

The National Environmental and Epidemiological Assessment of Recreational Water:

The relationship between novel indicators of water quality and health

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BEACHES Act of 2000

1. Determine microbial indicators for beach water quality
 2. Develop efficient protocols for monitoring
 3. Assess human health risks
 4. Provide guidance to beach managers
- Final Goal: New risk-based water quality guidelines & rapid monitoring methods for recreational waters.

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Research Question

Is there an association between illness and recreational water quality as measured by rapid methods of determining water quality?

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STUDY APPROACH

Water sampling methods



New rapid detection methods



Health studies



**New, rapid, validated water quality indicators
(under 2 hours for results)**

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Water Sampling Strategy

- Taken 3 times daily

8:00 AM
11:00AM
3:00 PM

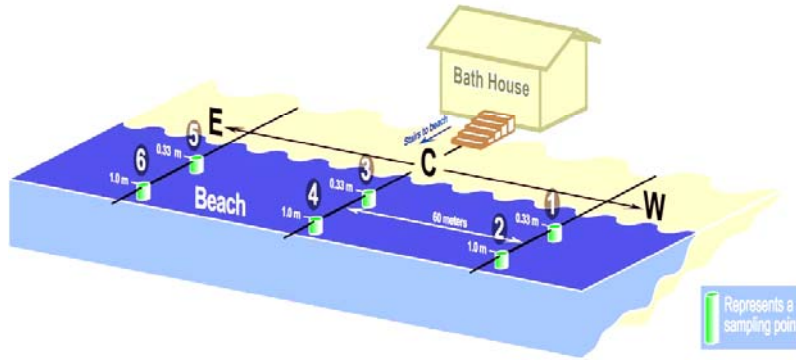
- Two depths

.3 meters
1.0 meter

- Modified sampling scheme according to beach area

Lake Michigan

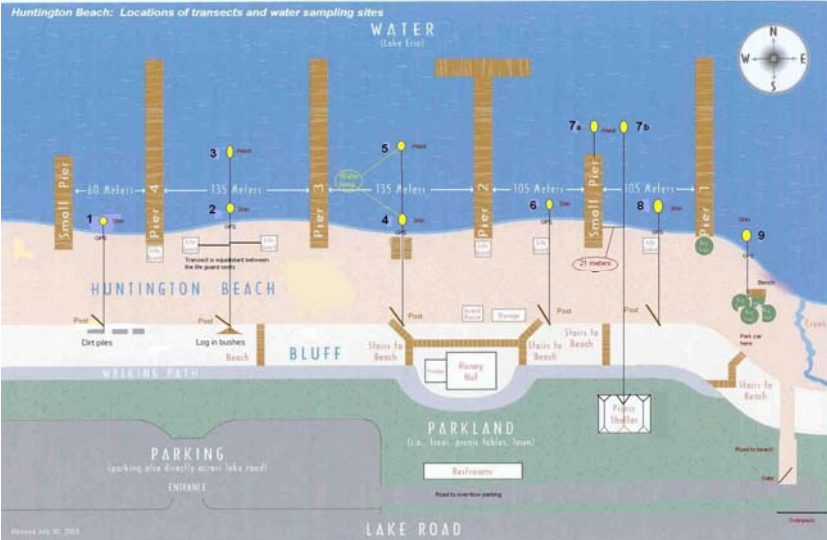
Water Sampling Points



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Lake Erie



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Water Quality Measures

- **Enterococci Method 1600**
 - Current standard
 - Colony forming units 24-48 hrs
 - Intestinal tract bacteria, warm blooded animals
- **QPCR: Enterococci and Bacteroides**
 - Quantitative (real time) polymerase chain reaction
 - DNA based technology
 - Two hours
 - Intestinal tract bacteria
 - Bacteroides, 2-3 log higher density, anaerobe, dies in environment
 - Measured in cell equivalents (QPCRCE)

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Exposures and Health Outcomes

- **Exposures:**
 - Any contact with water (“any contact”)
 - Immersed body in water (“body contact”)
 - Head under water (“head under”)
- **Outcomes**
 - Gastrointestinal illness (GI), skin rash, earache, eye irritations, respiratory illness (URI)

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2003 Data Collection

Lake Michigan

- May 31-August 3
- 20 days of surveying
- 2877 completed interviews
- 67% completion rate

