The Metropolitan

Water Reclamation District

of Greater Chicago

WELCOME
TO THE JULY EDITION
OF THE 2014
M&R SEMINAR SERIES

BEFORE WE BEGIN

- **PLEASE SILENCE CELL PHONES & SMART PHONES**
- **QUESTION AND ANSWER SESSION WILL FOLLOW PRESENTATION**
- **PLEASE FILL EVALUATION FORM**
- **SEMINAR SLIDES WILL BE POSTED ON MWRD WEBSITE (www. MWRD.org: Home Page ⇒ Reports ⇒ M&R Data and Reports ⇒ M&R Seminar Series ⇒ 2014 Seminar Series)**
- **STREAMING VIDEO WILL BE AVAILABLE ON MWRD WEBSITE (www.MWRD.org: Home Page ⇒ MWRDGC RSS Feeds)**

Brendan Daley

Current: **Director of Strategy and Sustainability, the Chicago Park District.**
Manage the strategic plan

Experience: **Director of Green Initiatives for the Chicago Park District.**
Overseeing environmental remediation management, brownfields work, river issues relating to the District, overall stormwater and water conservation efforts, utility management and energy efficiency initiatives, and the District's beach monitoring and notification program.
Deputy Commissioner, Chicago Department of Environment,
Overseeing Energy & Air Quality Division,
Legislative Liaison,
Project Coordinator, Permitting & Enforcement & Natural Resources Divisions

Education: BA in Political Science, Roosevelt University
LLB in Law from Queen's University Belfast, Northern Ireland

Professional: LEED accredited professional with the US Green Building Council
Certified Park and Recreation Professional through the National Recreation and Parks Association.

Meredith B. Nevers

Current: **Research ecologist with the U.S. Geological Survey, Great Lakes Science Center in Porter, Indiana.**

Experience: Worked with the USGS for the past 17 years.

- Research interests in microbiological contamination of beaches, water and public health microbiology, impact assessments on biological communities, and aquatic ecology.
- Extensive publication on beach science and improving monitoring accuracy through predictive modeling as well as in the ecology and natural occurrence of indicator bacteria.
- Leader of the Environmental Health theme research at the science center

Education: B.A. in biology/English from Wittenberg University
M.S. in marine biology from the University of North Carolina at Wilmington

Professional: President-elect for the Great Lakes Beach Association
Active member of the American Society for Microbiology
Active member of the International Water Association (IWA)

Predictive Modeling in Chicago

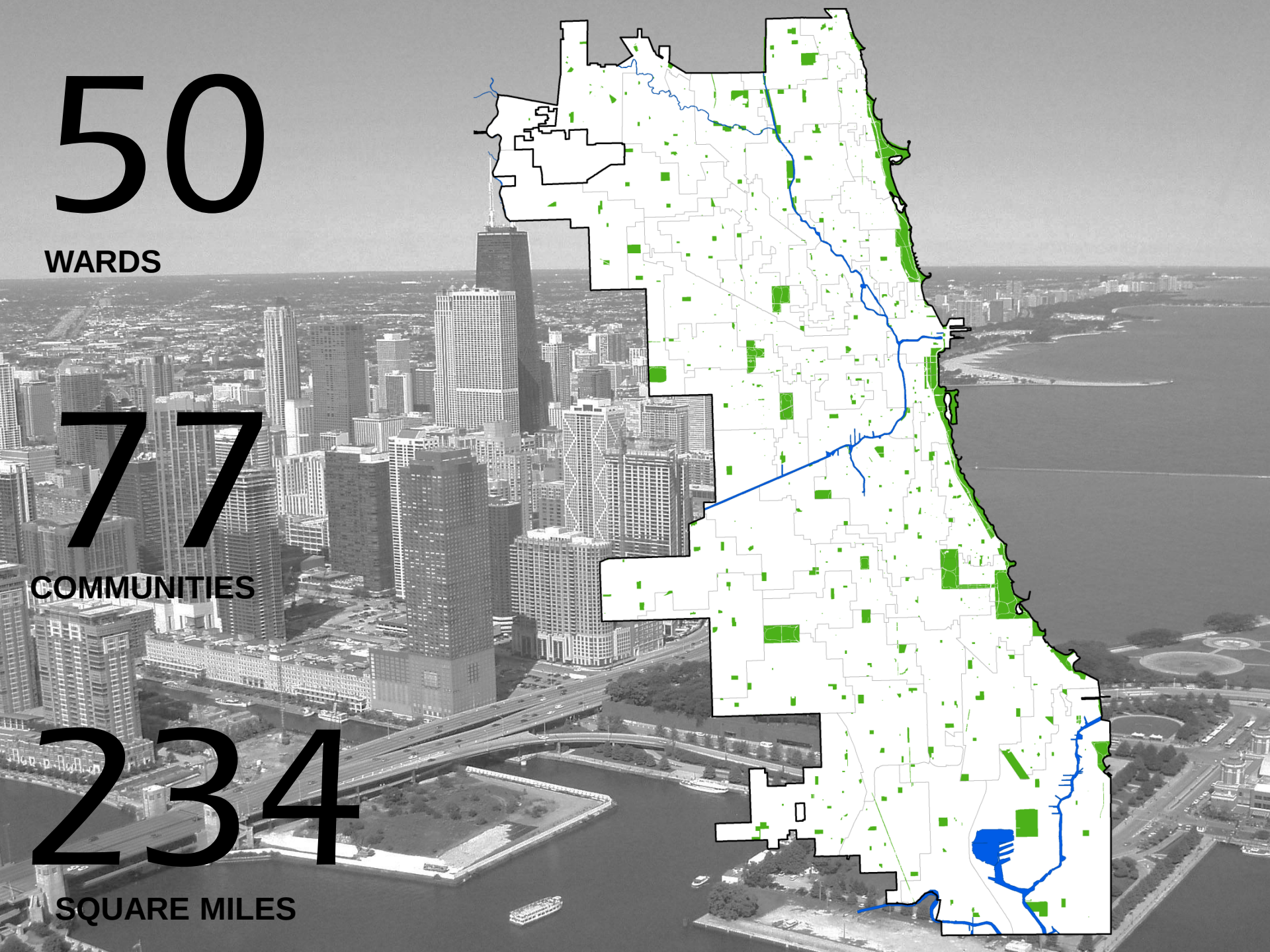
Meredith Nevers
US Geological Survey

Brendan Daley
Chicago Park District


CHICAGO
PARK DISTRICT


CHICAGO
PARK
DISTRICT

BIRD'S-EYE VIEW OF THE BUSINESS DISTRICT OF CHICAGO


50
WARDS
77
COMMUNITIES
234
SQUARE MILES

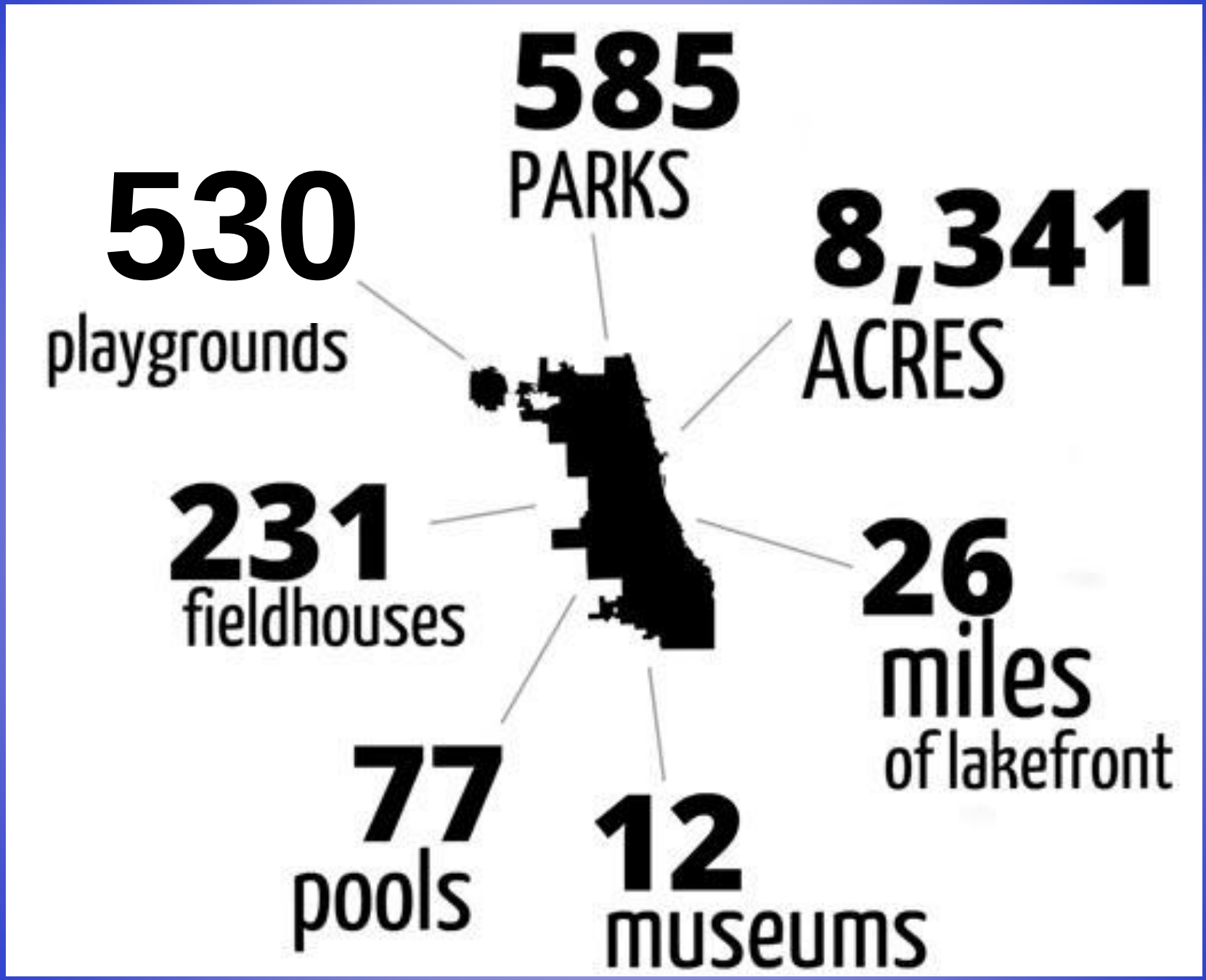

585
PARKS
530
playgrounds
8,341
ACRES
231
fieldhouses
26
miles
of lakefront
77
pools
12
museums

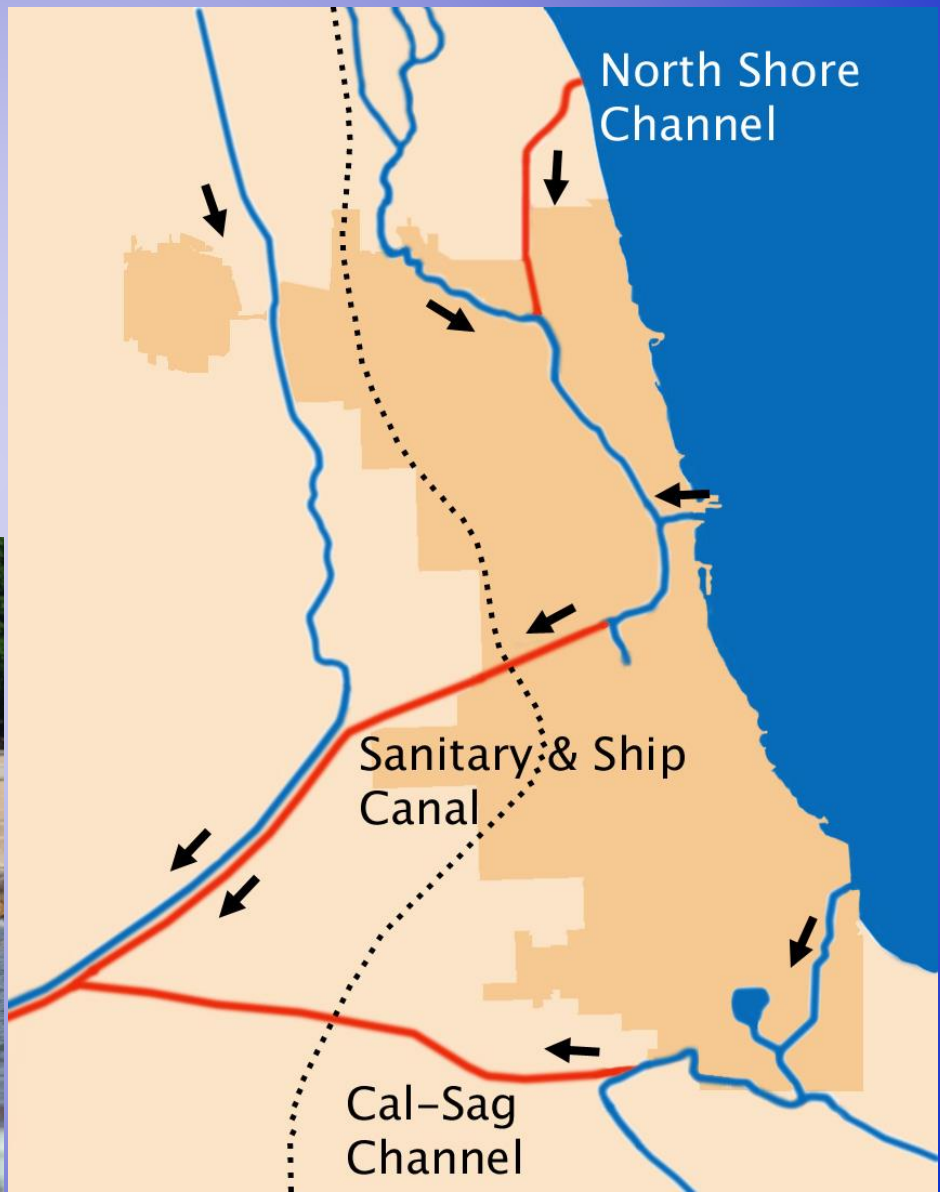
Photo by: Michael Chrzastowski, Illinois State Geological Survey

