Quantitative Microbial Risk Assessment (QMRA)

Why Health Risk Models (like QMRA)?

- Human health risk models are not new
- Risk models are much cheaper than epidemiology studies
- But nobody has used one for regulating body contact regulation

Three Basic Steps to a QMRA

- Source identification
- Pathogen loading
- Dose-response modeling
- [translating results into site-specific water quality criteria]

SCCWRP Has Conducted Three QMRAs

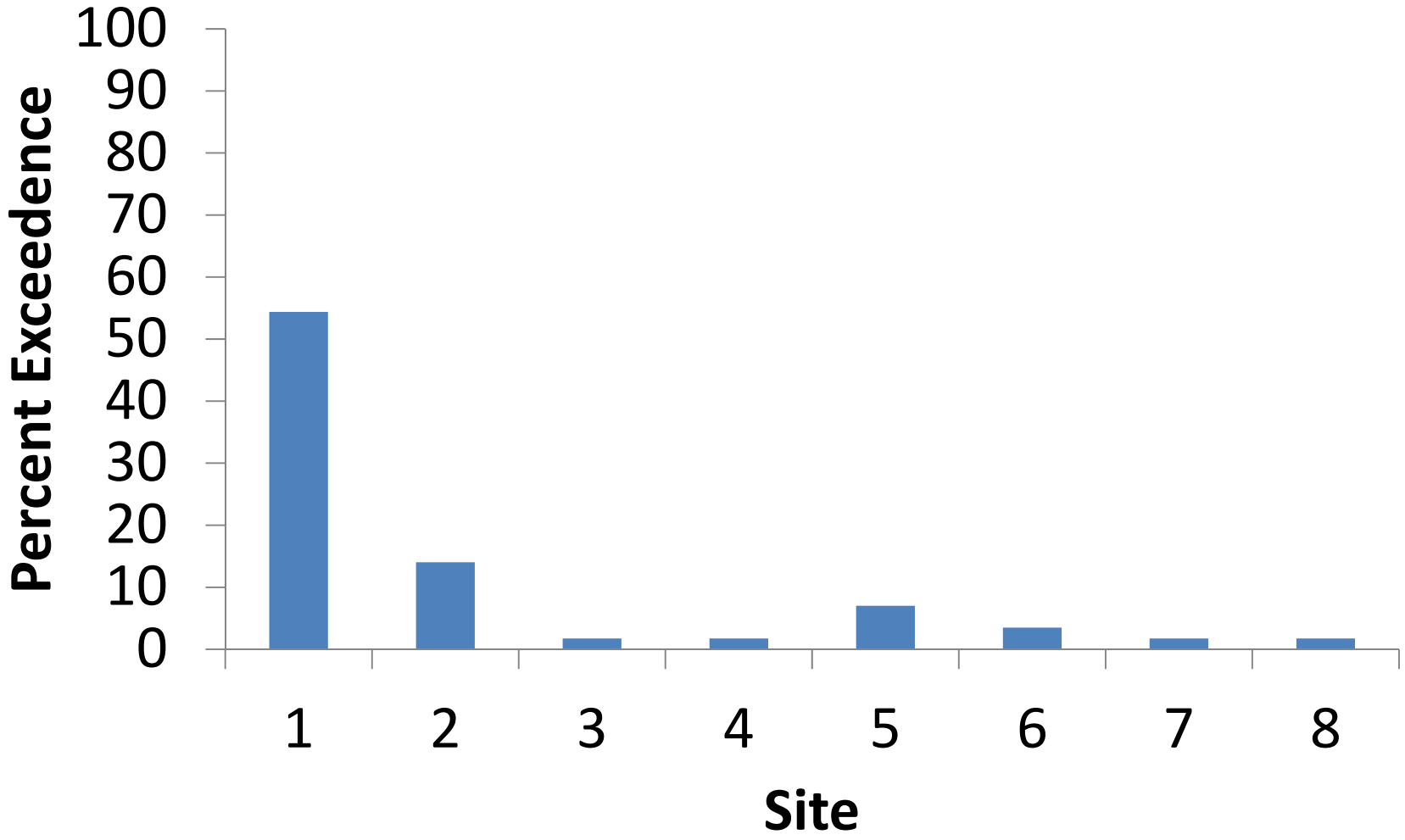
- Hobie/Kiddie Beaches, Ventura Harbor
  - Stopped at source identification
- Inner Cabrillo Beach, Los Angeles Harbor
  - Stopped at source identification
- Ocean/Tourmaline Beaches, San Diego
  - QMRA model being used in regulatory decision making right now

