Effect of wastewater-derived microbial contaminants on Welsh fresh and marine waters

Kata Farkas, PhD

Bangor University

Better Water Quality for Wales Conference

27th - 29th June 2023, Environment Platform Wales

Environment-borne diseases

Winter vomiting bug alert over UK oysters as three-quarters are found to contain the norovirus

- **Bug causes symptoms such as vomiting and diarrhoea**
- **Cooking kills virus but oysters are eaten raw**

By DAILY MAIL REPORTER
UPDATED: 13:55, 29 November 2011

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More than three-quarters of British-grown oysters contain norovirus, known as the 'winter vomiting bug', experts have warned.

A study conducted on behalf of the Food Standards Agency found that 76 per cent of oysters tested from UK oyster growing beds had traces of the infectious bug.

Low levels of the virus, which causes symptoms such as vomiting and diarrhoea, were found in 52 per cent of the positive samples, according to the data.

The outbreak has been traced back to mussels brought for an inpatient

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of norovirus in

20:31, UK,
Friday 22 December 2017

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Norovirus outbreak from B.C. oysters makes dozens sick

Vancouver oyster bar owner expects his business to take a hit, as health officials issue warning

By Rafferty Baker, CBC News Posted: Jan 13, 2017 9:40 AM PT | Last Updated: Jan 13, 2017 2:20 PM PT

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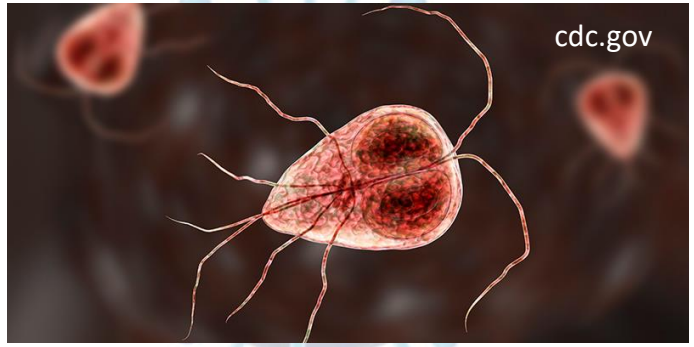
Vancouver Kelowna Abbotsford Prince George Victoria

Environment-borne pathogens

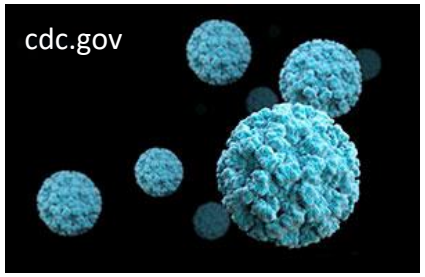
Bacteria
Salmonella sp.
Escherichia coli
Shigella sp.
Vibrio cholerae
Helicobacter pillory
Campylobacter sp.

Helminths
Dracunculus medinensis

Protozoa
Cryptosporidium sp.
Giardia sp.
Entamoeba histolytica



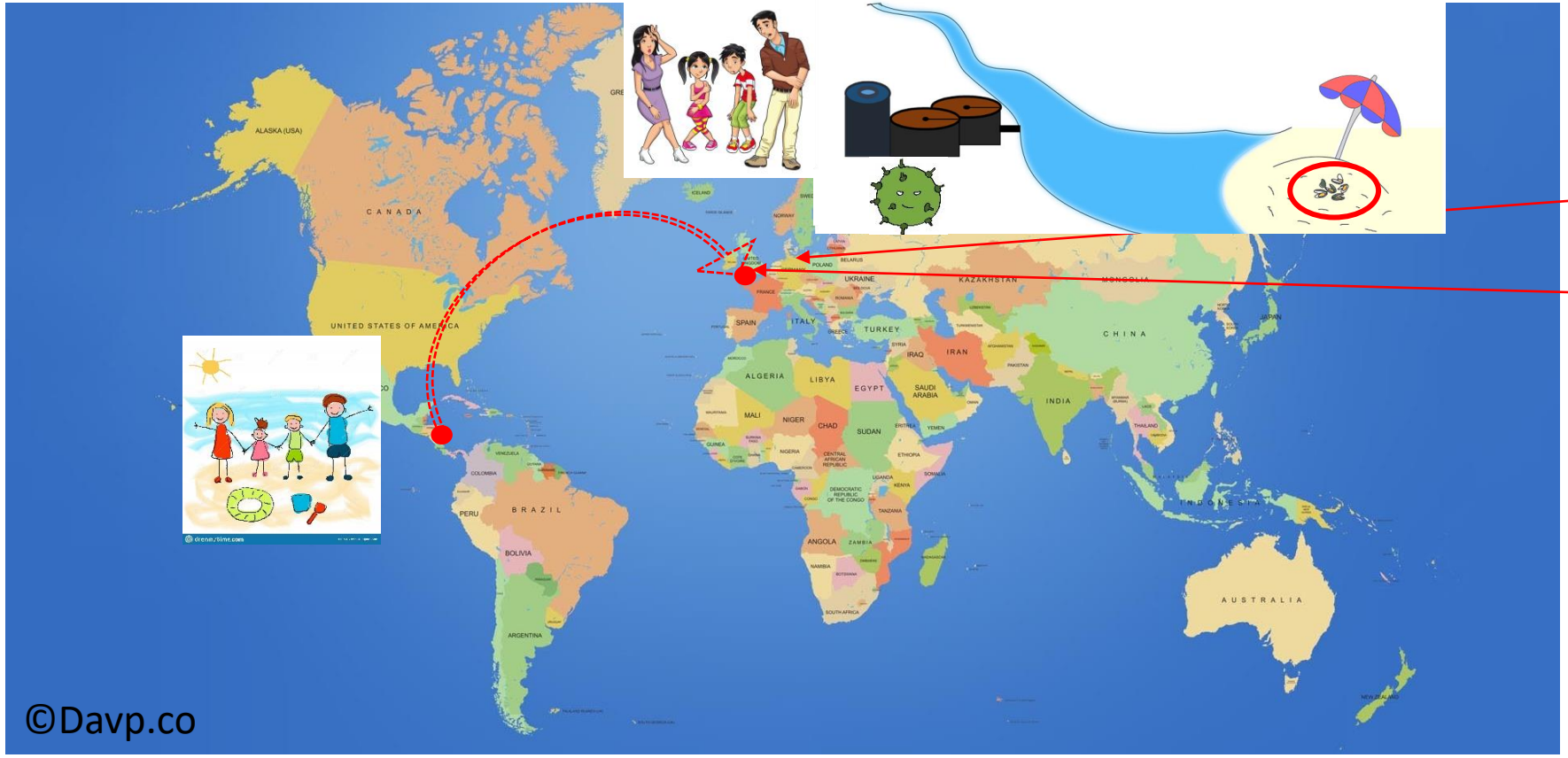
Viruses
Noroviruses
Sapoviruses
Hepatitis A/E viruses
Rotaviruses
Mastadenoviruses
Astroviruses



Waterborne viruses

Geographic dispersion of outbreaks with food as vehicle:

Euro Surveill. 2016;21(3):30113. doi: 10.2807/1560-7917.ES.2016.21.3.30113.

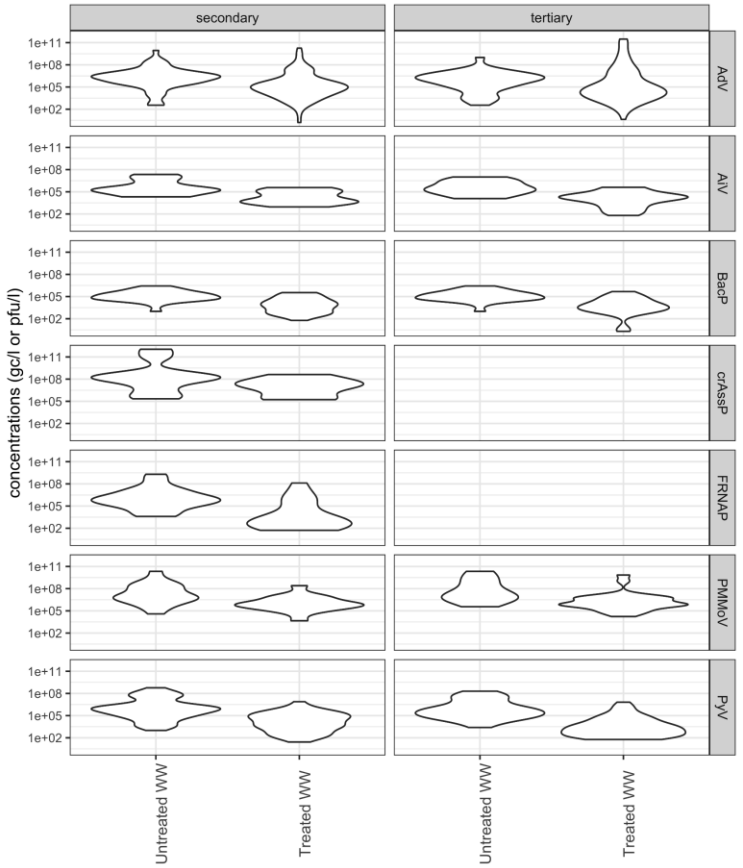


Hepatitis A virus infection

Denmark
9 primary cases

England
3 primary cases

Wastewater treatment and discharge



Adenoviruses (human)

Aichi virus (human)

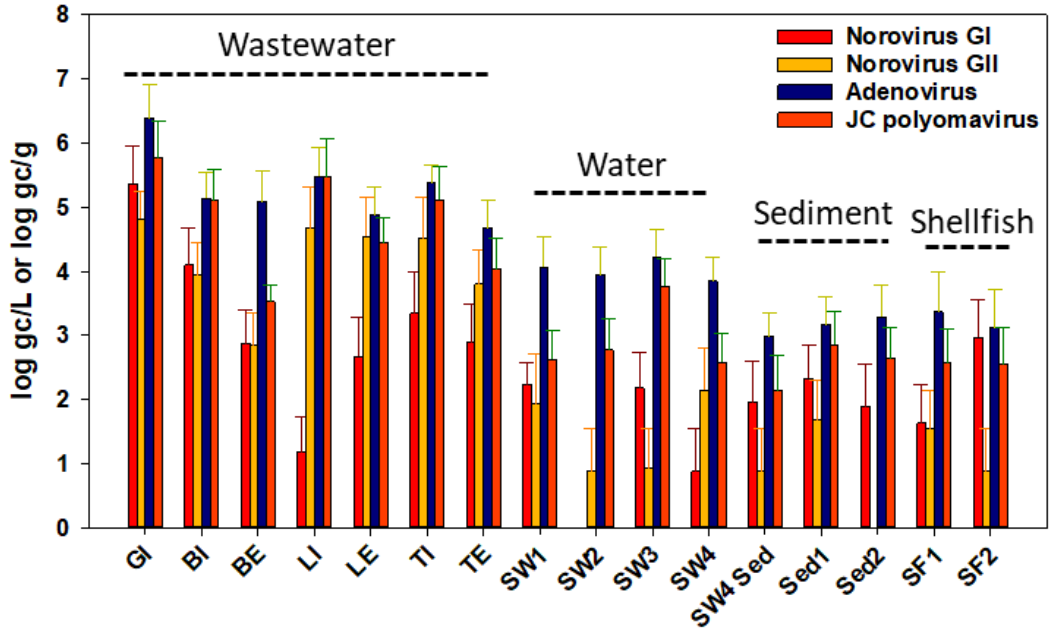
culturable *Bacteriodes* phages

CrAssphage

FRNA phages I and II

Pepper mild mottle virus

Polyomaviruses (human)



