Use of QMRA to Assess the Human Health Risk of the Mataura River, Southland

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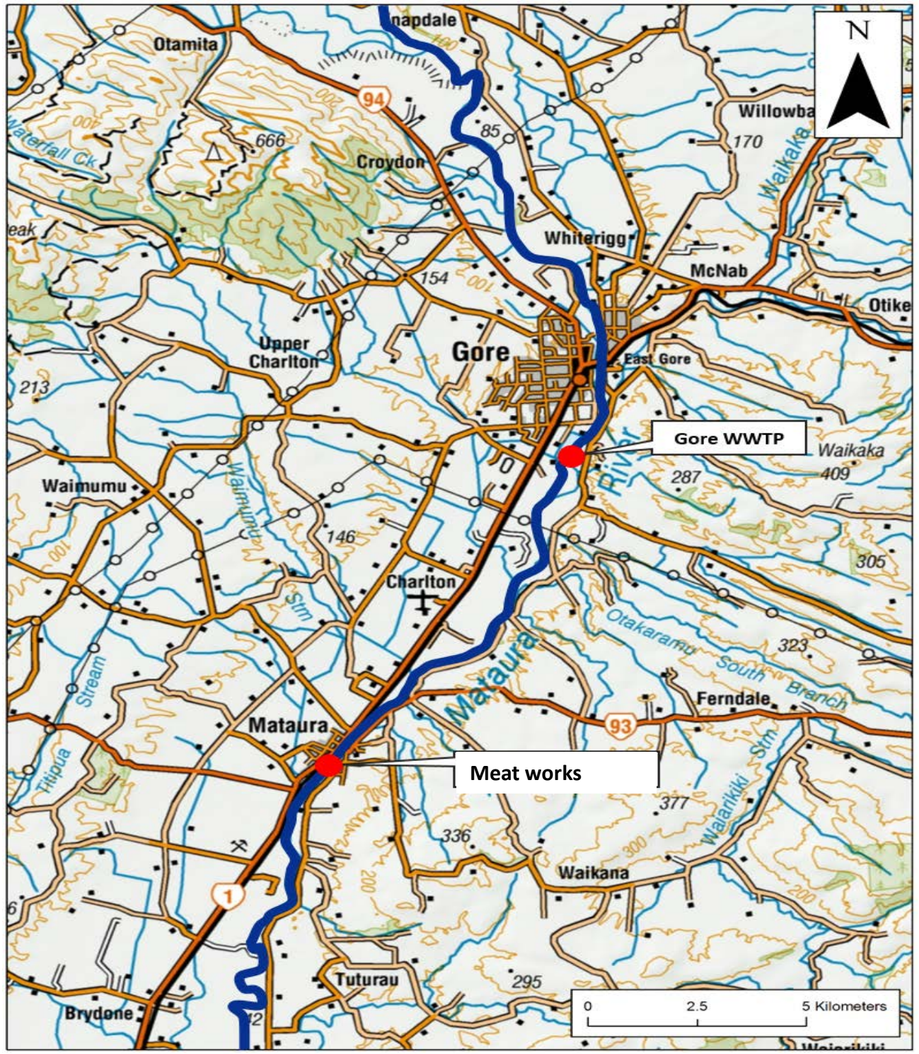
Outline

- Background
  - The Mataura River
  - The microbiological water quality guidelines
- The QMRA
- Conclusions

