


# Source Tracking in the Saginaw Bay and Great Lakes Applications

A scenic landscape photograph of a river flowing through a forest with autumn foliage and large rocks. The river is in the foreground, with several large, smooth, grey rocks protruding from the water. The background shows a dense forest of trees with vibrant autumn colors (red, orange, yellow, and green) and a rocky hillside. The sky is overcast with grey clouds. A green decorative line curves across the top of the image.

**Marc P. Verhougstraete and Joan B. Rose**  
**Ottawa County Water Quality Forum**

**26 October 2009**

# Saginaw Bay Issues

Nutrients

Light

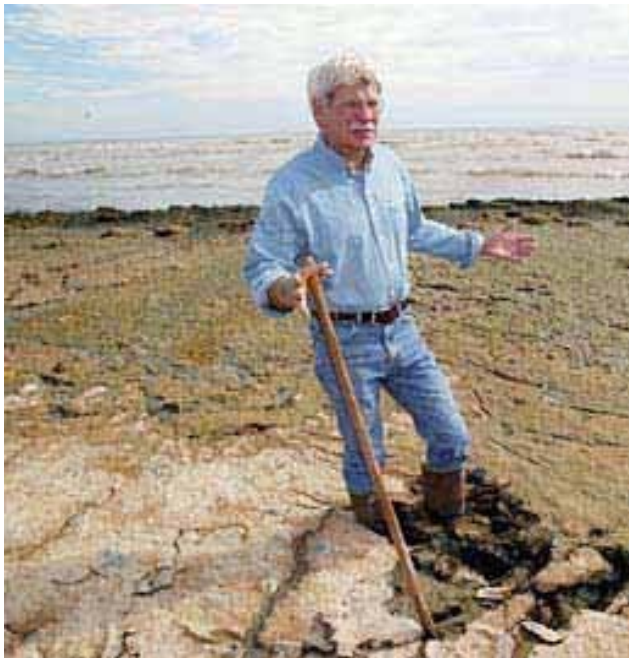


Temperature

Physical stressors



*Spirogyra*



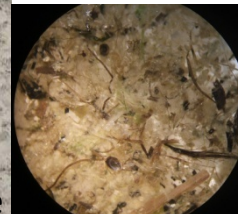
Dr. Juli Dyble Bressie

## Muck

- *Spirogyra*, *Cladophora*, detritus
- Masses do contain bacteria (Whitman et al. 2003, AEM v.69)
- Aesthetic issues
- People removing it from beach

## Pollutants

- Urban development
- Wetland degradation
- Wastewater discharges
- Agriculture waste
- Industrial outfalls



# Research Questions

- What are the sources of fecal pollution entering Saginaw Bay?
- What are the bacteria concentrations in Saginaw Bay across beach transects?
- How do environmental conditions relate to bacteria concentrations on the beach?

# Measuring Water Quality

***E. coli***: Drinking and recreational water quality criteria but regrow in environment, high correlation with gastroenteritis in freshwater

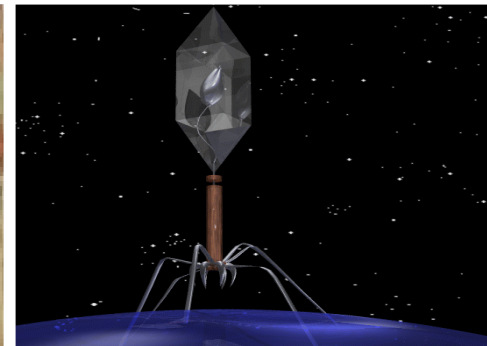
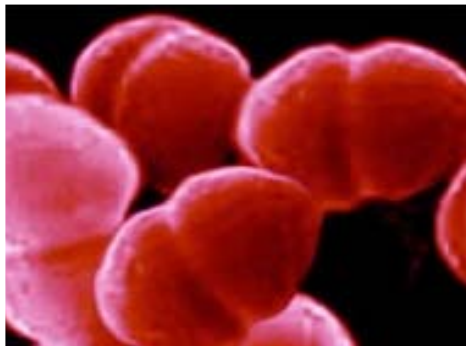
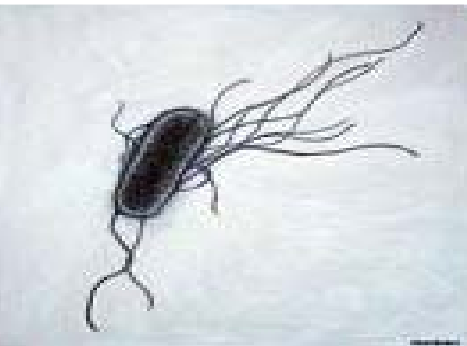
**Enterococci**: Indicator of recent fecal pollution but regrow in environment, high correlation with gastroenteritis in freshwater,

***C. perfringens***: Indicator of persistent intestinal pathogens like viruses and oocysts of protozoa and long term, older inputs of fecal pollution

