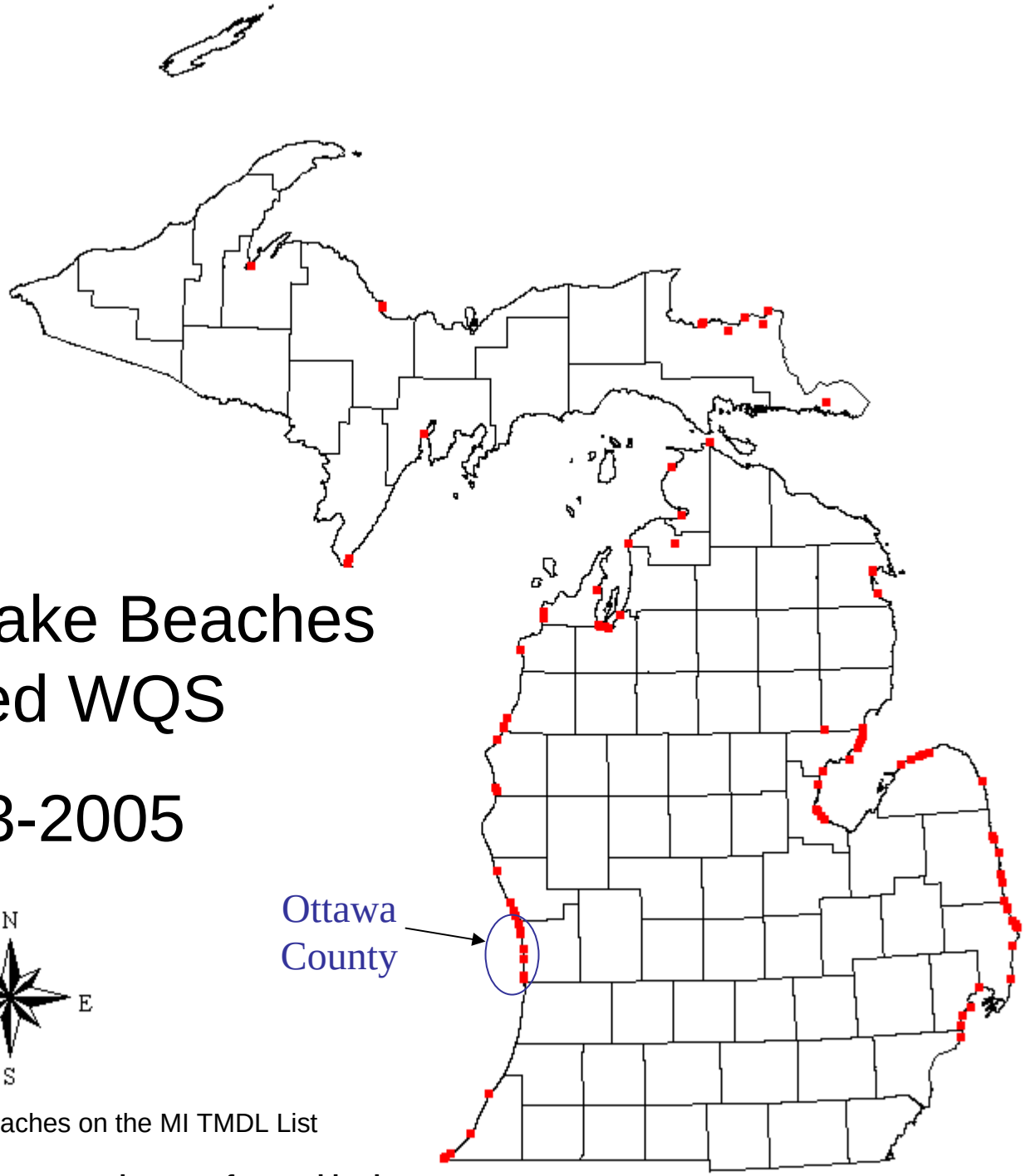
Water Pollution Studies for the Lower Grand River, Michigan

Dr. Joan B. Rose
rosejo@msu.edu
Dr. Phanikumar Mantha
phani@msu.edu
Rebecca Ives, Shikha Singh and Theng Theng Fong and Chao Peng

MICHIGAN STATE UNIVERSITY

Grand River, MI

- Longest river in Michigan at 420 km (260 miles)
- Water shed drains an area of 14, 431 km^2 (5572 mi^2)
- Trout and salmon stream
- Pasture and cropland comprise of 63% of river basin (EPA)