Chicago's Beach Water Quality

- CPD monitors each beach for E. coli bacteria a minimum of 5 days per week.
- We use the federal single sample maximum standard of 235 mpn/100 ml, and the 18-hour Colilert method for analyzing samples.
- The standard is based on a statistical association with the rate of gastrointestinal illness:
  235 = 0.8 percent risk
  (yellow flag – swim advisory)

Chicago's Beach Water Quality

- Causes of advisories in Chicago:
  - Gull / wildlife / pet waste
  - Bather load (people in the water shedding bacteria)
  - Stormwater
  - Regional & unknown
  - Very rarely human sewage
- Advisories also issued based on weather



Metropolitan Water Reclamation District *of* Greater Chicago

Press Release

Allison Fore
Public and Intergovernmental Affairs Officer
312.751.6632
allison.fore@mwrd.org
100 East Erie Street, Chicago, Illinois 60611

For immediate release
July 1, 2014

Severe storms impact Cook County

The Metropolitan Water Reclamation District of Greater Chicago (MWRD) has been working around the clock to provide flood protection for Cook County. All systems are running at full capacity as an average of 1.83" fell across Cook County: 3.08" in the north, 1.45" central and 1.63" in the south. Today's rain event began at 7 p.m. on June 30 and ended at 1:35 a.m. this morning.

When the Chicago area waterway levels are higher than Lake Michigan and certain elevations are reached, the MWRD opens control structures to move as much water as possible out of the system. This provides overbank flooding protection as well as more capacity for stormwater. The gates at Wilmette were opened at 11:23 p.m. and closed at 5:50 a.m. The gates on the Chicago River Controlling Works downtown were opened at 12:58 a.m. and closed at 7:10 a.m. The amount of

Daily Maintenance

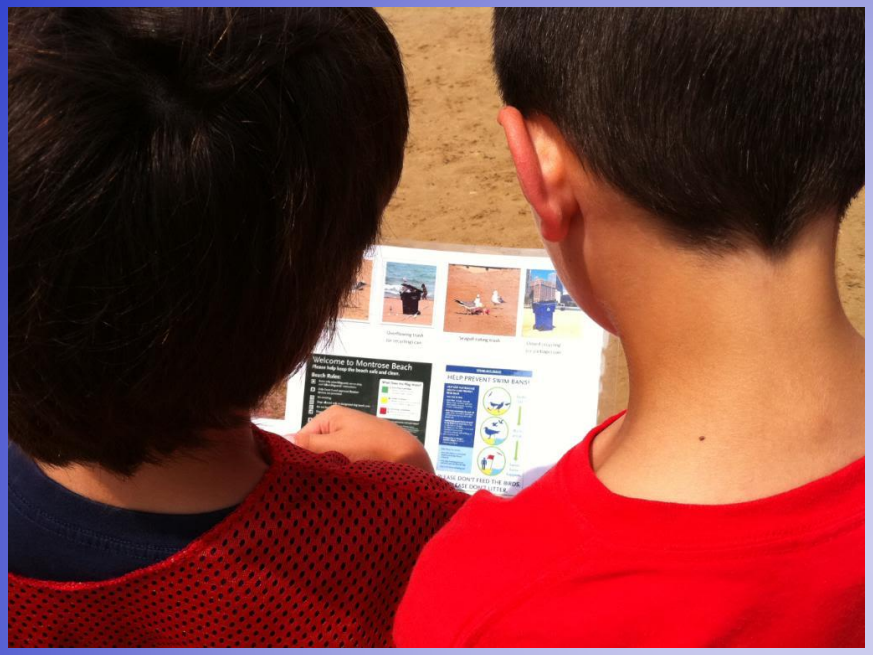
All beaches are
Groomed seven days per week

Rakes with deep tines were specially designed for Chicago

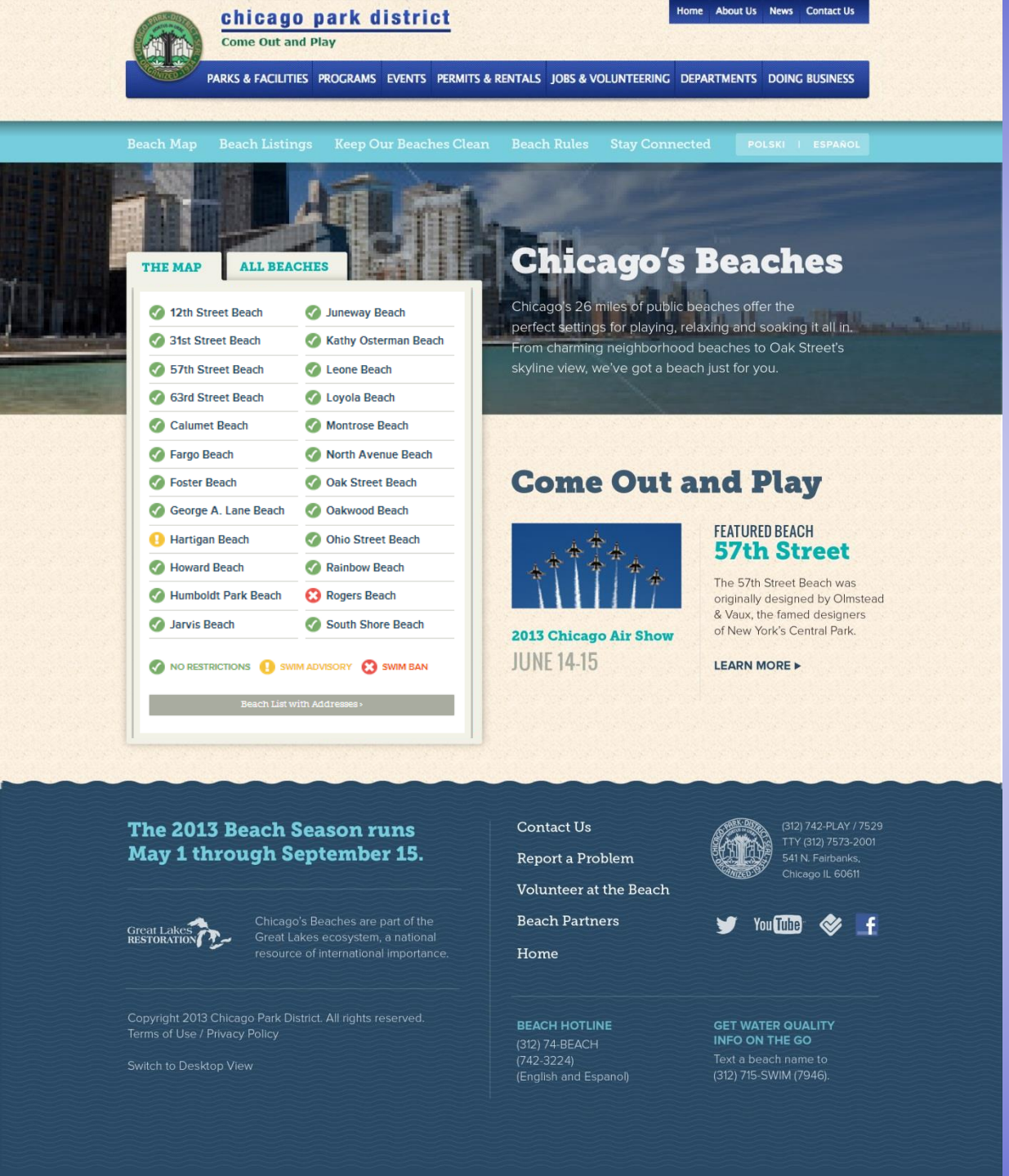
Trash & recycling are collected in lidded containers to minimize the attraction to gulls

Beach Grooming

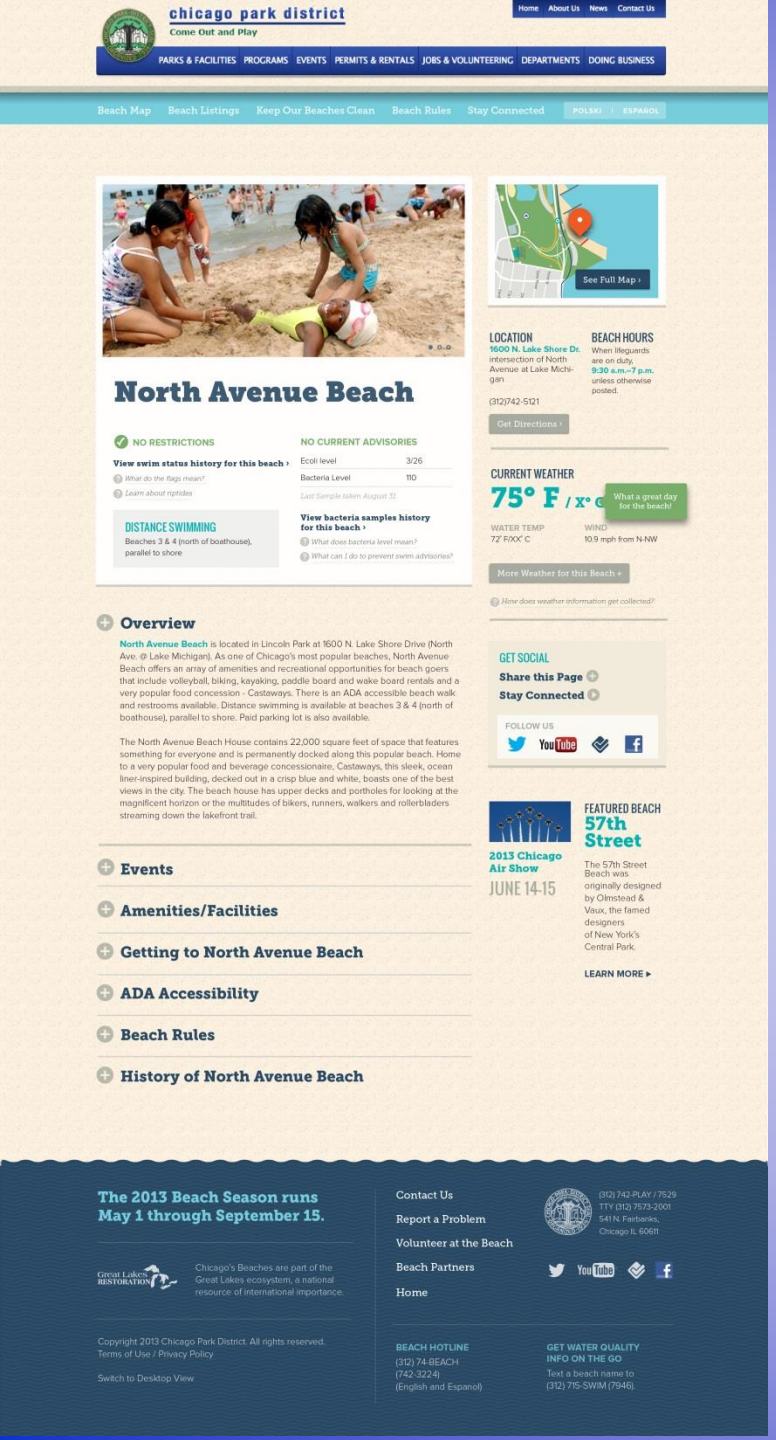
Beach Ambassadors



- Direct outreach to the public to provide info on beach health and encouraging people not to feed the birds and clean up after themselves
- Activity for CPD summer camps at beaches



New Beaches Website



Site features

- Interactive & comprehensive map
- Responsive design for mobile and tablet use
- Map, beach list and beach pages will reflect swim status at the beach (swim advisories and bans)
- Dynamic weather data will update hourly
- Pilot project with Google = additional visibility

Swim Status: No restrictions

Reason (if Advisory or Ban): _____

Water Temperature: 70 degrees

What does the water quality test result mean?

The Chicago Park District tests the water for *E. coli* bacteria. *E. coli* is not harmful itself and is naturally occurring in the environment. However, this bacteria is an indicator of the presence of other germs that could make you sick. US Environmental Protection Agency (EPA) beach policy recommends notifying the public when *E. coli* bacteria levels are above the federal water quality standard, which is 235*. This standard is used at beaches throughout the Great Lakes region.