**Coliphage**: A good indicator of enteroviruses and recent fecal contamination

**Enterococci esp gene and Bacteroides human and bovine markers**

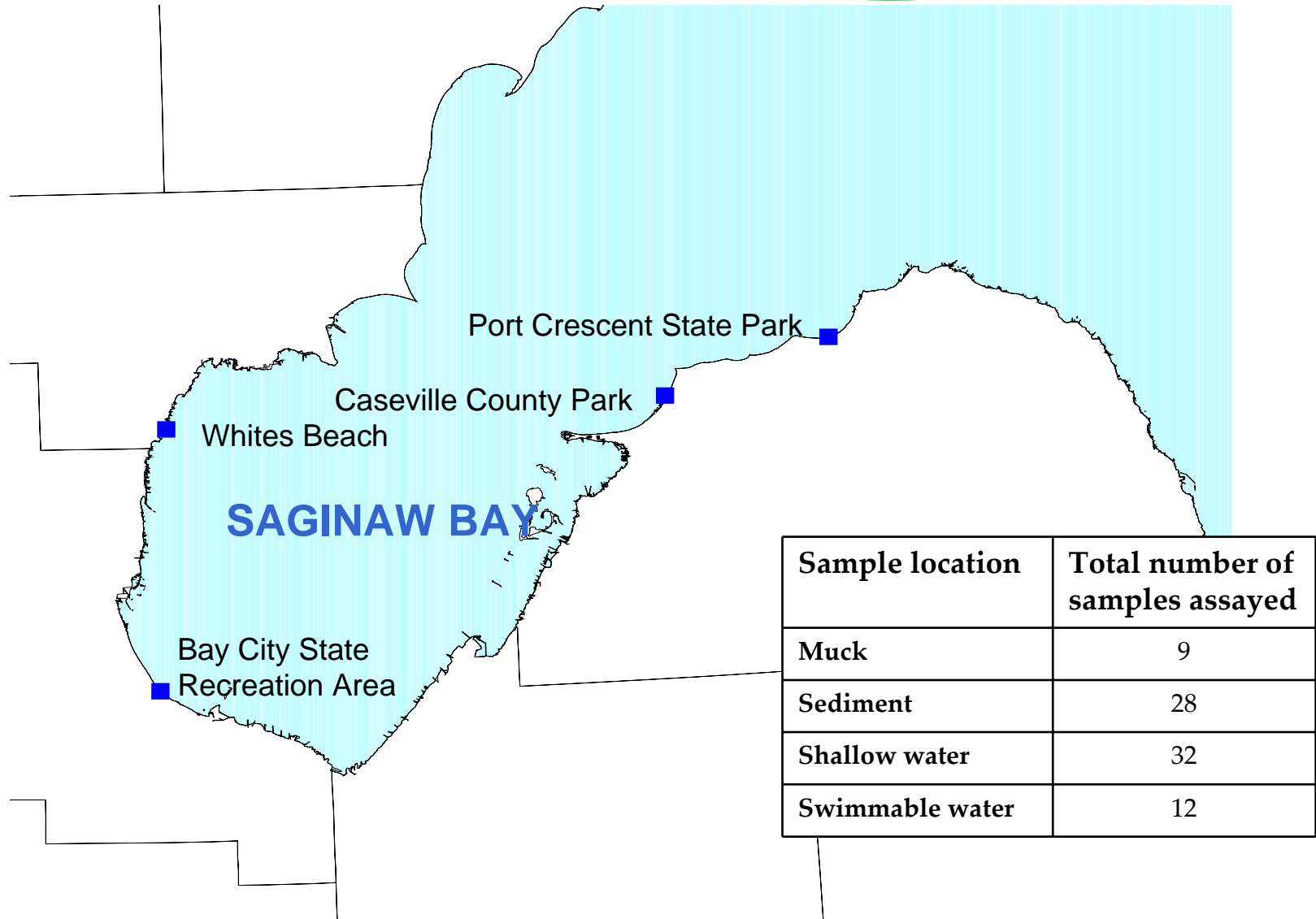
**Sanitary surveys and GIS**



# The Beachscape



# Sample Sites



# Beachscape

## Analysis in SPSS:

- Linear regression
- Pearson correlations
- ANOVA
- ANCOVA

**Swash**

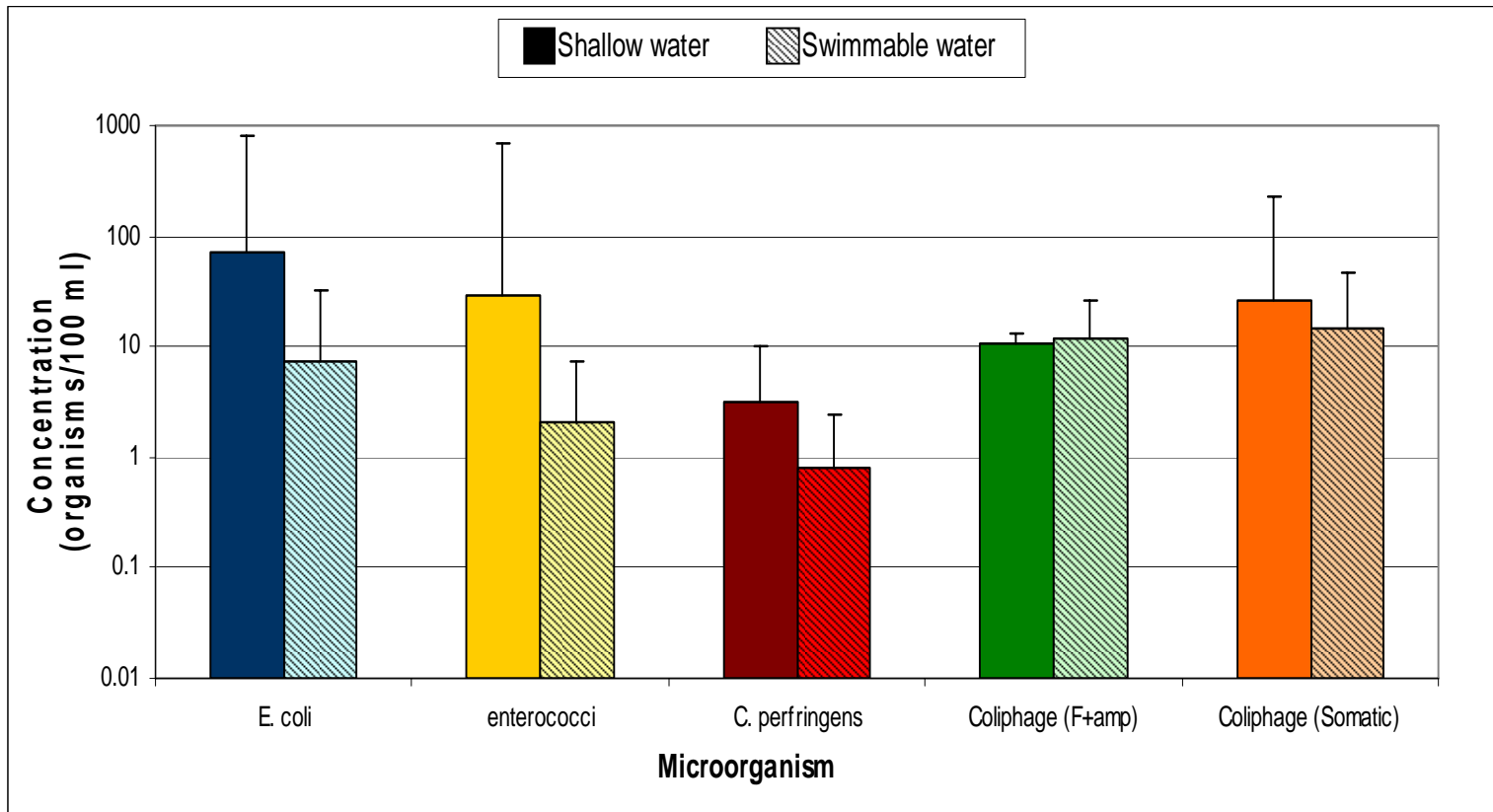
**Shallow**

**Swimmable**

Sampling dates	Number of samples collected	Sediment samples	Muck samples	Shallow water samples	Swimmable water samples
7/10/2008	8	0	0	4	4
7/15/2008	13	4	1	4	4
7/22/2008	9	4	1	4	0
7/29/2008	10	4	2	4	0
8/5/2008	10	4	2	4	0
8/12/2008	9	4	1	4	0
9/6/2008	9	4	1	4	0
9/30/2008	13	4	1	4	4

