

Advancing the use of predictive models for estimating recreational water quality at beaches

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Recreational water-quality advisories

Based on *E. coli* or enterococci state standards

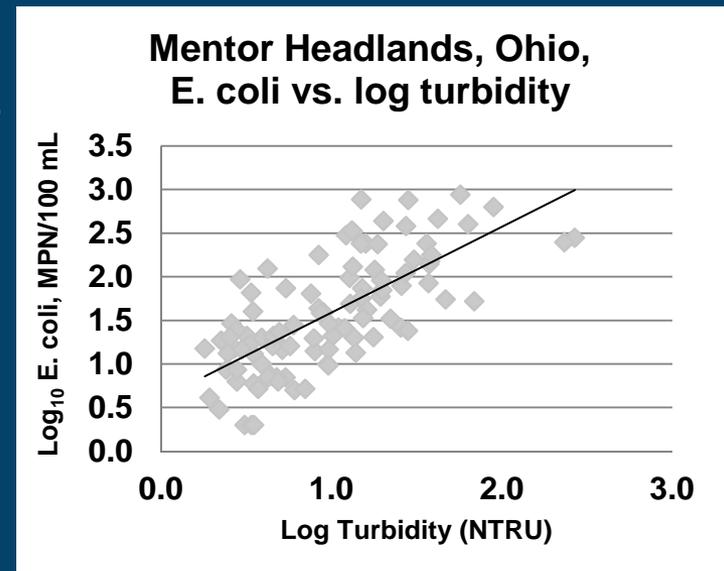
1. Culture methods that take 18–24 hours
2. Real-time tools included in new recreational water quality criteria (EPA, 2012)
 - Quantitative polymerase chain reaction (qPCR)
 - Predictive models



EPA 820-F-12-058

Predictive models

- Use to supplement monitoring using culture-based methods (USEPA, 2012)
 - Rainfall-based notifications
 - Decision trees
 - Deterministic models
 - Statistical regression models
- Site specific
- Tools are available
- Relatively inexpensive



Nowcasts

- Systems that inform the public of beach closures or advisories based on predictive models.
- Use environmental and water quality variables
- Estimate conditions in real-time
 - Predicted concentration
 - Probability that standard will be exceeded



Coastal and Marine Geology Program
Prepared in cooperation with the U.S. Environmental Protection Agency,
Great Lakes Restoration Initiative

**Developing and Implementing Predictive Models for
Estimating Recreational Water Quality at
Great Lakes Beaches**

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Scientific Investigations Report 2013–5166

