While we're waiting …

- Please complete the:
  - Pre-test (blue)
  - Background information (pink)
  - Photo release (white) – **Hand in**
- Put your name on a piece of paper to win one of the Giant *E. coli* Microbes

E. coli Monitoring in Streams by Volunteers

Barb Liukkonen, U of MN
Eric O'Brien, Iowa DNR
Jerry Iles, Ohio State University
Kris Stepenuck, WI Extension & DNR
Lois Wolfson, Michigan State University

Introduction & Project Summary

- Project funding and partners
- Kits evaluated
- Statistical analysis
- Using the data
- Recommendations

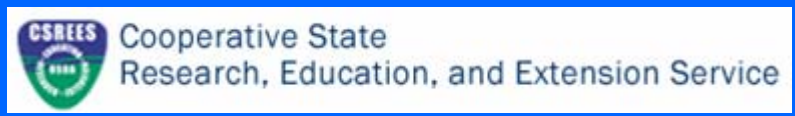
Citizens Monitoring Bacteria

Oct 2003 – Sep 2007

- 6-state research and outreach project
  - IN, IA, MI, MN, OH, WI
- Funding from CSREES
- Goal: to test accuracy, reliability, and user satisfaction with test kits

Photo by C. Kowalczak

Project Partners



Project Team Members

Why research *E. coli* test kits with volunteers?

- **Many kits available and being used**
- **No comparative, independent study**
- **Cost of lab analysis is high; access to certified labs is problematic**
- **Citizens are interested and knowledgeable**
- **Citizens want an *easy*, *reliable*, *inexpensive* test kit**

2004 – Year 1

- 5 methods tested in Iowa and Indiana
  - Coliscan® Easy Gel (incubated)
  - Coliscan® Easy Gel (not incubated)
  - 3M™ Petrifilm™
  - Coliscan® MF Method Kit *(IN only)*
  - Colisure® Method with IDEXX Quanti-Tray/2000™ *(IA only)*


Photo by L. Crighton

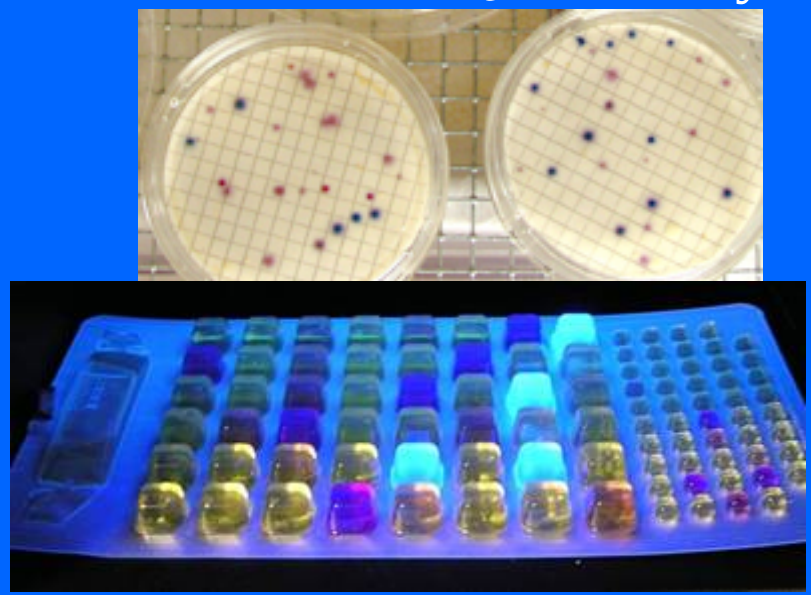



Photo by L. Crighton

Recommended the “best” kit from Year 1

Selected on the basis of:

- **Accuracy**
- **Volunteer satisfaction**
- **Cost**

Photo by L. Crighton

Test Kits - Years 2 & 3

Coliscan Easygel-incubated

Photo by E. Doberstein

Used in MI, MN, OH, WI;

IA & IN continued others

3M Petrifilm -incubated

Photo by L. Wolfson

Each test costs about $2

Consistent volunteer training

- **4-5 hour training, covering …**
  - **Background, protocols, QA, practice preparing and interpreting plates**
- **Standardized curriculum and manual**
- **Evaluation and tracking**
- **Used same equipment and supplies**

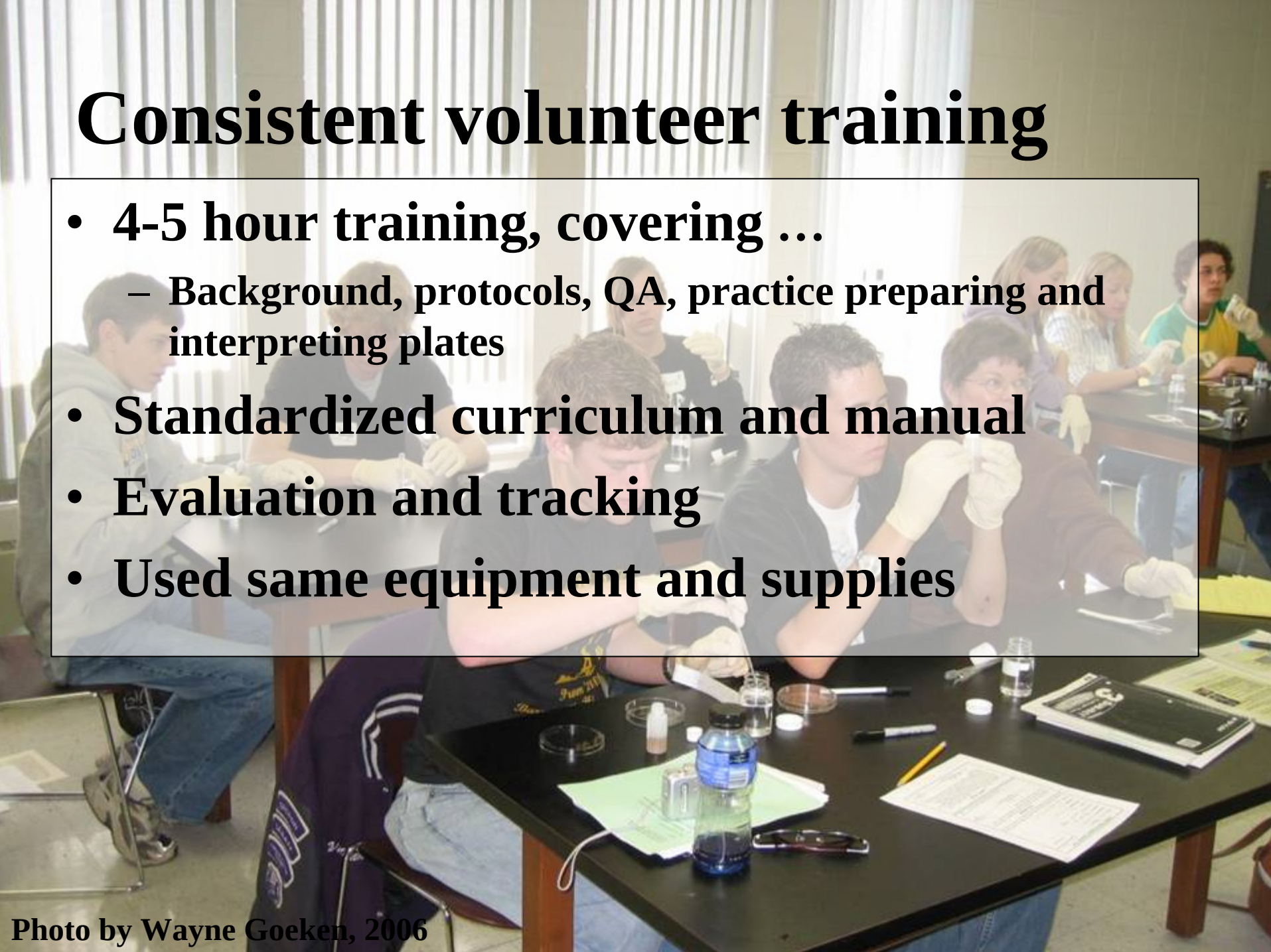


Photo by Wayne Goeken, 2006

Consistent volunteer training

- **4-5 hour training, cover**
  - **Background, protocols, QA, interpreting plates**
- **Standardized curriculu**
- **Evaluation and tracking**
- **Used same equipment a**

