BEACH MONITORING IN CONNECTICUT

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CT Department of Public Health

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Part 1: Swimmer Risk


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

- 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

Attributes:
- Combined use of sanitary assessment or inspection and measurement of water quality
- Provides data on possible pollution sources 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, classification

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

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

$^b$ 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*

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Enteric Viruses</th>
<th>Salmonella</th>
<th>Giardia</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of cells or particles</td>
<td>$1 &gt; 10$</td>
<td>$&gt; 10^3$</td>
<td>25–100</td>
</tr>
<tr>
<td>Amount in feces</td>
<td>$10^6–10^{10}$/g</td>
<td>$10^{10}$/g</td>
<td>$9 \times 10^6$/g of stool</td>
</tr>
<tr>
<td>Concentration in raw sewage (No./L)</td>
<td>$10^3$</td>
<td>$5,000–80,000$</td>
<td>$9,000–200,000$</td>
</tr>
<tr>
<td>% Removal of pathogens during</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary treatment</td>
<td>50–98.3</td>
<td>95.8–99.8</td>
<td>27–64</td>
</tr>
<tr>
<td>Number remaining</td>
<td>1,700–50,000</td>
<td>160–3,360</td>
<td>72,000–146,000</td>
</tr>
<tr>
<td>Number remaining</td>
<td>85–47,500</td>
<td>3–1,075</td>
<td>6,480–109,500</td>
</tr>
<tr>
<td>Number remaining</td>
<td>0.0002–17</td>
<td>0.000004–7</td>
<td>0.099–2.951</td>
</tr>
</tbody>
</table>


The number of crypto outbreaks reported for a given year has increased significantly since 1978.
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)

<table>
<thead>
<tr>
<th>Etiology</th>
<th>Outbreaks</th>
<th>Cases</th>
<th>Hospitalized</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bacterium</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campylobacter jejuni</td>
<td>1</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Escherichia coli O157:H7</td>
<td>3</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Legionella spp.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pseudomonas aeruginosa</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Shigella sonnei</td>
<td>1</td>
<td>68</td>
<td>6</td>
</tr>
<tr>
<td><strong>Parasite (Cryptosporidium)</strong></td>
<td>3</td>
<td>16</td>
<td>0</td>
</tr>
<tr>
<td><strong>Virus (Norovirus)</strong></td>
<td>1</td>
<td>69</td>
<td>2</td>
</tr>
</tbody>
</table>

*No outbreaks of cryptosporidiosis have been associated with marine beach use.*


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

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

From Boehm & Sassoubre (2014)
The Normal Distribution and the 95% Value

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

95% Value
95% Value of intestinal enterococci / 100ml

Average probability of one case of gastroenteritis in 20 exposures.

Greater than 10% chance of gastroenteritis per single exposure.

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:*

<table>
<thead>
<tr>
<th>Sanitary Inspection Category (susceptibility to faecal influence)</th>
<th>A (≤40)</th>
<th>B (41–200)</th>
<th>C (201–500)</th>
<th>D (&gt;500)</th>
<th>Exceptional circumstances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very low</td>
<td>Very good</td>
<td>Very good</td>
<td>Follow up^1</td>
<td>Follow up^1</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Very good</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>Moderate</td>
<td>Good</td>
<td>Good</td>
<td>Fair</td>
<td>Fair</td>
<td>Poor</td>
</tr>
<tr>
<td>High</td>
<td>Good</td>
<td>Fair</td>
<td>Poor</td>
<td>Very poor</td>
<td></td>
</tr>
<tr>
<td>Very high</td>
<td>Follow up^2</td>
<td>Fair^2</td>
<td>Poor</td>
<td>Very poor</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exceptional circumstances</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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^1 Follow up: Additional or more frequent sampling
^2 Action: See text for details
State of Connecticut
Guidelines
for
Monitoring Swimming Water
and
Closure Protocol

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

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

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

Robert J. Klee
Commissioner

March 2016
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 **sanitary survey** 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 **sewage** treatment plant location, pump station location, industrial plant discharge points and other areas that may impact the bathing area waters.

