



PRIFYSGOL  
**BANGOR**  
UNIVERSITY

# Grand Challenge

## Use of hospital- and community-derived wastewater for AMR surveillance

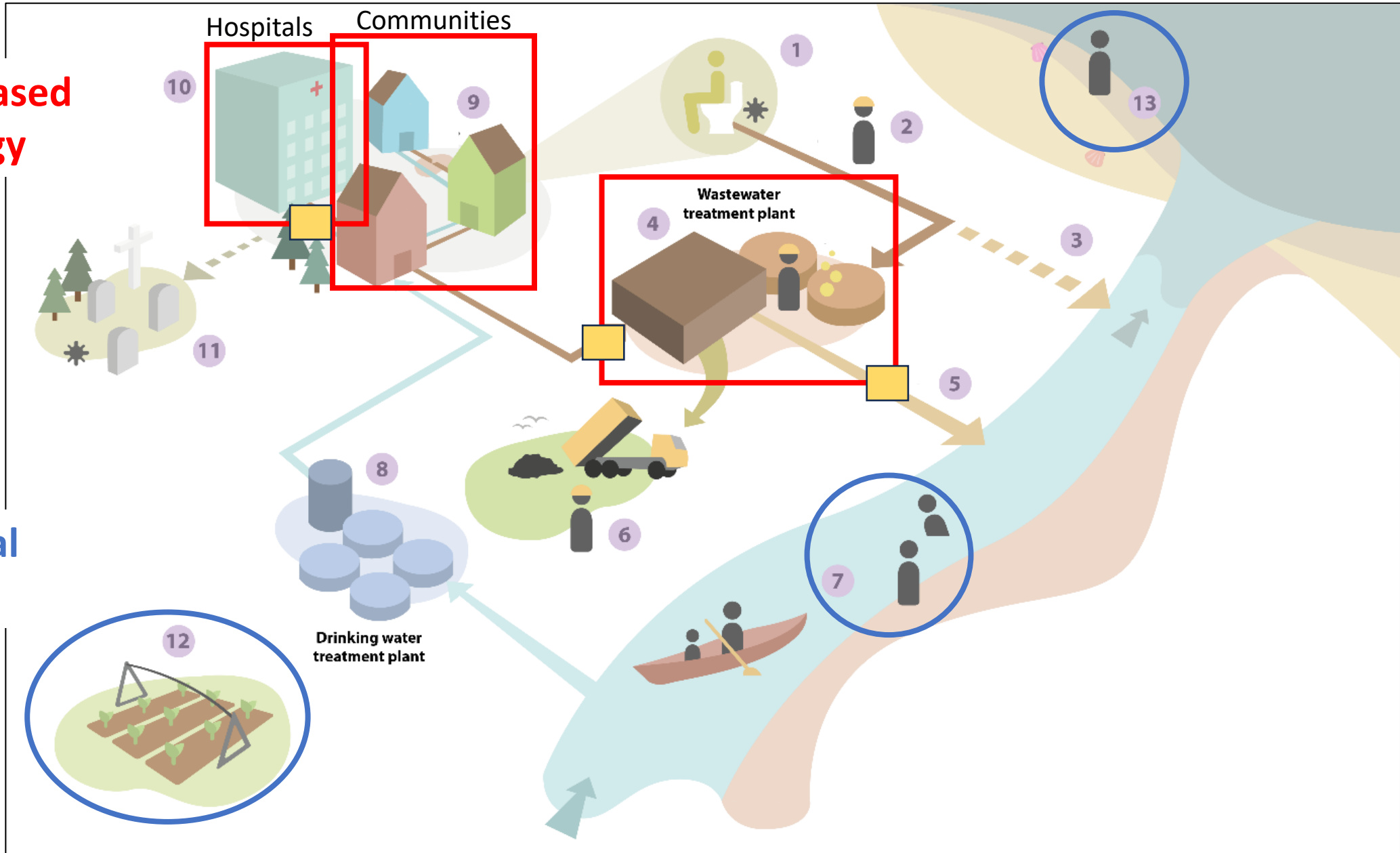
Davey Jones



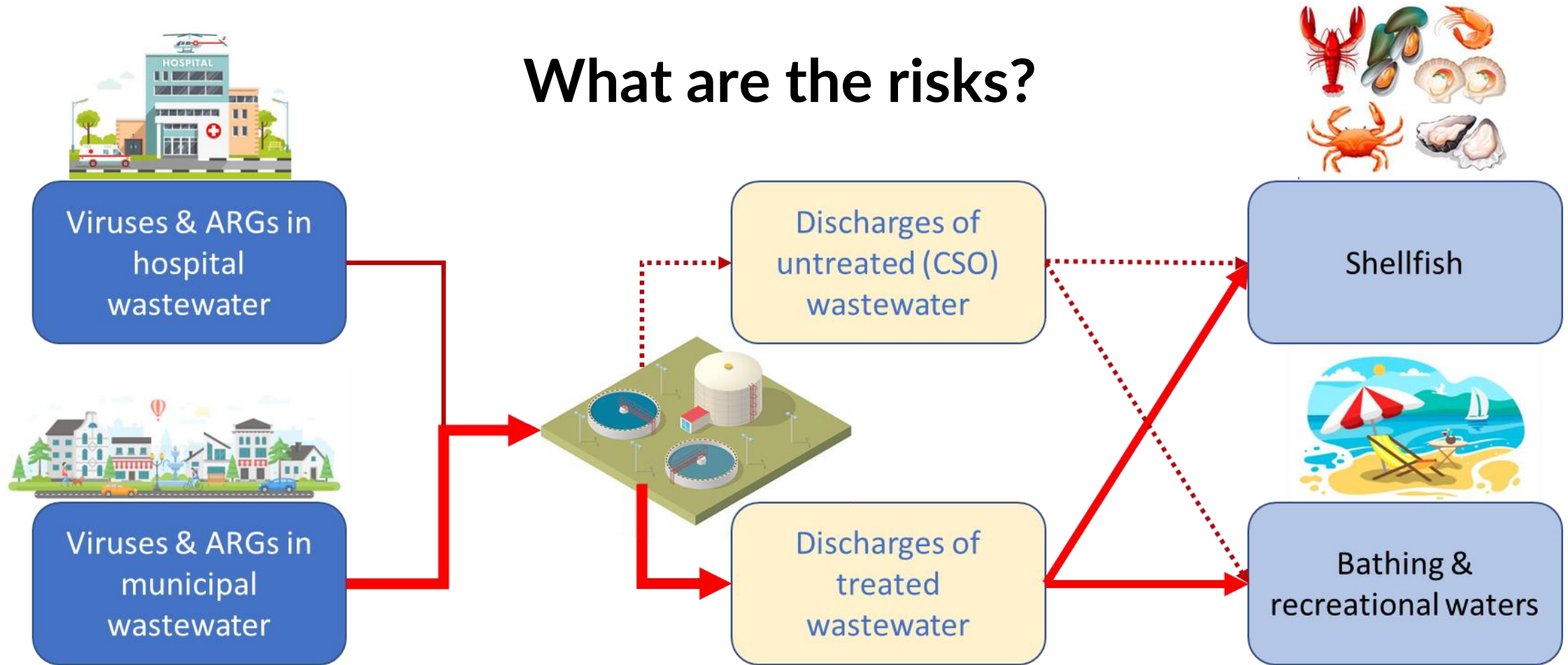
# One Health: Wastewater- and environmental-based AMR surveillance

