# STREAM report Card 1: An examination of the relationships between Shellfish Classification, Salinity, Rainfall and Temperature (Castletownbere).

## Contents



The STREAM project is part funded through the ERDF Ireland Wales Programme

## Introduction

Understanding the interrelationships between various environmental factors and microbial contamination is crucial to Aquaculture operators cultivating or harvesting bivalve molluscs.

In the context of seawater quality, examining the connections between *Escherichia coli* numbers, norovirus presence, salinity, nutrient inputs and temperature can provide insights into potential contamination sources and risks. The relationship between *E. coli* and norovirus is indirect but significant. Elevated *E. coli* levels suggest the possible presence of faecal matter containing norovirus. The correlation is stronger when considering areas with inadequate sewage treatment or during heavy rainfall events that can lead to runoff and increased microbial load in seawater.

In this report, we (STREAM) examine a temporary drop in the Classification of a Bivalve Mollusc Production Area from an A to a B and the physiochemical and meteorological issues associated with the event.

**This report would not be possible without the extensive help and support of the National Fisheries and Dive College (BIM) Castletownbere.**

## Materials and methods

Bantry Bay is a drowned river valley (Ria) on the southwest coast of Ireland, and it is approximately five kilometres wide at its head (east), eight kilometres open at its mouth (west) and ~40 km in length. The waters along its shores along the edges and the eastern inner bay are typically <20 m, while maximum depths of ~60 m occur at its western opening to the Atlantic (Edwards et al., 1996). Due to its south-westerly aspect, the bay is exposed in nature, and surface salinities typically exceed 33 ppt (Marine Institute, 2017).

The town of Castletownbere is strategically located in the North Western part of Bantry Bay. It is an important fishing port and provides a sheltered haven on the Irish Coast to the Atlantic Ocean. The area between Castletownbere and Bere Island provides a study area where aquaculture and fishery activities are close together, along with other environmental anthropogenic influences. The STREAM project has established SETU meteorically instrumentation, MTU water and periodical harmful algal bloom (HAB) monitoring equipment at the National Fishery College.

In the Bantry Bay region, the annual rope mussel production has been between 1,952 and 4,648 metric tonnes recently (Dabrowski et al., 2016). The salmon farm located at the eastern end of the channel covers an area of approximately 5 $km^2$. For the salmon farms within the Beara Peninsula region in 2009, the total production of salmon was estimated to be around 6,345 tonnes, totalling approximately €12.4 million (BIM, 2012). Fucales and Laminaria production is planned in a licensed area of 75 hectares near the other aquaculture operations. Also within the bay is an inshore fishing fleet that trawls for whitefish and *Nephrops norvegicus*, pot for crab (*Cancer pagurus*), lobster (*Homarus gammarus*) and prawn (*Palaemon serratus*). In addition, there is also a limited amount of dredging for scallops and picking of periwinkles.

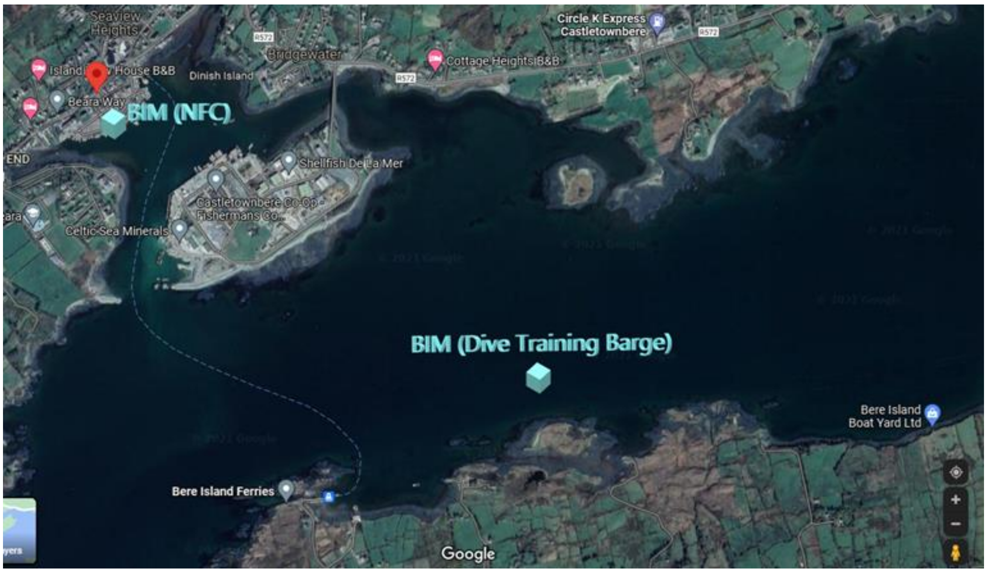
Figure 1 BIM National Fisheries College dive barge, MTU and water sampling