# FIB in Water

Fecal indicator concentrations in the shallow and swimmable waters



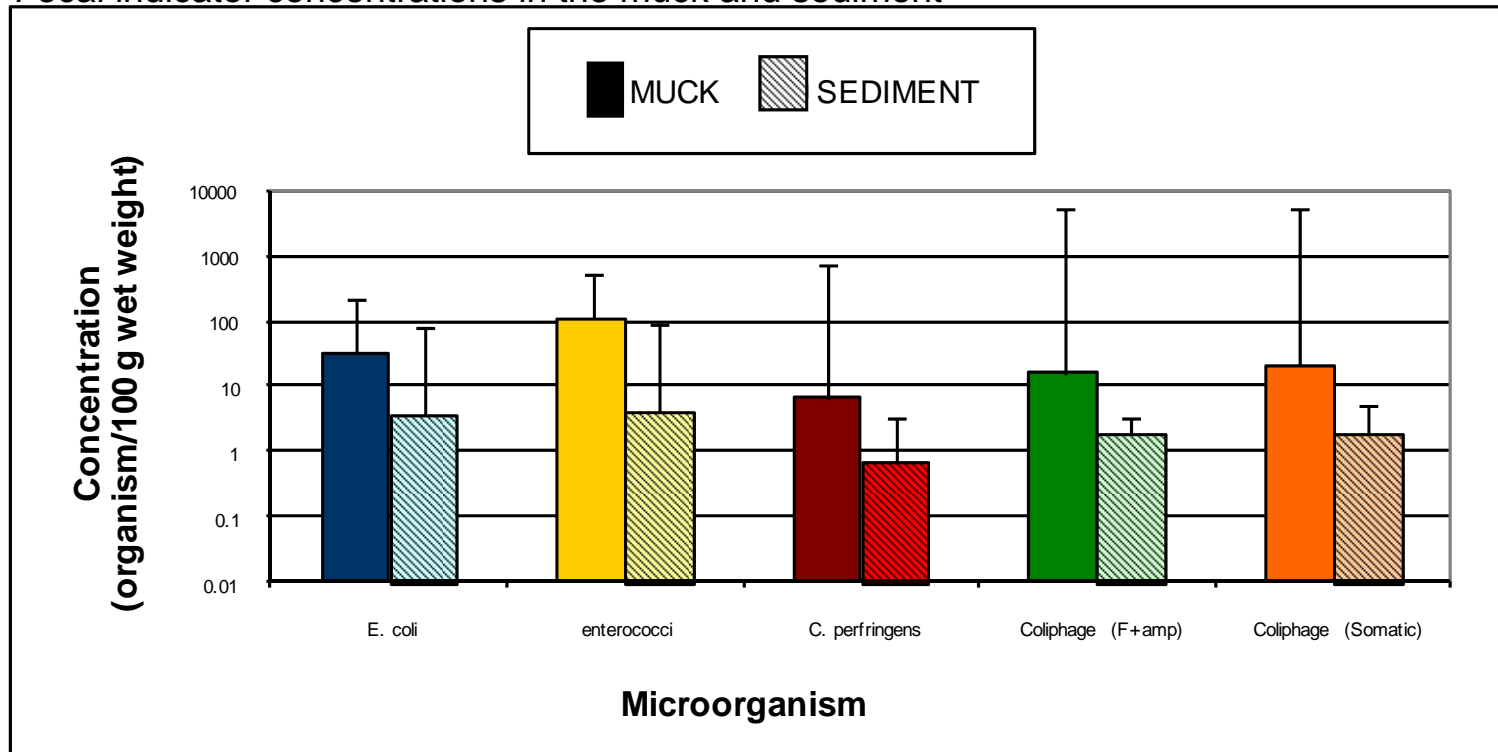
• *E. coli* exceeded standards 8 times in the shallow (235 CFU/100 ml)

• Enterococci exceeded standards 10 times in the shallow (61 CFU/100 ml)



