The Impact of Dog Fouling on Bathing Water Quality in Dublin Bay

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This brief interim report describes the impact of dog fouling on bathing water quality on four beaches in Dublin Bay. These are preliminary results of the Acclimatize project.

These beaches include Sandymount strand, Merrion strand, located within Dublin City Council, and Portrane and Donabate beaches located within Fingal County Council.

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The enumeration of the levels of FIB of Irish dogs along with the survey work carried out on Sandymount and Merrion strand was carried out by Niamh Martin.

All survey work carried out on Donabate and Portrane beaches was organised and carried out by Jayne Stephens as part of her PhD project, funded by Fingal County Council.

This work was carried out with the assistance of Dr. Liam J. Reynolds, Dr. Laura Sala-Comorera, Tristan M. Nolan, Megan Whitty and Mona Alanazi under the guidance and supervision of Prof. Wim Meijer (Acclimatize coordinator).

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Introduction

Over the years, there has been increased concern over the impact of non-point sources of faecal pollution, such as dog fouling, on bathing water quality in Dublin Bay. Dog faeces contains many dangerous pathogens that can pose a significant threat to public health when it is not recovered by pet owners when walking their dogs in public areas. This threat is particularly evident on public beaches where people are more likely to come into direct contact with dog faeces through swimming and other recreational activities. Studies have shown that unrecovered dog faeces can significantly contribute to elevated levels of FIB in bathing water[1]. Dublin beaches such as Sandymount and Merrion are very popular with dog walkers. A previous study analysing sand samples taken from Sandymount Strand found that elevated intestinal enterococci levels were associated with dog fouling events left behind on the beach sand [2]. These events were identified using Microbial Source Tracking (MST), a molecular tool used to identify the source of faecal pollution using quantitative PCR. Moreover, the Acclimatize project has detected the dog MST marker in a number of bathing water samples taken from Sandymount and Merrion[3].

The objective of this study was to quantify the contribution of dog fouling on faecal pollution levels on four beaches in Dublin, including the at-risk bathing zones of Sandymount and Merrion located in south Dublin, and Donabate and Portrane beaches located in north county Dublin. This was done by quantifying the levels of FIB, that is *Escherichia coli* and intestinal enterococci, in the faeces of Irish dogs and assessing the loading of dog fouling onto these beaches.

Enumeration of Faecal Coliform Bacteria from the Faeces of Irish Dogs

To determine the level of FIB in Irish dogs, it was important to obtain fresh canine faecal samples from different breeds of healthy dogs. These samples were collected from 30 different dogs from DSPCA and the KWWSPCA. Samples were collected in the morning before the kennels were cleaned. All samples were weighed, and the levels of *E. coli* and Intestinal enterococci were determined for each sample using membrane filtration.

These results show that a single dog fouling event can have a significant impact on the bathing water quality around it as the tide moves in. One event has the potential to fail an area of 585m² which is equivalent to two tennis courts (see Figure 1.). This is particularly concerning in shallow waters in proximity to compliance points.

Table 1. The levels of FIB found in the faeces of Irish dogs. All FIB results are expressed as the number of Colony forming units (CFU) per faecal event. On average, the levels FIB in one dog faecal event were almost 3 billion CFU for *E. coli* and 350 million CFU for intestinal enterococci.

		E. coli	Intestinal Enterococci
Prevalence (%) (n=30)		93.3	96.6
CFU per faecal event	Avg	2.94×10^{9}	3.53×10^{8}
	Max	5.44×10^{10}	2.38×10^{9}
Weight of faeces (g)	Avg	75.47	
	Max	241	