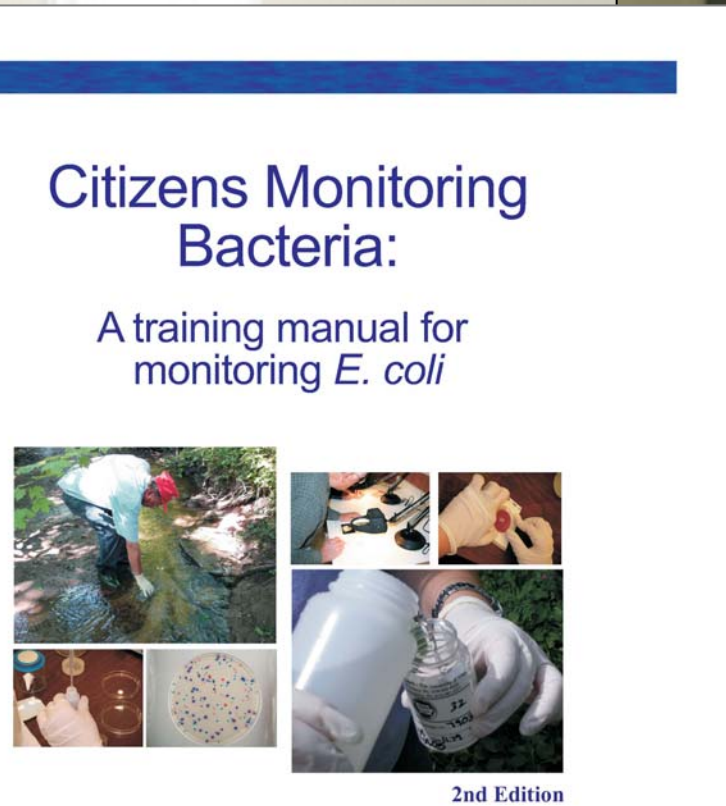


Photo by Wayne Goeken, 2006

Field Visits

- Sampled weekly, 1 or 2/month
- Recorded field conditions: stream level, weather, temps, T-Tube
- Collected one sample – split into 2
  - 1 sample sent to certified lab
  - 1 tested at home
- Sample sent to lab on ice, within 24 hrs

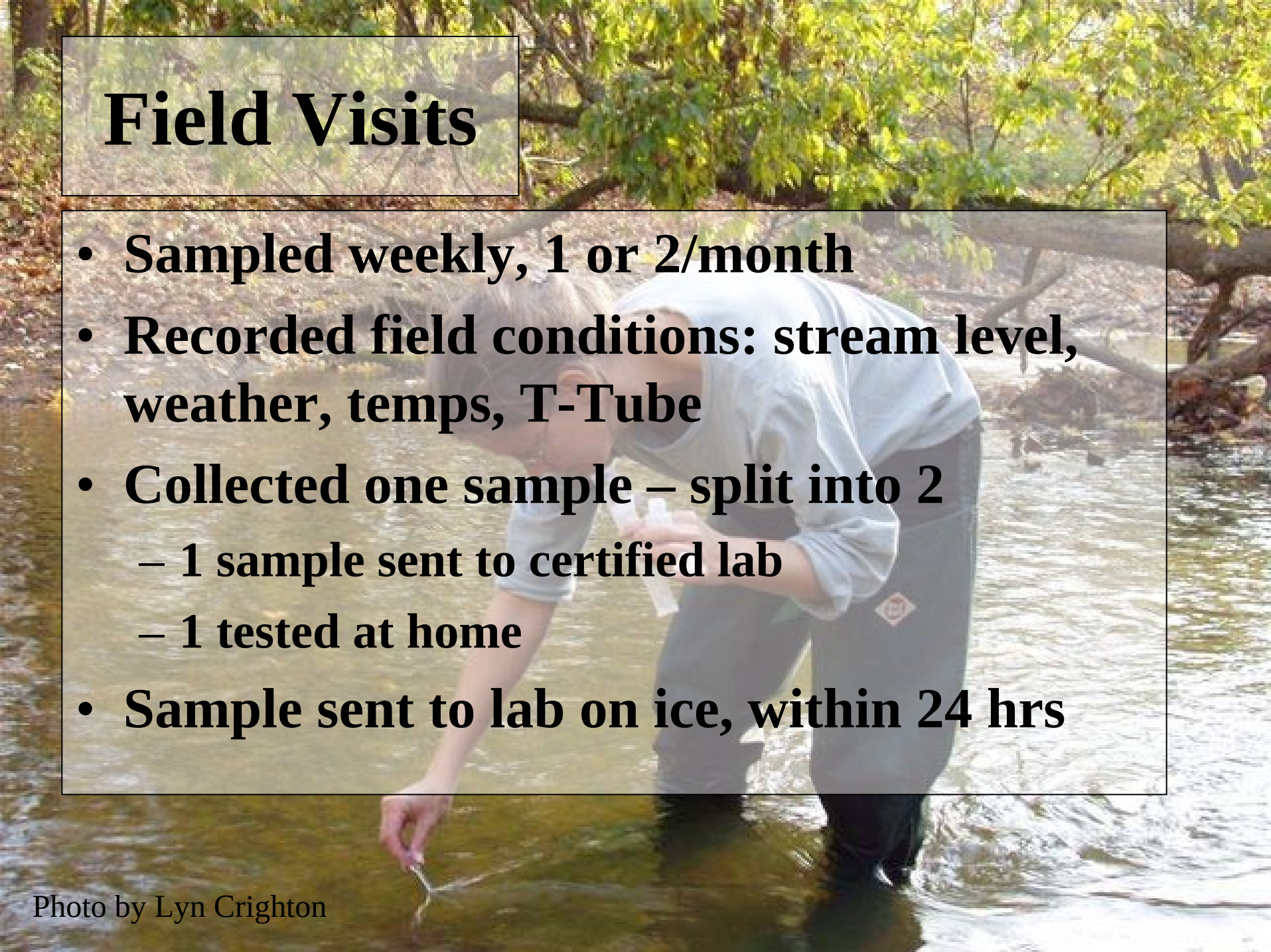


Photo by Lyn Crighton

Test kit procedures

- **Samples plated asap**
- **Triplicate tests for each kit**
- **Incubated at 35°C**
- **Read at 24 and 48 hours**