Farkas et al, 2020 https://doi.org/10.1016/j.watres.2020.115926

Farkas et al, 2018 https://doi.org/10.1016/j.scitotenv.2018.04.038

Wastewater surveillance in Wales

Llywodraeth Cymru
Welsh Government

- Sampling 5 times a week
- 75% of the population is covered
- Tracking and predictions: 5-14 days
- Variant-level identification
- Enteric and respiratory virus surveillance
- Poliovirus monitoring

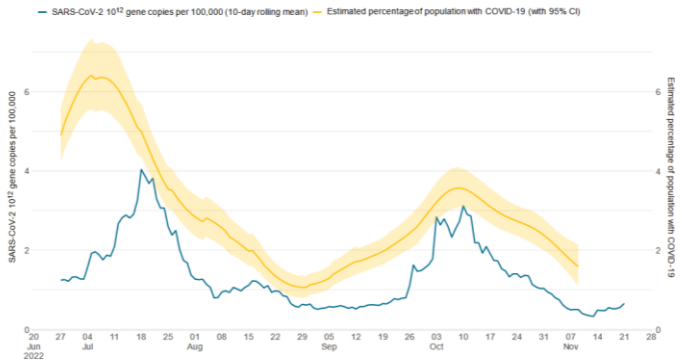


Figure 47 – ONS CIS vs Wastewater National Mean (SARS-CoV-2 gc/day per 100k)

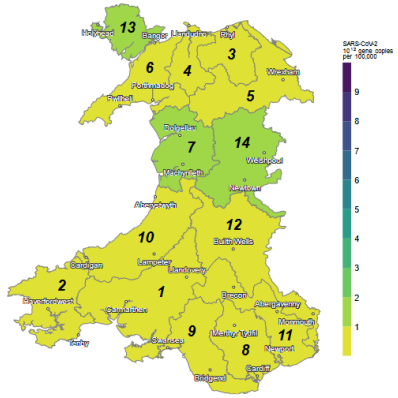


Figure 3 - National Heat Map showing Regional Mean SARS-CoV-2 gc/day per 100k

https://www.gov.wales/wastewater-monitoring-reports-coronavirus

PRIFYSGOL BANGOR UNIVERSITY

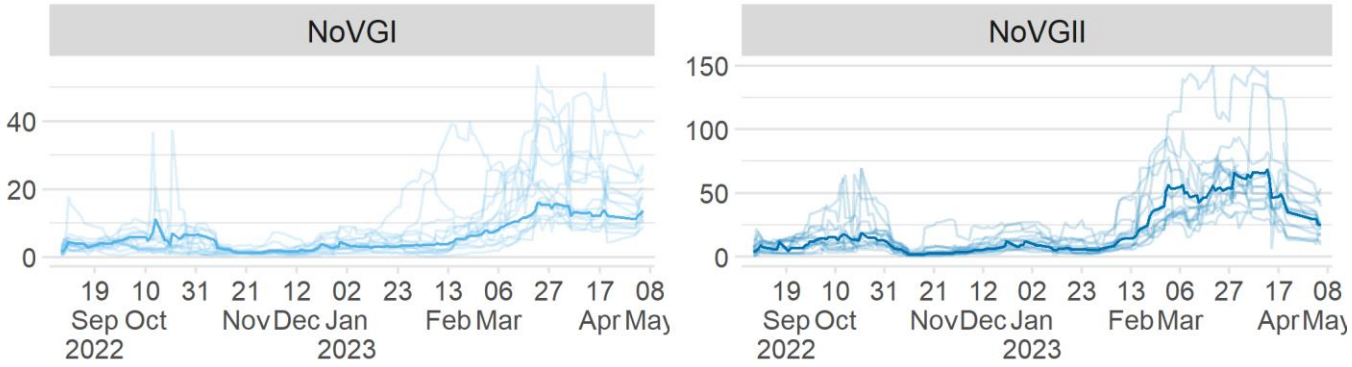
CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

Norovirus surveillance

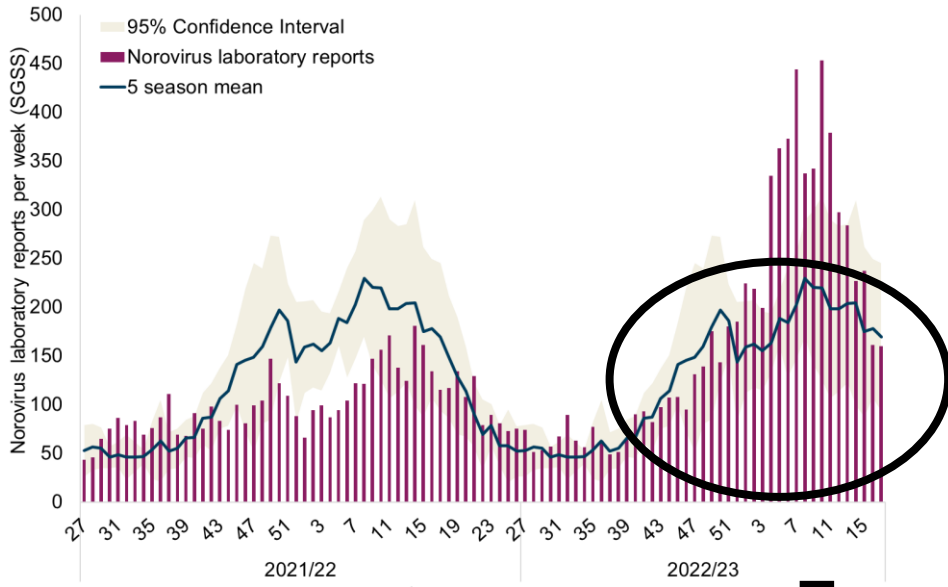
600,000 – 1,000,000 cases/year

130 – 250 reported outbreaks/year

- Contaminated humans are supershedders
  - 10^5-10^{11} norovirus particles/g stool
- Released daily in wastewater
  - 10^2-10^8 norovirus particles/litre
  - Resistant to treatment

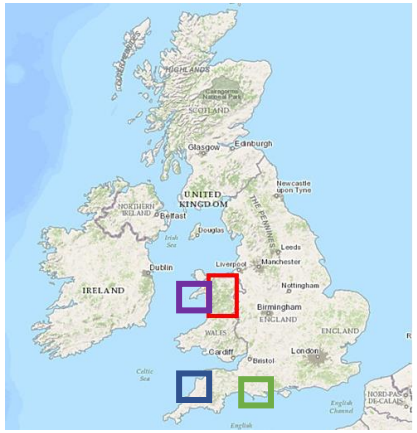


Welsh wastewater surveillance data, unpublished, 2023



UKHSA, www.gov.uk

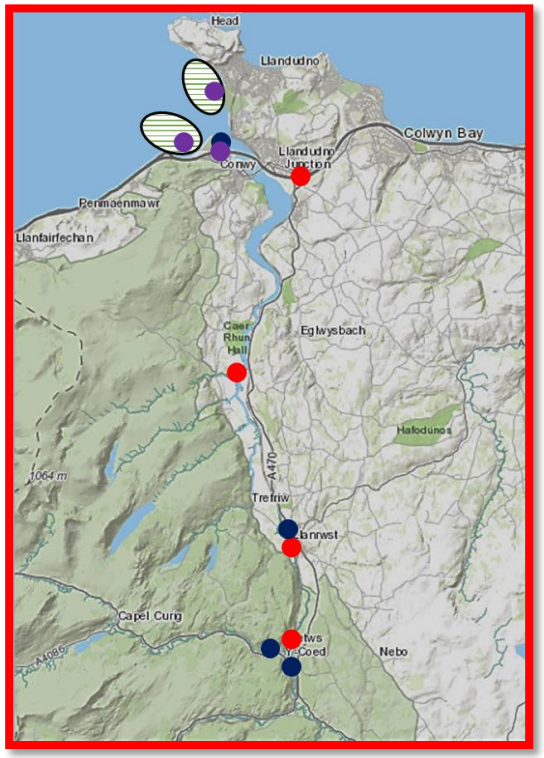
Other monitoring projects



Tracing the fate and infectivity of human pathogenic viruses through the environment 2015-2018

Natural Environment Research Council

Viraqua



Developing an Assurance Scheme for Shellfish and Human Health 2019-2021

Microbial source tracking in the Menai Strait, North Wales 2021-2022

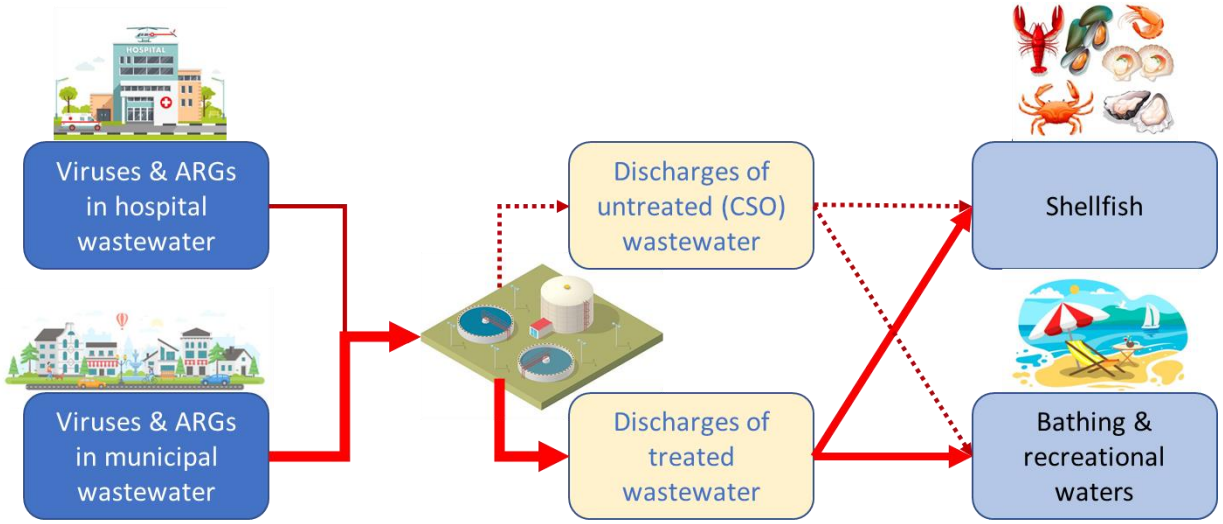
THE SHELLFISH CENTRE
CANOLFAN PYSGOD CREGYN

