Lake Michigan Beach Monitoring

National Water Quality Monitoring Conference
May 22, 2008

U.S. Department of the Interior
U.S. Geological Survey

Great Lakes Beaches

America's 4th Coast

About 10,000 miles of beaches

USGS

Relation of Beach Issues to Regional and National Priorities

Great Lakes Beach Association

Great Lakes Regional Collaboration

Ocean Action Plan

USGS

Highest Priority Issues for Beach Monitoring

1. Affordable Rapid Test Methods
2. Predictive Models
3. Better Access to Real-Time Data
4. Source Tracking Tools
5. Epidemiological Data
6. Training both Technical and to Communicate with Public
7. Standardized Beach Sanitary Surveys
8. Standardized Monitoring Protocols
9. Better Communication among Agencies
10. Determination of Health Risks from Algae, Wildlife and Invasive Species

USGS

Transferable Lessons

Collaborations among Lake Michigan beach managers with each other and states and countries

USGS

Transferable Lessons

Lessons learned from Lake Michigan beaches are transferable to inland lakes and ocean beaches.

USGS

beachnet@great-lakes.net

Your link to 800 beach buddies!

USGS

Management Issues and Science Needs

Is the beach safe NOW?

- Need methods that provide real-time water-quality information

Can we reduce fecal contamination?

- Need to find source(s)
- Need to understand pathway(s)

Are there organisms in the water that will make me sick?

- Need to know if current methods indicate the presence of pathogens

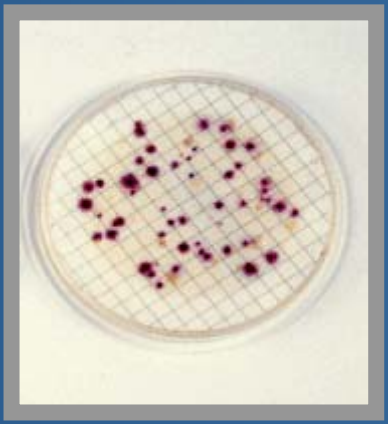
USGS

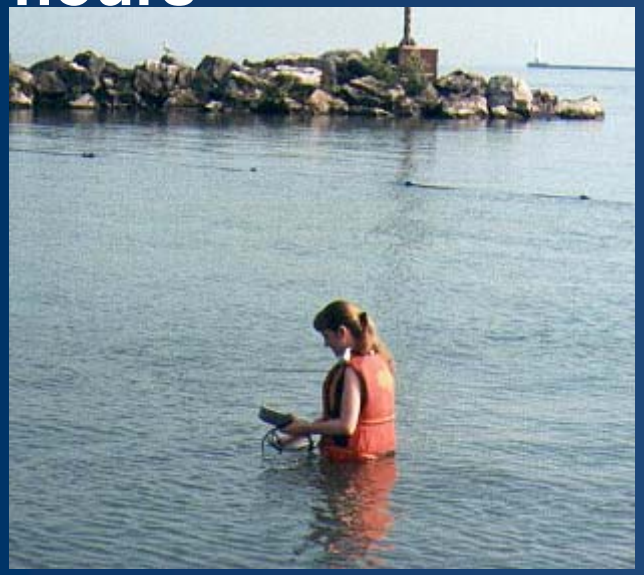
Need for Predictive Models

Is the beach safe NOW?

Beach conditions change constantly and rapidly

Most current methods provide results in 18-24 hours





USGS

Need for Predictive Models

USEPA addressing this issue with RAPID TEST METHODS

MOLECULAR

(QPCR)

$40,000

SURFACE RECOGNITION

(IMS/ATP)

$5,000

USGS

Need for Predictive Models

Multi-stakeholder meeting December 2006
Locals/State discussed limitations of rapid tests

- Expensive
- Difficult Procedures
- QA/QC issues
- Still not Real-Time

USGS

Need for Predictive Models

<u>Predictive models</u> are one means to provide a quick, reliable indication of the water quality conditions.

They are used to supplement, not replace, monitoring….. (USEPA, 2002)

Project SAFE--Swimming Advisory Forecast Estimate

A Pilot Experiment by **USGS, i**n cooperation with **NOAA, City of Gary, NPS, and Indiana Department of Environmental Management**

USGS

Need for Predictive Models

Huntington MLR Model in 2006

Predictive tool	Sample size	Correct	False positive	False negative
Model	85	80%	10%	42%
Previous day's *E. coli*	84	57%	30%	72%

