CHEERS:
The Chicago Health, Environmental Exposure and Recreation Study

MWRD Research Seminar
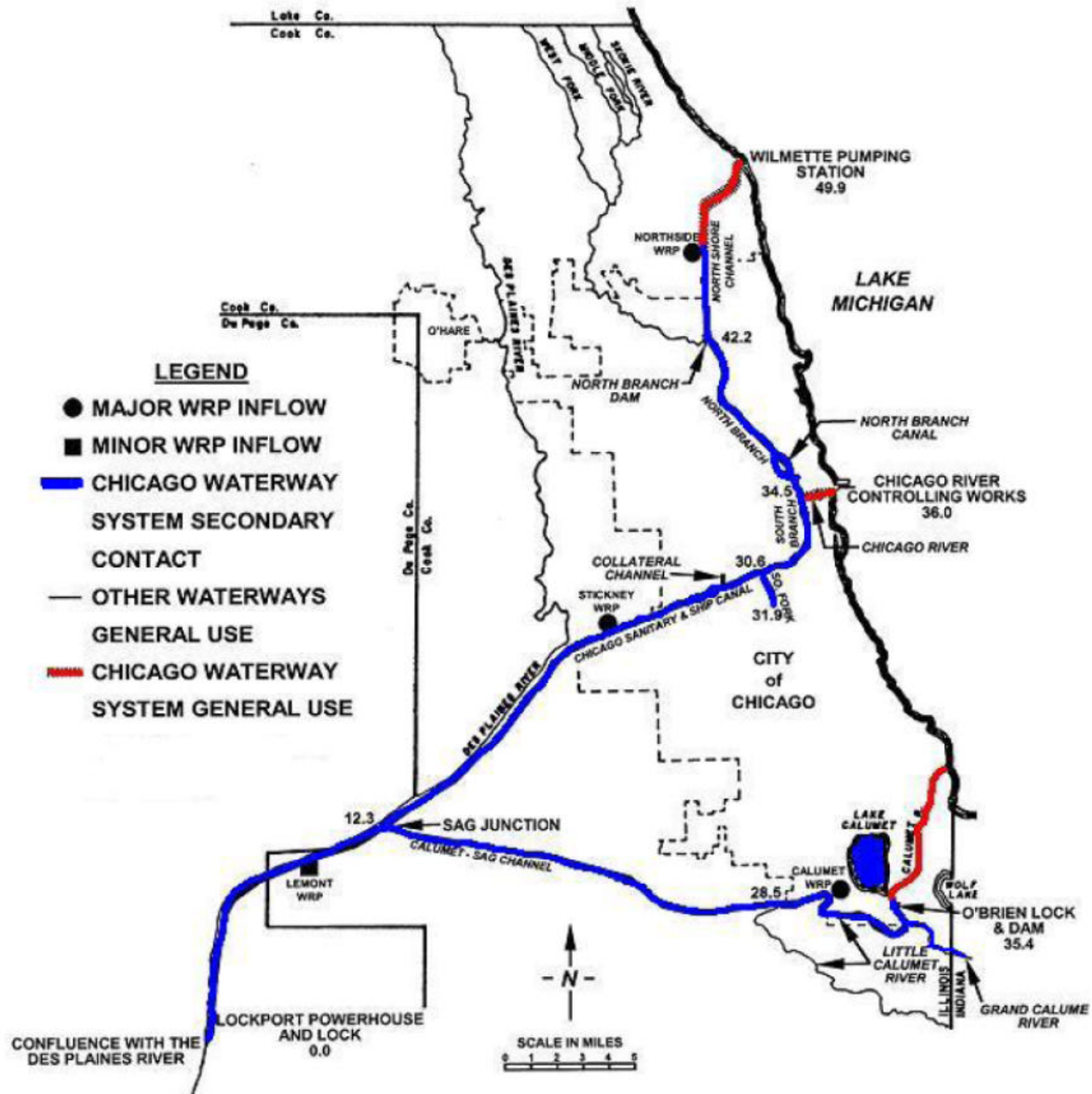
March 28, 2008

Sam Dorevitch, MD, MPH

UIC School of Public Health

Overview

- Why study health risks of CAWS recreation?
- Why an epidemiologic study ?
- What is CHEERS?
- How did things go in 2007?
- What are the plans for 2008?

Chicago Area Waterway System (CAWS)

LEGEND
- ● MAJOR WRP INFLOW
- ■ MINOR WRP INFLOW
- ▬ CHICAGO WATERWAY SYSTEM SECONDARY CONTACT
- — OTHER WATERWAYS GENERAL USE
- ∿∿ CHICAGO WATERWAY SYSTEM GENERAL USE

WILMETTE PUMPING STATION 49.9

LAKE MICHIGAN

NORTHSIDE WRP

NORTH SHORE CHANNEL

42.2

NORTH BRANCH DAM

NORTH BRANCH

NORTH BRANCH CANAL

CHICAGO RIVER CONTROLLING WORKS 36.0

34.5

SOUTH BRANCH

CHICAGO RIVER

COLLATERAL CHANNEL

30.6

31.9

STICKNEY WRP

SOUTH FORK

CHICAGO SANITARY & SHIP CANAL

CITY of CHICAGO

DES PLAINES RIVER

12.3 ← SAG JUNCTION

CALUMET-SAG CHANNEL

LAKE CALUMET

CALUMET R.

LEMONT WRP

CALUMET WRP

28.5

WOLF LAKE

O'BRIEN LOCK & DAM 35.4

LITTLE CALUMET RIVER

ILLINOIS INDIANA

GRAND CALUME RIVER

-N-

SCALE IN MILES
0 1 2 3 4 5

CONFLUENCE WITH THE DES PLAINES RIVER

LOCKPORT POWERHOUSE AND LOCK 0.0

Lake Co. / Cook Co.

Cook Co. / Du Page Co.

O'HARE

De Page Co. / Cook Co.

3

Why study health risks of CAWS recreation?

- Clean Water Act: swimmable and fishable
- Use Attainability Analysis
- Proposed use designation changes
- Policy development for those uses:
  - **What are the health risks?**
  - **What protection would the public gain from microbial water quality standards?**

Why study health risks of CAWS recreation?