Phased Source Identification Approach Works Best

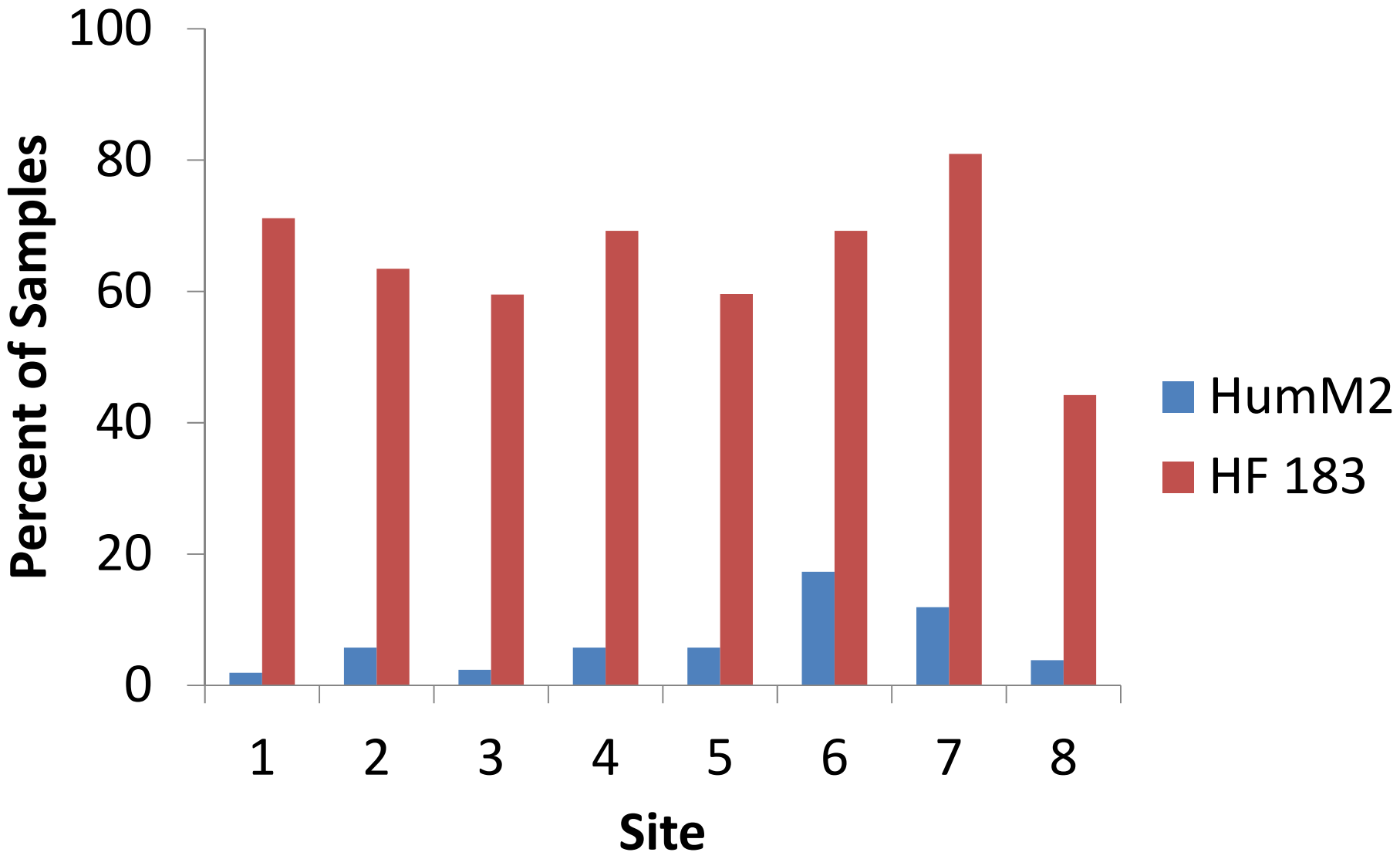
- Mine historical data, reconnaissance
- Intensive beach sampling for indicator bacteria
  - Gradients give clues to potential sources
- More expensive sampling and/or analysis for confirmation
  - Genetic source markers
  - Circulation, fate & transport studies

