i34BLUE GROWTH

green innovation for blue growth

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Acknowledgments

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Special thanks go to the staff of organisations who piloted each thematic workshop: Merinova, Baltic Sea & Space Cluster, ANI, Unknown Group, Clust-ER Agrifood, and Pôle Mer Bretagne Atlantique. The strength of these workshops came from the diversity of expertise represented by these organisations and their capacity to mobilize their networks to promote interregional innovation.

For their support, advice and action, we would like to thank the I3-4 Blue Growth project consortium and the staff of partner organizations, the commitment and quality of their contributions to the work on this activity was exemplary. Many current and former staff members within their own organizations offered support, guidance and assistance for which they are extremely grateful and without which the workshops would not have been possible. The contributions of Blue Bio Alliance to the communications around the workshops and the efforts of the same organisation as well as CTAQUA, HAMAG BICRO, and the Regional Directorate for Science, Innovation and Development of the Azores (DRCID) in engaging themselves and their networks in fruitful exchanges during these workshops was indispensable.

Finally, we thank I3-4 Blue Growth project promoters, technology providers and other blue economy ecosystem stakeholders. Their questions, comments and suggestions gave our work life and allowed for insights and improvements a less engaged audience would not have yielded. We hope that our actions will continue to promote their development and lead to continued opportunities for collaboration in the future.

Introduction

The I3-4 Blue Growth project was an excellent opportunity to promote peer learning amongst blue economy actors throughout Europe. It offered the time, resources and structure that allowed stakeholders to come together to share best practices and engage in discussions around green solutions for the marine and maritime sectors. Knowledge sharing took many forms throughout the project. Numerous capacity building actions, roundtables and in-person site visits brought the community together for mutual learning.

The current deliverable focuses on the thematic workshops held in person and simultaneously online during the three ecosystem visits held from December 2024 through October 2025. With these workshops, I3-4 Blue Growth partners set out to promote peer-to-peer learning through exchange of blue economy interregional good practices and flagship innovation experiments and projects from the two value chains at the heart of the project. The core audience of the events were the in-person participants on the

ecosystem visits, with the reach of the actions expanded via simultaneous diffusion of the sessions online and publications of workshop recordings and materials online for impact beyond the project lifetime.

While the I3-4 Blue Growth ecosystem visits were densely programmed with a multitude of site visits and sessions aimed at sharing knowledge and brokering B2B partnerships, this deliverable focuses exclusively on those workshops which were delivered in a combined format online and in-person during regional ecosystem visits. They numbered five in total, 2 each focusing on the project's 2 value chains and one transversal topic. This included:

Value Chain #1

- "Digitalisation in Aquaculture: Trends, Challenges and Solutions" Organized by CLUST-ER
- "Integrated Multi-Trophic Aquaculture: Best Practices and Paths to Commercialization" Organized by PMBA

Value Chain #2

- "Hybrid Workshop with Maritime Decarbonisation Best Practices: Building innovative solutions through collaboration" Organized by Merinova and BSSC
- "Digital Twins for Offshore Renewables & Marine Ecosystems" Organized by Unknown Group

Transversal

- "RIS3T – Cross-Border Smart Specialization Strategy (Galicia – Norte de Portugal)" Organized by ANI

This deliverable will discuss the methodology pursued in programming and executing the sessions, a discussion of the content and outcomes of each the thematic workshops, a look at participation data and participant feedback, and a conclusion incorporating lessons learned from the workshops.

Methodology

The thematic workshops were approached as opportunities for organizing partners to highlight an area of expertise present in their networks in I3 priority identified areas with project partners and participants. As such, partners responsible for each session were given autonomy to shape the workshops to this end, highlighting flagship innovation projects and large-scale demonstration initiatives from their regions. Common aims and broad frameworks were agreed upon in work package meetings with an insistence on the hybrid nature of the sessions and attempts to iterate intelligently by responding to lessons learned from audience feedback to previous sessions. An initial brainstorming exercise highlighted above all the need to insure the pertinence of the workshops to participants and stakeholders.

Plans for thematic workshops subjects and speakers were discussed with project partners during monthly WP5 meetings to validate pertinence and solicit additional best practices to be highlighted during the sessions. Examples explored were deployed at local, cross border, and European levels with an eye to transferability of best practices to other regions. Ad-hoc meetings between workshop co-organizers and ecosystem visit organizers were held in the run-up to ecosystem visits to plan and execute workshops, integrating them within the context of the broader field visit. Appropriate venues with internet connectivity and sufficient timeslots were identified to carry out the actions according to our commitments to simultaneous online and in-person participation.

Synergies with other European initiatives were pursued on multiple occasions. As evidenced by the content section of this report, the results of European funded projects featured often in workshops. In two workshops, an explicit cooperation between European projects was established, with the coorganization of a workshop on digitalization in aquaculture with the Interreg Atlantic Area project Blue Shuttle, and the prominent dissemination of the results of the Horizon-funded Astral project during the workshop on Integrated Multi-Trophic Aquaculture. As such the reach of these actions and I3-4 Blue Growth was expanded to additional stakeholder networks.

Communications promoting the sessions included their descriptions in ecosystem visit agendas shared with project promoters, tech providers and other stakeholders. Each workshop was also promoted via the project's linkedin page and its I3-4 Blue Growth Hub for a Sustainable Blue Growth LinkedIn group. Partners were encouraged to disseminate information about the online sessions within their networks to boost engagement.

Uniform participant feedback forms were drawn up by PMBA and administered following each thematic workshop to gauge the success of the actions. The forms were also a key tool in improving workshops in subsequent iterations. Observations from this feedback led to a reduction in the duration of workshops and sparked attempts to enhance the interactivity of the sessions during the French field visit, with the use of pre-session surveys and dedicating a greater portion of time to discussion with participants. Invitations were also proffered to project partners to propose project participants and stakeholders to present during workshops, though organizations preferred to maintain their role as participants.

Publications of workshop recordings and materials were foreseen to extend the impact of the actions. The hybrid nature of the events, however, left this aspect of the action vulnerable to error. Workshops during the ecosystem visit to the Netherlands lacking recordings were thus disseminated online via slides and session summaries as a mitigation measure. While technical checks were performed in advance of the sessions, changes in technical material used and the spontaneity of speakers addressing an in-person audience led in, notably the case of the workshop on Integrated Multi-Trophic Aquaculture to recordings of a lesser quality than a fully online session would likely have yielded.