Current policy

- Benefits
- Risks

Alternative policies

- Benefits
- Risks

Ways to evaluate health risks of CAWS recreation

1. Prior studies of secondary contact recreation in other settings

2. Estimate risk based on risks of primary contact recreation

3. Quantitative microbial risk assessment

Approach 1: Prior studies of limited contact recreation in other settings

- Few studies of secondary contact recreation

- Range of activities limited to paddling

- Water quality not comparable to CAWS

- Limitations of methods used in those studies

Approach 2: Estimate risk based on primary contact recreation risks

- Don't know how much water is ingested or inhaled in secondary contact activities

- Couldn't estimate risk as a fraction of the primary contact risk without knowing relative doses of water in primary vs. secondary contact activities

Approach 3: Quantitative Microbial Risk Assessment

- Measure pathogens in water at range of locations, times of year

- Estimate amount of water ingested for various activities relying on the literature

- Based on the "infectious dose" of pathogens, model the likelihood of ingesting an infectious dose

- Analysis suggests a risk of 1 illness per 1,000 recreational exposures

9

Approach 3: Quantitative Microbial Risk Assessment

- Health risks are modeled rather than measured

- The modeled risk is dependant on model assumptions

- Regulatory authorities may place more weight on epidemiologic studies than risk assessments

Alternative: measure health risks

"And it was so typically brilliant of you to have invited an epidemiologist."

11

What is epidemiology?

The study of the <u>distribution</u> and <u>determinants</u> of <u>disease</u> in <u>populations</u>

"Determinants"

- CAWS recreation
- Microbial measures of water quality
- Demographic variables

"Disease"

- Dermatitis
- Skin infection
- Respiratory infection
- Gastrointestinal infection

Achilles heals of epidemiology

- "Confounding"
  (non-causal associations)

- "Statistical power"
  (real difference exists, but insufficient study participants to identify difference with confidence)

What is CHEERS?

Chicago
Health,
Environmental
Exposure, and
Recreation
Study

Study Objectives

1. To determine rates of acute gastrointestinal and non-gastrointestinal illness attributable to CAWS recreation.

2. To characterize the relationship between concentrations of microbes and rates of illness among secondary contact recreators.

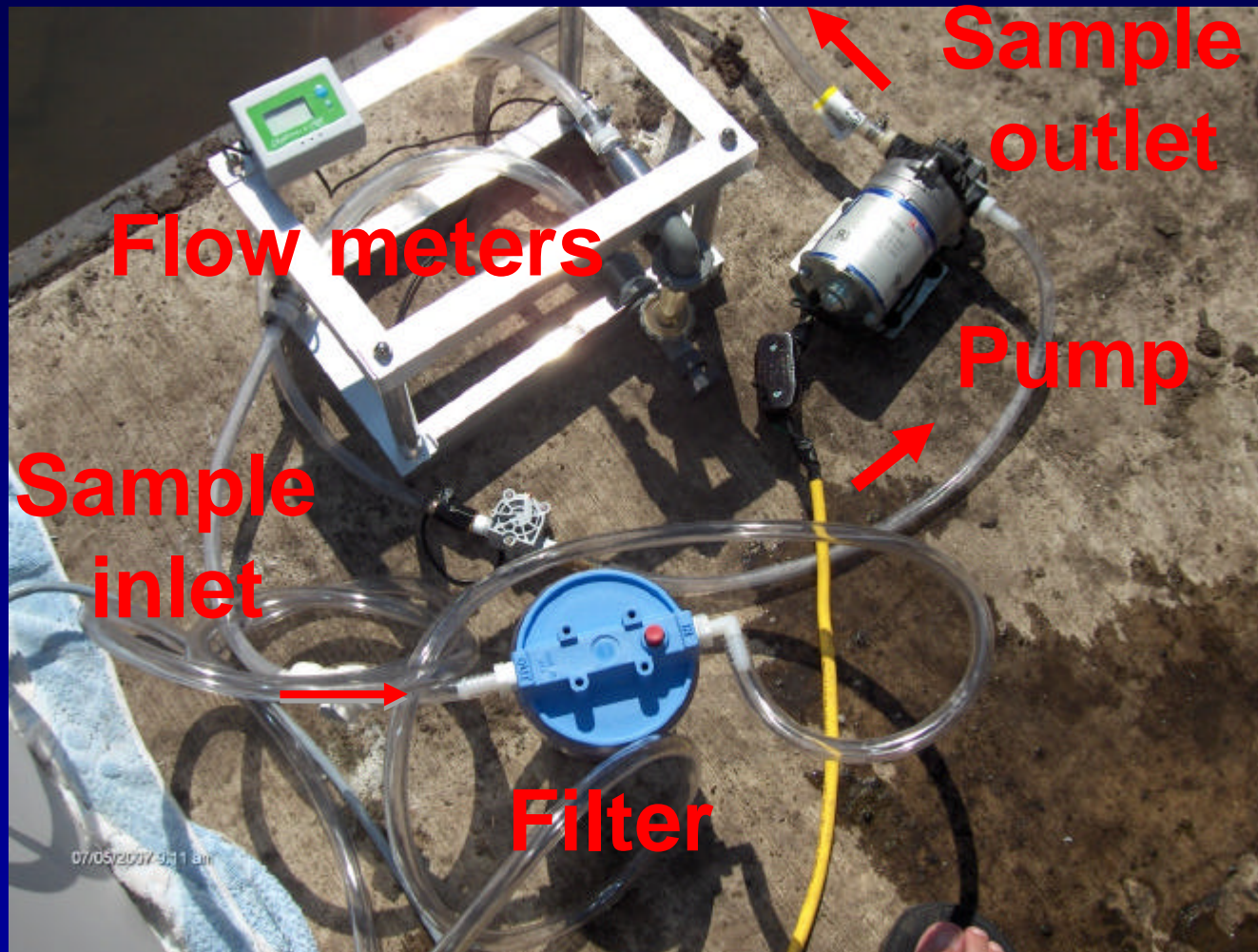3. To identify pathogens responsible for acute illness among recreators, and to explore sources of those pathogens on the CAWS.

16

Objective 1

To determine rates of acute gastrointestinal and non-gastrointestinal illness attributable to CAWS recreation

What might be responsible for in illness among CAWS recreators?

