BEACH MONITORING IN CONNECTICUT

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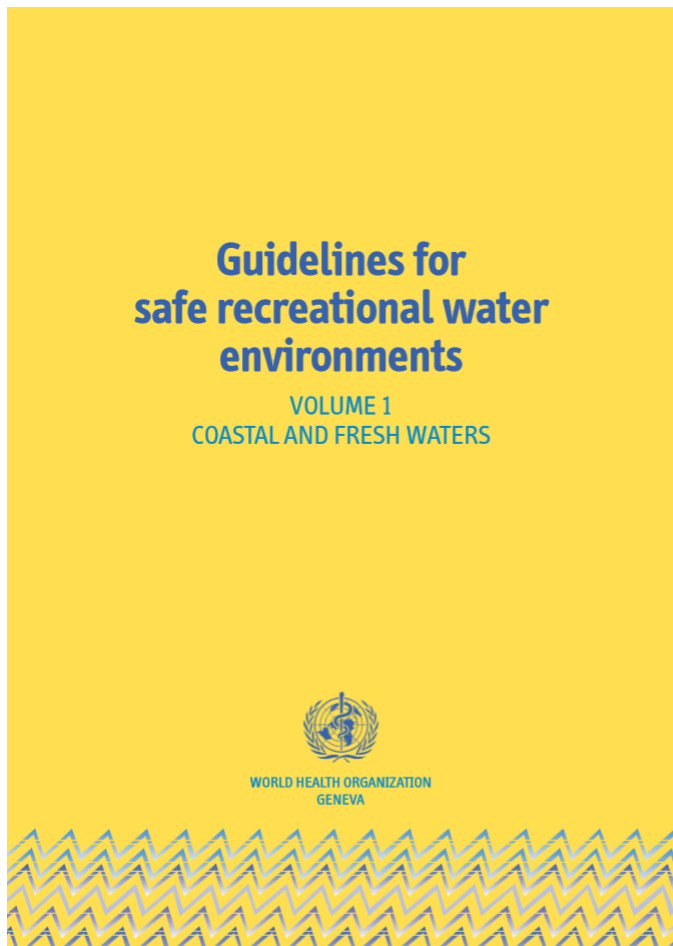
April 9th, 2019

Part 1: Swimmer Risk

World Health Organization Guidelines (2003)

The best discussion of the public health implications of being at the beach.

Guidelines for safe recreational water environments

VOLUME 1
COASTAL AND FRESH WATERS

WORLD HEALTH ORGANIZATION
GENEVA

- A comprehensive review and assessment of the health hazards encountered.
- Addresses a wide range of types of hazard:
  - Drowning
  - Injury
  - Water quality
  - Exposure to heat & cold
  - Sunlight
  - Dangerous aquatic organisms
  - Algae & Cyanobacteria
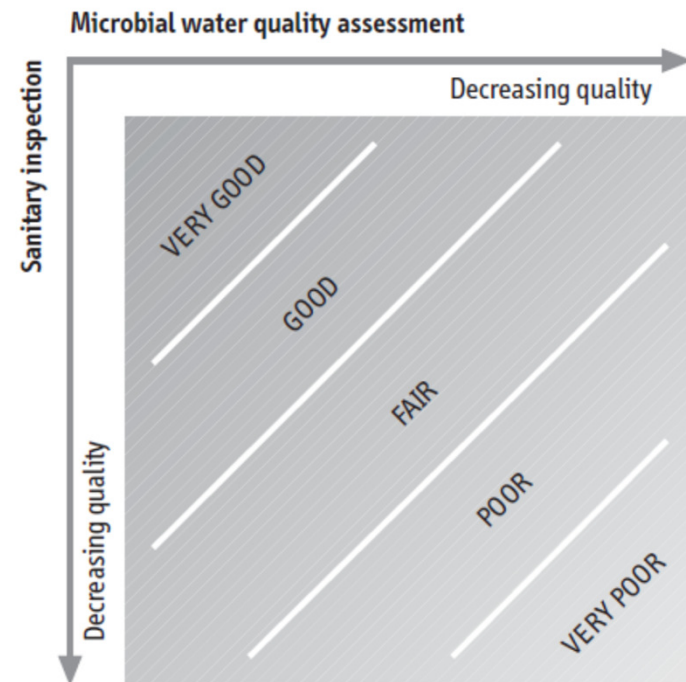   - Fresh water
    - Marine

WHO Health Risk Based Approach to Recreational Water Quality (2003)
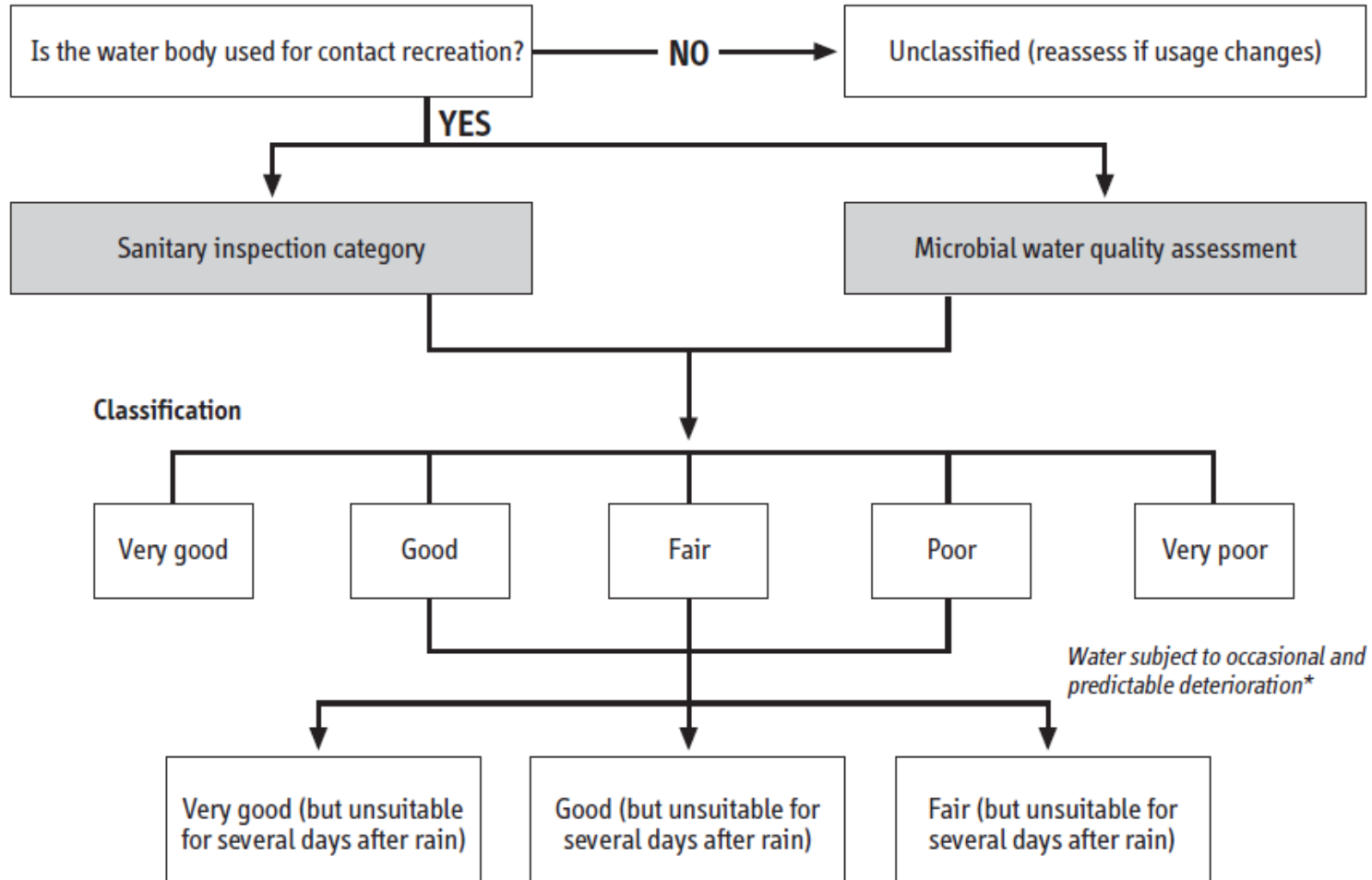
Attributes:

