

# Post Survey Report

**Vessel Name:** Celtic Voyager

**Call Sign:** EIQN

**Type of Vessel:** Research Vessel

**Cruise Name:** Winter Environmental Survey 2016 - Northabout

Environmental Survey of Coastal and Shelf Waters Dublin – Galway: – Winter nutrients, benthos and contaminants monitoring.

**Cruise Code:** CV16008

**Start Date:** 10/02/2016

**End Date:** 22/01/2016

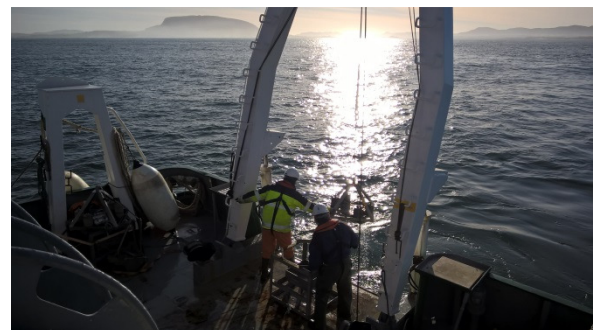
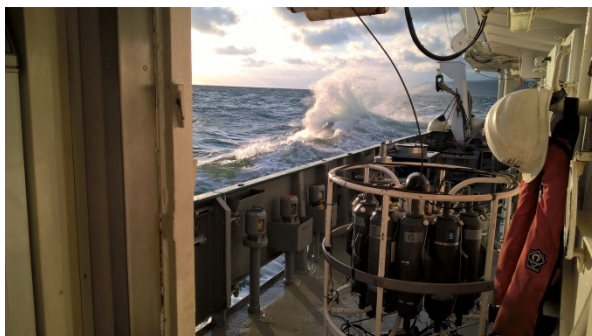
**Port of Dept:** Howth

**Port of Return:** Galway

## Responsible Organisation

**Name:** Marine Environment & Food Safety Services, Marine Institute

**Address:** Rinville, Oranmore, Co. Galway



# 1. Introduction & Rationale

The 2016 survey continues the Marine Institute's Winter Nutrients monitoring that commenced in 1990/91. The survey has evolved and expanded during this time period with respect to target areas, parameters and sampling strategy. In 2011 this survey was reestablished as a *winter environmental survey* with a broader remit to provide supporting information for OSPAR and Water Framework Directive (WFD-Directive 2000/60/EC) assessments and also to maintain the winter time series on key biogeochemical parameters in Irish waters in response to pressures such as land based inputs of nutrients and climate change. Since 2011 the survey circumnavigates the Island of Ireland every two years, alternating southabout (odd years) and northabout (even years), starting in the Irish Sea and ending in Galway. This provides a complete coverage of Ireland's coastal waters over 2 year periods. However, given the timing of the surveys, winter by necessity to ensure minimal biological activity and therefore highest concentrations of dissolved nutrients, the weather is a significant factor in determining the actual as opposed to planned coverage of the target stations. This work is complementary to inshore water quality monitoring activities of the Irish Environmental Protection Agency and Marine Institute and the annual offshore oceanographic survey/climate section (53N/Rockall Trough) on the *RV Celtic Explorer* led by the Oceanographic Science Services group at the Marine Institute.

The 2016 survey was designed to collect multidisciplinary information on physical conditions, water chemistry (dissolved nutrients, dissolved oxygen, total alkalinity (TA), dissolved organic carbon (DIC), dissolved trace metals, and total organic carbon, salinity), sediment chemistry (persistent organic pollutants POPs and trace metals), sediment particle size distribution and benthic macroinvertebrates (at targeted waterbodies around the coast). This contributes to data collection needs of various statutory drivers (WFD and the Marine Strategy Framework Directive (MSFD) Directive 2008/56/EC) as well as providing a research dataset on status and changing conditions (trends and variations) for key environmental variables.

## 2. Objectives

**A) Winter Nutrients Survey:** The survey aims to fulfil Ireland's requirements under the Coordinated Environmental Monitoring Programme (CEMP) of the 1992 'Oslo Paris Convention for the Protection of the North East Atlantic' (OSPAR) and to contribute to assessments under the Common Procedure for the Identification of the Eutrophication Status of the OSPAR maritime area. This requires the answering of 3 key questions:

1. What is the spatial distribution of winter nutrients in Irish coastal and shelf waters?
2. Are nutrient concentrations changing over time (trends)?
3. Are nutrient concentrations significantly elevated in coastal waters (>50%) above salinity related and/or regionally specific background levels and what are the background concentrations?

Coastal nutrient data are provided to the EPA and to contribute to the assigning of *ecological status* to coastal water bodies in accordance with the requirements of the Water Framework Directive (Directive 2000/60/EC)

Offshore nutrient profiles in shelf waters contribute to determining long term variability which can be influenced by climate change related processes

As weather down time frequently disrupts coverage of Winter Surveys in a vessel of the size of the *RV Celtic Voyager* the sampling plan assigns a priority ranking to the stations.

**B) Collect sediment samples for assessment of hazardous substances in the marine environment:**

- obtain sediment samples to be used for trend analysis (Dublin Bay & Irish Sea) for organic and inorganic hazardous substances (OSPAR CEMP, WFD).

**C) Conduct Water Framework Directive monitoring (Dir 2000/60/EC) and provide supporting information for the implementation of the Natura Directives (Habitats Directive 92/43/EEC).**

- Collect samples to provide data to contribute to classification of WFD (client EPA) ecological status of selected water bodies for physico-chemical (nutrients, DO) and benthic macro-invertebrate ecological quality elements in a select number of waterbodies in the Irish Sea and North Western coastal waters.
- Using benthic invertebrates and associated sediment information (Particle Size Analysis) the survey will be able provide additional habitat distribution data (ground truth data) for a variety of Natura sites along the Eastern, Southeastern and southwestern Seaboard.