## Sensors

MTU STREAM sensors were deployed close to the Berehaven channel between the Beara Peninsula and Bere Island in Bantry Bay. This channel contains multiple marine aquaculture sites, including mussels (*Mytilus edulis*), oysters (Crass*ostrea gigas*), and salmon (*Salmo salar*) farms. The depth at which the STREAM sensors were deployed was >2m. A STREAM weather station was deployed on the roof of the National Fisheries College (NFC).

Figure 2 shows the location of the BIM National Fisheries College (NFC), where a STREAM weather station was established, and the site of the Dive barge, where the MTU STREAM sensors were installed.

Figure 2 Google earth, the National Fisheries College location and their dive barge.



## Water Quality

When assessing water quality, different parameters such as chemical, physical, and biological properties can be tested to evaluate the status of a waterbody. An MTU YSI Exo2 multiparameter SONDE (see https://www.ysi.com/exo2) was deployed from the barge along with a power supply and a telemetry unit for broadcasting live data. The STREAM project is developing sensors and monitoring for changes in temperature, dissolved oxygen, salinity (conductivity), pH, turbidity, chlorophyll, and nutrients.

Figure 3 An Exo2 Sonde on the deck of the BIM barge in Castletownbere.

**A brief description of some physiochemical parameters:**

**Temperature ($^{O}$C):** is a critical factor that affects biological life as it impacts lifecycle and growth. Warmer waters also contain less dissolved oxygen than cool water, which can affect the survival and distribution of aquatic organisms. The water temperature regulates the rates of biological and chemical reactions, making some compounds may be more toxic at higher temperatures.

**Dissolved oxygen (%):** Marine plants, such as the microscopic phytoplankton and seaweeds, convert carbon dioxide into sugars and oxygen by photosynthesis. They produce over half of the oxygen in our atmosphere. While marine animals require dissolved oxygen through diffusion into their body tissue or gills.

**Salinity (PSU):** The salt concentration in seawater is measured in Practical Salinity Units (PSU). Around Ireland, in offshore waters, the salinity may reach levels approaching 35 PSU. In contrast, in estuaries, the levels may reduce to close to zero when there is a lot of freshwater inputs. The salinity affects the distribution of many plants and animals.

**pH (0 to 14 scale):** This measures how acid or alkaline the seawater is in coastal waters such as an estuary. This is strongly influenced by the area's geology, the river's source flows and biological activity.

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**Turbidity (NTU):** Measures how clear or cloudy the seawater is. The clarity is affected by the amount of sediment silt particles and tiny marine organisms in the water column.

**Chlorophyll (mg/L):** Seawater contains microscopic organisms called phytoplankton and fragments of aquatic plants that use pigments such as chlorophyll-a to convert carbon dioxide into sugars and oxygen. By measuring chlorophyll, we can estimate these plants' biomass (amount), which tend to vary seasonally and follow nutrient levels in the water.

**Nutrients** – A vital property of seawater is the concentration of dissolved nutrients as they significantly influence the health of a waterbody and stimulate primary production by phytoplankton. The concentration of nutrients is measured by optical cells and a spectrophotometer tuned to defined wavelengths for nitrogen and phosphorous compounds (below are some parameters applicable to remote sensors).

Table 1. List of *additional* water quality parameters of interest.

| |
|---|
| fDOM_RFU: Fluorescent Dissolved Organic Matter measured in Relative Fluorescent Units. |
| fDOM_QSU: Fluorescent Dissolved Organic Matter measured in Quinine Sulphate Units. |
| Chlorophyll_ugl: Chlorophyll measured in micrograms per litre. |
| Chlorophyll_RFU: Relative Fluorescent Units. |
| BGAPE_ugl: Blue-Green Algae Phyco Erythrin (photosynthetic pigment associated with Marine Phytoplankton) measured in micrograms per litre. |
| BGAPE_RFU: Blue-Green Algae Phyco Erythrin measured in Relative Fluorescent Units. |
| $NNO_3$_mgl: Complete Nitrogen – Nitrate in milligrams per litre. |
| $NNO_2$_mgl: Complete Nitrogen – Nitrite in milligrams per litre. |
| TSSQeq: Total Suspended Solids as an equivalent. Parameters with the eq prefix are associated with the TriOS OPUS spectrometer, the company has developed a library of absorption spectra associated with the parameter. |
| SAC254_lm: Spectral Absorption Coefficient at 254 nano metres, measures the dissolved organic material that absorbs UV light at a wavelength of 254 nm. May be used to monitor diffuse and point source pollution in water bodies. |
| Abs360_AU: Light absorption at 360 nm measured in Absorbance Units.* |
| ABS210_AU: Light absorption at 210 nm measured in Absorbance Units.* |
| ABS254_AU: Light absorption at 254 nm measured in Absorbance Units.* |
| NO3_mgl: measures the Nitrate in the water in milligrams per litre. |

