BLUE MISSION BANOS

Supporting the Mission Ocean Lighthouse in the Baltic and North Sea Basins

Deliverable 5.3 Recommendations for BANOS area monitoring framework

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Abstract	This deliverable provides final recommendations for a monitoring and reporting framework for the Baltic and North Sea region. The report synthesizes insights from previous project outputs and stakeholder collaboration, presenting a three-level monitoring framework (project, program, and Mission levels) that tracks progress from individual activities to systemic impacts by combining the Pathway to Impact model with PESTLE analysis. A key achievement is the development of validated Key Performance Indicators (KPIs) and robust data practices, supported by the WaveLinks platform for harmonized, machine-readable data sharing. The deliverable highlights ongoing challenges and calls for continued collaboration to ensure the long-term sustainability and efficiency of Mission monitoring.
Keywords	BlueMissionBANOS, Mission Ocean, KPI, monitoring, Pathway to Impact, PESTLE, WaveLinks

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2.0	30.10.2025	Final version

BLUEMISSION BANOS PROJECT

BlueMissionBANOS (BMB), as a Coordination and Support Action (CSA) for the Baltic and North Sea (BANOS) Mission Ocean Lighthouse, inspires, engages, and supports stakeholders across the BANOS region in taking positive action to reach the Mission Ocean objectives. In particular, the uptake of a sustainable, carbon-neutral, and circular blue economy is facilitated by connecting national, regional, and transnational actors from politics, industry, and science, thereby creating a governance model that is conducive to innovation.

While fostering the transition towards a climate-neutral and circular sustainable blue economy, BlueMissionBANOS supports the prevention and elimination of water pollution, as well as the protection and restoration of biodiversity and marine and freshwater ecosystems. The project focuses on reducing governance fragmentation, facilitating evidence-based decision-making and fostering citizen engagement across the BANOS area. These supporting actions raise awareness, showcase opportunities, and inspire stakeholders to actively contribute to the transition and preservation of oceans, seas, and waters through 2030 and beyond.

To accelerate the transition towards an innovative and circular blue economy, in line with regions' strategic priorities, as defined by their Smart Specialisation Strategies (S3), BlueMissionBANOS facilitates synergies and matchmaking between actors working towards achieving the Mission Ocean objectives in the BANOS area. To that end, BlueMissionBANOS organised regional pilot demonstration arenas (Mission Arenas), systematically bringing together innovators, business support and training organisations, authorities and other local stakeholders from a geographically defined area to collaborate and thus accelerate the uptake of innovative solutions in support of Mission Ocean. As part of the project, BlueMissionBANOS provides a catalogue of projects, partners involved and technical expertise and solutions to foster progress, collaboration and knowledge sharing. Furthermore, BlueMissionBANOS develops a consistent monitoring framework to assess progress in achieving carbon neutrality and circularity.

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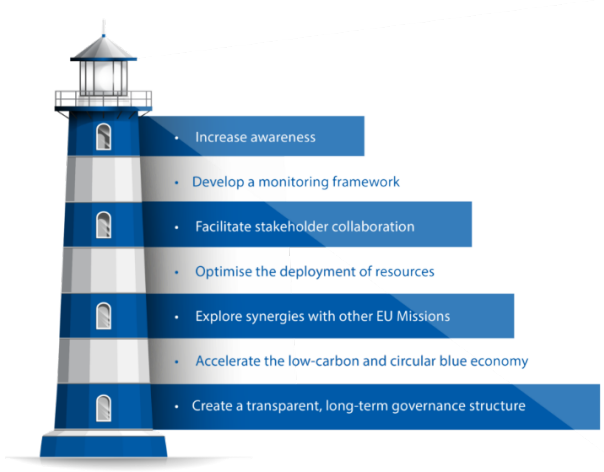

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ACRONYMS

BANOS	Baltic and North Sea
BMAA	BlueMissionAA - Building a Coordination Hub to Support the Mission Implementation in the Atlantic and Arctic Basin
BMB	BlueMissionBANOS - Supporting the Mission Ocean Lighthouse in the Baltic and North Sea Basin
BMM	BlueMissionMed - Building a Coordination Hub to Support the Mission Implementation in the Atlantic and Arctic Basin
CSA	Coordination and Support Action
DG MARE	Directorate General for Maritime Affairs and Fisheries
DTO	Digital Twin of the Ocean
EcoDaLLi	Ecosystem-based governance with Danube lighthouse Living Lab for sustainable Innovation processes
EEA	European Environmental Agency
EMODnet	European Marine Observation and Data Network
EOSC	European Open Science Cloud
EU	European Union
GVA	Gross Value Added
ICES	International Council for the Exploration of the Sea
JRC	EC Joint Research Centre – Ispra (IT)
KPI	Key Performance Indicator
MIP	Mission Ocean and Waters Implementation Platform
MO	Mission Ocean
MOOnt	Mission Ocean Ontology
nr	Number
P4B	PREP4BLUE: Preparing the Research & Innovation Core for Mission Ocean, Seas & Waters
PESTLE	Political, Economic, Sociological, Technological, Legal and Environmental
PP	Project Partners
PtoI	Pathway to Impact
WISE Marine Platform	Marine Water Information System for Europe
WP	Work Package

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EXECUTIVE SUMMARY

This deliverable from the BlueMissionBANOS (BMB) project provides the final recommendations for a monitoring and reporting framework for the Baltic and North Sea (BANOS) region, supporting the EU Mission “Restore our Ocean and Waters”. BlueMissionBANOS aims to accelerate the transition to a sustainable, carbon-neutral, and circular blue economy by fostering stakeholder engagement, innovation in governance, and evidence-based decision-making.

The report synthesizes insights from previous project outputs and stakeholder collaboration, presenting a three-level monitoring framework, project, program, and Mission levels, that tracks progress from individual activities to systemic impacts. The framework combines the Pathway to Impact (PtoI) model with PESTLE analysis, ensuring both internal project logic and external drivers are addressed. A key achievement is the development of validated Key Performance Indicators (KPIs) and robust data practices, supported by the *WaveLinks.eu* platform. WaveLinks serves as a central digital tool that facilitates data sharing, showcases projects and stakeholders, and enables synergies, matchmaking, and access to resources critical for the success of Mission Ocean objectives.

In addition, the report introduces a practical, hands-on implementation guide: a structured, action-oriented set of recommendations referred to as a *blueprint* (Chapter 3). The blueprint guides the implementation of monitoring and reporting for sustainable blue economy activities, serving as a practical checklist that offers step-by-step instructions for actors at all levels. Rather than a conceptual framework, the blueprint takes the form of a clear, step-by-step guide for stakeholders at all levels, from local actors to large institutions. It ensures harmonized approaches, supports data comparability, encourages openness and interoperability, and strengthens the link between grassroots activities and policy frameworks. While developed from BANOS experiences, the blueprint is scalable and transferable across other Lighthouse regions, providing a foundation for evidence-based decision-making and long-term impact beyond the lifetime of Missions.

The recommendations emphasize standardized data, transparent indicator selection, and alignment with Mission Ocean objectives at all levels. The framework is adaptable for monitoring and reporting of future indicators for other Mission Ocean objectives, including ecosystem restoration and pollution reduction.

1. BACKGROUND AND CONTEXT

1.1. BALTIC AND NORTH SEA AND MISSION OCEAN

The Baltic and North Sea (BANOS) area is at the forefront of Europe's transition toward a sustainable, carbon-neutral, and circular blue economy. This area holds significant economic potential but also faces complex environmental and socio-economic challenges, including marine pollution, biodiversity loss, and fragmented governance (European Commission, 2025). These challenges present opportunities for solution-oriented research and innovation.

The EU Mission "Restore our Ocean and Waters", a flagship initiative under Horizon Europe, aims to address these urgent challenges facing Europe's aquatic ecosystems through research, innovation, and stakeholder engagement (WISE Marine, 2024). The Mission is structured around three core objectives: (1) protect and restore marine and freshwater ecosystems and biodiversity, (2) prevent and eliminate pollution of our ocean, seas, and waters, and (3) make the sustainable blue economy carbon-neutral and circular. Each of these objectives is supported by measurable targets to be achieved by 2030, including restoring at least 25,000 km of free-flowing rivers, reducing plastic litter at sea by at least 50%, and ensuring that blue economy sectors contribute to climate neutrality.

The Mission is being implemented in two phases: the piloting phase (2022–2025) involves testing innovative approaches in designated "Lighthouse" areas, each focusing on one of the three objectives (European Commission, 2021). For the BANOS region, the focus is on objective 3, transition to a sustainable, carbon-neutral, circular blue economy. The implementation phase (2025–2030) will scale up successful solutions across Europe. While the work will continue to be organized in Lighthouse areas, the implementation will tackle all three primary objectives and targets across Europe.

1.2. MONITORING SUSTAINABLE BLUE ECONOMY IN THE OCEAN MISSION CONTEXT

The blue economy is widely recognized as playing a significant role in the global economy. In 2023, the EU blue economy demonstrated strong performance, with notable increases in gross value added (GVA) and employment across sectors such as maritime transport, renewable energy, and coastal tourism (European Commission, 2025). Coastal tourism remained the largest contributor; however, the offshore wind energy sector was the fastest growing, with GVA rising by 42% compared to 2021 and profits reaching €4.1 billion in 2022. Emerging sectors relevant to the EU Ocean Mission, such as ocean energy, blue biotechnology, and desalination, also gained momentum, creating new business opportunities and fostering innovation. In this context, the systematic monitoring of the blue economy is becoming increasingly important, particularly in support of the EU Ocean Mission "Restore Our Ocean and Waters." Tracking economic trends and environmental impacts ensures that blue economy activities align with the Mission's objectives of protecting biodiversity, eliminating pollution, and enabling a sustainable, carbon-neutral ocean and water system by 2030.

