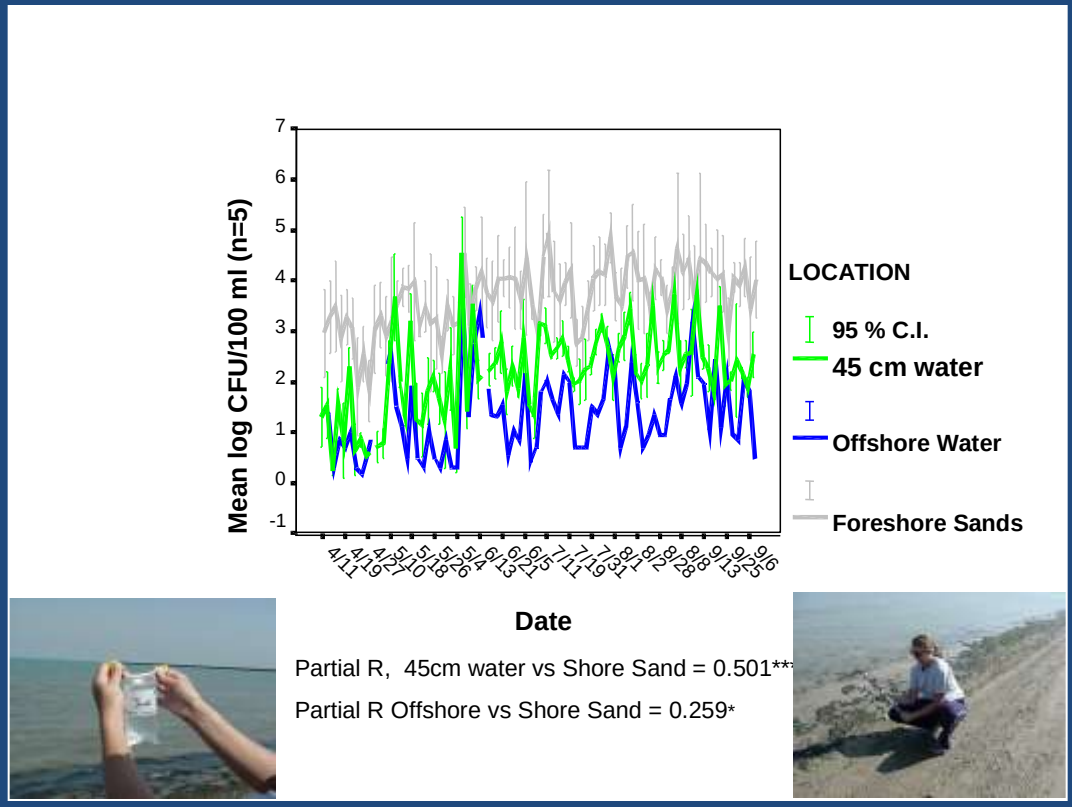
E. coli in Sand May Cause Beach Closures

Linear regression of
E. coli concentrations in sand and water
63rd St. Beach, Chicago, Summer, 2000



R sq. =0.43

E. coli in beach sand and water



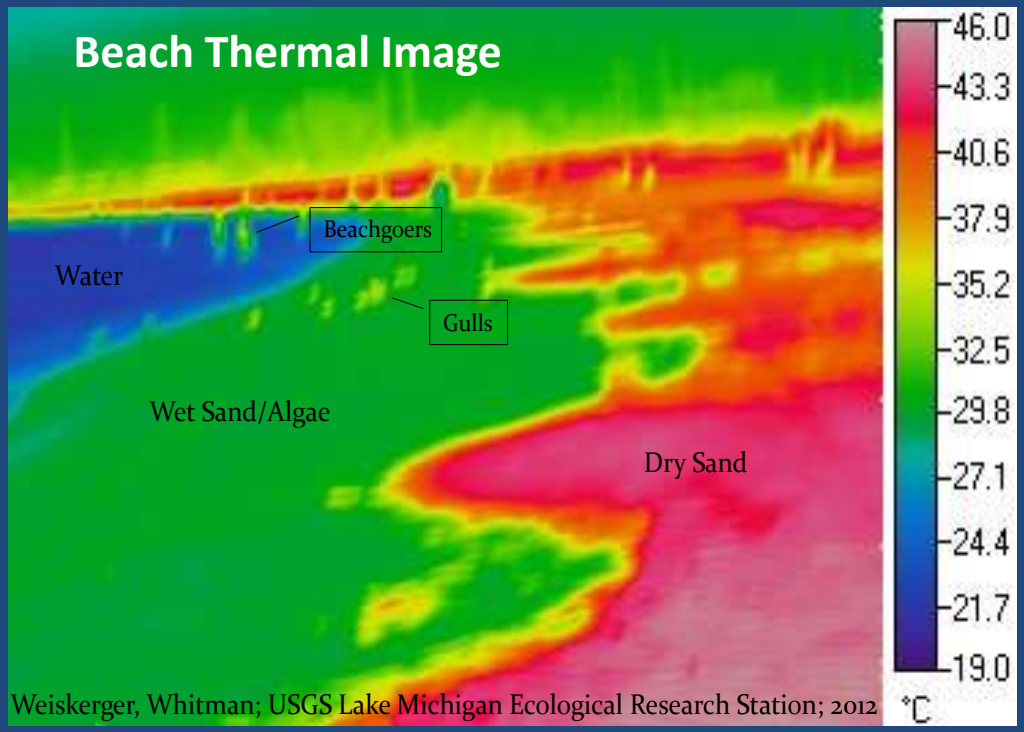
Partial R, 45cm water vs Shore Sand = 0.501**

Partial R Offshore vs Shore Sand = 0.259*

Whitman RL, Nevers MB. 2003. **Foreshore sand as a source of *Escherichia coli* in nearshore water of a Lake Michigan beach.** Appl. Environ. Microbiol. 69:5555–5562.

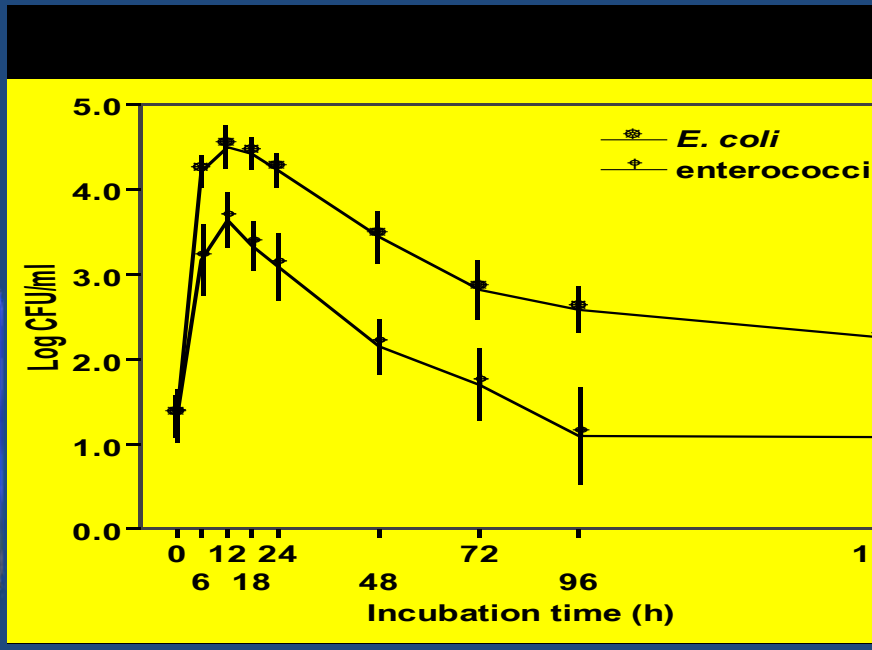
- **Beach closures may be false alarm**
  November 2001
- **Beach sand can be a petri dish of bacteria**
  July 2005
- **Beach bacteria warning: That sand may be contaminated**
  July 2005
- **Beachgoers beware: Stomach bugs lurk in sand**
  July 2009
- ***E. coli* found in lake water, sand**
  August 2009
- **2 Investigators: How safe is the sand at Chicago beaches?**
  July 2013