<http://pubs.usgs.gov/sir/2013/5166/>

Results from a study of 49 Great Lakes beaches

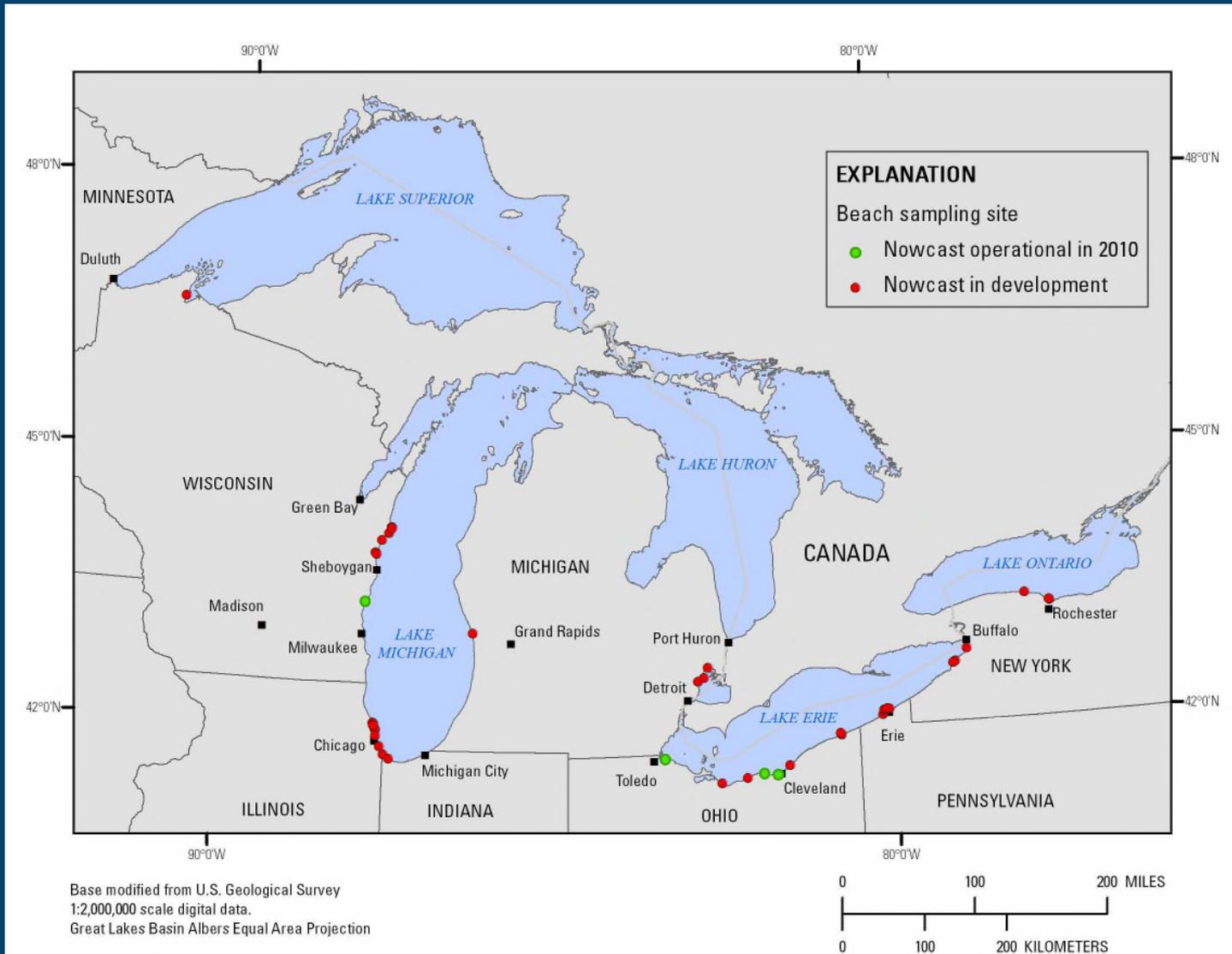
Study Objectives, 2010–12

- Expand operational nowcasts
- Improve existing nowcasts
- Install or maintain equipment for collecting data on model variables
- Provide tools for compiling data and developing predictive models



Weather station (Headlands State Park, Ohio) and buoy (Calumet Beach, Chicago)