Monitoring development has been a cornerstone of the EU Ocean Mission since the beginning of the pilot phase, with the aim of developing a framework that can track measurable, long-term transformation (European Commission, 2021). The monitoring of the Mission's third objective, "Make the

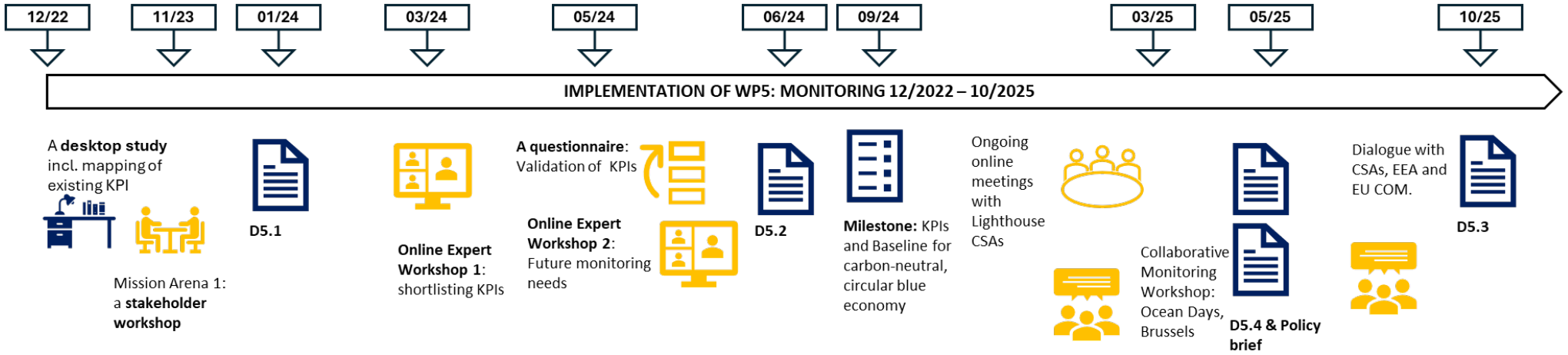
sustainable blue economy carbon-neutral and circular", is particularly complex, as it requires tracking progress across diverse sectors, including aquaculture, offshore energy, maritime transport, and multi-use of marine space. These sectors are not only interdependent but also influenced by dynamic political, economic, and environmental conditions. Effective monitoring must therefore go beyond traditional output-based reporting to capture systemic change, external drivers, and progress along the entire pathway to impact (Asmala et al., 2024).

The monitoring of the EU Mission "Restore our Ocean and Waters by 2030" is aimed to be carried out by a dynamic and near-real-time monitoring framework by the European Environment Agency in collaboration with DG MARE (WISE Marine, 2024). At the time of writing, it includes 21 indicators aligned with policy targets on Mission's three objectives. The data is derived from Mission-funded projects and complemented by environmental baselines. The first comprehensive Monitoring Assessment Report was published in September 2025 (*EU Mission: Restore Our Ocean and Waters*, n.d.), with annual updates provided through the WISE Marine platform (*WISE Marine Platform*, n.d.). This process ensures the transparent tracking of progress achieved within the current 67 Horizon Mission-funded projects, with a joint budget of EUR 374 million (*WISE Marine Platform*, n.d.). These projects cover over 300 demonstration sites and involve 838 participants from across Europe and beyond. While the monitoring initially focuses on Mission-funded activities, other initiatives are acknowledged as supporting implementation. Overall, the approach aims to combine scientific rigor and policy relevance to guide adaptive management toward the Mission's 2030 objectives.

Monitoring within the EU Ocean Mission is essential not only for tracking progress but also for ensuring that projects and funding initiatives align with broader sustainability goals (European Commission, 2021). For project implementers, monitoring provides a structured way to assess the effectiveness of their interventions, identify gaps, and adjust strategies in real time to maximize impact. For funders, the ability to track performance and outcomes is crucial for ensuring that investments are generating tangible results, ultimately driving the Mission's objectives forward. Beyond individual projects, effective monitoring also fosters transparency and accountability, enabling stakeholders, from policymakers to the general public, to understand the progress toward the Mission's ambitious 2030 targets. Notably, while the third Mission objective that focuses on a sustainable, carbon-neutral, and circular blue economy is specific to the BANOS region, the monitoring framework must also cover the first two objectives to ensure comprehensive and impactful results for the future of our oceans and waters.

1.3. DEVELOPMENT OF MONITORING FRAMEWORK IN THE BLUEMISSION BANOS CSA

The recommendations presented in this deliverable have been developed over the lifetime of the BlueMissionBANOS CSA project and are in line with the vision presented for the future by the EEA (WISE Marine, 2024). The output presented here is based on a cumulative co-creation process starting with a desktop study, building on stakeholder and expert engagement (Figure 1). The most recent work has focused on collaboration with other Lighthouse CSAs, EEA and EU Commission policy officers. The workflow and major outputs are summarized in Figure 1 and in the following paragraphs.



Major outputs of WP5 Monitoring in BlueMissionBANOS CSA
D5.1 Sustainable climate-friendly; circular Blue Economy in the BANOS Area (01/24)
D5.2 KPIs for sustainable blue economy in BANOS area (06/24)
D5.4 Outcomes on transferring monitoring practices among different lighthouse areas (05/25)
Policy brief: Monitoring for Transformational Change: Integrating Pathways to Impact and PESTLE in Support of the Sustainable Blue Economy (EMD, 05/25)
D5.3 Recommendations for BANOS area monitoring framework (10/25)

Figure 1: Implemented Workflow of Monitoring WP in BlueMissionBANOS CSA.

1.3.1. THE MAIN OUTCOMES OF THE RELEVANT PAST DELIVERABLES

Here, we present the main outcomes of the previous BlueMissionBANOS deliverables (D5.1, D5.2, and D5.4) in the context of the recommendations we put forward in this deliverable.

Deliverable 5.1 provided a comprehensive baseline assessment of the sustainable blue economy in the BANOS area (Ikauniece et al., 2024). It mapped national strategies, policy frameworks, and existing indicators across nine countries, highlighting both commonalities and gaps. In total, the study identified over 400 Mission Ocean relevant KPIs. The report emphasized the need for harmonized data collection, cross-sectoral integration, and stakeholder engagement. The deliverable 5.1. "Sustainable climate-friendly; circular Blue Economy in the BANOS Area: Current Status and Assessment and Monitoring Approaches" can be found on the BlueMissionBANOS internet page in: https://bluemissionbanos.eu/wp-content/uploads/2024/06/D5.1-UPDATED.pdf.

Deliverable 5.2 focused on the formulation and validation of KPIs for a carbon-neutral, circular blue economy (Asmala et al., 2024). Using a co-creation approach, the project team engaged experts and stakeholders in a multi-phase process that included desktop research, in-person workshops, and online consultations. The result was a shortlist of 50 validated KPIs, each assessed for relevance, data availability, and readiness for implementation. The KPIs were also aligned to the sustainability framework, leading to KPIs with a specific focus on economic, governance, social and environmental aspects of the sustainable blue economy. The deliverable 5.2 "KPIs for a carbon neutral, circular blue economy" can be found on the BlueMissionBANOS internet page at: https://bluemissionbanos.eu/wp-content/uploads/2024/10/Attachment_0.pdf.

Deliverable 5.4 documented the outcomes of a joint workshop held during the European Ocean Days 2025, where all five Lighthouse CSAs collaborated to align their monitoring approaches across lighthouse areas and Mission Ocean objectives (Purkamo & Nuottimäki, 2024). The workshop highlighted the benefits of combining Pathway to Impact (PtoI) and PESTLE approaches (Info Box 1, Figure 2), the importance of long-term funding for monitoring, and the need for a unified platform for data sharing and its visualization.

In parallel with D5.4, the **Policy brief "Monitoring for Transformational Change"** articulated the rationale for integrating PtoI and PESTLE, outlining practical steps for implementation (BlueMissionBANOS, 2024). It called for the piloting of the framework in Mission-funded projects, the alignment of KPIs across sea basins, and the inclusion of PtoI/PESTLE-informed monitoring in funding guidelines.

In addition to activities in WP5, the monitoring framework has been developed in collaboration with the BANOS CSA WP6 Technical Services Provision. This effort included the development of the WaveLinks dashboard (see section below) as well as further dialogue and collaboration with the Mission Implementation Platform and Lighthouse CSA (Table 1). There have been seventeen editions of a monthly CSA and MIP Working Group Meeting, in which general alignment and opportunities for collaboration are discussed. In these meetings, listed below, the Mission monitoring framework is discussed regularly.

Meeting date	Participants (groups)	Topic/Aim of meeting
31 August 2023	BMB, BAA, P4B, BMM, EcoDaLLi	Introductions to the projects and their objectives, governance and structure of the working groups, and synergies and key areas for collaboration.
25 October 2023	BMB, BAA, P4B, BMM, EcoDaLLi	Updates on synergies and areas of collaboration including knowledge exchange and communication channels, UN Decade conference
27 November 2023	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on synergies and areas for collaboration, first meeting with MIP
16 January 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Discussion of UN Ocean Decade, WaveLinks and MIP dashboard – usage of databases, Mission Forum
7 May 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Presentation by the World Ocean Council, preparation of CSA legacy document, discussion of Mission governance
2 July 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Presentation and discussion of Mission Arena events, discussion of WaveLinks going public, BMB's Ocean Literacy Repository, presentation of the Sustainable Rivers event
6 August 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Discussion of the CSA Legacy document and contributions of the CSAs to Mission Ocean
17 September 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Discussion of the CSA Legacy document, discussions on the Workshop on Ocean Mission Indicators at Ocean Days, presentation of Mission-related side events at UNOC, announcement of Mission Arena 3, presentation of solutions for the MIP
5 November 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on CSA Legacy document, planning for the Mission Annual Forum, discussion of Mission monitoring across the CSAs
3 December 2024	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on the CSA Legacy document, discussion of upcoming events including Ocean Days and UNOC, discussion of the Mission Charter and stakeholder engagement
7 January 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on the CSA Legacy document, discussions of workshops at Ocean Days (Harmonizing KPIs, Transferring Knowledge, Supporting an Enabling Environment), discussion of the Blue Rivers & Lakes award
21 January 2025 - 25 February 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	"Harmonizing Monitoring Approaches & KPIs across CSAs and IAs" – weekly meeting for workshop planning for EU Ocean Days
4 February 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on the CSA Legacy document, planning for the CSA event on 7th March at Ocean Days, updates on all Ocean Days workshops

27 February 2025	BMB, BAA, P4B, BMM, EcoDaLLi	Wrap-up meeting on workshop ”Harmonizing Monitoring Approaches & KPIs across CSAs and IAs” at the EU Ocean Days
1 April 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on the CSA Legacy document, feedback round on Ocean Days workshops, planning for stands at the EMD, discussion of the Prep4Blue final meeting, presentation of the BlueMissionMed Support Programme
6 May 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Updates on the CSA Legacy document, presentation of the Capraia Smart Island event, discussion of plans for UNOC and EMD
26 May 2025	BMB, P4B, EcoDaLLi	Joint publication on KPIs and monitoring
3 June 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Discussion of takeaways from the EMD, discussion of indicators with all CSAs and MIP, discussions of the CSA Legacy document and the end of Prep4Blue
1 July 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Presentation of CO-WATERS, presentations of all catalogues of solutions
2 September 2025	BMB, BAA, P4B, BMM, EcoDaLLi, MIP	Discussion of CSA Legacy document and 2nd phase, preparation for Danish Mission Ocean event and the All-Atlantic Forum, discussion of WaveLinks and other solution repositories

Table 1. List of Lighthouse CSAs and MIP Working Group Meetings

What are the Pathway to Impact and PESTLE methods?

