

UNCERTAINTY ISSUES RELATING TO DETECTION OF HUMAN INDICATORS

Yiping Cao, Ph.D.
Senior Microbiologist

Southern California Coastal Water Research Project



State-of-the-science: Fecal source identification and
associated risk assessment tools workshop

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Why this topic?

- ◎ Your question: “Does my beach have a human fecal problem?”
 - Remediation planning
 - Eligibility for QMRA, NSE
- ◎ Your approach: Fecal source identification
 - Complex process
 - Many sources of uncertainty
 - Leading to different conclusions and management actions

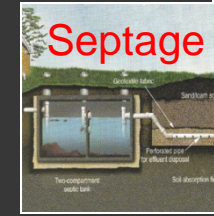
An example

- ⦿ Temporal sampling design
 - Daily, weekly, monthly
- ⦿ If your beach has transient sources
 - Compared to daily sampling
 - Weekly sampling may miss 75% exceedance
 - Monthly sampling may miss 95% exceedance

Different conclusions on extent of exceedance
→ large uncertainty in characterization of the beach



Environment



Sewage

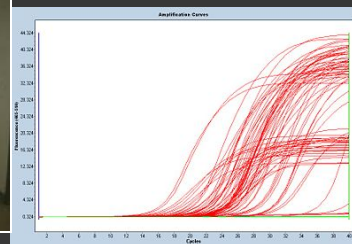
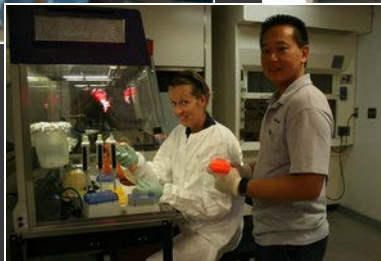
human

Human sources

Sources of uncertainty



Sampling



Lab processing / analysis



Interpret results

(Photo: Google, Holden, sccwrp)

Biological uncertainty

- Human markers' abundance differ
 - greatly among three human sources
 - little within sewage sources, but likely quite a bit among individual humans and septic systems
 - Human markers cross react with different animals
- Guidance on marker / method selection based on suspected human and non-human sources at your beach

Environmental, sampling uncertainty

- Marker fate and transport
 - dilution, decay, persistence etc.

- Sampling design

- temporal
 - spatial
 - sample size



→ Guidance on sampling design that is statistically sound, appropriate for the site conditions and the FSI goal

Analytical uncertainty

- Laboratory setup
 - Instrument, reagents, personnel skill level
- Analysis and data processing
 - DNA isolation (efficiency and consistency)
 - Normalization: Biomass per reaction
 - Establishing LOD and LOQ
 - Standards and quantification models
 - Inhibition controls