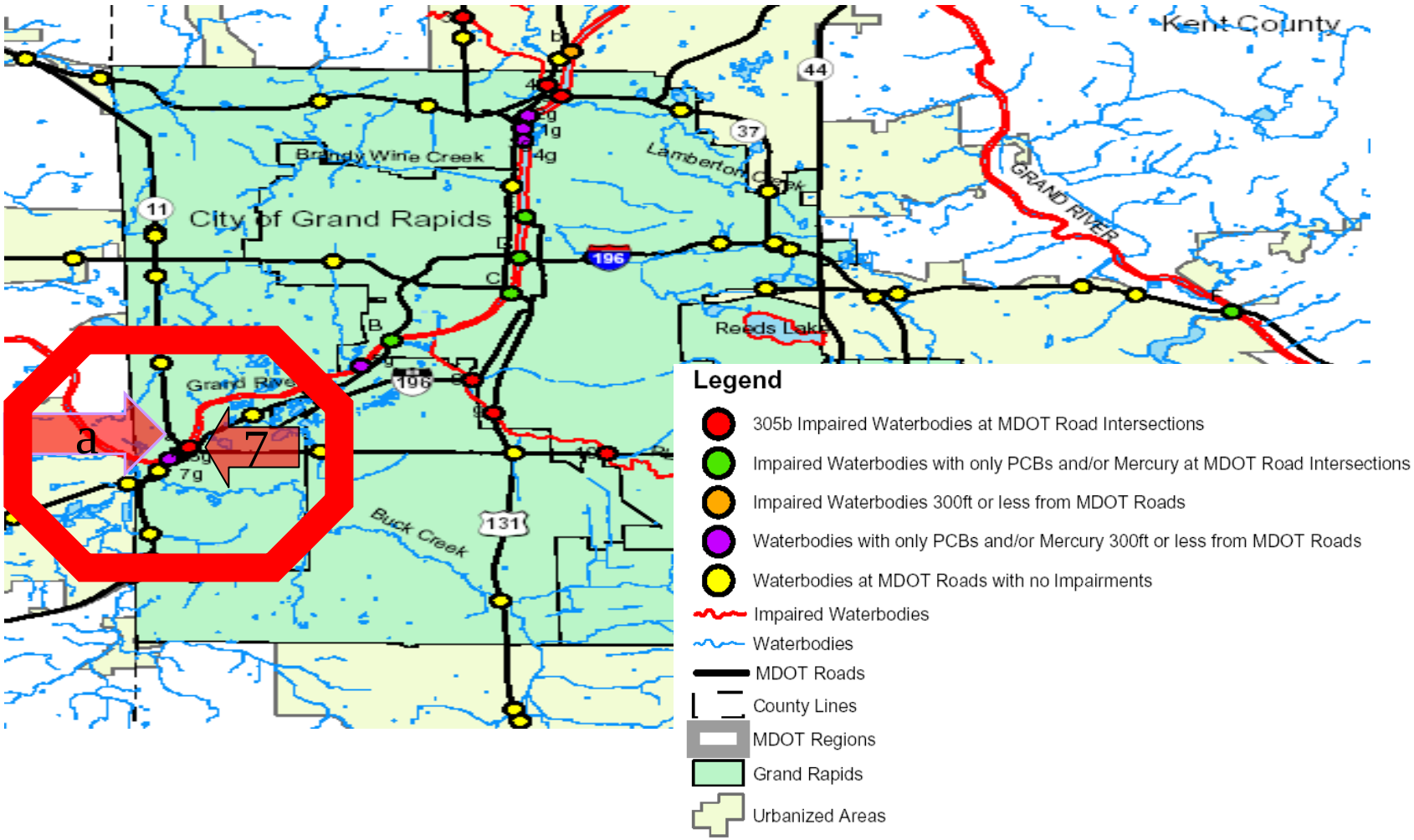
96 Great Lake Beaches Exceed WQS

2003-2005

*There are 41 Inland and GL Beaches on the MI TMDL List

WQS = 300 E. coli/100 ml daily geometric mean for total body contact

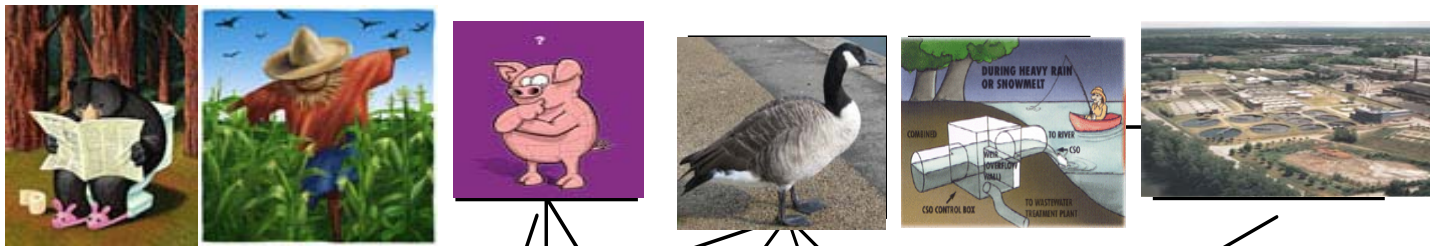
MDOT Water Impairment map-2003



7 Grand River @ M-11 →CSO & Pathogens

a Grand River → CSO & Pathogens

Web of Surface Water Impact



Rivers and Streams

Lakes

Beaches

Soil

Sediment

Sand

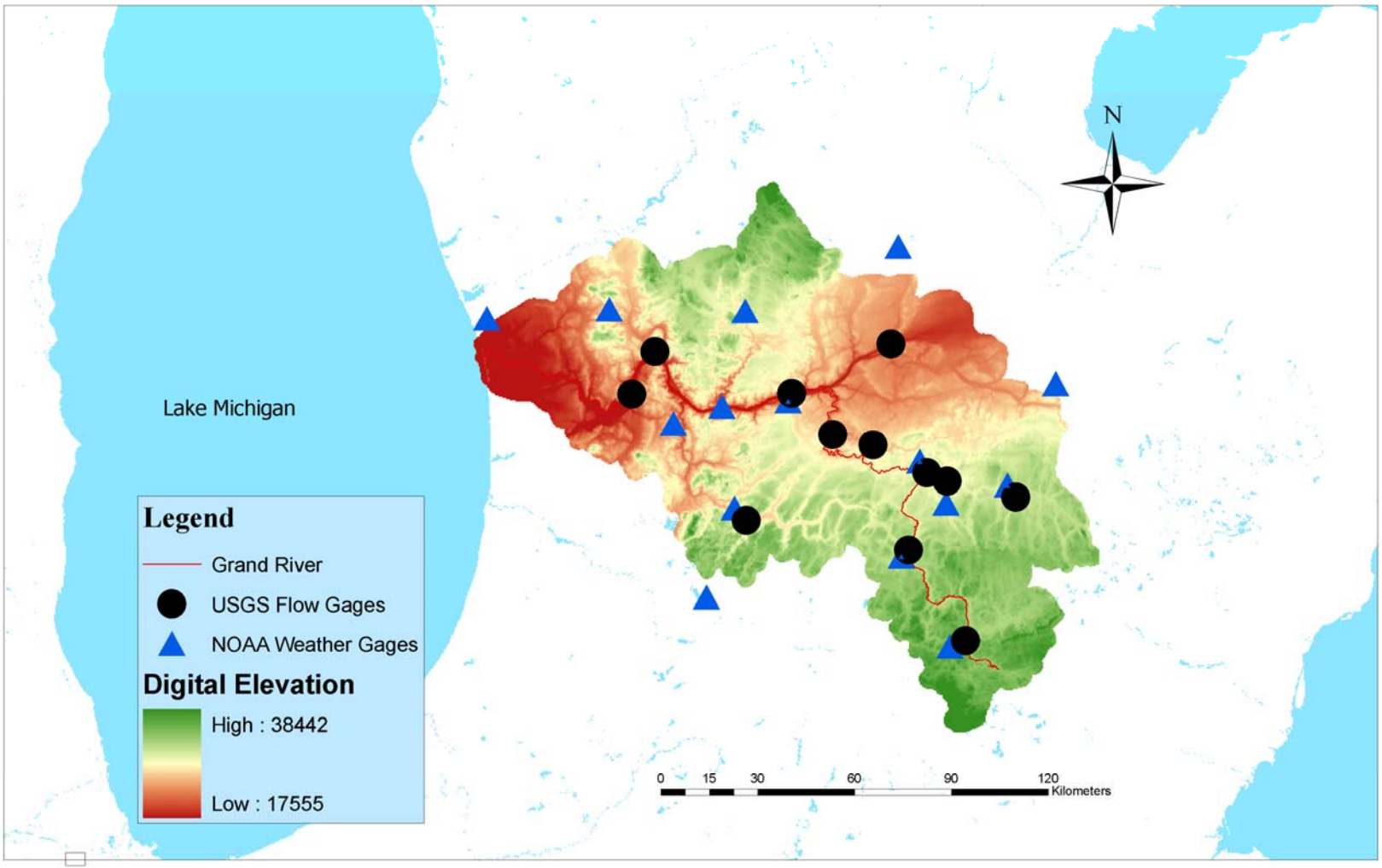
Direct / Indirect Compromization of Human Health

Study Site: The Grand River Watershed (I)

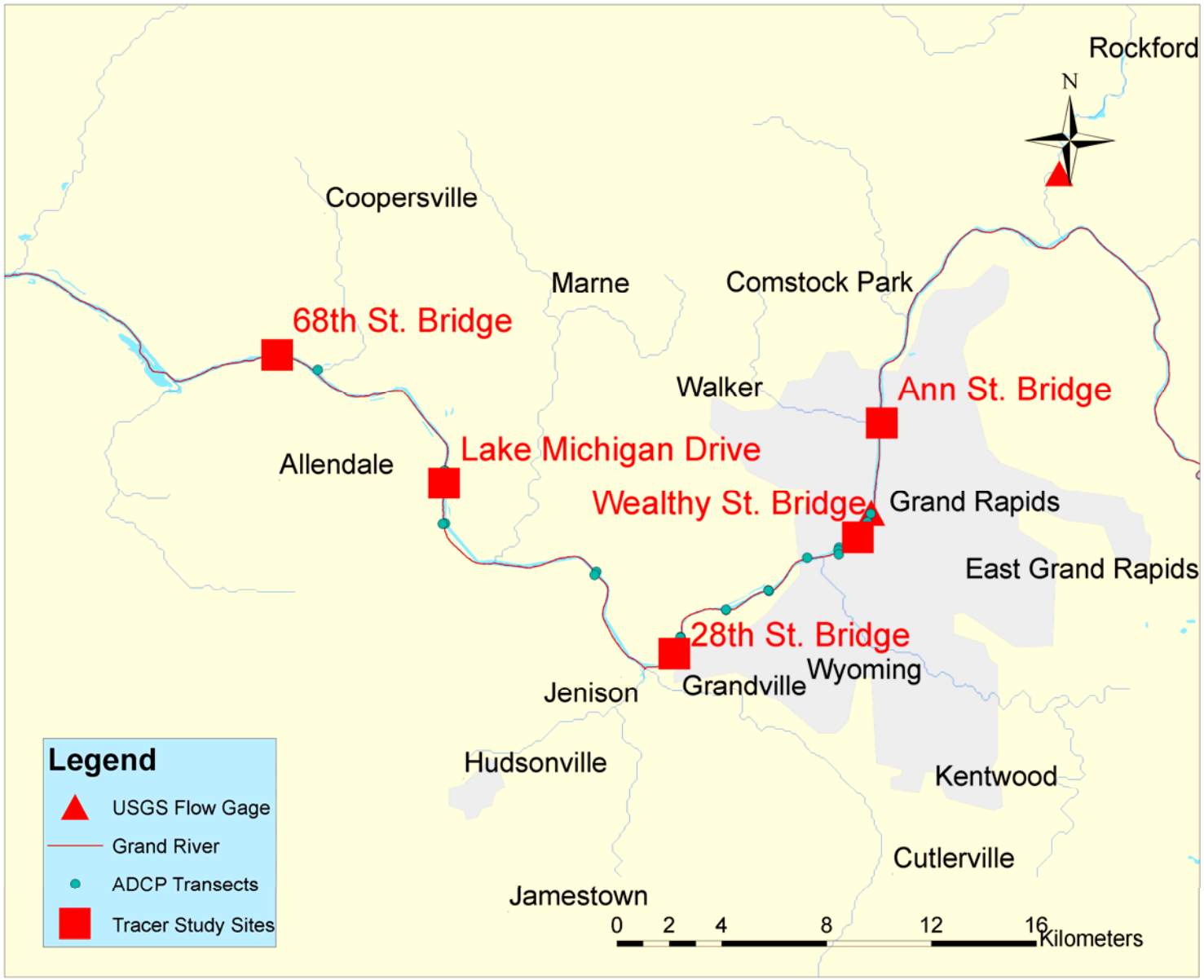
The *objectives* of this study…

1) Examine the occurrence of fecal bacterial indicators, E.coli, Enterococci, Clostridium and coliphage, as well as parasitic pathogens *Cyrptosporidium* and *Giardia* along the Grand River
2) Examine the relative levels of Bacterial fecal indicators and coliphage in sediments
3) Examine spatial changes in water quality
4) Evaluate the transport of contaminants in the river

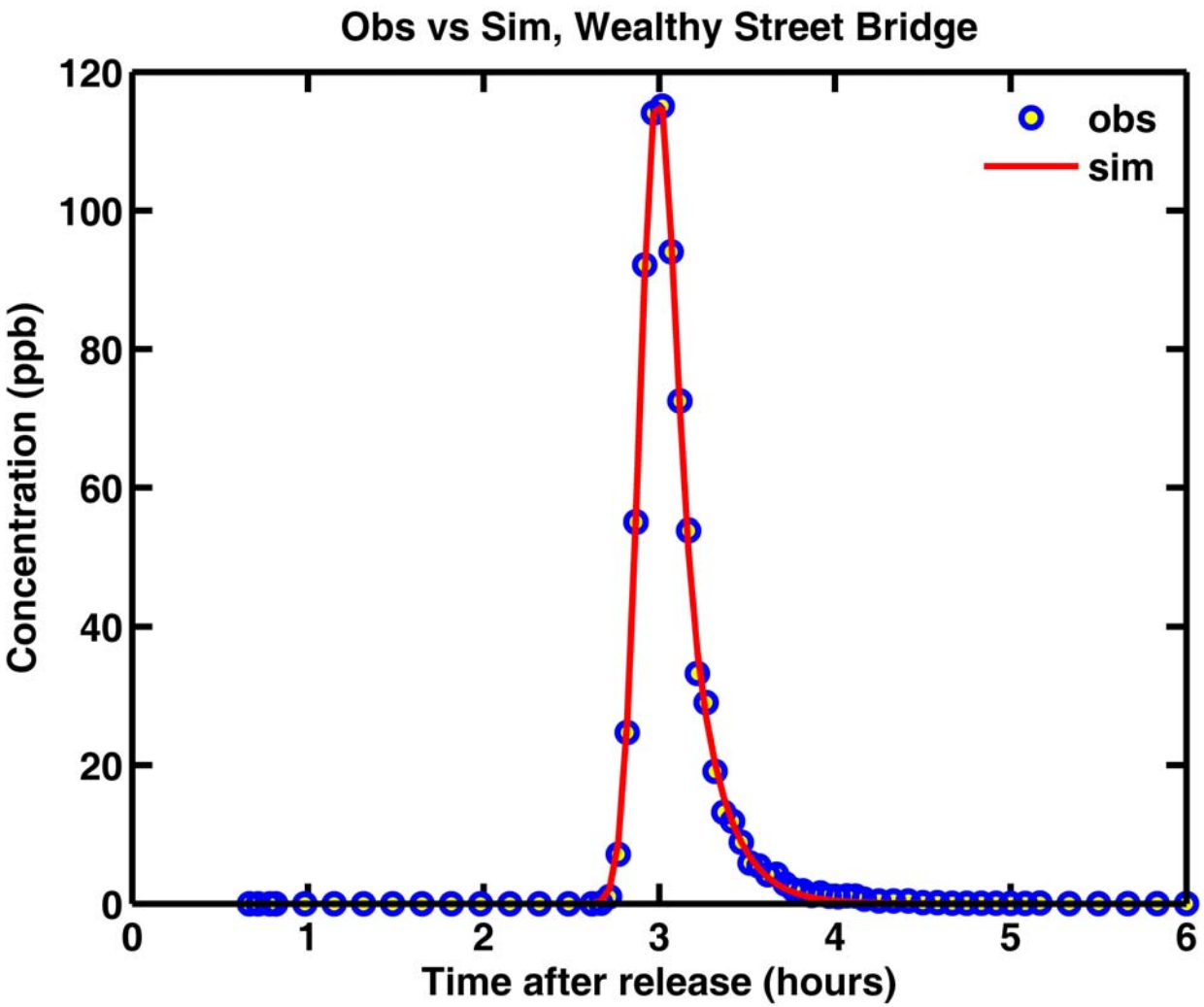
Study Site: The Grand River Watershed (II)



