

Bacterial Pathogens and Microbial Source Tracking Markers at Great Lakes Beaches – Summer 2010

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Bacterial Pathogens of Interest

CDC reports four major pathogens associated with outbreaks of illness acquired from ambient recreational water:

- *E. coli* O157:H7 bacteria
- *Shigella* spp. bacteria
- *Cryptosporidium* spp. protozoa
- Norovirus

Salmonella and *Campylobacter* bacteria together accounted for fewer than 5% of cases, but in up to 15% of cases, the causative agent was not determined

Analyses not complete

- Reporting on 4 beaches/ 3 pathogens

Bacterial Pathogens of Interest

Methicillin-resistant *Staphylococcus aureus* recently reported from marine beaches

- Basic analyses complete
- Reported in poster

Microbial Source-Tracking

- *Bacteroides* (all, human, and bovine)
- Gull marker
- Only on select samples
- Analyses not initiated yet

Study Approach

Twelve Great Lakes beaches

- Range of land uses and settings
- Approval to test for pathogens
- Responsible agency agreed to
 - Sample under various conditions
 - Collect and ship samples
 - Obtain and record environmental data
 - Swimmer and bird counts
 - Turbidity, wave height, current direction
 - Measures of algae, debris



Study Approach

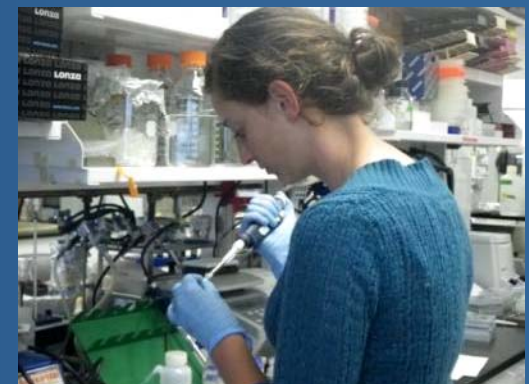
Approximately 25 samples per beach shipped overnight

- Collected under a range of environmental conditions
- Samples were composites of the usual number of beach *E. coli* samples

Samples processed day of receipt

- Dispersed to appropriate media
- Also filters for subsequent qPCR

Growth frozen for DNA extraction and PCR



Summary of Assays

Shiga-toxin producing *E. coli* genes tested:

- *eaeA*, *stx2*, *stx1*, *rfbO157*

Shigella gene tested:

- *ipaH* (specifically pathogenic *Shigella*)

Salmonella genes tested:

- *invA* (>95% of *Salmonella*), *spvC* (pathogen specific)