Algae is an Issue



Pathogens

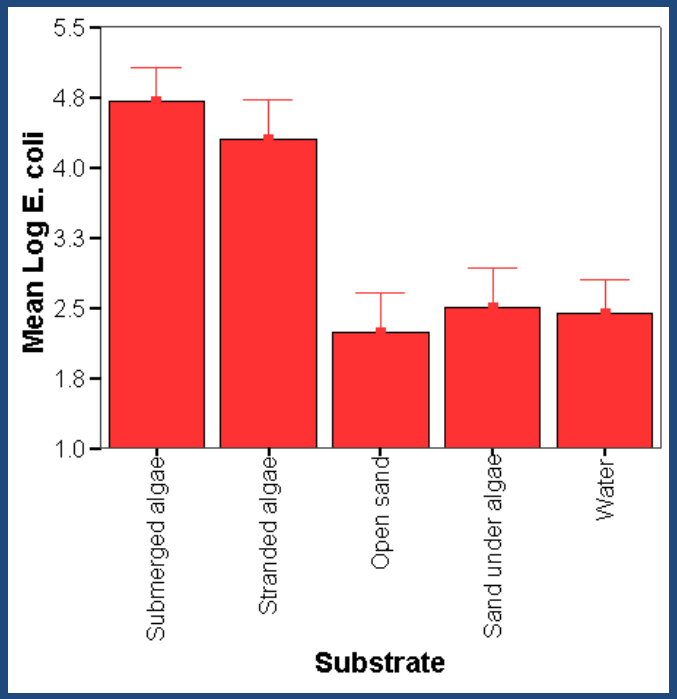
- *Salmonella*
- *Shigella*
- *Campylobacter*
- *C. perfringens*
- *C. botulinum*



- Foul smelling beaches
- Loss of use & recreational dollars
- Citizen Complaints
- Habitat for toxic microbes
- Threat to pets, wildlife and human health
- e.g. Great Lakes

  bird botulism

Algae is an Issue at Jeorse Park



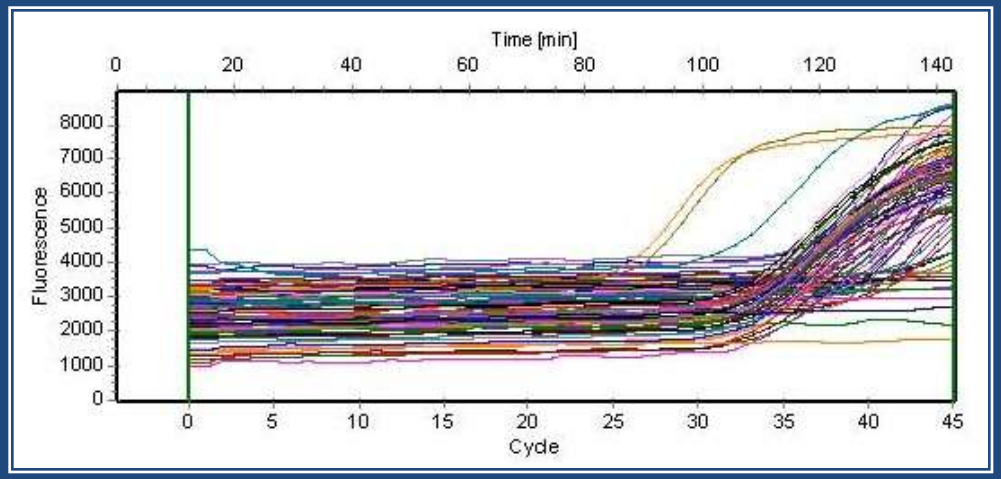
E. coli densities for sand and algae are expressed as log MPN/g dry weight and water as log MPN/100 ml

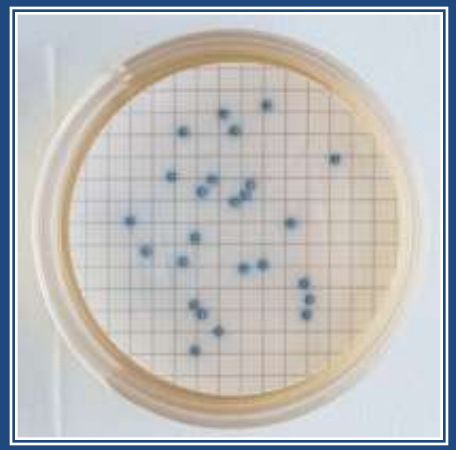
- Algae is a source of *E. coli* for water and sand
  - Algae very high in *E. coli*
  - Floating algae > stranded
  - Sand under algae > open sands