- **Water recreation**
- **Having kids in day-care**
- **Eating contaminated food**
- **Taking antibiotics**
- **Having lactose intolerance and other intestinal conditions**
- **Skin, respiratory: Water, not microbe exposure**

18

Differentiating sources of risk

- Identify rates among those with the potential risk factor
- Identify rates among those without the potential risk factor

19

Enroll groups with and without the factor of interest, in this case, exposure to CAWS water

Unexposed recreators

General use recreators

CAWS recreators

Sources of risk, by group

Unexposed   General Use   CAWS

Study objective #2

To characterize the relationship between concentrations of microbes and rates of illness among secondary contact recreators

Water Quality: Direct sampling

- E. coli (EPA reference method 1603)
- Enterococci (EPA reference method 1600)
- Coliphages (EPA reference method 1602)

Water Sampling: CFC for *Giardia* and *Cryptosporidium*

Intake

Effluent

Peristaltic Pump

Centrifuge

Water Sampling: Norovirus

Water Quality: Non-microbial measures

pH
Dissolved Oxygen
Conductivity
Turbidity
Temperature

Study Objective #3

To identify pathogens responsible for acute infections among recreators, and to explore sources of those pathogens on the CAWS.

Pathogens responsible for GI illness

- *Salmonella*
- *Shigella*
- *Campylobacter*
- *Yersinia*
- *Pleisiomonas*
- Shigatoxin
- *E. coli* 0157:H7
- Norovirus
- Rotavirus
- Adenovirus
- Enterovirus

- *Giardia*
- *Cryptosporidium*
- *Cycolospora*
- *Entamoeba*

28

Pathogens responsible for non-GI illness

Skin/wound drainage

- Bacterial culture

Eye discharge

- Bacterial culture
- Viral culture

Study design

- Prospective cohort, the "gold standard" in epidemiology
- 9,330 study participants
- Neutral stance
  - **"The risks aren't known; we want to find out"**
  - **Training**
  - **Recruiting materials**
  - **Content of survey questionnaires**
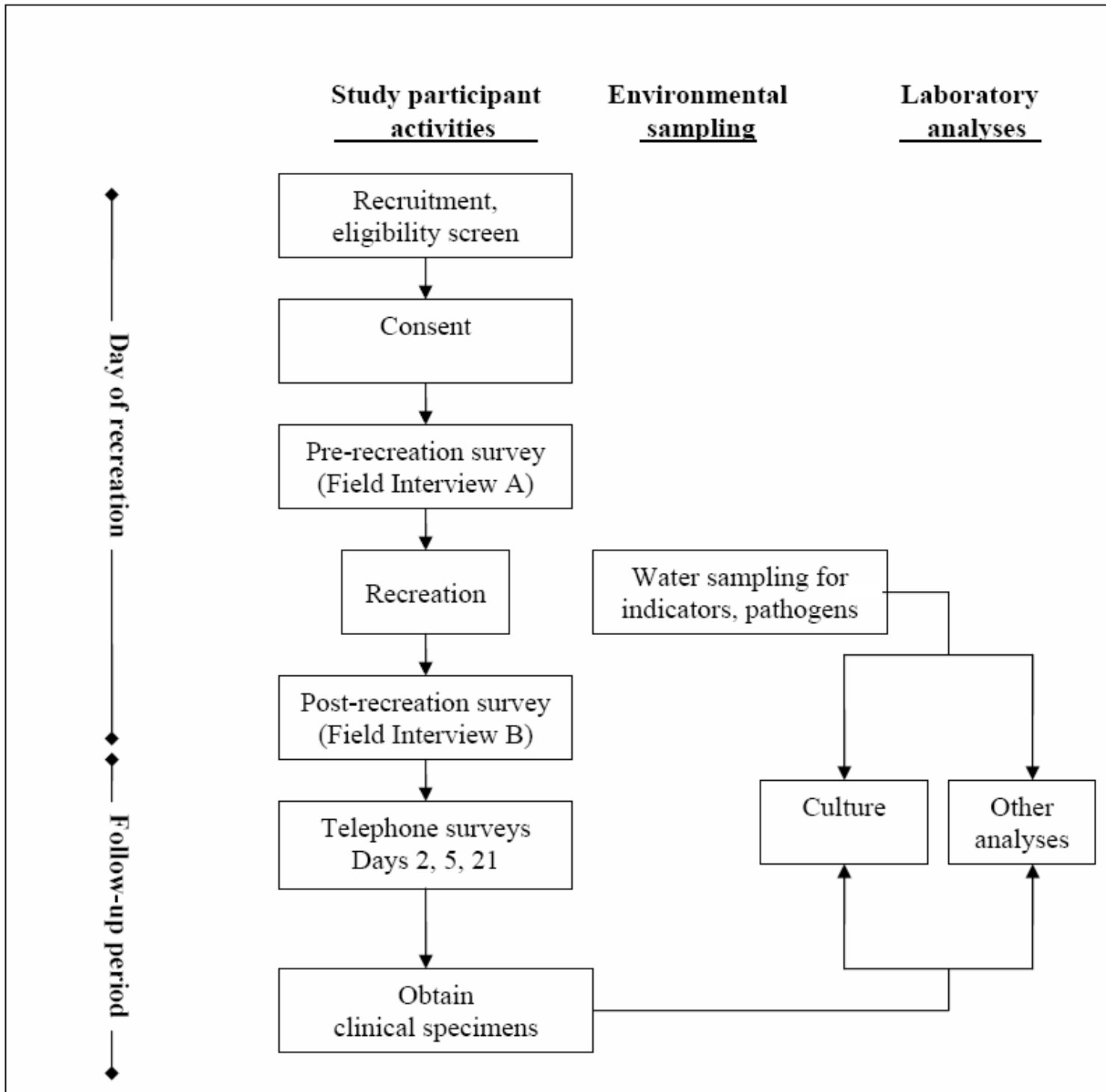
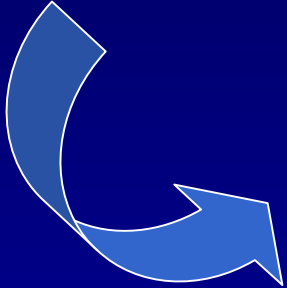# Eligibility