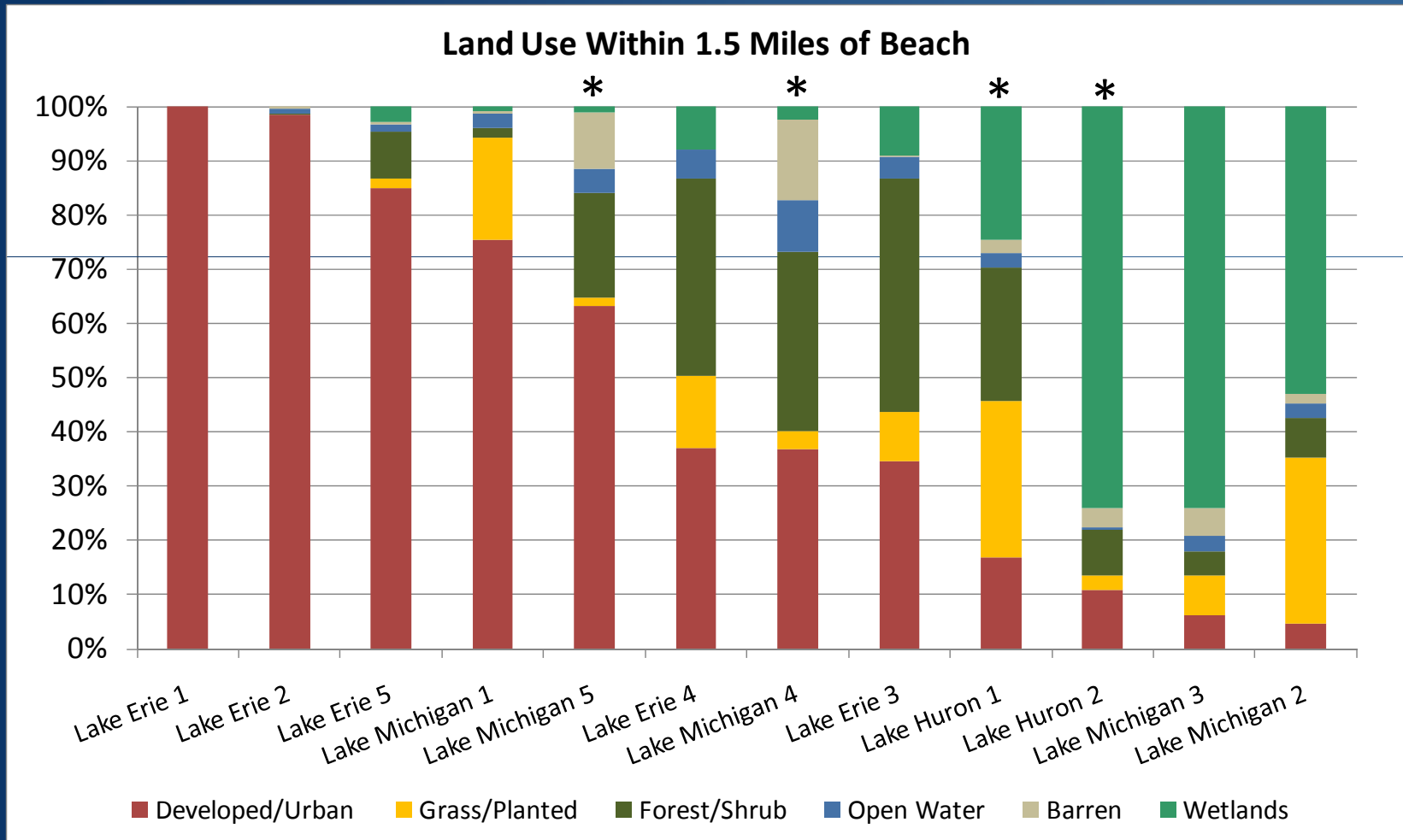
Campylobacter genes tested

- 16S rDNA for *C. jejuni* and *coli*

All assays performed on cultures

- Indicates viable organisms in the 100 mL beach-water sample

Beaches Varied By Land Use



* Beaches reported in this talk

Beach Characteristics

Beach	Number of Samples	Land Use	<i>E. coli</i> Density (Exceed)*	Enterococci Density (Exceed)*	Average Number of Swimmers	Average Number of Birds	Average Turbidity (NTU)	Average Wave Height (ft)
<i>Lake Huron 2</i>	21	Forest/Wetland	5 (0)	2 (0)	3	18	7	0.21
<i>Lake Michigan 5</i>	27	Urban	20 (0)	15 (3)	133	131	10	1.37
<i>Lake Michigan 4</i>	27	Mixed	18 (0)	10 (2)	1	62	8	1.26
<i>Lake Huron 1</i>	21	AG	146 (4)	93 (15)	<1	1	11	0.34

*Bacterial geometric mean density in CFU/100 mL; single sample exceedances; results for indicated number of samples

Pathogen Detections

Beach	Land Use	<i>E. coli</i> Density (Exceed)	Enterococci Density (Exceed)	Average Number of Swimmers	All Samples*			Subset of Samples		
					<i>Shigella</i>	<i>Campylo- bacter jejuni/ coli</i>	<i>E. coli</i> O157	<i>Shiga toxin 2</i>	<i>Shiga toxin 1</i>	<i>E. coli</i> O157 + stx 2 + stx 1
<i>Lake Huron 2</i>	Forest/Wetland	5 (0)	2 (0)	3	0	1	2	2/7	2/7	0/7
<i>Lake Michigan 5</i>	Urban	20 (0)	15 (3)	133	1	1	3	0/14	0/14	0/14
<i>Lake Michigan 4</i>	Mixed	18 (0)	10 (2)	1	2	0	2	2/14	2/14	1/14
<i>Lake Huron 1</i>	AG	146 (4)	93 (15)	<1	0	3	5	1/7	2/7	0/7

*21-27 samples

E. coli and Enterococci Densities for Samples With Pathogen Detections

No clear relation between indicator concentrations and pathogen detections

No relation between *E. coli* and enterococci exceedances

Beach	<i>Shigella</i>	<i>Campylobacter jejuni/coli</i>	<i>E. coli</i> O157	<i>E. coli</i> O157 + stx 2 + stx 1
Lake Huron 2		2/1*	13/1 2/0	
Lake Michigan 5	33/15	4/15	3/7 18/34 19/42	
Lake Michigan 4	45/15 8/1		45/15 6/8	45/15
Lake Huron 1		334/510 127/76 21/187	745/700 146/187 113/73 108/147 118/212	

*EC/ENT individual sample CFU/100 mL

Factors Correlated with Pathogen Detections

Beach	<i>Shigella</i>	<i>Campylobacter jejuni/coli</i>	<i>E. coli</i> O157
<i>Lake Huron 2</i>	0	1 (algae)	2 (birds)
<i>Lake Michigan 5</i>	1 (none)	1 (none)	3 (none)
<i>Lake Michigan 4</i>	2 (birds)	0	2 (birds)
<i>Lake Huron 1</i>	0	3 (FIB)	5 (FIB)

Simple Pearson correlations

FIB related at the one beach with relatively high FIB concentrations

Next Steps

Complete all pathogen analyses

Evaluate relations among pathogen detections and environmental conditions

- **At each beach**
- **Among all beaches**

Evaluate relations among pathogen detections and indicator bacteria concentrations

- **Evaluate models**

Follow up selected samples with

- **qPCR for pathogen genes**
- **Microbial source-tracking**

Summary

Bacterial pathogens at Great Lakes beaches are indicated by presence/absence PCR

- Needs more detailed analysis of numbers and isolate characteristics

There is no obvious relation to FIB concentrations

- Needs analysis of factors related to pathogen detections

Pathogen detections appear to vary by beach

- Land use and geologic nature of beach may influence
 - Exploring with GIS analysis
 - Possible to establish risk categories?