National Research Vessels

SHIP-TIME PROGRAMME

RESEARCH SURVEY REPORT

Survey Code:	Survey Name:	Chief Scientist/ Institution
CE24011	AMIGOS (Acoustic Monitoring from Ireland to Gibraltar Oceanic waters Survey)	Dr. María Pérez Tadeo

Section A: Award Summary

Title of Research Survey and Survey Code:	AMIGOS (Acoustic Monitoring from Ireland to Gibraltar Oceanic waters Survey) CE24011	
Co-Ordinator/ Chief Scientist:	María Pérez Tadeo	
Vessel used for ship-time:	*RV Tom Crean* ☐ *RV Celtic Explorer* ☒	
Total number of days at sea:	15	
Total number of grant-aided ship-time days awarded:	15	
Dates of survey:	17th to 31st October 2024	
Mobilisation/Demobilisation Ports	Lisbon/Galway	
Survey Personnel:	*No. of Scientists* *16*	*No. of Students* 3
Final Report Completed by:	María Pérez Tadeo	**Date**: 08/01/2025

Section B: Description of the Research Survey

B1 Overview of survey personnel

Names	***Institute/ Department/ Course***	***Position (undergraduate/ post graduate etc)***	***Number of Days***
Scientists			*15*
María Pérez Tadeo	*ATU / MFRC*	*Postdoctoral researcher*	
Joanne O'Brien	*ATU / MFRC*	*Lecturer/Researcher*	
Morgane Pommier	*ATU / MFRC*	*Postdoctoral researcher*	
Ellen White	*Univ of Southampton*	*Postdoctoral researcher*	
Sean O'Callaghan	*ATU / MFRC*	*PhD student*	
Cilia Kootstra	*ATU / MFRC*	*PhD student*	
Miguel Blázquez Hervás	*ATU / MFRC*	*PhD student*	
Rita Meireles de Castro	*ATU / MFRC*	*PhD student*	
Yaiza Pilar Pozo Galván	*ATU / MFRC*	*PhD student*	
Andrea Parisi	*ATU / MFRC*	*PhD student*	
Ankit Swaraj	*Univ of Galway*	*PhD student*	
Bárbara	*Univ of Galway*	*PhD student*	
Pádraic	*Univ of Galway*	*Post graduate*	
Joanne Monaghan	*-*	*Post graduate*	
Hannah	*Irwin Carr*	*Environmental consustant*	
Emilie De Loose	*IWDG*	*Post graduate*	
Students			*15*
Lena Anna Lingenfelder	*ATU*	*MSc students - IMBRSea programme*	
Maria del Mar León Salmerón	*ATU*		
Ricardo Mendes	*ATU*		

B2 Objectives

Briefly outline the overall objectives of the research survey.
Please state if objectives have changed from the original proposal. If survey included a training element please outline clearly.

To contribute to the objectives that the Atlantic Technological University has within the four-year project STRAITS (Strategic Infrastructure for improved animal Tracking in European Seas), funded under the EU's Horizon research and innovation programme, by conducting real-time Passive Acoustic Monitoring to record underwater noise levels and the soundscape around the Strait of Gibraltar. This will provide information to assess impacts of anthropogenic noise on cetaceans and other species, complying with EU regulations.

To contribute to the objectives that ATU has within the STRAITS project, by deploying Static Acoustic Monitoring (SAM) equipment, including a SoundTrap, an F-POD, and an AudioMoth, attached to the CTD cast, at 16 stations of either 30 min or 1 hour to record underwater noise and marine mammals.

To conduct real-time acoustic monitoring of marine mammals and underwater noise levels/soundscape along the survey track in EU waters (I.e., Ireland, France, Portugal, and Spain).

To perform double-platform visual surveys of marine mammals to complement acoustic surveys and provide absolute abundance estimates in the surveyed areas, with special emphasis on waters around the Strait of Gibraltar.

To conduct a visual survey of other marine megafauna, including sharks, turtles, and sunfish.

To conduct visual surveys of seabirds in Irish, French, Portuguese, and Spanish waters following the European Seabirds at Sea (ESAS) methodology contributing to existing datasets, as well as using seabird data as an indicator of ecosystem health.

To obtain data on bio-optical, macronutrient, carbon system and O2/Ar for gross primary productivity estimates across the Irish continental shelf.

To conduct CTD sampling at different stations to gather oceanographic parameters that can be included in modelling approaches, helping to identify environmental drivers of cetaceans' spatial and temporal occurrence, distribution, and abundance along the surveyed areas.

To deploy a recorder SM4 during the nights to acoustically sample nocturnal migration of seabirds.

To provide training opportunities to young researchers (i.e., M.Sc., Ph.D., and postdoctoral researchers) to conduct research in challenging environments, with the possibility to collect data for their own projects. This will contribute to the quality and the development of marine research in Ireland and beyond.

To assess the efficacy of the acoustic equipment (e.g., PAM, F-PODs, SoundTraps) in a high noise levels environment, i.e., the Strait of Gibraltar.

To apply novel techniques aiming to draw recommendations regarding their efficiency and therefore contributing to the development of more cost-effective methods.

To establish and reinforce national and international collaborations between institutions.

To raise awareness and enhance public engagement about the importance of the conservation of these marine ecosystems and the wonderful species they host within Irish and European waters.

To update existing datasets allowing to identify temporal trends, assess areas of conservation concern, and identifying hotspots.

To highlight the scientific, technical, and logistical capabilities of the Marine Institute's research vessels and how they can contribute to research projects across Europe.

B3 Overview of research survey

Provide a narrative overview of the research survey including survey timelines
The information provided in this section should not exceed 5 pages (excluding tables and maps)

The R.V. Celtic Explorer departed Lisbon Port on 20 October 2024 at 15:00, marking the start of the survey. Marine Mammal and Seabird observers initiated their watches shortly after departure, as the vessel transited toward the Gulf of Cadiz. Observations were conducted during daylight hours (approximately 07:00–18:00 UTC) on most days, recording marine mammals, other megafauna, seabirds, plastic and marine debris, and vessels along the survey transects. However, effort had to be interrupted in some occasions due to unfavourable

weather conditions (i.e., sea state > 6, visibility < 1 km and/or swell > 2m). Marine mammal survey effort amounted to 95 hours 46 minutes and 46 seconds, with a total distance surveyed of 1,498.86 km.

In total, 95 hours, 46 minutes, and 46 seconds of marine mammal survey effort were completed, covering a distance of 1,498.86 km. Marine Mammal Observations were carried out by a team of four observers and one data logger: two observers positioned on the Monkey Island and two observers with a data logger on the Crow's Nest. Due to unfavorable weather, watches were relocated to the bridge from 25–28 October 2024. Seabird observations were conducted by a team of three observers on the Monkey Island.

Passive Acoustic Monitoring (PAM) was conducted 24/7 along the survey transects using a towed hydrophone, with interruptions only during CTD station operations.

The vessel reached the Gulf of Cadiz on 21 October 2024, where zig-zag transects were conducted between 21–23 October 2024. The Strait of Gibraltar was traversed on 23 October 2024, with the vessel entering the Mediterranean before returning to the Atlantic on 24 October 2024. The survey then proceeded northward on 25 October 2024. The survey concluded on 30 October 2024, with the vessel arriving at Galway docks at approximately 18:00 (Figure 1).