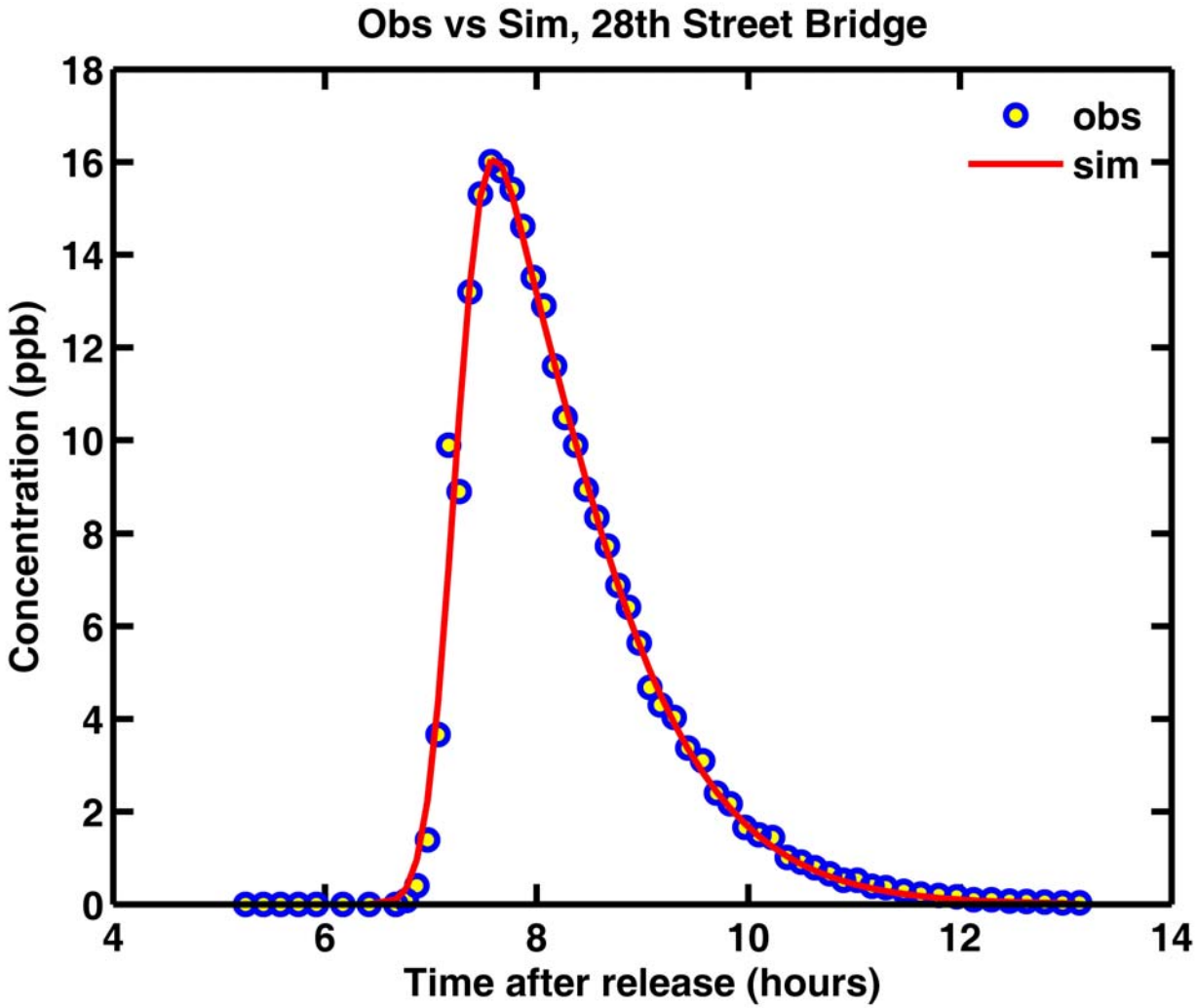
Study Reach


Rockford
N
Coopersville
Marne
Comstock Park
68th St. Bridge
Walker
Ann St. Bridge
Lake Michigan Drive
Allendale
Wealthy St. Bridge
Grand Rapids
East Grand Rapids
28th St. Bridge
Wyoming
Grandville
Jenison
Hudsonville
Kentwood
Cutlerville
Jamestown
Legend
USGS Flow Gage
Grand River
ADCP Transects
Tracer Study Sites
0 2 4 8 12 16
Kilometers

Observed vs Simulated Rhodamine First Site: Wealthy St. Bridge



Observed vs Simulated Rhodamine: Second Site: 28th St. Bridge



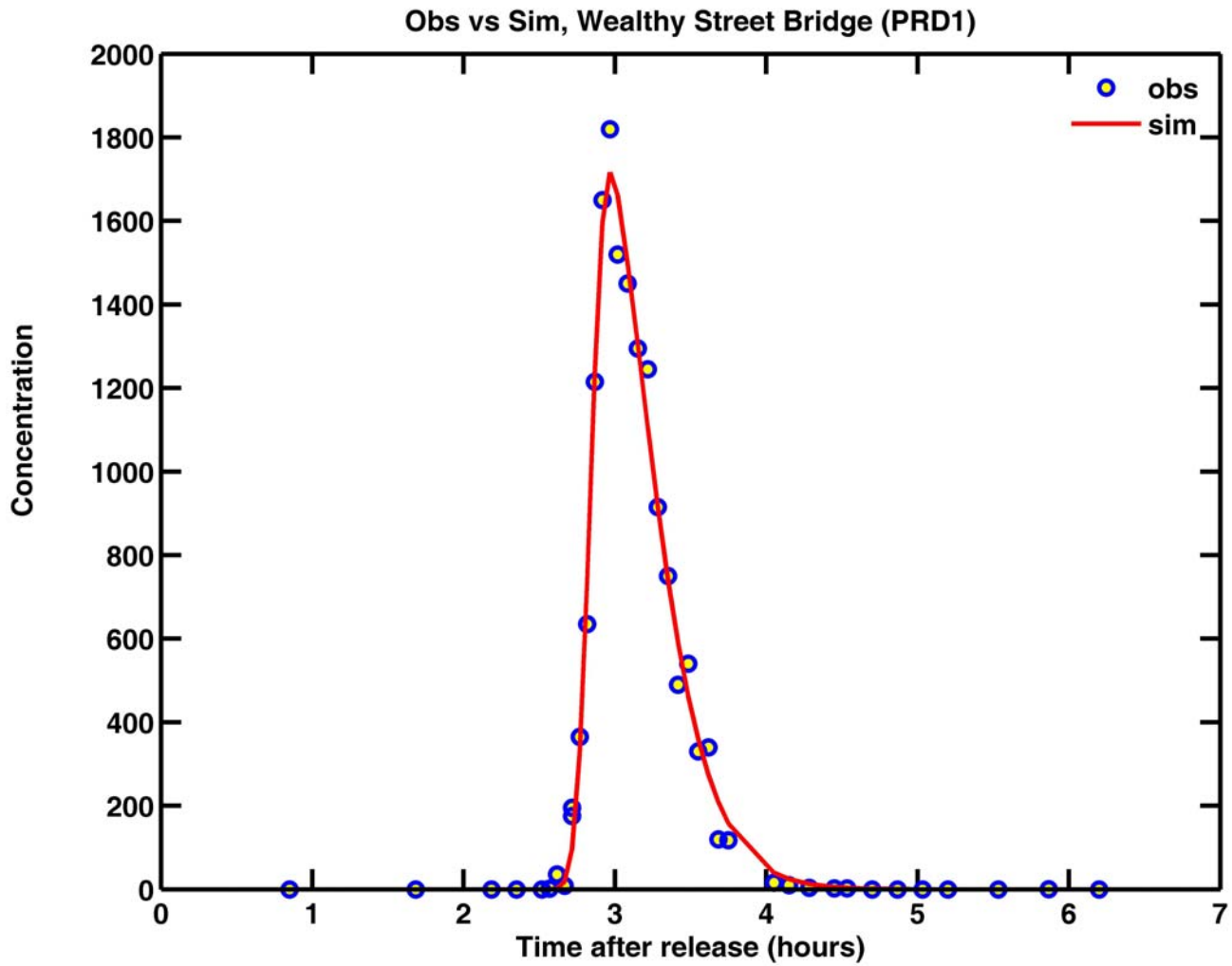
Observed vs. Simulated Rhodamine
Third Site: Lake Michigan Drive Bridge