Study sites



Methods

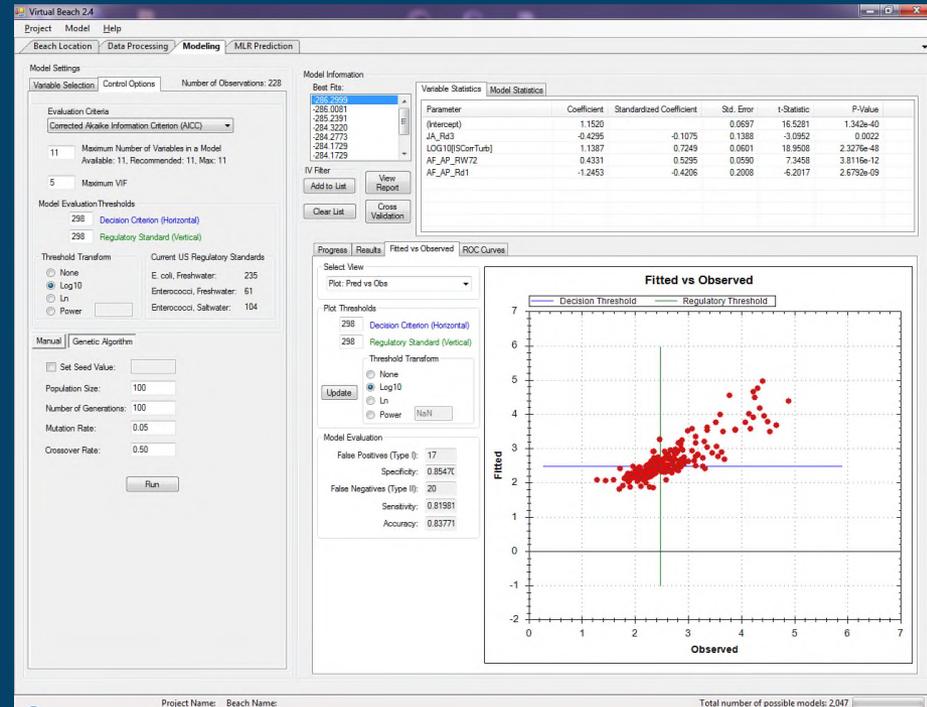
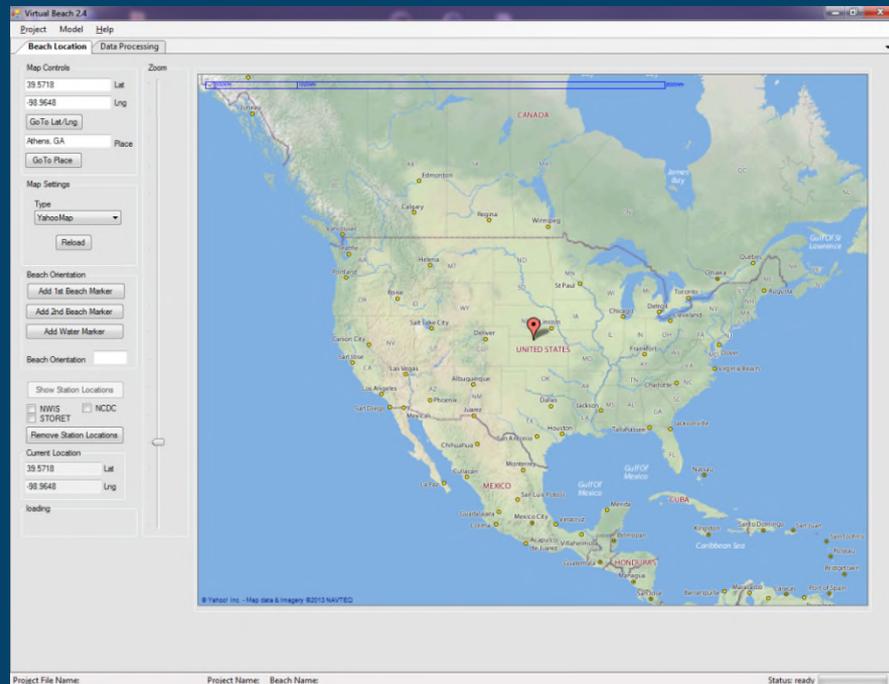
- Data collected by local agencies
 - Field measurements and observations
 - *E. coli* concentrations
- Site-specific data from nearshore buoys, weather stations, rain gages, staff gages, other sensors
- Data compiled from existing sources
- Operational nowcasts run 4–7 days/wk