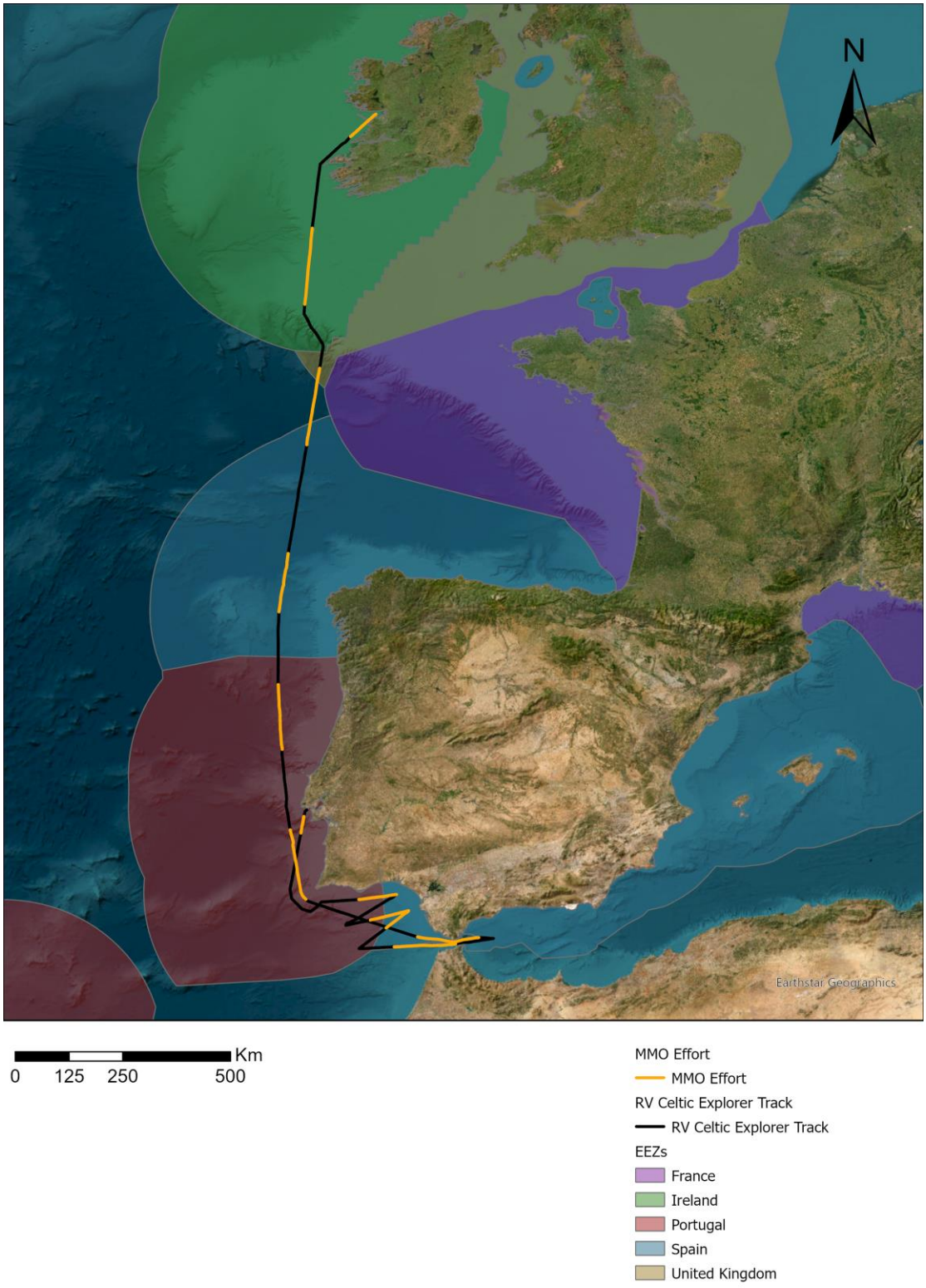


Figure 1. Vessel track, Marine Mammal Observer survey effort, and Exclussive Economic Zones during the AMIGOS survey.

B4 Benefits, impact and contribution of the outputs to marine research and the marine sector in general.

Outline clearly the specific outcomes and benefits of the research survey.
The information provided in this section should not exceed 1/2 page (excluding tables and maps)

The AMIGOS research survey has provided extensive bioacoustic and environmental data across Irish, French, Portuguese, and Spanish waters, with especial focus on the Strait of Gibraltar. Static Acoustic Monitoring (SAM) and real-time PAM data will contribute to understanding low- and high-frequency cetaceans, overlapping spatial and temporal distribution with anthropogenic noise levels. These findings support compliance with the EU Habitats Directive and MSFD, aiding in the development of mitigation strategies to minimise human impacts on marine life. The Strait of Gibraltar, characterised by high shipping activity, serves as a model for assessing noise impacts, with applications for Irish waters.

The survey supports biodiversity monitoring under the EU Horizon STRAITS project, addressing data gaps in marine mammal distribution, abundance, habitat use, and movements across European waters. Insights into seabird abundance also contribute to ecosystem health indicators. This work aligns with Ireland's renewable energy targets, helping identify critical habitats for cetaceans and informing mitigation plans for wind farm and ocean energy projects.

Data collected will be used for future M.Sc. and Ph.D. research at ATU and shared with partner organizations to build time-series datasets. Acoustic and oceanographic data will advance statistical models and multidisciplinary studies on cetacean behavior and habitat use.

The survey has enhanced research capacity by training early-career scientists in offshore research methods, fostering collaboration, and advancing marine mammal science at both Irish and European levels. It supports national and international frameworks, contributing to sustainable marine resource management and conservation.

B5 Data

Provide a description of the data collected from the research survey, the usage of the data and how it will be stored.
The information provided in this section should not exceed 1/2 page (excluding tables and maps)

1. **Underwater Acoustic Data**

- Passive Acoustic Monitoring data collected with a towed hydrophone 24/7 along survey transects.
- Static Acoustic Monitoring data collected with a SoundTrap, and F-POD, and a HydroMoth at 17 stations (Table1; Figure 2).

Table 1. Passive Acoustic Monitoring stations conducted during the AMIGOS survey using a SoundTrap, an F-POD, and a HydroMoth attached to the CTD cast.

Station	Lat	Long	Date	Start time UTC	End time UTC	Water depth	CTD Depth
1	37.0476	-9.5912	21/10/2024	00:35	01:05	1702	80
2	36.7363	-8.8162	21/10/2024	08:01	08:30	1386	80
3	36.8087	-7.9473	21/10/2024	13:04	13:34	740	80

4	36.9418	-7.0053	21/10/2024	18:05	18:35	74	60
5	36.6053	-7.5924	21/10/2024	22:39	23:09	634	80
6	36.2655	-8.1925	22/10/2024	03:41	04:11	1620	80
7	36.4276	-7.4396	22/10/2024	08:17	08:47	916	80
8	36.6096	-6.6901	22/10/2024	13:26	13:56	82	70
9	35.7869	-7.8404	22/10/2024	22:08	22:38	1591	60
10	35.9745	-5.2383	23/10/2024	20:12	21:13	714	60
11	36.0181	-4.9341	24/10/2024	00:01	01:01	906	60
12	36.0677	-4.5992	24/10/2024	04:10	05:10	1120	60
13	35.9825	-5.6546	24/10/2024	11:54	12:54	356	60
14	36.0253	-5.9188	24/10/2024	14:38	15:38	171	60
15	48.3471	-10.0550	29/10/2024	23:02	23:32	2734	80
16	48.9520	-10.6719	29/10/2024	07:15	07:45	149	80
17	50.7860	-10.7336	29/10/2024	18:27	19:27	170	80