For high status water bodies, ideally the values of the physico-chemical elements should correspond totally or nearly totally to undisturbed conditions. Nutrient concentrations should also remain within the range normally associated with undisturbed conditions. Levels of salinity, pH, oxygen balance, acid neutralizing capacity, and temperature do not show signs of anthropogenic disturbance.

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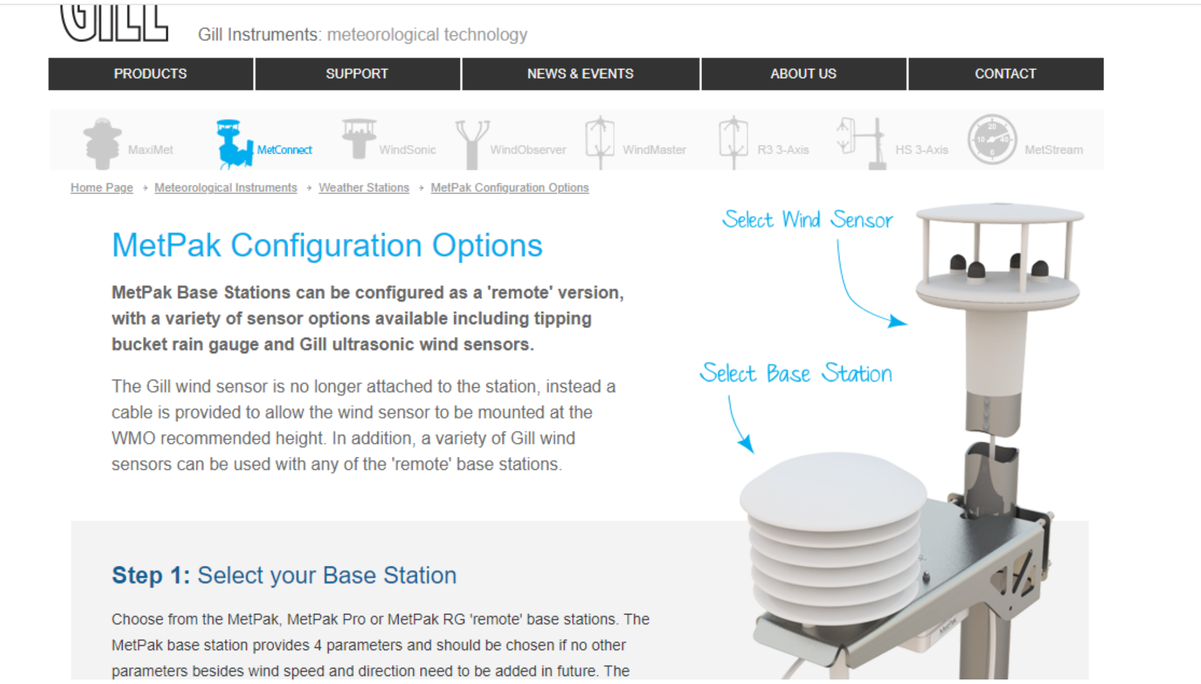
A Gill MetPak-Pro weather station (Figure 3) was erected as a base station on the roof of the NFC in Castletownbere, and it utilises Gill WindSonic ultrasonic technology, a barometric pressure sensor, and a Rotronic Hygroclip HC2-S3-GI temperature/humidity probe. In addition to these instruments a rain gauge was installed along with telemetry to broadcast the data live online.

The design of the MetPak-Pro allows for accurate measurements without influencing other measured parameters. The unit is especially suitable for harsh or marine environments and is supplied with selectable Gill ASCII, NMEA SDI-12 and Modbus outputs.

The STREAM weather station data outputs are as follows: Temperature, pressure, humidity, dew point, rainfall amount, wind speed and direction.

Figure 4 A Gill MetPak-Pro weather station.




