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Institute of Information Science and Technologies "A. Faedo"



# External Advisory Board Report 4

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<b>V2.0</b>	18/12/2024	Gabriele Pieri	Final version after revision

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<b>DEC</b>	Websites, patents, filing, etc.	
<b>DEM</b>	Demonstrator	
<b>O</b>	Other	

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<b>PU</b>	Public	✓
<b>CO</b>	Confidential, only for members of the Consortium (including the Commission Services)	

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NAUTILOS - New Approach to Underwater Technologies for Innovative, Low-cost Ocean observation is an H2020 project funded under the Future of Seas and Oceans Flagship Initiative, coordinated by the National Research Council of Italy (CNR, Consiglio Nazionale delle Ricerche). It brings together a group of 21 entities from 11 European countries with multidisciplinary expertise ranging from ocean instrumentation development and integration, ocean sensing and sampling instrumentation, data processing, modelling and control, operational oceanography and biology and ecosystems and biogeochemistry such, water and climate change science, technological marine applications and research infrastructures.

NAUTILOS will fill-in marine observation and modelling gaps for chemical, biological and deep ocean physics variables through the development of a new generation of cost-effective sensors and samplers, the integration of the aforementioned technologies within observing platforms and their deployment in large-scale demonstrations in European seas. The fundamental aim of the project will be to complement and expand current European observation tools and services, to obtain a collection of data at a much higher spatial resolution, temporal regularity and length than currently available at the European scale, and to further enable and democratise the monitoring of the marine environment to both traditional and non-traditional data users.

NAUTILOS is one of two projects included in the EU's efforts to support the European Strategy for Plastics in a Circular Economy by supporting the demonstration of new and innovative technologies to measure the Essential Ocean Variables (EOV).

More information on the project can be found at: <http://www.nautilus-h2020.eu>

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## EXECUTIVE SUMMARY

The following document provides the fourth and final annual report and evaluation by the External Advisory Board (EAB). It provides their assessment of NAUTILOS and advice on the project's future direction. The following deliverable is the report following the third EAB meeting held at the end of the fourth year of NAUTILOS, in Month 48. The EAB meeting has been confirmed for month 48 despite the project extension being approved, with the last amendment being approved by the EU for a formal contractual agreement with the EAB members.

The following deliverable has four main sections:

- **Section I: Introduction**  
The chapter briefly reviews the project management structure, giving a more detailed recap of the specific role of the External Advisory Board and its organisation within all the governing bodies of NAUTILOS.
- **Section II: External Advisory Board Related Deliverables** describes the scheduling and due dates for the NAUTILOS deliverables, focusing on the reports directly related to the EAB.

- **Section III: Report On The Fourth EAB Meeting**  
This section first describes the activities of the EAB since the last report and then reports on the EAB's final meeting, highlighting the board members' advice and suggestions.
- **Section IV: Conclusion** recap the document and resume some final recommendations from the EAB meeting.

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## LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
<b>AI</b>	Artificial Intelligence
<b>AIR-centre</b>	Atlantic International Research Centre
<b>AQUA-lit</b>	Preventive measures for averting the discarding of litter in the marine environment from the aquaculture industry
<b>BANOS</b>	Baltic and North Sea lighthouse
<b>CA</b>	Consortium Agreement
<b>CAPARDUS</b>	Capacity-building in Arctic Standardisation Development
<b>CS</b>	Citizen Science
<b>CMEMS</b>	Copernicus Marine Environment Monitoring Service
<b>DFKI</b>	German Research Centre for Artificial Intelligence ( <i>Deutsches Forschungszentrum für Künstliche Intelligenz</i> )
<b>DMP</b>	Data Management Plan
<b>EAB</b>	External Advisory Board
<b>EB</b>	Engagement Board
<b>EC</b>	European Commission
<b>EMSO ERIC</b>	European Multidisciplinary Seafloor and water-column Observatory
<b>EthAB</b>	Ethical Advisory Board
<b>EU</b>	European Union
<b>Euro-Argo</b>	European research infrastructure consortium for observing the oceans
<b>EuroGOOS</b>	European Global Ocean Observing System
<b>GA</b>	General Assembly
<b>GrAg</b>	Grant Agreement
<b>HCMR</b>	Hellenic Centre for Marine Research
<b>HRB</b>	Horizon Results Booster
<b>INTAROS</b>	Integrated Arctic observation system
<b>IOC-UNESCO</b>	Intergovernmental Oceanographic Commission - UNESCO
<b>IPR</b>	Intellectual Property Rights
<b>IPMA</b>	Instituto Português do Mar e da Atmosfera
<b>JERICO RI</b>	Joint European Research Infrastructure for Coastal Observatories.
<b>LifeWatch ERIC</b>	European Research Infrastructure Consortium providing e-Science research facilities to scientists investigating biodiversity and ecosystem functions and services to support society in addressing key planetary challenges
<b>MINKE</b>	Metrology for Integrated marine management and Knowledge-transfer nEtnetwork
<b>NIVA</b>	Norwegian Institute for Water Research (Norsk Institutt for Vannforskning)
<b>NERSC</b>	Nansen Environmental and Remote Sensing Center
<b>OAIR</b>	Open-Access Instrumentation Roadmap
<b>TIB</b>	Technical and Innovation Board
<b>TNA</b>	Transnational Access
<b>TRL</b>	Technology readiness level
<b>UN</b>	United Nations
<b>UNIS</b>	The University Centre in Svalbard
<b>WP</b>	Work Package

## I. INTRODUCTION

This document represents the fourth and final yearly report on the NAUTILOS Project External Advisory Board (EAB) activities.