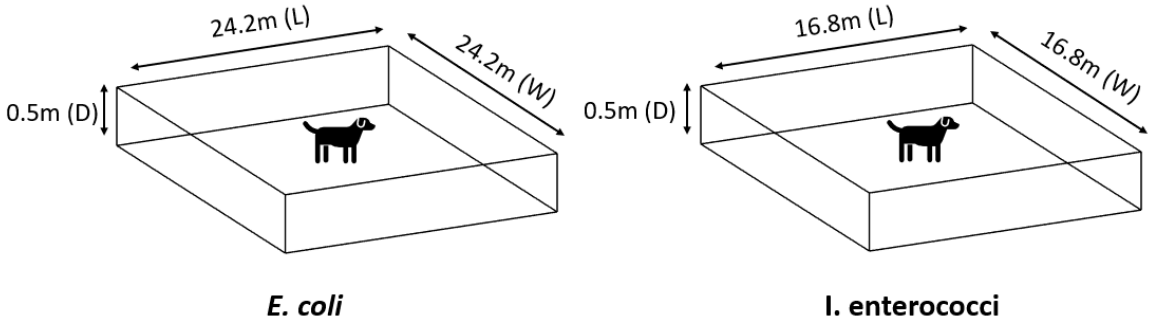

Figure 1. Schematic representation calculating an area of seawater, 0.5m in depth, that a single dog fouling event can have on bathing water quality around it based on the EU Bathing Water Directive criteria, i.e., >1000 CFU for *E. coli* and >250 CFU for Intestinal enterococci [6]. One event has the potential to fail and area approximately 585m² (24.2m X 24.2m) and 282m² (16.8m X 16.8m) for *E. coli* and intestinal enterococci respectively. This calculation assumes homogeneous distribution of the faecal matter and are based on the average CFU per one dog event (Table 1).

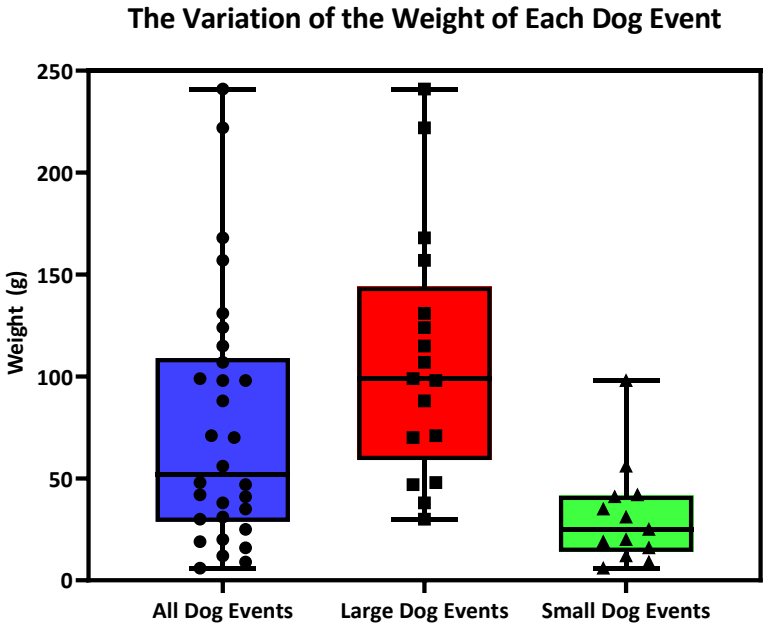

Figure 2. Box plot showing the variability in the weight of each dog event taken from the DSPCA and the KWWSPCA. The whiskers represent the minimum and maximum values. Large dogs (red) represent dog breeds with an average weight of >9kg such as a greyhound, small dogs (green) represent small dog breeds with an average weight of <9kg such as a pug. The Dog samples taken for this study, shown in blue, ranged in size from 6g up to 241g. The average weight of all faecal samples was 75.47g (see Table 1.). The average weight of faecal samples taken from large and small dog breeds was 109.06g (n=17) and 31.54g (n=13) respectively.