To effectively monitor progress toward the objectives of the EU Mission "Restore our Ocean and Waters," a dual-framework approach that combines the Pathway to Impact (PtoI) model with PESTLE analysis is suggested (Figure 2). While related, these two approaches differ. Most significantly, PtoI tracks project internal activities, whereas PESTLE tracks external drivers and the enabling environment. The approach is adaptable to each Mission Objective; however, it is presented here in the context of Objective 3, which supports the development of a sustainable and carbon-neutral blue economy, piloted in BANOS during Phase 1 of the Mission Implementation.

Pathway to Impact (PtoI) is a structured, time-based logic model that maps how activities can lead to long-term change. It outlines five key stages:

1. Inputs: Resources such as funding, expertise, and infrastructure.
2. Activities: Project actions like pilots, stakeholder engagement, or training.
3. Outputs: Immediate results, such as reports, datasets, or new tools.
4. Outcomes: Medium-term effects, including policy uptake or behavioral change.
5. Impacts: Long-term transformations, including ecosystem recovery and decarbonization.

This model helps projects articulate their intended change and track progress beyond short-term deliverables (Fryirs et al., 2019; Koho et al., 2020).

PESTLE Analysis is a contextual tool that identifies external factors influencing project success across six dimensions:

1. Political: Governance, policy frameworks, and regulatory stability.
2. Economic: Market trends, funding mechanisms, and investment incentives.
3. Social: Public awareness, stakeholder engagement, and equity.
4. Technological: Innovation readiness, digital tools, and infrastructure.
5. Legal: Laws, standards, and compliance requirements.
6. Environmental: Climate change, pollution, and ecosystem conditions.

By applying PESTLE, projects can anticipate external risks and opportunities in their operating environment and select context-sensitive indicators (Hasler-Sheetal et al., 2025).

Info Box 1. Explanation of Pathway to Impact and PESTLE methods

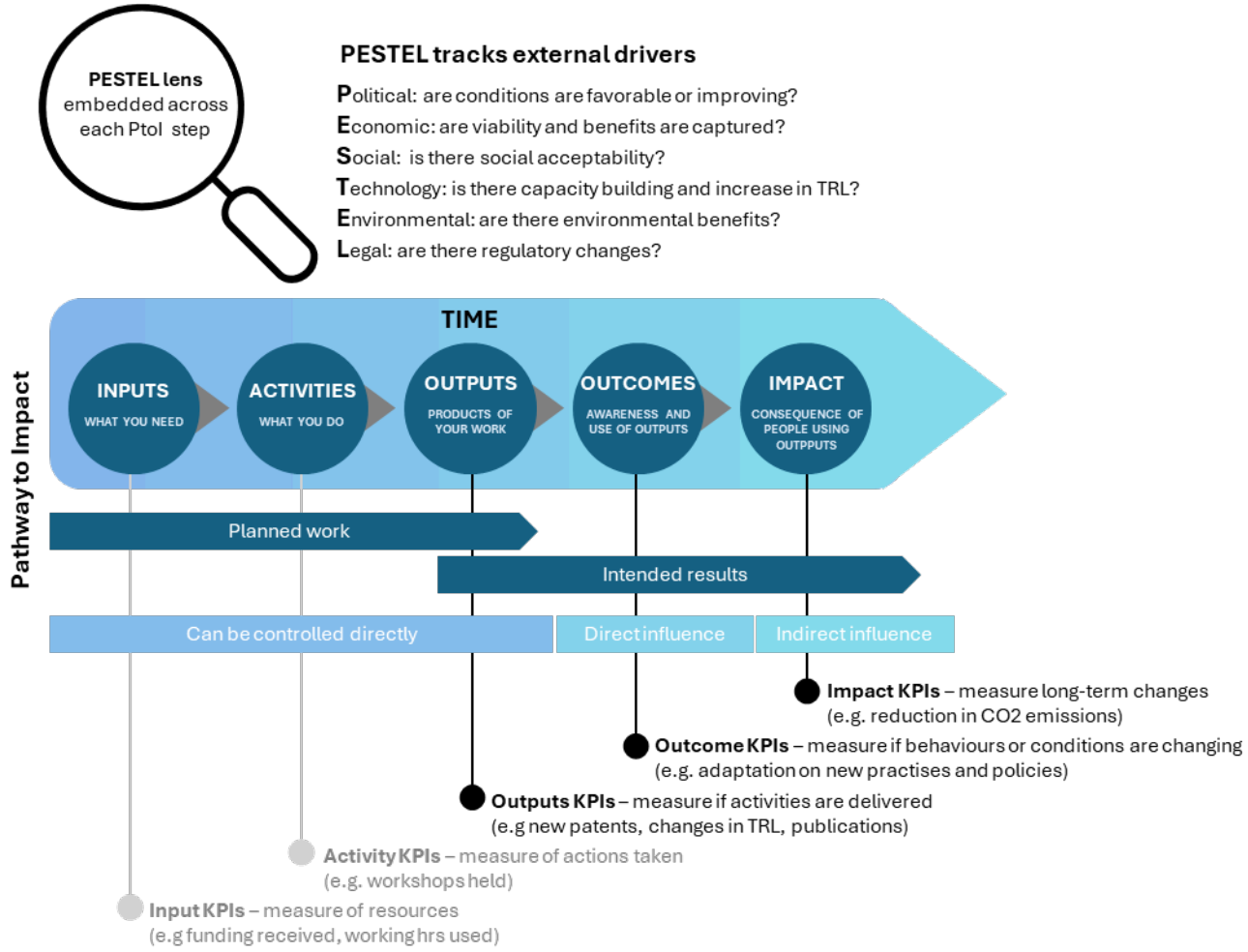


Figure 2. Comparison of Pathway to Impact and PESTLE approaches.

1.3.2. THE MAIN OUTCOMES OF THE WORK DONE IN BLUEMISSION-BANOS WP6 THAT FEED INTO DELIVERABLE 5.3

WP6 of the BlueMissionBANOS project, “Technical Services and provisions”, focuses on developing and providing digital tools that enable synergies and matchmaking among stakeholders working towards the EU’s Mission "Restore Our Ocean and Waters" (Mission Ocean). To that end, WP6 has created the WaveLinks.eu platform, a central online tool designed to facilitate access to data and resources critical for the success of Mission Ocean, especially within the BANOS region. This platform was developed in close collaboration with the BlueMissionAA and PREP4BLUE projects and showcases a wide range of projects, stakeholders, engagement methods, citizen science initiatives, and solutions linked to the three objectives of Mission Ocean.

The platform's main technological infrastructure comprises a robust and scalable stack built with Django, PostgreSQL, and Next.js, ensuring the efficient management of large datasets from various sources, including open-source platforms such as the Mission Ocean Charter, the UN Decade of the Ocean, and Cordis. With over 5900 projects, 14000 stakeholders, 50 engagement methods, 950 citizen science initiatives, and 170 solutions currently featured, WaveLinks provides a valuable tool

for facilitating collaboration and monitoring the progress of Mission Ocean. The platform design and construction was organized though a series of tasks in WP6 including T6.1 that identified and mapped of existing ontologies, data providers, and users within the sustainable blue economy domain, T6.2 that focused on stakeholder consultation, feedback, and platform feature refinement, and the more technical T6.3 that collected, harmonized and curated the data that populates the platform, but also contributed to the development of the Mission Ocean Ontology (MOOnt) and the construction of the platform itself.

The WP6 deliverables, Mission Ocean Ontology (D6.1), Catalogue of Projects (D6.2), and Solutions (D6.3), describe the structure and logic behind the data organisation on the platform and provide a snapshot of the two major databases: projects and solutions. They serve as documentation of the platform architecture and content, but the WaveLinks platform itself is really the main product of WP6, and it continues to play a key role in fostering collaboration, transparency, and accountability among all Mission Ocean actors, and demonstrates how monitoring can be integrated into digital tools supporting the Mission.

1.4. COMBINING PATHWAY TO IMPACT AND PESTLE APPROACHES

The integration of both Pathway to Impact and PESTLE analysis represents a methodological framework of innovation for monitoring the sustainable blue economy as well as the wider Mission Ocean and Waters framework. While PtoI provides a time-based process logic model that links inputs, activities, outputs, outcomes, and impacts (Figure 2.), PESTLE complements this by offering a structured lens to assess external factors (see also Info Box 1.). A combination of these two approaches provides a unique and systematic method for assessment of progress as well as cause and effect of external factors on achieving impact.

Together, these approaches enable the development of KPIs that are both causally grounded and contextually relevant. For example, a KPI tracking the uptake of low-emission shipping technologies (PtoI: outcome) can be enriched by analyzing the enabling or constraining role of policy incentives, market trends, and technological readiness (PESTLE: political, economic, technological).

The framework also facilitates the harmonization of indicators across projects and regions, enabling comparability, scalability, and aggregation. By identifying feedback loops and learning opportunities, the framework supports adaptive management and enhances policy relevance by linking monitoring insights to governance strategies.

