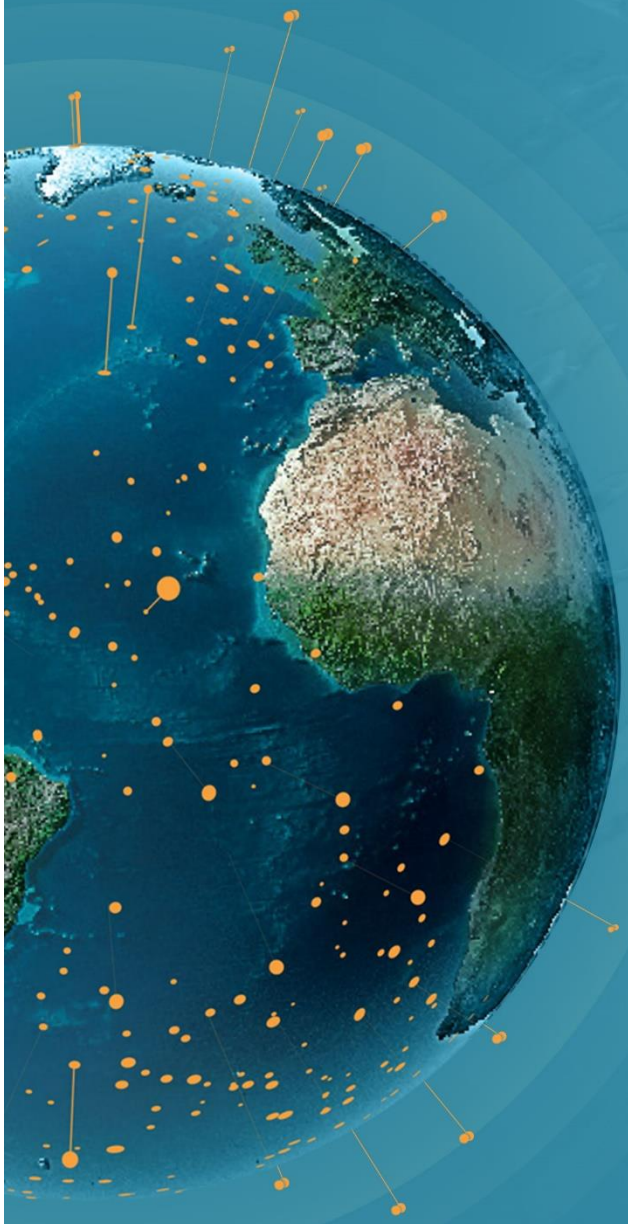


# ALL-ATLANTIC OCEAN RESEARCH ALLIANCE

Creating an Atlantic Ocean Community by Implementing the Galway and Belém Statements

# AA-MARINET Report – I/ITAPINA line of activity:

## Network activities and Roadmap

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement


## Report Identifier

| | |
|---|---|
| Report name | **AA-MARINET Report – I/ITAPINA line of activity – Network Activities and Roadmap** |
| Related Project title | All AtlaNtic Cooperation for Ocean Research and innovation |
| Related WP | WP7 - Convergence and Alignment of R&I Infrastructure Initiatives |
| Joint Pilot Action name | All-Atlantic Marine Research Infrastructure Network (AA-MARINET) |
| Related JPA Task | Task 6.1 I/ITAPINA Pilot action - Task 6.1.1 - I/ITAPINA session (at ASLO Aquatic Sciences meeting) and workshop (after ASLO Aquatic Sciences meeting) |
| Authors | Rainer Kiko (Sorbonne University) |

## Disclaimer



## Copyright





AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


## ALL-ATLANTIC JOINT PILOT ACTIONS

Following a year-long collaborative process among more than 70 stakeholders at the Atlantic level, the All-Atlantic Ocean Research Alliance Multi-Stakeholder Platform, divided into 5 sub-multi-stakeholders platforms, identified more than 1000 initiatives towards strengthening marine research and innovation collaboration at the Atlantic level, 56 gaps and 79 needs/recommendations to achieve the All-Atlantic Ocean Research Alliance ambition, guided by a total of 20 Strategic Objectives, 20 Operational Objectives, and 10 Key Performance Indicators.

Based on these findings and on the idea of collaboration, alignment, and use of existing resources, they have developed six ambitious and long-term collaborative Joint Pilot Actions:

- All-Atlantic Training Platform (AA-TP)
- All-Atlantic Aquaculture Technology and Innovation Platform (AA-ATiP)
- All-Atlantic Marine Biotechnology Initiative (AA-BIOTECMAR)
- All-Atlantic Data Enterprise 2030 (AA-DATA2030)
- All-Atlantic Blue Schools Network (AA-BSN)
- All-Atlantic Marine Research Infrastructure Network (AA-MARINET)

This report is developed by the **All-Atlantic Marine Research Infrastructure Network (AA-MARINET)** Joint Pilot Action, that provides tools to support a transatlantic network of Research Infrastructures initiatives, promoting Trans-National Access and other methods for sharing infrastructures in the Atlantic area. It will work as a platform where stakeholders can share information about planned observation activities and available spare capacities, creating a forum where thematic networking and synergies will bring a better articulation of infrastructure-related activities in the Atlantic basin, improving the support of multidisciplinary science to address global societal challenges.

This report is a deliverable in scope of AA-MARINET, I/ITAPINA line of activity, task 6.1.2 “I/ITAPINA session (at ASLO Aquatic Sciences meeting) and workshop (after ASLO Aquatic Sciences meeting)” that aimed to organize one “I/ITAPINA scientific session + workshop”. The suggested outcomes for this task were a “workshop report and I/ITAPINA roadmap (including activities to spread tools, to provide transnational access to the respective hardware and to aggregate the resulting data)”.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 818395.

## CONTENTS





AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


## SUMMARY

I/ITAPINA is a networking activity, implemented under the umbrella of AA-MARINET All-Atlantic JPA and supported by the All-Atlantic Ocean Research Alliance. I/ITAPINA aims to build the All-Atlantic Pelagic imaging community and to develop a framework for operational marine ecosystem monitoring with pelagic imaging techniques via a "Distributed and Operational Pelagic Imaging Network". This report refers to task 6.1.2, which initially related to a scientific session at the ASLO Aquatic Sciences meeting 2021 and physical I/ITAPINA workshop to be conducted in conjunction with the ASLO Aquatic Sciences meeting. During this workshop a roadmap for pelagic imaging should also have been developed. Due to the COVID19 pandemic, the ASLO meeting and the I/ITAPINA workshop were conducted as an online only events. We hence, in addition to the original plans, I/ITAPINA worked together the AtlantECO training school in 2022, and was able to (1) teach pelagic imaging techniques in the AtlantECO training activity, (2) conducted an Underwater Vision Profiler User Meeting at Villefranche-sur-Mer as a hybrid event, (3) conducted an online only lecture series, (4) developed the roadmap via online consultations and (5) established the website for I/ITAPINA, as well as a mailing list. The statutes for I/ITAPINA were also established under task 6.1.1. (see the respective report for further details). The present report on Task 6.1.2 provides a summary of the remaining activities and makes recommendations for the future development of I/ITAPINA.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


# 1. Task objectives

Imagine/Imaging the Atlantic - A Pelagic Imaging Network Approach (I/ITAPINA) is a networking activity, implemented under the umbrella of AA-MARINETv and supported by the All-Atlantic Ocean Research Alliance. I/ITAPINA aims to build the All-Atlantic Pelagic imaging community and to develop a framework for operational marine ecosystem monitoring with pelagic imaging techniques. The term "pelagic imaging" refers to the growing field of applications that aim to image all objects that drift or swim in the ocean, including planktonic organisms such as microscopic algae, crustaceans and jellyfish, detrital particles, plastics, as well as fish and in principle even whales. Commercially available and custom-built pelagic imaging instruments, such as the UVP5/UVP6, the Zooscan, the Video Plankton Recorder and others already are used by a loosely organized research community.