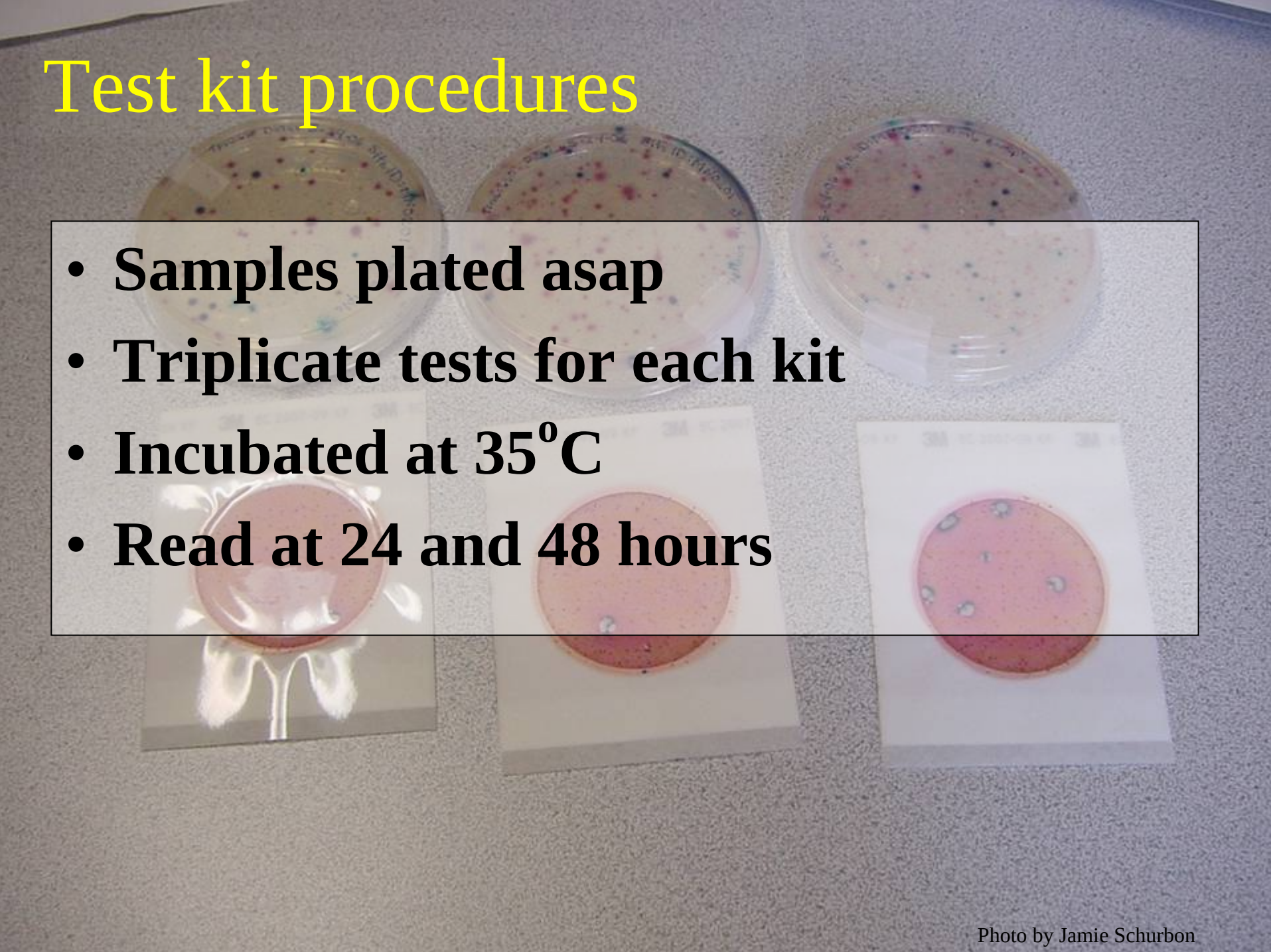
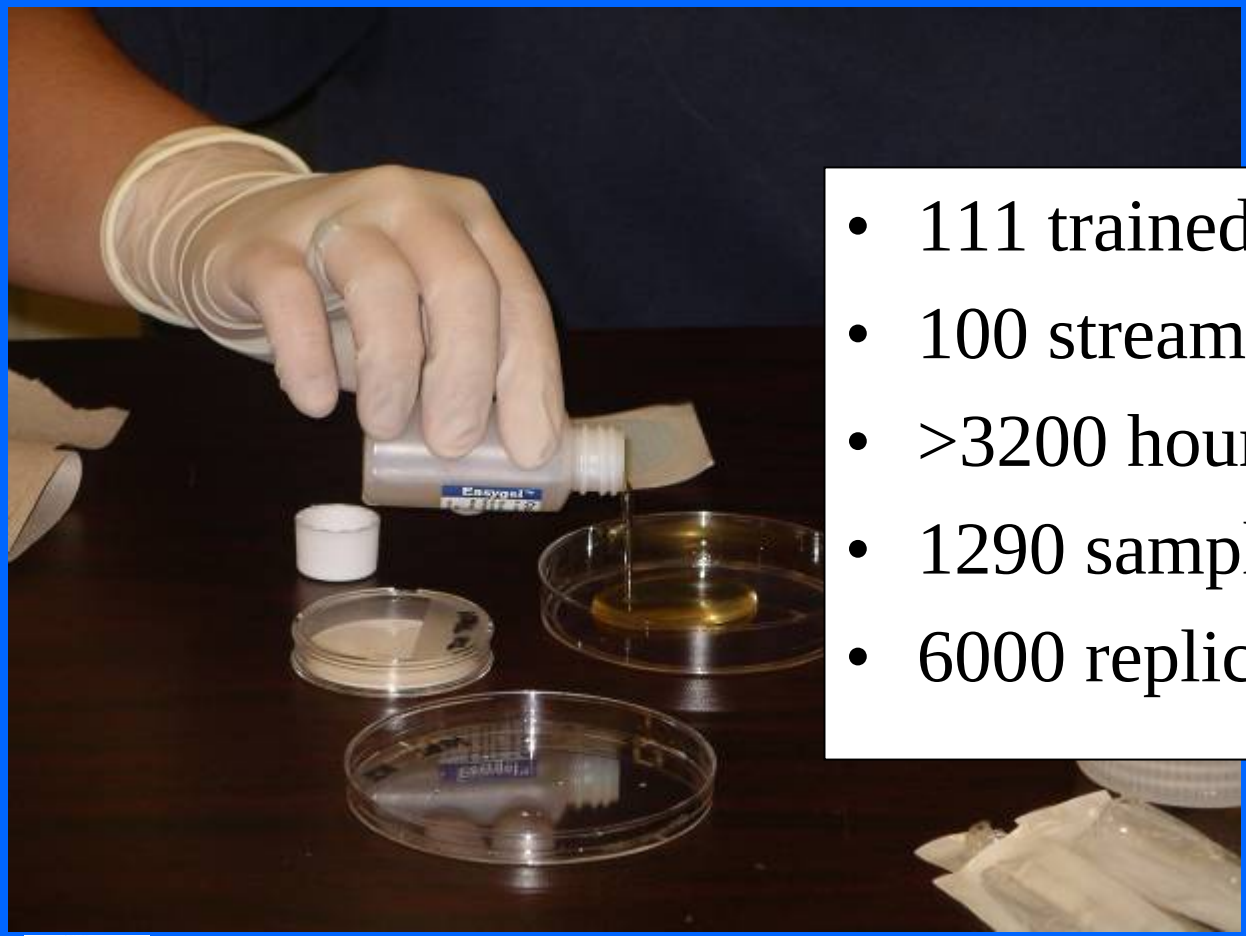