- Combined use of <u>sanitary assessment</u> or inspection and measurement of water quality
- Provides <u>data on possible pollution sources</u> in a recreational water area and numerical information on actual level of fecal pollution
- Combine these elements to provide a basis for a robust, graded, <u>classification</u>

Microbial water quality assessment

Goals:

- Grade beaches to support informed personal choice
- Provide on-site guidance to users on relative safety
- Assist in identifying and promoting effective management interventions
- Provide an assessment of regulatory compliance.

WHO Simplified Framework for Assessing Recreational Water Environments

| Is the water body used for contact recreation? | — NO → | Unclassified (reassess if usage changes) |

YES

Sanitary inspection category   **Microbial water quality assessment**

Classification

| Very good | Good | Fair | Poor | Very poor |

Water subject to occasional and predictable deterioration*

| Very good (but unsuitable for several days after rain) | Good (but unsuitable for several days after rain) | Fair (but unsuitable for several days after rain) |

* where users can be shown to be effectively discouraged from entering the water following occasional and predictable water quality deteriorations (linked to, for example, rainfall), the area may be upgraded to reflect the water quality that users are exposed to, but only with the accompanying explanatory material.

WHO Framework for Risk Assessment of Aquatic Pathogens

From the Annapolis Protocol (1999)

1) Called for less reliance on fecal indicator as the sole determinant of risk

   "No single indicator or approach is likely to represent all the facets and issues associated with contamination of waterways with faecal matter."

2) Supported combined use of sanitary assessment and measurement of fecal indices

"..classification is based upon the combination of an inspection-based assessment of the area's susceptibility to influence from human faecal contamination and a microbiological indicator."

Result: A "Harmonized" approach to risk assessment and risk management

Surveillance:
- Sanitary inspection and subsequent ranking
- Direct measurement of fecal indicator

→

Intervention:
- Provide a system to account for the impact of actions to discourage water use during periods of higher risk

Examples of Bacterial and Viral Pathogens Found in Raw Sewage

Pathogen/index organism	Disease/role	Numbers per 100 ml
Bacteria		
Campylobacter spp.	Gastroenteritis	10^4–10^5
Clostridium perfringens spores	Index organism	$6 \times 10^4 - 8 \times 10^4$
Escherichia coli	Index organism (except specific strains)	10^6–10^7
Faecal streptococci/intestinal enterococci	Index organism	$4.7 \times 10^3 - 4 \times 10^5$
Salmonella spp.	Gastroenteritis	0.2–8000
Shigella spp.	Bacillary dysentery	0.1–1000
Viruses		
Polioviruses	Index organism (vaccine strains), poliomyelitis	180–500 000
Rotaviruses	Diarrhoea, vomiting	400–85 000
Adenoviruses	Respiratory disease, gastroenteritis	not enumerated[b]
Norwalk viruses	Diarrhoea, vomiting	not enumerated[b]
Hepatitis A	Hepatitis	not enumerated[b]

b Many important pathogens in sewage have yet to be adequately enumerated, such as adenoviruses, Norwalk-like viruses, hepatitis A virus.

Effectiveness of Treatment on Pathogen Removal From Raw Sewage
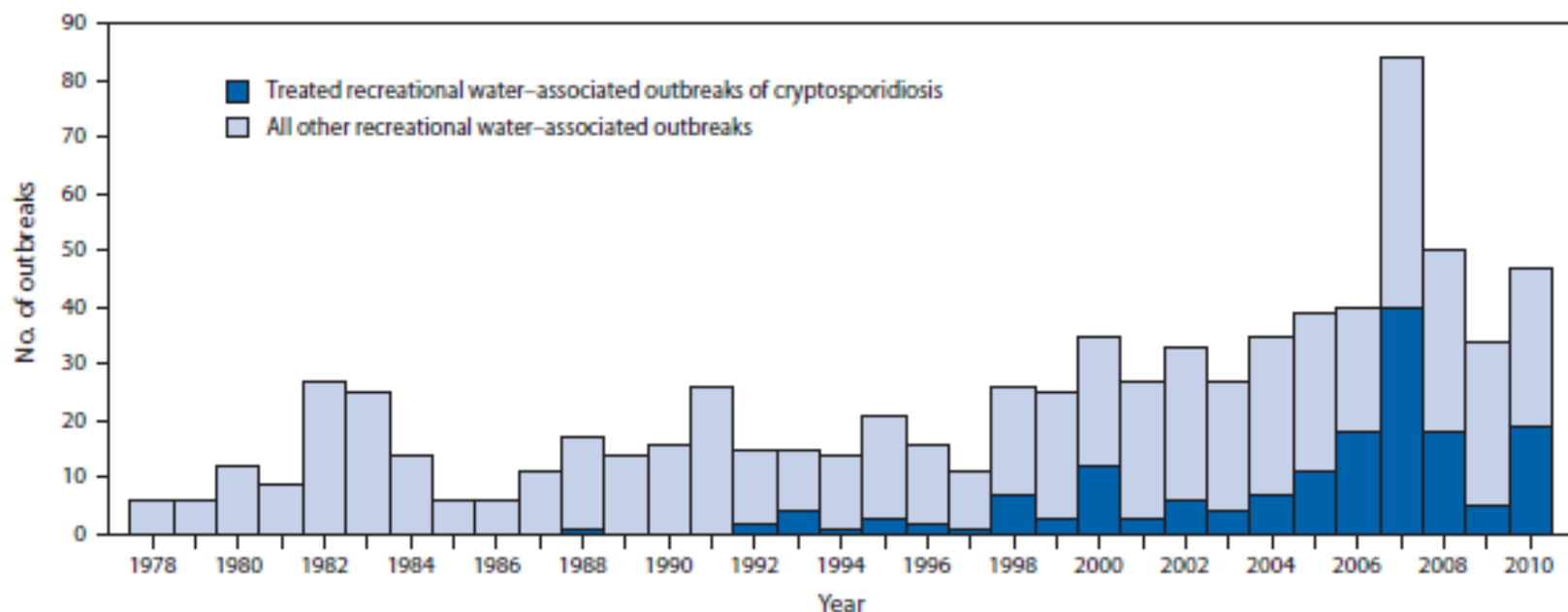
Treatment Systems: The First Line of Defense

Infective dose of pathogen	Enteric viruses	Salmonella	Giardia
No. of cells or particles	$1 > 10$	$>10^3$	25–100
Amount in feces	10^6–10^{10}/g	10^{10}/g	9×10^6/g of stool
Concentration in raw sewage (No./L)	10^3	5,000–80,000	9,000–200,000
% Removal of pathogens during			
Primary treatment	50–98.3	95.8–99.8	27–64
Number remaining	1,700–50,000	160–3,360	72,000–146,000
Secondary treatment	53–99.92	98.65–99.996	45–96.7
Number remaining	85–47,500	3–1,075	6,480–109.500
Tertiary treatment	83–99.9999998	99.99–999999995	98.5–99.99995
Number remaining	0.0002–17	0.000004–7	0.099–2,951

Adapted from Yates (1998) and Toze (2006).