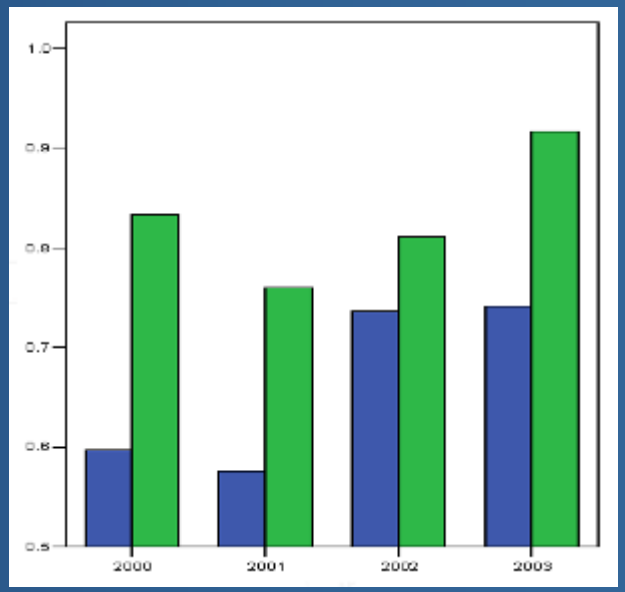
Beach advisory if probability of exceeding standard $\geq$ 27%

USGS

Need for Predictive Models

EXAMPLE—Regional Forecast Model

- 4 years of data
- 3 states
- 10,000+ E. coli values
- Multi-agency meteorological data



USGS

Need for Predictive Models

Example Issue—What are conditions at the hundreds of miles of unmonitored beaches on Lake Michigan?

- Synthesize available monitoring and geographic data
- Characterize factors affecting monitored beaches
- Transfer understanding to unmonitored beaches

USGS

Need to Understand Source and Path

Grand Traverse Bay, Michigan

(left)

Ashtabula, Ohio

(below)

GL Beach Sanitary Survey Pilot

Common bacterial sources on Lake Michigan

- Stormwater
- Natural events (rain, wind, hydrology)
- Birds (daily and seasonal beach maintenance)
- Rivers, drains
- Structures and geography that limit circulation (at times protective, depends)
- Algal mats
- CSO/SSO on occassion, improvements due to partial treatment & corrective actions

USGS

Need to Understand Source and Path

Example—Multiple tools needed

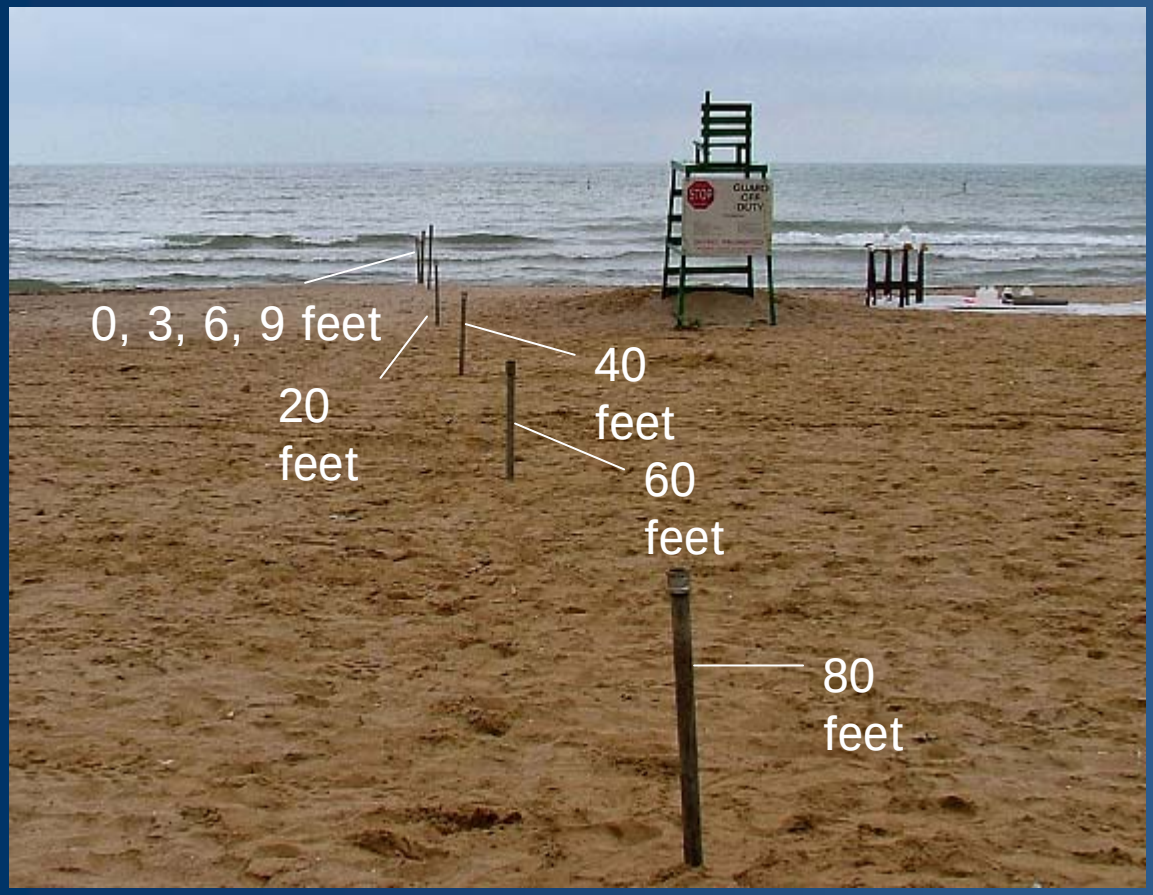
- Nearshore and spatial sampling
- Hydrologic and meteorologic factors
- Ground-water / sand interactions
- Chemical indicators
- Microbial source tracking