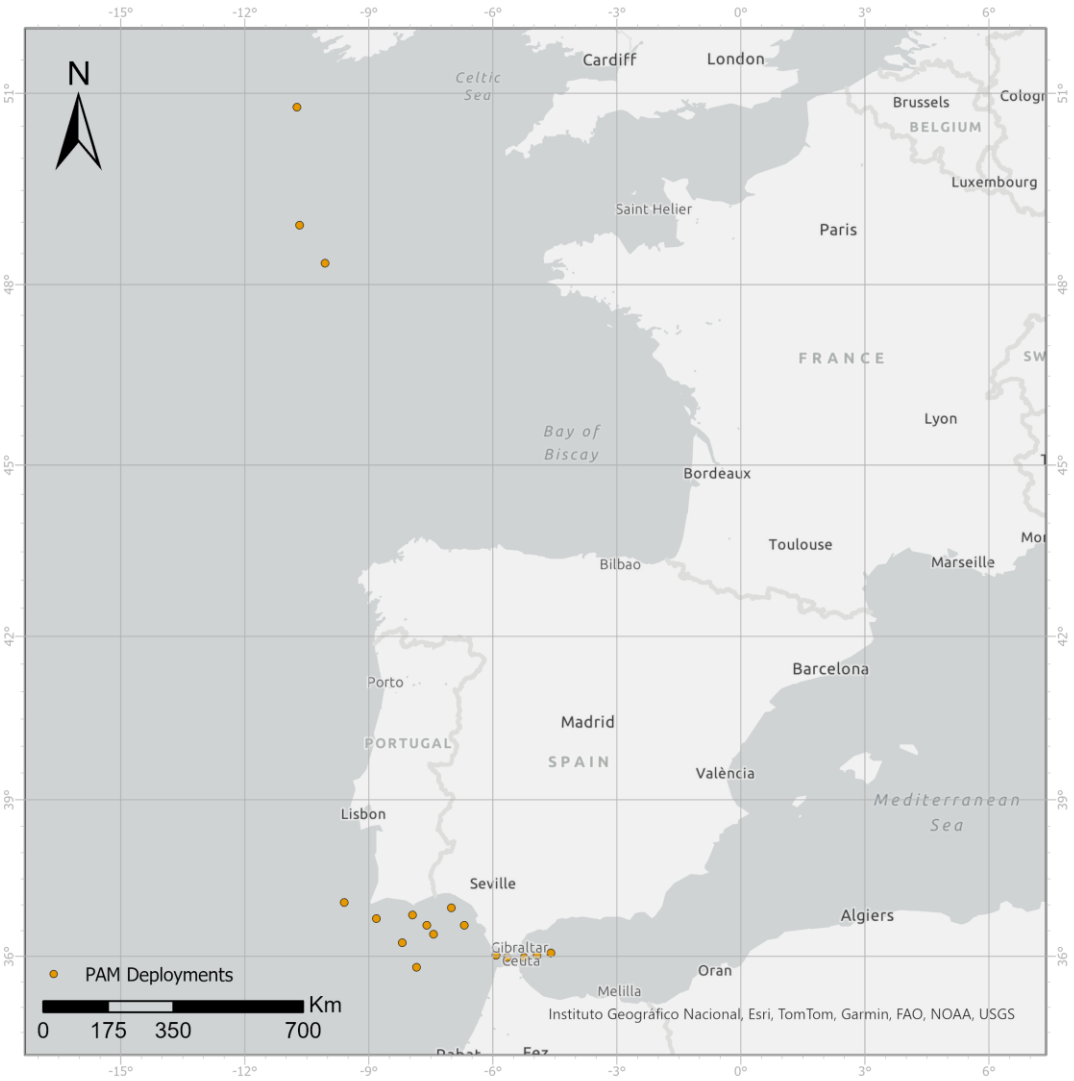


Figure 2. Passive Acoustic Monitoring stations conducted during the AMIGOS survey using a SoundTrap, an F-POD, and a HydroMoth attached to the CTD cast.

2. In-air Acoustic Data

Acoustic data collected as .wav files with a sound recorder SM4 to record bird migrations. The device was attached to the rail of the vessel imn the Monkey Island (Figure 3). This data was collected from sunset to sunrise everyday along survey transects.

Figure 3. Sound recorder SM4 used during the AMIGOS survey.

3. Sightings of Marine Mammals recorded during the survey.

- Primary Platform Sightings: Sightings detected from the Crow's Nest (Figures 3-10).

Figure 3. Sightings of bottlenose dolphins recorded during the survey.

Figure 4. Sightings of common dolphins recorded during the survey.

Figure 6. Sighting of harbour poropoise recorded during the survey.

Figure 9. Sightings of stripped dolphins recorded during the survey.

Figure 7. Sightings of pilot whales recorded during the survey.

Figure 8. Sightings of spotted dolphins recorded during the survey.

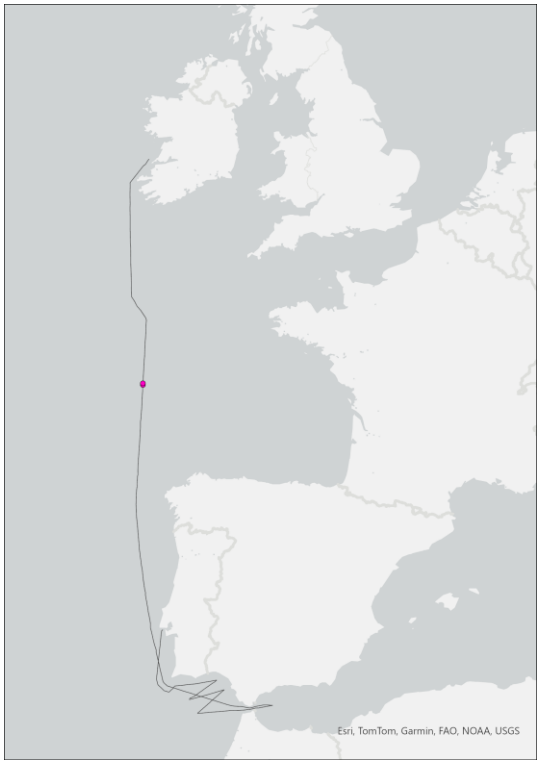


Figure 5. Sighting of fin whale recorded during the survey.

Figure 10. Sightings of unidentified cetaceans (UIC), unidentified dolphins (UID), and unidentified whales (UIW) recorded during the survey.

- Tracker Platform Sightings: Sightings detected from the Monkey Island (Figures 11-15).

Figure 11. Sightings of bottlenose dolphins recorded during the survey.

Figure 12. Sightings of common dolphins recorded during the survey.

Figure 13. Sighting of fin whale recorded during the survey.

Figure 14. Sightings of stripped dolphins recorded during the survey.

Figure 15. Sightings of unidentified cetaceans (UIC), unidentified dolphins (UID), and unidentified whales (UIW) recorded during the survey.

4. Sightings of fish species along survey transects.

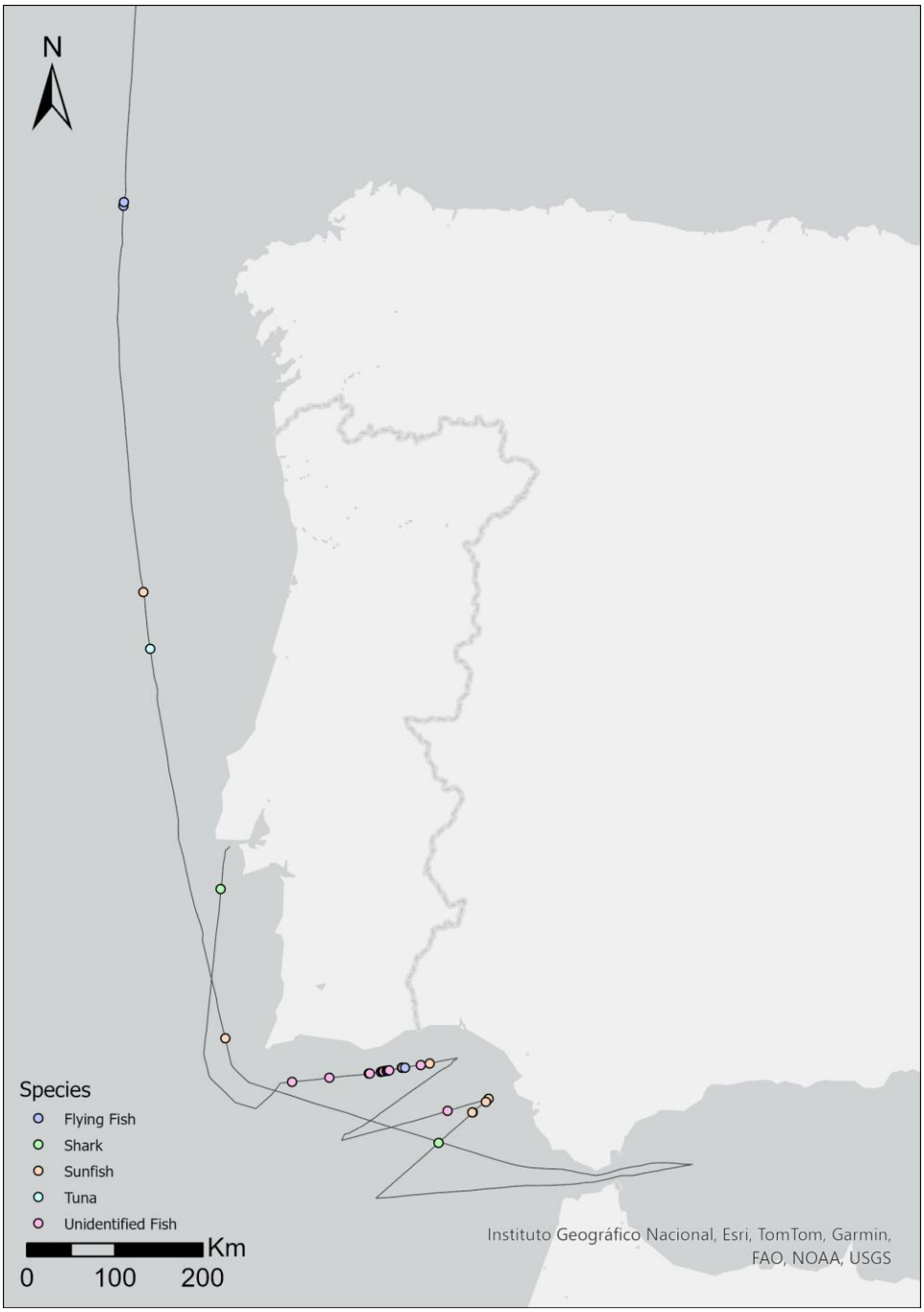


Figure 16. Sightings of fish species recorded during the survey.

