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D 6.8 – Floating Universities Course Report

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1 Eurofleets+ Floating University Programme Introduction

The Eurofleets+ Floating University Program aimed to implement five Floating Universities onboard research vessels operated by Eurofleets+ participating partners, with three vessels not already providing Transnational Access, at no cost to the project. Onboard training courses were designed and implemented in the preceding Eurofleets and Eurofleets2 projects.

In close collaboration with participants across the project, courses:

- assembled an international group of senior instructors that jointly organized floating university events and outlined its educational elements;
- defined selection criteria based on previous projects;
- drafted and published Calls for student recruitment;
- and select the participating early-stage researchers.

Researchers completed an application form and their submission was evaluated on the basis of their scientific background, training needs, and coherency between their studies and topics offered by Floating Universities. Furthermore, travel grants were provided to participants in addition to concentrated efforts made to promote and increase the participation of women and people from less equipped countries.

Each Floating University course began with introductory day(s) devoted to lectures covering planned activities, survey design & planning and practical & safety issues. Activities combined lectures, laboratory work and practical sampling/measurements and interpretation of data. As a follow-up, each student contributed to the official cruise report and submitted a report on the outcome of their own project work.

Eurofleets+ utilised the unique facilities offered by the fleet, equipment and the experience and knowledge of the consortium to deliver five accredited ship-based training courses or 'Floating Universities' to postgraduate students of marine-related disciplines in specific regions and sea basins:

1. Eurofleets+ Floating University onboard RV Celtic Voyager: "*Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying*" (Atlantic Ocean).
2. Eurofleets+ Floating University onboard RV Oceania: "*Use bio-optical parameters as convenient tool to study marine biogeochemical processes*" (Baltic Sea)
3. Eurofleets+ Floating University onboard RV Mario Ruivo: "*Meeting societal needs for impartial evidence on the state and sustainable use of the ocean biological resources: the case of the Neophrops norvegicus (Norway Lobster)*" (Atlantic Ocean)

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4. Eurofleets+ Floating University onboard RV Dallaporta: "*Multiple platforms to measure the Ocean*" (Mediterranean Sea)
5. Eurofleets+ Floating University onboard RV Svea: "*Modern techniques and platforms for Ocean observation*" (Baltic Sea)

Furthermore, the Eurofleets+ '**Research Vessel Training Toolkit**' (Deliverable 6.1) produced for course directors contains common procedures and templates, to ensure a standardised approach to course development and ensured consistent standards and high quality across all Eurofleets+ training. The toolkit includes information on how to produce module descriptors, learning outcomes, organize accreditation/CPD recognition, organize pre- and post-cruise workshops, develop digital learning resources and identify on-board social media and outreach activities. Each Floating University course will be supported by a suite of e-modules.

At the end of each course, a certificate of completion was delivered to all participants.

These courses also generated on line teaching material creating a free resource available to a great number of students/scientists published on the Eurofleets Ocean Classroom Portal here: https://www.eurofleets.eu/classroom/ TRAINING

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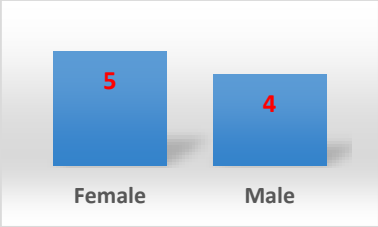
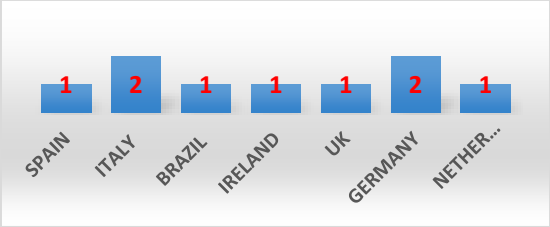
2 Floating University onboard RV Celtic Voyager

The Floating Univeersity "*Mapping the Ocean Floor: an introduction to practical aspects of hydrographic surveying*" was organized by the Marine Institute, on board the RV Celtic Voyager in Cork (Ireland) from 19th to 25th February 2020. It was offered to post-graduate students of all nationalities enrolled at European universities.

The call and application form were published on the Eurofleets+ website on 18th October 2019, and closed at 16th December 2019. The call template was developed and promoted throughout the Eurofleets+ Website and all social channels. The call was disseminated across partners' social channels and a direct e-mail was issued to all Eurofleets+ partners and contacts.

Open to both MSc and PhD students enrolled at European Universities, a total of 28 applications were received for eight places available. The applications were evaluated by two oceanographic experts and the course coordinator from the Marine Institute, based on set criteria. Due to the standard of application being so high and following consultation with the vessel operator, an additional applicant was accommodated bringing the total number of course participants to nine (6 MSc and 3 PhD), from 7 different nationalities.





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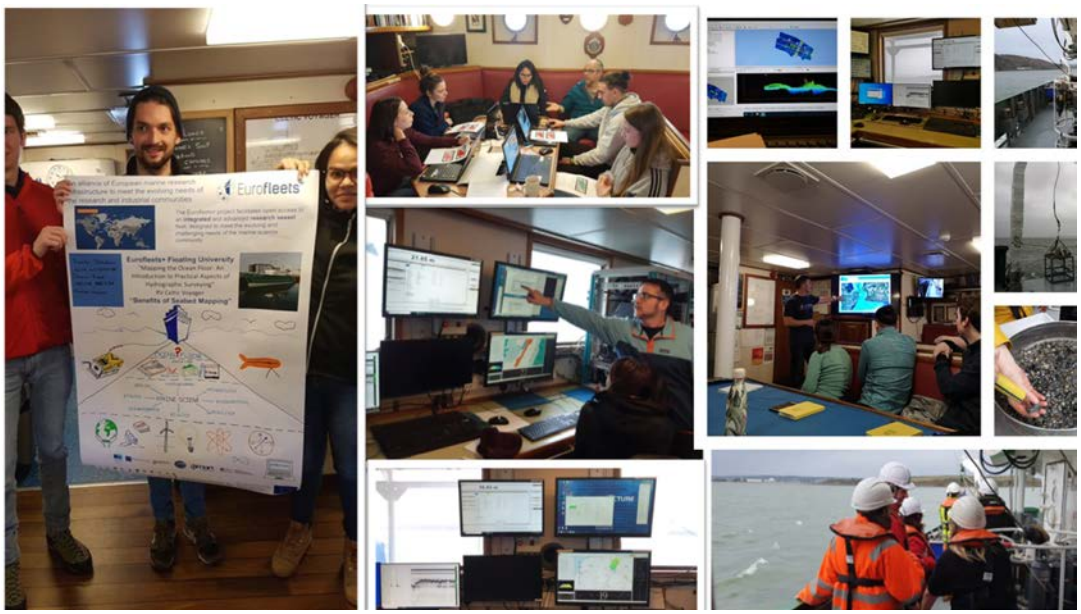
The course was delivered over seven days, with four onshore days giving an overview of the science of seabed mapping classroom based learning ahead of practical offshore survey experience. The lectures included an Overview of seabed mapping, Fundamentals (oceanography & sampling), Marine Geohazards, Seafloor Mapping, Marine Survey Planning & Ocean mapping, Global Perspective and Seabed Classification Practical.

On-board the RV Celtic Voyager the students were rotated through each station in three groups to ensure that each student had the opportunity to learn the skills involved. Practical's on seabed sampling and data collection took place, physical sampling of the seabed at each station and sound velocity probe was lowered for MBES calibration and to establish temperature and salinity profiles of the water column, with data processing taking place on board by each student.

Students were also tasked with an exposition of a scenario challenging to develop a survey plan for dredging the shipping channel. Students were divided into two groups with each group roleplaying a surveying consultancy firm. Finally, students completed a poster presentation challenge and presented the results to instructors. Students were asked to complete detailed evaluation questionnaires providing feedback on their experience. The results of evaluation questionnaires indicate that all aspects of the course were well received by the participants and considered very useful. Video report of the course is available here: https://youtu.be/xY271nHomrc



See **Annex 1** for the Eurofleets+ Floating University on board RV Celtic Voyager.

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3 Floating University onboard RV Oceania

The Floating Univeersity "*Use bio-optical parameters as conveniente tool to study marine biogeochemical processes*" was organized by the Institute of Oceanology Polish Academy of Sciences, IOPAS, on board the RV Oceania in Sopot (Poland) from 31st May to 8th January 2021.

Following the guidance included in the "Eurofleets+ Research Vessels Training Toolkit for course directors", the announcement on the "Floating University" opportunity on board RV Oceania (4-16 June 2020) was developed. The call for the "*Use bio-optical parameters as a convenient tool to study marine biogeochemical processes*" Floating University Course on board RV Oceania was launched at Eurofleets+ web page in mid-January 2020. The deadline for submission of applications was set for March 15th, 2020. A total of 15 applications were submitted. The selection committee formed by OGS (Dr Andrea Caburlotto) and IOPAN (Dr Piotr Kowalczujk) granted 8 participants a place on the course and conditionally accepted 2 applicants who were added to a waiting list. Students and early career scientists from 8 nationalities has been accepted (4 MSC, 3PhD and 1 PostDoc).

Due to COVID-19 pandemic lockdown and effective ban on international travel to and from Poland (port of embarkation) and Norway (port of disembarkation), the Floating University action on board RV Oceania was postponed until June 2021. All accepted participants were enrolled to the course without any further application process. One of the selected participant was unable to join, and was replaced with a candidate from the waiting list. After the communication to the selected candidates, another selected candidate gave up due to personal reasons. 7 participants from 6 nationalities (3 MSC, 3PhD and 1 PostDoc) were enrolled to the course at the end.

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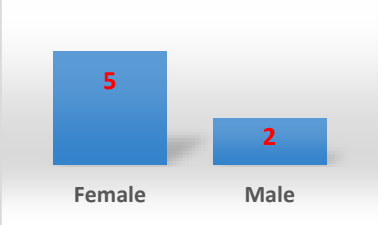

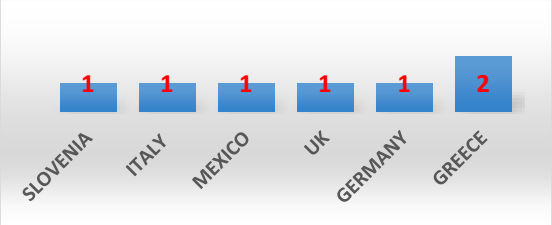

The EUROFLEETS+ Floating University "*Use bio-optical parameters as convenient tool to study marine biogeochemical processes*" was a combination of theoretical lectures and practical experience in conducting instrumental measurements of inherent and apparent optical properties in marine waters and collecting water samples for determination of concentrations of optically significant sea water constituent. Students were familiarized with latest IOCCG measurements and sampling protocols and state of the art optical instrumentation. The course was composed of a combination of presentations, lectures, laboratory work and practical sampling, measurements, and interpretation of optical and bio-geochemical data in working groups.

The course focused on basic theory, applications and practical exercises in marine optics and bio-optics in general. The course provided a lecture on basics of Baltic Sea hydrology, to explain the scientific objectives of the cruise and why the optical measurement in the Danish Straits is important to explain optical properties of stagnant water in the Baltic Sea Deep.

The theory of marine optics included explanations of the concept of inherent and apparent optical properties and relationships between those quantities. The lectures also explained the role of the of phytoplankton as the one the major contributor to variability in inherent optical properties, modification of the spectral properties of apparent optical properties and ocean color. Students were trained in which dissolved and particulate constituents of sea water contribute most to the variability of inherent and apparent optical properties of marine waters. Students learned about spectral properties of absorption by chromophoric dissolved organic matter, CDOM absorption by phytoplankton pigments and suspended particulate matter. The theory on bio-optics explained the concept of the "optical proxies" for determination of essential biogeochemical variables and bio-optical models used for inversion of optical properties to concentrations of specific marine water constituents. There were lectures on basics of ocean color remote sensing. During the workshop in the laboratory, students learned the methodology of spectrophotometric measurements for determination of chlorophyll a concentration with spectrophotometric method by Lorenzen, 1967.

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See **Annex 2** for the Eurofleets+ Floating University on board RV Oceania.

4 Floating University onboard RV Mario Ruivo

Originally, the floating university organised by the Portuguese Institute of the Sea and Atmosphere (IPMA) was in the summer of 2021 on board the RV Mario Ruivo, "Meeting society's need for impartial knowledge on the state and sustainable use of ocean biological resources: the case of Norway lobster", and was open to 8 young scientists.

Due to travel restrictions and the reduction of capacity on board the vessel itself related to the Covid 19 pandemic, it was decided to organise two courses (2021 and 2022) with 4 participants each.

4.1 Floating University on board RV Mario Ruivo 2021

The Floating University "*Meeting society's need for impartial knowledge on the state and sustainable use of ocean biological resources: the case of Norway lobster*" were organized by IPMA on board the

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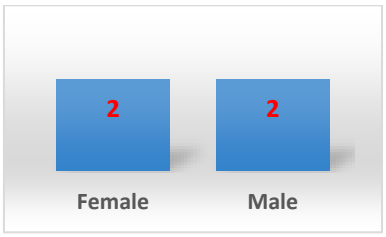
RV Mario Ruivo off the southwestern – southern Portugal coast, from 15th June to 5th July 2021, to post-graduate students of all nationalities enrolled at European universities.

The call and application form were published on the Eurofleets+ website on 9th April 2021, and closed at 10th May 2021. The call template was developed and promoted throughout the Eurofleets+ Website and all social channels. The call was disseminated across partners' social channels and a direct e-mail was issued to all Eurofleets+ partners and contacts.

Open to both MSc and PhD students enrolled at European Universities, a total of 22 applications were received for 4 places available. The applications were evaluated by a team composed by OGS (WP6 coordinator) and the course organizers, based on set criteria.

The 4 selected candidates (2 PhD and 2 MSc) were from 4 different nationalities.



The general objective of the course was to provide theoretical background and practical experience on scientific understanding of marine ecosystems and the services they provide, and on the application of the outcome knowledge to generate state-of-the-art advice for meeting conservation, management, and sustainability goals using *Nephrops norvegicus* (the Norway lobster) as case-study.

The course was designed to include a combination of lectures, practical sampling/measurements, onboard laboratory work and data interpretation.

The scientific team and students mustered onboard R/V Mário Ruivo on June 14th, 2021 and left the harbour on the next day. They were integrated in the sampling teams and were able to participate in all activities, including the regular activities designed according to DCF requirements, as well as supplemental activities in collaboration with a PhD program on survival of Elasmobranchs.

The lectures were spread throughout the three weeks of the survey so students could intersperse the theoretical and practical approaches of the lessons learnt. This approach enabled a better engagement of the students on the subjects and on the subsequent discussions, avoiding an overload of information at once. All lectures onboard were prepared and led by IPMA's Scientific staff.

Due to technical constraints, not all equipment's were available for the survey and consequently for students to operate, including the box-corer for sediments sampling and CTD for temperature, salinity and conductivity measurements.

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The course ended prematurely in Lisbon (Portugal), because of technical problems with the vessel, with the students disembarking three days before the end of the survey, without the opportunity for a final presentation/open discussion on the analyses of collected data.

See **Annex 3** for the Eurofleets+ Floating University on board RV Mario Ruivo 2021.

4.2 Floating University on board RV Mario Ruivo 2022

The 2nd Floating University "*Meeting society's need for impartial knowledge on the state and sustainable use of ocean biological resources: the case of Norway lobster*" were organized by IPMA on board the RV Mario Ruivo off the southwestern – southern Portugal coast, from 5th to 29th April 2022, to post-graduate students of all nationalities enrolled at European universities.

The call and application form were published on the Eurofleets+ website on 5th April 2022, and closed at 10th May 2021. The call template was developed and promoted throughout the Eurofleets+ Website

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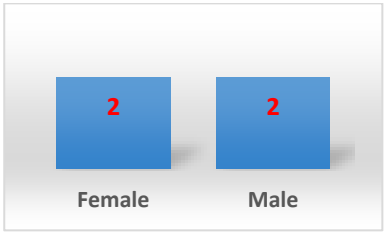
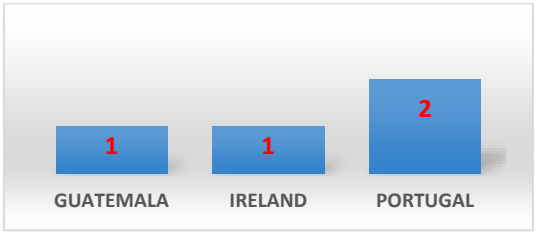
and all social channels. The call was disseminated across partners' social channels and a direct e-mail was issued to all Eurofleets+ partners and contacts.

Open to both MSc and PhD students enrolled at European Universities, a total of 14 applications were received for 4 places available. The applications were evaluated by a team composed by OGS (WP6 coordinator) and the course organizers, based on set criteria.

The selected candidates (2 PhD and 2 MSc) were from 3 different nationalities.





The Crustaceans survey took place off the Southwest and South coasts of Portugal, onboard the R/V Mário Ruivo.

The course included lectures on the first day, before departure and during the three weeks at sea, during which IPMA's scientific team provided training and guidance on sampling protocols, species identification, and collection of biological data.

The course was designed to include a combination of lectures, practical sampling/measurements, onboard laboratory work and data interpretation. The scientific team and students mustered onboard R/V Mário Ruivo on June 7th, 2022 and left the harbour on the next day.

The students were integrated in the sampling teams and were able to participate in all activities, including the regular activities designed according to DCF requirements, as well as supplemental activities in oceanographic sample collection.

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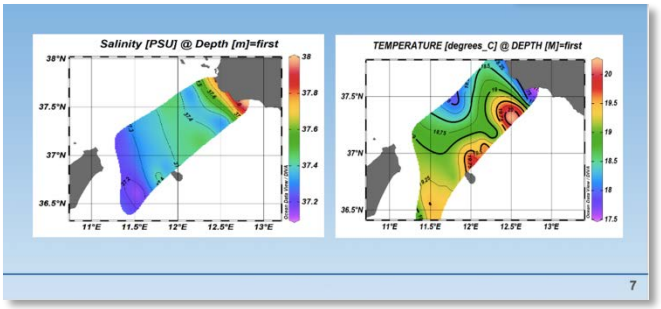
The lectures were spread throughout the three weeks of the survey so students could intersperse the theoretical and practical approaches of the lessons learnt. This approach enabled a better engagement of the students on the subjects and on the subsequent discussions, avoiding an overload of information at once. All lectures onboard were prepared and led by IPMA's Scientific staff.

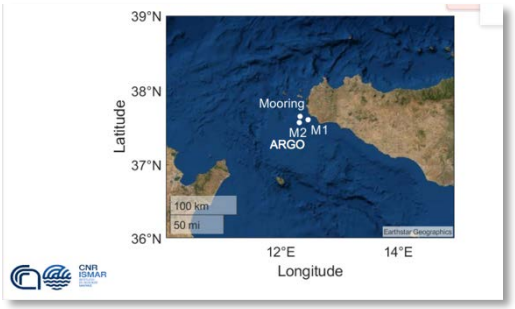
Due to technical constraints, not all equipment were available for the survey and consequently for students to operate, including the box-corer for sediments sampling and CTD for temperature, salinity and conductivity measurements.

See **Annex 4** for the Eurofleets+ Floating University on board RV Mario Ruivo 2022.

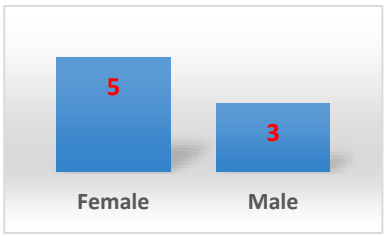
5 Floating University onboard RV Dallaporta

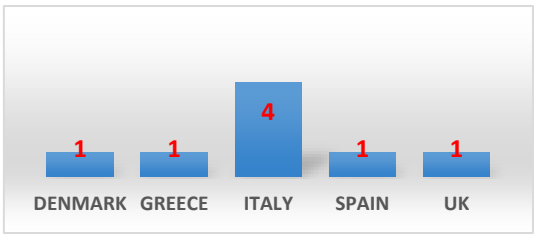
The Eurofleets+ Floating University "Multiple platforms to measure the ocean" on board the CNR operated RV Dallaporta took place Italy, from 17th to 23rd September 2022, offered to post-graduate students of all nationalities enrolled at European universities. Designed in collaboration with Euro-ARGO ERIC, was based in the harbor of Mazara del Vallo (Sicily, Italy) and focused on the South-Western coast of Sicily.





The call for applicants was opened at 22nd June 2022 and closed on 12th July 2022; the evaluation procedures ran in July 2022 and the selection results were notified in July 2022. A total of 24 applications were received, among those 8 students (7 PhD and 1 MSc) from 5 countries were selected.





The overarching objective of the training programme was knowledge transfer in state-of-the-art oceanographic surveying from scientists and technicians to groups of students in different fields of marine sciences. 8 students from 5 European countries (Italy, Portugal, Greece, UK and Denmark)

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attended a seven day course that started with two days of preparatory training followed by three days of offshore activities onboard the R/V Dallaporta. During the last two days of training a series of group activities gave participants the opportunity to practice their newly acquired skills with a team exercise based on the analysis of oceanographic data sets.

During the course students took part in modules on the oceanographic characteristics of the survey area, on field data acquisition systems, data-sets and analysis of seawater samples and autonomous measurements. Survey planning for water mass mapping, site exploration and environmental status were also included.

The main topics covered by the lectures and on filed activities were:

- designing and executing an onshore oceanographic survey;
- articulate understanding of the principles and methods applied to seawater measuring with a variety of techniques;
- data acquisition and preliminary data processing for CTD and ADCP systems;
- data acquisition and scientific exploitation of IOPs and AOPs acquired with autonomous robot platforms;
- knowledge on moored systems deployment, recovery and data retrieval;
- knowledge on autonomous platform testing, deployment, recovery and data management (from quality control to data distribution and acquisition);
- complement observations of a variety of variables from multiple platforms;
- perform salinity measurements on seawater samples;
- operate software suites for data visualization (Ocean Data View);
- recognize the interpersonal skills for professional conduct on board research vessels.

See **Annex 5** for the Eurofleets+ Floating University on board RV Dallaporta.

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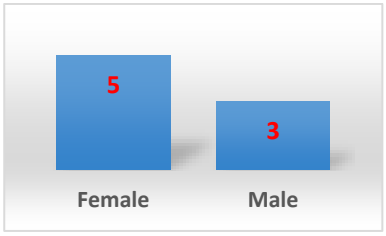
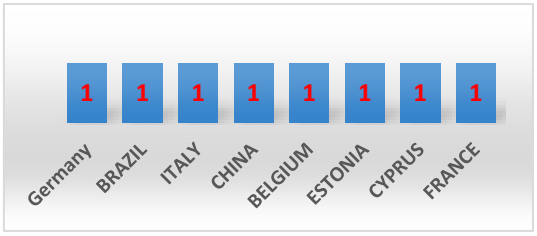
6 Floating University onboard RV Svea

The Eurofleets+ Floating University "Modern techniques and platforms for ocean observation" on board the RV Svea took place in Sweden (Lysekil), from 24th to 28th October 2022, offered to post-graduate students of all nationalities enrolled at European universities. This training courese was originally planned to take place onboard both the RV SKAGERAK and the RV SVEA as (Sveriges lantbruks universitet (SLU) joined Eurofleets+ as 'Observers' in 2021 and provided vessel acces inkind to the project). RV Skagerak had technical problems and was unavailable for the training course.

The call for applicants opened on 26th August, and closed on 18th September 2022; the evaluation procedure run in September 2022. A total of 10 applications were received, among those 8 students (4 PhD, 2 junior engineers, 2 early career scientists) from 8 nationalities were selected.





This international Eurofleets course exposed the participants to several state-of-the-art ocean observing platforms available in West Sweden. Training aspects include understanding of ship- and robotic-based observing techniques and their associated sensors and measurement capabilities. The

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course will provide ship time and to deployment of autonomous platforms. Participants Learned about instrument and platform deployments, robotic-platform piloting, to gain understanding of how different platforms collect data and through data processing and visualization, investigate which platforms are best to use for various scientific questions.

The course started with background lectures on the available infrastructure and instrumentation, the scientific rationale, the physical conditions and cruise planning. A glider was deployed in the end of the first day using smaller vessels and the first data from it was presented and processed the day after. Two days was spent on board RV Svea for data collection with CTD, ADCP, MVP and Ferrybox. The data was then handled in a smaller workshop and presented as a group project.

The learning objectives of the course were to:

- Better understand modern techniques and platforms to collect ocean observations
- Go to sea on short research voyages to collect their own observations and deploy/recover instruments
- Better understand which types of platforms (e.g. ship vs glider) are suited to make the required measurements/survey
- Better understand how certain platforms and instruments function/are controlled remotely
- Plot and visualize near-real time data and data type comparisons, including data quality control
- Be exposed to examples of how such techniques and data are used in science/monitoring

See **Annex 6** for the Eurofleets+ Floating University on board RV Svea.

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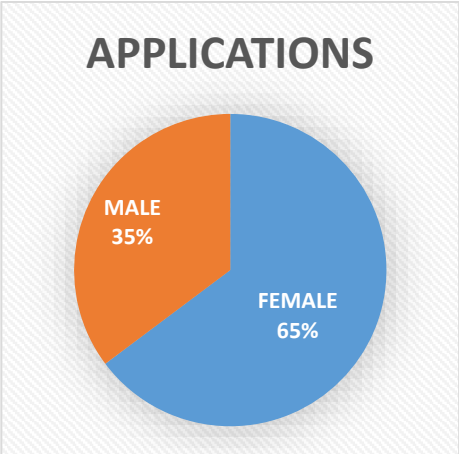
7 Concluding remarks

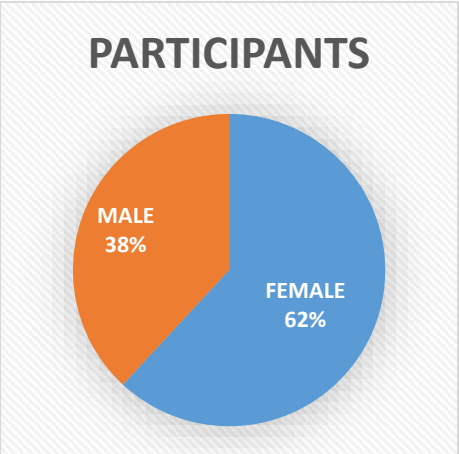
The experience of designing, organising and evaluating on-board training within EUROFLEETS was the starting point for EUROFLEETS2 on-board training and the Floating University programme. A comparison with the onboard training conducted within the framework of EUROFLEETS and EUROFLEETS2 also shows that the demand for the practical onboard training is constantly and impressively increasing.

In this context, the "Research Vessel Training Toolkit" represents another step towards a higher level of training in marine research and improves and consolidates the organisation and development of the Floating University courses. The experience in designing, organising and evaluating training courses on board research vessels was the legacy of previous EUROFLEETS projects and the starting point of the EUROFLEETS+ Floating University programme, which ensures uniform standards and high quality for all Eurofleets+ training courses.

The successful Eurofleets+ training activities confirmed that the education and training programmes are integrated with existing national and international schools and postgraduate programmes and that EUROFLEETS remains a reference programme for training at EU level, as shown by the number of enquires received.

105 applications were submitted for the 40 places available on board the 5 Floating University , most of them from female academics.





The selected participants confirmed the gender balance in the applications, came from 20 different nationalities, and consisted mostly of Phd (21) and Master (14) students as well as post-docs (5).

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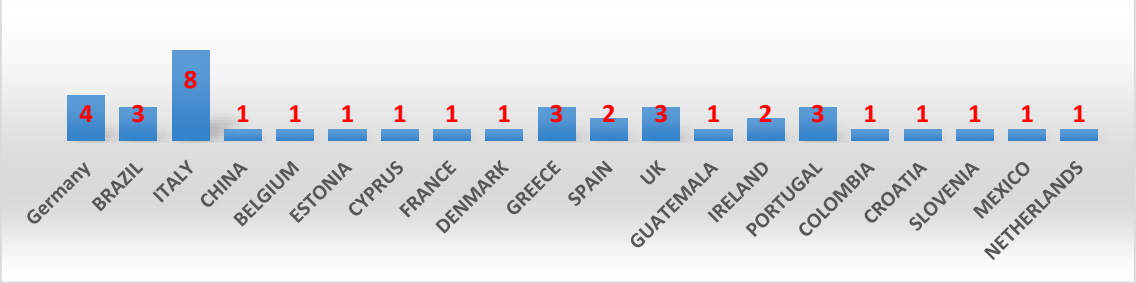

The mission of EUROFLEETS+ to provide EU research vessels to young scientists and students across Europe through a well-publicised and organised programme was very well demonstrated by all students who participated in the floating university courses. All evaluations by the course participants refer to the experience as a very valuable training, with the message that the Eurofleets+ training programme provides offshore opportunities that would not otherwise be available to most of them, using the existing and extremely valuable capacity within the EU research vessel fleet.

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EUROFLEETS+ Floating University

Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"

On-board the R/V Celtic Voyager

Cork, Ireland, 19th to 25th February 2020

This project has received funding from the EU H2020 research and innovation

Eurofleets+ Floating University

Scientific Participants

Name	Organization	Role
Fergal McGrath	INFOMAR	Course leader
John Boyd	SMART	Cruise Leader
Ronan O'Toole	INFOMAR	Lecturer
Dr. Silvia Ceramicola	OGS	Lecturer
David O'Sullivan	INFOMAR	Lecturer
Eoin McCraith	INFOMAR	Lecturer
Oisin McManus	INFOMAR	Lecturer
Aileen Bohan	INFOMAR	Lecturer
Mike Arrigan	INFOMAR	Lecturer
Fabio Sacchetti	INFOMAR	Lecturer
Eimear O'Keefe	INFOMAR	Lecturer
Nicola O'Brien	INFOMAR	Instructor
Niamh Flavin	Eurofleets+	Course Coordinator
Bernadette Ni Chonghaile	Eurofleets+	Course Coordinator

Name	**Role**
Francesca Giovanna Battaglia	Student/ Course Participant
Elaina O' Brien	Student/ Course Participant
Larissa Macedo Cruz de Oliveira	Student/ Course Participant
Kirsty Eleanor Black	Student/ Course Participant
Maarten Heijnen	Student/ Course Participant
Nil Rodes	Student/ Course Participant
Ruaihri Strachan	Student/ Course Participant
Stefania Bulzacchelli	Student/ Course Participant
Thomas Frank	Student/ Course Participant

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Eurofleets+ Floating University

Course and cruise objectives

This *Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" Floating University* was a combination of theoretical and practical based sessions using both commercial and open source software.

The course was taught within three broad areas:

i. Ocean remote sensing, marine survey framework and applications.
ii. Irish national seabed mapping programme, INFOMAR (www.infomar.ie), detailing the current and future science and technologies employed in ocean mapping
iii. Datasets and spatial data management tools for ocean remote sensing.

Lecture Topics included; INFOMAR overview, ocean science policy framework; historical development of ocean remote sensing; platforms and systems; marine survey planning; processing bathymetry and backscatter data, habitat and ecosystem product derivation, data interpretation, mapping products, data quality framework, data connectivity and impact, stakeholders and users.

Practical sessions included shipboard and laboratory training in survey operations, multibeam-echosounder data acquisition, sediment sampling, habitat mapping, data processing and analysis.

On successful completion of the module, students were able to:

- Contrast the science of marine remote sensing with terrestrial techniques.
- Identify key systems and practices used in the field of marine remote sensing.
- Recognize the range of integrated data and products associated with marine remote sensing, as well as constraints and limitations, both on individual datasets, and merged products.

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- Demonstrate an appreciation of mapping scales, data resolutions and density in the context of seabed mapping.
- Analyse system performance characteristics and assess data quality.
- Select and apply suitable seabed mapping workflows. Propose image processing techniques for correcting and analysing marine remote sensing datasets.
- Detail the user requirements, stakeholders and added value products in the INFOMAR catalogue
- Identify the policy framework underpinning ocean science and Identify and source additional marine data and supports via repositories such as the Copernicus Marine Environment Service

Nature of the course and work carried out on the course

The EuroFleets+ Floating University introduced students to the principles and methods applied to hydrographic surveying, through four days of lectures and workshops and three days of training offshore on board the RV Celtic Voyager. Students gained practical experience in seabed mapping, by operating multibeam echosounders and sub-bottom profiler systems, designing and implementing a hydrographic survey in Cork Harbour, as well as practicing data acquisition and data processing by producing a detailed model of the area surveyed.

The hydrographic surveying component of the Eurofleets+ Floating University is part of a postgraduate module (Level 9) developed by INFOMAR, Ireland's seabed mapping programme, a partnership between Geological Survey Ireland and the Marine Institute.

Students engaged in workshops led by expert practitioners from INFOMAR and guest lecturers from the National Institute of Oceanography and Applied Geophysics (OGS) Italy, SMART Sea School, and supported and hosted by University College Cork.

Outcome and benefits of the Eurofleets+ training survey include but are not restricted to:

- Extends the opportunity to train on a national research vessel for early career stage researchers from Irish and European Higher Education Institutes.
- Provides necessary experience for young scientists to identify career and research pathways, realise their potential and contribute to the sustainable development of the blue economy.
- Makes available a fully equipped platform for the collections of real time data for project work and module practical sessions with a comprehensive suite of mechanical, acoustic and hydrographic equipment and instrumentation.
- A structured offshore learning environment for developing a critical understanding of the provenance of hydrographic data sets.
- Delivers authentic experience of offshore operations, vessel management and survey design and planning to emerging hydrographers.
- Produces a cohort with an enhanced offshore skill set and increased ability to compete for employment across different sectors of the marine economy.
- Puts an international RV fleet at the disposal of an international student body through the collaboration of international research partners around the North Atlantic Basin.

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- Builds international capacity for the conservation and sustainable development of marine natural resources.
- Consolidates and builds on the achievements of previous EUROFLEETS programmes in extending opportunities for training in offshore data collection to an international student community.
- Fosters collaborative marine research between key marine agencies and institutes on a national, European and international level.

Full Course Outline.

EDUCATIONAL ACTIVITIES		
Learning and teaching methods	Topic	Hours
Presentations	**Presentation 1** Eurofleets+ Overview **Presentation 2** "Ocean mapping: A Global Perspective "	2.5hrs
Lectures	**Topic 1**: "Overview of seabed mapping" **Topic 2:** "Fundamentals (oceanography & sampling)" **Topic 3**: "Marine Geohazards" **Topic 4:** "Seafloor Mapping " **Topic 5**: "Marine Survey Planning" **Topic 6**: "Products & Dissemination" **Topic 7:** "Impact of Seabed Mapping"	14hrs
Fieldwork (Ship)	**Topic 1**. Vessel Safety Tour and Orientation **Topic 2.** Marine Mammal Observation **Topic 3.** Drylab Overview **Topic 4.** Sound Velocity Profile **Topic 5.** Sedimentology **Topic 6.** Benthic Ecology **Topic 7.** MBES/SB Data Acquisition **Topic 8**. MBES Data Processing Practical **Topic 9.** Sub-bottom Profiling Data Processing Practical **Topic 10.** Bridge Tour **Topic 11.** Presentation of Scenario **Topic 12.** FMGT Practical **Topic 13.** Ground-truthing Survey **Topic 14.** Mini-ROV Investigation **Topic 15.** Gravity and Box Core Practical Session **Topic 16.** Beam Trawl Fisheries and Megabenthos Practical **Topic 17.** Survey Report Overview	24 hrs
Laboratory Practical	"Seabed Classification"	2hrs
Group project	Importance of Seabed Mapping Presentations	3 hrs
Report	Cruise Report	6hrs

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ASSESMENT
• Presentation of the on-board activity and preliminary results by students • Pre- and post-course evaluation test

Course and cruise Log

Onshore Lectures

The onshore lectures provided an overview of the science of seabed mapping by providing class based learning ahead of practical offshore survey experience.

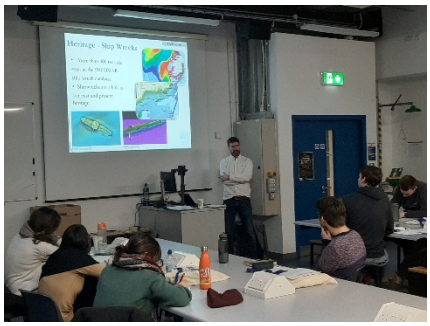
The course outlined the importance and impact of seabed mapping, and featured a range of topics outlined below delivered over three 4 days:

Pre-Cruise

Day 1 Training Activities –

- **Overview of seabed mapping,**

An introduction to seabed mapping, and more specifically Ireland's seabed mapping programme efforts over the past twenty years were presented including examples of different applications of seabed mapping. Introduction to other National mapping efforts around the globe were also presented. The lecture also introduced the importance of our ocean resources and their value in terms of blue growth for the marine sector.



- **Fundamentals (oceanography & sampling)**

This lecture introduced the physical characteristics of the ocean, its effect on other Earth systems and discussed the interdisciplinary nature of oceanography. Topics included the origin of oceans/seas and seafloor features/landforms (tectonic plates, mid-ocean ridges and subduction zones & ocean currents (surface and deep-water) and their influence. The basic principles of seabed sediment classifications and composition were discussed together with the methods and techniques for ground truthing seabed sediments. International projects relating to ocean science are presented.

- **Marine Geohazards**

Marine Geohazards are conditions which exist at the seabed or within the seabed subsurface that have the potential to cause significant disruption to marine operations (e.g. exploration, seabed mapping, hydrographic survey, offshore installation).

This lecture introduced the different types of marine geohazards that are encountered in the course of offshore operations. The major marine geohazards are shallow gas and associated escape structures,

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mud volcanoes, diapirism, earthquakes, submarine landslides, subsidence, tsunamis, and bedforms (sand waves).

Day 2 Training Activities

- **Seafloor Mapping**

This lecture provided an overview on the history and evolution of underwater acoustics, how sound waves travel and interact with the seabed and three of the main modern methods we have for seabed mapping – singlebeam echosounder (SBES), side scan sonar (SSS) and multibeam echosounder (MBES). It begins with the emergence of underwater acoustic science from the 19th century, followed by an examination of how sound propagates through water, its frequency, wavelength, spreading and absorption properties and how these relate to the resolution of our mapping. With these topics covered, the lecture moves on to the principles of echosounding, on which seabed mapping technology is based. This gives us the fundamental knowledge of how depth can be measured using sound, from which we describe how various mapping technologies work and present an overview of the various types of data that are output from multibeam echosounder surveys and their applications.

- **Marine Survey Planning & Ocean mapping: A Global Perspective**

This lecture covered a wide range of aspects in relation to survey planning, all of which must be considered when mapping an area of seabed for any application. An overview of different applications and their respective survey needs were presented first, from nautical charting to dredging and offshore renewable energy. This was followed by survey planning considerations – legal aspects such as environmental legislation with regard to vulnerable species and potential diplomatic clearances that may be needed, followed by looking at considerations such as the marine environment itself and safety at sea. The second section of the lecture dealt with survey specification, such as the accuracy and resolution requirements for different surveys depending on the intended use of the data, following which we deal with the task of choosing the appropriate vessel from a wide range of platforms such as large offshore vessels, smaller inshore craft and autonomous or remotely operated vehicles. Once the vessel and instruments were selected, the next task to be discussed was mobilisation of the equipment and the different ways it can be mounted on the vessel. Finally, considerations about weather and sea state were discussed in the context of survey planning.

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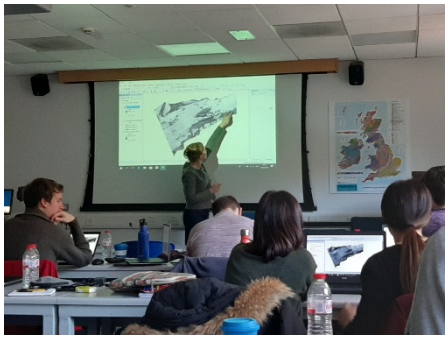
Post Cruise

Day 6 Training Activities

- **Products & Dissemination**

This lecture provided a clear and interactive overview of the INFOMAR data life cycle.
Key data concepts were introduced with a focus on the various datasets created and showcased the various solutions implemented by INFOMAR to deliver data and services. This was followed by an overview of the data integration programme describing how various national and international portals and initiatives utilise seabed mapping data and handle data visualisation including novel methods such as 3d virtual solutions, sand boxes and augmented reality.

- **Seabed Classification Practical**

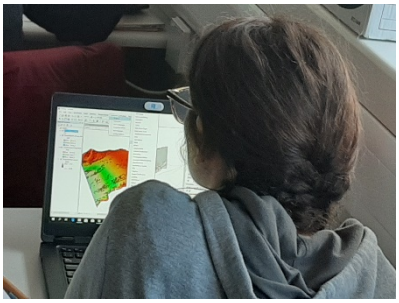


This practical provided a step-by-step guide on how to classify MBES bathymetry and backscatter into a substrate map using ArcGIS tools divided into 3 main sections:

1. Tracing rock outcrops from a shaded relief image of the bathymetry.
2. Classifying backscatter into discrete acoustic classes corresponding to different sediment types using isoclustering.
3. Ground-truthing acoustic classes into sediment classes using sample data.

An additional exercise on estimating the area of potential kelp habitat using the extent of rock substrate and calculated infralittoral depth zone was also provided.

Day 7 Training Activities



A detailed knowledge of the seafloor contributes to an understanding of the marine environment and underpins marine spatial planning decisions relating to range of sectors including Navigation & Safety at Sea, Fisheries, Aquaculture, Renewable Energy and Habitat Mapping to name a few. This lecture explored and discussed the wider impacts and benefits of seabed mapping and provided practical examples based on the learnings and experience of the wider INFOMAR team. From the lecture the students gained a clear understanding in societal, environmental and economic contexts of the impacts of seabed mapping.