3. Large populations of **waterfowl** 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.
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 prior to receiving any sample results.

2. When a single sample result exceeds the standards for bathing water quality established by the commissioner, a resample should be taken 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 even if the water quality is good.

4. The director of health may also want to consider bathing beach closures established by evaluating rainfall data.
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 not later than 4 hours.

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: within 6 hours of reopening.
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.”

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
Also:
- American Samoa
- Commonwealth of Northern Marianas
- Hawaii
- Guam
- Puerto Rico
- U.S. Virgin Islands
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
CT Has 5.5 Miles of Regulated Beaches
2003-2015 Connecticut Marine Beach Days

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

- 97.64% (Open)
- 2.35% (Closed)
- 0.56% (Advisory)
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 Connecticut

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.
“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

<table>
<thead>
<tr>
<th>Outbreak</th>
<th>Treated Water</th>
<th>Untreated Water</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Incidence (N=115)</td>
<td>% Incidence (N=10)</td>
</tr>
<tr>
<td>AGI</td>
<td>60.9</td>
<td>50</td>
</tr>
<tr>
<td>Dermal</td>
<td>17.4</td>
<td>30</td>
</tr>
<tr>
<td>ARI</td>
<td>16.5</td>
<td>10</td>
</tr>
<tr>
<td>Both AGI&amp;ARI</td>
<td>3.5</td>
<td>0</td>
</tr>
<tr>
<td>Dermal&amp;ARI</td>
<td>1.7</td>
<td>10</td>
</tr>
</tbody>
</table>

*Dermal effects are proportionately greater in untreated waters*
Endotoxin in Lake Water Health Effect

GI1 (moderate) GI2 (severe)

Contact Tranche Relative Risk Relative Risk T1 (<26 endotoxin/ml) 1.37 1.03 T2 (26-48 endotoxin/ml) 1.35 2.06 T3 (> 48 endotoxin/ml) 2.87 3.11

ENDOTOXINS, LIPOPOLYSACCHARIDES (LPS) and LIPID A

A broad class of many structurally similar and uncharacterized toxic agents

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

a Université Laval, Faculté de médecine, Département de médecine sociale et préventive, 945 Ave. Wolfe, Québec City, Québec G1V 5B3, Canada
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 Blvd. 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
“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.”

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

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One</strong></td>
<td>Visible material is not likely cyanobacteria or water is generally clear.</td>
</tr>
<tr>
<td><strong>Two</strong></td>
<td>Cyanobacteria present in low numbers. There are visible small accumulations but water is generally clear.</td>
</tr>
<tr>
<td><strong>Three</strong></td>
<td>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.</td>
</tr>
</tbody>
</table>
# Blue-Green Algae (Cyanobacteria)

## Interventions

<table>
<thead>
<tr>
<th>Observations</th>
<th>Notifications</th>
<th>Further monitoring</th>
<th>Public Posting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Visual Rank Category 1</strong></td>
<td>Not needed</td>
<td>No change</td>
<td>Not needed</td>
</tr>
<tr>
<td><strong>Visual Rank Category 2, or blue-green algae cells &gt;20k/ml and &lt; 100k</strong></td>
<td>Notify CT DPH, CT DEEP</td>
<td>Increase regular visual surveillance until conditions change.</td>
<td>Consider cautionary postings at public access points. (See Appendix C, Example B)</td>
</tr>
<tr>
<td><strong>Visual Rank Category 3, or blue-green algae cells &gt;100k/ml</strong></td>
<td>Update/inform CT DPH &amp; CT DEEP and expand risk communication efforts. (See Risk Communication section.)</td>
<td>Collect samples for analysis and/or increase frequency of visual assessment.</td>
<td>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)</td>
</tr>
</tbody>
</table>
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.”

**Scheme A:** Visual assessment remains at the Category 1 condition for at least two successive and representative observational rounds one week apart.

**Scheme B:** 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.

**Scheme B+:** 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.