Estimation of the number of dogwalkers on Dublin Beaches

The Acclimatize project has carried out numerous water sampling regimes on these beaches from 2018 until 2021. Over a 12 hours period, water samples were collected every 30mins at the compliance point following the tide in and out. During these sampling days, the number of dogwalkers were recorded throughout the 12-hour period, i.e., from 7am to 7pm around each compliance point. These figures provide an indication on the number of dogs that frequent each beach.

Survey	The No. of Dogs Recorded during a 12hr period			
	Sandymount*	Merrion*	Donabate	Portrane
1	160	111	87	13
2	250	33	64	35
3	207	38	85	22
4	-	-	-	18
5	-	-	-	17
Avg	206	61	79	21

Table 2. The number of dogs recorded on each beach during a 12-hour period, from 7am to 7pm. It should be noted that the surveys on Sandymount and Merrion strands were carried out on the same day. Due to their close proximity, the same dog walkers may have been recorded on both beaches.

Estimation of dog fouling on Dublin Beaches

Dog fouling surveys were conducted at each beach during the bathing season from April to August in 2019 and 2021. Adjacent transects were established on each beach parallel to the mean low tideline [4]. A team of observers walked along each transect area and recorded all dog fouling events using a handheld GPS Unit (Garmin). All surveys were carried out during dry weather and between early morning and late afternoon to include peak and non-peak times. The average number of dog fouling events on each beach was used to calculate the estimated loading of FIB from dogs onto each beach during a 24-hour period. These results provide an estimation on the impact of dog fouling on nearshore water quality. These results also identify the hot spot areas where localised pollution events are more likely to occur.

Sandymount and Merrion Strand

Due to the close proximity of Sandymount to Merrion strand, these two beaches were combined into one study area. As this study aims to assess the impact of dog fouling on bathing water quality, the surveys were conducted on the beach area surrounding the two compliance points. The transect started at the metal sculpture entitled "Awaiting the Mariner" on Sandymount and finished at the Elm-park stream discharge point on Merrion, running parallel to the pathway, approximately 1.6km in length and 100m wide. An additional area of 250m X 500m was surveyed around each compliance point. The total transect area was 360,000m².

The results showed that 88% of dog fouling was found within 20 metres of the shoreline (Figure 3.). This is a concern as both compliance points are located within this are. Furthermore, this indicates that most dog walkers stay close to the to the pathway and walk their dogs parallel along the shoreline. There was less dog fouling found around the Merrion compliance point where there are less access points and pathways. These results were reflected in the dog count surveys conducted on each beach. Over three survey days, an average of 205 dogs were recorded on Sandymount, and an average of 60 dogs were recorded on Merrion, throughout the 12-hour period.

These results suggest that people are not picking up after their dogs, even when they are less than 20 metres away from a bin. One solution may be to increase the number of bins present along the walkway or place bins directly onto the beach during low tide.

Table 3. The number of dog fouling events recorded during each survey of Sandymount and Merrion strands. These results show that dog fouling can contribute an average of 43 billion CFU of *E. coli* and 5 billion CFU of intestinal enterococci onto Sandymount and Merrion in one day.

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	2.35×10^{10}	2.82×10^{9}
2	30	2264.1	8.81×10^{10}	1.06×10^{10}
3	14	1056.58	4.11×10^{10}	4.94×10^{9}
4	12	905.64	3.52×10^{10}	4.23×10^{9}
5	17	1282.99	4.99×10^{10}	6.00×10^{9}
6	27	2037.69	7.93×10^{10}	9.52×10^{9}
7	12	905.64	3.52×10^{10}	4.23×10^{9}
8	16	1207.52	4.70×10^{10}	5.64×10^{9}
9	10	754.7	2.94×10^{10}	3.53×10^{9}
Avg	**15**	**1122**	**4.37×10^{10}**	**5.25×10^{9}**
Max	**30**	**2264.1**	**8.81×10^{10}**	**1.06×10^{10}**

***The Total Weight (g/day) was calculated using the average weight of faecal samples collected from the DSCPA and KWWSPCA (Table 1.)**