On board operation

Day 3 Training Activities

Training on day 3 began with embarkation at 08:30 at Horgan's Quay. After embarkation there was a safety tour followed by round table introductions of instructors and students, lay out of training objectives and schedule, and a presentation on the Cork Harbour study area. Students then divided into two groups for

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toolbox talAB on the vessel data acquisition systems and Marine Mammal Observation guidelines for acoustic surveys.

Seabed sampling and data collection practicals took place in the shipping channel of the tidal River Lee between Ringaskiddy and Cobh. Weather conditions confined sampling and data collection to this area. Physical sampling of the seabed was carried out with a day grab and sought to characterise the geophysical and biological properties of sediments in the shipping channel at three stations between Ringaskiddy and Cobh. At each of these stations a sound velocity probe was lowered for MBES calibration and to establish temperature and salinity profiles of the water column. Students were rotated through these stations in three groups to ensure that each student had the opportunity to learn the skills involved.
On completion of station data collection and sampling students broke into two groups for alternating practical sessions of MBES and Sub-Bottom Profiling data acquisition and, MBES data processing. Data acquisition took place in the dry lab and processing utilised the mess.
The return transit to Cork was occupied with exposition of a scenario challenging students to develop a survey plan for dredging the shipping channel. For this students again separated into two groups with each group roleplaying a surveying consultancy.
Students disembarked at 17:00.

Day 4 Training Activities
Students boarded the vessel at 08:30 and divided into two teams to formulate and present to instructors their responses to the channel dredging scenario laid out the previous day.

Following this student divided into two groups and carried out a survey of the shipping channel between Ringaskiddy and Cobh using elements of their own presentations and practicing the sampling and ground truthing skills taught on day 1. For this students divided into two groups and alternated between acoustic data acquisition using MBES and SBP in the drylab and ground truthing using the day grab on the deck and in the wetlab. A key element of day two of SMART lead student training programmes is that practical sessions are student led.

Additional activities on day 2 included an exposition of wheelhouse operations concentrating on the pivotal role of the vessel crew in ships navigation, instrument deployment and delivery of the survey's goals. Passage back to the ship's berth at Horgan's quay were taken up with the exposition of a poster composing challenge. For this students divided into two teams where each team was tasked with the production of a poster to present the products and societal benefits of seabed mapping. Design and layout of the poster was discussed on the return passage to the Port of Cork with drawing and production

Students disembarked at 17:00.

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Day 5 Training Activities

Students boarded the vessel at 08:30 and divided into two teams to complete the poster challenge and present to instructors.

Following this a station was occupied in the Anchorage off Spike Island to launch the Videoray mini ROV and to collect Core samples using a 2m gravity core and Reineck Box Corer. The high sediment load and strong currents generated by heavy catchment rainfall and strong winds in the harbour constrained clear images of the seabed. Of the cores, the Reineck was the most successful in penetrating the seabed and obtaining a sample.

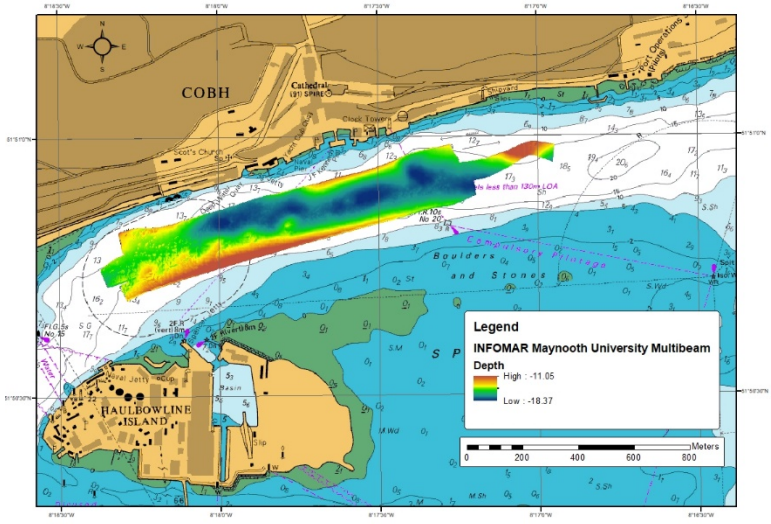

Figure 1Survey Area with student bathymetric data

Operations then progressed to deployment of a 4m beamtrawl to demonstrate fishery and megabenthos sampling. For this students again divided into two groups and rotated through fisheries and benthic data collection practical's.

The return passage to the Port of Cork was occupied by a recapitulation of the day's activities and a Multiple Choice Question (MCQ) quiz on acoustic data acquisition and seabed surveying. Students were also asked to evaluate the training experience through an online form.

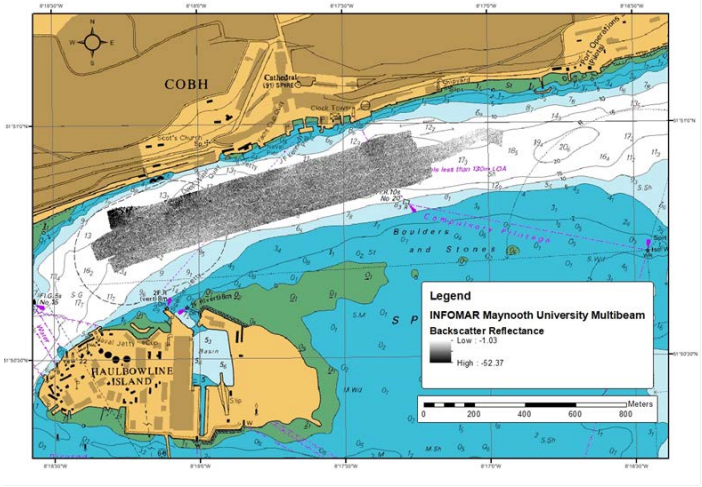

Figure 2 Survey Area with student backscatter data

It should be noted that weather conditions at the time of the survey would have prevented it taking place in any location other than Cork Harbour.

Figures 1 and 2 show survey transects and data products from multibeam and sub-bottom profiling.

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Table 1. Timetable for offshore Day 1 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity			Duration
Alongside	08:30	08:45		Students join vessel			15
	08:45	09:00		On-board Safety Tour			15
Depart & passage	09:00	09:40		Welcome and vessel / team orientation. Intro to the day & Learning Outcomes (JB/OM). Story map of Cork (AB/JB).			40
Group split into 2				Red Watch	Green Watch		
Passage	09:40	10:00	MMO	MMO Deck watch (JB)	Drylab Overview (AB)		20
Passage	10:00	10:20	MMO	Drylab Overview (AB)	MMO Deck watch (JB)		20
	10:20	10:30		Break			10
Group split into 3				Red Watch	Green Watch	Blue Watch	
Marino Point	10:30	11:15	Grabs/SVP	SVP - Drylab (OM)	Sedimentology – Wetlab (AB)	Benthic Ecology – Deck (JB)	30
Marino Point	11:15	12:00	Grabs/SVP	Benthic Ecology – Deck (JB)	SVP - Drylab (OM)	Sedimentology – Wetlab (AB)	30
Steam to Whitegate	12:00	12:45		Lunch			45
Marino Point	12:45	13:30	Grabs/SVP	Sedimentology – Wetlab (AB)	Benthic Ecology – Deck (JB)	SVP - Drylab (OM)	30
Group split into 2				Red Watch	Green Watch		
On station Near Whitegate	13:30	14:45	SVP	MBES/SBP Data acquisition. (AB)	MBES Data Processing Practical (OM)		75
On station Whitegate	14:45	16:00	SVP	MBES Data Processing Practical (OM)	MBES/SBP Data acquisition. (AB)		75
	16:00	16:30		Exposition of seabed survey dredging scenario (T			30
	16:30	17:00		Group discussion / planning of scenario			30
	17:00	17:15		Disembark			15

Table 2. Timetable for offshore Day 2 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity	Duration

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Alongside	08:30	08:45		Students join vessel		15
Depart & passage	08:45	09:45		Survey design & planning – group preparation. (All)		55
	09:45	10:15		Survey plan presentations X 2		20
Group split into 2				Red Watch	Green Watch	
	10:30	11:30	Grab SVP	Survey (MBES/SVP/SBP)(AB)	FMGT practical (OM)/ groundtruthing (JB)	60
	11:30	12:30		Lunch break		60
	12:30	13:00		Wheelhouse operations exposition		30
Group split into 2				Red Watch	Green Watch	
	13:00	14:30	Grab SVP	FMGT practical (OM) / groundtruthing (JB)	Survey (MBES/SVP/SBP) (AB)	60
	14:30	15:30	Grab SVP	Survey (MBES/SVP/SBP) (AB)	FMGT practical (OM) / groundtruthing (JB)	60
	15:30	15:45		Break		15
Passage to Cork	15:45	16:30		Seabed Mapping Poster Challenge		45
	16:30	17:30		Disembark		30

Table 3. Timetable for offshore Day 3 training activities

Vessel Op	Start Time	End Time	Deck Ops	Student Activity	Duration
Alongside	08:30	08:45		Students join vessel	15
Depart & passage	08:45	09:45		Poster Production (All)	6
	09:40	10:00		Poster presentations X 2 (All)	20
Group split into 2				ALL	
	10:00	11:30	ROV	Video Ray Mini ROV Demonstration (All & Brendan Barry)	30
	11:30	12:30		Lunch break	60
	12:30	13:30	Cores	Gravity Core and Box Core	60

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	13:30	12:30		Lunch break		60
Group split into 2				Red Watch	Green Watch	
	13:00	14:30	Beam Trawl	Fisheries Beam Trawl (JB & AB)	Benthos Beam Trawl (JB & AB)	60
	14:30	15:30		Benthos Beam Trawl (JB & AB)	Fisheries Beam Trawl (JB & AB)	60
	15:30	15:45		Break		15
Passage to Cork & alongside	15:45	16:00		Multiple choice test		15
Alongside	16:00	16:30		Closure discussion Debrief about experience, future career. Feedback questionnaire.		30
Alongside	16:30	16:45		Disembark		15

Preliminary results

The samples and data acquired during the course of the survey were worked up in a series of practical's provided on day 6 of the course during the "Seabed Classification" laboratory practical.

Data sets collected include:

- SVP data
- Sediment data for geophysical characterisation
- MBES and Sub-bottom Profiling Products

Evaluation of student learning

Students participated in a Pre-cruise Pre Evaluation of Participant Learning Test to establish a baseline knowledge of the participants to estimate whether the key learning objectives of the EUROFLEETS+ Floating University *"Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying"* were met. The Participant Learning Test consisted of 21 multiple choice questions based on the key learning objectives for the Floating University. Participants were also tasked with developing and presenting their understanding of Sea Bed Mapping while working collaboratively in teams to the instructors. The results of which can be seen in Appendix 1. Additional students had the opportunity to each present their specific area of study to the instructors and the participants as an exercise during the course.

Students course evaluation

The students were invited to provide feedback for the course on the final day, and submitted their answers through an online form, the results of which are detailed in the table below.

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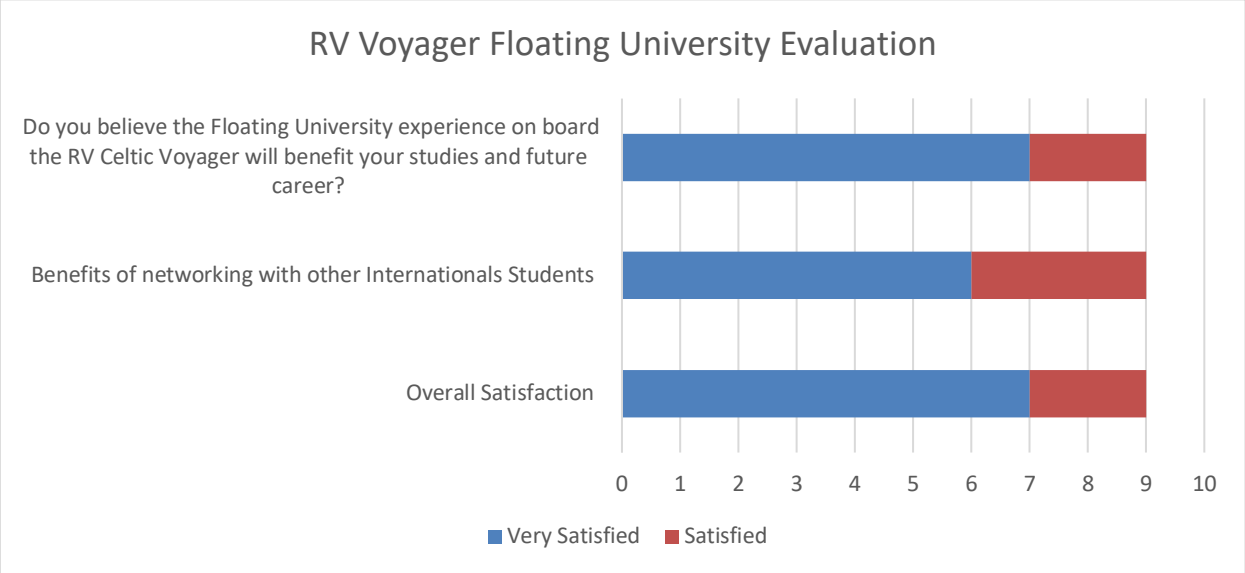
Eurofleets+ Floating University

Overall the response to the delivery of the Eurofleets+ RV Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying Floating University was highly rated with 78% of participants Very Satisfied and 22% satisfied. Although all students felt that they benefited from networking with other international students, some felt that the group was small and that they had an expectation that there would be more PhD students taking part. However, the majority of students were confident that the experience would benefit their studies and future careers.

Student highlights were their experience on board the RV Voyager and the opportunity to put into practice first hand their knowledge and skills, and complemented the depth of experience and the openness of the lecturer both on board and in class. It was suggested that an improvement could be more time devoted to Sub-bottom Profiling Data and Processing as well as more time on-board the vessel.

A video capturing the students experience was made and can be found here: [RV Celtic Voyager Floating University Eurofleets+]



On Board Activities Evaluation Survey Response

Programme Elements	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	Total
Sound Velocity Profile	8	1	0	0	0	9
Beam Trawl Fisheries & Benthos Practical	8	1	0	0	0	9
Sedimentology -Wetlab	7	1	1	0	0	9
Benthic Ecology-Deck	7	2	0	0	0	9
MBES/SB Data Acquisition- Drylab	7	2	0	0	0	9
MBES Data Processing Practical	7	2	0	0	0	9
Bridge Tour	7	2	0	0	0	9
Ground-truthing Survey	7	2	0	0	0	9
Drylab Overview	6	3	0	0	0	9
Presentation of Scenario	6	3	0	0	0	9
FMGT Practical	6	3	0	0	0	9
Poster Production Practical	6	3	0	0	0	9

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Marine Mammal Observation	5	4	0	0	0	9
Gravity and Box Core Practical Session	5	2	1	1	0	9
Survey Report Overview	5	4	0	0	0	9
Vessel Safety Tour and Orientation	4	5	0	0	0	9
Sub-bottom Profiling Data Processing Practical	4	2	0	2	1	9
Mini-ROV Investigation	4	3	2	0	0	9
Whole Survey	4	3	2	0	0	9

Classroom Based Learning Activity Survey Response

Programme Elements	Very Satisfied	Satisfied	Neutral	Unsatisfied	Very unsatisfied	Total
Overview of seabed mapping	6	3	0	0	0	9
Fundamentals oceanography & sampling	4	4	1	0	0	9
Marine Geohazards	4	4	0	1	0	9
Seafloor Mapping	5	4	0	0	0	9
Marine Survey Planning]	4	4	1	0	0	9
Products & dissemination	5	4	0	0	0	9
Seabed Classification Practical	6	2	1	0	0	9
ArcGIS Practical	6	2	1	0	0	9
Impact of Seabed Mapping	6	2	1	0	0	9

Concluding remarks

Overall the floating university provided an overview of remote sensing techniques, helping them to understand bathymetric data products, to recognize data limitations, and to identify key systems and practices used in the field of seafloor surveying. Students also developed a technical grounding in mapping at different resolutions, and the importance of instrumentation calibration, quality control and processing of bathymetry datasets, before product delivery to end users.

The course was taught within the context of end users, stakeholders and the policy framework underpinning ocean science and Ocean Literacy, highlighting both the relevance and importance of mapping the Earth's seafloor.

Eurofleets+ would like to sincerely thank and acknowledge the INFOMAR, Marine Institute, Geological Survey Ireland, SMART Sea School (GMIT) and UCC School of Biological, Earth and Environmental Sciences teams for their outstanding support in delivering the first Eurofleets+ Floating University Mapping the Ocean Floor: An Introduction to Practical Aspects of Hydrographic Surveying" On board the R/V Celtic Voyager.

Appendix 1Poster Presentation

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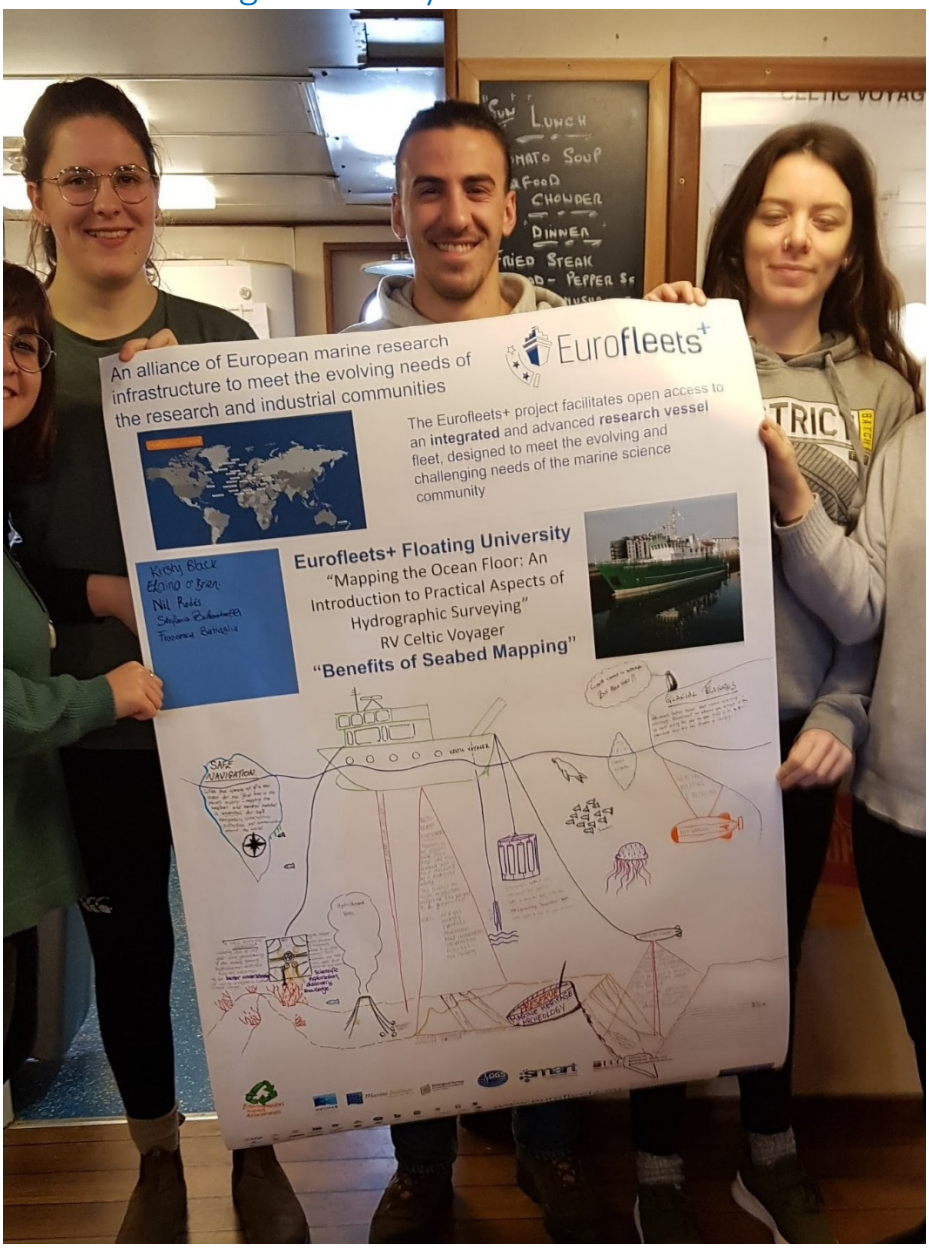

Sebed Mapping Poster Group 1

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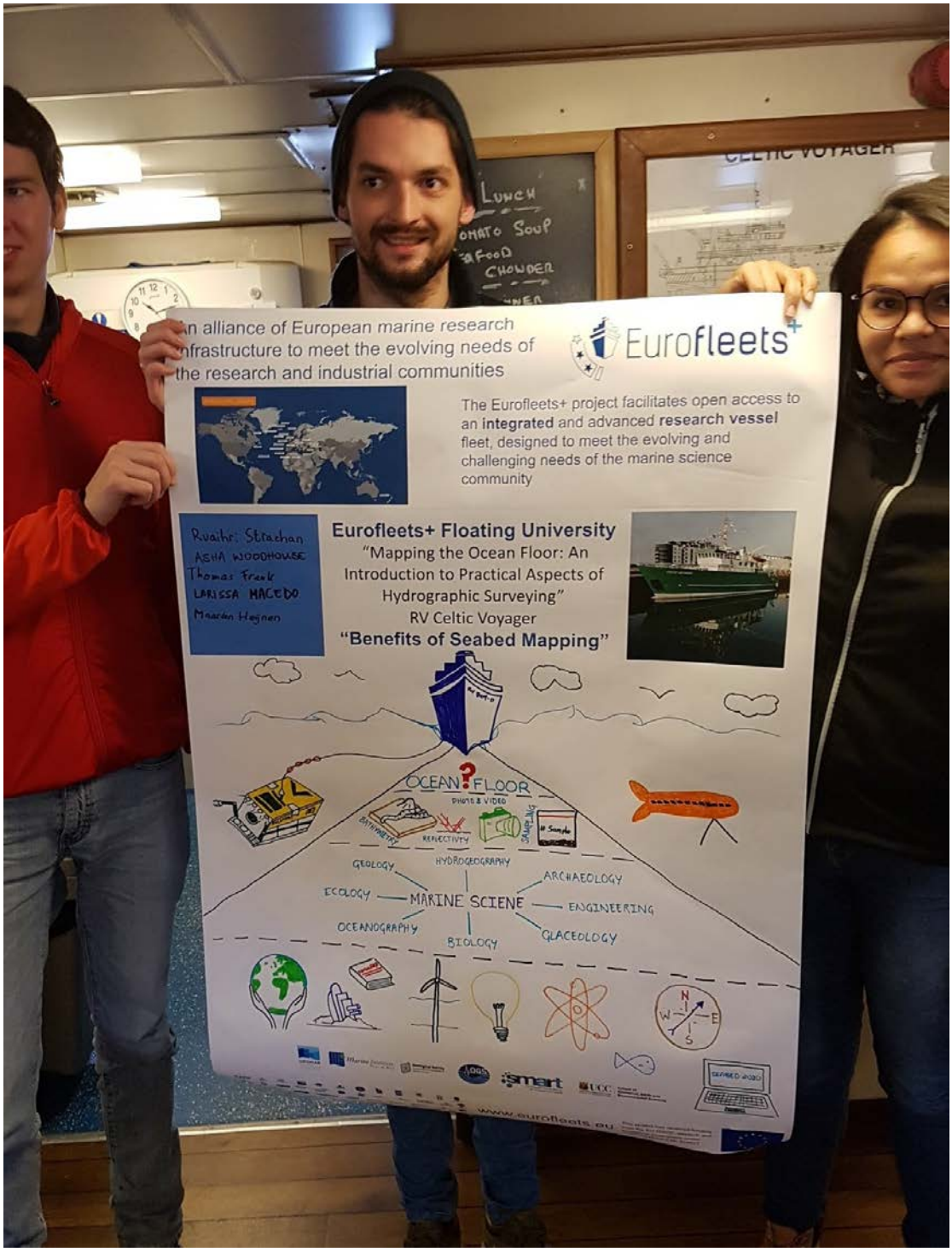

Sebed Mapping Poster Group 2

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Eurofleets+ Floating University

Appendix 2 Images From Offshore Activity

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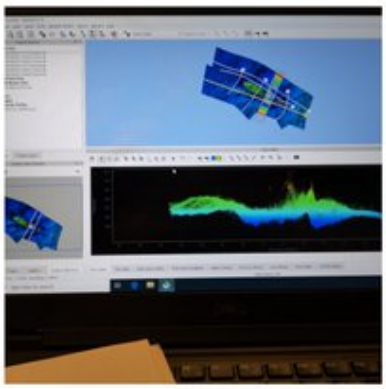

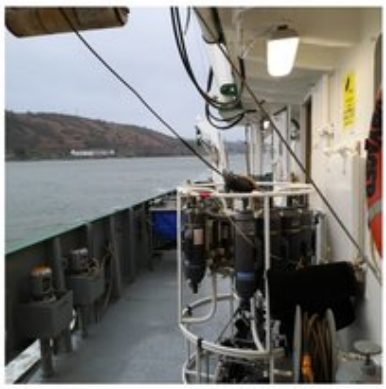


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Appendix 3 Certificate of Participation

Appendix 4 RV Celtic Voyager Floating University Eurofleets+ Video

EUROFLEETS+ Floating University

" Use bio-optical parameters as convenient tool to study marine biogeochemical processes "

On board the R/V *OCEANIA.*

Sopot, Poland, 31 May – 8 June 2021.

Eurofleets+ Floating University COURSE REPORT

Scientific Participants

(role / organization)

Piotr Kowalczuk (Cruise and course leader / Institute of Oceanology Polish Academy of Sciences - IOPAS)	Africa Paulina Gomez Castillo (student / University of Southampton)
Mirosław Darecki (Course coordinator, Lecturer / IOPAS)	Alexandros Menegatos (student / University of Patras)
Joann Stoń- Egiert (Lecturer / IOPAS)	Antonia Kloecker (student / University of St Andrews)
Violetta Drozdowska (Lecturer / IOPAS)	Elena Terzić (student / National Institute of Oceanography and Applied Geophysics (OGS) Trieste, Italy)
Monika Zabłocka (Lecturer / IOPAS)	
Tomasz Krawczyk (Technician / IOPAS)	Joseph Parkinson (student / Denmark Technical University)
Anna Makarewicz (Organization and technical support / IOPAS)	
Niamh Flavin (Project Coordinator - Eurofleets+)	Lorena Gil Calo (student / Università di Milano-Bicocca)
Bernadette Ni Chonghaile (Project Coordinator - Eurofleets+)	
Sandra Sá (Media and Public relation - Eurofleets+)	Stamatia Konstantina Tsouvaltzi (student / University of Patras)

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Course and cruise objectives

Figure 1. Course participants: scientific crew, students and the captain of the ship.

Figure 2. Students.

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Information about the course:

The EUROFLEETS+ Floating University "Use bio-optical parameters as convenient tool to study marine biogeochemical processes" was a combination of theoretical lectures and practical experience in conducting instrumental measurements of inherent and apparent optical properties in marine waters and collecting water samples for determination of concentrations of optically significant sea water constituent. Student were familiarized with latest IOCCG measurements and sampling protocols and state of the art optical instrumentation. The course was composed of a combination of presentations, lectures, laboratory work and practical sampling, measurements, and interpretation of optical and bio-geochemical data in working groups.

The course focused on basic theory, applications and practical exercises in marine optics and bio-optics in general. The course provided a lecture on basics of Baltic Sea hydrology, to explain the scientific objectives of the cruise and why the optical measurement in the Danish Straits are important to explain optical properties of stagnant water in the Baltic Sea Deep.

The theory of marine optics included explanations of the concept of inherent and apparent optical properties and relationships between those quantities. The lectures also explained the role of the of phytoplankton as the one the major contributor to variability in inherent optical properties, modification of the spectral properties of apparent optical properties and ocean color. Students were thought which dissolved and particulate constituents of sea water contribute most to the variability of inherent and apparent optical properties of marine waters. Student learned on spectral properties of absorption by chromophoric dissolved organic matter, CDOM absorption by phytoplankton pigments and suspended particulate matter. The theory on bio-optics explained the concept of the "optical proxies" for determination of essential biogeochemical variables and bio-optical models used for inversion of optical properties to concentrations of specific marine water constituents. There were lectures on basics of ocean color remote sensing. During the workshop in the laboratory, students learned the methodology of spectrophotometric measurements for determination of chlorophyll a concentration with spectrophotometric method by Lorenzen, 1967.

LEARNING OUTCOMES
On completing this course the participant were able to: • Summarize the apparent and inherent optical properties of seawater (aquatic optics theory). • Explain how the optical properties of seawater are linked to hydrographic conditions, with focus on the Baltic Sea. • Perform measurements of apparent and inherent optical properties of sea water using set of state of the art instruments integrated into optical-hydrological probe and profiling radiometer and floating radiometer • Analyse the data collected from underway and vertical profile measurements (data extraction, data correction and presentation). • Collect water samples for laboratory measurements, for determination of concentrations of optically significant sea water constituents • Interpret the measurements in relation to water constituents and hydrography. • Summarize findings and interpretations in a report and presentation.

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Information about participants:

The course was addressed to post-graduates students (students of all nationalities enrolled at European universities) conducting education and research for development of Master of Science and Ph.D. degree. The eight final students were carefully selected from 13 applications submitted to an open call handled by Eurofleets+ application submission system. One student, unfortunately had to withdraw from the course due to personal reasons and the pandemic restriction in Europe. The seven students were of 6 different nationalities (British, Greek, German, Italian, Mexican, Slovenian) and were affiliated to 6 different institutions (see section: Scientific Participants) with varying levels of education from MSc, PhD to postdoc. Each of them had different research interests in Marine Science: marine engineering and artificial reef technology, optical oceanography, marine acoustic, physical oceanography, marine biogeochemistry, marine geology, marine ecology. Most of the participants had not been on an oceanographic research vessel before, despite studying marine science field. They all motivated their participation in the course as extremely beneficial to the development of their scientific interests, because course offered a great hands-on experience where theory and techniques learnt in the classroom were put into practice.

Figure 3. Final 7 students.

Information about research vessel:

The RV OCEANIA which is 48.9m in length and 9.0M wide, was built in 1985 in the Gdansk Shipyard in Poland in 1986. Oceania accommodates 27 personnel, including 14 scientists and 13 crew member

Figure 4. R/V OCEANIA.

(http://www.iopan.gda.pl/oceania.html). The ship is equipped with laboratories able to support hydrographic, optic, acoustic, chemical, biological measurements, experiments and observations. During the year, research cruises onboard RV Oceania take place mainly in the Baltic Sea. Each year during the summer RV OCEANIA sails to the 3-month cruise to the Arctic region: around Svalbard and the Nordic Seas (AREX cruise).

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Nature of the course and work carried out on the course

The course was designed to enable students to acquire theoretical background and advanced practical skills for conducting instrumental measurements of inherent and apparent optical properties in marine waters and collecting water samples for determination of concentrations of optically significant sea water constituent.

The course was composed of a combination of lectures, laboratory work and practical sampling and measurements, and interpretation of optical and bio-geochemical data. Before the cruise, trainees have been attended at introductory day (May 31, 2021) at Institute of Oceanology Polish Academy of Sciences in Sopot (Poland), with lectures covering the theoretical background in ocean optics and geochemistry. A description of planned experimental work, survey design & planning, and practical issues were carried before boarding the research vessel. Students and scientific crew were mustered on board RV Oceania on June 1, 2021 in the morning, and the ship has left the Gdansk harbor the same day around noon. On board students were working in three groups. Students guided by scientist conducted measurements and were sampling water on selected station in the Danish straits and along the ship track during passage around Danish Island of Sjælland (Figure 1). Data acquisition and processing workshops were conducted in the evenings together with lectures presenting the scientific aspects of the study area. Analysis and interpretation of the instrumental measurements data collected during the cruise were performed on board until the last day. Practical training in laboratory measurements took place on the ship. During the last day of the cruise we were focused on the open discussion on the data collected, and the compilation of the cruise report by students.

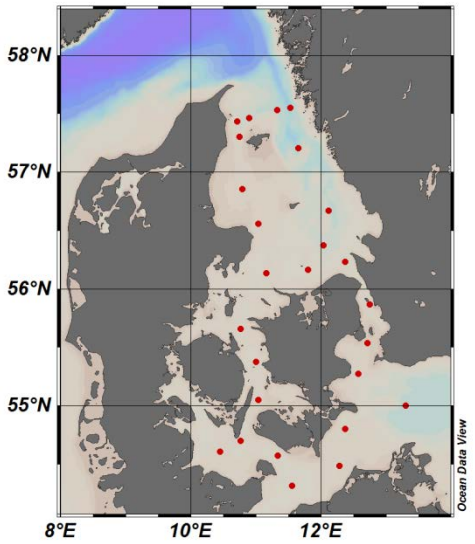

Figure 5. Sampling area.

The practical workshops on ship included the measurements of the inherent optical properties using Integrated Hydrological Optical probe that consist with submersible marine spectrophotometer ac-9, set of fluorometers and CTD probe (ac-9 plus attenuation and absorption meter (WET Labs Inc., USA), a WETStar CDOM fluorometer (WET Labs Inc., USA), a microFlu-chl chlorophyll a fluorometer (Trios GmbH, Germany), and a Sea-Bird SBE 49 FastCAT CTD probe (Sea-Bird Electronics, USA). These instrumental package has been deployed in two modes - flow-through underway and vertical profiling. We have also conducted radiometric measurements with use of set of RAMSES Trios radiometers and profiling free fall radiometers set C-OPS. The bio-optical measurements included deployment of the 4 channel phytoplankton pigments fluorometer in underway and profiling mode to determine

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abundance of different r phytoplankton groups based on their fluorescence signatures. The profiling 4-channel fluorometer has been deployed at every measurement station.

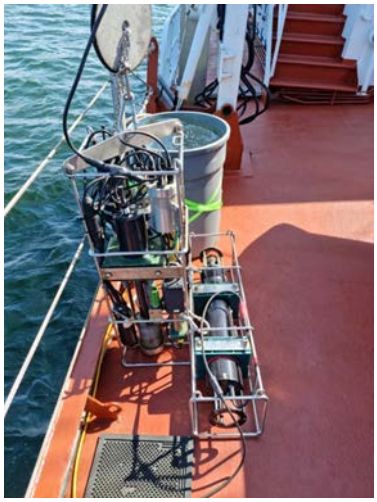

Figure 7. Integrated Hydrological Optical probe.

Figure 8. Profiling free fall radiometers set C-OPS.

The laboratory exercises included water sampling and processing, and preservation of water samples for spectrophotometric determination of chlorophyll-a, CDOM/FDOM, particulate absorption, and phytoplankton pigments determination through HPLC. There was one primary production incubation with C14 method at measurement station in Danish coastal waters.

Collected instrumental data has been processed on board and used during on-board data processing workshops, to get calibrated values and noise reduced data files that were later imported to Ocean Data View. The data workshops included basic training in usage Ocean Data View data banking and visualization software. Students were given instruction on basic functions of data exploring for determination of key processes that were driving variability in acquired data sets. Based on those exercises students prepared short presentation on variability and interrelationships between various optical variables.

The following types of assessment has been be used for the Eurofleets+ Floating University course:

- pre- and post-course evaluation test
- preliminary results from group project
- cruise report compilation and student presentation.

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Course and cruise Log

1st day: 30.05.2021 – Sunday – location: Gdańsk airport, railway station / Sopot (on land)

Arrival to Gdansk. Check in the hotel Haffner in Sopot.

Figure 8. R/V Oceania in the Harbour.

2nd day: 31.05.2021 - Monday – location: IOPAN Sopot (on land)

9:00, Welcome at the Institute.

9:10, COVID testing.

9:30 – 10:45, Introductory meeting and safety briefing. Students short presentation.

10:45 – 11:00, Coffee break and snacks.

11:00 – 12:00, Introductory lecture on Baltic Sea hydrography.

12:00 – 13:00, Lunch.

13:00 – 15:00, Lecture on basics of marine optics.

15:00 – 15:30, Questions and Answers.

3rd day: 01.06.2021 – Tuesday – location: IOPAN Sopot/ r/v Oceania (on land/on vessel)

8:30 – 9:30, Transportation to r/v Oceania.

9:30 – 10:00, Embarkation.

10:00 – 11:30, Boarding of the science team and students. Inspection and installation of telemetry cables connecting instruments with power supply and data acquisition units. Testing equipment. Briefing students with safety at sea procedures, house rules and emergency drill by ship captain.

Figure 9. Exercises of safety drills.

11:30 – 12:30, Lunch.

13:00, Leaving Gdansk Harbour.

13:00 – 14:30, Exercises of safety drills. Passage to station P104.

14:30 – 17:00, Start of measurements at P104. Presentation of optical measuring instruments and operational manuals and procedures by dr Piotr Kowalczuk. Presentation of the wet laboratory operational procedures and manuals by dr Joanna Stoń-Egiert and dr Monika Zabłocka. Equipment deployments and in situ instrumental measurements and water sampling on station P104.

Figure 10. Explaining the measurements procedures by Piotr Kowalczuk.

17:15, Departure from station P104. Passage to Sund Strait between Denmark and Sweden. Start of inherent optical properties measurements underway along the ship track. Measurements were continued until the morning of the next day.

17:00 – 17:30, Dinner.

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17:30 – 21:00 Presentation by Piotr Kowalczuk "Use bio-optical parameters as convenient tool to study marine biogeochemical processes- course objectives" and "Presentation of modern optical instruments for in situ measurements of inherent and apparent optical properties".

Figure 11. Lectures by Piotr Kowalczuk in the ship lounge.

4th day: 02.06.2021- Wednesday – location: r/v Oceania (on vessel)

Sailing toward Sund Strait. During passage underway measurements of inherent optical properties along the ship track. Collection of water samples for referencing and validation of instrumental measurements at 06:45, 08:35 and 10:45, UTC.

13:23 – 14:10 UTC, Arrival to measurements station DK441 at approaches to Sund Strait. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

Figure 12. Students in the Sund Strait.

14:10 – 16:50 UTC, During passage between stations DK441 and DK1712 underway measurements of inherent optical properties along the ship track. Passage to station DK1712 in Sund Strait.

16:50 – 18:00 UTC, Arrival to station DK1712. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Malfunction of the pump switch at IOP instrumental package, vertical profile of the IOPs at station DK1712 skipped. Departure from station DK 1712 at 18:00 UTC. Malfunction of pump switch fixed on board.

18:00 UTC, Sailing toward station DK418, passing the Sund Strait and entering Kattegat. During passage between stations DK1712 and DK418 underway measurements of inherent optical properties along the ship track.

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5th day: 03.06.2021- Thursday – location: r/v Oceania (on vessel)

00:40 UTC, Arrival to station DK418. Anchored at this station until sunrise.

06:30 – 09:10 UTC, Start of measurements at station DK418. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

Figure 13. Water sampling for CDOM and chlorophyll a concentration.

09:10 – 12:50 UTC, Passage to station DK415. During passage between stations DK418 and DK415 underway measurements of inherent optical properties along the ship track.

12:50 – 13:30 UTC, Arrival to station DK415. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

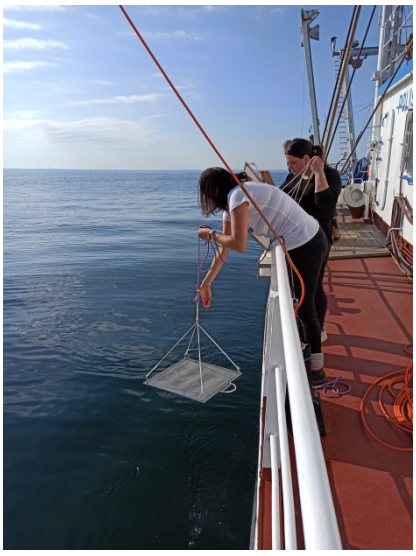

Figure 14. Sea surface Microlayer sampling.

13:30 – 17:00 UTC, Passage to station DK925. Arrival to station DK925 at 17:00 UTC. During passage between stations DK415 and DK925 underway measurements of inherent optical properties along the ship track. During ship passage lectures given by dr Piotr Kowalczuk, dr Joanna Stoń-Egiert and dr Violetta Drozdowska: Dr Piotr Kowalczuk “Inherent and apparent optical properties of Baltic Sea waters and their link to biogeochemistry”. Dr Joann Stoń-Egiert “Light in the sea – biophysics” and “Methodology of measurements biogeochemical parameters of suspended particles and dissolved material in seawater”. Dr Violetta Drozdowska “Sea Surface Microlayer”.

Stay anchored on station DK925 until morning next day. Servicing and cleaning optical instruments.

6th day: 04.06.2021- Friday – location: r/v Oceania (on vessel)

06:30 – 12:20 UTC, Start of measurements at station DK925. Collection of water samples for incubation of primary production with C14 method. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials. Primary production

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incubations started at 07:40 UTC. During primary production incubations optical measurements at 9:25 and 11:20 UTC. Primary production incubation finished at 11:45 UTC. Lectures by Dr Violetta Drozdowska “Research Cruises – my work”.

Figure 15. Preparation and measurements of primary production.

12:20 – 15:50 UTC, Departure from station DK925 toward station DK935. During passage between stations DK925 and DK935 underway measurements of inherent optical properties along the ship track.

15:50 – 16:50 UTC, Arrival to station DK935. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

16:50 – 23:50 UTC, Departure toward station DK450. During passage between stations DK935 and DK450 underway measurements of inherent optical properties along the ship track. Sailing through the Great Belt and under the Great Belt bridge. In the evening data workshop part 1 led by Piotr Kowalczuk. Spectrophotometric laboratory workshop led by dr Joanna Stoń-Egiert “Spectrophotometric laboratory – measuring chlorophyll a concentration with spectrophotometric method by Lorenzen, 1967”. Arrival to station DK450 at 23:50 UTC. Stay anchored at station DK450 until morning June 5, 2021.

Figure 16. Spectrophotometric laboratory – measuring chlorophyll a concentration.