## Issue addressed in this report card

A producer of mussels in Castletownbere reached out to STREAM after receiving an unusual laboratory result for *E. coli* in their shellfish production area. As a result of this microbial result on the 24th of October 2022, the classification of their bivalve mollusc production area temporarily dropped from an A to a B, which mean that the mussels sold requires depuration before they could be consumed. The producer asked if the STREAM project had detected any abnormal readings in the area with its sensors. In response to this request, STREAM conducted an investigation to determine the cause of the issue.

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## Shellfish Classification

Mussels, oysters, and other live bivalve molluscs filter their food from the water they grow in, which means they may accumulate harmful microorganisms or biotoxins in their flesh. The Sea Food Protection Authority (SFPA) has a monthly shellfish sampling programme based on *E. Coli* presence in shellfish flesh for all active molluscan production areas around Ireland. The results of these tests determine whether the harvested shellfish can be sold directly for human consumption as Class A. Where there are less than <230 *E. Coli* per 100 g of shellfish flesh. Or, they must go through a treatment process (Class B), or Class C must be relayed for two months (Table 2).

Table 2 Shellfish Classification based on *E. coli* monitoring. (See https://www.sfpa.ie/What-We-Do/Molluscan-Shellfish/Shellfish-Safety).

| Category | Microbiological Standard (MPN 100g-1 shellfish flesh) | Treatment required |
|---|---|---|
| Class A | <230 E.coli | May go direct for human consumption |
| Class B | <4,600 E.coli (90% compliance) | Must be depurated, heat treated or relayed to meet class A requirements |
| Class C | <46,000 E.coli | Must be relayed for 2 months to meet class A or B requirements or may also be heat treated |

The microbial sample that resulted in a reduced seasonal classification from an A to a B being addressed in this report was collected on the 24th of October 2022.  Table 3 shows the normal classification A* from the 1st of December to the 1st of May for mussels from Castletownbere.

Table 3 Castletownbere and the classification of mussels, oysters and urchins within the designated area.

| | | | |
|---|---|---|---|
| **Castletownbere** | **Mussels** | **A*** | ***Seasonal Classification 01 Dec – 01 May reverts to Class B at other times (Note 1).** |
| | **Oysters** | **B** | |
| | **Urchins** | **A** | |

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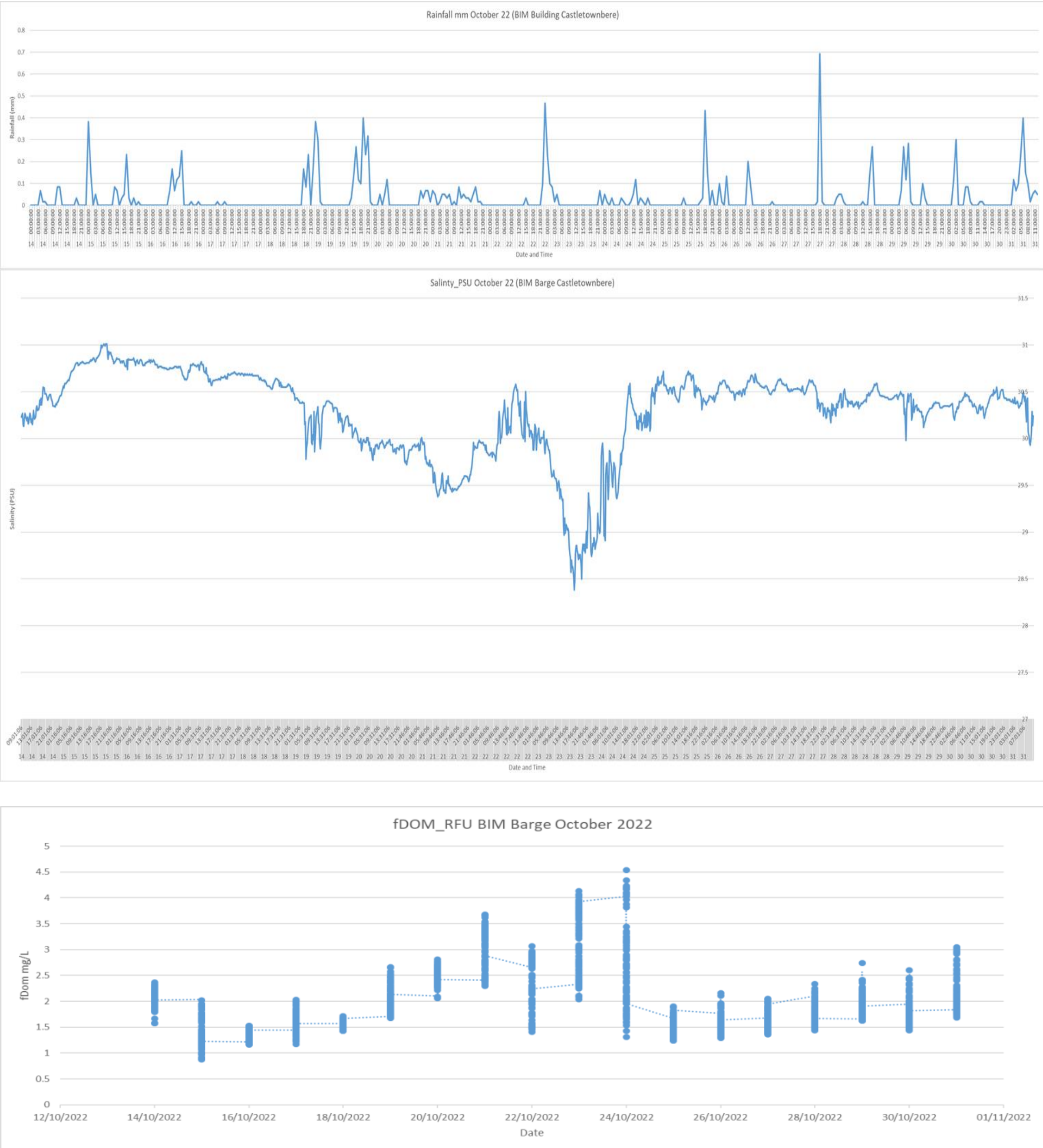
## STREAM Results