- u=0.533052 m/s
- D=5.11896 m2/s
- St=2072.66 s
- Eps=0.145672

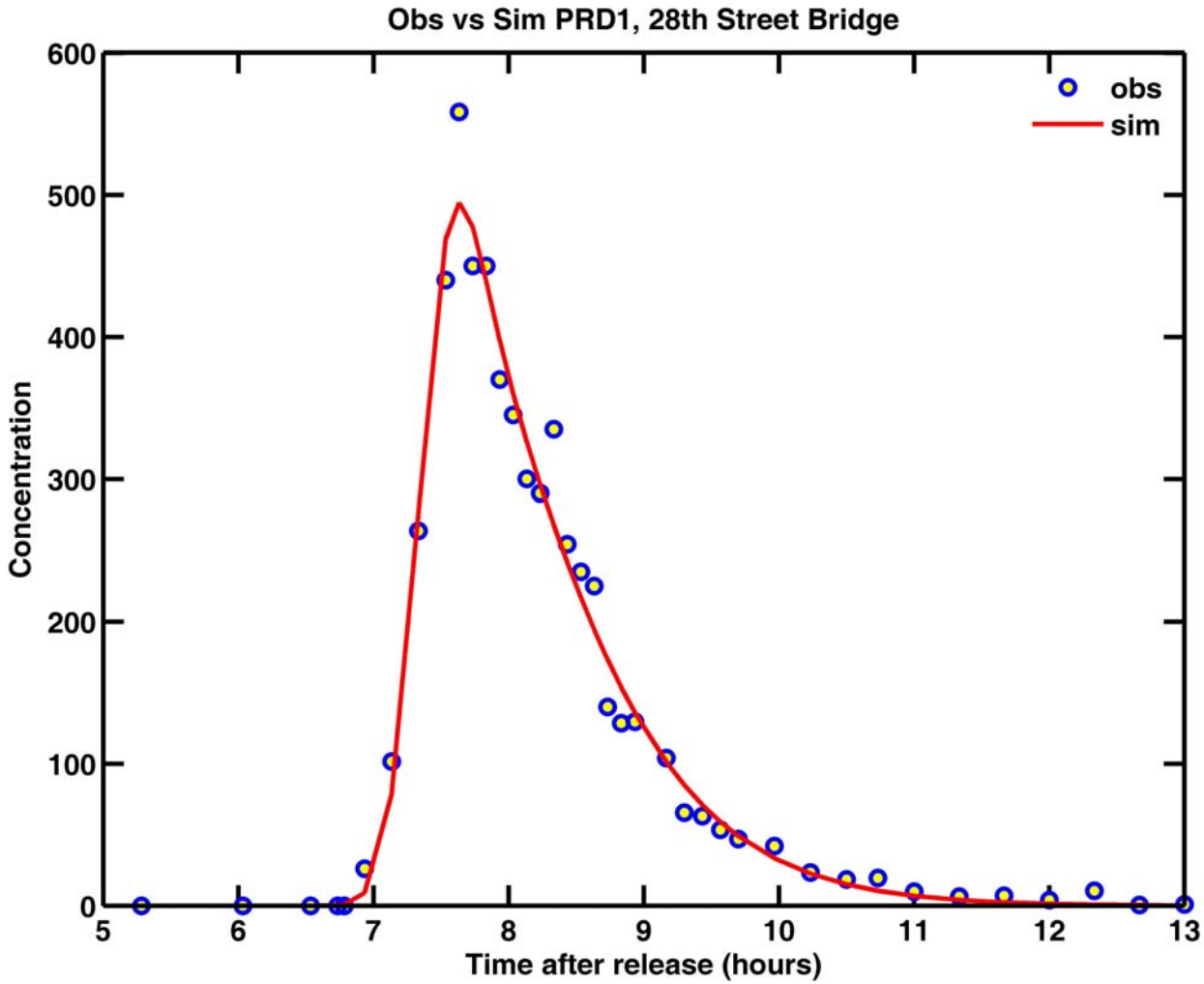
Observed vs Simulated Rhodamine: Fourth Site: 68th St. Bridge (SCUFA)

- u=0.529935 m/s
- D=1.01021 m2/s
- St=1772.61 s
- Eps=0.104519

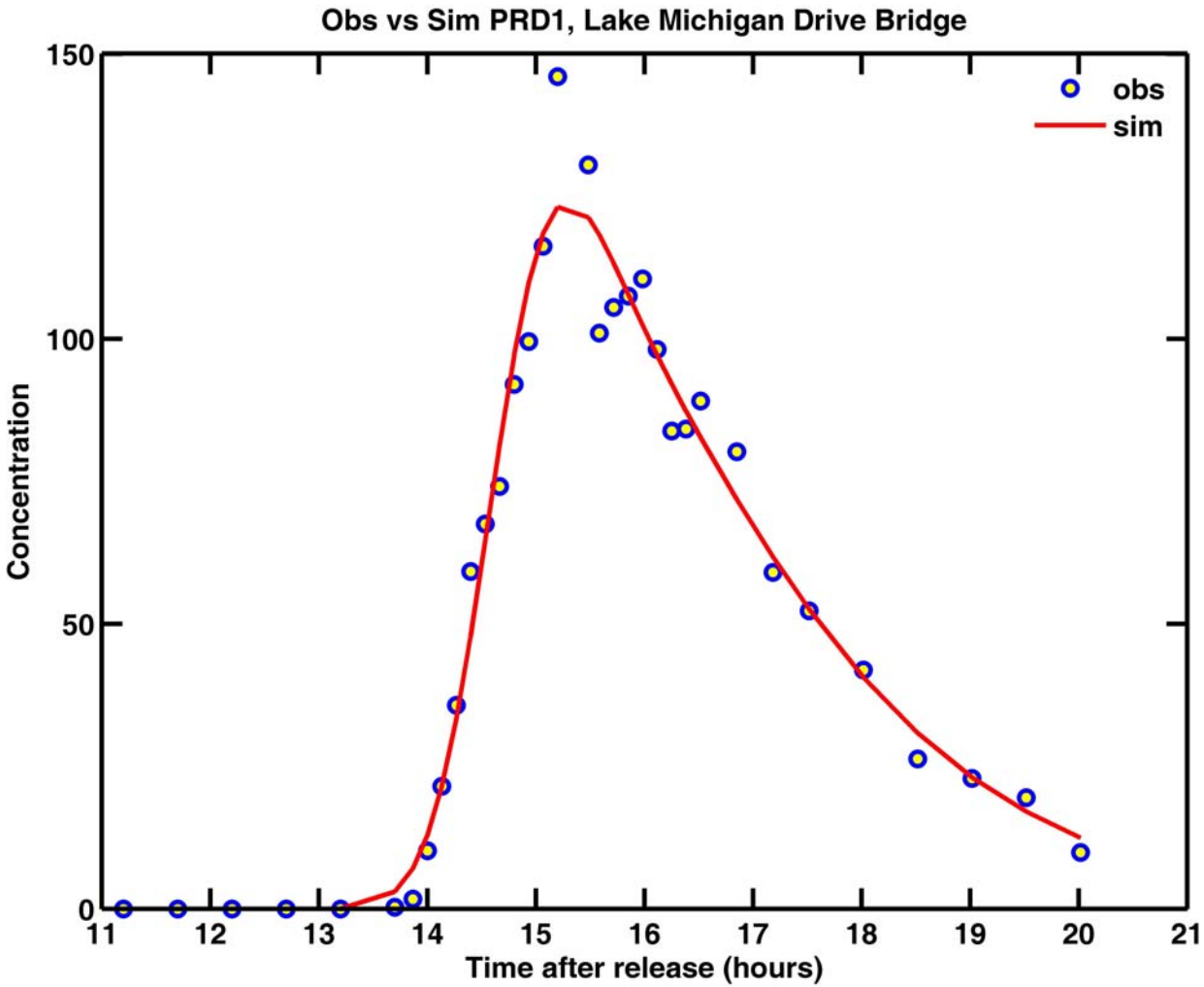
Observed vs Simulated (PRD1)
First Site: Wealthy St. Bridge



Observed vs Simulated (PRD1)
Second Site: 28th St. Bridge

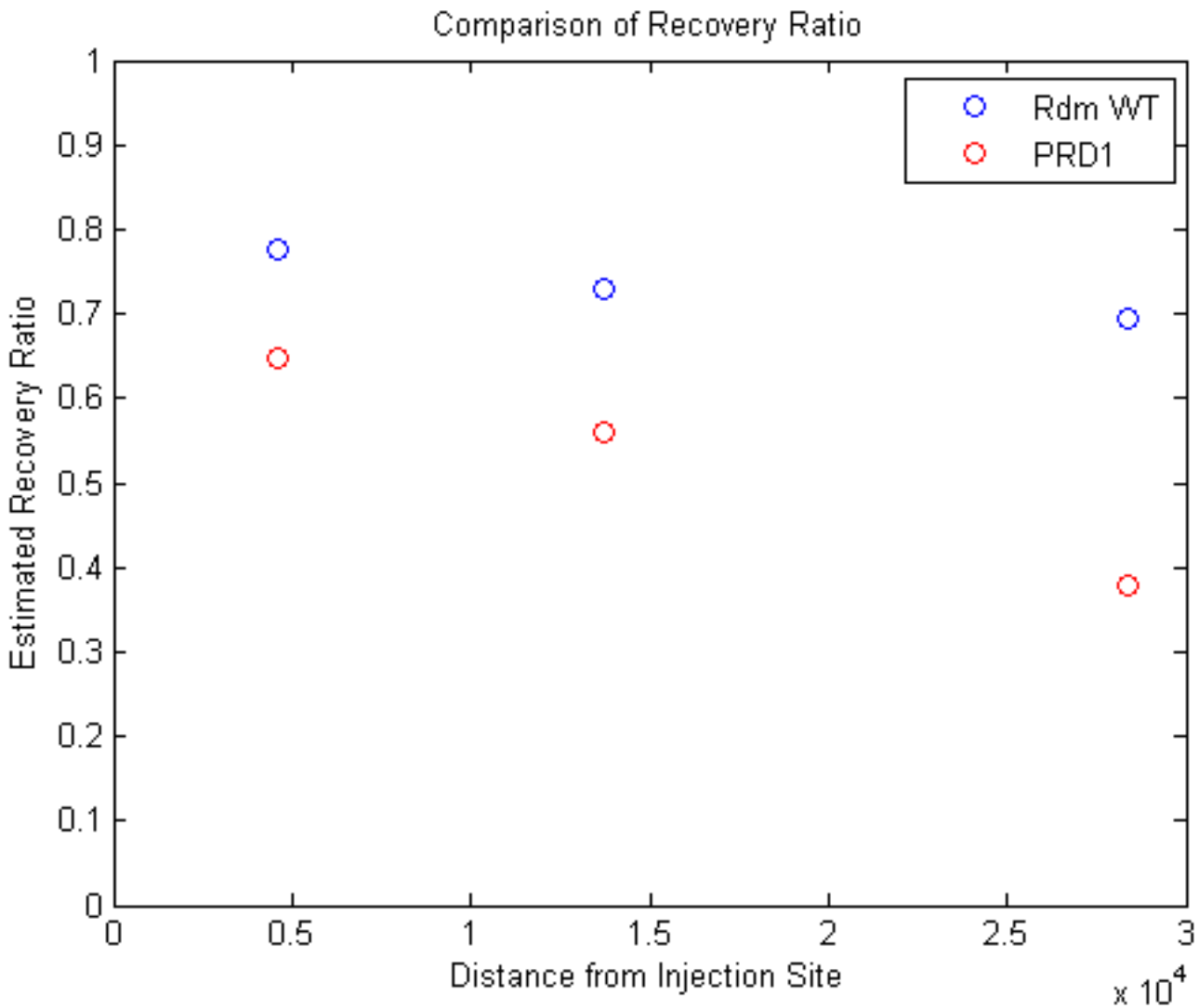


Observed vs Simulated (PRD1) Third Site: LM Drive Bridge



Rhodamine vs PRD1

- Recovery Ratio (Estimated from Average Breakthrough Curve)



Water Parameters

- Water Temperature:15.9 -18 °C
- pH: 8.5 and 9.0.
- Average daily stream-flow:3190 ft^3/s

Sampling stations	Distance from injection site (km)
Wealthy St. Bridge	4.54
28th St. Bridge	13.56
Lake Michigan Dr Bridge	27.88