I/ITAPINA will help to consolidate this community and strengthen it in South Atlantic countries, which are slightly underrepresented in the community. Network members are encouraged to share data, code, knowledge and instruments for pelagic imaging. Long-term objective of I/ITAPINA is the development of pelagic imaging towards operationality. I/ITAPINA was originally led by Dr. Rainer Kiko (Sorbonne University, France, now at the GEOMAR Helmholtz Centre for Ocean Research Kiel, Germany; I/ITAPINA lead and lead of the European & North American node), Prof. Rubens M. Lopes (Sao Paulo University, Brazil; I/ITAPINA co-lead and lead of the South American node) and Dr. Margaux Noyon (Nelson Mandela University, South Africa; I/ITAPINA co-lead and lead of the African node). Dr. Margaux Noyon left science at the end of 2022 and Dr. Yavouwi Dodji Soviadan (Sorbonne University, France & Universite Lomé, Togo) has taken over her responsibilities.

Task 6.1.2, "I/ITAPINA session (at ASLO Aquatic Sciences meeting) and workshop (after ASLO Aquatic Sciences meeting)", initially had the objective to kick start the I/ITAPINA activities and to develop a roadmap for pelagic imaging.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

# 2. Description of the work

## a. I/ITAPINA session at the ASLO Aquatic Sciences meeting 2021 and the I/ITAPINA workshop

Due to the COVID19 pandemic, the I/ITAPINA session at the ASLO Aquatic Sciences meeting 2021 and the I/ITAPINA workshop were conducted as online only events on the 26th June 2021 (I/ITAPINA session) and on the 28th and 29th June 2021 (I/ITAPINA workshop).

Twelve presentations were given at the scientific session and these served as a basis for the following workshop. Recordings of all presentations can be found at https://www.aa-mari.net/itapina-events/aslo-2021-aquatic-sciences-meeting/.

The following online workshop was attended by in total 192 participants. During the workshop the goals and plans for I/ITAPINA were presented by the I/ITAPINA lead, Dr. Rainer Kiko. The different I/ITAPINA members then presented past and ongoing pelagic imaging work and reported on future plans. Open discussions at the end of both days enabled a further platform for exchange. The meeting report and recordings of all presentations and discussion rounds can be found at https://www.aa-mari.net/itapina-events/first-i-itapina-workshop/ (see also Annex I – agenda and Annex II – Meeting Report).

The workshop and meeting made I/ITAPINA known in the community and several new members were attracted to the network. In addition, a mailing list for all members was established following the meeting, and content for the I/ITAPINA website was collected (e.g. information about protocols, instruments and other resources, to be found at https://www.aa-mari.net/i-itapina-online-resources/).

## b. Underwater Vision Profiler User meeting

The Underwater Vision Profiler User meeting took place in Villefranche-sur-Mer, France on the 15th and 16th September 2022. The meeting was funded using AANChOR seed funds and co-sponsored by MOPGA-TAD (a third party funded project of Dr. Rainer Kiko) and Sorbonne University (meeting venue).

In total, the meeting was attended by 30 people in person and 30 further online participants. All presentations and discussions were recorded and these recordings, as well as the meeting report can be found at https://www.aa-mari.net/itapina-events/first-underwater-vision-profiler-user-meeting/. (see also Annex III – agenda and Annex IV – Meeting Report).



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


## c. I/ITAPINA online lecture series - Open course on "Advances in marine pelagic ecology: Imaging an Ocean of Change"

The I/ITAPINA online lecture series on "Advances in marine pelagic ecology: Imaging an Ocean of Change" was initiated by the I/ITAPINA co-leader Prof. Rubens M. Lopes and held between the 24th June and 20th September 2022. The course was open to graduate students, post-doctoral investigators, technicians, and scientists interested in expanding their background and establishing potential collaborations with colleagues from countries around the Atlantic basin and beyond. The open online course was attended by 30 to 100 participants. The following lectures were given:

- **24th June: Course introduction History of plankton imaging**
  Speaker(s): I/ITAPINA coordinators; Mark Benfield, Louisiana State University, U.S.A.
- **5th July: Harry Nelson & Savannah Judge - FlowCAM applications in plankton studies**
  Speaker(s): Harry Nelson & Savannah Judge, Yokogawa Fluid Imaging Technologies, U.S.A.
- **26th July: HAB monitoring in the Gulf of Mexico with the Imaging FlowCytobot**
  Speaker(s): Lisa Campbell, Texas A&M University, U.S.A.
- **9th August: Applying the ZooGlider and acoustics to study plankton dynamics in the California Current**
  Speaker(s): Mark Ohman, Scripps Institution of Oceanography, U.S.A.; Sven Gastauer, Thünen Institute of Sea Fisheries, Bremerhaven, Germany; Jeffrey S. Ellen, NIWC, San Diego, California, USA
- **16th August: Plankton communities seen through in-situ digital holography**
  Speaker(s): Aditya Nayak, Florida Atlantic University, U.S.A.
- **23th August: Observations on the biological pump over small scales**
  Speaker(s): Melissa Omand, Schmidt Ocean Institute & University of Rhode Island, U.S.A.
- **30th August: Exploring the abundance, composition, and structure of ocean plankton through digital imaging**
  Speaker(s): Fabien Lombard, Institut de la Mer de Villefranche, France
- **6th September: Resolving biogeochemical processes via pelagic imaging**
  Speaker(s): Rainer Kiko, Institut de la Mer de Villefranche, France
- **13th September: Machine learning for plankton and particle imaging**
  Speaker(s): Jean-Olivier Irisson, Institut de la Mer de Villefranche, France


AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

- **20th September: CPICS and HABStats, the Raman Imaging Flow Cytometer**
  Speaker(s): Scott Gallager, Coastal Ocean Vision

Recordings of all presentations can be found at https://www.aa-mari.net/itapina-news/advances-in-marine-pelagic-ecology-imaging-an-ocean-of-change-open-course/.

## d. Roadmap for pelagic imaging

The roadmap for pelagic imaging – which initially should have been an outcome of the first I/ITAPINA workshop – was developed during online consultations of Dr. Rainer Kiko, Prof. Rubens Lopes, Dr. Yavouwi Dodji Soviadan and Prof. Lars Stemmann, based on the experiences made during I/ITAPINA.

The roadmap is available at https://www.aa-mari.net/wp-content/uploads/2023/02/I_ITAPINA-roadmap.pdf (see also Annex V) and will be further developed through discussions with I/ITAPINA members.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

## 3. Outcomes

Work in task 6.1.2 resulted in the successful establishment of the I/ITAPINA network. In total, I/ITAPINA has now 265 members, many of whom attended the different I/ITAPINA activities (see Annex IV).

I/ITAPINA has led to further exchange within the community, organised several relevant and appreciated events and established the basis for further extension, e.g. via coordinated research programs.

Overall, I/ITAPINA has highlighted the great potential of pelagic imaging for environmental monitoring, basic and applied research. In the following sections – set in italics – we repeat a few of the main findings and statements of the I/ITAPINA "Roadmap towards a distributed and operational pelagic imaging network". Please refer to https://www.aa-mari.net/wp-content/uploads/2023/02/I_ITAPINA-roadmap.pdf (and Annex V) for the complete document.

*"""Laboratory-based and in situ imaging instruments now generate information on plankton and particle abundance, diversity and size distribution with an unprecedented sampling frequency, comparable to that achieved with environmental probes and orbital sensors. Underwater camera systems can be remotely operated from research vessels, on autonomous floats or connected to mooring arrangements to perform observations at relevant spatial and temporal scales. This has led to a revolution in the way we interpret marine ecological processes because instead of integrating plankton diversity, abundance and biomass across depth layers or long time intervals, as achievable with traditional plankton net sampling, researchers can now "see" the aquatic world with much higher resolution than before."""*

*"""Several scientific communities spread in different continents have initiated regional, disciplinary (phytoplankton, or zooplankton) or instrument specific networks that are already used in monitoring programs (Campbell et al., 2013; Benedetti et al., 2019)."""*

*"""However, the user communities of the different imaging devices (e.g. IFCB, UVP, Flowcam, PlanktoScope, Zooscan) are often not formally organized and in particular they are not interconnected. Hence, these spread networking efforts will obviously benefit from further communication that would make protocols, instrument descriptions, QC procedures, data analysis repositories and databases interoperable and accessible for all users. However, the concept of a distributed and operational pelagic imaging network goes beyond such simple communication."""*

*"""The goal of a distributed network is the sharing of resources, to accomplish a common objective (Balda, Braveem, 2015). In a strict sense, "distributed network" is a term from computer science that describes a*



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

*network of interconnected computer networks, which are orchestrated to deliver a final data product or service. For our purposes, we can extend this concept to also include digital pelagic imaging devices.*