**D) Collect samples for measuring carbonate system parameters ( $DIC$ ,  $TA$ ,  $pCO_{2calc}$ ,  $pH_{calc}$ , and  $\Omega_{calc}$ ) in coastal waters to contribute to baseline dataset for these variables.**

**E) Collect samples for measuring levels of dissolved trace metals in coastal and shelf waters.**

- Pilot sampling to assess methodology for surface sampling seawater for dissolved trace metals from Celtic Voyager. Data to contribute to WFD assessments and characterization of trace metal concentrations in offshore/shelf areas (MSFD)

### 3. Personnel

**Role:** Chief Scientist

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**Crew:** Master and 5 crew. **Master** Phillip Baugh

**Technical support:** Lukasz Pawlikowski

## 4. Methods & Protocol

### 4.1. Equipment Listing

#### 4.1.1. CTD Profiler and Rosette Sampler

**Make:** Seabird SBE 911

**Model:** SBE 911plus

**Sampling Protocols** - CTD deployed at designated stations and times. Data collected from temperature, conductivity and pressure sensors. Water samples for nutrients, DO, DIC/TA and DOC/TOC were collected at most stations from the maximum depth reached and surface (~ 3 metres) using niskin bottles (5L) and applying standard MI procedures in line with best practice (Dickson et al. 2007, Grasshof et al 1999). Water samples for metal testing were collected using GO-FLO bottles. GO-FLO bottles were acid cleaned in the laboratory and tested for contamination in advance of the survey

Also deployed on frame was Wetlabs fluorometer, transmissometer, DO Sensor (see sect 5)

#### 4.1.2. Fluorometer

**Make:** Wetlabs

**Model:**

**Sampling Protocols** - OSS fluorometer deployed on CTD frame

#### 4.1.3. Transmissometer

**Make:**

**Model:**

**Sampling Protocols** - Deployed on CTD frame

#### 4.1.4. DO sensor

**Make:** Seabird

**Model:** SBE-43

**Sampling Protocols** - Deployed on CTD frame

SBE-43 DO sensor deployed on the frame calibrated shortly before the survey as Winkler titrations were not carried out on this survey.

#### 4.1.5. On board Seawater Pump

**Make:**

**Model:**

**Sampling Protocols:** The seawater pump was used to collect surface water at all underway stations.

#### 4.1.6. Data were also generated by underway fluorometer, onboard ADCP and MDM 400.

#### 4.1.7. Reineck Box Corer

**Make:** Reineck

**Model:**

**Sampling Protocols:** Sediment samples were taken for contaminant monitoring: Surface sediment was transferred into glass and plastic bottles

for organic and inorganic analysis respectively. Sampling material in contact with the side of the grab was avoided

#### 4.1.8 Grab sampler

**Make:** Day Grab

**Model:** P&O design

**Sampling Protocols:** Sediments were sampled for benthic infauna using Day grab. Sediment samples were removed from the grab and a small subsample retained (and frozen) for PSA and organic carbon analysis (LOI). The remaining sediment was sieved through a 1mm mesh sieve and fixed in formalin (5%).

#### 4.1.9 Shipek sediment grab sampler

**Make:** Shipek

**Model:**

**Sampling Protocols:** Not used

#### 4.1.10 SCS system: The system was used to log all sampling events with automated date, time and GPS stamping.

## 4.2. On-board processing

### ***Water Samples - chemistry:***

Surface Samples (~3m) from underway stations were collected for nutrients and salinity as below using the onboard pump. From CTD stations the following were sampled using Niskin bottles according to standard protocol and in the following order: Dissolved oxygen (Winkler), TA/DIC (selected stations), nutrients and salinity.

1. Samples for accurate salinity measurement: Unfiltered glass bottle stored at room temperature for subsequent salinity analysis. Sample salinities measurements will be measured in the Marine Institute using a laboratory high-precision benchtop salinometer. Note this analysis is not completed at time of writing due to instrument problems. Analysis will be completed following acquisition of a replacement.
2. 2 x 50 ml PP tubes filled with water filtered through a 0.45 $\mu$  cellulose acetate (acid-cleaned polycarbonate) filter and frozen immediately after collection for post-cruise nutrient analysis. These analyses will be carried out at the Marine Institute using a standard colorimetric methods for determination of nutrients in seawater employing a Seal Analytical instrument using air segmented continuous flow analysis.
3. DIC/TA samples collected at designated stations. Samples preserved with mercuric chloride (Dickson et al. 2007). Samples are being sent to a specialist laboratory for testing using appropriate methodology Dickson et al (2007).
4. Surface seawater dissolved trace metal samples were collected at selected stations using the pre acid-washed and contaminant checked (laboratory) GO-FLO bottles mounted on the CTD rosette. Samples were collected from the GO-FLOs into acid washed 1L plastic bottles. Approximately 50 mls are transferred to a new Fortuna plastic 2 piece syringe (no bung) and filtered through a cellulose acetate syringe filter unit. The first 5mls are filtered to waste and the remainder is collected in acid washed 100ml nalgene bottles containing 1 ml of concentrated nitric acid. The bottles are closed and stored on board at ~4°C. Samples were analysed within 1 month at the Marine Institute using ICPMS.

## **Sediment Samples**

### ***Sediment Samples – marine chemistry:***

Surficial sediments for metal analysis (station ENV 1002 Dublin Bay) were sampled using Reineck box core. However, in poor weather it was proving difficult to collect sufficient sample, so the day grab was deployed off the stern. The day grab was also used for sampling stations ENV 1003 (Dublin Bay 2) and ENV 1001 (N Irish Sea). Surface sediment was split between glass (solvent washed – for organic analysis) and plastic jars (acid washed – metals) and frozen immediately after collection. Samples will be analysed (<63µ fraction) in the MI and additional specialist labs for a variety of persistent organic pollutants, trace metals and various cofactors.