Workshop Contents

Finnish Ecosystem Visit Workshop

"Hybrid Workshop with Maritime Decarbonisation Best Practices: Building innovative solutions through collaboration: from purpose to impact"

December 10th, 2024 14:00-16:15 EET (GMT+2)

On the occasion of the I3-4 Blue Growth Ecosystem Visit to Vaasa, Finland, the I3-4 Blue Growth organized the first of its hybrid thematic workshops. The workshop, organized by project partners Merinova and BSSC, took place live on the Aurora Botnia ferry as it carried the project delegation on its route between the Finnish and Swedish coasts. The session was dedicated to highlighting flagship projects for maritime decarbonization in Finland, a presentation of the ferry itself by Catarina Fant of Wasaline, and Poland, presented by Marek Grwybowski of the Baltic Sea and Space Cluster. The session concluded with an interactive workshop entitled "Ecosystem Handbook" presented and facilitated by Sari Kola of Merinova, aimed at building capacity for effective collaboration for innovation.

Catarina Fant, Wasaline - "Presentation of Aurora Botnia Ferry"

Following a presentation of the I3-4 Blue Growth project by Ethan Holaday of PMBA, Catarina Fant welcomed the delegation to the Aurora Botnia Ferry describing its dimensions and many amenities before coming to the heart of her presentation on the sustainable innovation driving the ferry. The Aura Botnia is a hybrid vessel powered by battery and by LNG, with the capacity to operate on an entirely C02 neutral basis. Shore power is used to power and recharge the batteries of the vessel. Intelligent ventilation and lighting in passenger areas, the use of environmentally friendly materials like recycled fishnets, and policies for recycling damaged equipment contribute to a global approach to sustainability on the ferry. The ferry company aims to achieve emissions neutrality by 2030. With its important role in transporting cargo, the ferry is an important connection between global logistics hubs of Southern Sweden and the deep-water harbours of Norway. Comparing

Figure 1 Photo Vaasa Workshop Fant

intermodal transport from Barcelona to Vaasa via Swedish rail and Vasaline to a route via Germany to Finland, the former saw an 80% reduction in Greenhouse gases, 99% reduction in Sulfur Oxides, 93% reduction in Nitrogen Oxides and a 99% reduction in particulate matter.

Marek Grwybowski, Baltic Sea and Space Cluster – "Presentation on Production of Zero-Emission Vessels"

Professor Grwyzbowski then took the stage to present the Baltic Sea and Space Cluster(BSS) Zero-Emission Vessels Innovation Hub. He began the presentation with an overview of the various Hubs organized by the cluster and the international projects it is involved in, emphasizing its global mindset and field of action. He mapped the clusters cooperation in a number of global and European networks and initiatives for maritime innovation. In the context of maritime decarbonization, Poland is a key player, being the European leader and 2nd in the world in the production of boats between 9 and 15 meters. Among the actions taken by the cluster include the promotion of the adoption of ICT tools that support ferry operators and cargo transport to optimize routes, support for internationalisation and business development for South Baltic SMEs producing electric propulsion vessels, the creation of the Zero-emission vessel production hubs in the context of a Horizon-funded project and Noway grants resulting in the production of 3 electic ferries for Scandinavian ship owers. The presentation concluded with an overview of several zero-emission vessels produced by members of the ZEV hub and pointing to opportunities for future interregional innovation and business between Poland and Finland.

Figure 2 Photo Vaasa Workshop Grwyzbowski

Sari Kola, Merinova - "From Purpose to Impact: Ecosystem Handbook"

Following a break Sari Kola of Merinova led a session on "collaboration and how to capture value from it." She started off by situating leadership and trust as necessary to working on projects with members of diverse backgrounds and cultures. The objective she set for the workshop was to build trust. "The fundamentals of strategy are changing," she insisted. "Today strategy is peace," pointing to the increasing complexity of value propositions and the necessity of collaboration. Situating the various natures and functions of clusters, networks, ecosystems and platforms and identifying the most common motivations of stakeholders in innovation projects, Kola underlined that building trust requires clearly articulated

purpose, helping establish rational and emotional engagement. Kola then set out the phases of the "ecosystem journey" of a collaborative entity from Emergence (where key collaborators join the initiative) to Evolution (where communication key as the ecosystem or project orchestrator communicates joint objectives and gets partners excited) to Adaptation (emerging tensions between key players may require mediation and resolution) to Expansion (bringing on ever more stakeholders to your consolidated initiative to enhance impact). "It is anything but straightforward, but it should be always measurable, always exciting, and always tangible," she concluded.

Group Discussions and Conclusions

To apply these lessons and build trust amongst participants in the session, Kola then opened the interactive, group work session. After examining the "superpowers" participants identified on a collaborative online platform ahead of the session, the in person and online participants then split into groups.

These teams:

Identified ecosystem journey participants, working to identify key institutions, people or roles in a collaborative innovation initiative

Discussed what was needed to accelerate their collaboration: Identifying the phase of the journey, key challenges, help needed, how to request this support, and whether team members were helping others

Following these discussion sessions, representatives from the groups came forward to share their conclusions. Emerging from these conversations were the following observations:

For some innovation projects, objectives are aligned and the bases of fruitful collaboration are set but communicating the value of the collaboration to a third party is the blocking point for securing funding.

The complexity and shifting nature of contemporary environment, including geopolitical uncertainty, demanded that even mature, well-established entities adapt and find new ways of operating

Figure 3 Photo Vaasa Workshop Kola and Online Participants

Other Challenges include funding, establishing networks, building trust, and determining the management of intellectual property, the high rate of technological change, and skills and eductation

The presentation also provoked participants into contemplating reaching beyond their sector of activity to find new solutions and partners

In conclusion Kola stressed the importance of open communication and the power of asking for and giving help to others. She pointed participants to an online ecosystem toolbox to build upon the session in a more concrete manner after the visit, consolidating and applying the lessons learned.

