

# Beach Quality in Ontario

## Summary of Recent MOE Projects

***Presentation to:***  
**Great Lakes Beaches Association**  
**October 20, 2010**

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Standards Development Branch

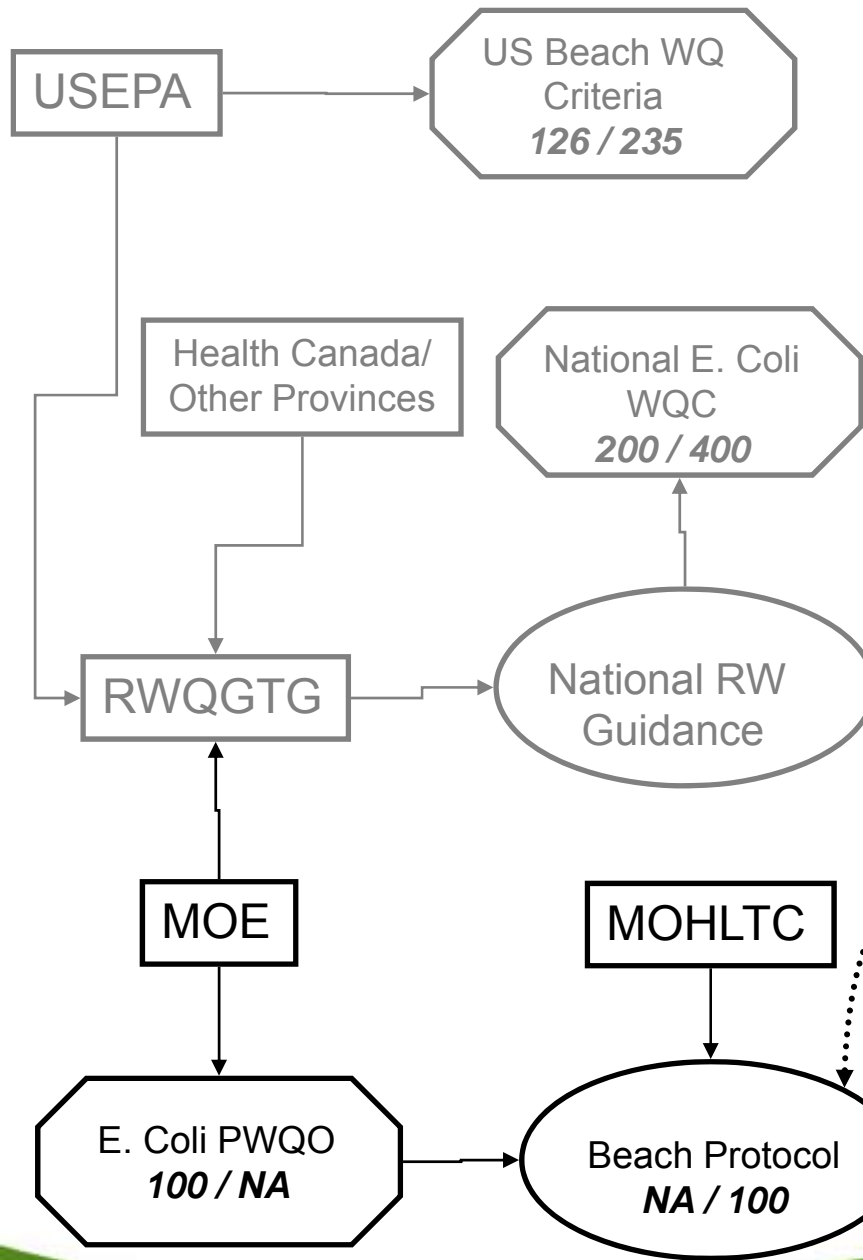
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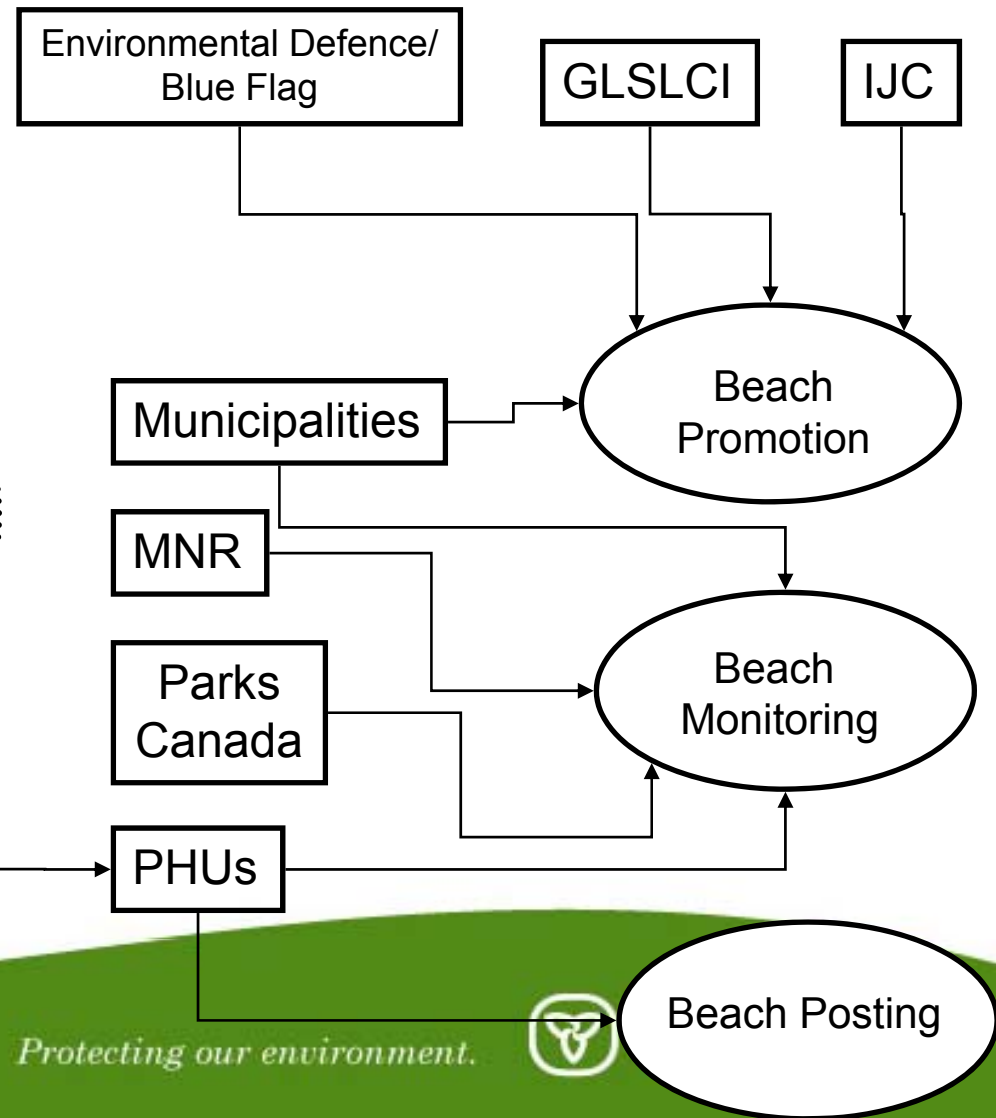
**Ontario**

# Topics

- Federal Role In Beach Quality
  - Status of Canadian Recreational Water Quality Guidelines (revised)
  - SWMRS
- Role of Ministry of Environment on Beach Quality
  - Provincial Water Quality Objective for E. coli
  - Survey of Beach Quality in Ontario
  - Toronto Beach Forecasting Project



## Provincial Beach Management has Many Partners



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A map of the province of Ontario, Canada, is shown in a light purple color. The text "Federal Role" is centered on the map in a bold, black, sans-serif font. The map is set against a white background with a gold wavy banner at the top and a green wavy banner at the bottom.

