

Acclimatize outcome and impacts in Ireland

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Acclimatize



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Areas Eventoreado Areas Eventoreado Confa Datblygu Rhanbarthol Ewrop European Regional Development Fund















Cyfoeth Naturiol Cymru Natural Resources Wales



BITHSFÉIR Chuan Bhaile Átha Clia Dublin Bay BIOSPHERE





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Strong interdisciplinary and complementary team





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Wales

Bathing waters primarily impacted by agricultural activities

Nolton Haven (Pembrokeshire), Traeth y Dolau and Traeth Gwyn (Ceredigion) and Cemaes Bay (Anglesey)

Ireland

Urban bathing waters Merrion Strand, Sandymount Strand, Dollymount strand – Dublin Bay Donabate (Balcarrick Beach) Portrane (Brook Beach) – Fingal

'Urban' rivers and streams

Outreach activities important component of Acclimatize









Acclimatize: six years of research focusing on Dublin Bay

NOW:

Identify the main pollution pressures on Dublin Bay.

• Evidence based, targeted interventions to improve water quality

FUTURE:

Determine how Climate Change driven effects alter these pollution pressures

- 'Climate proof' investments
- · Identifies potential new threats or benefits









Overview and functional relationship between Acclimatize work packages.





Acclimatize related activities

- Antimicrobial resistance in catchments and bathing waters in relation to faecal contamination
- National SARS-CoV-2 Wastewater Surveillance Programme
- Routine MST analysis of water samples provided by local authorities and government agencies





Intensive fieldwork with participation of MSc Biotechnology students and BSc students from six Irish Universities during the summer



Sandymount compliance point

Merrion compliance point

Google

Measurement of total faecal pollution

Identification of the biological source

Instrumentation of

rivers & streams to quantify their contribution to pollution discharge

Microbial source apportionment to determine the FIB loading by each source

Modelling to analyse connectivity and climate change effects











Dublin Bay water quality and modelling



- 4 clusters containing 4 sampling sites each
- Each site sampled every hour for 12 hours

Dry conditions: neap & spring Wet conditions: neap & spring

- E. coli
- Enterococci
- Clostridium spores
- Coliphages

Microbial Source Tracking

Physical parameters – Salinity, pH, Temp, Turbidity

Acoustic Doppler Current Profiler (ADCP)



Data Collection – Rivers/ Streams



ADCP Data Collection – Short and Long-Term Deployments



Data inventory

1 km x 1 km gridded bathymetry for Irish Sea, Celtic Sea and North Channel

Dublin Bay Model - hydrodynamics

Water Quality Modelling (shown for E. coli)

E. coli distribution 03/08/2018

Particle Tracking - Ringsend Outfall (Neap tide)

Particle Tracking – Elm Park Stream (Spring Tide)

Dublin Bay water quality and modelling

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Microbial Source Tracking

Physical parameters – Salinity, pH, Temp, Turbidity

Acoustic Doppler Current Profiler (ADCP)

Offshore Dublin Bay water is generally excellent

Water quality at Merrion and Sandymount strands is predominantly determined by nearshore events

BW Quality Merrion - 12hr Transects - IE

Water sampling every 30 minutes for 12 hours

Water sampling within an hour at high tide

Transect studies, sampling every 30 minutes

- The classification of bathing water quality is affected by sampling time, especially on beaches strongly affected by the tide.
- Current monitoring protocols based on compliance data in a single monitoring point do not adequately reflect this variability in bathing water quality.

Sandymount compliance point

High tide transect

Merrion compliance point

Google

Transect completed in one hour

- FIB are not homogenously distributed in the water column
- Water quality improves as depth increases
- Within 2 km water quality ranges from poor to excellent
- Local high level bird contamination
- Birds contribute to poor water quality

Sala-Comorera et al et al 2021, Science of the Total Environment 789, 147828

Estimation of E. coli and intestinal enterococci loading by birds

E. coli				
CFU/g	5.52E+07			
CFU/Bird Poo	5.51E+07			
Intestinal Enterococci				
CFU/g	1.21E+06			
CELI/Dird Doo				

(N=28)

Month	Total No. Birds in the highlighted area	E.coli	E.coli IE		IE CFU/100ml
May	1003	9.38E+11	1.43E+10	33	0
June	1370	1.28E+12	1.95E+10	44	1
July	1689	1.58E+12	2.41E+10	55	1
August	4018	3.76E+12	5.72E+10	130	2
September	4046	3.79E+12	5.76E+10	131	2

Estimation of E. coli and intestinal enterococci loading by dogs

Completed for Merrion, Sandymount, Portrane and Donabate

- MST analysis shows occasional dog fouling
- Number and location of fouling events per day
- Determination of *E. coli* and intestinal Enterococci cfu per gram and per event
- Average loading per bathing water