According to the EPA, the number 235 corresponds to a risk level of 0.8% of swimmers becoming sick to their stomachs – or 8 out of 1000 people. For comparison, a bacteria level of 1000 corresponds to a 1.4 % risk, and a bacteria level of 2000 corresponds to a 1.8% risk.

The Chicago Park District, in partnership with the US Geological Survey, has also developed statistical models that use weather data to predict the bacteria levels in real-time. These models provide information about water quality in real-time, compared to 18-24 hours to get results from a lab for traditional water quality testing. The models were developed with grant funding from the EPA's Great Lakes Restoration Initiative.

*The unit of measurement for water quality testing is CFU/100 ml; which stands for colony forming units of *E. coli* per 100 milliliters of water.

Most recent water quality test result:

124 (Test result) 6/30/12 (Date of test)

Predicted water quality today:

54

chicago park district

Please do your part to keep this beach clean. Properly dispose of garbage and recycling, don't feed the birds, pick up pet waste, and use waterproof swim pants for babies and toddlers.

For more information, please visit
www.chicagoparkdistrict.com/facilities/beaches

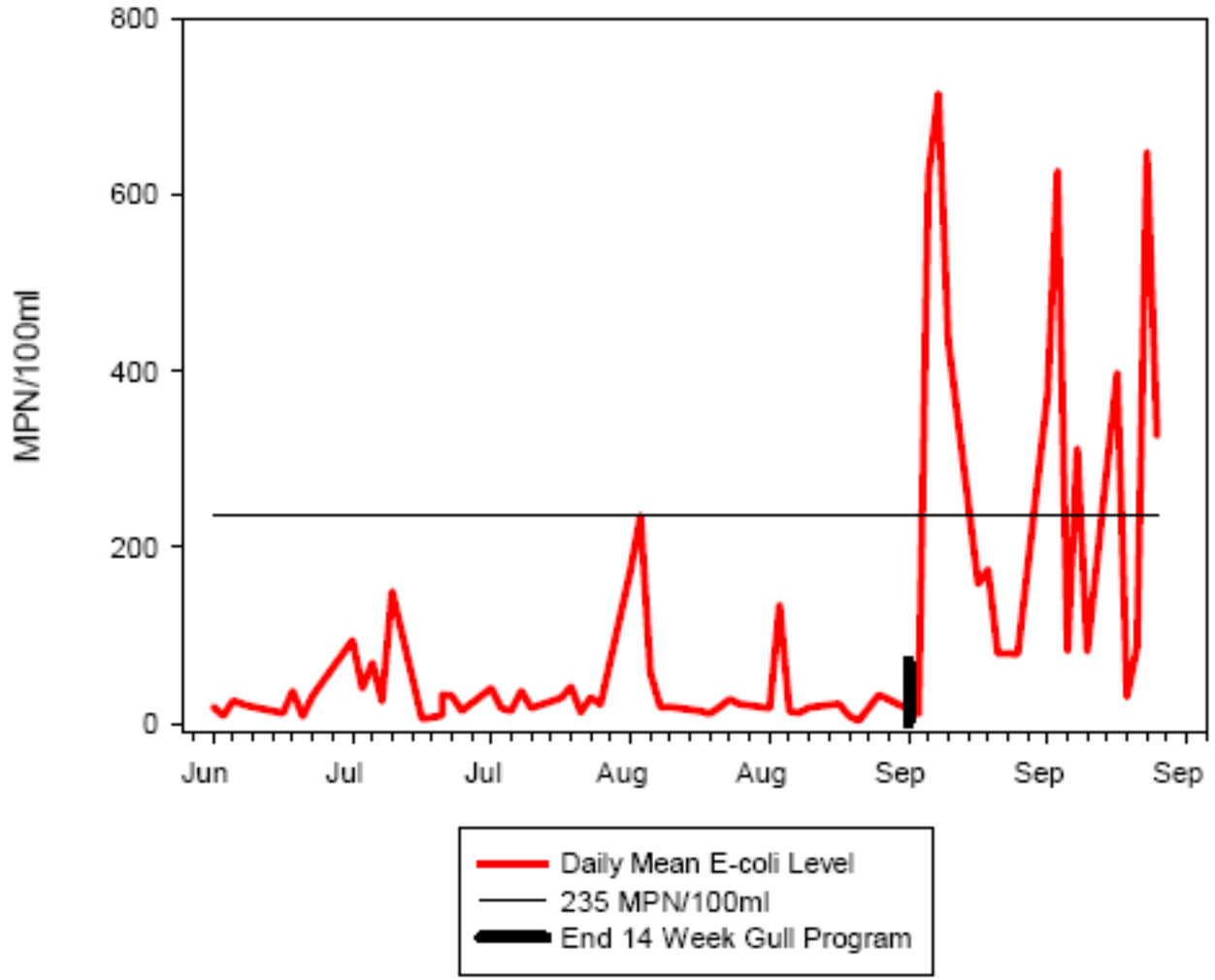
Gull Management

↑ Ring-billed gull nesting colony at Dime Pier
Gulls snacking on trash at 63rd Street Beach →

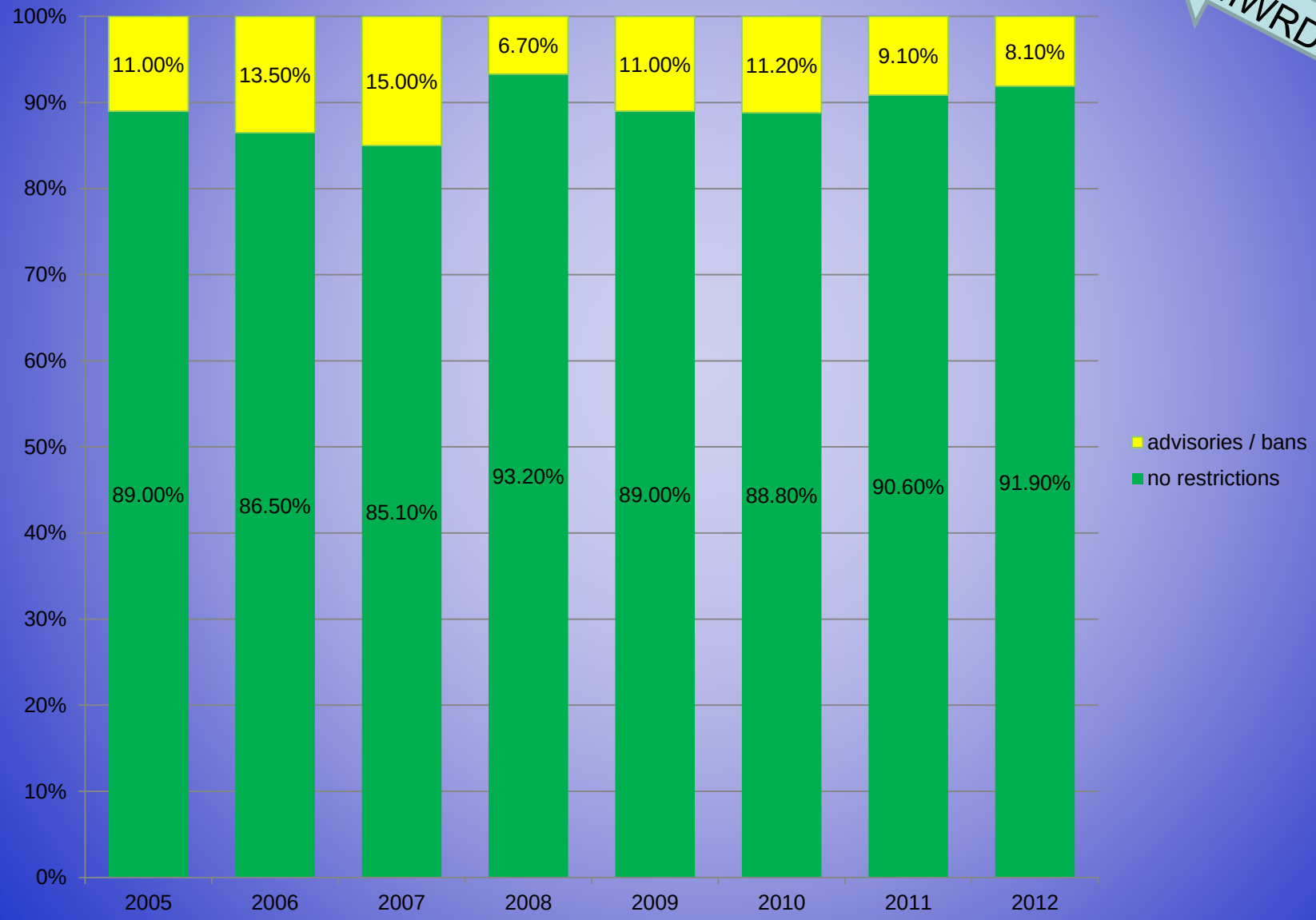
Wildlife Services
Protecting People
Protecting Agriculture
Protecting Wildlife

Gull Management

Chicago Park District
63rd Street Beach
Escherichia coli Daily Means

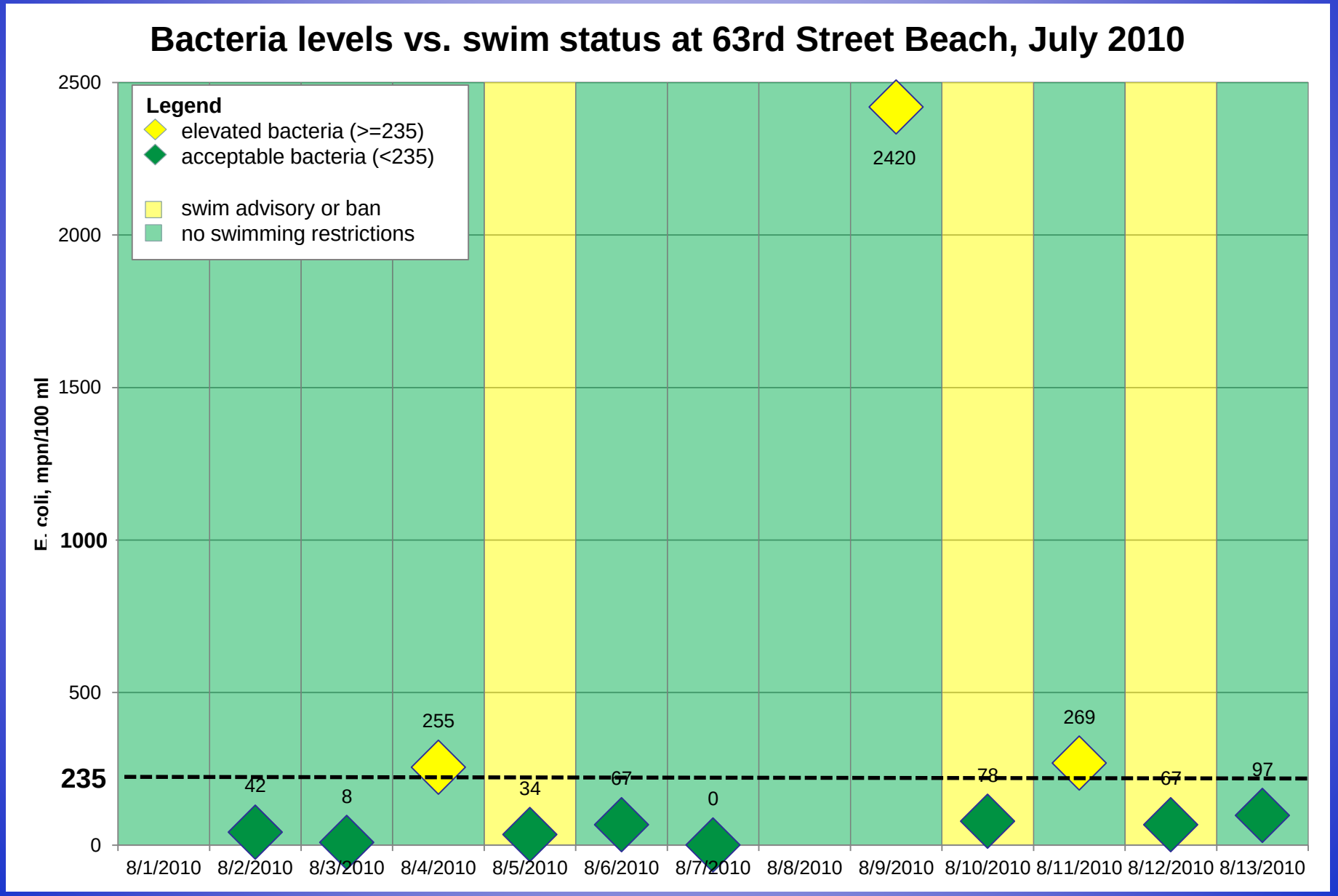


Advisories due to water quality exceedances at all beaches, 2005 – 2012 (*figure also includes precautionary bans due to river reversals)



MWRDGC

Why predictive modeling?