5. Sightings of Plastic and other marine debris along survey transects.

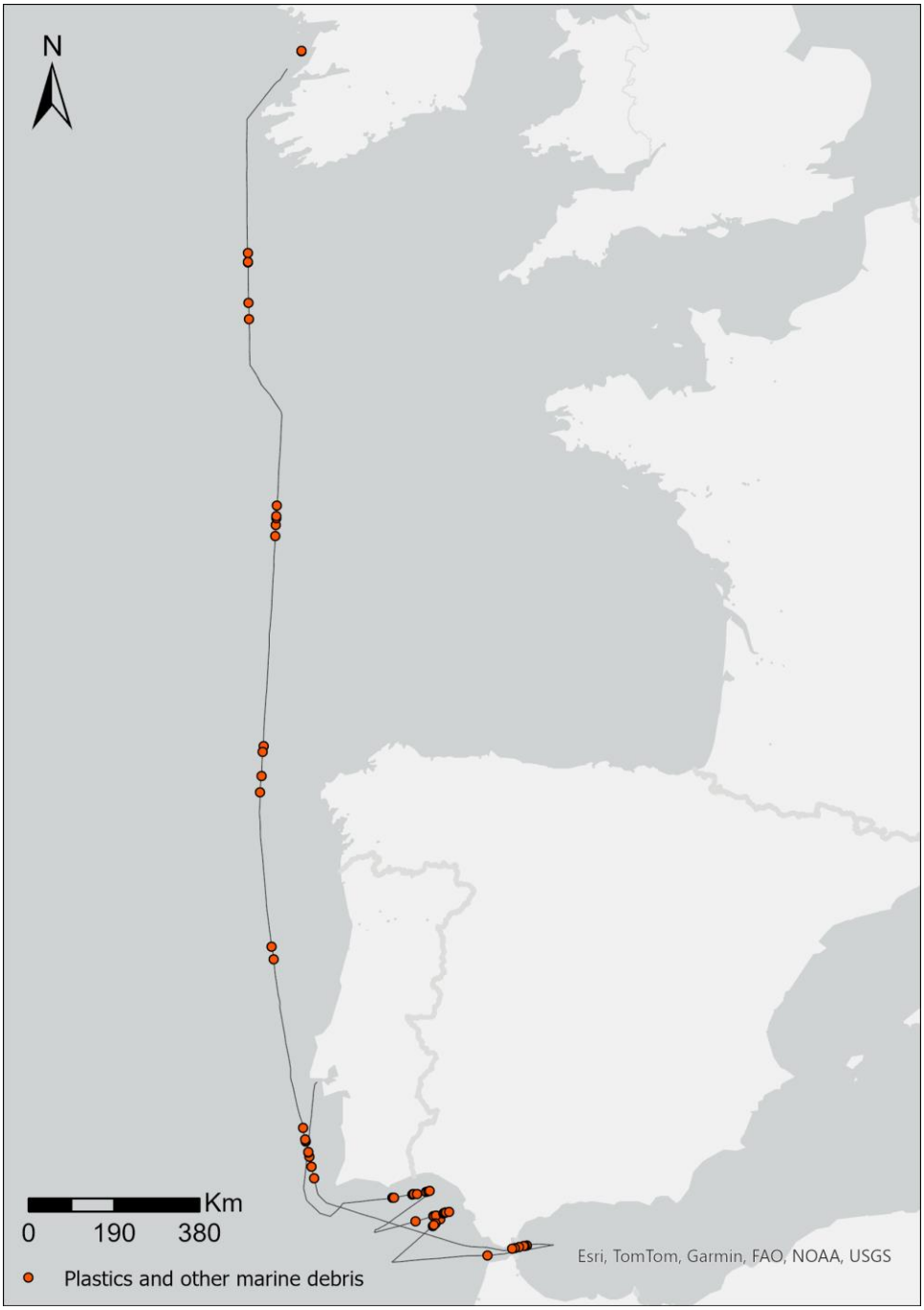


Figure 17. Sightings of plastics and other marine debris recorded during the survey.

6. Sightings of vessels along survey transects.

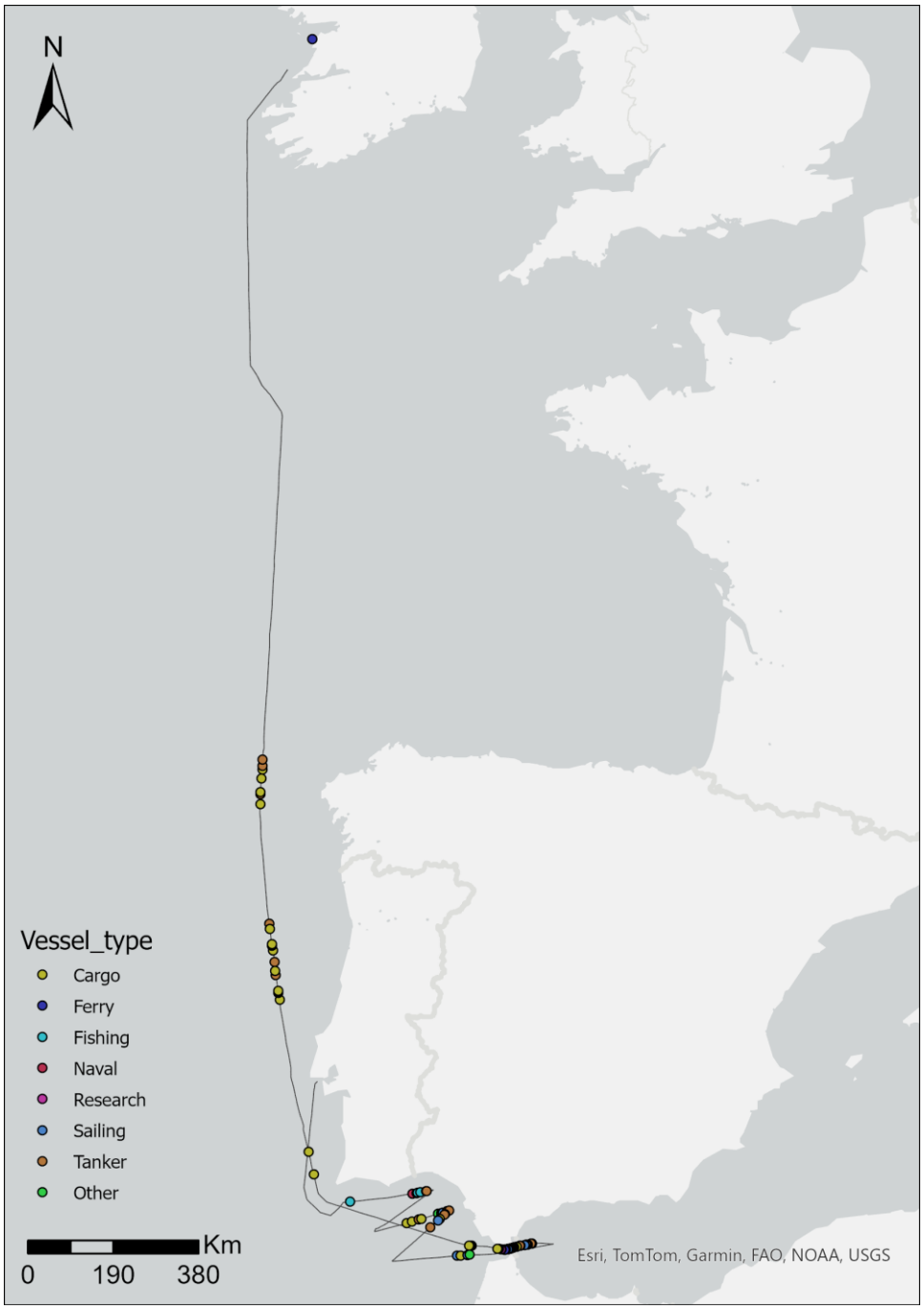


Figure 18. Sightings of fish species recorded during the survey.

7. Environmental conditions.

Environmental conditions were recorded at 245 stations.

8. Seabirds data along survey transects.

Seabird data was collected following the ESAS (European Seabirds At Sea) protocol. Observations were carried out on board from different platforms (bridge or monkey island) and sides (port or starboard) depending on weather

conditions, glare and ship crew instructions. Seabirds were surveyed daily from 8 am to 6 pm (See Appendix 1).

9. Hydrography and Biogeochemical Data

Water samples were taken at different stations and nutrients, bacterial and phytoplankton analysis, chlorophil content, and dissolved gases were assessed from the samples (See Appendix 2). This data will contribute to a PhD project being undertaken at the University of Galway by Ankit Swaraj.

10.CTD data

26 CTD stations were conducted (See Appendix 3).

11. **Thermal camera data**

A Sea.AI thermal camera was installed on the Crow's Nest, which continuously recorded both visual and thermal imagery along survey transect. A camera operator on board moved and manipulated the camera based on MMO and PAM input to capture any marine mammal sightings. This data will be used to train and validate AI softeare on whale detections to create an automatic detection softwre. This data will be used as part of the Atlantic Whale Deal EU funded project dedicated to preventing ship-strikes on whales in the Atlantic Ocean.