Wastewater-based epidemiology

Environmental surveillance



# What are the risks?



## SHELLFISH

- Shellfish bioaccumulate AMR carrying organisms
- Re-introduction on AMR into the food chain

## BATHING WATERS

- Infections, skin rashes, wound infections & sepsis
- Exposure to AMR genes, which can increase the risk of developing or spreading AMR



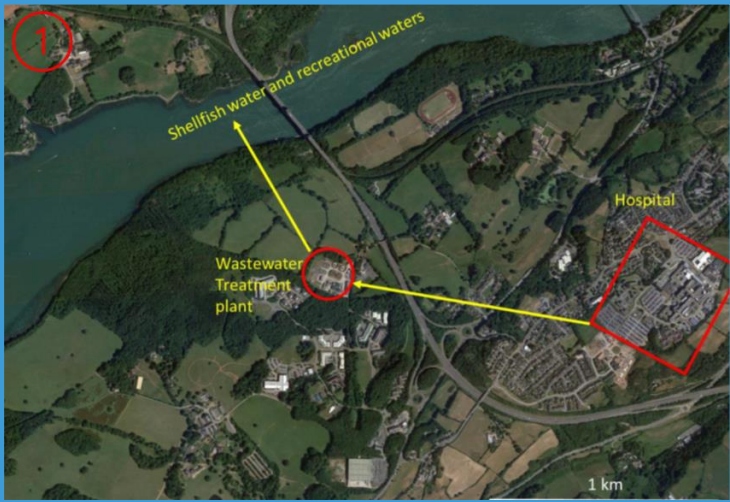
# SAMPLING LOCATIONS

Ysbyty Gwynedd wastewater  
 Bangor Treborth influent  
 Bangor Treborth effluent  
 Ysbyty Glan Clwyd wastewater  
 Kinmel Bay influent  
 Kinmel Bay effluent  
 Ysbyty Maelor wastewater  
 Wrexham Five Fords influent  
 Wrexham Five Fords effluent

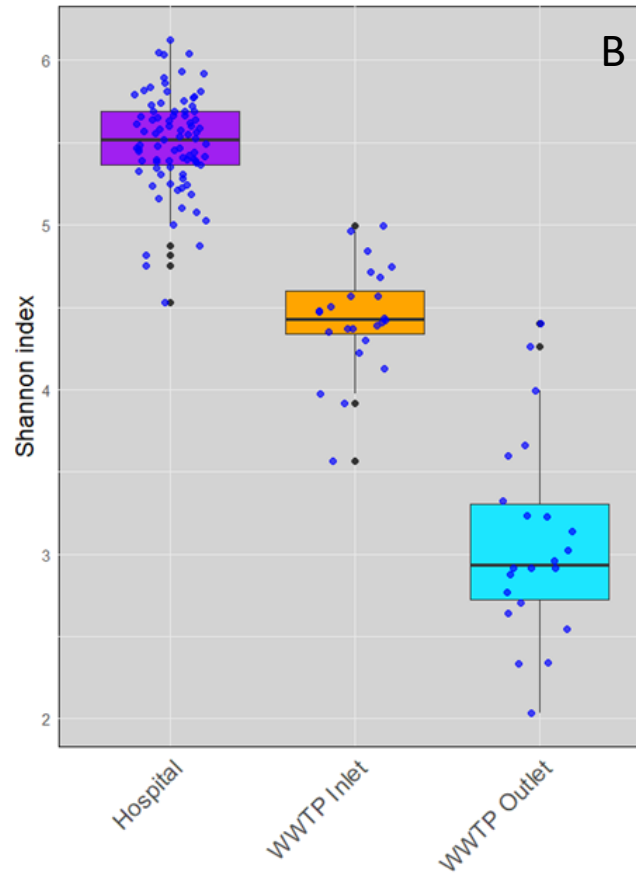
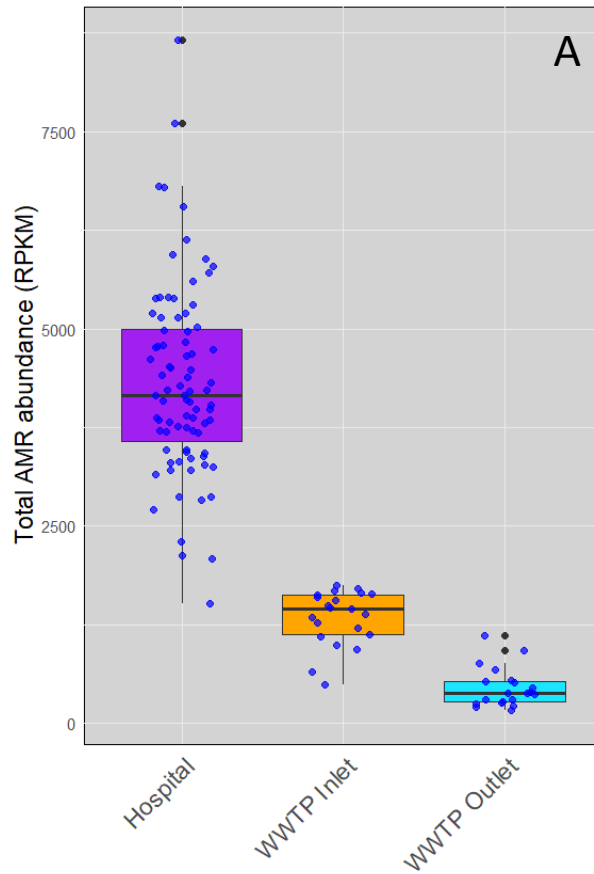
Hospital  
 WwTW  
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 Hospital  
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 Hospital  
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## Legend

