Uncertainty issues relating to application of QMRA

Session 3: How well does present science support the QMRA process?

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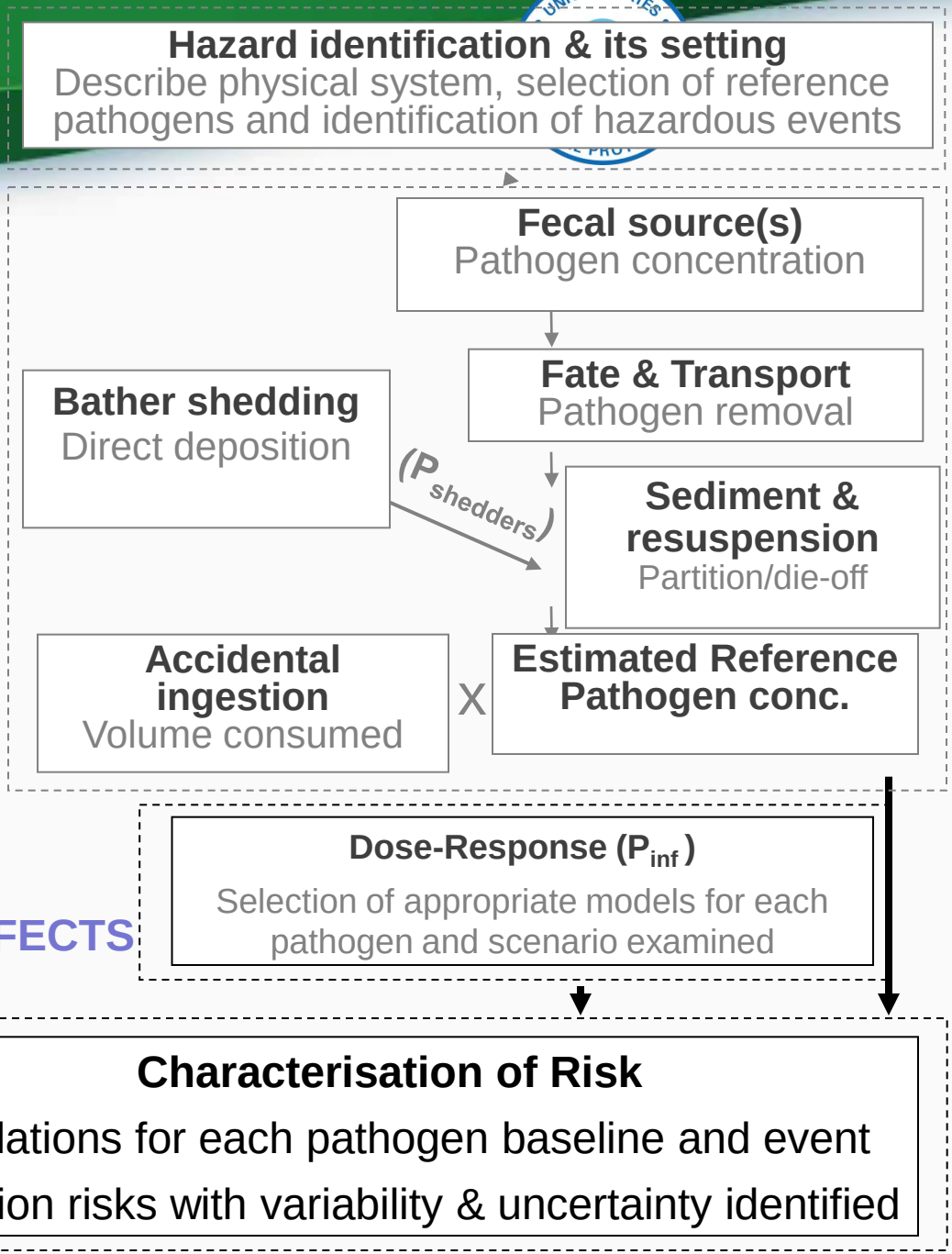