*Operational oceanography aims to provide routine oceanographic information needed for decision-making purposes and depends on sustained research and development. A multi-platform observation network, a data management system, a data assimilative prediction system, and a dissemination/accessibility system are the core components of operational oceanographic systems (Davidson et al., 2019). The time lag between data acquisition and product provisioning needs to be short enough to enable decision making at the necessary time scale. Hence, for pelagic imaging approaches this needs to be on the order of hours to weeks, if we aim to catch and react to the high frequency and short time events occurring in the ocean (frontal dynamics of eddies, harmful algal blooms, processes related to ebb and tide). Currently, such a time lag is reached in only a few cases (UVP6 on Argo floats, phytoplankton monitoring using the Imaging Flow Cytobot). In most other cases, it takes several months to years for the data obtained with an imaging device to become publicly available, and such data might not be converted into indicators suitable for decision making. Further digitalization of the entire pipeline from image to open access data and the automation of data aggregation and modeling tools will enable us in the near future to deliver products for decision makers that are based on several different, distributed imaging techniques (e.g. covering different size-ranges and stemming from different research groups), possibly even integrated with other environmental sensor data. Once the framework is established, users (scientists and monitoring agencies) can select an imaging strategy adapted to their context, but can also automatically contribute with their datasets to a wider context and thereby benefit research and society in several ways."""*

*"""To reach the goal of a Distributed and Operational Pelagic Imaging Network, we first of all need the pelagic imaging research community to embrace this concept and to commit to the open science approach of operational oceanography. In particular, data needs to be released directly after recovery. To enable this, funders need to recognize the extreme value of pelagic imaging approaches and the added value of an operational pelagic imaging network. It will increase the value of funding that goes into individual imaging approaches, as it promotes the connected reuse of data and hence provides higher level products. However, this distributed network requires support for coordination, development, maintenance and infrastructure that funding agencies need to consider.*

*We recommend the following voluntary activities that will pave the way towards a distributed and operational Pelagic Imaging Network:*

*- Promote discussions at all levels - international, local, high-level, informal - on the current status and future of pelagic imaging in marine and freshwater environments.*



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

*- Raise awareness for the importance of plankton for global food security, ocean health and global biogeochemical cycles*

*- Further develop imaging instruments and server hardware via the integration of technological improvements in camera and computer development. Backwards compatibility should be considered during these developments, to e.g. enable the maintenance and consistency of long-term time series.*

*- During development, prioritize the establishment of low-cost approaches (such as the PlanktoScope), which will increase applicability in developing countries, for citizen scientists and generally can result in widespread adoption of pelagic imaging techniques. The inter- and intra comparability of new instruments, their data processing tools and data output should also be considered.*

*- Further develop data pipelines that enable the fast/automated processing and upload of image data to central server systems or archives. These server systems/archives should also enable the automated download of images and/or data by higher level network components.*

*- Establish and maintain repositories for best practices guidelines, processing software, benchmark image datasets, research datasets and derived products. A first collection of such tools can be found at https://www.aa-mari.net/i-itapina-online-resources/.*

*- Train the next generation of scientists, not only in the use of single imaging devices, but also teach how different image datasets can be merged and how artificial intelligence and network tools can be used to process the data.*

*- Consider and enable the integration of imaging data with other data types, in particular environmental data such as temperature, salinity, oxygen concentration and nutrient levels, but also other data types such as genetic data should be archived together, or linked with the image data.*

*- Develop pelagic imaging based environmental indicators and products to reduce the costs and increase the spatial and temporal resolution of environmental monitoring approaches."""*

The I/ITAPINA co-leads are dedicated to further push the idea of a "Distributed and Operational Pelagic Imaging Network". To enable this, the I/ITAPINA website should be maintained, including the support to make changes to the website by sciencecrunchers.com. Further support via the funding of a person to conduct outreach and administration support (approximately 4 months per year; to be located at GEOMAR or at PLOCAN), for the publication of the I/ITAPINA roadmap in an open access journal, as well as for an



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

informal gathering of I/ITAPINA members at the ASLO Aquatic Sciences Meeting would be welcome to further develop the I/ITAPINA network. The overarching idea of a "Distributed and Operational Pelagic Imaging Network" should receive dedicated funding to enable the establishment of core components of such an approach.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


# Annex I – I/ITAPINA Workshop Agenda, 2021

**I/ITAPINA: Imagine/Imaging The Atlantic**
**– A Pelagic Imaging Network Approach**

**I/ITAPINA aims to build the All Atlantic Pelagic imaging community and to develop a framework for operational marine ecosystem monitoring with pelagic imaging techniques.**

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

**We cordially invite you to join the first I/ITAPINA workshop to be held on the 28th and 29th June 2021.**

**Monday, 28th June:** Existing infrastructure, data sources and needs.

12:00 - 12:20 UTC: Rainer Kiko - I/ITAPINA workshop program and goals

12:20 - 13:30 UTC: Partners presenting imaging activities and projects (Chair: Lars Stemmann)

| | |
|---|---|
| Ralf Schwamborn | (Federal University of Pernambuco, Brazil) |
| Rubens M. Lopes | (University of São Paulo, Brazil) |
| Margaux Noyon | (Nelson Mandela University, South Africa) |
| Klas Ove Moeller | (Helmholtz Center HEREON, Germany) |
| Sarah Lou Giering | (National Oceanography Centre, Southampton, United Kingdom) |

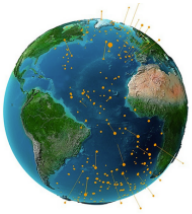
13:30 - 13:40 UTC: Break

13:40 - 15:00 UTC: Partners presenting imaging activities and projects (Chair: Margaux Noyon)

| | |
|---|---|
| Fabien Lombard | (Laboratoire d'Océanographie de Villefranche, France) |
| Lionel Guidi | (AtlantEco; Laboratoire d'Océanographie de Villefranche, France) |
| Rainer Kiko | (TRIATLAS; Laboratoire d'Océanographie de Villefranche, France) |
| Lee Karp-Boss | (University of Maine, USA) |
| Heidi Sosik | (Woods Hole Oceanographic Institution, USA) |
| Felipe Artigas | (Université du littoral Côte d'Opale, Wimmereux, France) |

15:00 - 15:15 UTC: Break

15:15 - 16:00 UTC: General discussion - sharing of opportunities, knowledge and data





AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

**Tuesday, 29th June:** Instrument development and data aggregation

12:00 - 12:10 UTC: Welcome and introduction to Day 2 (Rubens Lopes)

12:10 - 13:20 UTC: Short presentations - instrument development (Chair: Rubens Lopes)

| | |
|---|---|
| Thibaut Pollina (Stanford University): | PlanktoScope |
| Melissa Omand (Woods Hole Oceanographic Institution): | Minions |
| Marc Picheral (Laboratoire d'Océanographie de Villefranche): | UVP6 |
| Mark Ohman (Scripps Institution of Oceanography): | Zooglider |
| Aditya Nayak (Florida Atlantic University): | Holographic imaging |

13:20 - 13:30: Break

13:30 - 14:30: Short presentations - image analysis and data aggregation (Chair: Rainer Kiko)

| | |
|---|---|
| Jean-Olivier Irisson (LOV): | EcoTaxa, WWW.PIC |
| Simon-Martin Schröder (Kiel University): | MorphoCut & MorphoCluster |
| Jeffrey Ellen (University of California San Diego): | Zooglider analysis pipeline |
| Leandro De La Cruz (Universidade São Paulo): | Real time classification |
| Jessica Luo (Princeton University/NOAA): | Pelagic Size Structure database |

14:30 - 14:50: General discussion - Instrument development and data aggregation

14:50 - 15:00: Break

15:00 - 15:15: François Michonneau, Senior Director of Technology, TheCarpentries
Software Carpentry bootcamps - goals and organization

15:15 - 16:00: General discussion - I/ITAPINA actions and roadmap development



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

## Annex II – I/TAPINA Workshop Report, 2021

# Report of the first I/ITAPINA workshop, held online on the 28th and 29th June 2021

Dr. Rainer Kiko; rainer.kiko@imev-mer.fr

On June 28th and 29th 2021, the first I/ITAPINA (Imagine/Imaging the Atlantic - a Pelagic Imaging Network Approach) workshop took place. I/ITAPINA is a networking activity, implemented under the umbrella of the AA-MARINET Joint Pilot Action and supported by the All-Atlantic Ocean Research Alliance. I/ITAPINA aims to build the All-Atlantic Pelagic imaging community and to develop a framework for operational marine ecosystem monitoring with pelagic imaging techniques. The I/ITAPINA Joint Pilot Action is led by Dr. Rainer Kiko (LOV, France), Dr. Rubens M. Lopes (University of Sao Paulo, Brazil) and Dr. Margaux Noyon (Nelson Mandela University, South Africa). The workshop was conducted as an online only event. It started at 9:00 CET on both days and ended on 18:00 CET on the first day and at 16:00 . In total, 197 people joined the workshop. On the 28th June 167, on the 29th June 151 participants were present. The program and recordings of all presentations and discussions of the workshop are available online at https://www.aa-mari.net/itapina-events/first-i-itapina-workshop/. The workshop was held after the scientific session **"Imagine/Imaging the Ocean – Pelagic imaging for a sustainable future",** conducted as part of the virtual ASLO 2021 Aquatic Sciences Meeting on the 26th June 2021. This scientific session served to set the scene for the I/ITAPINA workshop and recordings of all presentations can be found online as well (https://www.aa-mari.net/itapina-events/aslo-2021-aquatic-sciences-meeting/).