DNA vs Culture Method

2-3 hours

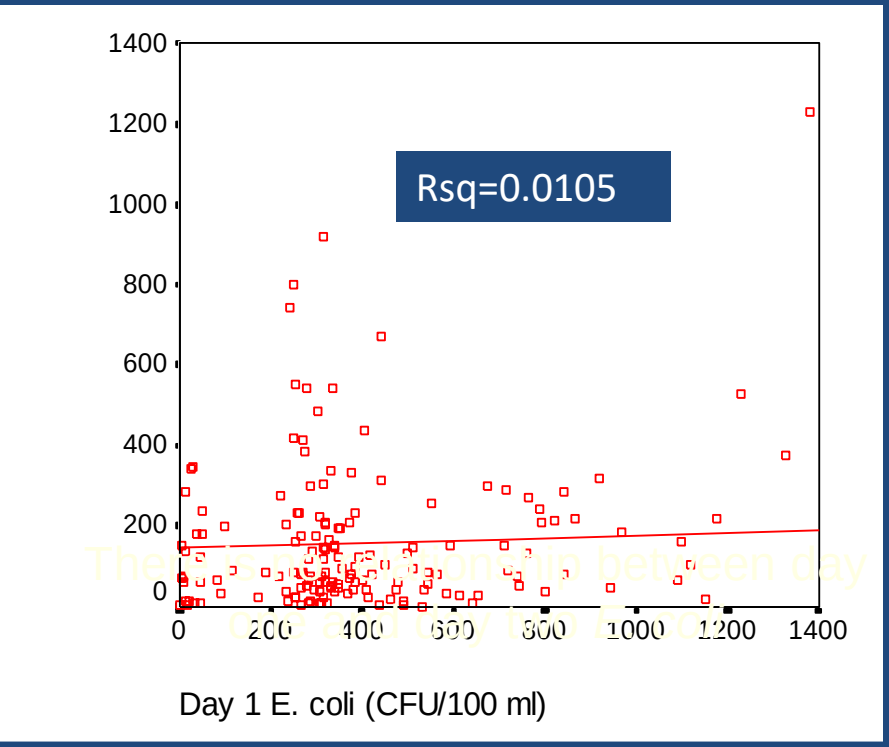
18-20 Hours

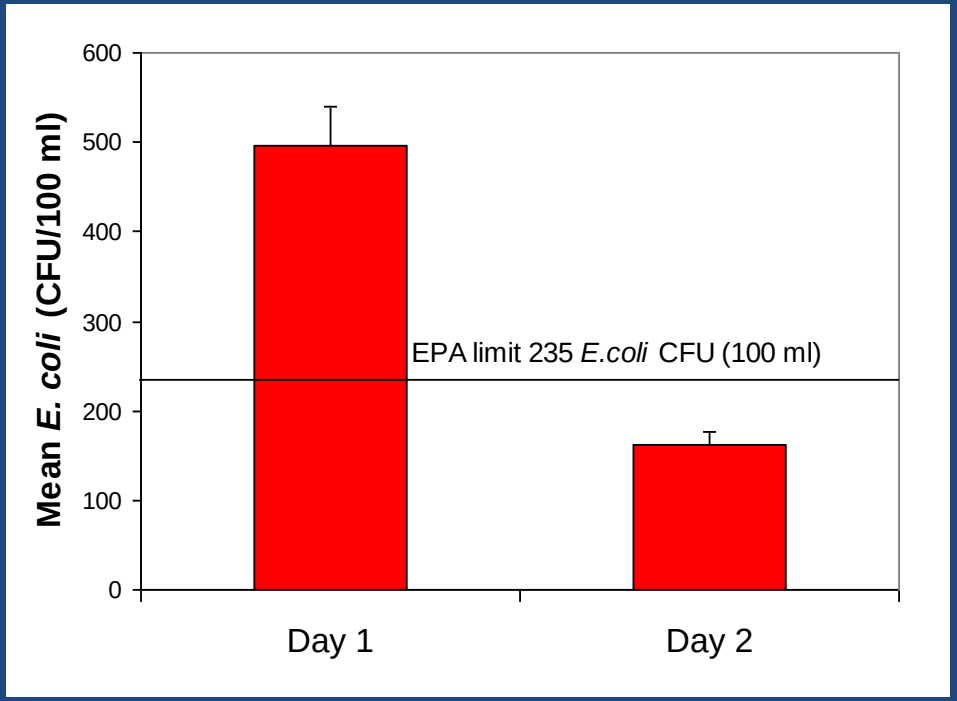




Problems with *E. coli* monitoring protocols:

- Results not available until 18-24 hours after sample collection
- Tells you if safe to swim <u>yesterday</u>
- Twice a month!





Whitman, R. L., M. B. Nevers, and P. J. Gerovac. 1999. Interaction of ambient conditions and fecal coliform bacteria in southern Lake Michigan waters: Monitoring program implications. Natural Areas Journal 19:166-171.

Predictive Model (S.A.F.E.) Used as a Beach Management Tool

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Project S.A.F.E.

Monday, July 9, 2007

Swimming Advisory Forecast Estimate

Recreational Water Quality

Beach	SAFE Estimate
Lake St.	OPEN
Marquette Park	OPEN
Wells St.	OPEN
Ogden Dunes	OPEN

Anticipated Beach Conditions	
Rain 24 h total (in)	0.0
Wind Speed (kts)	10
Wind Direction	SW
Air Temperature (°F)	78
Water Temperature (°F)	69
Wave Height (ft)	1-2

The EPA recommends issuing a swimming advisory when E. coli counts exceed 235 cts/100ml

For more information, please contact Richard Whitman, USGS Lake Michigan Ecological Research Station
Ph: 219 926-8336 ext. 424; E-mail: rwhitman@usgs.gov

Useful Links

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At least 12 samples needed for 70% precision.

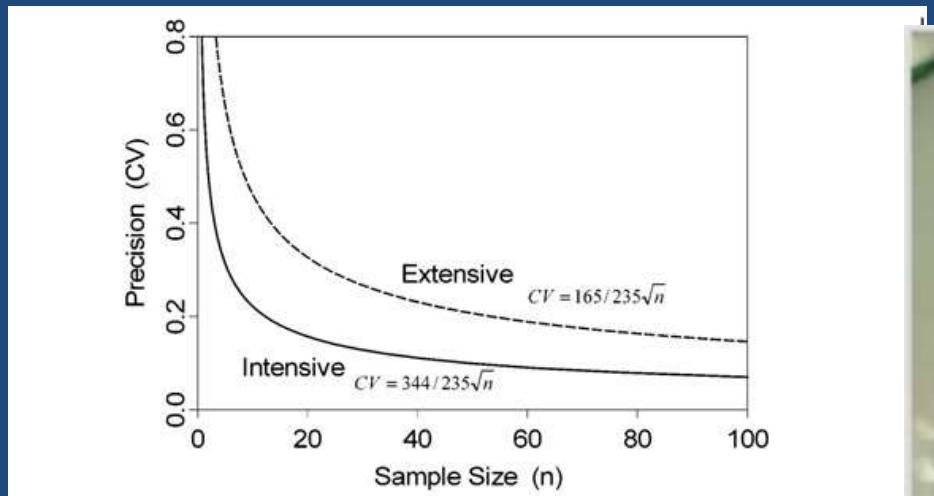
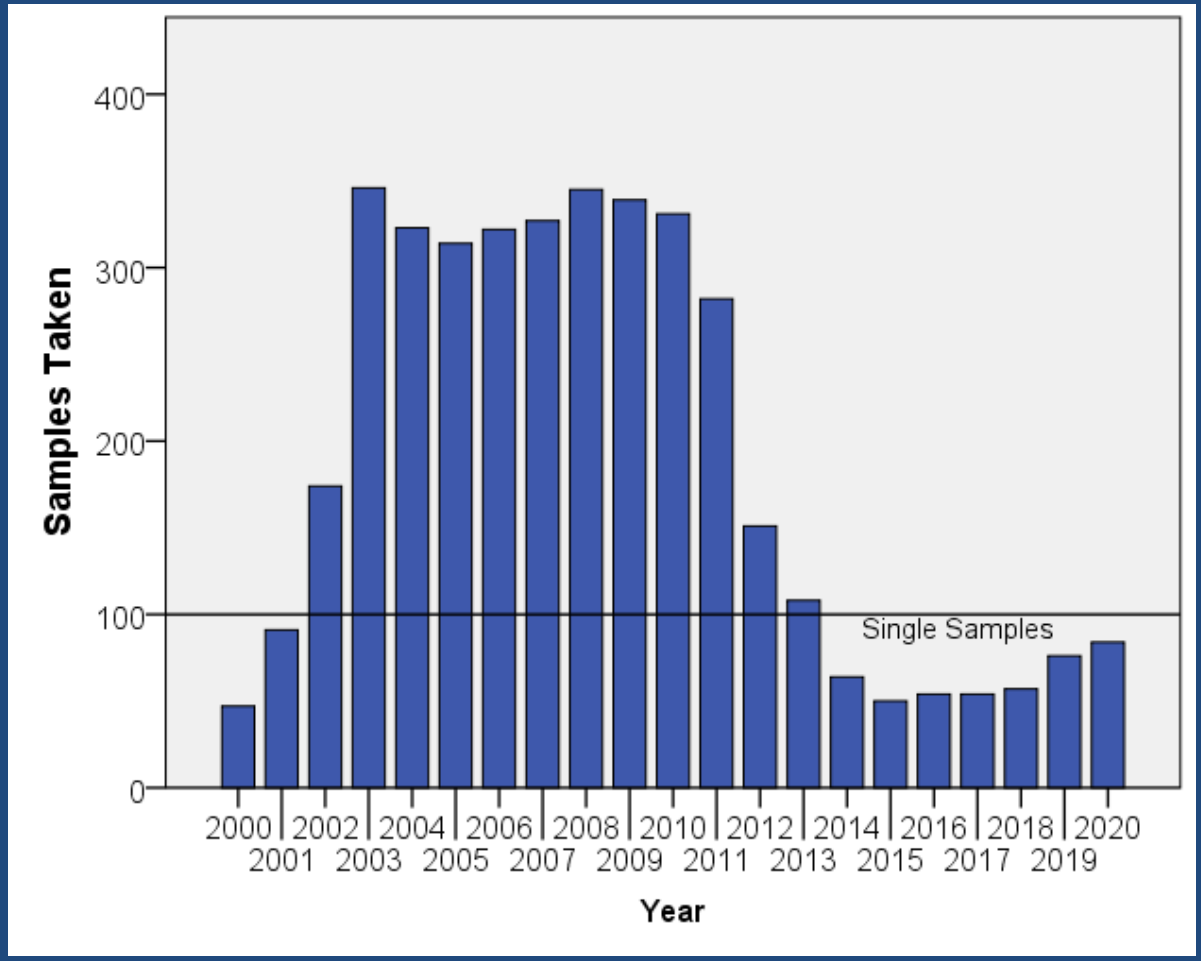