In summary, the combined PtoI–PESTLE framework offers a powerful tool for tracking transformational change in the BANOS area. It aligns with the objectives of the Mission Ocean initiative, responds to stakeholder needs, and provides a scalable model for monitoring across the EU's sea basins.

1.5. THREE-LEVEL MONITORING FRAMEWORK

To address these challenges, we propose a three-level monitoring framework for BlueMission-BANOS and the EU Mission "Restore our Ocean and Waters" that operates across the following levels:

- Project level: Tracks direct activities, outputs, and immediate outcomes
- Program level: Monitors aggregated progress and sectoral change, primarily through output-level KPIs. Here applied to Mission Ocean funded projects. Measuring
- Mission level: Assesses systemic impact and alignment with Mission objectives, using outcome and impact-level KPIs. Here going beyond Mission Ocean funding, including also e.g. national activities that contribute toward the Mission Objectives.

The framework in presented in the table below (Table 2), which illustrates how monitoring is structured at project, program and mission levels, detailing what is monitored, the types of outputs produced, and the expected outcomes at each scale

	Project level	**Program level**	**Mission level**
What is monitored	Direct activities, outputs, and immediate outcomes **Examples**: - Number of planted seagrass hectares in a pilot site - Nutrient concentrations projected to be reduced in a specific estuary based on project activities applied - Local stakeholder engagement (e.g. workshops held, SMEs involved) - New or improved solutions found to apply low-impact aquaculture or products based on low-trophic species (i.e. algae) - Deployment of specific monitoring instruments (buoys, sensors)	Cross-project progress and sectoral change **Examples**: - Aggregate % of Baltic/North Sea marine habitats under restoration - Trends in cross-project indicators like nutrient load reduction, microplastic monitoring, biodiversity indices - Regional progress in sustainable aquaculture/ports/renewables - Knowledge transfer and replication across lighthouse regions	Alignment with mission objectives and systemic impact (EEA level) **Examples**: - Overall progress towards EU Mission targets (e.g. restoring 25,000 km of free-flowing rivers, protecting 30% of EU seas) - Systemic reduction in nutrient loads at basin scale (e.g. HELCOM and OSPAR reporting) - Alignment with EU Green Deal & SDGs - Long-term improvements in ocean health indicators (EEA, Copernicus data)
Types of outputs	Project-specific deliverables, reports, data, demonstrations	Aggregated results across projects, synthesis of lessons learned, sectoral indicators	System-level assessments, progress toward overarching mission targets, policy-relevant insights
Expected outcomes	Immediate and tangible project results (proof-of-concepts, pilots, knowledge generation)	Transferable lessons, identification of barriers, coherence across projects, evidence of sectoral transition	Long-term systemic change, cumulative impact beyond individual projects, contribution to mission goals and societal transformation

Table 2. Three-level monitoring framework for BlueMissionBANOS

A comprehensive monitoring framework must reflect the complex, dynamic, and non-linear nature of impact realization (Figure 3). Impact is ultimately a sum of activities and outputs of multiple projects. In line with the PESTLE approach, measures are typically required at multiple levels, which often cannot be achieved by a single project on its own, but must be tackled in a synchronized way through a systematically applied series of parallel, ongoing projects.

Depending on the level of assessment (*i.e.* individual project, program or overarching Mission level) the performance of these other actions are therefore assumptions that project or programme managers take into account when planning their own project activities. Whereas the quality of outputs should be within the control of project partners involved in activities, such external factors (PESTLE, assumptions) influence projects, as well as their activities, outputs and especially impact. Careful consideration of such outside influences and potential risks on achieving project results, should be considered and mitigation strategies formulated and implemented not only at the project proposal phase, but also continuously during the implementation phase.

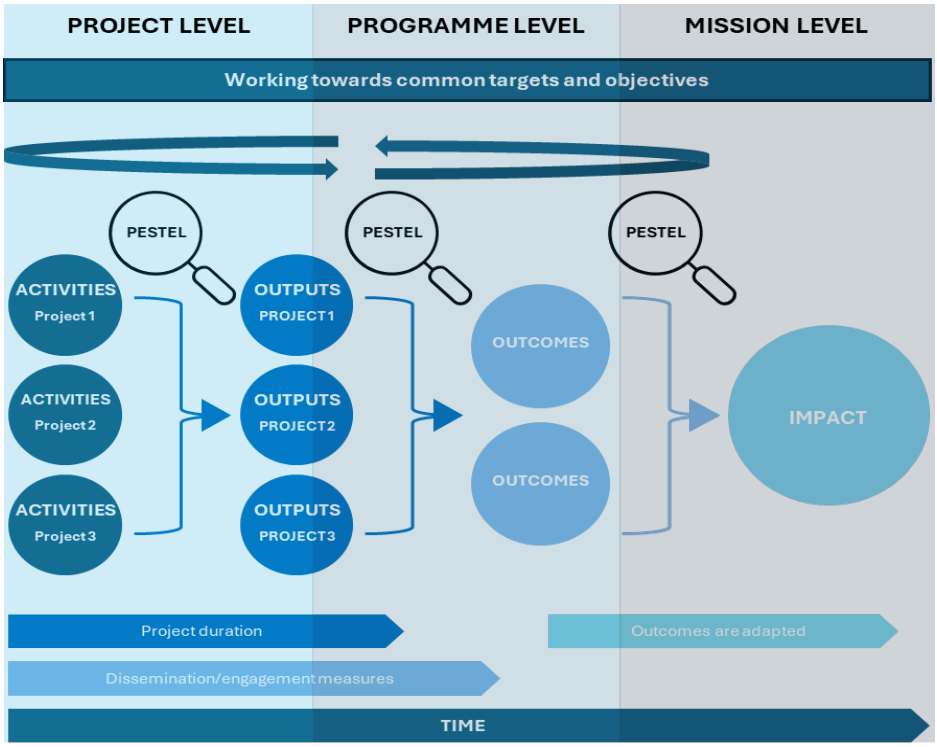


Figure 3. Pathway to impact is complex, typically a non-linear process.

Common targets and expected outcomes, for example, set by research funding programs can steer the projects towards objectives and impact. Each step can be viewed through the PESTLE lens that can assist in the steering process. Appropriate dissemination and engagement measures are crucial for the uptake of outputs, the materialisation of outcomes, and ultimately, impact.

Impact typically unfolds over extended timeframes, often beyond the lifespan of individual projects, and emerges cumulatively from multiple interlinked efforts. The process may also be cyclical, where outcomes from one project catalyze the development of another. Hence, impact, especially in view of environmental and socio-economic effects, can often only be measured long-term after the activities have been implemented. Impact to be measured short-term after the conclusion of one or a collection of projects can only be projected.

The strength of the three-level PtoI–PESTLE framework approach lies in its scalability. Projects with diverse contexts can align with overarching goals and targets, enabling the identification of local barriers, the sharing of transferable lessons, and building toward broader coherence and impact.

Critically, it addresses the challenge of tracking changes, especially for outcomes that are difficult to monitor in isolation.

In the following Chapter 3, practical guidelines in the form of a blueprint for actionable recommendations are provided, which can be applied across sectors, governance levels, and regions. The blueprint is designed to ensure consistency with the original research plan and task descriptions, offering a scalable and adaptable framework for monitoring transformational change in the sustainable blue economy/all the Mission Objectives. Examples of KPIs, specifically those that were first included in the WaveLinks platform, as well as the analysis of their properties are included in the section 2.5 below. Additional KPIs can also be found in BlueMissionBANOS D5.2 (Asmala et al., 2024).

1.6. MONITORING BEYOND MISSION-FUNDED PROJECTS

One of the key objectives of the Mission approach is to increase the impact of individual projects by systematically bundling Mission Ocean-relevant projects and initiatives at the level of Lighthouse Areas, as well as at the national and regional levels. This is partially done through the collection of endorsements of the Mission Ocean & Waters Charter, but has also been supported through the systematic approach taken within BlueMissionBANOS to map EU-funded projects relevant to Mission Ocean objectives and sub-goals.

As shown in the visuals below (Figure 4-7), BlueMissionBANOS has done the following to analyse which projects are pursued with how funding for each of the objectives and sub-goals in each of the BANOS countries:

1. Comprehensive mapping of all past and ongoing EU-funded projects related to Ocean & Waters topics covering the following programs: Horizon Mission, Horizon Clusters, I3, LIFE, INTERREG, EMFAF, CBE and relevant other partnerships like the SBEP, BioDiversa, Water4All.
2. Comprehensive analysis of all Mission Charter pledges, which are not connected to any of the EU-funded projects listed under Point 1.
3. Analyzing projects under Point 1 and 2 according to their link to Mission Ocean Objectives as well as sub-goals.
4. Mapping of individual project partners in each project by country.
5. Collating the projects and partners by country and topic.
6. Collating the data on how much budget has gone in each country to which Mission Ocean objective & sub goal.
7. All above data can then also be aggregated back to the BANOS Lighthouse area.

Within BlueMissionBANOS, this data has been supplemented by further national data (i.e., projects funded under national schemes, philanthropic funding, and devolved EU funding).

This has been done so far in a more or less unsystematic manner as part of the preparation for the four geographically defined arenas. It is, however, foreseen to take a more **systematic approach** to this through Mission Ocean National Contact Points in the next phase of the BANOS CSA project.

For the near future, such work is expected to remain at the discretion of the National Contact Points (rather than implementing an automatic data generation solution) due to the varying standards of project data sets, especially in the case of non-EU-funded projects. Hence, it is also the work of National Contact Points to complement the data on Horizon Mission-funded projects related to 'national demo sites' and/or 'impact indicators'. Such data/information has already been very valuable in supporting Mission Ocean implementation within various topic fields, as well as in specific countries/regions. Lighthouse CSAs, as well as their National Contact Points, can support individual projects, which face the same PESTLE to increase their impact by coordinating their efforts during the project implementation.