### ***Benthic Sediment Samples:***

Sediment samples: At all benthic stations where suitable sediments could be sampled, a subsample of sediments (100-200g) was taken for Particle Size Analysis (PSA) and Loss on Ignition (LOI). The samples were labelled and stored in plastic zip-loc bags and frozen.

Macroinvertebrate samples: At each station sufficient sediment (>2.5L) was retained for faunal analysis. These samples comprised single Day grab samples. Upon retrieval all sediment were washed on a 1mm mesh sieve. All faunal and residue (e.g. sediment and shell matter) were retained and stored in a plastic container and fixed with V:V 4% neutral buffered formalin.

## **4.3. Equipment Issues**

4.3.1 SCS system was used to log sample events at the chemistry sampling stations. Paper records were not taken during this year's survey. There are a few suggestions for improving the system that will be dealt with for next year's survey.

4.3.3 A number of the sampling bottles were firing and some of the valves and spigots were very stiff. These issues were mostly dealt with during the survey but some additional repair of bottles and firing may be required.

## 5. Narrative

The proposed survey was scheduled from 10<sup>th</sup> Feb (Howth) to 21<sup>st</sup> Feb (Galway Port). Overall the weather conditions for the survey were moderate. However, very poor weather for some of the survey meant that 62% of the planned seatime was achieved. Weather forced the vessel to pull into Killybegs for close to 3 days and came in to Galway 1.5 days ahead of schedule. The actual sampling plan was dictated by the weather/sea conditions.

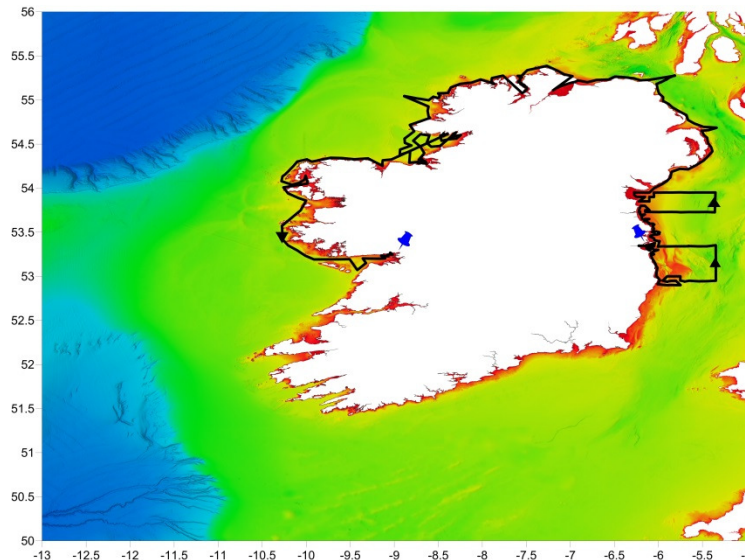


Figure 1: Station track Survey CV16008

In total 203 underway stations were sampled for surface water chemistry via the onboard non-toxic system; 96 CTD deployments were undertaken, typically at surface and bottom but occasionally at mid-depths where some stratification was seen in the water column, resulting in 197 CTD sampling events.

### 10<sup>th</sup> Feb

The scientific complement joined the vessel on the evening of Tues 9<sup>th</sup> Feb and set up the laboratory. The survey departed from Howth Harbour at 1000 of the 10<sup>th</sup> Feb. Sampling was commenced with underway stations before steaming to commence sampling within Dublin Port just outside the East Link Bridge. Sampling in Dublin Bay involved intensive sampling for all parameters, including sediment sampling for contaminant chemistry (ENV1002 ENV 1003) using the Reineck Box Core off the stern, benthic infauna sampling using the Day Grab off the stern, CTD/ sensor package/ rosette deployments, and sampling for a full suite of seawater chemistry parameters (salinity, dissolved inorganic nutrients, DIC, TA, trace metals (dissolved)). Following sampling in Dublin Bay the vessel proceeded south along the coast collecting water samples at designated stations.

### 11<sup>th</sup> Feb

Nutrients sampling along the Wicklow transect. The CTD pump was adjusted following problems with the CTD pump not automatically switching on. Sailed north from easternmost point of Wicklow transect (st 419) to st 322 on Dublin Transect and worked east sampling underway stations and at CTD stations for carbon and metals (GoFLO). Following Dublin transect, the vessel worked northwards along the coast sampling for benthic fauna and underway nutrient

### 12<sup>th</sup> Feb



Boyne transect. Sediment samples for hazardous substance testing (metals and organics) collected at 9001 sediment trend station. Worked Dundalk transect westward before sampling coastal stations around Dundalk Bay. Carlingford Lough now requires a pilot and in any case was under a localised fog. With weather forecast indicating worsening conditions it was decided to drop sampling in Carlingford Lough and proceed northwards along the coast.

### **13<sup>th</sup> Feb**

Commenced Ards – Galloway transect in poor conditions and after third station (641) the decision was taken by master to abandon the transect as deployment of CTD was unsafe.

Mull transect was completed including DIC/TA samples. Sampled carbon, metals and nutrients at CTD stations in Lough Foyle. Very high SPM was noted as in previous years requiring frequent filter changes

### **14<sup>th</sup> Feb.**

Rounded Malin head and sampled Lough Swilly to station 711. DIC/TA samples also collected. Benthic stations sampled in Lough Swilly. Subsequently sampled around the Donegal coast including 2 stations in Sheephaven Bay. Benthic samples collected at Aranmore.