### 1. RECAP OF PROJECT MANAGEMENT STRUCTURE

The project management structure of NAUTILOS has been designed as outlined in Figure 1. The management structure and procedures to be applied within NAUTILOS are established in the Grant Agreement (GrAg) and Consortium Agreement (CA).

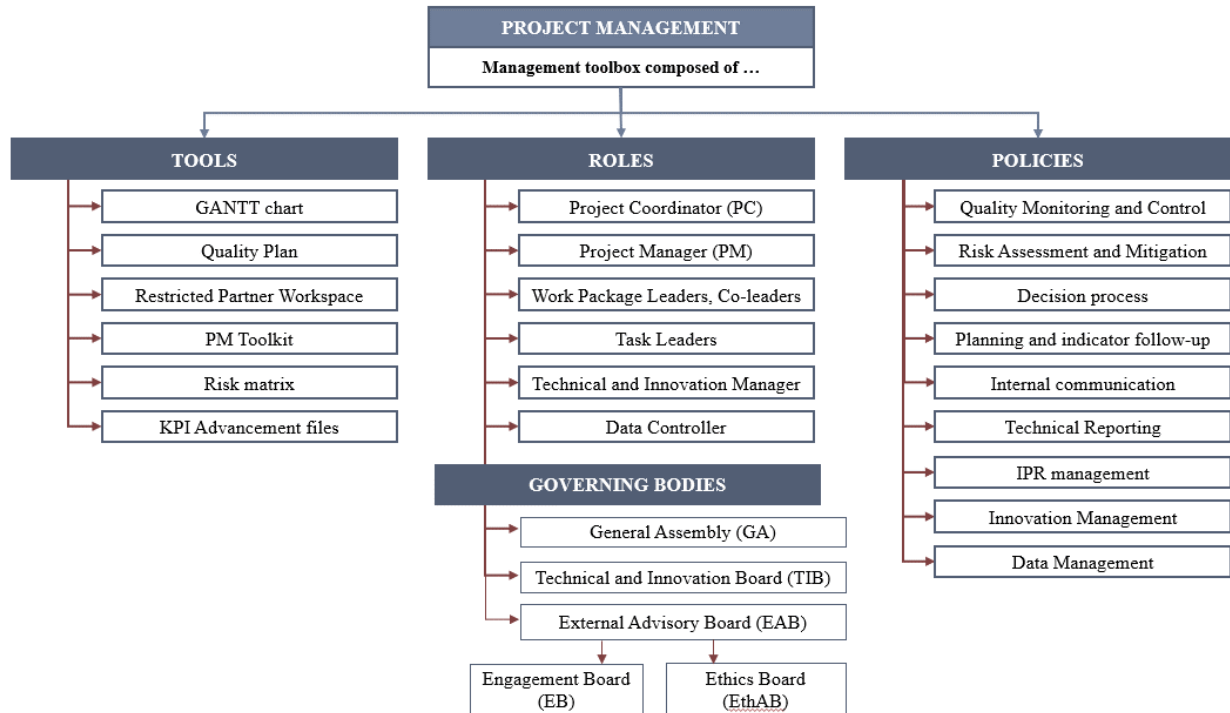


Figure 1. NAUTILOS Project Management Structure and Governing Bodies

As reported in the figure, among the **project's governing bodies** (as further detailed in Deliverable D1.1), there is the External Advisory Board (EAB), along with the General Assembly (GA) and the Technical and Innovation Board (TIB).

The EAB, chaired by the Coordinator, is composed of external experts who bring their expertise and ensure an external point of view concerning the implementation of the project. This organisational and decision-supporting structure will cover all necessary competencies regarding the quality of project implementation, supervision and correction actions, if required, based on the complexity of procedures. The EAB receives updates and reports on the project's progress and related outputs and provides feedback to the GA concerning the strategic view and the TIB regarding the technical point of view.

### 2. EXTERNAL ADVISORY BOARD ORGANISATION

The EAB acts as an independent external body that reviews the project's progress and provides advice and guidance. EAB aims to ensure that the project is in support of the implementation of the "G7 Future of the Seas and Oceans" initiative, the "Paris Climate Agreement", the "UN Decade of Ocean

Science for Sustainable Development", and the needs of the "EC Integrated Maritime Policy" and the "Marine Strategy Framework Directive".

The EAB aims to:

- Provide ongoing connection and compliance to EuroGOOS, CMEMS, EMODnet, and European Marine Research Infrastructures (EMSO ERIC, Euro-Argo, JERICO RI, LifeWatch ERIC);
- Provide expert advice, feedback and input into a better understanding of the barriers facing effective Transfer of Marine Technologies within NAUTILOS;
- Build relationships with stakeholders in Europe and internationally, where relevant;
- Promote and enhance the project's external communication activities.

The EAB meets once per year and is responsible for supervising the achievement of the project's objectives, overseeing the project developments, results, constraints, obstacles, and ways to overcome them.