Photo by Jamie Schurbon

2004 - 2006 in 6 states



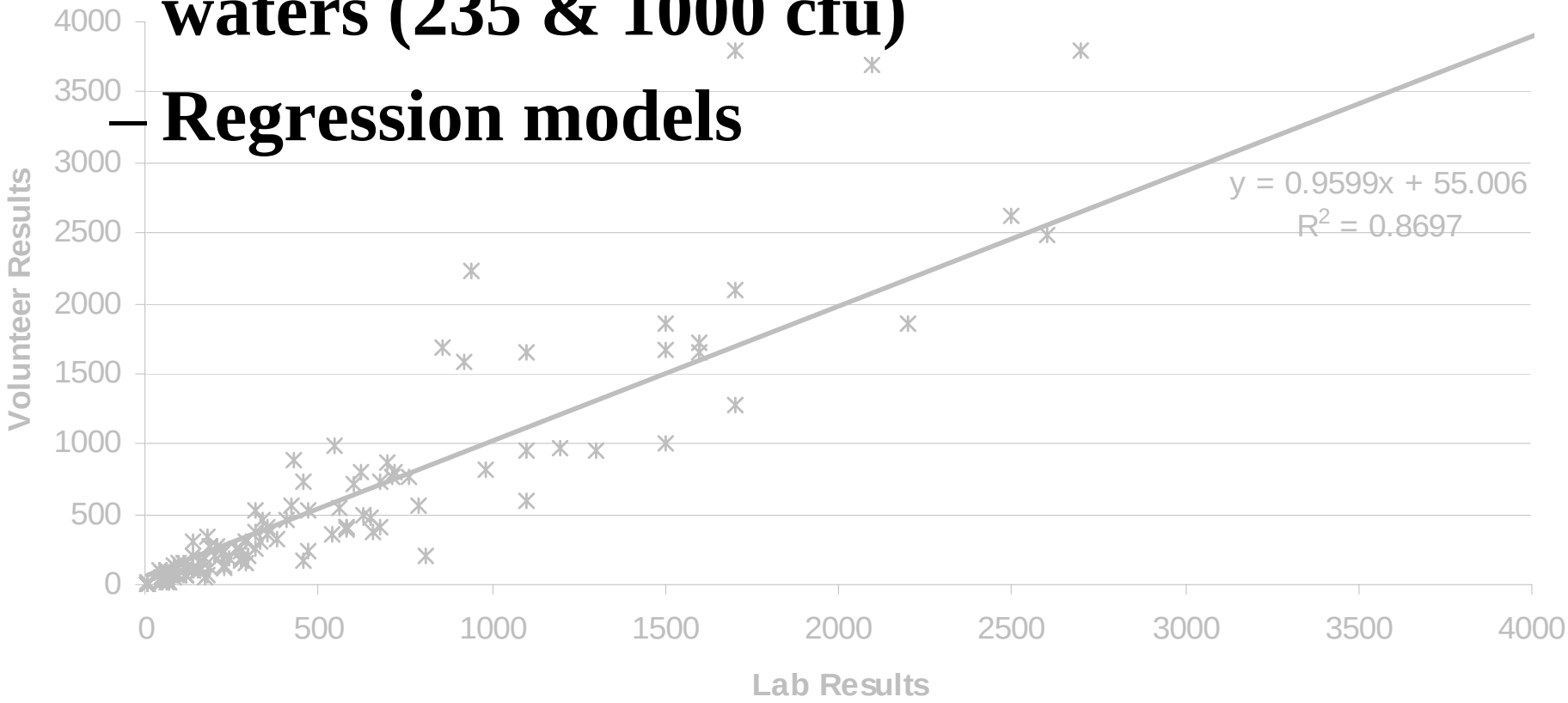
- 111 trained volunteers
- 100 stream & lake sites
- >3200 hours contributed
- 1290 samples collected
- 6000 replicates with test kits

So … how well do they work?

Photo from Putting Green, 2005

Data Analysis

- Evaluation of:
  - **Ability to make distinctions on impaired waters (235 & 1000 cfu)**
  - **Regression models**



Threshold levels

Petrifilm @24 hrs, 2006

Percent of samples with test kit and lab values **both** either above or below the 235cfu value

80.9% agreement

kit \ lab	< 235 cfu	> 235 cfu
< 235 cfu	64.6 %	6.1
> 235 cfu	12.9	16.3

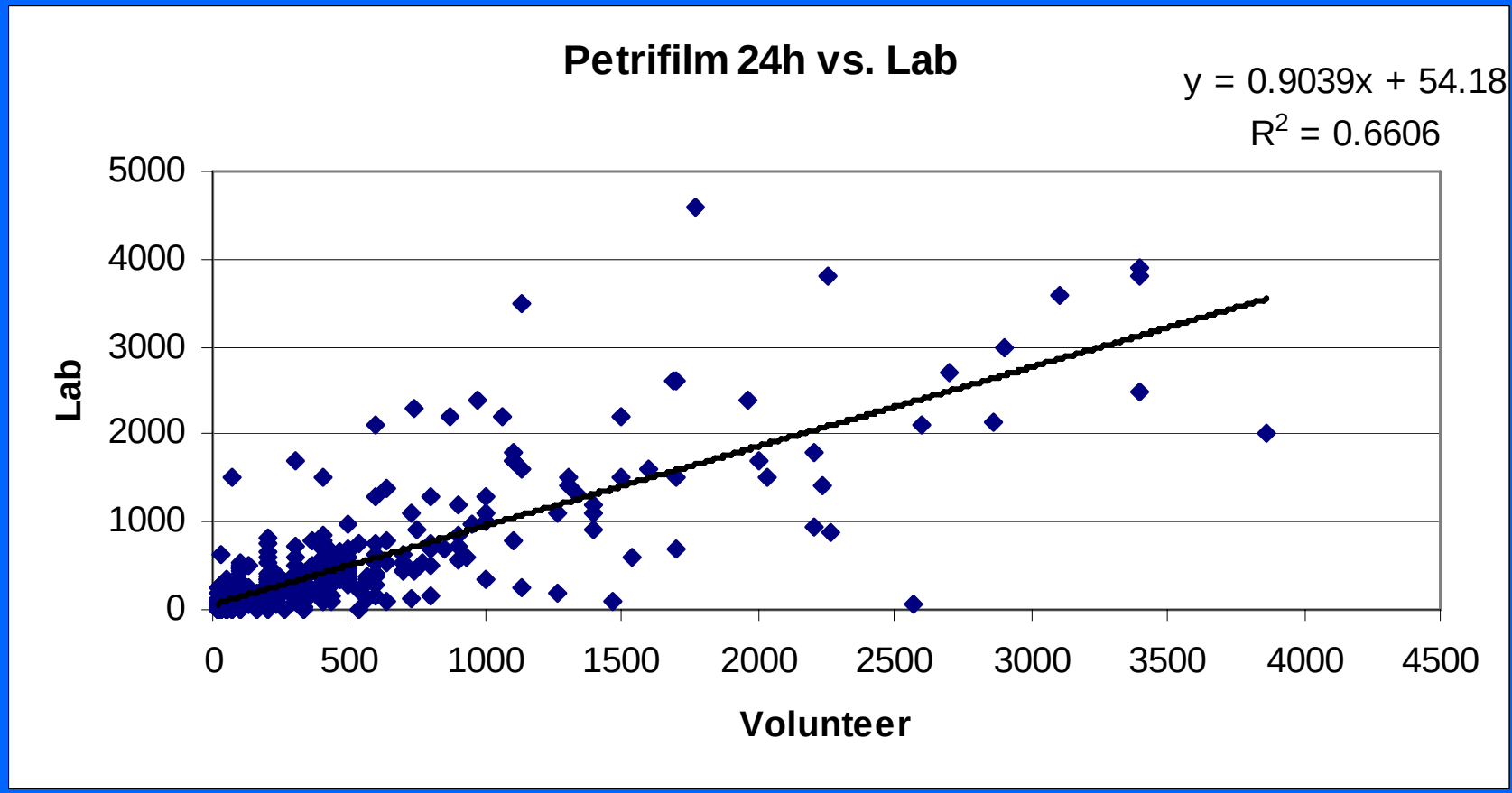
Threshold levels
Petrifilm @24 hrs, 2006

Percent of samples with test kit and lab values **both** either above or below the 1000 cfu value

93.2 % agreement

kit \ lab	<1000 cfu	>1000 cfu
<1000 cfu	89.8 %	4.1
>1000 cfu	2.7	3.4

Petrifilm vs lab results, all data



Volunteers …

- **Preferred Petrifilm (71%)**
  - **Ease of use, interpretation**
  - **Limitation of just 1 ml**
- **Contributed (on average):**
  - **Time - 35 hours**
  - **Direct expenses - $15.25**
  - **Mileage – 200 miles**

Volunteers shared information

- 64% shared with neighbors and friends
- 30% with Lake or River Associations
- 24% with local resource managers
- 30% with elected officials
- 11% with state agencies
- 3 used the data to secure grant funding