**Federal Role**

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# Status of National Guidelines For RWQG

- Consultation Draft posted on Health Canada website for comment until Jan. 8 2010.
- Re-affirmed existing National E. coli guidelines of 200 and 400 E. coli/100 ml (geomean of > 5 samples) for “primary” contact
- Addition of new “secondary” contact guidelines of 1000 E. coli /100 ml
- Addition of guidelines for Cyanobacteria (100,000 cells/mL total microcystin) and Cyanobacterial toxins (20 ug/L total microcystins)
- Final release expected ????

Health Canada Santé Canada

Your health and safety... our priority. Votre santé et votre sécurité... notre priorité.

## Guidelines for Canadian Recreational Water Quality

### Third Edition

The online consultation is now closed. Comments and suggestions received during the public consultation period are being considered in the finalization of this document. The final report will be made available as soon as possible.

Document for Public Comment

Prepared by the  
Federal-Provincial-Territorial Working Group on  
Recreational Water Quality of the  
Federal-Provincial-Territorial Committee on  
Health and the Environment

Consultation Period Ends  
January 8, 2010

September 2009

Canada

# Seasonal Water Monitoring and Reporting System



Photo credit S. Holland-Hibbert

- Web-based data entry system for the collection and dissemination of bacteriological information for swimming beaches on the Canadian side of the Great Lakes
- Represents the collaboration of federal, provincial and municipal governments to better collect beach posting information in a timely manner and in one place where no single site currently exists.

Slides Courtesy of  
Environment Canada

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# Benefits of SWMRS

1. Provides one-window data reporting.
2. Reporting mechanism for beach posting information.
3. Allows beach posting information to be available in one place.
4. Allows HUs access to weather data for improved analysis and predictability.
5. Facilitates the adoption of a standard monitoring and reporting system by HUs.

Slides Courtesy of  
Environment Canada

# Future Ideas for SWMRS

- Expanding SWMRS to include beaches on inland lakes/rivers in Great Lakes basin and possibly other beaches within Canada.
- Satellite imagery linked to the Great Lakes beaches and web mapping application.
- Public-friendly website for beach posting information.
- Links to RésEau portal.
- Links to US Beach Advisory and Closing On-line Notification (BEACON).

Slides Courtesy of  
Environment Canada

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Visit the SWMRS display for more information!

[www.ec.gc.ca/SWMRS](http://www.ec.gc.ca/SWMRS)

Photo credit: City of Toronto

A map of the province of Ontario, colored in light cyan, with a dark purple outline. The text "Provincial Role" is centered on the map. A small pink dot is located on the eastern coast of the province.

## Provincial Role

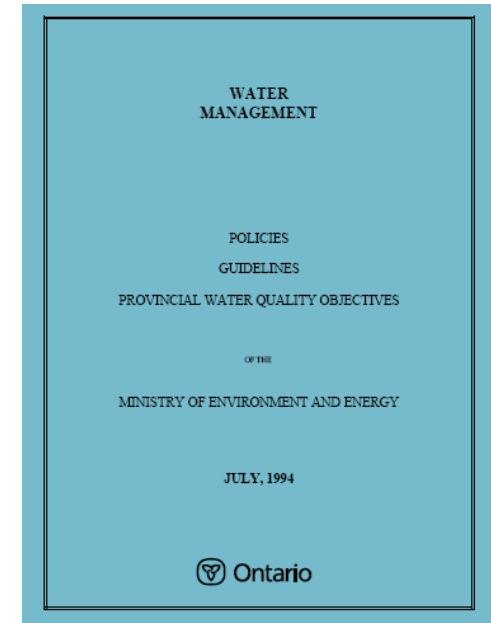
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# Provincial Water Quality Objectives

*“To ensure that the surface waters of the Province are of a quality which is satisfactory for aquatic life and recreation”.*



- Are numerical and narrative ambient surface water quality criteria
- Represent desirable surface water concentrations to protect all aquatic life and recreational water uses, including taste and odour of water and fish flesh.
- Are strictly science-based, and do not consider implementation issues (i.e. technological and economic feasibility)
- PWQOs are not regulatory instruments (i.e. not true Standards)

# Recreational PWQOs

- *“the use of water for swimming, bathing, and other recreational activities requiring immersion of the user should not cause disease in the human user ... or irritation or to loss of enjoyment of the water”*
- 1984 MOE SCD for Standard Development – Microorganisms in Recreational Water
  - PWQO for FC – 100 E. coli per 100 mL (based on geometric mean of at least 5 samples)
  - About 7 swimmers per 1000 (about 0.7%) are at risk of contracting GI symptoms
  - *“to ensure that the Provincial Standards reflect the most recent scientific advances in public health protection, regular review is strongly recommended”*
- 1992 RWQG (provincial) Committee report
  - Use a MAC of 100 E. coli per 100 mL (even though National numbers are 200/400)

# Beach Management Protocol

- Developed by the Ministry of Health and Long Term Care
- Assists in the prevention and reduction of water-borne illness and injury related to recreational water use at public beaches
- Assist boards of health in the delivery of local, comprehensive public beach management programs:
  - Surveillance and inspection
  - Management and response to adverse events
  - communication strategies for the public and stakeholders
- Public beaches within provincial parks are generally the responsibility of the Ministry of Natural Resources; however, this is done in consultation with the board of health.
- The board of health is not responsible for routine monitoring of private residential beaches.

# State of Ontario Beaches



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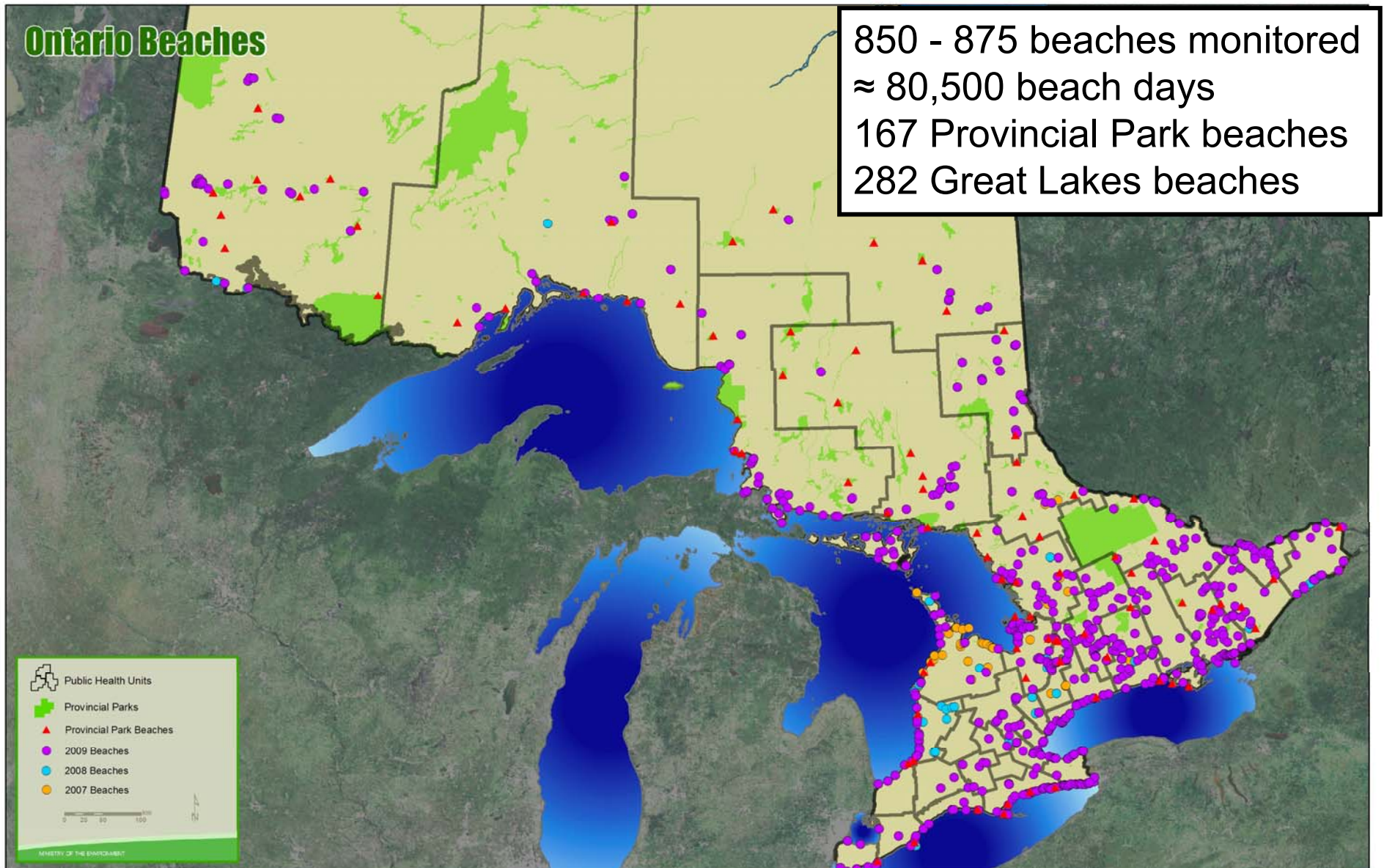