7th day: 05.06.2021- Saturday – location: r/v Oceania (on vessel)

At station DK450, servicing and cleaning optical instruments.

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06:30 – 07:20 UTC, Start of measurements at station DK450. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

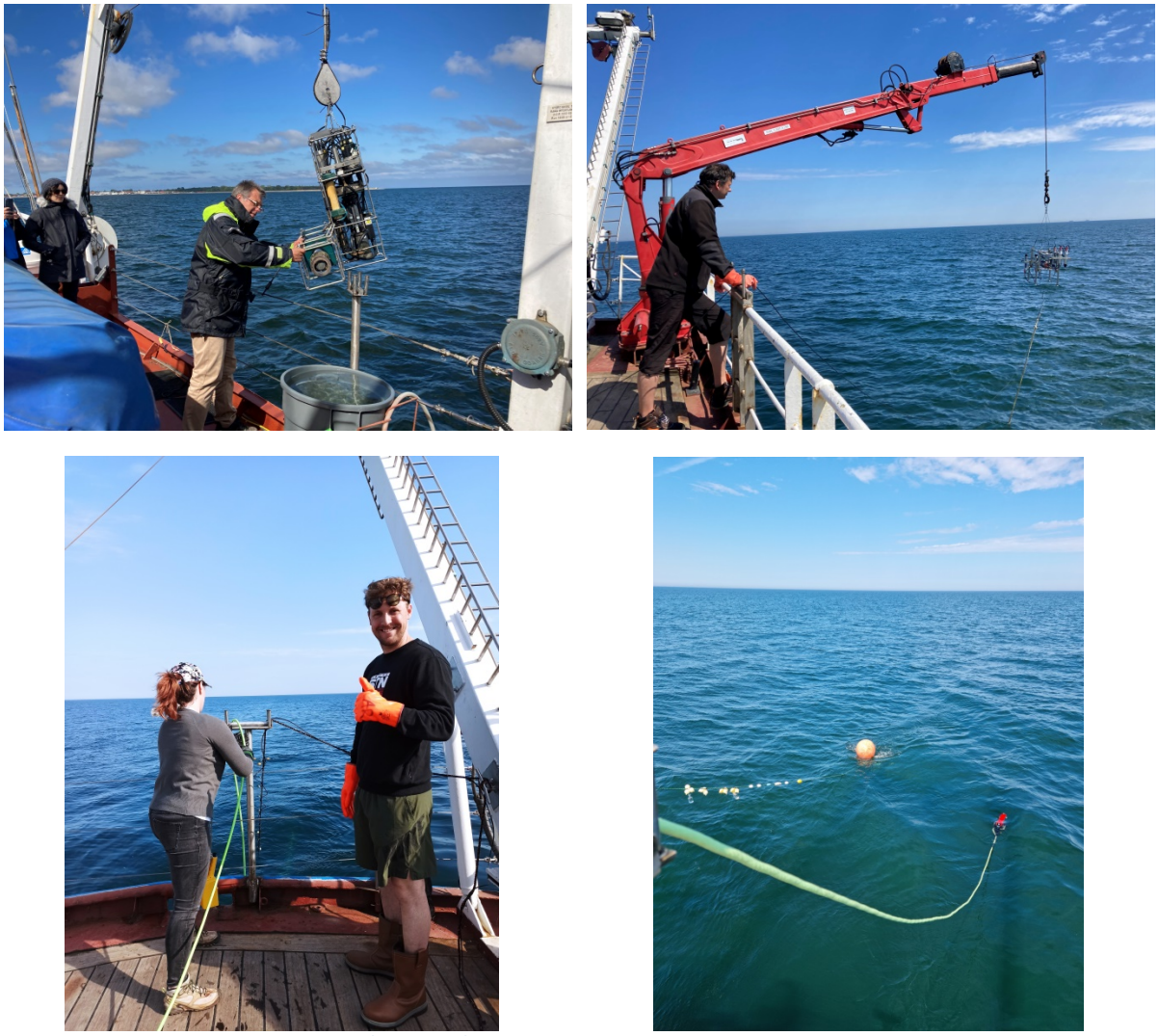

Figure 17. Instrumental measurements (From left): Integrated Hydrological Optical probe vertical profiles, radiometric measurement of top and bottom lighting, profiling free fall radiometers set C-OPS vertical profiles.

07:20 – 10:15 UTC, Passage to station DK952. During passage between stations DK450 and DK952 underway measurements of inherent optical properties along the ship track.

10:15 – 11:20 UTC, Arrival to station DK952. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

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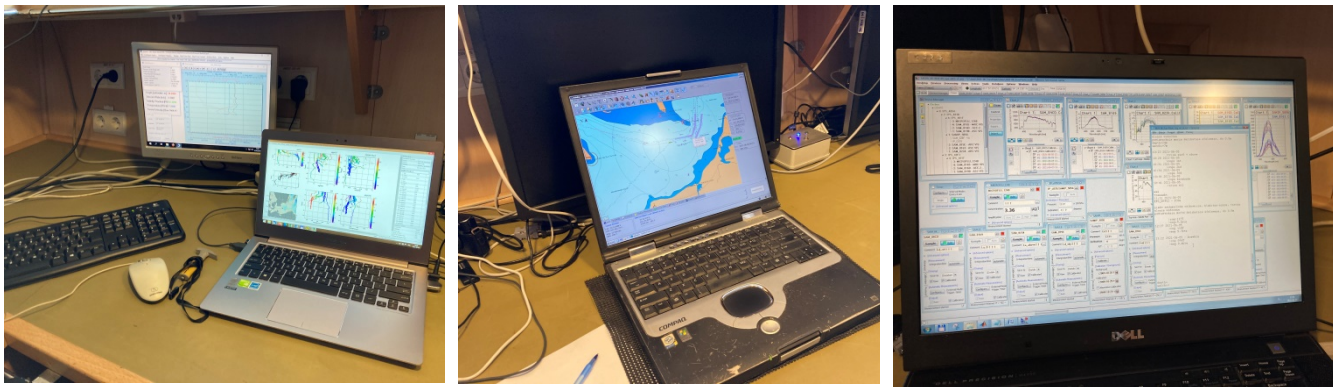

Figure 18. Computer laboratory.

11:20 UTC, Departure to station P39a in Polish Economical Exclusion Zone. During passage between stations DK952 and P39a underway measurements of inherent optical properties along the ship track. Collection of water samples for referencing and validation of instrumental measurements at 13:05, and 15:45, UTC. In the evening data workshop part 2 led by dr Piotr Kowalczuk. Spectrophotometric laboratory workshop led by dr Joanna Stoń-Egiert "Spectrophotometric laboratory – measuring chlorophyll a concentration with spectrophotometric method by Lorenzen, 1967".

8th day: 06.06.2021- Sunday – location: r/v Oceania (on vessel)

01:05 UTC, Arrival at station P39a. Stayed anchored until sunrise.

06:20 – 07:20 UTC, Start of measurements at station P39a. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

Figure 19. Salinity measurements.

07:20 – 09:00 UTC, Passage to station K12. During passage between stations P39a and K12 underway measurements of inherent optical properties along the ship track.

09:00 – 09:40 UTC, Arrival to station K12. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

09:40 – 12:00 UTC, Passage to station ZP1. During passage between stations K12 and ZP1 underway measurements of inherent optical properties along the ship track.

12:00 – 12:50 UTC, Arrival to station ZP1. Deployment of instruments and taking measurements of vertical profiles on inherent optical and apparent optical properties of sea water. Collecting sea water samples at discrete depth for determination of chlorophyll a concentration, concentration of phytoplankton pigments and absorption by particulate and dissolved materials.

12:50 UTC, Departure toward anchorage at port Darłowo at Polish coast. Group of students and dr Monika Zabłocka left for short visit at Darłowo.

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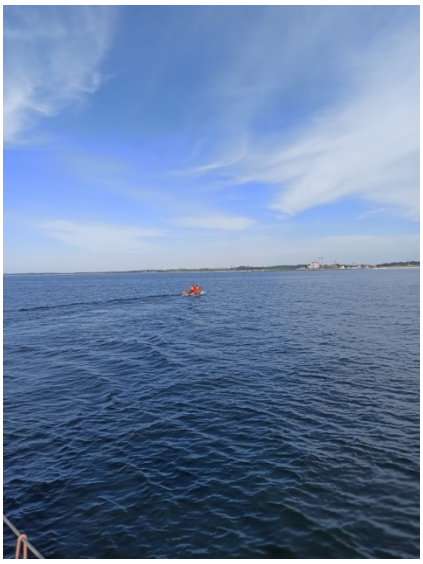
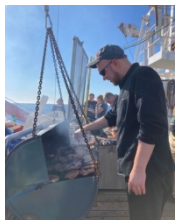


Figure 20. Group of students and dr Monika Zabłocka left for short visit at Darłowo.



In the evening training in ship evacuation in survival suits with participation of students volunteers and barbeque on the deck. Spectrophotometric laboratory workshop led by dr Joanna Stoń-Egiert and dr Monika Zabłocka "Spectrophotometric laboratory – measuring absorption coefficient by chromophoric dissolved organic matter". Stayed anchored until Monday June 7, 2021.

Figure 21. Barbeque on deck.

Figure 22. Ship evacuation training in survival suits with participation of students volunteers.

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9th day: 07.06.2021- Monday – location: r/v Oceania (on vessel)

In the morning data workshop part 3 led by Piotr Kowalczuk and dr Monika Zabłocka “Processing acquired instrumental data performing spectral and noise corrections. Processing acquired instrumental data to derive spectral remote sensing reflectance and downwelling irradiance diffuse attenuation coefficient. Importing processed data into the ODV program to visualize the results”. Students workshop on cruise data presentation.




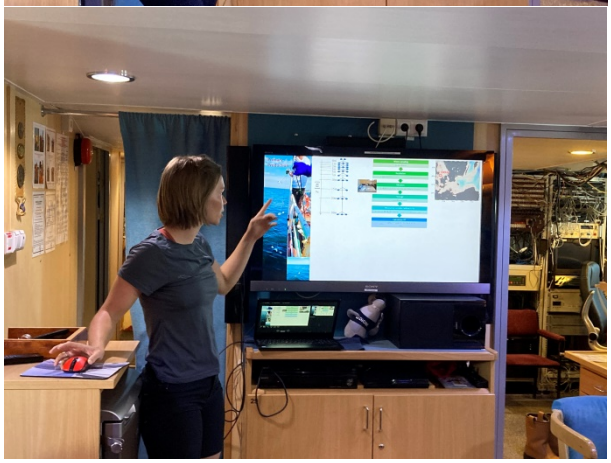
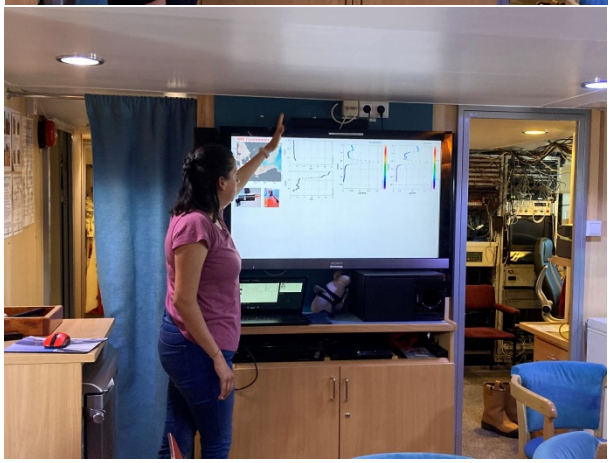

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Figure 23. Students presenting their work.

Post-cruise test. Graduation with certificates. In the evening cleaning laboratories and instruments. Packing instruments and materials. Departing anchorage at Darłowo at 15:00. Sailing toward port of Gdansk.

Figure 24. Graduation of the course with certificates.

10 day: 08.06.2021- Tuesday – location: r/v Oceania (on vessel)

Arrival to port of Gdansk at 06:00 UTC. Disembarkation. Unloading instruments and materials. End of the cruise.

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On board operation

Water sampling methodology

Water samples for determination of chlorophyll-a, CDOM/FDOM, particulate absorption, and phytoplankton pigments determination through HPLC were collected with a Niskin bottles. Samples were collected at three depths: near the surface at the chlorophyll *a* maximum, which was usually located between 10 and 20 m depth, and below the chlorophyll *a* maximum, between 20 and 40 m. Water samples for CDOM/FDOM absorption measurements were immediately filtered in two steps: first through acid-washed GF/F filters, and second through acid-washed Sartorius 0.2 µm pore size cellulose membrane filters to remove finer particles. All spectroscopic measurements for the determination of CDOM absorption were carried out in the laboratory on board R/V *Oceania* using a double-beam UNICAM UV4-100 spectrophotometer in the spectral range 200–700 nm.

Water samples for the determination of chlorophyll *a* concentration, particulate absorption, and phytoplankton pigments determination through HPLC were filtered immediately after collection under low vacuum on Whatman (GE Healthcare, Little Chalfont, UK) 25 mm GF/F filters. Filter pads with particulate material retained on them were immediately deep frozen in a freezer and thereafter stored at −80 ◦C prior to analyses. All detailed measurement and calculation procedures for CDOM/FDOM, chlorophyll *a* concentration, particulate absorption are given in Makarewicz et al. (2018).

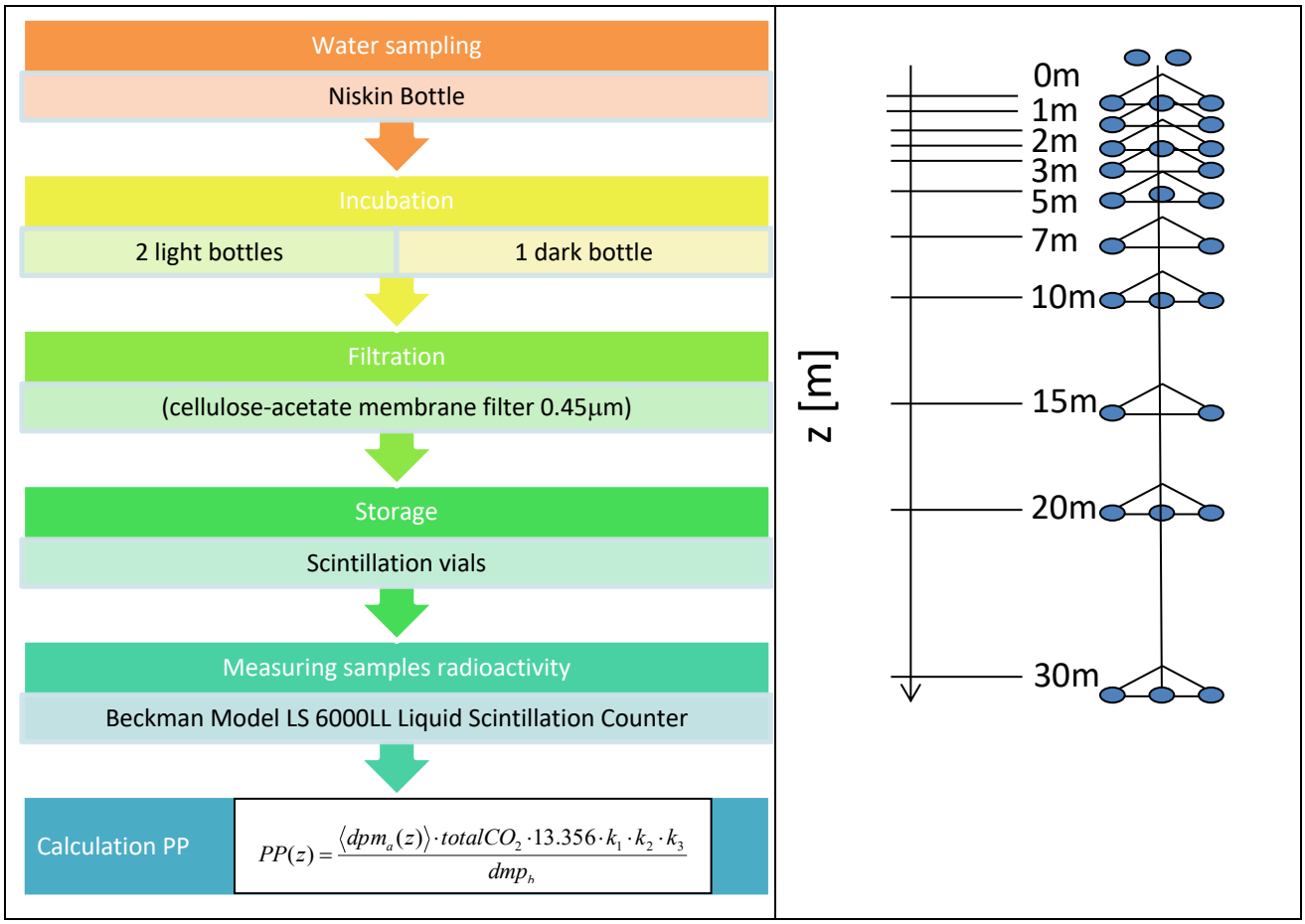

Figure 25 Schematic of the primary production incubation..

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The primary production measurements were done with the use of radioisotope method in light and dark bottles according to Stemmann Nielsen (1952); Strickland and Parsons (1972), Nielsen and Bresta (1984). The principle of the ^{14}C technique is the addition of $^{14}CO_2$ in the form of labelled sodium bicarbonate $NaH^{14}CO_3$ to the water sample, where during photosynthesis the algae incorporate the tracer into organic matter (Zdun et al., 2021). It allows to calculate the rate of the PP based on the known total content of CO_2 in water and known amount of added $^{14}CO_2$ (Zdun et al., 2021). The water samples production were taken at the selected depths: 0, 1, 2, 3, 5, 7, 10, 15, 20, and 30 m, see Figure 25, which enabled a better observation of the maximum of photosynthesis in the deep water profiles of PP as well as the photo-inhibition processes occurring in the Baltic phytoplankton cells near the surface. Two or three identical glass bottles (volume 100 ml) were immediately filled with the water samples and then the isotope with a known activity was added to each sample to obtain the final radioactivity of 37–296 kBq (1–8 µCi) per sample. The water samples were incubated in water column during the 4 h long exposition at midday. To avoid the potential shading the samples were attached to a drifting buoy about 50 m from the ship. After the incubation in the environment under the natural light conditions the radioactive contents of the bottles were filtrated through 25 mm diameter cellulose acetate filter with a pore size of 0.45 µm (Sartorius). Subsequently, the samples gathered on filters were placed in fumes of concentrated hydrochloric acid (HCl) for 5 min and put into scintillation vials. The vials were kept at room temperature in the dark until the measurements on scintillation counter were taken (Beckman LS 6000 IC). All detailed measurement and calculation procedures for primary production are given in Zdun et al. (2021).

Instrumental in situ measurements of inherent and apparent optical properties, FDOM, and chlorophyll a fluorescence

Vertical profiles of IOPs, FDOM, and chlorophyll *a* fluorescence together with conductivity, temperature, and pressure were measured at all stations from the surface down to the bottom (max to 200 m depth) using an Integrated Hydrological Optical probe that is integrated instrument package consisting of an ac-9 plus attenuation and absorption meter (WET Labs Inc., USA), a WETStar CDOM fluorometer (WET Labs Inc., USA), a microFlu-chl chlorophyll *a* fluorometer (Trios GmbH, Germany), and a Sea-Bird SBE 49 FastCAT CTD probe (Sea-Bird Electronics, USA).

Spectral light absorption, $a(\lambda)$, and beam attenuation, $c(\lambda)$, coefficients were measured at nine wavelengths (412, 440, 488, 510, 532, 555, 650, 676, and 715 nm). The ac–9 plus calibrations were performed regularly. After cleaning with ultrapure water, stability instrument readings were inspected with in-air measurements. The required correction of absorption signal for scattering was performed with the so-called proportional method by which zero absorption is estimated at 715 nm (Zaneveld et al., 1994). Subtraction of absorption coefficients from attenuation coefficients determined volume scattering coefficient, $b(\lambda)$. The excitation channel and maximum emission of light detector of the microFlu-chl chlorophyll *a* fluorometer were set at 470 and at 686 nm, respectively. Recorded chlorophyll *a* fluorescence intensity signals, I_{FChla}, were reported as analog voltage output in the range 0–5 V DC. The instrument setup is described in detail in Granskog et al. (2015).

FDOM was measured using a three-channel WET Labs WETStar fluorometer equipped with two laser LEDs that excited the water sample inside the flow-through quartz cell at 280 and 310 nm, and two detectors to measure emission intensity at 350 and 450 nm. Such construction allowed for combinations of three channels with distinct excitation–emission features in specific peak areas as given in Coble (1996): Channel 1 (CH1), ex. = 310 nm and em. = 450 nm, represents marine ultraviolet humic-like peak C and marine humic-like peak M; Channel 2 (CH2), ex. = 280 nm and em. = 450 nm, represents UVC terrestrial humic-like peak A; and Channel 3 (CH3), ex. = 280 nm and em. = 350 nm,

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represents the protein-like tryptophane peak *T*. I_{CHn} is the fluorescence intensity at a particular channel, where *n* denotes the channel number from 1 to 3.

The radiometric measurements were synchronized with the water sample collection. All radiometric acquisition and data processing routines were performed in compliance with NASA2003 protocol recommendations (Muller et al., 2003). The Apparent Optical Properties (AOP) were measured using a set of radiometers called C-OPS (the Compact Optical Profiling System). It consisted of 2 in-water radiometers that measured downward irradiance and upwelling radiance in the water column. The instrument was equipped with 19 spectral channels (340, 380, 395, 412, 443, 465, 490, 510, 520, 532, 555, 565, 589, 625, 665, 683, 710, 765 nm and PAR channel). They were deployed on a free-fall frame, up to 200m max depth depends on light conditions in the water column, away from the ship shadow. The underwater measurements were accompanied by the above-water measurements of spectral downwelling irradiance, Es(λ), with a sensor mounted on the ship deck. Measurements of diffuse and direct solar irradiance have been recorded. These profiles have been used to calculate level of PAR and spectral characteristic od of the light field in the depth profiles. Also Rrs at stations has been calculated from these measurements. Additionally two hyperspectral TriOS RAMSES radiometers were used, operating in the 320–950 nm spectral range and collecting information in 194 wavebands, each 3.3 nm wide. A RAMSES MRC-VIS radiometer, mounted on a frame floating at distance of 15–20 m from the ship, was used to measure the upwelling radiance Lu(λ) just below the sea surface. A RAMSESACC-VIS sensor, mounted on the top of the A-frame winch in the ship's stern, well away from the super structure, simultaneously recorded the incident solar irradiance Es(λ). From these values the remote-sensing reflectance Rrs (λ) can be calculated (Konik et al. 2020).

Processing methodology

All instrumental data from optical instruments has been processed on board using custom written software in Matlab. The software converted raw count transmitted from sensors deployed in sea water to deck receivers, into calibrated geophysical values of optical and bio-optical parameters. The second stage post processing was noise reduction and binning of profiles and transect data, and adding geo-referencing meta data. The noise corrected, geo- referenced and tabulated data were from Integrated Hydrological-Optical Probe were distributed to student on the workshop for exercises in data banking and visualisation with use of the Ocean Data View software. During data workshop we have been creating two data bases for different types of instrument deployment (see figure 25). The separate transect and profiles data base were created. Student has been taught to create data bases with geo-reference meta data, parameters visualisation, calculating of derivative variables using macros and basic analysis of the data using property vs. property plots. The preliminary data analysis was aimed to taught student identification of main driving factors influencing variability of optical coefficients in horizontal and vertical scales.

Preliminary results

Study area:

The scientific investigations during Eurofleets Floating University course has been carried out in the edge of the Gulf of Gdansk, south-western part of the Baltic Proper, Arkona Basin, Oresund, southern Kattegat Great Belt and Meklemburg Bight and southern part of Bornholm Basin. Majority of sampling station were placed in the Danish Straits: Oresund, southern Kattegat Great Belt; last three stations were located in the southern edge of Bornholm Basin in the Polish EEZ.

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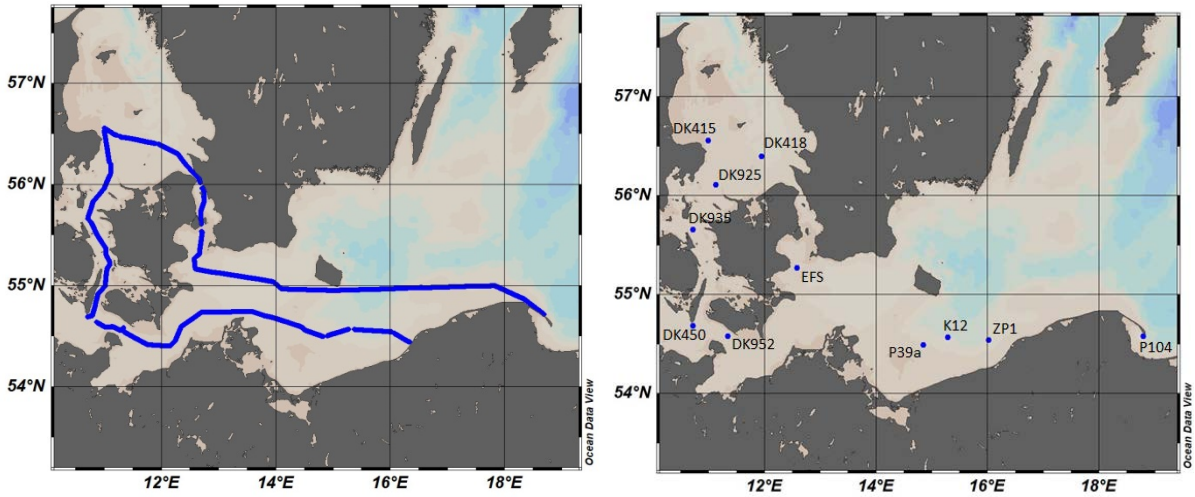

Figure 26. Maps presenting ship track and locations of the sampling stations visited during cruise Eurfleets Floating University

The scientific goal of the cruise was to characterize optical properties of the dissolved organic matter fluorescence in the mixing zone of the Baltic Sea water outflowing in the surface to the North Sea and inflowing North Sea water below halocline. The Danish Straits are the main gateways of the water exchange between those two marine basins and the most intensive mixing occurs usually in the Kattegat. Distribution of salinity and temperature measured in the surface waters is presented on Figure 27. Salinity I the surface waters of the western Baltic Sea in the Bornholm and Arkona Basins, Meklemburg Bight and Oresund was stable and varied between 7.5 – 8. The steady increase of salinity was observed in the Kattegat with maximum over 18 at the eastern coast of Jutland Peninsula. The surface temperature between 12-14 Deg. C was typical for beginning of summer. Two areas of increased temperature observed in the Kattegat and southern part of Bornholm Basin could result from local heating due to increased turbidity of surface water caused by phytoplankton blooms. There was also sharp drop of sea surface temperature below 10 deg. C in the Mecklenburg Bight, which could indicate coastal upwelling due to Eckman transport.

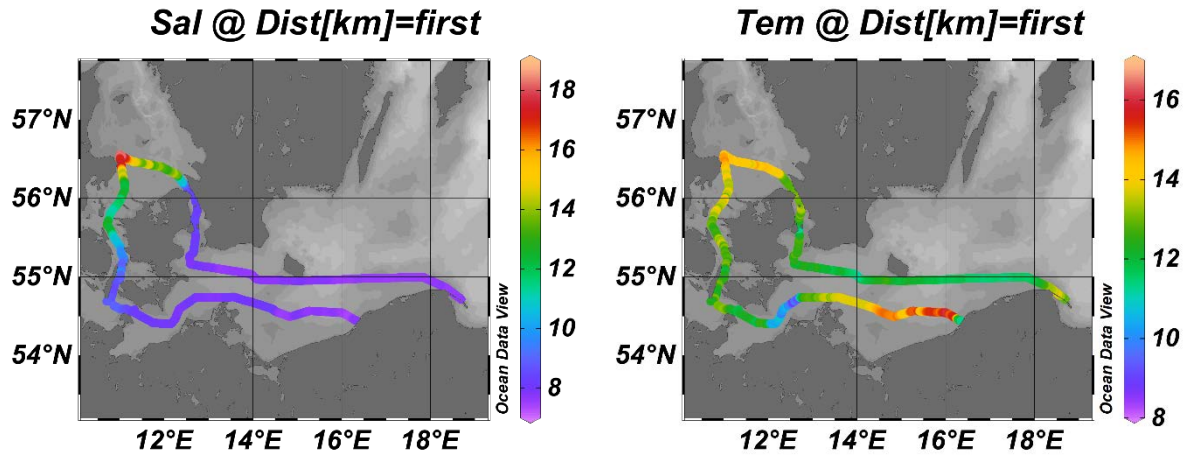

Figure 27. Maps presenting distribution of salinity and temperature along ship track during cruise Eurfleets Floating University

On the figure 28 we have presented horizontal distribution in the surface waters measured along the ship track of the optical parameters representing optical proxies for various biogeochemical variables.

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The fluorescence intensity of the humic-like fraction of dissolved organic matter, FDOM-Chn1, could be regarded a proxy for concentration of the dissolved organic carbon (Kowalczuk et al., 2010). The fluorescence intensity of the protein-like fraction of dissolved organic matter , FDOM-Chn3, and the phytoplankton pigments absorption line height at the 676 nm, alh(676) are associated with phytoplankton growth and usually well correlated with chlorophyll a concentration (Makarewicz et al., 2018, Kowalczuk et al., 2019). The light beam attenuation coefficient at 555 nm, cgp(555) is correlated with concentration of suspended matter in marine waters (Sagan 2008). Although all presented optical parameters showed similar trend in the spatial scale showing decreasing values from the Gulf of Gdansk toward Kattegat, there some difference that were specific to processed driving their variability.

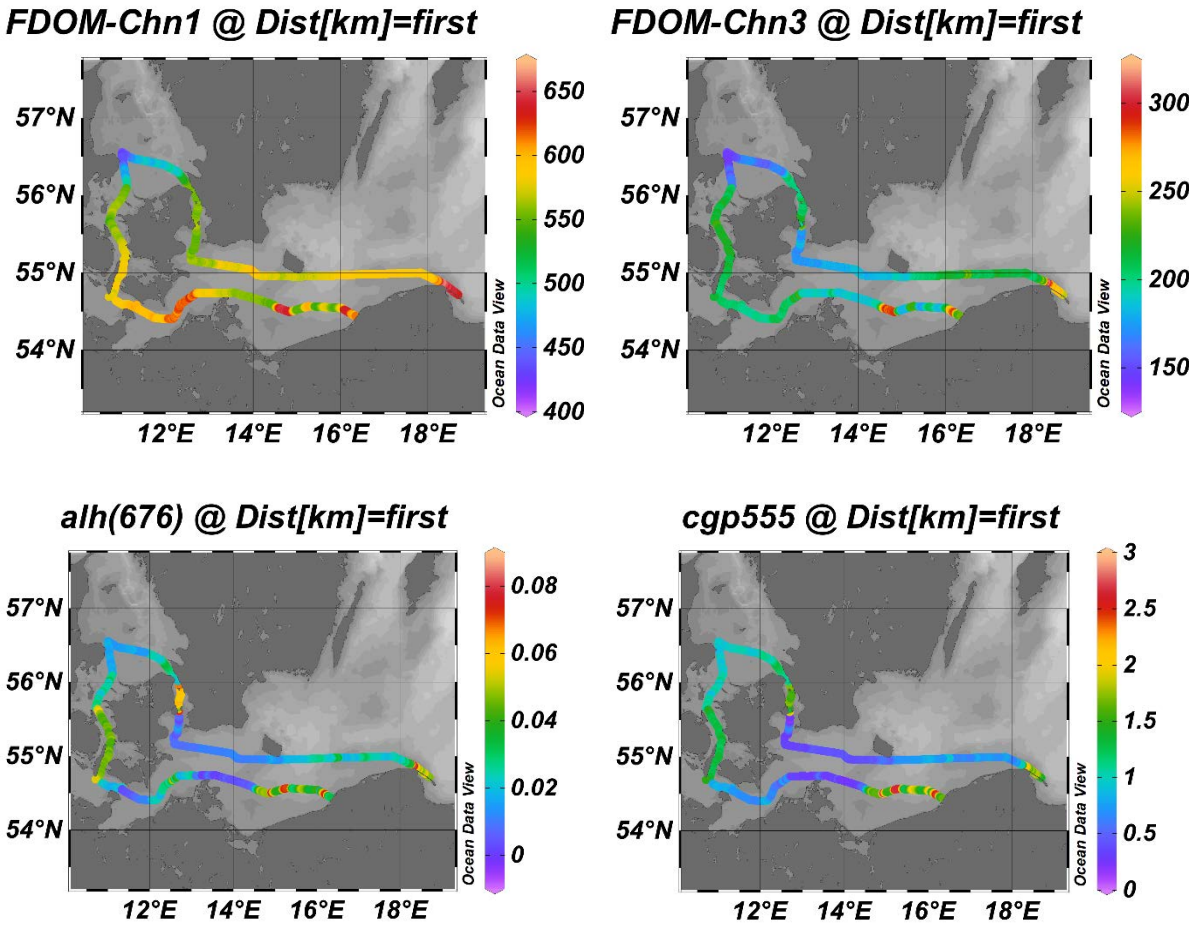

Figure 28. Maps presenting distribution fluorescence intensity of the humic-like, FDOM-Chn1, and the protein-like, FDOM-Chn3, fractions of dissolved organic matter, phytoplankton pigments absorption line height at the 676 nm, alh(676), light beam attenuation coefficient at 555 nm, cgp(555), along ship track during cruise Eurfleets Floating University

The spatial distribution of the humic-like fraction of dissolved organic matter, FDOM-Chn1, was controlled mostly by the salinity distribution, see Figure 29. However, there were two exceptional cases – in the Mecklenburg Bight elevated values of FDOM-Chn1, over 625 r.c could be associated with the local upwelling, and some patches of FDOM-Chn1 over 650 r.c could be associated with DOM production by phytoplankton blooms. Kowalczuk et al., 2006 has presented examples that in water with salinity over 7.6 in spring and summer CDOM absorption was correlated with chlorophyll *a* concentration. Also bottom sediments could be significant source of CDOM and FDOM, (Kowalczuk et al., 2015). The upwelled bottom water, enriched with CDOM and FDOM cause their elevated values of

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in the surface of the Mecklenburg Bight. The protein-like fraction of dissolved organic matter , FDOM-Chn3, co-varied spatially with the phytoplankton pigments absorption line height at the 676 nm, alh(676) and the light beam attenuation coefficient at 555 nm, cgp(555), Figure 28, indicating the phytoplankton dynamic is the key factor driving their variability in the Baltic Sea and Danish Straits.

To further explore impact of different process on the that regulated the spatial distribution of optical parameters values we have showed property vs. property plots. First two plots on figure 29 presented dependency of the FDOM-Chn1 and FDOM-Chn3 from salinity. The distribution of the humic-like DOM fraction represented by FDOM-Chn1 is almost entirely controlled by mixing of the fresher Baltic Sea coastal water with more saline Baltic Proper waters in the salinity range <6-7.8. The second process in miming of the Baltic Proper water with Kattegat waters in the salinity range 7.8 – 18.2. We could see two branches of the mixing line- one measured in the Great Belt – upper branch and one measured in Oresund – lower branch.

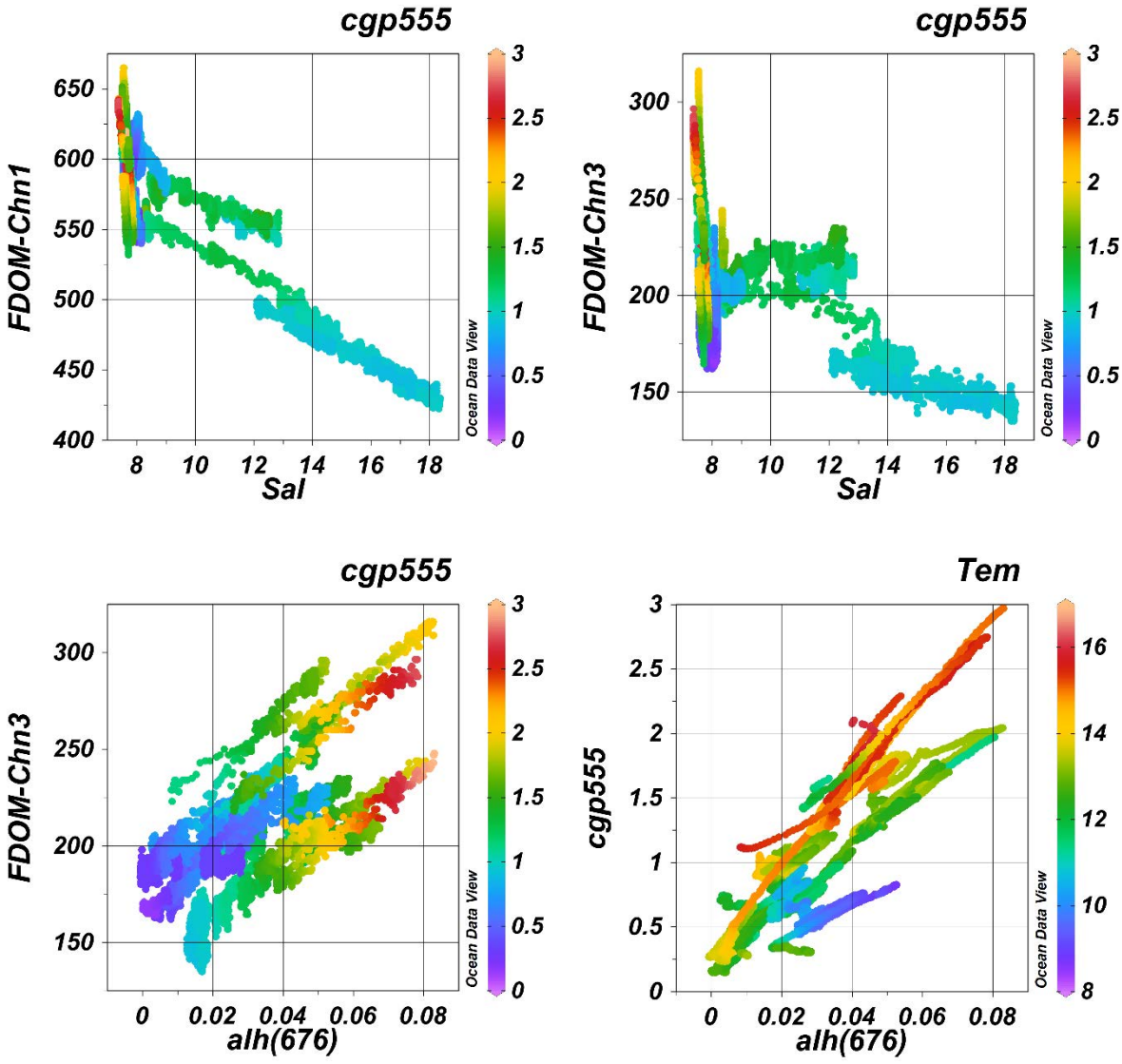

Figure 29. Property vs. property plots showing dependency between optical and physical parameters of the sea water during cruise Eurfleets Floating University

The distribution of the protein-like DOM fraction represented by FDOM-Chn3 is less dependent from mixing of different water masses. In the Baltic Sea the FDOM-Chn3 values changed in broad range from

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160-300 r.c., in the narrow salinity range 6.7.8. In the salinity range 8.5 – 12.5 the FDOM-Chn3 values were almost constant and in indicated linear decrease with increasing salinity in the Kattegat (12.5-18.5). This distinctly different distribution of the FDOM-Chn3 values with salinity could be explained by the local production of the protein-like DOM fraction by phytoplankton, which is visualized by the linear trends of increase of the FDOM-Chn3 values, with increasing phytoplankton pigments absorption line height at the 676 nm, which is a proxy of the chlorophyll a concentration and phytoplankton biomass. The phytoplankton growth was also controlling the amount of particulate matter in the Baltic Sea and Kattegat, which is showed on the plot of the light beam attenuation coefficient at 555 nm, cgp(555) in the function of the phytoplankton pigments absorption line height at the 676 nm. The depends of this trend from surface temperature indicated impact of phytoplankton physiology (controlled by temperature) and represent by multiple regression lines ordered by decreasing temperature.

We will explore collected data set further after processing of water samples that would enable better calibration of instrumental data. Instrumental data also need post-processing - trends removal due to biofouling, better spectral correction and blanking. After post-processing data should reach the publication quality.

Evaluation of student learning

The following types of assessment has been be used for the Eurofleets+ Floating University course:

- pre- and post-course evaluation test (40%)
- preliminary results from group project (30%)
- cruise report compilation and student presentation (30%)

We used a 15-question test (2 test questions, 2 questions to complete and 11 open questions) that covered the basics of the Marine Optics field as well as some more detailed issues that were to be deepened during the course. For the first time, the students completed the test at the start of the course just before all lectures and the cruise, to check their level and backgrounds in order to adjust the level and structure of the lectures and practical classes accordingly to students. The test has been designed to cover various aspects of the basics of optics as well as the basics of the area and measurement methods. The test results are shown in Figure 30 and the average score at the start of the course was 46% (the average across all questions). At the end of the cruise, students again completed the same test. The results show that the students improved their scores on 13 out of 15 questions and on 2 they answered at the same level as at the beginning. Average score for all test questions increased by 20% from 46% to 66%. The reported results shows that the lectures and practical classes on the ship had a significant impact on the understanding of the fundamentals and level of general knowledge in the field of marine optics of the students.

All students participated with great commitment in the processing of data from measuring instruments, the application of appropriate correction procedures in specialized software and importing data to programs for the purpose of their visualization and obtaining preliminary results. The group project of students consisting in the development of preliminary results of measurements performed on the ship was very successful. After analyzing the data, the students prepared a report on the cruise in the form of a presentation, during which each of them spoke with great commitment about the methodology, type of measurements and the results obtained during the cruise. The students formed a very well-coordinated team that was based on cooperation, taking care of the details and scientific content of the presentation. All students were highly rated in these aspects of the assessment.