All groups

No lake/river/lagoon use in the past 48 hours

Water exposed groups

No primary contact recreation (OK: rowing, paddling, fishing, power boating)

CHEERS procedures
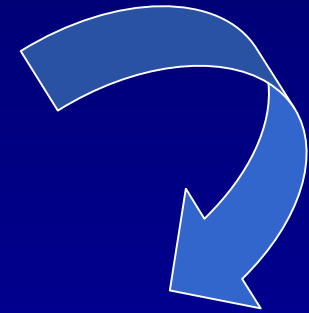
UIC Survey Research Laboratory Call Center

Approach to protocol development

- **Tried & true rather than novel and speculative**
  - **NEEAR study; EPA methods for water analyses**
- **Interdisciplinary**
  - **Infectious disease medicine**
  - **Microbiology**
  - **Biostatistics**
  - **Risk assessment**
  - **Survey research**
  - **Environmental science**
  - **Epidemiology**
- **Start small, evaluate, and scale up**
- **Quality benchmarks for measures, processes**

2007 Timetable

- **February-March: Develop research plan**
- **May-June 2007: Hiring, training, protocol development, human subjects research approval, preliminary water sampling, pilot study of questionnaires, publicity**
- **July 2007: Peer review**
- **August-November : Field study**

CHEERS 2007 performance measures

Key performance measures

- **Assumptions of sample size calculation**
  - **Background rates of GI illness**
  - **Attrition**
- **Water quality measurement**
  - **Holding time**
  - **Accuracy (recovery studies)**
  - **Precision**

Sample size calculation (9,330):

- **Assumption: 75 cases/1,000 (based on NEEAR rates)**
- **Actual: As expected**

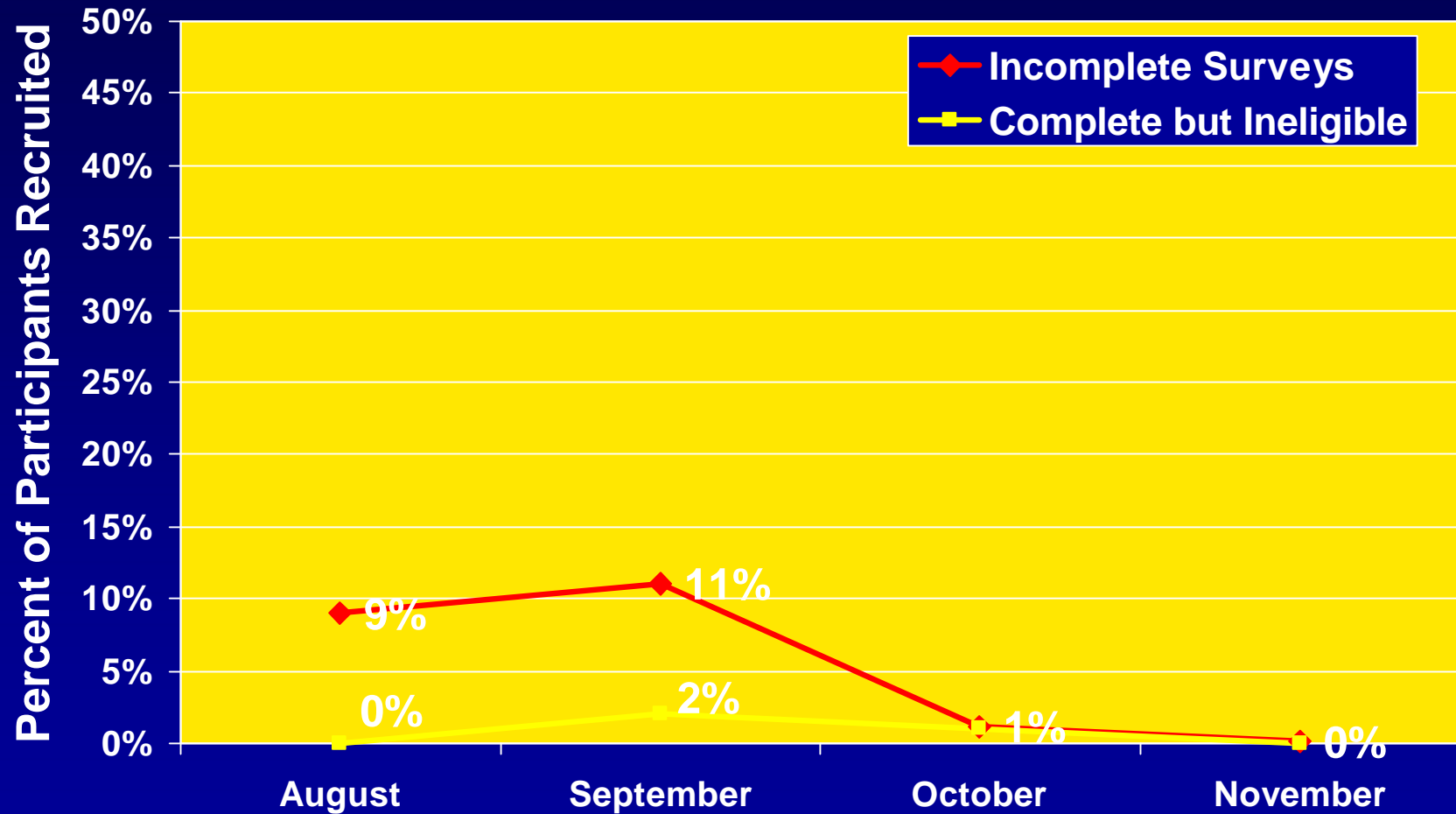- **Assumption: Attrition/incomplete data rate of 15%**
- **Actual: Lower (better) than assumed**

Number of participants at each field phase of study

886
Completed at least one field interview

→

824
Completed all field components

→

811
Completed all field components and remained eligible

Problem:
Difficulty reaching participants at end of day
Solution: added screening questions

