Slide 1

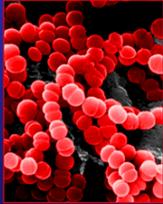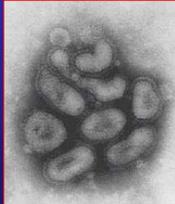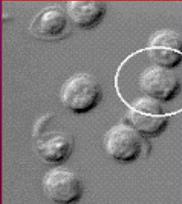**Introduction to Bacteria Monitoring of Surface water for Volunteers**

CWQ Winter Session
February 7, 2004

Slide 2

Is the water safe?

In part, the answer to this ? depends on presence or absence of pathogens in surface water associated with fecal waste (including bacteria, viruses, and protozoans) that can cause illnesses in humans.

Bacteria
(Streptococcus)

Viruses
(Norovirus, Hepatitis A)

Protozoa
(Cryptosporidium)

Slide 3

Sources of fecal contamination to water bodies
- Wildlife
- Human activities:
  - Human sewage:
    - Leaky septic systems
    - "straight pipes"
    - Poorly designed/maintained sanitary sewer or WWTPs
  - Agricultural waste:
    - "direct deposit" from farm animals – lack of steam side fencing
    - Improper manure application
    - Poorly constructed/maintained waste storage

Slide 4

Human uses of surface water are pathways for disease . . .

- Irrigation
  Eating raw crops > human diseases
- Drinking
  Dysentery, gastroenteritis, hepatitis, typhoid
- Recreation
  Immersion > infections
  Eyes, ears, nose, throat, digestive
- system problems
- Eating
  Shellfish consumption

Slide 5

Why not monitor directly for Pathogens?
- Impractical - too many pathogens
- Methods for some not available
- Labor intensive and expensive
- Long time for results
- Inconsistent concentrations - episodic
 - Instead, look for <u>indicators</u> of these pathogens

Slide 6

Good Indicator Criteria for Fecal contamination of Waterbody:
- High correlation between presence of indicator with presence of pathogens, ie likelihood that illness would occur
- Indicator should have survival time longer than pathogen
- Indicator shouldn't continue to grow on its own in water - indicator concentration should have correlation to degree of pollution
- Testing method should be easy to perform and relatively inexpensive

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Most commonly used bacterial indicators associated with intestines and feces of warm-blooded animals:

Coliform Group

Fecal Streptococcus Group
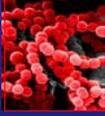
- Total coliforms
- Fecal coliforms
- *Escherichia coli*

- Enterococcus

Slide 8

What are bacteria?

Bacteria

Cholera
Typhoid Fever
Legionnaire's Disease

- Single-celled microorganisms with no membrane around the nucleus and a single strand of DNA.

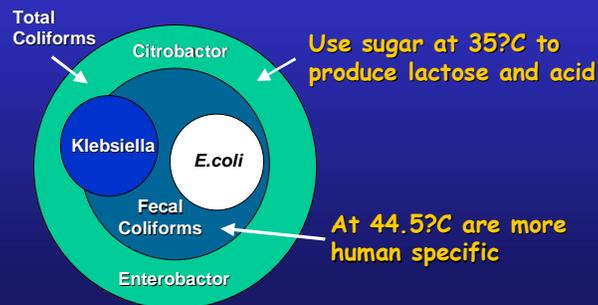- Multiply by splitting into 2 daughter cells

Slide 9

Not all Bacteria are bad !

- Bacteria have important role in the aquatic ecosystem:
    - Decomposition: break down plant and animal remains releases nutrients back into food web
    - Serve as food for other organisms
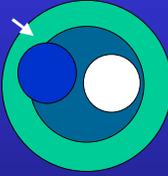   - Involved in important chemical conversions in water

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The Coliform Bacteria Group

Total Coliforms

Citrobacter

Use sugar at 35?C to produce lactose and acid

Klebsiella

E.coli

Fecal Coliforms

At 44.5?C are more human specific

Enterobactor

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Escherichia Coli (E. Coli)

- Occurs <u>only</u> in the feces of warm blooded mammals
- Based on 1986 EPA study, presence of E.Coli in freshwater had a much higher correlation with presence of human pathogens (0.8), whereas basically no correlation for Fecal coliform (-.08) - therefore, EPA recommends as best indicator of health risk for <u>freshwater recreation</u>

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Enterococcus

- Another group of bacteria (not a coliform) also found in intestinal tract of warm-blooded animals
- Salt tolerant (E. coli not as salt tolerant)
- Based on 1986 EPA study, presence of Eneterocci in both marine and freshwater had a very high correlation with presence of human pathogens (0.75 marine and .74 freshwater). Therefore, EPA recommends as best indicator of health risk for <u>marine recreation</u>

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Bacteria Water Quality Standards

- Drinking water standards - regulated by VA Department of Health – the Maximum Contaminant Level (MCL) for Total Coliforms (includes Fecal and E.Coli) is 0 colonies/ 100 ml.