Background – the Mataura River



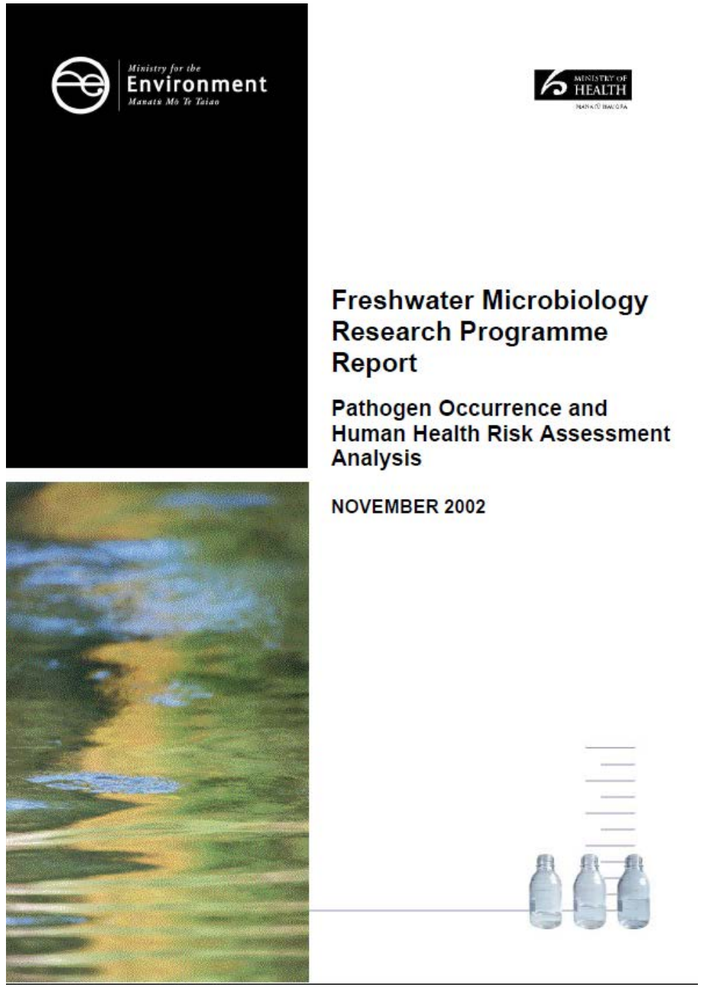
- Rises in Eyre Mountains (south of Lake Wakatipu) and discharges east of Invercargill
- In the environs of Gore/Mataura impacted by Gore WWTP and a meat processing plant
- Also significant farming and wild bird populations
- Below Mataura, the river often does not meet the *Escherichia coli* guideline levels for recreational water

Background – the Mataura River

- Faecal source tracking (200 m downstream of Mataura Bridge) consistently indicated a contribution from wildfowl, with more variable ruminant and human contributions
- Genotypic analysis of *Campylobacter* isolates also consistently implicated wildfowl

Microbiological water quality guidelines

- Expressed in terms of *E. coli* concentrations
- Under-pinned by a “moderate correlation between concentrations of *E. coli* and *Campylobacter*”
- Original data set had a mean *E. coli* concentration of 93 CFU/100 mL and a mean *Campylobacter* concentration of 0.9 MPN/100 mL (~1%)