Ventura Harbor Source Tracking

Enterococcus
Frequency of Exceedence



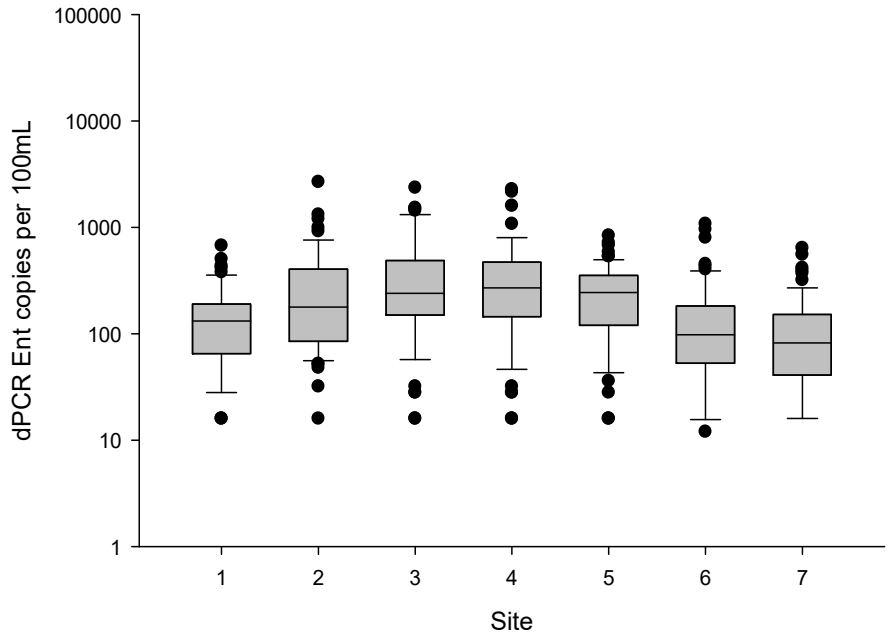
Presence of Human qPCR markers