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Throughout the cruise, the students asked a lot of questions and were not afraid to ask about the same things several times until they were sure they understood the aspect well. To sum up, the group of students was very well-coordinated and committed to work on the cruise and gaining new knowledge. They were eager to act and new activities as well as cooperative and curious.

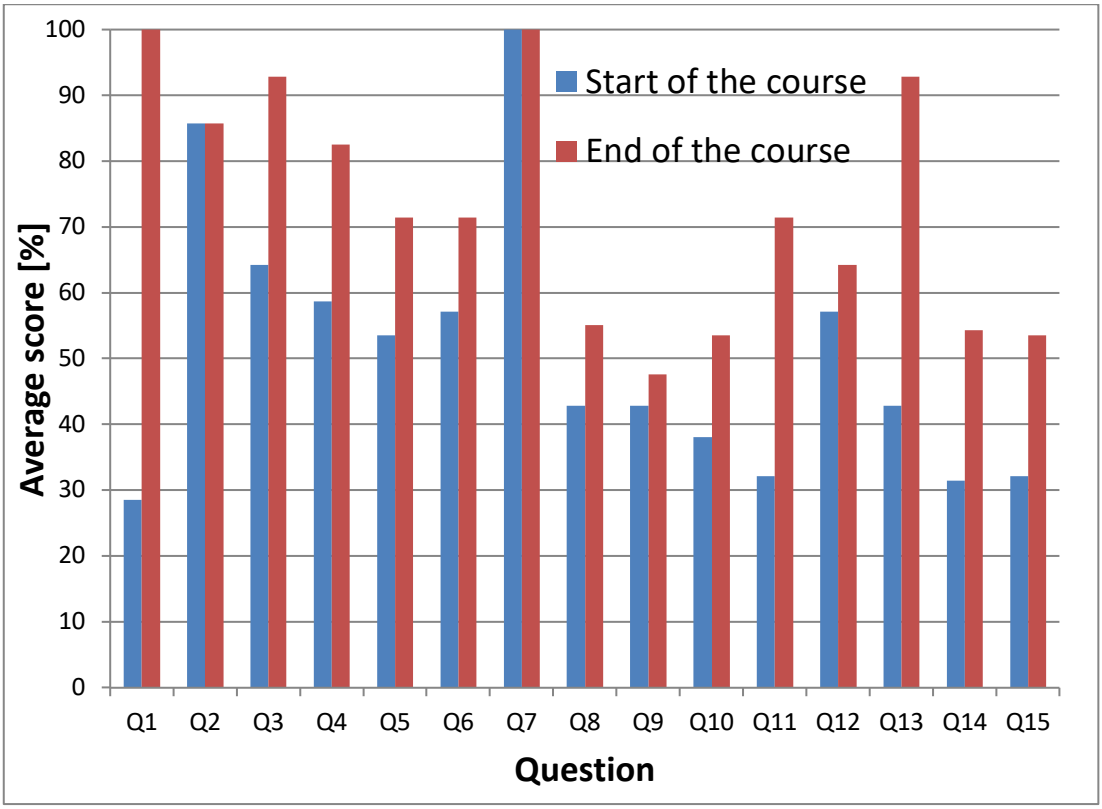

Figure 25. The averaged results of 15 questions of the quiz given to the students at the start and the end of the course.

Students course evaluation

After the cruise the students were asked to fill out evaluation course form. The results of evaluation are presented in the table 1 and answers to open questions are provided under each question. A score is given to each question ranging from 1 to 5 where 5 representing a very positive evaluation (e.g. “very satisfied” or “extremely beneficial”), 3 a neutral evaluation and 1 a negative evaluation. The scores for each category represent weighted averages where 5 is the maximum. All 7 students (2 males, 5 females) who were in age group of 25-34 with different academic profiles (4 MSc, 2 PhD, 1 postdoc) filled the questionnaire. Students learned about the course from various sources: Newsletter European Marine Board, Personal Contacts (4x), Eurofleets+ webpage/social (2x).

The evaluation results are very satisfactory - all evaluation scores are above 4.4 (>88%). The students were very satisfied with the lectures, presentation and practical scientific activities taking place on board the R/V Oceania as well as the knowledge they acquired during the course. The results show that all students find the course very valuable for their careers and very beneficial for network with International students and when asked if they believe the Floating University experience on board the RV Oceania will benefit their studies and future career all definitely agreed. Conversations with students show that without the financial support from the Eurofleets+ project, most of them would not be able to come and attend such a course.

In summary, the entire course can be considered as a success. Students gained the necessary skills and experience in the field of marine sciences, and expanded their international contacts not only with

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other students but also with academic staff, which may facilitate them with their future scientific career.

Table 1. Summary of results from the student evaluation of the course.

Question		Score: (max 5)
Please indicate how satisfied you were with the classroom lectures	Piotr Kowalczuk - Use bio-optical parameters as convenient tool to study marine biogeochemical processes- course objectives, 1h	4.6
	Piotr Kowalczuk – Presentation of modern optical instruments for in situ measurements of inherent and apparent optical properties, 2h	4.6
	Piotr Kowalczuk - Introduction to Baltic Sea hydrography, 1h	4.7
	Piotr Kowalczuk - Inherent and apparent optical properties of Baltic Sea waters and their link to biogeochemistry, 1h	4.7
	Mirosław Darecki - Light in the sea (part 1 and part 2), 2h	4.4
	Joann Stoń-Egiert - Light in the sea – biophysics, 1h	4.4
	Joann Stoń-Egiert - Methodology of measurements biogeochemical parameters of suspended particles and dissolved material in seawater, 1h	4.6
	Violetta Drozdowska – Sea Surface Microlayer, 1h	4.4
	Violetta Drozdowska – Research Cruises – my work, 1h	4.4
Please indicate how satisfied you were with on-board elements of the RV Oceania Cruise	Spectrophotometric laboratory – measuring chlorophyll a concentration with spectrophotometric method by Lorenzen, 1967 – 6 hours	4.9
	Spectrophotometric laboratory – measuring absorption coefficient by chromophoric dissolved organic matter – 2 hours	4.9
	List of the practical activities performed on-board (sampling, data acquisition, data processing, total 80h):	
	Collecting water from a different depth with use of a Niskin bottle	4.9
	Collecting water samples for dissolved and particulate absorption and concentration of chlorophyll a	4.9
	Performing the wet laboratory routines for samples processing and preservation for land based spectroscopic laboratory measurements of concentrations of optically significant sea water constituents (chlorophyll-a, CDOM/FDOM, particulate absorption, phytoplankton pigments determination through HPLC)	4.9
	Performing the measurement of primary production by incubation with C14 method	4.9
	Performing measurements inherent optical properties of sea water using set of state of the art instruments integrated into optical-hydrological probe	4.9
	Conducting measurement of apparent optic properties using profiling radiometer and floating radiometer	4.9
	Group project - Processing acquired instrumental data performing spectral and noise corrections. Processing acquired instrumental data to derive spectral remote sensing reflectance and downwelling	4.9

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	irradiance diffuse attenuation coefficient. Importing processed data into the ODV program to visualize the results. 8h Group project - Student Cruise Report with preliminary results. 8h	4.9
Overall how satisfied were you with the delivery of the Eurofleets+ RV Oceania Floating University?	Satisfaction	4.9
How beneficial do you feel it is to network with other European and International students?		5.0 Very beneficial
Do you believe the Floating University experience on board the RV Oceania Will benefit your studies and future career?		5.0 Definitely

Answers to open questions

Please outline your area of special interest or research in Marine Science: marine engineering and artificial reef technology, optical oceanography, marine acoustic, physical oceanography, marine biogeochemistry, marine geology, marine ecology.

Please feel you free to comment on the highlights and/or lowlights of the Floating University course:

- "Joint experience -> social network, openness to answer questions, good mix of practical exercise and theory, a lectures could been a bit more detailed and based upon each other-> more to explain, too quickly went over details".
- "Fantastic experience".
- "Everything was fantastic: the crew, teachers, subject, organization, friendliness, thank you! "
- "Very competent teachers, well organized activities, kind and familiar environment. Good choice of participants".
- "Everyone was very happy of answer questions and explain subjects more than once".
- "The only lowlight I can think of is the language barrier since we all speak English with different accents, but eventually got used to it. On highlights I would say everything else: the warm people, the good environment, the overall knowledge we gained from them and generally the whole experience was incredible".

Please outline any recommendations you may have for future Eurofleets+ Floating University programme:

- "Alumni events, join newsletters/further opportunities at IOPAN"
- "Keep the good work"
- "Please continue with such initiatives"
- "Start very slow with concepts and maybe related more to the procedures while we're doing them. Making link between theory and practice more obvious".
- "I only wish for more Eurofleets+ programme like this one because it is worth for all people in Marine Science to attend to these programmes".

Do you think it would be worthing the establishment of a permanent EU Floating University programme?

- "Definitely (2x)"
- "Yes (4x)"
- "Without a doubt this is one of the greatest experience of my life so it is definitely worth the establishment of a permanent EU Floating University programme".

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Concluding remarks

All in all, the floating university on board the r/v Oceania was a success and made a great impression on the students, from the organization to the theoretical and practical classes in particular. Overall the floating university provided an overview of basics of ocean optics field, the optical measurements possible on the research vessel, the analysis of the collected measurement data and their interpretation after appropriate visualization. Such a comprehensive practical experience will help them direct their interests in the future, broadens the horizons and knowledge about practical scientific research and develops a network of contacts necessary in science. Concluding from the scientific team, all were impressed by the selected group of students, their involvement in the entire course and their actions individually and as a well-coordinated group. Instructors highly recommend repeating this course in the future.

The course structure was well balanced and organized. Only more time could be devoted to combining research methodology and theory due to the different student background.

We thank the captain and crew of R/V *Oceania* and colleagues for their enthusiasm and assistance and the help on board. This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077.

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Appendix

Appendix 1: Presentation prepared by students

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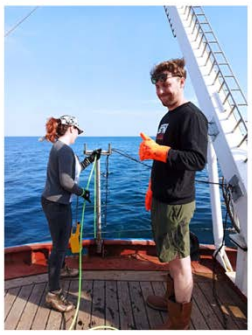
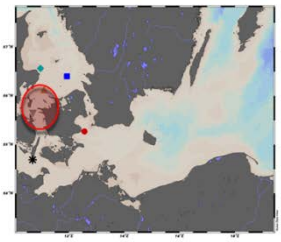
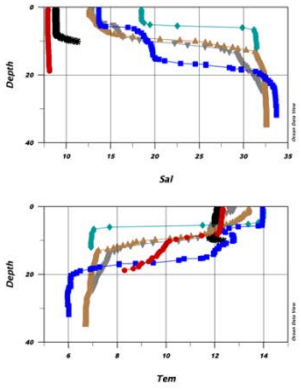
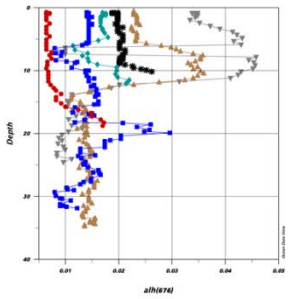



Radiometry




Hydrology, mixing zones & biomass in Danish Straits



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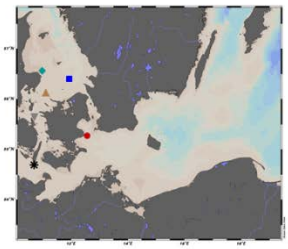
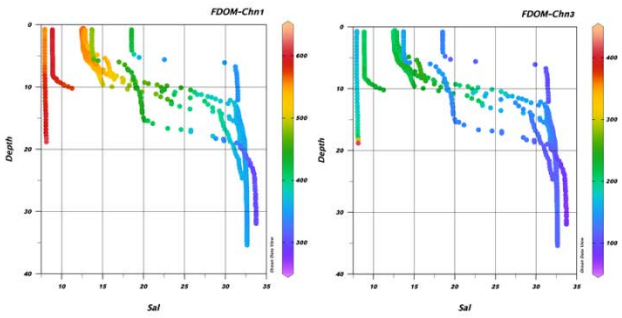
Influence of terrestrial and marine sourced particles around Danish Straits

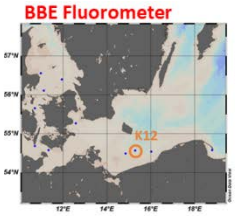
FDOM Chn1. -> terrestrial sourced

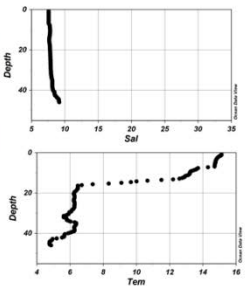
FDOM Chn3. -> marine sourced

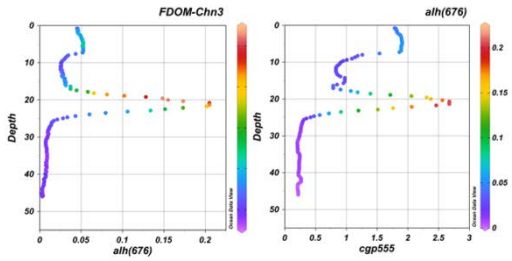




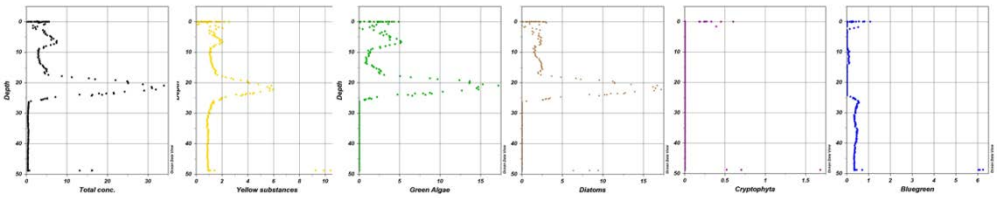
BBE Fluorometer







370 nm 470 nm 525 nm 570 nm 610 nm



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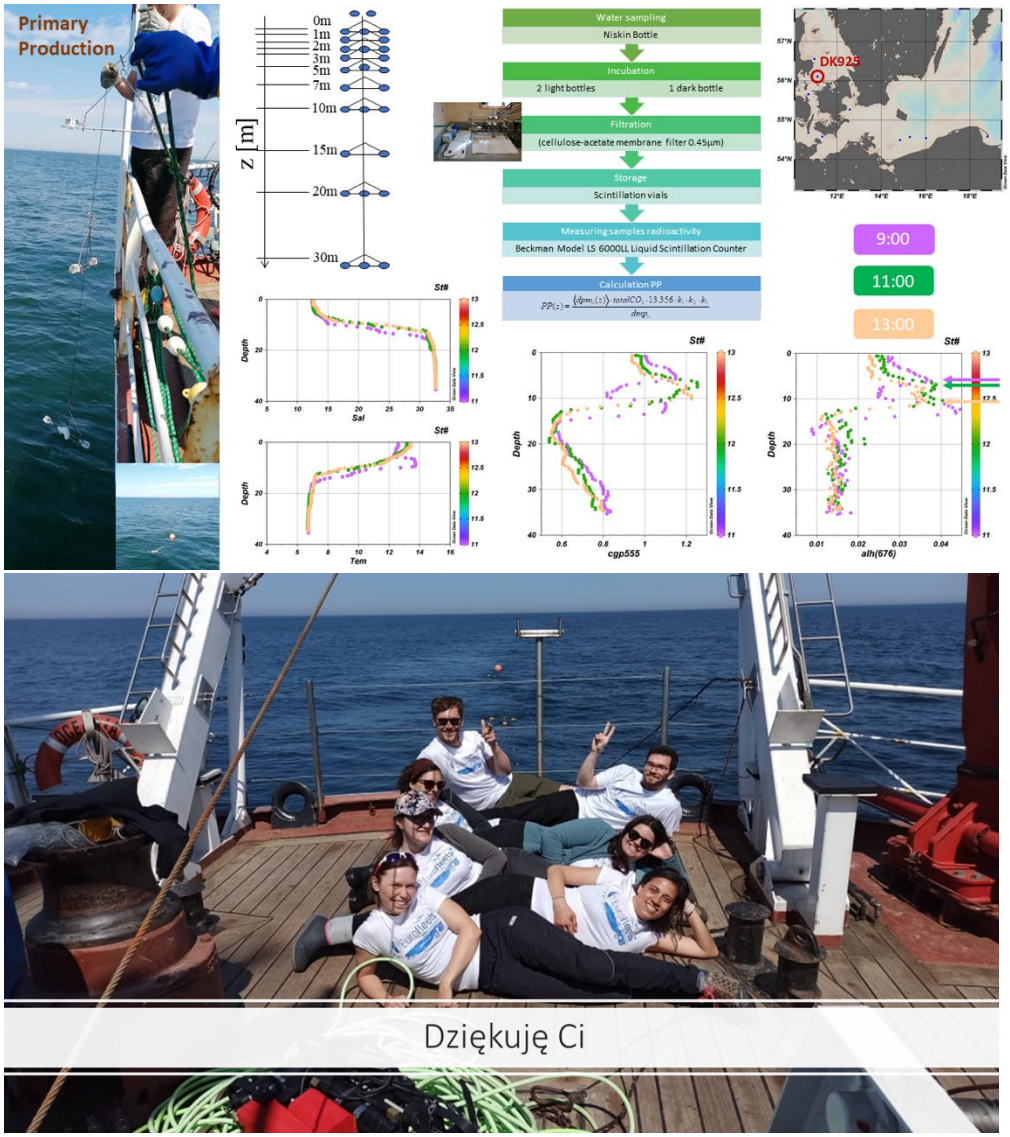

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Appendix 2: Certificate of Participation:

Eurofleets+

EUROFLEETS+
CERTIFIES THAT

NAME AND SURNAME

HAS SUCCESSFULLY COMPLETED THE

EUROFLEETS+ Floating University
" Use bio-optical parameters as a convenient tool to study marine biogeochemical processes "
On board the R/V OCEANIA (31 May - 8 June 2021)

AND IS THEREFORE AWARDED THIS

CERTIFICATE

GIVEN ON THE 8TH DAY OF JUNE, 2021

prof. dr hab. Piotr Kowalczuk
EUROFLEETS+ RV OCEANIA
Floating University Coordinator

prof. dr hab. Jan Marcin Węsławski
Director of the Institute of Oceanology
of the Polish Academy of Sciences in Sopot, Poland

Appendix 3: List of station locations and activities on board r/v Oceania.

Statnion name	Depth	START Date	START Time [UTC]	START Latitude	START Longitude	STOP Date	STOP Time	Measurements	Comments
P104	55	2021.06.01	12:30	54 34.993	018 47.543	2021.06.01	15:15		anchored
								Secchi: 4.5 m	
			13:11					CTD_DO	
			14:00				18:28	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			13:27					fluorimeter BBE_new	
			13:44					TRIOS -float and bow kit	
			13:49					C-Props	3 profile
			14:05					TRIOS -large profiling set	
			13:59					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	

Eurofleets+

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			13:30					FOTO	
			15:37			2021.06.02	13:05	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from P104 to Sund. During the night the computer controlling LISST crashed. Measurements with LISST switched on again on 2021-06-02 at 06:27 UTC
EFS001		**2021.06.02**	**6:45**	**54 57.687**	**014 17.450**	**2021.06.02**			**under way**
								ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from P104 to Sund
		2021.06.02	**6:35**					TRIOS - bow kit	Above water continues measurements along ship track of the remote sensing reflectance with TRIOS radiometers on the transect from P104 to Sund
		2021.06.02	**6:35**					fluorimeter BBE_new	Continues measurements along ship track on the transect from P104 to Sund
		2021.06.02	**6:45**					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, apl	Water collected from the integration tank during continues measurements along the ship track
EFS002		**2021.06.02**	**8:35**	**55 03.194**	**013 47.150**				**under way**
			8:35					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, apl	Water collected from the integration tank during continues measurements along the ship track
EFS003		**2021.06.02**	**10:45**	**55 06.451**	**013 07.596**				**under way**
			10:45					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, apl	Water collected from the integration tank during continues measurements along the ship track
ESF_DK441	**22**	**2021.06.02**	**13:23**	**55 16.325**	**012 34.526**	**2021.06.02**	**14:10**		**anchored**
								Secchi: 16 m	
			13:24					CTD_DO	
			13:42					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			10:17					fluorimeter BBE_new	
			13:23					TRIOS - float and bow kit	
			13:30					C-Props	3 profile
			13:54					TRIOS -large profiling set	
			13:42					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			13:30					FOTO	
			15:04				16:11	TRIOS - bow kit	Continues measurements along ship track on the transect fromEFS_DK441 to EFS_DK1712.
			14:36				16:15	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect fromEFS_DK441 to EFS_DK1712.
								fluorimeter BBE_new	Continues measurements along ship track on the transect fromEFS_DK441 to EFS_DK1712.
EFS_DK1712	**9**	**2021.06.02**	**16:50**	**55 31.021**	**012 38.964**	**2021.06.02**	**18:00**		**anchored**
								Secchi: 7 m	
			17:00					CTD_DO	
								ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Pump switch broken - system malfunction measurement aborted
			13:55					fluorimeter BBE_new	
			17:10					TRIOS - float and bow kit	
			17:14					C-Props	3 profile
								TRIOS -large profiling set	not done
								Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			17:20					FOTO	
			18:20				20:40	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK1712 to EFS_DK418
		2021.06.02	21:00			**2021.06.03**	0:32	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK1712 to EFS_DK418
EFS_DK418	**32**	**2021.06.03**	**6:30**	**56 23.970**	**011 56.706**	**2021.06.03**	**9:10**		**anchored**
								Secchi: 7.5 m	
			6:32					CTD_DO	
			06;55					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Pump switch broken - system malfunction measurement aborted
			6:50					fluorimeter BBE_new	
			7:19					TRIOS - float and bow kit	

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			7:03					C-Props	3 profile
								TRIOS -large profiling set	not done
			7:00					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			7:11					FOTO	
			9:23				12:45	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK418 to EFS_DK415
			9:20				12:45		Continues measurements along ship track on the transect from to EFS_DK418 to EFS_DK415
EFS_DK415	**12**	**2021.06.03**	**12:55**	**56 33.557**	**010 59.411**	**2021.06.03**	**13:30**		**anchored**
								Secchi: 7.5 m	
			12:59					CTD_DO	
			13:14					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			13:10					fluorimeter BBE_new	
			13:01					TRIOS - float	
			13:04					C-Props	
			13:04					TRIOS -large profiling set	not done
			13:12					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
								FOTO	
			13:53				17:00	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK415 to EFS_DK925
EFS_DK925	**36**	**2021.06.04**	**6:30**	**56 06.744**	**011 07.176**	**2021.06.04**	**12:00**		**anchored**
								Secchi: 7 m	
			6:37					CTD_DO	
			6:53				**7:21**	woda 0, 1, 2, 3, 4, 5, 6, 7, 10, 15, 20, 30 na aCDOM ,EEM, i chl a, HPLC, fik, distribution(D), SPM, apl i PP	
			7:20					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
								fluorimeter BBE_new	
			6:51					TRIOS - float and bow kit	3 profile
			6:53					C-Props	
			6:53					TRIOS -large profiling set	not done
			7:14					FOTO	
			7:40					PP	**start**
			9:25					CTD_DO	
			9:29					TRIOS - float and bow kit	
			9:31					C-Props	
			9:36					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			11:20					CTD_DO	
			11:21					TRIOS - float and bow kit	
			11:24					C-Props	
			11:27					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			11:45					PP	**end**
			12:29				**15:57**	TRIOS - float and bow kit	Continues measurements along ship track on the transect from to EFS_DK925 to EFS_DK935
			12:29				15:57	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK925 to EFS_DK935
EFS_DK935	**26**	**2021.06.04**	**15:55**	**55 39.368**	**010 43.084**	**2021.06.04**	**16:50**		**anchored**
								Secchi: 7 m	
			16:02					CTD_DO	
			16:17					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			16:17					fluorimeter BBE_new	
			16:02					TRIOS - float	
			16:07					C-Props	
			16:17					TRIOS -large profiling set	not done
			16:10					Water Samples at 0, 10, 24 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			16:10					FOTO	

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			17:01				18:28	TRIOS - float and bow kit	Continues measurements along ship track on the transect from to EFS_DK935 to EFS_DK450
			17:01			21.06.04	23:57	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK935 to EFS_DK450
EFS_DK450	**11**	**2021.06.05**	**6:30**	**54 41.249**	**010 42.557**	**2021.06.05**	**7:20**		**anchored**
								Secchi: 7 m	
			6:39					CTD_DO	
			6:48					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			6:24					fluorimeter BBE_new	
			6:42					TRIOS - float	
			6:44					C-Props	
			6:44					TRIOS -large profiling set	not done
			6:50					Water Samples at 0, 10, 24 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			6:50					FOTO	
			7:55				10:06	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK450 to EFS_DK952
			8:41				10:00	TRIOS - float and bow kit	Continues measurements along ship track on the transect from to EFS_DK450 to EFS_DK952
EFS_DK952	**24**	**2021.06.05**	**10:15**	**54 34.862**	**011 20.150**	**2021.06.05**	**11:10**		**anchored**
								Secchi: 7 m	
			10:19					CTD_DO	
								ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
								fluorimeter BBE_new	
			10:22					TRIOS - float and set above the surface	
			10:28					C-Props	3 profile
			10:41					TRIOS -large profiling set	
								Water Samples at 0, 10, 24 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			10:30					FOTO	
			11:20			06.06.2021	1:05	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from to EFS_DK952 to P39a
			11:31				17:07	TRIOS - float and bow kit	Continues measurements along ship track on the transect from to EFS_DK952 to P39a
			13:05					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, apl	Water collected from the integration tank during continues measurements along the ship track
EFS005		**2021.06.05**	**15:05**	**54 26.648**	**012 13.255**				**under way**
			15:05					Water Samples at 0 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, apl	Water collected from the integration tank during continues measurements along the ship track
P39a	**22**	**2021.06.06**	**6:20**	**54 29.585**	**014 50.500**	**2021.06.06**	**7:20**		**anchored**
								Secchi: 4.5 m	
			6:26					CTD_DO	
			6:37					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
			6:30					fluorimeter BBE_new	
			6:36					TRIOS - float and set above the surface	
			6:44					C-Props	3 profile
			6:56					TRIOS -large profiling set	
			6:30					Water Samples at 0, 10, 20 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			6:40					FOTO	
			7:37				8:52	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from P39a to K12
K12	**48**	**2021.06.06**	**9:00**	**54 34.102**	**015 16.993**	**2021.06.06**	**9:40**		**anchored**
								Secchi: 4.5 m	
			9:04					CTD_DO	
			9:14					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
								fluorimeter BBE_new	
			9:17					TRIOS - float and set above the surface	
			9:13					C-Props	3 profile

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			9:13					TRIOS -large profiling set	not done
								Water Samples at 0, 30, 45 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			9:15					FOTO	
			9:54				11:55	ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from K12 to ZP1
ZP1		**2021.06.06**	**12:00**	**54 32.464**	**016 01.112**	**2021.06.06**	**12:50**		
								Secchi: 4 m	
			12:12					CTD_DO	
			12:24					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	
								fluorimeter BBE_new	
			12:18					TRIOS - float and set above the surface	
			12:21					C-Props	
								TRIOS -large profiling set	
								Water Samples at 0, 20, 40 m, na aCDOM ,EEM, i chl a, HPLC, fik, PSD, SPM, apl	
			12:20					FOTO	
			13:02					ac9,CTD, LISST, Wetlabs Seastar 3 channel, FCHLA, FCDOM -Trios	Continues measurements along ship track on the transect from ZP1 to Darlowo
The end									

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EUROFLEETS+ Floating University

"Meeting societal needs for impartial evidence on the state and sustainable use of the ocean biological resources: the case of the *Nephrops norvegicus* (Norway lobster)"

Onboard the R/V Mário Ruivo

Off Portugal coast (Southwest and South) 15th June – 3rd July 2021

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Eurofleets+ Floating University

Scientific Participants

Cristina Silva (Course leader)

Mafalda Carapuço (Course leader)

Tanya Silveira (Lecturer)

Maria Adelaide Ferreira (Lecturer)

Marina Mašanović (Student)

Jaime Rios Osorio (Student)

Teresa Ferreira (Student)

Celso de Souza Filho (Student)

Corina Chaves (Cruise leader/Lecturer/Instructor)

Inês Farias (Lecturer/Instructor)

Pedro Gomes (Lecturer/Instructor)

Catarina Maia (Lecturer/Instructor)

Adelaide Resende (Instructor)

Ana Luísa Ferreira (Instructor)

Paula Abreu (Instructor)

Jorge Barra (Instructor)

Sofia Aranha (Invited PhD Researcher)

Scientific Team & Eurofleets+ Students

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Course and cruise objectives

The general objective of the course was to provide theoretical background and practical experience on scientific understanding of marine ecosystems and the services they provide, and on the application of the outcome knowledge to generate state-of-the-art advice for meeting conservation, management, and sustainability goals using *Nephrops norvegicus* (the Norway lobster) as case-study.

The Crustaceans survey took place off the Southwest and South coasts of Portugal, onboard the R/V Mário which is operated by IPMA (Portuguese Institute for Sea and Atmosphere). This edition of the Eurofleets+ Floating University included two Master students and two Doctoral students, all from different nationalities – Brazil, Colombia, Croatia and Portugal (Figure 1).

The course included lectures on the first day, onboard R/V Mário Ruivo, before departure and during the three weeks at sea, during which IPMA's scientific team provided training and guidance on sampling protocols, species identification, and collection of biological data.

The participating students learned about:

- Species abundance estimation following a stratified design;
- Geographical distribution of the target-species and the main characteristics of the Portuguese crustacean fishery;
- Data collection procedures to estimate biological parameters (sex-ratio, length-weight, maturity, growth) meeting the Data Collection Framework sampling requirements;
- Data collection for biodiversity studies and information on marine litter distribution to comply with the EU Marine Strategy Framework Directive requirements.

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Figure 1. The four participants of the Floating University undertaking several tasks onboard the R/V Mário Ruivo. Upper left: Celso (Brazil), Upper right: Jaime (Colombia), Lower left: Teresa (Portugal) and Lower right: Marina (Croatia).

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Nature of the course and work carried out on the course

The course was designed to include a combination of lectures, practical sampling/measurements, onboard laboratory work and data interpretation.

The scientific team and students mustered onboard R/V Mário Ruivo on June 14th, 2021 and left the harbour on the next day.

The students were integrated in the sampling teams and were able to participate in all activities, including the regular activities designed according to DCF requirements, as well as supplemental activities in collaboration with a PhD program on survival of Elasmobranchs.

The lectures were spread throughout the three weeks of the survey so students could intersperse the theoretical and practical approaches of the lessons learnt. This approach enabled a better engagement of the students on the subjects and on the subsequent discussions, avoiding an overload of information at once. All lectures onboard were prepared and led by IPMA's Scientific staff.

Due to technical constraints, not all equipments were available for the survey and consequently for students to operate, including the box-corer for sediments sampling and CTD for temperature, salinity and conductivity measurements.

The course ended prematurely in Lisbon (Portugal), as a consequence of technical problems with the vessel, with the students disembarking three days before the end of the survey, without the opportunity for a final presentation/open discussion on the analyses of collected data.

After the campaign, the students were asked to fill-in an online questionnaire to evaluate the course.

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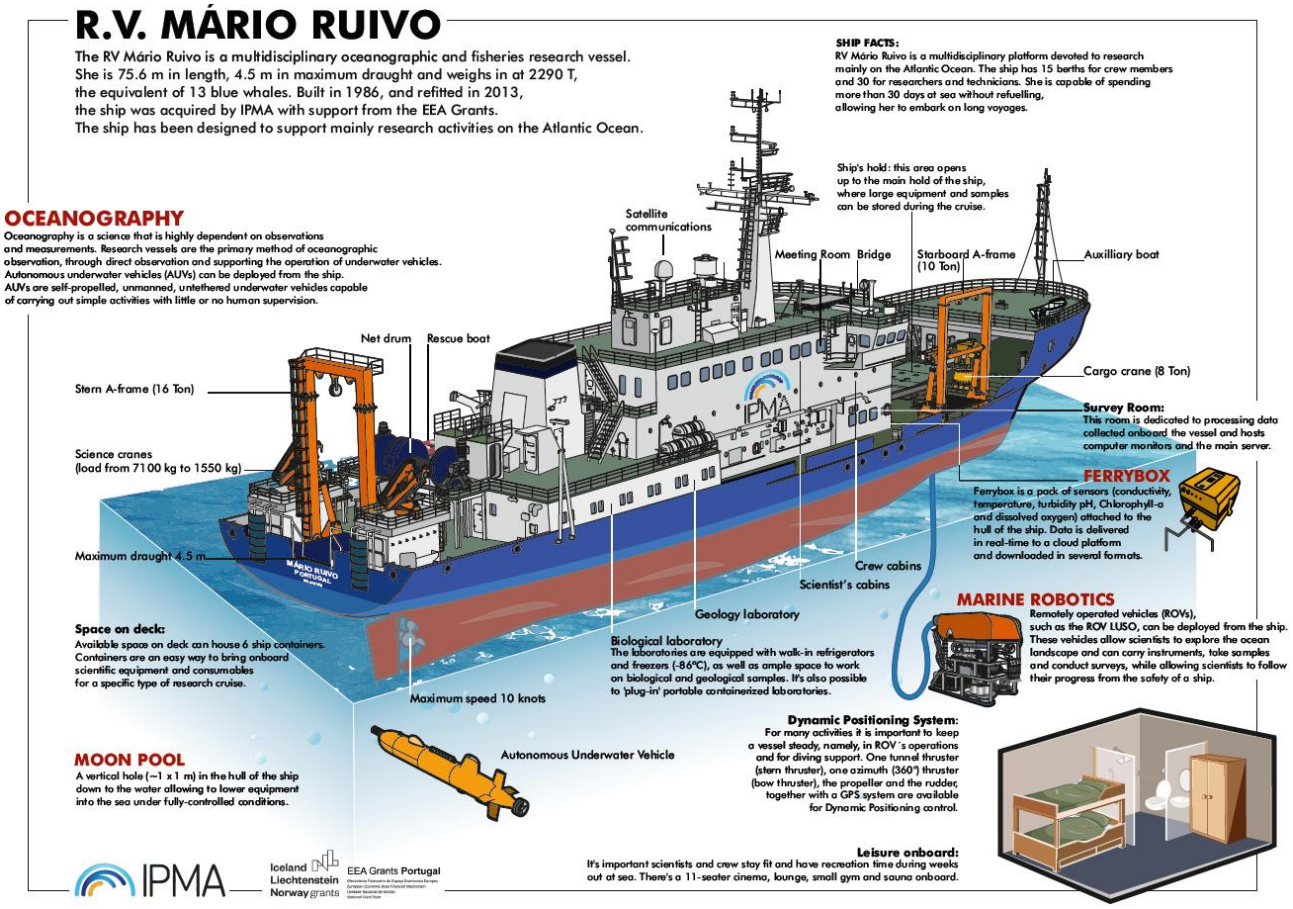
Course and cruise Log

Lectures were provided along the three-week survey, mixing theoretical and practical approaches as follows:

Day 1 -14/06/2021: Mustering - *Lisbon Naval Base*

1. Introductory lectures on Research Vessels. Mafalda Carapuço

The participants in the Floating University R/V Mário Ruivo were welcomed and introduced to the vessel officers. Some information on the vessel history, equipment and facilities was given. A guided tour was conducted at the end of the third lecture.



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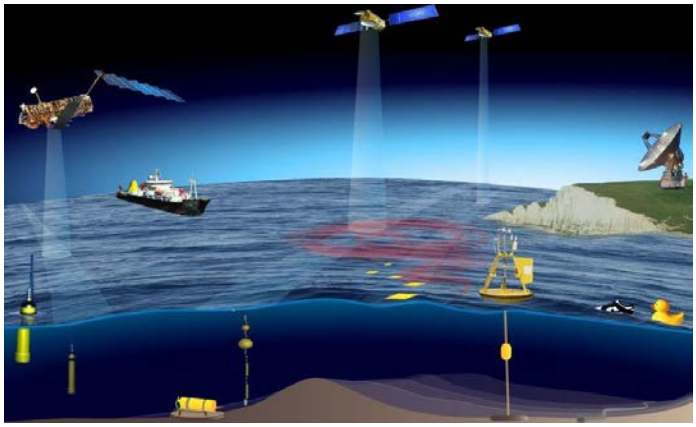
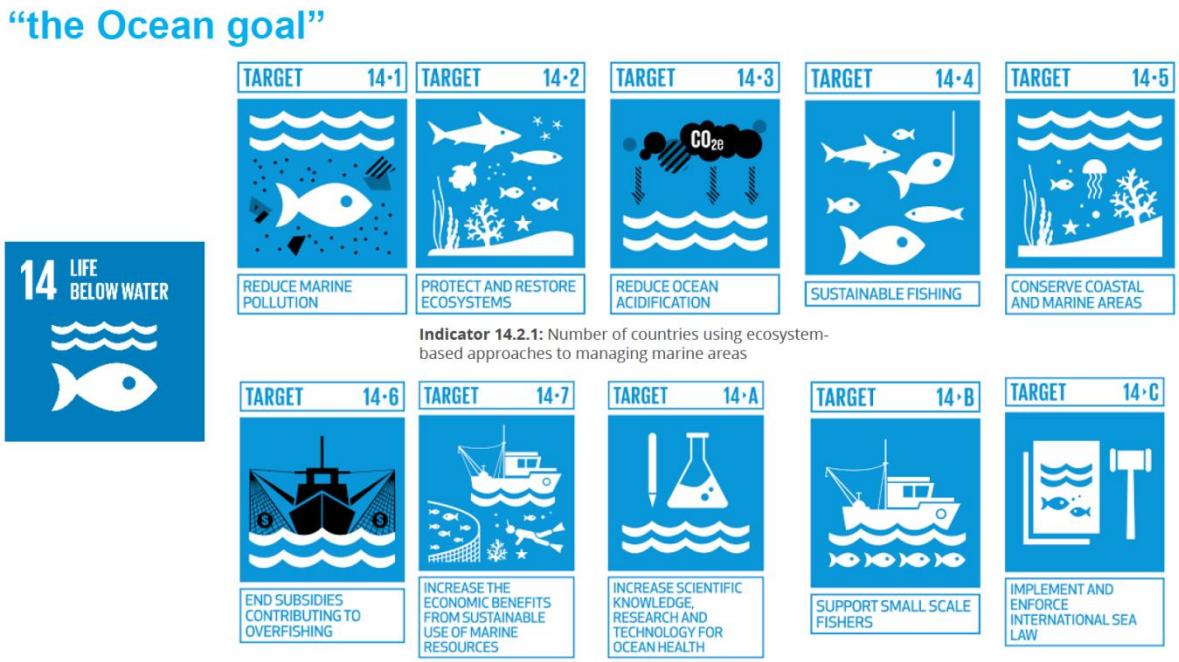
2. Ocean Observatories. Tanya Silveira



Introduction to Ocean observation: why and how. Identification of the main types of platforms used for observing the ocean and how they evolved through time: research vessels, submersibles, floats and buoys, submarine fixed stations, monitoring opportunities and remote sensing techniques. The paradigm shift, from local to global observation, and the concept of the Global Ocean and the challenge of data sharing. The Ocean observation value chain and the importance of data aggregators and data platforms. Examples of ocean monitoring networks in which IPMA collaborates: The EMSO-PT and the Atlantic Observatory – Data and Monitoring Infrastructure Projects. Visioning of the video logbook of the EMSO-PT Oceanographic Campaign Leg 1.

3. Ocean Ecosystem Services and Ocean Governance. Maria Adelaide Ferreira – Marine and Environmental Sciences Centre of the University of Lisbon (MARE-University of Lisbon)



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Introduction to our marine planet and to the concept of ecosystem services. The ocean as a key element of our life-support system. Blue growth and blue acceleration as drivers of ocean degradation. Examples of global impacts on ocean ecosystems: climate change and marine heatwaves; ocean acidification; ocean deoxygenation and dead zones. Need for urgent transformative change: United Nations 2030 Agenda and Sustainable Development Goals (SDGs), particularly SDG 14; Convention on Biological Diversity's post-2020 global biodiversity framework, particularly its sustainable fisheries and oceans transition. Ocean governance: United Nations Convention on the Law of the Sea (UNCLOS); Marine Spatial Planning (MSP); Portugal's national maritime space. A key role for ocean sciences over the next decade (UN Decade on Ocean Science for Sustainable Development 2021-2030).

Day 2 – 15/06/2021: Departure – *Lisbon Naval Base to Atlantic Portuguese Southwestern Coast*

Departure from Lisbon Naval Base, with route set to the survey area. During sailing a meeting was held for the presentation of the scientific team and students, survey tasks to be performed, planning for the following days and presentation of course outline and work assignment to the sampling teams.

Day 3 – 16/06/2021: Sampling –*Atlantic Portuguese Southwestern Coast*

Fishing day during which students were integrated in the work flow of a Scientific Fishing Survey with hands-on species identification and screening, morphological measurements and biological sampling.

Day 4 – 17/06/2021: Lectures – *R/V Mário Ruivo, stopover in Portimão harbour for fishing gear repair*

Full day dedicated to lectures.

4. Survey Overview – Corina Chaves and Cristina Silva. Lecture by Corina Chaves

The Portuguese *Nephrops* survey (FU 28-29) occurs annually along the Southwestern and south coast of Portugal to assess the relative abundance and distribution in space and time of *Nephrops*, as well as of other crustacean species, such as Deepwater Rose Shrimp and Red Shrimp. In recent years, the growing interest on Biodiversity and Marine Litter as descriptors of the European Marine Strategy Framework increased the importance of these two sampling objectives of the survey. On

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this lecture, an overview of the objectives, study area and sampling design were given as well as some expected results.