- Shellfish waters - criteria established by FDA and monitored by Virginia Department of Health. FDA requires analysis of fecal coliforms. Geometric mean shall not exceed MPN of 14/100 ml

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VA Surface Water Standards for Bacteria

- Bacteria Criteria designed to protect *Recreational* Uses

- Phasing out of Fecal coliform standard by 2008

- Effective January 2003, Standards developed for primary recreation uses for E.Coli for freshwater and enterococci for saltwater and *transitional* waters

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Fecal Coliform standard

•Geometric mean (applies if 2 or more samples collected during calendar month) maximum of 200 colonies/100 ml
•or 400 colonies/100 ml for >10% of samples per calendar month

•These criteria will not apply after 2008, or if 12 or more samples have been collected at a site, whichever comes first

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E.Coli surface water standard for Primary recreational use

	Geometric Mean	Single Sample maximum
E.Coli (Freshwater)	126	235
Enterococci (Saltwater and transition zone)	35	104

Geometric mean applies when 2 or more samples collected in a calendar month

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Geometric Mean

Reduces the influence of very high numbers on a data set . . .

- Data are transformed to log values
- Log values are averaged
- Results transformed back into original units
- Microsoft Excel can calculate geometric mean- choose function *geomean*

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E.Coli surface water standard for Secondary recreational use

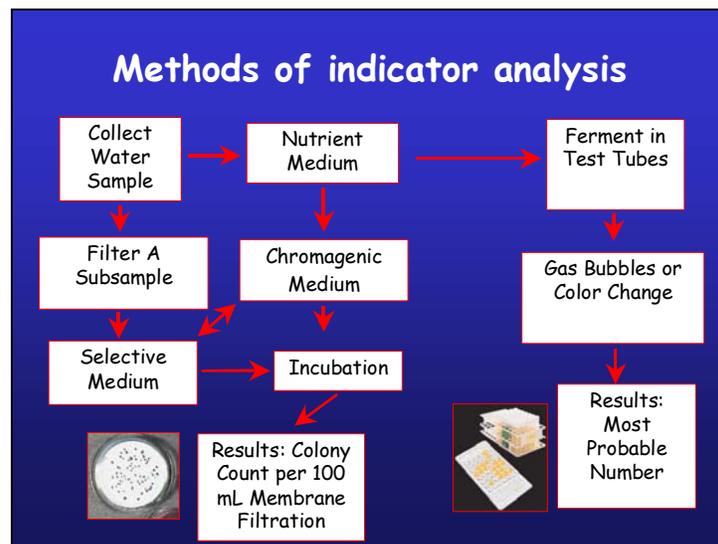|	Geometric Mean	Single Sample maximum
E.Coli (Freshwater)	630	1173
Enterococci (Saltwater and transition zone)	175	519

Effective Feb 12, 2004

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Secondary contact recreation:

•A water-based form of recreation, the practice of which has a low probability for total body immersion or ingestion of waters

•Ex: wading, boating fishing

•No secondary waters have been identified as of yet- primary uses can not be removed if use can be attained through point source controls and cost effective and reasonable BMPs. Use attainability analysis would have to be performed- very rigorous procedure

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Methods of indicator analysis

Collect Water Sample → Nutrient Medium → Ferment in Test Tubes

Filter A Subsample

Chromagenic Medium

Gas Bubbles or Color Change

Selective Medium → Incubation

Results: Colony Count per 100 mL Membrane Filtration

Results: Most Probable Number

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**Methods of indicator analysis –
options for volunteer groups:**

•**Alternatives to laboratory analysis of E.Coli:**

  •**Coliscan Easygel method**- for E. Coli - similar
to MF but filtration not required and can read
without microscope

    •good for volunteers for *screening purposes*
and assist with source tracking - not
currently approved by DEQ for assessment
purposes

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**Which indicator/method to
use?**

  •Freshwater? Saltwater/brackish?

  •For what will you use the results?

  •Screening v. assessment

  •Source identification?

  •Equipment, time, cost

  •Quality control

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Slide 28

Slide 29

Questions? Contact:

Stacey Moulds

Alliance for the Chesapeake Bay

Phone: (804) 775-0951

Fax: (804) 775-0954

Email: smoulds@acb-online.org