Below are the BIM Barge (STREAM sensors) Castletownbere October 2022 showing rainfall, salinity and fDOM (Figure 6). All the data points shown on the fDOM chart are recorded over the course of a day (every 15 minutes).

Figure 5 Rainfall (mm), salinity (psu) and fDom (mg/L) Castletownbere October 2022.

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One of the first things of note from the STREAM sensors was a significant amount of rainfall during October 2022, there was also a particularly notable reduction in salinity readings around the 23rd and 24th of October which corresponded with significantly elevated fDOM measurements at that time.

A more in depth analysis of fDOM data from Castletownbere recorded in September 2022 (with some erratic readings removed) and compared with those of October 2022 are shown below in Table 4. The relative increase in fDOM readings from the BIM barge in Castletownbere around the 24th of October indicates an increased input of organic material near the Exo2 Sonde.

The depth at which the STREAM sonde readings were taken from the barge was approximately 1.9m.

Table 4 shows the mean fDom readings mg/L readings in September and October 2022.

| *Castletownbere* | *fDOM Sep 22 with erratic's removed* | *fDOM Oct 22* |
|---|---|---|
| | | |
| fDOM Mean (mg/L) | 1.782750616 | 1.992994652 |
| Standard Error | 0.013847823 | 0.015182365 |
| Median | 1.7 | 1.83 |
| Mode | 1.75 | 1.51 |
| Standard Deviation | 0.738363038 | 0.622847164 |
| Count | 2843 | 1683 |
| Largest(1) | 3.93 | 4.54 |
| Smallest(1) | 0.03 | 0.88 |

## Discussion

At that time of the elevated *E. coli* readings in the mussels, the STREAM sensors in the bay recorded Fluorescent Dissolved Organic Matter (fDOM) readings that were significantly higher than the average typically observed in Castletownbere and appeared to indicate an exceeded threshold that resulted in the high results recorded at the mussel production site.

Fluorescent Dissolved Organic Matter (fDOM) denotes the portion of Coloured Dissolved Organic Matter (CDOM) that fluoresces. Both indicate organic matter in water, which absorbs in the ultraviolet

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(UV) spectrum. As a surrogate for CDOM, fDOM detection provides a valuable method for monitoring Dissolved Organic Matter (DOM) in natural water environments. The measurement of CDOM/fDOM is important because concentrations of CDOM can affect marine benthic plant and animal communities. The measure of fDOM/CDOM is also suitable for monitoring a wastewater/ sewage discharge, as the fluorescence of fluorescent dissolved organic matter (fDOM) indicates the total organic carbon (TOC) content. The concentration of fDOM in water can also provide insights into a water body's dispersion, transport, and mixing.

The input source needs to be identified, though, as there are several potential contributing inputs from the shore.