# FIB in Non-Water

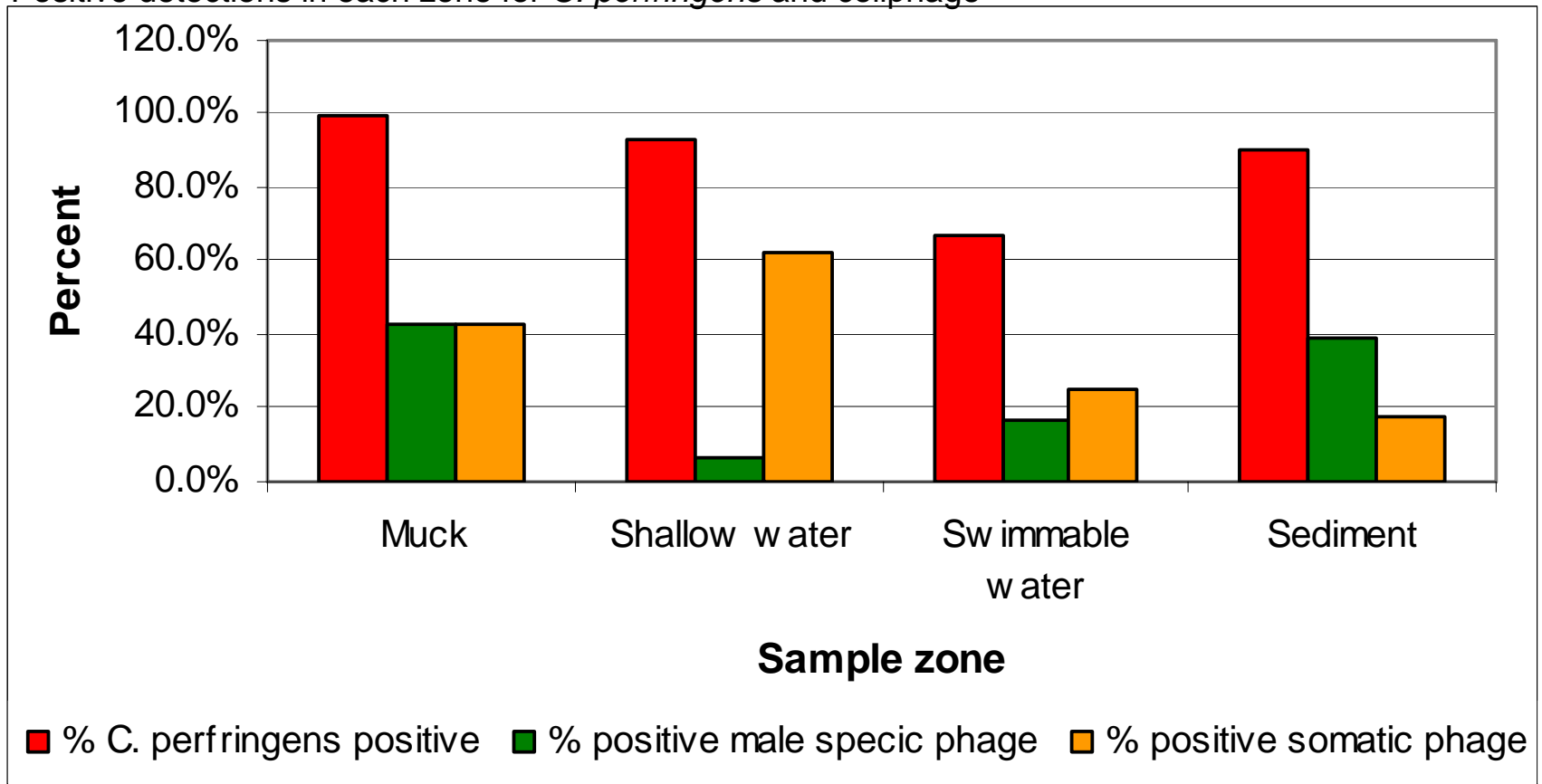
Fecal indicator concentrations in the muck and sediment



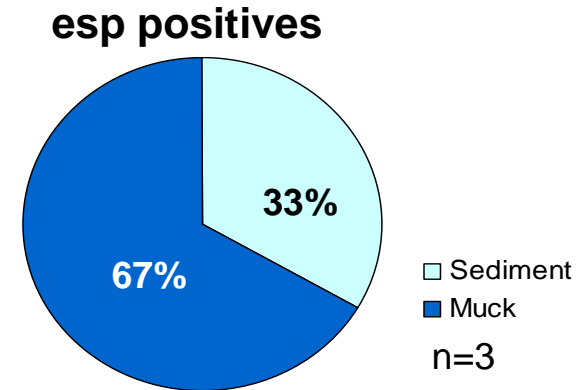
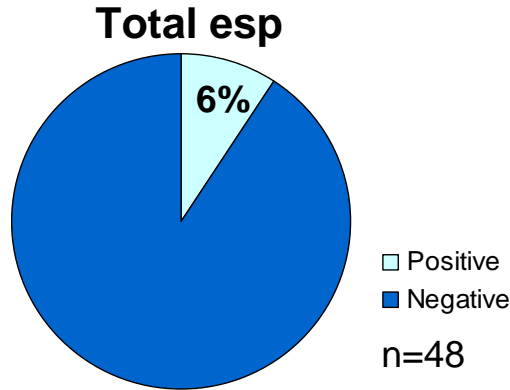
- Higher levels of fecal indicators in muck
- Standards and reporting

# Beachscape trends

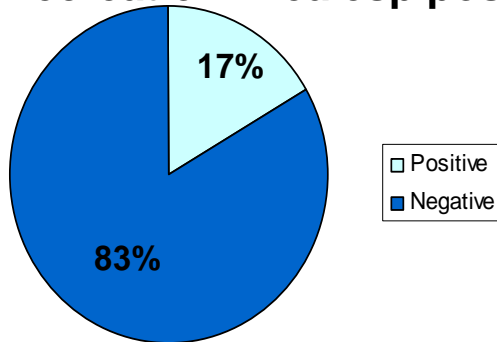
Positive detections in each zone for *C. perfringens* and coliphage