### **15<sup>th</sup> Feb**

CTDs sampled stations 743 - 745 (stratification evident) on Aranmore transect but decision taken not to sample further due to worsening conditions and poor forecast/time constraints. The Master indicated it was not possible to carry out benthic sampling in Gweebarra bay at night given the conditions so proceeded sampling along the Donegal coast and sampling in Donegal Bay and Sligo Bay. As with along the Donegal coast some clear water column structure was evident. Benthic: In the am, benthic sampling was completed in Sligo Bay and following Benthic sampling in McSwynes Bay, the vessel pulled into Killybegs at 0000 16th Feb due to incoming weather.

### **17<sup>th</sup> Feb**

Vessel had to switch berth so opportunity was taken to collect final benthic and water stations in McSwyne's Bay. (2 hours)

### **18<sup>th</sup> Feb**

Conditions indicated as still poor but forecast indicated marginal weather window to complete passage to Galway before worse weather due. As time window and forecast conditions meant remaining benthic sampling plan for Clew Bay and Killary Harbour was unlikely to be achievable, the benthic team departed the vessel. The vessel pulled away from Killybegs Harbour at 1800 and proceeded to complete chemistry sampling along the Sligo, North Mayo coast, including sampling DIC and TA in Killala Bay.

### **19<sup>th</sup> Feb**

Sampled along the Mayo/Galway coast, including Boadhaven Bay and Blacksod Bay but conditions/time window precluded sampling on Belmullet transect or in Clew Bay/Killary Harbour. The CTD could not be deployed around the Connemara coast so only underway samples were collected.

### **20<sup>th</sup> Feb**

Completed the outer stations in Galway Bay. Dock gate scheduled for afternoon tide (1400) so hove to at 01:30 until 09:00 before completing the remaining chemistry water sampling in Galway Bay. The vessel tied up in Dock's at 1500 and demobbed immediately. Samples were transferred directly to the Marine Institute and appropriately stored prior to analysis.

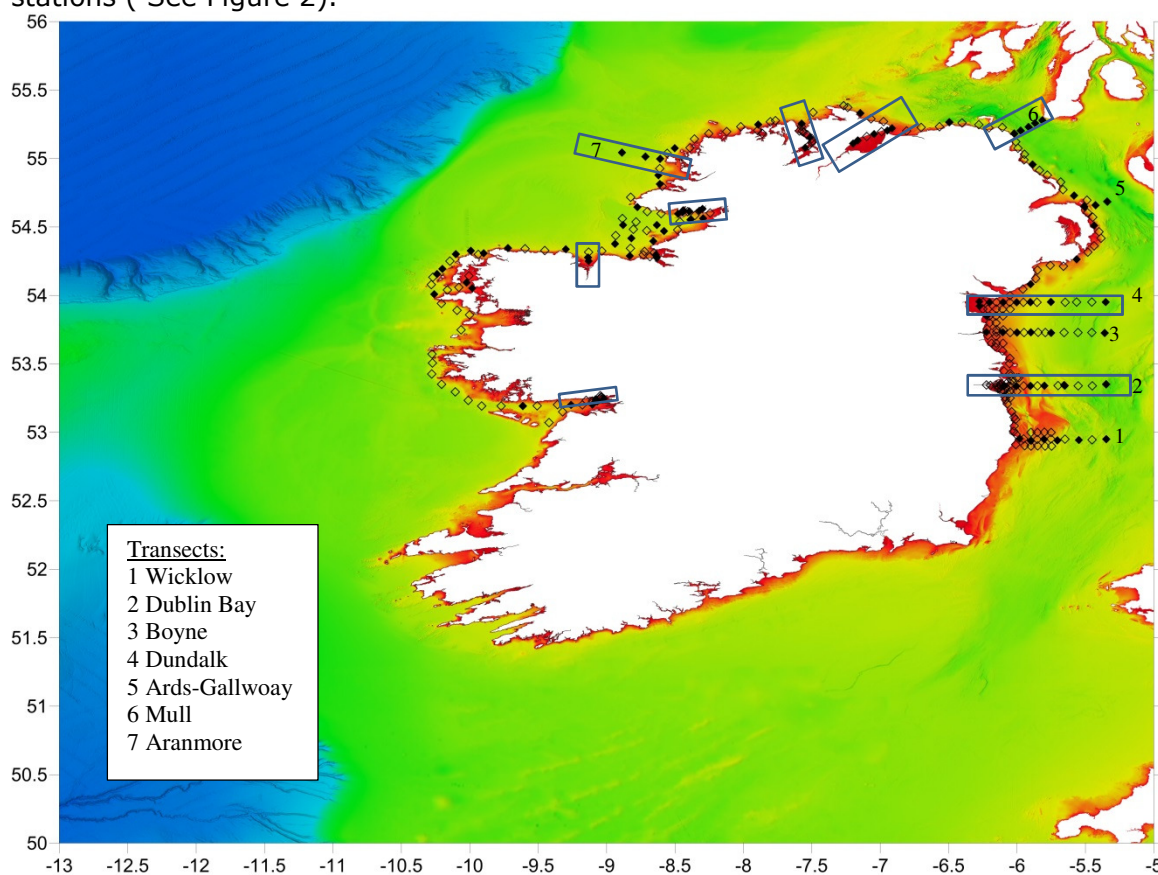
**Winter Nutrients:** Figure 2 shows the coverage achieved. 203 Underway stations were sampled for surface dissolved nutrients and bottle salinity. 96

In total 203 underway stations were sampled for surface water chemistry via the onboard non-toxic system; 96 CTD deployments were undertaken, typically at surface (2-4m) and near bottom depths but occasionally at mid-depths at certain stations where structure was observed in the water column (primarily Donegal coast and Donegal Bay), resulting in 197 CTD sampling events. Conductivity, temperature, DO and turbidity profiles were taken at CTD stations.

