Public Health Issues on Wisconsin Lakes

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What are going to talk about?

- What is the state of lake monitoring in WI?
- What do we monitor for?
- What things should we be concerned about?
- Lets look in the crystal ball!

Recreational Water:
An Integral Part of the Culture of Water-Rich States

Oshkosh, WI - 1911

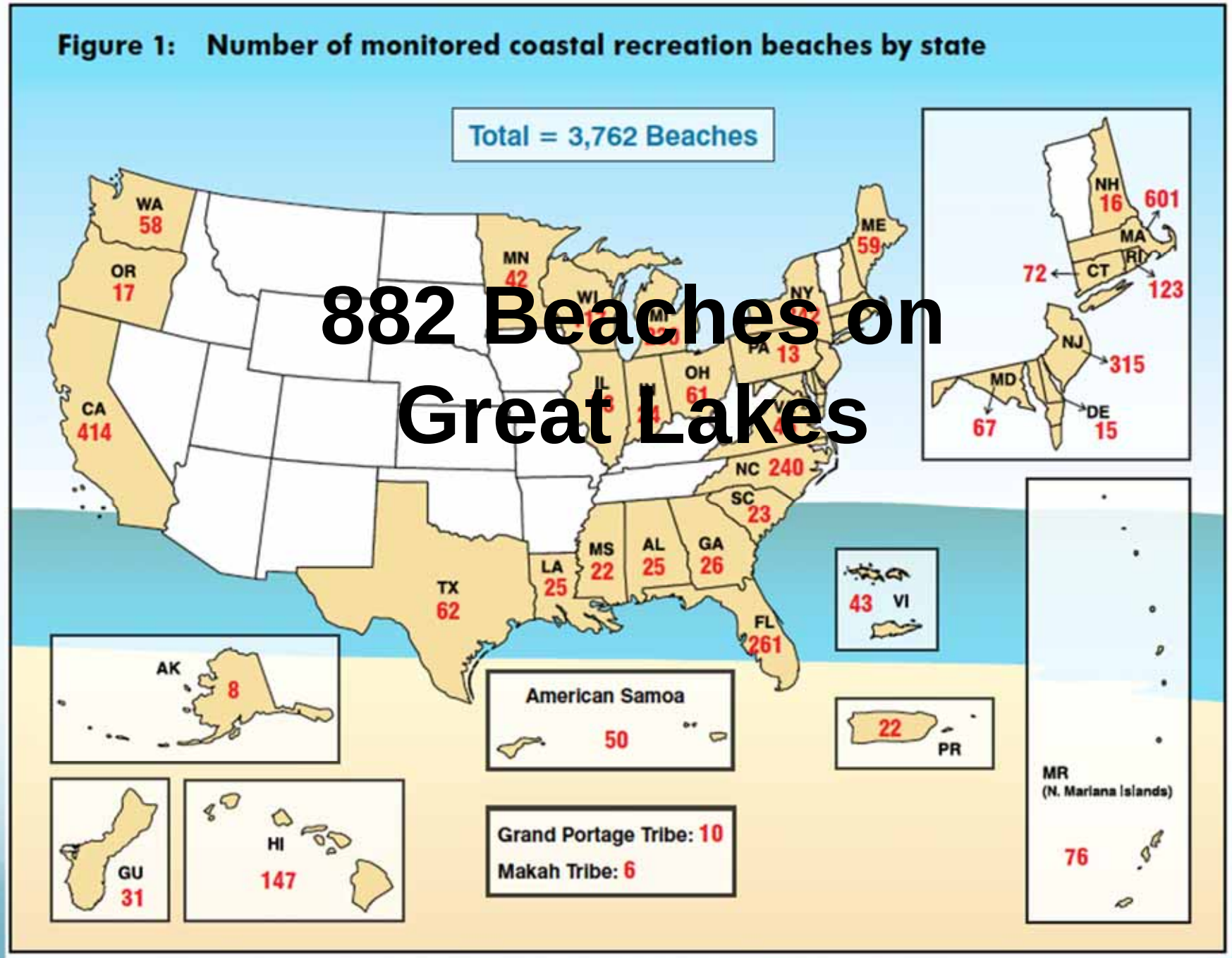
A Public Health Issue

The Problem and Implications to Public Health

- Annual increases in beach closures for per year
- >1,500 beach closures/advisories in the Great Lakes
- ~63 deaths/year in US due to recreational water (CDC)
- *Cryptosporidium* outbreak in WI
- Cyanobacterial toxins like Microcystin
- Milwaukee, Chicago, and below
- Door County, WI
- Emerging threats to WI from climate change and eutriphication

“Healthy Waters, Strong Economy”

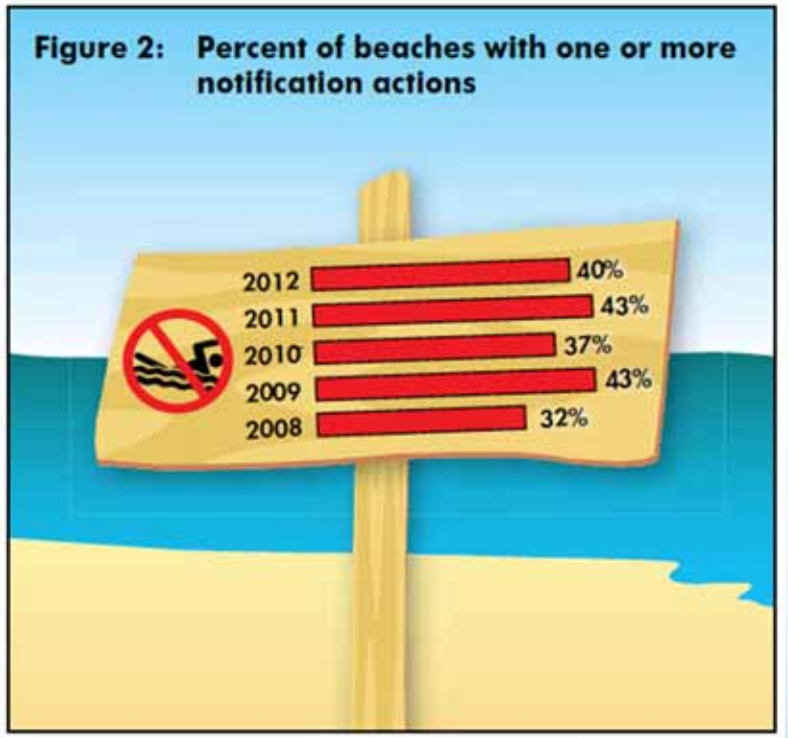
- The Brookings Institution, September 2007
  - http://www.healthylakes.org/site_upload/upload/GrtLakesCostBenefit.pdf
    - Investing $26 billion in the Great Lakes will result in $80 billion in short- and long-term economic benefits
    - Reinvigorate the economy regionally
    - Direct economic benefits from recreation (15,000+ lakes in WI)
    - Raises property values
    - Makes region more attractive to businesses and workers
    - Value of each person visiting a ‘beach’ or lake



EPA's Beach Report – 2012 Swimming Season EPA 820-F-13-014

Beach Closures in 2012

- 1504 beaches had at least 1 advisory/closure
- 5725 notification actions issued
- 66% of notifications were lifted within 1 or 2 days