Very importantly, Lighthouse CSAs and their National Contact Points can also serve the critical function of undertaking a systematic 'post-project' impact assessment; i.e., cross-checking whether measures implemented/suggested by projects during their project lifetime are taken up at Lighthouse Area/national levels post-project lifetime. This data has been gathered through ongoing desk research throughout the life of the BMB project.

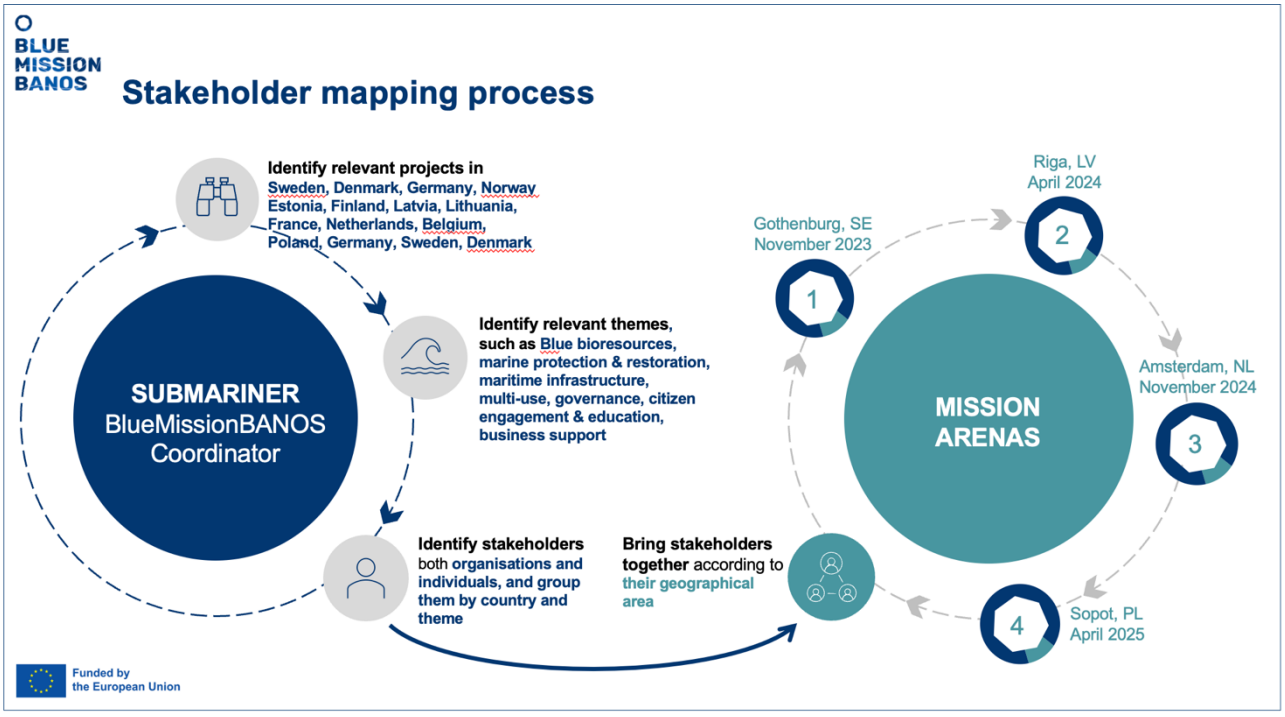
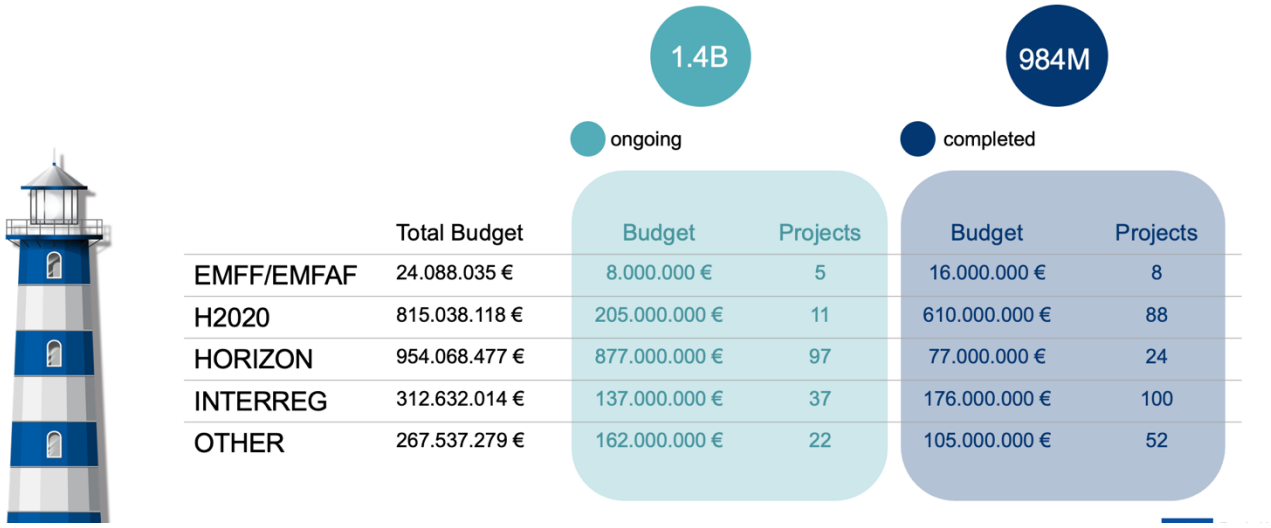


Figure 4. The BMB Stakeholder Mapping Process

Figure 5. Projects in the BANOS region (as of September 2025)



	Total Budget	Budget	Projects	Budget	Projects
EMFF/EMFAF	24.088.035 €	8.000.000 €	5	16.000.000 €	8
H2020	815.038.118 €	205.000.000 €	11	610.000.000 €	88
HORIZON	954.068.477 €	877.000.000 €	97	77.000.000 €	24
INTERREG	312.632.014 €	137.000.000 €	37	176.000.000 €	100
OTHER	267.537.279 €	162.000.000 €	22	105.000.000 €	52

Figure 6. Project budgets by funding programme (as of September 2025)

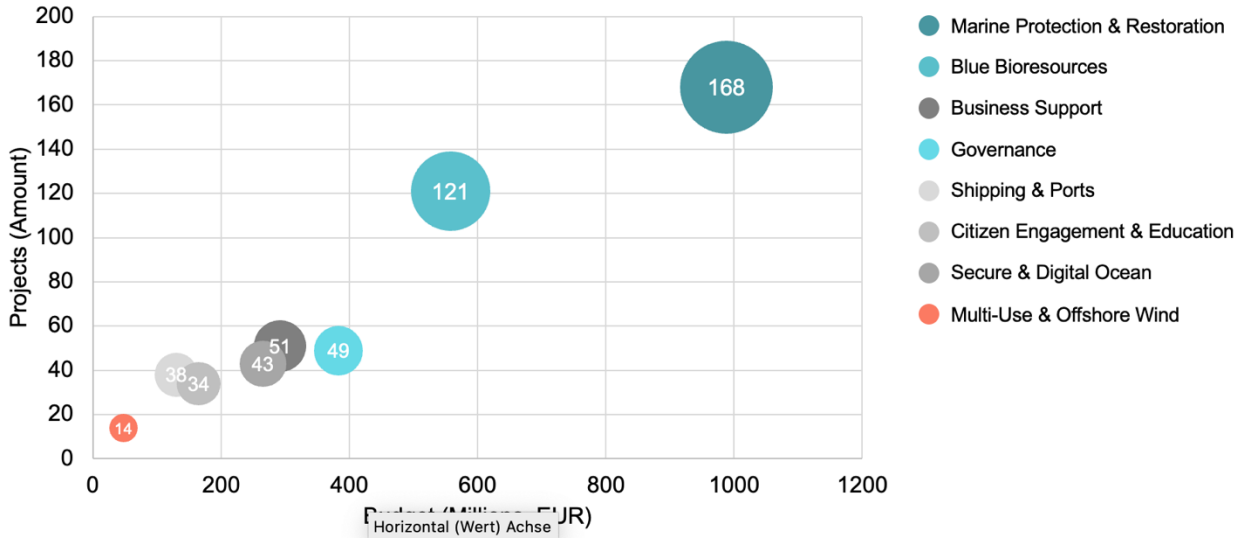


Figure 7. Project budgets by theme (as of September 2025)

As this work is being done continuously, data in the figures above represents the state of affairs as of September 2025. Further mapping and analysis will be done in the past month of the project and will be used to inform future work in the region.

2. THE ROLE OF WAVELINKS IN EFFECTIVE KPI TRACKING AND A CO-ORDINATED APPROACH TO DATA HANDLING

2.1. MOTIVATION FOR DATA PRACTICES

Effective monitoring of Key Performance Indicators (KPIs) is crucial to achieving the overall goals of the MO, as well as those of BlueMissionBANOS in particular. To support this, the WaveLinks platform relies on a robust, coordinated approach to data collection, storage, and sharing across a variety of data sources and types. Given the diverse stakeholders and multiple data sources involved, it was critical to develop clear guidelines for data integration to ensure consistency, accuracy, and accessibility. These guidelines, crafted through collaboration with partners and stakeholders in Task 5.3, serve to standardize data formats, ensure that updates are timely and reliable, and enable efficient integration with other relevant MO platforms like the MIP and EEA. Such practices not only streamline the data aspects of BlueMissionBANOS but also enhance the reliability of the KPIs used to track progress toward the Mission's goals, ultimately fostering transparent, scalable, and actionable insights across the blue economy.

2.2. COMPARISON WITH OTHER PLATFORMS

The EU Mission "Restore our Ocean and Waters" is supported by a growing digital infrastructure composed of multiple platforms, each developed to serve specific aspects of ocean monitoring, restoration planning, and stakeholder engagement. While WaveLinks, developed under BlueMissionBANOS, BlueMissionAA, and Prep4Blue project, plays a key role in tracking community-led actions and Mission-related data, it exists within a broader ecosystem of platforms, many of which have been in operation for over a decade and are likely to continue evolving well beyond 2030. Understanding the scope, longevity, and update mechanisms of these platforms provides context for WaveLinks and informs planning for its long-term sustainability.