Results

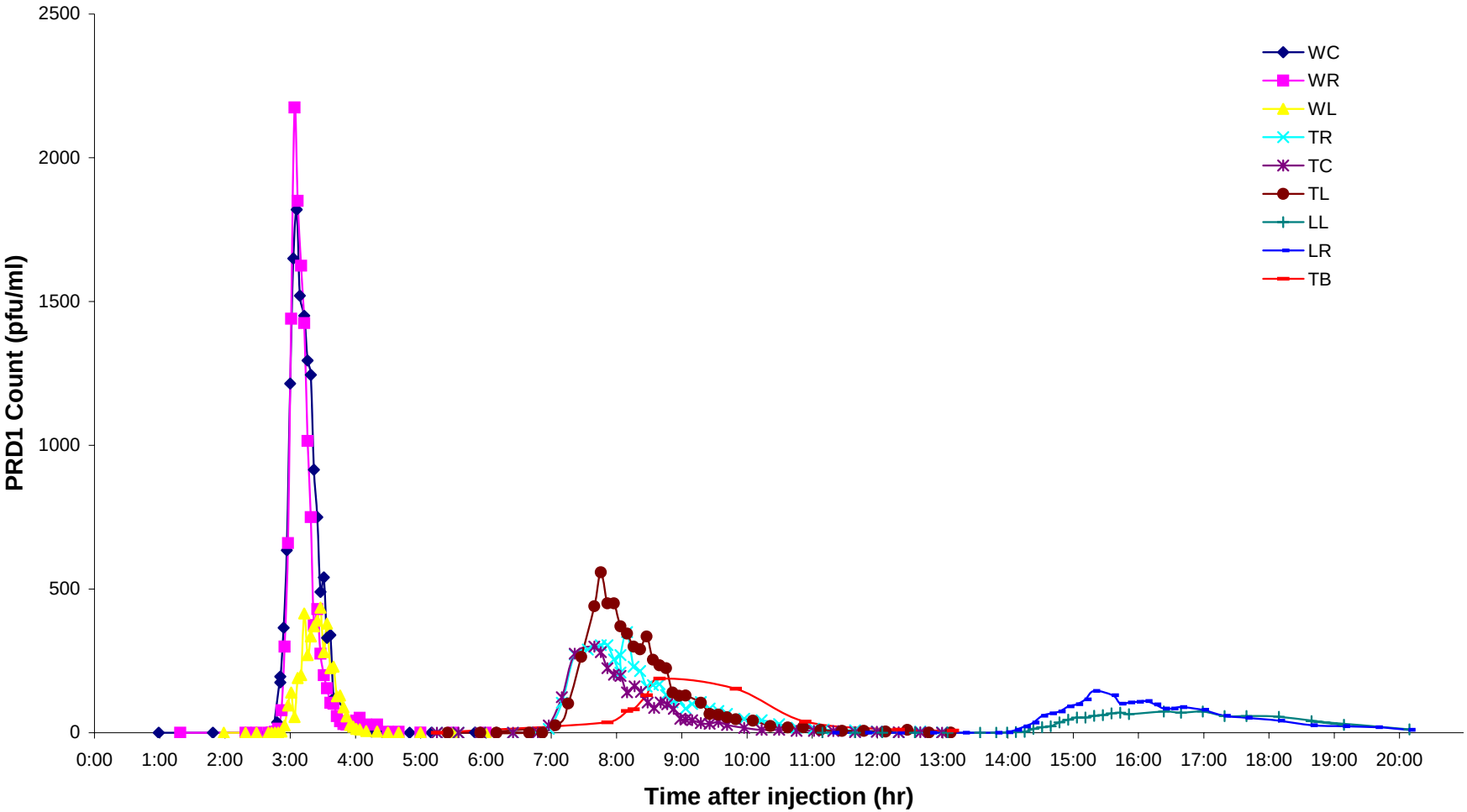
PRD1

- Average reduction per km: 3.97%
- Travel distance per hour: 0.50 km/hr

Rhodamine

- Average reduction per km: 3.73%
- Travel distance per hour: 0.49 km/hr

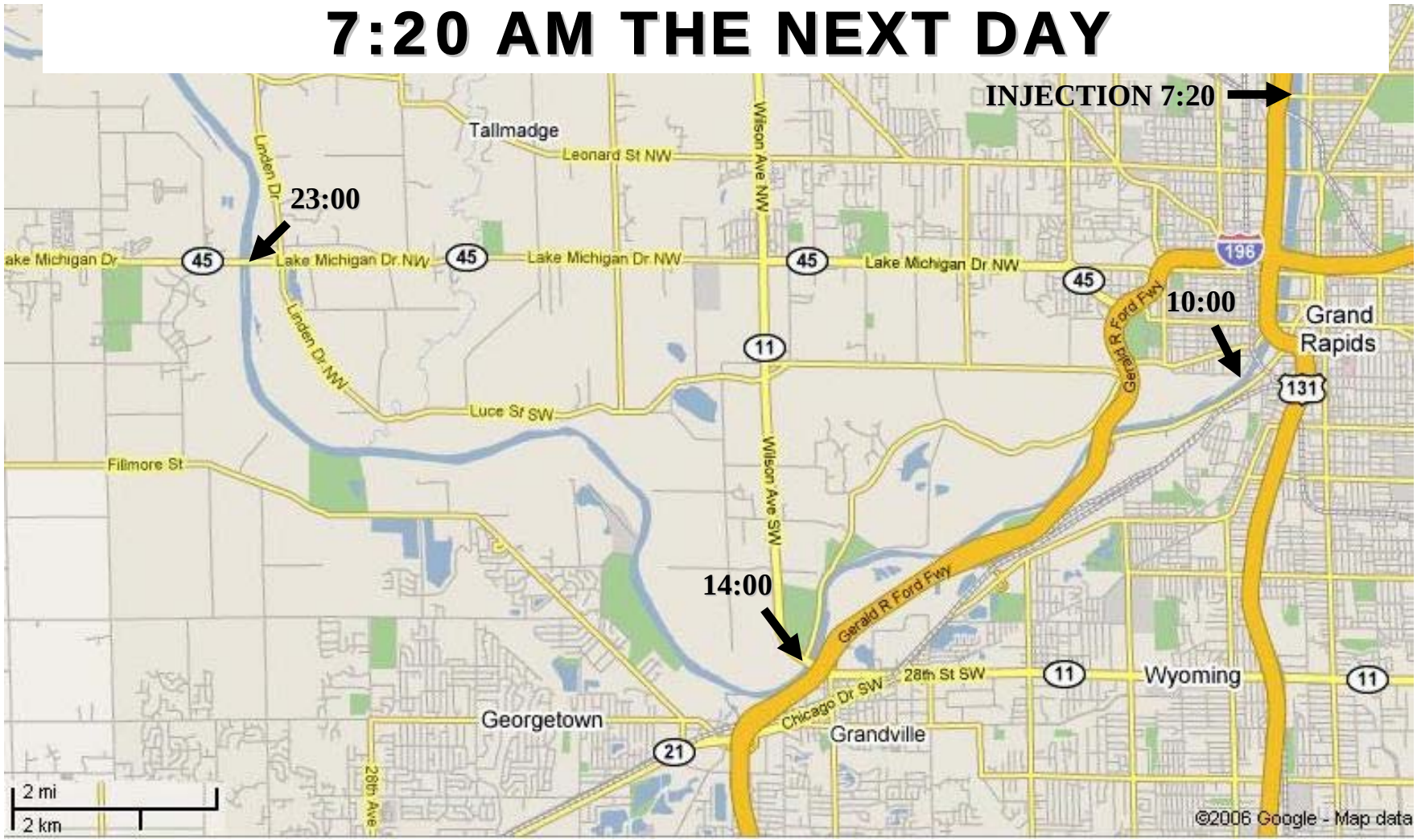
PRD-1


PRD1 Count (pfu/ml)
2500
2000
1500
1000
500
0
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00
19:00
20:00
Time after injection (hr)
WC
WR
WL
TR
TC
TL
LL
LR
TB