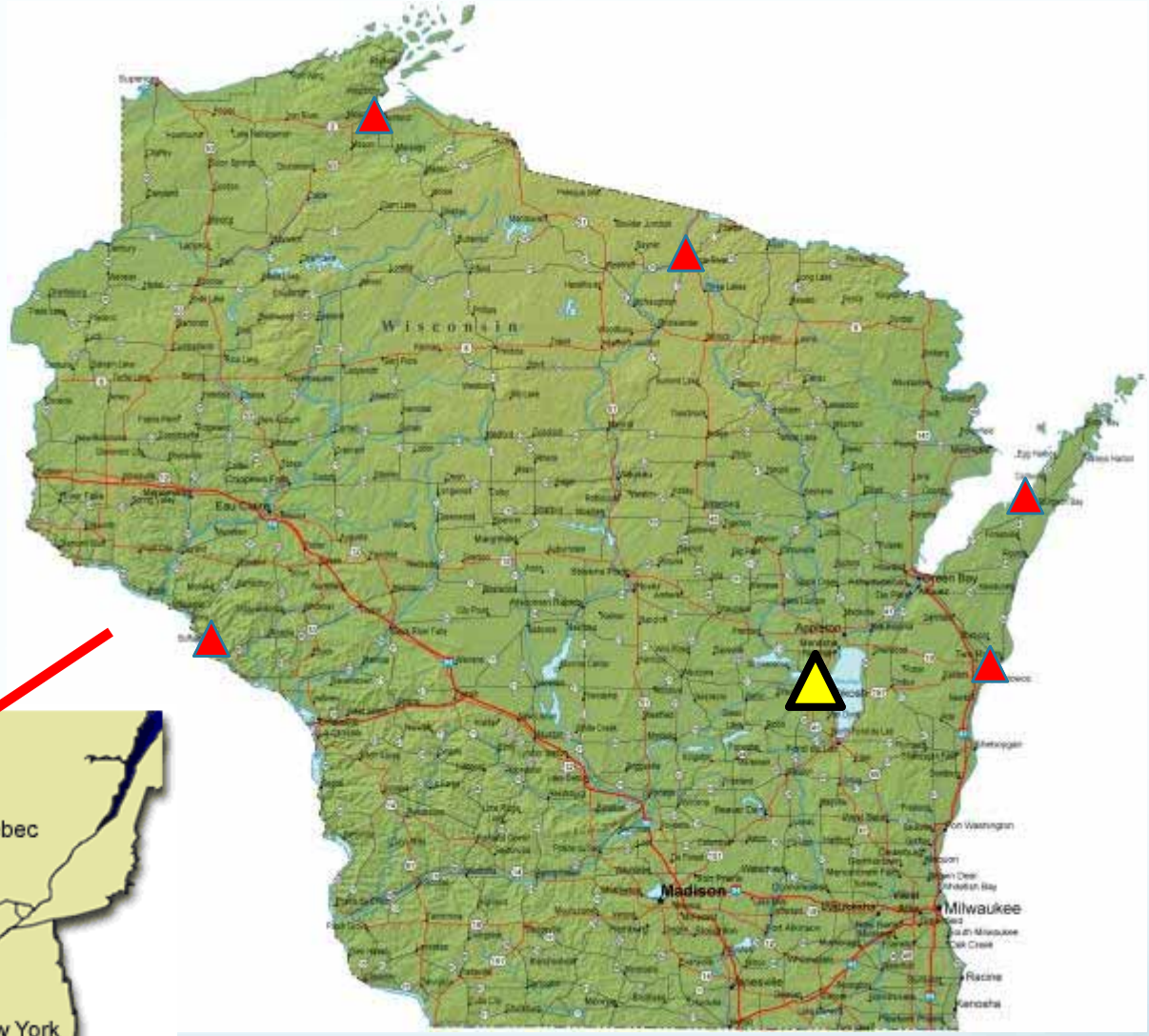
EPA's Beach Report – 2012 Swimming Season EPA 820-F-13-014

BEACH Act

- Beaches Environmental Assessment and Coastal Health Act
- Provides grants to states with Coastal or Great Lakes beaches (public) to develop water quality monitoring and public notification programs

http://water.epa.gov/type/oceb/beaches/upload/2006_06_19_beaches_beach-act-states-map.pdf

Group/Lab Locations



What are we monitoring for?

- BEACH Act = microbial contamination of recreational water
- Microbial contamination = FECAL contamination
- Feces from most animal species contain disease-causing microbes that could make bathers ill (GI tract disease)
- Most affected are small children, elderly, and immunocompromised






www.banner-button.com,instockphoto.com,getpetonline.com,mrneal.com,outerbanks.com

Sources of Fecal Contamination

- Point Sources
  - Sewer pipes
  - Stormwater pipes
  - Tiles
- Non-Point Sources
  - Tributaries
  - Rain
  - Sheet-flow
  - Waterfowl
  - Lake conditions
    - Wave height
    - Current speed and direction
    - Water temperature

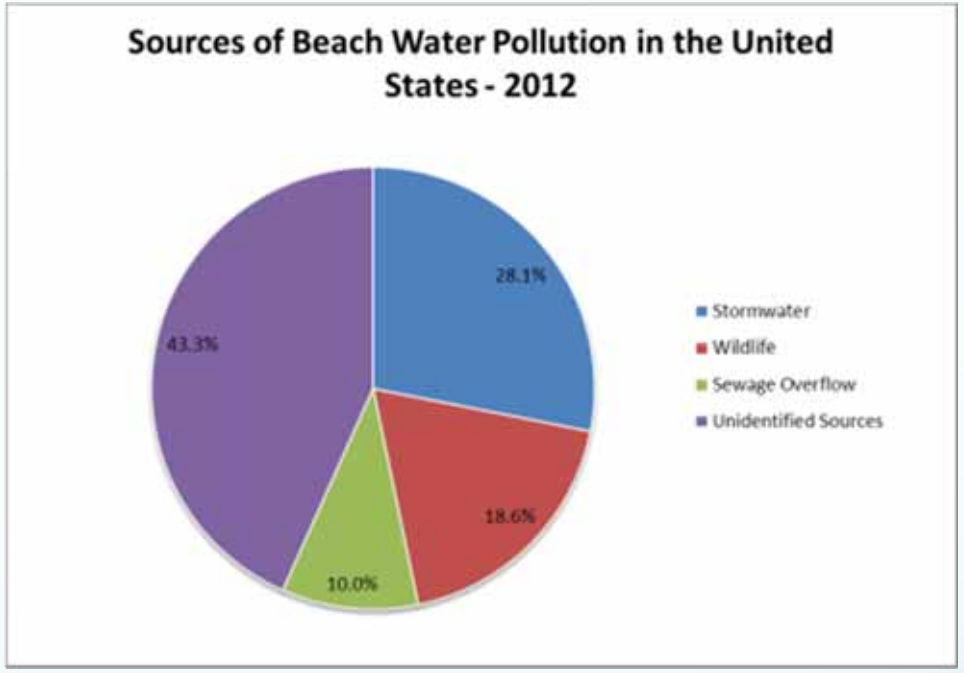


Figure adapted from http://www.nrdc.org/water/oceans/ttw/faq.asp

Indicator organisms vs. pathogens

- Feces contains millions of organisms/gram
- Some are harmless yet some could be harmful
- Pathogens (disease-causers) usually found in low numbers compared to the harmless microbes
- Pathogens are usually more difficult to culture than non-pathogens
- SO--- We look for harmless organisms that “indicate” that a recent fecal contamination has occurred (and that pathogens also are likely present)