5. Taxonomy, species identification, biodiversity. Part I – Pisces – Pedro Gomes

Fishes are the oldest, most diverse and most abundant group of vertebrates, making up more than half of the 55,000 species of living vertebrates, showing a staggering diversity of phylogenetic groups with amazing adaptations to a wide range of environments. This lecture surveyed the diversity and classification of fishes occurring in the Portuguese coast, paying special attention to morphology aspects and key distinguishing features that enable the correct identification of different fish species.

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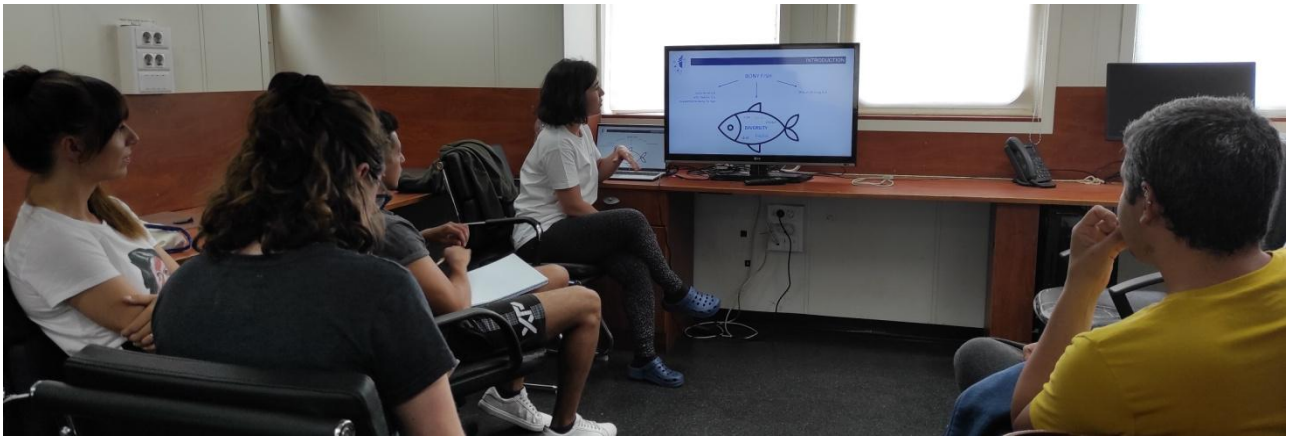
6. Biological Sampling – Teleosts – Inês Farias

Teleosts, commonly known as bony fish, are characterized by the presence of bony skeletons with flexible fins supported by bony fin rays, and represent 96% of all living fish. This group presents high diversity, not only morphologically but also in ecological traits, such as diet and habitat. The Portuguese Nephrops Survey (FU 28-29) covers the mesopelagic and bathydemersal habitat, between 200-750 m deep. This survey is very important for collecting biodiversity, geographical distribution, relative abundance, and morphological and biological parameters not only of teleost species with commercial interest but also of species for which fishery-dependent data are scarce. For the most important teleost species sampled on this survey, gonads and calcified structures such as otoliths (and illicia in *Lophius* spp.) are also collected for subsequent reproductive and growth studies, respectively. Each species sampling protocol and maturity stage scale was presented.



7. Taxonomy, species identification, biodiversity. Part II – Crustaceans – Pedro Gomes

Crustaceans are a diverse group of arthropods and include several species of lobsters, crayfish, crabs, prawns, shrimp, barnacles and pill bugs. This lecture surveyed the diversity and classification of crustacean species occurring in the Portuguese coast, in particular those targeted by the survey such as the Norway lobster *Nephrops norvegicus*, blue and red shrimp *Aristeus antennatus*, deepwater rose shrimp *Parapeneus longirostris*, scarlet shrimp *Aristaeopsis edwardsiana* and the giant red shrimp *Aristaeomorpha foliacea*. The main morphological aspects and key distinguishing features that enable the correct identification of different species were addressed during this lecture.

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Days 5 to 16 – 18-29/06/2021: sampling & lectures–*Atlantic Portuguese South Coast*

Days spent at sea, with practical sessions on species screening and identification, measurements and biological sampling. Students also participated in litter identification and classification.

During this period some of the days started with lectures.

8. ***Nephrops norvegicus*** – Cristina Silva. Lecture by Corina Chaves

An introduction to Norway lobster geographical distribution in Northeast Atlantic Ocean and Mediterranean Sea and assessment areas was presented. This presentation covers several topics and processes of the life history and population dynamics of *Nephrops norvegicus* as growth, reproductive cycle, feeding, predation and behaviour and activity patterns. The assessment of most of ICES *Nephrops* Functional Units is based on Under Water Video (UWTV) Surveys, where the Norway lobster absolute biomass or abundance is assessed and the harvest rate is estimated. This is not the case of most of Iberian stocks which assessment is performed with Surplus Production Methods or in length-based methods. In the case of the southern Portuguese Functional Units (FU 28 and 29), the survey is carried out by trawling and the abundance index series is used as an indicator. As overview of the crustacean fishery in these Functional Units was given, covering the location of fishing grounds, the target species and preferred depths and the national and EU current management measures.

9. **Biological Sampling – Crustaceans** – Inês Farias, Paula Abreu and Mónica Inácio. Lecture by Inês Farias

The Norway lobster *Nephrops norvegicus*, blue and red shrimp *Aristeus antennatus*, deepwater rose shrimp *Parapeneus longirostris*, scarlet shrimp *Aristaeopsis edwardsiana* and the giant red shrimp *Aristaeomorpha foliacea* are the target species of the Portuguese Nephrops Survey (FU 28-29). Data on these species´ spatial distribution, relative abundance and data for the determination of biological parameters (sex-ratio, length-weight relationships, maturity, growth) are collected during this survey. This lecture covered the crustacean species general life cycle characteristics, the biological measurements to be collected during the sampling procedures and the maturity scales adopted for each of the species.

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10. Taxonomy, species identification, biodiversity. Part III – Cephalopods – Pedro Gomes

The class Cephalopoda comprises 8 orders (Myopsida, Oegopsida, Sepiida, Spirulida, Teuthida, Octopoda, Vampyromorpha e Nautilida). This lecture surveyed the diversity and classification of cephalopods occurring in the Portuguese coast, paying special attention to morphological aspects and key distinguishing features that enable the correct identification of the different species.

11. Biological Sampling – Elasmobranches – Catarina Maia

Research surveys constitute valuable opportunity to collect fishery independent data and biological information on elasmobranch fishes, in particular on species with no commercial interest and for which there is no other source available. In this lecture the different types of information collected on elasmobranch species during the Portuguese Nephrops Survey (FU 28-29) such as biodiversity, geographical distribution, relative abundance, biological parameters and habitat parameters are addressed. Elasmobranch species sampling protocols to be followed onboard and measurements collected are presented as well as an overview on the main reproductive modes, oviparity and viviparity, and maturity scales applied. An overview of the use of these data on stock status assessment as well as its use for providing advice and management is also presented.

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12. **Marine Strategy Framework Directive - MSFD** – Patrícia Gonçalves, Teresa Moura and Clara Lopes. Lecture by Corina Chaves

The Marine Strategy Framework Directive (2008/56/EC)(MSFD) establishes a framework for community action in the field of environmental policy and requires the European Commission to set up criteria and methodological standards to allow consistency in approaches for evaluating the extent to which Good Environmental Status (GES) is being achieved. Under this directive, member states shall take the necessary measures to achieve or maintain good environmental status in the marine environment by adopting an ecosystem-based approach to the management of human activities, ensuring that pressure of such activities is kept within levels compatible with the achievement of GES. IPMA has a main role ensuring the characterization and assessment of GES, namely regarding biological diversity levels (Descriptor 1), commercially-exploited fish populations health status (Descriptor 3) and properties and quantities of marine litter (Descriptor 10). This lecture covered the criteria established and methodologies adopted by IPMA for evaluation of each of the Descriptors (D1, D3 and D10).

Day 17 – 30/06/2021: sampling & experience sharing–*Atlantic Portuguese South Coast*

During the afternoon, the students had the opportunity to present their current field of work, in a brief session with questions and answers from the whole scientific team. With this session, students were also given the opportunity to share their expectations and experiences from the two and a half weeks at the Floating University.

Days 18 & 19 – 30/06 & 01/07/2021: sampling –*Atlantic Portuguese South Coast*

Due to unexpected events, the survey was prematurely terminated. Consequently, the last lecture planned on Sampling Theory and the outline of expected report and data analysis to be performed by students were not completed. Consequently, no theoretical evaluation of the students was performed.

Day 20 – 03/07/2021: Disembarkation – *Lisbon Naval Base*

Disembarkation of students took place on this day, with mixed feelings about leaving early, but already missing home. Furthermore, the disembarkation of the scientific team was delayed for the morning of the 6th July and some students had already personal commitments on that day.

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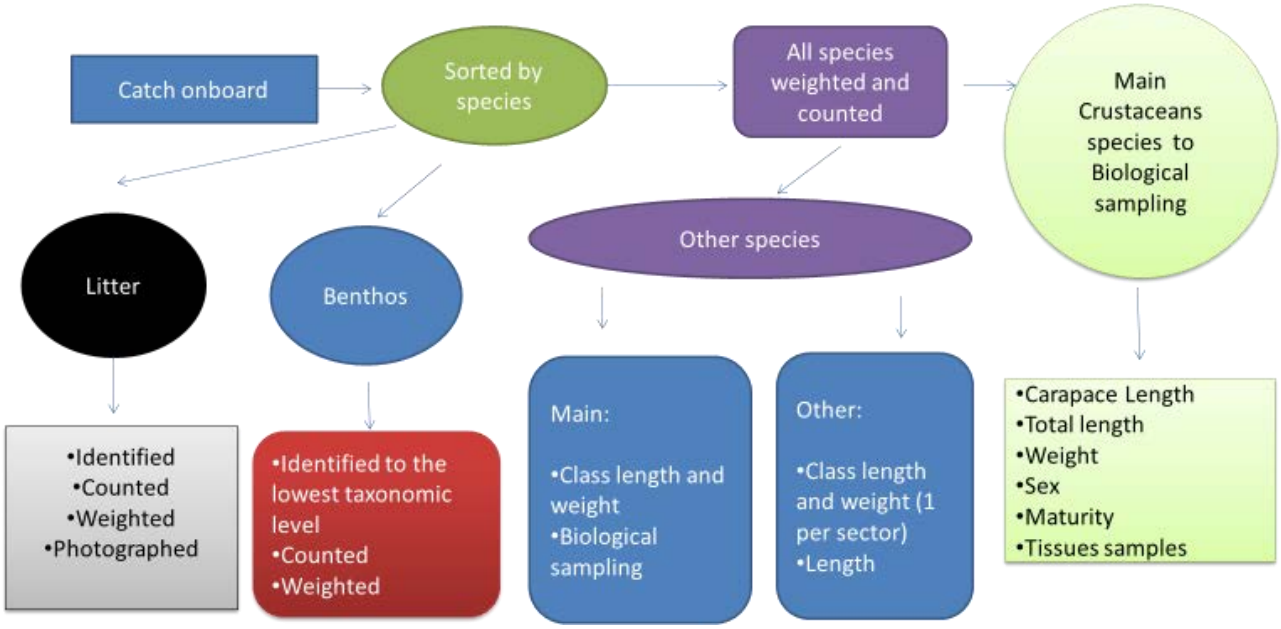
On board operation

Students were introduced to the sampling process onboard the Portuguese *Nephrops* Survey and were enrolled in all parts of the process. On each day, each student was introduced to a new routine in the survey, and all students spent a whole day performing sampling on one different sampling protocol. They were able to participate in all steps of the available onboard sampling programs and, by the end of the survey, were able to perform autonomous tasks. For some more complex tasks, they repeated the attendance. In each step they were scrutinized for a continuous evaluation.



Data are recorded into a database and processing and analyses were supposed to be performed on MS Excel or R, depending on student skills.

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Preliminary results

As the theoretical evaluation was not performed, no data analysis was performed and no discussion on the participation was recorded.

Evaluation of student learning

Formal theoretical evaluation was not performed.

Continuous practical evaluation was present in all stages of sampling with students able to perform autonomously some identification and sampling tasks.

Students course evaluation

No evaluation from students were available at the completion of this report.

Concluding remarks

As our first experience as Floating University, the schedule was not fine-tuned and synchronized with practical onboard work. This lead to some deviations that could not be corrected and were aggravated with the unexpected breakdown of the vessel before the end of the survey, reducing the time available for the missing tasks.

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Appendix

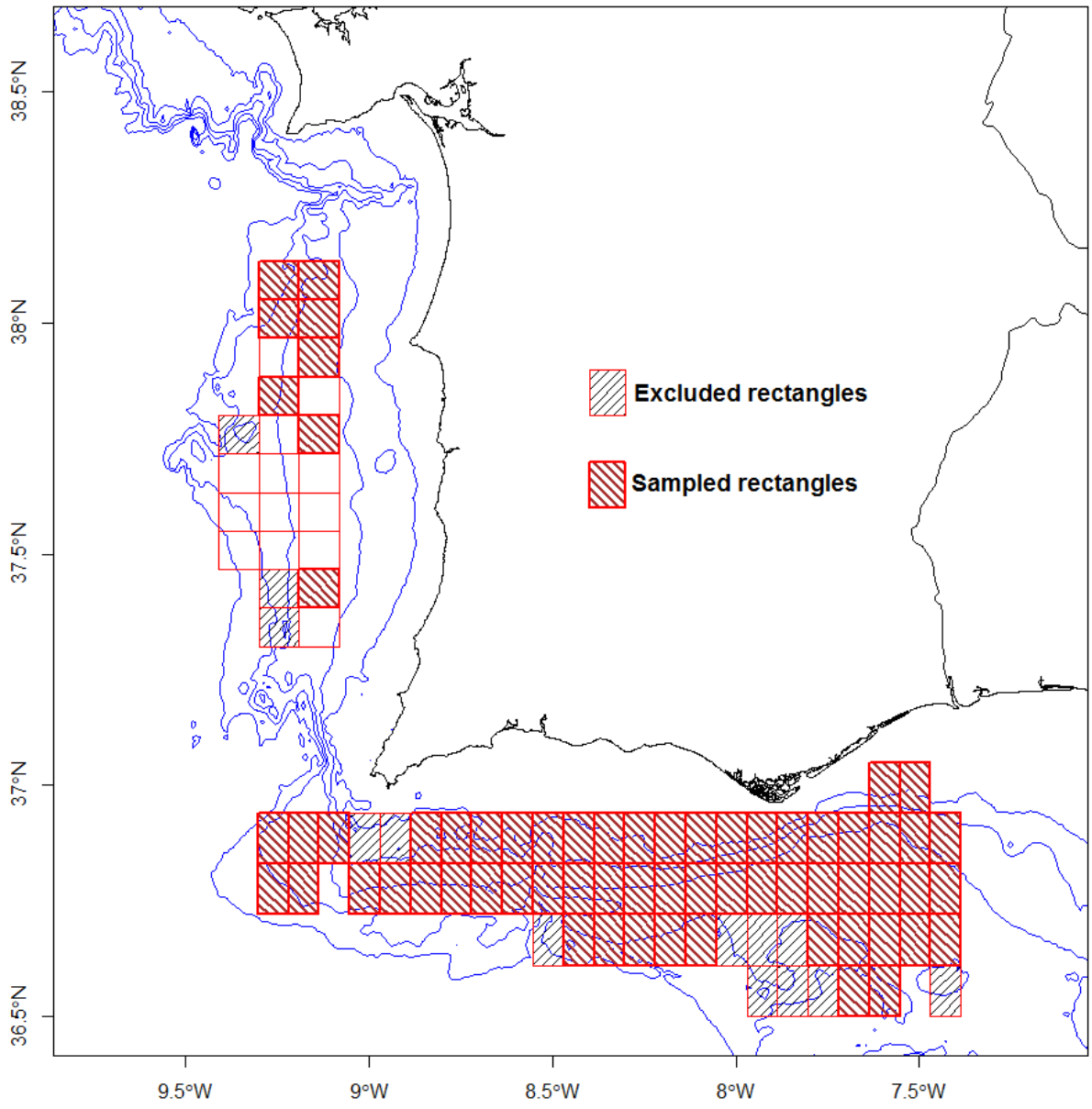

Figure 2 – Rectangles covered during Portuguese *Nephrops* Survey 2021

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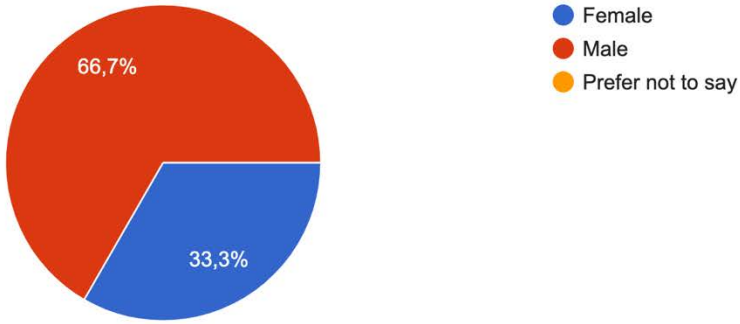
Please indicate your gender

3 risposte



Please indicate your age group

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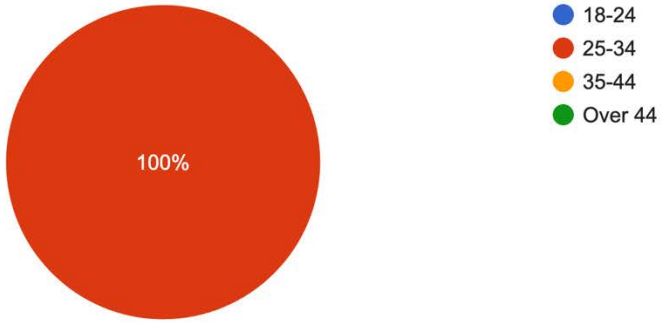
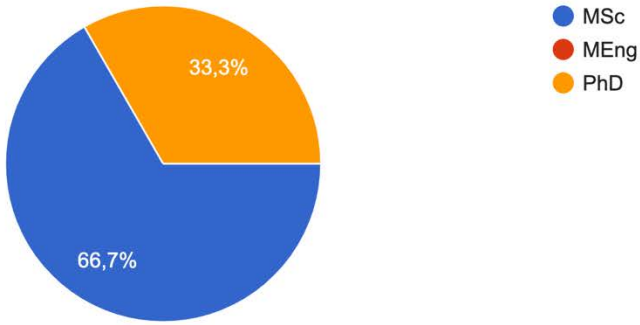


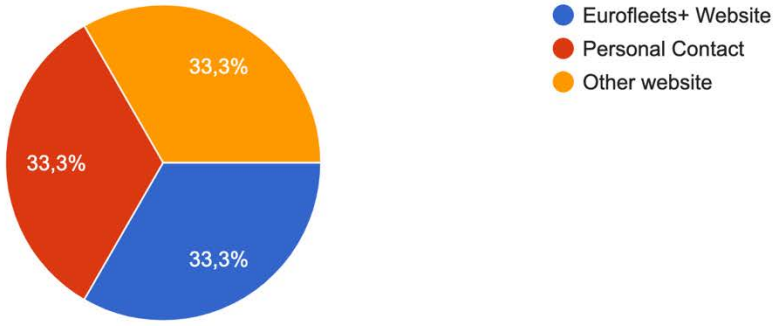
Which of the following best describes your current academic profile?

3 risposte



How did you know about the Floating University course?

3 risposte

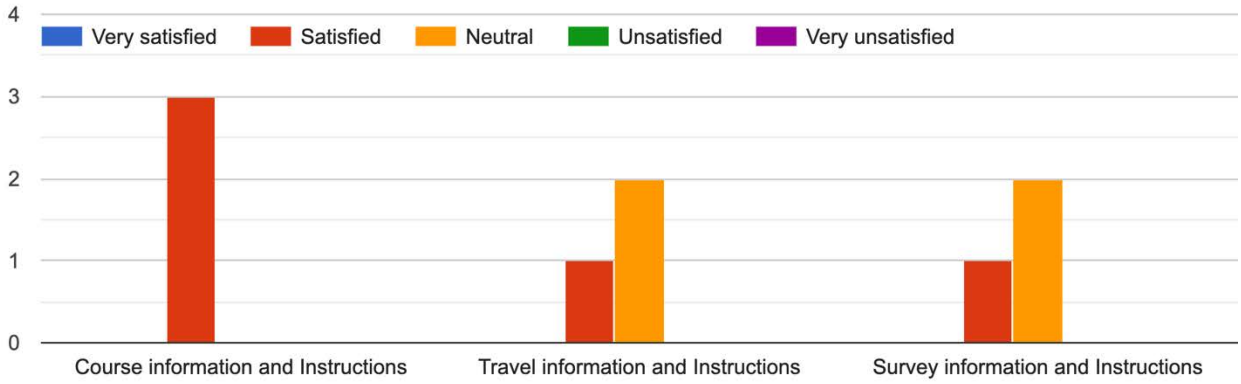


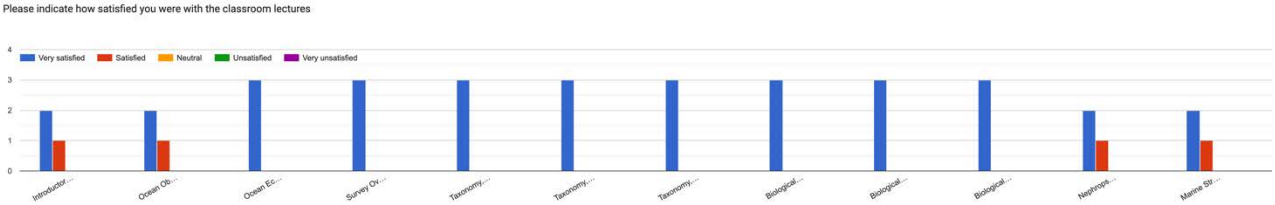
Please, outline our area of special interest or research in Marine Science

3 risposte

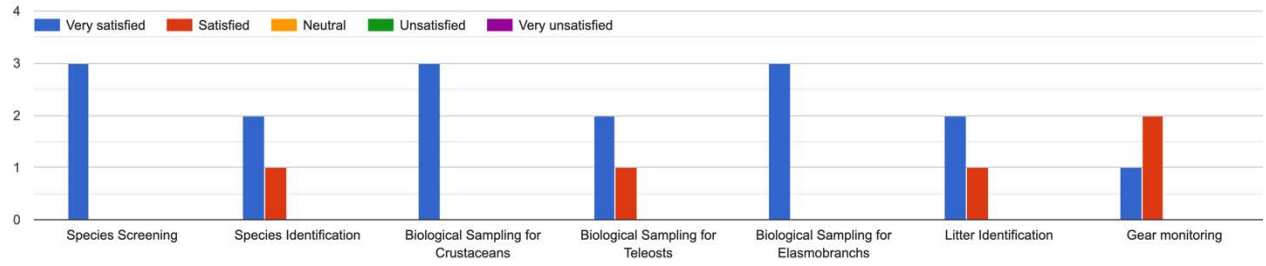
- Fisheries
- On one hand, I am interested in exploration of the benthic biodiversity and contribute to conservation measures, especially in vulnerable marine ecosystems. On the other hand I am interested on the restoration of blue carbon ecosystems (mainly sea grass), in parallel to the development of IMTA aquaculture approaches involving low trophic species (Including, crustaceans, echinoderms among others). Finally, I am also open to work and get more experience as observer of marine birds and mammals.
- Deep Sea

Please indicate how satisfied you were with the following pre-survey resources

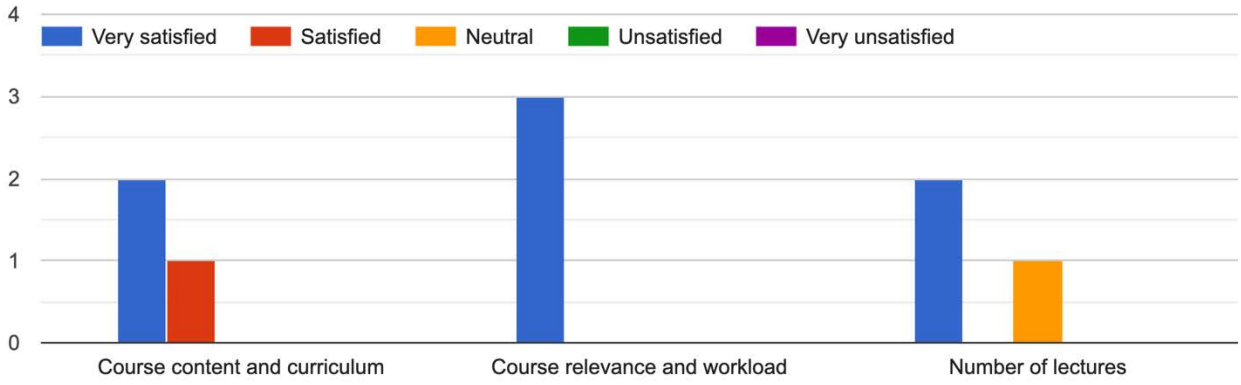




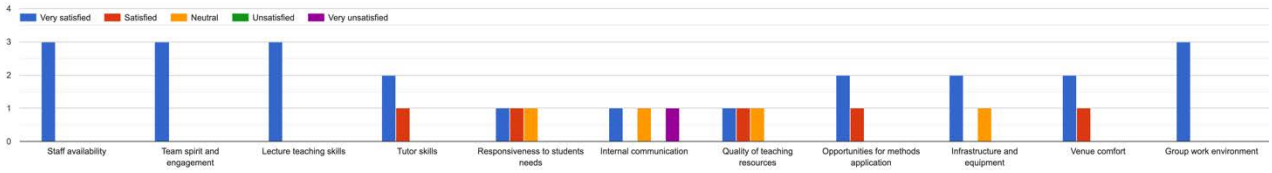
Please indicate how satisfied you were with on-board practical elements of the RV Mário Ruivo cruise



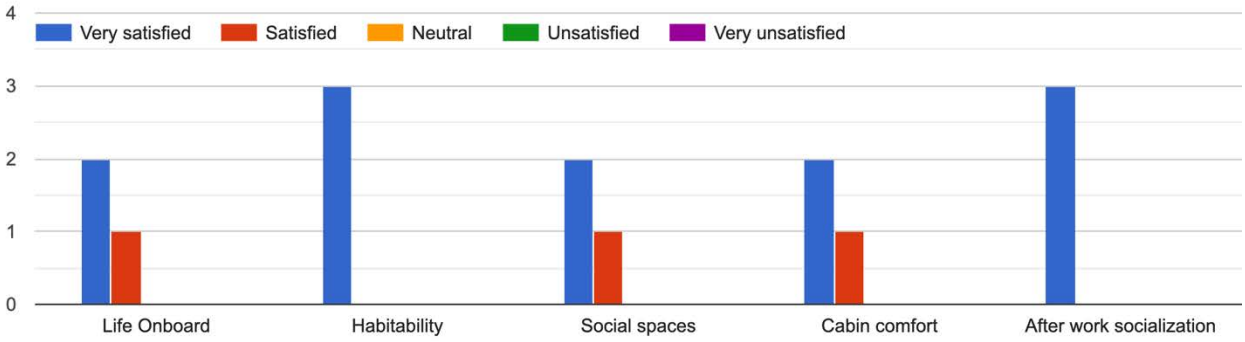
Please indicate how satisfied you were with course conduction on the RV Mário Ruivo cruise



Please indicate how satisfied you were with staff, the learning environment and learning environment on the RV Mário Ruivo cruise



Please indicate how satisfied you were with social habitability on the RV Mário Ruivo cruise



Overall how satisfied were you with the delivery of the Eurofleets+ RV Mário Ruivo Floating University?

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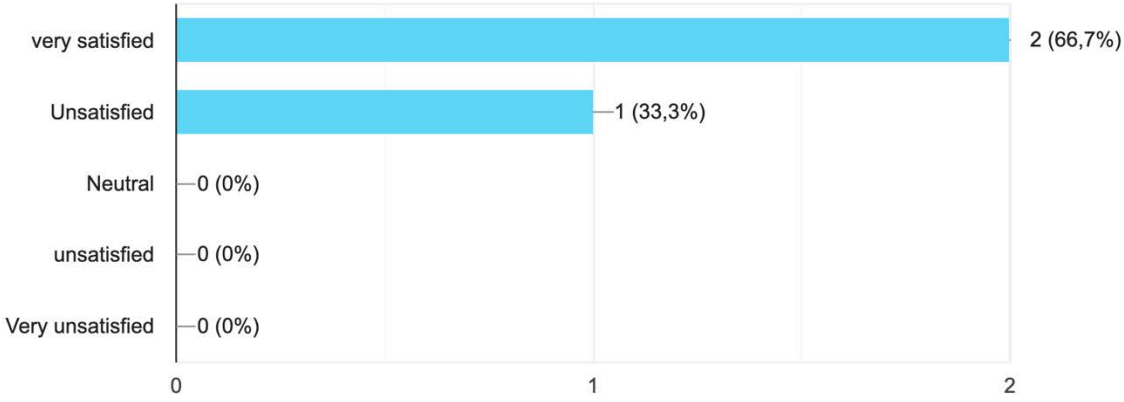
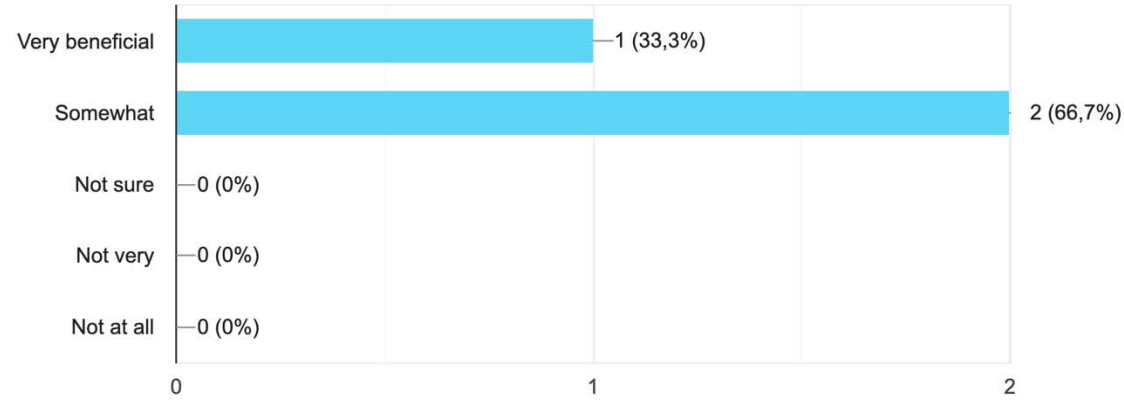


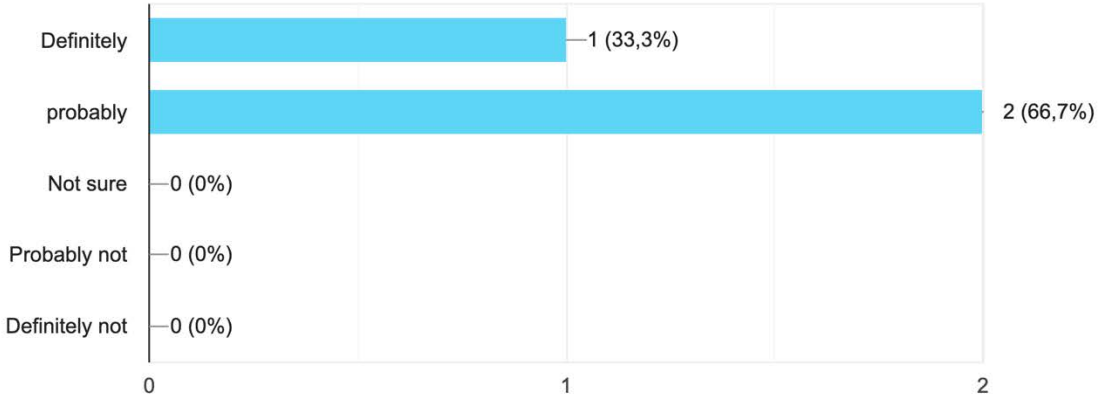
How beneficial do you feel it is to network with other European and International students?

3 risposte



Do you believe the Floating University experience on board the RV Mário Ruivo will benefit your studies and future career?

3 risposte



Please feel you free to comment on the highlights and/or lowlights of the Floating University course:

- Overall a beautiful experience. I have no coplains regarding the course. In future expeditions a better WiFi signal should be provided. There was also a huge delay of the reimbursement to same participants. After sending several Emails to the cordinators we were shifted from one to another department.
- For me this course was a wonderful and unique experience. I really enjoyed from the first to the las day being on board and sharing with very fabulous crew. Also I learnt and improved several skills on board of a research vessel, my skills in identification and team working. Food, accommodation and crew all great and very kind and nice people. I would love to be part of a course like this!
- NA

Please outline any recommendations you may have for future Eurofleets+ Floating University programme:

- Increase the number of International scientists and professionals.
- That the refund money should be managed and returned to the students directly by Eurofleets. In my case and a colleague of mine from Croatia, the IPMA institution lacked of good managing in the finances for the reimbursement. It took more than one year to have the reimbursement, after many and many emails and the lack of proper answers from them. It also be nice to have an Eurofleets+ network to find jobs or opportunities.
- NA

Do you think it would be worth the establishment of a permanent EU Floating University programme?

- Yes

- Totally yes, it is a wonderful opportunity for many students related to marine sciences that give a first experience or help to improve so many skills. I think its very needed a permanent programme. Thanks for the opportunity
- Yes

EUROFLEETS+ Floating University

"Meeting societal needs for impartial evidence on the state and sustainable use of the ocean biological resources: the case of the *Nephrops norvegicus* (Norway lobster)"

Onboard the R/V Mário Ruivo

Off Portugal coast (Southwest and South) 8th June – 3rd July 2022

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Scientific Participants

Cristina Silva (Course leader)

Mafalda Carapuço (Course leader)

Corina Chaves (Cruise leader/Lecturer/Instructor)

Tanya Silveira (Lecturer)

Alejandra Mejía (Student)

Haleigh Joyce (Student)

João Balsa (Student)

Margarida Lopes (Student)

Inês Farias (Lecturer/Instructor)

Pedro Gomes (Lecturer/Instructor)

Catarina Maia (Lecturer/Instructor)

Miguel Santos (IPMA Researcher)

Adelaide Resende (Instructor)

Ana Luísa Ferreira (Instructor)

Paula Abreu (Instructor)

Augusto Pombal (Instructor)

Celso Domingos (Ciimar Researcher)

Francesco Cuccaro (Trainee)

André Ferreira (Student – Univ Minho)

Meadow Hall (Student – Univ. Harvard)

Figure 1 - Scientific Team & Eurofleets+ Students

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Course and cruise objectives

The general objective of the course was to provide theoretical background and practical experience on scientific understanding of marine ecosystems and the services they provide, and on the application of the outcome knowledge to generate state-of-the-art advice for meeting conservation, management, and sustainability goals using *Nephrops norvegicus* (the Norway lobster) as case-study.

The Crustaceans survey took place off the Southwest and South coasts of Portugal, onboard the R/V Mário Ruivo which is operated by IPMA (Portuguese Institute for Sea and Atmosphere). This edition of the Eurofleets+ Floating University included two Master students and two Doctoral students, from three different countries – Republic of Ireland, Guatemala and Portugal (Figure 1).

The course included lectures on the first day, onboard R/V Mário Ruivo, before departure and during the three weeks at sea, during which IPMA's scientific team provided training and guidance on sampling protocols, species identification, and collection of biological data.

The participating students learned about:

- Species abundance estimation following a stratified design;
- Geographical distribution of the target-species and the main characteristics of the Portuguese crustacean fishery;
- Data collection procedures to estimate biological parameters (sex-ratio, length-weight, maturity, growth) meeting the Data Collection Framework sampling requirements;
- Data collection for biodiversity studies and information on marine litter distribution to comply with the EU Marine Strategy Framework Directive requirements.

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Figure 1. The four participants of the Floating University undertaking several tasks onboard the R/V Mário Ruivo. Upper left: Alejandra (Guatemala), Upper right: Haleigh (Ireland), Lower left: João (Portugal) and Lower right: Margarida (Portugal).

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Nature of the course and work carried out on the course

The course was designed to include a combination of lectures, practical sampling/measurements, onboard laboratory work and data interpretation.

The scientific team and students mustered onboard R/V Mário Ruivo on June 7th, 2022 and left the harbour on the next day.

The students were integrated in the sampling teams and were able to participate in all activities, including the regular activities designed according to DCF requirements, as well as supplemental activities in oceanographic sample collection.

The lectures were spread throughout the three weeks of the survey so students could intersperse the theoretical and practical approaches of the lessons learnt. This approach enabled a better engagement of the students on the subjects and on the subsequent discussions, avoiding an overload of information at once. All lectures onboard were prepared and led by IPMA's Scientific staff.

Due to technical constraints, not all equipments were available for the survey and consequently for students to operate, including the box-corer for sediments sampling and CTD for temperature, salinity and conductivity measurements.

After the campaign, the students were asked to fill-in an online questionnaire to evaluate the course.

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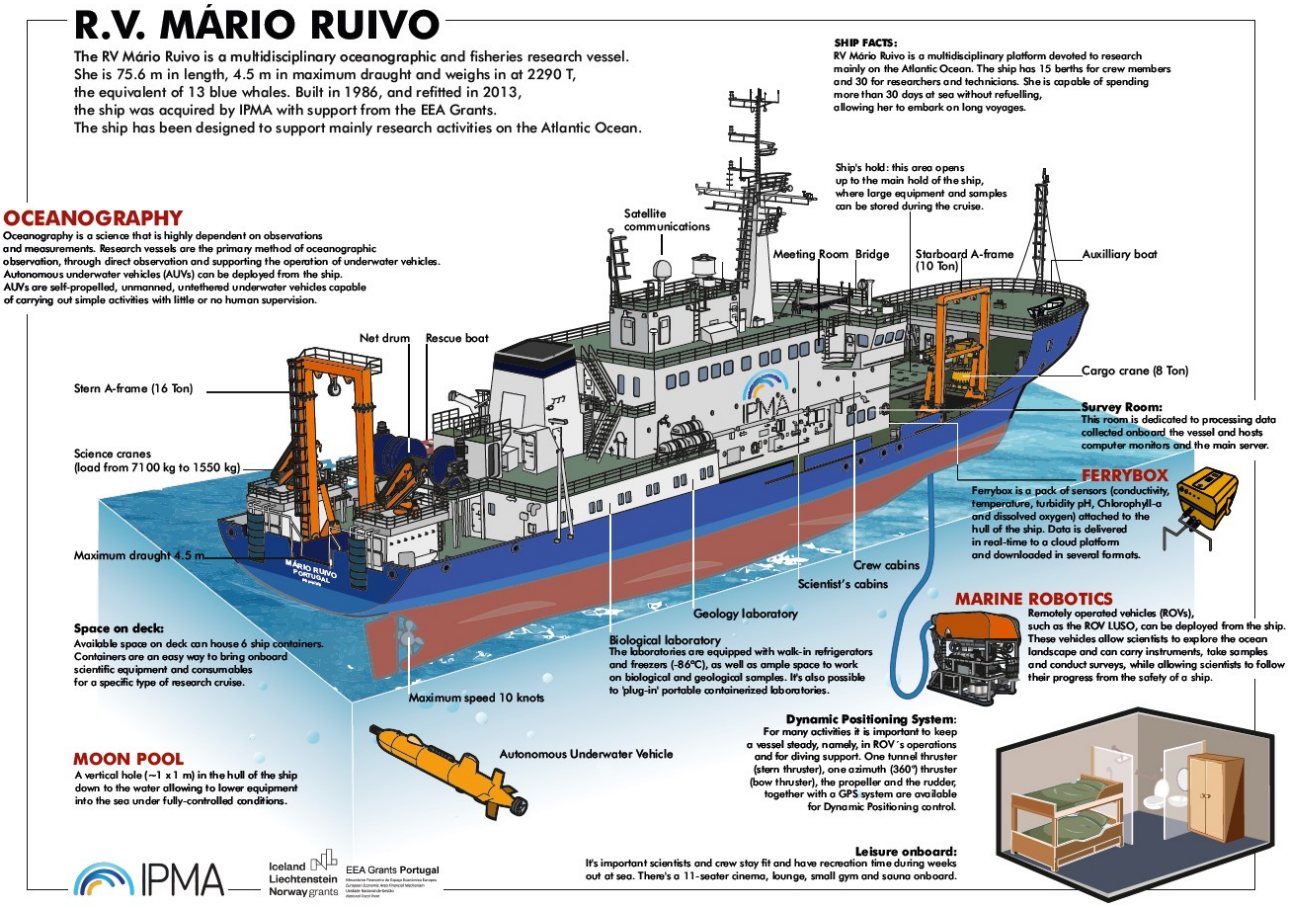
Course and cruise Log

Lectures were provided along the three-week survey, mixing theoretical and practical approaches as follows:

Day 1 -7/06/2022: Mustering - *Lisbon Naval Base*

1. **Introductory lectures on Research Vessels.** Mafalda Carapuço

   The participants in the Floating University R/V Mário Ruivo were welcomed and introduced to the vessel officers. Some information on the vessel history, equipment and facilities was given. A guided tour was conducted at the end of the third lecture.