Two main platforms to compare WaveLinks to are the Mission Implementation Platform (MIP) and EEA platform. Each of the three platform plays distinct but complementary roles in supporting the EU Mission "Restore Our Ocean and Waters." WaveLinks, developed within the BlueMissionBANOS, BlueMissionAA, and Prep4Blue projects, serves as a user-friendly, stakeholder-oriented platform designed to catalogue and connect Mission-relevant projects, stakeholders, technical services, citizen science initiatives, engagement methods and solutions. It emphasizes the harmonization of data from different sources, stakeholder-contributed data, and visibility across a broad spectrum of actors. In contrast, the EEA platform, led by the European Environment Agency in collaboration with DG MARE, provides a top-down, policy-focused monitoring framework based on up to 21 indicators aligned with the Mission's objectives. It aims to deliver near real-time, indicator-based assessments and annual progress reports through the WISE Marine platform. Meanwhile, the MIP functions as a central coordination and oversight tool for the Mission as a whole, enabling strategic alignment, performance tracking, and implementation support across all Mission-related projects. Together, these platforms form a cohesive digital ecosystem: WaveLinks fosters bottom-up engagement and data flow, the EEA platform ensures robust policy monitoring and transparency, and the MIP orchestrates strategic coordination and Mission delivery at the European level.

While they rely on some of the same data, either through direct exchange or by collecting data from the same sources, these platforms serve different, complementary purposes. Data sharing between WaveLinks, the EEA platform, and the MIP has been conducted periodically through various means, including direct exchanges of data files (such as Excel or JSON formats) and integration processes. In some instances, data from one platform was collected and incorporated into others to ensure consistency and alignment with the Mission's objectives. This exchange has been facilitated through a combination of automated methods, such as APIs and web scraping, as well as manual data transfers, ensuring that all platforms remain up-to-date with relevant information. These ongoing data-sharing efforts help maintain synergy across the platforms, enabling coordinated progress tracking and collaboration.

Besides the MIP and EEA platforms, some other relevant platforms are also briefly listed, highlighting their scores, roles, data handling methodologies, and examples of the types of data they include.

- **European Atlas of the Seas**. First conceptualized in 2008 and now in its 8th version, the Atlas is maintained by the European Commission (DG MARE) and designed to improve ocean literacy through interactive maps and educational content. Its **long-term stability is ensured b**y institutional support and regular updates tied to official EU marine datasets. While not a data entry or monitoring tool per se, it remains a persistent visualization platform for public-facing communication. It contains a significant amount of data on the transformation of the sector such as the number of low-trophic farms in Europe.
- **EMODnet (European Marine Observation and Data Network).** Operational since 2009, EMODnet aggregates and harmonizes marine datasets across geological, physical, biological, chemical, and human activity domains. Its thematic portals are continuously updated through formal data agreements with national agencies and research institutions. EMODnet is deeply embedded in EU data policy and receives long-term funding, ensuring sustainability. It focuses on raw and processed environmental data rather than project-specific indicators, and also directly addresses the transformation of the sector, containing relevant data such that on algae production facilities in Europe.
- **Copernicus Marine Service**. As part of the EU's Copernicus Program, the Marine Service provides operational ocean monitoring with near real-time data and forecasts. It benefits from a robust infrastructure and dedicated institutional funding, with updates scheduled in line with satellite missions and in situ observations. Its products are primarily physical (e.g., sea level, currents, temperature), and it serves as a foundation for real-time decision support.
- **Blue-Cloud and the European Open Science Cloud (EOSC)**. Blue-Cloud provides a Virtual Research Environment that enables marine researchers to access, share, and process datasets across repositories. As part of EOSC, it is designed for long-term operation under a federated model, where data providers and users contribute to platform growth. Its longevity depends on sustained engagement from the scientific community and the evolution of cloud infrastructure, but its design supports modular updates and reusability of analytical workflows.
- **Digital Twin of the Ocean (DTO).** DTO is a newer but high-priority initiative aimed at creating simulation models for ocean processes, climate change effects, and human impacts. Still in early stages, it is intended as a long-term flagship infrastructure, integrating multi-source data

(including EMODnet and Copernicus) and serving as the Mission's modelling engine. Longevity is assumed due to its integration in high-level policy strategies and significant EU investment.

Compared to the platforms listed above, WaveLinks is newer and more targeted, developed specifically to address stakeholder mapping, KPI tracking, and activity visibility in the context of Mission Objectives in the BANOS region. In terms of longevity, most of the established platforms (EMODnet, Copernicus, Atlas of the Seas) are supported by permanent EU institutions and funding structures. WaveLinks, by contrast, will require a post-project strategy for hosting, updates, and stakeholder engagement if it is to remain fully active beyond 2025. However, its modular design, open-source software implementation, and relevance to the evolving Mission implementation structure give it potential to either integrate with, complement, or inform future MO actions.

2.3. BEST DATA PRACTICES

To ensure the effective monitoring of Key Performance Indicators (KPIs) in BlueMissionBANOS, the WaveLinks platform required a coordinated approach to data sharing and collection across all partners. The guidelines outlined below were developed collaboratively as part of Task 5.3, "Systematic approach to data collection including requirements of the MIP", and adopted throughout the project. They reflect the technical requirements, preferred formats, and best practices necessary for sustainable, reliable data integration in support of Mission Ocean goals.

These rules are intended to ensure that all data sources used in WaveLinks are structured, accessible, updatable, and easily processed for automated ingestion. Together, they form a practical and replicable model for other Lighthouse areas or Mission Ocean initiatives.

(1) Prioritize machine readable formats

Project partners were strongly encouraged to provide data in formats that support automated processing. The preferred formats for WaveLinks were:

- **API-based access** (Application Programming Interface)
- **CSV** (Comma-Separated Values)
- **JSON** (JavaScript Object Notation)
- **ODS/XLSX** (Open Document or Excel Spreadsheets)

These formats allow the data team to integrate and update information efficiently, without requiring manual reformatting.

Conversely, PDF, DOCX, and ODT formats were explicitly discouraged. These formats are difficult to parse programmatically and often require manual extraction that is time-consuming and error-prone.

(2) Use API access where possible

APIs were identified as the optimal way to retrieve and update data, especially for sources that are dynamic or frequently updated. APIs offer:

- Automated data retrieval
- Real-time or scheduled updates
- Scalability for large datasets
- Ease of integration into backend systems

When using an API, teams were instructed to check for documentation, authentication requirements (e.g., API keys), and endpoint definitions. This ensured that the WaveLinks team could establish a direct data pipeline, reducing manual handling and increasing data freshness.

(3) Share data in consistent and predefined structures

While APIs, CSVs, and JSONs were preferred, **data structure consistency** was also essential. WaveLinks required that files be formatted according to **predefined templates** or with predictable, clearly labeled fields. This allowed the system to ingest data automatically.

Specific guidance included:

- Avoiding inconsistencies like different column headers for similar data (e.g., "Name" vs. "Full Name")
- Keeping each field clearly separated (e.g., not combining first and last names into one field unless documented)
- Using flat, non-nested structures where possible to simplify parsing

This rule ensured that data from different contributors could be integrated smoothly without requiring repeated reformatting or human intervention.

(4) Avoid PDF and Word-based documents for data sharing

Despite their ubiquity, formats like **PDF, DOCX, and ODT** were deemed unsuitable for KPI monitoring purposes. These formats:

- Lack standardized data structures
- Often contain embedded tables that are not machine-readable
- Require manual extraction or error-prone scraping

While they may be suitable for reporting or narrative summaries, such formats are not usable as primary data sources. Avoiding them helped streamline integration and reduce errors.

(5) Determine the best available data retrieval method

Partners were asked to assess each data source and choose the most effective retrieval method. The options were:

- **API integration**: Preferred where available and feasible
- **Manual export**: Acceptable if data could be downloaded in CSV or JSON formats
- **Regular updates**: Important to define and communicate expected update frequencies (real-time, daily, weekly, monthly, or annual)

Teams were reminded to verify whether export functions imposed download limits (e.g., maximum 10,000 rows) and to use filters or batch downloads when necessary. Manual export remained a viable method when structured formats were respected.

(6) Specify and document update frequencies

Accurate monitoring requires **timely data**. The guidelines defined best practices for setting appropriate update intervals depending on the nature of the data:

- **Real-time or daily updates** for dynamic data (e.g., weather, sensor feeds)
- **Weekly or monthly** for operational or activity-based metrics (e.g., port throughput, energy generation)
- **Quarterly or annual** for policy, governance, or structural data (e.g., reports, strategy documents)

Partners were instructed to clearly indicate update intervals for each data source and ensure consistency over time. The WaveLinks team flagged datasets that were updated infrequently or only available as static snapshots. These practices were successfully followed by partners throughout the project and contributed to the robust and scalable integration of KPI data into the WaveLinks platform. Together, they offer a replicable set of data governance principles that can inform future data collection efforts in EU Missions or other blue economy monitoring initiatives.

2.4. KPI SELECTION AND EXAMPLES

A list of eight criteria for the selection of KPI formulation was developed during BlueMissionBANOS project and reported in Deliverable 5.2: KPIs for a carbon neutral, circular blue economy (Asmala et al., 2024). Three of these criteria were considered critical and essential for setting the baseline for monitoring. They are listed below.

(1) Relevance to sector and sustainability area

- Sector specificity: The KPI should directly relate to the specific sector it is meant to represent, capturing its unique impact on or contribution to the sustainable blue economy.
- Sustainability focus: Each KPI must align with the sustainability area it's supposed to measure (economy, environment, governance, social), reflecting key aspects of sustainability relevant to that area.

(2) Data availability

- Accessibility: Data for the KPI should be readily available or obtainable with a reasonable effort, ensuring that monitoring is feasible over time.
- Reliability: The data source should be credible and consistent, coming from validated and respected sources (e.g., governmental agencies, recognized research institutions).

(3) Measurability and quantifiability

- Clear definition: The KPI should have a clear and unambiguous definition, making it straightforward to measure.
- Quantifiable: It should be possible to quantify the KPI, allowing for objective assessment and comparison over time.