**Sediment samples were collected for hazardous substances analysis (trace organics and heavy metals)** in Dublin Bay (2) and North Irish Sea (1) – trend stations samples were collected as per previous years (stations 9001, 9002 and 9003)

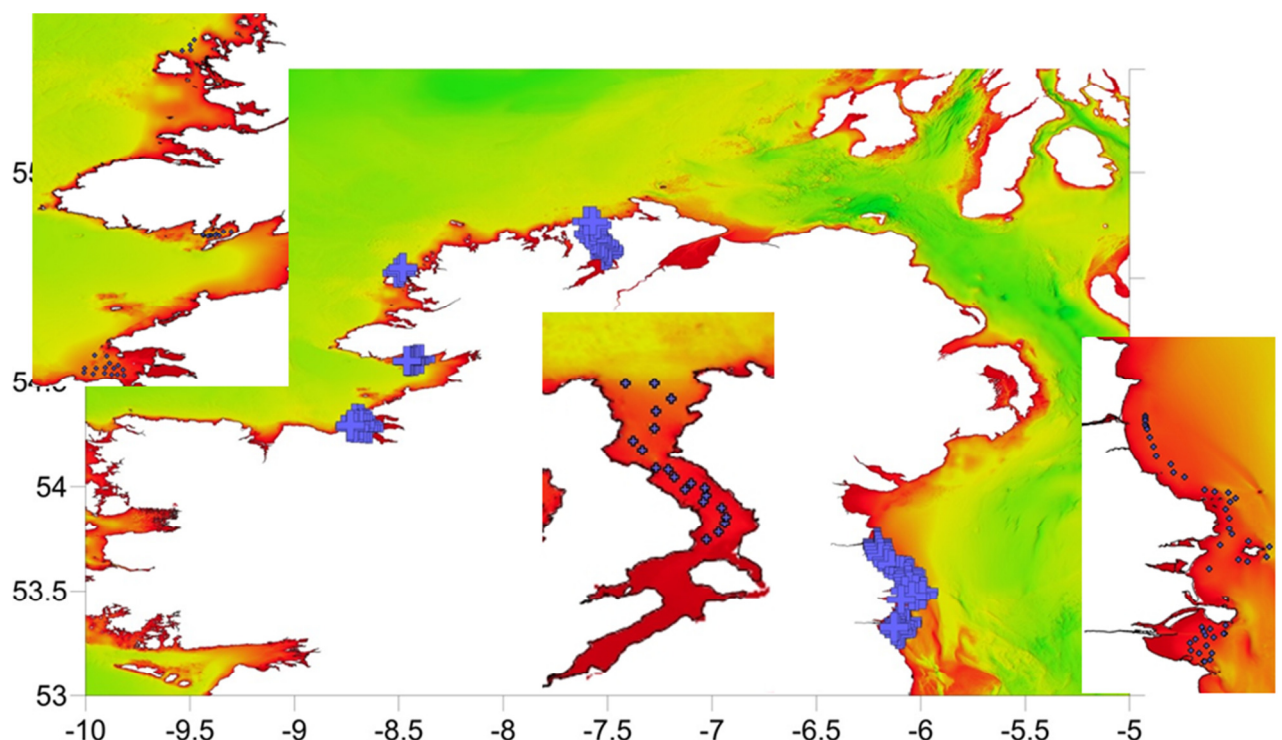
**DIC/TA Samples** ~ 84 samples (typically surface and bottom) were collected during CTD deployments during following transects/bays: Dublin Bay transect, Dundalk transect; Galloway and Mull transects, Lough Foyle, Lough Swilly, Aranmore, Donegal Bay, Killala Bay and Galway Bay. Regular duplicate samples were collected for quality control purposes during the survey

Samples were taken and filtered on board for the determination of **dissolved trace metals** (Ag, As, Cd, Co, Cu, Cr, Hg, Ni, Pb, U, V and Zn) in surface waters at 31~ stations ( See Figure 2).



**Figure 2: Stations sampled for seawater chemistry during CV15001 survey. (GEBCO Bathymetry shown in colour). Underway stations (open diamonds) sampled for dissolved inorganic nutrients and salinity. CTD deployments (closed diamonds) sampling for dissolved inorganic nutrients, salinity and at CTD stations on transects indicated by grey boxes carbonate parameters (DIC,TA), DOC, trace metals (note metals not sampled on Mull or Dundalk transects)**

**Benthic fauna:** 88 stations were sampled for benthic invertebrate analysis (Figure 3, table 1). Dublin Bay, Northwestern Irish Sea, Plume, Lough Swilly, Sligo Bay, McSwyne's Bay, Sub-Samples were retained for particle size analysis and loss on ignition. In addition, grab samples were sieved on a 1mm sieve and fixed in formalin (4%). Despite not completing the survey (Shannon estuary outstanding for benthic infauna) over 85% of planned benthic stations were sampled.