Arrival Time at Each Site

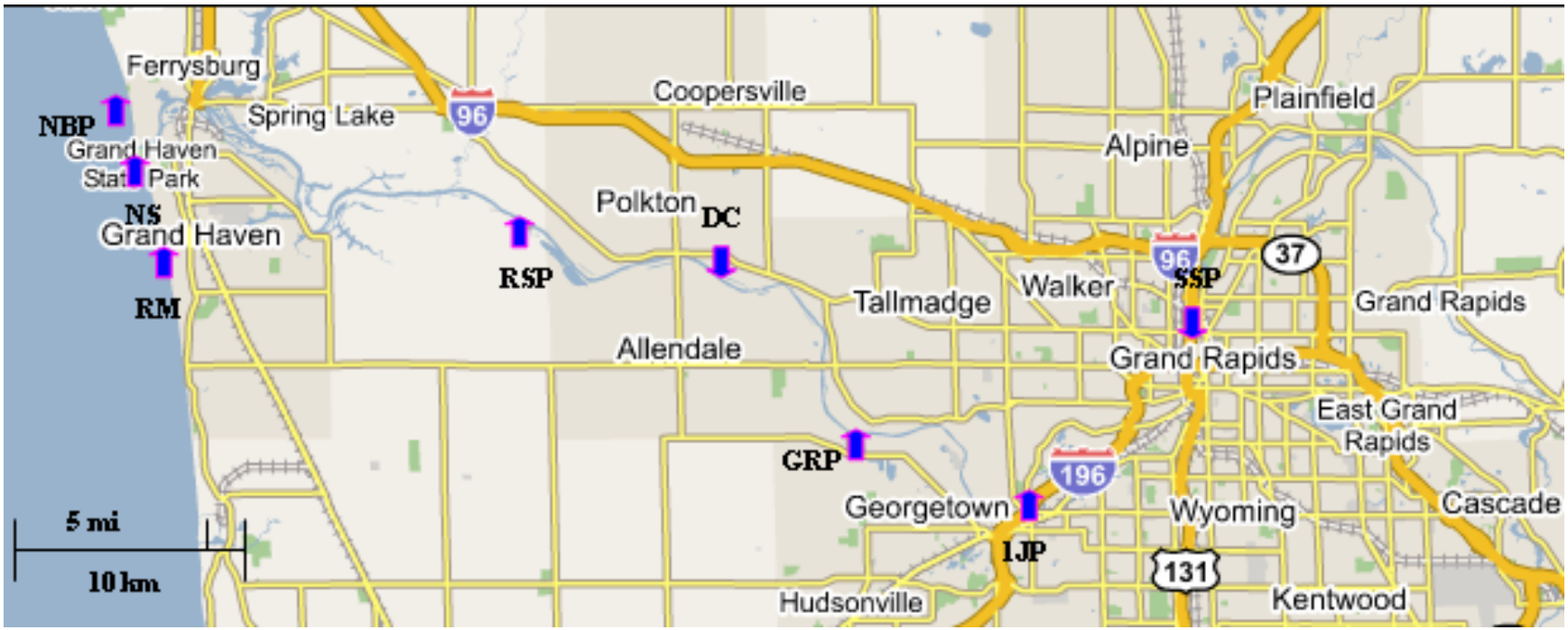
ESTIMATED ARRIVAL AT LK MICHIGAN

7:20 AM THE NEXT DAY

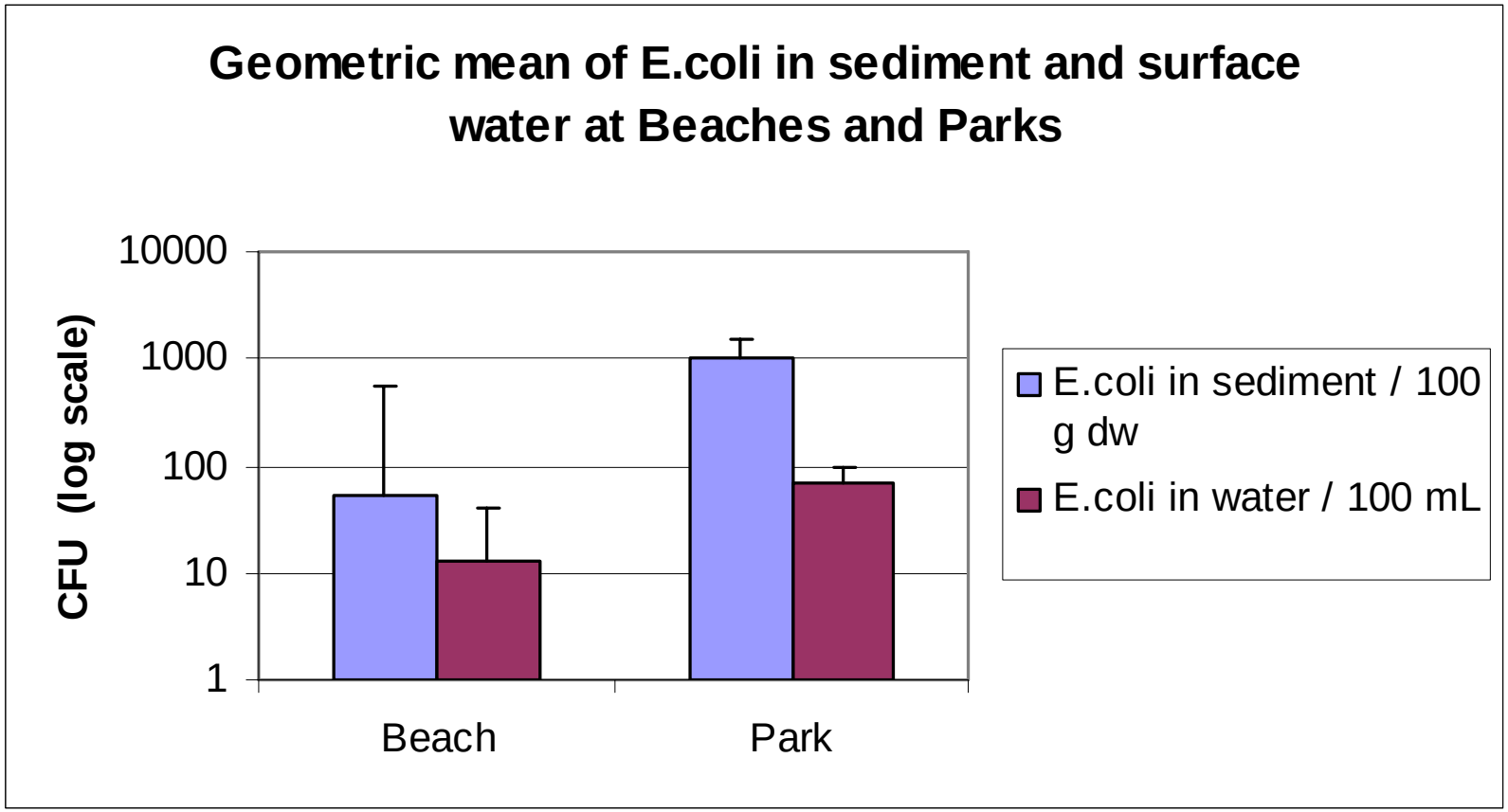


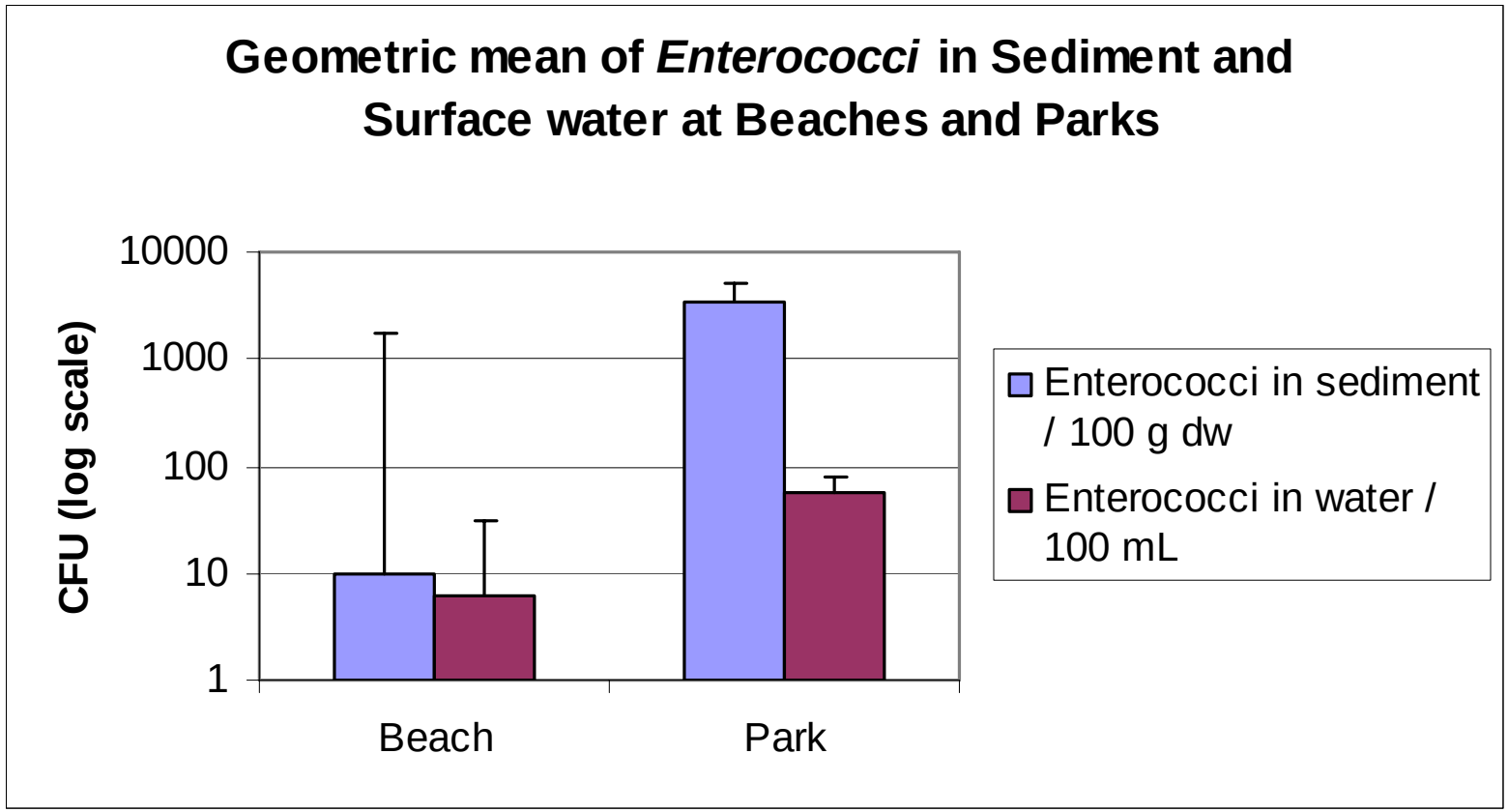
Conclusions

- Model was able to predict the observed Rhodamine and PRD1 concentrations well.
- Rhodamine recovery factors are comparable to the numbers from other similar studies in the US and around the world
- Comparison of recovery factors shows that PRD1 undergoes additional losses (sorption, inactivation)

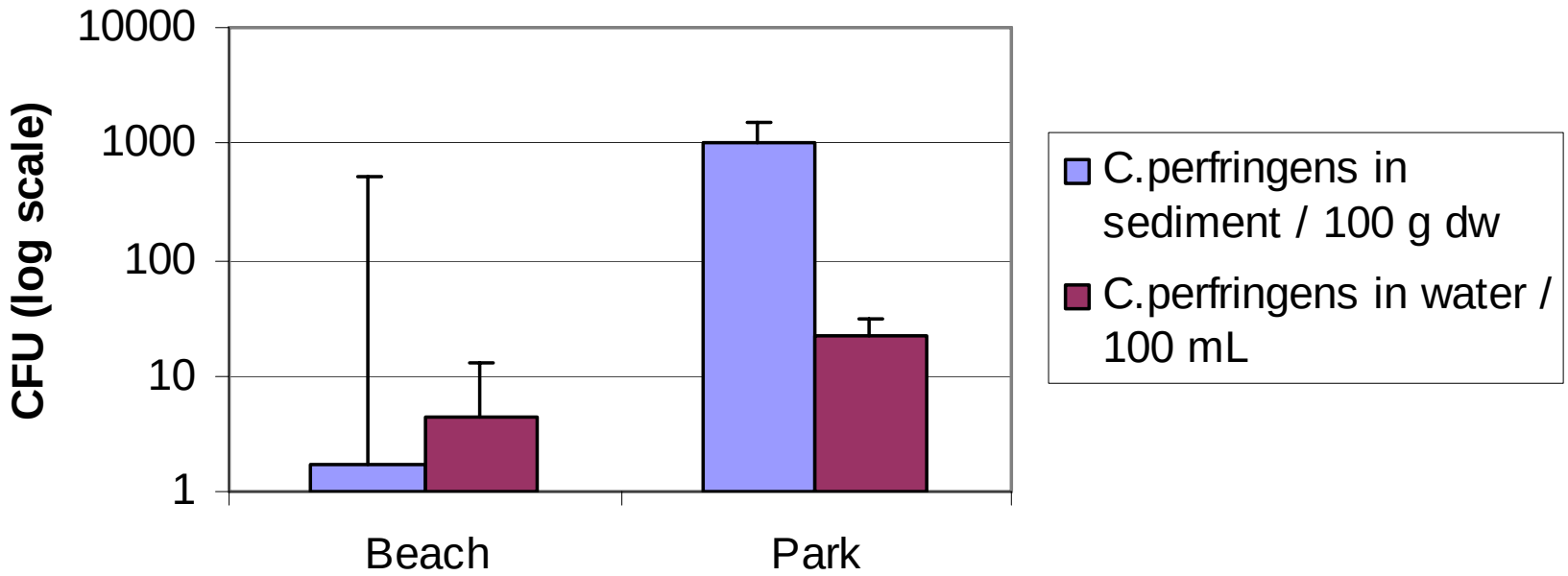


Sites sampled 1/week June to Sept and 1/month from Oct. to Dec.