2010 GLRI grant: development of predictive models for water quality

- $250,000 for equipment and contractual work (technical support and statistical work)
- Local funds: $75,00 in capital funds, plus significant operating support

- Partnership with USGS Lake Michigan Ecological Research Center

Year One (2011): Data collection during beach season
Model development during winter

Year Two (2012): Initial deployment of 5 models at 15 beaches
Model refinement and expansion during winter

Year Three (2013): Deployment of 9 models at all lakefront beaches

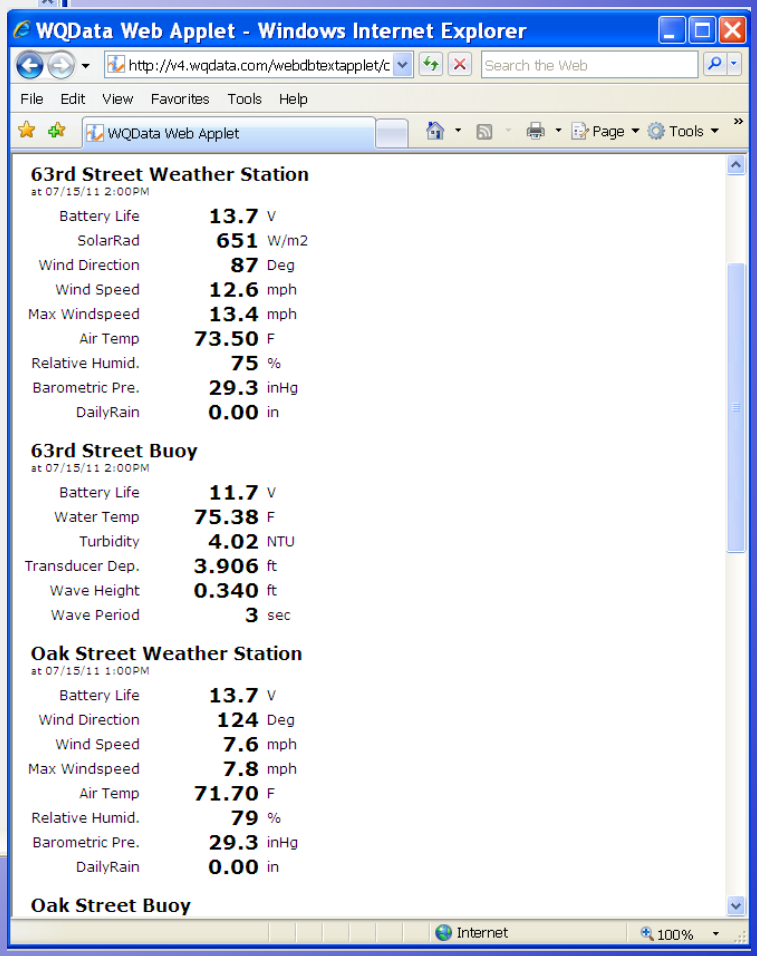
Ongoing: Further refinement of models & decision making protocols;
2014 continue predictive model at all lakefront beaches

Weather Station Installation

Buoy Installation & Maintenance

Buoy Maintenance

Real-time data available online



How does it work?

Equipment on lakefront measures weather/surf parameters

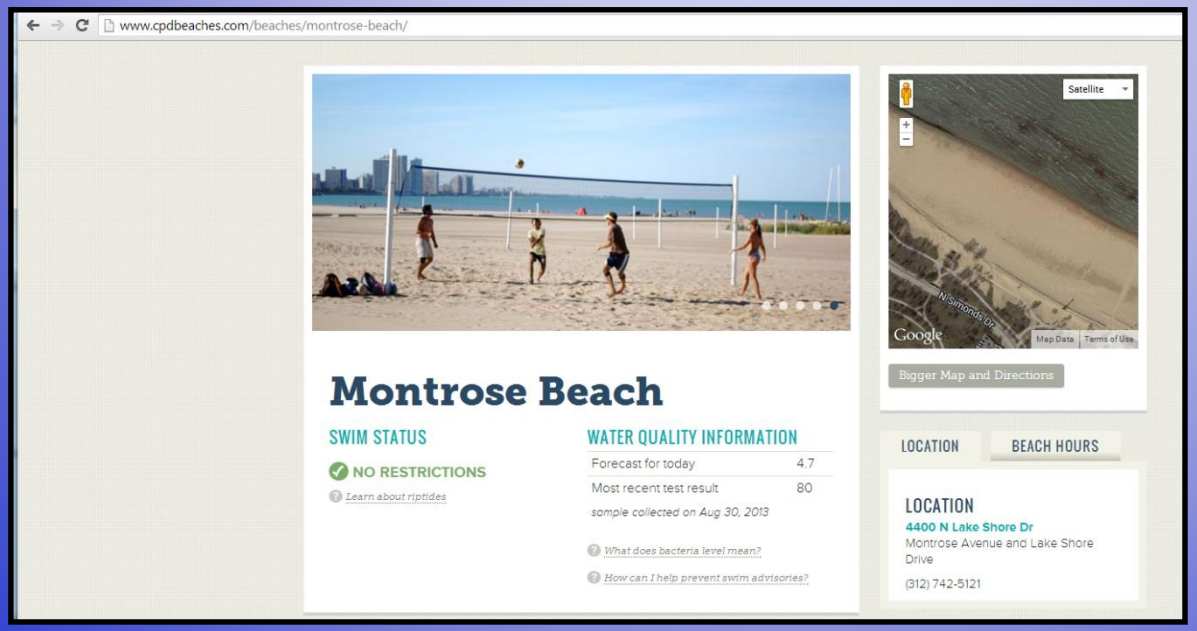
Data sent to web hosting service by cellular modem once per hour

Executable program calculates modeling results each morning at 8:30 AM

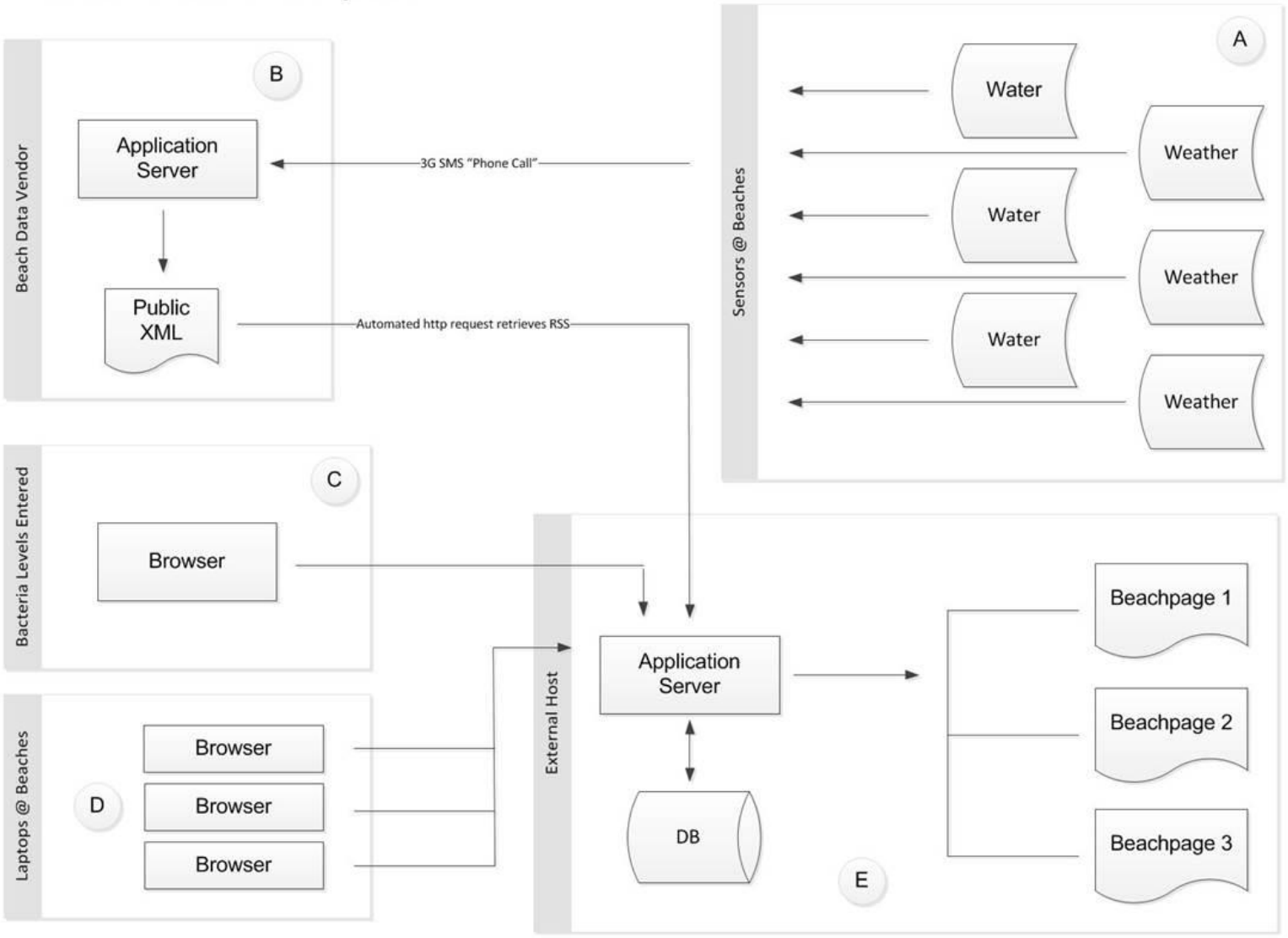
Example: Montrose Beach

Predicted log *E. coli*=2.038+(-0.006*solar radiation (4 hr))+(0.484*Log rainfall (24 hr))+ (-0.005*Day of year)+ (3.664*Log wave height (4 hr))

CPD website retrieves raw weather data and modeling results through RSS feed



Beach Data Transport



https://cms.cpdbeaches.com/showDataMap.cfm

Clear Logout Beach Alerts Sampling Points Chicago Feed Map Data www.cpdbeaches.com

MAPBEACHPAGE

beach page | devices | fields | data mapped 2 beachpage

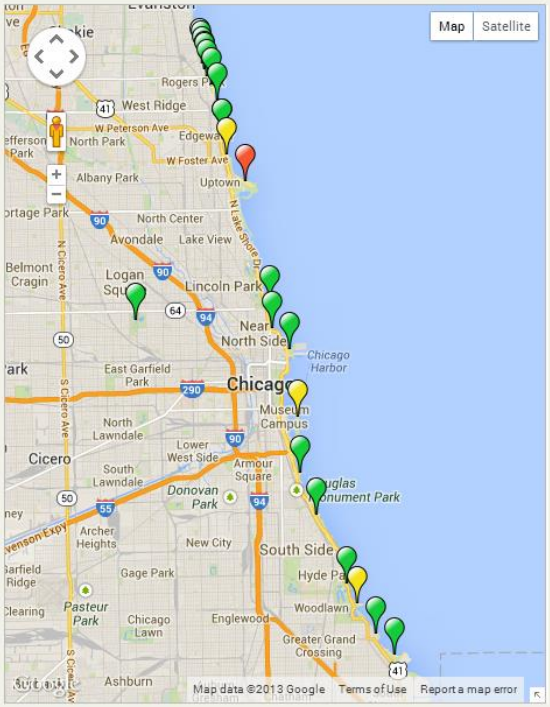
id	beachpage	buoy	weatherStation	model	samplingPoint
1	12th Street Beach	Ohio Street Beach	Oak Street Weather Station	Calumet Level	12th
2	31st Street Beach	63rd Street Beach	63rd Street Weather Station	Calumet Level	31st
3	57th Street Beach	63rd Street Beach	63rd Street Weather Station	63rd Street Level	57th
4	63rd Street Beach	63rd Street Beach	63rd Street Weather Station	63rd Street Level	Jackson-63rd
5	Calumet Beach	Calumet Beach	63rd Street Weather Station	Calumet Level	Calumet
6	Fargo Beach	Leone Beach	Oak Street Weather Station	Leone Level	Jarvis-Fargo
7	Foster Beach	Leone Beach	Oak Street Weather Station	Foster Level	Foster
8	Hartigan Beach	Leone Beach	Oak Street Weather Station	Leone Level	Hartigan
9	Howard Beach	Leone Beach	Oak Street Weather Station	Leone Level	Howard
10	Humboldt Beach	Not Mapped	Oak Street Weather Station	Not Mapped	Humboldt

Chicago Beaches 2013 | Home | CPDBeaches CMS

www.cpdbeaches.com/pages/home-map/

again on May 23, 2014.

BEACHES LIST | BEACHES MAP



Chicago's Beaches

Chicago's 26 miles of public beaches offer the perfect settings for playing, relaxing and soaking it all in. From charming neighborhood beaches to Oak Street's skyline view, we've got a beach just for you.

Come Out and Play!

Park Points

Sign Up For Park Points

FEATURED BEACH

Oak Street Beach

The mural entitled "You Know What You Should Do" by artist Jeff Zimmerman can be found along a wall running parallel to the Lakefront Trail at Oak Street Beach.