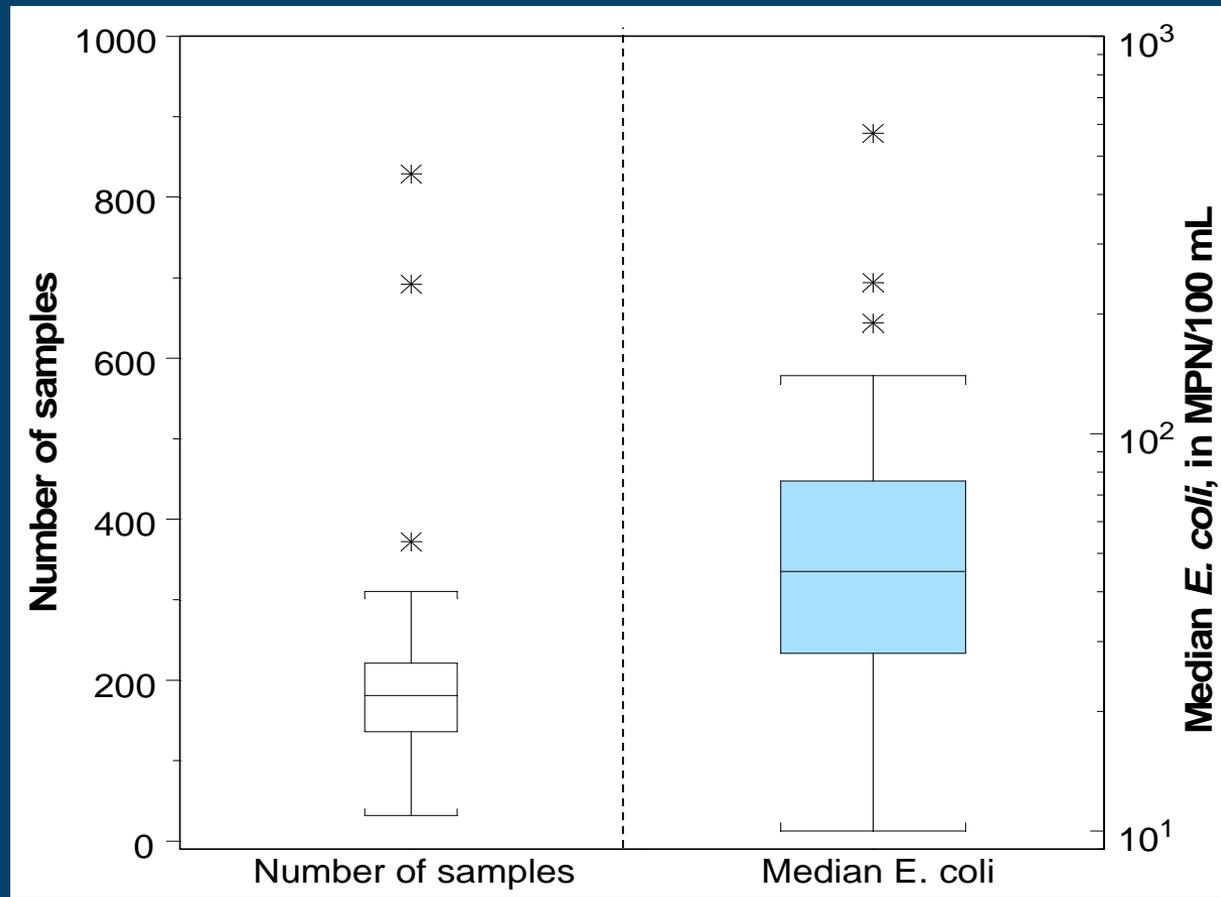
Edgewater,
Ohio Nowcast

Virtual Beach

- Free software developed by USEPA
- Exploratory data analysis, model development, and model validation



Results for 49 Great Lakes beaches 2010–12 (some earlier years)