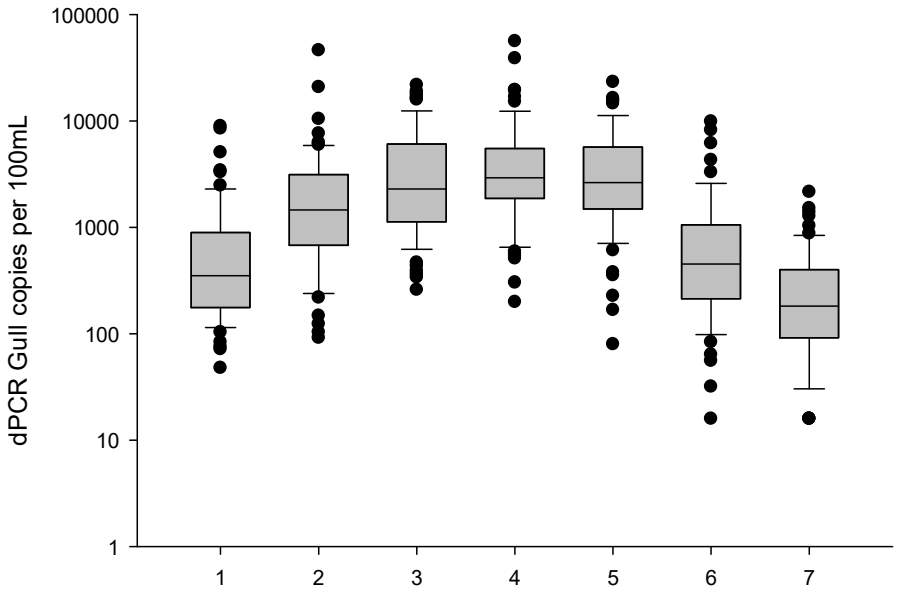
Inner Cabrillo Beach Source Tracking

Source Tracking Results: Inner Cabrillo Beach (Summer 2016)