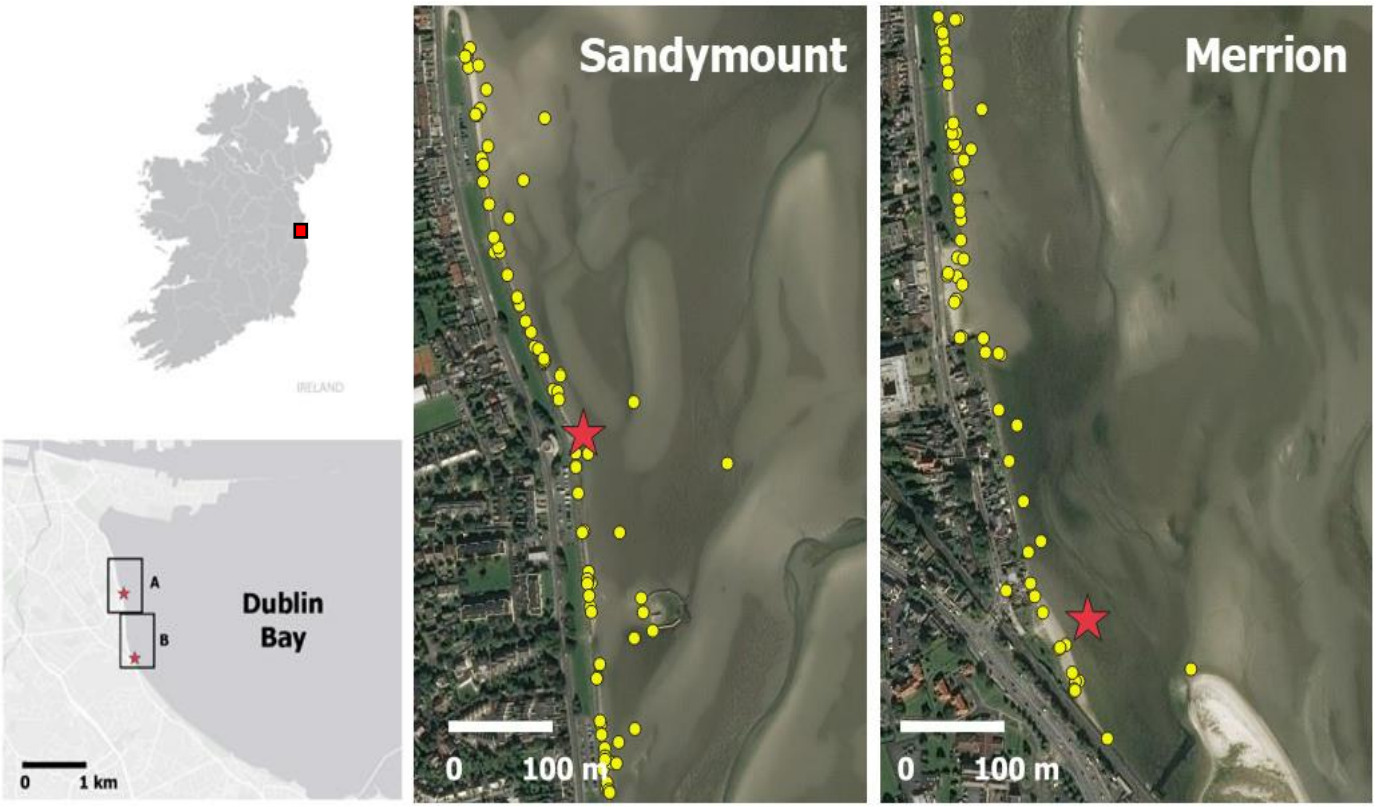

Figure 3. Map of Sandymount & Merrion strands with all dog faeces observed during this study represented by yellow points. The red stars represent the compliance point for each beach. Over 88% of dog fouling was found within 20m of the shoreline.