Model variables

43 Great Lakes beaches

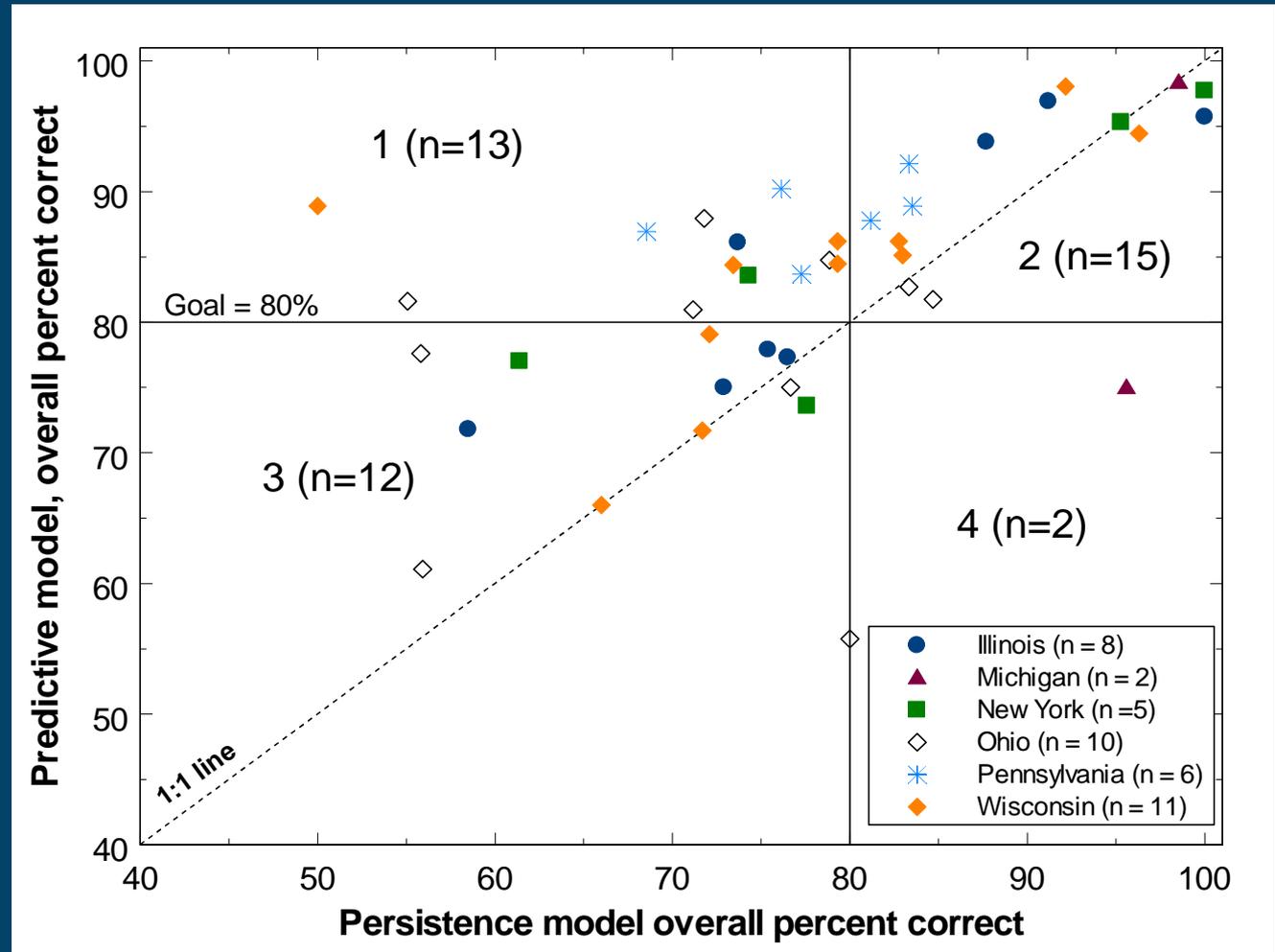
- **Field variables were used in 95% of models**
 - Turbidity (79%), day (37%), and wave height (33%)
 - Water Temp, bird count, algae category, conductivity <10%
- **Data compiled from other sources**
 - NOAA and Great Lakes Forecasting System (60%)
 - National Weather Service airport weather data (44%)
 - USGS gage or buoy measurements (33%)
 - Local sources of rain, winds, temperature, etc. (33%)

Model results

- Developed 43 models with data collected during **2010–11**
- Validated 42 models with data collected during **2012**
- Evaluated abilities of models to predict exceedance of the bathing-water standard
 - Overall correct percent
 - Specificity
 - Sensitivity