B6 Contribution to marine research programmes

Outline specific National/EU/International research programmes this survey supported. Please include the funding sources for these programmes as well as the total amount of funding leveraged (Repeat the table below, if necessary).

National/EU/International Research programme(s):	STRAITS project (Strategic Infrastructure for improved animal Tracking in European Seas), funded under the EU's Horizon research and innovation programme.
Total Programme cost:	
Value to Irish partners:	
Project duration:	2023-2027
Contract no.:	
Project partners:	Loughs Agency (lead), Atlantic Technological University (ATU), Technocal University of Denmark (DTU), Flanders Marine Institute (VLIZ), Ege University, Centro de Ciencias do Mar do Algarve (CCMAR), Instituto Andaluz de Investigación y Formación Agraria Pesquera Alimentaria y de la Producción Ecológica (IFAPA), Agencia Estatal Consejo Superior de Investigaciones Científicas (CSIC), Ocean Tracking Network (OTN).
Project web address:	https://www.europeantrackingnetwork.org/en/straits

National/EU/International Research programme(s):	EU funded Atlantic Whale Deal project
Total Programme cost:	
Value to Irish partners:	
Project duration:	2023-2026
Contract no.:	
Project partners:	Irish Whale and Dolphin Group
Project web address:	https://www.atlanticarea.eu/discover-our-projects/approved-projects/atlantic-whale-deal

Appendices

Please number and attach any relevant Appendices here.

Appendix 1. Report of seabird observation using the ESAS protocol as part of the AMIGOS research cruise

Authors: Andrea Parisi, Morgane Pommier, Joanne Monaghan

Methodology

The team consisting of Morgane Pommier, Joanne Monaghan, and Andrea Parisi collected seabird observations as part of the *AMIGOS* research cruise. Following the ESAS protocol, observations were carried out on board the research vessel Celtic Explorer. Different platforms (bridge or monkey island) and sides (port or starboard) were used depending on weather conditions, glare and ship crew instructions (see database for information). Seabirds were surveyed daily from 8 am to 6 pm, including a break of one hour for lunch. At any time, two people were on the platforms, an observer and a logger, so that every hour a person was on break. Binoculars for observations and a range-finder for distance estimation were used. Seabirds were identified to species level whenever possible, and counted into distance bins along the side of the trackline (0-50m, 50-100m, 100-200m, 200-300m, >300m). All birds sitting on the water were recorded, while snapshot counts of flying seabirds, were taken every 300m.

The data were recorded with the app *Survey123* with a pre-designed survey. The following fields were filled:

- Date and time (mandatory)
- Species (mandatory)
- Count (mandatory)
- Behaviour (mandatory)
- Transect (mandatory)
- Direction (optional)
- Height (optional)
- Distance (optional)
- Age class (optional)
- Sex (optional)
- Group ID (optional)
- Prey (optional)

As a result, a dataset with the seabird observations was compiled. Additionally, an effort dataset was produced to retrieve the active section of the transect, in which observations were carried out. Distribution of the sightings by group of seabird is also reported in Maps 1-7 (see below).

Results

The seabird observation effort amounted to 74h 16’ The final dataset consisted of 1459 observations with 51 species recorded, including 7 classes for unidentified seabird. Eighty eight percent of the observations were within transect, whereas twelve percent were off. Table 1 reports the count for each species in and off transect.

Table 1. Species count summary.

Species	Code	Count
Arctic skua	AC	2
Atlantic puffin	PU	3
Balearic shearwater	YQ	15
Barn swallow	SL	6
Barolo shearwater		1
Black redstart	BX	4
Black-headed gull	BH	4
Black-legged kittiwake	KI	150
Common guillemot	GU	592
Common chiffchaff	CC	3
Common gull	CM	20
Common tern	CN	20
Cory's shearwater	CQ	1040
Eurasian blackcap	BC	1
Eurasian goldfinch	GO	3
Eurasian skylark	S	2
Eurasian sparrowhawk	SH	1
European shag	SA	4
European storm petrel	TM	202
Goldcrest	GC	1
Great cormorant	CA	1
Great black-backed gull	GB	1
Great shearwater	GQ	913
Great skua	NX	18
Grey phalarope	PL	12
Herring gull	HG	6
Leach's storm petrel	TL	54
Lesser black-backed gull	LB	34
Manx shearwater	MX	9
Meadow pipit	MP	2
Mediterranean gull	MU	36
Northern fulmar	F	176
Northern gannet	GX	727
Pomarine skua	PK	4
Razorbill	RA	89
Redwing	RE	40
Sandwich tern	TE	8
Scopoli's shearwater		78
Sooty shearwater	OT	96
Unidentified auk	AU	30
Unidentified gull	UU	44
Unidentified passerine		18
Unidentified shearwater	V	2
Unidentified skua	UQ	1
Unidentified storm petrel	TQ	9
Unidentified tern	UT	4

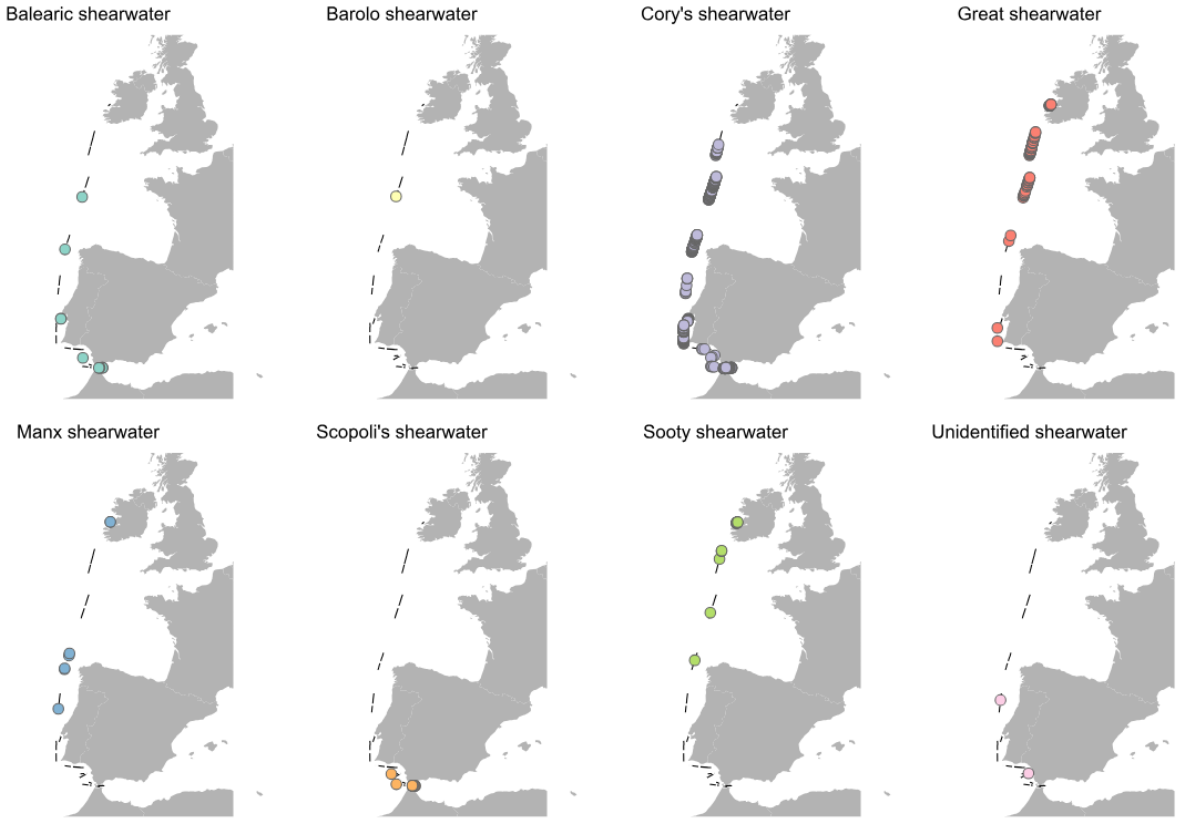
White stork	OR	123
White wagtail	WB	4
Wilson's storm petrel	IO	5
Yelkouan shearwater		4
Yellow-legged gull	YG	149

As we travelled leaving Lisbon, intense gull activity was observed, mainly ascribed to lesser-black-backed (LB), yellow-legged (YG) and Mediterranean gull (MU). Once in the open sea, we recorded a constant passage of Cory's shearwaters (CQ), the most abundant species in our database. Northern gannets (GX), which were the third most abundant species, were also recorded mostly as immature (1cy,2cy,3cy,4cy). The first great skua (NX) was also observed, a species that will be seen throughout the survey. Travelling South, occasional Balearic shearwaters (YQ) were spotted, mostly alone flying North and South (Plate 1). When we entered the Gulf of Cadiz, in a sea state <1, large numbers of storm petrels were observed, with extensive rafts made up to 66 individuals of European storm petrels (TM), mixed with two Wilson's storm petrel (IO) in one instance (Plate 2). In the same area, three additional Wilson's storm petrels (IO) were observed feeding around a dead cetacean carcass. Leach's storm petrels (TL) were often solitary (Plate 3) or in small flocks and were present throughout the survey area. A handful of grey phalaropes (PL) were also recorded as flying next to the vessel (Plate 4), landing and feeding on the surface.