**Figure 2: Stations sampled for Benthic Infauna (blue crosses) during CV 16008 survey. with insets showing Dublin Bay/Northeastern Irish Sea, Lough Swilly, Aranmore/Donegal Bay and Sligo Bay**

**Table 1. Benthic sampling summary table.**

Waterbody	Sample Code	Fauna sample	Sediment sample
Dublin Bay	MIBE16 -1	Yes	Yes
Dublin Bay	MIBE16 -3	Yes	Yes
Dublin Bay	MIBE16 -4	No	No
Dublin Bay	MIBE16 -6	Yes	Yes
Dublin Bay	MIBE16 -8	Yes	Yes
Dublin Bay	MIBE16 -9	Yes	Yes
Dublin Bay	MIBE16 -10	Yes	Yes
Dublin Bay	MIBE16 -10A	Yes	Yes
Dublin Bay	MIBE16 -11	Yes	Yes
Dublin Bay	MIBE16 12	Yes	Yes
Dublin Bay	MIBE16 -13	Yes	Yes
Dublin Bay	MIBE16 -15	Yes	Yes
Dublin Bay	MIBE16 -16	Yes	Yes
Dublin Bay	MIBE16 -17	Yes	Yes
Dublin Bay	MIBE16 -18	Yes	Yes
Dublin Bay	MIBE16 -19	Yes	Yes
NWIS	MIBE16 -21	Yes	Yes
NWIS	MIBE16 -22	Yes	Yes
NWIS	MIBE16 -23	Yes	Yes
NWIS	MIBE16 -24	Yes	Yes
NWIS	MIBE16 -25	Yes	Yes
NWIS	MIBE16 -26	Yes	Yes
NWIS	MIBE16 -27	Yes	Yes
NWIS	MIBE16 -28	Yes	Yes
NWIS	MIBE16 -29	Yes	Yes
NWIS	MIBE16 -30	Yes	Yes
NWIS	MIBE16 -30A	Yes	Yes
NWIS	MIBE16 -31A	Yes	Yes
NWIS	MIBE16 -31	Yes	Yes
NWIS	MIBE16 -32	Yes	Yes
NWIS	MIBE16 -33	Yes	Yes
NWIS	MIBE16 -34	Yes	Yes
NWIS	MIBE16 -35	Yes	Yes
NWIS	MIBE16 -36	Yes	Yes
NWIS	MIBE16 -37	Yes	Yes
NWIS	MIBE16 -38	Yes	Yes
NWIS	MIBE16 -39	Yes	Yes
NWIS	MIBE16 -40	Yes	Yes
NWIS	MIBE16 -41	Yes	Yes
Boyne Plume	MIBE16 -42	Yes	Yes

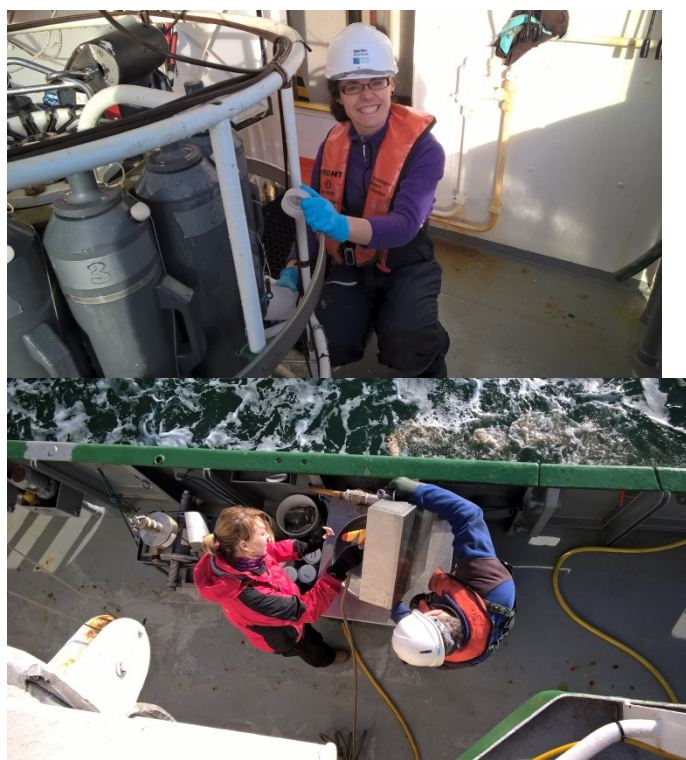
Waterbody	Sample Code	Fauna sample	Sediment sample
Boyne Plume	MIBE16 -43	Yes	Yes
Boyne Plume	MIBE16 -44	Yes	Yes
Boyne Plume	MIBE16 -45	Yes	Yes
Boyne Plume	MIBE16 -46	Yes	Yes
Lough Swilly	MIBE16 -47xx	Yes	Yes
Lough Swilly	MIBE16 -48	Yes	Yes
Lough Swilly	MIBE16 -49	Yes	Yes
Lough Swilly	MIBE16 -50	Yes	Yes
Lough Swilly	MIBE16 -51	Yes	Yes
Lough Swilly	MIBE16 -52	Yes	Yes
Lough Swilly	MIBE16 -53	Yes	Yes
Lough Swilly	MIBE16 -54	Yes	Yes
Lough Swilly	MIBE16 -55	Yes	Yes
Lough Swilly	MIBE16 -56	Yes	Yes
Lough Swilly	MIBE16 -57	Yes	Yes
Lough Swilly	MIBE16 -58	Yes	Yes
Lough Swilly	MIBE16 -58A	Yes	Yes
Lough Swilly	MIBE16 -59	Yes	Yes
Lough Swilly	MIBE16 -60	Yes	Yes
Lough Swilly	MIBE16 -61	Yes	Yes
Lough Swilly	MIBE16 -62	Yes	Yes
Lough Swilly	MIBE16 -63	Yes	Yes
Lough Swilly	MIBE16 -64	Yes	Yes
NW Atlantic Seaboard	MIBE16 -65	Yes	Yes
NW Atlantic Seaboard	MIBE16 -66	Yes	Yes
NW Atlantic Seaboard	MIBE16 -67	Yes	Yes
Sligo Bay	MIBE16 -68	Yes	Yes
Sligo Bay	MIBE16 -69	Yes	Yes
Sligo Bay	MIBE16 -70	Yes	Yes
Sligo Bay	MIBE16 -71	Yes	Yes
Sligo Bay	MIBE16 -72	Yes	Yes
Sligo Bay	MIBE16 -73	Yes	Yes
Sligo Bay	MIBE16 -74	Yes	Yes
Sligo Bay	MIBE16 -75	Yes	Yes
Sligo Bay	MIBE16 -76	Yes	Yes
Sligo Bay	MIBE16 -77	Yes	Yes
Sligo Bay	MIBE16 -78	Yes	Yes
Sligo Bay	MIBE16 -79	Yes	Yes
Sligo Bay	MIBE16 -80	Yes	Yes