- Helps target resources more effectively

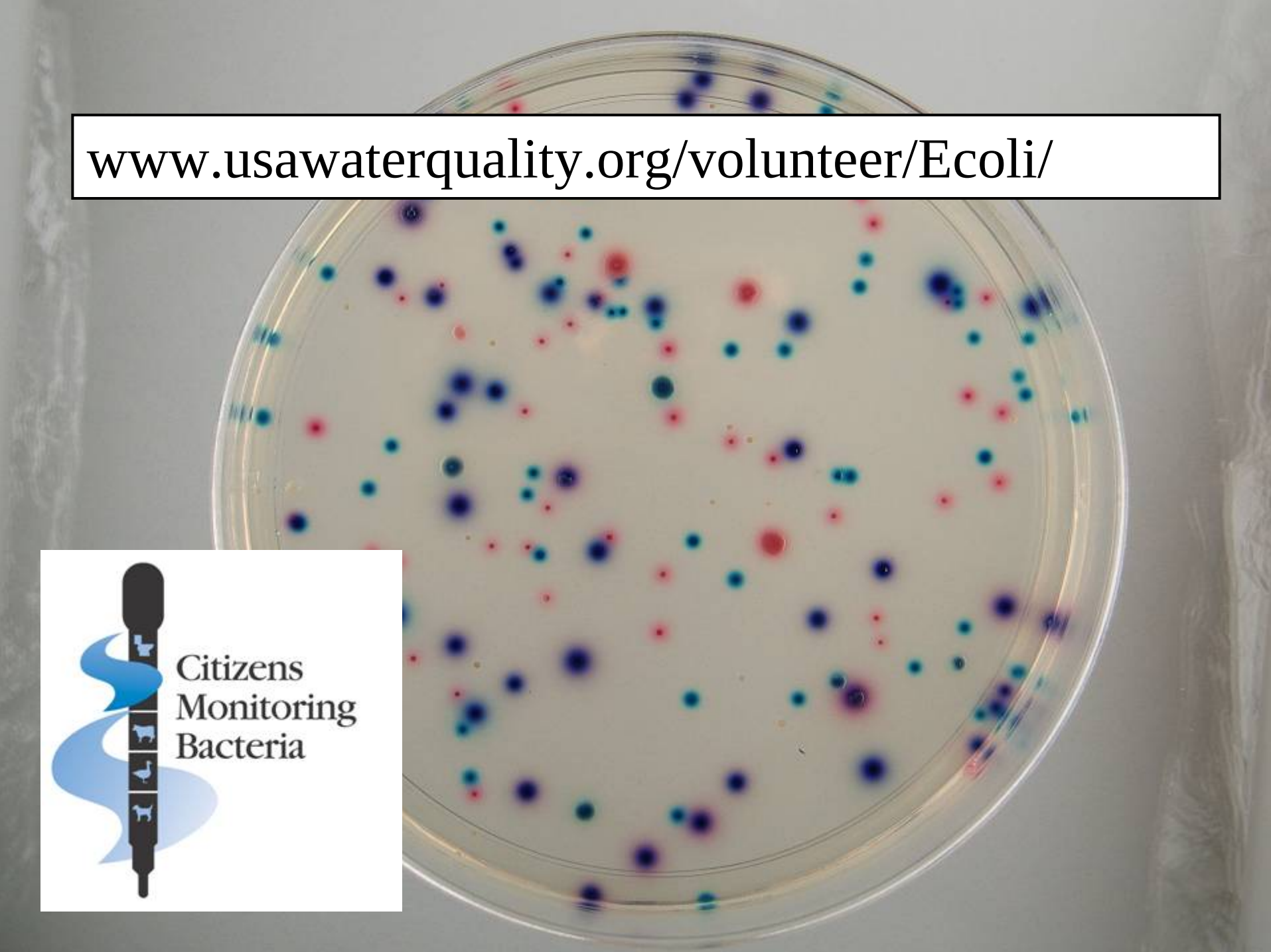
What can the data be used for?

Photo by Wayne Goeken, 2006

- Classroom education
- Volunteer knowledge
- Public awareness
- Local decision-making
- Targeting resources
- Assessing water quality
- Impaired waters - TMDLs

Conclusions

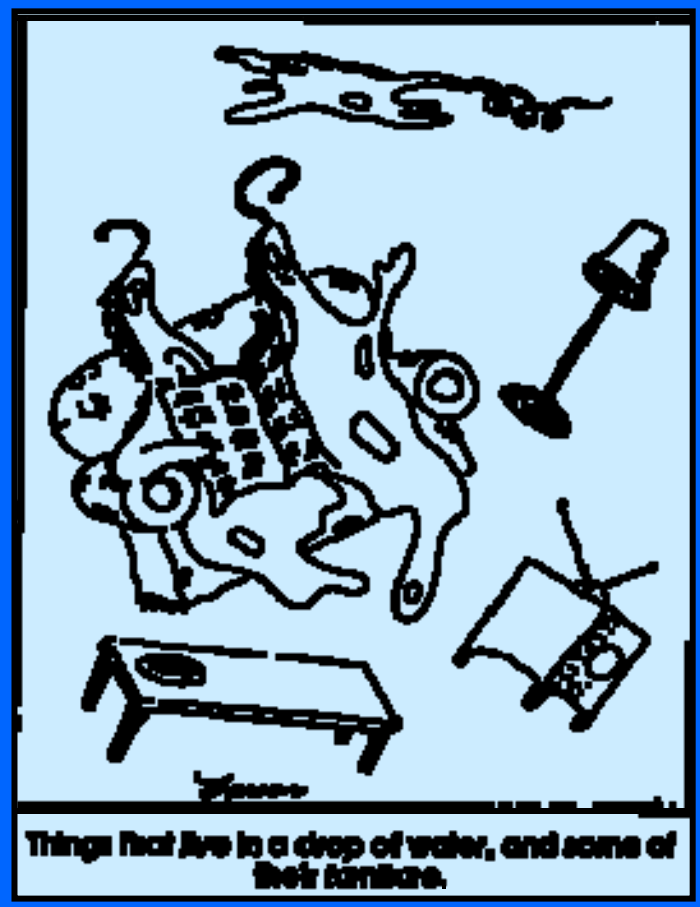
- Kits compared fairly well with lab analysis
- Kits are good for screening & targeting resources
- As much variability between labs as between test kits and labs
- Petrifilm and IDEXX essentially equal in performance
- Volunteers preferred Petrifilm & lower cost


www.usawaterquality.org/volunteer/Ecoli/
Citizens
Monitoring
Bacteria


TIME
WILL CLINTON TESTIFY?
THE CAPITOL HILL GUNMAN
THE KILLER GERM
It's turning up everywhere: in your water, your food, the pool. How to protect yourself from
E.COLI

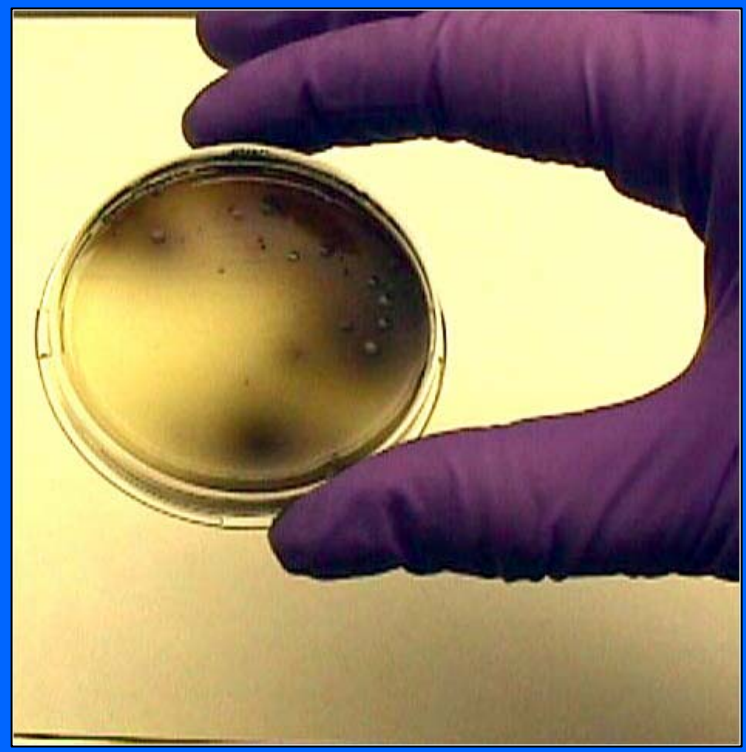
Bacteria 101 - Scope

- Bacteria as indicators
- Sources of fecal bacteria
- Health risks
- Standards for bacteria



Quick Review: Rules for Fecal Indicator Bacteria

- Bacteria from feces of warm-blooded animals
- Present in higher number than pathogens
- Nonpathogenic