The actual list of External Advisory Board Members in NAUTILOS is the following:

1. Dr Juanjo Dañobeitia, former Director General EMSO-ERIC, currently a delegate at IOC-UNESCO.
2. Dr Alessandra Giorgetti, Coordinator of EMODnet Chemistry.
3. Dr Christos Arvanitidis, CEO and Director General LifeWatch ERIC.
4. Dr Stein Sandven. NERSC, Coordinator of INTAROS H2020 project.
5. Dr Mariana Mata Lara, Coordinator of the AQUA-LIT project.
6. Dr Haizea Jimenez, former Head of Expertise Dept. - Surfrider Foundation Europe, currently a member of the International Union for Conservation of Nature, French committee.
7. Prof. Jorge Miguel de Miranda, Executive Administrator of Atlantic International Research Centre - AIR Centre.
8. Dr Mafalda Carapuço. Former Member of the Portuguese Institute for the Ocean and Atmosphere-IPMA, currently Deputy Executive Director of Atlantic International Research Centre - AIR Centre.
9. Dr Nina J. Zugic, independent research ethics expert.

The external advisory board will have two subsections within it:

1. The *Ethics Advisory Board (EthAB)* supervises and monitors the project's ethical aspects. The EthAB is an independent body advising the GA and all NAUTILOS members on ethical, regulatory and socio-environmental issues raised by the research and development to be undertaken under NAUTILOS. It consists of Dr Nina J. Zugic, an independent ethics research expert.
2. The *Engagement Board (EB)* ensures that stakeholders' inputs have been considered in all aspects of the proposed implementation. The EB is part of EAB advising the GA and all NAUTILOS members regarding the stakeholders' engagement. Dr Haizea Jimenez, representing Surfrider Foundation, is part of the EB.

## II. EXTERNAL ADVISORY BOARD-RELATED DELIVERABLES

NAUTILOS foresees a comprehensive list of the project's deliverables; thus, achieving a high level of quality for these target landmarks is essential to the success and impact of the project. While some will be confidential to protect copyrights and companies' assets, most of the deliverables will be available to the public. A quality assurance plan for deliverables has been organised to maximise the project's impact and ensure the above. The program is centred on timely deliverable preparation by all partners and an internal peer-reviewing system. NAUTILOS creates deliverables that are either reports, prototypes or demonstrators as described in "Annex I of the Grant Agreement". For those that do not take the form of a written report, an accompanying record in the form of a document will nevertheless be prepared to include supporting material for the accomplishment. For demonstrators, a technical report will be created, capturing the outcomes of the demonstration. For more detail, see Deliverables D1.4 "Quality Plan" and D1.9 "Quality Plan – final version". All deliverables are listed and available on the dedicated project web page if already prepared and not confidential.

### 1. LIST OF DELIVERABLES RELATED TO EAB ACTIVITIES

Table 1 is an extract from the project list of deliverables, which includes the ones directly linked with the EAB activities. As can be noticed, these belong all to WP1 (Project Management) and WP13 (Ethics).

The present document (underlined in the table) and the Ethics-related deliverables D1.5 and D13.9 are the only remaining deliverables until the end of the NAUTILOS project. The present document was postponed contextually with the last project amendment to Month 51, while the two remaining mentioned documents have been postponed until the end of the Project at Month 57.

**Table 1. The updated list of NAUTILOS Deliverables related to the EAB**

Del. No.	Deliverable Title	WP no.	Lead beneficiary	Type	Dissemination level	Due Date (in months)
<b>D1.2</b>	<i>External Advisory Board Report 1</i>	WP1	1 - CNR	Report	Public	12 <i>Accepted</i>
<b>D1.6</b>	<i>External Advisory Board Report 2</i>	WP1	1 - CNR	Report	Public	24 <i>Accepted</i>
<b>D1.7</b>	<i>External Advisory Board Report 3</i>	WP1	1 - CNR	Report	Public	36 <i>Accepted</i>
<b><u>D1.8</u></b>	<u>External Advisory Board Report 4</u>	<u>WP1</u>	<u>1 - CNR</u>	<u>Report</u>	<u>Public</u>	<b><u>51</u></b>
<b>D1.5</b>	EthAB Reports	WP1	1 - CNR	Report	Public	<b>57</b>
<b>D13.1</b>	<i>H - Requirement No. 1</i>	WP13	1 - CNR	Ethics	Confidential	3 <i>Accepted</i>
<b>D13.2</b>	<i>POPD – Requirement No. 2</i>	WP13	1 - CNR	Ethics	Confidential	3 <i>Accepted</i>
<b>D13.3</b>	<i>A - Requirement No. 3</i>	WP13	1 - CNR	Ethics	Confidential	3 <i>Accepted</i>
<b>D13.4</b>	<i>NEC - Requirement No. 4</i>	WP13	1 - CNR	Ethics	Confidential	3 <i>Accepted</i>
<b>D13.5</b>	<i>EPQ - Requirement No. 5</i>	WP13	1 - CNR	Ethics	Confidential	3 <i>Accepted</i>
<b>D13.6</b>	<i>DU - Requirement No. 9</i>	WP13	1 - CNR	Ethics	Confidential	6 <i>Accepted</i>
<b>D13.10</b>	<i>GEN – Requirement No. 13</i>	WP13	1 - CNR	Ethics	Confidential	6 <i>Accepted</i>
<b>D13.7</b>	<i>GEN – Requirement No. 10</i>	WP13	1 - CNR	Ethics	Confidential	18 <i>Accepted</i>