Detection of Norovirus in Wastewater - assessing community prevalence and risk of shellfish contamination 2022-2023

FISHERIES & SEAFOOD SCHEME

PathSafe project

Development of pre-emptive data-driven tools to predict the risk posed by Norovirus and AMR in coastal waters and entry into the food chain



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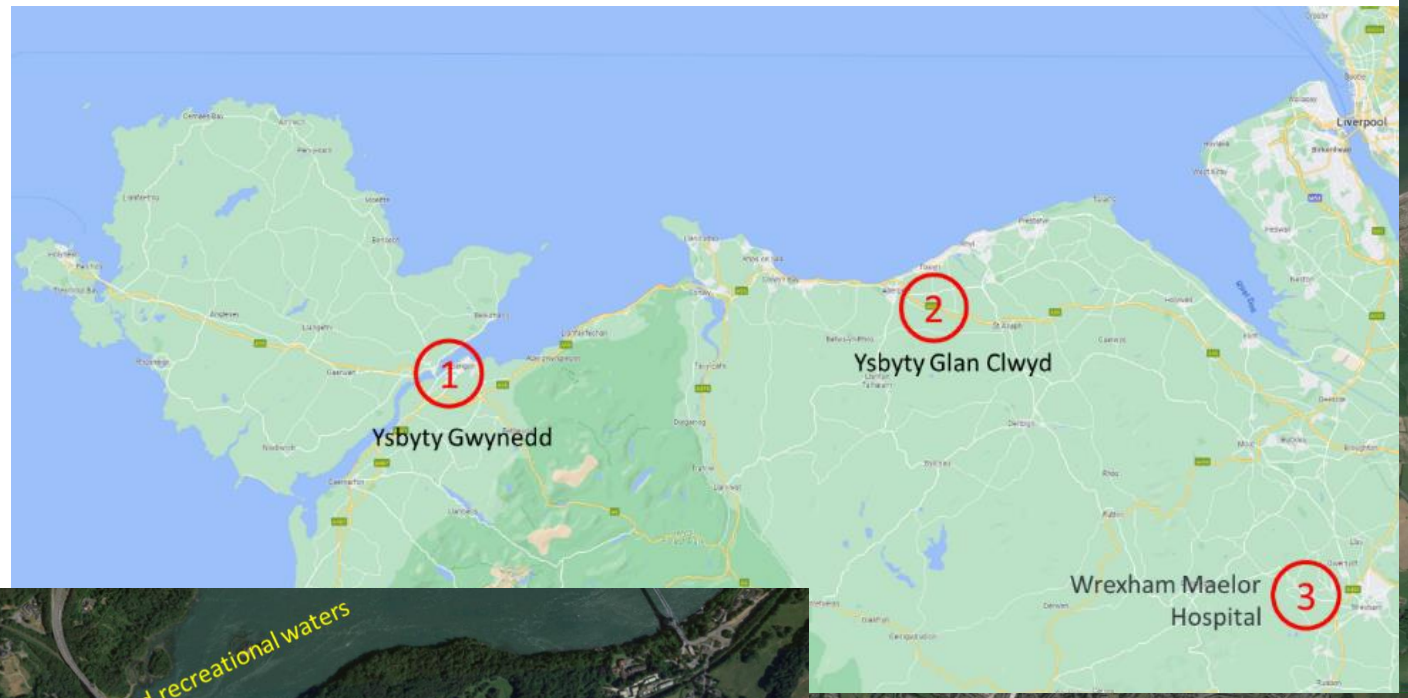
Dŵr Cymru Welsh Water