LEARN MORE ▶

The 2013 Beach Season runs

Contact Us

(312) 742-PLAY / 7529

Montrose Beach | Chicago × | Home | CPDBeaches CMS ×

www.cpdbeaches.com/beaches/montrose-beach/

Montrose Beach

SWIM ADVISORY

Swim advisory due to water quality

Learn about riptides

WATER QUALITY INFORMATION

Forecast for today	315
Most recent test result	80

sample collected on Aug 30, 2013

About Montrose Beach

New in July 2013: Montrose Beach offers free wifi for beach visitors.

This popular Uptown neighborhood beach located in Lincoln Park offers patrons many amenities. South of the recreational beach, a natural area attracts many migratory birds during the fall and spring seasons. A serene dune area hosts a rare "panne" habitat — a flat, wet and open sandy area — for birds. Endangered plant life thrives at this location.

Parking

DISTANCE SWIMMING

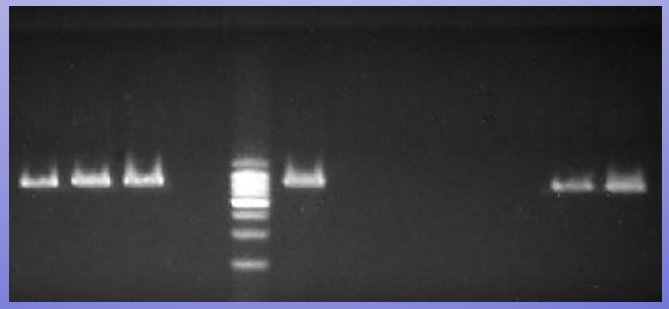
tower 4 (north of boathouse), parallel to shore

CURRENT BEACH WEATHER

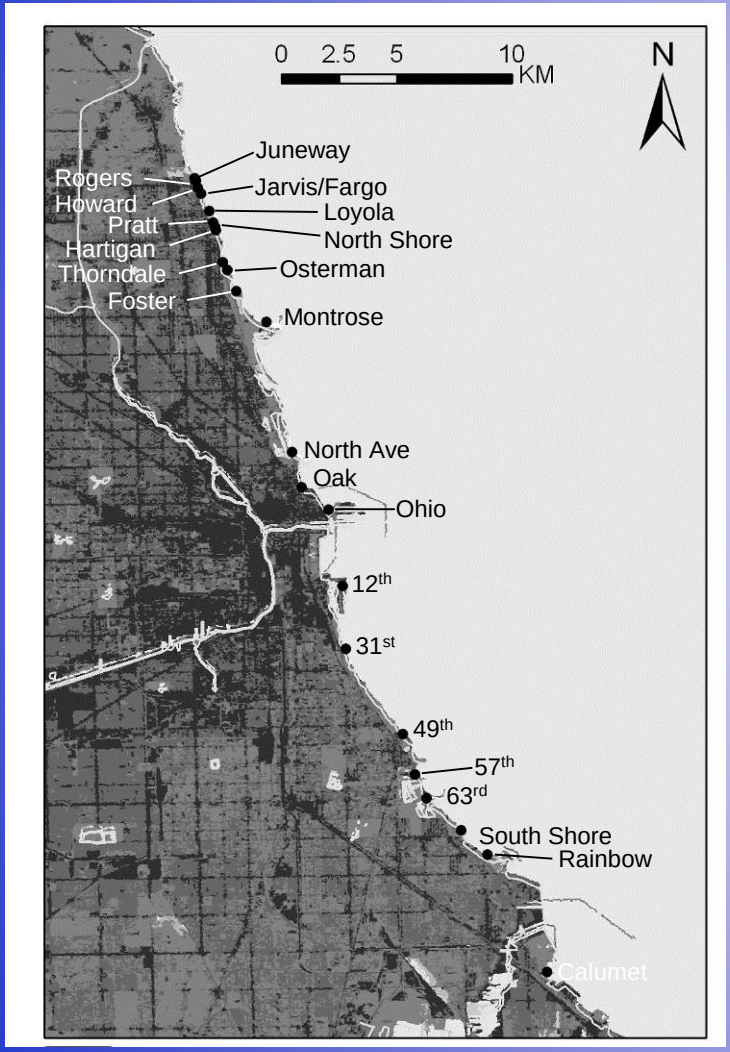
62.6° F/17° C

Multi-tiered Approach to Understanding Recreational Beach Water Quality

- Source of contamination
- Microbial source tracking
- Mechanistic modeling
- Empirical predictive modeling



Chicago Shoreline



23 Chicago beaches considered for model development

- No nearby river inputs
- Variable closure rates (13-37%)
- Urban development

Percent exceedances per year

Beach	Exceedances (%)		
	2011	2012	2013
Leone	6	7	6
Osterman	10	9	9
Foster	4	11	11
Montrose	21	25	32
Oak	4	0	5
Ohio	9	7	7
63rd	12	24	18
Rainbow	23	30	20
Calumet	13	16	17

Additional Sources of Fecal Indicator Bacteria


stormwater outfall


birds


sand resuspension by waves


parking lot drainage


beachgoers


Cladophora algae

E. coli and enterococci are present in recreational beach sand

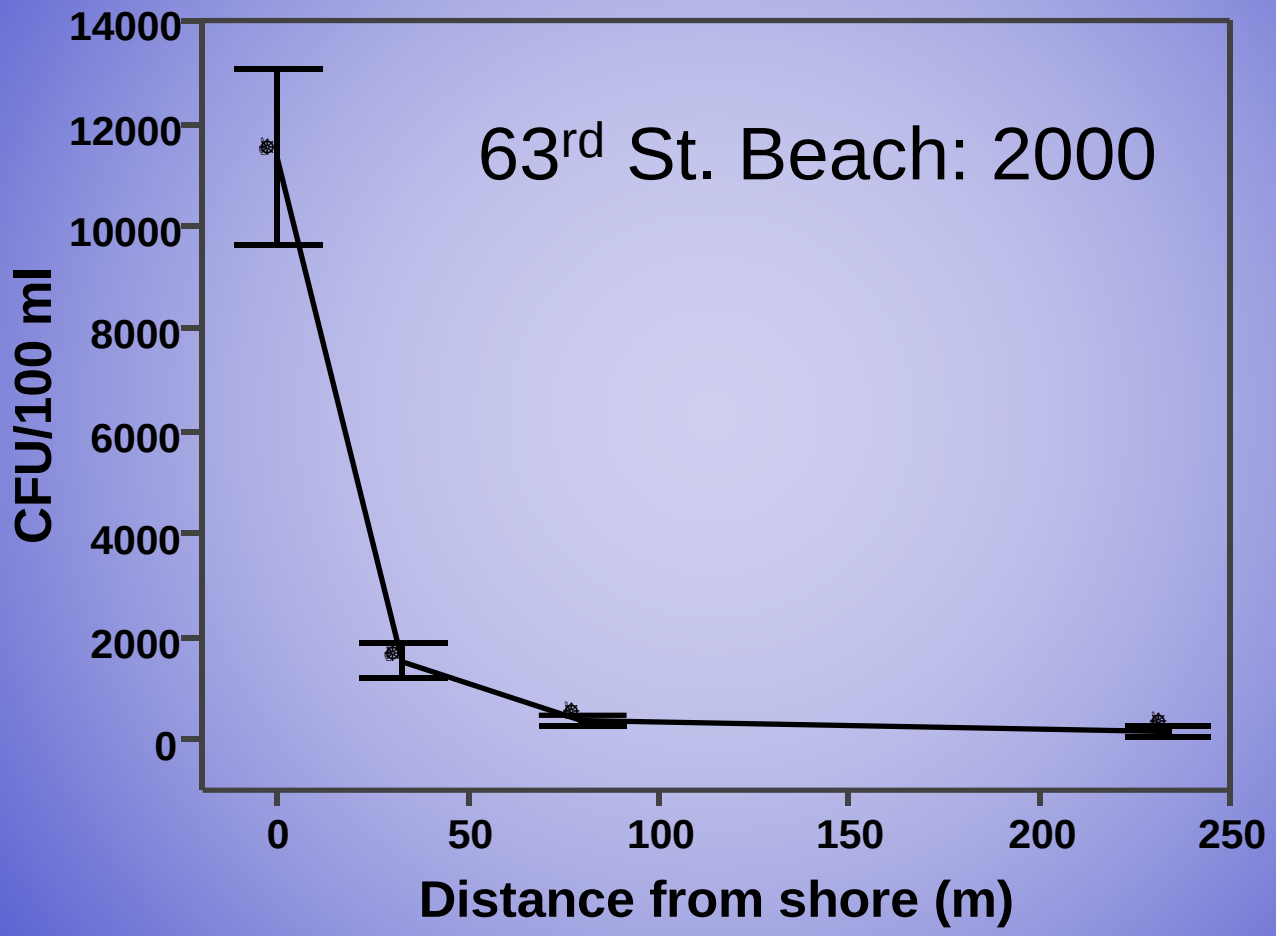
***E. coli* and enterococci persisted in sub-surface sand year-long at two Indiana beaches**

Sand along with associated fecal indicator bacteria is re-suspended into beach water through wave action

Gulls may increase *E. coli* concentrations in sand and beach water

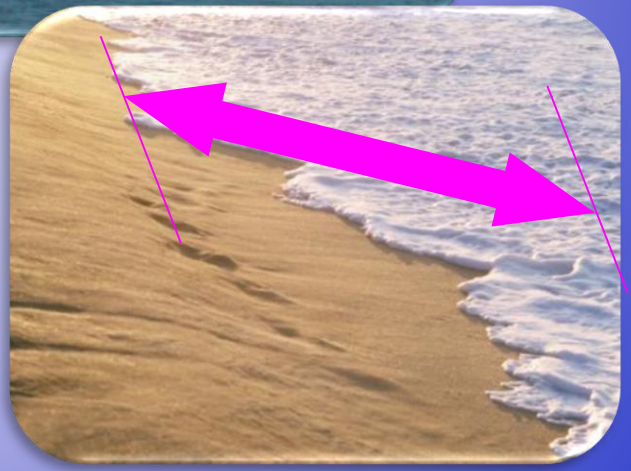
	# gulls lagged 1 day, P values
Foreshore sand	0.000
45 cm water AM	0.004
90 cm water AM	0.001

E. coli Concentrations are Highest in Sand and Diminish in Water With Distance From Shore

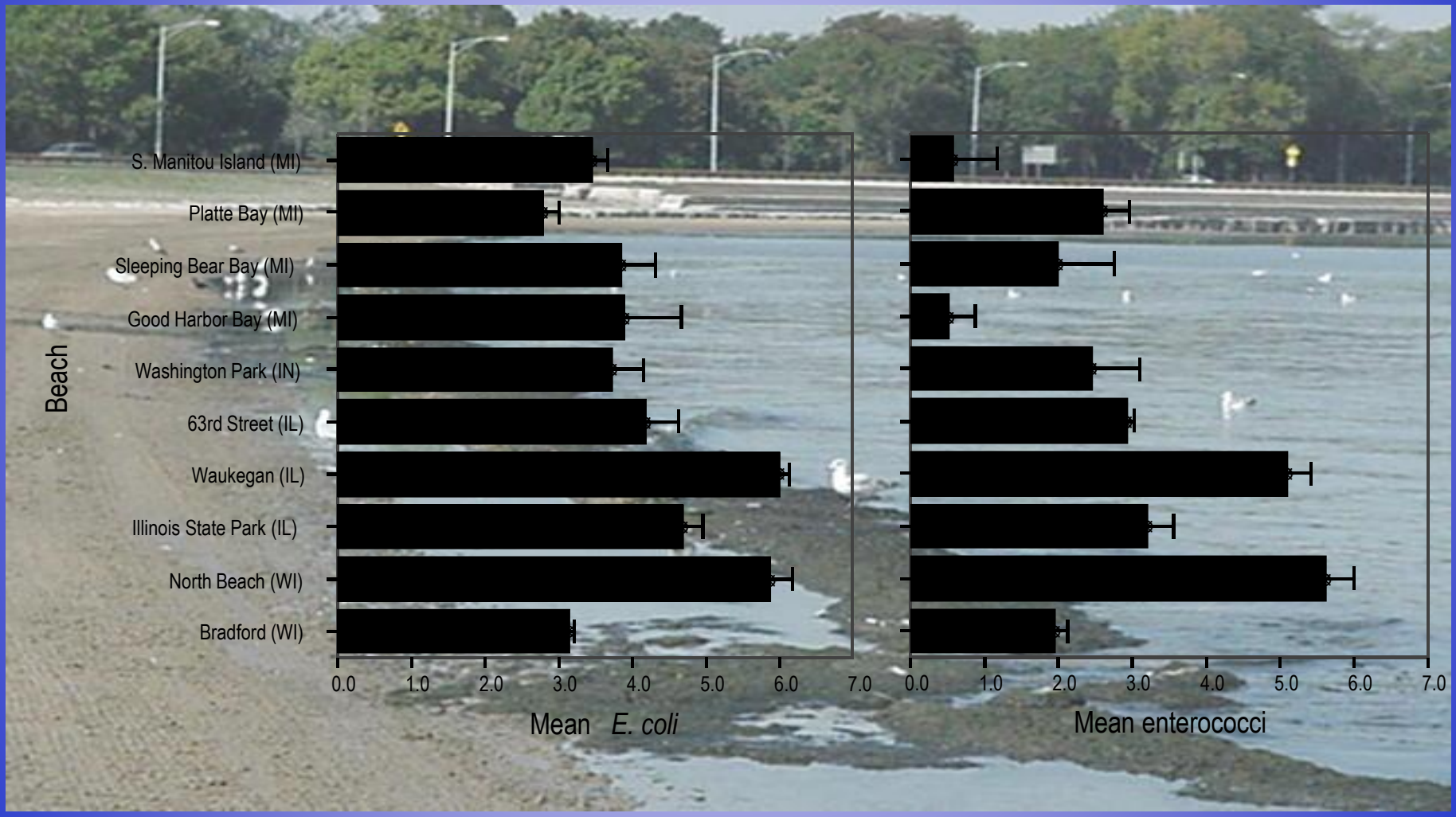


Whitman, R. L. and M. B. Nevers. 2003. Foreshore sand as a source of *Escherichia coli* in nearshore water of a Lake Michigan beach. Applied and Environmental Microbiology **69**:5555-5562.