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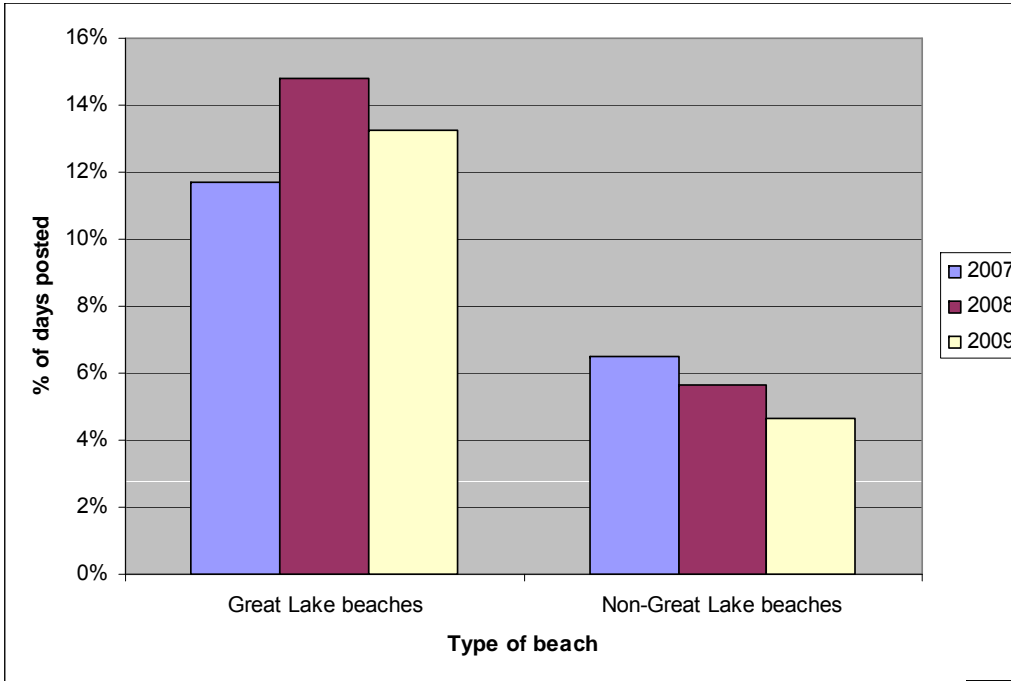
# State of Ontario Beaches: 2007 to 2009

- Initiated a beach monitoring data collection from PHUs in late 2008
- Goal:
  - Gain a province-wide perspective on beach quality in ON (i.e. beyond SOLEC)
  - Evaluation of implications of revising the E. coli PWQO
- 19 PHUs provided GIS co-ordinates for their beaches
  - Attempted to locate remaining beaches through Google Earth, etc.
- Challenges with “normalizing” data
  - Some PHUs provided raw data, others provided GeoMean data
  - Beach Seasons
  - Monitoring frequency (daily, weekly, monthly or other)
  - Variability in determining whether beach should be posted (number of exceedences, standard, etc.)
- Arbitrary Decisions were taken
  - Single Beach Season (June 4/2 to September 3/1)
  - Single approach to determining posting (see paper)
- *Results may be different than PHU reportings and from SOLEC data*