<b>D13.8</b>	<i>GEN – Requirement No. 11</i>	<i>WP13</i>	<i>1 - CNR</i>	<i>Ethics</i>	<i>Confidential</i>	<i>36 Accepted</i>
<b>D13.9</b>	<i>GEN – Requirement No. 12</i>	<i>WP13</i>	<i>1 - CNR</i>	<i>Ethics</i>	<i>Confidential</i>	<b>57</b>

### III. REPORT ON THE FOURTH EAB MEETING

The EAB was formed during the project's first year (2021); in particular, the administrative actions to finalise the contacts were completed by the end of July 2021. The outcomes of the previous EAB meetings and recommendations from the board are reported in the approved document deliverables D1.2, D1.6, and D1.7 (mentioned in Table 1 above).

During the last year (Months 37-48) of the NAUTILOS project, many activities were completed, and some previously delayed activities were also concluded. The main point of discussion concerned some delays that led the Consortium to unanimously ask for an extension of the project closing date to carry out all the planned activities entirely and successfully. These delays, as also mentioned and discussed during the second review meeting (after Month 36, held as a hybrid meeting in Brussels), would have put in jeopardy the successful delivery of a few final deliverables, as well as reduced the amount of time dedicated to demonstration activities, that in its turn could have impacted the final TRL of a few technologies developed. Thus, a nine (9) month extension request was submitted to the NAUTILOS Project Officer, and after discussion, it was approved during the summer of 2024. This amendment brings the new end of the NAUTILOS project to Month 57 (end of June 2025). In this way, proper implementation of the delayed activities, particularly the delayed demonstrations, could be achieved.

Consequently, several deliverables and milestones deadlines have been adapted to the new deadline (see again Table 1).

This section first describes the activities performed by the Ethics Advisory Board (EthAB) during this period, followed by a recap of the activities of the Engagement Board (EB). Then, a detailed description and comments on the fourth and final EAB meeting will be provided. The meeting took place virtually on 11<sup>th</sup> October 2024.

#### 1. ETHICS ADVISORY BOARD ACTIVITIES

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Following the ongoing actions, the EthAB, with the support of several internal members, kept on drafting the more general report dealing with Research Ethics in a multidisciplinary project, which is now foreseen to be completed and presented along with the project's final deliverables.

The organisation and drafting of such a comprehensive document are in progress thanks to the contribution of many different partners covering various aspects of NAUTILOS activities dealing with very diverse topics, led by the coordinator of the external EthAB, Dr **Nina Zugic**.

More details on this will be available in the deliverables D13.9 "GEN – Requirement No. 11" and D1.5 "EthAB Reports", which are due at Month 57 at the end of the project.

#### 2. ENGAGEMENT BOARD ACTIVITIES

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Within the frame of NAUTILOS governing bodies, the EB represent an example of a stakeholder concerning the NAUTILOS field of activities. The stakeholder representative in NAUTILOS EAB is the Surfrider Foundation<sup>1</sup>, a non-profit organisation dedicated to protecting and enjoying the world's oceans for all people through a powerful activist network. In NAUTILOS, it is represented by Dr **Haizea Jimenez**. Still, mention should also be given to her participation in several engagement activities within international organisations and activities and the support provided within the EB by Dr **Mariana Mata Lara**.

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<sup>1</sup> <https://www.surfrider.org/>

In the fourth year, the support of the EB continued following the previous activities and bringing the points of view and experience of a prominent stakeholder, especially considering the extent to which the Citizen Science activities have been achieved for the NAUTILOS Project. A particular highlight during the period is represented by the organisation of the Citizen Science session at the end of the 8<sup>th</sup> Consortium meeting held in Heraklion, Crete. The "Collaborative efforts for addressing Citizen Science challenges in the marine environment" session focused on Citizen Science and ocean literacy actions as cross-cutting activities<sup>2</sup>. The session was led by Eva Chatzinikolaou (HCMR), Louise Valestrand (NIVA), and Andrew King (NIVA), and many different actors were involved in presenting different activities and points of view. **Dina Eparkhina**<sup>3</sup> (EuroGOOS; Senior Policy and Communications Officer) presented "Scientists for Ocean Literacy – EuroGOOS recommendations for the UN Ocean Decade"; **Roula Andriopoulou**<sup>4</sup> (HCMR Inst. of Marine Biological Resources and Inland Water & Education Unit; Greek Plastic Pirates; Scientist) discussed "Plastic Pirates Go Europe: a citizen science initiative for 'capturing' the plastic waste on the riverbanks and near water bodies"; **Mariana Mata Lara**<sup>5</sup> (Sustainable Projects; Submariner Network; Senior Project Manager; NAUTILOS EAB) presented "SUBMARINER Network: Citizen science & engagement in the BANOS area and beyond"; **Arianna Liconti**<sup>6</sup> (OutBe; Marine Science Expert) showed "Outdoor for Good: how waterspouts activities can contribute to Ocean Monitoring"; and finally, **Haizea Jimenez** (Surfrider Foundation Europe; Head of Expertise Department; NAUTILOS EAB) discussed "Citizen Science at Surfrider: from data to advocacy".

In the end, a lively discussion took place, featuring numerous questions from the participants and the audience.