Connecting Bacteria in Foreshore Sands and in the Swash Zone

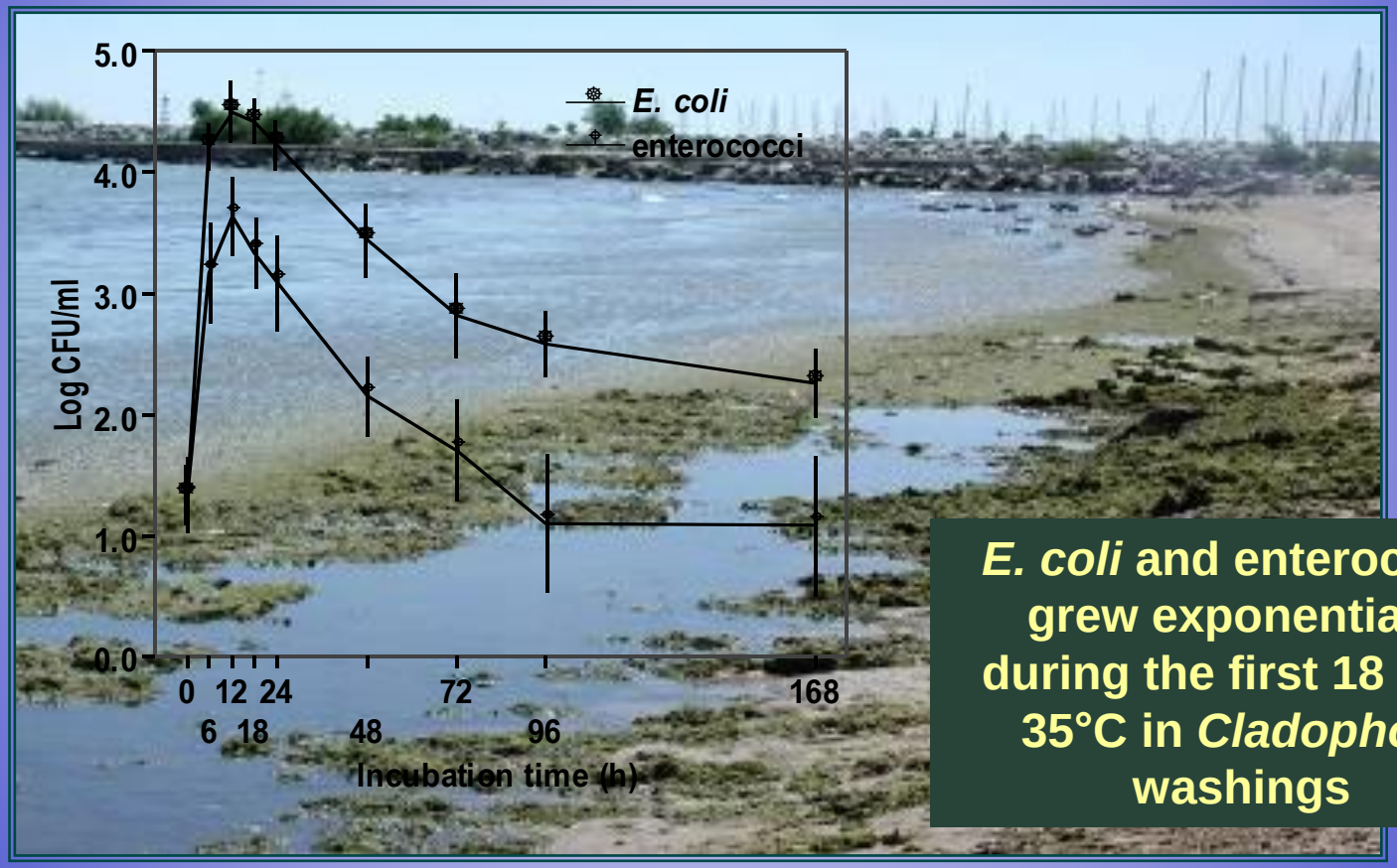


E. coli and Enterococci are Commonly Found in *Cladophora* in Lake Michigan



Whitman, R. L., D. A. Shively, H. Pawlik, M. B. Nevers, and M. N. Byappanahalli. 2003. Occurrence of *Escherichia coli* and enterococci in *Cladophora* (Chlorophyta) in nearshore water and beach sand of Lake Michigan. Applied and Environmental Microbiology **69**:4714-4719.

Nutrients in Algal Washings Promoted *In vitro* Growth of *E. coli* and Enterococci

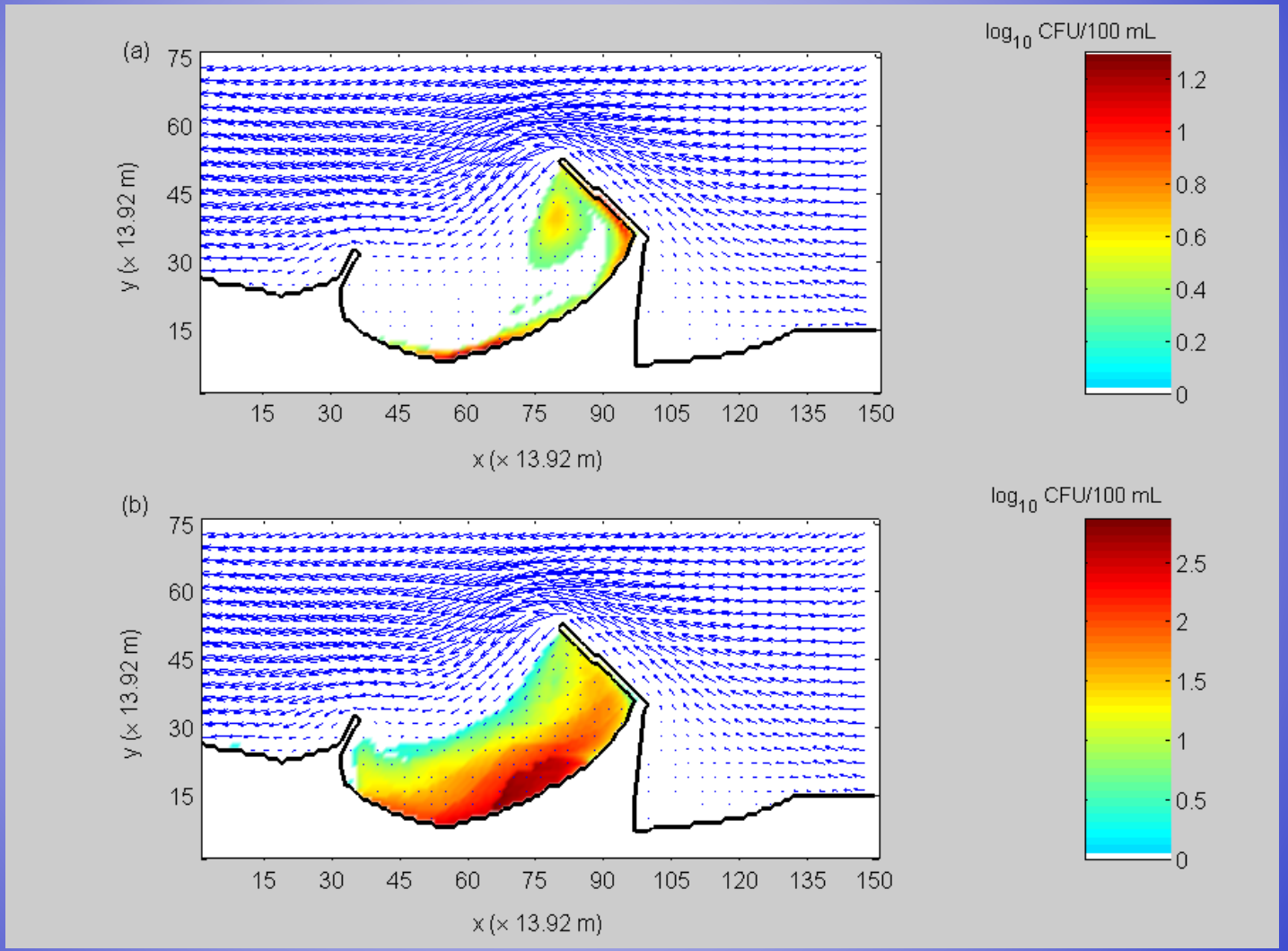


***E. coli* and enterococci grew exponentially during the first 18 hr at 35°C in *Cladophora* washings**

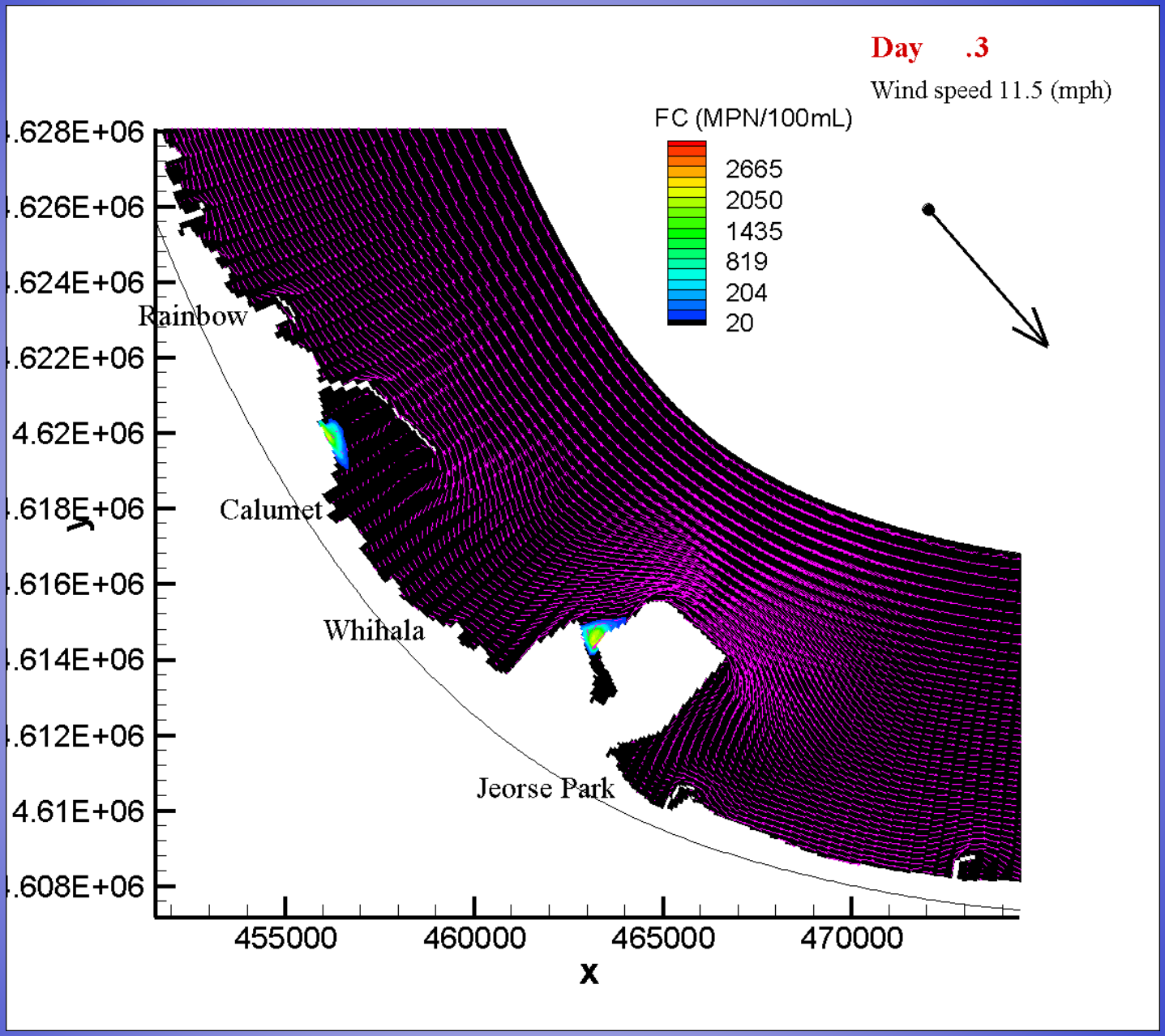
Byappanahalli, M. N., D. A. Shively, M. B. Nevers, M. J. Sadowsky, and R. L. Whitman. 2003. Growth and survival of *Escherichia coli* and enterococci populations in the macro-alga *Cladophora* (Chlorophyta). FEMS Microbiology Ecology **46**:203-211.