Enterococcus



Gull Marker



Human Marker

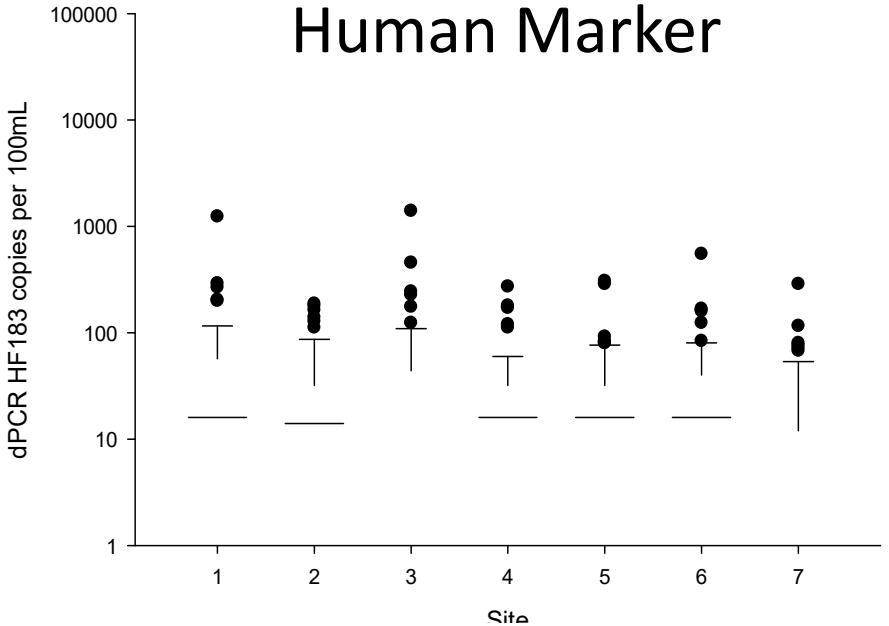
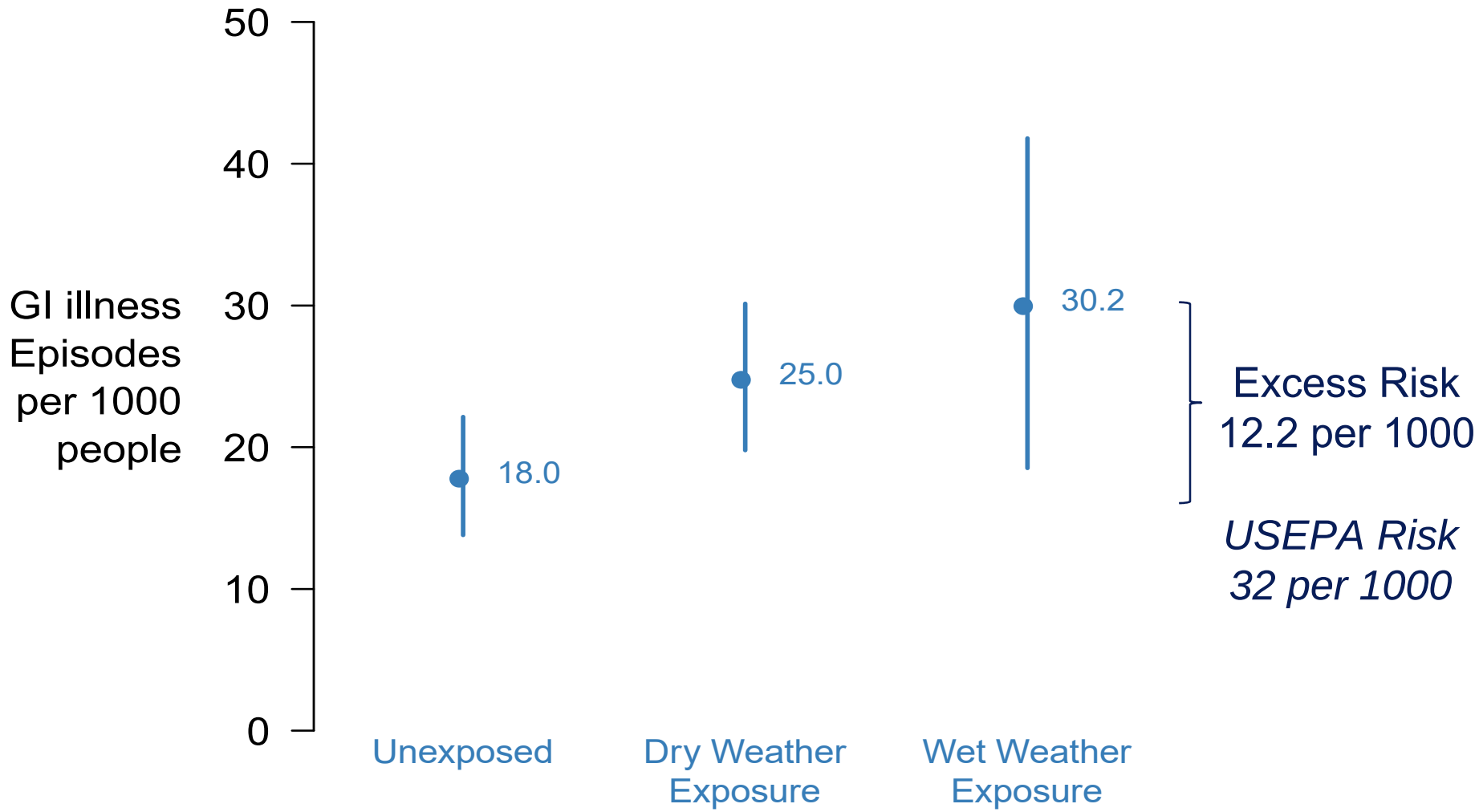