→ Standardization protocol including all aspects of lab procedures



Interpretational uncertainty

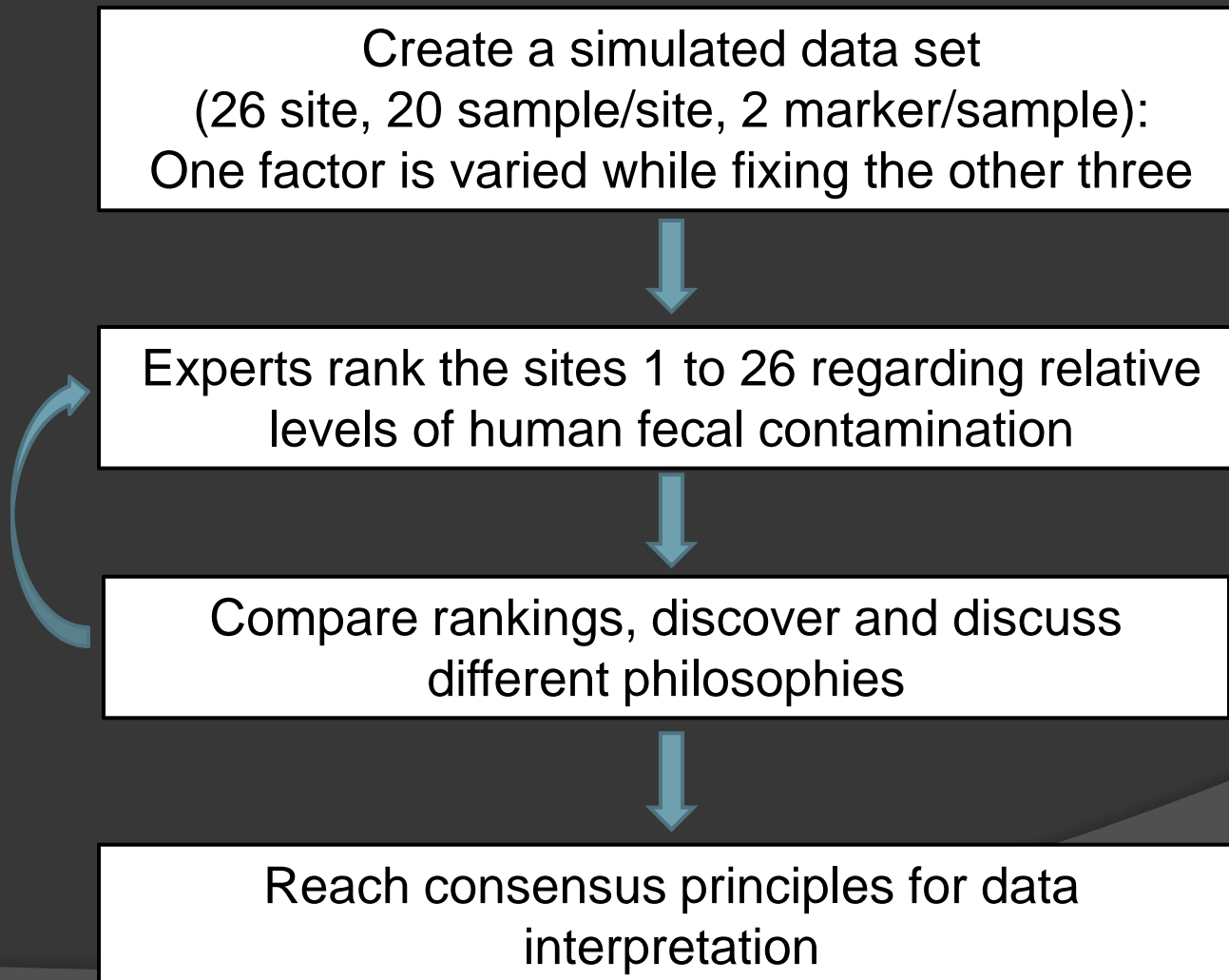
- putting things together

- ⦿ Use the data to answer your question: “Does my beach have a human fecal problem?”
- ⦿ Many factors to consider
 - Enterococcus concentration
 - Magnitude of marker concentration
 - Frequency of marker detection
 - Consistency between markers
- ⦿ Currently no algorithm/mechanism to integrate these factors



The exercise

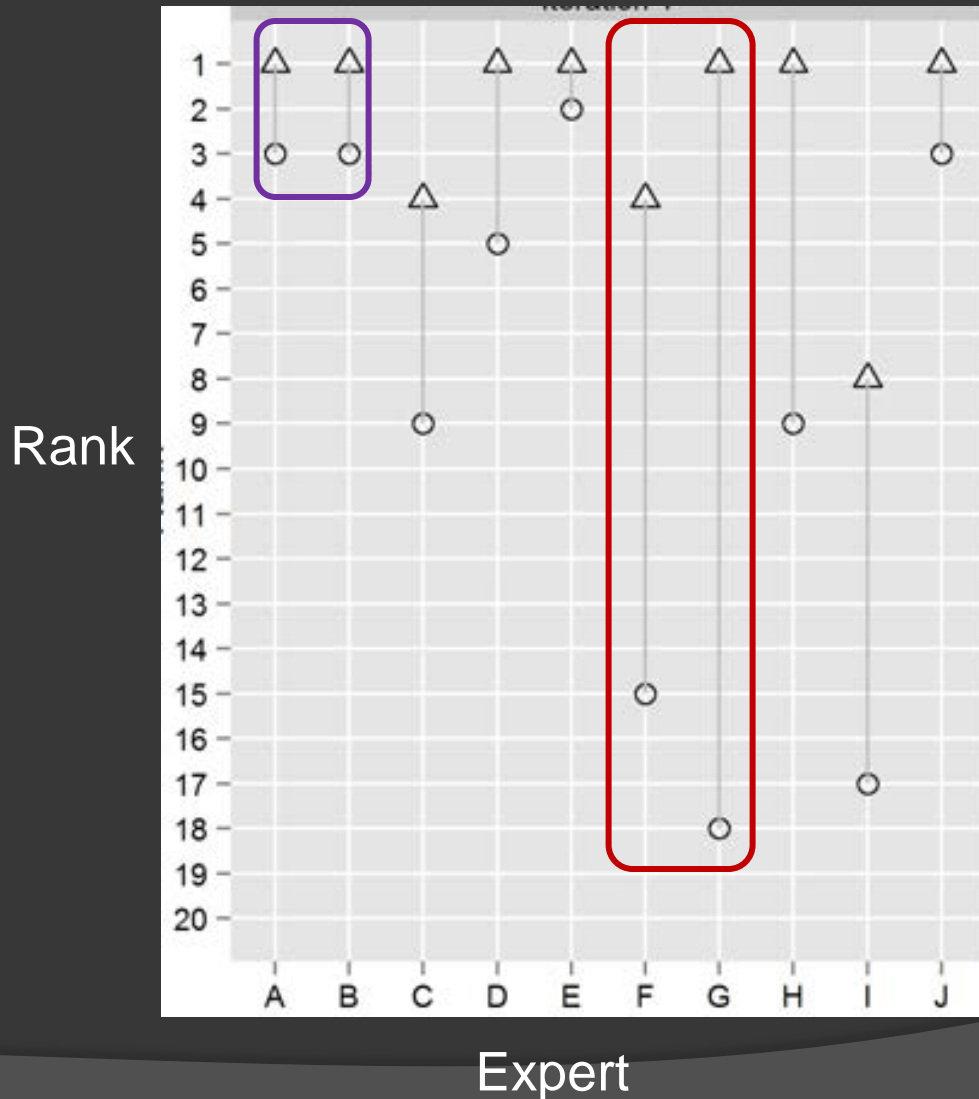
- Assess and resolve uncertainty in data interpretation