- Do not persist in the environment

E. coli are used as indicators because they:

- Indicate fecal contamination
- Suggest the presence of pathogens
- Are easy to collect and analyze
- Are relatively safe to handle and generally harmless

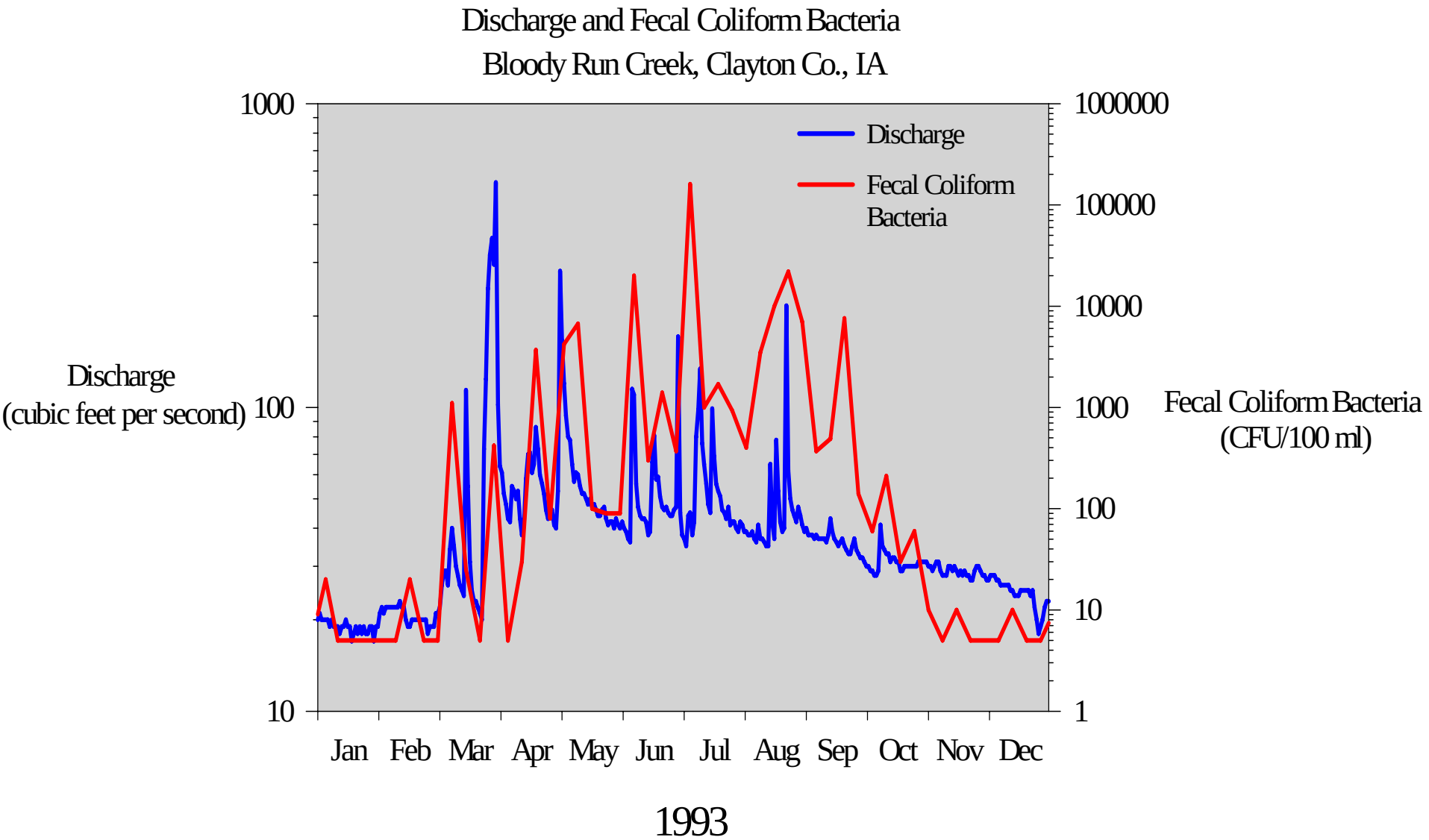
Applying knowledge to improve water quality
Great Lakes Regional Water Program
A Partnership of USDA CSREES & Land Grant Colleges and Universities

Indicator bacteria survival in environment

- Sunlight (UV radiation and white light) – *can cause die off*
- Temperature – *freezing destroys cells, but can survive at cold temps below the ice*
- In sediment – *may survive and thrive in bottom or bank sediments or at water interface in beach sand*
- In algal mats – *Cladophera, sun-dried, stored at 4°C 6 months*
- Water body conditions that enhance survival – *low light penetration, high turbidity, low salinity, presence of elevated nutrients and organic matter*

Bacteria levels can be related to flow:

More runoff = Higher bacteria counts



Persistence in the environment (Academy Creek–Brunswick, GA)

Condition	Enterococci Most Probable Number
	Colony-forming units g^{-1} of dried sediment
Moist sediment	3,160
Dried 2 days and rewet	16,980
24 h after rewet	23,440
Dried 30 days and rewet	510
24 h after rewet	16,980
Dried 60 days and rewet	1,200
24 h after rewet	28,840

**Provided by Peter Hartel*

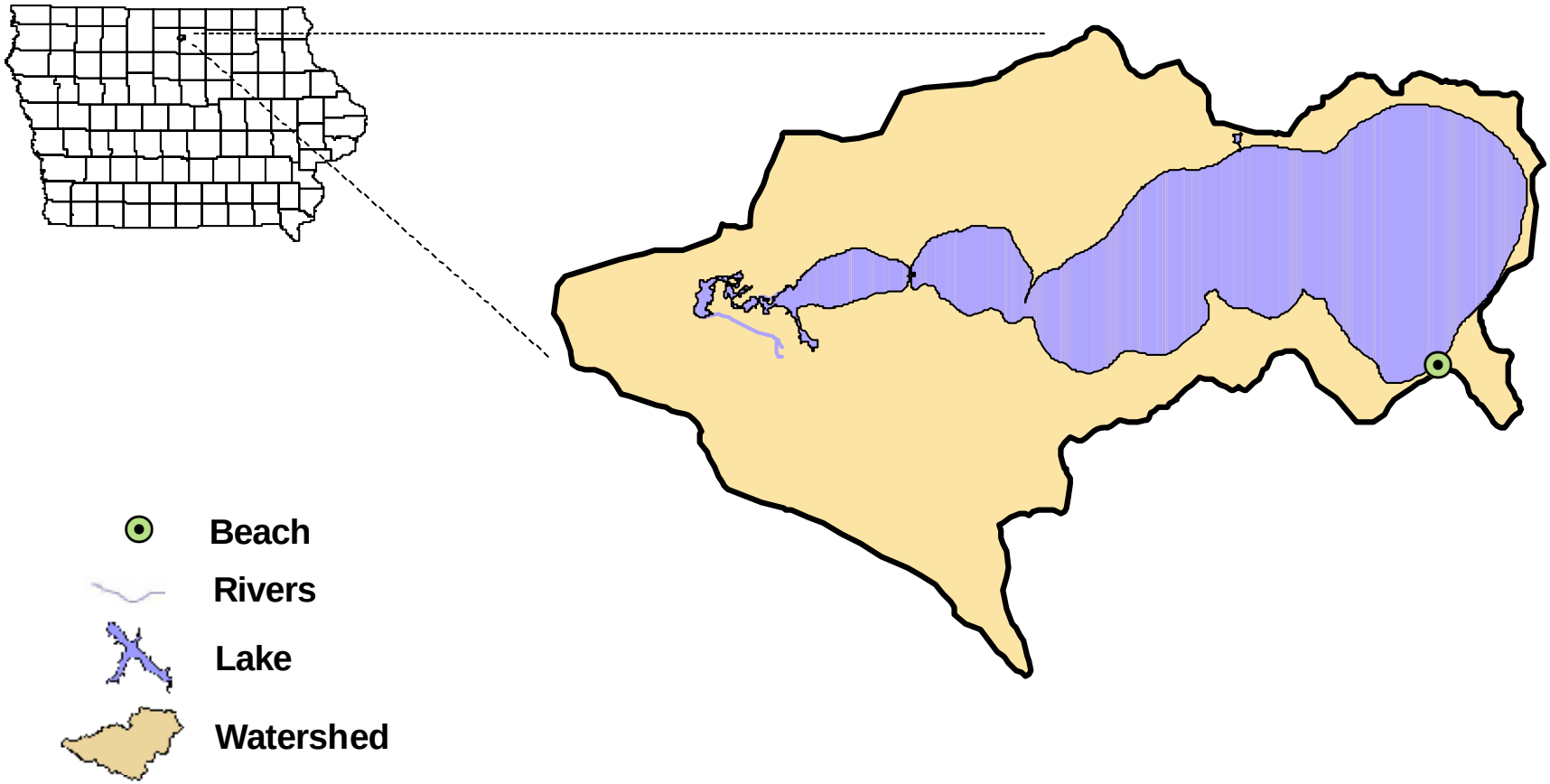
Bacteria levels are affected by:

- Source and amount of loading
- Air and water temperature
- Rainfall and runoff

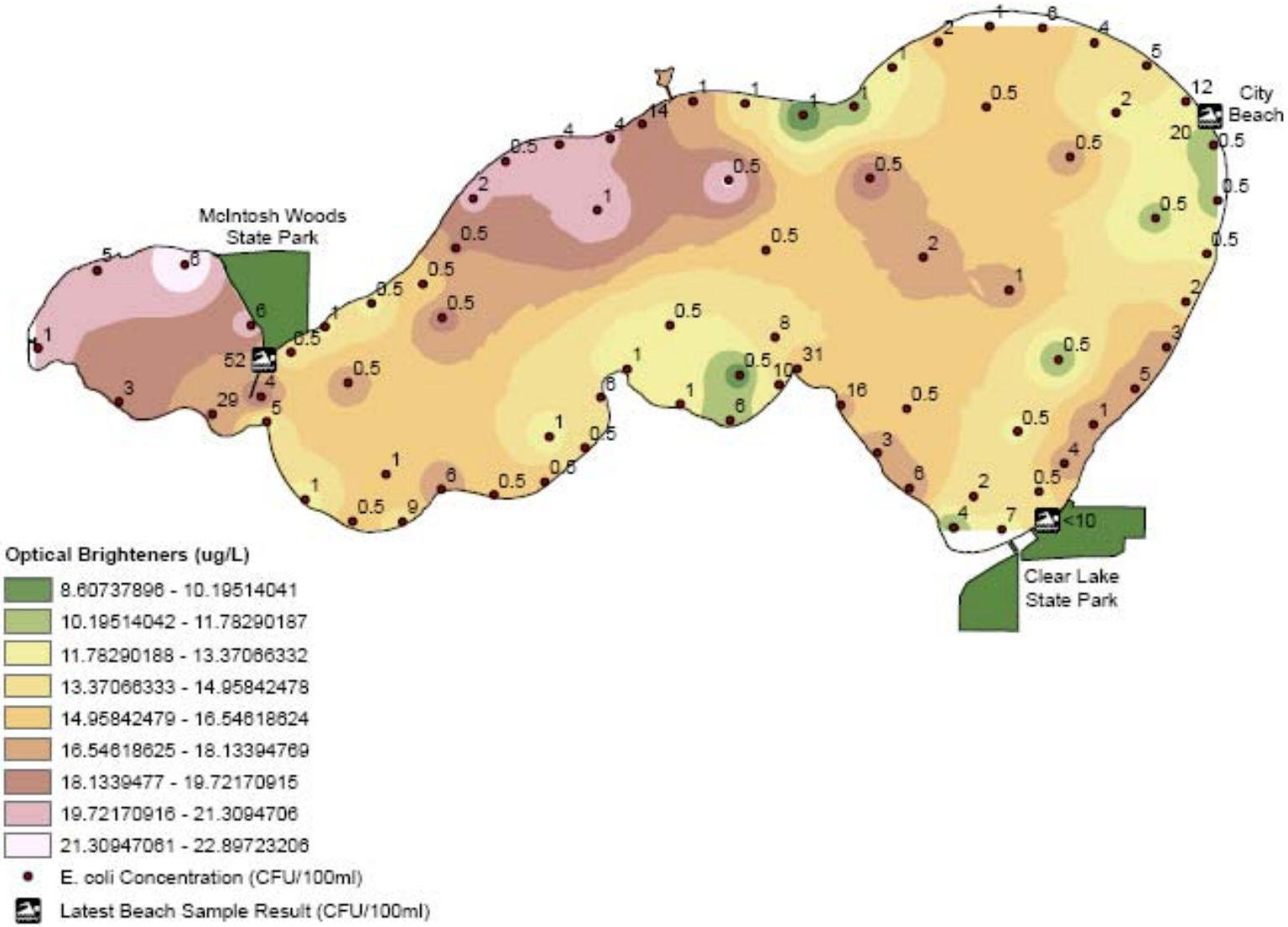
Sources of fecal bacteria

- Human sources – anytime fecal matter reaches water there will be bacteria
  - Wastewater treatment – inadequate or leaky septic systems or discharge from municipal systems
  - Swimming *"accidents"*, diapers
  - Boat dumping, fish derbies, water recreation