Dutch Ecosystem Visit Workshops

"Interregional Governance & Regional Best Practices"

May 21st, 2025, 15:30 CET

The thematic workshop organized by project parter ANI (Agência Nacional de Inovação) during the I3-4 Blue Growth Ecosystem visit to the Netherlands, took as its topic interregional good practices. The session put the spotlight on a case of effective cross-border collaboration between the Norte region of Portugal and the Galicia region in Spain. Paulo Santos, Head of the Strategic Planning and Regional Development Division of the Comissão de Coordenação e Desenvolvimento Regional do Norte (CCDR-N), spoke to online and onsite participants via video link to discuss the two regions' Cross-Border Smart Specialization Strategy (RIS3T).

Context

Santos shared that the Euroregion Galicia–Norte de Portugal is a long-standing cooperative area that encompasses more than 6.4 million inhabitants and is characterized by shared cultural and economic ties, as well as institutional collaboration dating back to 1983. He noted that both regions demonstrate moderate innovation performance and face common development challenges, including low productivity and lower-than-average GDP per capita, while also possessing complementary strengths.

What is RIS3T?

Santos explained that the Cross-Border Smart Specialization Strategy (RIS3T) serves as a coordinated innovation framework between Galicia (Spain) and Norte (Portugal). Its purpose is to align public policies and funding, build shared innovation ecosystems, strengthen scientific, technological, and business capacity, and support the green, digital, and just transitions through joint initiatives and investments.

How Has it Evolved?

Figure 4 Photo RIS3T Workshop Santos, Ribeiro, Audience

Santos then outlined the evolution of RIS3T from the 2014–2020 period to the 2021–2027 cycle. During 2014–2020, RIS3T became the first cross-border smart specialization strategy in Europe, achieving the establishment of joint governance structures, the creation of an R&D observatory, the organization of cross-border brokerage events, and recognition as a best practice in EU S3 policy. For 2021–2027, the strategy has expanded to include a Joint Investment Programme, broader priority areas—such as agri-food, marine resources, health, industry and energy, and tourism and creative industries—and deeper collaboration with EU programmes including Horizon Europe and Interreg POCTEP.

The Blue Economy and the RIS3T

Santos emphasized that Marine Resources and the Marine Economy constitute a strategic priority for RIS3T 2021–2027. The shared ambitions for this domain include advancing ocean renewable energy technologies (such as offshore wind and wave energy), developing blue biotechnology and valorizing marine bio-resources, promoting clean technologies and advanced materials for the naval industry, improving digital technologies for marine monitoring and sustainable resource use, and supporting biodiversity conservation along coastal habitats. The overarching goal is to combine applied engineering, sustainable resource management, and regional talent to foster a resilient and innovative blue economy.

He also highlighted several key joint projects for 2021–2027, including TWIN_NAV_AUX (digital twin applications in the Galician naval auxiliary industry), AOWINDE (support for Atlantic offshore wind energy and related value chains), BLUE_WWATER (monitoring microplastics and pollution in coastal waters), CAPTA (blue carbon and climate neutrality on the coast), and BIOCOSTEIRO (biodiversity conservation in Natura 2000 coastal habitats).

Governance & Implementation

Regarding governance and implementation, Santos described a multi-level structure that includes a cross-border innovation council, thematic platforms—such as those for marine, health, and industry—and a shared R&D&I observatory. This structure focuses on strengthening territorial cohesion across the border, attracting and retaining talent, and harmonizing administrative and funding mechanisms.

Conclusion

Santos concluded with several key lessons and takeaways: political commitment and continuous coordination are essential; smart specialization must remain place-based and partnership-driven; and RIS3T demonstrates how cross-border regions can pool resources, innovate collectively, and respond to global challenges such as climate change and digitalization.

"Digital Twins for Offshore Renewables & Marine Ecosystems"

May 22nd, 2025

The thematic workshop Unknown Group organized as part of the program of the visit to their ecosystem in South Holland, was focused on how digital twins can contribute to a sustainable blue economy. The featured speaker was Nico van der Kolk of AlbatrosDigital, whose company creates Digital Ships for Design, Controls and Monitoring. As such the session straddled the line between the two focuses of Value Chain 1: Marine Renewable Energies and Maritime Decarbonisation with a primary emphasis on the latter.

Introduction

Van der Kolk presented AlbatrosDigital's cutting-edge approach to digital twins in the maritime sector, highlighting how the company combines physics-based modelling with real-world operational data to simulate, predict, and optimize vessel performance. He emphasized that this approach is particularly relevant to offshore renewables and the integration of marine ecosystems, as it supports accurate modelling of fuel consumption, emission reductions, and vessel–environment interactions.

Key Components of the Digital Twin Framework

He outlined the key components of the digital twin framework. First, the physics-based ship models can achieve up to 95% accuracy, taking into account hull shape, engine type, propulsion systems, and environmental factors such as waves, wind, and hull fouling. Second, machine learning integration allows the models to be refined with in-service data, ensuring high fidelity even when sensor data are sparse or noisy. Third, digital ship revisions use live calibration—based on noon and voyage reports—to continuously validate and improve performance estimates. Finally, virtual voyages use AIS tracks and metocean data, whether forecast, hindcast, or statistical, to simulate real-world conditions. These simulations provide actionable insights for route optimization, technology validation—such as assessing Wind Propulsion Systems (WPS)—and emission minimization.

Figure 5 Photo Digital Twins Workshop Van der Kolk and audience

Applications to Offshore Renewables

Van der Kolk discussed several applications of digital twins to offshore renewables. In the area of wind-assisted ship propulsion, AlbatrosDigital has evaluated WPS retrofits on large commercial vessels such as the HUMBRIA SEAWAYS, with simulations demonstrating fuel savings of up to 16%, thereby illustrating the contribution of wind power to decarbonization objectives. Digital twins also support design optimization for vessels equipped with renewable or hybrid technologies, including sails, air lubrication systems, and hybrid engines, by simulating vessel behaviour under varying weather and loading conditions. In addition, he noted that route and fuel optimization can indirectly benefit marine ecosystems by reducing underwater noise, emissions, and the likelihood of fuel spills.

Technical Innovations

He also highlighted several technical innovations within the platform. The modular model architecture enables the integration of third-party OEM tools, black-box simulations, and high-frequency onboard data streams. A hybrid modelling approach merges physics-based and data-driven methods, addressing sensor limitations and supporting early-stage evaluation of emerging technologies. Full-voyage analysis is enabled through extensive fuel tables—sometimes exceeding 167,000 entries per scenario—allowing the system to predict vessel performance across dynamically changing ocean conditions.