These criteria lead to an extended list of 50 criteria, 10 per each of the 5 use domains, namely aquaculture, energy, waterborne transport, ports, and multiuse. While these KPIs were developed and collected specifically for BlueMissionBANOS, they may be relevant for other lighthouses as well, but many could also be specific to BANOS. The KPIs that were to be included in WaveLinks platform as pilot KPIs and demonstrate the strength of this approach were selected from this list. The 5 KPIs were chosen based on the availability of and ease of access to the relevant data, the diversity of use domains, and the diversity of visual representations that can be used to showcase them (Table 3). The diversity criteria were included as these KPIs are meant to be demonstrators, showcasing as many different options as possible for data display and analysis that could be used for KPIs in the future. Some of the KPIs that are described in BlueMissionBANOS Deliverable 5.2 may address more directly the transformation of the sector (*e.g.* KPIs measuring the share of innovative renewable energy or the number of ports with a carbon neutrality strategy), however, they could not be easily included into WaveLinks due to data not being readily available. In BlueMissionBANOS Deliverable 5.1 we have specifically discussed low-trophic farming, including seaweed production. Additional data on various relevant KPIs can be found on the European Environment Agency, Eurostat, European Atlas of the Seas, EMODnet, OECD, and other European and global databases aggregating ocean data.

KPI domain	KPI description	Readiness Level	Framework	Stage	Data source
Aquaculture	People employed in aquaculture sector (nr)	5	societal	OUTPUT	OECD statistics
Aquaculture	Profitability (and amount of new investments) (€/nr)	3	economical	OUTPUT	The EU Blue Economy Observatory
Energy	Share of growth in RE capacity in lighthouse area against baseline of 2021 (%)	5	environmental	IMPACT	OEE reports, Eurostat
Energy	Persons employed full time (nr)	2	societal	OUTPUT	OECD statistics, The EU Blue Economy Observatory
Waterborne transport	Maritime Transport CO2 Emissions (experimental) (Mt CO2eq)	4	environmental	IMPACT	OECD statistics

Table 3. KPI examples integrated into WaveLinks

One of the KPIs selected for displaying on WaveLinks was Measures and incentives by ports taken to reduce nutrient emissions. This KPI can be used to illustrate how KPI contributions and measurements can be considered in different ways, depending on the scale, going from project, through program and to the Mission level. At the project level, a contribution towards this KPI could be a single port updating its waste treatment facilities, waste-related services or disseminating information about its already existing advanced status for vessels to reduce nutrient and other chemical releases to the sea. The result could be expressed as nutrient/chemical load as kg of nutrient/chemical treated

on land from the starting point of operation of the new system, or number of vessels visiting this environmentally more advanced port. On a program level, the same indicators could be collected, for example, for a geographical region or as a share of recreational harbors, taking these measures under a certain permitting authority. At the Mission level, the development within this indicator could be measured as progress in a sea basin area or at the EU level, and its estimated effect on recreational value or improvement of environmental status of the areas, number of new technologies launched or share of ports that have upgraded their waste treatment systems.

The KPIs are presented though a series of visualizations. One example focusing on France is presented in the figure below (Figure 8). The visualization will be further refined and adjusted in the future. The visualization images can be downloaded directly from WaveLinks, and the underlying data will also be directly available for download in a future platform release.

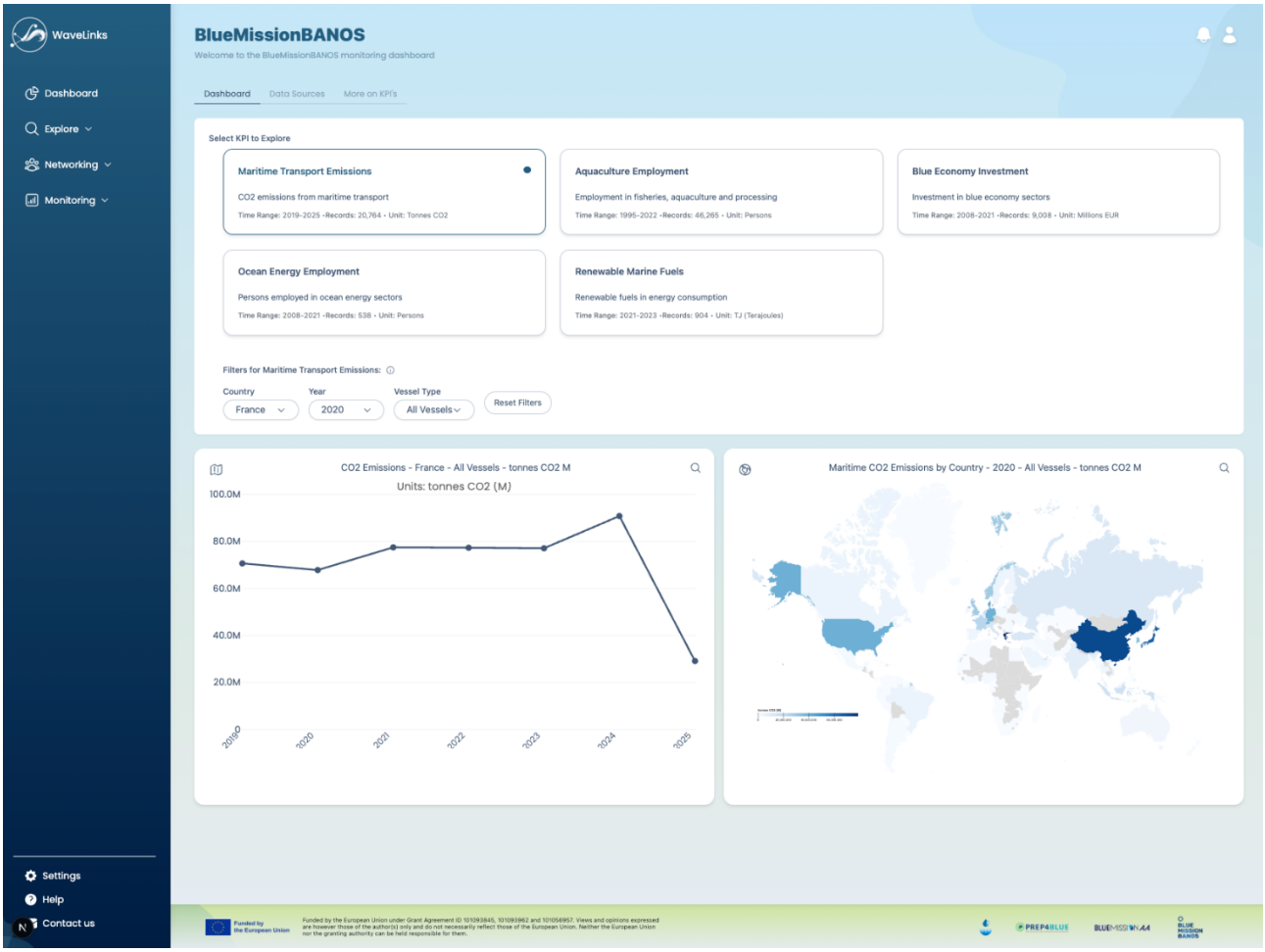


Figure . Example of KPI visualizations on WaveLinks

2.5. CHALLENGES ENCOUNTERED IN OPERATIONALISING KPIS

While the WaveLinks platform ultimately achieved its goal of integrating a diverse set of data sources to support KPI monitoring in the BANOS region, several recurring challenges emerged during the data collection and sharing process. These challenges are not unique to BlueMissionBANOS but

reflect broader systemic issues often encountered in cross-sectoral, multi-partner EU projects focused on digital transformation and monitoring.

- **Fragmentation of Data Sources.** Many relevant datasets are dispersed across institutions, agencies, and platforms, with no centralized access point. In some cases, data was available only through proprietary systems, password-protected databases, or national portals with limited export functionality. This required additional coordination with data owners and increased the time needed to evaluate source suitability.
- **Inconsistent Data Formats and Structures.** Even when data was available, it was often provided in formats that were not directly usable (e.g., poorly structured Excel files, PDFs with embedded tables, or inconsistent field labels across similar datasets). This led to standardization and a need for manual reformatting and quality checks, reducing the potential for automation and increasing the workload for the integration team.
- **Limited API Availability.** Despite the push toward open data and automation, many institutional datasets still lacked API endpoints or structured export options. In cases where APIs did exist, authentication requirements (e.g., token management, rate limits) or lack of documentation posed additional technical barriers to integration.
- **Irregular or Unclear Update Schedule.** Understanding how often data sources were updated and whether those updates reflected real-world change was not always straightforward. Some data providers did not document update frequencies, while others published irregularly, making it difficult to establish confidence in time-series comparisons or near real-time monitoring.
- **Variable Data Quality and Completeness.** Data quality varied significantly between sources. Some datasets contained missing values, unclear definitions, or outdated information. Without common data standards, comparing or aggregating data across countries and sectors was sometimes challenging.
- **Duplicate Data Across Source.** Duplicate data was a common issue, with the same information often appearing in multiple datasets from different providers. These overlaps were not always obvious, as files could vary in format, structure, or naming conventions, even when reporting on the same underlying content. This created confusion about which source to prioritize, increased the risk of double counting, and added unnecessary volume to the integration process. Identifying and resolving duplicates required extensive data cleaning and manual checks.

Despite these challenges, the collaborative approach adopted in BlueMissionBANOS was supported by clear data guidelines, regular partner engagement, and iterative problem-solving and successfully enabled the successful integration of diverse datasets into the WaveLinks platform. Many of the obstacles encountered are common in cross-sectoral digital initiatives, and the lessons learned here provide valuable insight for future efforts under the Mission Ocean framework and beyond.

3. THE BLUEPRINT: RECOMMENDATIONS FOR MONITORING FRAMEWORK

3.1. OBJECTIVES, SCOPE, AND APPLICABILITY OF THE MONITORING BLUEPRINT

In this report, the "*blueprint"* refers to a structured, action-oriented set of recommendations designed to guide the implementation of post-project monitoring and reporting of sustainable blue economy activities in the BANOS area (Baltic and North Sea). Rather than a conceptual framework, it takes the form of a practical to-do list, offering clear, step-by-step guidance for changemakers at all levels, from local actors to EU institutions.