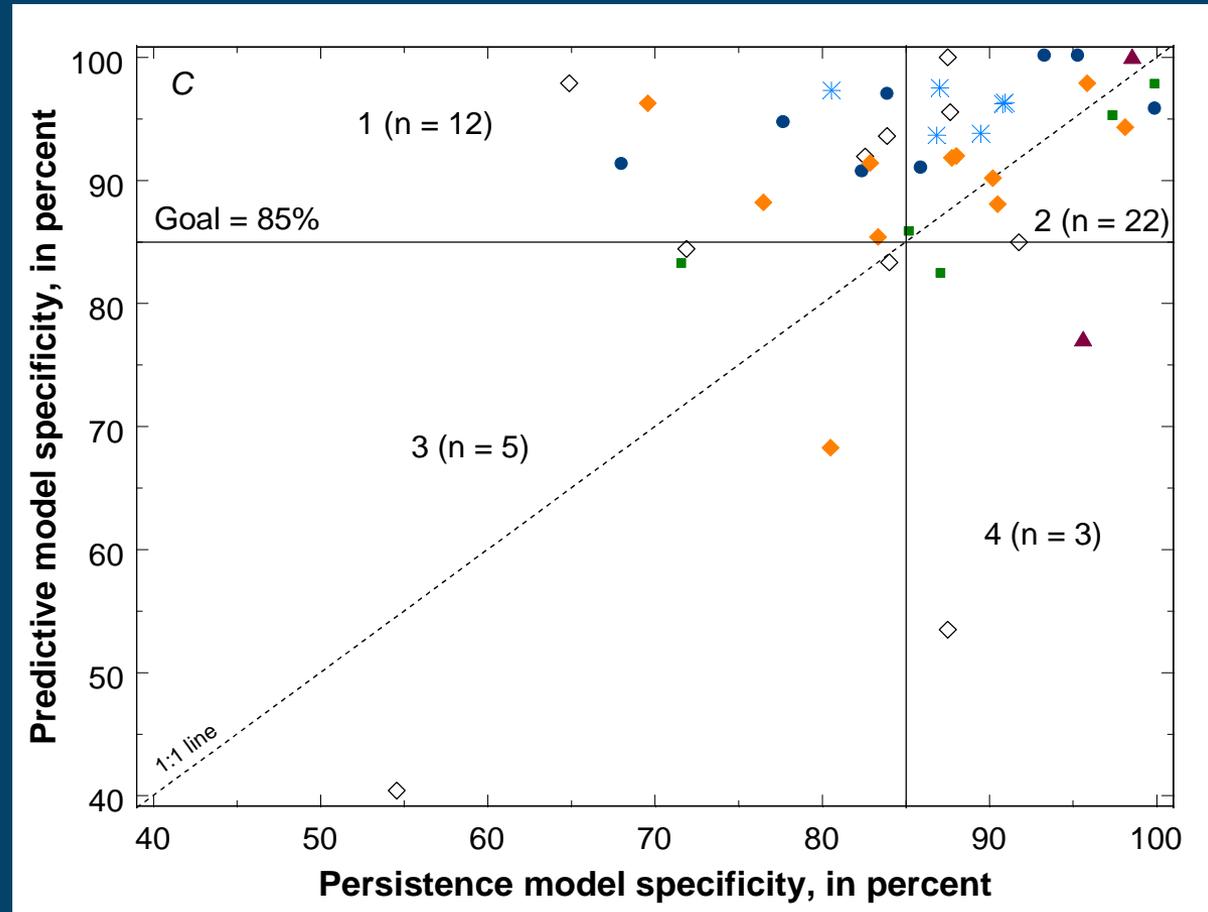
Validation of 42 beach models, 2012

Overall
percent
correct
80% goal



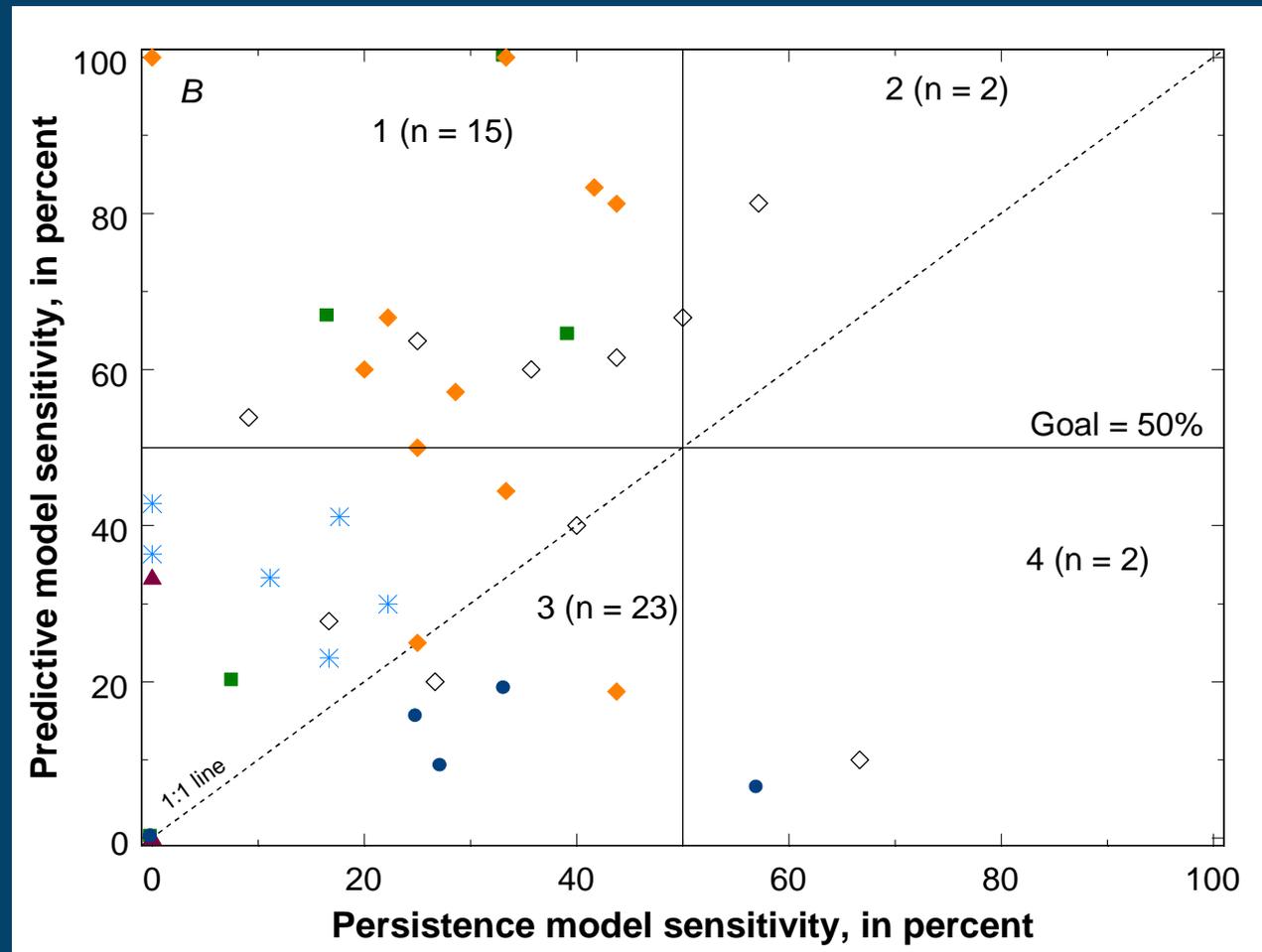
Validation of 42 beach models, 2012

Specificity,
correctly predict
non-exceedances
85% goal



Validation of 42 beach models, 2012

Sensitivity,
correctly
predict
exceedances
50% goal



Edgewater, Lakefront Reservation, Cleveland, Ohio

2 models

- **qPCR**

qPCR for *E. coli*

- **Backup (no qPCR)**

Turbidity, wave height,
pH, day of the year, and
rainfall



 **Northeast Ohio
Regional Sewer District**

Sampling, model development, and daily
operation of the Ohio Nowcast

Maumee Bay State Park, Oregon, Ohio

2 models

- **Positive discharge**

Turbidity, wind direction code

- **Negative discharge**

Turbidity, discharge, solar radiation, lake level, wind



Sampling, model development, and operation of the Ohio Nowcast

2014

8 Lake Erie beaches

1 river site

1 inland lake beach

Ohio Nowcast
A daily nowcast of recreational water quality conditions

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Is it safe to swim in the lake or canoe in the river?
To find out, local agencies monitor the water daily to determine levels of a bacterium, *E. coli*, found in sewage and other animal wastes. But because results of *E. coli* levels take 18-24 hours by conventional methods, we are using other quickly-obtained measurements to estimate when *E. coli* levels will be high. This is called a "nowcast." [Find out more about why we need the nowcast.](#)

How does the nowcast work?