Once in the Strait of Gibraltar, we spotted the first juvenile common terns (CN) and some additional Mediterranean gulls (MU). The first Scopoli's shearwaters were also observed mixed with Cory's shearwaters (CQ) (Plate 5). Passerine activity was visible, with a few species, such as black redstart (BX) (Plate 6), Eurasian blackcap (BC), common chiffchaff (CC), goldcrest (GC), and white wagtail (WB) landing on the vessel. Active migration was also visible, as Eurasian skylarks (S.), meadow pipits (MP), goldfinches (GO) and five barn swallows (SL) flew by. Remarkably, a large flock of white storks (OR) flew from South to North on the Strait, while Sparrowhawks (SH) flew across possibly hunting on small migrating passerines. Heading out the Strait, another consistent stream of Scopoli's and Cory's shearwaters (CQ) was recorded, together with some Balearic (YQ) and three Yelkouan shearwaters. The sightings dropped as we went back to the open sea. The first Manx shearwater (MX) was recorded at a 40° latitude (Leira, Portugal) and the first sooty shearwater (OT) at 43° latitude (Galicia, Spain). Seabird activity increased as we entered the Bay of Biscay with multiple sightings of great shearwaters (GQ) (Plate 7), fewer but still abundant Cory's shearwaters (CQ), and a single Balearic (YG). An exceptional sighting of Barolo shearwater occurred at 46° latitude; the bird was flying West about 500 m from the vessel (Plate 8).

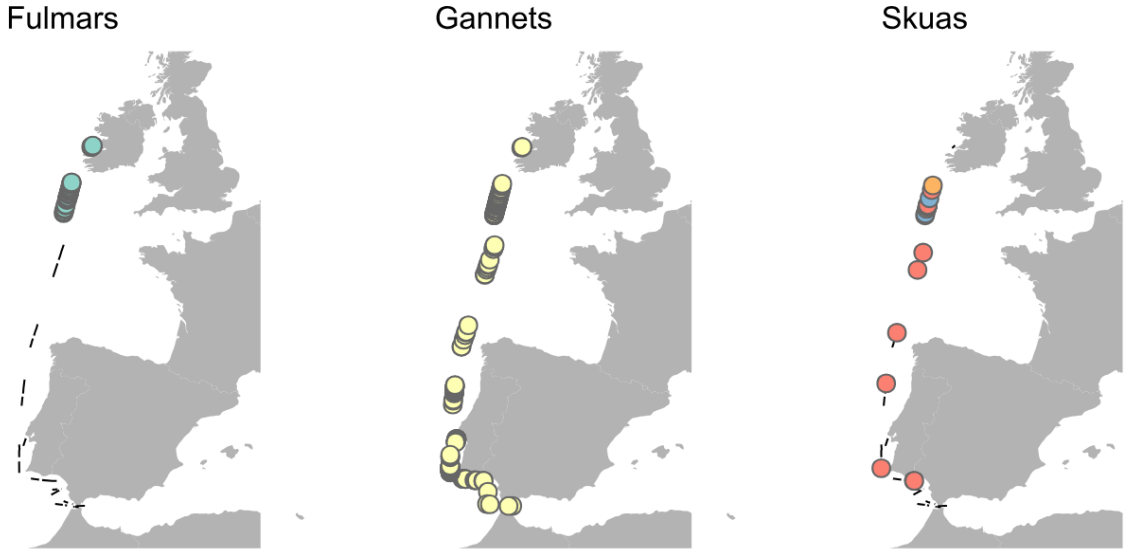
The activity remained mostly quiet up to 50° latitude (Irish waters) when frequent feeding activity of dolphins overlapped with seabird sightings (Plate 9). An additional grey phalarope (PL) was sighted, together with the first Atlantic puffins (a pair), a European storm petrel (TM) and the first black-legged kittiwakes (KI) and fulmars (F.). Interestingly, we came across an dead adult gannet (GX) floating next to the vessel, and a few minutes later we observed a great skua (NX) feeding on another floating dead adult gannet (GX) (Plate 10), while fulmars were waiting around. At an early start (7 am) on the last day, we heard and saw (in the dawn light and on the thermal cameras), large flocks (>40 individuals) of redwings (RE). When travelling from the Clare coast to Galway Bay, another Atlantic puffin was sighted and the last three Manx shearwaters (MX). Great shearwaters (GQ), sooty shearwaters (OT) and

northern gannets (GX) were frequent sightings in these waters. Once at the edge of Galway Bay, several common guillemots (GU) and razorbills (RA) were observed rafting in mixed flocks with shearwaters (sooty and great) and fulmars (F.). Finally, common (CM), herring (HG) and black-headed (BH) gulls were observed as we approached Galway.

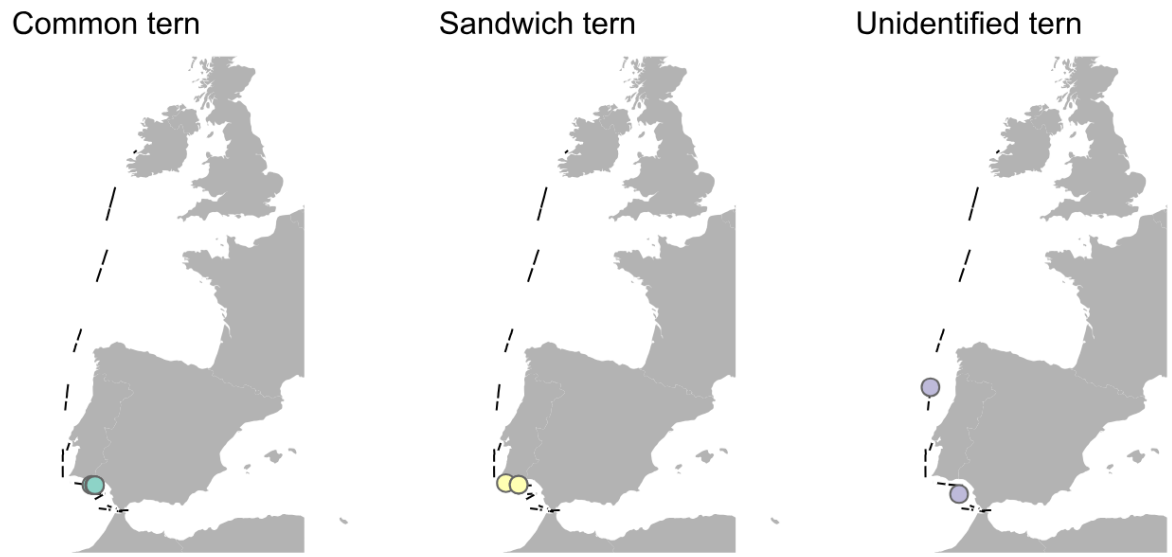


Map 1: Distribution of shearwater spp. observations.

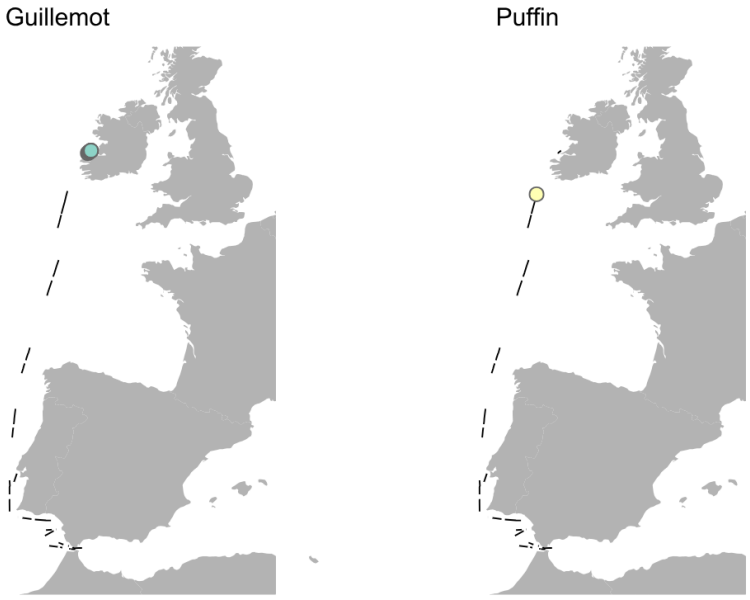
Map 2: Distribution of gull spp. observations.