The monitoring blueprint presented here is designed to support the implementation of the EU Mission "Restore Our Ocean and Waters" by providing a practical, scalable, and context-sensitive tool for actors across all Mission Lighthouse regions. The recommendations are developed from experiences in the BANOS area, and the blueprint is applicable and supports all three Mission objectives: ecosystem restoration, pollution reduction, and transition to a sustainable, carbon-neutral blue economy.

This blueprint is intended for use by a wide range of stakeholders: local businesses, research projects, regional authorities, national governments, and EU-level programs. It offers tangible recommendations in the form of ready-to-use instructions for projects, funders, and officials to act upon, ensuring that their activities align with Mission objectives from the earliest stages of planning to the implementation. Importantly, the blueprint is designed to be used early in the lifecycle of projects and initiatives, embedding monitoring into the full range of planned activities. This proactive approach ensures that data collection, indicator development, and impact tracking are not afterthoughts but integral components of strategic planning.

By providing ready-to-use instructions, the blueprint supports early integration of monitoring into project planning, ensures alignment with Mission objectives, and promotes consistency and continuity in data collection and reporting practices. Furthermore, it facilitates long-term impact by encouraging automation (linked to data collection described above) and interoperability with existing EU infrastructures, thereby increasing the relevance and usability of the blueprint beyond the lifetime of the Mission BANOS project.

As outlined above, the blueprint aims to harmonize Mission monitoring approaches, supporting the development of a coherent framework that ensures comparability and usability of monitoring results across projects, regions and governance levels. The approach presented here is also aligned with ongoing developments of Mission Monitoring Framework developed by EEA available in WISE MARINE Platform, further supporting the monitoring of project level activities and achievements (WISE Marine, 2024). It engages a broad range of actors, including local businesses and operators, research projects, regional authorities, national governments and EU-level programs. By addressing these actors collectively, the blueprint strengthens links between grassroots activities and policy frameworks. It explicitly supports the three Mission objectives by embedding monitoring as a guiding principle throughout project lifecycles.

The blueprint is also developed to improve the long-term usability of data by encouraging common standards, openness and interoperability with existing EU infrastructures. It provides tangible recommendations that can be adapted to different contexts while keeping alignment with shared Mission objectives. While developed based on experiences from the BANOS region, the blueprint can be scaled and transferred across other Lighthouse regions. In this way, it acts as both a practical tool and a strategic set of guidelines of consistency across Europe. By facilitating integration, comparability and sustainability, the blueprint creates a foundation for evidence-based decision-making that remains relevant well beyond the lifetime of Missions.

3.1.1. WHAT THE BLUEPRINT OFFERS: SOLUTIONS AND TOOLS FOR PROJECTS, RESEARCH FUNDERS, OFFICIALS AND AUTHORITIES

BlueMissionBANOS monitoring blueprint provides a practical package to plan, conduct and communicate monitoring and to support forecasting. It includes guidance for 1) selecting relevant indicators, 2) defining baselines and targets and 3) establishing clear metadata, data quality and stewardship practices. It outlines consistent reporting timelines and audience-tailored outputs, supports transparent aggregation and synthesis across initiatives and promotes interoperability with established European data practices without prescribing a single platform. Role definitions and governance checkpoints help allocate responsibilities among implementers, funders and authorities.

3.1.2. HOW TO ENSURE ENGAGEMENT WITH MISSION OBJECTIVES AND ALIGNMENT OF DIFFERENT LEVELS OF MONITORING

Engagement and alignment with Mission objectives can be sustained through clear governance, shared incentives and a common language for monitoring. A light but explicit monitoring coordination model designates accountable leads at project, regional, national and EU levels, supported by regular and open interactive dialogue among stakeholders (e.g. roundtables) and agreed communication plan. A minimal “common core” of concepts (definitions, metadata elements and reporting vocabulary) is maintained alongside more detailed, context-specific modules where needed. Interoperability is treated as a policy principle across actions and levels, rather than a single platform choice, which requires transparent data stewardship roles and data flow guidelines from collection to synthesis. BlueMissionBANOS approach creates the conditions for coherent monitoring of the progress towards Mission objectives that translate into concrete, step-by-step actions listed below.

3.1.3. RECOMMENDATIONS FOR IMPLEMENTATION

1. **Clarify monitoring purpose and intended audience**: Monitoring efforts should begin by clearly defining why the data is collected and who will use it (“*Data is collected correctly only if you know what you are going to do with it”*, (Frontier, 1983)). Results should be framed so they serve both technical experts and non-technical stakeholders, from local actors to EU policymakers.
2. **Align monitoring with Mission objectives at all levels**: Each indicator and dataset should be linked with one or more Mission Ocean objectives. This ensures that project-level actions, program-level syntheses and EU-level reporting remain coherent and comparable.

3. **Select transparent and relevant indicators**: Indicators should be directly linked to the sector and sustainability goals they are meant to represent. They should be based on reliable data sources, clearly defined and measurable over time.
4. **Apply common data standards and openness**: Data should be shared in machine-readable formats with consistent structures and declared update frequencies. Open access via repositories, dashboards or APIs ensures comparability across projects and long-term usability.
5. **Connect monitoring results to progress and context**: Monitoring should show whether results reflect outputs, outcomes or long-term impacts (following Pathway to Impact analysis). Each indicator should also consider external drivers such as political, economic or environmental conditions that influence change (using e.g. PESTLE analysis).
6. **Provide timely and tailored reporting outputs**: Reporting should match the needs of the audience, from simple factsheets at the local level to synthesis briefs and policy updates at program and EU levels. Outputs must be produced regularly to track change and inform decision-making.
7. **Ensure continuity and long-term relevance**: Responsibilities for data hosting, reporting and knowledge transfer must be clear beyond individual project lifespans. Alignment with permanent EU infrastructures such as EEA, WISE, EMODnet, JRC, and Copernicus safeguards the sustainability of monitoring results.

3.2. CURRENT LIMITATIONS AND FUTURE DEVELOPMENT NEEDS

Despite progress in harmonizing monitoring practices and developing KPIs for the BANOS region, challenges remain. Data fragmentation, inconsistent indicator definitions, and varying national approaches hinder comparability and the effective use of monitoring results. Harmonizing data collection is essential for building robust long-term repositories, whether managed nationally or by platforms such as the MIP or EEA. The use of differing indicators across projects and lighthouses complicates progress tracking and burdens data managers, especially when baseline data is missing or unevenly available across sectors.

The BANOS region benefits from established actors such as HELCOM, OSPAR, ICES, and the Union of the Baltic Cities, who coordinate maritime and water-body monitoring, facilitate cross-country activities, and share best practices. Their active involvement in future development is considered important for wider acceptance, visibility, and meaningful results. Including these organizations in collaborative efforts ensures that monitoring outcomes are relevant and actionable for key stakeholders.

Mission Ocean projects are influenced by external factors like political frameworks, community engagement, and technological readiness. Mapping PESTLE factors to indicators helps anticipate changes and ensures no key dimension is overlooked. While Pathway to Impact (PtoI) and Theory of Change (ToC) approaches measure project progress, PESTLE analysis clarifies sectoral context and external drivers, enabling the creation of holistic KPIs across monitoring levels. If the enabling environment, such as funding, political will, or societal acceptance, is lacking, progress toward Mission Ocean aims may be slowed.

In the second implementation phase (2025–2030), the Lighthouse CSA will be pivotal in aligning monitoring practices and data collection. Regular roundtable discussions, organized by DG MARE, EEA, and the Lighthouse CSA, should include all relevant stakeholders, especially regional actors. These forums will facilitate best practice exchange, address challenges, and ensure consistency with Mission objectives and WISE Marine Platform requirements.

3.3. EXPECTED IMPACT

Strengthened collaboration, harmonized and continuous monitoring of reliable and accurate data, and open dialogue will position the BANOS region to deliver robust, comparable data to the EU Mission. This will support adaptive management, policy development, and achievement of Mission targets, ensuring monitoring efforts translate into meaningful, long-term impact for Europe's oceans and waters.

In addition, the implementation of the blueprint will foster greater transparency and accountability across all levels of governance. By standardizing indicators, reporting formats, and data stewardship practices, stakeholders will be able to track progress consistently, identify gaps early, and adjust interventions as needed. This approach will facilitate evidence-based decision-making, providing both local actors and EU-level policymakers with reliable, actionable insights.

Ultimately, the expected impact extends beyond immediate project outcomes. The BANOS region will serve as a model for other Lighthouse regions, demonstrating how practical, harmonized, and scalable monitoring approaches can accelerate progress toward EU-wide sustainability goals while fostering collaboration, innovation, and long-term resilience in marine and coastal management.

4. CONCLUSIONS

The BlueMissionBANOS monitoring blueprint provides a practical and scalable framework to guide post-project monitoring and reporting across the BANOS region, supporting the EU Mission "Restore our Ocean and Waters." By integrating a three-level monitoring approach (project, program, and mission levels), the blueprint ensures that individual actions are linked to systemic impacts, while combining Pathway to Impact and PESTLE analyses to capture both internal logic and external drivers. Its actionable recommendations, standardized indicators, and clear governance structures enable stakeholders at all levels, from local operators to EU policymakers, to implement monitoring that is consistent, transparent, and aligned with Mission objectives.

Beyond immediate project implementation, the blueprint fosters long-term benefits for the BANOS region and beyond. Harmonized data practices, interoperability with EU infrastructures, and clearly defined responsibilities enhance the usability, comparability, and sustainability of monitoring results. This approach supports adaptive management, evidence-based policymaking, and meaningful progress tracking, while connecting grassroots activities with higher-level governance frameworks. By embedding monitoring early in project lifecycles, stakeholders can anticipate challenges, respond to evolving conditions, and ensure that monitoring outputs translate into actionable insights.

Finally, while the blueprint draws from experiences in the BANOS region, its principles and recommendations are broadly applicable across other Lighthouse regions and Mission Ocean initiatives. Its emphasis on practicality, scalability, and stakeholder engagement creates a foundation for long-term, system-wide impact, enabling transition toward a sustainable, carbon-neutral blue economy in Europe, while strengthening collaboration, innovation, and resilience in marine and coastal management.