Saxena, Gaurav & Bharagava, Ram Naresh & Kaithwas, Gaurav & Raj, Abhay. (2015). Journal of Water and Health. 13. 319-339. 10.2166/wh.2014.275

Waterborne Cryptosporidium Disease Outbreaks Associated With Recreational Waters
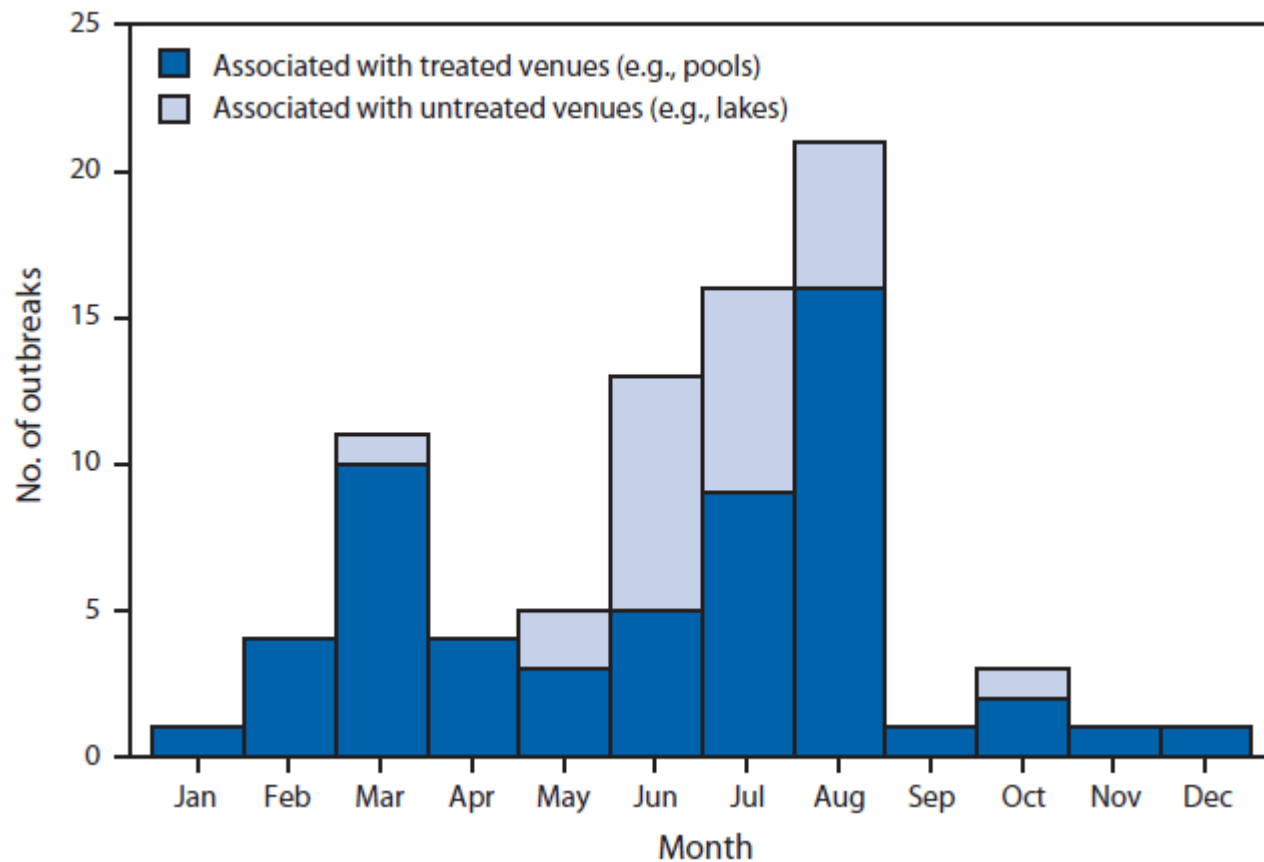
United States (1978-2010)

Source: CDC's Waterborne Disease and Outbreak Surveillance System, as reported via the National Outbreak Reporting System.

The <u>number</u> of crypto outbreaks reported for a given year has increased significantly since 1978.

Waterborne Disease Outbreaks Associated With Recreational Waters: Treated vs. Untreated

Number of waterborne disease outbreaks associated with recreational water United States, 2009–2010

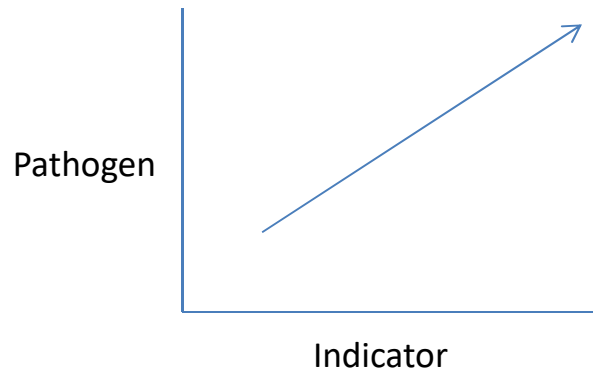*The incidence of bacterial outbreaks is two-fold greater in treated waters.*

Waterborne Disease Outbreaks Associated With Recreational Waters of the US

Bacterial, Parasitic and Viral

Untreated Waters (2009-2010)

Etiology	Outbreaks	Cases	Hospitalized
Bacterium	**5**	**91**	**18**
Campylobacter jejuni	1	6	4
Escherichia coli O157:H7	3	17	8
Legionella spp.	0	0	0
Pseudomonas aeruginosa	0	0	0
Shigella sonnei	1	68	6
Parasite (Cryptosporidium)*	3	16	0
Virus (Norovirus)	**1**	**69**	**2**

*No outbreaks of cryptosporidiosis have been associated with marine beach use.
Ronald Fayer, Lihua Xiao (2007). *Cryptosporidium and Cryptosporidiosis, Second Edition:* CRC Press, p. 350.