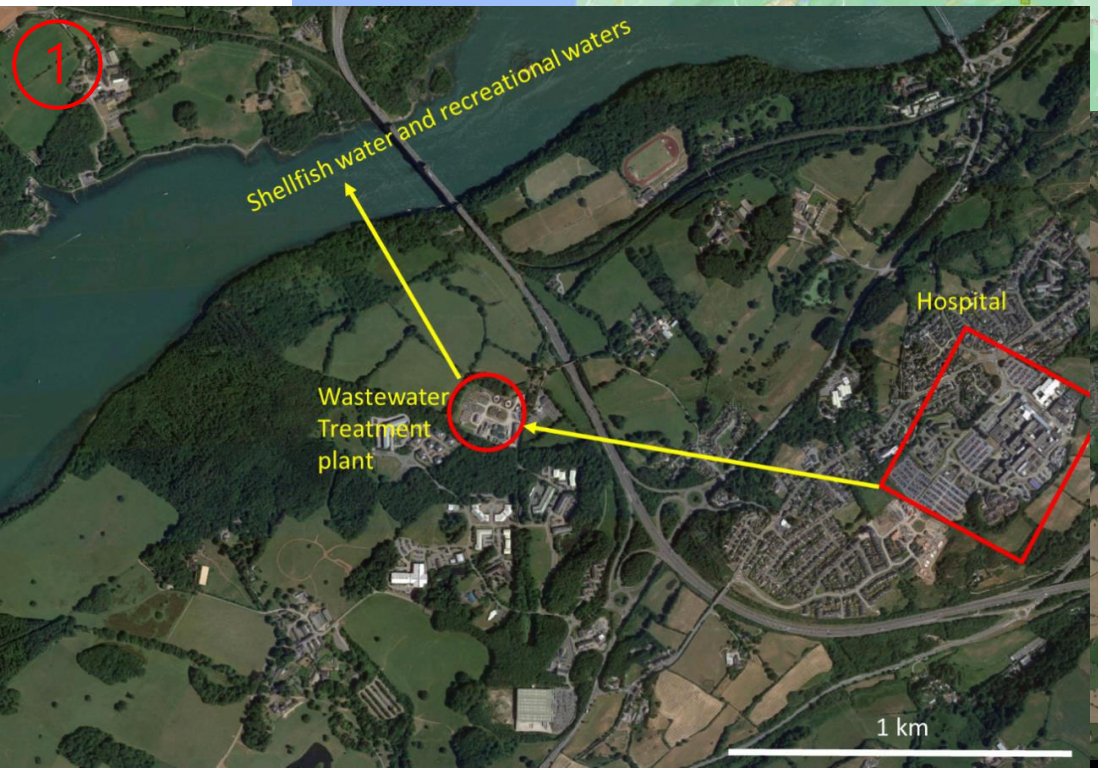
GIG CYMRU NHS WALES

Iechyd Cyhoeddus Cymru Public Health Wales

Cefas

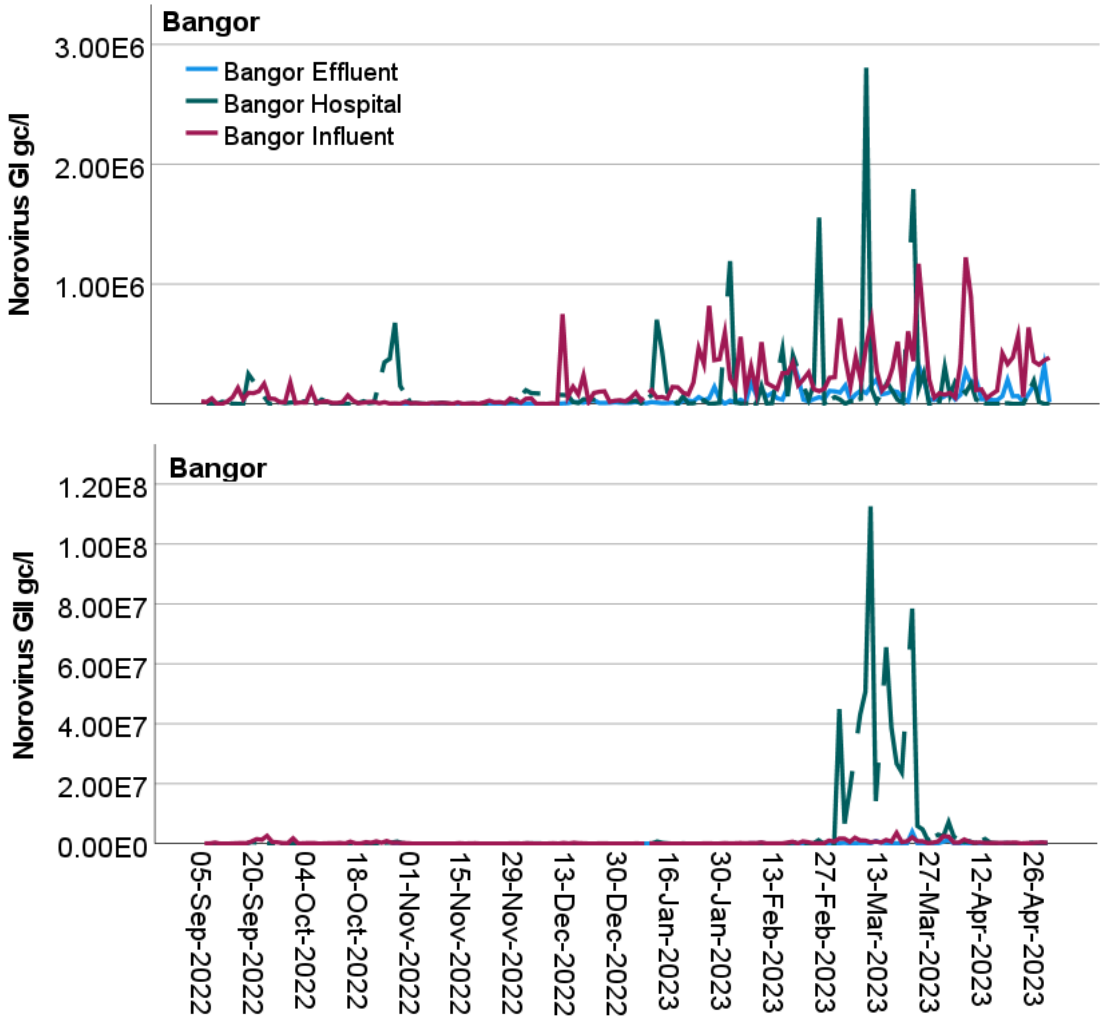

1
Ysbyty Gwynedd
2
Ysbyty Glan Clwyd
Wrexham Maelor
Hospital
3


Bathing waters
2
Wastewater
Treatment
plant
Hospital
1 km

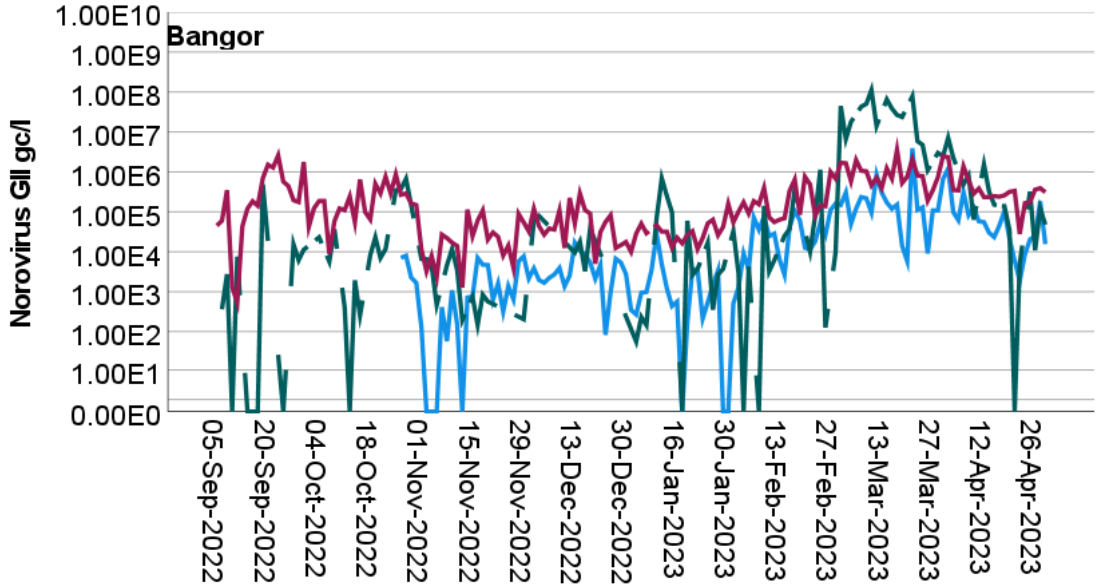

1
Shellfish water and recreational waters
Hospital
Wastewater
Treatment
plant
1 km


Hospital
3
Wastewater
Treatment
plant
1 km
River Dee discharge

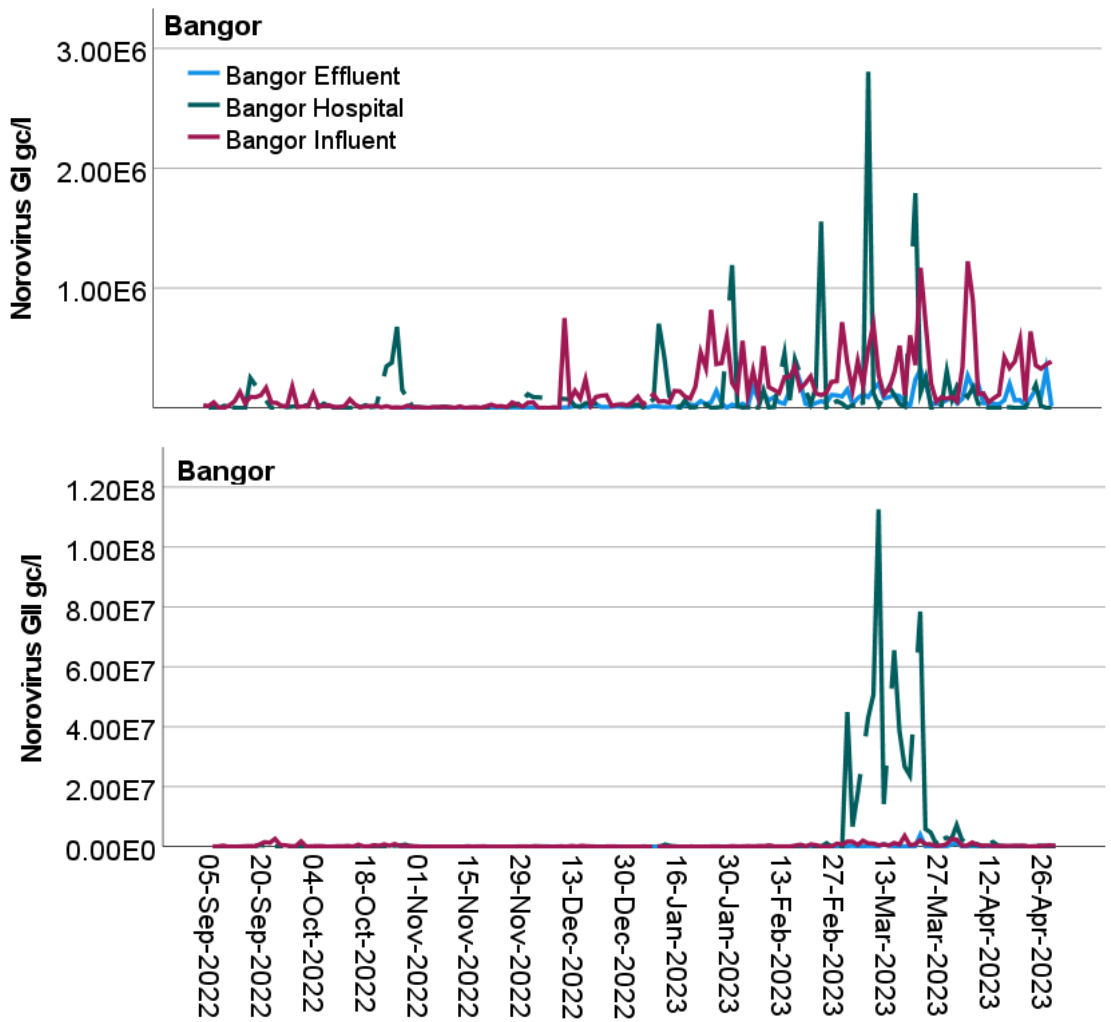
Norovirus surveillance

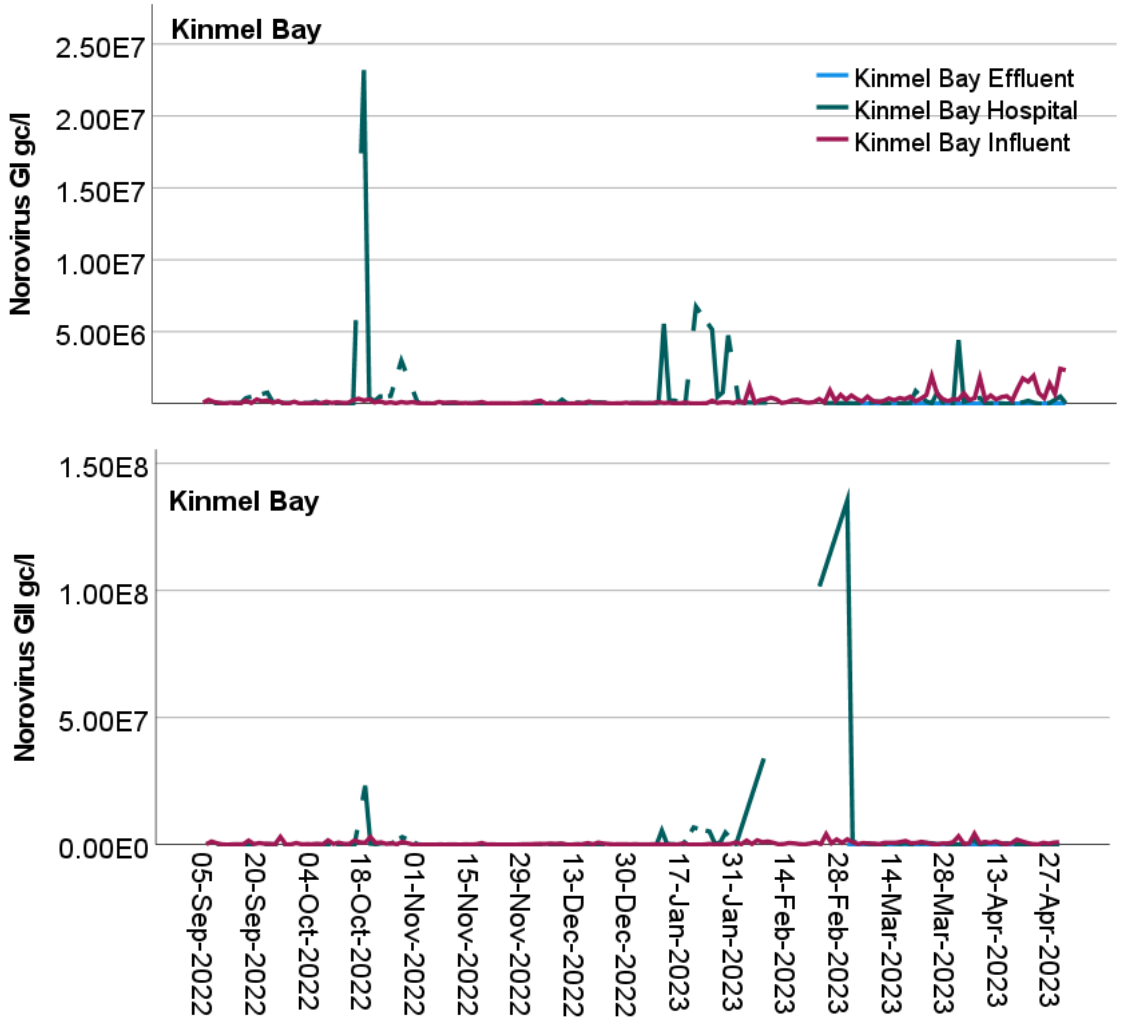


- Elevated norovirus levels in municipal wastewater February to April
- Little RNA decay during wastewater treatment
- Clear outbreak of norovirus GII in hospital in February-March