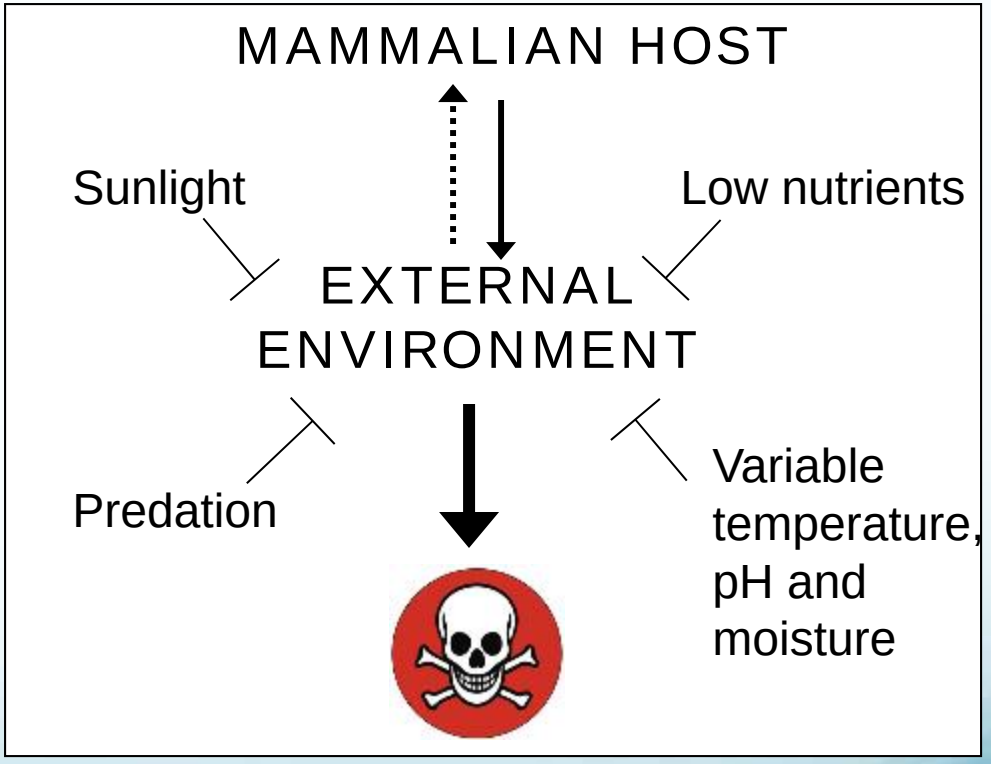
Indicator organism results provide an assessment of the “RISK” of contacting a more pathogenic microorganism.

What is “Risk”?

A statistical probability of an event occurring in a population

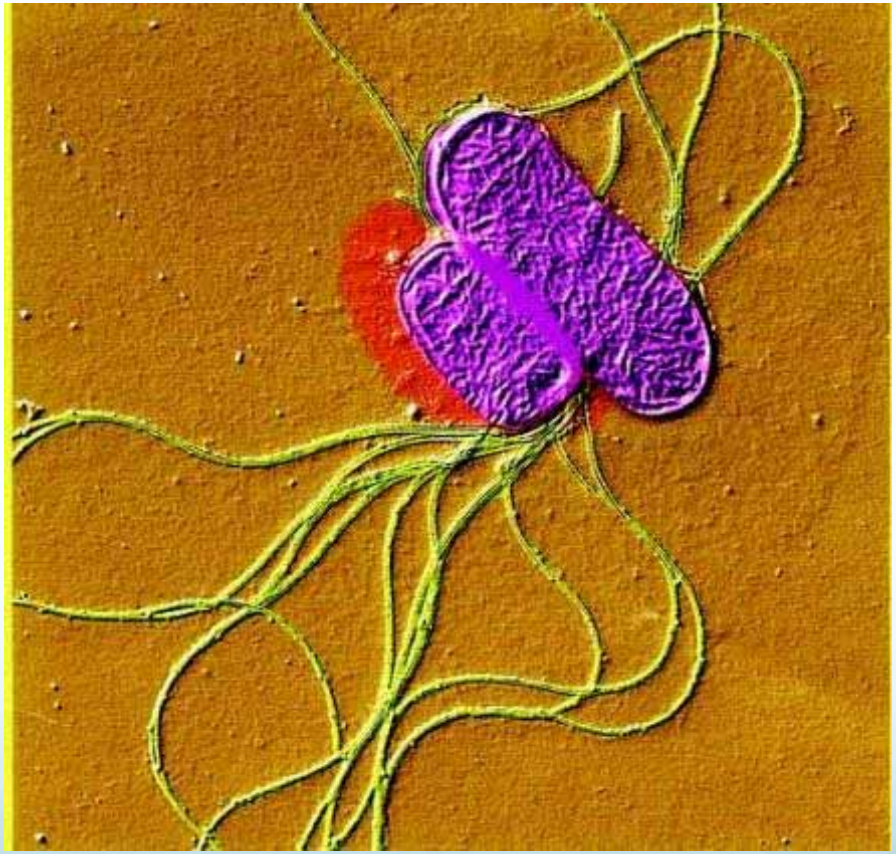
Indicator Organisms

- Commensal organism found in intestines of warm blooded animals
  - Primary (Host) Environment
  - Secondary Environment

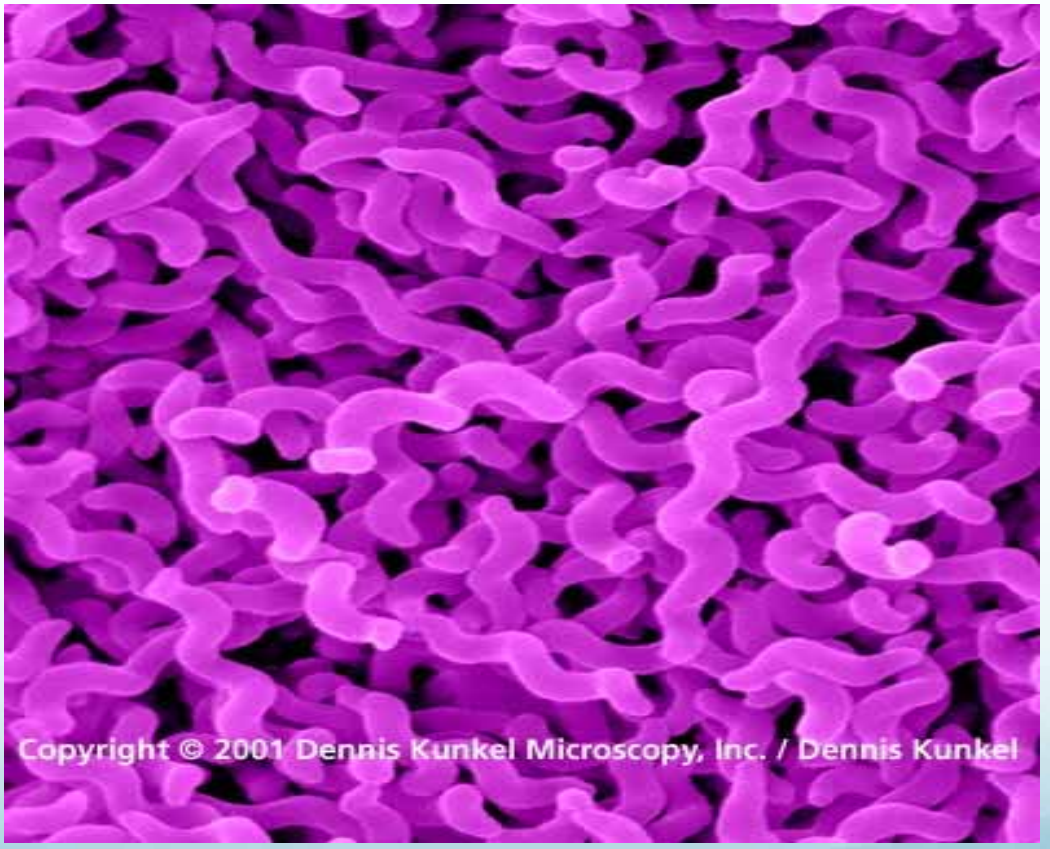


Adapted from Winfield and Groisman. 2003.

