



# KNOWLEDGE AND UNCERTAINTY IN DEVELOPING SANITARY PROFILES FOR RECREATIONAL AND SHELLFISH GROWING WATERS

Carlos Campos, Jonathan Banks, Ben Knight Coastal & Freshwater Group



#### MICROBIAL WATER QUALITY: A GLOBAL PROBLEM

- Faecal pollution is a major threat to water quality worldwide. Human health risks occur through contact recreation/consumption of contaminated shellfish.
- Waterborne diseases are responsible for 2 million deaths each year (WHO).
- In New Zealand, poor microbial water quality affects bathing waters/shellfish harvest areas.



#### HEALTH RISKS FROM MICROBIAL CONTAMINATION

Pathogen	Disease					
Bacteria			SANITATION	CLEAN WATER SUP	PLY	
Escherichia coli (enteropathogenic)	Gastroenteritis	PRIMARY	BARRIER	BARRIER		
Helicobacter pylori	Gastritis	ROUTES OF				
Legionella pneumophila	Legionellosis	EECAL-OPAL				
Leptospira	Leptospirosis	DISEASE				
Pseudomonas	Infections in immuno- compromised individuals	TRANSMISSIO				
Salmonella typhi	Typhoid fever	BARRIERS		1 🎦 🖌		3
Shigella	Shigellosis					
Vibrio cholerae	Cholera		BARRIER /			<b>F</b>
Yersinia enterolitica	Yersiniosis		SANITATION	н		
Protozoans			BARRIER	B	ARRIER	
Balantidium coli	Balantidiasis					
Cryptosporidium	Cryptosporidiosis					
Entamoeba histolytica	Amoebiasis (amoebic dysentery)	Relative ris	ks associate	ed with patho	gen group	S:
Giardia lambia	Giardiasis	Detherion		Derejetoree	Detenov	700001
Naegleria fowleri	Amoebic meningo- encephalitis	group	in faeces	Persistence	Potency	<b>200</b> 00t
Viruses		<b>3</b> • • •				
Adenovirus (31 types)	Respiratory disease	Bacteria	High	Low	Medium	High
Astrovirus	Gastroenteritis	-				
Enterovirus (67 types, e.g. polio, echo and Coxsackie viruses)	Gastroenteritis	Protozoans	Medium	Medium	Medium/	High
Hepatitis A and E	Infectious hepatitis				High	
Norwalk- and Sapporo-like viruses	Gastroenteritis	Viruses	High	Medium	High	Low
Reovirus	Gastroenteritis		_			
Rotavirus	Gastroenteritis	ſ				Source: Aw (2

Source: USEPA 2001.

8)

## SANITARY SURVEYS: A RISK MANAGEMENT TOOL

The purpose of the sanitary survey is to **identify and document sources of microbiological contamination** affecting recreational/shellfish waters.

Provides a measure of health risk together with:

- Monitoring of microbiological contaminants/other quality parameters
- Classification of the 'sanitary' status of the waters

Components of the survey:

- Shoreline survey
- Survey of the microbiological quality of the waters
- Assessment of the effect of meteorological, hydrodynamic and geographic factors
- Sampling plan (shellfish growing waters)





#### TECHNICAL GUIDANCE: RECREATIONAL WATERS





#### TECHNICAL GUIDANCE: SHELLFISH GROWING WATERS

Overview of bivalve mollusc fishery



TECHNICAL GUIDANCE FOR THE DEVELOPMENT OF THE GROWING AREA ASPECTS OF BIVALVE MOLLUSC SANITATION PROGRAMMES

	Martin of Martin Control of State			
Animal Products Notice	Regulated Control Scheme - Bivalve Molluscan Shellfish for Human Consumption			
альных альных Ма <u>мальн</u> ослениет.				



Fishery

Aquaculture or wild stocks
Production area or relay area

Location and extent

- Seasonality of harvest
- Harvesting techniques
- Any controls under other legislation
- Location, size and treatment level of human sources of contamination
- Location and estimated volume/load of agricultural sources of contamination
- Significant wild animal/bird populations
- Maps, seasonality effects, for these factors
- Records of shoreline surveys
- Hydrography/hydrodynamics
- Analyses of historical microbiological data
- Records of bacteriological survey results
- Assessment of effect on contamination of bivalve molluscs

The outcome of the sanitary survey determines the content of the sampling plan in terms of the number and location of representative sampling points and the frequency and timing of sampling.



Source: Cefas (2017)

#### SANITARY SURVEYS FOR SHELLFISH GROWING AREAS

Study to identify factors that resulted in failure to prevent norovirus contamination of oysters in growing areas Re-analysis of 8 cases from 5 growing areas

Sources of information:

- Sanitary survey reports
- Epidemiological reports
- Reports of growing area investigations
- Correspondence
- Monitoring data
- Meetings with food authorities, Councils, industry.



#### Conclusions:

- > The way FIOs are used in the programme fails to predict NoV risk.
- Sources of contamination were acknowledged in the sanitary survey report, but significant details had not been thoroughly investigated/assessed.