- ▶ Treatment Plant
- + Hospitals



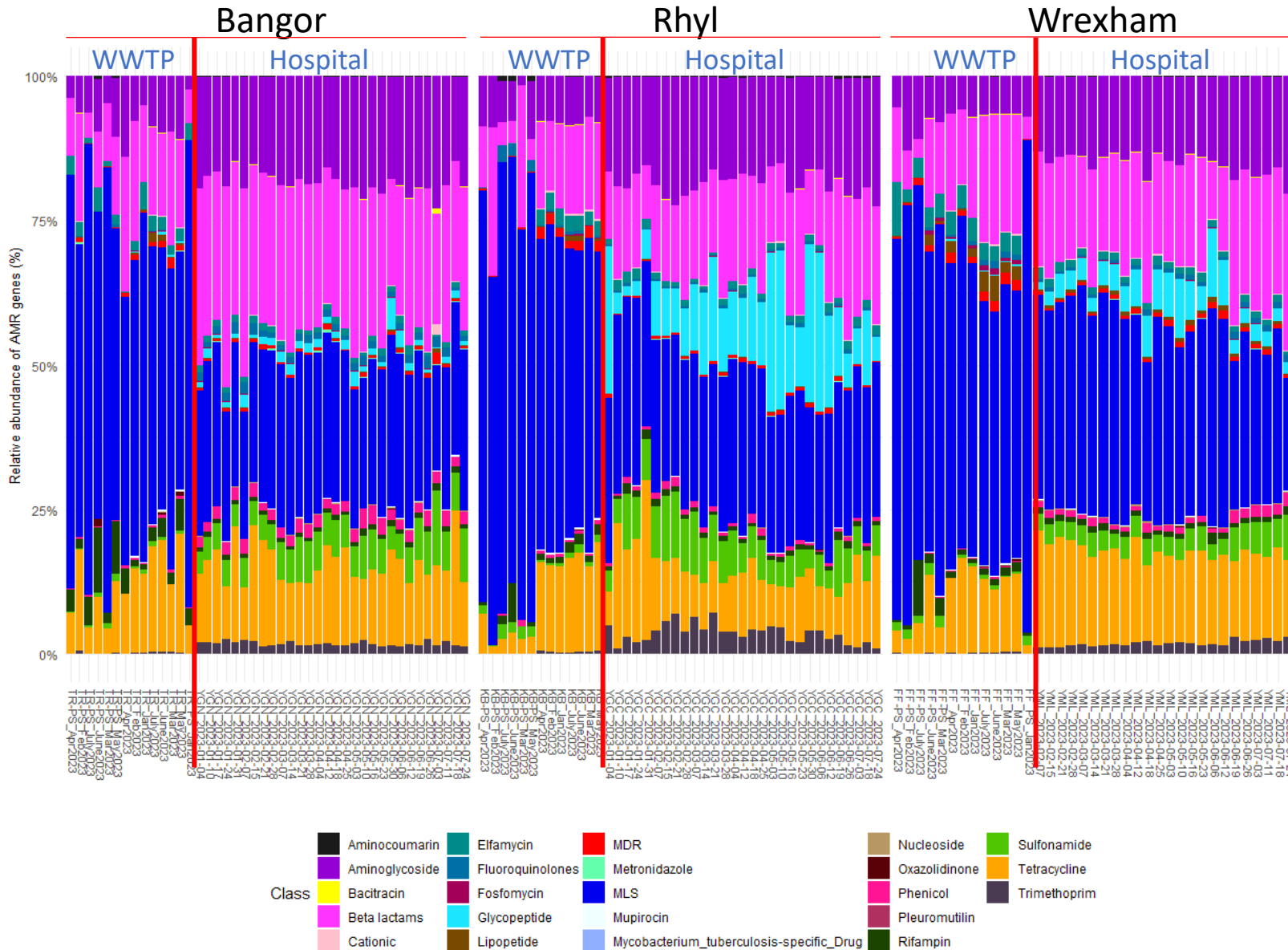
# Prevalence and diversity of antibiotic resistance genes (ARGs) in hospital and WWTP wastewater



- Higher abundance and diversity of antibiotic resistance genes (ARGs) detected in hospital wastewater compared to WWTPs
- Still a baseload of ARGs released through treated effluents into receiving waterbodies

Boxplots showing (A) total AMR Reads Per Kilobase per Million mapped reads (RPKM) per sample, and (B) resistome diversity (Shannon index) stratified by sample (hospitals, WWTP inlet, and outlet).