A nowcast estimates current conditions similar to how a weather "forecast" looks to the future. [Find out more about how the nowcast works.](#)

How does the nowcast perform?
We are continuously monitoring performance of the nowcast and working to improve the predictive abilities of the nowcast. [Find out more about how the nowcast performed in past years.](#)

Welcome to the Ohio Nowcast

Closed for the season -- see you in May!

A system that uses near real-time information to "nowcast" water-quality conditions at eight Lake Erie beaches, one inland lake beach, and one recreational river.

GOOD: *E. coli* bacterial levels are estimated to be within the water quality standard and acceptable for swimming.

ADVISORY: *E. coli* bacterial levels are estimated to exceed the water quality standard and be unacceptable for swimming.

Click on a beach from the list below or from the map above to find out more!

- [Atwood Lake](#) coming soon...
- [Cuyahoga River](#)
- [Edgewater](#)
- [Fairport Harbor](#)
- [Huntington](#)
- [Maumee Bay State Park](#)
- [Mentor Headlands](#)
- [Nickel Plate](#)
- [Vermillion](#)
- [Villa Angela](#)

Logos at the bottom include: USGS, Cleveland Metropolitan, Ohio Water Development Authority, Muskingum Watershed, Lake County General Health District, Ohio Lake Erie Commission, and others.



New York NowCast 2014

Welcome to *New York NowCast!* Follow these steps to find your beach:

[Home](#) | [Publications](#) | [Contact Us](#)

- 1 Select County
- 2 Select Beach
- 3 Find it Now