Norovirus surveillance





AMR monitoring

Tackling antimicrobial resistance 2019–2024

The UK's five-year national action plan

Published 24 January 2019

Llywodraeth Cymru
Welsh Government

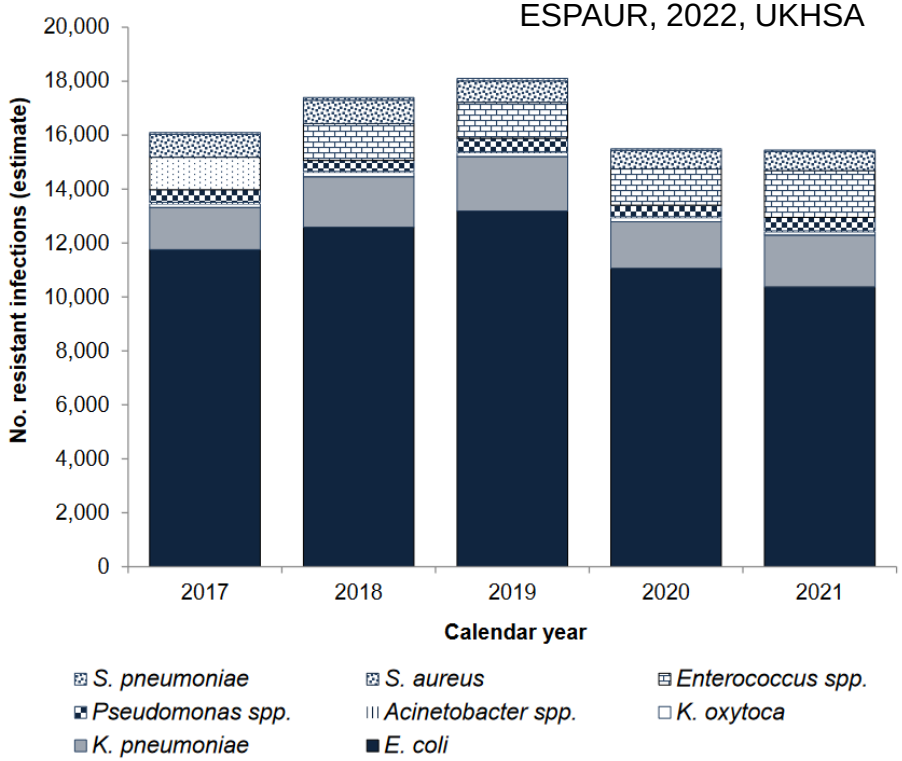
Antimicrobial Resistance in Animals and the Environment

Five Year Implementation Plan for Wales 2019-2024

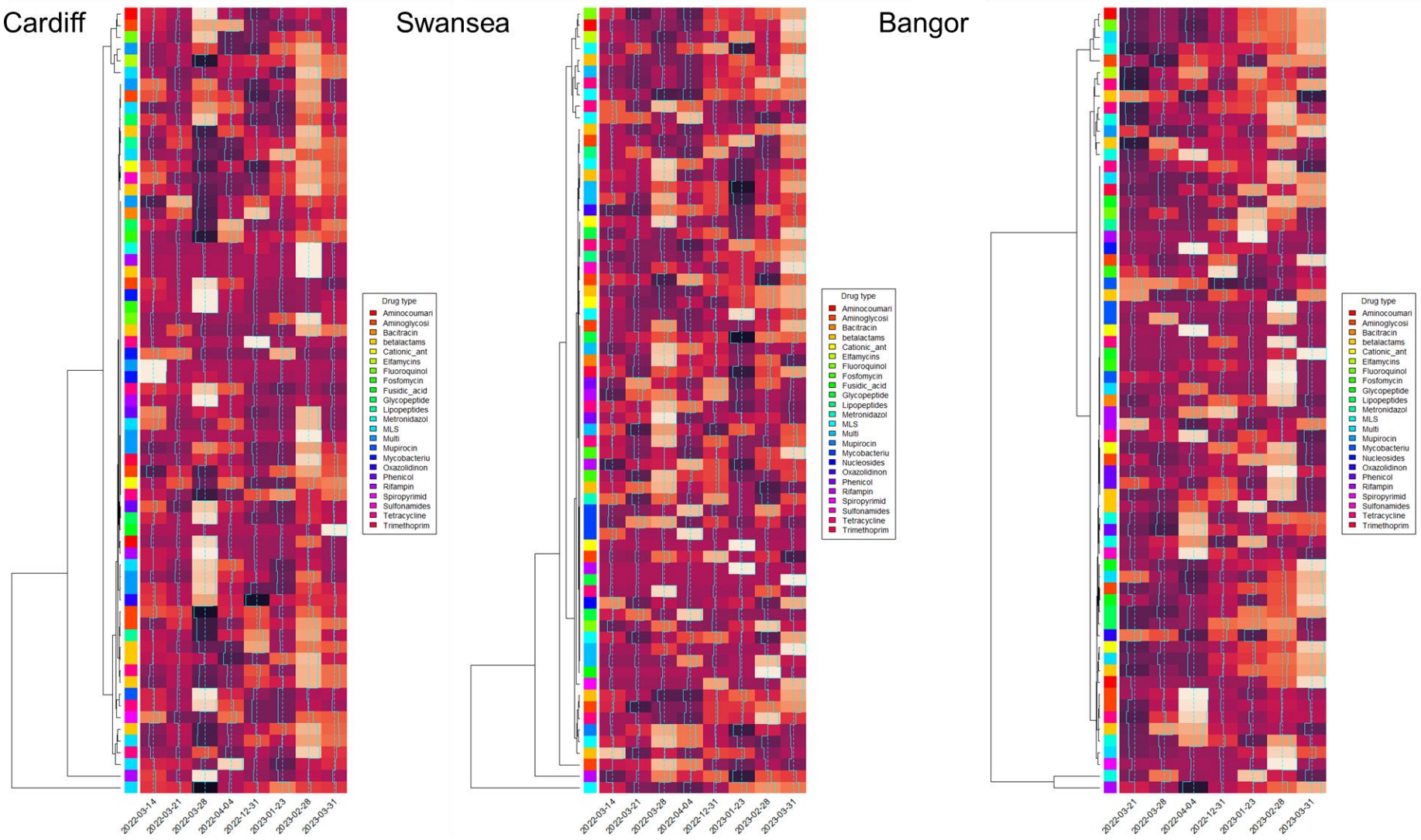
- optimise the use of antimicrobials
- reduce the need for, and unintentional exposure to antibiotics
- support the development of new antimicrobials

Figure 2.2 Annual estimated total of (the burden) of antibiotic-resistant bloodstream episodes, England 2017 to 2021