Mechanistic Models

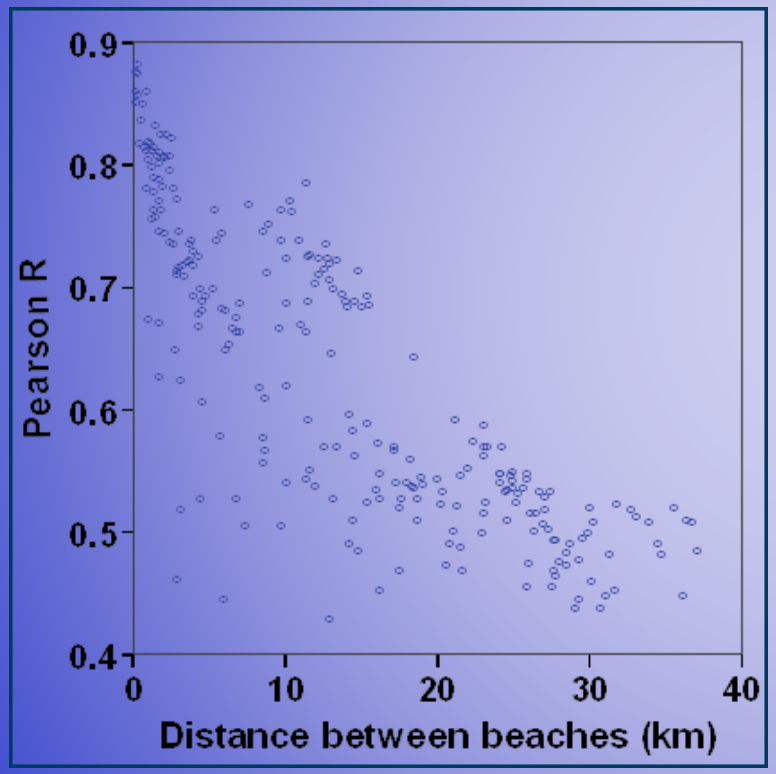
EC distribution in the water and in the sediment at hour 20 after a sediment resuspension event near the shoreline at hour 0

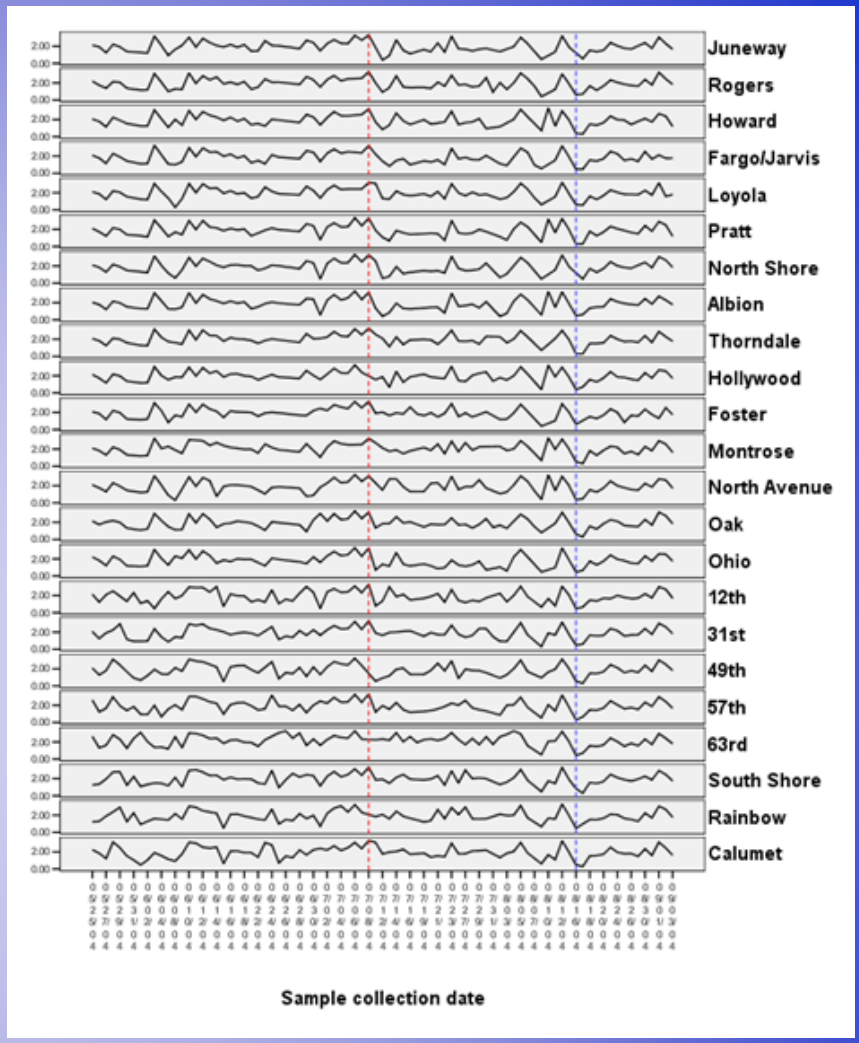


(a): suspended EC in the water; (b) settled EC in the sediment. Blue arrows: current field, note the gyre that concentrates E. coli in (a). This plot shows that under a typical current pattern EC cannot be released efficiently from inside to outside the embayment. Settling occurs faster (see (b)) than transport because of the shallow water nearshore.


Day .3
Wind speed 11.5 (mph)
FC (MPN/100mL)
2665
2050
1435
819
204
20
Rainbow
Calumet
Whihala
Jeorse Park
.628E+06
.626E+06
.624E+06
.622E+06
4.62E+06
.618E+06
.616E+06
.614E+06
.612E+06
4.61E+06
.608E+06
Y
455000
460000
465000
470000
X

Historically there is a relationship between *E. coli* measured at Chicago beaches (2000-2005) and the distance between beaches





Simultaneous fluctuations of *E. coli* at Chicago beaches

Whitman, R. L. and M. B. Nevers. 2008. Summer *E. coli* patterns and responses along 23 Chicago beaches. Environmental Science & Technology **42**:9217-9224

Microbial Source Tracking – summer 2010

	No. of Samples	HF183 human marker	Gull-2 Marker
Foster	55	4 (7%)	0
Montrose	55	4 (7%)	0
Calumet	55	1 (2%)	0
63rd	55	0	0
Jeorse Park	54	8 (15%)	20 (37%)

Fecal markers correlated with sanitary survey observations

	Human marker	Gull marker
Swimmers	0.200**	-0.006
Birds	0.048	0.306**
Algae	0.047	-0.096
Debris	-0.015	-0.051
Fecal Material	0.178**	0.328**

Potential Solutions

- Modeling
- Rapid Testing
- Refined Source Identification

Independent variables incorporated into models used during 2013 season

Solar Radiation	9/9
Rainfall	7/9
Wind Direction x Wind Speed	5/9
DOY	4/9
Water Depth	3/9
Wind Direction	3/9
Air Temperature	2/9

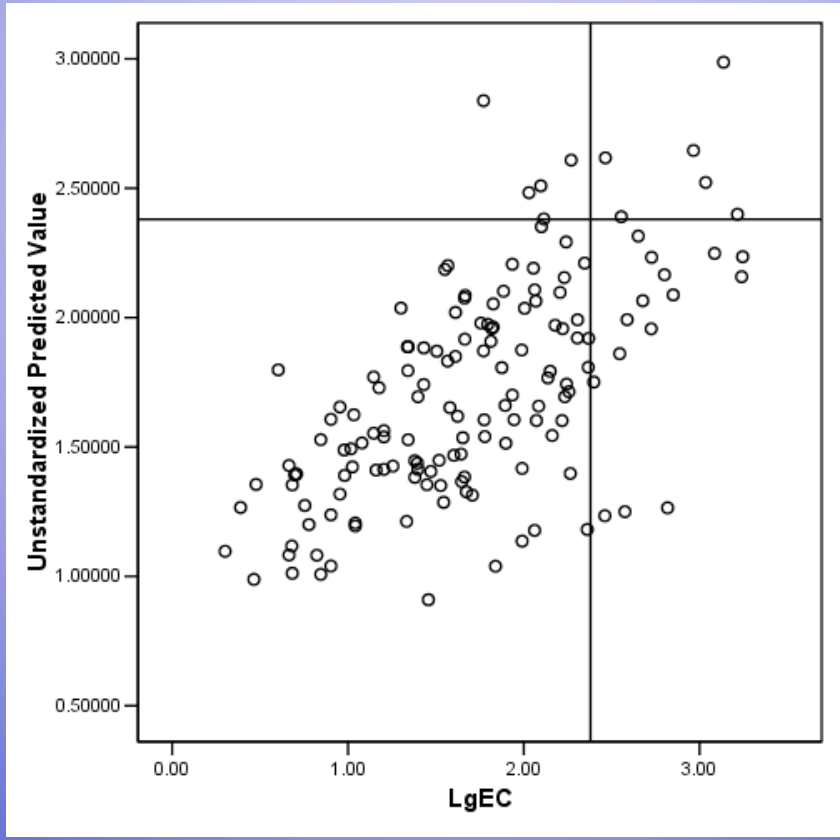
Barometric Pressure	1/9
Wave Height	1/9
Turbidity	1/9
DOW	1/9

Predictive Model Performance Adjusted R^2 by year

	2012	2013	2014
Leone		0.381	0.341
Osterman		0.364	0.397
Foster	0.306	0.329	0.353
Montrose	0.334	0.238	0.191
Oak	0.220	0.167	0.267
Ohio		0.272	0.310
63rd	0.367	0.286	0.144
Rainbow		0.103	0.117
Calumet	0.390	0.378	0.169

Calumet

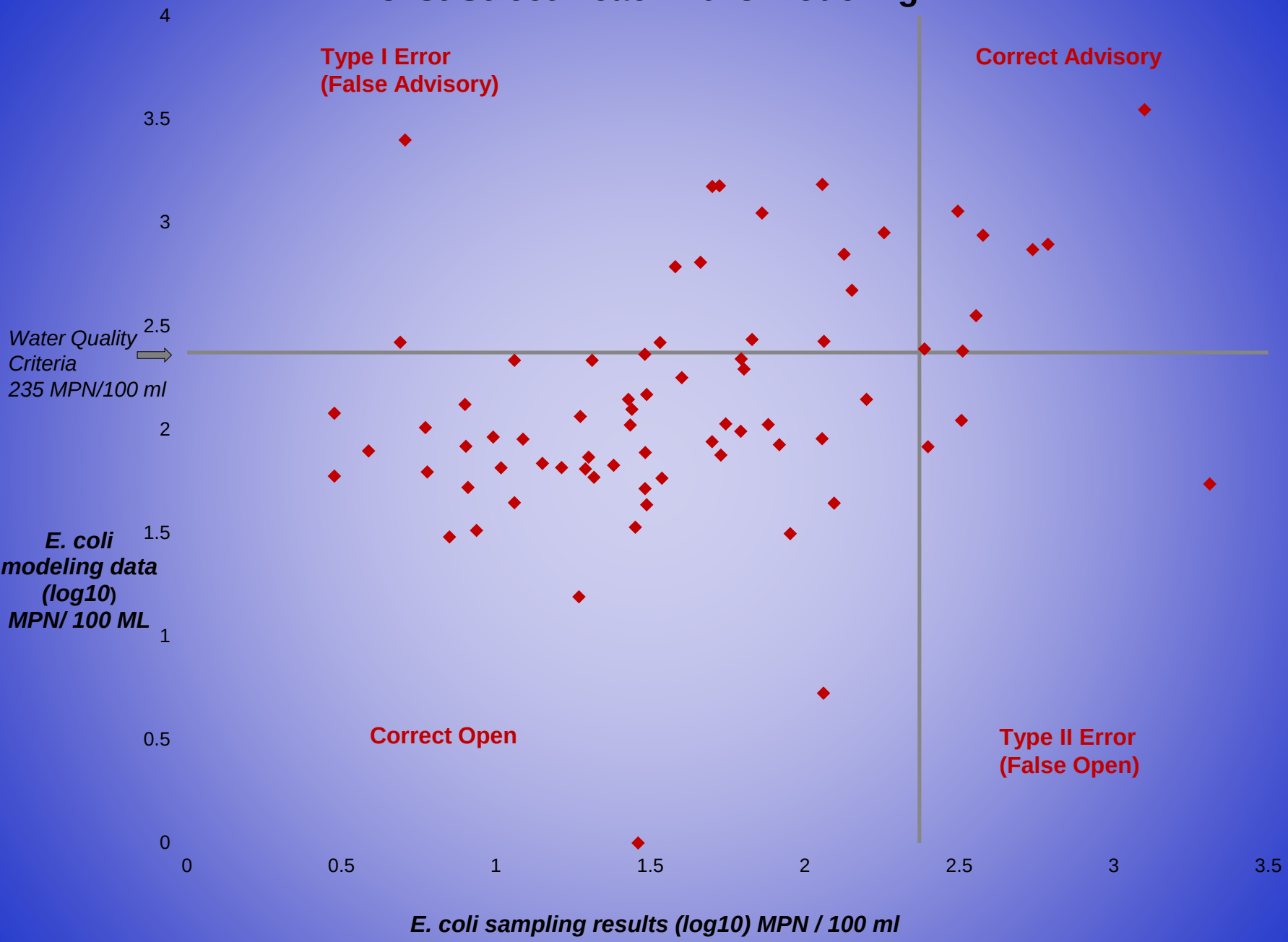
Beach	Coefficients	Model Adj R2	Pers Adj R2
Calumet	Wave height	0.378	-0.005
	Solar radiation		
	Downshore wind		
	Depth		
	Turbidity		