Conclusion

Van der Kolk concluded that AlbatrosDigital's digital twin platform represents a scalable, accurate, and forward-looking solution for supporting the adoption of offshore renewable technologies, reducing environmental impacts, and enhancing the operational intelligence of ships. He emphasized that this work effectively bridges the gap between the integration of green technologies and the protection of marine ecosystems, making it a powerful tool for advancing maritime decarbonization.

French Ecosystem Visit Workshops

"Digitalisation in Aquaculture: Trends, Challenges and Solutions"

September 30th, 2025 11:15 - 12:45 (CET)

Clust-ER Agrifood shared its expertise in the I3-4 Blue Growth value chain #2 and especially sustainable aquaculture to organize a thematic workshop on the topic of Digitalization in Aquaculture. The workshop was co-organized as a "Blue Skills Classroom" of the Interreg Atlantic Area Project Blue Shuttle via project partner Pôle Mer Bretagne Atlantique (PMBA) on the first day of the ecosystem visit to Brest, France. Moderated by Elisabetta Leoni (Clust-ER), the workshop featured the contributions of Massimo Bellavista (Legacoop Agroalimentare), Prof. Luisa Fasti (University of Ferrara) and Charlotte Dupont (Bioceanor). Each shared their vision of the trends, challenges, and solutions present in this innovation area.

Introduction and Context

The session opened with an invitation for participants were invited to scan a QR code to contribute keywords on the challenges facing digitalization in aquaculture. Presentations of I3-4 Blue Growth and of Blue Shuttle (by Ethan Holaday and Yannis Kablan, both of PMBA) were followed by a session introduction by Elisabetta Leoni who set the scene for the session and introduced the three members of the roundtable.

Massimo Bellavista – Legacoop Agroalimentare (Italy)

Bellavista began the round of presentations by sharing insights from 25+ years of experience in fisheries and aquaculture. He described Italy's Emilia-Romagna region as an important centre for mussel and clam farming, supported by over 1,600 workers and 70 cooperatives.

Massimo emphasized challenges such as:

Digital skill gaps: Many producers lack training or even basic computer literacy, limiting adoption of digital tools.

- Language barriers: EU projects generally operate in English, excluding farmers who need translated materials
- Bureaucracy: Regulatory complexity delays innovation and adaptation
- Scaling & Sustainability: scaling pilot sensor networks or digital twins from a few farms to many across regions with consistent performance is challenging

Bellavista's presentation also situated the challenges facing the sector more broadly, pointing to the impact of the invasive blue crab, which has devastated clam production and forced farmers to diversify into new species like oysters.

Massimo pointed to the promise of digitalization to enhance aquaculture in his region and discussed initiatives seeking to address the challenges he detailed earlier, presenting the BOUTCAR Digital Aquaculture project and AQUATECHinn4.0 Optima. also highlighting the importance of training, safety, and supporting fishermen during transitions driven by environmental change.

Prof. Luisa Pasti – University of Ferrara (Italy)

Pasti provided an overview of digital technologies in aquaculture, dividing applications into: production-phase tools (water monitoring, biomass estimation, predictive models) and post-harvest tools (traceability, lab data, logistics, customer feedback).

Among the key challenges she identified were:

Figure 6 Photo Digitalisation in Aquaculture Workshop Pasti, Dupont, Leoni, Holaday and Bellavista

- Infrastructure gaps and poor connectivity at remote sites
- High initial and ongoing costs (e.g., calibration, maintenance)
- Limited digital skills among operators
- Standardization, interoperability, and data-sharing concerns
- Privacy, ethics, and data ownership

She presented examples from Italian clam-farming regions, where simple smartphone-based monitoring tools improved oxygen and chlorophyll management. Projects succeeded largely due to extensive operator training.

Luisa also introduced the I-FISH project on intelligent systems for production, distribution, and functional fish-based foods, highlighting the role of data collection from environmental, nutritional, and processing parameters to ensure traceability and consumer transparency.

Charlotte Dupont – BiOceanOr (France)

Dupont described how BiOceanOr provides real-time water monitoring and forecasting, combining biology and AI to help aquaculture operators anticipate issues such as oxygen drops or harmful algal blooms.

Key trends she highlighted included:

- Rising use of digital twins to simulate scenarios (e.g., feeding regimes, catastrophic events)
- Increasing deployment of AI at the edge, allowing processing on-site without relying on cloud connectivity

The major challenges she identified were:

- Data quality: Sensors may be unmaintained or suffer inconsistent calibrations leading to gaps in datasets
- Connectivity constraints in remote farms: Poor bandwidth, low power reliability and maintaining offshore hardware for edge computing is hard. As such sometimes data is only retrieved monthly
- Validation of digital twins: which require accurate "ground truth" data which farms are often reluctant or unable to share

She then presented BiOceanOr's solution, the AquaHeal platform for water quality monitoring. The solution integrates multiple data sources and includes a Data Consistency Tool that checks data quality and provides alerts, helping users address sensor or environmental issues. Rich with features, the platform provides an innovative solution to optimize offshore aquaculture production.

Interactive Session

The presentations were followed by an interactive session. It took as a starting point workshop participants' crowd-sourced keywords, which highlighted three dominant challenges: funding, costs and data integration. All speakers agreed that those challenges reflect real-world constraints. They emphasized that fish farmers are often hesitant to invest in digital solutions without clear ROI and that funding is critical, especially for small enterprises and cooperatives. Collaborative, shared solutions (e.g., through associations) reduce barriers for small-scale producers. As reflected in each of their presentations, data-collection, availability, integration, and visualization are central to every digital challenge.

The discussion also returned to the blue crab crisis. Massimo described emergency measures in Italy: financial compensation, creation of a national commissioner, and experimentation with clam-protection cages and alternative species. Market barriers persist because crab consumption is not culturally mainstream in Italy.

Conclusion

The workshop concluded with thanks to speakers, organizers, and online participants. The session emphasized that digitalization holds transformative potential for aquaculture, but adoption depends on addressing skills, costs, data quality, and regulatory complexity. Cross-border EU collaboration remains essential for scaling solutions, which makes enhancing the accessibility of such initiatives a key lever for impact.