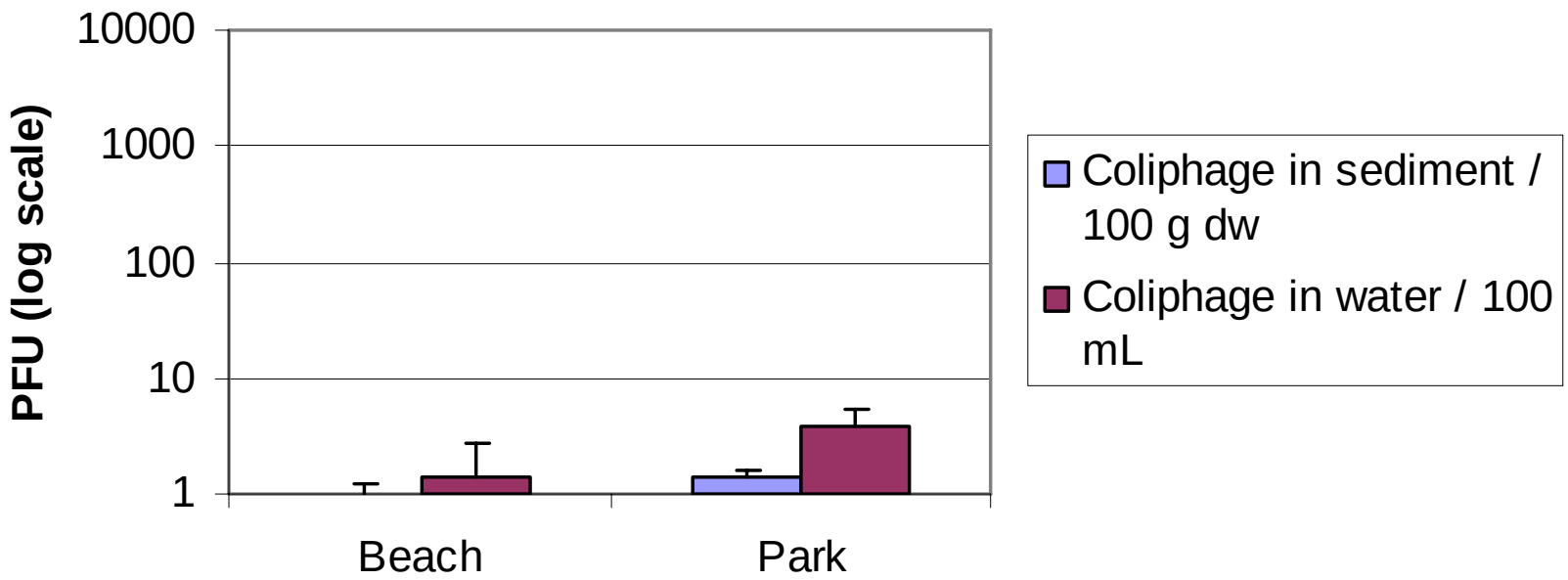

Geometric mean of E.coli in sediment and surface water at Beaches and Parks
CFU (log scale)
10000
1000
100
10
1
Beach
Park
E.coli in sediment / 100 g dw
E.coli in water / 100 mL

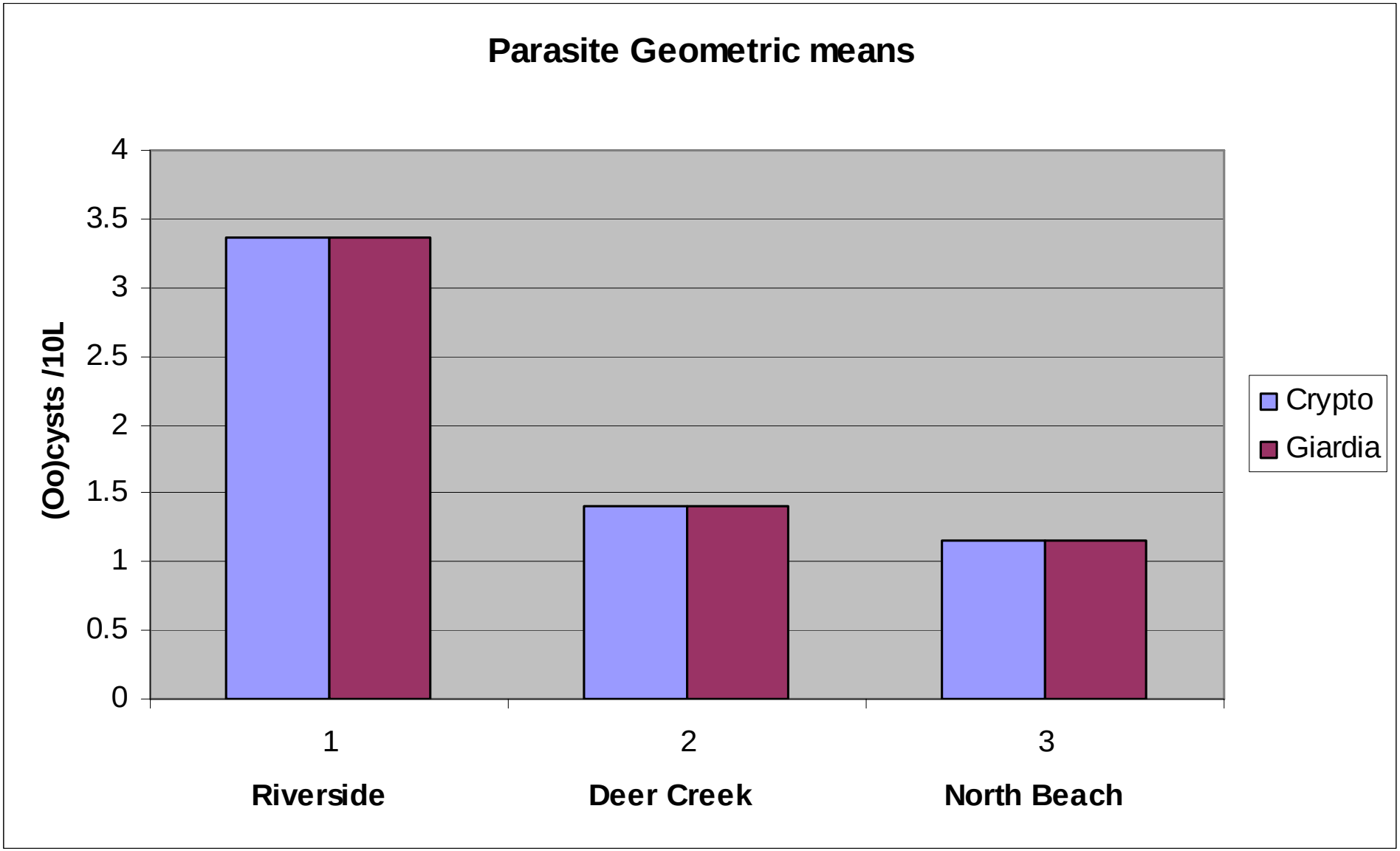

Geometric mean of *Enterococci* in Sediment and Surface water at Beaches and Parks
CFU (log scale)
10000
1000
100
10
1
Beach
Park
Enterococci in sediment / 100 g dw
Enterococci in water / 100 mL

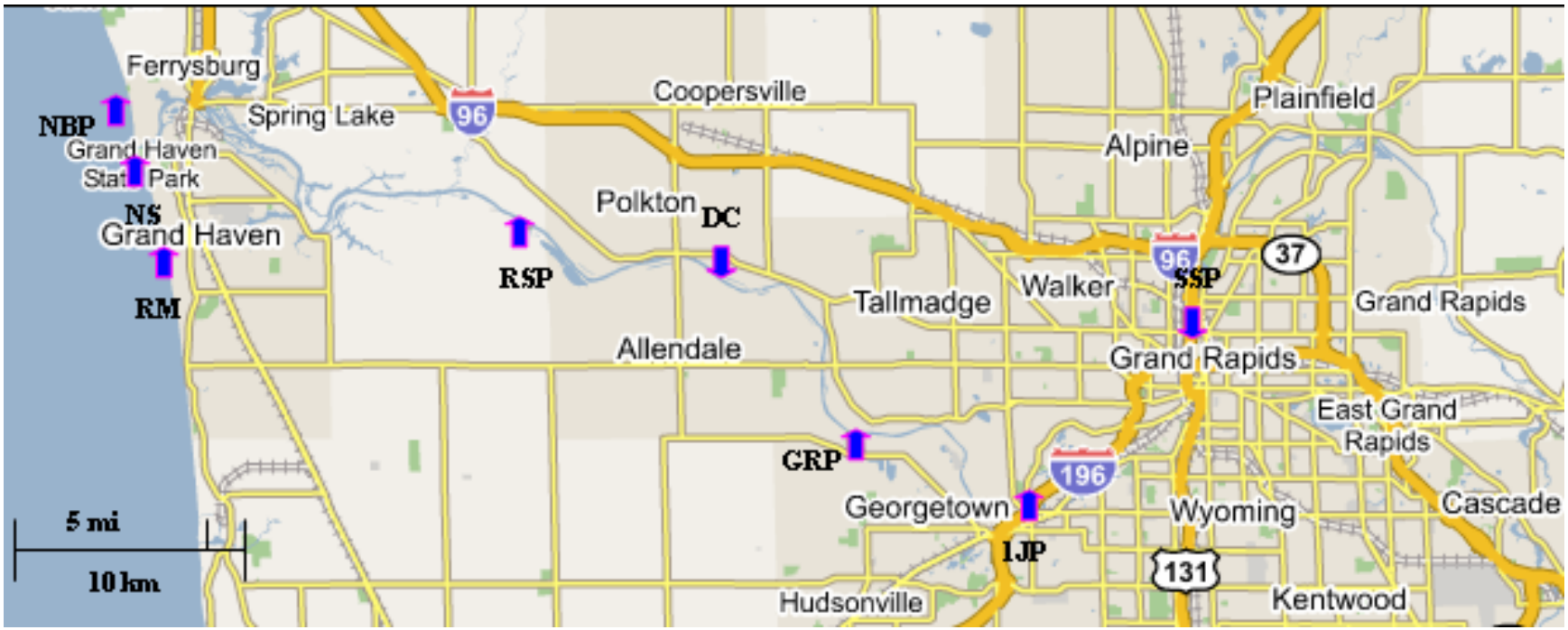
Geometric mean of *C.perfringens* in sediment and surface water at Beaches and Parks