# Monitored Beaches in Ontario

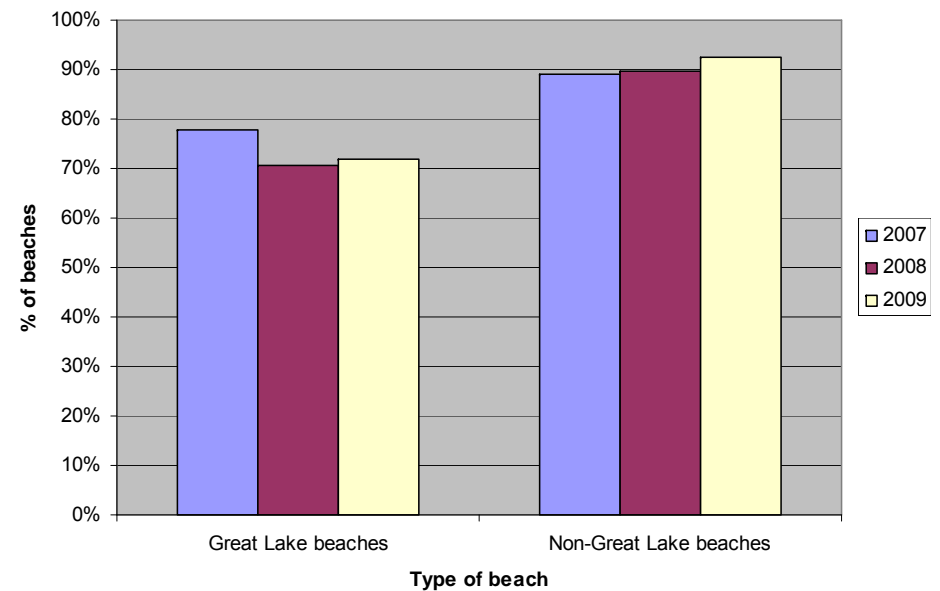


# Beach Posting Statistics



- Great Lakes beaches are posted more often than interior beaches

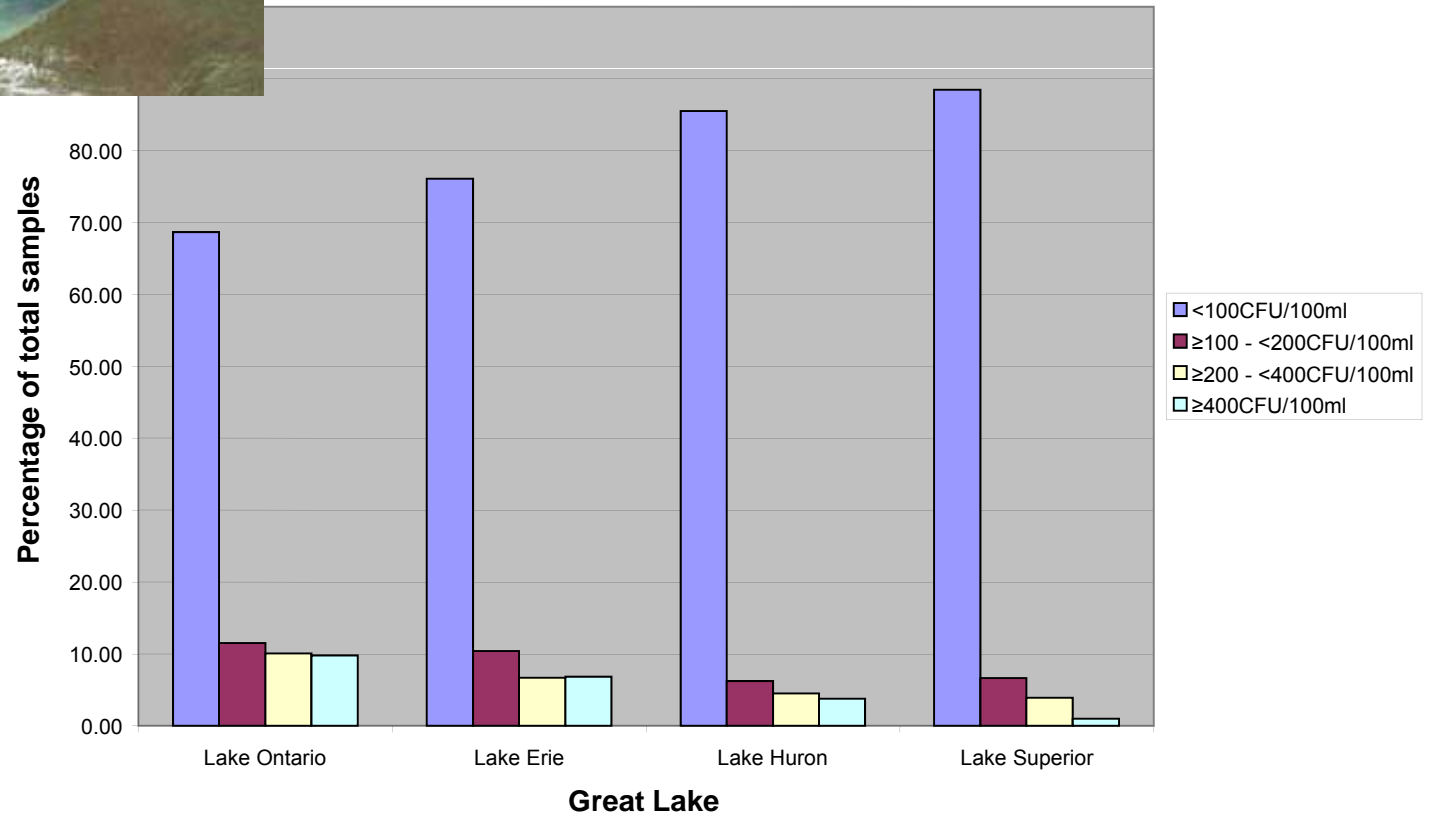
- GLSLCI target: Beaches open > 80% of season
  - 2007 85.0%
  - 2008 83.6%
  - 2009 85.7%



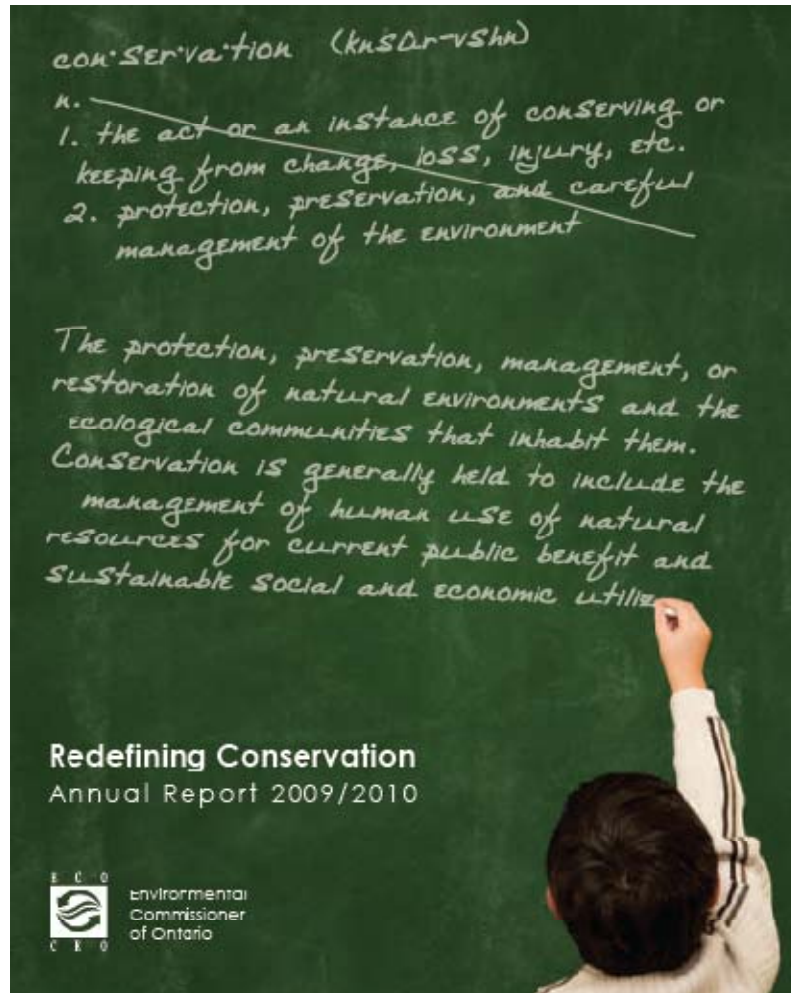
# E. Coli counts at Ontario Great Lakes Beaches