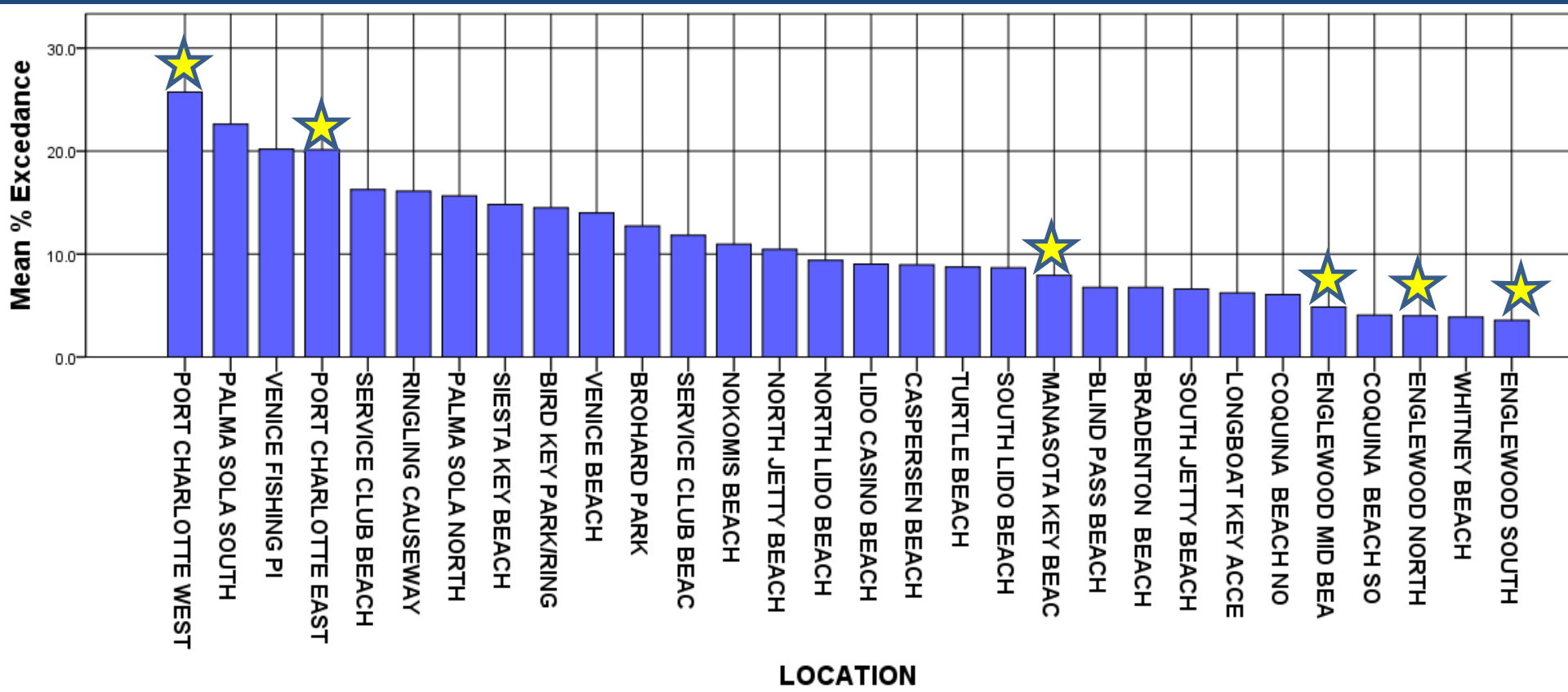
FIGURE 3. Level of precision achieved given the sample size for two spatially intensive and spatially extensive sampling plans.

Number of Beach Samples Taken Charlotte County

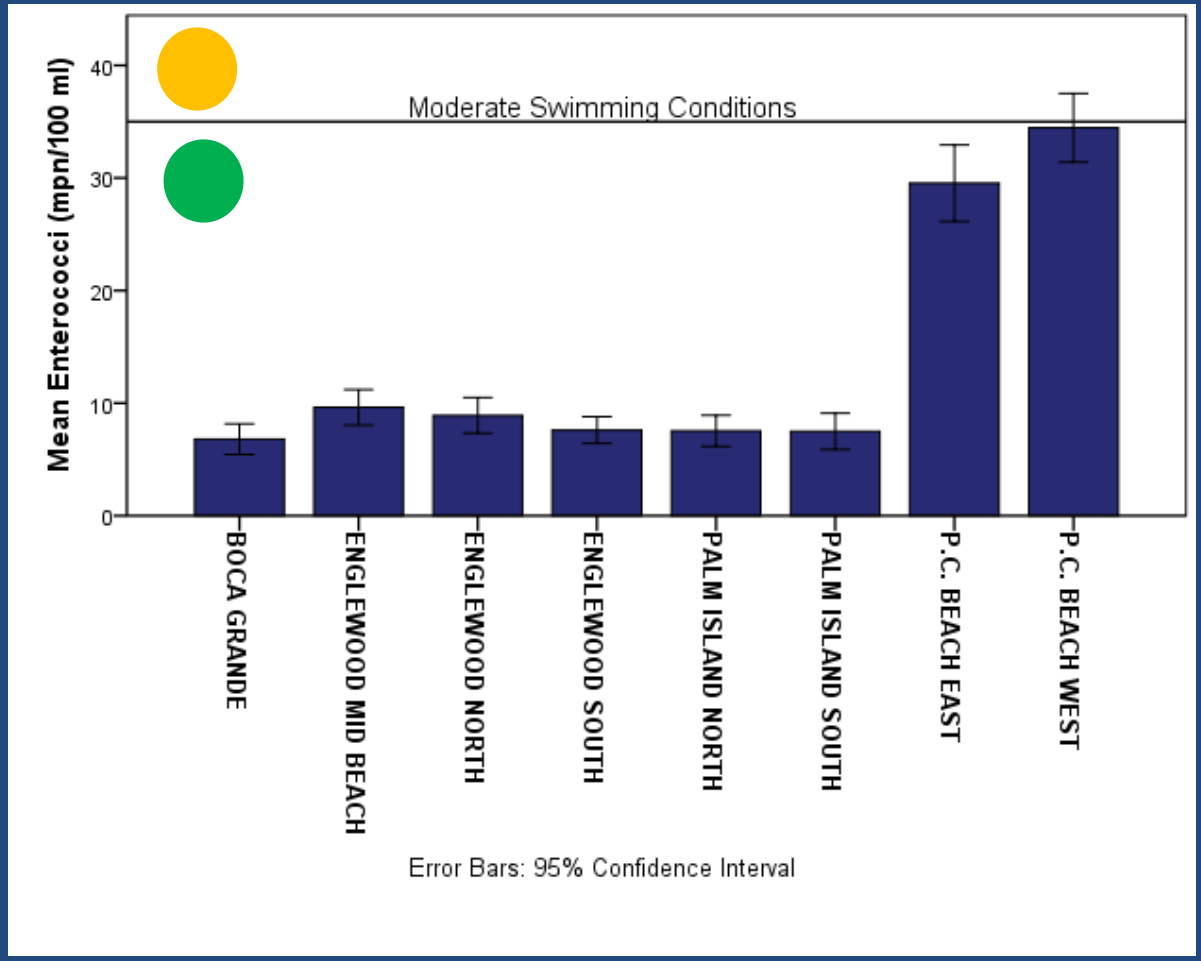


Historical Percent Beach Moderate-Poor WQ (>35 cfu enterococci/100ml)