Photo: Paul Fisher / Surfline.com

Surfer Health Study: Empirical and Model

- Epidemiology study collects water quality AND health effects data
  - Wet weather, >10,000 surf exposures, 12 symptoms
- Measured estimate of risk ground-truths model estimates
- Source identification focused on the wet weather discharge

Cumulative Incidence of Gastrointestinal Illness



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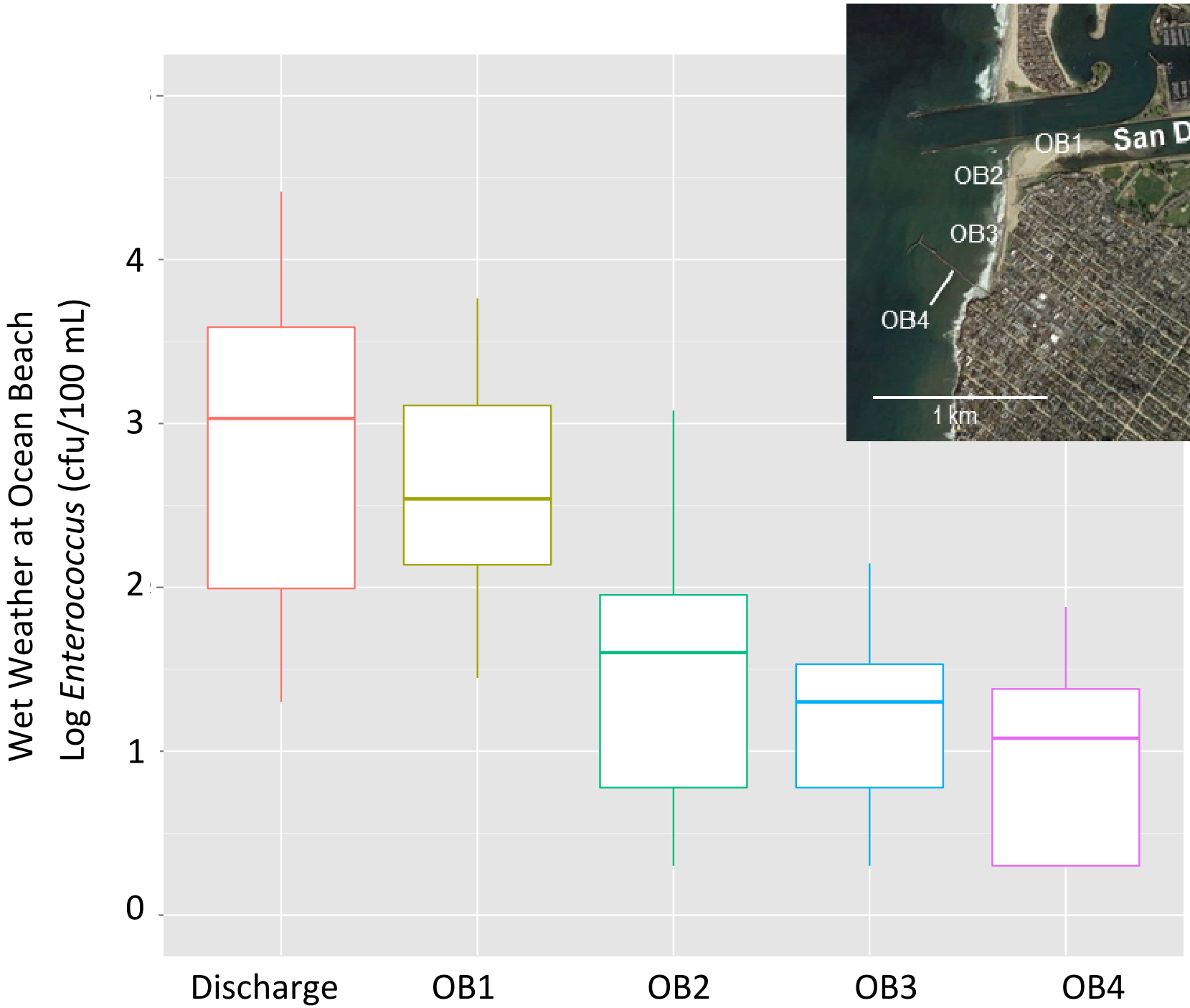

Wet Weather at Ocean Beach
Log Enterococcus (cfu/100 mL)
0
1
2
3
4
Discharge
OB1
OB2
OB3
OB4
N
OBDIS
San Diego River
OB1
OB2
OB3
OB4
1 km

Wet Weather Discharge Pathogen Loading: Detection Frequency for Pathogens and Human Markers