Histogram of E. coli concentrations

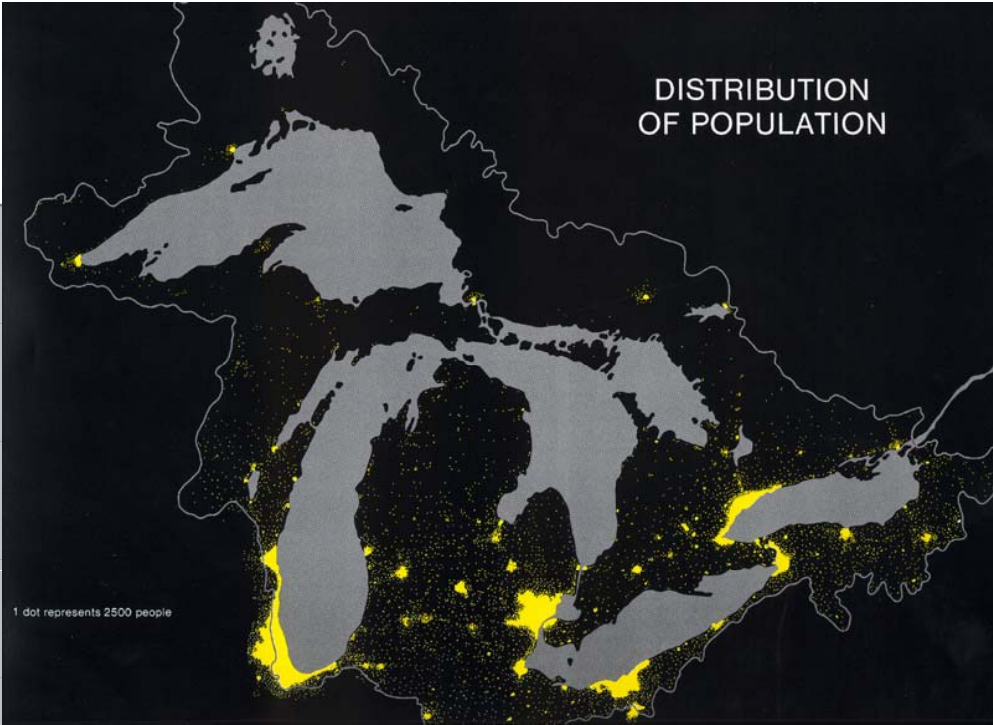


# Criticisms of Ontario Beach Quality

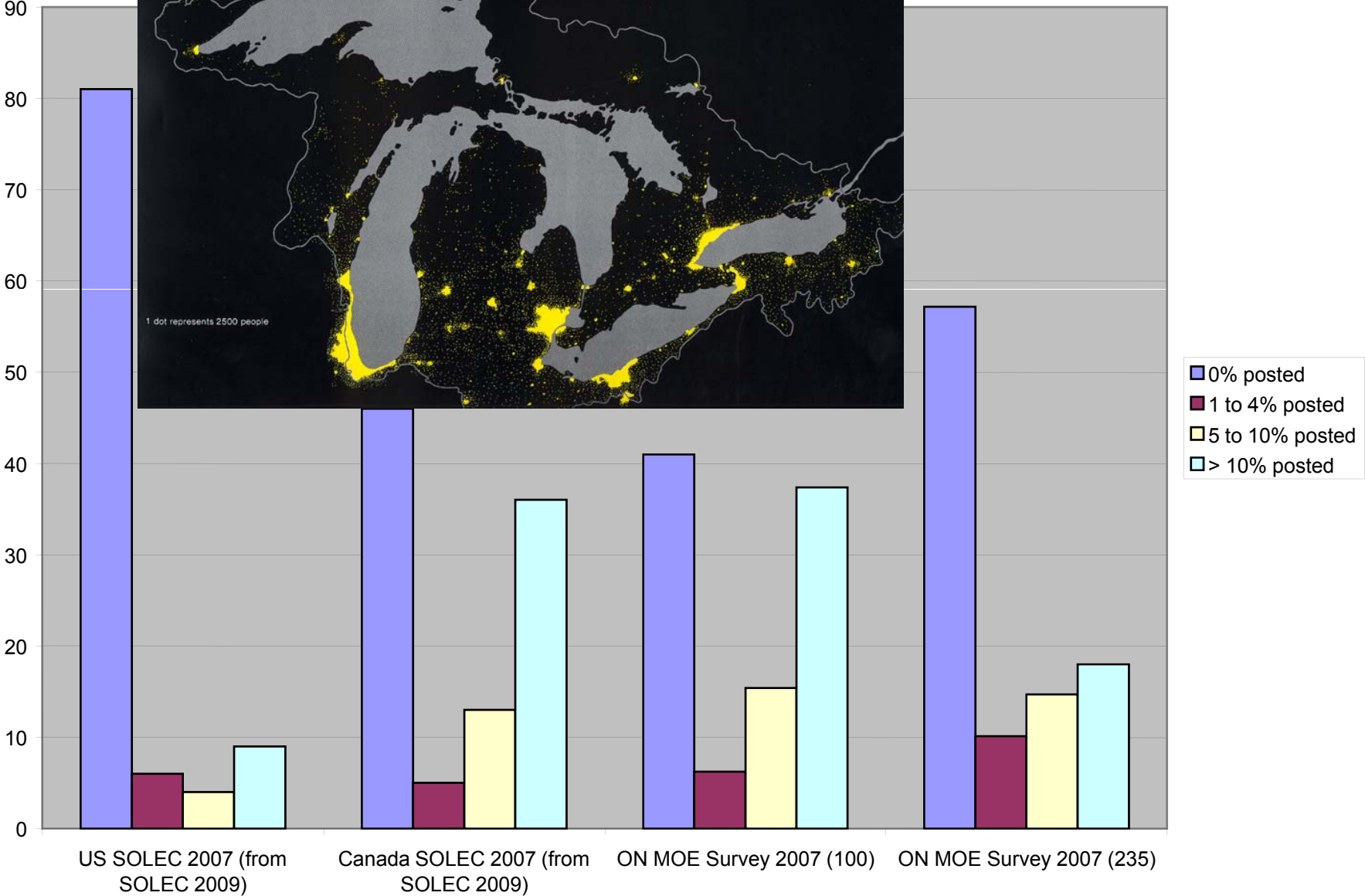


“The quality of beaches in Ontario is “poor” and “deteriorating” over time not just for Lake Erie, but also for Lake Ontario. For 2006-07, only a quarter of beaches on our side of Lake Ontario were clean enough for swimming over 95 per cent of the beach season. Beaches on the U.S. side of the lake were much cleaner.”

ECO Report (2010)

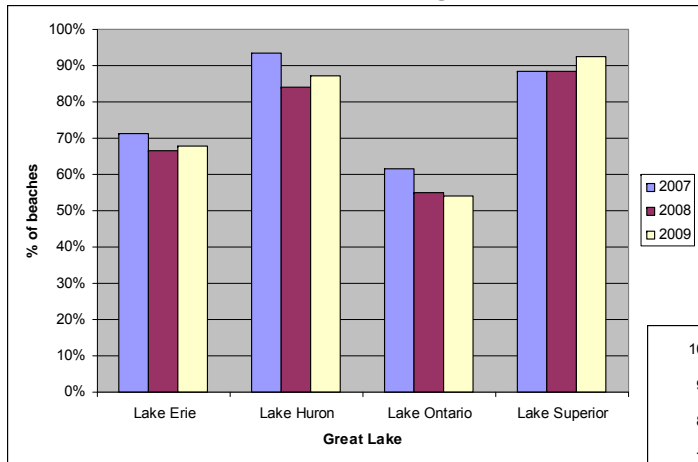


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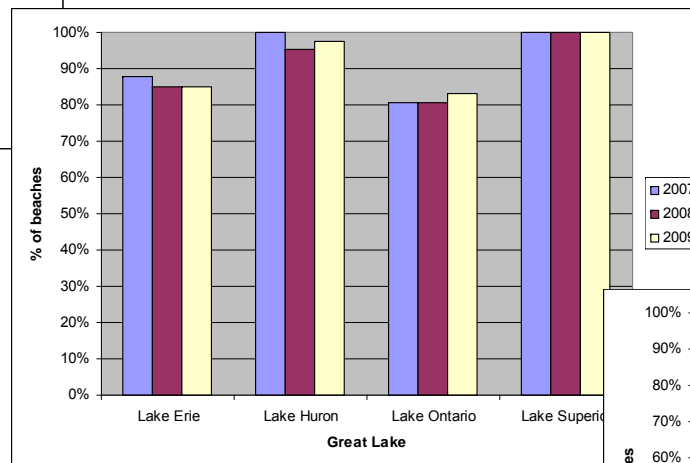
# Influence of Standard

- Retrospective look at beach postings using USEPA SSM (235) and Health Canada SSM (400) values
- Not surprisingly, making the standard less stringent would reduce the number of beach postings