Waterbody	Sample Code	Fauna sample	Sediment sample
Sligo Bay	MIBE16 -81	Yes	Yes
Sligo Bay	MIBE16 -82	Yes	Yes
McSwynes Bay	MIBE16 -83	Yes	Yes
McSwynes Bay	MIBE16 -84	Yes	Yes
McSwynes Bay	MIBE16 -85	Yes	Yes
McSwynes Bay	MIBE16 -86	Yes	Yes
McSwynes Bay	MIBE16 -87	Yes	Yes
McSwynes Bay	MIBE16 -88	Yes	Yes
McSwynes Bay	MIBE16 -89	Yes	Yes
McSwynes Bay	MIBE16 -90	Yes	Yes
McSwynes Bay	MIBE16 -91	Yes	Yes
McSwynes Bay	MIBE16 -92	Yes	Yes



**DIC/TA samples**



**Sampling seawater (top) and benthic infauna (bottom)**

## 5. Preliminary Findings

Analysis and processing of data is mostly carried out post cruise. Nutrients, carbon, benthic, contaminant and other data will be available via Marine Institute data request system when post cruise analysis and quality assurance has been completed ([www.marine.ie](http://www.marine.ie)). Selected preliminary salinity and temperature sections are given in Figure 3. Preliminary results for dissolved trace metals in seawater sampled during the survey are given in table 2.

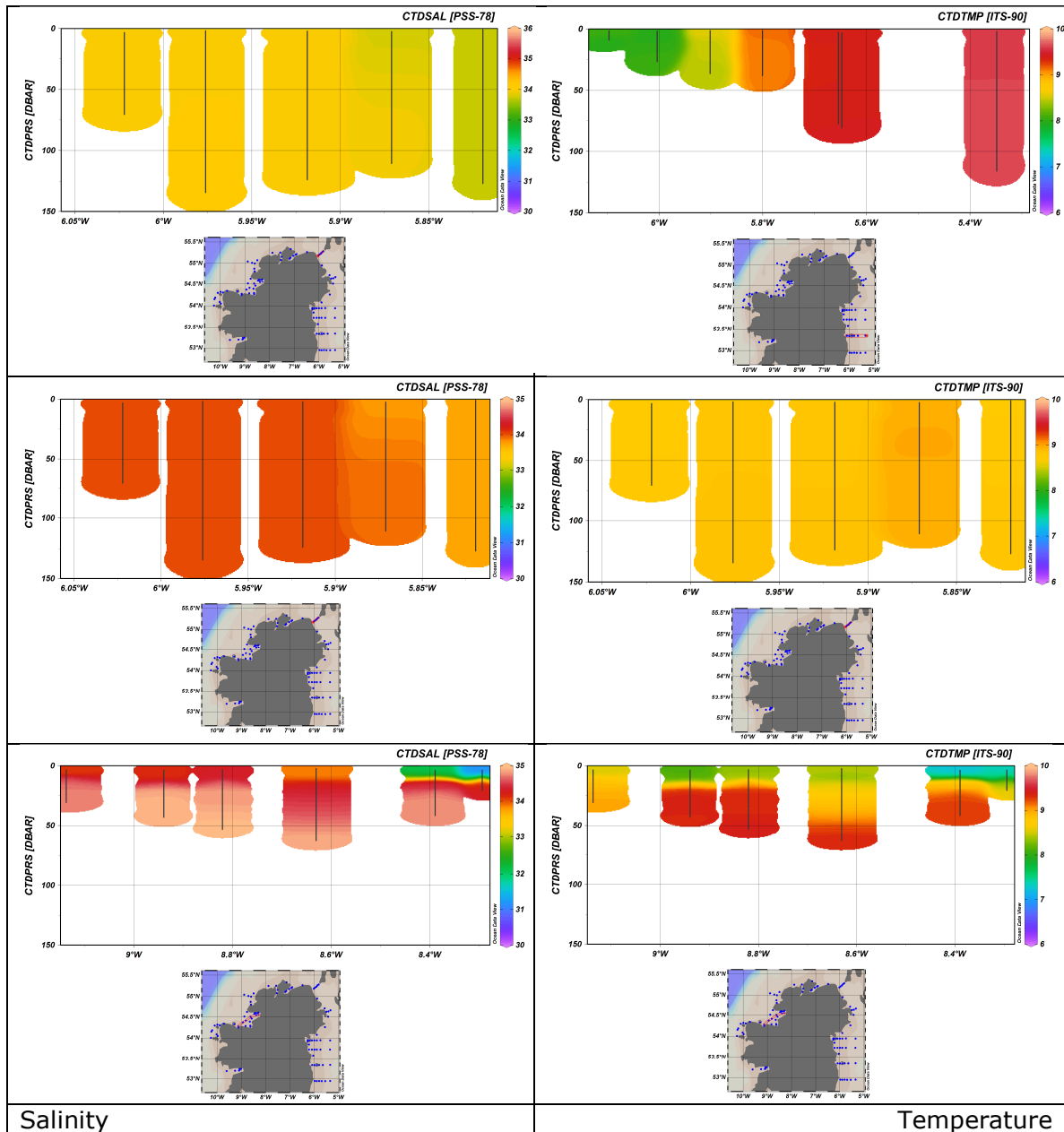


Figure 3. Preliminary plots of salinity (left column) and temperature (right column) for three sections from CV16008: Dublin Bay section (top row); Mull section (middle row) and NE-SW running section from inner Donegal Bay to Killala Bay (Bottom Row). Plotted using ODV4 Schlitzer, R, Ocean data View. <http://odv.awi.de>, 2015.