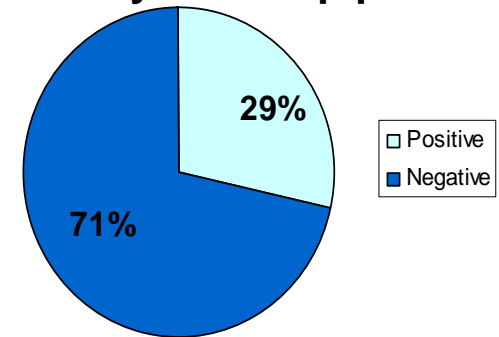
# Prevalence of Markers



**Bay City Recreation Area esp positive**



**Caseville County Park esp positive**

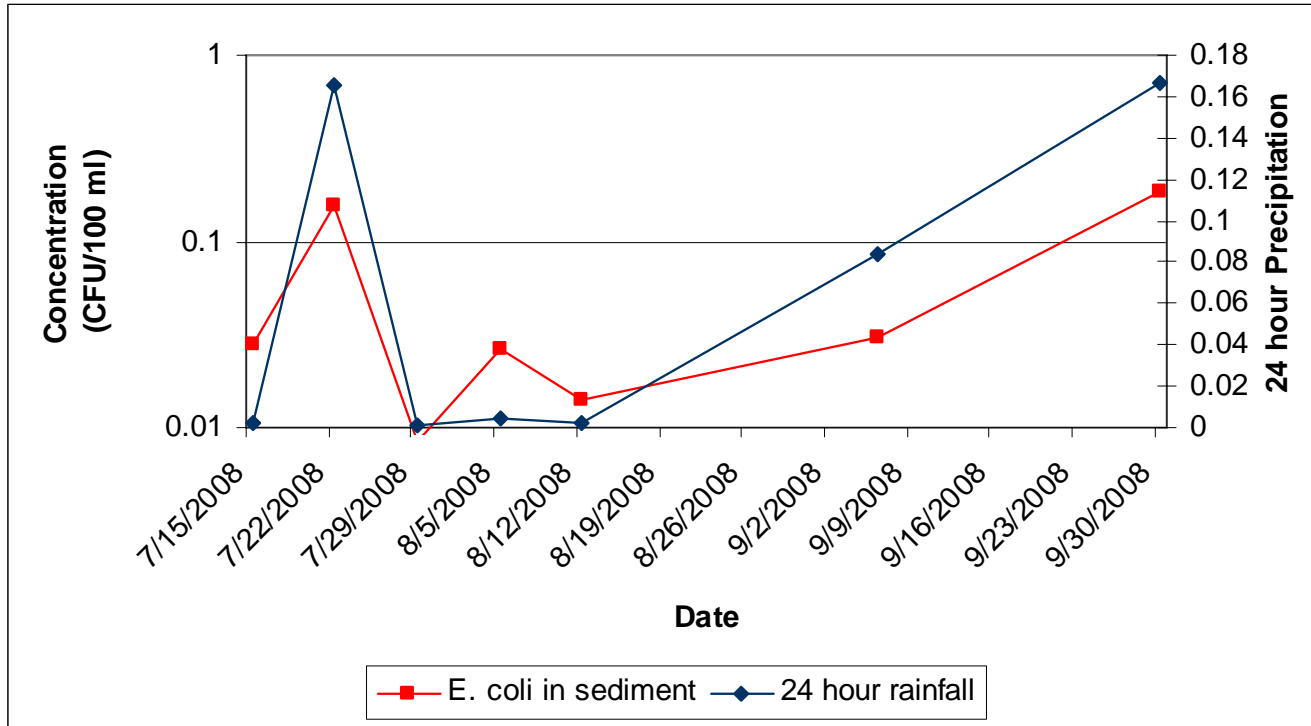


•Bovine and human Bacteroides not detected in 27 samples assayed

•esp not detected in swimmable or shallow water samples

# Precipitation and FIB

Total 24 hour rainfall and *E. coli* concentrations in the sediment



•**Rainfall decrease water quality** (Whitman and Nevers 2003, AEM v.69, Boehm et al. 2002, EST v.36; Lipp et al. 2001, Estuaries v.24)

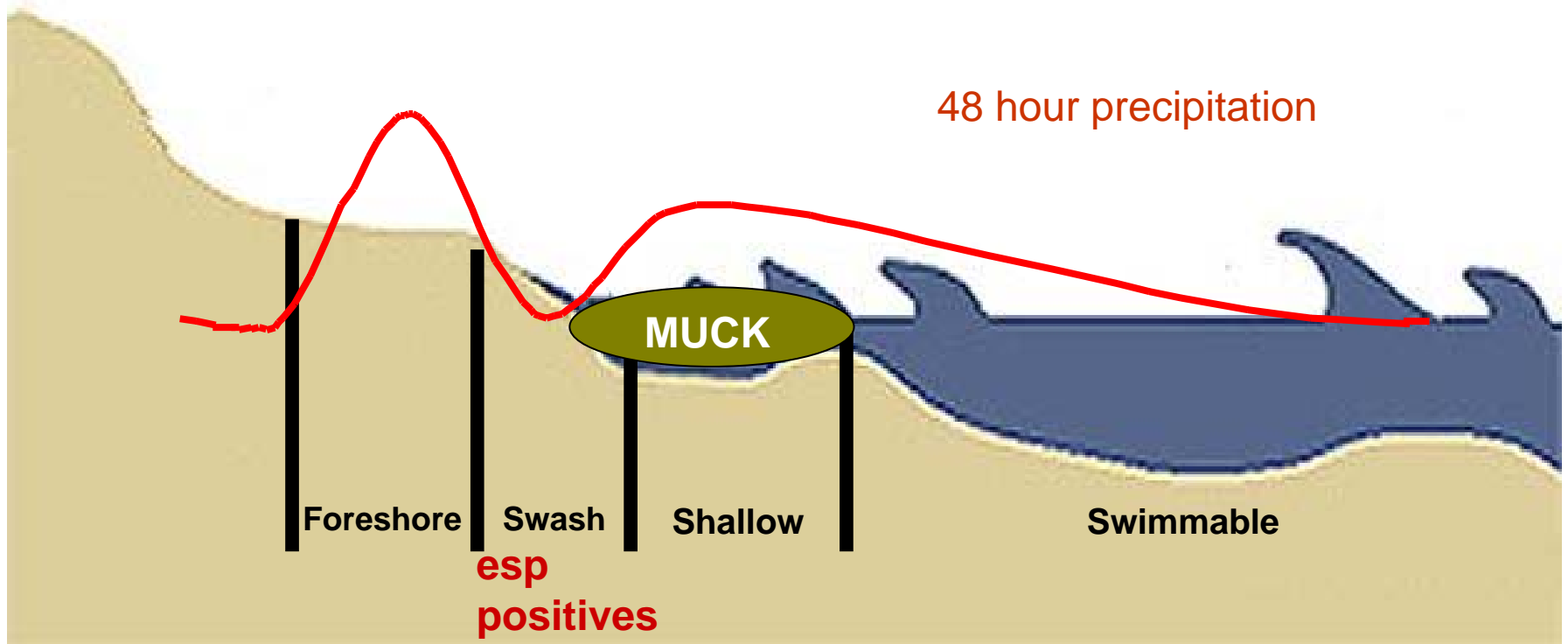
- Temperature indirectly related to *E. coli* levels**
- Wind driven system**