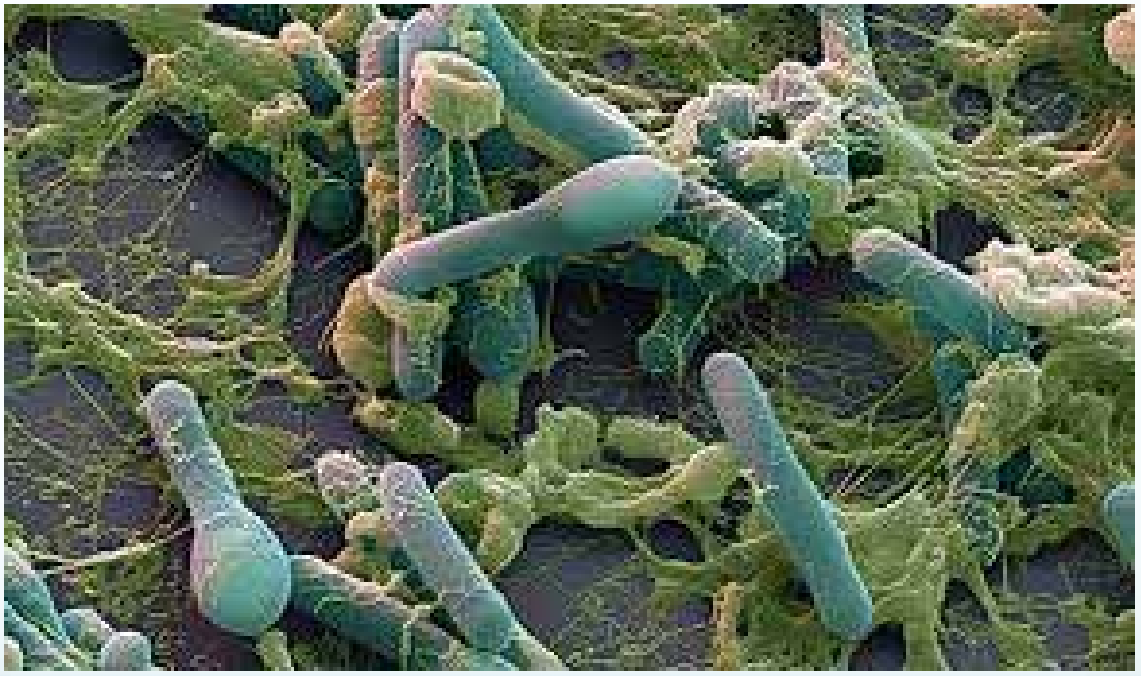
Salmonella



Campylobacter sp.

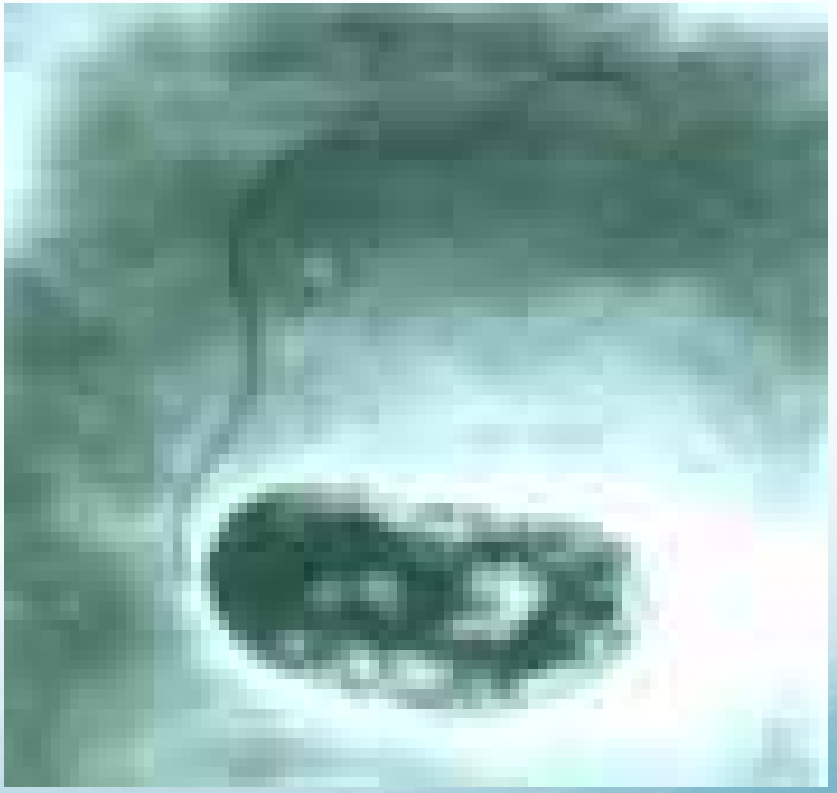


Botulism

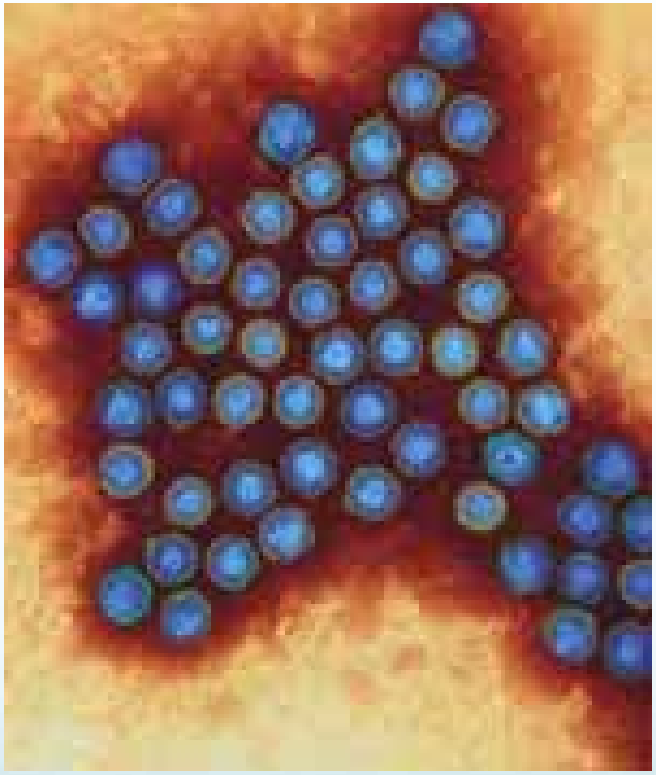


Vibrio vulnificus (Vv)