Rainer Kiko, the I/ITAPINA lead presented the goals of the workshop at the beginning of the first day. Thereafter partners from Brazil, South Africa, Germany, UK, France and USA had the opportunity to present ongoing imaging activities in their respective countries and from projects, such as AtlantEco and TRIATLAS, covering existing infrastructures, data sources and needs.

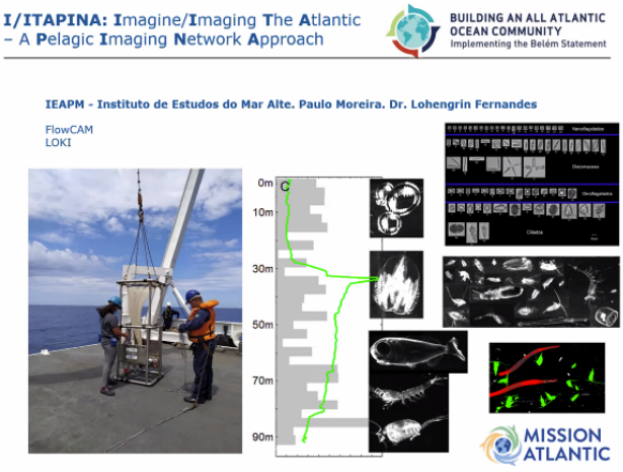



Fig. 1: Screenshot: Rubens M. Lopes (University of São Paulo, Brazil) presenting data on the vertical distribution of zooplankton using the FlowCam and LOKI, obtained during Mission Atlantic.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

On the second day, the workshop focused on instrument and data analysis pipeline development. Experts from several organizations presented the instruments such as the PlanktoScope, Minions, the Underwater Vision Profiler 6, the Zooglider and Holographic imaging.


Fig. 2: Instruments operated by the attendants of the workshop. Numbers in the top left indicate the workshop attendees per instrument.

Image processing and classification tools such as ECOTAXA, MorphoCut & MorphoCluster and Real Time classification approaches were presented and the plans to develop a Pelagic Size Structure database were discussed. Capacity development for pelagic imaging was another major point discussed during the workshop, including a presentation by François Michonneau about "The Carpentries" organization that conducts workshops globally to boost data processing skills of students and researchers.

The sessions of each day were followed by a general discussion where speakers and attendees had the chance to interact and share knowledge.

AA-MARINET

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

This Joint Pilot Action is supported under AANChOR, a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


# Annex III – Underwater Vision Profile User meeting Agenda, 2022

**First Underwater Vision Profiler user meeting and MOPGA-TAD midterm symposium**

at the Laboratoire d'Océanographie de Villefranche, Villefranche-sur-Mer, France and online

15th & 16th September 2022

supported by AANChOR CSA via I/ITAPINA

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

and

MAKE OUR PLANET GREAT AGAIN

Please register for day 1 and day 2 separately with these links for online participation:

Day 1: https://cnrs.zoom.us/webinar/register/WN_OIwBZlsBSuuwbqOjHky1fw
Day 2: https://cnrs.zoom.us/webinar/register/WN_X3G95o8tSKW18VOsJkqpWQ

**Day 1, Thursday, 15th September 2022**

Times are Central European Summer Time, CEST = UTC/GMT +2

9:00 - 9:10: Rainer Kiko - Welcome and general info
9:10 - 9:30: Sofia Cordeiro, Florence Coroner, Rainer Kiko - AANCHOR - AA-MARI.Net - I/ITAPINA

9:30 - 11:00: what's going on - Hawaii, China, Africa, Europe
- 9:30 - 9:45: University of Hawaii, USA - Reece James (online)
- 9:45 - 10:15: LOV, France - Marc Picheral - LOV/PIQv operational services available to the UVP user community
- 10:15 - 10:30: LOV, France - Camille Catalano: UVP development activities at LOV
- 10:30 - 10:45: Jiaozhou Bay Marine Ecosystem Research Station, China - Xiaoxia Sun (online)
- 10:45 - 11:00: Nelson Mandela University, South Africa - Margaux Noyon



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

11:00 - 11:15: Break

11:00 - 13:00: what's going on - Europe:

- 11:15 - 11:45: France, LOV - Rainer Kiko - MOPGA-TAD midterm: Establishing sustained zooplankton and particle observations to study Tropical Atlantic Deoxygenation
- 11:45 - 12:00: France, LOV - Alberto Baudena - MOPGA-TAD midterm: 5 months in the lifetime of an eddy observed with a UVP6 on an ARGO float
- 12:00 - 12:15: France, LOV - Hervé Claustre - Robotic Exploration of plankton-driven Fluxes in the marine twIlight zoNE - REFINE (online)
- 12:15 - 12:30: France, LOV - Thelma Panaïotis - Deployment of a UVP6 on a glider
- 12:30 - 12:45: France, LOV - Lionel Guidi - Assessing marine biogenic matter Production, Export and Remineralization: from the surface to the dark Ocean - APERO (online)

- 12:45 - 12:55: Discussion
- 12:55: Group picture

13:00 - 14:00: Lunch break

14:00 - 15:30: what's going on - US East Coast, Europe

- 14:00 - 14:15: U. of Vermont, USA - Jason Stockwell - UVP deployments in Lake Champlain
- 14:15 - 14:30: GEOMAR, Germany - Helena Hauss - Comparison of UVP5, UVP6 and other imaging sensor deployments in two Norwegian Fjords
- 14:30 - 14:45: Woods Hole Oceanographic Institution, USA - Elena Ceballos - Use of UVPs at WHOI - part 1
- 14:45 - 15:00: Woods Hole Oceanographic Institution, USA- Clarissa Karthäuser - Use of UVPs at WHOI - part 2
- 15:00 - 15:15: U. Maine, USA - Lee Karp Boss - NAAMES and GO-Ship (online)
- 15:15 - 15:30: Discussion

15:30 - 16:00: Break

16:00 - 17:30: what's going on - US East Coast, Canada, US West Coast, Europe

- 16:00 - 16:15: U. South Carolina, USA - Alexander Barth
- 16:15 - 16:30: National Oceanographic Center, Southampton, UK - Marika Takeuchi
- 16:30 - 16:45: Memorial University Newfoundland, Canada - Maxime Geoffroy -Linking hydroacoustics with UVP imagery to study the Arctic pelagic ecosystem (online)
- 16:45 - 17:00: U. of Alaska, USA - Stephanie O'Daly - (online)
- 17:00 - 17:15: UC Santa Barbara, USA - David Siegel - First results from UVP deployments during NASA's EXPORTS experiment (online)
- 17:15 - 18:00: Discussion



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

**Day 2, Friday, 16th September 2022**

9:00 - 9:15: Jerome Coindat (Hydroptic) - UVP sales and future developments
9:15 - 9:30: Discussion w. Hydroptic

Image classification:

9:30 - 9:45: Florian Ricour (LOV) - Embedded classification algorithm for the UVP6
9:55 - 10:00: Emilia Trudnoswska (IOPAN, Poland) - Appearance – how morphological traits of marine snow and zooplankton shed a new light on ecological observations
10:00 - 10:15: Martin Schröder (Kiel University, Germany) - MorphoCluster
10:15 - 10:30: Lars Schmarje (Kiel University, Germany, online) - Fuzzy overclustering
10:30 - 10:45: General discussion
10:45 - 11:00: Break