# Relative abundance of AMR genes per antibiotic class



- ARGs encoding resistance towards MLS (macrolides-lincosamide-streptogramin),  $\beta$ -lactams, aminoglycosides, and tetracyclines dominated across all the samples throughout the study period
- Glycopeptide ARGs mainly confined to hospitals
- The relative proportion varied according to sample type and sites





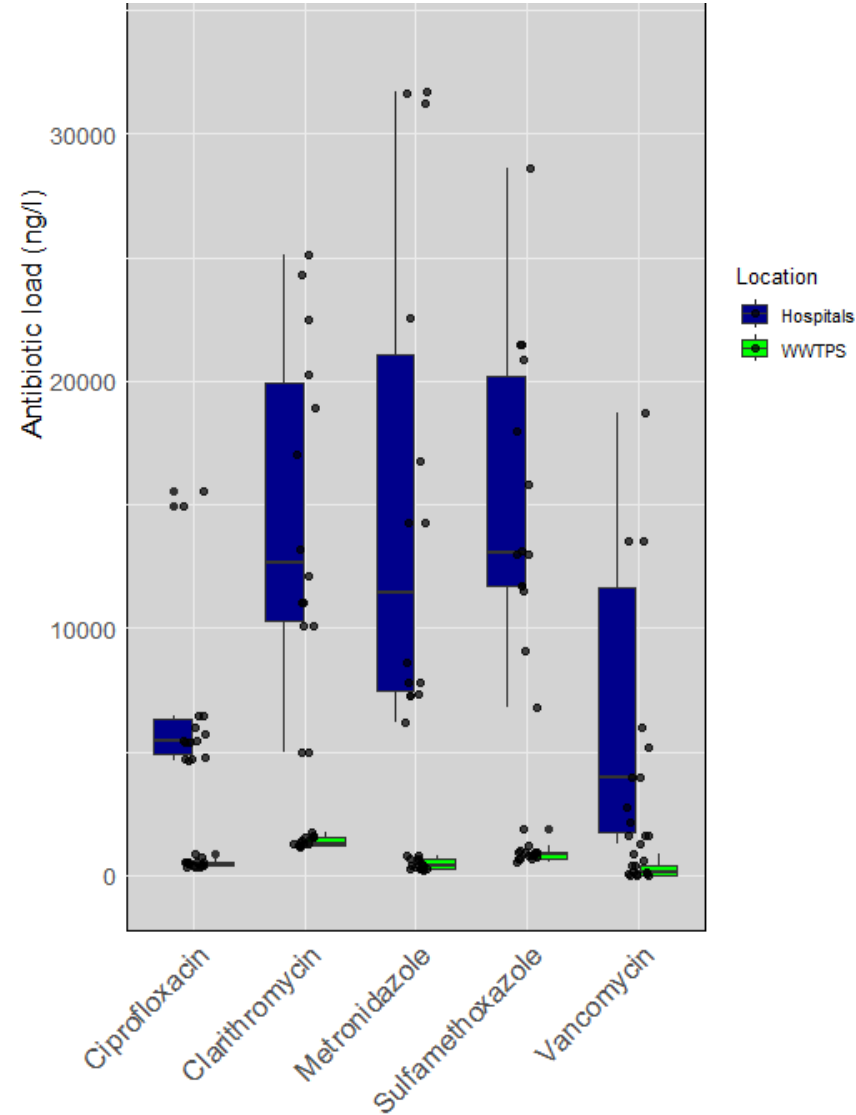
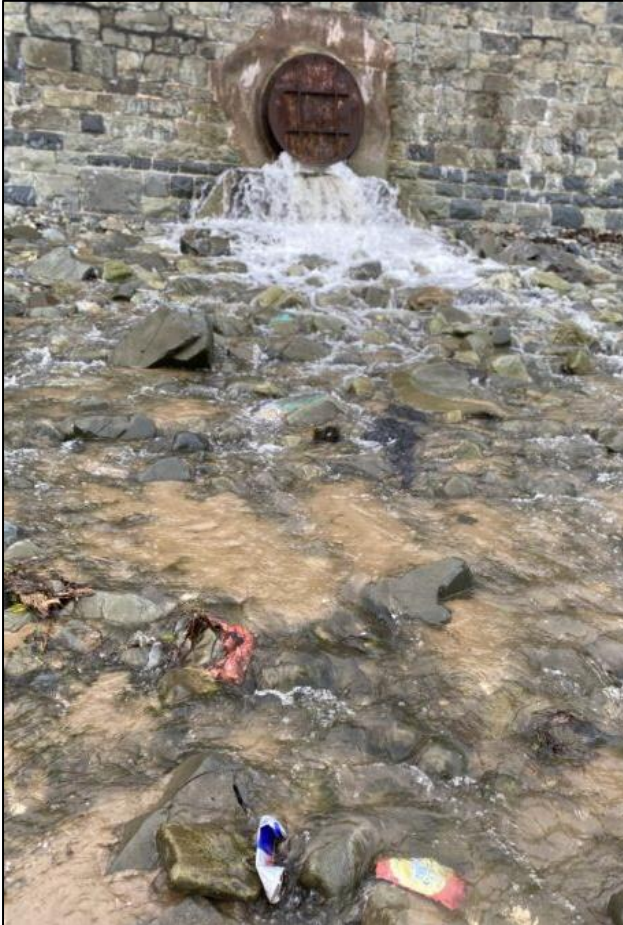


Can we use this to inform decision making in healthcare settings?

- Promoting engagement with clinical infection teams (dashboarding and data systems)
- Timeliness (early warning)
- Economic benefits
- Health outcome benefits