Problem:
**Intentional swimming**
Solution:
Added screening questions

Actual attrition rate

Participant telephone survey

811 Participants eligible for telephone follow-up surveys

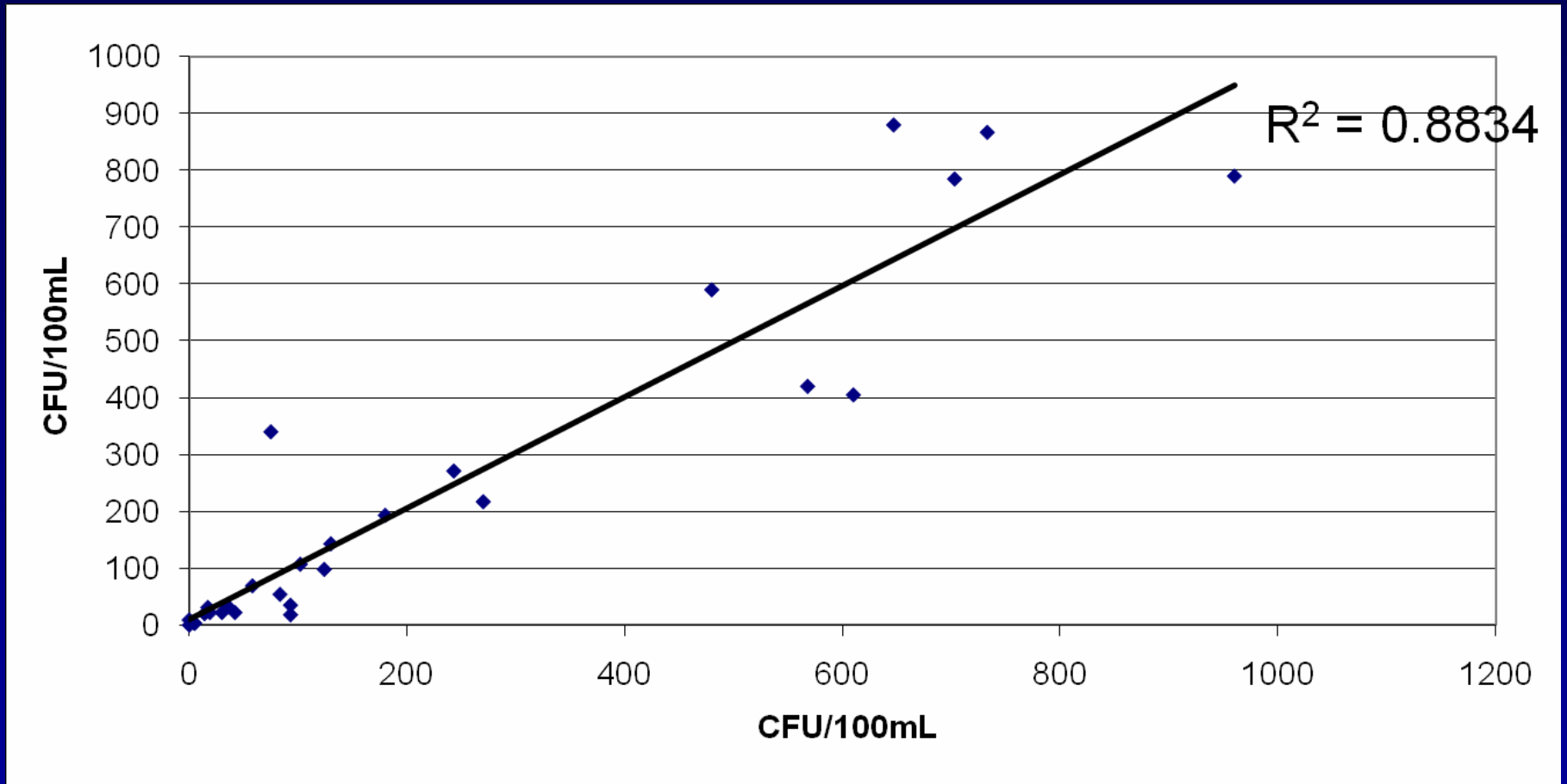**809 (99.8%)** Participants completed at least one telephone follow-up surveys
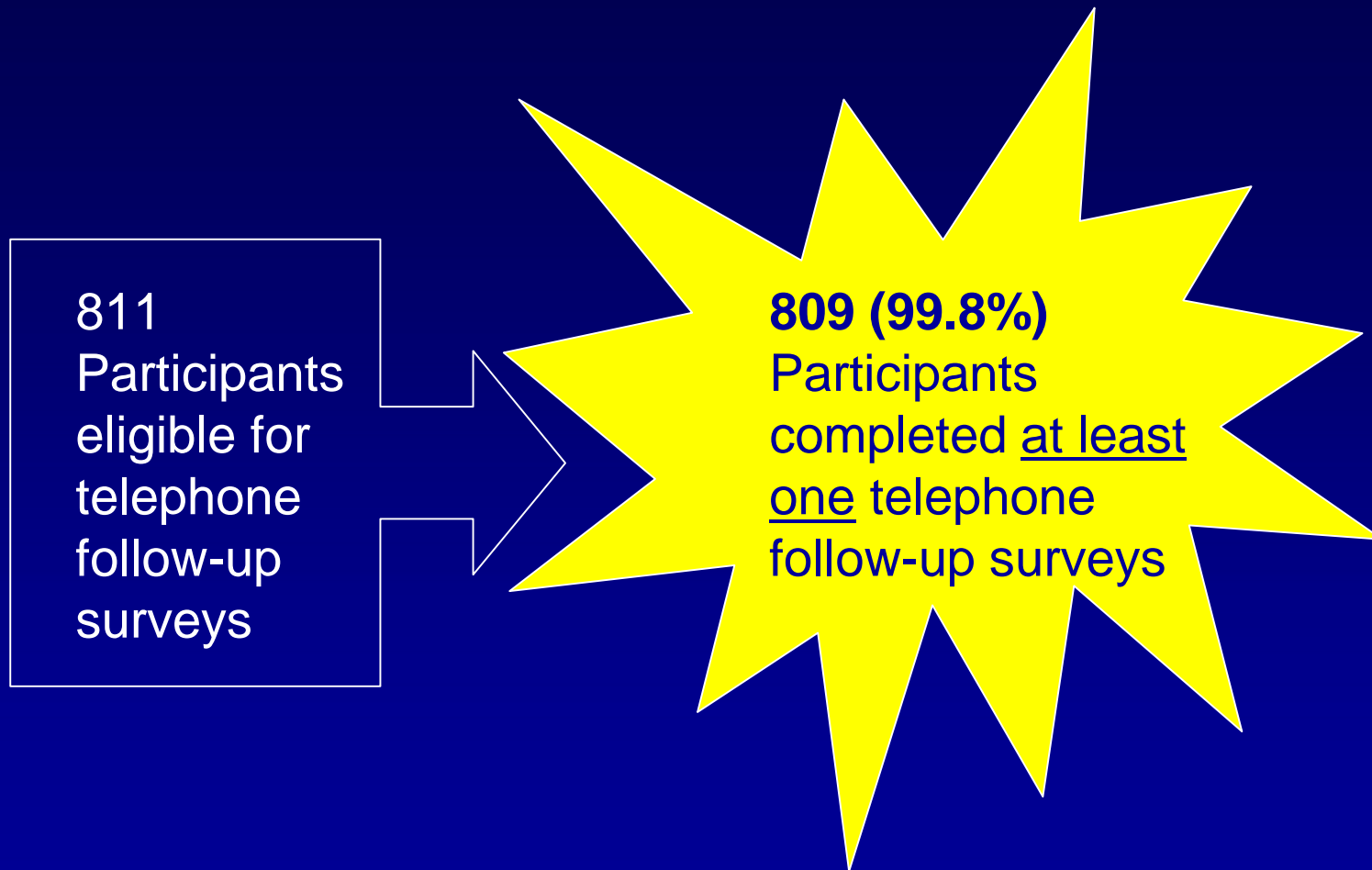
CHEERS 2007 performance measures: Water quality