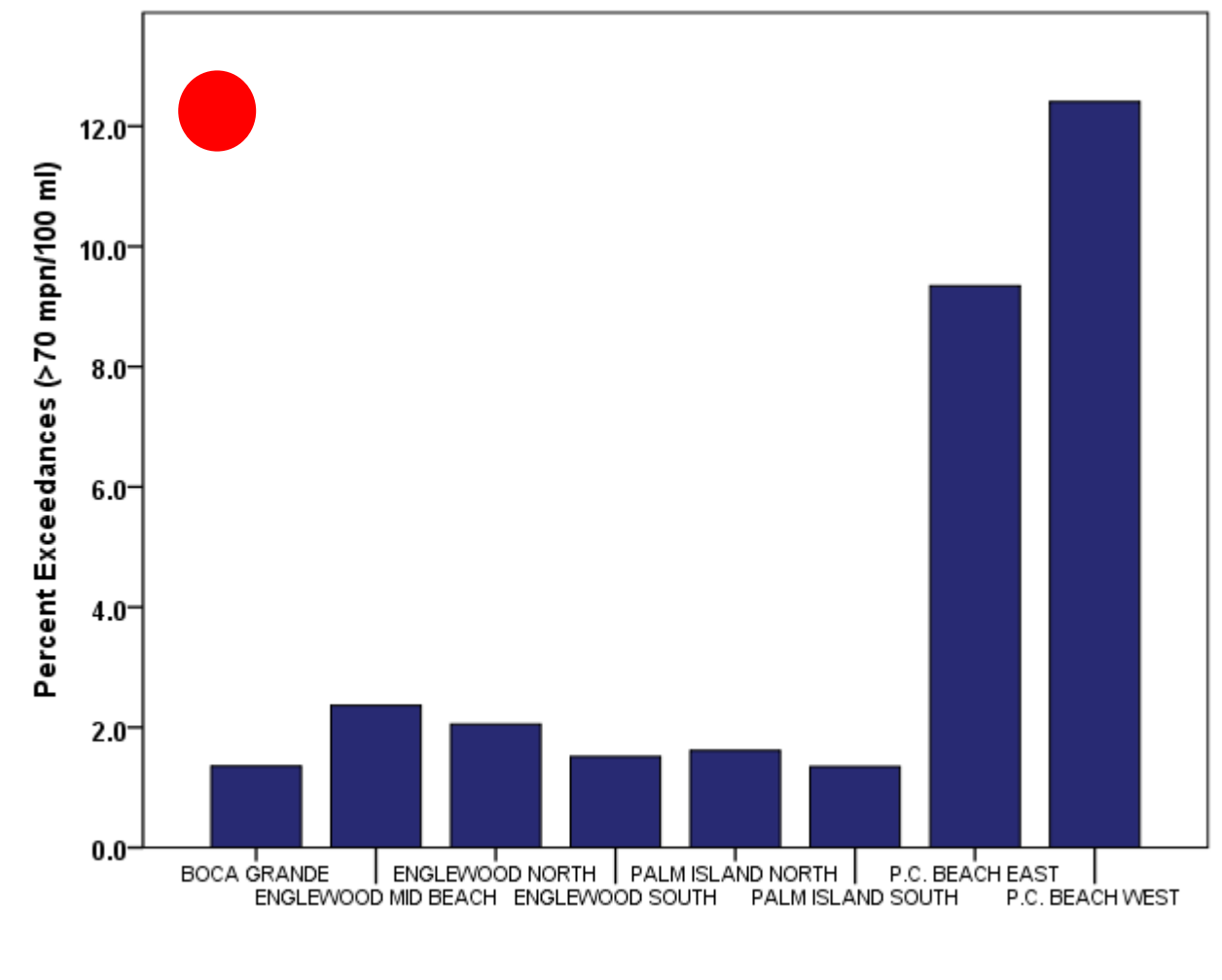
★ Charlotte County Beach



Mean Enterococci Charlotte County Beaches



Percent exceedence (>70 mpn/100ml) Charlotte County Beaches



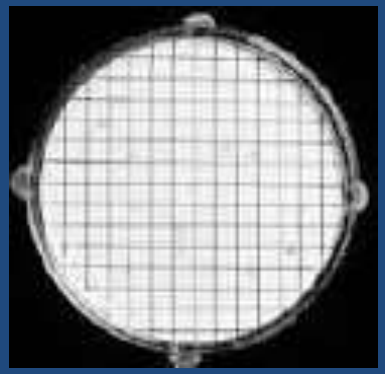
Beach Vulnerability

High-energy beach

+

Steep profile beach

=



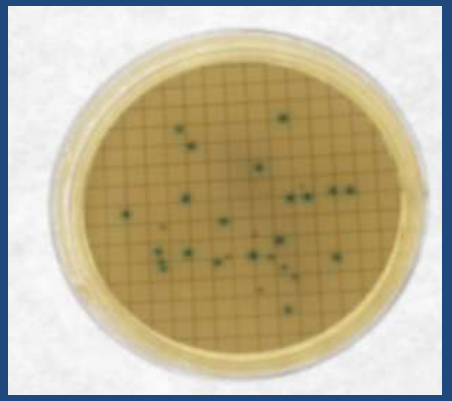
Low bacteria

Low-energy beach

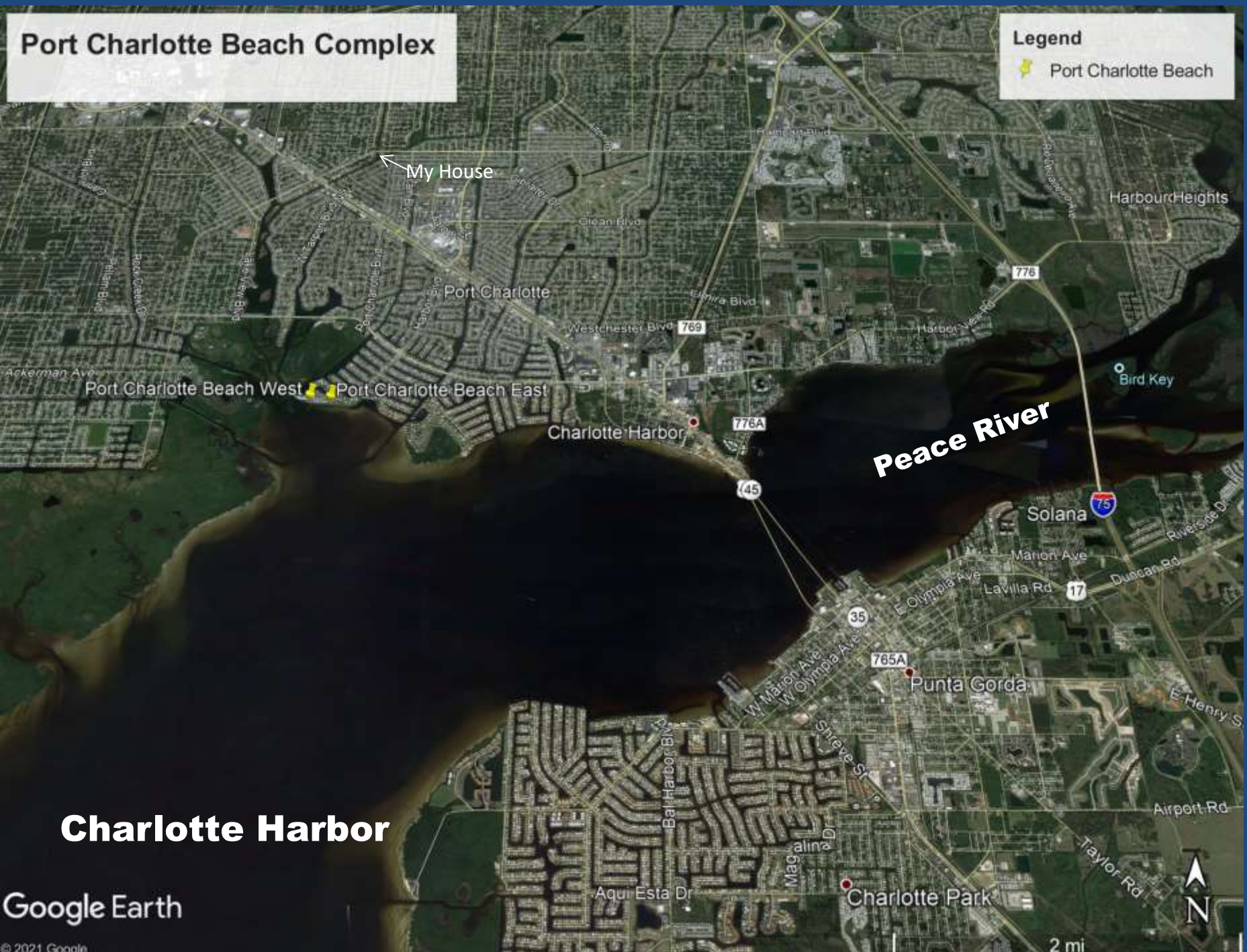
+

Flat, low profile beach

=



High bacteria


Port Charlotte Beach Complex
Legend
Port Charlotte Beach
My House
Harbour Heights
Port Charlotte