Geometric mean of Coliphage in sediment and surface water at Beaches and Parks

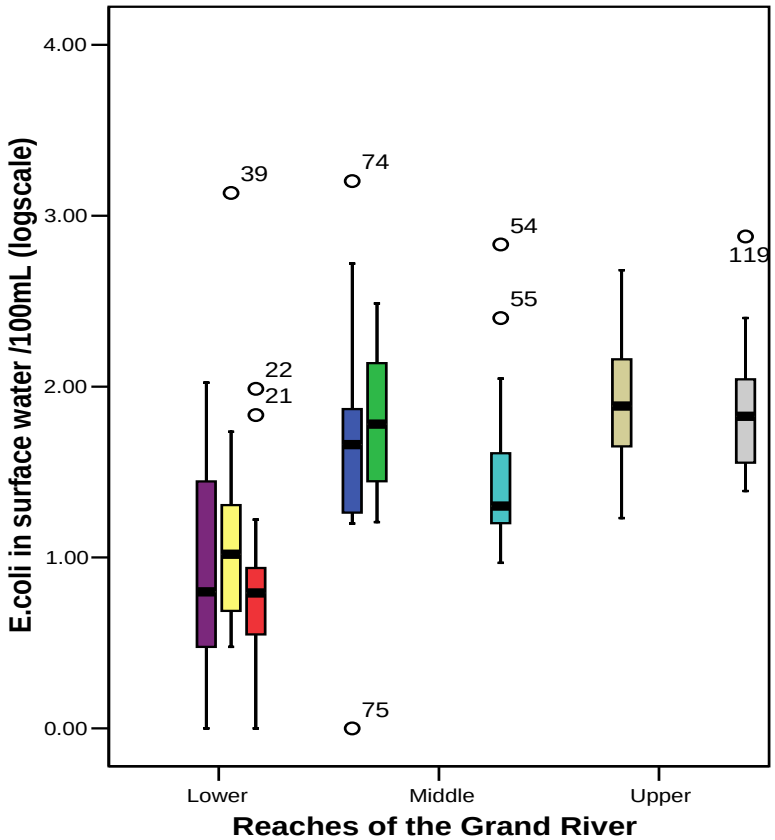



Parasite Geometric means
(Oo)cysts /10L
4
3.5
3
2.5
2
1.5
1
0.5
0
1
2
3
Riverside
Deer Creek
North Beach
Crypto
Giardia

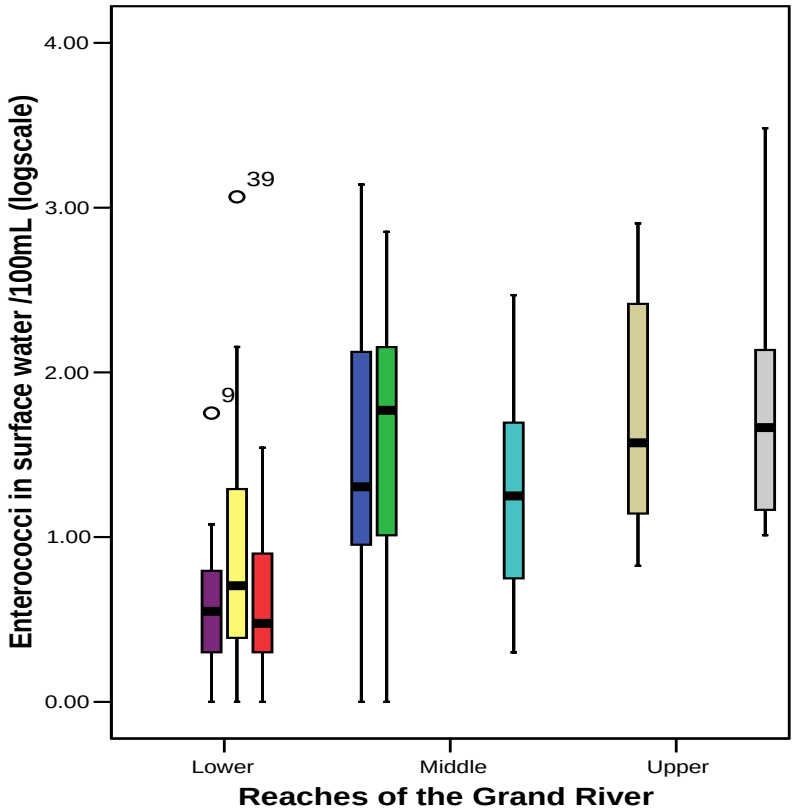


Sites sampled 1/week June to Sept and 1/month from Oct. to Dec.

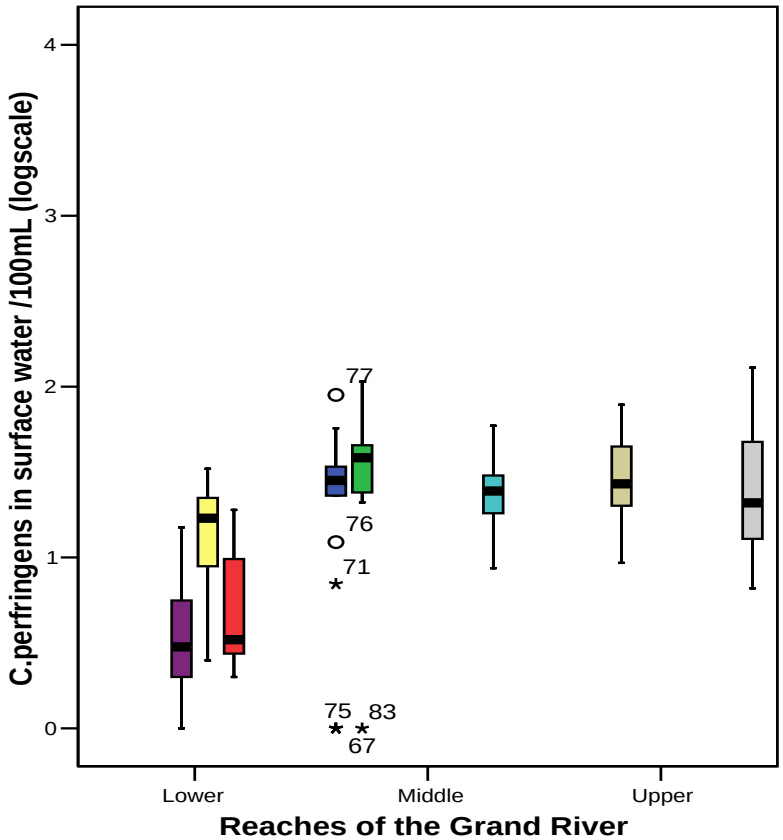
E. coli



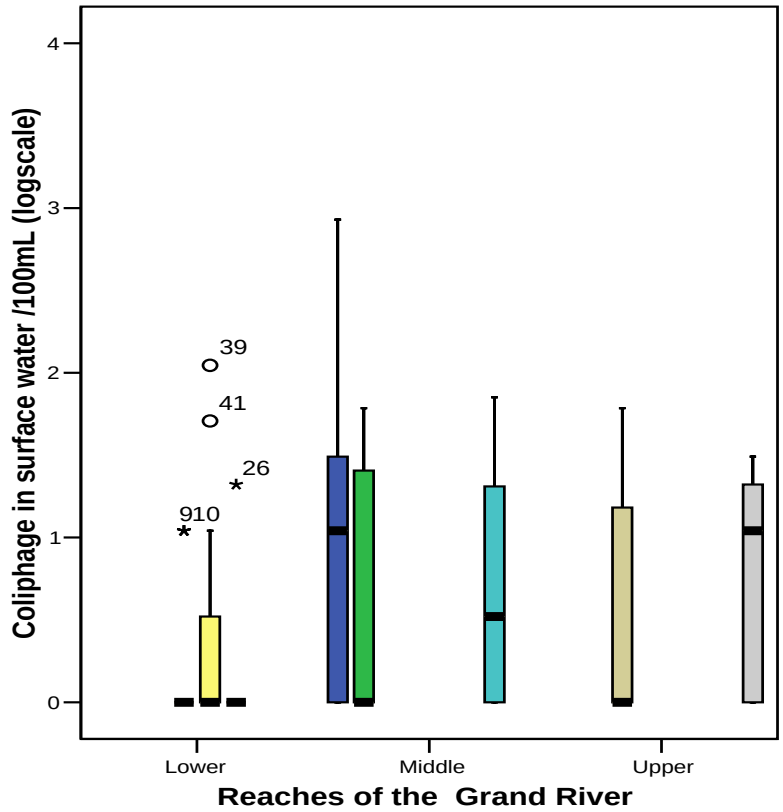
Enterococci



Clostridium perfringens



Coliphage



Indicator Violations in the River for full body contact

- 26.6 % samples exceeded the US EPA *Enterococci* criterion
- 9.4 % samples exceeded US EPA criterion for *E.coli*
- 5.5 % samples exceeded Michigan standard for *E.coli*
- 10.2% samples exceeded the Hawaii fresh water criteria for *C. perfringens*

Summary

- Sediments are a likely source of bacteria.
- There is a dilution effect downstream.
- There is an accumulation or increase at Deer Creek and Riverside Park.
- There is slightly greater impact at the North Shore.
- Enterococci could be used as another bacteria for issuing beach advisories.
- Coliphage and *Clostridium* can be used and they indicate lower risk from the sand and at the beach.
- Parasites show a small risk at the beach.

Future Protection of Public Health

- The transport modeling can now be used to advise the public at the beach after spills, large rain events that carry sediments and/or CSOs.
- Food and drink should be separated from wet & play areas and the hands should be sanitized after playing in the sand.
- Continue to examine the hot spots including Deer Creek and River Side Park.
- Use the sewage markers for enterococci and examine the viability of *Cryptosporidium* in the river.
- Explore ways to handle the contaminated sediments.
- Continue to Improve infrastructure.