MMWR: January 10, 2014 / 63(01);6-10
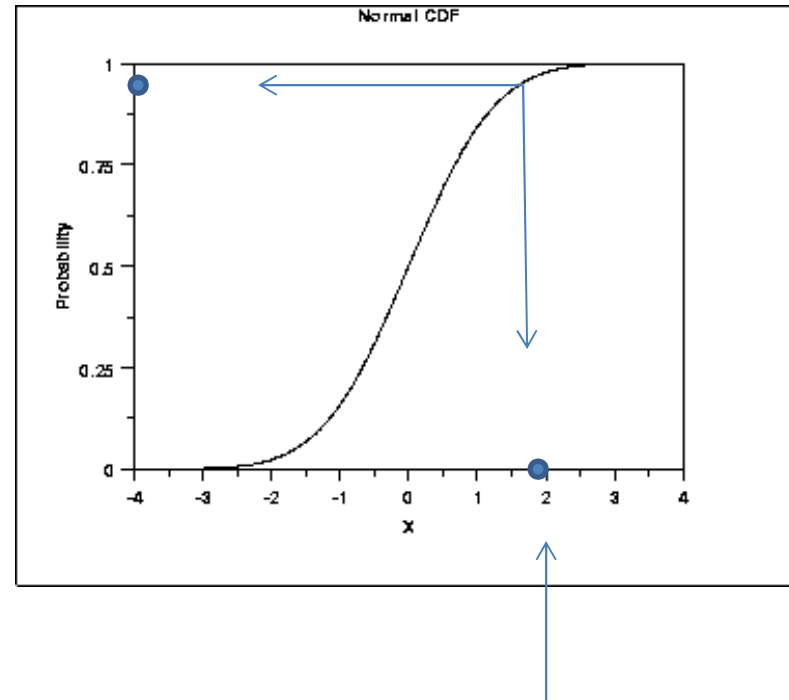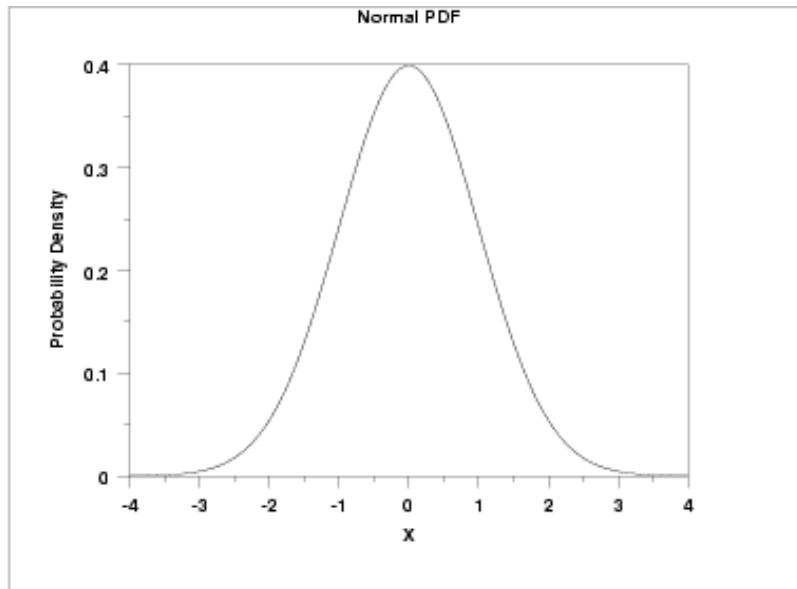
Pathogen Indicator Organisms

Pathogen

Indicator

- In 2004, Enterococci sp. took the place of fecal coliforms as the new USA federal standard for water quality at public saltwater beaches.
- The genus Enterococcus includes more than 17 species, although only a few cause clinical infections in humans.

Enterococci are Distributed Throughout the Beach Environment

Source	Concentration
Kelp wrack	10^1-10^4 CFU/ dry g
Sand	1-10^4 CFU/g
Bather shedding	10^6 CFU/person
Urban runoff	10^3 MPN/100 ml
Stormwater	0-10^6 MPN/100 ml
Dog feces	10^4-10^8 CFU/g feces
Bird feces	10^2-10^6 CFU/g
Groundwater	10^2 MPN/100 ml
Raw sewage	10^5 MPN/100 ml
Agricultural runoff	10^3 MPN/100 ml

From Boehm & Sassoubre (2014)

The Normal Distribution and the 95% Value

Normal PDF

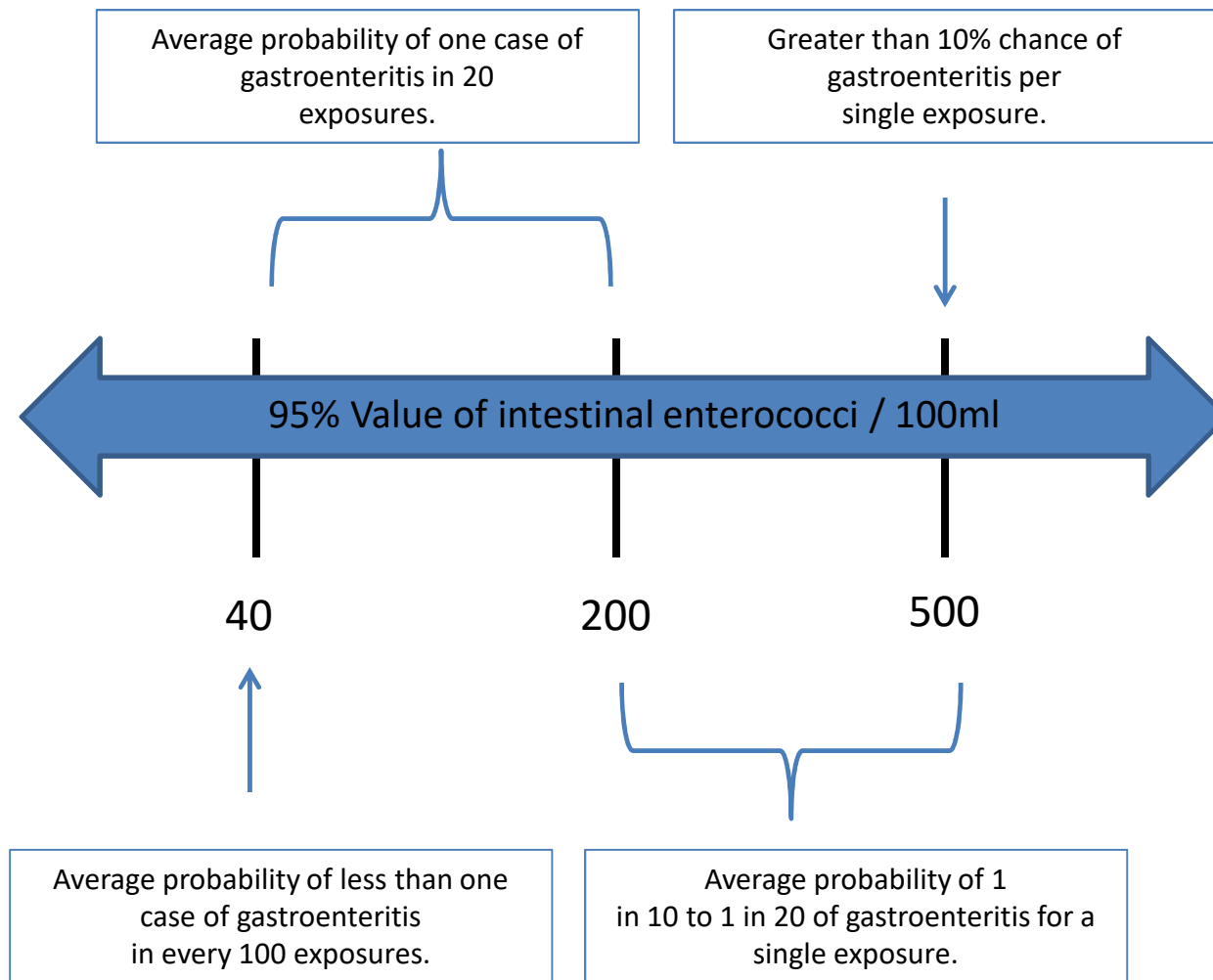## Normal CDF

95% Value

- 5% area on right
- 95% area on left

Swimmer Risk: WHO Guideline Values for Microbial Quality of Recreational Waters

Average probability of one case of gastroenteritis in 20 exposures.