Overall correlation of ranks

- ◎ Experts ranked sites #1 to #26
 - #1 indicating most human contamination
- ◎ Correlation coefficients
 - Range: - 0.33 to 0.98
 - Average: 0.41

Frequency of detection



Frequency of detection

○ 10%

△ 30%

A higher frequency of detection → more contaminated

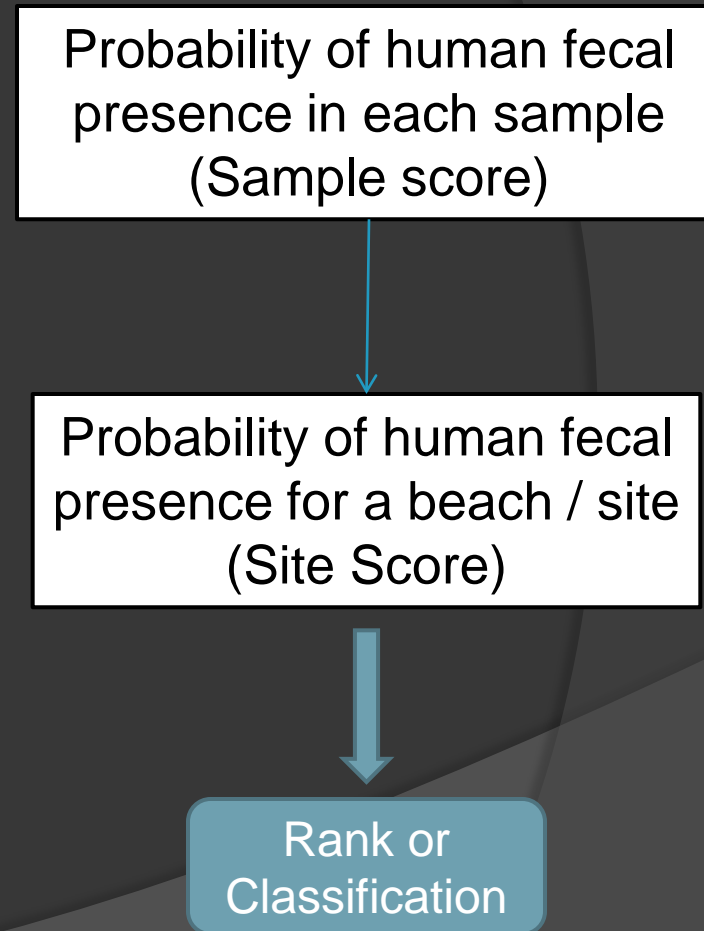
How much more? → answers varied greatly!


Consensus principles

- ◎ Frequency of human marker detection is the most important factor in assessing extent of human fecal contamination
- ◎ Magnitude and consistency between human-associated FSI markers should also be considered, but as weights to support the primary factor of frequency
- ◎ *Enterococcus* is of least importance
 - We would not be studying the beach if there hasn't been an *Enterococcus* problem

Towards standardization of data interpretation

- Realize the consensus principles through a probabilistic framework
 - An algorithm to assign probabilities to assessments
- Incorporate uncertainty measurements into management decision making





**“Recognize and embrace uncertainty.
We shall be closer to truth, or at least
to consistency.” ☺**

Thank you!