Lake Erie

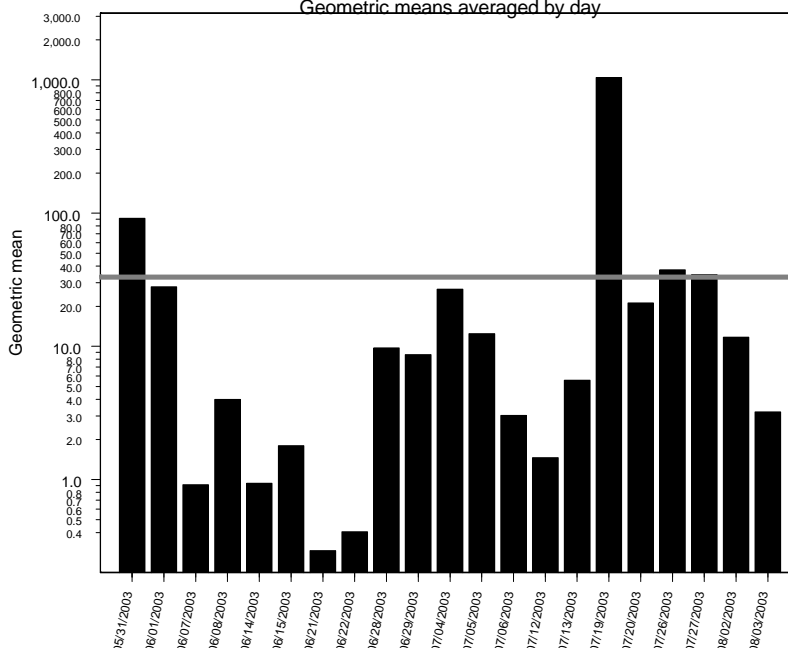
- July 27-September 14
- 16 days of surveying
- 2840 completed interviews
- 60% completion rate

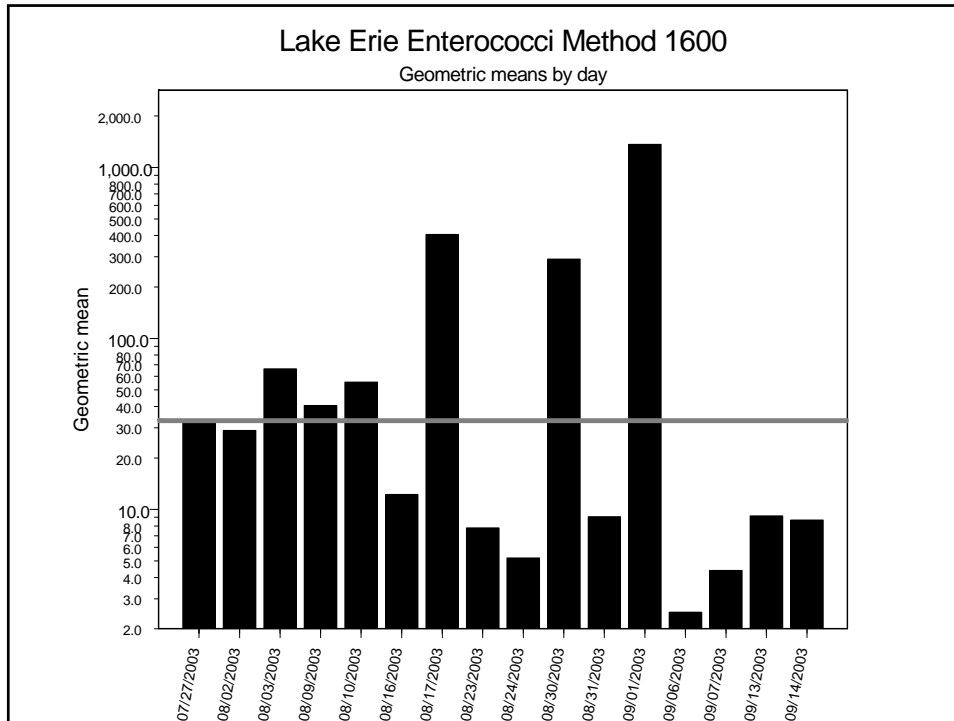
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Lake Michigan Enterococcus Method 1600

Geometric means averaged by day





Survey Results: Swimming

	Lake Michigan	Lake Erie
Any contact	75%	46%
Body contact	58%	27%
Head under	42%	18%
Water in mouth	19%	12%
Gagged on water	6%	3%
Swallowed water	7%	4%
Wave riding	9%	5%