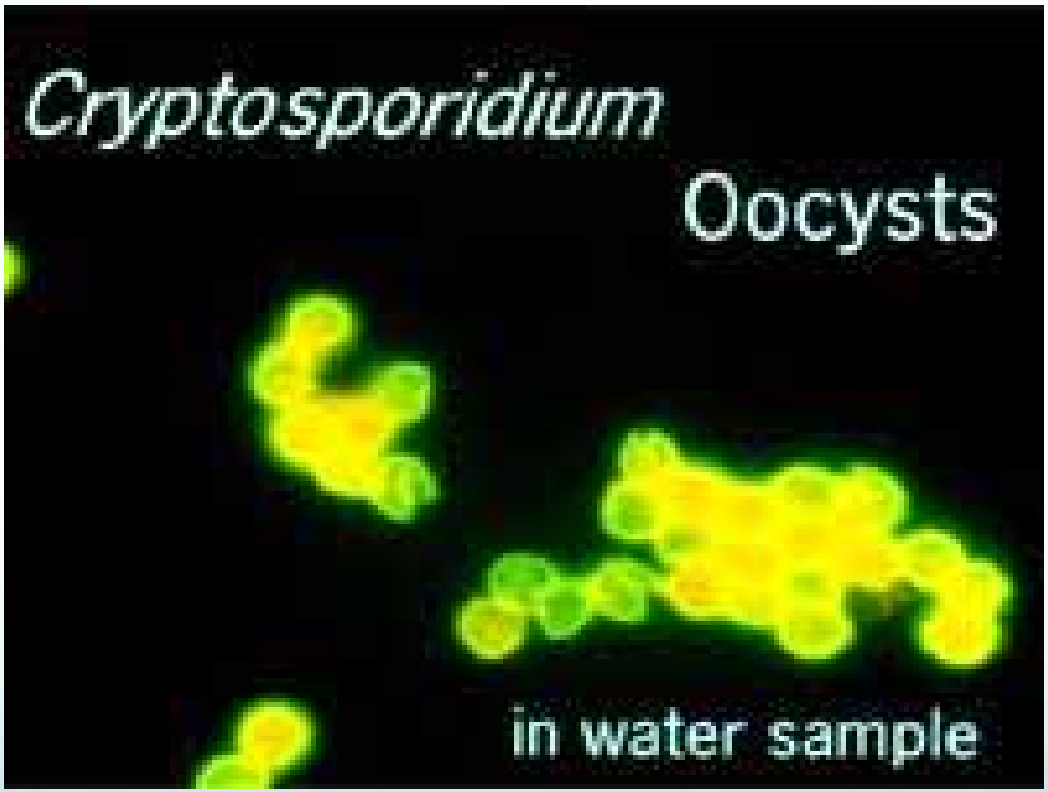
- Commonly found in the Gulf of Mexico
- Occurs naturally, rather than as a result of pollution
- Accumulates in oysters and other shellfish
- Presence is highly correlated with water temperature