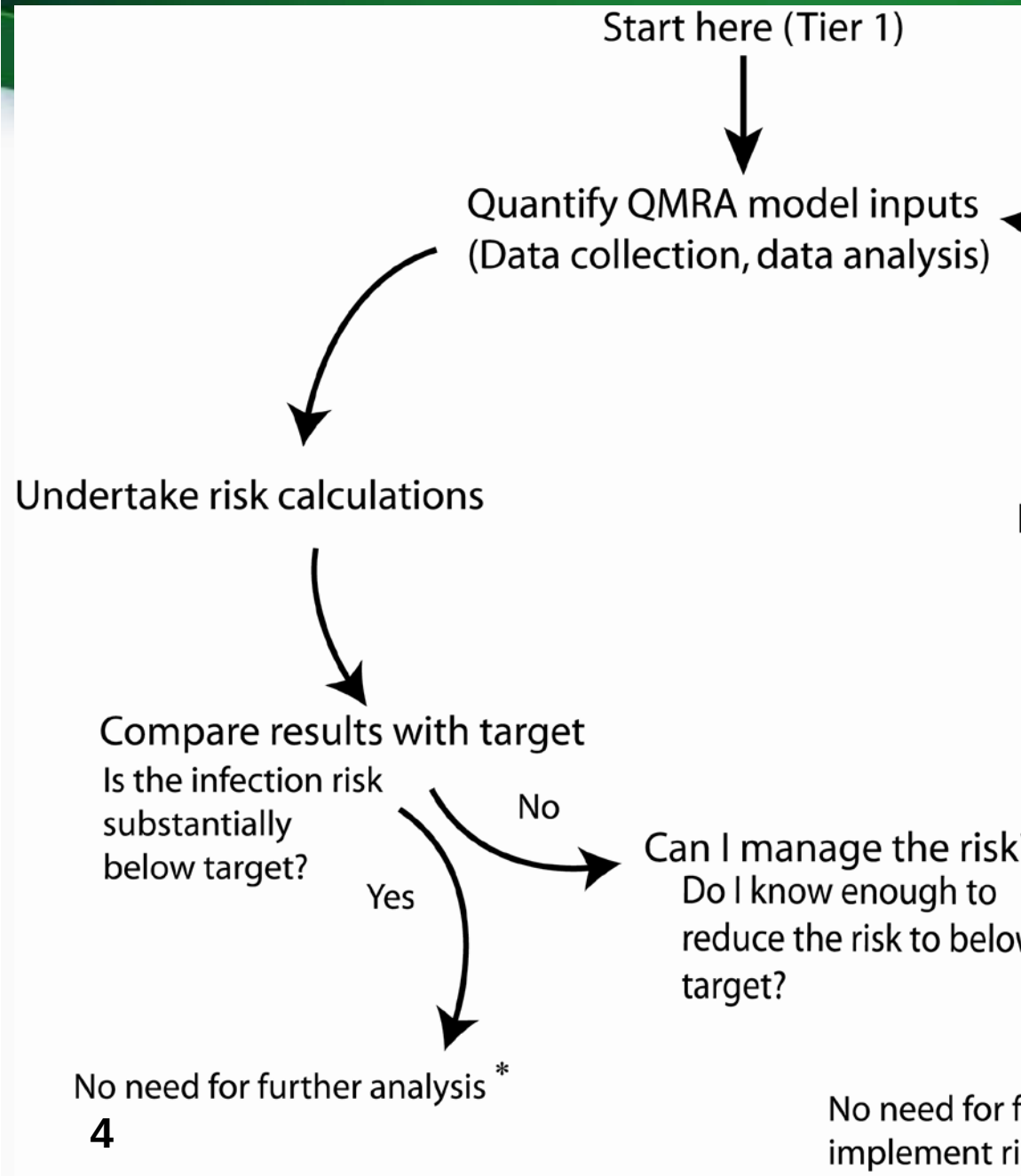
State-of-the-Science: Fecal Source Identification and Associated Risk Assessment Tools
SCCWRP, 3535 Harbor Blvd. Costa Mesa, CA Nov 29th, 2012