ESPAUR, 2022, UKHSA

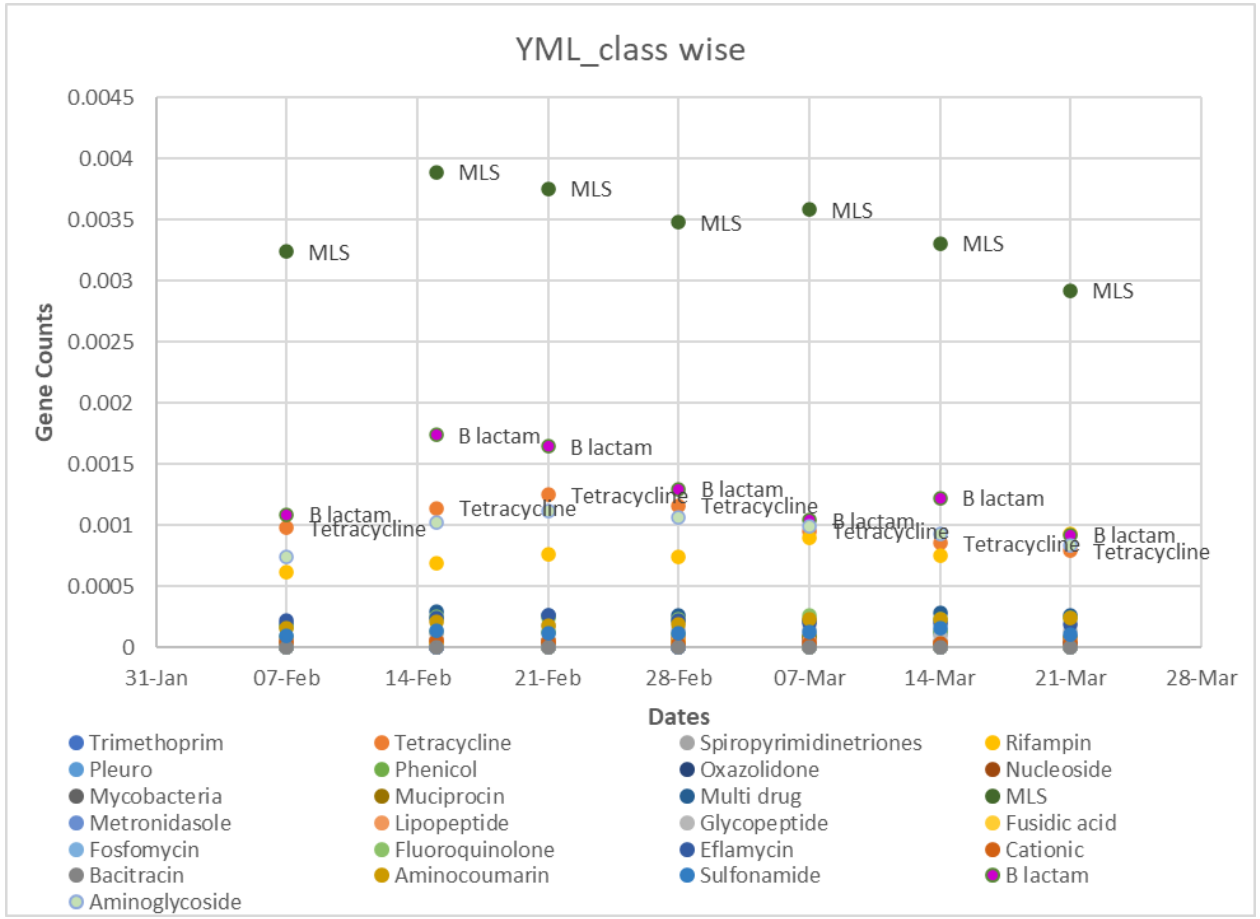


AMR monitoring



Dr William Perry
Water Research Institute
Cardiff University

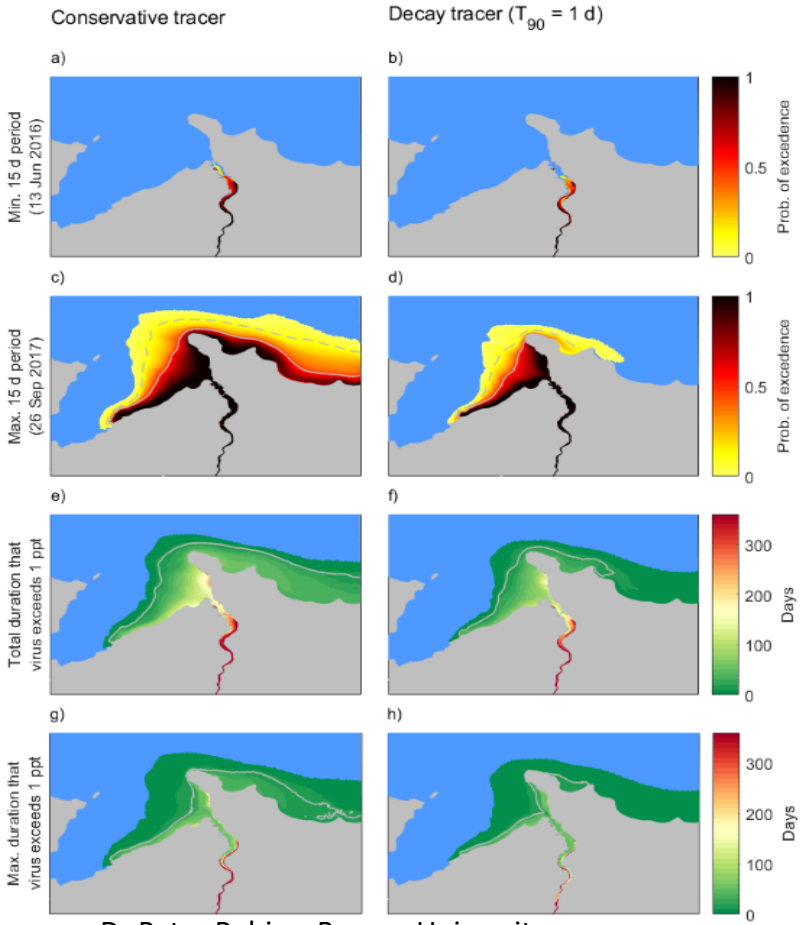
AMR monitoring in hospital wastewater



Dominated by MLS (Macrolide, lincosamide, Streptogamins)- clinically relevant class used in treatment of MDR *Stapylococcus aureus*

Dr Reshma Silvester
Bangor University

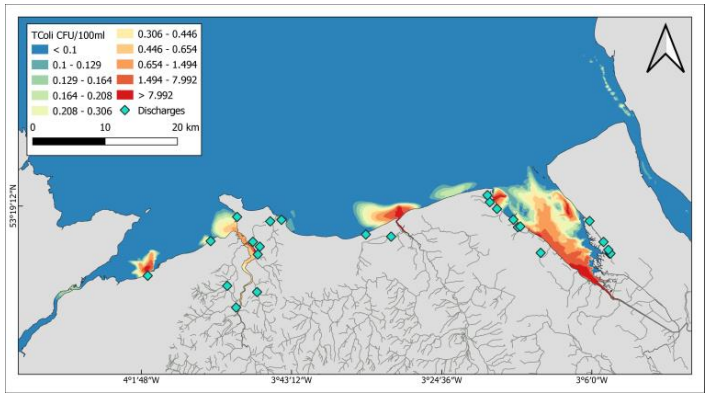
Pathogen transport modelling



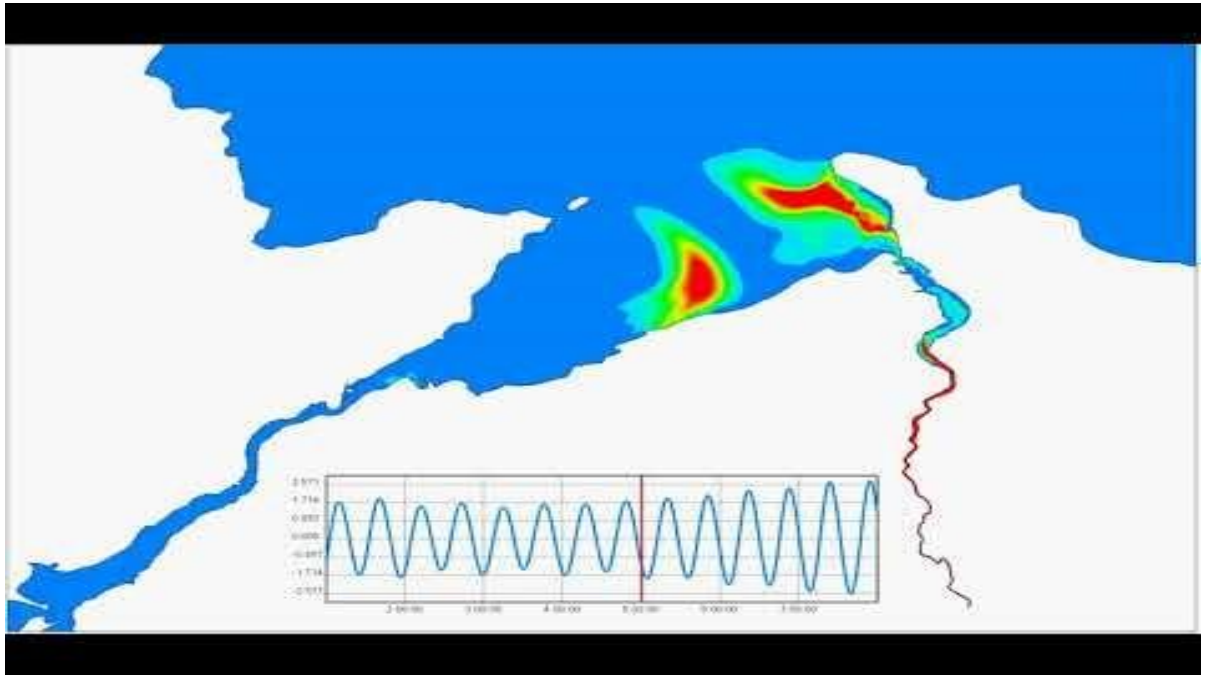
Dr Peter Robins, Bangor University

http://www.viraqua.uk/models/

Robins et al, 2019 doi.org/10.1016/j.envint.2019.02.042



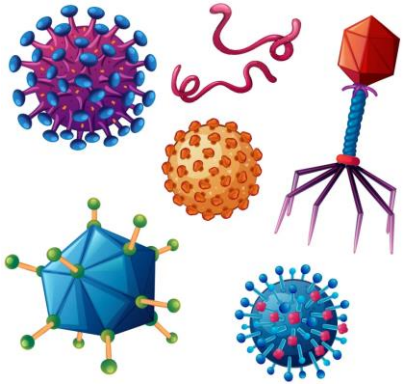
Thomas Clough, Bangor University



Dr Peter Robins, Bangor University

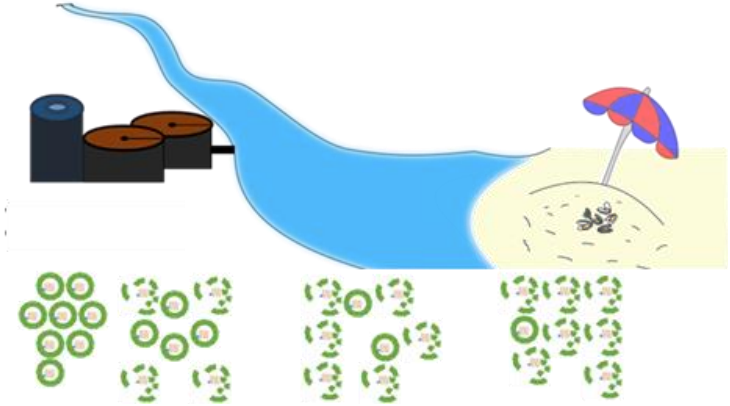
Summary

Source of contamination monitoring is essential to understand contaminant discharge into the aquatic environment.



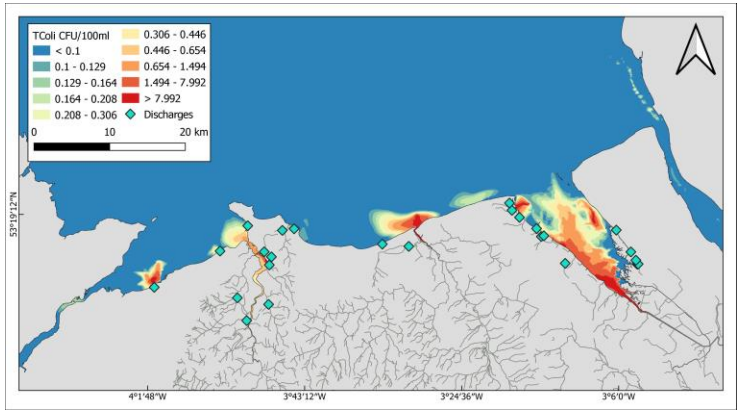
Wastewater-based surveillance can be applied for most enteric pathogens, **viruses, bacteria, protozoa.**

Pathogen survival rates during wastewater treatment and in the aquatic environment to be determined.



Holistic – **One Health** – approach to be applied for animal, human and zoonotic diseases and for the protection of the environment.

Pathogen transport can be modelled to estimate waterborne infection risks.