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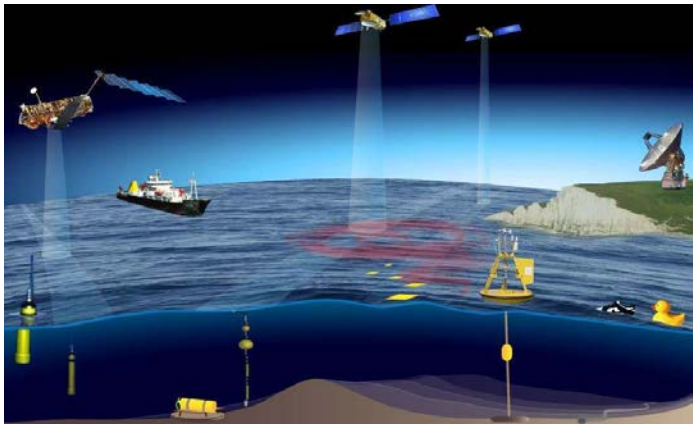
2. Ocean Observatories. Tanya Silveira



Introduction to Ocean observation: why and how. Identification of the main types of platforms used for observing the ocean and how they evolved through time: research vessels, submersibles, floats and buoys, submarine fixed stations, monitoring opportunities and remote sensing techniques. The paradigm shift, from local to global observation, and the concept of the Global Ocean and the challenge of data sharing. The Ocean observation value chain and the importance of data aggregators and data platforms. Examples of ocean monitoring networks in which IPMA collaborates: The EMSO-PT and the Atlantic Observatory – Data and Monitoring Infrastructure Projects. Visioning of the video logbook of the EMSO-PT Oceanographic Campaign Leg 1.

Day 2- – 08/06/2022: Departure – *Lisbon Naval Base to Atlantic Portuguese Southwestern Coast*

Departure from Lisbon Naval Base, with route set to the survey area. During sailing a meeting was held for the presentation of the scientific team and students, survey tasks to be performed, planning for the following days and presentation of course outline and work assignment to the sampling teams. Security briefing was held for the team and students to be familiarized with emergency procedures.

After the lecture on Survey overview, an explanatory visit was made to the fishing laboratories and decks.

3. Survey Overview – Corina Chaves and Cristina Silva. Lecture by Corina Chaves

The Portuguese *Nephrops* survey (FU 28-29) occurs annually along the Southwestern and South coast of Portugal to assess the relative abundance and distribution in space and time of *Nephrops*, as well as of other crustacean species, such as Deepwater Rose Shrimp and Red Shrimp. In recent years, the growing interest on Biodiversity and Marine Litter as descriptors of the European Marine Strategy Framework increased the importance of these two sampling objectives of the survey. On this lecture, an overview of the objectives, study area and sampling design were given as well as some expected results.

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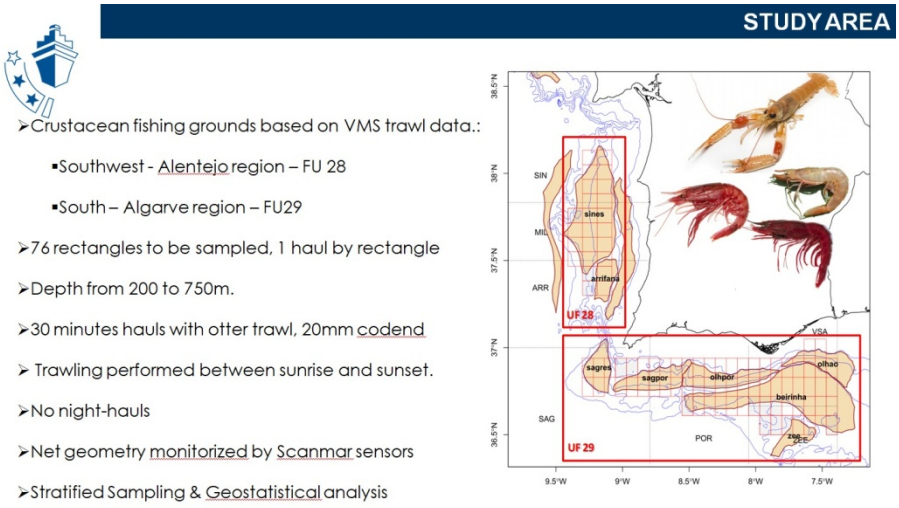

Days 3-25 – 09/06 – 01/07/2022: Sampling –*Atlantic Portuguese Southwestern Coast*

Days spent at sea, with lectures been done in the morning. For the rest of the day, students were integrated in the work flow of a Scientific Fishing Survey with hands-on species identification and screening, morphological measurements and biological sampling. Students also participated in litter identification and classification.

4. Taxonomy, species identification, biodiversity. Part I – Pisces – Pedro Gomes

Fishes are the oldest, most diverse and most abundant group of vertebrates, making up more than half of the 55,000 species of living vertebrates, showing a staggering diversity of phylogenetic

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groups with amazing adaptations to a wide range of environments. This lecture surveyed the diversity and classification of fishes occurring in the Portuguese coast, paying special attention to morphology aspects and key distinguishing features that enable the correct identification of different fish species.

5. Biological Sampling – Teleosts – Inês Farias

Teleosts, commonly known as bony fish, are characterized by the presence of bony skeletons with flexible fins supported by bony fin rays, and represent 96% of all living fish. This group presents high diversity, not only morphologically but also in ecological traits, such as diet and habitat. The Portuguese *Nephrops* Survey (FU 28-29) covers the mesopelagic and bathydemersal habitat, between 200-750 m deep. This survey is very important for collecting biodiversity, geographical distribution, relative abundance, and morphological and biological parameters not only of teleost species with commercial interest but also of species for which fishery-dependent data are scarce. For the most important teleost species sampled on this survey, gonads and calcified structures such as otoliths (and illicia in *Lophius* spp.) are also collected for subsequent reproductive and growth studies, respectively. Each species sampling protocol and maturity stage scale was presented.

6. Taxonomy, species identification, biodiversity. Part II – Crustaceans – Pedro Gomes

Crustaceans are a diverse group of arthropods and include several species of lobsters, crayfish, crabs, prawns, shrimp, barnacles and pill bugs. This lecture surveyed the diversity and classification of crustacean species occurring in the Portuguese coast, in particular those targeted by the survey

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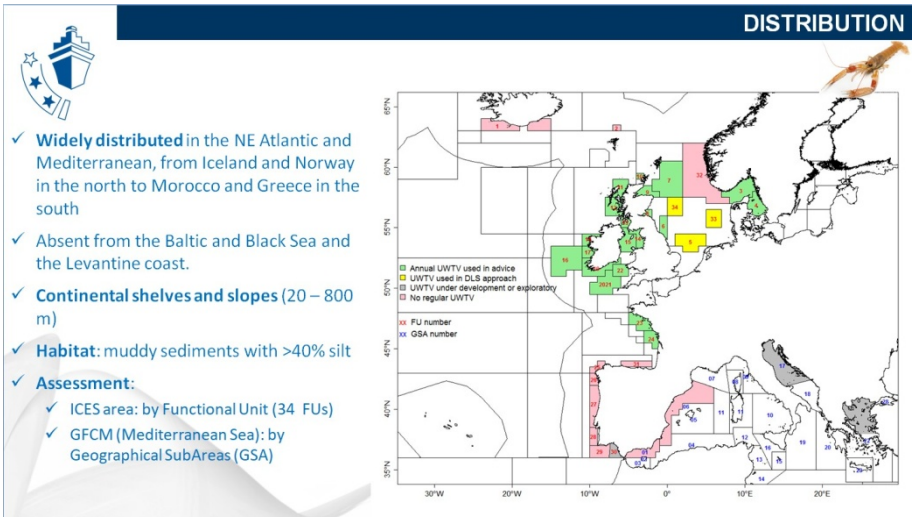
such as the Norway lobster *Nephrops norvegicus*, blue and red shrimp *Aristeus antennatus*, deepwater rose shrimp *Parapeneus longirostris*, scarlet shrimp *Aristaeopsis edwardsiana* and the giant red shrimp *Aristaeomorpha foliacea*. The main morphological aspects and key distinguishing features that enable the correct identification of different species were addressed during this lecture.

7. ***Nephrops norvegicus*** – Cristina Silva. Lecture by Corina Chaves

An introduction to Norway lobster geographical distribution in Northeast Atlantic Ocean and Mediterranean Sea and assessment areas was presented. This presentation covers several topics and processes of the life history and population dynamics of *Nephrops norvegicus* as growth, reproductive cycle, feeding, predation and behaviour and activity patterns. The assessment of most of ICES *Nephrops* Functional Units is based on Under Water Video (UWTV) Surveys, where the Norway lobster absolute biomass or abundance is assessed and the harvest rate is estimated. This is not the case of most of Iberian stocks which assessment is performed with Surplus Production Methods or length-based methods. In the case of the southern Portuguese Functional Units (FU 28 and 29), the survey is carried out by trawling and the abundance index series is used as an indicator. As overview of the crustacean fishery in these Functional Units was given, covering the location of fishing grounds, the target species and preferred depths and the national and EU current management measures.



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8. **Biological Sampling – Crustaceans** – Inês Farias, Paula Abreu and Mónica Inácio. Lecture by Inês Farias

The Norway lobster *Nephrops norvegicus*, blue and red shrimp *Aristeus antennatus*, deepwater rose shrimp *Parapeneus longirostris*, scarlet shrimp *Aristaeopsis edwardsiana* and the giant red shrimp *Aristaeomorpha foliacea* are the target species of the Portuguese *Nephrops* Survey (FU 28-29). Data on these species´ spatial distribution, relative abundance and data for the determination of biological parameters (sex-ratio, length-weight relationships, maturity, growth) are collected during this survey. This lecture covered the crustacean species general life cycle characteristics, the biological measurements to be collected during the sampling procedures and the maturity scales adopted for each of the species.

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9. Taxonomy, species identification, biodiversity. Part III – Cephalopods – Pedro Gomes

The class Cephalopoda comprises 8 orders (Myopsida, Oegopsida, Sepiida, Spirulida, Teuthida, Octopoda, Vampyromorpha e Nautilida). This lecture surveyed the diversity and classification of cephalopods occurring in the Portuguese coast, paying special attention to morphological aspects and key distinguishing features that enable the correct identification of the different species.

10. Biological Sampling – Elasmobranches – Catarina Maia

Research surveys constitute valuable opportunity to collect fishery independent data and biological information on elasmobranch fishes, in particular on species with no commercial interest and for which there is no other source available. In this lecture the different types of information collected on elasmobranch species during the Portuguese *Nephrops* Survey (FU 28-29) such as biodiversity, geographical distribution, relative abundance, biological parameters and habitat parameters are addressed. Elasmobranch species sampling protocols to be followed onboard and measurements collected are presented as well as an overview on the main reproductive modes, oviparity and viviparity, and maturity scales applied. An overview of the use of these data on stock status assessment as well as its use for providing advice and management is also presented.

11. Marine Strategy Framework Directive - MSFD – Patrícia Gonçalves, Teresa Moura and Clara Lopes. Lecture by Corina Chaves

The Marine Strategy Framework Directive (2008/56/EC)(MSFD) establishes a framework for community action in the field of environmental policy and requires the European Commission to

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set up criteria and methodological standards to allow consistency in approaches for evaluating the extent to which Good Environmental Status (GES) is being achieved. Under this directive, member states shall take the necessary measures to achieve or maintain good environmental status in the marine environment by adopting an ecosystem-based approach to the management of human activities, ensuring that pressure of such activities is kept within levels compatible with the achievement of GES. IPMA has a main role ensuring the characterization and assessment of GES, namely regarding biological diversity levels (Descriptor 1), commercially-exploited fish populations health status (Descriptor 3) and properties and quantities of marine litter (Descriptor 10). This lecture covered the criteria established and methodologies adopted by IPMA for evaluation of each of the Descriptors (D1, D3 and D10).

12. Sampling theory – Corina Chaves

The Portuguese *Nephrops* survey (FU 28-29) occurs annually to assess the relative abundance and distribution in space and time of crustacean species. But how is that done after data is collected was the main goal of the lecture, to explain Sampling Theory. As it is not possible to collect data on the whole population, samples are taken in a way that is expected to reflect it and to produce useful conclusions (or inference) on the population as a whole. In the case of the survey, several statiscical schemes are used, from the simple random, to the stratified and systematic sampling. Examples where given and theory explained. The lecture then explained the estimation method for abundance indices, length-weight relationships and biodiversity estimates.

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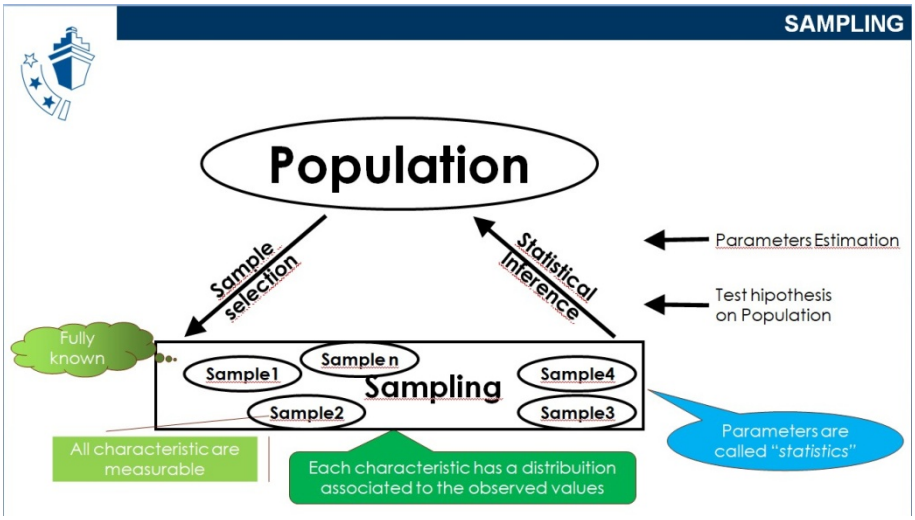
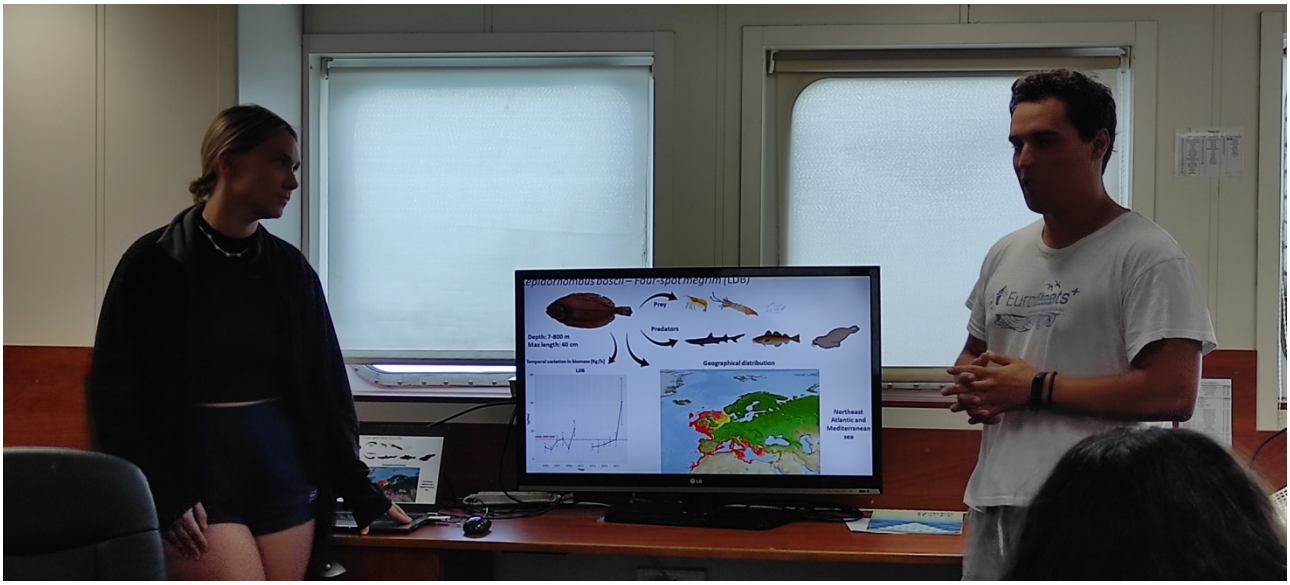


Day 26 – 02/07/2022: Students presentations–*Atlantic Portuguese South Coast*

During the afternoon, the students had the opportunity to present their current field of work, in a brief session with questions and answers from the whole scientific team. With this session, students were also given the opportunity to share their expectations and experiences from the two and a half weeks at the Floating University.



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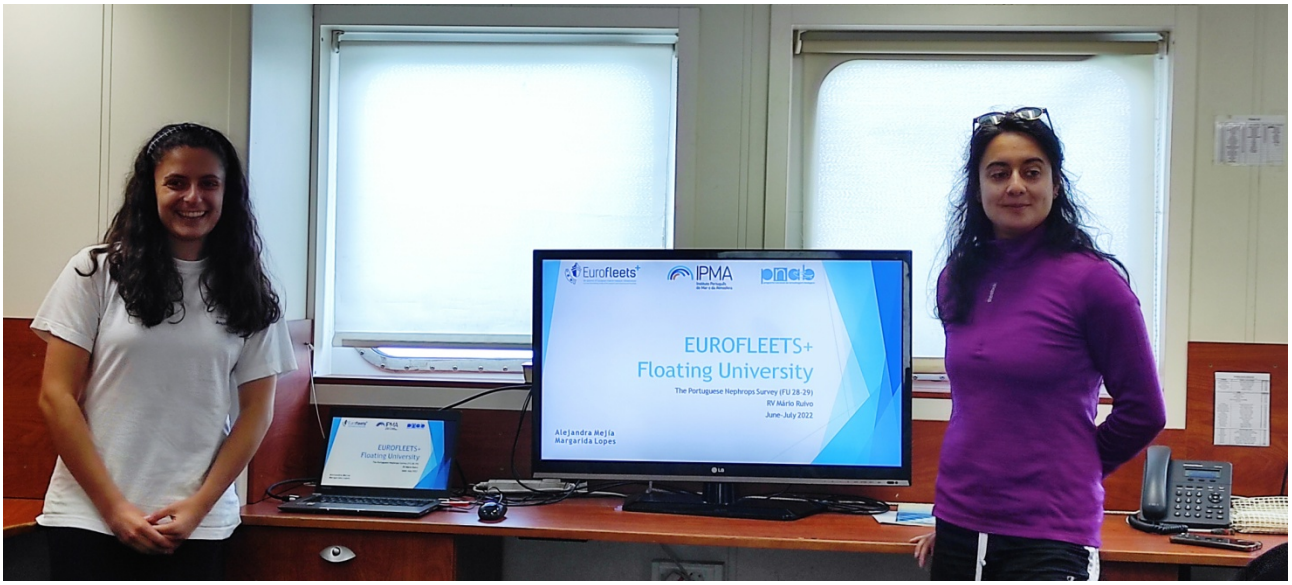

Day 27 – 03/07/2022: Disembarkation – *Lisbon Naval Base*

Disembarkation of students took place on this day, with mixed feelings about leaving, but already missing home.

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Eurofleets+ Floating University

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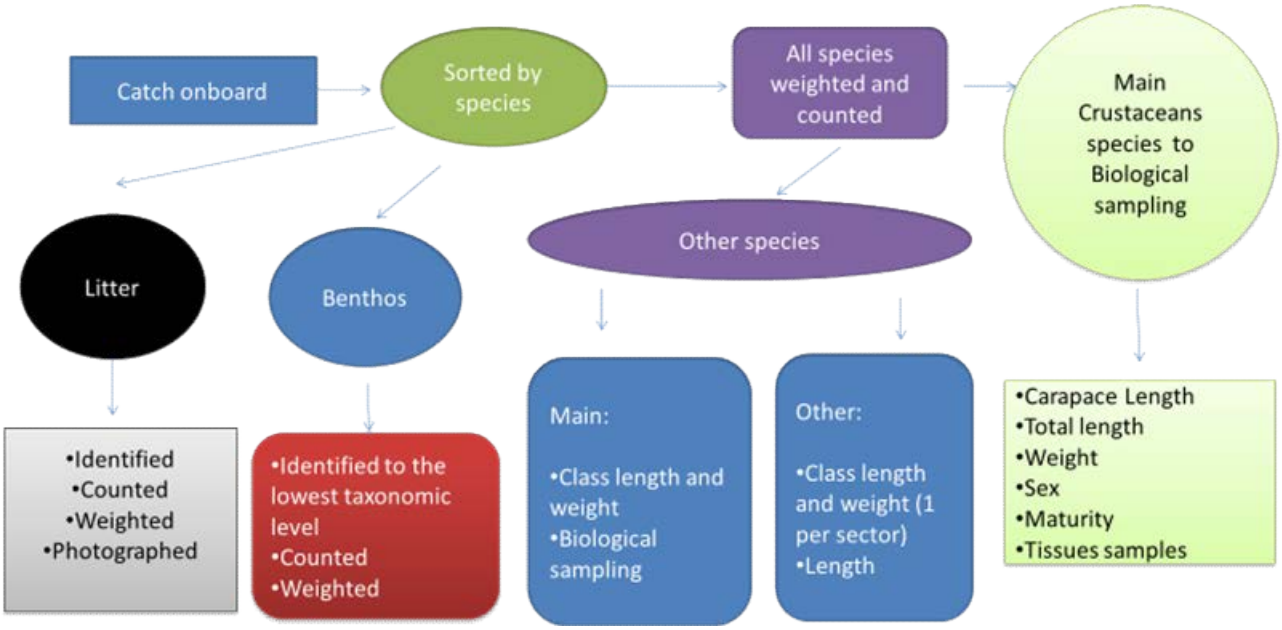
On board operation

Students were introduced to the sampling process onboard the Portuguese *Nephrops* Survey and were enrolled in all parts of the process. On each day, each student was introduced to a new routine in the survey, and all students spent a whole day performing sampling on one different sampling protocol. They were able to participate in all steps of the available onboard sampling programs and, by the end of the survey, were able to perform autonomous tasks. For some more complex tasks, they repeated the attendance. In each step they were scrutinized for a continuous evaluation.



Data are recorded into a database and processing and analyses were supposed to be performed on MS Excel or R, depending on student skills.

Preliminary results

As the theoretical evaluation was not performed, no data analysis was performed and no discussion on the participation was recorded.

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Evaluation of student learning

Evaluation was performed in 2 steps: the formal one with students' presentations on the theoretical work of the survey, and a continuous practical evaluation, present in all stages of sampling with students able to perform autonomously some identification and sampling tasks.

Theoretical evaluation was structured as follows:

1. Students will be grouped in pairs constituted by one PhD and one MSc
2. Each group will be provide a final report, that will be presented as a slideshow or poster on Saturday 2nd July
3. Each group will have three species:
    - one crustacean (Norway lobster or Deepwwater roseshrimp)
    - one bony fish (Blue whiting or Bluemouth or Monkfish or 4-spot Megrim)
    - one elasmobranch (*Galeus Atlanticus* or *Galeus melastomus*)
4. The analyses can be performed on any software that the group feel confortable with. R-scripts can be shared for guidance.
5. The report will not exceed 10 pages and should contain:
    - Survey objectives, sampling scheme and catches sampling protocol (Lectures 1 & 5)
    - Description on each species biology, distribution and sampling protocol for biological parameters (Lectures 2 & 3)
    - Results on (Lectures1 & 5, R-scripts) :
        1. Species abundance indices by zone or sex
        2. Distribution maps by sex or other parameter
        3. Length distributions by zone and sex
        4. Length-weight relationships
        5. Maturity ogives
        6. Sex ratio by depth or region (or both)
        7. Maturity stages by sex/depth or region

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Students course evaluation

No evaluation from students were available at the completion of this report.

Concluding remarks

As the second experience as Floating University, the schedule was synchronized with practical onboard work. This lead to a better integration and understanding of work performed onboard.

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Appendix

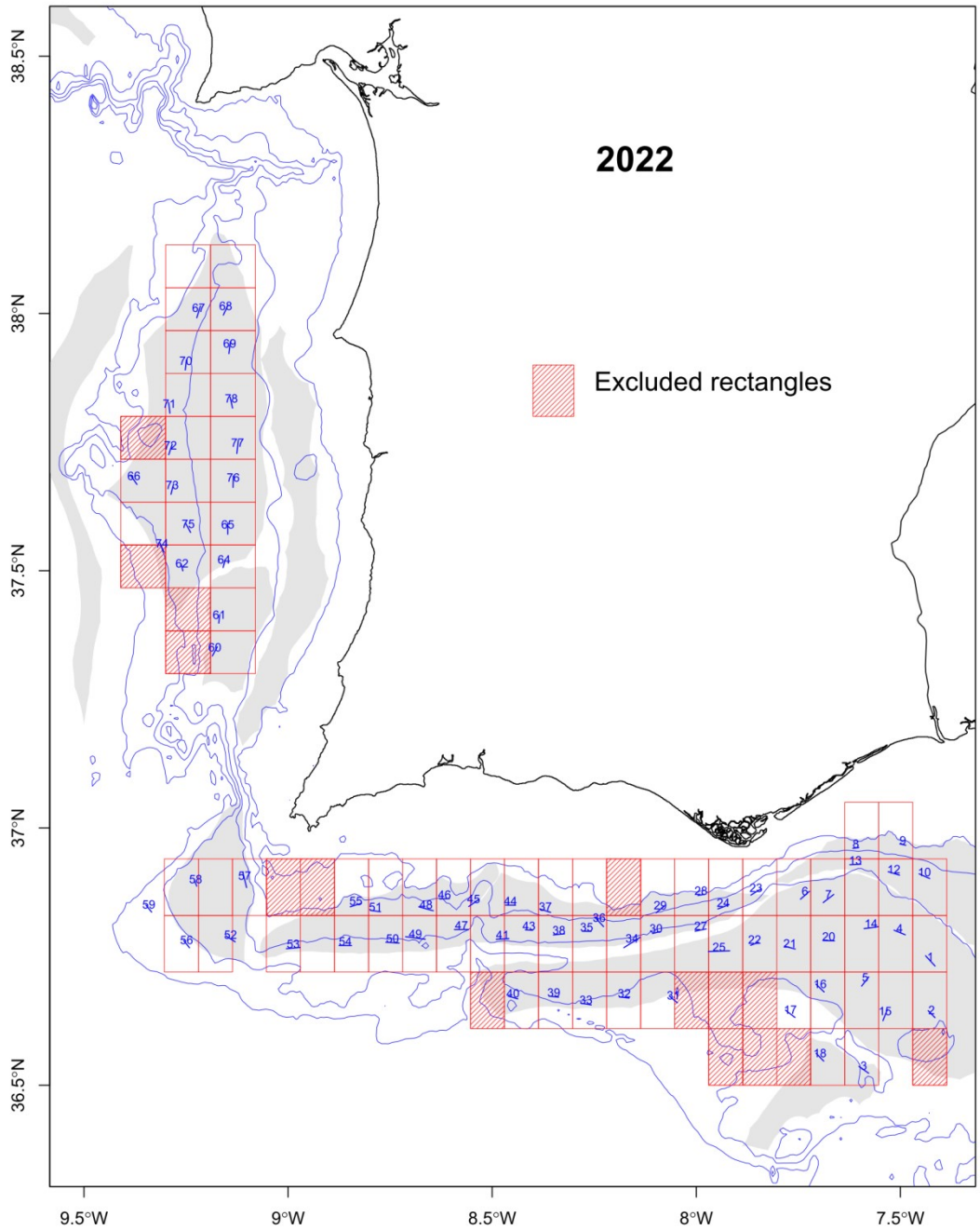

Figure 2 – Survey grid and coverage in 2022

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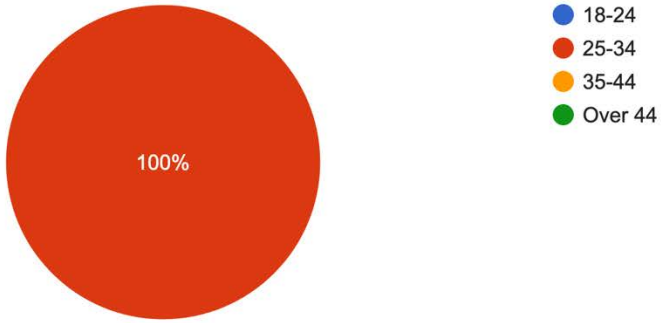
Please indicate your gender

1 risposta

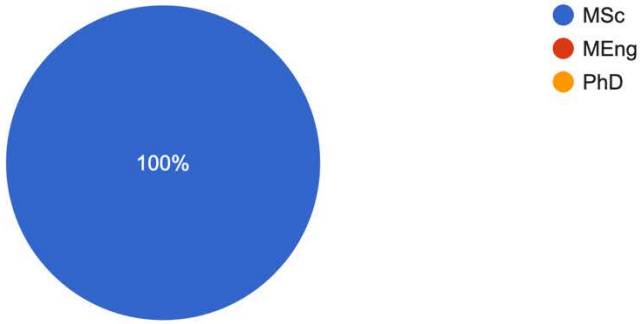
Please indicate your age group

1 risposta



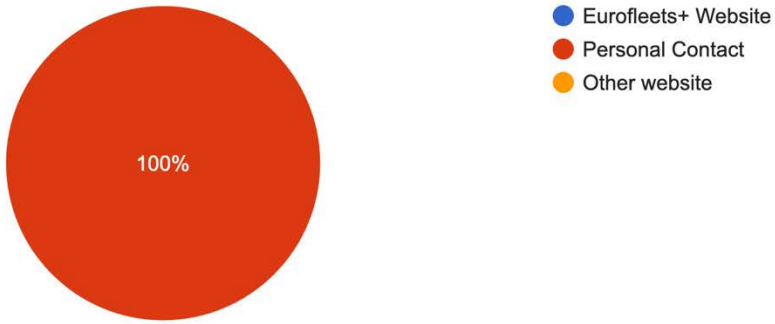
Which of the following best describes your current academic profile?

1 risposta



How did you know about the Floating University course?

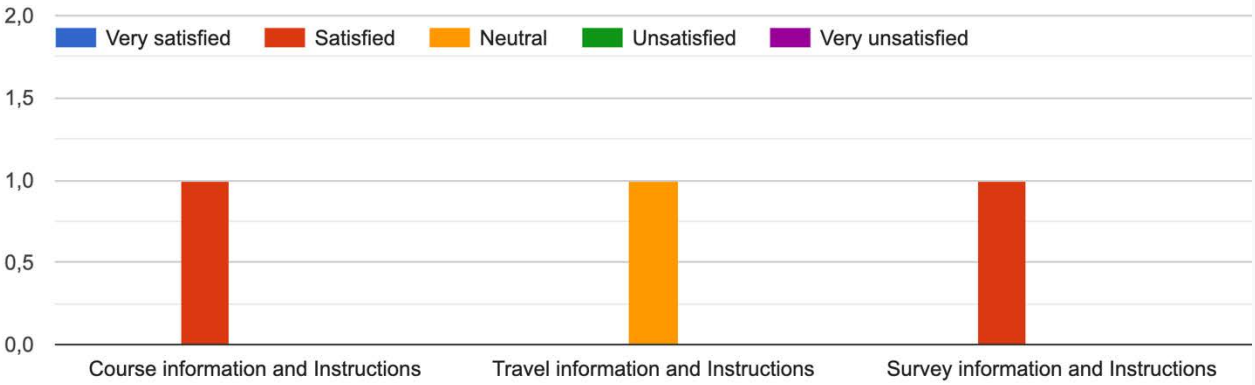
1 risposta



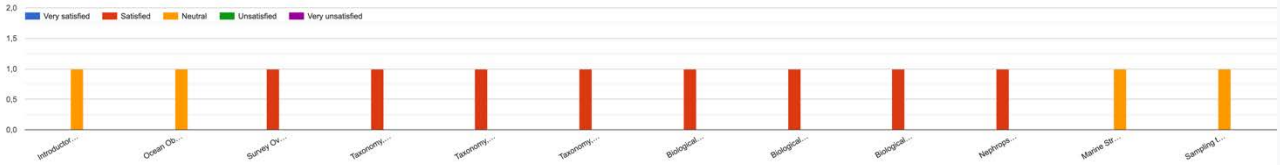
Please, outline our area of special interest or research in Marine Science

- Benthic ecology

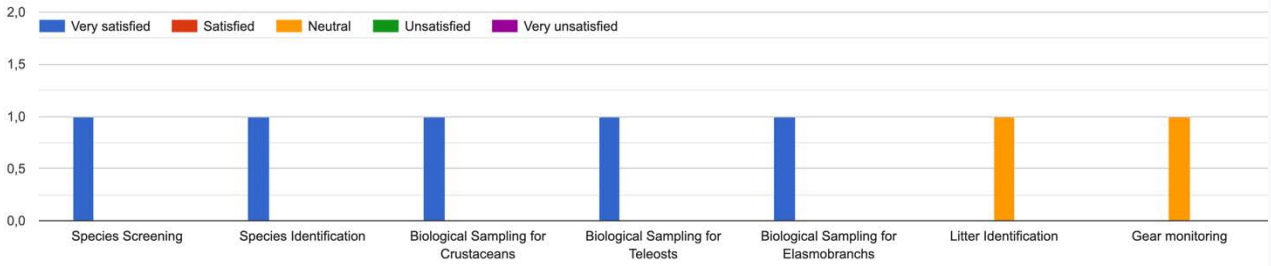
Please indicate how satisfied you were with the following pre-survey resources



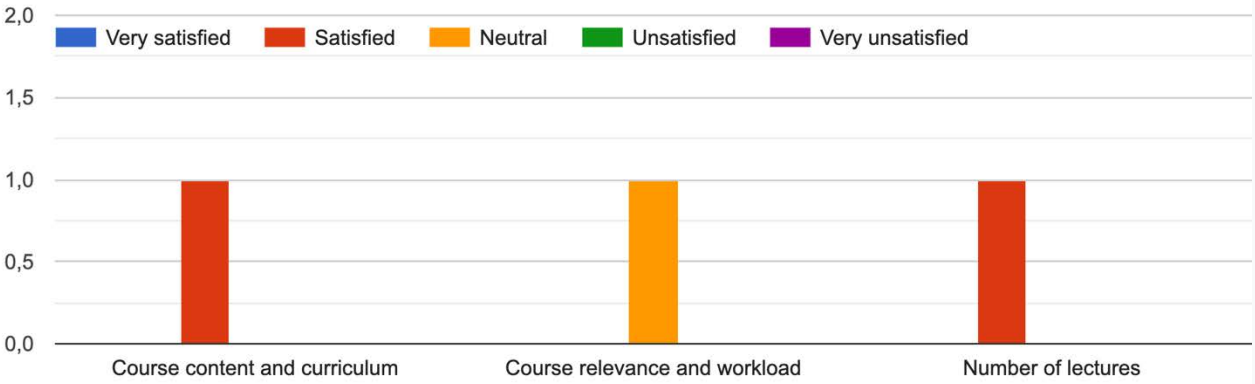
Please indicate how satisfied you were with the classroom lectures



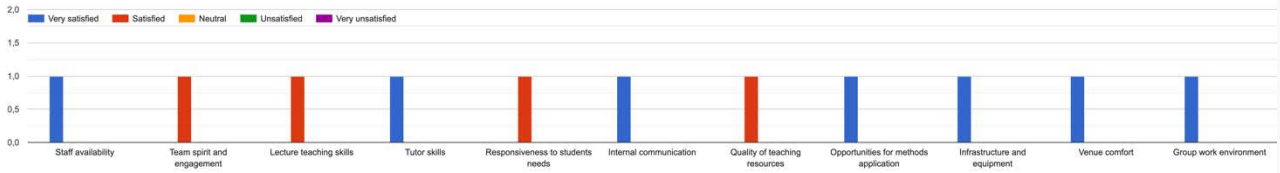
Please indicate how satisfied you were with on-board practical elements of the RV Mário Ruivo cruise



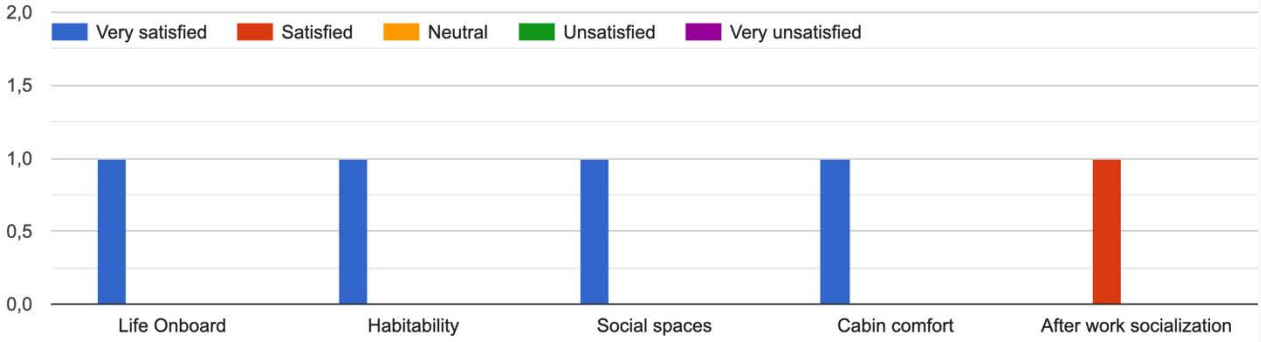
Please indicate how satisfied you were with course conduction on the RV Mário Ruivo cruise



Please indicate how satisfied you were with staff, the learning environment and learning environment on the RV Mário Ruivo cruise

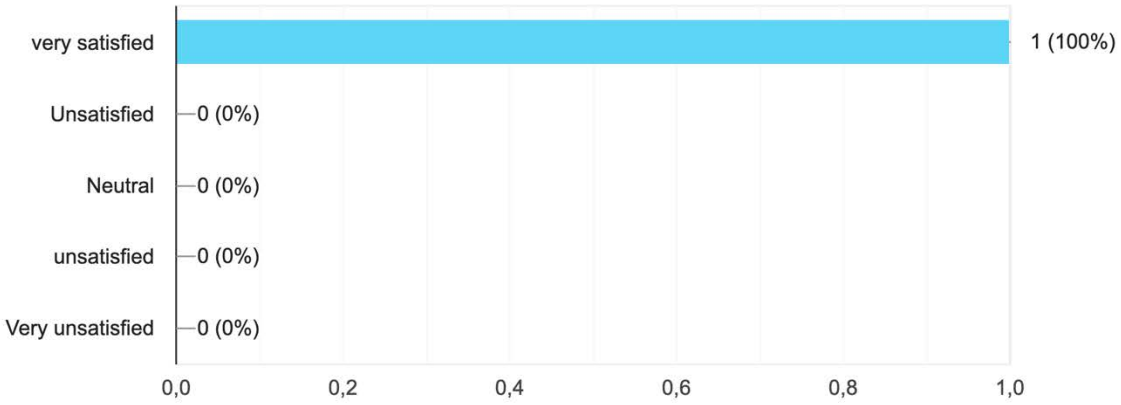


Please indicate how satisfied you were with social habitability on the RV Mário Ruivo cruise



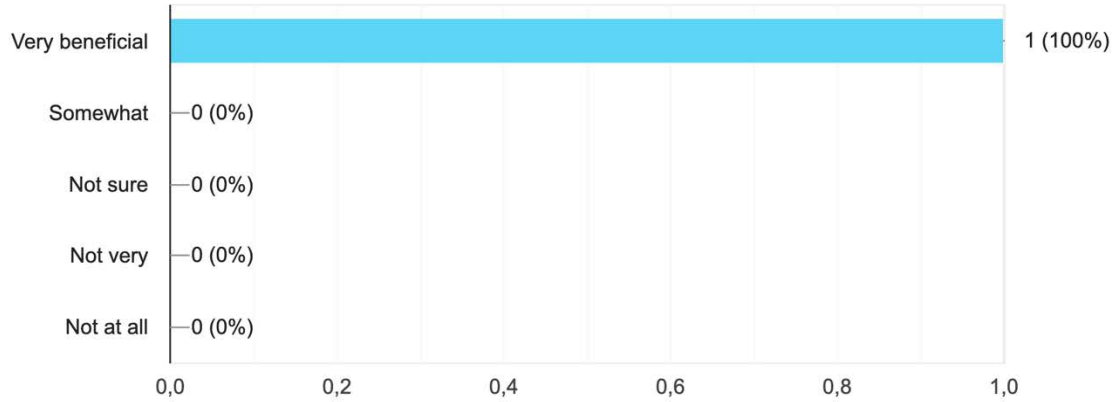
Overall how satisfied were you with the delivery of the Eurofleets+ RV Mário Ruivo Floating University?

1 risposta



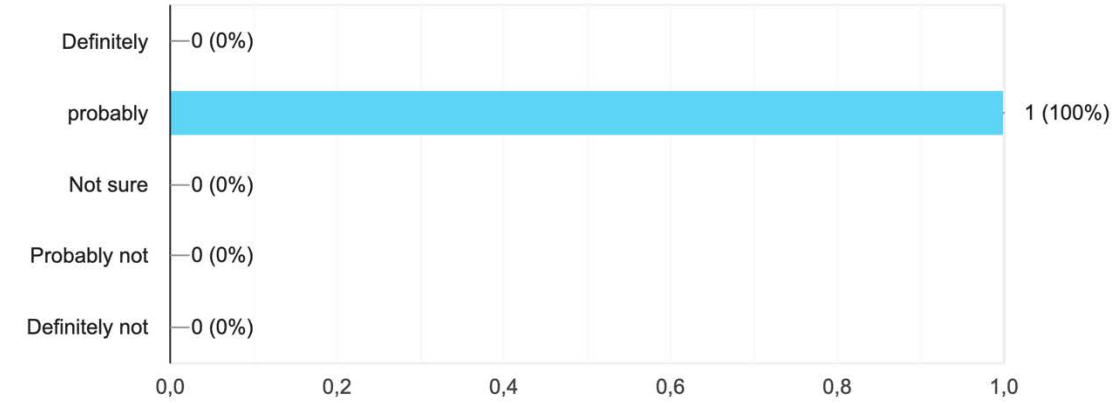
How beneficial do you feel it is to network with other European and International students?

1 risposta



Do you believe the Floating University experience on board the RV Mário Ruivo will benefit your studies and future career?