Westchester Blvd
769
776
Bird Key
Port Charlotte Beach West
Port Charlotte Beach East
Charlotte Harbor
776A
Peace River
45
Solana
75
Marion Ave
Lavilla Rd
17
Duncan Rd
E Olympia Ave
W Olympia Ave
W Marion Ave
35
765A
Punta Gorda
Shreve St
Bal Harbor Blvd
Airport Rd
Taylor Rd
Aqui Esta Dr
Charlotte Park
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2 mi
Charlotte Harbor
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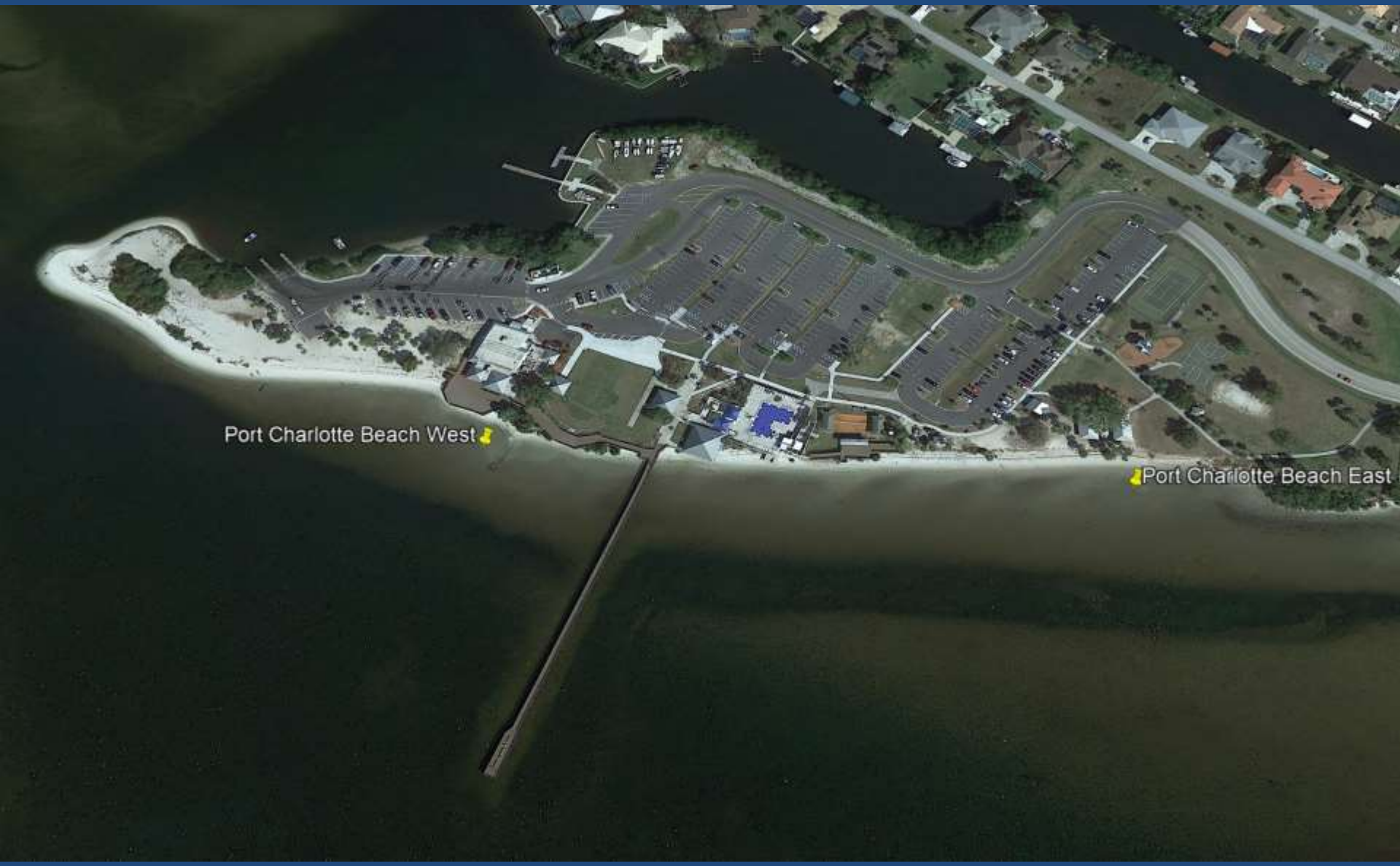
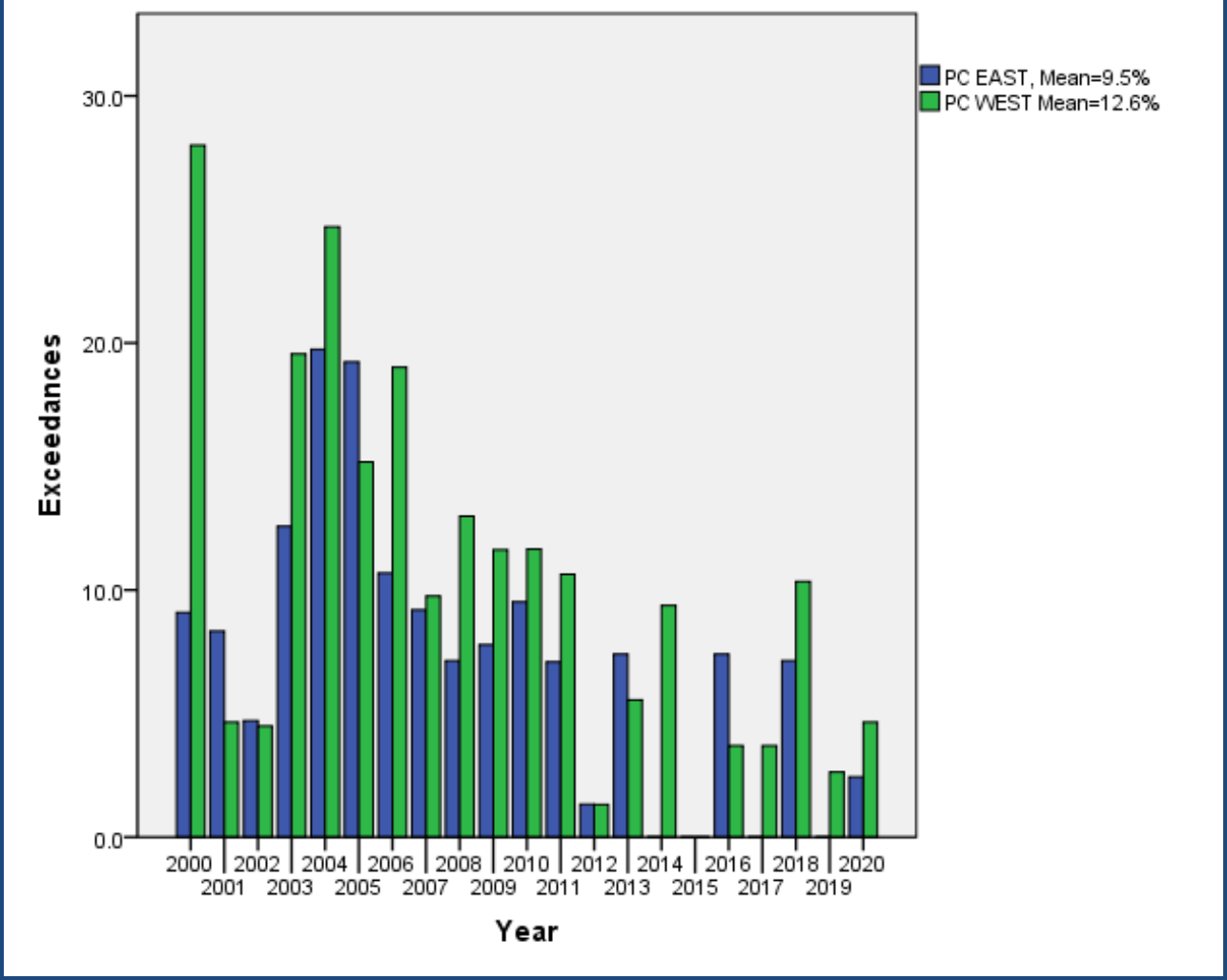
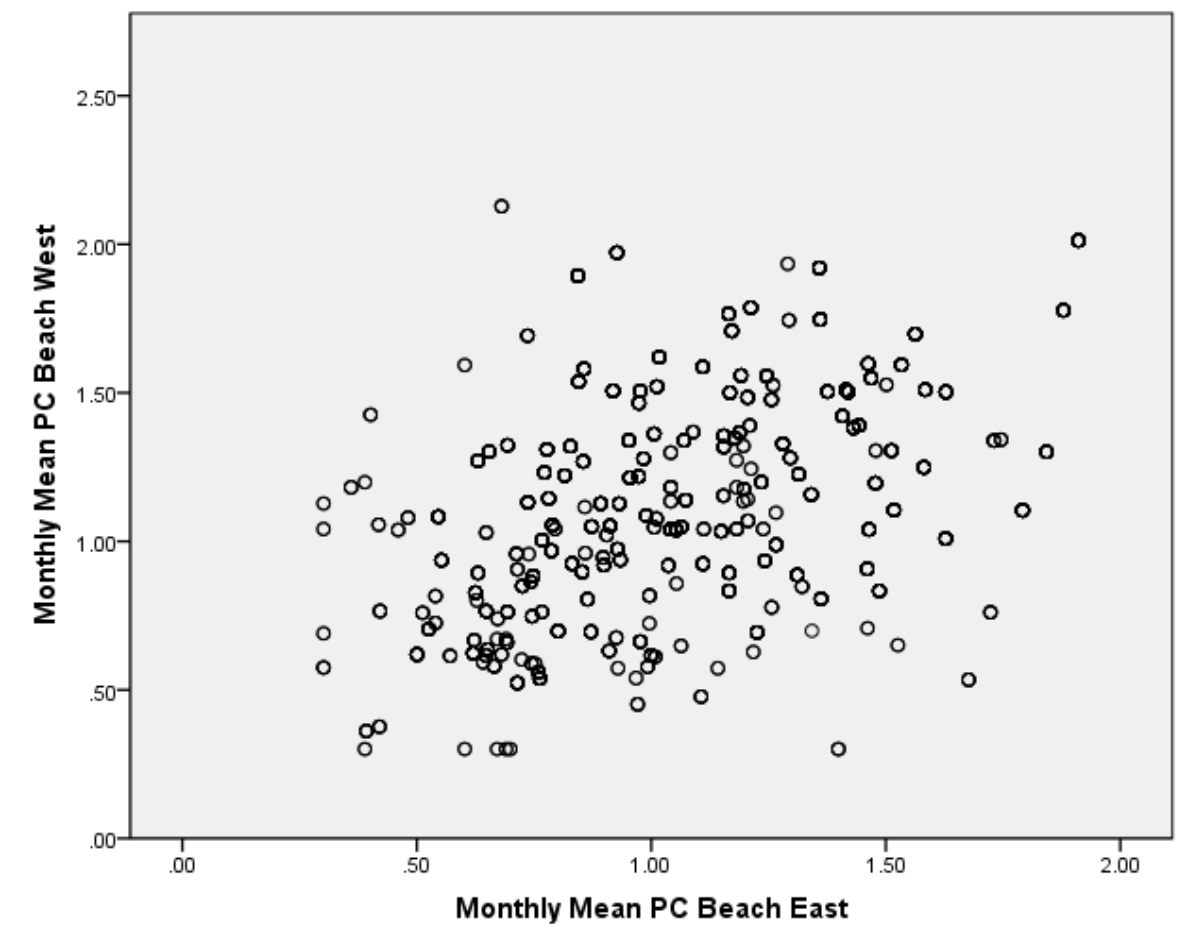