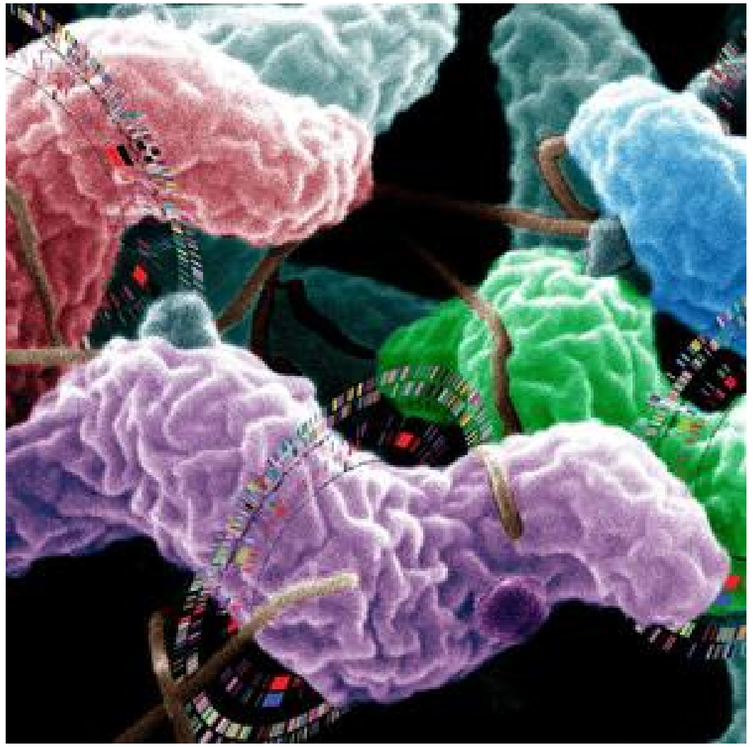
QMRA – Model structure

- The model has three primary components
  - Estimation of the concentration of *Campylobacter* in the Mataura River, downstream of Mataura Bridge
  - Estimation of the amount of water ingested (and the dose of *Campylobacter*) during a swimming event in the Mataura River
  - Estimation of the probability of *Campylobacter* infection resulting from the ingested dose (dose-response)

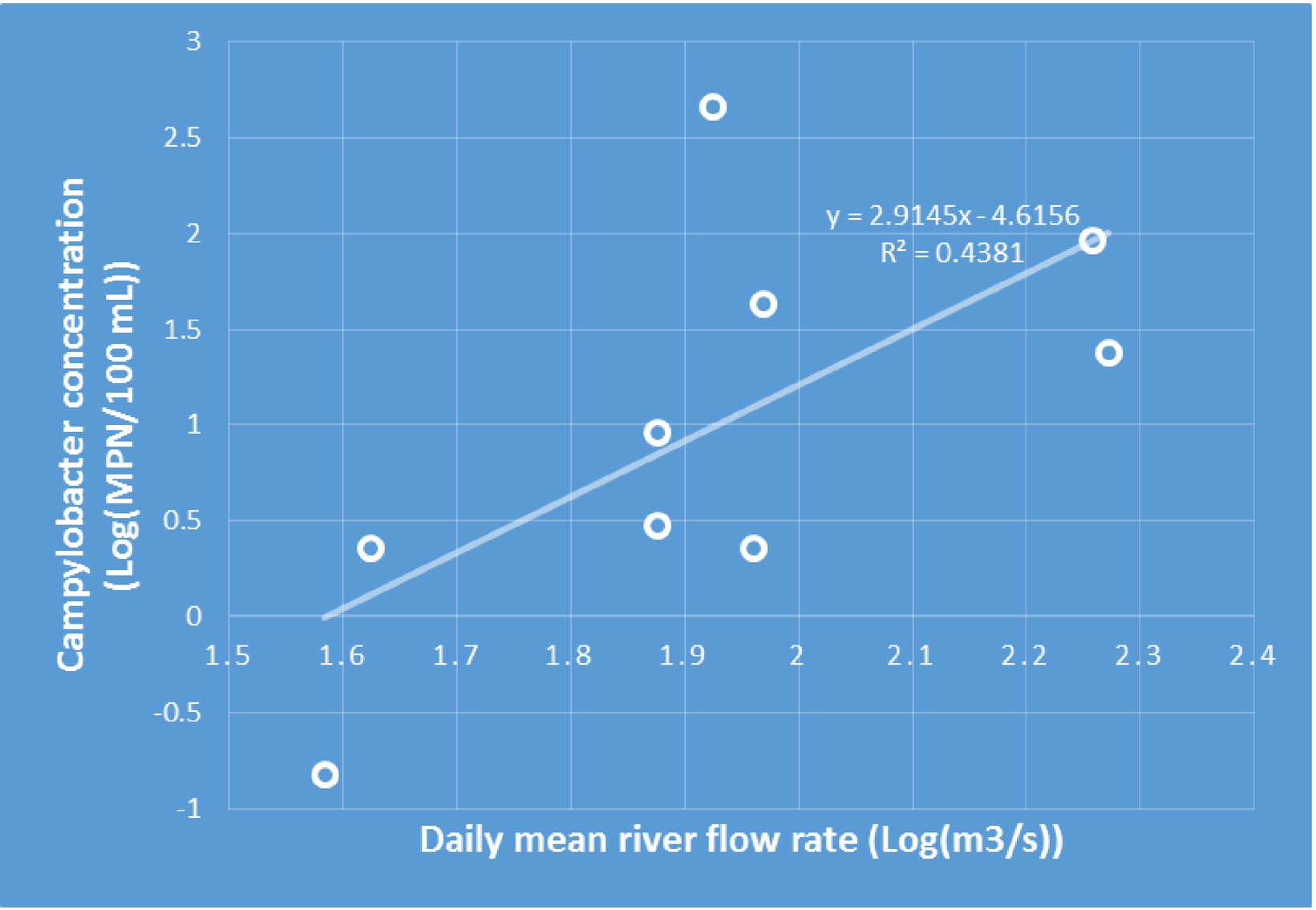
- The model focussed on children swimming, as this is the contact recreation scenario resulting in the greatest water ingestion