# Beachscape

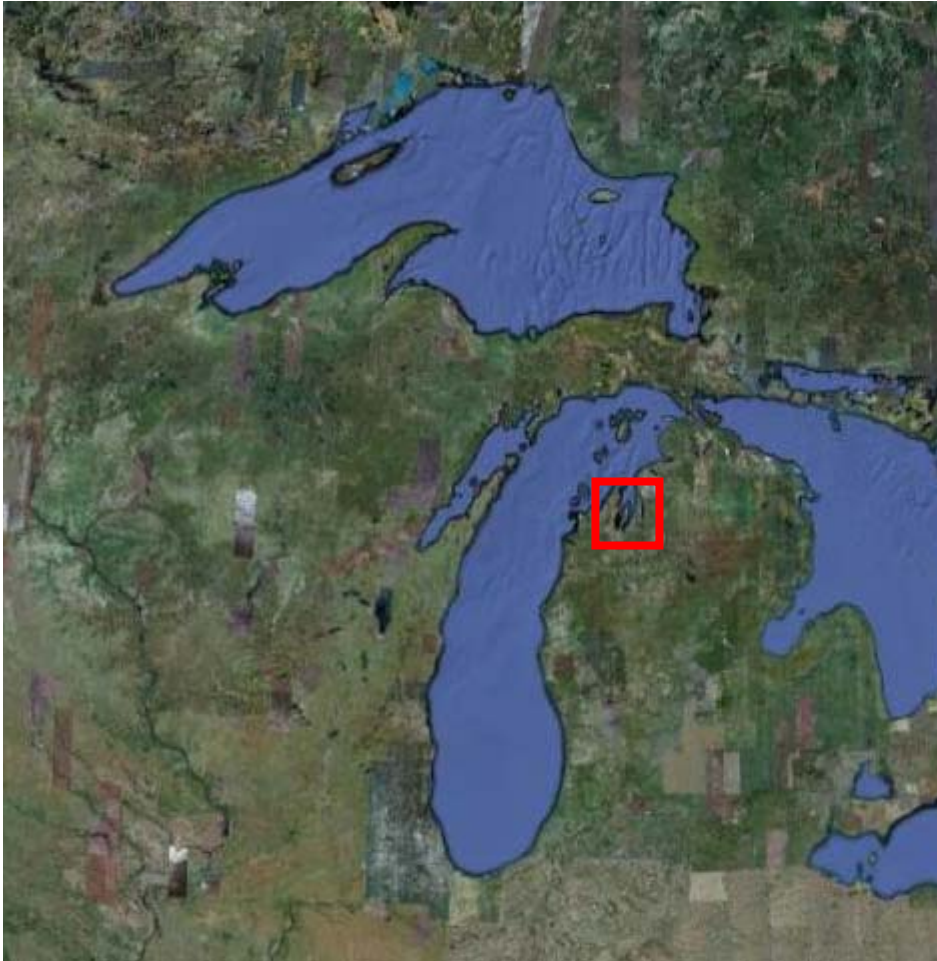
24 hour precipitation

24 hour precipitation, nearshore algal masses

48 hour precipitation



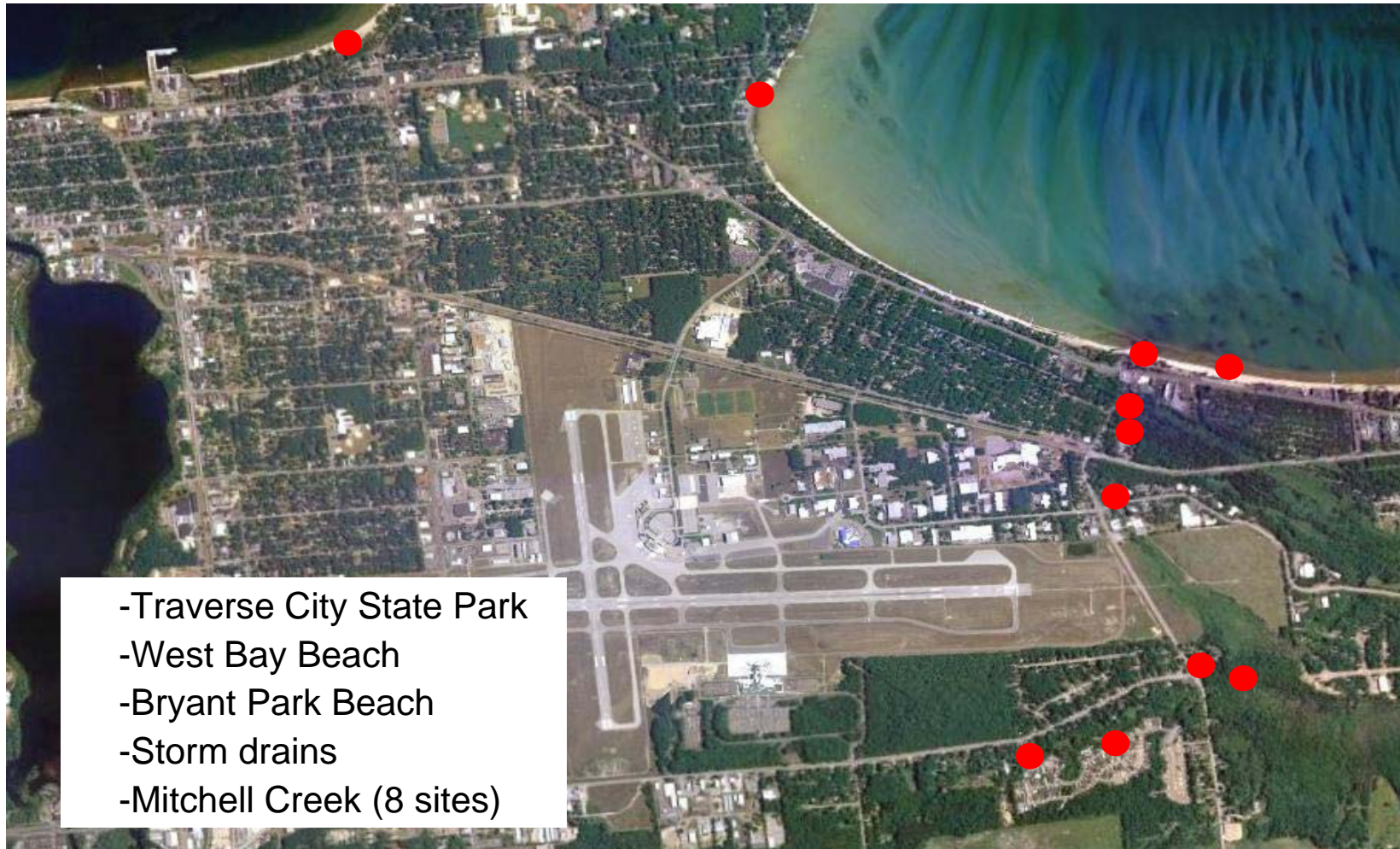
# Grand Traverse Bay Watershed



- 976 square miles of residential, forest, and agricultural land use
- 181 miles of shoreline
- 130 public beaches
- 149 inland lakes