### 3. AGENDA AND COORDINATOR REPORT

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All 9 EAB members were invited to participate in the fourth yearly virtual EAB meeting. Unfortunately, a few of them could not join the meeting due to last-minute commitments, but they were provided with the presentation given during the meeting and the meeting recordings. They provided delayed feedback after the meeting.

The agenda for the meeting was the following:

- The coordinator presented the project's activities at the end of the fourth year, focusing on the amendment approved for the extension and the upcoming final period of the project.
- A recall of the amendments requested and obtained by the Consortium so far was presented.
- The coordinator presented the general status of the NAUTILOS project, with the main achievements of the last year; moreover, a summary presentation of the activities in each WP was given, as well as the foreseen activities for the subsequent period.
- A specific focus was given to the organisation of the second NAUTILOS Summer School.
- A final round table with questions and comments was established, and all members of the EAB commented and requested clarifications.
- In the end, there was a discussion and wrap-up of the Board meeting.

The presentation given by the coordinator is stored and available on the Project's Team Drive.

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<sup>2</sup> <https://nautilus-h2020.eu/nautilus-hybrid-event-on-collaborative-efforts-for-addressing-citizen-science-challenges-in-the-marine-environment/>

<sup>3</sup> <https://eurogoos.eu/secretariat/>

<sup>4</sup> <https://io.hcmr.gr/science-for-society/k-12-resources/hcmr-education-unit/>

<sup>5</sup> <https://www.sustainable-projects.eu/about/team>

<sup>6</sup> <https://www.outbe.earth/>

In the first part, the coordinator presented the project's status, starting with the outcome of the second Review Meeting (held in January 2024 in Brussels) and related reports, and then following with a specific focus on the outcomes of the status and delays that brought the discussion within the Consortium to the amendment request, and the description of the approved amendment process.

A presentation of NAUTILOS' achievements within the last year of the project has been presented. In brief:

- i) Three WPs correctly concluded on time and achieved their foreseen goals (WP4, WP5 and WP6);
- ii) All foreseen (76 for the whole period until M48, updated after the extension amendment) deliverables submitted or under submission phase;
- iii) All foreseen milestones until M48 were achieved (and new deadlines after extension amendment); in particular, Milestone M13-Installation of new sensors on commercial vessels was achieved even before M48;
- iv) All foreseen sensors/prototypes are developed and ready for the next stage;
- v) Some delays exist, but contingency plans have been applied to overcome the delays;
- vi) Dissemination and communication activities widely proceeding and successfully promoting NAUTILOS;
- vii) Broad participation in many public events both in terms of general NAUTILOS project presentations as well as specific technical presentations;
- viii) The organisation of the NAUTILOS Citizen Science session during the 8<sup>th</sup> Consortium Meeting held in Crete, Greece;
- ix) In the context of the project's capacity-building activities, the successful organisation of the second NAUTILOS Summer School, held in Crete, Greece;
- x) Several Citizen Science campaigns were held;
- xi) Synergies activities continue to be established;

Finally, each WP's status was presented with details on issues, deliverables and future activities.

#### **4. EAB COMMENTS, FEEDBACK AND RECOMMENDATIONS**

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After this step, the EAB members commented and gave specific feedback on various aspects for which they could provide direct support or help to achieve the strategic objectives of NAUTILOS, considering its actual status.

**Mariana Mata Lara (Coordinator of AQUA-LIT project; member of the SUBMARINER network)** asked for more details about the NAUTILOS Open-Access Instrumentation Roadmap (OAIR) and its relationship with other projects and what is planned to come after the end of NAUTILOS project. The coordinator explained more about the OAIR document and the synergies that NAUTILOS established during the project with other projects and initiatives, confirming that they already brought as an outcome some of the initiatives presented in the initial presentation and where NAUTILOS partners were invited or participated in. The legacy of the NAUTILOS project and the continuation of its activities have recently come under increased scrutiny by the Consortium, also based on the suggestions received from the EAB and the External Experts evaluating the NAUTILOS projects together with the Project Officer. The coordinator explained that parts of the NAUTILOS consortium had already joined efforts to participate in a few follow-up project proposals (3 at this moment).

In the meantime, exploiting the extension, the Consortium will pursue the Horizon Results Booster (HRB) initiative as well in an effort to extend the exploitation pathway, including the demonstration that we are dealing with and the increase of the activities in terms availability of sensors and samplers

to be ported into some operational platforms. Finally, a mention was made to the application made for some NAUTILOS sensors to exploit the possibilities given by the Transnational Access (TNA) activity in the MINKE Project<sup>7</sup> for supporting the development of technologies in key infrastructures. Mata Lara then asked about the possibility of activating, as part of the exploitation plan, the creation of a spin-off to bring to the market any of the sensors. The coordinator explained that this is consistent with the work that the Consortium has been doing, especially the work done and presented in the latest deliverables like the Socioeconomic impact assessment<sup>8</sup>. The coordinator briefly described the exploitation status for the NAUTILOS sensors and sampler.