**Municipal wastewater inputs**

In 2018, a Castletownbere Sewage Scheme project was announced to develop a wastewater treatment plant in the area by 2021 and end the practice of discharging “over 1,700 wheelie bins of raw sewage into Bantry Bay per day” (*Castletownbere Sewerage Scheme | Our Projects | Irish Water*, 2018). In late 2022 a treatment system was delivered by Glan Agua MEIC on behalf of Uisce Éireann that includes:

- A new wastewater treatment plant at Drom South, to serve a population equivalent of approximately 2,200.
- A 100m long marine outfall pipeline to safely discharge treated wastewater to the sea near Doctor’s Rock to the south of Castletownbere.
- Construction of 750m of new sewer pipelines and 1,700m of rising mains to transport untreated wastewater to the proposed new wastewater treatment plant.
- Construction of 4 new wastewater pumping stations across Castletownbere.


See: https://www.water.ie/projects/local-projects/castletownbere-sewerage-s/

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**Shellfish Sanitary Surveys relating to bivalve mollusc production in Ireland. (Paraphrased from https://www.sfpa.ie/What-We-Do/Molluscan-Shellfish/Sanitary-Surveys).**

Under Commission Implementing Regulations (EU) 2019/627, the competent authorities must conduct a sanitary survey before classifying a bivalve mollusc production area.

| |
|---|
| Each survey must include the following: |
| An inventory of the sources of human and animal pollution |
| An examination of the seasonal variation in sources and quantities of organic pollutants |
| A determination of how these are likely to circulate in the production area |

Based on the sanitary survey results, the competent authority will establish a monitoring programme and sampling plan for each bivalve mollusc production area. This programme sets out the geographical location of the sampling points within the bivalve mollusc production area and the frequency with which they should be sampled. The programme is so designed that the results of the monitoring will be representative of the production area.

The actual surveys contain most of the following elements:

| |
|---|
| Desktop survey – data gathering |
| Shoreline survey – physical site inspection |
| Bacteriological survey – can include shellfish and water sampling |
| Overall assessment |
| Monitoring programme/sampling plan |

Information used in generating each survey is garnered from many different sources, including existing published data, data already held by the authority, discussions with other government agencies, and meetings with members of the shellfish industry. A physical site visit to each production area is carried out by Authority staff. Where possible, the whole production area is surveyed to detail any human and animal pollution sources.

Authority staff may also carry out water sampling of discharges, streams, and drains to assess levels of organic pollutants reaching the production area. In addition, Authority staff may take shellfish samples from various locations within the production area to examine levels of organic pollutants impacting the shellfish. Combining this physical shoreline data with the initial desktop study allows the authority to conclude the sanitary survey for each production area and generate the subsequent monitoring programme and sampling plan.

***E. coli* numbers and norovirus Presence**

*E. coli* is a common indicator of faecal contamination in water bodies, including seawater. High *E. coli* numbers may also signify the presence of pathogens that could pose health risks to humans, including norovirus. Norovirus is a highly infectious virus responsible for causing gastroenteritis outbreaks, commonly associated with consuming contaminated water or seafood. According to the Interim

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Guidance on the Management of Norovirus in Oysters by Shellfish Producers High (2018) “risk factors for shellfish-related norovirus include cold weather (low water temperatures), high prevalence of norovirus gastroenteritis in the community, and high rainfall (potentially leading to sewage system overflows).”

For example in an SFPA sanitary report on Adrigole which is a sheltered harbour area located on the northern side of Bantry Bay on the Beara Peninsula. It is situated between the Glengariff and Beara Peninsula Water Management Units (WMUs) in the South Western River Basin District, south of the Caha Mountains range. “It is likely that the increased contamination seen after rainfall arises from a combination of agricultural runoff and unsecured septic tanks. It is recommended that the area maintains the existing ‘B’ classification for mussels and that a preliminary ‘B’ classification is assigned for oysters subject to weekly monitoring during periods following heavy rainfall if necessary.