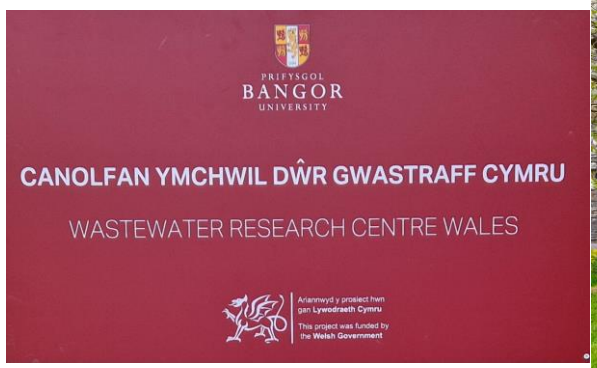
Acknowledgement

www.viraqua.uk
https://www.gov.wales/wastewater-monitoring-reports-coronavirus

@WEWASH3
@KataFarkas211

k.farkas@bangor.ac.uk

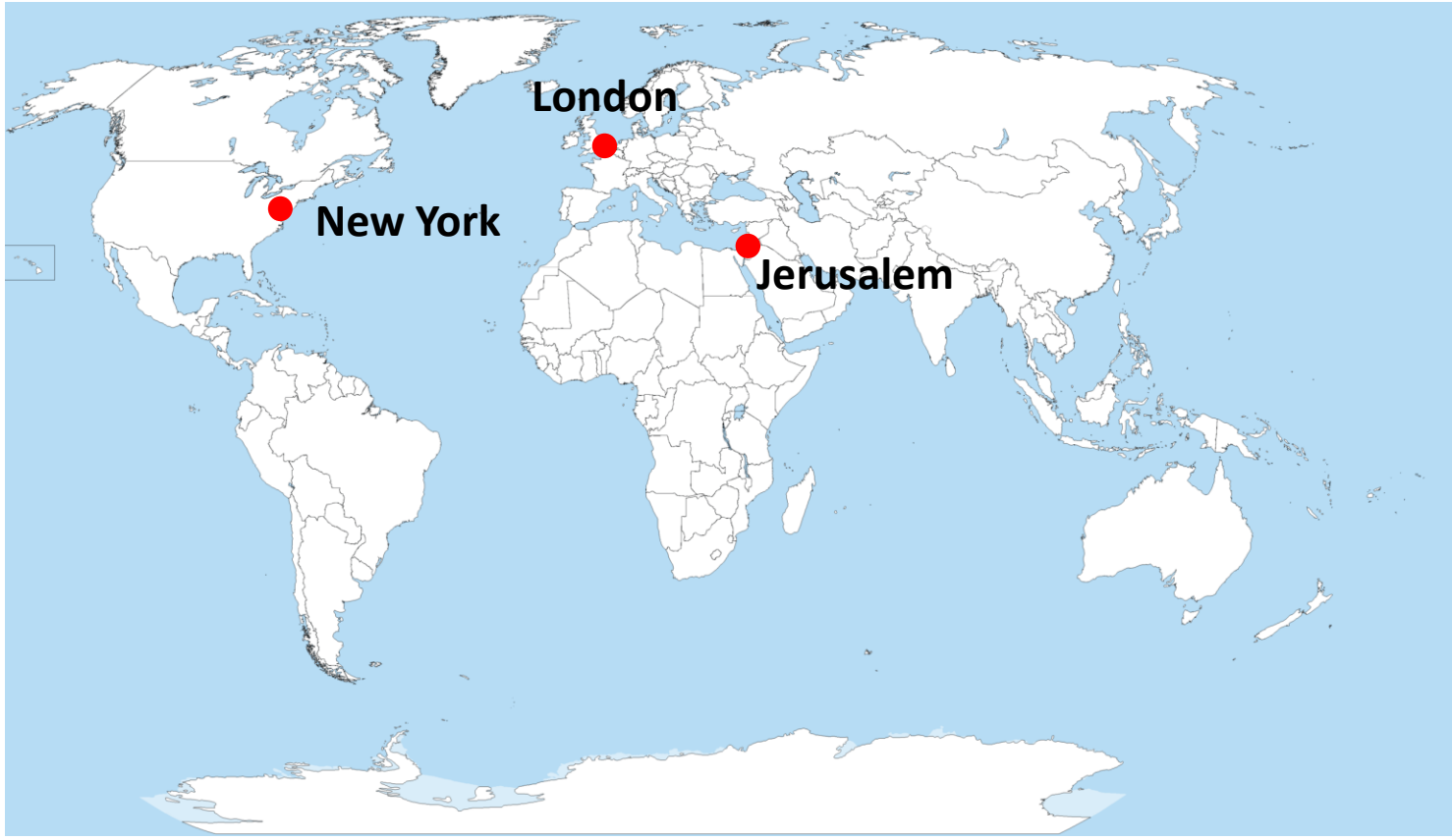
PIs: Prof Davey Jones and Dr Shelagh Malham, Bangor University
AMR: Dr Reshma Silvester, Bangor University,
Dr William Perry, Cardiff University
Modelling: Dr Peter Robins,
Thomas Clough, Bangor University



Extra slides

Poliovirus surveillance

- Vaccine-derived poliovirus type 2 found in London Beckton Feb-June 2022
- Oral vaccine: inactivated virus that may mutate



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HEALTH AND SCIENCE

How polio came back to New York for the first time in decades, silently spread and left a patient paralyzed

PUBLISHED TUE, OCT 4 2022•10:14 AM EDT | UPDATED TUE, OCT 4 2022•1:09 PM EDT

Spencer Kimball
@SPENCEKIMBALL

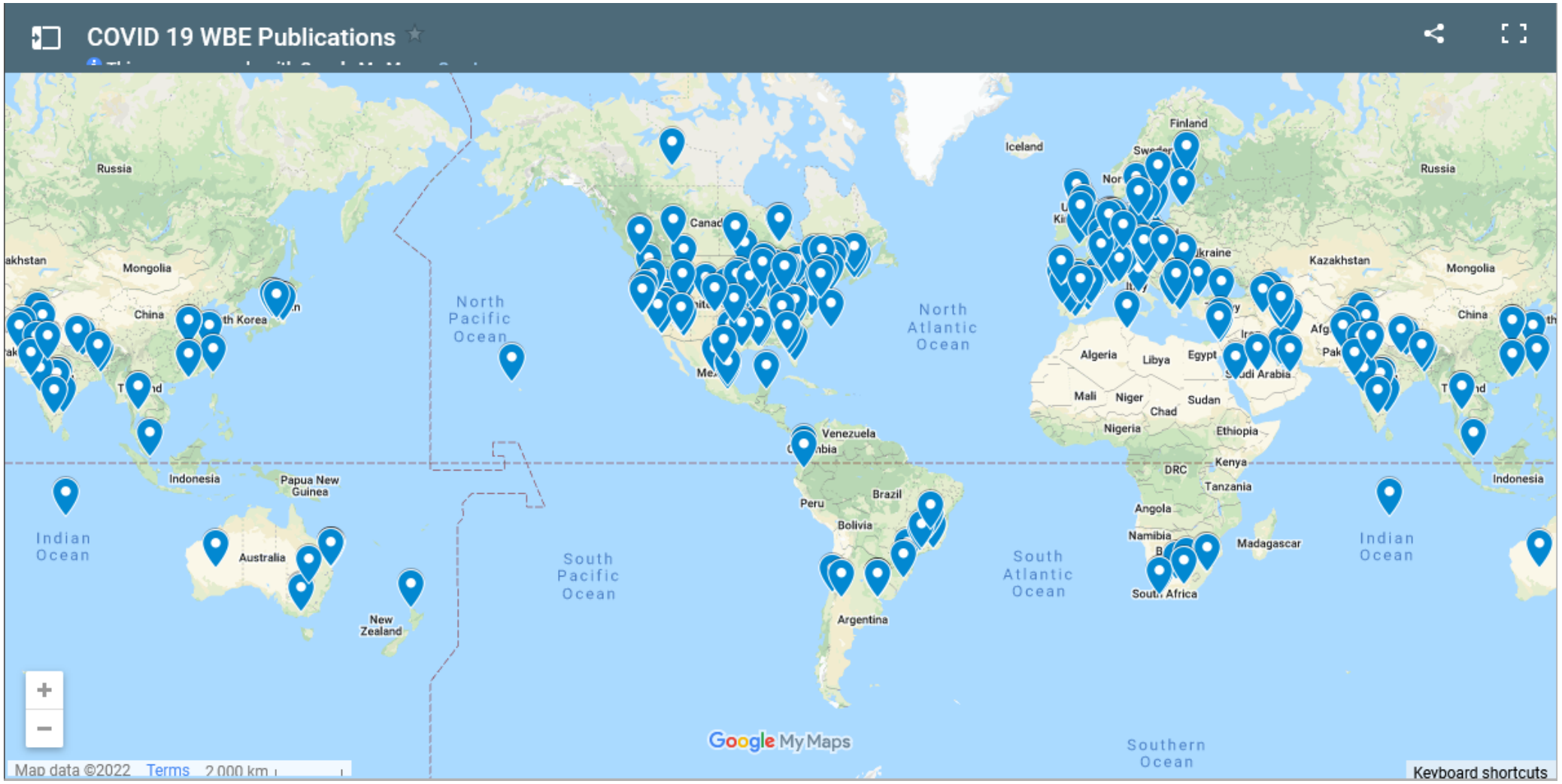
SHARE

KEY POINTS

- An unvaccinated adult suffered paralysis in June from polio, the first case in New York since 1990.
- Wastewater surveillance later found the virus had been spreading silently in the New York City area for months.