Ecopart and Ecotaxa dataset collection and evaluation

11:00 - 11:15: Lars Stemmann (LOV) - Generation of a global UVP image dataset
11:15 - 11:30: Shreya Mehta (Physical Research Laboratory, India, online) - Trichodesmium distribution - a study based on a large UVP data set
11:30 - 11:45: Rainer Kiko (GEOMAR/LOV) - The UVP5 particle dataset
11:45 - 12:00: Kelsey Bisson (Oregon State University, USA, online) - Uncertainties of particle size measurements of the UVP5
12:00 - 12:15: Anna Sommer (U. of East Anglia, UK, online ) - Testing the reconstruction of modeled POC
12:15 - 12:30: Daniel Clements (UCLA, USA, online) - Global reconstruction of the particle size spectrum
12:30 - 12:45: Mathilde Dugenne (LOV) - Generating PSSdb - The pelagic size structure database
12:45 - 13:00: General discussion on dataset collection and evaluation

13:00 - 14:00: Lunch break


AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

14:00 - 15:00: Community development of data processing tools

14:00 - 14:15: Jean-Olivier Irisson (Ecotaxa API and other software tools)

14:15 - 14:30: Alexander Barth - R tools to query Ecotaxa

14:30 - 15:00: Processing tools discussion

15:00 - 15:45: Towards operationality - development of the UVP user network and deployment planning for the next 15 years

Discussion led by Lars Stemman to outline a white paper that aims to develop an integrated science plan. Topics: Further development of data sharing models, image and data processing and streaming, deployment planning, open scientific problems and how to solve them

15:45 - 16:15: Break

16:15 - 18:00: Open discussion


This event is supported by a Make Our Planet Great Again grant from the French National Research Agency within the "Programme d'Investissements d'Avenir" (grant no. ANR-19-MPGA-0012), the Laboratoire d'Océanographie de Villefranche, France and the AANChOR Coordination & Support Action project, aimed to support the implementation of the Belém Statement. The AANChOR project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

## Annex IV – Underwater Vision Profile User meeting Report, 2022

# Report of the first Underwater Vision Profler workshop, held as hybrid event on the 15th and 16th September 2022

Dr. Rainer Kiko; rainer.kiko@imev-mer.fr

On September 15th and 16th 2022, the first Underwater Vision Profiler (UVP) user meeting took place at the Laboratoire d'Océanographie de Villefranche, supported by "Imaging/Imaging the Atlantic - A Pelagic Imaging Network Approach. I/ITAPINA is a networking activity, implemented under the umbrella of the AA-MARINET Joint Pilot Action and supported by the All-Atlantic Ocean Research Alliance. I/ITAPINA aims to build the All-Atlantic Pelagic imaging community and to develop a framework for operational marine ecosystem monitoring with pelagic imaging techniques. The I/ITAPINA Joint Pilot Action is led by Dr. Rainer Kiko (LOV, France), Dr. Rubens M. Lopes (University of Sao Paulo, Brazil) and Dr. Margaux Noyon (Nelson Mandela University, South Africa). The UVP users are a group of scientists that collaborate in different ways to use the UVP at local to global scales. Due to the high level of automation reached for UVP deployments, parts of the UVP user community are heading towards distributed and operational imaging. The first UVP user meeting was held to further consolidate the user group, to identify and possibly solve problems with instrument deployment and data processing and to further develop operational capacities towards a distributed network. The user meeting was conducted as a hybrid event, and Dr. Rainer Kiko, Dr. Margaux Noyon and 29 further UVP users and stakeholders - including representatives from the manufacturing company attended in person, whereas Prof. Rubens M. Lopes and 30 UVP users joined online. The workshop started at 9:00 CET on both days and ended at 18:00 CET on the 15th September and on 16:00 CET on the 16th September 2022. The program and recordings of all presentations and discussions of the workshop are available online at https://www.aa-mari.net/itapina-events/first-underwater-vision-profiler-user-meeting/.

Rainer Kiko, the I/ITAPINA lead, presented the goals of the user meeting at the beginning of the first day, followed by a presentation from Sofia Cordeiro and Florence Coroner about the AANCHOR and AA-MARINET projects. Thereafter partners from around the world - from South Africa, China, Germany, the UK, France and the USA had the opportunity to present ongoing imaging activities in their respective countries and from past or future expeditions, covering existing infrastructures, data sources and needs, as well as scientific results.



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

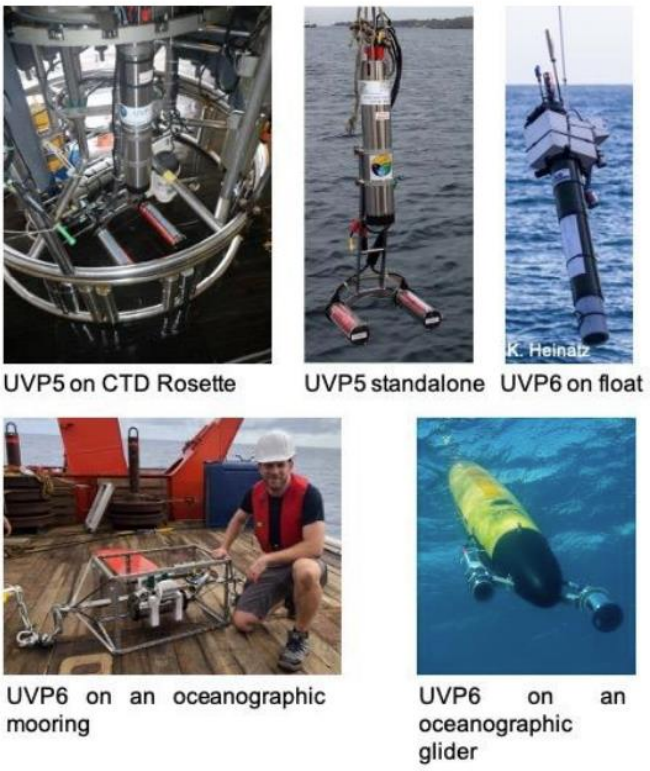



Fig. 1: The Underwater Vision Profiler 5 and 6 on different deployment vectors.

The second day started with a presentation by Jerome Coindat about the past and future of Hydroptic, the company that builds the UVPs. The further meeting focused on image classification approaches for UVP data and classification tools such as ECOTAXA, MorphoCut & MorphoCluster and Real Time classification approaches were presented. Thereafter, the development and use of global UVP datasets for pelagic imaging and the plans to develop a Pelagic Size Structure database were discussed. During the final discussion, activities to move forward towards operational imaging with the UVP were discussed.

AA-MARINET

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

This Joint Pilot Action is supported under AANChOR, a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

## Annex V – Roadmap for pelagic imaging


# Roadmap towards a distributed and operational pelagic imaging network

Rainer Kiko, Rubens M. Lopes, Yawouvi Dodji Soviadan, Lars Stemmann

## Targets of pelagic imaging

In principle, all particulate objects floating, sinking or swimming in ponds, rivers, lakes and the ocean (particles, plankton, fish, plastics, whales etc.) are targets of pelagic imaging. Imaging of individual organisms and particles, as long as the volume analyzed is well quantified, makes it possible to obtain simultaneously: (1) abundance of the different groups of plankton and their relative contribution to total abundance and biomass as well as the assessment of plastics pollution, (2) morphological or optical characteristics of the organisms that can be used to obtain their biovolume as a proxy of their biomass, to derive size spectra of the imaged objects and other functional traits (3) contextual information on individual behavior or life cycle traits (e.g., reproduction, parasitism, predation) that can be used to analyze ecological processes, and (4) production of a digital archive of images and optical properties that can be shared or reprocessed if more information is needed. In addition, imaging systems can be operated on samples obtained with nets and bottles or with *in situ* camera systems. *In situ* imaging has the advantage of being non-destructive. Net sampling yields concentrated samples, and these samples can be imaged immediately after catch or fixed for later processing (Lombard et al., 2019). Pelagic imaging can provide environmental indicators such as plankton community composition or biomass, which are needed to monitor aquatic ecosystems (Giering et al., 2022). Different imaging systems (Planktoscope, ZooScan, FlowCam, ISIIS, IFCB, Cytosense, CPICS, LOKI, UVP5, UVP6, among others) are needed to cover the entire size range from microscopic plankton organisms to fish. The capacity to assess plankton with imaging systems increases the temporal and spatial resolution attainable when compared to classic studies where humans identify and count the organisms or other targets. Pelagic imaging yields lower taxonomic resolution than such an approach, but can provide other trait information (size distribution, developmental status, symbiotic interactions etc.). The recent and ongoing development of *in*



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

*situ* imaging technologies that can be deployed at large scales on autonomous platforms, coupled with artificial intelligence and machine learning (AI/ML) for image analysis, promises a solution to overcome the practical limitations of traditional collection and analytical methods (Giering et al., 2022) and opens up new ways for research and ecosystem management.