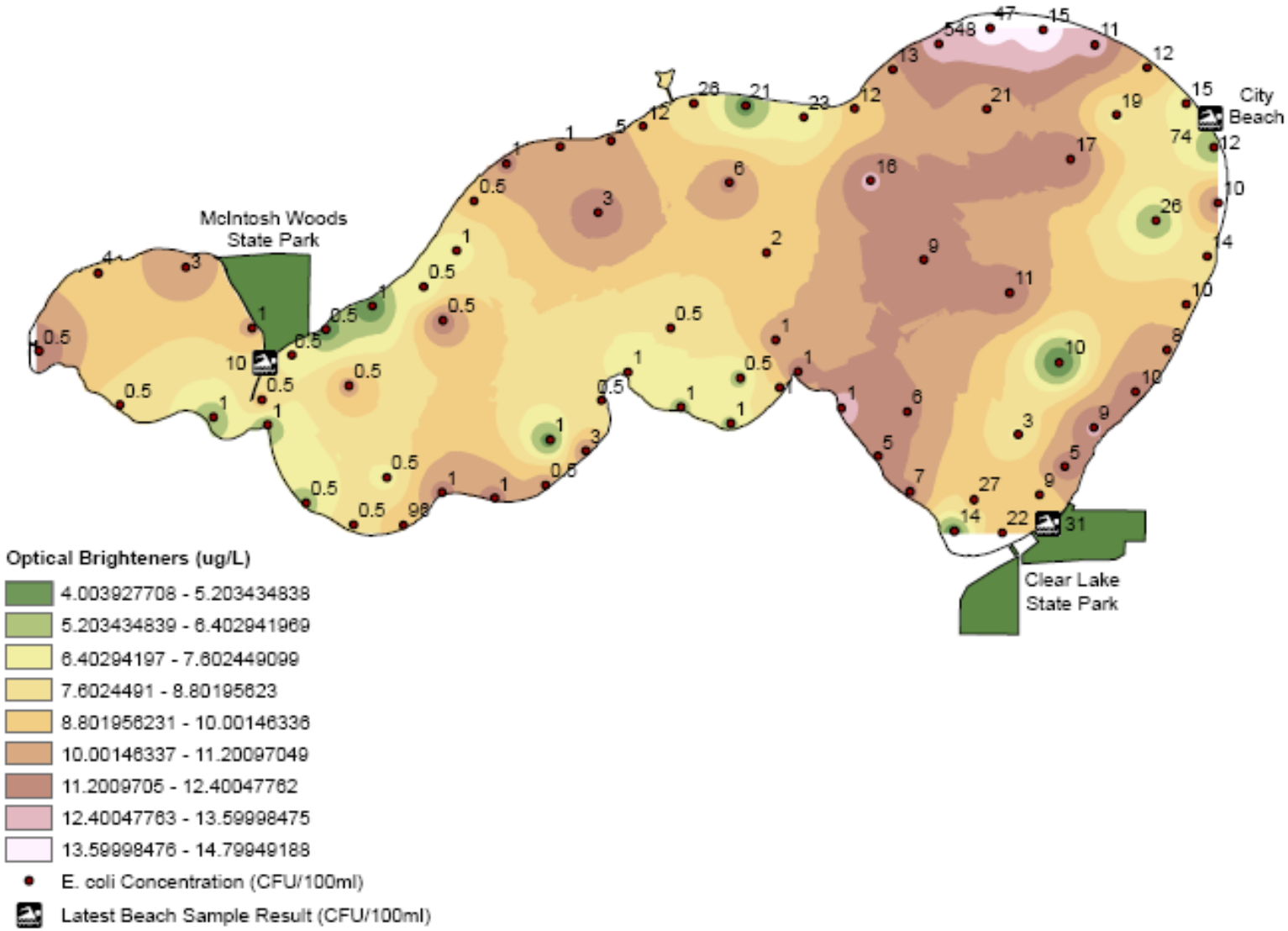
Clear Lake, Iowa



Clear Lake Fluorometry - July 5, 2007



Clear Lake Fluorometry - September 17, 2007



More bacteria sources

- Animal sources
  - Livestock – in streams, manure applied to fields, manure pits or lagoons
  - Wildlife – geese, ducks, deer, etc.
  - Pets

Waterborne Illnesses

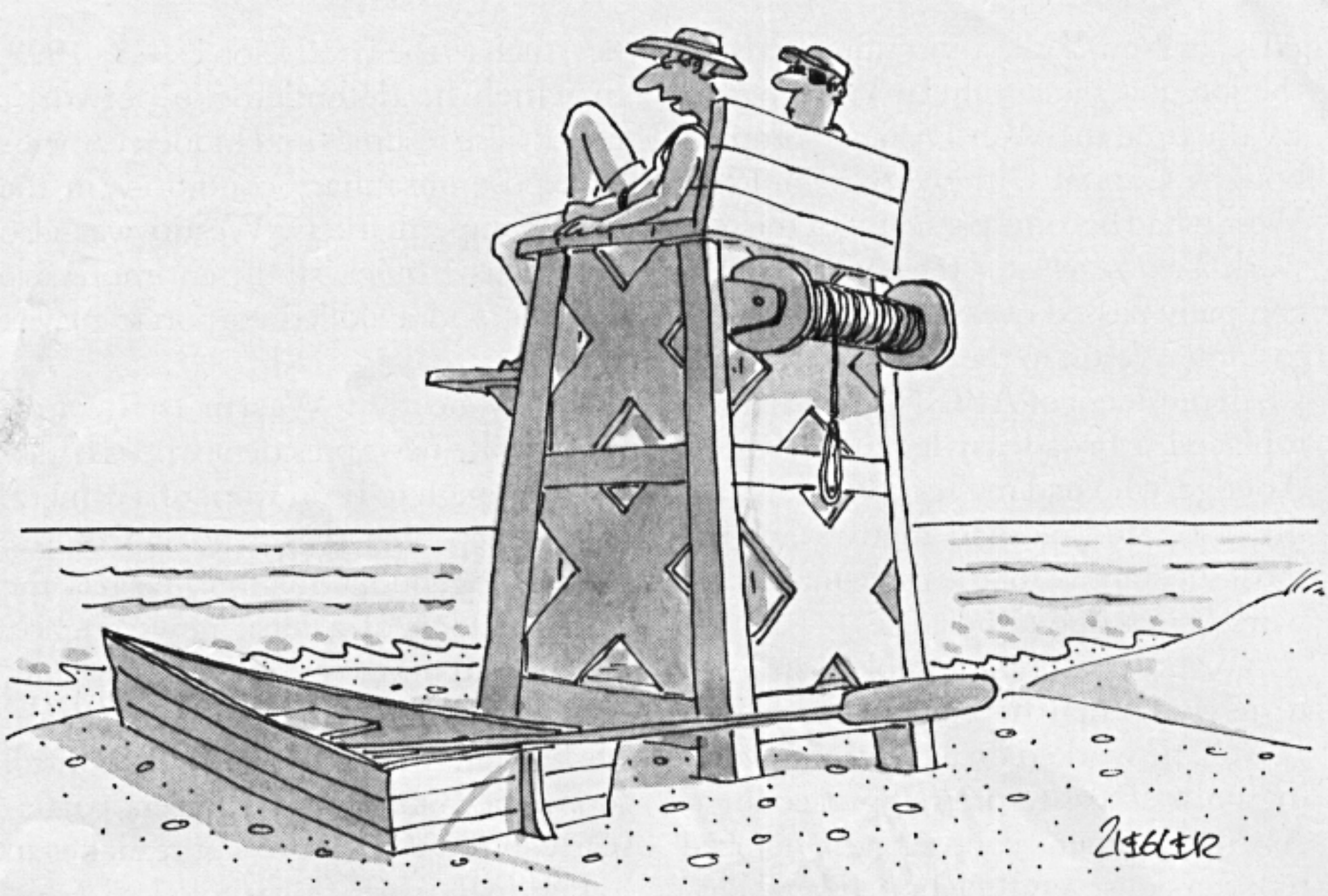
- Pathogens are disease causing micro-organisms
- Three families cause illnesses (bacteria, viruses, and protozoans)
- Symptoms may be mild and confused with other diseases, so people may not realize that water made them sick

Keep in mind …

- Not all bacteria present a health risk
- Most won't make you sick, but some may
- Low infectivity rates

Why not sample for pathogens?

- Few laboratories have the capacity
- It's expensive
- Takes a long time for analysis
- Requires a large volume of water
- Most tests identify only one pathogen
- Most polluted waters have few pathogenic organisms - they are difficult to isolate and identify



"I adore the beauty and tranquillity of these raw-sewage days."

Current Monitoring Approach Leads to Errors

1

2

3

4

Courtesy Richard Whitman - USGS

Body contact standard

- Indicator of potential health risks from body contact
- Varies by state – check YOUR state's standards
- EPA one time standard is 235 cfu per 100 ml for swimming beach advisories

Applying knowledge to improve water quality
Great Lakes Regional Water Program
A Partnership of USDA CSREES & Land Grant Colleges and Universities

Water Quality Guidelines-1986

US EPA recommended guidelines

- Geometric Mean Shall not exceed 126 *E. coli* / 100ml
- Geometric Mean shall not exceed 33 *enterococci* / 100ml

- Geometric Mean shall not exceed 35 *enterococci* / 100ml

Recommended Guideline = $\frac{\text{Fecal Coliform Std x Geo. Mean of New Indicator}}{\text{Geo. Mean of Fecal Coliforms}}$

Example for enterococci in fresh waters:

Recommended Guideline $= \frac{200\ \text{FC}/100\ \text{ml} \times 19\ \text{ENT}/100\ \text{ml}}{115\ \text{FC}/100\ \text{ml}}$

$= \frac{3800\ \text{ENT}/100\ \text{ml}}{115}$

$= 33\ \text{ENT}/100\text{m}$

where: FC = Fecal Coliforms
ENT = enterococci

Where did the numbers come from?

Pre-1968	Most States	1000 Coliforms
1968	NTAC recommendation	200 fecal coliforms – same as 1000 coliforms
1986	EPA recommendation	FW - 126 *E.coli* 33 enterococci
		MW 35 enterococci
		All equivalent to 200 fecal coliforms

How far have we come with water quality guidelines?

Courtesy Alfred Dufour - EPA

Geometric Mean

Method recommended by EPA. Based on 5 samples collected over a 30-day period. Minimizes influence of a one-time high result.

Example: Sunshine Lake with bacteria readings of 5, 10, 120, 20, 2700

Average would be $= \frac{5 + 10 + 120 + 20 + 2700}{5} = 571$

GM $= \sqrt[5]{5 * 10 * 120 * 20 * 2700} = 50$