Portrane Beach

Surveys on Portrane Beach and Donabate beach were carried out during the summer of 2021. The Portrane transect area was 500,000m² (1,000m X 500m, L*W). All dog events were collected and weighed on Portrane and Donabate beaches. The results show that dog events collected from the beaches weighed less than the samples taken from the DSPCA and KWWSPCA. This may be due to the age of the events and their exposure to the environment.

Over five dog count surveys, an average of 21 dogs were recorded throughout a 12-hour period on Portrane beach. This was surprising considering the high levels of fouling recorded on this beach.

However, it should be noted that out of 112 dog fouling events recorded during the six surveys, 45 (approx. 40%) were found inside the coastal erosion structures located on the periphery of the beach. This indicates that there are insufficient waste disposable facilities available at this beach.

Table 4. The number of dog fouling events recorded during each survey of Portrane beach. These results show that dog fouling can contribute an average of 49 billion CFU of *E. coli* and almost 6 billion CFU of intestinal enterococci onto Portrane in one day.

Survey	No. of Dog Events/day	Total Weight* (g/day)	*E. coli* CFU Loading (CFU/day)	Intestinal enterococci CFU Loading (CFU/day)
1	17	617.55	4.99×10^{10}	6.00×10^{9}
2	21	1060	6.16×10^{10}	7.41×10^{9}
3	23	530.3	6.76×10^{10}	8.11×10^{9}
4	26	836.8	7.64×10^{10}	9.17×10^{9}
5	11	213.2	3.23×10^{10}	3.88×10^{9}
6	7	259.2	2.06×10^{10}	2.47×10^{9}
Avg	**17**	**612**	**4.91E+10**	**5.90×10^{9}**
Max	**21**	**1060**	**6.16E+10**	**7.41×10^{9}**

*** All dog fouling events were collected and weighed to determine the Total Weight (g/day).**

Donabate Beach

The Donabate transect area was 150,000m² (1000m X 150m, L*W).

This beach is very popular with dogwalkers as an average of 60 dogs were recorded over the 12-hour period over four survey days. This survey recorded lower levels of fouling on Donabate than the other beaches. This may be due to the increased waste management and signage at this beach. However, it should be noted that many dog events were recorded adjacent to the compliance point.

Table 5. The number of dog fouling events recorded during each survey of Donabate beach. These results show that dog fouling can contribute an average of 11 billion CFU of *E. coli* and almost one billion CFU of intestinal enterococci onto Donabate in one day.

Survey	No. of Dog Events/day	Total Weight* (g/day)	*E. coli* CFU Loading (CFU/day)	Intestinal enterococci CFU Loading (CFU/day)
1	3	181.54	8.81×10^{9}	1.06×10^{9}
2	2	205.2	5.87×10^{9}	7.06×10^{8}
3	2	60.7	5.87×10^{9}	7.06×10^{8}
4	4	119.5	1.17×10^{10}	1.41×10^{9}
5	7	130.8	2.06×10^{10}	2.47×10^{9}
6	10	271.8	2.94×10^{10}	3.53×10^{9}
Avg	**4**	**146**	**1.14×10^{10}**	**1.37×10^{9}**
Max	**10**	**271.8**	**2.94×10^{10}**	**3.53×10^{9}**

*All dog fouling events were collected and weighed to determine the Total Weight (g/day).

Figure 4. Map of Portrane & Donabate beaches with all dog faeces observed during this study represented by yellow points. The red stars represent the compliance point for each beach.

The impact of dog fouling on Bathing Water Quality in Dublin Bay

The impact of dog fouling on bathing water quality can be severe, particularly in shallow water beaches like Sandymount and Merrion. On four occasions in the summer of 2021, compliance samples have failed bathing water criteria in several locations around Dublin. MST analysis by the Acclimatize group indicates that dog fouling contributed to high FIB levels on those days (Table 5.). This provides further evidence that bathing water quality can be considerably impacted by dog fouling left behind on the beach.