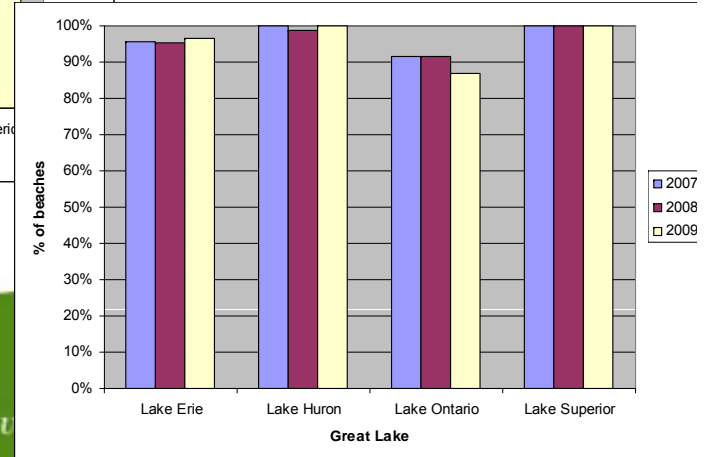


100 cfu/100ml

At 235 ≈ 95% meet GLSLCI goal  
At 400 ≈ 98% meet GLSLCI goal



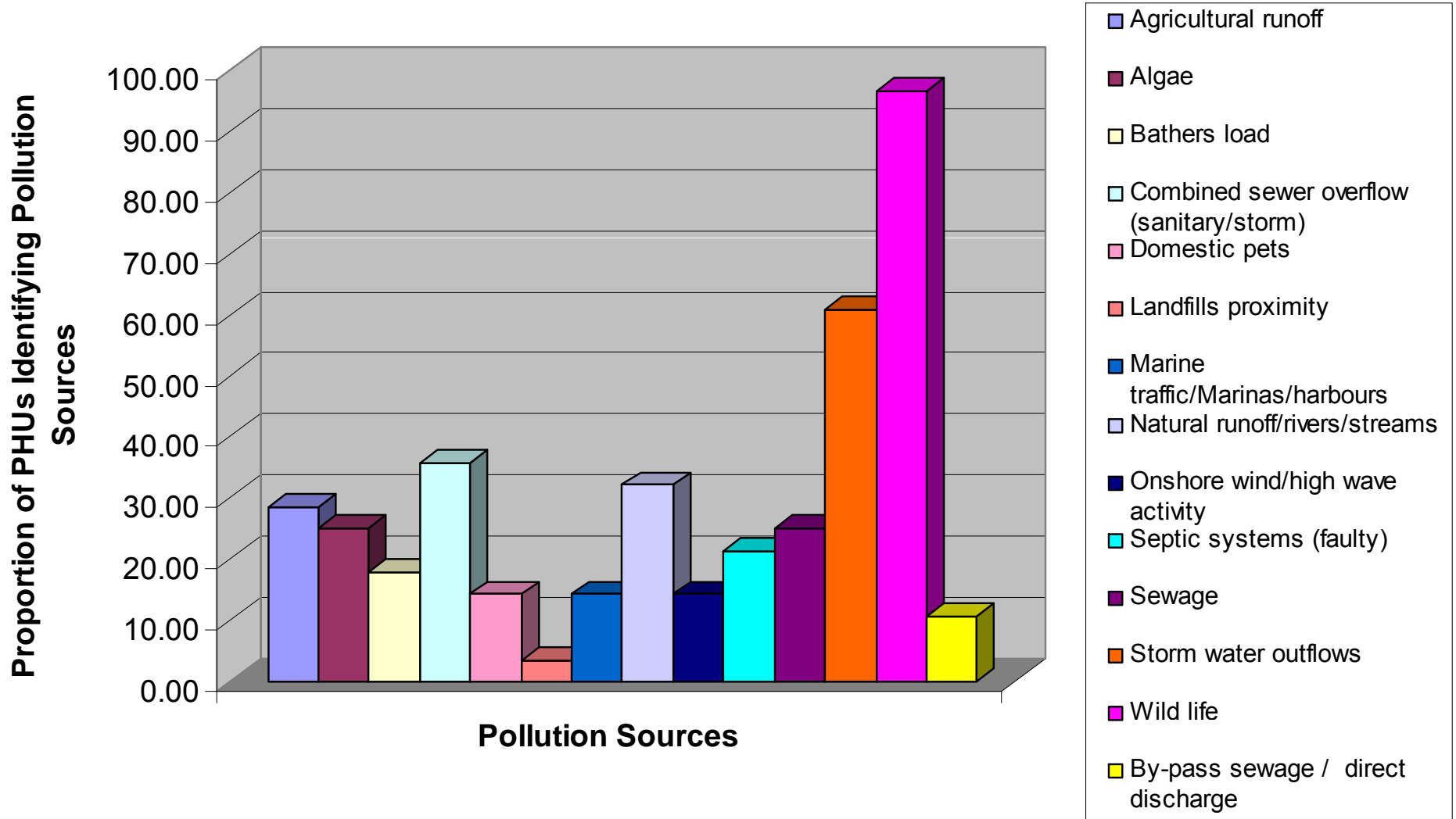
235 cfu/100ml



400 cfu/100ml

## Sources of Beach Bacterial Contamination

### Pollution Sources Identified by Public Health Unit



A stylized, light gray illustration of the Toronto skyline, featuring the CN Tower and several skyscrapers, positioned behind the main title. The illustration is set against a white background with a gold wave at the top and a green wave at the bottom.

# Toronto Beach Modeling Project

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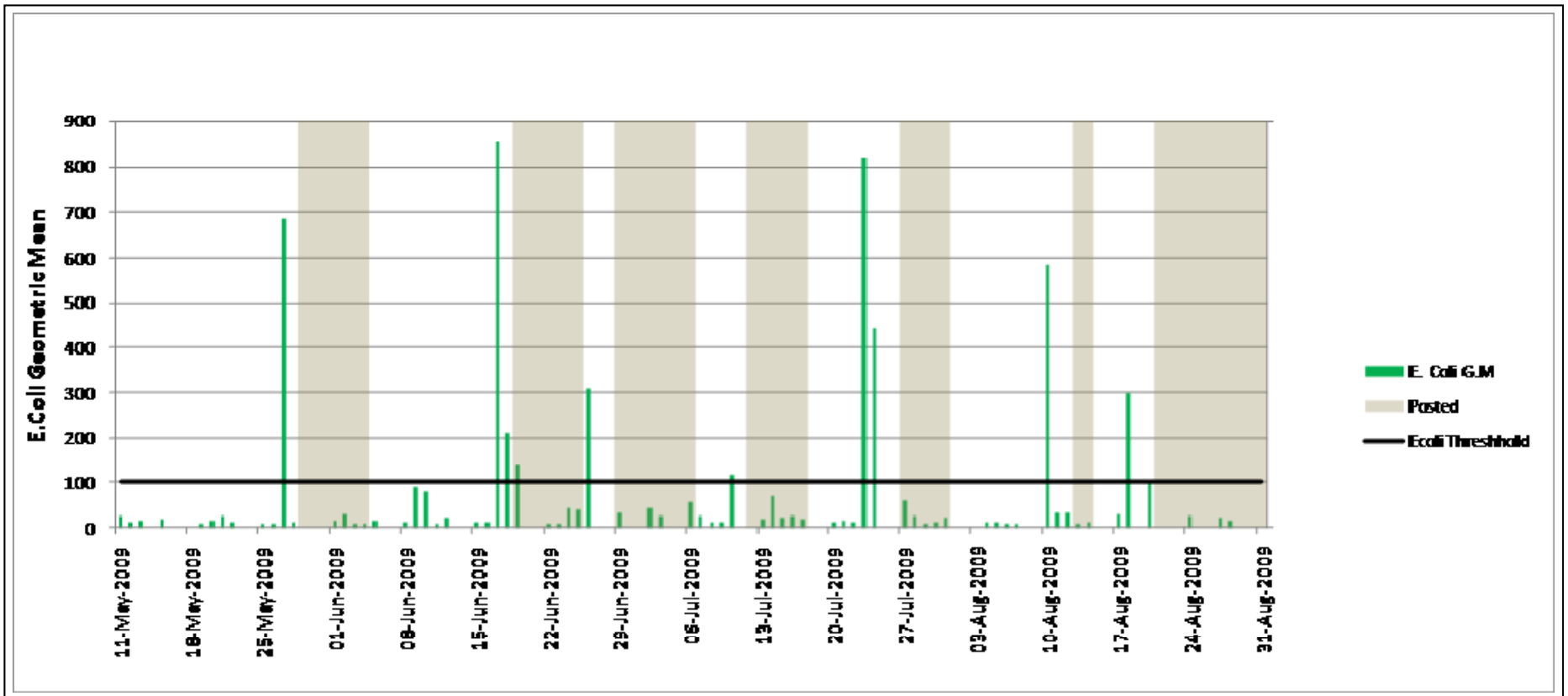