## Pelagic imaging for research and ecosystem management

Laboratory-based and *in situ* imaging instruments now generate information on plankton and particle abundance, diversity and size distribution with an unprecedented sampling frequency, comparable to that achieved with environmental probes and orbital sensors. Underwater camera systems can be remotely operated from research vessels, on autonomous floats or connected to mooring arrangements to perform observations at relevant spatial and temporal scales. This has led to a revolution in the way we interpret marine ecological processes because instead of integrating plankton diversity, abundance and biomass across depth layers or long time intervals, as achievable with traditional plankton net sampling, researchers can now "see" the aquatic world with much higher resolution than before.

Practical applications of *in situ* imaging systems to characterize aquatic ecosystems and help understand and mitigate environmental impacts are widespread. For instance, the Imaging FlowCytobot (IFCB) has been operating in the Gulf of Mexico for more than 15 years, capturing high-frequency images (at ~20-minute intervals) to generate data on microplankton community composition (Fiorendino et al., 2021). This has provided important early warning information on the advection of toxic microalgal blooms towards aquaculture sites, preventing seafood consumption, and thus public health issues and economic losses. The Underwater Vision Profiler (UVP, Picheral et al., 2010, 2022) has been applied worldwide for more than a decade (Kiko et al., 2022) to estimate particle vertical flux and its influence on the carbon pump, yielding crucial data on biogeochemical cycles (Clements et al., 2022). Potential impact of global climate change on marine ecosystems has been investigated using a lab scanner (Beaugrand et al., 2019). In the offshore fisheries industry, pelagic imaging has been used to perform fish counts and species identification during net trawls, enabling the acquisition of distribution data at fine scales for better interpretation of acoustic results (Allken et al., 2021). Salmon aquaculture facilities in Chile apply regular monitoring of algal blooms and potential pests using the benchtop FlowCAM, an imaging flow cytometer and microscope (Mardones et al., 2022). In addition, imaging acquisition tasks can now be carried out with low-cost instruments such as the recently developed Planktoscope (Pollina et al., 2022). Combined with other contemporary approaches in aquatic research, such as genomics and acoustics, pelagic imaging will certainly continue to deliver important insights on the status and development of aquatic environments for decades to come.

However, the new avenue of research opened by pelagic imaging still needs to reach a wider community of scientists, stakeholders and decision-makers. The global south is particularly underrepresented in the pelagic imaging community, a problem demanding efforts in capacity building and technological advances towards more affordable instrumentation. In another


AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

perspective, public and private companies are required to carry out environmental impact assessments for licensing purposes in many countries, but imaging is not included in the methodological provisions to be strictly followed in accordance to the environmental law. For instance, when species-specific biodiversity indices are required, traditional microscopic techniques are the only option to analyze samples and thus monitoring is circumscribed to plankton net tows at very low temporal and spatial resolution. However, suitability of pelagic imaging for such monitoring purposes has been demonstrated in the open and coastal oceans(Romagnan et al., 2016; Lombard and et al., 2019; Pitois et al., 2021). With the recent development of instruments, data software and recognition algorithms (Irisson et al., 2022), some key locks for widespread application of pelagic imaging have been technically resolved. Pelagic imaging - possibly combined with genetic approaches - can lower the costs and increase the resolution for environmental monitoring as a high degree of automation can now be attained.

Several scientific communities spread in different continents have initiated regional, disciplinary (phytoplankton, or zooplankton) or instrument specific networks that are already used in monitoring programs (Campbell et al., 2013; Benedetti et al., 2019). Few international coordination attempts have been made in the past, for example through the establishment of SCOR groups, with the development of open-access internet repositories (ecotaxa.obs-vlfr.fr) and datasets (Kiko et al., 2022), the organization of international training opportunities (AtlantEco, PIQv) or the development of databases that combine different instruments (PSSdb; https://www.st.nmfs.noaa.gov/copepod/pssdb/). However, the user communities of the different imaging devices (e.g. IFCB, UVP, Flowcam, PlanktoScope, Zooscan) are often not formally organized and in particular they are not interconnected. Hence, these spread networking efforts will obviously benefit from further communication that would make protocols, instrument descriptions, QC procedures, data analysis repositories and databases interoperable and accessible for all users. However, the concept of a distributed and operational pelagic imaging network goes beyond such simple communication.

# Characteristics of a distributed and operational pelagic imaging network

The goal of a distributed network is the sharing of resources, to accomplish a common objective (Balda, Braveem, 2015; Srinivasa and Muppalla, 2015). In a strict sense, “distributed network” is a term from computer science that describes a network of interconnected computer networks, which are orchestrated to deliver a final data product or service. For our purposes, we can extend this concept to also include digital pelagic imaging devices. Operational oceanography aims to provide routine oceanographic information needed for decision-making purposes and depends on sustained research and development. A multi-platform observation network, a data management system, a data assimilative prediction system, and a dissemination/accessibility system are the core components of operational oceanographic systems (Davidson et al., 2019). The time lag between data acquisition and product provisioning needs to be short enough to enable decision making at the necessary time scale. Hence, for pelagic imaging approaches



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No. 818395.

this needs to be on the order of hours to weeks, if we aim to catch and react to the high frequency and short time events occurring in the ocean (frontal dynamics of eddies, harmful algal blooms, processes related to ebb and tide). Currently, such a time lag is reached in only a few cases (UVP6 on Argo floats, phytoplankton monitoring using the Imaging Flow Cytobot). In most other cases, it takes several months to years for the data obtained with an imaging device to become publicly available, and such data might not be converted into indicators suitable for decision making. Further digitalization of the entire pipeline from image to open access data and the automation of data aggregation and modeling tools will enable us in the near future to deliver products for decision makers that are based on several different, distributed imaging techniques (e.g. covering different size-ranges and stemming from different research groups), possibly even integrated with other environmental sensor data. Once the framework is established, users (scientists and monitoring agencies) can select an imaging strategy adapted to their context, but can also automatically contribute with their datasets to a wider context and thereby benefit research and society in several ways. As a first example, mesoscale plankton dynamics can be studied using a UVP6 - lp mounted on a BGC Argo float (Picheral et al., 2022). However, as the data is collected and made available via an open access server system, it can also be included in global datasets and hence benefit the global carbon cycle assessment. Further developing and interfacing the different spread pelagic imaging networks with this first prototype of an operational pelagic imaging platform could lead to the envisioned distributed and operational pelagic imaging network.

## How can we realize a distributed and operational pelagic imaging network in the near future?

To reach the goal of a Distributed and Operational Pelagic Imaging Network, we first of all need the pelagic imaging research community to embrace this concept and to commit to the open science approach of operational oceanography. In particular, data needs to be released directly after recovery. To enable this, funders need to recognize the extreme value of pelagic imaging approaches and the added value of an operational pelagic imaging network. It will increase the value of funding that goes into individual imaging approaches, as it promotes the connected reuse of data and hence provides higher level products. However, this distributed network requires support for coordination, development, maintenance and infrastructure that funding agencies need to consider.