1 risposta



Please feel you free to comment on the highlights and/or lowlights of the Floating University course:

- In general, FU was a fantastic opportunity and I am very grateful to have been included. This was my first long experience at sea and, in addition to seeing the best sunrises and sunsets, I got to learn how to sample benthic organisms and all the information that can be extracted from them. IPMA staff tried their best to keep a good environment. Everyone was very friendly and open to having students helping them with the biological sampling. However, they all seemed to be extremely overloaded with their own work and still got given additional FU responsibilities. More than once, some had to continue working after dinner. I hope in future occasions there are more staff and fewer guests (there were more than just FU students), to avoid IPMA staff having to overwork like they did during this campaign. They all deserve a medal. Another thing to consider for the future is language. Although my Portuguese improved a lot in those weeks, at the beginning I felt pretty much lost when people were speaking among them. There were two other people that didn't speak Portuguese and I know that they struggled even more than me. I think there was a lot of miscommunication regarding food. I am a vegetarian and the cook was unaware until I told him, already onboard, even though weeks in advance I had filled a form that

specifically asked about this. The cook tried his best with the resources he had, but there were simply not enough sources of protein for me. People onboard told me that in the past vegetarians had brought some food with them (e.g. tofu, seitan, or even legumes) and given it to the cook for him to prepare. This did not even cross my mind. By ticking the option vegetarian in the food requirements, I assumed this would be taken care of. I hope in future campaigns there are more protein-rich options for vegetarian students. Finally, the reimbursement for travel expenses was extremely frustrating. I sent multiple emails and they were ignored for months by both Mafalda and Vera. I tried calling IPMA and leaving messages and I still got no reply. It was not until I contacted Eurofleets directly, that the processed seemed to start moving. It was such a shame that a great experience like Floating University got darkened by slow and rude administration.

Please outline any recommendations you may have for future Eurofleets+ Floating University programme:

- See answer above

Do you think it would be worth the establishment of a permanent EU Floating University programme?

Yes

EUROFLEETS+ Floating University

"Multiple platforms to measure the ocean"

Onboard the R/V Dallaporta

Mazara del Vallo - Sicily, Italy

17-23 September, 2022

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Table of Contents

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Eurofleets+ Floating University

Scientific Participants

Name	*Organization*	*Role*
Francesco M. Falcieri	CNR	Course Leader
Katrin Schroeder	CNR	Lecturer
Mireno Borghini	CNR	Lecturer
Emanuele Organelli	CNR	Lecturer
Romain Cancouët	Euro-Argo	Lecturer
Lorenza Evangelista	CNR	Logistics/administration
Laura Barbieri	CNR	Logistics/administration

Name	Role
Elisa Carli	Student/Participant
Isabell Susan Cox	Student/Participant
Francico Joao Dias Silva	Student/Participant
Sofia Flora	Student/Participant
Antonino Ferola	Student/Participant
Beatrice Giambenedetti	Student/Participant
Caroline Gjelstrup	Student/Participant
Iason Theodorou	Student/Participant

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Course and cruise objectives

The Eurofleets+ Floating University "Multiple platforms to measure the ocean" on board the CNR operated RV Dallaporta took place in September 2022. Designed in collaboration with Euro-ARGO ERIC, was based in the harbor of Mazara del Vallo (Sicily, Italy) and focused on the South-Western coast of Sicily.

The overarching objective of the training programme was knowledge transfer in state-of-the-art oceanographic surveying from scientists and technicians to group of students in different fields of marine sciences. 8 students from 5 European countries (Italy, Portugal, Greece, UK and Denmark) attended a seven days course that started with two days of preparatory training followed by three days of offshore activities onboard the R/V Dallaporta. During the last two days of training a series of group activities gave participants the opportunity to practice their newly acquired skills with a team exercise based on the analysis of oceanographycal data sets.

During the course students took part in modules on the oceanographycal characteristics of the survey area, on field data acquisition systems, data-sets and analysis of seawater samples and autonomous measurements. Survey planning for water mass mapping, site exploration and environmental status were also included.

The lecturers team was composed of several CNR scientists: Dr. Francesco M. Falcieri (course director), Dr. Katrin Schroeder, Dr. Emanuele Organelli and Mireno Borghini; in the framework of the collaboration with Euro Argo Dr. Romain Cancouët participated to the Floating University as a lecturer.

The main topics covered by the lectures and on filed activities were:

- designing and executing an onshore oceanographic survey;
- articulate understanding of the principles and methods applied to seawater measuring with a variety of techniques;
- data acquisition and preliminary data processing for CTD and ADCP systems;
- data acquisition and scientific exploitation of IOPs and AOPs acquired with autonomous robot platforms;
- knowledge on moored systems deployment, recovery and data retrieval;
- knowledge on autonomous platform testing, deployment, recovery and data management (from quality control to data distribution and acquisition);
- complement observations of a variety of variables from multiple platforms;
- perform salinity measurements on seawater samples;
- operate software suites for data visualization (Ocean Data View);
- recognize the interpersonal skills for professional conduct on board research vessels.

The call for applicants was opened and closed in April 2022; the evaluation procedure run in June 2022 and the selection results was notified in July 2022. A total of 24 applications were received, among those 8 students from 5 countries (Denmark, Greece, Italy, Spain and the UK) were selected.

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Nature of the course and work carried out on the course

The EuroFleets + Floating University in Mazara del Vallo and on R/V Dallaporta aimed to provide to participants a comprehensive introduction to the organization and planning of a research cruise (i.e. application for grants, planning, request of access permits, logistics) and to familiarize with the main instruments and methodologies used on field. Students engaged both in lectures from CNR and Euro-ARGO, had the chance to interact with local scientists from CNR IRBIM and with the vessel staff. The lecture program was structured in lectures of 1.5 h, two days of field work and two days of group work.

During the on field training students had the opportunity to do an hands on experience with:

- Euro-ARGO floats programming, deployment, and recovery;
- CTD casts and collection of water samples with rosette;
- Set up, deployment and recovery of a mooring;
- Onboard salinity analysis with a salinometer;

In table 1 a detailed schedule of the Floating University is provided.

Table 1: Detailed agenda of the Floating University

Time	Time	Session	Lecturer
17/09/2022 DAY 1 - Introductory lecture, pre-cruise planning			
9:30	11:00	Introduction of Lecturer, staff and participants, planning, logistics, presentation of participants (1 slide to be prepared in advance)+Introduction to the study area (Katrin, 20 min)	Francesco M. Falcieri Katrin Schroeder
11:00	11:30	break	
11:30	13:00	Ocean Observing System and Platforms	Katrin Schroeder
13:00	14:00	Lunch	
14:00	15:30	design of a campaign (logistics, shipping, custom, meteo, clearances, role of chief scientist) and navigation	Francesco M. Falcieri Mireno Borghini
15:30	16:00	break	
16:00	17:30	Introduction to ARGO and BGC-Argo, application of ARGO-based bio-optics to study the ocean carbon cycle	Emanuele Organelli
18/09/2022 DAY 2 - Instrumentation Orientation			
9:30	11:00	Sensors and CTD post processing	Katrin Schroeder
11:00	11:30	break	
11:30	13:00	Exercise: definition of the stations and cruise plan for the offshore training, sampling schemes and water budgets	Francesco M. Falcieri
13:00	14:00	Lunch	
14:00	15:30	BGC-ARGO data quality control	Emanuele Organelli
15:30	16:00	break	

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16:00	17:30	EURO-ARGO visualization tools	Roman Cancouët
19/09/2022 DAY 3 - Offshore training			
9:00		Meeting at the port to board on the R/V Dallaporta	
		Preparation of the mooring experiment	
		CTD survey and use of salinometer	
17:00		Return to port	
20/09/2022 DAY 4 - Offshore training			
9:00		Meeting at the port to board on the R/V Dallaporta	
		CTD Survey Mooring recovery ARGO deployment and recovery	
		ARGO deployment and recovery	
		Mooring recovery	
17:00		Return to port	
21/09/2022 DAY 5 – on ship activities and data processing			
9:30	11:00	Visit to ship engine room / salinometer analysis / basic nautical knots	Francesco Falcieri Katrin Schroeder Mireno Borghimi Emanuele Orlandini
11:00	14:00	Lunch	
14:00	15:30	ARGO visualization	Emanuele Organelli Roman Cancouët
15:30	16:00	break	
16:00	17:30	Exercises on CTD post-processing + visualization and analysis (Ocean Data View)	Katrin Schroeder Mireno Borghini
22/09/2022 DAY 6 - Screening, analysis and visualization of the survey data			
9:30	11:00	Exercises on CTD post processing + visualization and analysis (Ocean Data View)	Katrin Schroeder Mireno Borghini
11:00	11:30	break	
11:30	13:00	STUDENTS ACTIVITY	Mireno+Katrin
13:00	14:00	Lunch	
14:00	15:30	STUDENTS ACTIVITY	
15:30	16:00	break	
16:00	17:30	STUDENTS ACTIVITY	
23/09/2022 DAY 7 - Poster presentations by the students of their data and findings			
9:30	11:30	Students presentations	all students
11:30	11:45	break	
11:45	12:45	Q&A and Closing session	

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12:45	14:30	Lunch

Course and cruise Log

Pre-Cruise activities and training

Day 1 – September 17th 2022

- **introductory lecture**
- **Ocean observing System and platforms:** the lecture covered the main instruments and platforms that are used to collect ocean data. Specifically: AUVs, R/V, Ships of opportunity, Satellites, moorings, buoys, drifters and floats, gliders, CTD probes.
- **Design of an oceanographic campaign:** the lecture covered the main aspects of planning an oceanographic campaign (i.e. application process, budget, logistics, customs, meteo, clearance, roles on board,...)
- **Introduction to Argo and BGC-ARGO:** the first lecture on ARGO floats was focus on the structure and internal functioning of the instrument and on the sensors that it can host. Moreover, the main aspects of planning an ARGO survey were covered

Day 2 – September 18th 2022

- **Sensors and CTD calibration:** the lecture covered the main aspects of the CTD probe and sensors and their calibration.
- **Exercise: cruise planning:** students, divided into 3 groups, were asked to prepare a cruise plan for the field activities of day 3 and 4 by defining the sampling scheme, schedule and water budget for the rosette.
- **BGC-ARGO data quality control:** this lecture focused on the Biogeochemical ARGO floats
- **EURO-ARGO visualization tool:** practical lecture on how download and process ARGO data.

Day 5 – September 22nd 2022

- the mooring of the 5 day was spent on the R/V Dallaporta with the students divided in two groups that rotated. One on the deck to work with the crew on the basics of navigation (chars, knowts, safety on board) and one analyzing the water samples with the salinometer.
- **Argo visualization:** this lecture focused on the visualization tools and methods for ARGO float data.
- **CTD postprocessing and visualization:** hands on lecture on the most common processing and visualization software (SBE data processing, Ocean data view)

Day 6 – September 23rd 2022

- **CTD postprocessing and visualization:** hands on lecture on the most common processing and visualization software (SBE data processing, Ocean data view)
- students were divided into two groups with the task of writing the cruise report and then analyzing two data-sets collected in the Sicily Channel provided by CNR

Day 7 – September 24th 2022

- **Working group presentations**
- **Q&A closing session**

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

On board operation

Day 3 – September 20th 2022

- 09.00: ship boarding at Mazara's Port
- 09.30: transfer to the mooring deployment site. During transfer the mooring was prepared for deployment by installing the instruments on the chain
- 11.00: mooring deployment
- 12.00: CTD survey. Students rotated between the deck unit and the CTD deployment
- 17.00: return to port

Day 4 – September 21st 2022

- 09.00: ship boarding at Mazara del Vallo and transfer to the study site
- 10.00: preparation of the ARGO float
- 10.30: deployment of the ARGO float
- 12.00: CTD survey and collection of water samples with the rosette
- 17.00: return to port

Preliminary results

This Floating University had just 2 days of on field activities. Those were used mostly to show to the participants how to operate the instruments during on field activities and just a few stations were collected. Students were divided into two groups and each group had write a full cruise report with:

- the description of the instruments used during the cruise;
- a cruise narrative;
- location of each station and deployment;
- a preliminary data analysis;
- calibration of salinity observations between the CTD and the salinometer data.

Given the short duration of the cruise students were provided with data sets collected in the Sicily channel in previous cruises to use as the starting point of a data analysis.

Evaluation of student learning

The last day of the Floating University was dedicated to the presentations of the two working groups. Each group was asked to prepare a cruise report and a presentation based on the Sicily Channel data set provided. During their presentation students were asked additional question and had to support their scientific hypothesis and results. The additional questions were:

1. How has the salinity changed in the Sicilian channel since 1987?
2. How does the mixed layer depth vary spatially and temporarily along the twi transects? And what is its relation to fluorescence ?

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Students course evaluation

After the end of the course participants were asked to answer to an anonymous online survey to address their satisfaction with the organization, lectures, and field activities. Out of 8 students only 5 filled out the questionnaire.

Below are reported all the answers received.

1. Please indicate your gender:

   60% male, 40% female

2. Please indicate your age group:

   18-24 (20%), 25-34 (80%), 35-44(0%)

3. Which of the following best describes your current academic profile?

   PhD (80%), Msc (20%), Meng (0%)

4. How did you know about the Floating University course?

   Eurofleet+ web page (20%), personal contacts (80%), other websites (0%)

5. Please outline your area of special interest or research in Marine Sciences

Physical oceanography	4 replies
Biological oceanography / remote sensing	1 reply

6. Please indicate how satisfied you were with the pre-survey presentations

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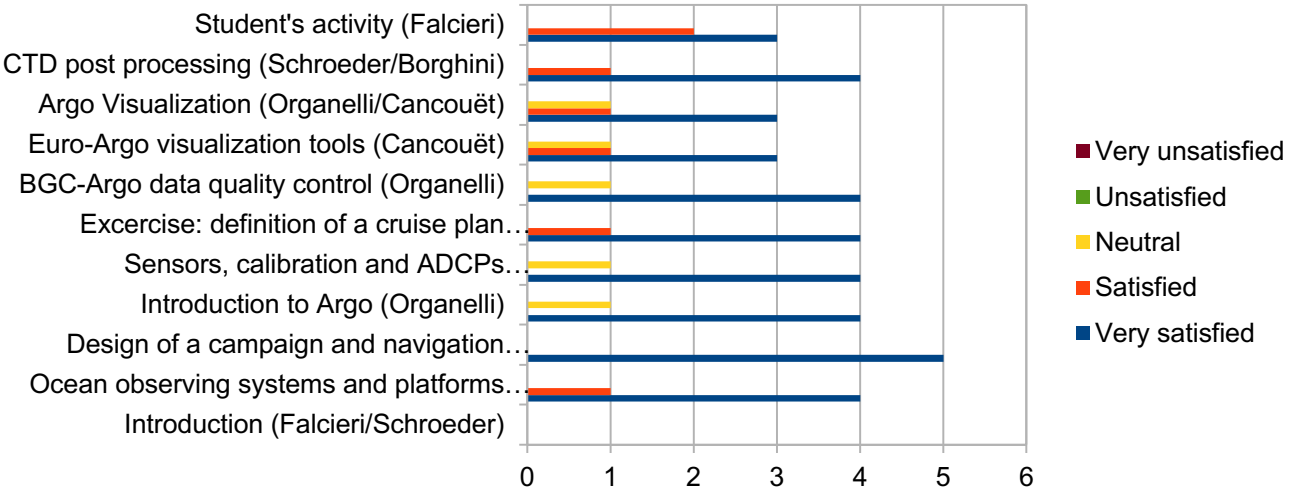

7. Overall how satisfied were you with the delivery of the Eurofleets+ RV Dallaporta Floating University?

Very Satisfied	4
Satisfied	1
Neutral	0
Unsatisfied	0
Very unsatisfied	0

8. How beneficial do you feel it is to network with other European and International students?

Very	4
Somewhat	1
Not sure	0
Not very	0
Not at all	0

9. Do you believe the Floating University experience on board the RV will benefit your studies and future career?

Definitely	3
Probably	2

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Not sure	0
Probably not	0
Definitely not	0

10. Concluding remarks

The Floating University "Multiple platforms to measure the ocean" on R/V Dallaporta provided a unique chance to participants to follow introductory lectures on different aspects of a research cruise (from logistics to planning) and on commonly used instruments. In this Floating University the collaboration with Euro-ARGO gave also the chance to work with a state-of-the-art ARGO float and learn on its operational applications.

Appendix

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

EUROFLEETS+ Floating University

Modern techniques and platforms for ocean observations"

Onboard the R/V Svea (and almost on R/V Skagerak)

Lysekil, Sweden 24-28 October 2022

Scientific Participants

Niklas Andersson (Course leader, UGOT)

Sebastiaan Swart (Teacher, UGOT)

Marcel Du Plessis (Teacher, UGOT)

Estel Font Felez (Teacher, UGOT)

Johan Edholm (Teacher, UGOT)

Bastien Queste (Teacher, UGOT)

Louise Biddle (Teacher UGOT, VOTO)

Ola Kalén (Teacher, SMHI)

Örjan Bäck (On board teacher, SMHI)

Martin Hansson (On board teacher, SMHI)

Björn Lindell (Teacher, SLU)

Nimal Sudhan Saravana Prabahar (Student, Sweden)

Kai Salm (Student, Estonia)

Loizos Groutas (Student, Cyprus)

Sarah Rautenbach (Student, Portugal)

Viviana Belvisi (Student, Portugal)

Yaomei Wang (Student, UK)

Ivia Closset (Student, France)

Fernando Segio Gois Smith (Student, Italy)

Cem Serimozu (Student, Turkey)

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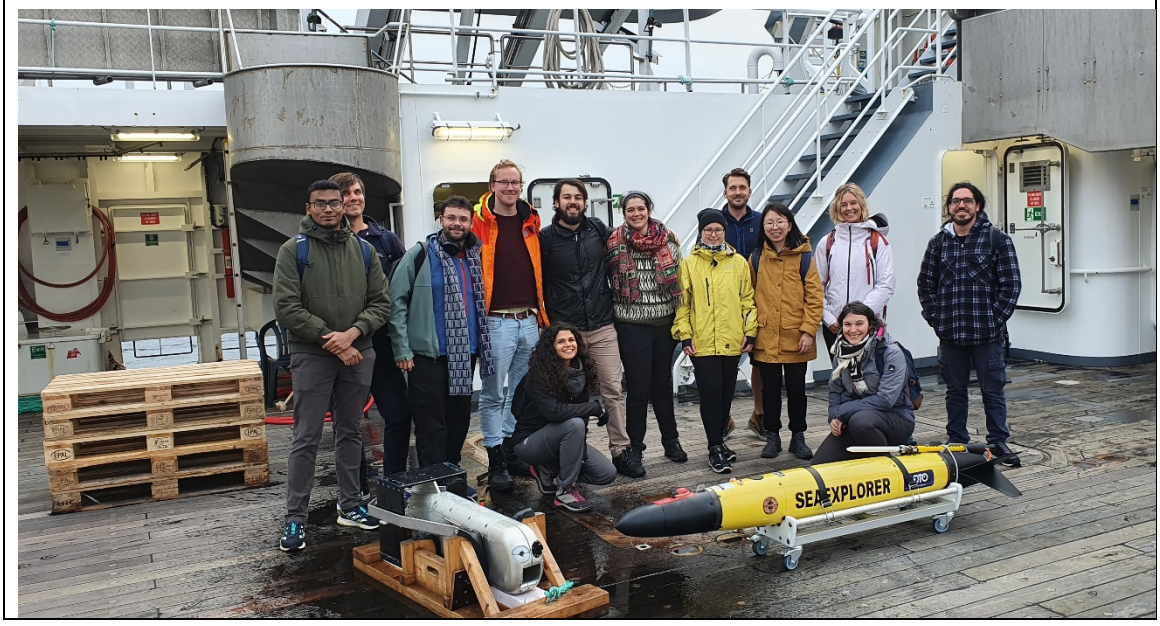
under Grant Agreement No 824077

Eurofleets+ Floating University

Course and cruise objectives



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MULTI
SEAEXPLORER

Eurofleets+ Floating University

This international Eurofleets course exposed the participants to several state-of-the-art ocean observing platforms available in West Sweden. Training aspects include understanding of ship- and robotic-based observing techniques and their associated sensors and measurement capabilities. The course will provide ship time and to deployment of autonomous platforms. Participants Learned about instrument and platform deployments, robotic-platform piloting, to gain understanding of how different platforms collect data and through data processing and visualization, investigate which platforms are best to use for various scientific questions.

The course started with background lectures on the available infrastructure and instrumentation, the scientific rationale, the physical conditions and cruise planning. A glider was deployed in the end of the first day using smaller vessels and the first data from it was presented and processed the day after.

Two days was spent on board RV Svea for data collection with CTD, ADCP, MVP and Ferrybox. The data was then handled in smaller workshop and presented as a group project.

The learning objectives of the course were to:

- *Better understand modern techniques and platforms to collect ocean observations*
- *Go to sea on short research voyages to collect their own observations and deploy/recover instruments*
- *Better understand which types of platforms (e.g. ship vs glider) are suited to make the required measurements/survey*
- *Better understand how certain platforms and instruments function/are controlled remotely*
- *Plot and visualize near-real time data and data type comparisons, including data quality control*
- *Be exposed to examples of how such techniques and data are used in science/monitoring*

SHIPS

RV Svea, https://www.slu.se/rv-svea

The students

Nimal Sudhan Saravana Prabahar (University of Gothenburg, Sweden)

Kai Salm (Tallinn Institute of Technology, Estonia)

Loizos Groutas (University of Nicosia, Cyprus)

Sarah Rautenbach (CCMAR, Portugal)

Viviana Belvisi (University of Lisbon, Portugal)

Yaomei Wang (National Oceanography Center, UK)

This project has received funding from the EU H2020 research and innovation programme under Grant Agreement No 824077

Eurofleets+ Floating University

Ivia Closset (Finnish Meteorological Institute, Finland)

Fernando Segio Gois Smith (Università Degli Studi di Firenze, Italy)

Cem Serimozu (Middle East Technical University, Turkey)

Nature of the course and work carried out on the course

The course was initially designed by a group of teachers, technicians, and researchers at the University of Gothenburg. A draft idea of the course content was already written in the Eurofleets+ grant agreement and with that as a base and the research interests of the available scientists at UGOT we formed an initial plan.

We then had several meetings with RV Svea operators and researchers at the Swedish Agricultural University SLU and the Swedish Meteorological and Hydrographical Institute SMHI to broaden the scope of the course.

The UGOT, SLU and SMHI group decided that one or two days of lectures about the hydrographical and physical background of the area, the capabilities of the vessels, the science available to research with the available equipment and the capabilities and limitations of different platforms was needed.

The students were given the task of being “trainee cruise leader” making them responsible for the on-board activities.

The limited time of the course made the UGOT, SLU, SMHI take the decision that no course report was needed. It was sufficient that the students made presentations and actively participated in a discussion on the last day of the course.

Course and cruise Log

Write a log of the activities carried out day by day

1st day (24 October 2022) – Kristineberg Marine Research Station
Description of activities: Introduction to participants, teachers, course outline and objectives. Scientific background to geographical area, scientific field, available instrumentation, platforms and research vessels.

Glider deployment from small boats.

2nd day (25 October 2022) – Kristineberg Marine Research Station
Description of activities: Continued scientific background. Cruise planning. Starting to look at glider data. Start of discussion on advantages and disadvantages of different platforms.

3rd day (26 October 2022) – RV Svea
Description of activities: Safety briefing on research vessel. On board lectures on equipment. Measurements with Ferrybox, ADCP, CTD and MVP.

4th day (27 October 2022) – *RV Svea*
Description of activities: Continued measurements with Ferrybox, ADCP, CTD and MVP. Glider recovery with RV Svea’s working boat. Looking at data. Preparing presentations.

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5th day (28 October 2022) – *Kristineberg Marine Research station*
Description of activities: Preparing student's presentations. Presentation. Departure.

On board operation

- Sampling methodology: MVP, CTD rosette; ADCP, Ferrybox and SeaExplorer glider

Preliminary results

The students found the data from MVP, CTD, ADCP and glider consistent.
The students saw the differences between different sampling methods and understood capabilities and limitations between research vessels and gliders and other autonomous platforms.
Their conclusion was that both research vessels and autonomous platforms are needed in the research of today and the future.

Evaluation of student learning

The students presented their work in a join oral presentation. Participants and evaluators were present both in the room and virtually. Each individual student had to show what they had learned during the week.

Students course evaluation

"Everything was PERFECT, so my suggestion is just to keep the same format. Everybody will probably suggest more time but, to be honest, the short time to make the decisions due to the deadlines was super important to push the group."

„That structure and organization is key for efficient and continuous data acquisition. To see the redundancy of (meta)data documentation during the CTD casts was surprising and impressive at the same time. By doing so, it appears that the sampling can be reproduced on a regular base and that the data can be trusted as it was collected with so much care."

„Platforms for marine observation have very distinct advantages and disadvantages. The lectures and the practical experience with them provided a good comparison of their strength and weaknesses."

„The classes in the first two days were well structured, starting with some basic information about the Fjord and the surrounding environment as well as introductions into the different instruments. It was great that the cruise planning had to be done by the students and the teachers were there only to guide us. This experience was unfamiliar but was great to face that challenge together in a team.

The two days on Svea were sufficient to understand the instruments and the different deployments and data acquisition, which left us enough time after to process and interpret the data and putting it all together in a presentation."

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Concluding remarks

A very intensive course with lots of information in only 5 days. Students were happy with the opportunity to plan their own cruise and compare research vessels and autonomous platforms. The students wished the course was longer so they could get an even better understanding of the data.

Appendix

Agenda

Final presentation

This project has received funding from the EU
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	Monday 24 okt, Lecture day	**Place**	**Lecturer**
8:00	Breakfast	Mässen	
9:00	Arrival, introduction of participants,	Fyren	Niklas Andersson
10:00	Coffee	Mässen	
10.15	Outline and objectives	Fyren	Niklas
10:45	Gliders	Fyren	Louise Biddle, UGOT/VOTO
11:30	Kattegatt, Skagerack, Gullmarsfjord Hydrography	Fyren	Niklas
12:00	Lunch	Mässen	
13:00	Start of cruise planning, deadline Tuesday 16.00	Fyren	Niklas
15:00	Glider deployment	Small vessel	Bastien, Johan
16:00	Glider deployment	Small vessel	Bastien, Johan
17:00	Tour of Kristineberg		Niklas
18.00	Dinner	Mässen	

	Tuesday 25 october,		
8:00	Breakfast	Mässen	
9.00	Overview and plan of the day. Housekeeping	Fyren	Niklas
9:15	ADCP	Fyren	Ola Kalén, SMHI
10.15	Coffee	Mässen	
10.30	Lectures/discussion: ● scales (spatial.- temporal) ● Ship instrumentation ● Processes/dynamics that could be interesting to identify ● Weather conditions (windy) ● Current data:Brief look at the glider data	Fyren	Seb Marcel Johan
12:00	Lunch	Mässen	
13.00	Continue morning discussions and cruise planning	Fyren	
14.00	R/V Svea capabilities	Fyren	Björn Lindell, Lasse Thorell, Bochra Boudiaf
14.30	Continued cruise planning		
16.00	Deadline cruise plan to Svea		

18:00	Dinner	Mässen	

	Wednesday 26 Oct, RV Skagerak and RV Svea		
7:00	Breakfast	Mässen	
7.30	Departure to Lysekil		Estel, Marcel, Johan
7.55	Ferry departs Fiskebäckskil brygga		
8.30	Safety briefing, Svea		
9.00	Departure, on board instruments CTD, ADCP, etc	RV Svea	Svea Tech
12:00	Lunch	RV Svea	
16.40	Ferry back to Fiskebäckskil		
16.00	Deadline cruise plan to Svea		
17.00	Data analysis	Fyren	Johan, Estel
18:00	Dinner	Mässen	

	Thursday 27 october, RV Svea		
7:00	Breakfast	Mässen	
7:30	Walk to ferry		Estel, Bastien
8:30	Departure Svea	Lysekil	
12:00	Lunch		
15.00	Glider recovery		Estel, Bastien
16:00	Ship return to Lysekil		
17.00	Data analysis	Fyren	Estel, Johan
18:00	Dinner	Mässen	

	Friday 28 october, Reporting day		
8:00	Breakfast	Mässen	
9:00	Writing presentations	Fyren	Marcel available online
12:00	Lunch	Mässen	
14:00	Student presentations	Lyktan Zoom	Niklas, Louise N Online: Eurofleets, GROOM
16:45	Bus 845 departs		


Eurofleets+
An alliance of European marine research infrastructure
to meet the evolving needs of the research and industrial communities
www.eurofleets.eu


GROOM II
GLIDERS FOR RESEARCH, OCEAN OBSERVATION &
MANAGEMENT : INFRASTRUCTURE AND INNOVATION

Eurofleets+ Floating University

Gullmar Fjord, 24-28 October 2022

The Final Presentation:

An overview from the students

Belvisi Viviana
Closset Ivia
Grouta Loizos

Salm Kai
Saravana Nimal
Serimozu Cem

Smith Fernando
Rautenbach Sarah
Wang Yaomei

Eurofleets+
An alliance of European marine research infrastructure to meet the evolving needs of the research and industrial communities

UNIVERSITY OF GOTHENBURG

SLU
SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

SMHI

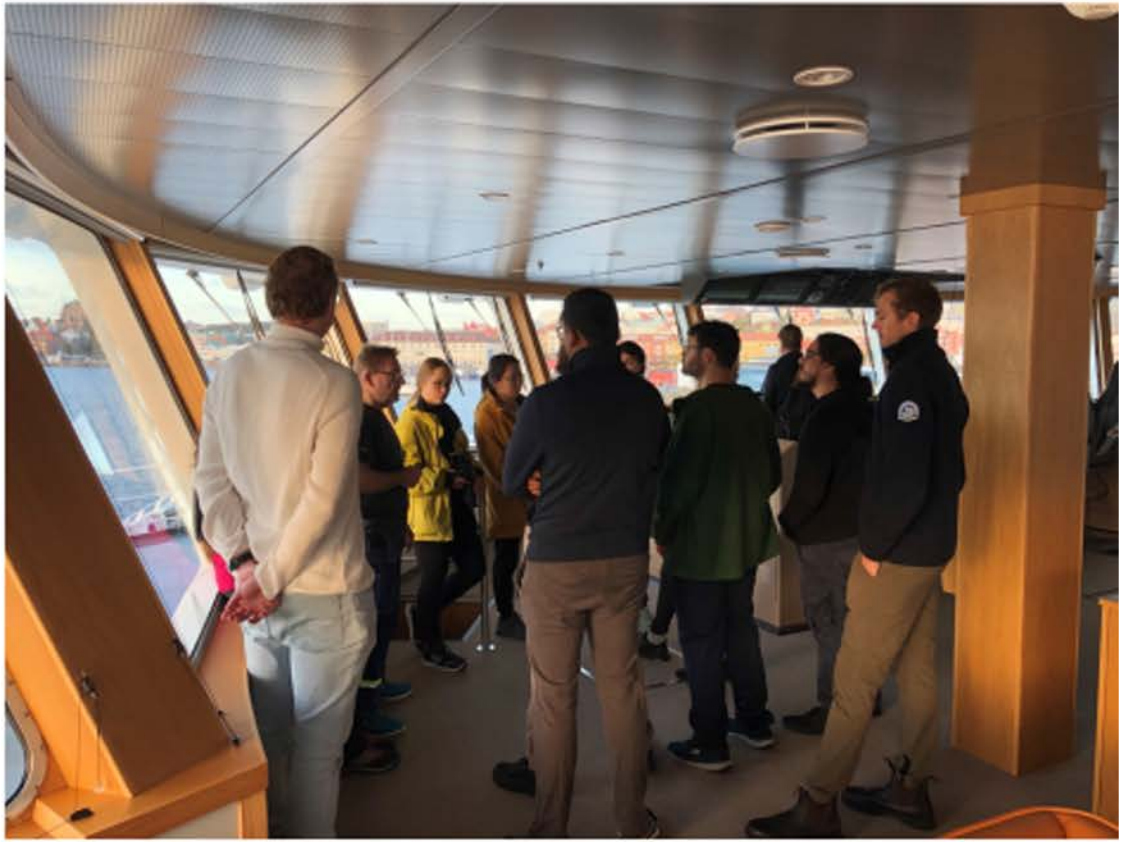
GROOM II

Introduction

Eurofleets Floating University course was an opportunity to learn, to experience, to share point of views and thoughts about scientific issues and innovative systems and instruments in marine research.

This presentation resumes the work done during these four full-immersion days.

We will show the results from a scientific point view, instruments used and their advantages and disadvantages.



Gullmar Fjord Setting

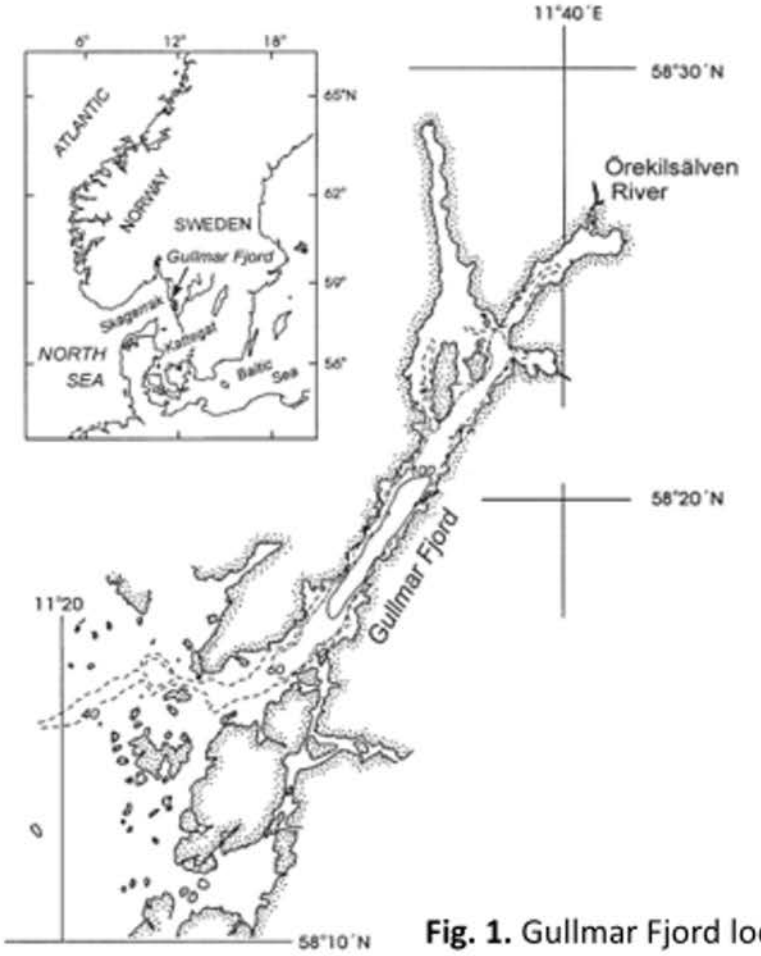


Fig. 1. Gullmar Fjord location.

Gullmar Fjord is located on the Swedish west coast. It is oriented southwest to northeast, it is 28 km long and 1–2 km wide (Fig. 1). The sill depth is 42 m, and maximum depth is 120 m. The fjord's deep basin, below 100 m, is approximately 5 km long and 1 km wide. The adjoining Skagerrak largely determines the hydrography of the fjord (Rydberg 1977). The water masses in the fjord are stratified and three layers can be recognized.

Scientific Questions

(1) Water mass distribution within the Fjord? How do we explain them? Where do they come from?

(2) How are the currents/water mass motion within the Fjord?

Optional questions:

(3) Are they internal waves, can we identify them?

(4) Temporal variation of biological activity/Primary production?

Methods: Station Maps

RV Svea

Glider (virtual mooring for 3 days)

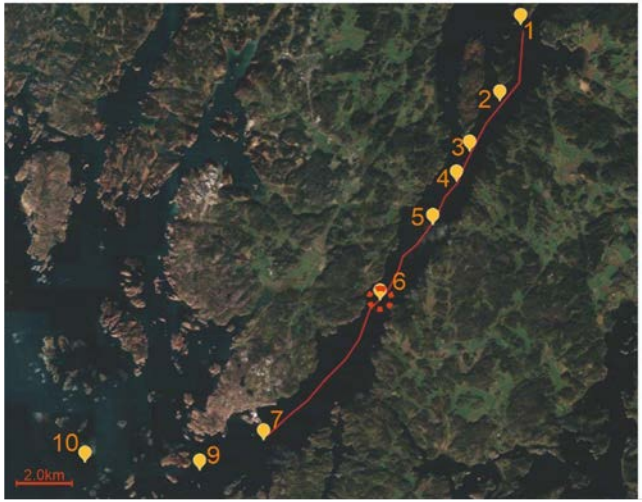
CTD (9 cast along the Fjord)

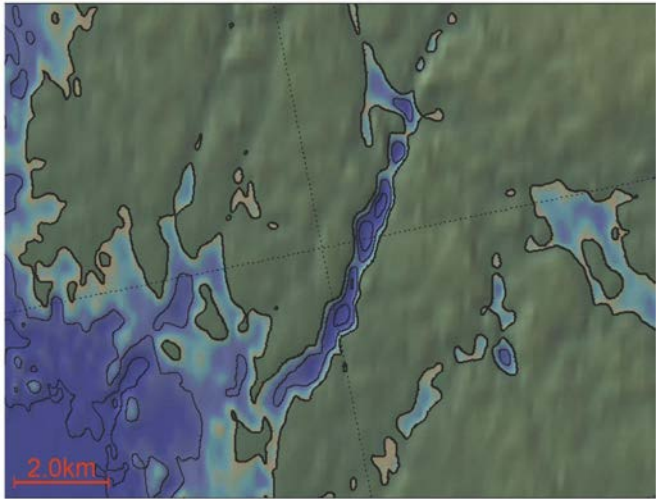
MVP (3 deployments along the Fjords)

ADCP (turn on all the time)

Water samples (nutrients - data not used, one station)

(Ferrybox - data not used)





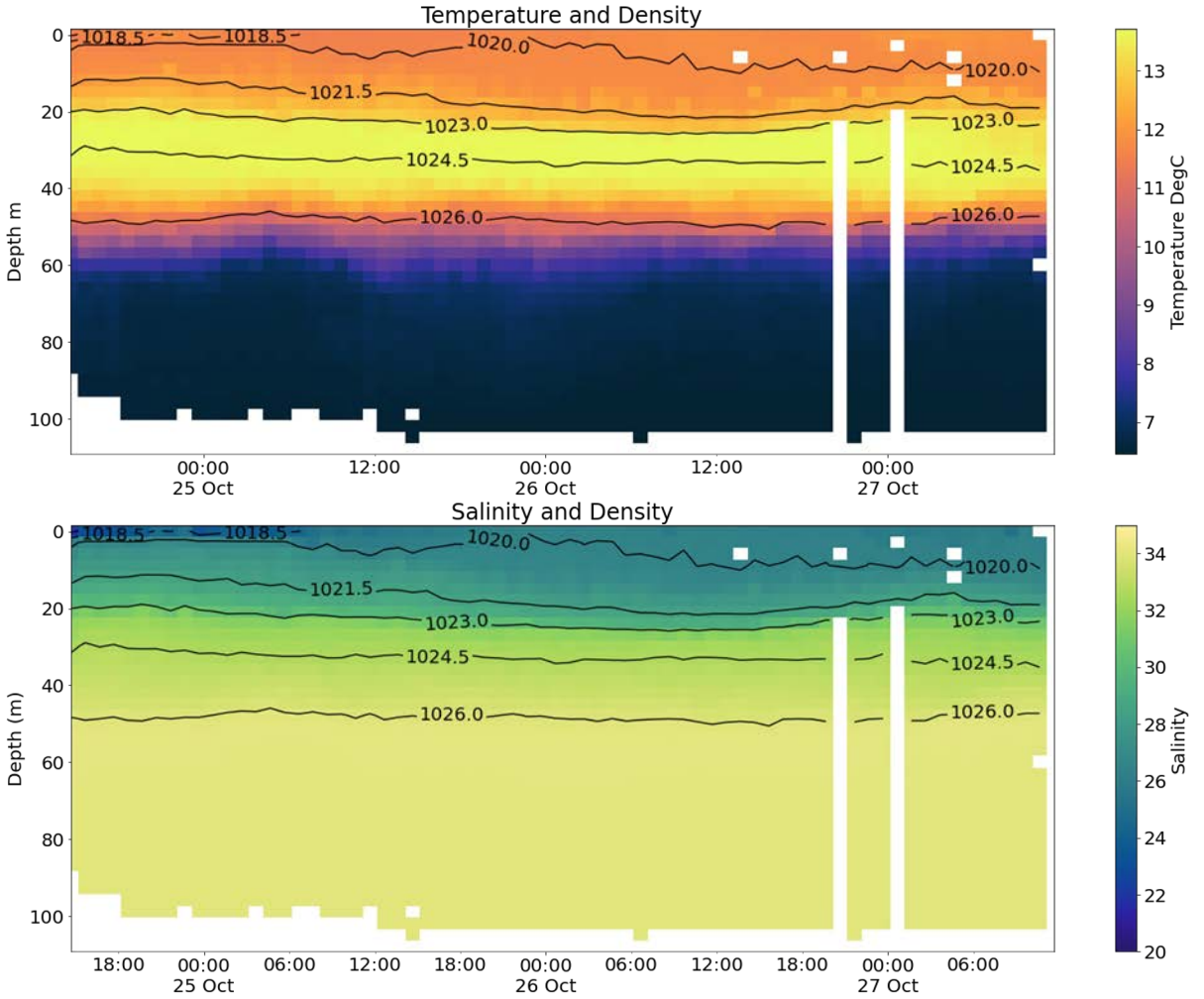

SVEA


SEAEXPLORER

Glider results

Hydrology

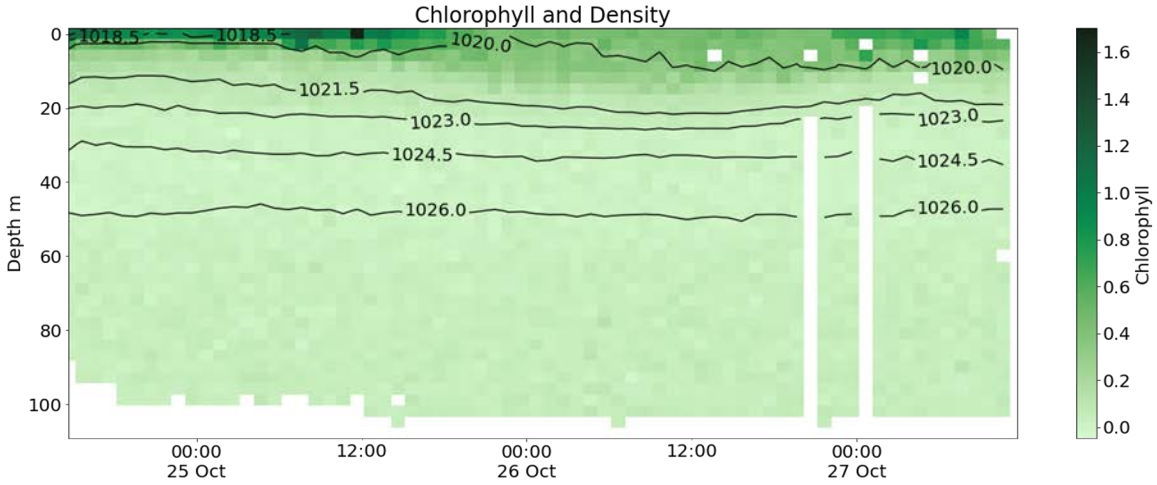
- Higher stratification at the beginning -> rain
- Warmer subsurface temperature
- Salinity controls density
- Internal waves (Temp)