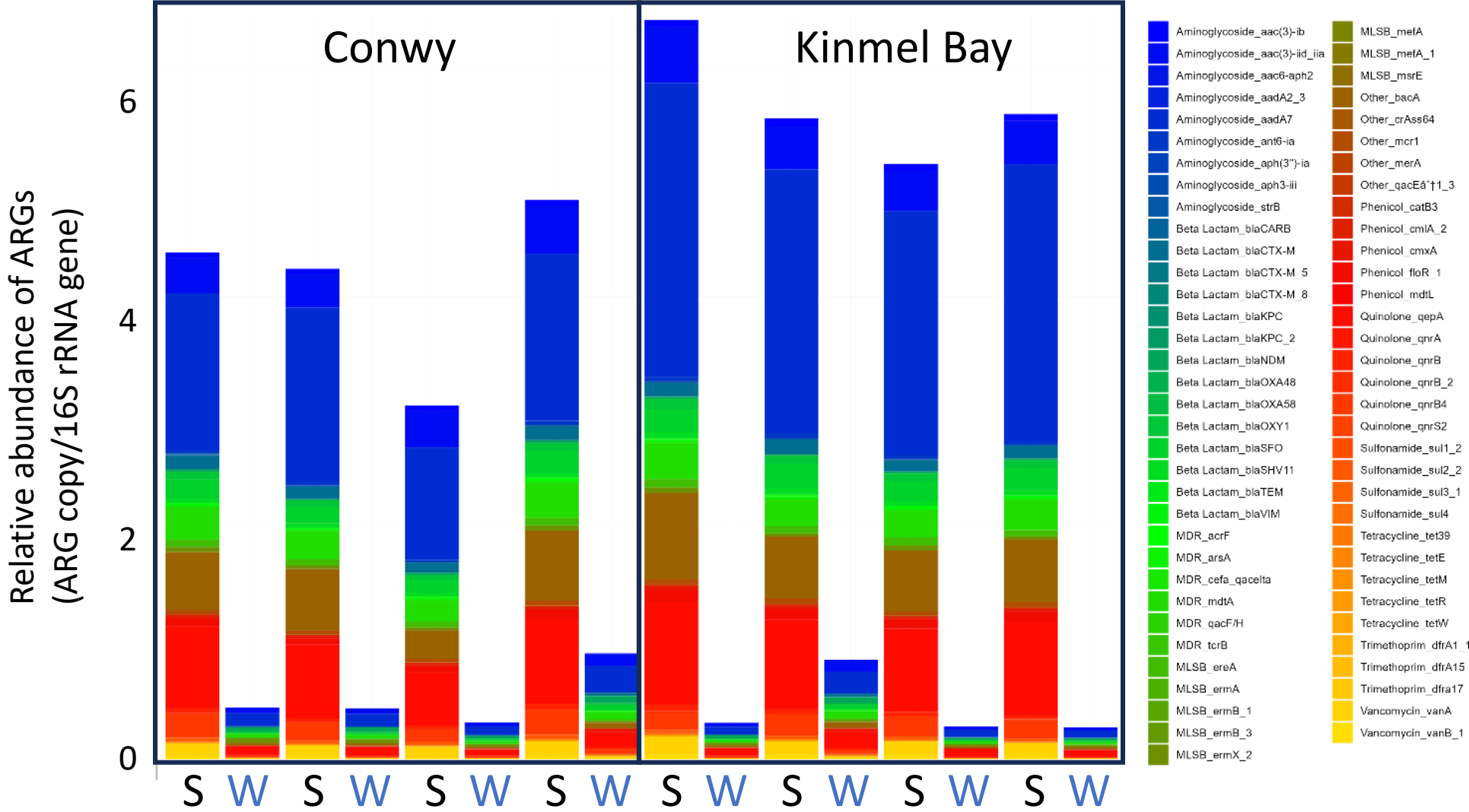
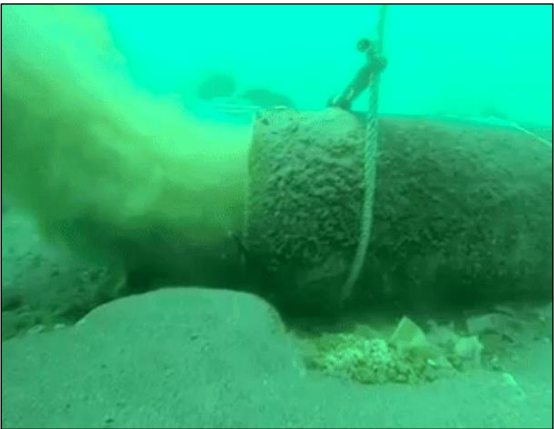