Survey	No. of Dog Events/day	Total Weight* (g/day)	E. coli CFU Loading (CFU/day)	Intestinal enterococci CFU Loading (CFU/day)
1	8	603.76	2.35E+10	2.82E+09
2	30	2264.1	8.81E+10	1.06E+10
3	14	1056.58	4.11E+10	4.94E+09
4	12	905.64	3.52E+10	4.23E+09
5	17	1282.99	4.99E+10	6.00E+09
6	27	2037.69	7.93E+10	9.52E+09
7	12	905.64	3.52E+10	4.23E+09
8	16	1207.52	4.70E+10	5.64E+09
9	10	754.7	2.94E+10	3.53E+09
Avg	15	1122	4.37E+10	5.25E+09
Max	30	2264.1	8.81E+10	1.06E+10

Number of dogs on the beach

Survey	Sandymount	Merrion		
1	200	127		
2	324	38		
3	261	50		
4	205	84		

Dog fouling locations
Compliance points

Analysis of failing compliance samples shows that dog fouling may impact bathing water classification

				MST Results* (gene copies/100ml)		
Location	Date	Sample	E. coli MPN/100 ml	Human Faecal Marker	Gull Faecal Marker	Dog Faecal Marker
Sandymount	15/06/2021	1845907	9208	BQL ¹	BDL ²	15,755
Half Moon	13/07/2021	1857132	1785	BDL ²	BDL	119,040
Merrion Strand	13/07/2021	1857134	2014	BDL	BDL	79,024
Dollymount	20/07/2021	1859638	836	BQL	BDL	14,663

Leave only paw prints campaign

- Animation to inform public
- Nationwide coverage in over 80 newspaper articles & interviews

Dollymount Strand (DMC) Sandymount Strand (SMC) Merrion Strand (MC) Elm Park stream (EP) Trimleston stream (TS)

Human Source tracking marker

Reynolds et al 2020, Correlation between antimicrobial resistance and faecal contamination in small urban streams and bathing waters, Science of the Total Environment 739, 140242

Merrion and Sandymount strands

Strong correlation between human pollution and FIB, especially after rainfall

The Elm Park and to a lesser extent the Trimleston streams are the main impactors on Sandymount and Merrion Strands water quality

Gull and dog fouling can be significant, especially in Merrion

Dog and gull fouling

Elm Park Stream Canal 'pushed' to compliance points by migrating sandbar

Sala-Comorera et al et al 2021, Science of the Total Environment 789, 147828

Sandymount compliance point

Merrion compliance point

Google

Elm Park Stream

Microbial Source Apportionment

Mean and maximum loadings

Assuming homogenous distribution

Martin et al (2023) Marine Pollution Bulletin (under review)

Elm Park Stream catchment analysis

E. coli, intestinal enterococci, ammonium, nitrates, nitrites, phosphorous, human faeces marker (HF183).

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E. coli

Ammonium

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Tristan Nolan

Antimicrobial resistance genes in the environment and in urban populations

River Source Farm house Farm Liffey house Urban Agricultural faecal & AMR gene pollution 8 Urban faecal & AMR gene 8 pollution

Metagenome Water Concentration

Concentrated water samples - From 10L to 100ml

Concentration Methods:

Primary (10L to 100ml) - Tangential flow ultrafiltration

Metagenomic Sequencing Illumina NovaSeq platform

Agricultural and urban activities drive changes in the resistome of riverine systems – metagenomic analysis

Nolan et al (2024) Science of the Total Environment, 927, 172261

Conclusions

- FIB in bathing waters are not homogenously distributed, neither in space nor in time
- Water quality classification as required by the EU Bathing Water Directive is not fit for purpose
- Poor water quality in Dublin Bay is primarily caused by nearshore events
- The northside of Dublin Bay is subject to different pollution pressures than the southside
- Merrion and Sandymount strands are impacted by polluted streams (Elm Park and Trimleston) which are almost exclusively polluted by human sewage
- Forensic catchment analysis reveals location of pollution events
- Merrion and Sandymount strands are to a lesser extend impacted by dog fouling and bird fouling. However, pollution by these sources can locally be very high and cause failure
- Predicted changes in bathing water quality to 2100, are typically, location specific
- In general, predicted sea level rises (dependent on tidal range) are expected to reduce FIB concentrations in the estuary, but outside of the estuary, predicted changes depend on prevailing environmental conditions
- FIB concentrations are higher for neap, rather than spring tides, reflecting the greater dilution and water exchanges at higher tides
- Increases in riverine pollution loadings will increase FIB concentrations in Dublin Bay, particularly in the estuary, but with significantly lower impacts beyond the estuary

Present

Climate change effects

Recent publications (2020-2023)

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- 9. Steenbeek R, Emke E, Vughs D, Matias J, Boogaerts T, Castiglioni S, Campos-Mañas M, Covaci A, de Voogt P, ter Laak T, Hernández F, Salgueiro-González N, Meijer WG, Dias MJ, Simões S, van Nuijs ALN, Bijlsma L, Béen F (2022) Spatial and temporal assessment of crack cocaine use in 13 European cities through wastewater-based epidemiology. Sci Total Environ 847: 157222
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