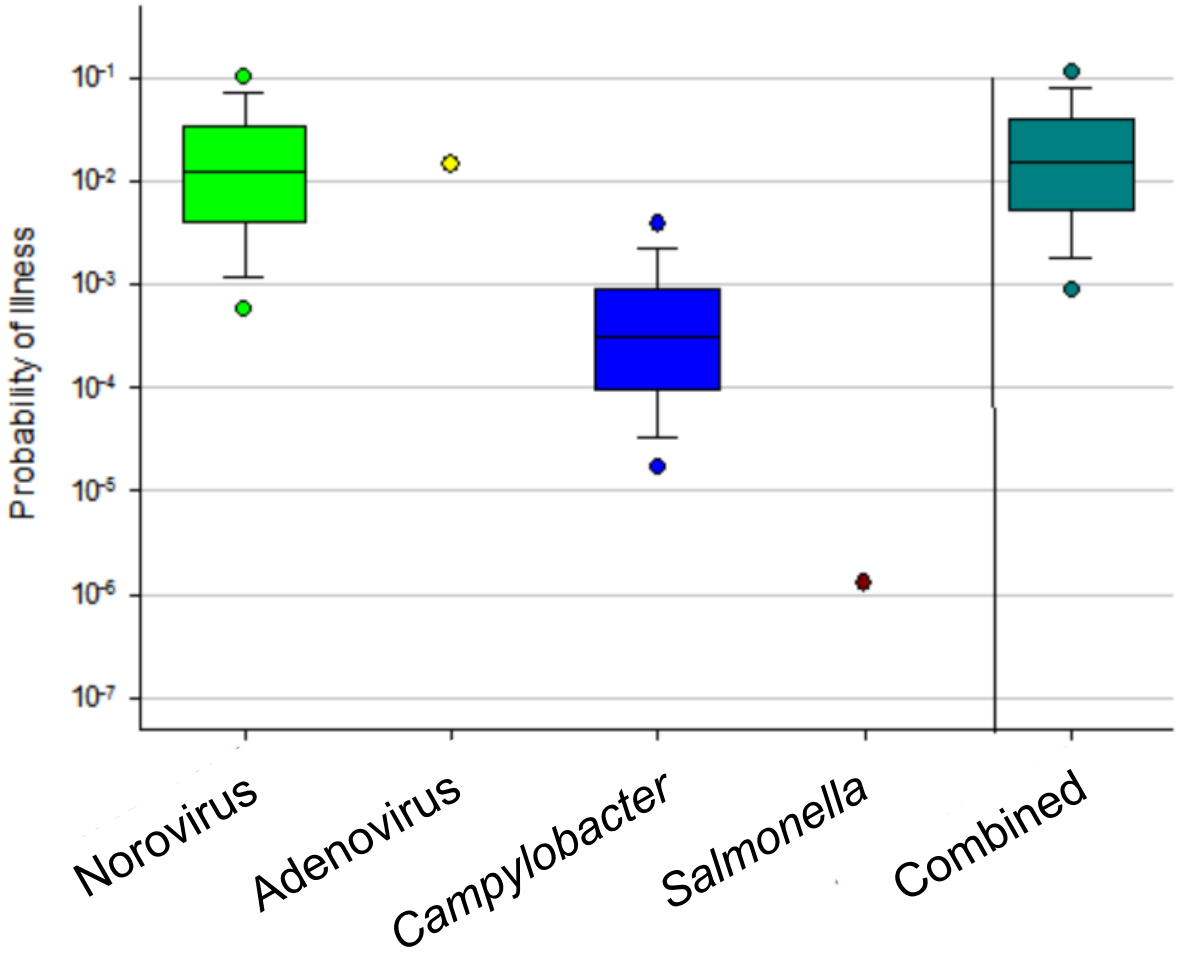
	Noro-virus	Adeno-virus	Entero-virus	*Campylo-bacter*	*Salmo-nella*	Human Marker (HF183)
San Diego River	96%	22%	0%	100%	25%	86%
Tourmaline Creek	72%	9%	0%	45%	9.5%	95%

Dose-Response Modeling Factors

- Pathogen concentration
  - Dilution
- Volume of water ingested*
- Relationship between number of pathogens ingested and probability of infection*
- Number of infections that result in illness*