# Antibiotic loads in wastewater



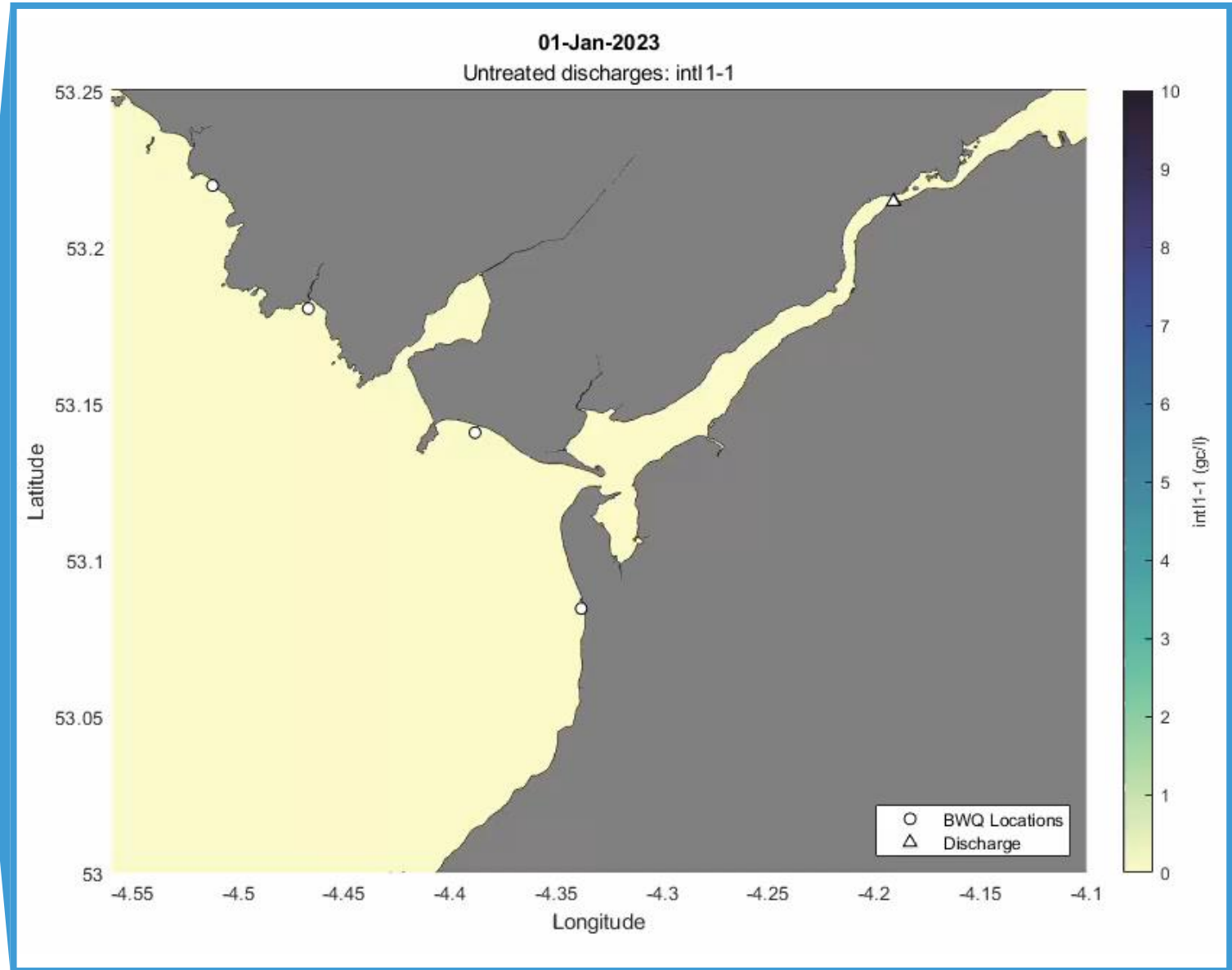
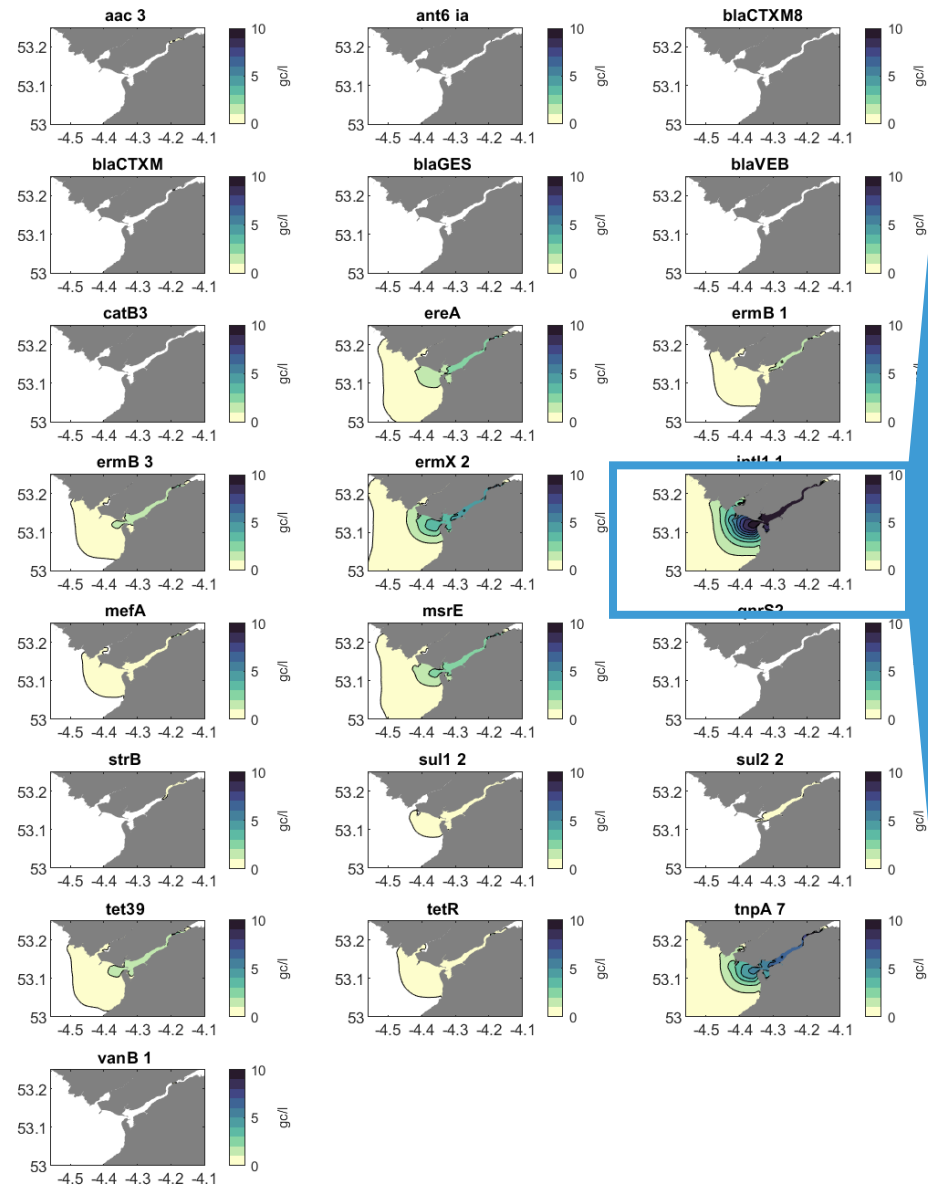
- Antibiotic and viral loads very high in hospital wastewater
- Sewer pipes = AMR evolution hotspots
- Vancomycin load (glycopeptide) very high in Glan Clwyd