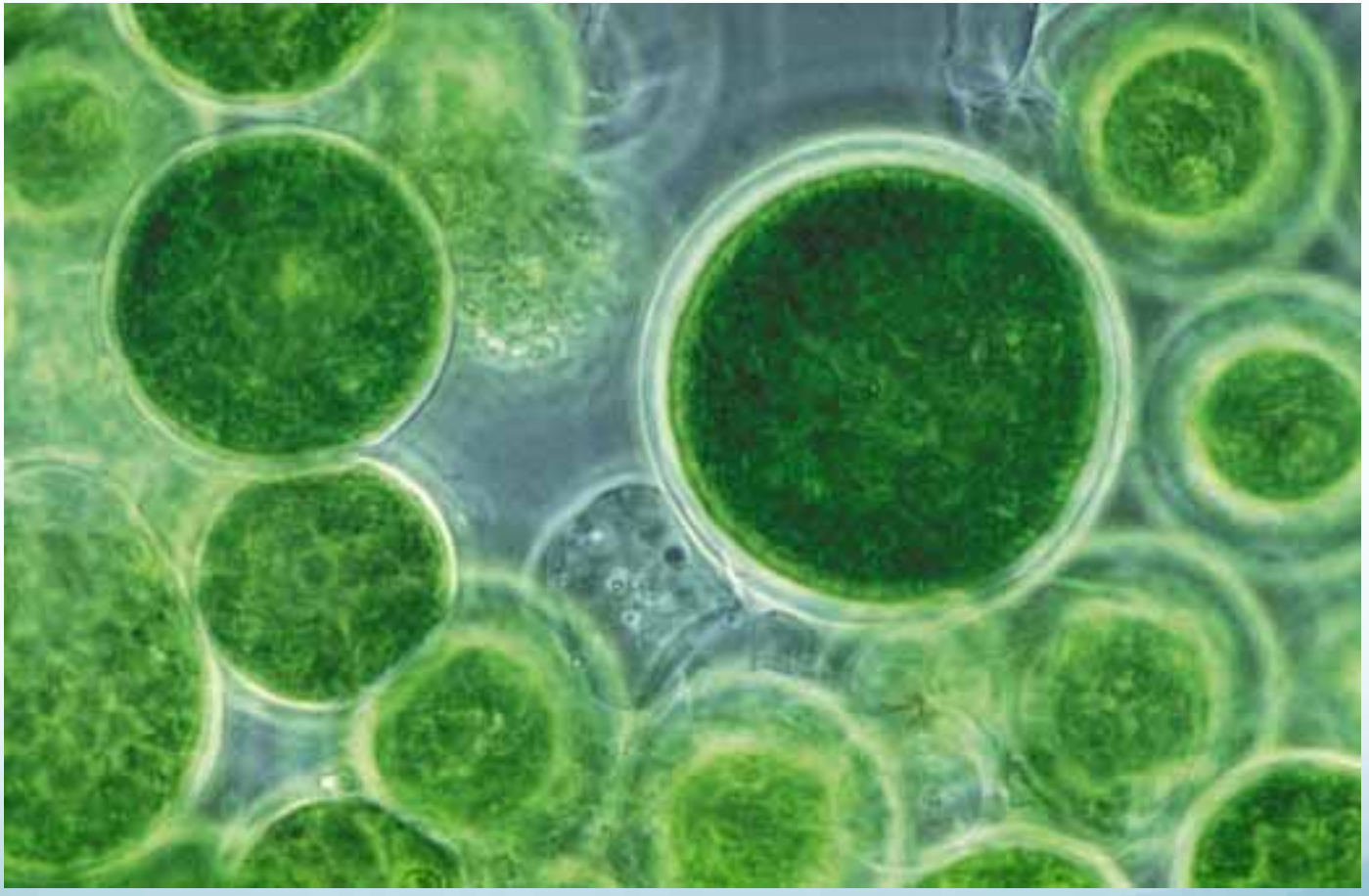
Norovirus



Cryptosporidium parvum



Cyanobacteria

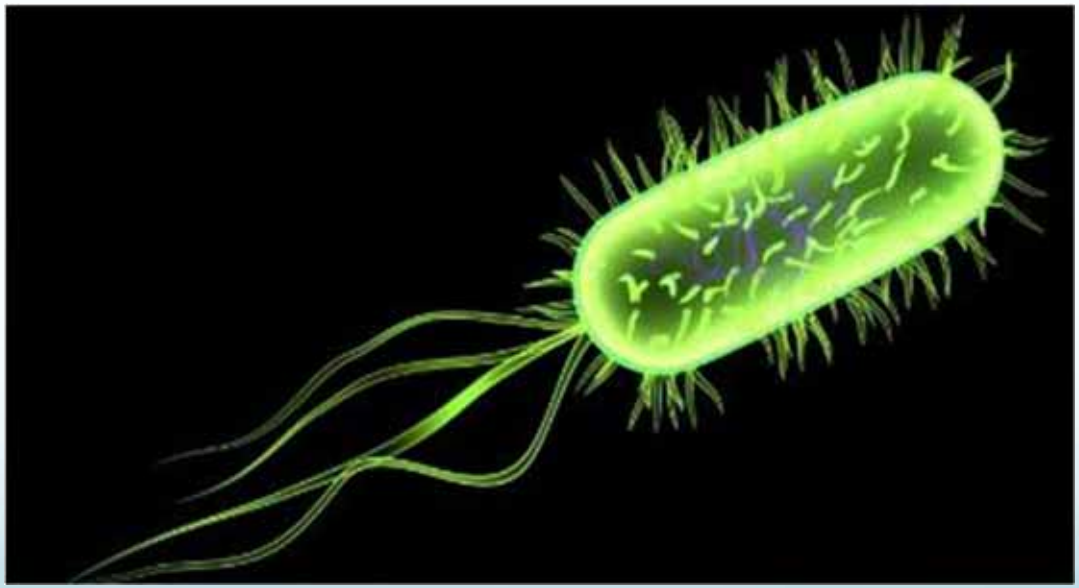


What are the best indicators?

- Bacteria easier to detect
- Aerobes or facultative anaerobes are easier to detect than strict anaerobes
- *Escherichia coli* (*E. coli*) and enterococci are indicator organisms of choice
  - Enterococci = salt water
  - *E. coli* or enterococci = fresh water
- Wisconsin (and other Great Lakes states) use *E. coli* as indicator
  - BUT, this could be changing!!

E. coli a pathogen?

- 2000+ different strains of *E. coli*
- Only a small proportion have the **“**tools**”** to cause illness
  - E.g. *E. coli* O157:H7



Collecting Water Samples

- Samples collected from center of beach at 24 inches depth 12 inches below the surface
  - Avoid stirring up sediment while entering water
  - Avoid collecting debris with the water (brush, algal strands, etc.)
- Sample collected into sterile 100 mL bottle
- Sample placed on ice immediately after collection and remains on ice until it arrives at lab
- Labs must be returned to lab and analyzed within 6 hours

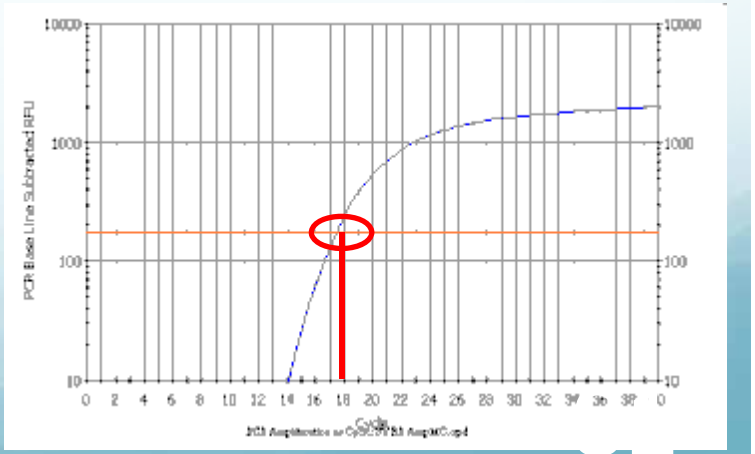
How can we detect the indicator organisms?

- Collect water sample
- Two basic techniques to detect *E. coli*
  - Membrane filtration
  - Defined Substrate
  - qPCR

qPCR

Membrane Filtration

Defined Substrate



Guidelines

- Limit for Open Beach
  - 0-234 *E. coli*/ 100 ml water
- Limit for Poor Water Quality Advisory
  - 235-999 *E. coli*/ 100 ml water
- Limit for Beach Closure
  - >999 *E. coli*/ 100 ml water

CAUTION:

WATER QUALITY ADVISORY

FOR YOUR SAFETY

Do Not Ingest Lake Water

- **Shower After Swimming**
- **Wash Hands Before Eating**
- **Do Not Swim if You Are Ill**

Increased Risk of Illness May Be Present
Based on recent monitoring for *E. coli* bacteria

FOR MORE INFORMATION:

1-800-441-4636 ext. 1500 **www.beachhealth.net**

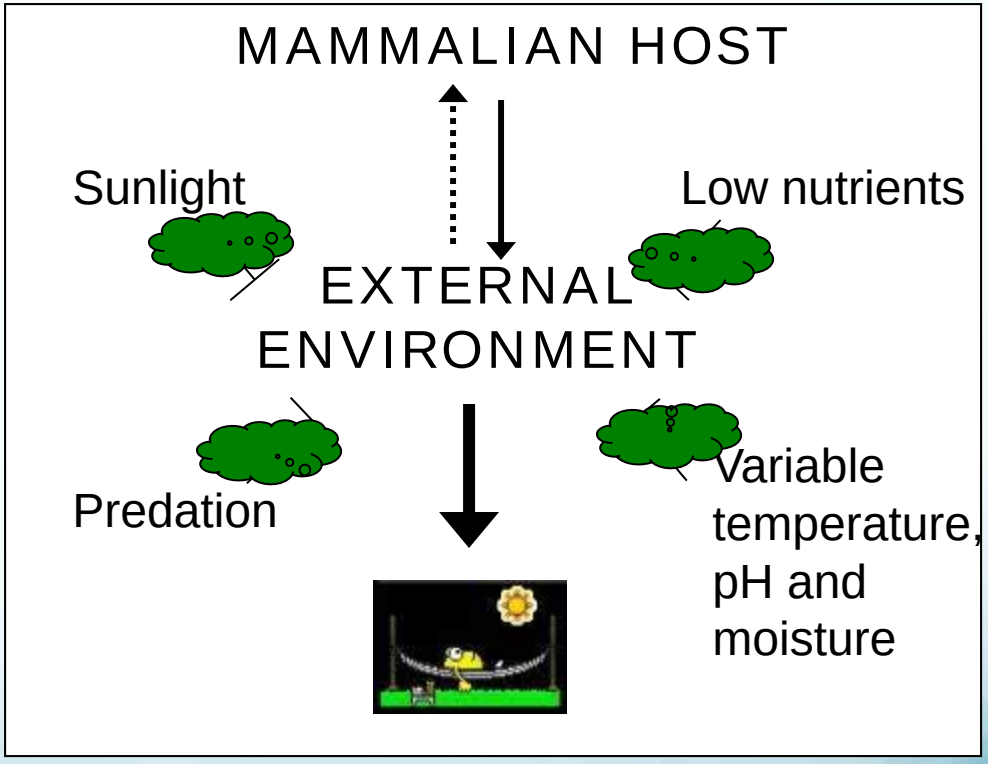

STOP
CLOSED
Based on recent monitoring for E. coli bacteria
Serious risk of illness may be present
THIS AREA IS CLOSED
TO SWIMMING
FOR MORE INFORMATION:
1-800-441-4636 ext. 1500
www.beachhealth.net

What do we do with the data?