***E. coli* Numbers, Salinity, and Temperature**

Carlucci and Primer, in 1959, wrote about the need to evaluate the many physicochemical factors in an environment known to influence the activities of microorganisms. Salinity and temperature play critical roles in shaping microbial communities in seawater. *E. coli* survival and growth are influenced by these factors. Salinity, which affects osmotic balance, can influence microbial cell viability. They found E. coli cell deaths were more rapid in pure freshwater than in 25 per cent seawater. Jozic et al. (2014) studied the simultaneous effects of temperature, salinity, and solar radiation, on different strains of Escherichia coli (*E. coli*) bacteria to assess their survival in seawater under experimental and natural conditions. The experiments were conducted within a natural temperature range (12 °C, 18 °C, and 24 °C) and salinity (30.0 psu and 36.5 psu). Microbiologically contaminated seawater samples were taken in September 2011, when the temperature and salinity of the seawater were stable (23–24 °C, 36–37 psu). In the absence of solar radiation, the mean T90 values differed, depending on the bacterial strain and were 42.50 h for *E. coli* ATCC 35218 and 33.55 h for *E. coli* ATCC 8739. No significant effect of temperature or salinity on T90 was found. But they recorded a substantial adverse impact on T90 of both *E. coli* strains. Depending on the bacterial strain, the dominant effect of solar radiation reduced the T90 of *E. coli* by 15- to 70-fold. Within the ultraviolet A (UVA) and photosynthetically active radiation (PAR) spectrums of solar radiation, the wavelengths 320–360 were the most bactericidal. Seawater samples were depleted of culturable *E. coli* cells even during 24-hour storage under appropriate conditions if exposed to solar radiation. A higher resistance of wild *E. coli* cells to the adverse effects of environmental conditions than cultivated cells was also found.

**Nutrient monitoring**

Seawater samples were collected from the barge for nutrient analysis by a commercial laboratory to establish the range of findings within the area, see appendix 1. The samples were analysed the next day by an accredited laboratory for total nitrogen as N, Phosphate as P filtered (low level/saline), Nitrate as N saline waters, Nitrite as N saline waters, Total Phosphorus as P (low level), chlorophyll a, Silica Si O2, Ammonia as N (saline water), pH and Salinity (see Appendix 1 for the results of the analysis of seawater samples collected by STREAM off Castletownbere).

### Marine Institute Monitoring

The Marine Institute has designated the Castletownbere production area as set out in (*Molluscan Shellfish Production Areas, Sample Points and Co-Ordinates for Biotoxin and Phytoplankton Samples. Species Names / Common Names*, 2017) Figure 6.

**Figure 6. Castletownbere is a designated production area CK-CE (Marine Institute 2021).**

**Production Area: CK-CE** **Location: Castletownbere**


**Production area is defined as area inside boundary line:**

From Adrigole Point to Easternmost Point Bear Island and Ardnakinna Point and Headland West Bear Island as shown on chart, up to and including the mean high water mark and coordinates defined as:

| Name | Longitude | Latitude |
|---|---|---|
| Adrigole Point | -9.72589 | 51.66565 |
| Easternmost Point Bear Island | -9.78491 | 51.64430 |
| Ardnakinna Point | -9.91575 | 51.62113 |
| Headland West Bear Island | -9.92713 | 51.61886 |

The sampling locations and the shellfish species collected for biotoxin analysis are shown in in Figure 7.

**Figure 7. Castletownbere and Bere island sampling points and species collected for biotoxin analysis.**

**Sample Points:**

| Location Code | Location | Species | Longitude | Latitude |
|---|---|---|---|---|
| CK-CE-CE | Castletownbere | *Mytilus edulis*<br>*Echinus esculentus*<br>*Littorina littorea* | -9.83806 | 51.65556 |
| CK-CE-BI | Bear Island | *Mytilus edulis* | -9.8240 | 51.6393 |

### Interplay of Factors

The relationships between *E. coli*, norovirus, salinity, and temperature are complex and influenced by various factors. Human activities, such as sewage discharge, agricultural runoff, and urban development, can elevate *E. coli* levels and contribute to norovirus contamination. Climate events like heavy rainfall can exacerbate contamination risks.

For coastal regions, understanding these relationships is essential for managing water quality and public health. Monitoring *E. coli* and norovirus levels along with salinity and temperature variations can aid in the early detection of potential contamination events. By identifying trends and correlations, authorities can implement timely measures to mitigate risks, such as issuing advisories, enhancing sewage treatment, and promoting better land use practises.

## Summary and conclusions

In summary, the relationships between *E. coli* numbers, norovirus presence, salinity, and temperature in seawater are intricate and interconnected. A comprehensive understanding of these factors is vital for safeguarding the health of coastal communities and maintaining the integrity of marine ecosystems.

In the field of aquaculture, it is imperative for operators engaged in the cultivation or harvesting of bivalve molluscs to gain a comprehensive understanding of the intricate connections among various environmental factors and microbial contamination. Specifically, the quality of seawater serves as a critical focal point, wherein an exploration of the interplay between Escherichia coli (*E. coli*) levels, the presence of norovirus, salinity, nutrient inputs, and temperature holds the key to unraveling potential sources of contamination and associated risks.