NIBSC
Confidence in Biological Medicines

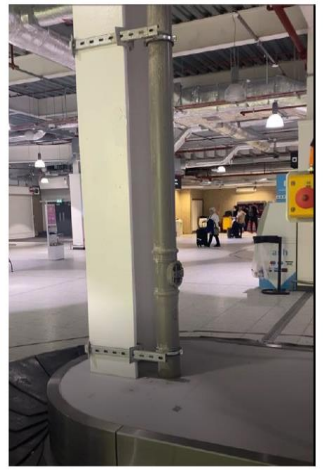
Wastewater-based epidemiology worldwide

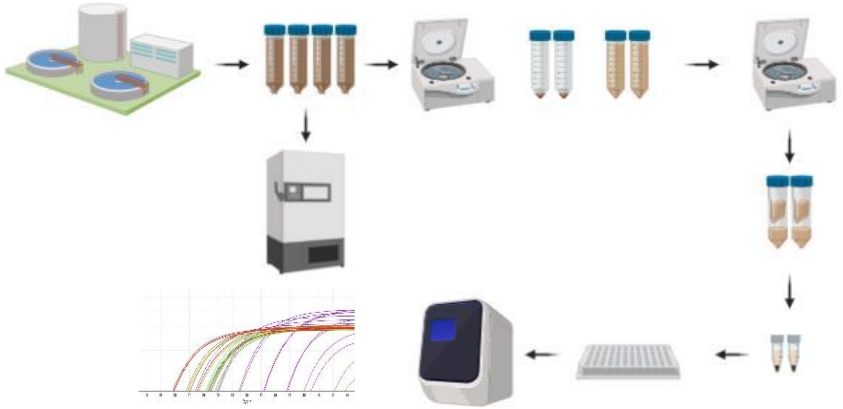


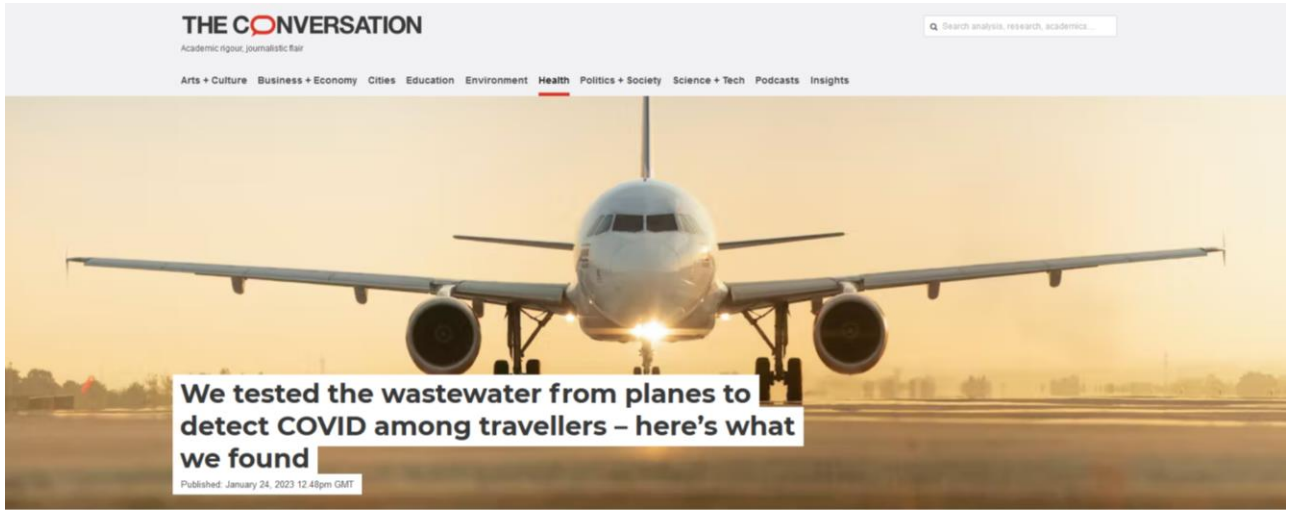
https://www.covid19wbec.org/

Research and innovation

- Gold standard lab in the UK for sample process and qPCR
- Method development for the sampling and concentration of viruses in wastewater for England and Wales
- Quantitative data for ~20 viral targets
- Rapid detection of emerging viruses and variants
- Borders protection: identifying variants upon arrival







UK Health Security Agency

Department of Health & Social Care

Llywodraeth Cymru
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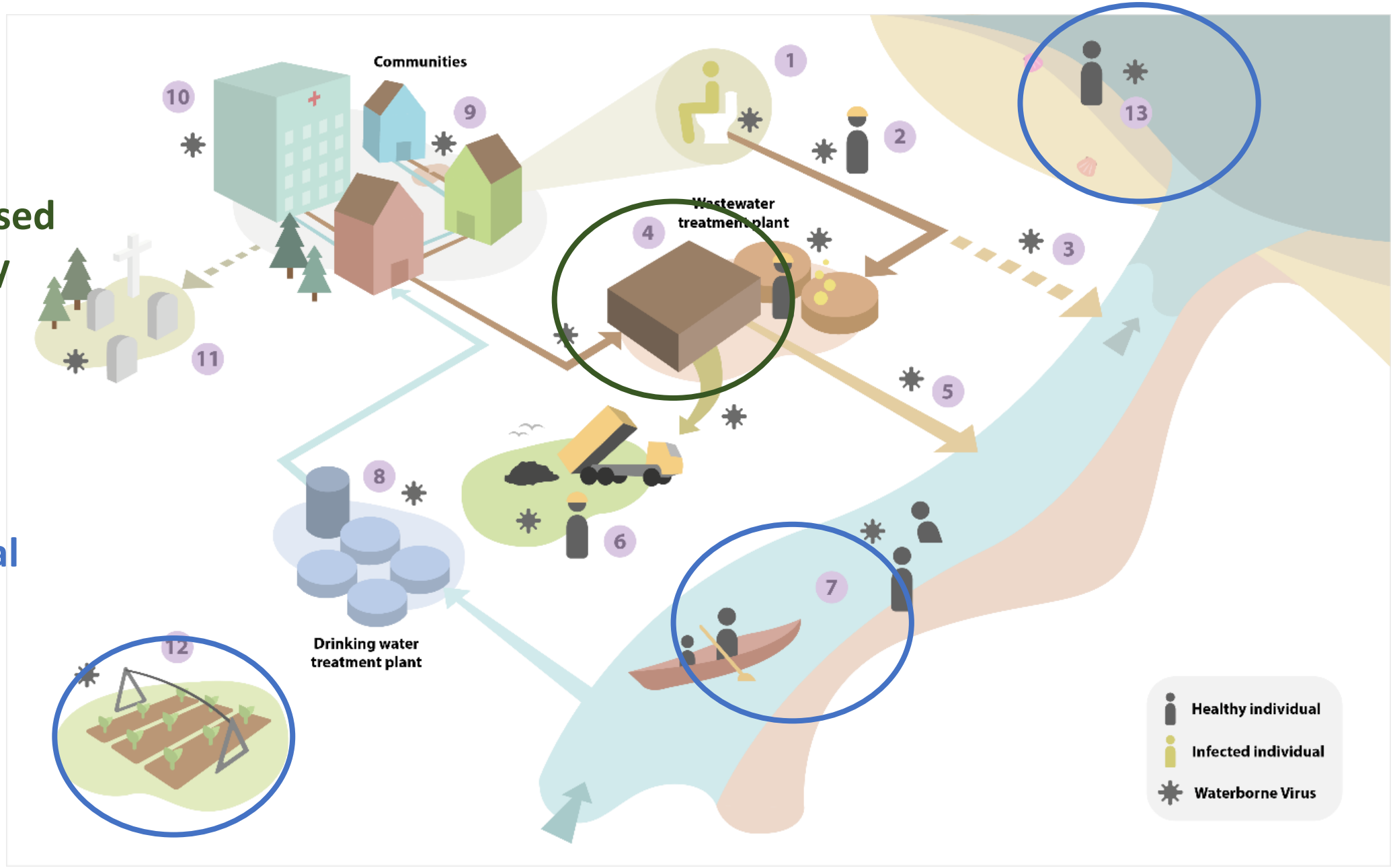
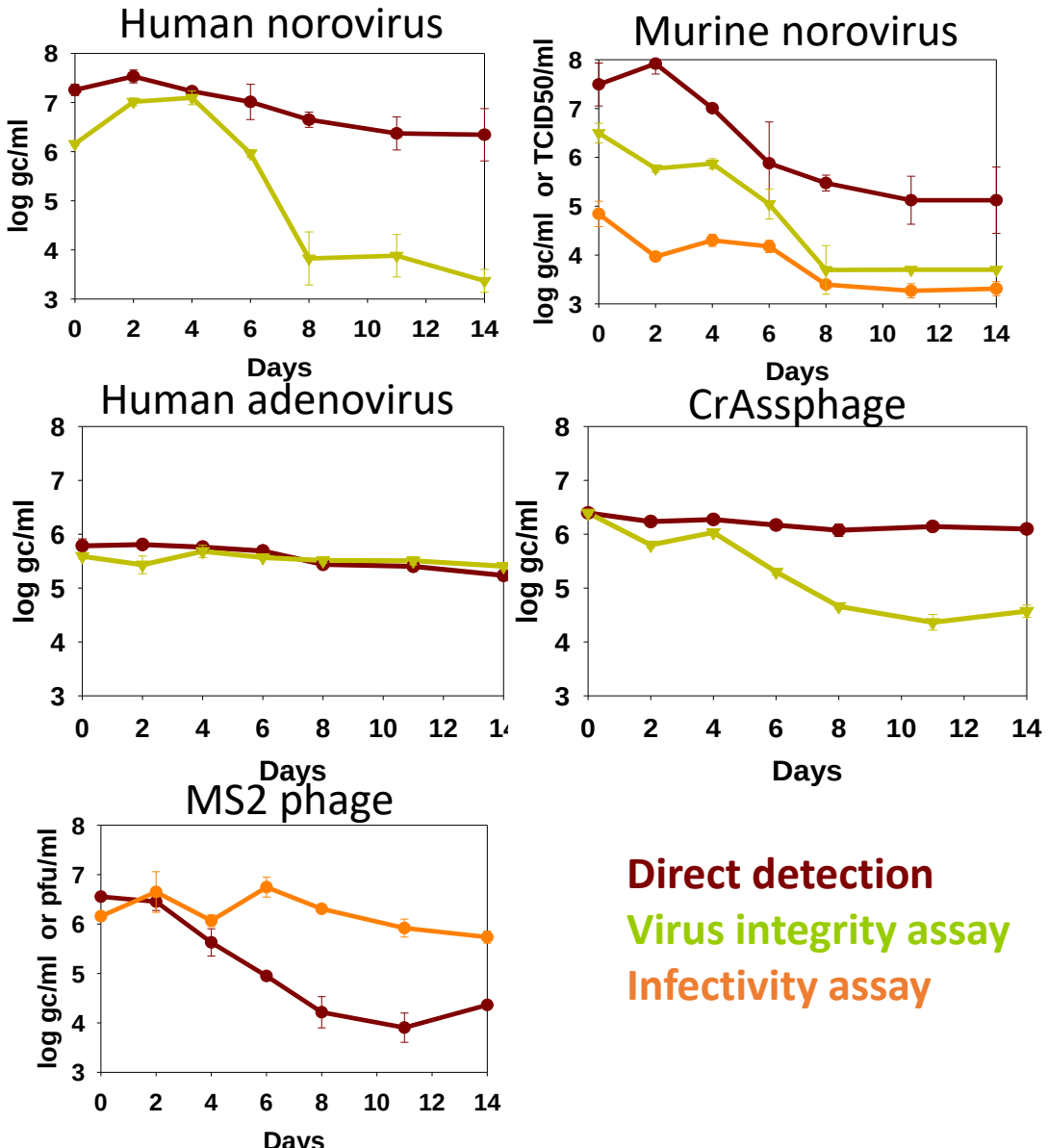
Wastewater-based epidemiology

Environmental surveillance



Assessing viability



Direct detection

Virus integrity assay

Infectivity assay

How long a virus survives in seawater?

PCR – unreliable

Culturing – not available

Laboratory experiment

- Five viruses
- Three methods