Port Charlotte Beach West
Port Charlotte Beach East

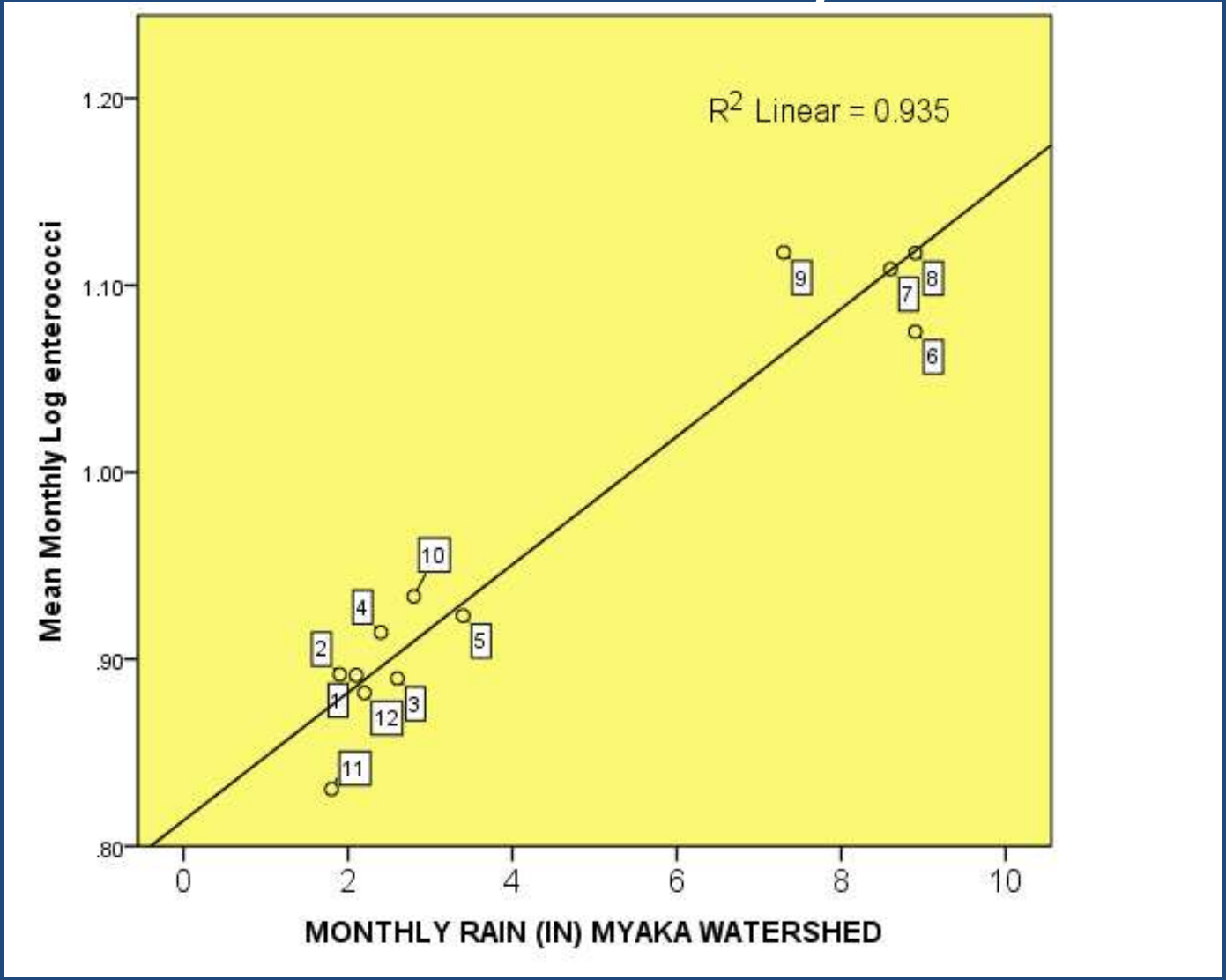
Numerical Exceedances (>70 mpn/100ml) Port Charlotte Beach