"Integrated Multi-Trophic Aquaculture: Best Practices and Paths to Commercialisation"

October 1st, 2025, 10:00 to 11:00 (CET)

The final thematic workshop was held live from the aquaculture farm France Haliotis in Plouguerneau as a part of the I3-4 Blue Growth Ecosystem Visit in France. It would be dedicated to an exploration of approaches to Integrated Multi-Trophic Aquaculture and paths to commercialisation available to sustainable aquaculture producers. Featured speakers included, Ethan Holaday (PMBA) who would present the results of the Horizon-funded project Astral regarding the deployment of IMTA, and Sylvain Huchette (France Haliotis) who would present his farm's approach to sustainable aquaculture for abalone and seaweed production.

Introduction and Context

The session opened with introductory remarks and, like the workshop on digitalization in aquaculture, a short participant activity using a QR-code survey to generate a word cloud on perceptions of effective sustainable aquaculture practices. Participants were welcomed both onsite and online. Ethan Holaday of PMBA explained that the session would include presentations, a project overview, an on-site case study from a local producer, and a concluding interactive discussion. As part of the I3-4 Blue Growth project presentation, a new project video was also shared highlighting stakeholder perspectives on the project's ecosystem visits.

Presentation of the ASTRAL Project – Ethan Holaday, PMBA

The first presentation of the workshop was a summary of the ASTRAL project (All Atlantic Ocean Sustainable, Profitable and Resilient Aquaculture), a Horizon initiative (2020–2024). The project's overarching objective was to enhance the sustainability, value, and resilience of IMTA systems across diverse Atlantic regions. Holaday briefly defined IMTA, noting that conceptual clarity has evolved over time. IMTA was described as the coordinated cultivation of organisms from different trophic levels so that

waste outputs from one species become nutrient inputs for another, circularity is increased, and environmental pressures are reduced.

Holaday shared that ASTRAL developed and analysed a suite of IMTA pilot systems in different geographies and production contexts: Ireland (open-water IMTA), South Africa (land-based shore system), Scotland (open-water IMTA), Brazil – recirculating aquaculture system integrating shrimp, tilapia, oysters, and seaweed in closed loops using biofloc, and Argentina – prospective IMTA site. A short explanation was provided of how the Brazilian system circulates nutrients: shrimp waste feeds tilapia and oysters; nitrate-rich effluent then fertilizes seaweed tanks, which filter the water before recirculation.

ASTRAL incorporated both technical and socio-economic analysis in its advancing the understanding of the context of IMTA's deployment. This included: environmental analysis– nutrient remediation potential, progress toward "zero-waste" loops, and life-cycle environmental performance of IMTA vs. monoculture; circular economy considerations– quantifying material flows within IMTA systems; compliance and standards–evaluation of IMTA performance under existing regulatory frameworks; socio-economic assessment (PESTEL)–political, economic, social, technological, ecological, and legal factors influencing IMTA implementation in each region; and business model analysis for each of the case systems.

Technological innovations developed within the project included IoT sensors and vision systems to support monitoring and optimisation of IMTA operations. Participants were invited to consult the project website to consult the many valuable resources developed over the course of its lifecycle.

Case Study: IMTA Practices at a Brittany Farm – Sylvain Huchette, France Haliotis

Sylvain Huchette a local aquaculture entrepreneur and operator with over twenty years of experience presented integrated system employed by his business, France Haliotis, which includes a land-based hatchery and nursery, seaweed-cultivation tanks, and offshore grow-out sites where abalone are raised in benthic cages. Because coastal space is limited by tourism and real-estate pressures, production has shifted offshore. Abalone are fed primarily with fresh seaweed, now mostly cultivated on-site to improve reliability.

The system has gradually taken on IMTA characteristics. Long-submerged abalone cages function as artificial reefs, accumulating seaweed and attracting marine organisms, while long-line seaweed cultivation positioned above the cages aligns nutrient release with algal uptake. The farm produces about 20 tons of Saccharina annually across 2.5 km of long lines. Additional species—such as scallops, flat oysters, and sea urchins—are being tested for their potential to use different parts of the nutrient loop, with sea urchins integrating naturally into the abalone cages.

Biological and economic interactions shape the farm's operations. Producing 1 kg of abalone requires roughly 10 kg of seaweed, making large-scale seaweed production essential. Cultivated seaweed improves feed consistency and enhances abalone growth and profitability compared with wild harvests. Developing markets for surplus seaweed remains difficult, prompting collaboration with chefs, restaurants, and hospitals to create new seaweed-based culinary products.

Figure 7 Photo IMTA Workshop Huchette

Huchette highlighted major challenges. Spatial competition along the Brittany coast makes securing farm sites difficult, even offshore. Environmental pressures include microbiological pollution from tourism and agriculture, increasing microplastics, warming waters that threaten seaweed species, and ocean acidification affecting abalone larvae. Economically, profitability took nearly fifteen years to achieve, and competition from low-priced Asian imports constrains market growth. Public support mainly targets production, with limited aid for market development, though strong local gastronomic networks have helped expand demand.

Interactive Session

The discussion that followed focused on sustainability and circularity. Participants emphasized the need to balance resource extraction with regeneration and highlighted the role of lower-trophic species—such as seaweed and bivalves—in capturing nutrient outputs. Some discussed circularity solutions in RAS aquaculture. While IMTA can reduce environmental impacts, trophic ratios impose limits, such as the large algal biomass required for abalone. Participants noted that herbivorous, lower-trophic aquaculture species may offer more sustainable options and that IMTA systems, although beneficial, require external inputs that must also be sustainably sourced.

Conclusion

In conclusion, the workshop provided a multifaceted perspective on IMTA by combining European project findings with practical insights from a working farm. The session highlighted that IMTA delivers meaningful

opportunities for circularity, waste reduction, and ecosystem-based management, but its real-world implementation is shaped by challenges related to spatial allocation, environmental pressures, market dynamics, and long investment horizons. The discussion reinforced that successful IMTA development requires coordinated attention to technical, economic, and policy considerations, as demonstrated by both the ASTRAL project results and the experiences shared by France Haliotis. Further discussion and on-site exchanges continued after the formal session.