Greater than 10% chance of gastroenteritis per single exposure.

95% Value of intestinal enterococci / 100ml

40   200   500

Average probability of less than one case of gastroenteritis in every 100 exposures.

Average probability of 1 in 10 to 1 in 20 of gastroenteritis for a single exposure.

WHO's 4X5 Matrix of Classification Categories

Putting the Annapolis concept into practice:

		Microbial Water Quality Assessment Category (95th percentile intestinal enterococci/100 ml)				
		A ≤40	B 41–200	C 201–500	D >500	Exceptional circumstances
Sanitary Inspection Category (susceptibility to faecal influence)	Very low	Very good	Very good	Follow up[1]	Follow up[1]	Action
	Low	Very good	Good	Fair	Follow up[1]	
	Moderate	Good[2]	Good	Fair	Poor	
	High	Good[2]	Fair[2]	Poor	Very poor	
	Very high	Follow up[2]	Fair[2]	Poor	Very poor	
	Exceptional circumstances	Action				

PART TWO: CT DPH GUIDANCE

State of Connecticut Guidelines for Monitoring Swimming Water and Closure Protocol

Connecticut Department of Public Health

Connecticut Department of ENERGY & ENVIRONMENTAL PROTECTION

STATE OF CONNECTICUT
DEPARTMENT OF PUBLIC HEALTH
410 Capitol Avenue
Hartford, CT 06134-0308

STATE OF CONNECTICUT
DEPARTMENT OF ENERGY &
ENVIRONMENTAL PROTECTION
Bureau of Water Protection and Land Reuse
79 Elm Street
Hartford, CT 06106-5127

Raul Pino, M.D., M.P.H.
Commissioner

Robert J. Klee
Commissioner

March 2016

Statutory Authority For Beach Monitoring and Notification

The Connecticut General Statutes, Chapter 98, Municipal Powers.   Section 7-148:

- Municipalities have the power to "control and operate" recreation places, public beaches and beach facilities.

- They also have the power to "regulate and prohibit swimming or bathing in the public or exposed places within the municipality".
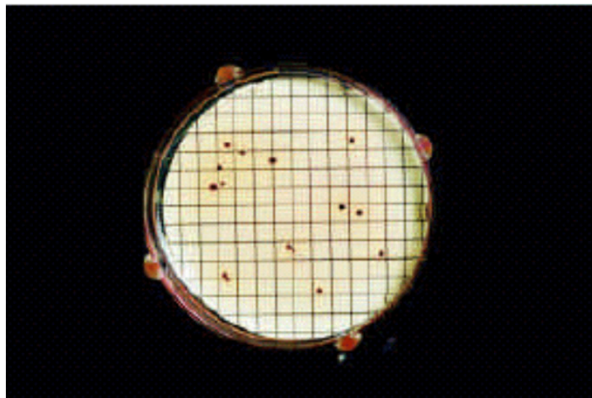
Watershed Survey Guidelines:

Three on the to-do list:

1. Annually prior to the bathing season, the local health department should conduct a <u>sanitary survey</u> of any watershed which drains to a public bathing area. If any source of contamination which may adversely affect the bathing area is observed, the local director of health shall take appropriate action under his/her authority to correct the violation.

2. When conducting a watershed survey for a coastal bathing area special consideration should be given to <u>sewage</u> treatment plant location, pump station location, industrial plant discharge points and other areas that may impact the bathing area waters.

3. Large populations of <u>waterfowl</u> should be noted on the survey report because this can be a contributing factor to elevated bacterial levels in the bathing area.

Approved Methods for Counting Enterococci in CT Marine Waters

EPA Method 1106.1

Enterolert Method

Colony Forming Units (CFU)

Most Probable Number (MPN)

Indicator Criterion for CT Marine Beaches

- A concentration of enterococcal organisms less than or equal to 104 per 100 ml is satisfactory for a single sample from a bathing area.

- A single sample with a concentration of enterococcal organisms greater than 104 per 100 ml is in excess of that considered acceptable for bathing.

- An acceptable geometric mean for enterococcal indicator organism density for bathing waters is less than or equal to 35 per 100 ml.

- The running geometric mean should be based on at least 5 sample results per sample station, per 30-day period.

Beach Closure Guidelines

1. If there is a known waste contamination event such as a sewage bypass or mechanical failure at a sewage treatment plant, pump station failure or ruptured sewer pipe, beach closures may be recommended by the local health department <u>prior to receiving any sample results</u>.

2. When a single sample result exceeds the standards for bathing water quality established by the commissioner, <u>a resample should be taken</u> and a survey made to determine if raw or partially treated sewage is contributing to the elevated bacterial levels.

3. If the bathing area is impacted by a mass of floating debris, the director of health may close the area to bathing for safety reasons <u>even if the water quality is good</u>.

4. The director of health may also want to consider bathing beach closures established by evaluating <u>rainfall data</u>.

Notifying CT DPH of Beach Closures and Openings

1) If the local director of health deems it necessary to close a bathing beach, the DPH should be advised of such closure by telephone as soon after the closure as possible but <u>not later than 4 hours</u>.

Information to be provided to the DPH concerning the closure should include:

The reason for such closure
The names of the affected areas

2) The DPH shall be notified when any bathing beach has reopened and the rationale for reopening such beach. Notice shall be provided by: <u>within 6 hours of reopening</u>.

PART THREE: The EPA Beach Act of 2000

The Beaches Environmental Assessment and Coastal Health (BEACH) Act:
- signed into federal law on October 10, 2000, amending the Clean Water Act
  - addressed pathogens and pathogen indicators in coastal recreation waters
  - authorized at $30 million; never fully funded
  - In 2007 Congress made $9.9 million available
  - cut to $9.75 million for 2008
  - cut to $9.5 million for 2016

EPA Office of Inspector General (1/18/2018): "Despite the EPA's proposal to eliminate this grant program since FY 2013, Congress continues to provide the funding for this program, either through continuing resolutions or by including the program in the EPA's budget. Members of Congress have expressed support for continuing funding for the grant program."

https://www.epa.gov/sites/production/files/2018-01/documents/_epaoig_20180118-18-p-0071.pdf