Concentration of *Campylobacter*

- Three approaches taken:
  - Direct measurements of *Campylobacter* in the Mataura River were made on 23-24 May 2017
  - Measurements of *Campylobacter* in Gore WWTP effluent and meat processing plant effluent were made on 23-24 May 2017 and combined with discharge volumes and river flow rates to estimate resultant concentration in the Mataura River
  - A wider data set was used to establish a relationship between river flow rate and river *Campylobacter* concentration



Campylobacter and river flow



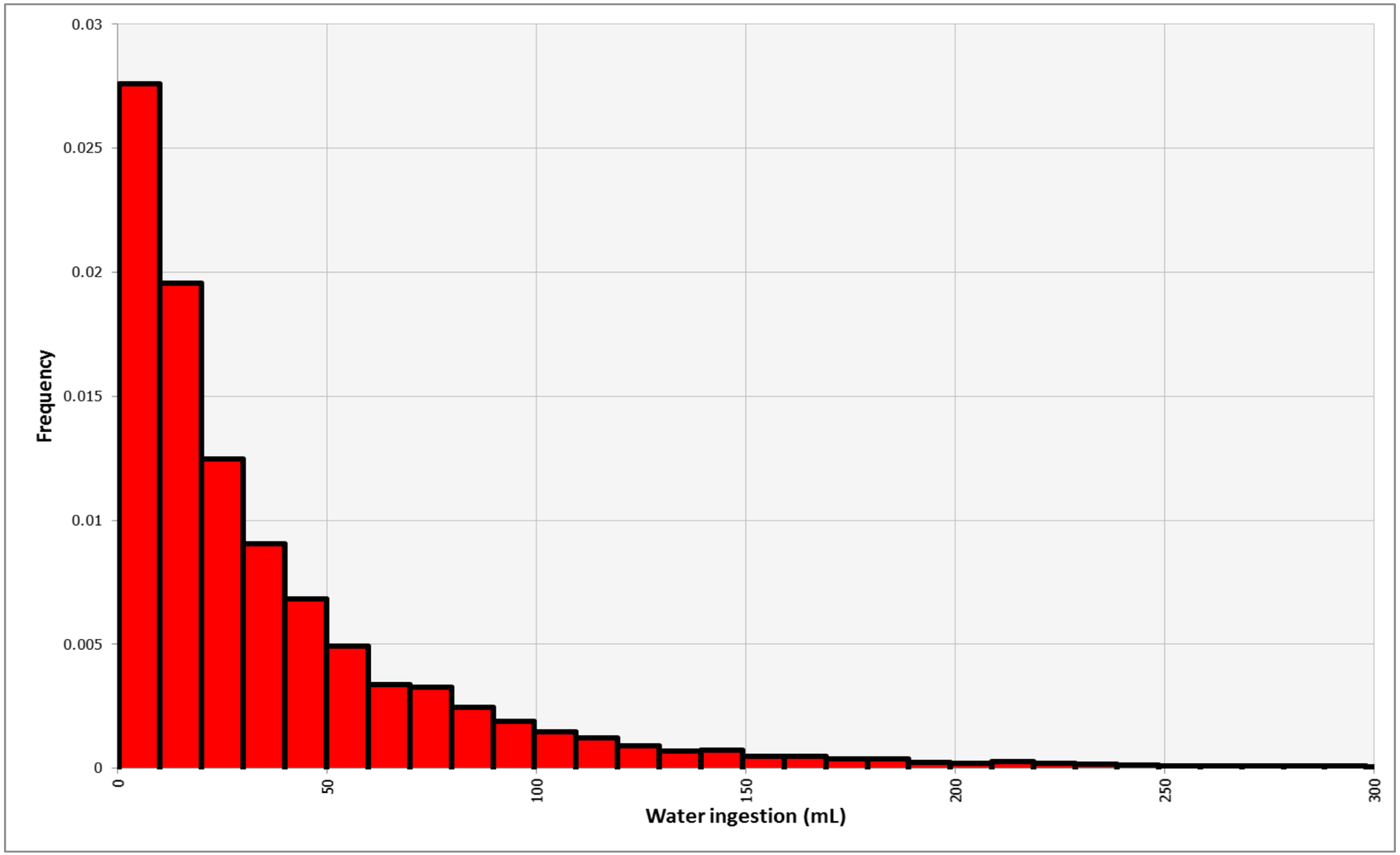
This approach resulted in much higher estimates of *Campylobacter* concentrations – mean 8 MPN/100 mL, compared to 0.3 MPN/100 mL from direct measurement and 0.02 MPN/100 mL from input simulation