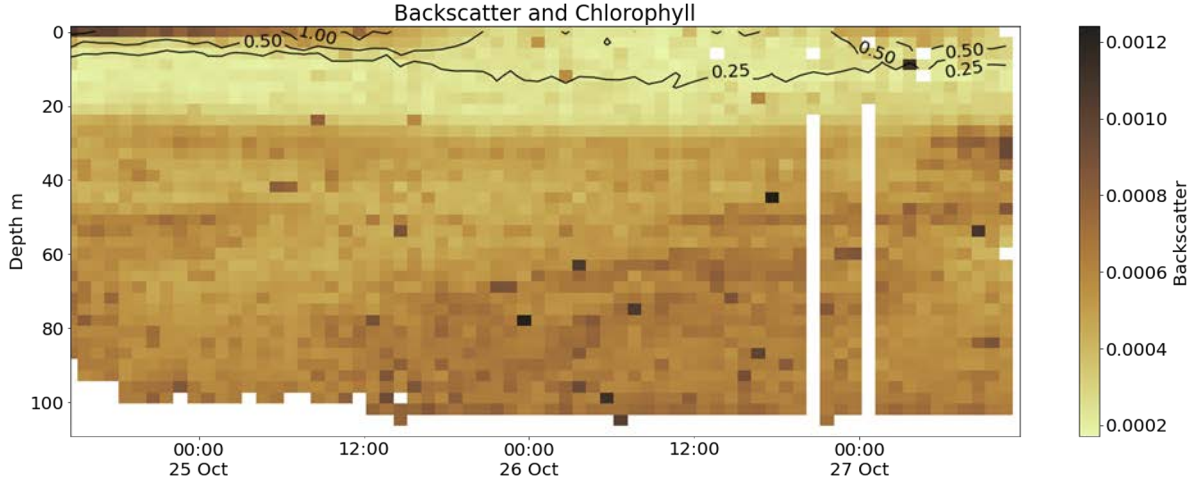


Glider results

Biology

- Higher chlorophyll a when water is stratified
- Backscatter = particles
- At the surface backscatter and chlorophyll a are correlated

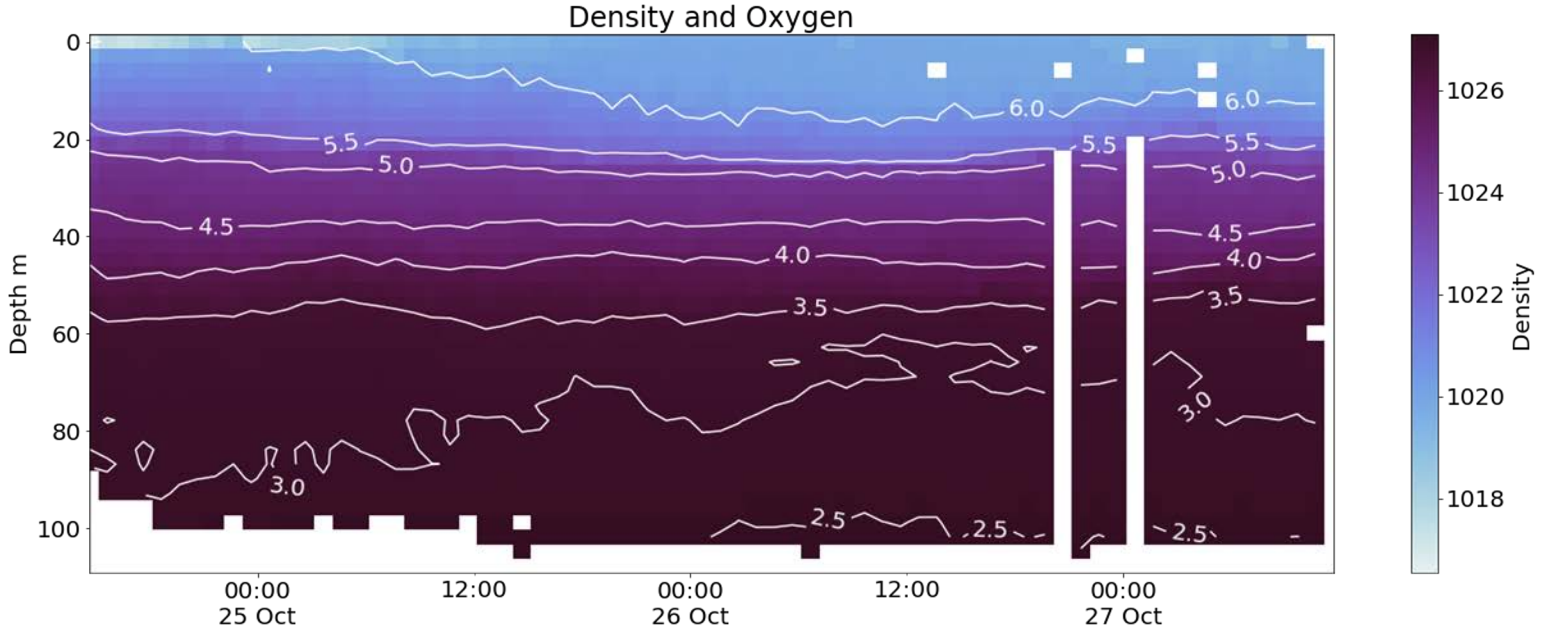




Glider results

Oxygen

- Higher oxygen at the surface -> deepen with time
- Low oxygen at the bottom -> expand with time

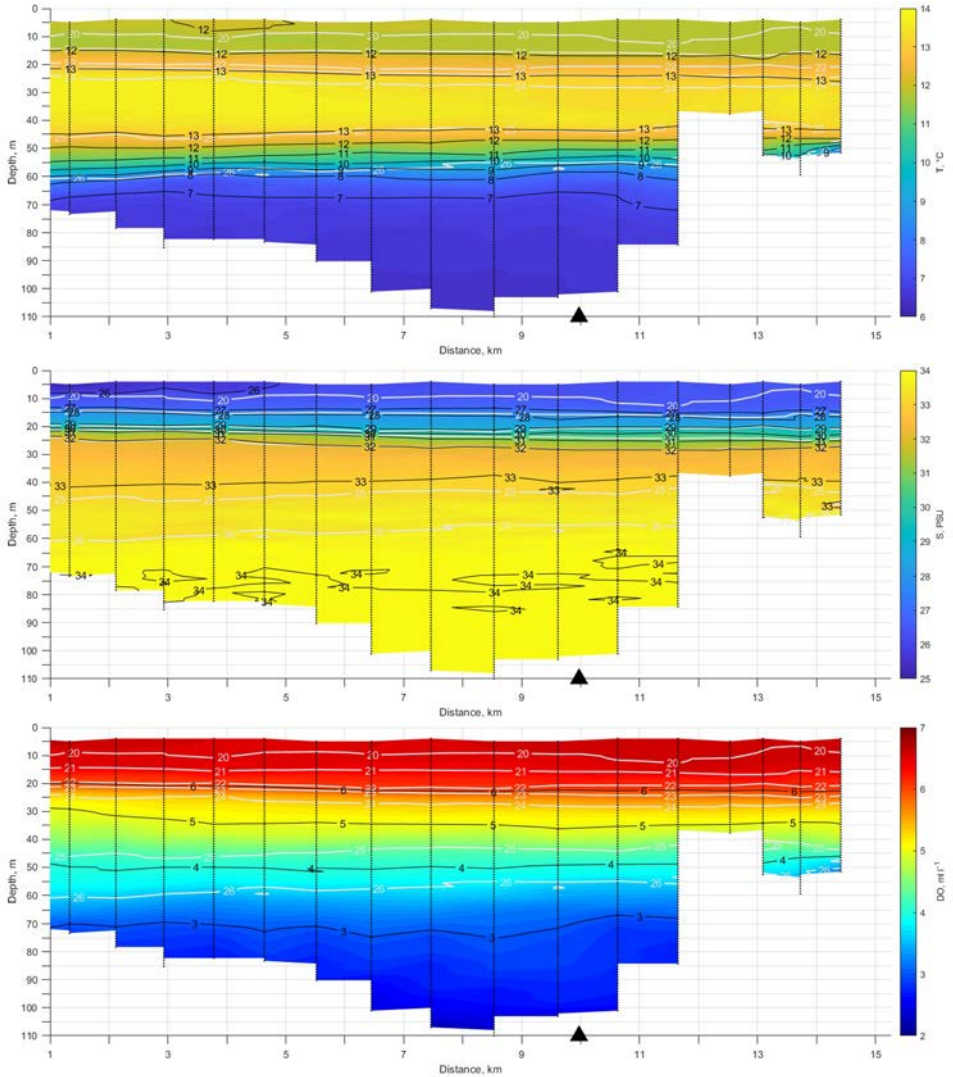


MVP results

Three MVP sections

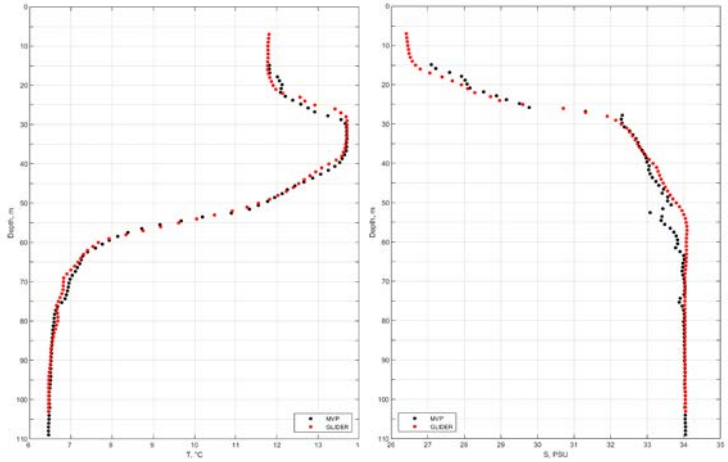
section on 27.10.2022 →

Glider location with black triangle

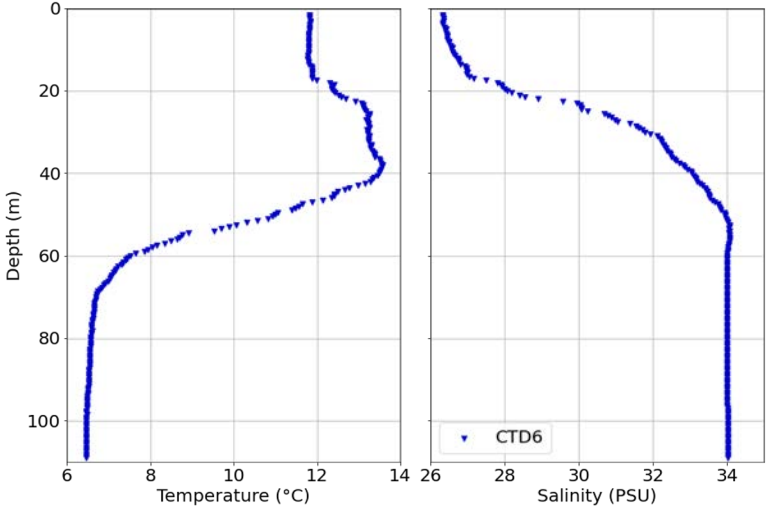


MVP results

MVP (red dots) and GLIDER (black dots) profiles on 26.10.2022 afternoon

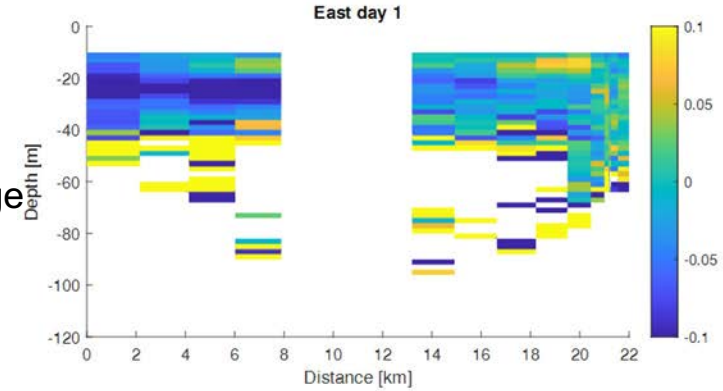


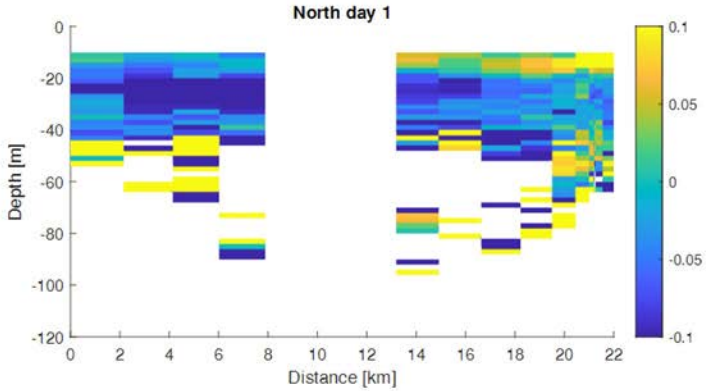
CTD (blue dots) profile on 27.10.2022



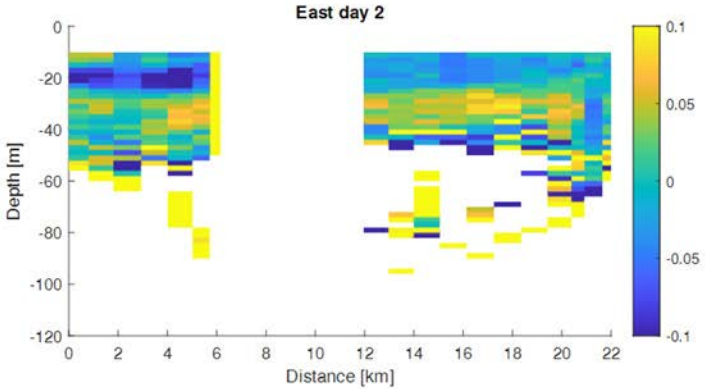
ADCP Workhorse 600 Results

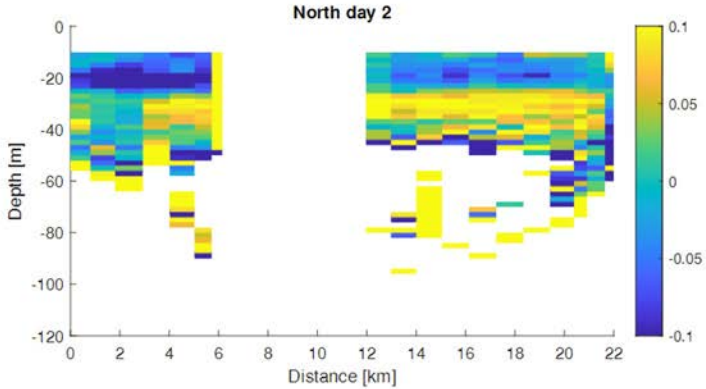
- OS insufficient resolution
- Gap WH due to insufficient range
- 1st bin at 10m depth
- Bin size 2 m





- Distinct surface current at 20 m
- Noise below sill depth





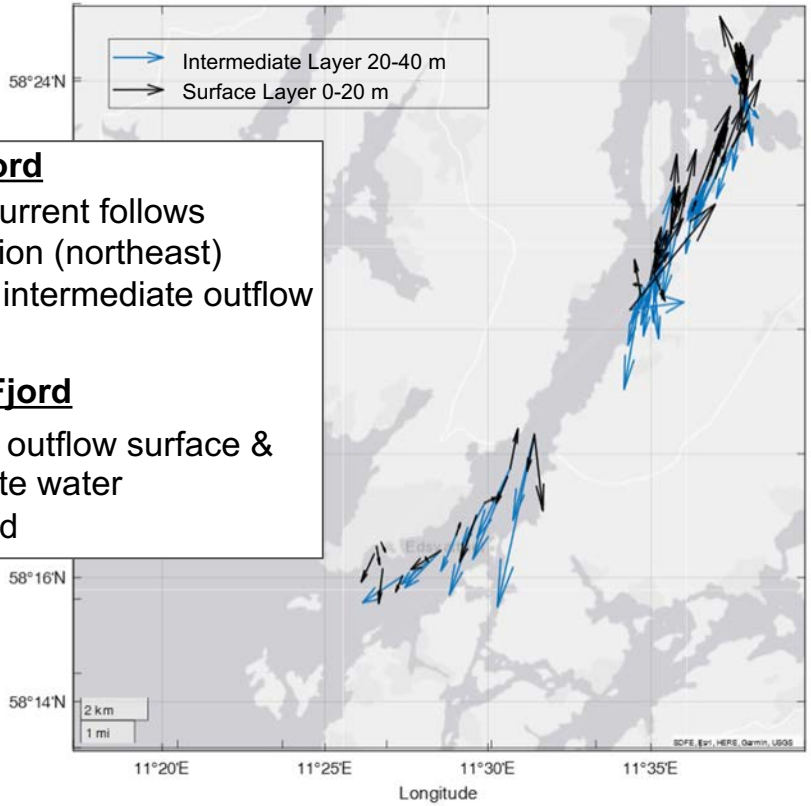
ADCP - October 26th

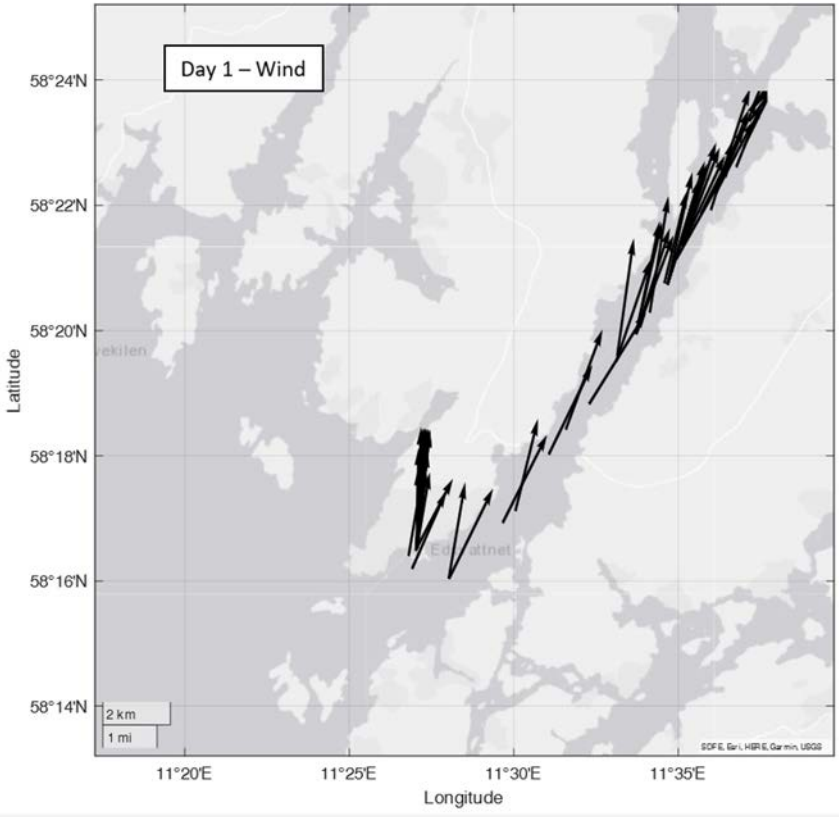
Inside Fjord

>Surface current follows wind direction (northeast)
>Southern intermediate outflow
>stratified

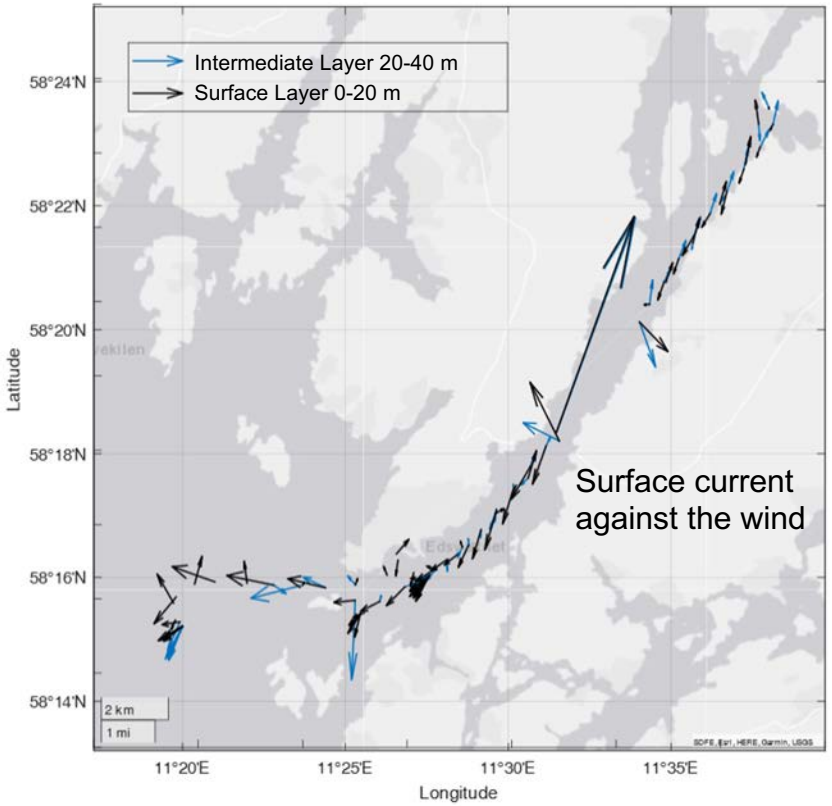
Outside Fjord

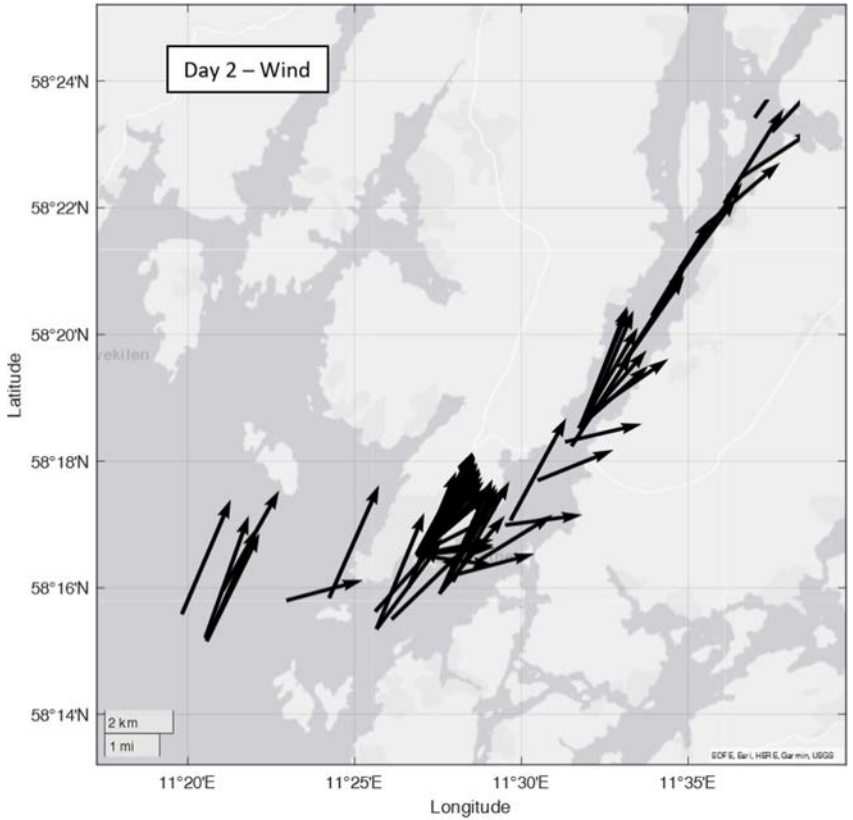
>Southern outflow surface & intermediate water
>well mixed





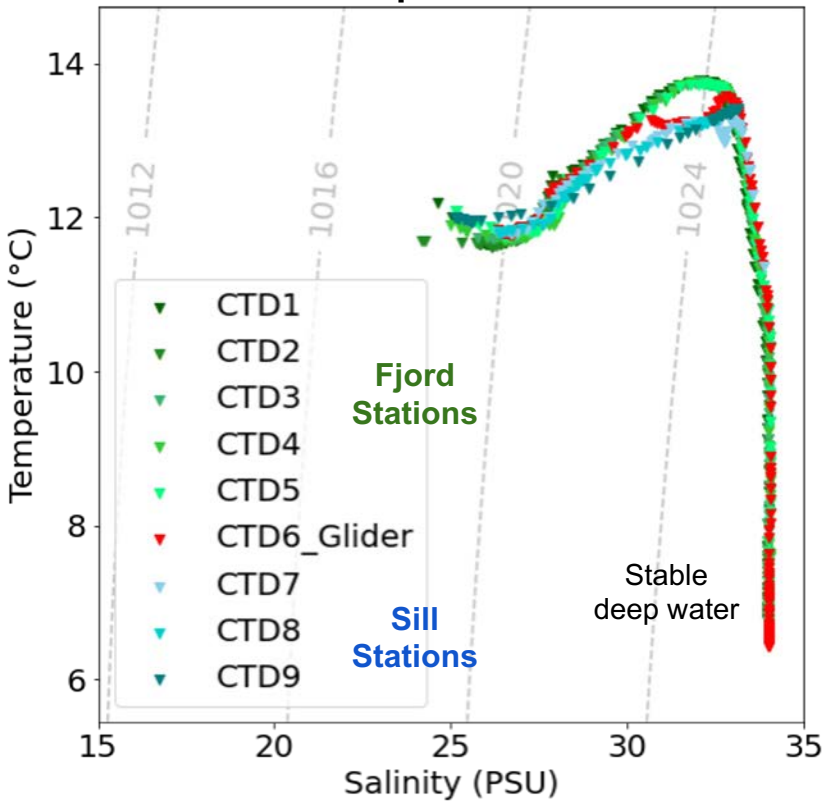
ADCP - October 27th



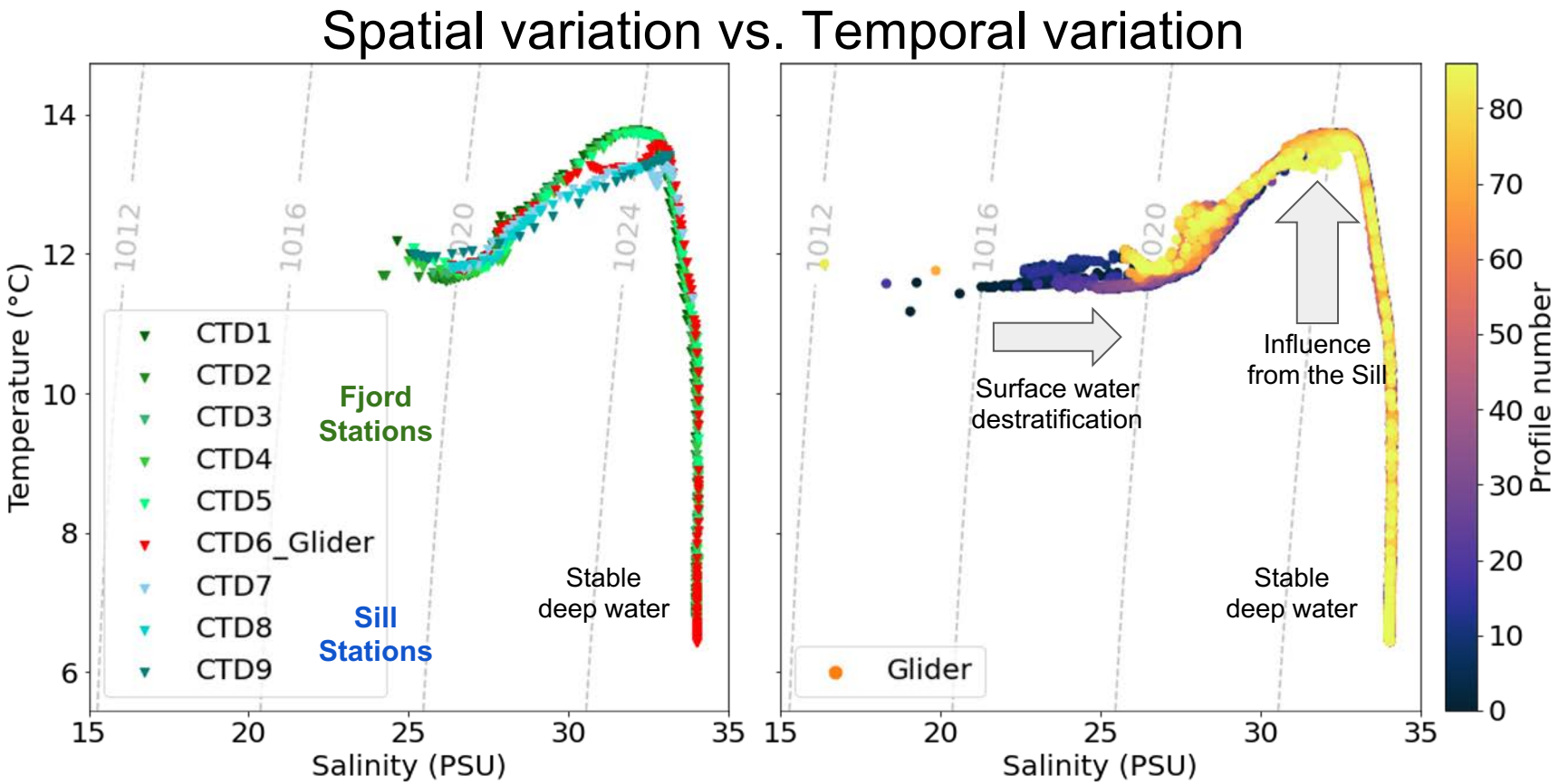


Water mass distribution

Spatial variation vs. Temporal variation



Water mass distribution



Instrument intercomparison

RV Svea with ADCP

FerryBox

CTD-rosette

MVP

SeaExplorer Glider

Techniques and platforms to collect ocean observations

Mobility	Median	Median	Low	Low	High
Autonomy	Median	Median	Low	Low	High
Deployment cost	Median	Median	High	High	Low
Response speed	Median	Median	Low	Low	High
Capability	Low	Low	High	Median	Median
Data volume	Median	Median	Low	Low	High

Sailbuoy

Autosub5

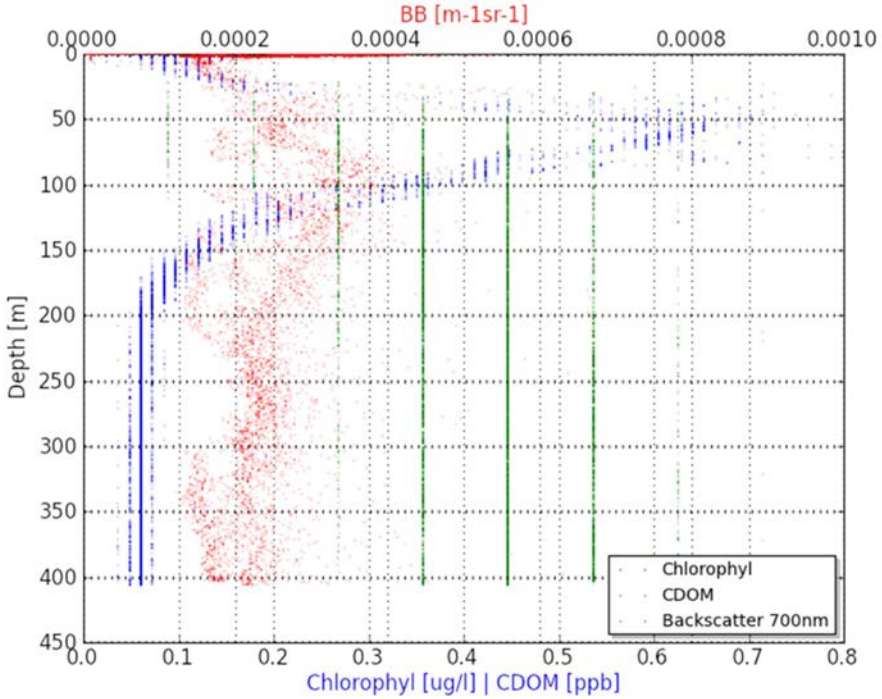
Mobility: under ice, deeper ocean, solar system (NASA BRUIE)

Quick response: helicopter speed: 140 knots; RV Svea: 11 knots

Data volume:Autosub (MVP, CTD, ADCP, FerryBox, BioCam, Water sampler)

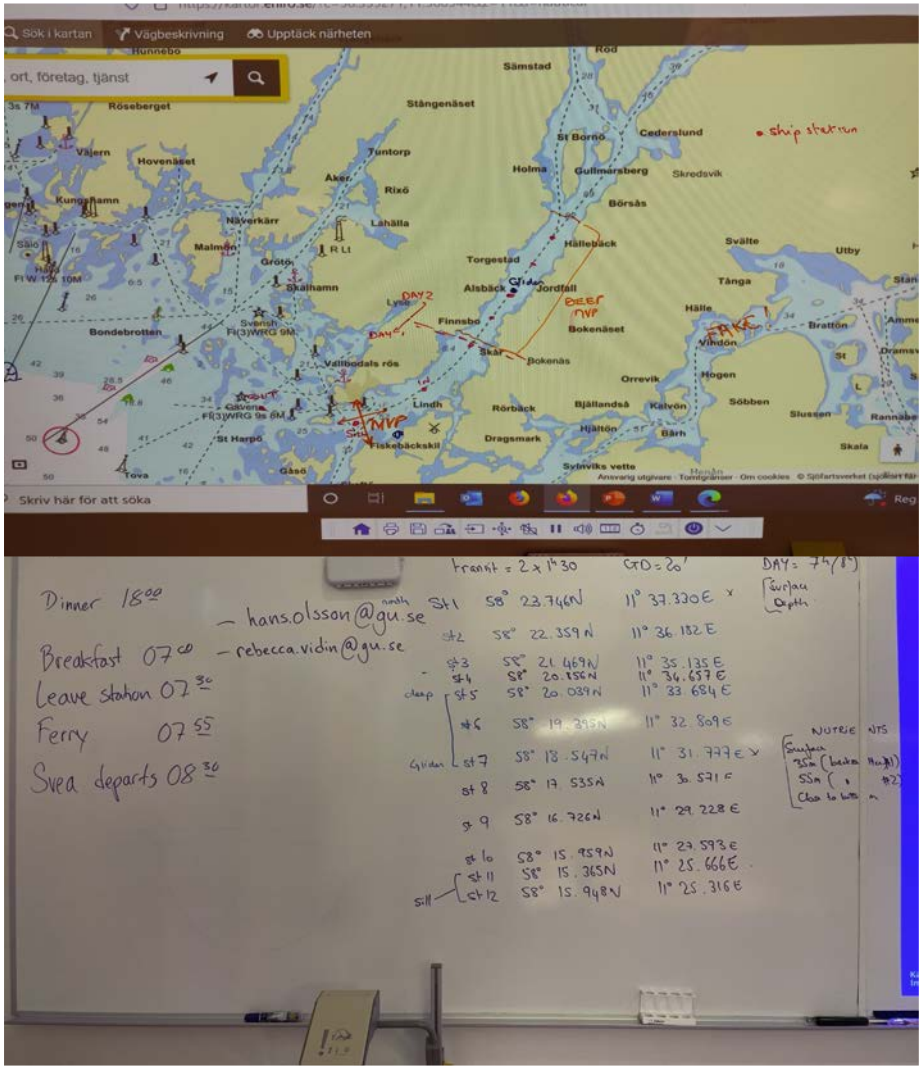
Data processing

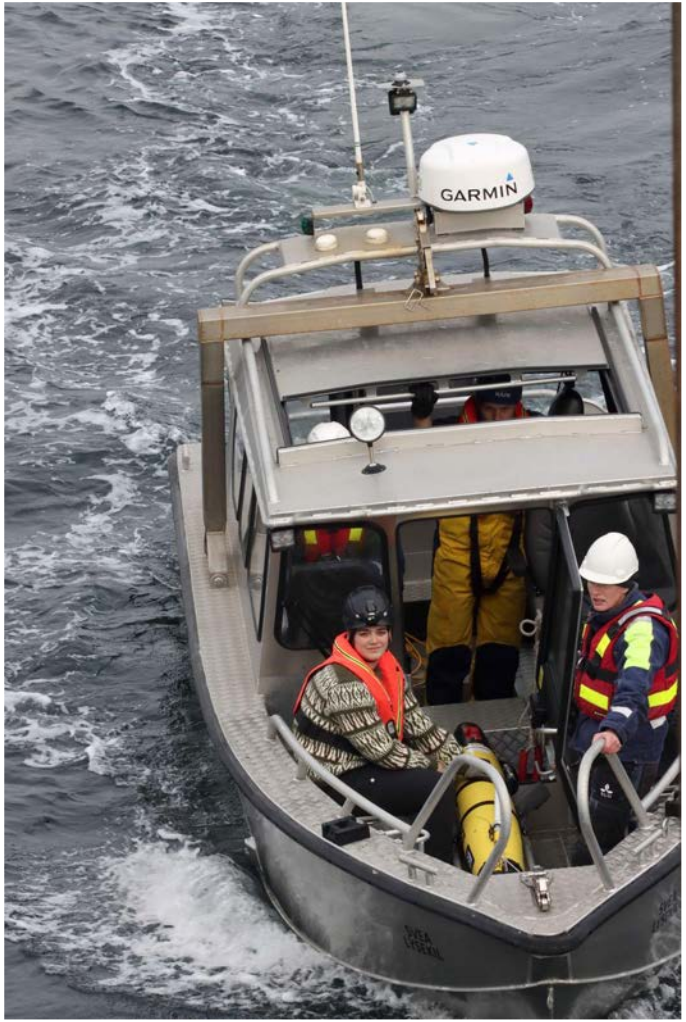
1. Calibration of sensors
2. Comparison with previous results
3. Specifications (1)Precision (2)Accuracy
4. Sensor properties (1)Fluorescence: ambient light (2)Backscattering: bubbles from waves



Eco Puck performance from ACSA ALCEN

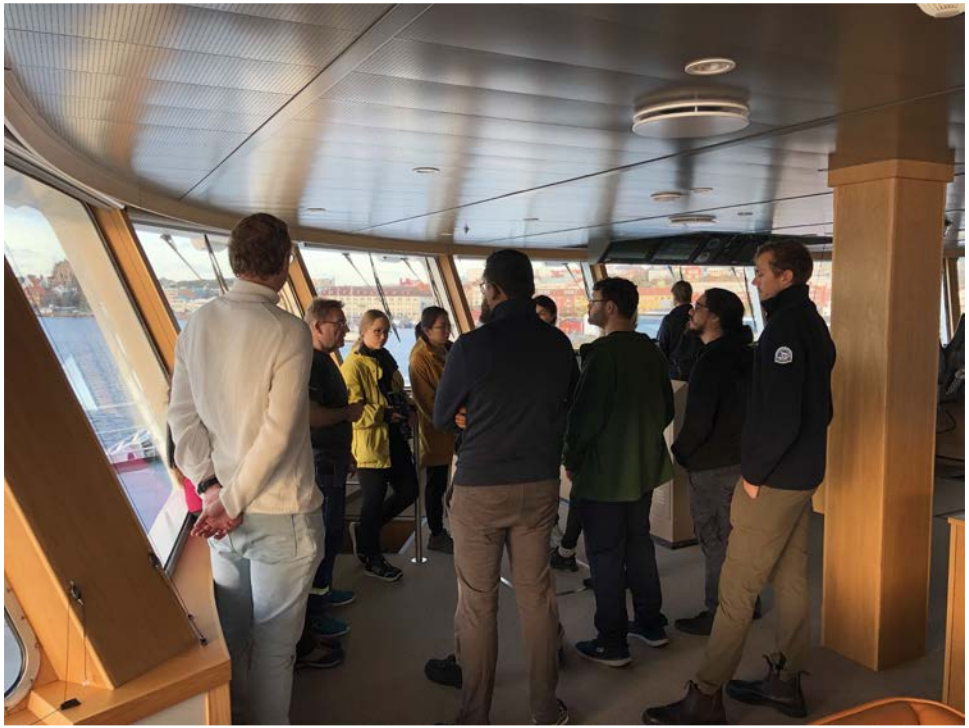
Cruise Planning




GARMIN


SEAEXPLORER

Thank you!



Questions ?


Science and Education for Sustainable Life
SVEA