Ontario

## Benefit of Beach Forecasting Models

- Decisions to close beaches are based primarily on the assumption that *E. coli* concentrations persist for a number of days following sampling (persistence model).
- Studies show that this method has a relatively low success rate as *E. coli* rates can fluctuate considerably over a 24h period
- Several models that predict *E. coli* levels are being used (primarily in US) which seem able to predict *E. coli* levels better than persistence model

# Beach Posting Based on “Persistence Model”



Credit: Glen Hudgin (NRPH)

# Beach Forecasting Model Project

- MOE working with City of Toronto (Toronto Water, TPH) on project
- Contracted Fuss and O'Neill (Dr. Diane Mas, lead investigator) who has extensive experience in developing beach forecasting tools (multiple regression and ANN)
- Tasks
  - Identify 3-5 Toronto beaches of interest for model development
  - Analyze 2-3 years of water quality data for influencing factors
  - Develop draft models for beaches (tiered approach)
  - Refine models over 2010 beach season
  - Discussion document on requirements to roll out process to other beaches in ON

# Test Beaches

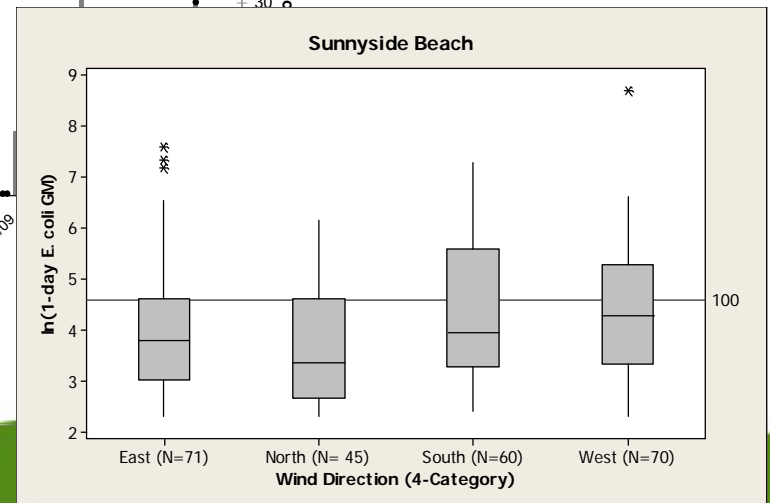
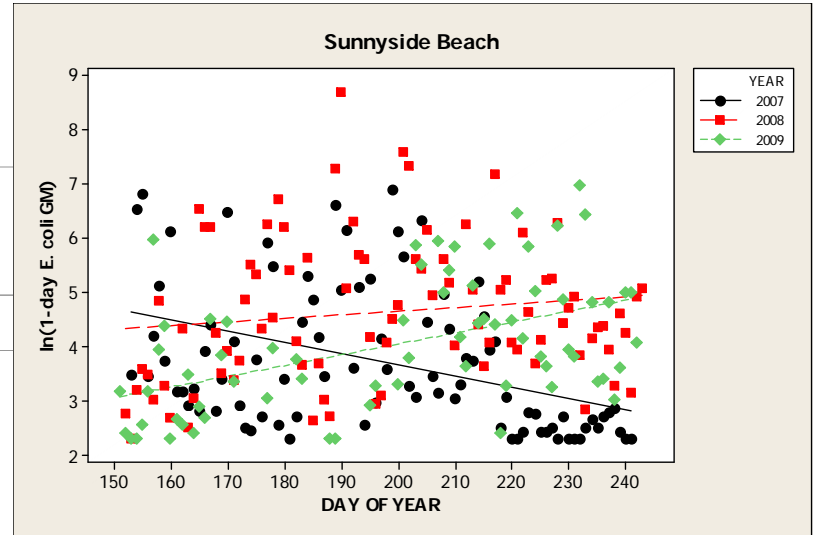
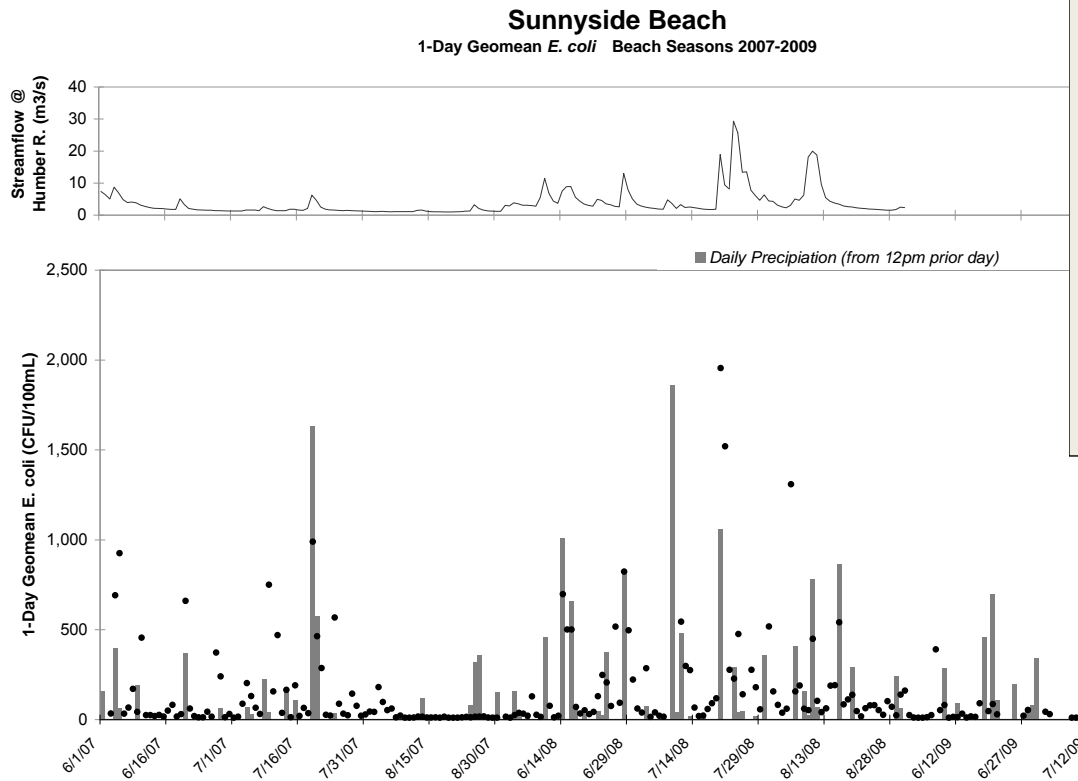