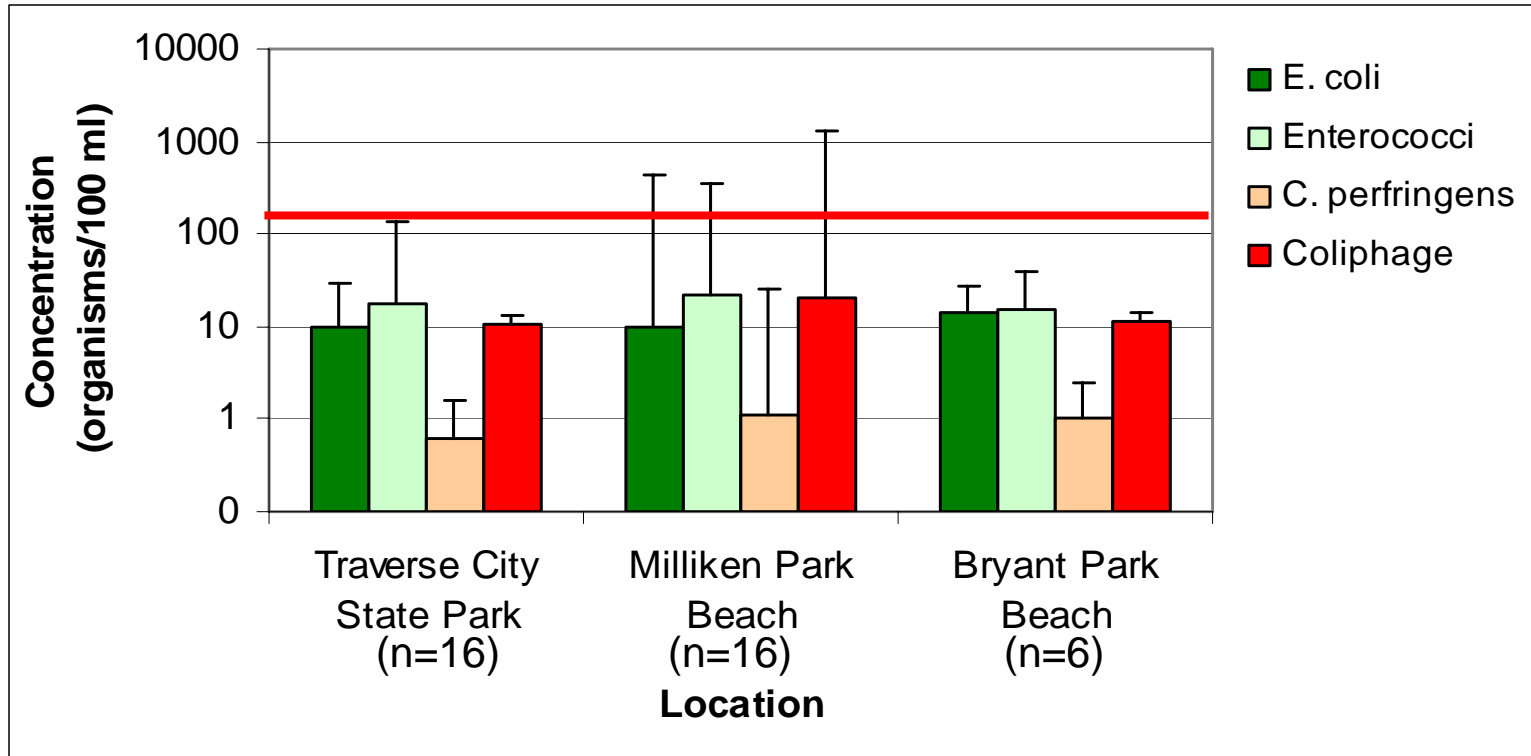
# Sample Sites



- Traverse City State Park
- West Bay Beach
- Bryant Park Beach
- Storm drains
- Mitchell Creek (8 sites)