Table 5. Shows the Microbial Source Tracking results of compliance samples collected by DCC during the summer of 2021. These samples were delivered to UCD and analysed by the Acclimatize team.

Location	Date	Sample	*E. coli* MPN/100 ml	MST Results* (gene copies/100ml)		
				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
Sandymount	07/09/2021			228	BDL	13500
Merrion Strand	07/09/2021			1242	BDL	9151

[1]BQL for the Human marker is <140 GC/100ml

[2]BDL for the Human marker is <70GC/100ml and the gull marker is <525GC/100ml

*It should be noted that the units between each MST marker are not equivalent. One human marker does not equal one gull or dog marker. Each assay amplifies a different target microorganism that are found at different concentrations within faeces.

Although dog fouling has been identified as a major problem, it is possible that it is a controllable source of faecal contamination. However, several solutions may be needed to tackle this issue. The first solution would be to increase the number of waste disposal facilities at beaches such as Sandymount, Merrion and Portrane. Although there are already bins present on these beaches, this study provided evidence that the number is not sufficient. The coastal erosion structures (Figure 5.) present on Portrane may be an invitation for the public to dispose of dog waste. This issue may be resolved by placing prevention signage on these structures or covering up the hollow opening.

Secondly, increased measures are needed to deter pet owners from leaving behind dog waste in the first instance. Under section 22 of the Litter Pollution act, pet owners can face an on the spot fine of €150 if they do not clean up after their dog. However, only two fines were issued to dog owners by DCC in 2020. Evidently, this does not reflect the level of dog fouling taking place. Moreover, there has been a 27% increase in the number of complaints received by the DCC in relation to dog fouling in the past year[5]. There is a clear need to increase the enforcement of this act through increasing the presence of litter wardens on these beaches particularly during busy periods.

Finally, local education programs and anti-dog fouling campaigns may be key to easing this problem. A study carried out in the USA in 2013 found that low investment education programs can considerably

reduce canine faecal pollution[1]. Local residents were informed of the potential impact that dog fouling can have on water quality and were asked to prevent this type of faecal pollution from entering waterways. These programs were carried out by calling door to door but also could be carried out through increased signage in the local area. This type of campaign could potentially be very successful in areas such as Sandymount and Merrion.

Figure 4. Coastal erosion structures found on Portrane beach.

Conclusions

- This study has shown that dog fouling can greatly contribute to failing bathing water quality in Dublin Bay. This is of particular concern in shallow water beaches like Sandymount, Merrion and Portrane.
- The levels of FIB in Irish dog faeces show that one unrecovered dog event has the potential to fail a body of water with area of 585m² with a depth of 0.5m assuming homogeneous distribution.
- The results of the dog fouling surveys show that dog fouling is occurring on and within the vicinity of the compliance point on Sandymount, Merrion, Portrane and Donabate.
- The results of MST analysis of bathing water samples taken by DCC shows direct evidence that dog fouling can elevate FIB levels above the failure threshold under the EU Bathing Water Directive criteria[6].
- Increased measures need to be taken to increase the management of dog fouling on these beaches. These measures include
    1. Increasing the number and strategically placing bins on beaches such as Sandymount and Portrane,
    2. Increasing the presence of dog wardens and similar deterrents during peak times
    3. The implementation of anti-dog fouling public campaigns and education programs.

Abbreviations

AVG	Average
BDL	Below Detection Limit
BQL	Below Quantification Limit
CFU	Colony Forming Unit
DCC	Dublin City Council
DSPCA	The Dublin Society for Prevention of Cruelty to Animals
FIB	Faecal Indicator Bacteria
GC	Gene Copies
KWWSPCA	The Kildare and West Wicklow Society for Prevention of Cruelty to Animals
MAX	Maximum
MPN	Most Probable Number

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