Also on a wider scale, according to (Raine et al., 2010) "it is understood that virtually all harmful algal bloom events that occur in the bays of southwestern Ireland arise as a result of the transport of damaging phytoplankton populations from the continental shelf via wind-driven exchange. The principal feature of this flow is a narrow (10 km) density-driven coastal jet which results from the increasing effect of tidal mixing on a stratified water column as one nears the coast (Fernand et al., 2006). These jets have been considered as important transport pathways for potentially harmful plankton populations (Brown et al., 2001; O'Boyle and Raine, 2007; Hill et al., 2008), and there is now direct evidence for this (Farrell et al., 2008)," As cited in Raine et al., 2010. A practical measure suggested by (Raine et al., 2010) to provide prediction would be the deployment of offshore plankton observatories.

The European Directorate-General for Environment (2023) report that there is a lot of data available, such as weather monitoring, which can help with environmental risk management. However, it is difficult to predict natural hazards because they involve multiple factors. Data-driven forecasting models can be effective, but to date they have relied on incomplete and inconsistent data. Researchers in the US (Searcy et al 2022) have used a method to predict water quality at recreational beaches. Where beach water is monitored for faecal indicator bacteria (FIB). However, monitoring is infrequent and the laboratory analysis takes time, which can cause delays between detection and notification. For that reason researchers developed models to forecast when bacteria levels might exceed safety thresholds up to three days in advance. The models use environmental data, such as tide level and precipitation, and have been found to perform as well as real-time models. This tool might be integrated into beach and shellfish water quality to improve risk management and could be extended to other phenomena, such as algal blooms.

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SFPA Norovirus Guidance Document Published 13 December 2018 – see https://www.sfpa.ie/Search/resource/147

Shellfish Sanitary Surveys – see https://www.sfpa.ie/What-We-Do/Molluscan-Shellfish/Sanitary-Surveys.

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## Appendix 1. Nutrient Analytical Results Castletownbere

| Sample No | Report No | Receipt Date | Sample ID | Date sampled | Salinity | Phosphate as P filtered (low level SW or saline) | Nitrate as N saline waters | Nitrite as N saline waters | Chlorophyll | Suspended Solids | pH | TOC | DOC | Ammonia as N (saline water) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1537628 | 500962 | 07/10/2022 | Castletownbere A (Composi | 03/10/2022 | 34.5 | 0.009 | 0.036 | 0.006 | <1 | 13 | 8.0 | 1.48 | <1 | 0.027 |
| 1537629 | 500963 | 07/10/2022 | Castletownbere B (Composi | 03/10/2022 | 34.5 | 0.011 | 0.043 | 0.007 | <1 | 12 | 8.1 | 1.62 | <1 | <0.010 |
| 1547449 | 503629 | 04/11/2022 | Castletownbere 03/11/2022 | 03/11/2023 | 33.0 | 0.007 | 0.046 | 0.006 | 1.07 | | 8.0 | 1.52 | 1.29 | 0.025 |
| 1553107 | 504995 | 18/11/2022 | Castletownbere | 17/11/2022 | 31.3 | 0.015 | 0.100 | 0.009 | 1.07 | 6 | 7.9 | 1.82 | 1.20 | <0.010 |
| 1560994 | 506855 | 08/12/2022 | Castletownbere | 08/12/2022 | 33.5 | 0.021 | 0.131 | 0.005 | <1 | 5 | 8.1 | 1.98 | 1.37 | <0.010 |
| 1583665 | 512335 | 20/02/2023 | Castletownbere | 17/02/2023 | 34.5 | 0.021 | 0.119 | 0.003 | <1 | 4 | 8 | 1.11 | 1 | 0.018 |
| 1593784 | 514889 | 16/03/2023 | Castletownbere | 15/03/2023 | 34.3 | 0.019 | 0.02 | 0.004 | 2.14 | 9 | 8.1 | 1.25 | <1 | <0.010 |
| 1601469 | 517039 | 07/04/2023 | Castletownbere | 06/04/2023 | 33.9 | 0.026 | 0.014 | 0.004 | 2.14 | 17 | 8 | 1.36 | 1.32 | 0.06 |
| 1613741 | 520526 | 12/05/2022 | Castletownbere | 11/05/2023 | 34.4 | 0.01 | 0.039 | <0.003 | <1 | 38 | 8 | 1.38 | 0.691 | 0.024 |

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STREAM

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**Report**

SETU -Dr. Ronan Browne, John Ronan, Benyuan Yu, Ailish Tierney, Dr Mitra Abedini and Dr Joseph O'Mahony

MTU - Dr Ambrose Fury, Mike Griew and Paul Shanahan