## WIDER WATER QUALITY MANAGEMENT EFFORTS

- Sanitary surveys are only one part of a water quality management plan.
- Components of a management plan:
- Risk assessment of the shoreline and catchment area
- > Water quality monitoring plan
- Notification plan to communicate risk levels to the public
- Regulatory/community action plans to protect/improve water quality





#### WATER QUALITY PROGRAMMES AT RECREATIONAL WATERS

HILCHEST TAKAPUIL

HALRAK

Q

GLENFIELD

WAIRAD VALLEY



Search

#### Welcome to Safeswim

#### Nau mai ki Safeswim

Check Safeswim for live information on water quality and swimming conditions at your favourite swimming spots



For injuries or medical issues ass for Ambriance, for rescue emergencies ask for Police



SREN HT HE

Ð

CAWTHRON



#### SOURCES OF MICROBIOLOGICAL POLLUTION

- Terrestrial sources produce highly variable contaminant loads.
- Rainfall events generate the transport energy to deliver microbial inputs.
- In the nearshore zone, hydrodynamic processes dominate microbial transport.



Phased approach to survey - focus on problematic areas.



 Targeting human sources often results in measurable water quality improvements.

#### POLLUTION SOURCE IDENTIFICATION AND TRACKING



#### Sensors/video surveillance







Source: Eawag (2019)



## CATCHMENT POLLUTION SOURCE APPORTIONMENT



Source: Stapleton et al. (2015)

E. coli

Rivers

Bounty Seachanne

Modelled

2013-2017

<3.1

3.1-13.1

13.1-51.1 51.1-180.2 180.2-351.2 >351.2

Leafet | @ ESRI OceanBasemap

Source: Stats New Zealand

Median (cfu/100mL)

#### WASTEWATER DISCHARGES IN NEW ZEALAND

- Detailed information on WWTP performance is lacking
- Government has proposed targeted reforms to improve the regulation and performance of wastewater and stormwater systems



Source: WHO (2010)



#### FAECAL INDICATOR BACTERIA AND NOROVIRUS IN SEWAGE



Source: Kay et al. (2018)

Source: Campos et al. (2018)

## **MICROBIAL LOADING AND ATTENUATION IN FARMS**

Animal	Faecal production (g/day)	<i>E. coli</i> /g faeces	<i>E. coli</i> load/day
Human	150	1.3 x 10 <sup>7</sup>	1.9 x 10 <sup>9</sup>
Sheep	1,130	1.6 x 10 <sup>7</sup>	1.8 x 10 <sup>8</sup>
Cow	23,600	2.3 x 10 <sup>5</sup>	5.4 x 10 <sup>9</sup>
Gull	15	1.3 x 10 <sup>8</sup>	2.0 x 10 <sup>9</sup>
Duck	336	3.3 x 10 <sup>7</sup>	1.1 x 10 <sup>10</sup>

Sources: Geldreich (1978); Ashbolt et al. (2001)



FIO attenuation for six farm management practices:



#### BMP (number of data sets):

† n = number of observations

Ponds: Farm and sewage treatment ponds (4) VTAs: Vegetative treatment areas for feedlot runoff (18) CWs: Constructed wetlands, including sewage treatment systems (37) WCs: Woodchip corrals (2) VBSs: Vegetated buffer strips, including riparian buffer strips (46) ISPs: In-stream ponds (3)

Median

Source: Kay et al. (2012)

>Interquartile range

Minimum



## INTERMITTENT DISCHARGES





AWTHR

The power of science\*



#### WASTEWATER TREATMENT UPGRADES



Campos et al. (submitted)

#### FORECASTING OF MICROBIAL RISKS IN COASTAL WATERS

Remote sensing



# Hydrodynamic modelling



CAWTHRON The power of science\*



Outcome Refined criteria

and daily

forecasts lead

to reduced

closures

Discharge plumes and illness risk



MIW Southe

Clution (Tress risk) C+000 (+10%) 201, 2 500 (5%) 10 %)

01-15 000 (1%-5%)

#### CONCLUSIONS

- Sanitary survey is a risk assessment tool with public health and regulatory management benefits.
- Sanitary survey reports contain qualitative/quantitative information on pollution sources, microbial levels and environmental pathways.
- Technical guidance (for recreational/shellfish waters) facilitates implementation and greater harmonisation of assessment procedures.
- A sanitary survey is not a 'linear process'.
- Sanitary surveys can help inform pollution reduction programmes and support more effective management of water resources.



#### KNOWLEDGE GAPS

- Characterisation of point- and non-point sources of fecal contamination and associated health risk.
- Fate, transport and persistence of novel indicators and pathogens in sewerage systems/receiving waters to better inform monitoring programmes, risk assessments and discharge consenting.
- Development of monitoring tools to characterize lag times, tipping points and distinguish unusual changes from normal variations.
- Microbial risk communication strategies for 'at risk' populations.
- Associations between viral indicators and disease.





# Acknowledgements: Seafood Safety Programme (CAWX1317) National Science Challenges: Sustainable Seas





#### THANK YOU