Multitude of physical, biological, and chemical tools require interdisciplinary approach

USGS

Need to Understand Source and Path

EXAMPLE—Ground water sampling



E. coli **in ground water as high as 2,000 CFU/100 mL. Highest <10 ft inland**

USGS

Need to Understand Source and Path

Example Issue—Sand and algae as a reservoir of bacteria at Lake Michigan beaches

Sand

Resuspension reservoir?
Harmless bacteria or pathogens?
Sample 2-3 ft deep or ankle deep?

Algae mats

Health Dept response to mats on beach?
Exposure to algal toxins from algae mats?
Bacteria or pathogen growth in algae mats?

Need to Understand Source and Path

Example—Sand and algae as a reservoir at Lake Michigan beaches

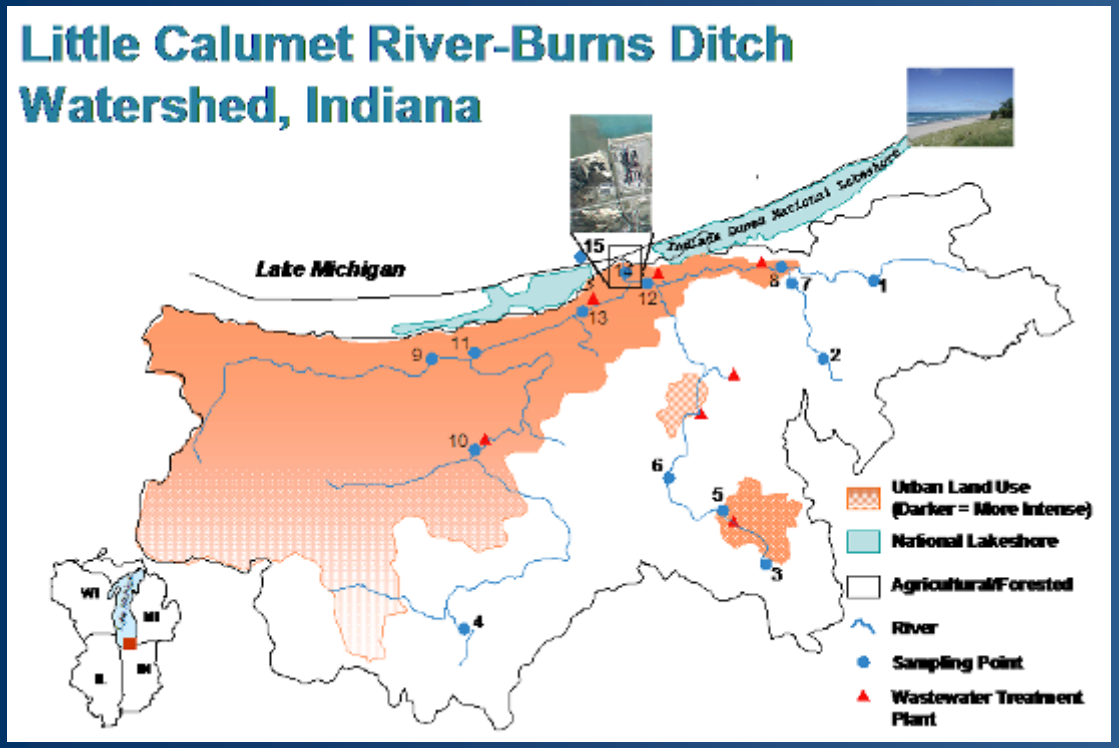
E. coli counts in sand often many orders of magnitude higher than in water

E. coli and Enterococci abundant and persist in Cladophora

USGS

Need to Understand Source and Path

Example—Chemical indicators of pathogen sources



E. coli concentrations related to primary wastewater chemicals (PWWCs) concentrations

Sites with high PWWCs also had human marker

Rainfall affected bacterial and chemical detections

USGS

Need to Understand Pathogens

Beaches monitored for indicator organisms

Pathogen occurrence, source, and pathway not necessarily similar to indicators

Science being done for indicators needs to be replicated and expanded for pathogens

- When are pathogens present?
- What is the pathogen source and pathway?