Table 2: Preliminary measured concentration ranges for dissolved trace metals in seawater sampled during the survey (n=25, see fig 1). Samples were analysed post survey at Marine Institute using an accredited ICP-MS method (Agilent 7700x)

	Range $\mu\text{g l}^{-1}$
Arsenic	0.99 - 1.69
Cadmium	<0.05
Chromium	0.26 - 0.40
Cobalt	0.01 - 0.15
Copper	0.28 - 2.76
Lead	<0.10
Nickel	0.14 - 0.50
Silver	nd(<0.002)
Uranium	1.78 - 3.68
Vanadium	0.78 - 1.57
Zinc	<1.00 - 1.04

## 6. Conclusions & Recommendations

### *Effective completion of the cruise objectives.*

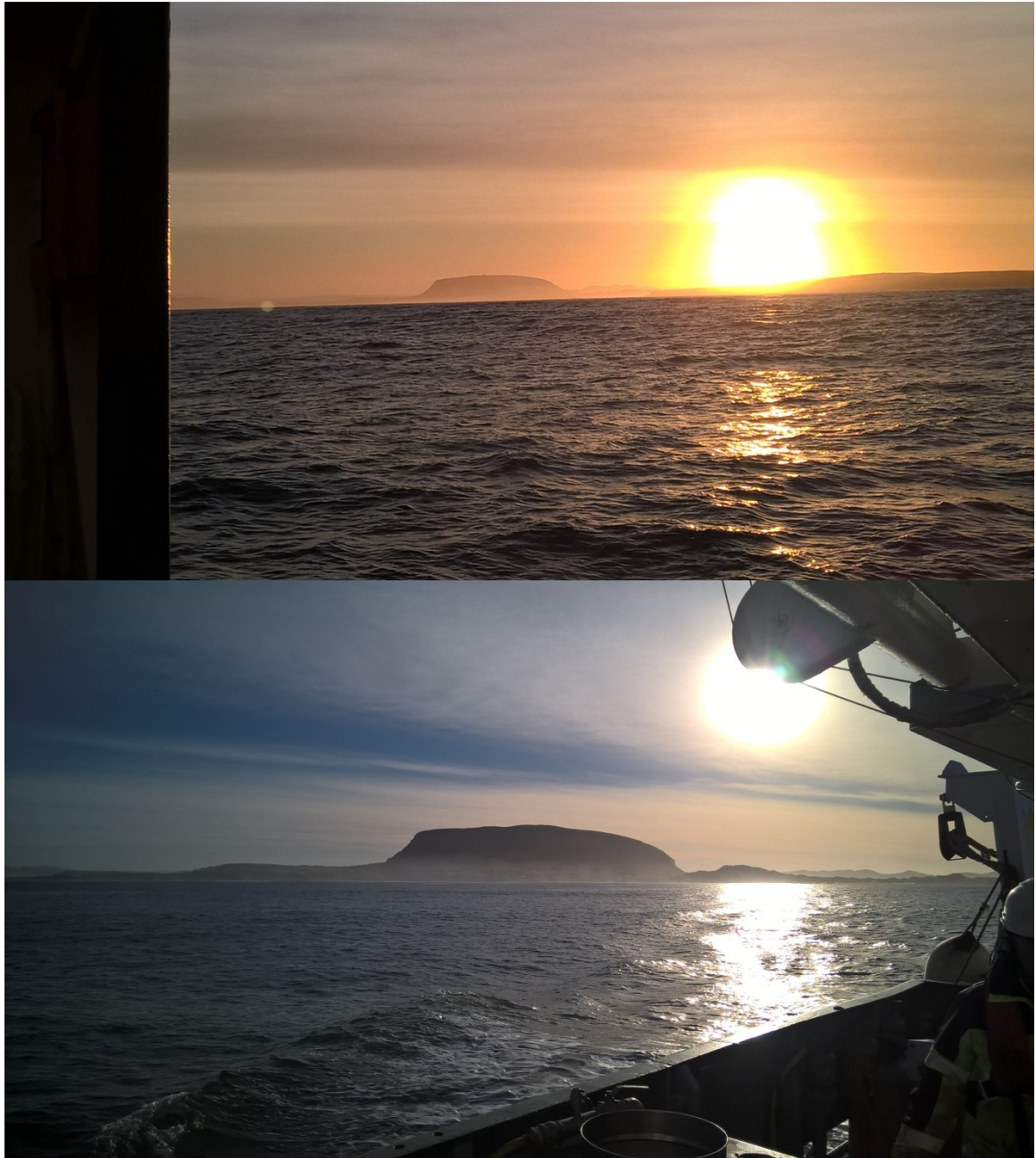
The survey was reasonably successful given weather conditions though offshore sampling was limited due to weather conditions and time constraints. 203 underway and 94 CTD stations were sampled for water chemistry Sediments for OSPAR Hazardous Substance monitoring were acquired at target stations and seawater samples were collected for trace metal testing. Benthic sampling was completed for all the priority areas targeted with the exception of the Gweebarra Bay, Killary Harbour and Clew Bay. DIC/TA samples were collected in a number of bays and on selected transects.

The scientific team would like to thank the master (Philip Baugh), and all of the crew, on-board technical support (Lukasz) and shore based RV operations/P&O team for their excellent support and help over the course of this survey.

## 7. References

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