Uncertainties arises from:

- Uncertainty in overall QMRA model chosen
- Representativeness of environment samples
  - Hydrodynamics/events important to known
- Method used to assay target microbes
  - Present/absence, MPN, CFU, PCR method & QC/QA uncertainties and pathogen/indicator relationships
- Stochastic distribution form used to model the range of microbes in a recreational water body
- Dose-response equation parameterization

Rec water QMRA model





Iterative tiered approach for undertaking QMRA & asking what further info is required to manage risks

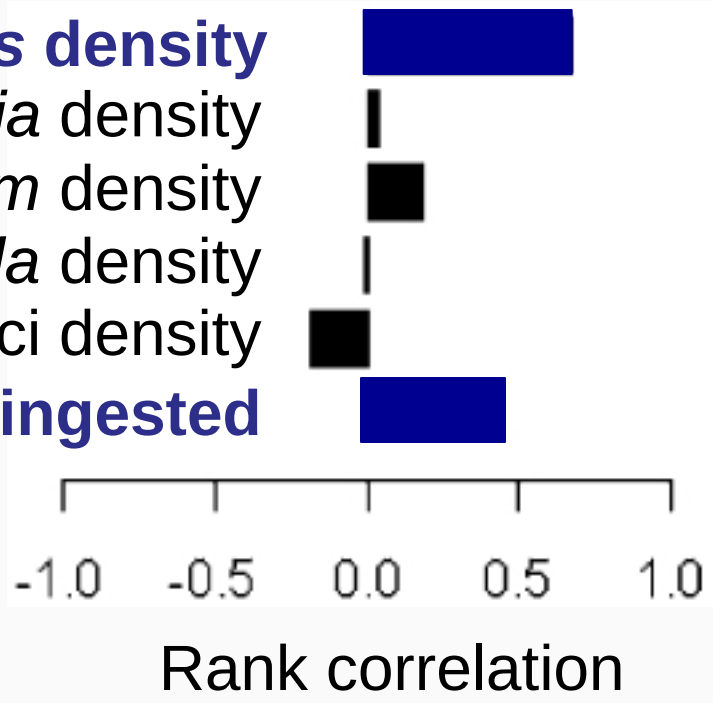
Pathogen recovery estimates

- Most important to include recoveries for waters with ~2-10% pathogen recovery;
  - As 10-100 fold underestimations of path densities
- Recoveries generally not necessary in every sample if able to collect 15~20 recovery samples to describe recovery uncertainty
- Recoveries (as for all likely variables impacting results: infectivity, D-R etc.) need uncertainties to be included in interpreting QMRA estimates

Petterson *et al.* 2007 J Wat Health 5(S1):51-65

Sensitivity analysis to explore QMRA model assumptions

- Spearman rank correlation coefficient to the predicted probability of GI illness from accidental ingestion of recreation water
- For fresh sewage contamination at 35 enterococci/100 mL