# AMR in the seawater and sediments around sewage outfalls



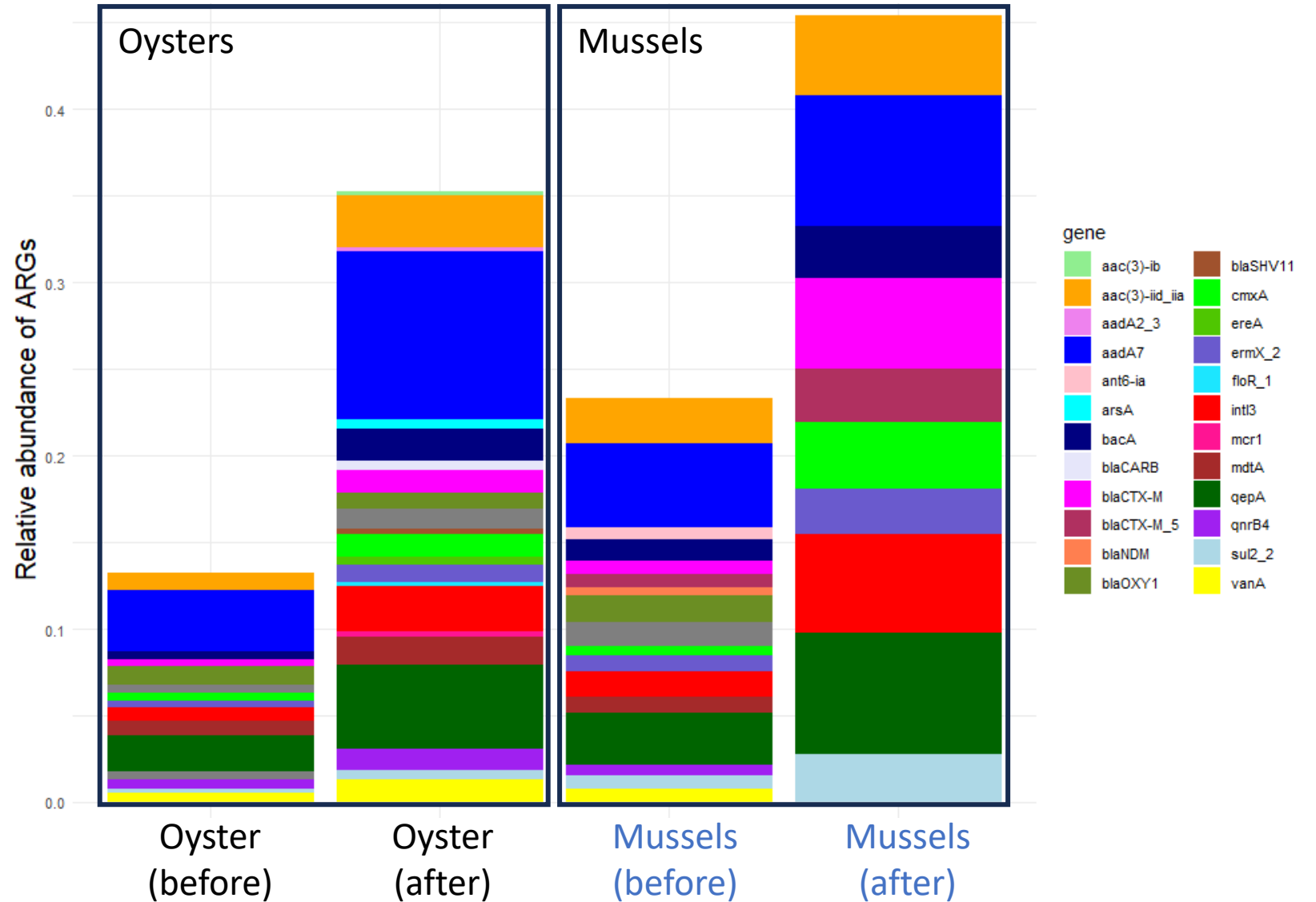
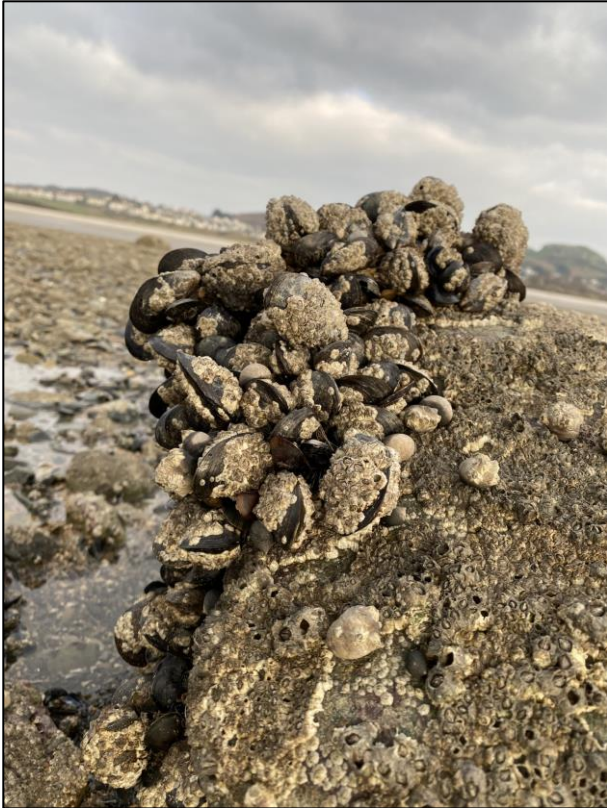
# Models to predict AMR dispersal in the coastal environment

Maximum untreated AMR discharges. Q1 2023





# AMR accumulation in shellfish near sewage outfalls



# Going full circle – back to the hospital



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## Exposure to and colonisation by antibiotic-resistant *E. coli* in UK coastal water users: Environmental surveillance, exposure assessment, and epidemiological study (Beach Bum Survey)

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### ARTICLE INFO

#### Keywords:

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Coastal waters  
Surfers  
*Escherichia coli*  
CTX-M

### ABSTRACT

**Background:** Antibiotic-resistant bacteria (ARB) present a global public health problem. With numbers of community-acquired resistant infections increasing, understanding the mechanisms by which people are exposed to and colonised by ARB can help inform effective strategies to prevent their spread. The role natural environments play in this is poorly understood. This is the first study to combine surveillance of ARB in bathing waters, human exposure estimates and association between exposure and colonisation by ARB in water users.