We recommend the following voluntary activities that will pave the way towards a distributed and operational Pelagic Imaging Network:

- Promote discussions at all levels - international, local, high-level, informal - on the current status and future of pelagic imaging in marine and freshwater environments.
- Raise awareness for the importance of plankton for global food security, ocean health and global biogeochemical cycles



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

- Further develop imaging instruments and server hardware via the integration of technological improvements in camera and computer development. Backwards compatibility should be considered during these developments, to e.g. enable the maintenance and consistency of long-term time series.
- During development, prioritize the establishment of low-cost approaches (such as the PlanktoScope), which will increase applicability in developing countries, for citizen scientists and generally can result in widespread adoption of pelagic imaging techniques. The inter- and intra comparability of new instruments, their data processing tools and data output should also be considered.
- Further develop data pipelines that enable the fast/automated processing and upload of image data to central server systems or archives. These server systems/archives should also enable the automated download of images and/or data by higher level network components.
- Establish and maintain repositories for best practices guidelines, processing software, benchmark image datasets, research datasets and derived products. A first collection of such tools can be found at https://www.aa-mari.net/i-itapina-online-resources/.
- Train the next generation of scientists, not only in the use of single imaging devices, but also teach how different image datasets can be merged and how artificial intelligence and network tools can be used to process the data.
- Consider and enable the integration of imaging data with other data types, in particular environmental data such as temperature, salinity, oxygen concentration and nutrient levels, but also other data types such as genetic data should be archived together, or linked with the image data.
- Develop pelagic imaging based environmental indicators and products to reduce the costs and increase the spatial and temporal resolution of environmental monitoring approaches.

# References

Allken, V., Rosen, S., Handegard, N.O., Malde, K., 2021. A deep learning-based method to identify and count pelagic and mesopelagic fishes from trawl camera images. ICES Journal of Marine Science 78, 3780–3792. https://doi.org/10.1093/icesjms/fsab227

Balda, Braveem, 2015. "Security Enhancement in Distributed Networking" (PDF). International Journal of Computer Science and Mobile Computing. 4 (4): 761. Retrieved 24 September 2018. IJCSMC.

Beaugrand, G., Conversi, A., Atkinson, A., Cloern, J., Chiba, S., Fonda-Umani, S., Kirby, R.R., Greene, C.H., Goberville, E., Otto, S.A., Reid, P.C., Stemmann, L., Edwards, M., 2019. Prediction of unprecedented biological shifts in the global ocean. Nat. Clim. Chang. 9, 237–243. https://doi.org/10.1038/s41558-019-0420-1

Benedetti, F., Jalabert, L., Sourisseau, M., Becker, B., Cailliau, C., Desnos, C., Elineau, A., Irisson, J.-O., Lombard, F., Picheral, M., Stemmann, L., Pouline, P., 2019. The Seasonal and Inter-Annual Fluctuations of Plankton Abundance and Community Structure in a North Atlantic Marine Protected Area. Front. Mar. Sci. 6, 214. https://doi.org/10.3389/fmars.2019.00214



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

Campbell, L., Henrichs, D.W., Olson, R.J., Sosik, H.M., 2013. Continuous automated imaging-in-flow cytometry for detection and early warning of Karenia brevis blooms in the Gulf of Mexico. Environ Sci Pollut Res 20, 6896–6902. https://doi.org/10.1007/s11356-012-1437-4

Clements, D.J., Yang, S., Weber, T., McDonnell, A.M.P., Kiko, R., Stemmann, L., Bianchi, D., 2022. Constraining the Particle Size Distribution of Large Marine Particles in the Global Ocean With In Situ Optical Observations and Supervised Learning. Global Biogeochemical Cycles 36, e2021GB007276. https://doi.org/10.1029/2021GB007276

Davidson, F., Alvera-Azcárate, A., Barth, A., Brassington, G.B., Chassignet, E.P., Clementi, E., De Mey-Frémaux, P., Divakaran, P., Harris, C., Hernandez, F., Hogan, P., Hole, L.R., Holt, J., Liu, G., Lu, Y., Lorente, P., Maksymczuk, J., Martin, M., Mehra, A., Melsom, A., Mo, H., Moore, A., Oddo, P., Pascual, A., Pequignet, A.-C., Kourafalou, V., Ryan, A., Siddorn, J., Smith, G., Spindler, D., Spindler, T., Stanev, E.V., Staneva, J., Storto, A., Tanajura, C., Vinayachandran, P.N., Wan, L., Wang, H., Zhang, Y., Zhu, X., Zu, Z., 2019. Synergies in Operational Oceanography: The Intrinsic Need for Sustained Ocean Observations. Frontiers in Marine Science 6.

Fiorendino, J.M., Gaonkar, C.C., Henrichs, D.W., Campbell, L., 2021. Drivers of microplankton community assemblage following tropical cyclones. Journal of Plankton Research fbab073. https://doi.org/10.1093/plankt/fbab073

Giering, S.L.C., Culverhouse, P.F., Johns, D.G., McQuatters-Gollop, A., Pitois, S.G., 2022. Are plankton nets a thing of the past? An assessment of in situ imaging of zooplankton for large-scale ecosystem assessment and policy decision-making. Front. Mar. Sci. 9, 986206. https://doi.org/10.3389/fmars.2022.986206

Irisson, J.-O., Ayata, S.-D., Lindsay, D., Karp-Boss, L., Stemmann, L., 2022. Machine Learning for the Study of Plankton and Marine Snow from Images. Annual Review of Marine Science 14. https://doi.org/10.1146/annurev-marine-041921-013023

Kiko, R., Picheral, M., Antoine, D., Babin, M., Berline, L., Biard, T., Boss, E., Brandt, P., Carlotti, F., Christiansen, S., Coppola, L., de la Cruz, L., Diamond-Riquier, E., Durrieu de Madron, X., Elineau, A., Gorsky, G., Guidi, L., Hauss, H., Irisson, J.-O., Karp-Boss, L., Karstensen, J., Kim, D., Lekanoff, R.M., Lombard, F., Lopes, R.M., Marec, C., McDonnell, A.M.P., Niemeyer, D., Noyon, M., O'Daly, S.H., Ohman, M.D., Pretty, J.L., Rogge, A., Searson, S., Shibata, M., Tanaka, Y., Tanhua, T., Taucher, J., Trudnowska, E., Turner, J.S., Waite, A., Stemmann, L., 2022. A global marine particle size distribution dataset obtained with the Underwater Vision Profiler 5. Earth System Science Data 14, 4315–4337. https://doi.org/10.5194/essd-14-4315-2022

Lombard, F., et al., 2019. Globally Consistent Quantitative Observations of Planktonic Ecosystems. Front. Mar. Sci. 6, 196. https://doi.org/10.3389/fmars.2019.00196

Mardones, J.I., Krock, B., Marcus, L., Alves-de-Souza, C., Nagai, S., Yarimizu, K., Clément, A., Correa, N., Silva, S., Paredes-Mella, J., Von Dassow, P., 2022. Chapter 4 - From molecules to ecosystem functioning: insight into new approaches to taxonomy to monitor harmful algae diversity in Chile, in: Clementson, L.A., Eriksen, R.S., Willis, A. (Eds.), Advances in Phytoplankton Ecology. Elsevier, pp. 119–154. https://doi.org/10.1016/B978-0-12-822861-6.00011-X

Picheral, M., Catalano, C., Brousseau, D., Claustre, H., Coppola, L., Leymarie, E., Coindat, J., Dias, F., Fevre, S., Guidi, L., Irisson, J.O., Legendre, L., Lombard, F., Mortier, L., Penkerch, C., Rogge, A., Schmechtig, C., Thibault, S., Tixier, T., Waite, A., Stemmann, L., 2022. The Underwater Vision Profiler 6: an imaging sensor of particle size spectra and plankton, for autonomous and cabled platforms. Limnology and Oceanography: Methods 20, 115–129. https://doi.org/10.1002/lom3.10475

Picheral, M., Guidi, L., Stemmann, L., Karl, D., Id Daoud, G. (Rizlene), Gorsky, G., 2010. The Underwater Vision Profiler 5: An advanced instrument for high spatial resolution studies



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

of particle size spectra and zooplankton. Limnology and oceanography, methods 8, 462–473. https://doi.org/10.4319/lom.2010.8.462

Pitois, S.G., Graves, C.A., Close, H., Lynam, C., Scott, J., Tilbury, J., van der Kooij, J., Culverhouse, P., 2021. A first approach to build and test the Copepod Mean Size and Total Abundance (CMSTA) ecological indicator using in-situ size measurements from the Plankton Imager (PI). Ecological Indicators 123, 107307. https://doi.org/10.1016/j.ecolind.2020.107307

Pollina, T., Larson, A.G., Lombard, F., Li, H., Le Guen, D., Colin, S., de Vargas, C., Prakash, M., 2022. PlanktoScope: Affordable Modular Quantitative Imaging Platform for Citizen Oceanography. Front. Mar. Sci. 9, 949428. https://doi.org/10.3389/fmars.2022.949428