**Lake Michigan:
Adjusted Odds Ratios for Swimming**

	GI	URI	Eye	Rash	Earache
Any contact	2.22*	1.09	1.09	2.35*	1.40
Body contact	2.54*	1.06	1.19	2.44*	1.72
Head under	2.37*	1.09	1.25	2.42*	2.29*
*p<0.1					

**Lake Erie:
Adjusted Odds Ratios for Swimming**

	GI	URI	Eye	Rash	Earache
Any contact	1.43*	1.08	0.65	1.23	1.74
Body contact	1.62*	1.03	0.62	0.86	1.46
Head under	1.68*	1.11	0.51	1.00	1.36
*p<0.1					

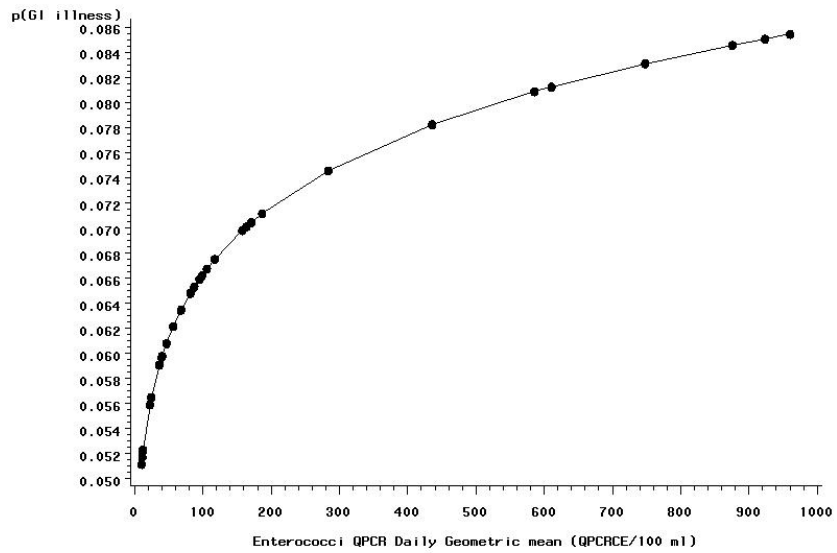
Lake Michigan: Trends for GI illness

	Enterococcus Method 1600		Enterococcus QPCR		Bacteroides QPCR	
	OR*	P-trend	OR**	P-trend	OR**	P-trend
Any contact	1.11	0.43	1.78	0.04	0.66	0.11
Body contact	1.08	0.62	1.94	0.04	0.64	0.12
Head under	0.96	0.82	2.15	0.03	0.58	0.12
	*30 unit increase		**100 unit increase		**500 unit increase	

Lake Erie: Trends for GI illness

	Enterococcus Method 1600		Enterococcus QPCR		Bacteroides QPCR	
	OR*	P-trend	OR**	P-trend	OR**	P-trend
Any contact	1.07	0.62	1.71	0.07	1.55	0.15
Body contact	1.59	0.15	2.06	0.07	1.95	0.08
Head under	0.95	0.90	1.51	0.37	2.10	0.09
	*30 unit increase		**100 unit increase		**500 unit increase	

Relationship between Enterococci QCPRCE and GI Illness: Lake Michigan and Lake Erie Beaches Combined



Probabilities predicted from multivariate logistic regression
Swimming definition: head immersed under water

Risk of GI Illness: Method 1600

**GI illness among Swimmers above vs. below daily
geometric means of 33 cfu:**

Enterococci (cfu/100ml)	GI illness-Yes	GI illness-No
>=33	70 (13.0%)	470 (87.0%)
<33	200 (10.6%)	1684 (89.4%)

OR (adjusted)=1.28 (95% CI: 0.95-1.73) p=0.11

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Data Collection 2004

- Two Lake Michigan beaches
- Over 15,000 completed individual interviews
- GI illness-7%
- Swimming:
 - Any contact - 69%
 - Body contact- 52%
 - Head under - 37%
- RR for body contact (unadjusted)
 - 1.29 (95% CI 1.14-1.45)

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Summary and Conclusions

- QPCR appears to be a promising predictor of gastrointestinal illness in fresh water
- First rapid indicator to be correlated with health effects
- Trends were not observed for respiratory illness
- Trends were not observed for rash, earache, and eye ailments, but more data may be necessary

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Future Directions

- **Better define risk to high risk groups such as children**
- **Evaluate other potential rapid indicators such as chemicals associated with sewage**
- **Studies in marine waters**

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