**Methods:** 97 bathing water samples from England and Wales were analysed for the proportion of *E. coli* harbouring *bla*<sub>CTX-M</sub>. These data were used to estimate the likelihood of water users ingesting *bla*<sub>CTX-M</sub>-bearing *E. coli*. Having identified surfers as being at risk of exposure to ARB, a cross-sectional study was conducted. Regular surfers and non-surfers were recruited to assess whether there is an association between surfing and gut colonisation by *bla*<sub>CTX-M</sub>-bearing *E. coli*.

**Results:** 11 of 97 bathing waters sampled were found to contain *bla*<sub>CTX-M</sub>-bearing *E. coli*. While the percentage of *bla*<sub>CTX-M</sub>-bearing *E. coli* in bathing waters was low (0.07%), water users are at risk of ingesting these ARB. It is estimated that over 2.5 million water sports sessions occurred in 2015 resulting in the ingestion of at least one *bla*<sub>CTX-M</sub>-bearing *E. coli*. In the epidemiological survey, 9/143 (6.3%) surfers were colonised by *bla*<sub>CTX-M</sub>-bearing *E. coli*, as compared to 2/130 (1.5%) of non-surfers (risk ratio = 4.09, 95% CI 1.02 to 16.4, *p* = 0.046).

**Conclusions:** Surfers are at risk of exposure to and colonisation by clinically important antibiotic-resistant *E. coli* in coastal waters. Further research must be done on the role natural environments play in the transmission of ARB.

### 1. Introduction

There is little doubt that the extensive anthropogenic use of anti-

resistance has been described as “one of the greatest health threats faced today” (Davies et al., 2011). If current trends continue, rates of morbidity and mortality from infections caused by ARB will increase





## Can we use this to inform decision making in environmental settings?

- How do we easily bring these datasets together?
- Effective communication & behaviour change?
- Real-time water quality alerting?
- Infrastructure improvements?
- Economic benefits?
- Health benefits?



# Acknowledgements



## Data generation team

Peter Robins

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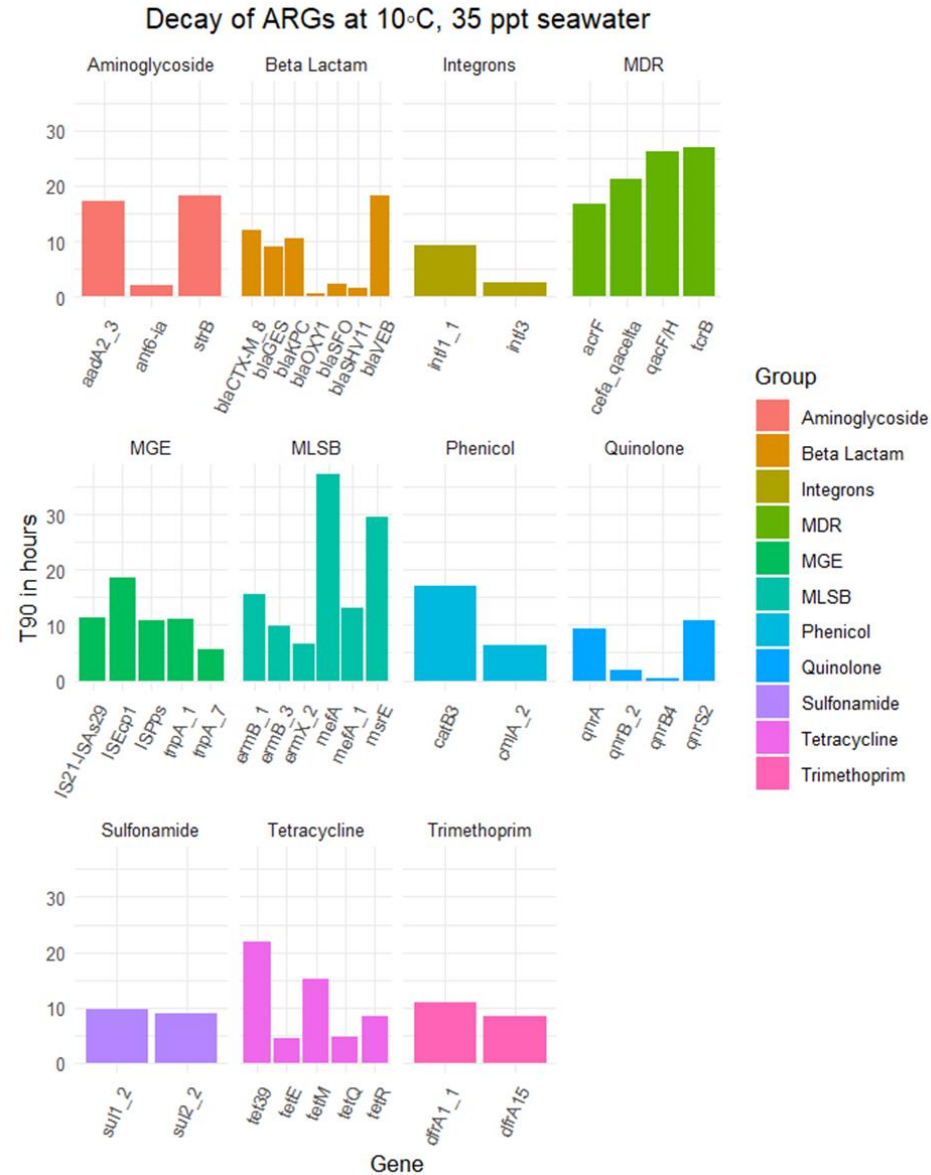
Pete Kille

Maggie Knight

### One PDRA and two PhD studentships available

- i. PDRA on the AMR Hub
- ii. UCL & Bangor: AMR detection in wastewater
- ii. Bangor & Cardiff: Fungi & AMR in wastewater

# Persistence/decay of ARGs in coastal waters



Certain ARGs like MLSB (*msrE*, *mefA*) and multi-drug resistance (*qacF/H*, *tcrB*) persisted longer in coastal water than others