Romagnan, J.B., Aldamman, L., Gasparini, S., Nival, P., Aubert, A., Jamet, J.L., Stemmann, L., 2016. High frequency mesozooplankton monitoring: Can imaging systems and automated sample analysis help us describe and interpret changes in zooplankton community composition and size structure — An example from a coastal site. Journal of Marine Systems, Progress in marine science supported by European joint coastal observation systems: The JERICO-RI research infrastructure 162, 18–28. https://doi.org/10.1016/j.jmarsys.2016.03.013

Srinivasa, K.G., Muppalla, A.K., 2015. Introduction, in: Srinivasa, K.G., Muppalla, A.K. (Eds.), Guide to High Performance Distributed Computing: Case Studies with Hadoop, Scalding and Spark, Computer Communications and Networks. Springer International Publishing, Cham, pp. 4–8. https://doi.org/10.1007/978-3-319-13497-0_1

AA-MARINET

BUILDING AN ALL ATLANTIC OCEAN COMMUNITY
Implementing the Belém Statement

This Joint Pilot Action is supported under AANChOR, a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


## Annex V – I/ITAPINA members

Phangoxolo Sishuba, Limam Abdallahi, Abigail Blackburn, Abdoulaye Sarre, Ana Carolina Luz, Ana Fernandez Carrera, Antonio Goulart, ADAM LARSON, Aimee Neeley, Aitor, Anthony Akpan, Ahmed Kadhim, Alexandre Morimitsu, Pablo Alvarez, Andrew McDonnell, Amy Maas, Ana Fernandez Carrera, Ananya Ashok, Aditya Nayak, Andre Abreu, Andreas Rogge, Andrew Young, Andria Miller, Anna Oddone, Ana Noronha, Antonio José Homsi Goulart , Anya Waite, Astrid Cornils, Adam Greer, Anton Theileis, Barbara Niehoff, Jose Juan Barrera Alba, Dr. Jose Juan Barrera Alba, Baye Cheikh Mbaye, Stella Berger, Bethany Fowler, Biraja Kumar Sahu, Gabriel Bittencourt Farias, Bronwyn Lira Dyson, Bruna Oliveira, Bruno Pereira, Carla Edworthy, Colomban de Vargas, B. B. Cael, camille catalano, Catherine BORREMANS, Dr. Catarina Marcolin, Colleen Durkin, Charles Cousin, Ramesh Chatragadda, chrislainne alves, Christian Reiss, Christiane Sampaio, Claire Carre, Clara Flintrop, Claudeilton S de Santana, Cláudia Alves de Magalhães, Coleen Moloney, Alessandra Gomes, COMPLEX LOV, Caroline Sandmeier, Daniel Mayor, Daniele Bianchi, Danilo Luis Calliari Cuadro, Deon Louw, Casha de Vos, Didier Dumet, Ndague Diogoul, Dong-gyun Kim, Douglas da Silva Rodrigues, Dana Yoerger, Elena Ceballos , Taylor Crockford, Elena García-Martín, Elisa Romanelli, Elizandro Rodrigues, Eloise Savineau, Eloise Savineau, Emilia Trudnowska, Emily Peacock, Érica Caroline Becker, Emma Rocke, Elaine Fileman, Eva Chamorro, Fabio Nascimento, Felipe Artigas, Fernand Assene, Florence Coroner, Florian Ricour, Franck LE GALL, Andrea Freire, Virginia A. García Alonso, George Cutter, George Watters, Gilles Orazi, Dr. Gleyci Moser, Dr Gerardo M. E. Perillo, Gelaysi Moreno Vega, Gabriel Gorsky, Guilherme Morsch von Montfort, Guilherme Nascimento Corte, Hannah Haines, Harry Nelson, Hannah Kepner, Helena Hauss, Heidi Sosik, Ivory Engstrom, Iheb KHELIFI, Ibrahima Ndiaye, Bellamare (ISIIS), Inia , Jean-Olivier Irisson, Ivona Cetinic, James Fox, James Scott, Jan Schulz, Adams, Janine, Javier Díaz Pérez, Jenny Huggett, Jerome Coindat, Jessica Luo, Josean Fernandez, Jose H Muelbert, Joaquin E. Chaves, José Landeira, Jose Mountinho, Jack Williams, John San Soucie, Jan Taucher, Kaisa Kraft, Katharina Kordubel, Kathryn Morrissey, Catarina Ruby, Kelly Robinson, Ketil Malde, Klas Ove Möller, Kristen Sharpe, Keshnee Pillay, Laetitia Drago, Laura Rodrigues da Conceição, Laure Vilgrain, M.Sc. Leandro Ticlia de la Cruz, Lee Karp-Boss, Daniel Lemley, Leo Berline, Leocardio Blanco-Bercial, Lionel Guidi, Marcelina Fernandes, Nathalia Lins Silva, Lisa Campbell, Dr. Lohengrin Fernandes, Fabien Lombard, M.Sc. Luciana Frazão , Luiz Fernando Loureiro Fernandes, Mfundo Bizani, Maeva Gesson, Manu Prakash, Marc Picheral, Margaux Noyon, Margherita Zorgno, Maria, Marie Flatow, Marie Walde, Dr. José Eduardo Martinelli Filho, Mark Benfield, Marco Corrales, Filomena Velho, Mark Gibbons, Mikaelle Helena Santos da Silva, Mayara Sousa, Malcolm McFarland, Monique Nunes, Mark Ohman, Morten Iversen, María Santos Mokoroa, Michael Stukel, Marco Worship, Jens Nejstgaard, Nicolas Gosset, Nicole Hildebrandt, Nicole, Dr. Nina Hirata, Fabrice Not, Octavio Esquivel Garrote, Olivia robson , Rodrigo Gonçalves, Patrice Brehmer, Patricia Cabrera, Patrick Gray, Patrick Duffy, Paulo Mafalda, Pedro Melo, Stephane Pesant, Peter Croot, Pieter Hovenkamp, Polly Barrowman, Paulo Coelho, Carina Poulin, Priscila Lange, Rene Plonus, Rachele Spezzano , Rainer Kiko, Ralf Schwamborn, Rosana Di Mauro, Renato



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.

Nagata, Ratjingisiua, Richard Horaeb, Erica Ewton, Ross-Lynne Gibb, Romy Hentinger, Rosana Di Mauro, Ralf Schwammborn, Rubens Mendez Lopes, Rune Lagaisse, Sari Giering, Stephanie Henson, Samuel Woodman, Sandy Thomalla, Gleice Souza Santos, Saskia Rühl, Savannah Judge, Steven Burton, Moritz Schmid, Sebastien Colin, Scott Galagher, Khutso , Santiago Hernández-León, Silvana Penninck, Simon J Geist, Sasha Kramer, Simon-Martin Schröder, Sophie Pitois, Wilson de Oliveira Souza, Simone Pennafirme , Sylvia Patricia Jimenez Rosenberg , Lars Stemmann, Stephanie O'Daly, Joshua Stone, Dodji Y. SOVIADAN, Sylvain Fèvre , Tamar Guy-Haim, Thomas Kelly, Thelma Panaiotis, Thibaut Pollina, Tim Dudeck, Tina, Trevor McKenzie, Tom Marquis Lawrence, Tristan Biard, Colomban de Vargas, Vanessa Trindade Bittar, Dr Veronique CREACH, Viviana A Alder, Virginie Ramasco, Tim Walles, Werner Ekau, Will Major, Yang Xiang, Zrinka Ljubesic, Zack Wistort



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.


## AA-MARINET Contact Details

Main contact: Jose Moutinho; I/ITAPINA line of activity: Rainer Kiko

Email: jose.moutinho@airecentre.com; rainer.kiko@obs-vlfr.fr

Web: https://www.aa-mari.net/ AND https://allatlanticocean.org/jointaction/all-atlantic-marine-research-infrastructure-network-

## All-Atlantic Ocean Contact Details

Coordination: FCT – Fundação para a Ciência e a Tecnologia

Email: info@allatlanticocean.org

Web: http://www.AllatlAnticOcean.org/

Twitter**: @AllAtlanticO**

Facebook**: @AllAtlanticOcean**

YouTube: **All-Atlantic Ocean Research Alliance**



AANChOR is a Coordination & Support Action project aimed to support the implementation of the Belém Statement. It has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818395.