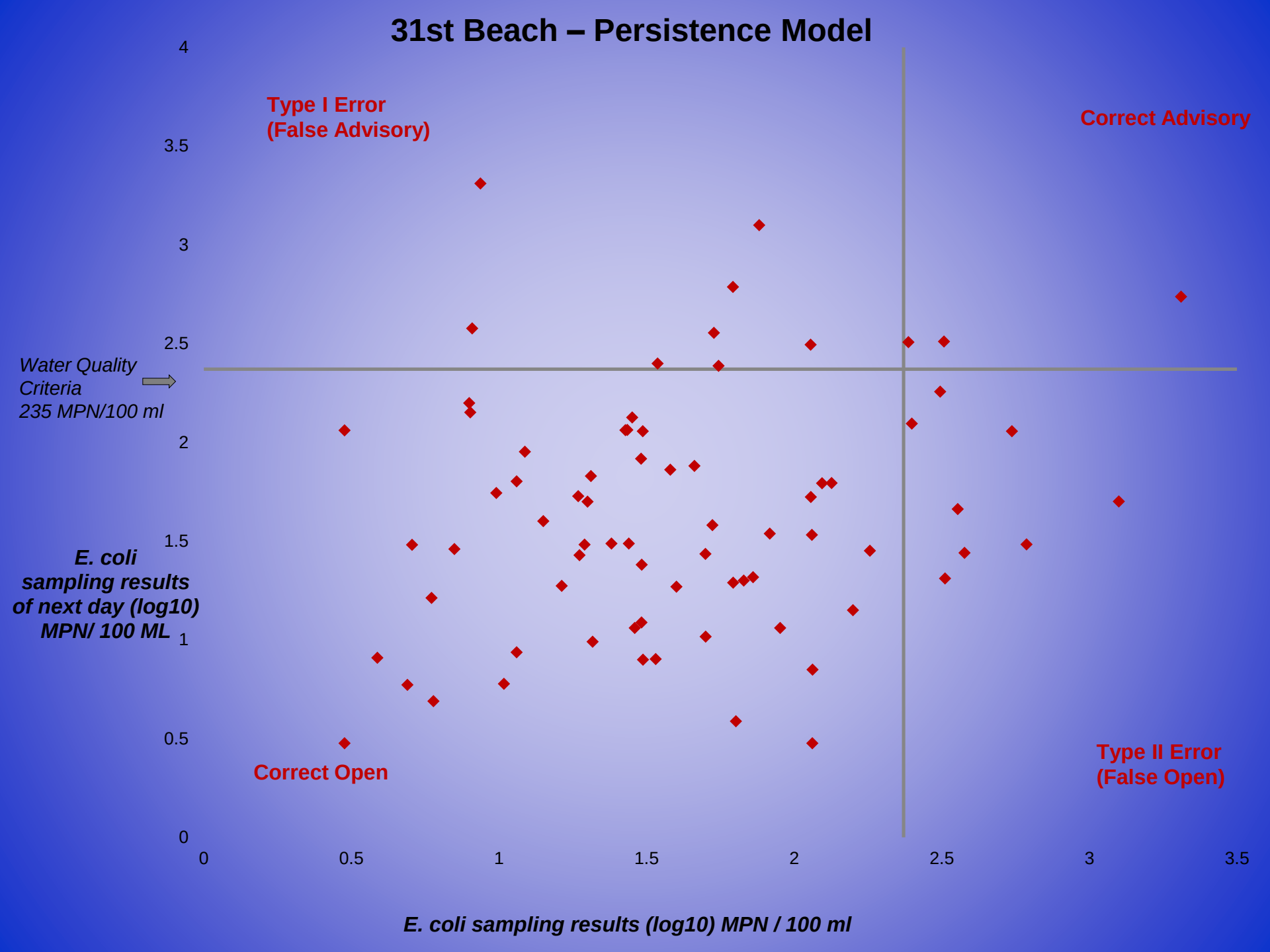
2013 Validation Results

	Accuracy (%)		Sensitivity (%)		Specificity (%)	
	Empirical Model	Persistence Model	Empirical Model	Persistence Model	Empirical Model	Persistence Model
Leone	94	87	0	0	100	92
Osterman	92	84	0	20	100	90
Foster	90	82	14	33	100	88
Montrose	71	57	14	38	94	66
Oak	97	91	0	0	100	96
Ohio	92	89	25	75	100	91
63rd	78	75	25	45	89	82
Rainbow	84	66	8	25	100	77
Calumet	67	72	36	17	72	83

31st Street Beach 2013 Modeling



31st Beach – Persistence Model



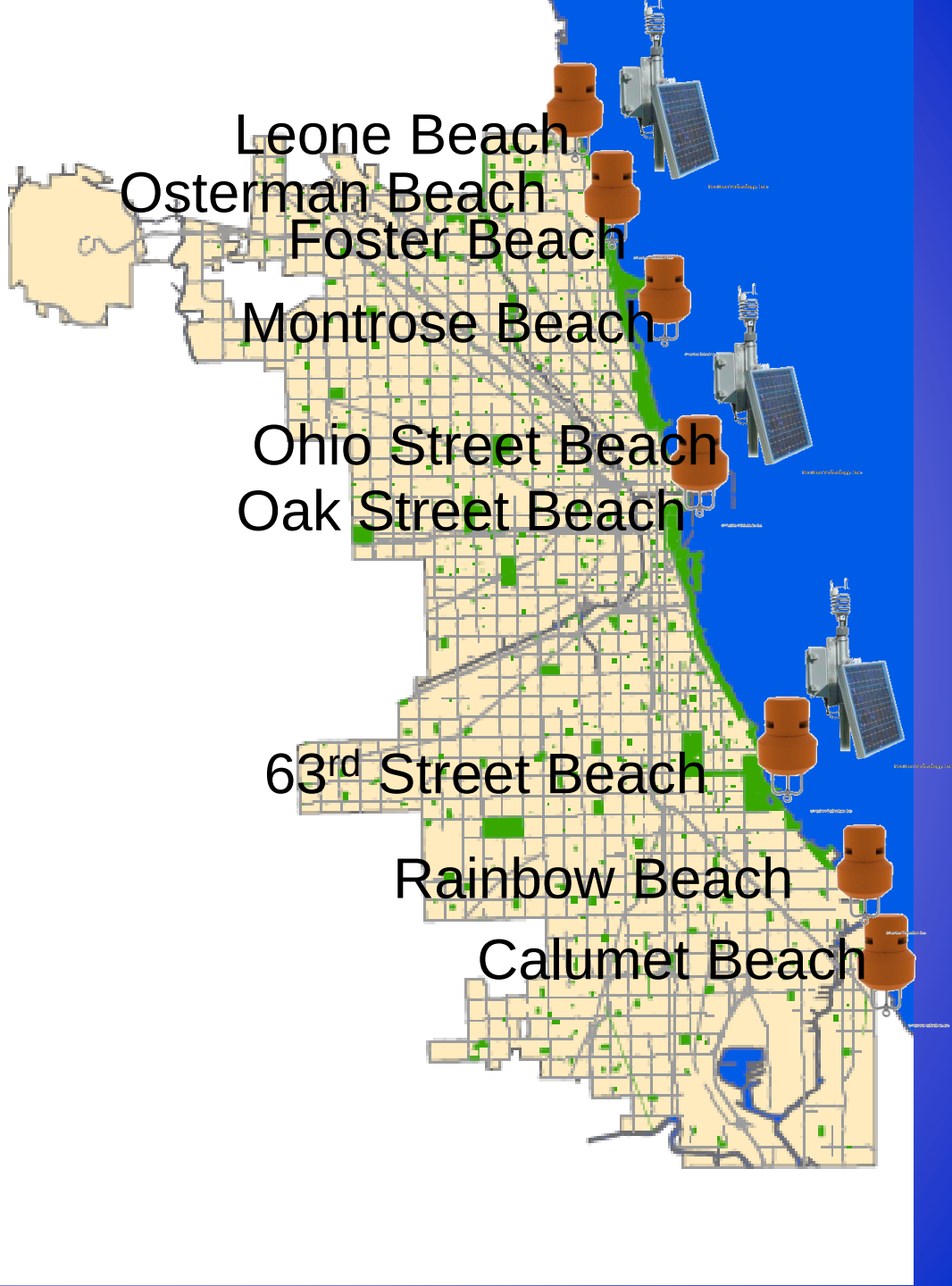
Predictive modeling: 2014

9 new models were developed using three years of data

Models will be applied at all beaches

Example: Montrose

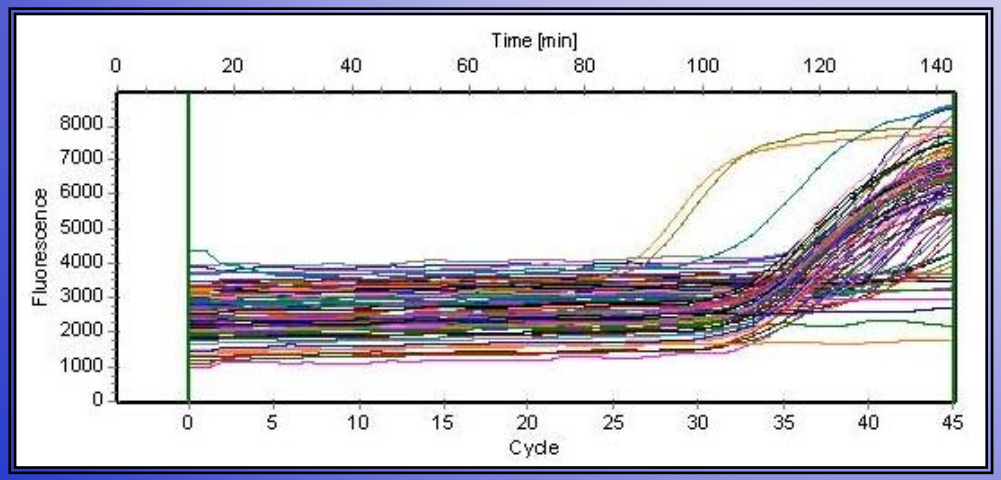
Predicted log *E. coli*=2.038+(-0.006*solar radiation (4 hr))+(0.484*Log rainfall (24 hr))+ (-0.005*Day of year)+ (3.664*Log wave height (4 hr))

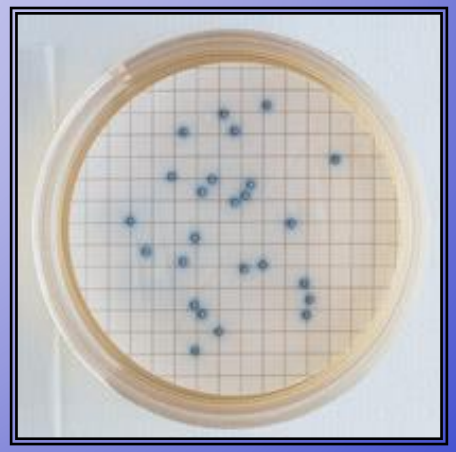


Potential Improvements

- Maximize monitoring effectiveness at Chicago's beaches by using a variety of field-based and laboratory-based methods
- Rapid Testing using qPCR

Rapid Analytical Methods decrease the time between sample collection and results availability: QPCR assay vs. traditional membrane filtration





Rapid Testing using qPCR: Pilot Study 2014

Table 2. Comparison of the Percent of Samples Exceeding a Beach Action Value (BAV) for Three Analytical Methods Tested, Using the Same Water Sample[a]

	EC %exceeding	ENT %exceeding	QENT %exceeding	*N*
Calumet 2010	25	27	3	33
Foster	13	12	3	33
Montrose 2009	18	42	12	33
Montrose 2010	27	55	6	33
63rd 2009	76	97	64	33
63rd 2010	24	21	0	33
Jeorse 2010	78	44	26	32

Conclusions

- **Models can be used for source identification, transport, and predicting contamination events**
- **Chicago beaches are exposed to similar nonpoint sources of contamination**
- **Wind characteristics describe much of the *E. coli* variation, indicating significant resuspension of sediment-borne bacteria**
- **Predictive modeling is an effective method for real-time monitoring at Chicago's beaches**

Thank You!

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