Participation Data and Feedback

Participation in the Thematic Workshops was strong, with participation concentrated in the in-person members of the delegations taking part in I3-4 Blue Growth ecosystem visits. Online participation allowed for engagement for project promoters and technology providers engaged in the project but unable to participate in person, while even extending the reach of the action to participants not otherwise formally involved in our activities. Indeed, the KPI of 100 participants set by project partners was comfortably surpassed. The total of participants in each workshop came to 218. Indeed, if in-person participants for workshops held during a single ecosystem visit are counted only once the figure still surpasses our target reaching 134.

Table 1 Participation Figures

	Maritime Decarbonisation	**Digital Twins**	**Interregional Best Practices**	**Digitalisation in Aquaculture**	**IMTA and Paths to Commercialisation**	**Total**
In-Person	34	38	36	46	38	192
Online	7	5	5	4	5	26
Total	41	43	41	50	43	218

Over the course of these sessions, best practices from across Europe were featured with contributions from innovators in Finland, Poland, Portugal, the Netherlands, Italy and France. Attendees who took part in these interactive sessions covered the geographical span of the I3-4 Blue Growth consortium, with, in addition to the countries listed above, Croatia and Spain also represented. Meanwhile, online participants included attendees from further afield, some of them technology providers engaged in the project, hailing from Belgium, Greece, Hungary, Sweden and the United Kingdom.

In order to evaluate participant satisfaction with thematic workshops and provide data to inform the design of subsequent events in the series, online feedback surveys were created for each of the

workshops. The QR code for the survey was displayed in slideshow presentations at the end of each workshop and links to the feedback forms were sent to ecosystem visit participants in instant messaging groups created for the events. (These groups were established on a voluntary basis in compliance with data protection regulations with participants opting in to receive messages facilitating organization of to the visit).

The forms were designed to be quick to complete while offering useful detail for evaluating and improving the sessions. On a scale including the degrees Very Satisfied, Satisfied, Neutral, Unsatisfied and Very Unsatisfied, respondents were asked to indicate their satisfaction with the workshops along the following parameters:

- Presentations
- Discussions
- Format
- Pertinence of topics to development of your organization
- Pertinence of session to development of your local Blue Growth Innovation Ecosystem

A yes-no question was also featured for the first five workshops "Would you attend our workshops in the future?" And an open-ended question allowed for more precise feedback: "How can we improve our workshops?" (For the final workshop this was adapted to "How can we improve similar events in the future?")

The results which are detailed in the figures below, were in the large majority positive. It was clear that the topics selected and developed in the workshops were pertinent to our target audiences and regions and that global satisfaction with the workshops was quite high. Where constructive criticism was offered in the open question, it concerned the format and discussion sections of the workshops, with some participants calling for more interactivity or formats that innovated on the presentations + Q&A format. Others expressed frustration with the inclusion of the workshops within the programs of field visit, where they felt more time for site visits and open exchanges carried more added value. In the first three workshops, participants more directly involved in VC2 requested a greater focus on aquaculture and the valorisation of marine, validating the topical focuses of the final workshops to be held in France.