- Notification of general public and beach managers
  - Post signs at the beaches daily
  - Post data to the EPA BEACH Act website daily
  - Call +/or email health department personnel if advisory or closures occur
- Add data to our own spreadsheets, analyze data for further use, information for the public

Macrophytes & *E. coli*

- Likely that plants and mats provide more favorable environment
- Recent research shows high levels of *E. coli* in *Cladophora* mats and on macrophytes



Mean = 10^5 CFU/g

Harmful Algal Blooms

- Direct Health Effects
  - Due to toxins
  - Human
  - Animal
- Economic Impacts
  - Direct economic impact, i.e. lost revenue
  - Loss of utility
    - Indirect economic impact, i.e. lack of satisfaction

Increase in Freshwater HAB

- Naturally occurring
- Altered nutrient regimes
- Modified hydrology
- Non-native species
  - Modified food web
- Increased pollutant inputs

NOAA GLERL

Cyanobacteria

- Formerly Blue-green algae
- High biomass and/or toxins
- Taste/odor compounds
  - Drinking water reservoirs
- Animal Fatalities
- Human illness
- Off flavor compounds
  - Aquaculture

Managing Cyanobacteria

- Report blooms to DNR or Local Public Health Department
- Do not use algaecides
  - Algaecides release toxins upon cell death
- Don’t irrigate lawns and golf courses with water that looks or smells bad
- Post signs or close beach
  - Toxins may persist after visible signs of bloom are gone

Cladophora

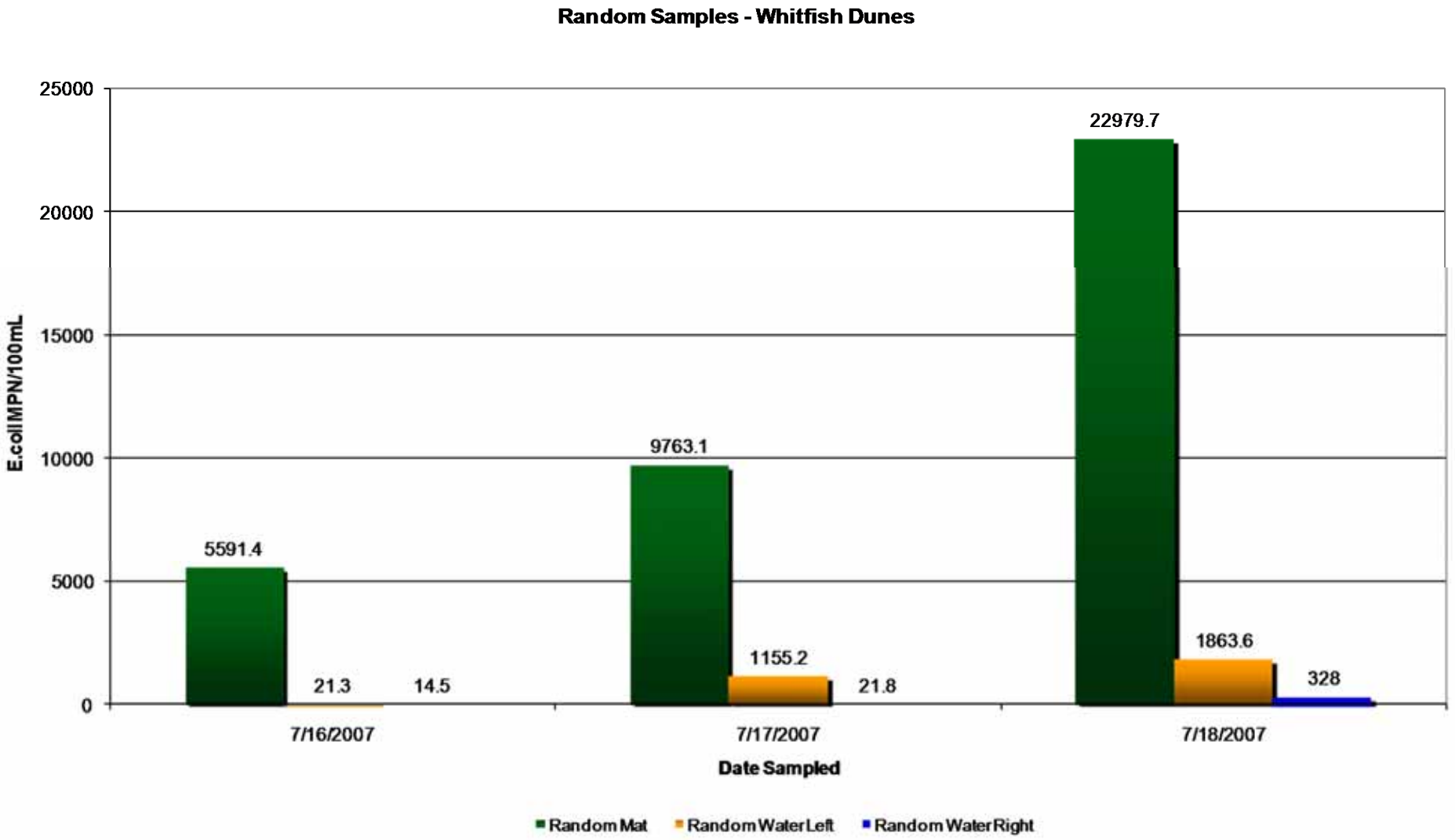
- Filamentous green algae
- Grows in response to nutrients/light
  - Resurgence may be linked to invasive mussel species
- Appears throughout summer
- Benthic
  - Float to surface on death
  - Final resting place depends on wind/waves
- Not known to produce toxins
- Bacterial pathogens?

Other Aquatic Macrophytes

- Various aquatic plants can also become stranded on beaches
- Can serve as attachment point of *E. coli*
- Can attract waterfowl