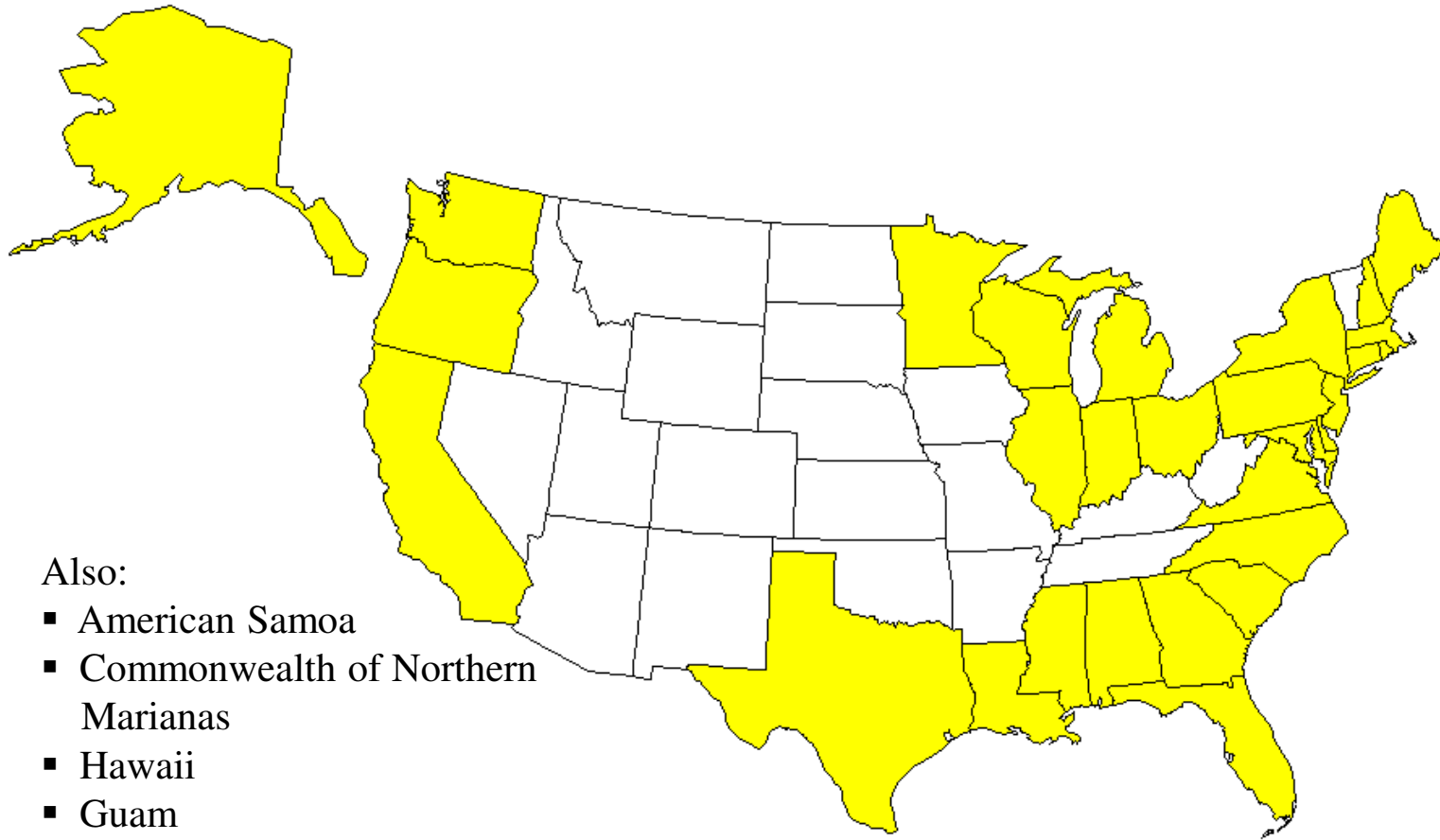## The Beach Act Funding is Administered by US EPA

US EPA in turn provides grants to States for implementing their public health plan at the State's beaches.

Some key features:
1) **The EPA plan places an emphasis on enterococci testing**
2) **Requirements include having grant recipients identify:**

a) the use of a rapid testing method (i.e.; < six hours)
b) measures for communicating the results of a water sample concerning pollutants within 24 hours of receipt
c) measures for an annual report to the Administrator
d) the availability of a geographic information system database that is publicly accessible and searchable, that is updated within 24 hours of the availability
e) measures to ensure that closures or advisories are made within two hours after the receipt of the results of a water quality sample that exceeds applicable water quality standards