- **2,600 samples for 4,500 analyses**
- **Field blanks: 16.4% of samples**
- **Field replicates: 23.4% of samples**
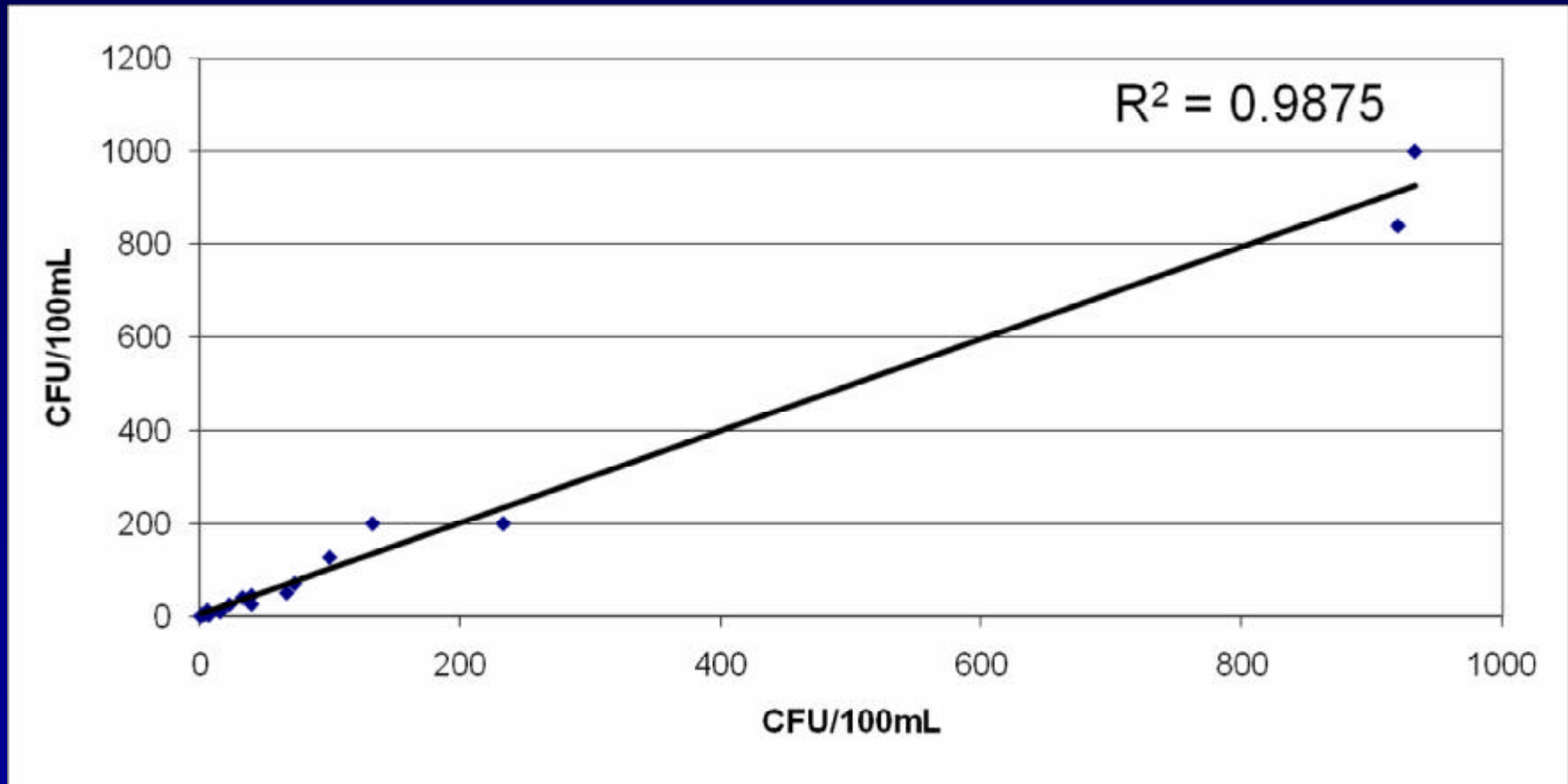- **Spiked matrix: 11.9% of samples**
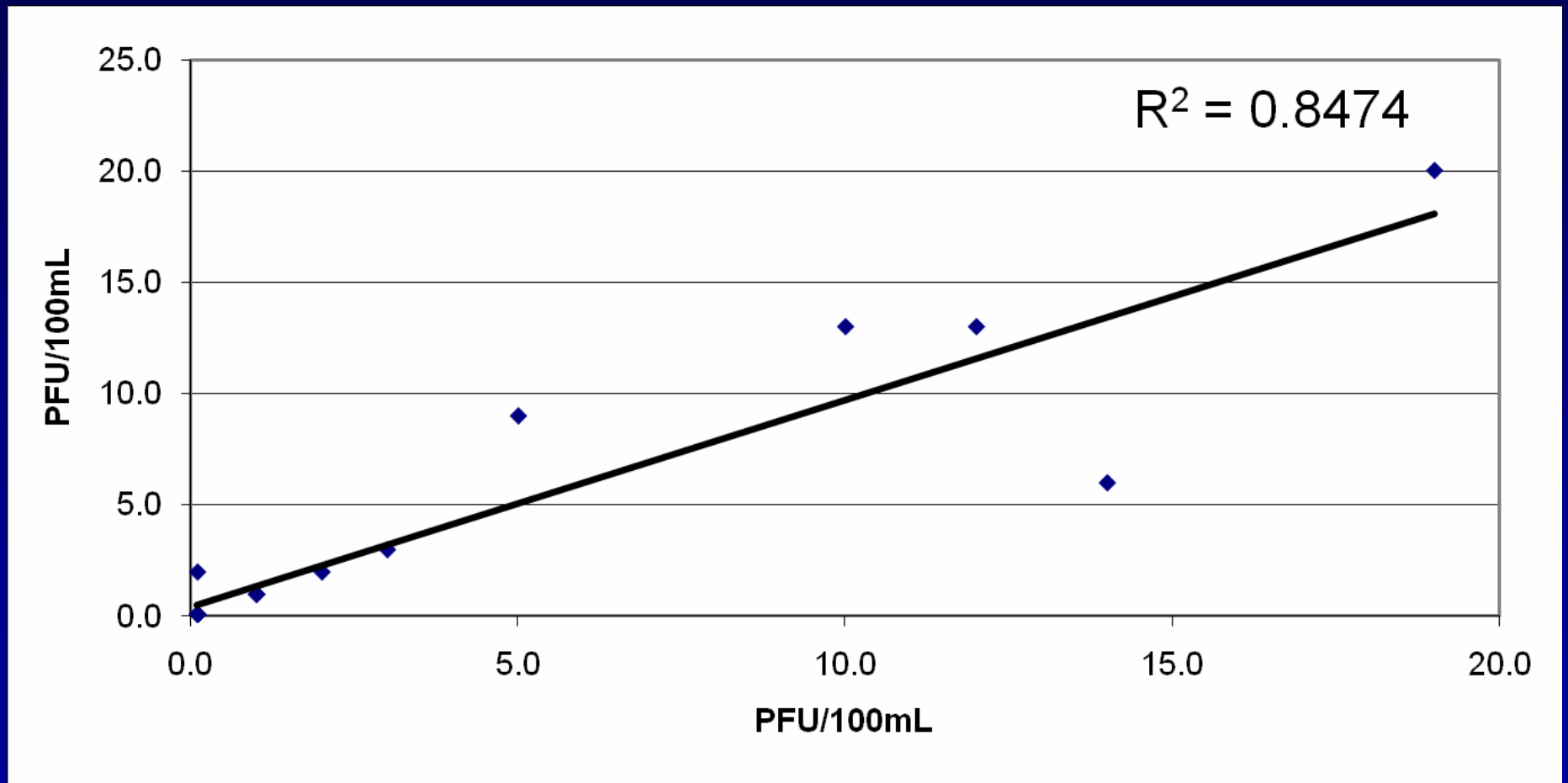
Enterococci and *E. coli* IPR and OPR Summary
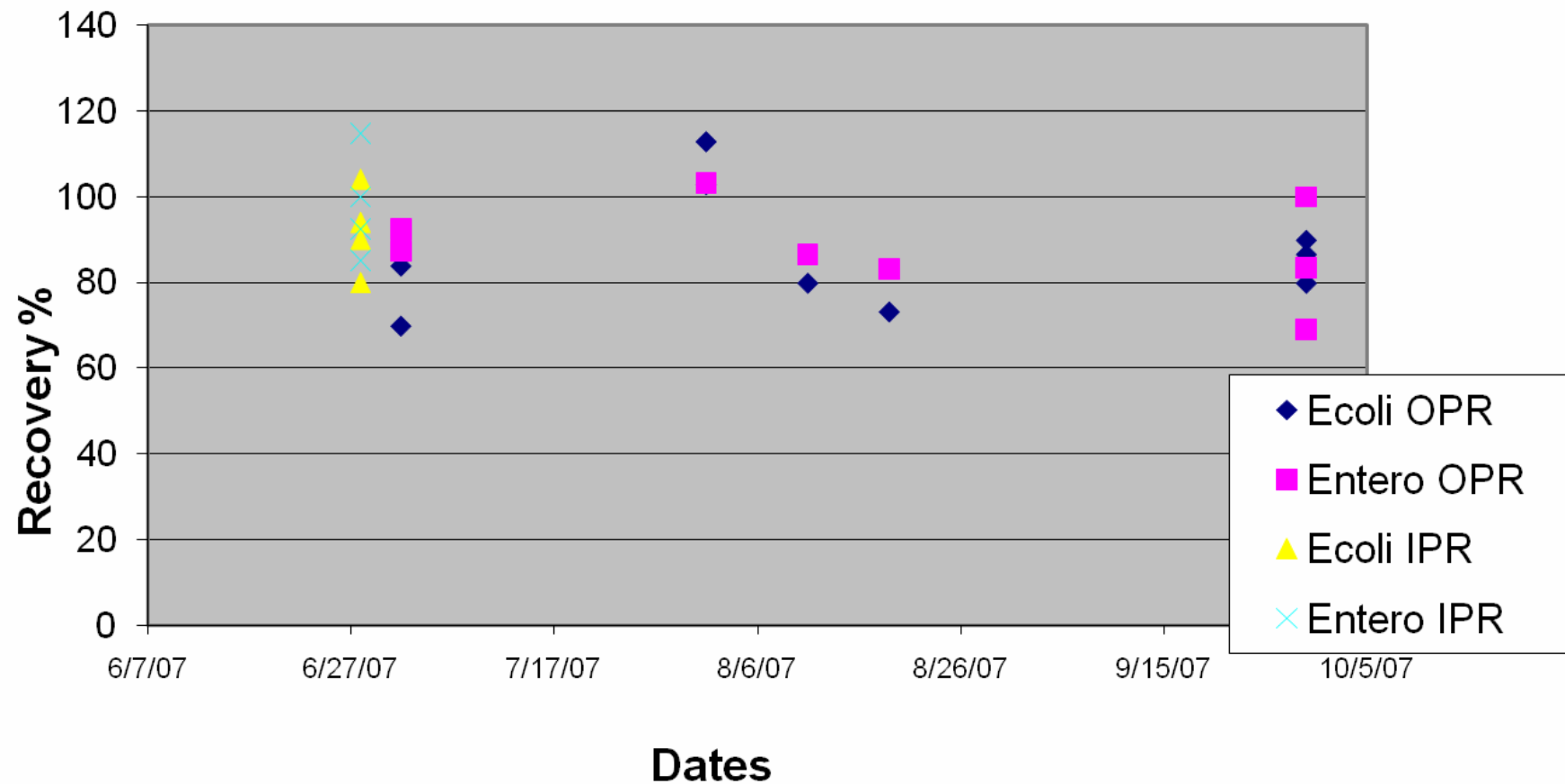
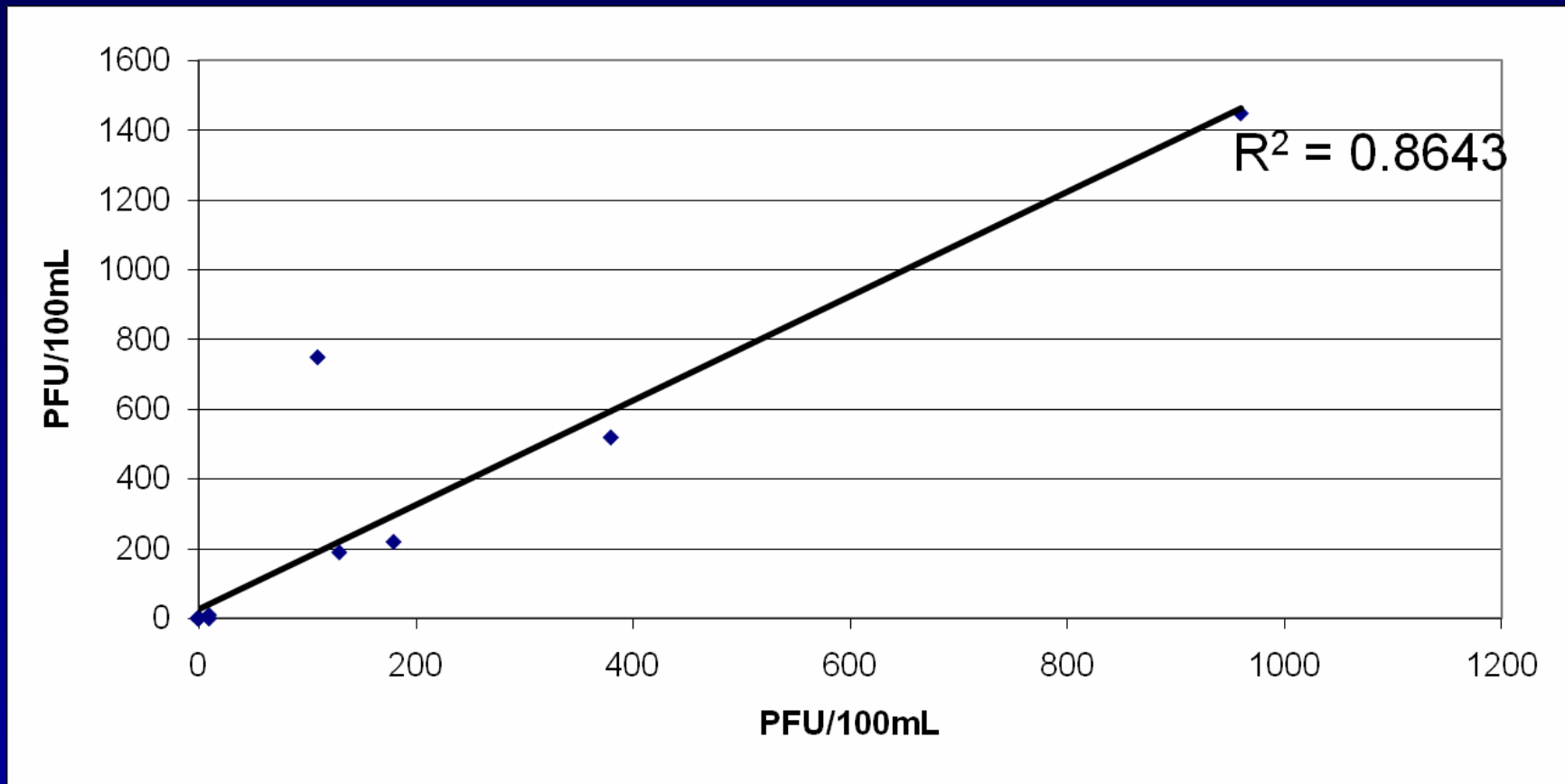# Field Splits: Enterococci, data truncated above 1000 CFU/100mL

Field Splits: *E. coli*, data truncated above 1000 CFU/100mL (median)

Field Splits: Male-specific coliphage, data truncated above 20 PFU/100mL (median)

$R^2 = 0.8474$

Field Splits: Somatic coliphage, data truncated above 1000 PFU/100mL (median)

Holding Time

- 1066/1082 (98.5%) enterococci and *E. coli* samples arrived at lab within 6 hours
- Of the 16 that arrived outside of 6 hrs:
  - **14 were "spikes" from the UIC lab**
  - **2 were blanks**
- Average time to lab: 3.5 hr

It took a strong team in 2007….

...and we're scaling up in 2008

- **Enhanced partnerships with clubs/teams/event organizer**

- **More "general use waterways" locations**

- **Improved methods for collecting and transporting clinical specimens to UIC**

52

Other 2008 enhancements

- **Weekends and holidays: 4 sites per day simultaneously, two 6-hour shifts of recruitment**
- **Performance evaluation water samples better integrated into ongoing water collection**

- **Expanded efforts to find and recruit CAWS fishers**
- **Spanish language study documents, field personnel, call center staff**
- **"Real time" process monitoring**
- **Off to a strong start, even in snow!**

53

Questions?