Mata Lara then addressed a series of recommendations on many different aspects of the project, that will be very useful and taken into consideration by the Consortium:

1. Strengthen Commercialisation Pathways: Focus on clearly defining market entry strategies for the sensors and tools developed. Consider developing partnerships with commercial players to facilitate smoother technology transfer.
2. Expand Stakeholder Engagement: Improve outreach to non-traditional users of marine data (e.g., NGOs, startups) to increase the adoption of tools.
3. IPR Strategy: Ensure a flexible intellectual property strategy that encourages collaboration while safeguarding critical innovations.
4. Communication and Outreach: Enhance visibility through targeted communication campaigns, sharing results and tools with policymakers, marine industries, and the public. Maybe add videos on the website showcasing the prototypes and/or short clips about case studies or external partners showing successful implementations of NAUTILOS tools.
5. Scalability and Interoperability marketing: When promoting the tools, emphasise how the instruments are compatible with existing marine infrastructure and scalable to meet growing demands for ocean monitoring.
6. Actionable steps: The policy briefs are very good as they are short and visually appealing. However, some direct, actionable steps would be helpful to include where you leave short and clear the recommendation and the action decision-makers could take. For example:
  - a. Foster Data Infrastructure Improvements:
    - i. Recommendation: Encourage governments to invest in cloud-based marine data infrastructure to support real-time data sharing across national and international platforms.
    - ii. Action: Policymakers can incentivise public-private partnerships to co-fund and manage these data infrastructures.
  - b. Promote Capacity Building in Marine Data Management:
    - i. Recommendation: Establish training programs to enhance technical skills in marine data collection, management, and usage, especially in underrepresented regions.
    - ii. Action: Governments should support collaboration between academic institutions and marine research centres to develop open-access training modules.
  - c. Expand Participation in Open Data Initiatives:

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<sup>7</sup> <https://minke.eu/services/transnational-access-tna/>

<sup>8</sup> Deliverable D11.5 – final version (submitted at M45).

- i. Recommendation: Advocate for integrating open data-sharing protocols into national marine strategies, ensuring compatibility with international databases like EMODnet and Copernicus.
- ii. Action: To boost data transparency, governments can incentivise data-sharing agreements between industries, research institutions, and public sector entities.
- d. Drive Cross-Sector Collaboration:
  - i. Recommendation: Encourage collaboration across sectors (academia, government, NGOs, and private industry) to ensure the effective use of ocean data in policymaking and conservation efforts.
  - ii. Action: Develop multi-stakeholder forums or committees to facilitate regular exchanges on best practices, technological advancements, and policy needs.
- e. Incorporate Ocean Literacy in Education:
  - i. Recommendation: Integrate ocean literacy and data-sharing principles into school curricula to raise awareness of marine conservation from an early age.
  - ii. Action: Policy frameworks can support initiatives to develop educational resources, such as MOOCs and training tools, that are aligned with marine sustainability goals.

**Juanjo Dañobeitia (former EMSO-ERIC Director General, currently delegate at IOC-UNESCO)**: congratulated the NAUTILOS Consortium for the status of the project and its activities, then mentioned that, as it was clear since the beginning, a project such as NAUTILOS dealing with the development of new technologies, is always risky and the possibility of incurring into delays is something that could happen. Then he commented that there seem to be some unbalanced outcomes between different sensors/samplers; for instance, one sensor that is mounted on board a commercial ship Ferrybox is supposed to be almost reaching already TRL9, while others have lower TRLs, as it was also commented in the EU Periodic Review report. One of the main issues about this could be the calibration and validation activities needed to achieve higher TRLs. Testing these technologies in real operational conditions is also an issue, and there can be other connected issues, such as the available ship-time. One alternative could be to exploit existing calibration laboratories in the EU, when available, to perform compliant calibration based on accepted protocols with respect to sensors available in the market. Dañobeitia also commented about the recommendation in the EU Periodic Review report concerning the business plan; NAUTILOS established many a lot of different synergies with projects, but not with so many established EU Research Infrastructure (e.g., EMSO, EuroARGO), and these represent an important opportunity for a closing project, to realise some realistic legacy for the whole amount of knowledge, advancement, and work done, the key is not to look for another programme, but to establish synergies with platforms which are legal entities which will remain after the end of the project. This will be a significant transfer of knowledge for the whole NAUTILOS project. The coordinator replied that the low-cost term, which the project mainly used at the beginning of the activities, has now been chiefly corrected using the term cost-effective, and one of the reasons for the extension request was about being capable of applying a mitigation plan to complete the exploitation plan in full, as well as the demonstrations to achieve the due accomplishments. Concerning the different TRLs among sensors, some of the technologies were foreseen since the beginning of NAUTILOS to be achieving different TRLs (still above 6), and this is still valid, with some updates occurring during the project to adapt the status of all technologies.

**Jorge Miguel de Miranda (Executive Administrator of Atlantic International Research Centre - AIR Centre)**, commented that one of the biggest problems in dealing with low-cost solutions is that the companies selling them very often disappear quickly. For small companies with limited sales, it is often challenging to sustain their operations long-term. This uncertainty makes it difficult to rely on their

equipment for long-term observations, as there is no guarantee it will still be available in five years. As a suggestion, de Miranda proposes a solution: to get in touch with mainstream companies that have all these structures for maintenance, and to negotiate with them for these solutions, and at the same time, to help them in some sense, to have less costly solutions, but anyhow, sustainable on the long term. For instance, considering the work in the AIR Centre, which mostly involves Africa and South America, it would be great to have less costly sensors. Still, they need to assure the partners that those technologies will be maintained there for the long term.