35 States and Territories

Also:
- American Samoa
- Commonwealth of Northern Marianas
- Hawaii
- Guam
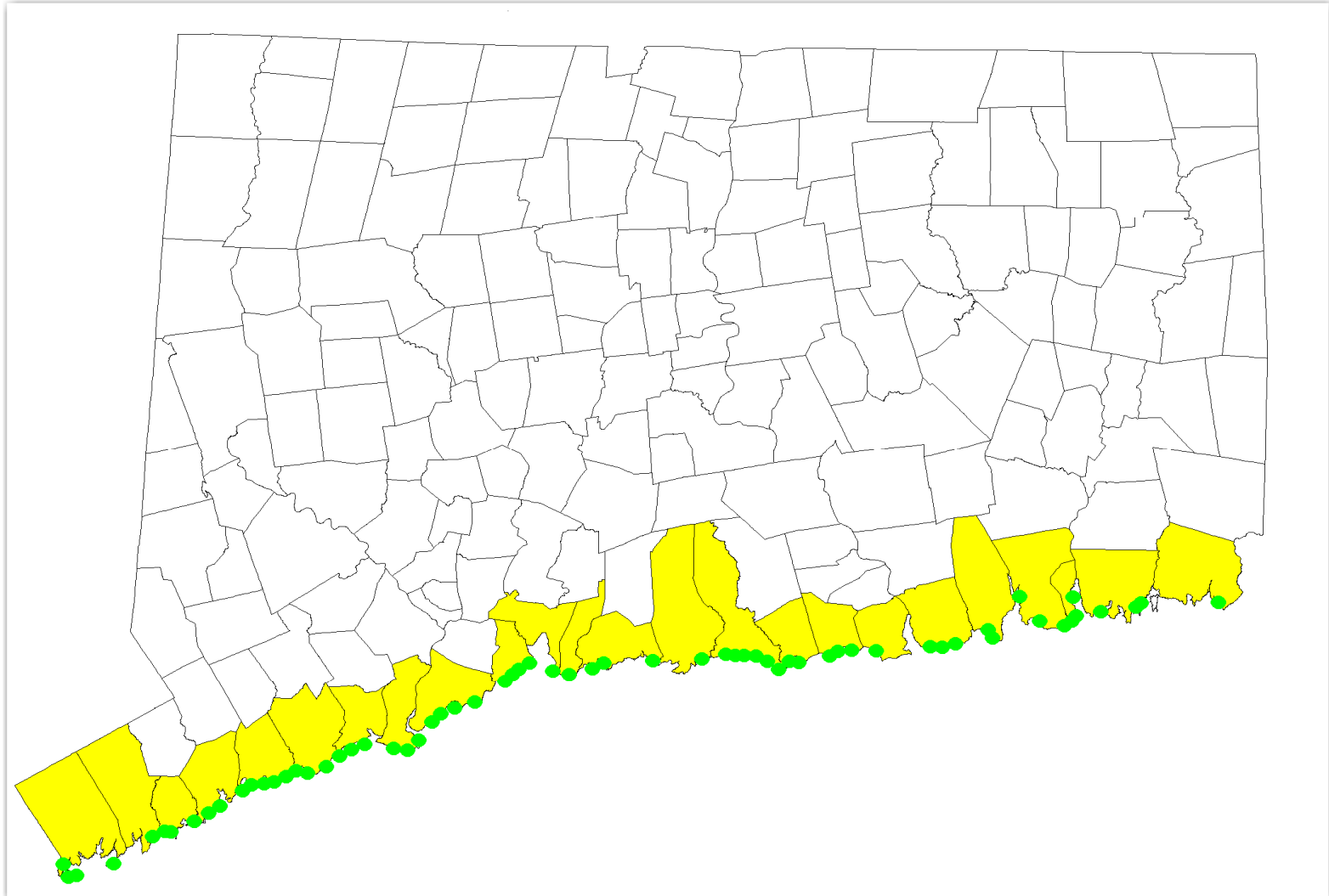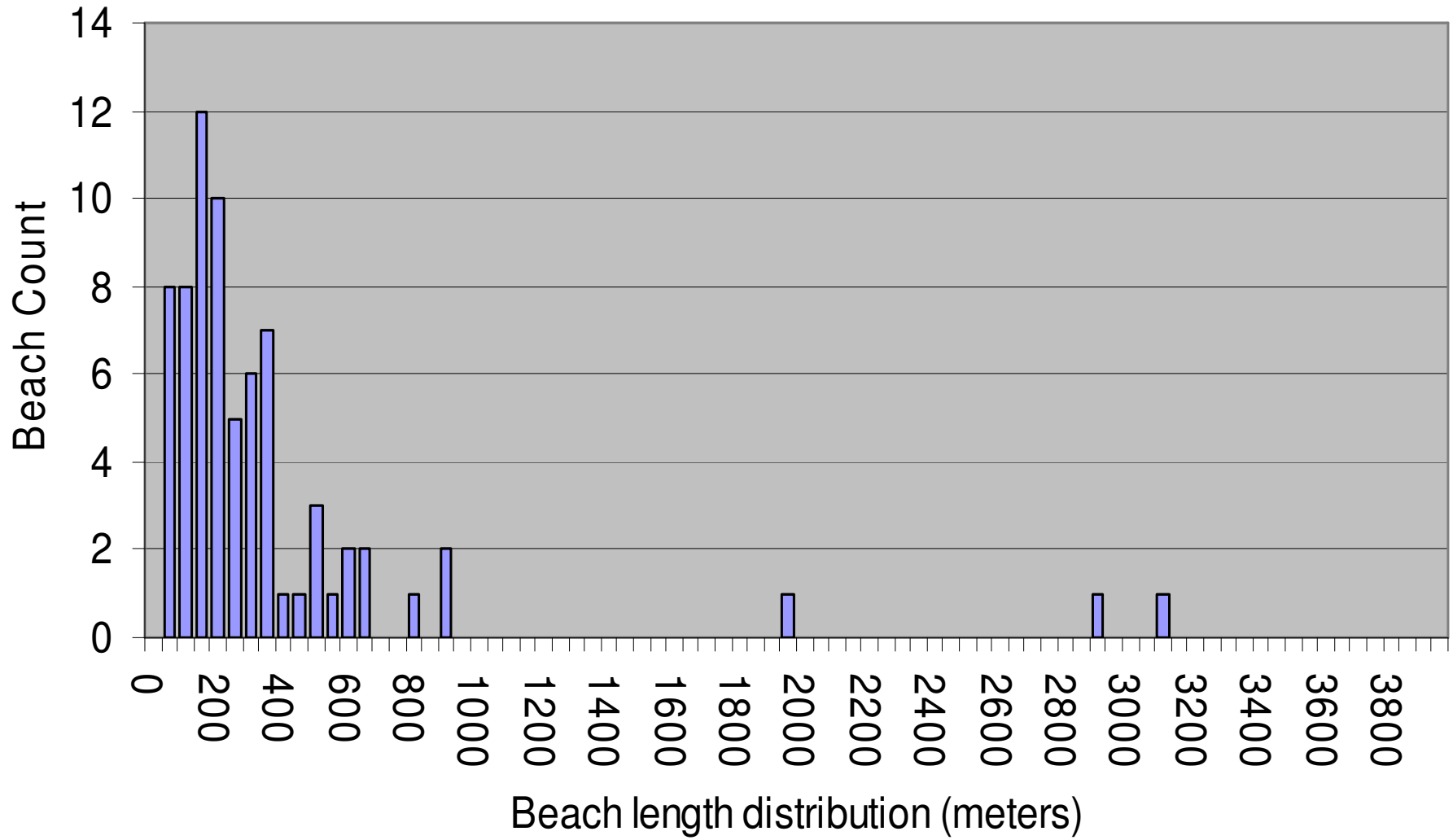- Puerto Rico
- U.S. Virgin Islands

BEACH ACT STATES

The Beach Act in Connecticut: Who is involved

- US Environmental Protection Agency

- Connecticut Department of Public Health

- The CT State Laboratory

- Connecticut Department of Energy and Environmental Protection
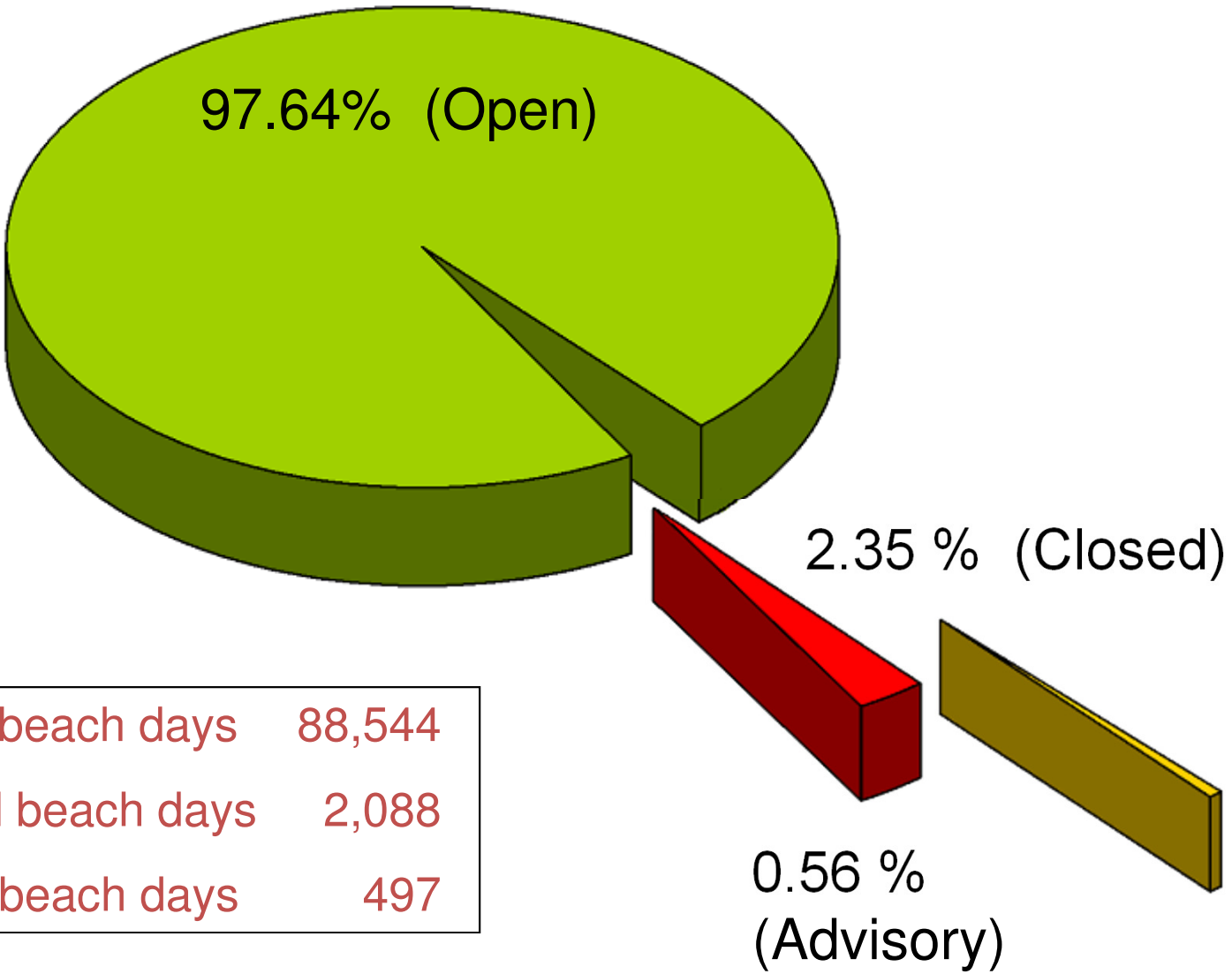
- Municipalities, local health departments and districts