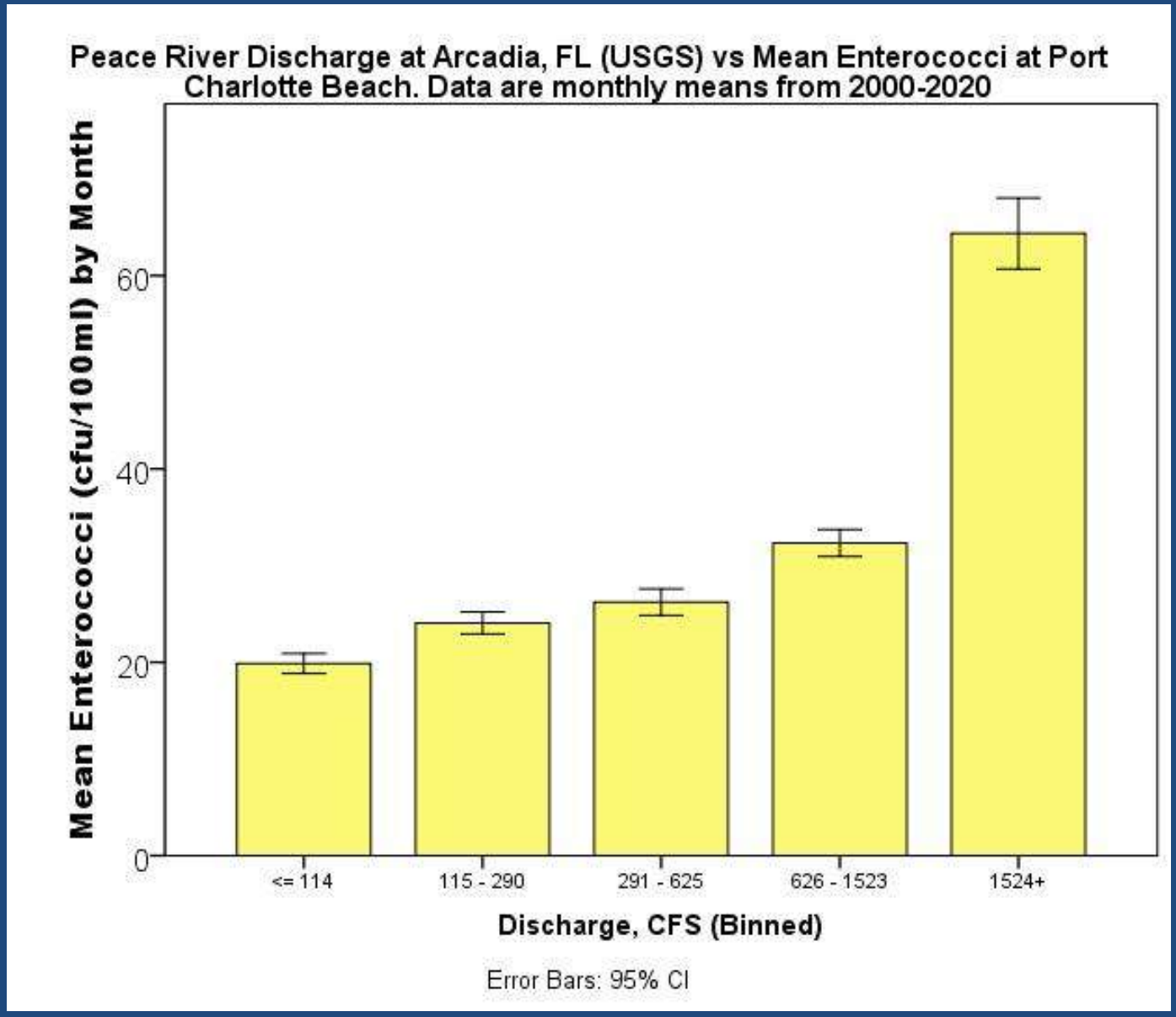


Scatter plot of East and West Sampling Point of P.C. Park Beach



Plot of Port Charlotte Beach Enterococci with nearby rainfall

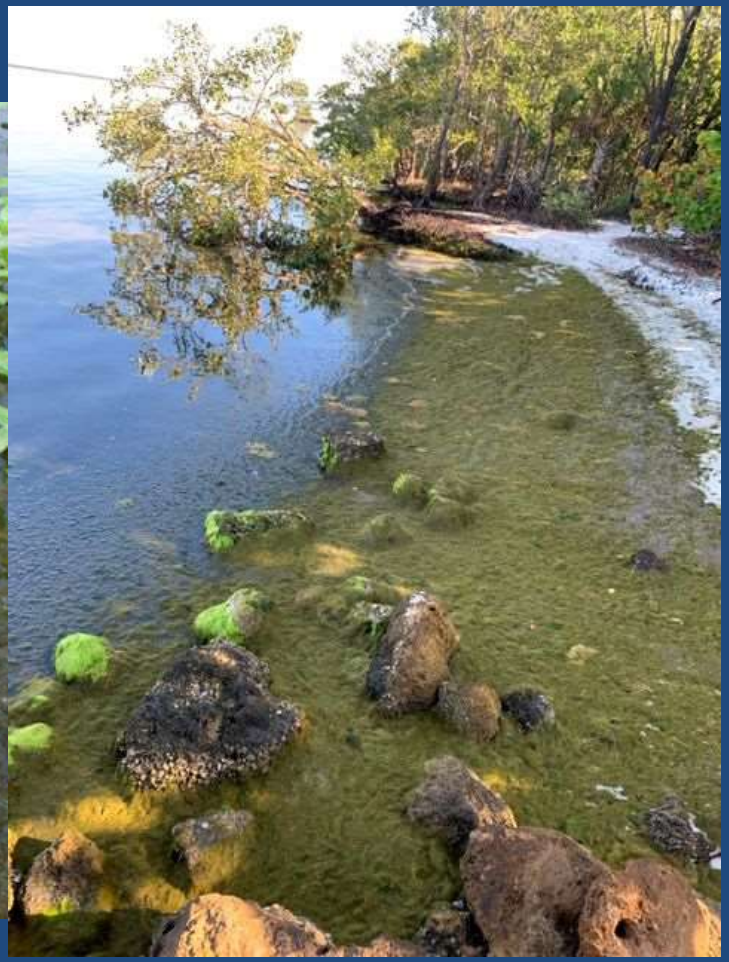



Peace River Discharge at Arcadia, FL (USGS) vs Mean Enterococci at Port Charlotte Beach. Data are monthly means from 2000-2020
Mean Enterococci (cfu/100ml) by Month
0
20
40
60
<= 114
115 - 290
291 - 625
626 - 1523
1524+
Discharge, CFS (Binned)
Error Bars: 95% CI

NO DOGS
ON BEACH
PER
CHARLOTTE
COUNTY
ORDINANCE
NO.98-70
ADVISORY
HIGH BACTERIA LEVELS
SWIMMING NOT RECOMMENDED
INCREASED RISK OF ILLNESS
AT THIS TIME

CHARLOTTE
COUNTY

Dapis (*Lyngbia*) Ponce Del Leon



Port Charlotte Beach, 10/3/2011

Conclusions

- Florida Water = Quality of Human and Wildlife
- Fecal Indictors Monitoring not ‘State of the Art’?
  Unreliable, poor notification, compliance and
  Inadequately applied, source identification, $
  – Better Techniques, better science, > mangagement
- Most Charlotte Co. Beaches Good (open coast)
- Port Charlotte Beach needs help
  – Social Justice Issues
  – HABs, Aesthetics

Thank You

Questions?