Water ingestion and dose response

- Duration of swimming taken from Dutch study (Schets et al., 2011). Mean duration (Children) = 1.32 hours (intermediate between duration in swimming pool and in seawater)
- Water ingestion rate taken from US swimming pool study (Dufour et al, 2017). Mean ingestion (Children) = 23.9 mL/hr

- Dose-response – beta-Poisson model, based on FAO/WHO analysis of Black et al. (1988)

Simulated water ingestion by children during swimming



QMRA outputs – Individual Infection Risk

Concentration scenario	Full river flow distribution, mean (95th percentile credible interval) (%)	Truncated river flow distribution, mean (95th percentile credible interval) (%)
Scenario 1 (actual)	0.070 (0.056-0.086) **A**	-[a]
Scenario 2 (sum of discharges)	0.012 (0.007-0.019) **A**	0.013 (0.007-0.020) **A**
Scenario 3 (from river flow regression)	2.8 (2.7-2.9) **C**	1.7 (1.7-1.8) **C**

QMRA outputs – New water quality parameters

Category	Percentage >5% Campylobacter risk[a]				Percentage >1% Campylobacter risk[a]			
	Attribute	Scenario1	Scenario2	Scenario3	Attribute	Scenario1	Scenario2	Scenario3
A (Blue)	<5%	0.05	<0.01		<20%	1.1	0.1	16.6
B (Green)	5-10%			6.9	20-30%			
C (Yellow)	10-20%				20-34%			
D (Orange)	20-30%				>34%			
E (Red)	>30%				>50%			

[a] The water quality categories are defined in terms of *E. coli* concentrations, but have been represented here as the equivalent *Campylobacter* infection risk break points

Conclusions

- Based on the QMRA results:
  - Effluent discharged from the Gore WWTP and the meat processing plant contribute a relatively small proportion of the overall *Campylobacter* risk. This is consistent with other work that indicated that *Campylobacter* contamination in this region of the Mataura River was predominantly of wild fowl origin
  - First two QMRA scenario would result in this region of the Mataura River being classified in the highest water quality category for microbiological quality under either the old or updated categorisation schemes. The third scenario would result in a lower water quality categorisation