* Literature values

QMRA Results: Probability of GI Illness



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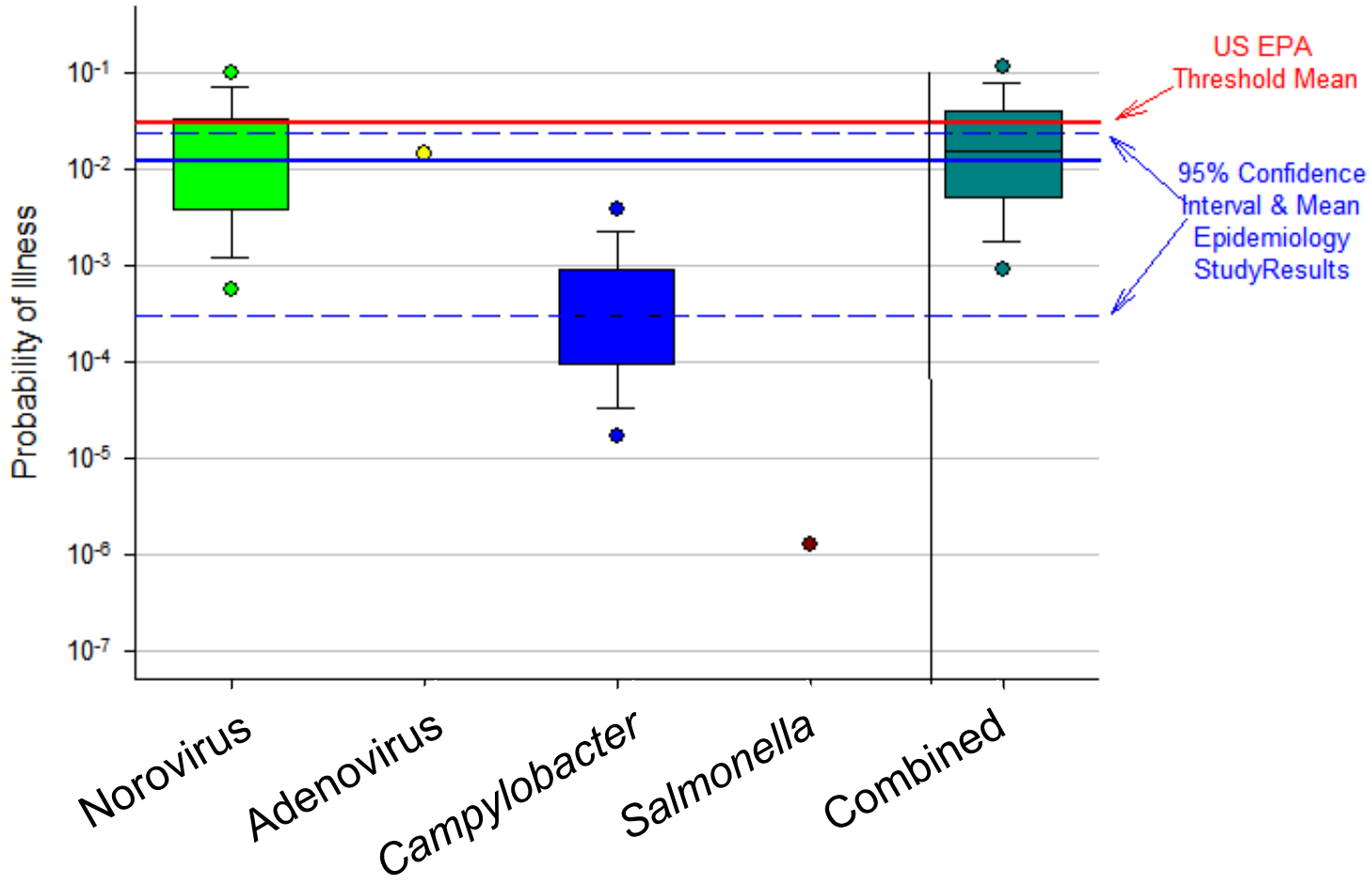

QMRAs Can Work

- Currently only mechanism for setting site specific criteria for indicator bacteria
- Based on human health risk
  - Primary hurdle for Natural Source Exclusion
- Technical challenges remain, but primary obstacles are non-technical