CT Regulates 73 Beaches Including 133 Sampling Stations

2003-2015 Connecticut Marine Beach Days

97.64% (Open)

2.35 % (Closed)

0.56 %
(Advisory)

Total beach days	88,544
Closed beach days	2,088
Advisory beach days	497

2003-2015 Connecticut Marine Closure/Advisory Days

Preemptive due to rainfall (52.9%)

Elevated bacteria (22.7%)

Other reasons (22.4%)

US EPA
BEACON2 WEBSITE

Part Four: Blue-Green Algae (Cyanobacteria)

An emerging issue?

Guidance to Local Health Departments For Blue–Green Algae Blooms in

A) All New England states have issued guidance on this issue.
B) In Connecticut during the summer of 2012, an algae bloom in Lower Bolton Lake raised concerns with the local community and the news media.
C) CT DPH, CT DEEP, and CADH first met in 2013, to discuss the issue and produce this plan.
D) This guidance outlines the rationale for a response and presents a scheme for surveillance and intervention.

The **CT** Guidance (Since 2013)

"Lower Bolton Lake suffered a major aquatic crisis in 2012. A huge expansion of naiad (najas guadalupensis) was followed by a blue-green algae bloom in August. As a result, the lake was closed by the state to boaters and swimmers." -Friends of Bolton Lake.

Adverse Health Effects Associated With Recreational Exposure to Freshwater

Surveillance for Waterborne Disease Outbreaks and Other Health Events Associated with Recreational Water -- United States, 2007--2008

Outbreak	Treated Water % Incidence (N=115)	Untreated Water % Incidence (N=10)
AGI	60.9	50
Dermal	17.4	30
ARI	16.5	10
Both AGI&ARI	3.5	0
Dermal&ARI	1.7	10

Dermal effects are proportionately greater in untreated waters

MMWR: September 23, 2011 / 60(ss12);1-32

ENDOTOXINS, LIPOPOLYSACCHARIDES (LPS) and LIPID A

A broad class of many structurally similar and uncharacterized toxic agents

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Short Communication

Exposure to cyanobacteria: acute health effects associated with endotoxins

B. Lévesque [a,b,c,*], M.-C. Gervais [b], P. Chevalier [b], D. Gauvin [b],
E. Anassour-Laouan-Sidi [c], S. Gingras [b], N. Fortin [d], G. Brisson [b], C. Greer [d],
D. Bird [e]

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[b] Institut national de santé publique du Québec, 945 Ave. Wolfe, Québec City, Québec G1V 5B3, Canada
[c] Centre de recherche du Centre hospitalier universitaire (CHU) de Québec, Santé publique et pratiques optimales en santé, Edifice Delta 2- Bureau 600, 2875 Blv. Laurier, Québec City, Québec G1V 2M2, Canada
[d] National Research Council Canada, Energy, Mining and Environment, 6100 Royalmount Avenue, Montréal, Québec H4P 2R2, Canada
[e] Université du Québec à Montréal, Département des sciences biologiques, Faculté des sciences, Case postale 8888, Succ Centre-ville, Montréal, Québec H3C 3P8, Canada

Recreational Exposure Pathways For Freshwater HAB Events

"For those recreating on or near an affected water body, the route of direct exposure to toxins from blue-green algae may be via ingestion [incidental to swimming], breathing, or contact with skin."

Level of Potential Exposure	Recreational Activity	Primary Exposure Pathway of Concern
High	Swimming/wading	Ingestion
	Diving	Ingestion
	Water skiing/wake boarding	Ingestion/inhalation
	Wind surfing	Ingestion/inhalation
	Jet skiing	Ingestion/inhalation
Moderate	**Fish consumption ***	Ingestion
	Canoeing	Inhalation/skin
	Rowing	Inhalation/skin
	Sailing	Inhalation/skin
	Kayaking	Inhalation/skin
	Motor boating	Inhalation
Low/none	Catch and Release fishing	Skin

Managing a HAB Event: Objectives and Phases

"The approaches [for managing a HAB event] do not include treatment, but involve implementing strategies that will decrease the extent of the public's exposure."

The approach can be outlined in three phases:

- Surveillance/Classification
- Intervention
- Re-Classification/Termination

Blue-Green Algae (Cyanobacteria)

Surveillance and Classification

Category	Description
One	Visible material is not likely cyanobacteria or water is generally clear.
Two	Cyanobacteria present in low numbers. There are visible small accumulations but water is generally clear.
Three	Cyanobacteria present in high numbers. Scums may or may not be present. Water is discolored throughout. Large areas affected. Color assists to rule out sediment and other algae.

Blue-Green Algae (Cyanobacteria)

Interventions

Observations	Notifications	Further monitoring	Public Posting
Visual Rank Category 1	Not needed	No change	Not needed
Visual Rank Category 2, or blue-green algae cells >20k/ml and < 100k	Notify CT DPH, CT DEEP	Increase regular visual surveillance until conditions change.	Consider cautionary postings at public access points. (See Appendix C, Example B)
Visual Rank Category 3, or blue-green algae cells > 100k/ml	Update/inform CT DPH & CT DEEP and expand risk communication efforts. (See Risk Communication section.)	Collect samples for analysis and/or increase frequency of visual assessment.	POSTED BEACH CLOSURE: If public has beach access, alert water users that a blue-green algae bloom is present. (See Appendix C, Example A) POSTED ADVISORY: At other impacted access points. (See Appendix C, Example C)

Termination Schemes:

"The recommendations for termination of an advisory or closure are either based on visual observations over time, or a combination of visual and laboratory data."

<u>Scheme A:</u> Visual assessment remains at the Category 1 condition for at least two successive and representative observational rounds one week apart

<u>Scheme B:</u> Scheme A plus cell count results of the water column indicate that blue-green algal cell abundance has markedly decreased over at least two successive and representative sampling rounds one week apart and is below 70,000 cells per ml.

<u>Scheme B+:</u> Scheme B plus toxin testing for microcystin at one or more of the sampling rounds at a concentration below below *the concentration set by EPA**.

*EPA is revising their current draft guidance value of 4 ppb and the revision has not been released.