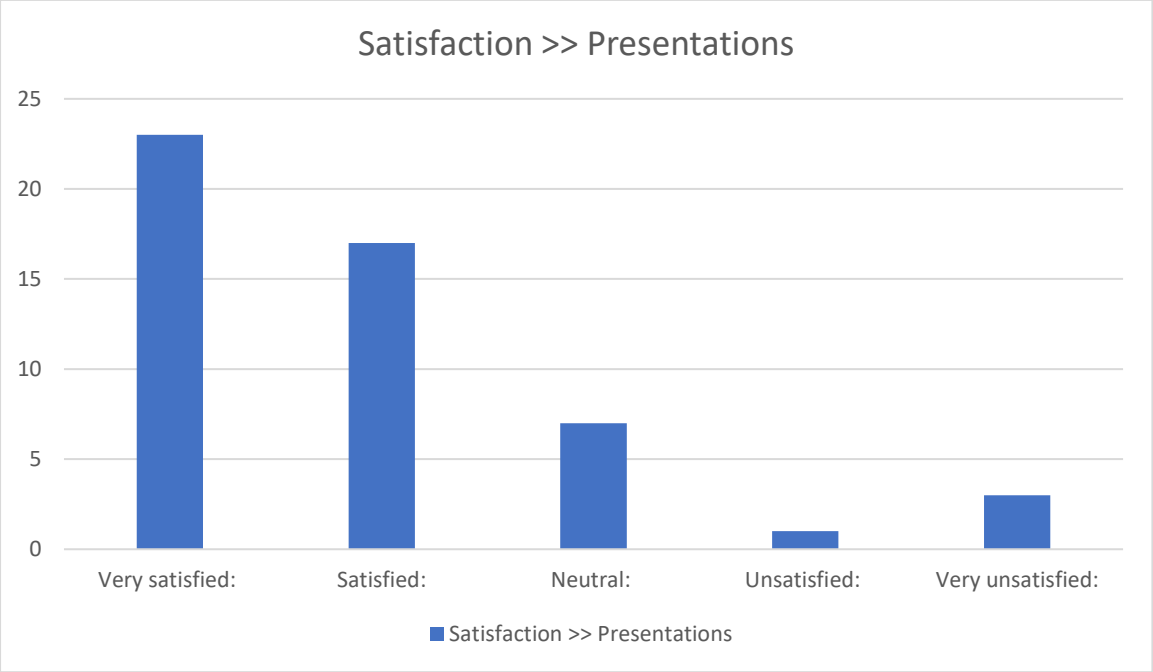

Figure 8 Graph Satisfaction Presentations

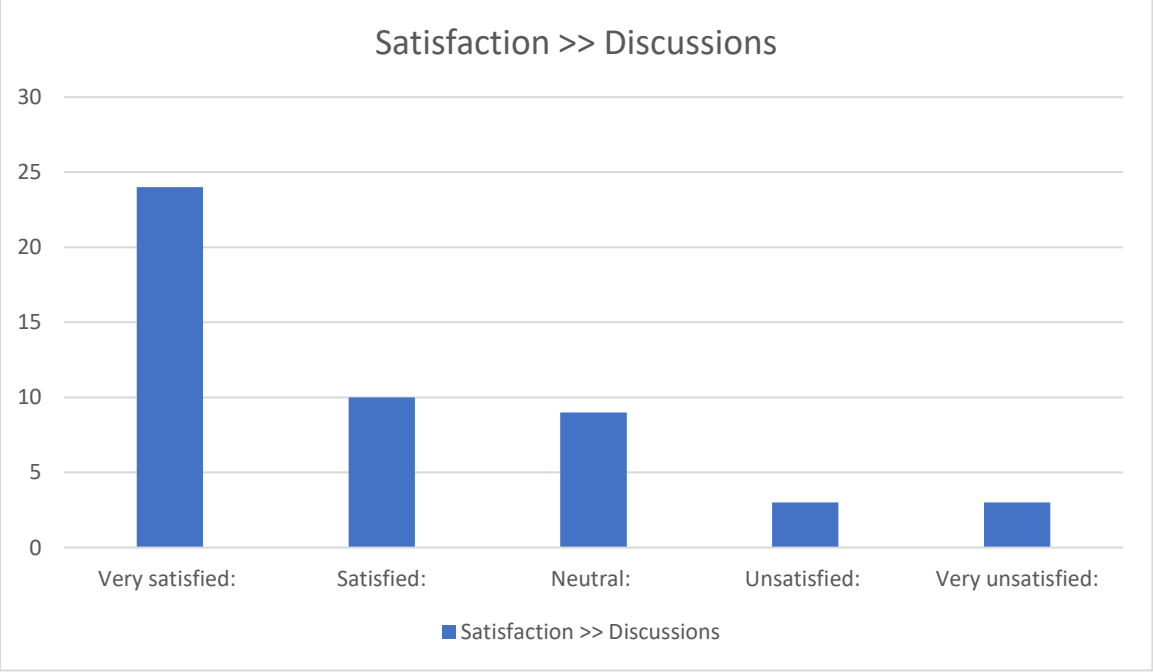

Figure 9 Graph Satisfaction Discussions

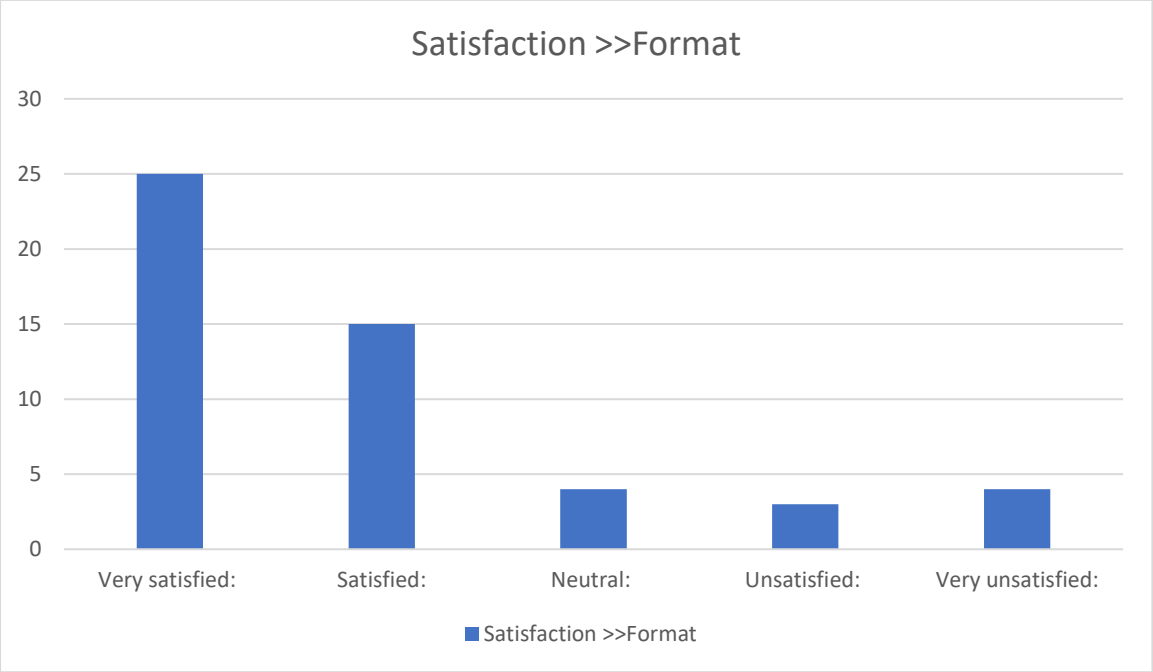

Figure 10 Graph Satisfaction Format

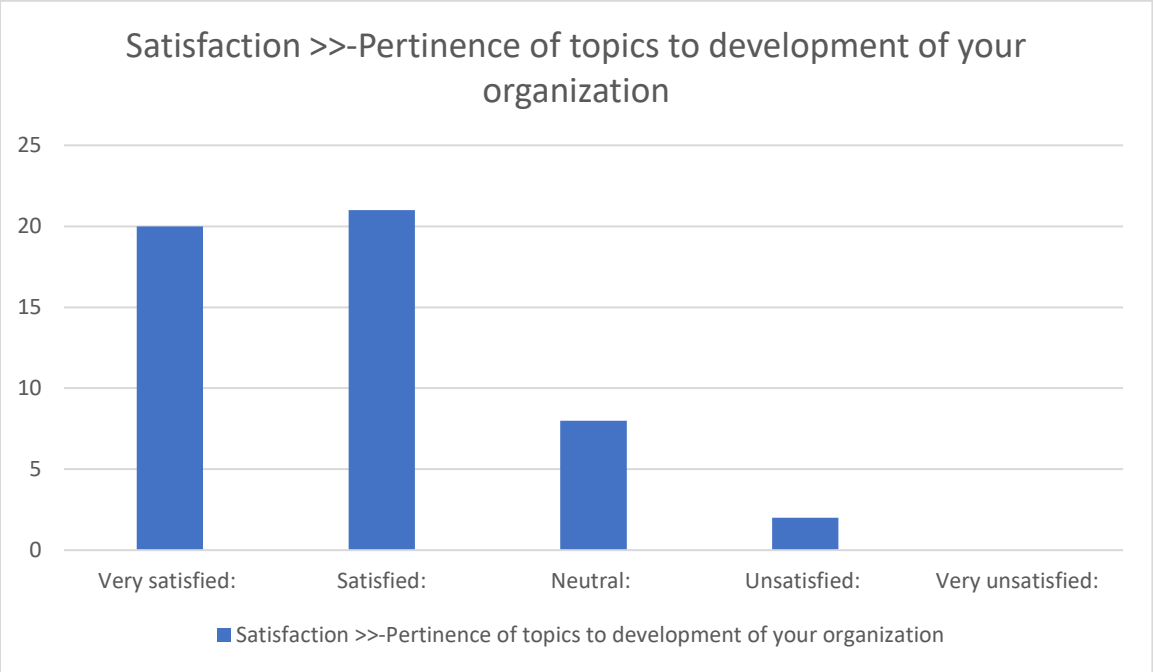

Figure 11 Graph Satisfaction Pertinence to Organisation

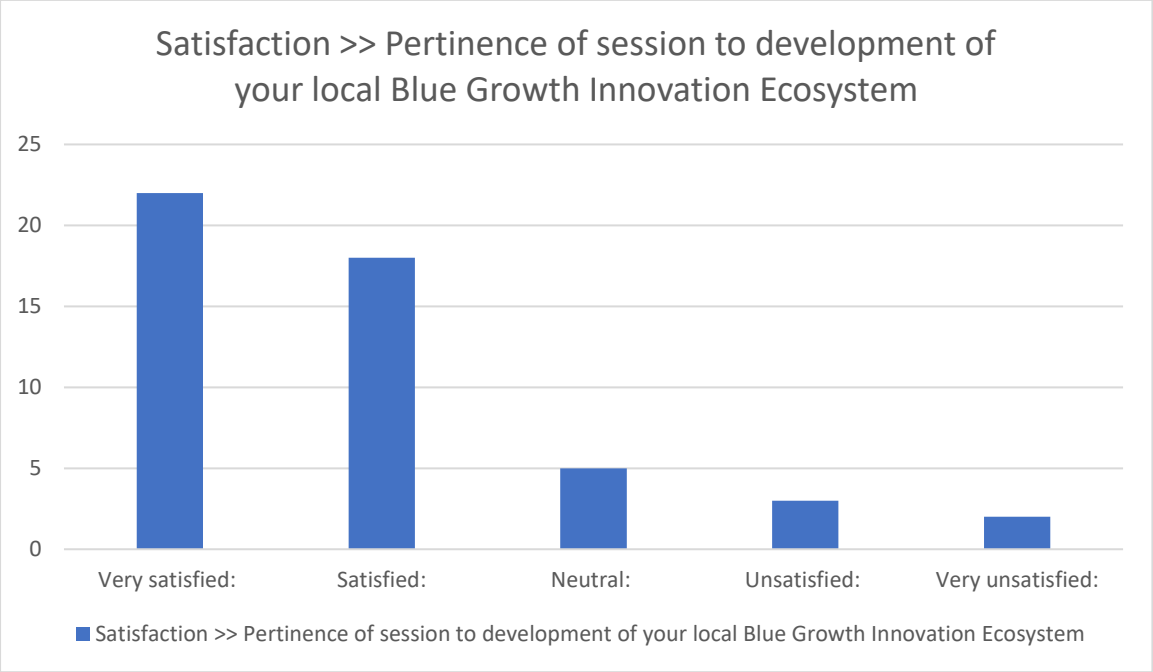

Figure 12 Graph Satisfaction Pertinence to Local Ecosystem

Taking on board this feedback, partners reduced the duration of workshops in subsequent iterations of the field visit while attempting to enhance interactivity with features like the audience polls and budgeting more time for audience interaction.

The overall picture that emerges from the feedback forms was one of workshops that featured valuable content and rich discussion for peer-to-peer learning around blue economy interregional good practices and flagship innovation experiments and projects of relevance to both the organisations participants represented and the ecosystems in which they were situated.

Conclusions and Lessons Learned

Across the five thematic workshops delivered during the I3-4 Blue Growth ecosystem visits, a consistent conclusion emerged: peer-learning actions can effectively mobilize the collective intelligence of Europe's blue economy actors when they are grounded in clearly defined thematic relevance and strong regional expertise. The sessions provided both high-quality technical insights—spanning maritime decarbonisation, digitalisation in aquaculture, IMTA deployment, maritime applications for digital twins, and interregional governance—and real opportunities for participants to compare practices across distinct innovation ecosystems. Their hybrid delivery broadened the reach of the project beyond in-person delegations,

enabling the dissemination of flagship regional initiatives to a wider audience and supporting knowledge transfer aligned with the I3 instrument's goals.