The coordinator replied that NAUTILOS partially considered this issue and that it is also part of the business plan to connect partners (note: primarily public/non-profit entities) unable to cope with running (i.e. maintenance) costs together with other partners (note: mostly private companies) having this capability and interest at the same time (Coordinator shared the example of NAUTILOS CTD sensor commercialisation agreements). Moreover, as part of the above-mentioned socioeconomic impact assessment, an analysis has been performed to describe all the costs connected with the operational life of the sensors and compare them with available correlated solutions on the market. Anyway, further investment will be made to look for more solutions.

**Mafalda Carapuço (former Coordinator of Research Vessels at the Portuguese Institute for Sea and Atmosphere, currently Deputy Executive Director of Atlantic International Research Centre - AIR Centre)** initially presented her new role at AIR Centre. This institution's activities switched from mainly being focused on stakeholder engagement to currently being more of an operational network with several countries (especially in the Atlantic), dealing with research vessels and observation modelling. Moreover, a significant emphasis is placed on supporting countries with fewer capabilities, such as less developed countries in Africa, to have more competencies and to increase their role within the Atlantic like other EU countries. Afterwards, she followed up with a recall to what was mentioned previously by de Miranda about low cost: first of all, she agrees that the designation of "cost-effective" corresponds more to reality, and when they tried to develop low-cost equipment, an important issue is not just the maintenance, it is even about the production of these equipment. When aiming to establish a network using these kinds of sensors, some of these companies sometimes do not disappear, but they just quit producing this equipment. In countries with limited resources, this becomes a greater challenge rather than a solution. While they may have some funds to invest, incorrect investments—whether due to equipment no longer being available on the market or the lack of ongoing support—can create significant setbacks. This situation not only requires us to persuade them that a particular solution is the best option but also to convince ourselves of its viability. As a result, it raises doubts about whether this is truly the best approach for low-income countries. Finally, Carapuço commended the Consortium for their efforts and for making the EAB's work during the project more manageable.

**Stein Sandven, (senior scientist at NERSC-Nansen Environmental and Remote Sensing Center, Professor at UNIS and former Director of NERSC, Coordinator INTAROS & CAPARDUS)** remarked that although many achievements have been attained, the final and most important outcome will be the success of the demonstrations of the developed technologies, and how the project will engage the users and stakeholders. Moreover, what should be emphasised is that for such an ambitious project, the improvements and innovations arising from the project have been significant, and this should be promoted to the end users. Furthermore, he observed that the involvement of stakeholders is also part of the obligation to exploit the project results even after its completion; the Consortium should plan how these users will be involved, and how the development could continue, resulting in an extended market share for such observing systems. Sandven then commented about the low-cost vs cost-effectiveness, stating that there is a main difference depending on who should be the expected users for various technologies: there can be some very high-tech, very advanced observing systems which only a few users can use, and then there can be another range of simpler technologies, which anybody can use. For example, Citizen Science needs very simple devices which many people can use.

In the end, a range of these advanced or simple systems are directed to different user groups. As an example, Sandven mentioned the eBird Project<sup>9</sup> as a successful CS project requiring very low-cost technology, turning out to be eventually the most important scientific database for all ornithologists and biologists who studied bird life. For plastics in the ocean and other pollution in the sea, CS will become a crucial mechanism to collect data.

Sandven pointed out that scientists seeking high-quality data are less concerned about cost. Instead, they are often willing to invest in more expensive instruments if they offer better data quality or greater durability. In ocean observation, long-term data collection is frequently essential. Instruments capable of functioning reliably for many years are usually preferred over those with shorter lifespans or requiring frequent replacement. Many users prefer high quality because by calculating the costs over a long period, it can turn out that buying a more expensive system can be more cost-effective because it can last for a longer time.

Regarding the TRL discussion, Sandven acknowledges that Technology Readiness Levels (TRLs) can vary across different platforms and sensors. He emphasises that expecting all outcomes to reach the highest TRL within the project timeframe is unrealistic. Instead, the focus should be on achieving at least TRL 7, where the prototype has been successfully demonstrated. Higher TRLs can be attained post-project through the technologies' operational deployment and market integration, enhancing their robustness and longevity. This is also connected to the Calibration/Validation phase; still, there can be improvements in the cal/val phase even after marketing the products.

A final comment from Sandven addressed the amount and heterogeneity of the data collected in NAUTILOS. The management and conservation of data is a big challenge, and he asks how NAUTILOS deals with new types of data with no standard formats or metadata and how the data management plan (DMP) deals with these.

The coordinator addressed integrating new data and metadata, referencing the example of the plastic from the previous presentation. This involves a collaborative effort among several partners and EMODnet, with iterative feedback to refine and specialise metadata tables into a new metadata definition. While some data types are well-established and require only alignment on the NAUTILOS side to match existing metadata, the plastic data collected by citizen scientists presents a unique challenge. Although plastics data already exists in EMODnet, alignment is needed with evolving categories currently under development by the EMODnet group. Regarding the TRL, the coordinator reported that NAUTILOS would be mostly achieving TRL 7 or above and that TRL 6 was the minimum mandatory requirement from the EU for this project call.