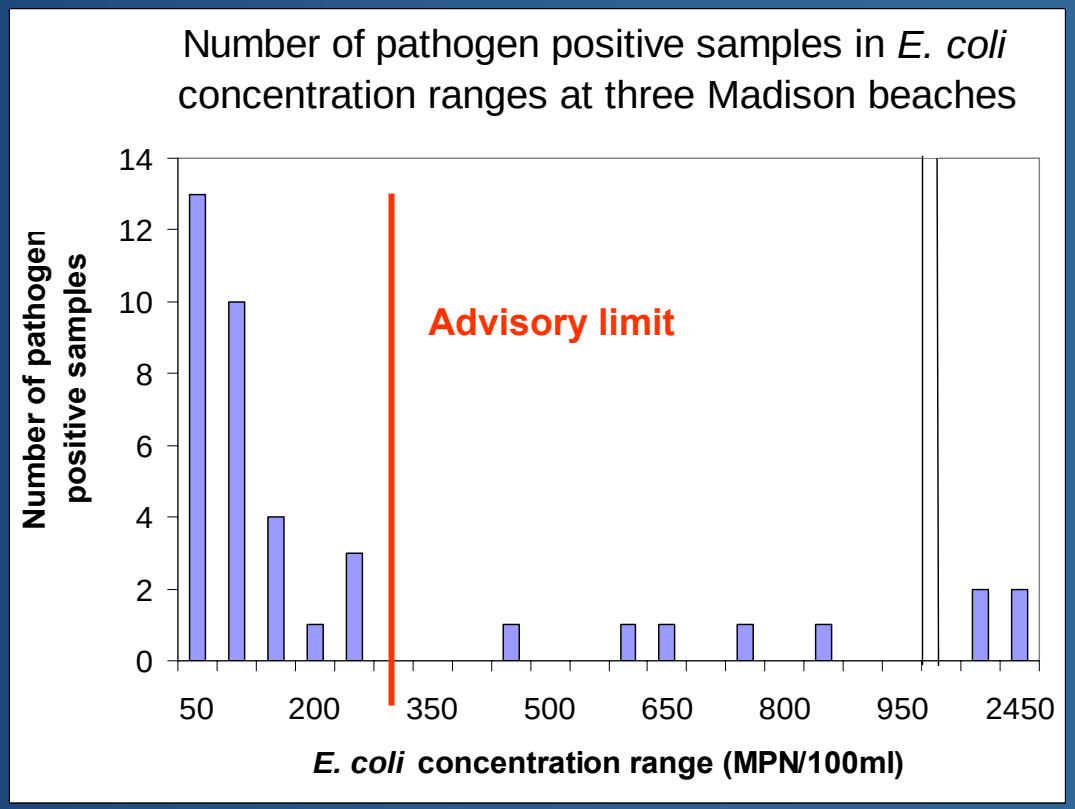
Need to Understand Pathogens

Example—Pathogens at Wisconsin beaches

37% positives (40/108)

39% were positive in samples when an advisory was <u>not</u> issued

33% were positive in samples when an advisory was issued



USGS

Need to Understand Pathogens

Example Issue—Reaction to Beach Closure

- Contamination issues intensely debated
- Health Departments had samples tested for pathogens
- Tests for pathogens used by Health Departments to confirm health risk
- Prompted further investigation by local, state, and federal agencies, including USGS

(left—using molecular tools for pathogens)

Need to Understand Pathogens

Example Issue—USEPA Water Quality Standards

Indicators vary with program, water type, and state: Total coliforms, Fecal coliforms, *E. coli*, and enterococci

USEPA required to update/revise criteria for water quality standards

- March 26-30, 2007—Pellston-type Expert Workshop on the Development of New or Revised Recreational Water Quality Criteria

USGS

Next Steps

Bring full range of scientific expertise to bear on the issues

Apply geographic science to relating land use and other factors to beach health

Apply coastal and marine science to nearshore transport of sand and pathogens

Above: Andrew Schwartz (left) and **Dan Hanes** maneuver an Aquadopp current profiler and its frame in the surf. Photographs by **Patrick Barnard**.

USGS

Recognition—thanks

USGS Great Lakes Science Center

USGS WI, OH, MI Water Science Centers

Corsi, Francy, Haack, Whitman and others

MDEQ and Shannon Briggs

USGS