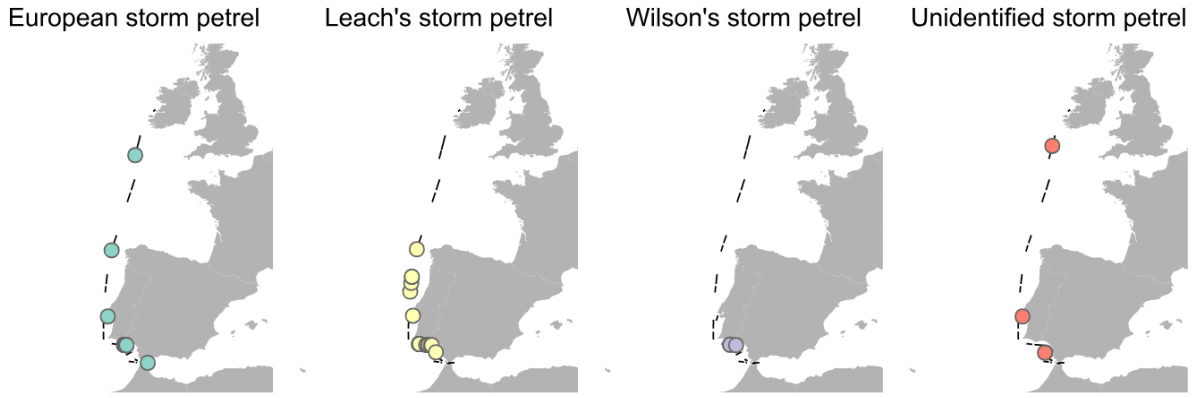
Map 3: Distribution of fulmars, gannets and skua sp. observations.



Map 4: Distribution of tern spp. observations.



Map 5: Distribution of auk spp. observations.



Map 6: Distribution of storm-petrels spp. observations.

Map 7: Distribution of red phalaropes observations.

Plate 1. Occasional sightings of Balearic shearwaters occurred throughout the transect until approximately 40° latitude. © Morgane Pommier, 24/10/2024.

Plate 2. The flock of European storm petrel (TM) mixed with two Wilson's storm petrel (IO) (one, the bird in the foreground with dark underwing). © Morgane Pommier, 21/10/2024.

Plate 3. Leach's storm petrels (TL) were a regular sighting troughout the transect until 50° latitude. © Andrea Parisi, 25/10/2024.

Plate 4. Grey phalaropes (PL) were flying in proximity of the vessel and sitting on the surface to feed. © Andrea Parisi, 27/10/2024.

Plate 5. Interesting photograph with a Cory's shearwater (CQ) on the left (possibly juvenile) and a Scopoli's shearwater. In this case the white extending on the underwing primaries is diagnostic. © Morgane Pommier, 24/10/2024.

Plate 6. Passerine migration was intense on the Strait of Gibraltar. Here is a juvenile black redstart (BX) that spent some time on the monkey island feeding on insects. © Morgane Pommier, 24/10/2024.

Plate 7. The great shearwater (GQ) was the second most abundant species with more than 900 sightings. The species became progressively more abundant as we travelled North, and the Cory's shearwater (CQ) became less numerous. © Morgane Pommier, 29/10/2024.

Plate 8. The rare sighting of a Barolo shearwater in Spanish water at 40° latitude. This species breeds mainly on Azores, Canary and Cape Verde but is hardly ever seen at sea. © Andrea Parisi, 28/10/2024.

Plate 9. Once over 50° latitude, the marine mammal activity increased along with seabird sightings. Here, two great shearwaters are gliding with a breaching common dolphin. © Morgane Pommier, 29/10/2024.

Plate 10. The unusual sighting of two adult dead gannet (GX) spaced a few kilometres apart. In the second instance, a juvenile great skua (NX) was feeding on the bird. © Andrea Parisi, 29/10/2024.

Appendix 2. Hydrography and biogeochemical data report.

Authors: Barbara Segato Monteiro, Padraic Mac Donnacha, Ankit Swaraj

OBJECTIVES

The main objective of this work is to combine and compare different approaches to the measurement of primary productivity in surface seawaters around Ireland to provide improved regional estimates of phytoplankton production from within the Irish EEZ and the European coastal shelf. This work directly addresses a critical knowledge gap in Irish/European marine science, with almost no data on primary productivity in Irish waters. While satellite data for net primary productivity has been available for over a decade now, there have been no systematic studies validating/ground truthing remote sensing estimates. Through cooperation with the Marine Institute, we will utilize the annual ship survey to obtain data on bio-optical, macronutrient, carbon system and O2/Ar for gross primary productivity estimates across the Irish continental shelf. The data gathered in this work will also help to inform baselines for carbon cycling budgets in Irish waters and help determine key parameters with regards to Ireland's Blue carbon footprint and inform policy for the Irish government's achieving its UN target of 30% of the Ireland's Maritime Area being designated as Marine Protected Areas by 2030.

SAMPLES COLLECTION

Nutrient sampling involves collecting seawater from the CTD, filtering it through 0.2 µm filters, and freezing the filtrate at -20˚C for later analysis of nitrite, nitrate, phosphate, and silicate using low-volume methods.
For bacterial and plankton analysis, unfiltered seawater is analysed onboard using **flow cytometry**, with specific staining methods to identify marine bacteria, phytoplankton, and heterotrophic flagellates.
Chlorophyll measurement is done by filtering 500 mL of seawater, freezing the filters, and later analyzing them in the lab using spectrophotometry after extraction with 90% acetone.
Dissolved gases are sampled by quickly transferring water from the Niskin sampler, minimizing turbulence, and preserving the sample with benzalkonium chloride, ensuring no air bubbles are introduced during the process.

Hydrography and water sampling

The CTD data comprises continuous downcast and upcasts records of the pressure, temperature, conductivity (salinity), dissolved oxygen, chlorophyll fluorescence and turbidity. The raw CTD data are processed according to GOSHIP guidelines via the Seabird software and incorporated into ODV files for the continuous downcast data and the discrete bottle data collected during the upcast.

Nutrient (NO_2^-, NO_3^-, PO_4^{3-}, $Si(OH)_4$) sampling

Seawater samples are collected from the CTD and immediately filtered through 0.2 µm syringe filters. The filtrate is then frozen at -20˚C until analysis in the laboratory in Galway. For analysis in the laboratory samples are thawed overnight and then analysed for Nitrite, Nitrate, Phosphate and Silicate using specially adapted low volume methods based on standard green chemistry methods for nutrient analysis in seawater.

Bacteria, Heterotrophic Nano flagellates, Pico and nanoplankton abundance

Unfiltered seawater samples collected directly from the CTD were run on an Accuri C6 flow cytometer while at sea according to established protocols (Marie et al., 1997; Marie et al., 2014). Briefly we initially run an untreated raw sample to identify the phytoplankton by size and fluorescence, Synechococcus species can be identified at this step by their unique combination of cell size and phycoerythrin fluorescence. A second sample is fixed with glutaraldehyde then treated with the DNA stain Syber Green to enumerate marine bacteria and phytoplankton via the combination of chlorophyll fluorescence (red) and the dna stain (green). We also use the Syber Green staining to identify heterotrophic flagellates (Christaki et al., 2011).