Moreover, regarding the high quality and cost-effectiveness, the comparison that will be provided by the business plan and other correlated WP11 deliverables (e.g. the market comparison) will be important and valuable for researchers and stakeholders to evaluate and understand the differences between the various proposed technologies and the already available alternatives. Finally, the involved partners are aware of the low-cost technologies to be used for CS activities beyond NAUTILOS, and we have also already established some contacts with external projects and other initiatives (e.g., the Plastic Pirates<sup>10</sup>). In the end, the coordinator also acknowledges the suggestion to prepare a concise and more captivating summary of the innovations and improvements resulting from the project.

**Nina Zugic (an independent research ethics expert)** congratulated the Consortium for the achievements and coordination of the activities in a strongly united Consortium. Regarding the ethical part of the project, she acknowledges the extension obtained by NAUTILOS so that all the foreseen

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<sup>9</sup> <https://ebird.org/home>

<sup>10</sup> <https://www.plastic-pirates.eu/en>

activities can be brought to a positive outcome. Moreover, Zugic mentioned that she is pleased about the decision not to involve an external ethics advisor because the established group has been working on the ethics side and knows exactly what was supposed to be done and what has been done so far. Concerning the remaining work, it will be extremely important to mention all the lessons learned from the ethical point of view because it is quite complex. NAUTILOS has the sensors, the citizen sciences, the platforms, data, etc. During the meeting, several mentions were made to different ethics issues that should be addressed and presented in the final report.

Moreover, some of the best practices, challenges, and cutting-edge technology are discussed, including the lower cost while using cost-effective technology. From the ethical point of view, how has this been dealt with, as well as the roadmap, and how can the technology be transferred to any other initiative or synergy project? Zugic also requested all the members of the EAB to bring up any other ethical issues that can feed the final deliverables.

Another remark was made about carefully integrating Artificial Intelligence (AI) tools and clearly and carefully covering any mitigating strategy needed for their ethically responsible use. Furthermore, she suggested continuing to focus on the circular economy and its essential connection with the extended CS activities done in NAUTILOS. A final suggestion is to increase the use of QR codes as an easy and helpful tool to disseminate more readily the various links used within the NAUTILOS project (putting them within presentations, leaflets, the CS app, etc.).

The coordinator replied about the AI integration, mentioning the work done jointly with DFKI partner in NAUTILOS for the automatic identification of plastics from beach photos taken by Citizen Scientists (thus integrated into the CS App); the results are only used for research and are simple statistical data trying to improve the understanding of the number of plastic types can be found yearly. The coordinator also recalled that the CS App developed in NAUTILOS is not intended to be used in connection with organisations arranging CS campaigns and activities and is not available to the general public.

Following the wrap-up, the coordinator and the project management shared the presentation and the recording of the meeting with the EAB (they are also available through the NAUTILOS website), which will be used by those members who could not join the virtual meeting.

## IV. CONCLUSIONS

Many different activities were performed in this fourth year of the project, involving various members of the EAB, and all received positive feedback and already proved helpful to the Consortium. The EAB's capability to capture the project's achievements and support the alignment with the objectives set out in NAUTILOS has been fundamental to the life cycle of the NAUTILOS project.

At the end of four years of intense activities, and with a major change in the life of NAUTILOS as the extension amendment approved to postpone the end date of the project, the final period of the project lies ahead with many deadlines and activities to be accomplished. In particular, two topics were discussed during the last review meeting and this last EAB meeting: the demonstrations and the exploitation activities.

With these two elements in mind, the advice from the EAB represents an invaluable asset and support, providing a novel perspective, highlighting the areas of strength, and suggesting strategic improvements.

Among the many pieces of advice, three main focuses or recommendations can be drawn:

### 1) Strengthen Commercialisation Pathways

- a) Clearly define market entry strategies for sensors and tools developed by NAUTILOS.
- b) Develop partnerships with established commercial players to ensure technology transfer and long-term sustainability.
- c) Address challenges related to maintaining and producing cost-effective equipment (with a possible focus on low-income regions).

### 2) Expand Stakeholder Engagement and Visibility

- a) Increase outreach to diverse stakeholders, including non-traditional users like NGOs, startups, and citizen scientists, to maximise adoption of developed technologies.
- b) Use targeted communication campaigns to enhance visibility, incorporating videos, case studies, and demonstrations showcasing innovations.
- c) Collaborate with established EU Research Infrastructures (e.g., EMSO, EuroARGO) to create a lasting legacy and promote cross-sector collaboration.

### 3) Focus on Scalability and Ethical Considerations

- a) Ensure the tools are scalable and compatible with existing marine infrastructure while emphasising their cost-effectiveness for different user groups.
- b) Address ethical concerns related to technology use, including responsible AI integration and adherence to circular economy principles.
- c) Document lessons learned and best practices to inform future projects and synergies.

These insights reflect the Consortium's focus on long-term impact, stakeholder inclusivity, and ethical, sustainable development of marine observation technologies.

## APPENDIX 1: REFERENCES AND RELATED DOCUMENTS

Deliverable 1.8 has been developed under the provision outlined within the following related documents:

ID	Reference or Related Document	Source or Link/Location
1	NAUTILOS Grant Agreement	NAUTILOS TeamDrive
3	NAUTILOS Deliverable D1.2.	NAUTILOS TeamDrive
4	NAUTILOS Deliverable D1.6.	NAUTILOS TeamDrive
5	NAUTILOS Deliverable D1.7.	NAUTILOS TeamDrive
7	NAUTILOS Deliverable D13.7.	NAUTILOS TeamDrive