# Analysis of Posting data - False Positive/Negatives

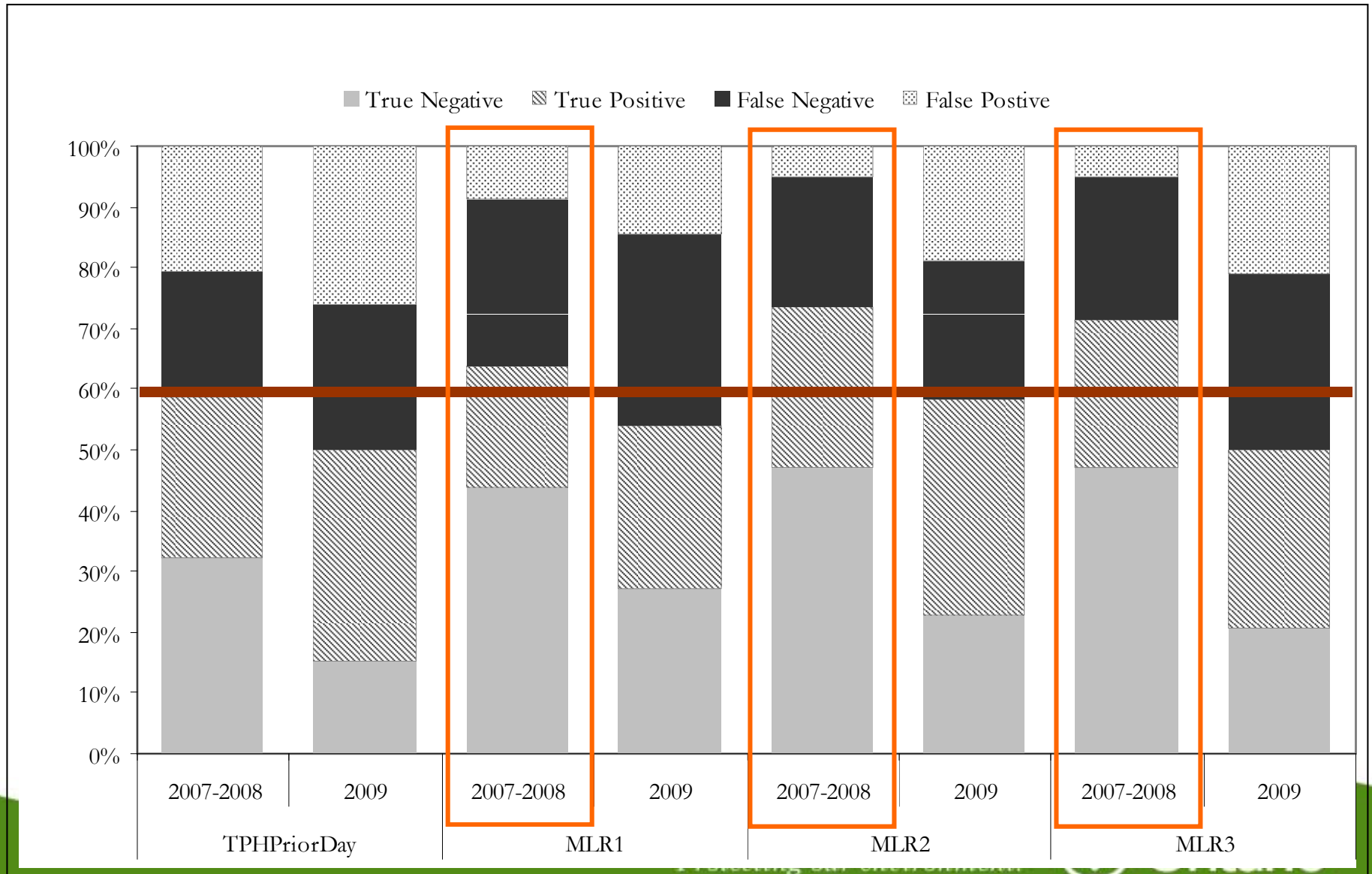
- “false negative” - beach was not posted when the measured 1-day geometric mean of *E.coli* samples > 100
- “false positive” - beach was posted although the measured 1-day geometric mean of *E.coli* < 100.

Beach	Days 1-day GM > 100 per 100 ml	Days posting agreed with same day <i>E. coli</i> GM	Days beach open with <i>E. coli</i> GM > 100 per 100 ml (False Negative)	Days beach posted <i>E. coli</i> GM < 100 per 100 ml (False Positive)	Percent False Negative
Marie Curtis Park East Beach	51	30	17	20	19.8%
Sunnyside Beach	42	28	12	20	13.5%
Hanlan's Point Beach	6	0	6	7	7.0%
Gibraltar Point Beach	5	1	4	2	4.7%
Centre Island Beach	12	2	9	6	10.6%
Ward's Island Beach	13	4	7	5	8.2%
Cherry Beach Park	14	2	11	8	12.4%
Woodbine Beaches	5	1	4	3	4.5%
Kew Balmy Beach	10	1	9	11	10.0%
Bluffer's Beach Park	16	4	12	10	13.3%
Rouge Beach	31	16	15	21	16.5%
Total	205	89	106	113	11.0%

# Analyzing Relationships



# Development of Beach-Specific Models



# Data Entry Screen

Explanatory Variables		Value	Notes
Date		8/6/08	
Rainfall	24-hr Rainfall (mm)	11.4	24-hr rainfall is measured rainfall at the University of Toronto for the 24 hour period ending at noon on the day of sample collection.
	48-hr Rainfall (mm)	11.4	48-hr rainfall is measured rainfall at the University of Toronto for the 48 hour period ending at noon on the day of sample collection.
	Previous day 24-hr Rainfall (mm)	0	Previous day 24-hr rainfall is measured rainfall at the University of Toronto for the 24 hour period ending at noon on the day previous of sample collection.
Streamflow	Etobicoke Streamflow (cms)	5.81	Mean Daily Streamflow of Etobicoke Creek at the monitoring station below Queen Elizabeth Highway
	Humber Streamflow (cms)	5.03	Mean Daily Streamflow of Humber River at the monitoring station at Weston
	Rouge Streamflow (cms)	3.06	Mean Daily Streamflow of Rouge River at the monitoring station near Markham
Lake Level (m)		0.918	Lake Ontario (Station 13320)
Average WindSpeed (km/h)		11.2	
Wind Direction	North Wind	0	Mark Only the Primary Wind Direction with "1", the other three are "0"
	East Wind	1	
	West Wind	0	
	South Wind	0	
Day of the Year (1 to 365)		219	Calculated based on Date entered in Cell C2
<b>Beach-Specific Data</b>			
Sunnyside Beach	Prior Day 1-day GM E. coli (#/100mL)	1309	
	Water Temperature (C)	19.7	
Woodbine Beaches	Turbidity (NTU)	8.6	
	Prior Day 1-day GM E. coli (#/100mL)	6.3	
Ward's Island Beach	Prior Day 1-day GM E. coli (#/100mL)	9.4	
Kew Balmy Beach	Prior Day 1-day GM E. coli (#/100mL)	6.1	
	Wave Height Group (1=low; 2=moderate; 3-high)	1	

# Prediction Screen

## Marie Curtis Park East Beach

### Multiple Linear Regression (MLR) Models

Model	$b_0$	$b_1 * \ln(\text{Etobicoke Streamflow (cms)})$	$b_2 * \text{South Wind}$	$b_3 * \text{West Wind}$
MLR#1	4.33	0.646		
MLR#2	4.41	0.702	0.736	-0.94
MLR#3	4.78	0.755		-1.68

### Logistic Regression (LR) Model

Model	$b_0$	$b_1 * \ln(\text{Etobicoke Streamflow (cms)})$	$b_2 * \text{West Wind}$
LR#1	0.662	0.987	-2.967

### Prediction

Data			
Date	$\ln(\text{Etobicoke Streamflow (cms)})$	South Wind	West Wind
06/08/2008	1.760	0	0

$\ln(1\text{-day GM } E. coli \text{ (#/100mL)})$			1-day GM <i>E. coli</i> (#/100mL)		
MLR#1	MLR#2	MLR#3	MLR#1	MLR#2	MLR#3
5.47	5.65	6.11	237	283	450

Exceedance Probability
LR#1
0.92

## Conclusions and Next Steps

- MLR and/or LR models using readily available data provide better overall correct classification and higher R-squared values than existing empirical model
- No single set of variables is applicable for all beaches
- Best candidates for predictive modeling are beaches with:
  - A greater number of exceedances
  - An obvious driver of water quality
- Findings are consistent with performance of models developed for other freshwater beaches
  
- Testing of models at Toronto Beaches over Summer 2010
- Refinement of models
- Discussion document on moving approach to other Ontario beaches
  
- However, Nevers (2009) wrt predictive models in the Great Lakes .....
  - Models for beaches with typically lower E. coli concentrations had poorer predictive performance
  - *“despite the attractiveness of predictive models as an alternative beach monitoring approach, it is likely that indicator bacteria fluctuations at some beaches defy simple prediction approaches”.*

Thank You