The workshops also highlighted several operational lessons. First, participant feedback consistently underscored the importance of interactivity and concise, well-structured sessions. Adjustments—such as shortening workshop duration, integrating pre-session surveys, and allocating more time for facilitated discussion—proved effective in increasing participant engagement. Second, the hybrid format, while expanding reach, introduced recurring technical challenges related to recordings and connectivity, particularly during site-based sessions. These experiences underline the need for robust technical protocols,but also bring into question the constraints imposed on in-person visits by simultaneous online broadcast. In future initiatives, it may be seen as more effective to hold online workshops ahead of ecosystem visits to ensure expanded impact and prepare participants for more in-depth personalized exchanges, while saving onsite programming for actions with a strong added value for in-person participation. Third, ensuring the accessibility of the workshops—linguistically, technologically, and in terms of digital skill requirements—emerged within the content of our workshop on digitalisation as a lever for more effectively engaging a more inclusive range of blue economy stakeholders.

Finally, the workshops reinforced the value of cross-project and cross-border cooperation. Consistent forefronting of successes in crossborder and transnational initiatives and synergies with Horizon and Interreg initiatives expanded the visibility of complementary European efforts and demonstrated how shared tools, pilots, and methodologies can accelerate innovation uptake across regions. The strong attendance levels and overall satisfaction expressed in feedback surveys confirm both the pertinence of the topics chosen and the appetite among stakeholders for continued structured exchanges on blue-economy innovation. Going forward, the lessons from this series point to a model of practice-centred, and highly interactive workshops that can continue to support interregional collaboration well beyond the I3-4 Blue Growth project's lifetime.