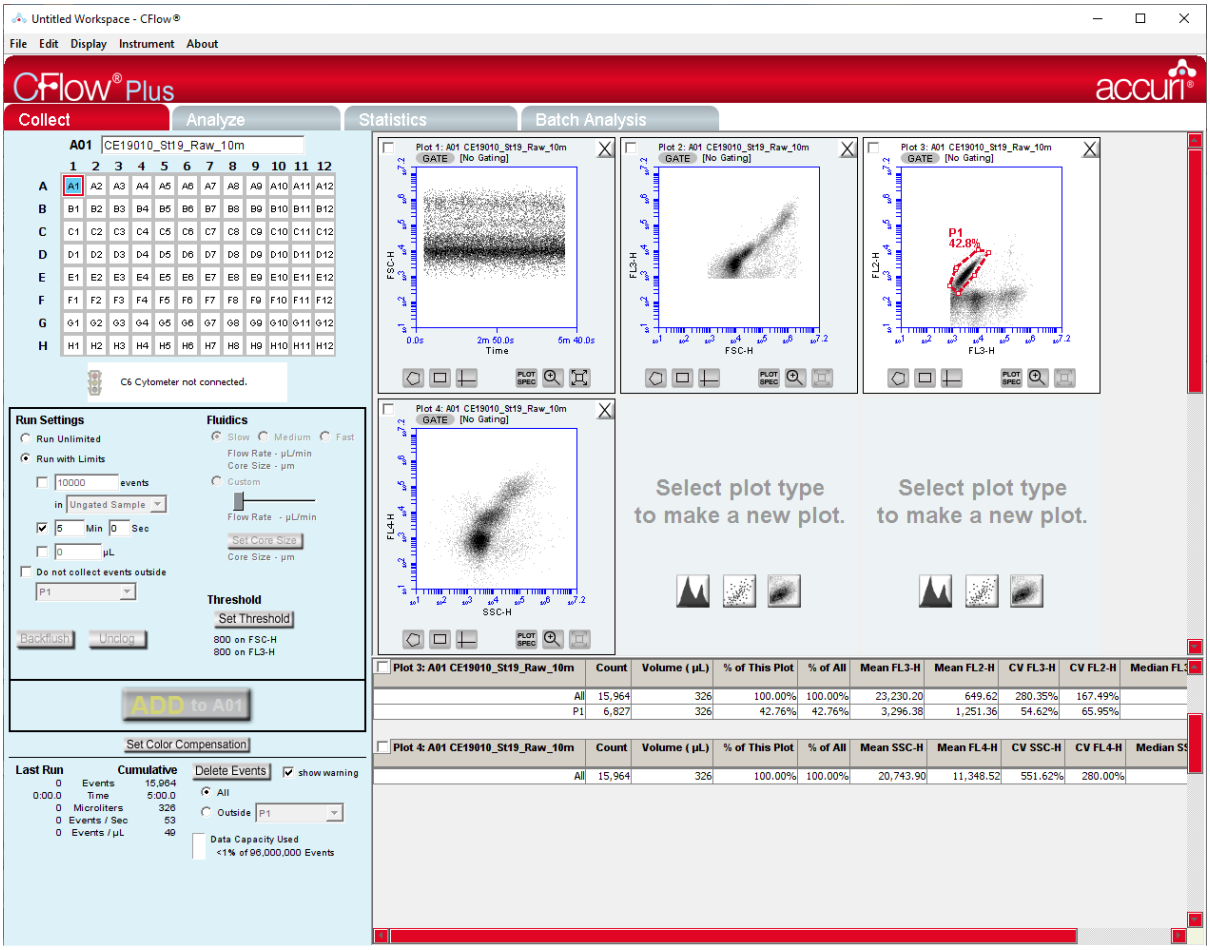


Fig 1: Live seawater samples for the measurement of phytoplankton. e.g., synechococcus (gated in red).

Chlorophyll measurements and Ocean Colour (Chlorophyll)

For each of the samples taken, a volume of 500 mL is filtered through a 25 mm Glass Fiber Filter (GF/F) and then frozen onboard for later analysis. They will later be analysed in the laboratory for chlorophyll a (b & c) concentrations after extraction with 90% acetone after overnight extraction in a -20˚C freezer and subsequent measurement of the solution absorbance using an Ocean Optics Flame spectrophotometer with a low volume 10 cm pathlength cell and DT-mini light source. The concentration of chlorophyll a is then calculated using the trichromatic equation.

Fig 2: Filtration unit for chlorophyll a (b & c) by measuring the absorption of the filter

Dissolved Gasses (MIMS)

Collection of seawater sample for oxygen analysis, quickly transfer water from the Niskin or another sampler as soon as it reaches the surface. Begin with the deepest Niskin sample to minimize changes in pressure and temperature. Attach a drawing tube to the sampler's petcock, ensuring air bubbles are removed by tapping the tube. Rinse the Exetainer by overfilling it with water. Insert the tube to the bottom of the Exetainer and fill it gently to reduce turbulence and bubbles, starting at a 45-degree angle and moving upright as it fills. Let the water overflow for 2-3 times the filling duration to ensure sample quality. Check for air bubbles and hand-tighten the cap. Preserve the sample immediately by adding 40 µL benzalkonium chloride with a gas-tight syringe through the Exetainer septum, avoiding air introduction. Alternatively, add the preservative before capping to prevent needle damage, ensuring no bubbles are introduced.

Annex 1

Station ID	Lat	Long	Depth (m)
CE24011-1	37 02’51 N	9 35’28 W	5, 30, 150
CE24011-5	36 36’24 N	7 35’22 W	5,46,88,130,200
CE24011-7	36 25’39 N	7 26’22 W	5,40,60,90,200
CE24011-8	36 36’34 N	6 41’24 W	5,26,65
CE24011 9	35 47’14 N	7 50’22 W	5,50,66,96,110,200
CE24011-10	35 58’28 N	5 14’17 W	5,35,120,132,200
CE24011-11	36 00’59 N	4 56’31 W	5,20,88,100,110,200
CE2401-12	36 04’04 N	4 35’53 W	5,30,40,105,160,200
CE24011-13	35 58’53 N	5 39’12 W	5,25,50,92,120

Appendix 3. CTD data summary

Cruise	Event no.	CTD Cast Number	Standard Station Name	Event type	CTD ID (electronic files; *.Hex etc.)	Date (dd/mm/yyyy)	Lat N Deg	Lat N (Dec.min)	Long W (Deg)	Long W (Dec.min)	Start Time UTC (hh:Mm)	Time End UTC (hh:mm)
CE24011	1	1	01	CTD	STN01_CTD_01	21/10/2024	37	02'51	9	35'28	01:29	02:08
CE24011	2	2	01	CTD	STN01_CTD_02	21/10/2024	37	02'51	9	35'28	02:17	02:30
CE24011	3	3	02	CTD	STN02_CTD_01	21/10/2024	36	43'56	8	49' 13	08:55	09:31
CE24011	4	4	3	CTD	STN03_CTD_01	21/10/2024	36	48'30	7	56'55	13:59	14:36
CE24011	5	5	4	CTD	STN04_CTD_01	21/10/2024	36	56'12	7	02'23	18:59	19:37
CE24011	6	6	5	CTD	STN05_CTD_01	21/10/2024	36	36'24	7	35'22	00:17	00:18
CE24011	7	7	5	CTD	STN05_CTD_02	21/10/2024	36	36'24	7	35'22	00:18	00:35
CE24011	8	8	6	CTD	STN06_CTD_01	22/10/2024	36	15'57	8	11'31	04:38	05:14
CE24011	9	9	7	CTD	STN07_CTD_01	22/10/2024	36	25'39	7	26'22	09:12	09:49
CE24011	10	10	7	CTD	STN07_CTD_02	22/10/2024	36	25'39	7	26'22	09:54	10:14
CE24011	11	11	8	CTD	STN08_CTD_01	22/10/2024	36	36' 34	6	41'24	14:21	15:00
CE24011	12	12	8	CTD	STN08_CTD_02	22/10/2024	36	36' 34	6	41'24	15:05	15:14
CE24011	13	13	9	CTD	STN09_CTD_01	22/10/2024	35	47'14	7	50'22	23:04	23:41
CE24011	14	14	9	CTD	STN09_CTD_02	22/10/2024	35	47'14	7	50'22	23:46	00:05
CE24011	15	15	10	CTD	STN10_CTD_01	23/10/2024	35	58'28	5	14'17	20:31	20:48
CE24011	16	16	10	CTD	STN10_CTD_02	23/10/2024	35	58'28	5	14'17	21:08	22:14
CE24011	17	17	11	CTD	STN11_CTD_01	24/10/2024	36	00'59	4	56' 31	00:17	00:37
CE24011	18	18	11	CTD	STN11_CTD_02	24/10/2024	36	00'59	4	56' 31	00:59	02:03
CE24011	19	19	12	CTD	STN12_CTD_01	24/10/2024	36	04'04	4	35'53	04:25	04:43
CE24011	20	20	12	CTD	STN12_CTD_02	24/10/2024	36	04'04	4	35'53	05:04	06:14
CE24011	21	21	13	CTD	STN13_CTD_01	24/10/2024	35	58'53	5	39'12	12:18	12:34
CE24011	22	22	13	CTD	STN13_CTD_02	24/10/2024	35	58'53	5	39'12	12:50	13:58
CE24011	23	23	14	CTD	STN14_CTD_01	24/10/2024	36	01'22	5	54'27	15:32	16:42
CE24011	23	23	15	CTD	STN15_CTD_01	28/10/2024	48	20'49	10	3'18		
CE24011	24	24	15	CTD	STN15_CTD_02	28/10/2024	48	20'49	10	3'18		
CE24011	25	25	15	CTD	STN15_CTD_03	28/10/2024	48	20'49	10	3'18		
CE24011	26	26	16	CTD	STN16_CTD_01	29/10/2024	48	57'07	10	40'18		