NOAA GLERL, Ladd Johnson

Random Sampling Example

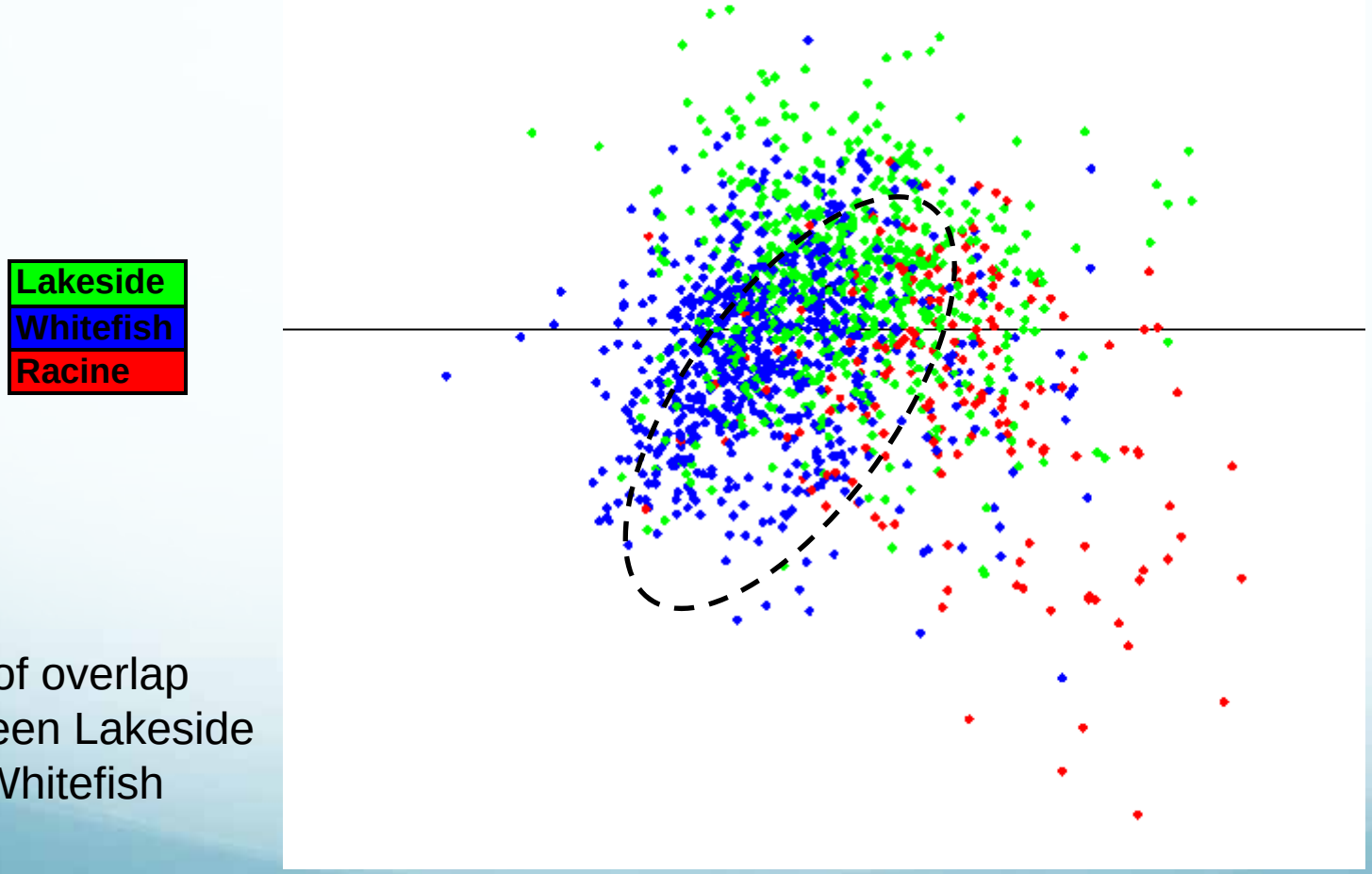


Jackknife Analysis

Average Similarities		
	Lakeside	Whitefish
Lakeside	**75.61**	48.12
Whitefish	24.39	**51.88**

Maximum Similarities		
	Lakeside	Whitefish
Lakeside	**71.85**	23.09
Whitefish	28.15	**76.91**

MANOVA



A lot of overlap between Lakeside and Whitefish

What are Sanitary Surveys?

GREAT LAKES BEACH ANNUAL SANITARY SURVEY

1. BASIC INFORMATION

Name of Beach:	Date(s) of Survey:
Beach ID:	Name of Waterbody:
Town/City/County/State:	Number of Routine Surveys Used:
Sampling Station(s) ID:	Name(s) of Surveyor(s):
STORET Organizational ID:	Surveyor Affiliation:

2. DESCRIPTION OF LAND USE IN WATERSHED

Current Land Use in Watershed

Type	Residential	Industrial	Commercial	Agricultural	Other (specify):
Percentage					

Development	Describe
% undeveloped	
% developed	

How was land use measured:

Waterbody Uses: ☐ Boating ☐ Fishing ☐ Surfing ☐ Windsurfing ☐ Diving ☐ Other (specify)

Are maps of the beach area attached? ☐ yes ☐ no Are maps of the watershed attached? ☐ yes ☐ no

List maps and their sources:

GREAT LAKES BEACHES ROUTINE ON-SITE SANITARY SURVEY

Name of Beach:	Date and Time of Survey:
Beach ID:	Surveyor Name(s):
Sampling Station(s) ID:	Surveyor Affiliation:
STORET Organizational ID:	

PART I – GENERAL BEACH CONDITIONS

Air Temperature: _____ °C or °F | Wind: Speed (mph) _____

Direction (e.g., E or 90°) _____ (From which direction the wind is coming)

Rainfall: ☐ <24 hours ☐ <48 hours ☐ <72 ☐ >72 hours since last rain event and _____ inches or _____ cm rainfall measured

Rain Intensity: ☐ Misting ☐ Light Rain ☐ Steady Rain ☐ Heavy Rain ☐ Other

Weather Conditions:

Sky Condition:	☐ Sunny	☐ Mostly Sunny	☐ Partly Sunny	☐ Mostly Cloudy	☐ Cloudy
Amount of cloud coverage	No Clouds	1/8 to 2/8	3/8 to 1/2	5/8 to 7/8	Total Coverage

Wave Intensity: ☐ Calm ☐ Normal ☐ Rough Wave Height: _____ ft ☐ Estimated or ☐ Actual

Longshore current speed and direction (cm/sec, S or 180°):

Comments/Observations

- Affordable, simple tool to evaluate sources of fecal pollution
- Routine Sanitary Survey (RSS)
  - 2-page form for recording environmental conditions and pollutants on the beach
- Annual Sanitary Survey
  - 8-page form for recording physical beach conditions and watershed characteristics

Environmental Data Collected - RSS

- **General Beach Conditions**
  - Air temperature
  - Wind speed/direction
  - Rainfall
  - Weather condition (sunny, etc.)
  - Current speed/direction
  - Wave Height
- **Water Quality**
  - FIB concentrations
  - Water temperature
  - Water color/odor
  - Turbidity (clarity)
- **Bather Load**
  - Total number of people at beach
  - Swimmers/non-swimmers
- **Potential Pollution Sources**
  - Sources of discharge
    - Rivers, outfalls, wetlands, etc.
  - Floatables
  - Amount of debris/litter
  - Amount of algae
    - Stranded on beach
    - Floating/submerged in water
  - Presence of wildlife
    - Gull counts
    - Geese, deer, other
  - Presence of domestic animals
    - Dogs, Horses

Land Use/Source ID Data Annual Sanitary Survey

- Wastewater discharge points
- Septic systems
- Subsurface sewage disposal
- Storm water outfalls
- Rivers, creeks & streams
- Agricultural run-off
- Urban run-off
- Industrial waste
- Marinas & harbors
- Moored boats
- Land Use (local & watershed)
- Annual bather load
- Combined sewage overflows
- Caged Animal Feeding Operations (CAFOs)
- Wildlife
- Domestic animals
- Stream bank erosion
- Landfills, open dumps
- Ground water
- Bathhouse toilet facilities
- Drains & pipes
- Wetland drainage
- Hydrological assessments
- Sediment/Sand assessments

Beach Sanitary Surveys – Goal

- To explore and accurately characterize beaches in terms of possible sources of microbial pollution entering the beach area.

Beach Sanitary Surveys:

Beach Sanitary Surveys:

Beach Sanitary Surveys:

Conclusion

- Inland lakes are critical to the ecology and economics of Wisconsin
- Inland beaches can learn from the Great Lakes experience
- Research and monitoring can be used to identify pollution, prevent public health ‘incidents’, and maintain (or increase) water quality
- Use common methods and notification methods throughout the state
- Water quality is better than it was in many cases!


THANK YOU!