Schoen & Ashbolt (2010) Environ. Sci. Tech. 44:2286-91

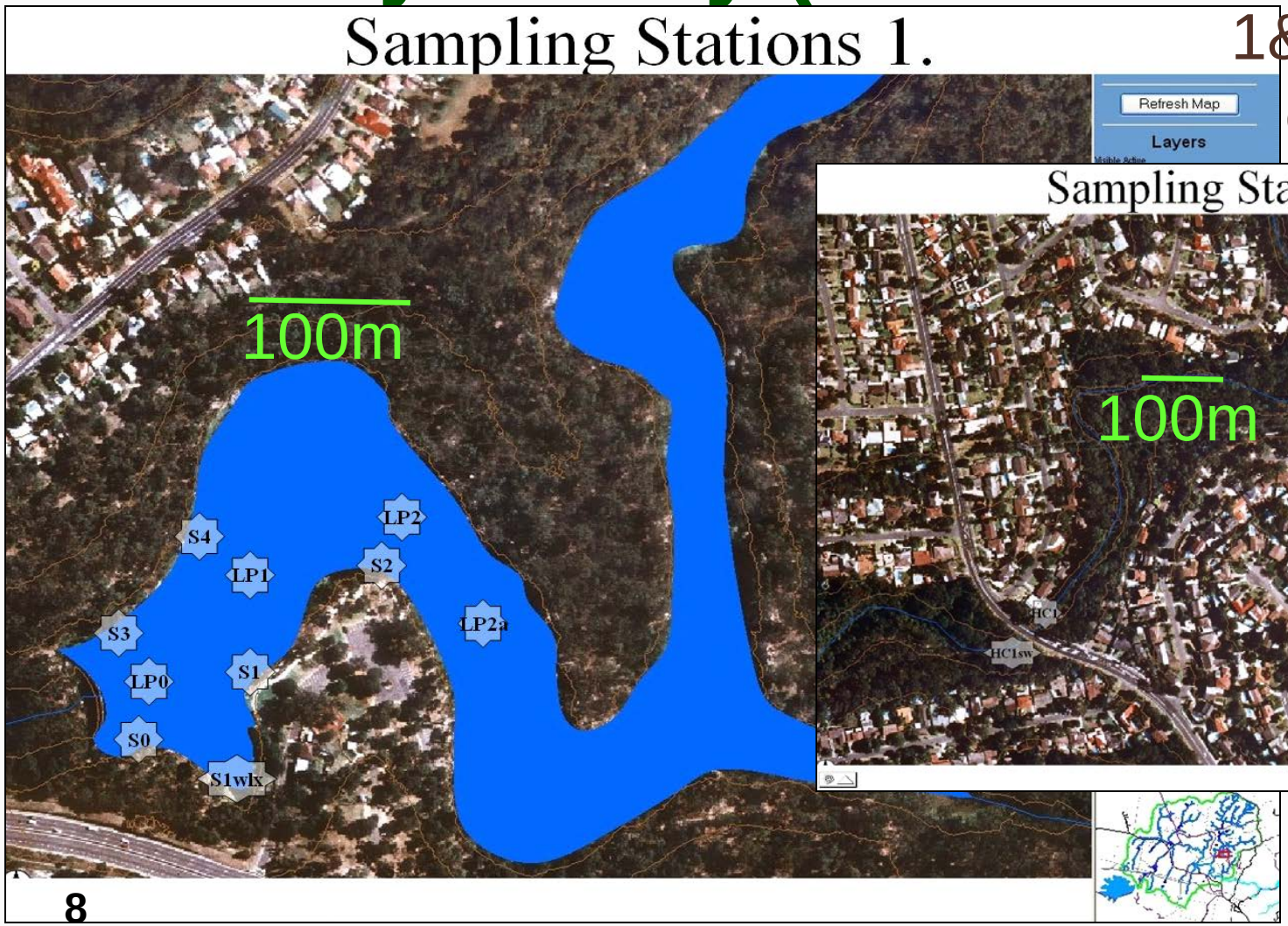
Site-specific management

- Lake Parramatta, Sydney
- 13 miles east Sydney CBD
- 70% urbanised / 30% bush
- 25 acre (lake) /
  1880 acre (catchment)

- Up to 43’ (13 m) deep with 6.5’ (2 m) surface layer
  0.12 M gallons (450 ML) water storage

Roser *et al*. 2007. Application of TMDL and risk assessment principles for pathogen management at an urban recreational lake, pp. 420-426, 4th Conf ASABE March 10-14, 2007 San Antonio, Texas

Sanitary survey (3 scenarios)



1&2 Dry & wet conditions

3. Lake turnover

Bather risk estimates for dry/wet weather & bather shedding:

Infection probability.person^{-1}.day^{-1}

Pathogen	Dry	10 mm	40 mm + 3d recovery	Bather shedding
Enterovirus	< 1/M	< 1/M	< 1/M	4/10,000
Campylobacter	< 1/M	2/1000	5/10,000	< 1/M
Crypto-Giardia	< 1/M	< 2/10,000	2/1000	< 1/M

< 1/M = less than one in a million

Solar inactivation important

- Solar irradiance required for 90% reduction ($S_{90}s$) are typically:
  - 2.5-5 $MJ.m^{-2}$ for *E. coli* and F-RNA coliphage
  - 1-2 $MJ.m^{-2}$ enterococci, *Clostridium perfringens* and DNA bacteriophages
- Measured T_{90S} (time for 90% reduction due to sunlight) were 1 to 2 days
- So swimming access closed if > 10 mm rain and for 4 days after end of an event

Approach Summary

- Uncertainties do not stop good management decisions – but glean as much info from site
- Incorporated other data sources including literature and expert knowledge
- Quantify uncertainty with increasing need
- Test the sensitivity of the overall risk model to known uncertainties that could not be quantified

Conclusions

- Including uncertainty allows for:
  - Correct data interpretation
  - Deeper insight
  - Allows (some) uncertainties to be quantified
  - Maximizes understanding from data

Acknowledgements

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