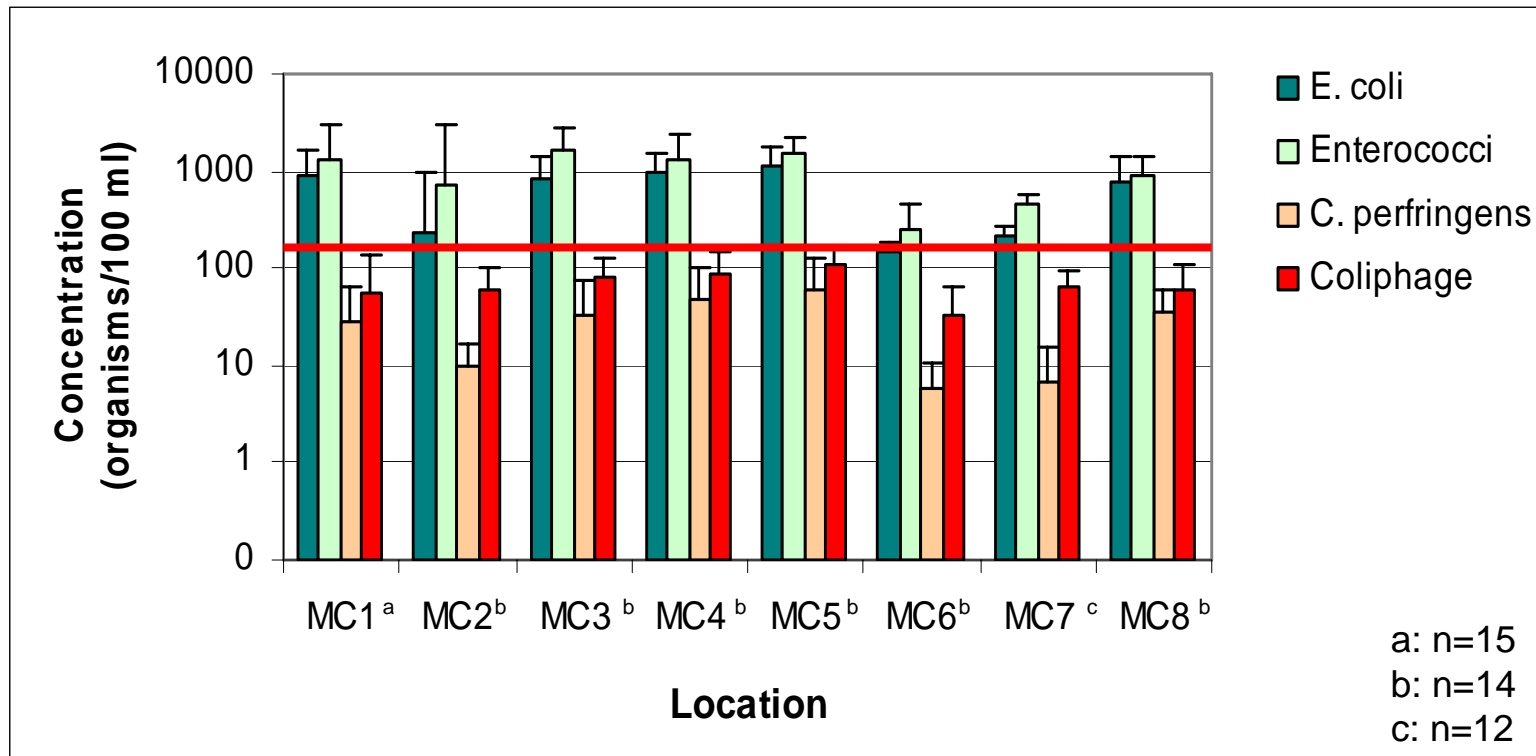


# Beach Water Quality



- Impacted by rain, wind, birds, wave height
- 6 (16%) enterococci exceedances (>61 organisms/100 ml) when *E. coli* was below EPA criteria (235 organisms/100 ml)

# Mitchell Creek Results



- Impacted by precipitation and air temperature
- 60 (54%) enterococci exceedances (>151 organisms/100 ml) when *E. coli* was below EPA criteria (575 organisms/100 ml)

# Preliminary Results

1. *E. coli* exceedances in 2009
  - 1 at Bryant Park Beach
  - 1 at Milliken Park Beach
  - 552 exceedances for all of Michigan
2. Beaches: Coliphage present in similar concentrations as *E. coli* at all sites: recent pollution
3. Mitchell Creek: Coliphage higher than *C. perfringens* at all sites: recent pollution
4. Water quality decreases prior to airport (MC 5) and remains elevated through mouth of river (MC 1)

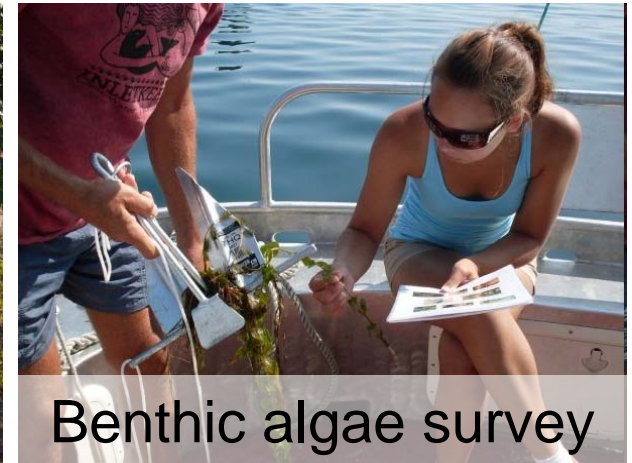
# Additional Efforts

## Beach protection and keeping them pristine

- Routine monitoring program
- Stormwater improvements
- Sanitary surveys



# Additional Efforts



# Additional Efforts

## Community outreach and education

Leave your worries



not your litter.

Please recycle or throw away your trash.



Healthy Beaches

13272 S. West Bayshore Dr.  
Traverse City, MI 49684  
935.1514 gtbay.org

Takin' care of business



Photo courtesy of Washington State's water quality education campaign.

is every pet owner's job.

Scoop it, bag it, trash it!



Healthy Beaches

13272 S. West Bayshore Dr.  
Traverse City, MI 49684  
935.1514 gtbay.org

Can a bird get some privacy?



You feed 'em on the beach,  
they go on the beach.

Please don't feed waterfowl to help reduce E. Coli.



Healthy Beaches

13272 S. West Bayshore Dr.  
Traverse City, MI 49684  
935.1514 gtbay.org



Artwork courtesy of the State of Maine's Healthy Beaches campaign.

Please keep our beaches healthy.

Take frequent bathroom trips.



Healthy Beaches

13272 S. West Bayshore Dr.  
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# Additional Efforts

## Community outreach and education



# Local Applications



## Buck Creek Watershed

- Allegan and Kent Counties
- Part of Lower Grand Watershed

## Outcomes

- Strong bovine influence
- Human sewage detected
- Stormwater runoff
- ID manure source





# Local Applications



## Coldwater River Watershed

- Kent, Ionia, Barry Counties
- Lower Grand River Watershed

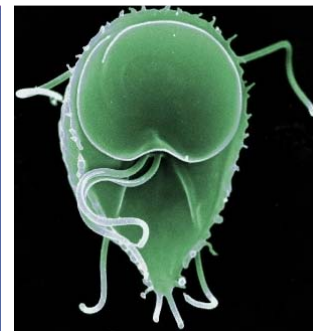
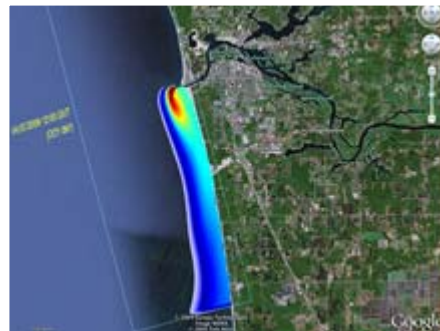
## Outcomes

- Strong bovine influence
- Human sewage detected
- Drain improvements
- Agriculture and community collaboration

# Local Applications

## Grand River

- Pathogen transport study
- Flow models
- Virus testing in sediment
- CSO characterization
- Human health implications



# Local Applications

- MSU/MSUE
- Grand Valley State University
- The Upper Grand River Watershed Alliance
- Friends of the Middle Grand River
- West Michigan Environmental Action Council
- West Michigan Strategic Alliance
- Watershed and river councils
- Health Departments

# Future Efforts

- Environmental factors impact on water quality
- ID sources of pollution
- Healthy Beaches Campaign
- Stormwater remediation
- Predictive models
- Form alliances



# Thank You



Marc P. Verhougstraete [verhoug3@msu.edu](mailto:verhoug3@msu.edu)

Joan B. Rose, Ph.D. [rosejo@msu.edu](mailto:rosejo@msu.edu)

**The Water Quality, Environmental, and Molecular  
Microbiology Laboratory**

<http://www.fw.msu.edu/~rosejo/>