About NowCast

New York NowCast provides near real-time information of water quality conditions at recreational swimming areas in New York state. The NowCast estimates current conditions similar to a weather forecast by measuring different variables at the beach.

Interstate County Boundaries



0 25 50 100 Miles

- Seven NY beaches
- Map interface reveals advisories
- Public Site access through QR Codes when visiting beach and seeing advisory sign



- NowCast predictions and historical data access
- Google map directions interface

Slide from Brett Hayhurst, USGS

Conclusions and future work

- Models can do better than the previous day's *E. coli* at most beaches
- Models met goals
 - Many years of data
 - Moderately contaminated beaches
 - Understanding of the factors affecting *E. coli*
- Models must be continuously tested and refined



Conclusions and future work

With reduced budgets.....

- Tiered approach
 - Reduce sampling to 2–3 days/week
 - Collect data with a wide range of environmental conditions
 - Standard model with field-measured data
 - Automated model for non-sampled days

Conclusions and future work

- Operational nowcasts
 - Illinois, 8 beaches
 - Ohio, 10 sites
 - New York, 7 beaches
 - Pennsylvania, 6 beaches
 - Wisconsin, 10 beaches
 - Others?
- Expand beyond the Great Lakes and at inland beaches



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- US EPA BEACH Act

Collaborations

- US EPA National Exposure Research Laboratory
- Many cooperating agencies and universities





THANK YOU!