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Deliverable 3.3

User manual for EA Wheel as decision support tool

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Abstract	The following deliverable discusses how companies in the Blue Bioeconomy can implement Ecosystem Approach (EA) in their business strategy. As marine industries face growing environmental and regulatory challenges, the EA provides a structured framework for balancing economic activities with ecosystem protection. Different tools and framework concerning ecosystem services are discussed with a specific focus on the EA Ladder, an evolution of the EA Wheel. This ladder incentivises and rewards companies adopting nature-inclusive practices, aligning economic development with conservation goals. Two case studies with implementation of the EA ladder for bluebio companies are described.
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Acronyms

ASC	Aquaculture Stewardship Council
ARIES	Artificial Intelligence for Ecosystem Services
ASC	Aquaculture Stewardship Council
BBC	BlueBioClusters
CBD	Convention on Biological Diversity
CDP	Formerly the Carbon Disclosure Project
CICES	Common International Classification of Ecosystem Services
CMS	Conservation Measures Partnership
EA	Ecosystem Approach
ES	Ecosystem Services
ESG	Environmental, Social, and Governance
ESR	Ecosystem Services Review
FAO	Food and Agriculture Organization (of the United Nations)
GHG	Greenhouse Gas
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
ISO	International Organization for Standardization
LCA	Life-Cycle Assessment
MAP	Measurement and Accountability for Performance (Seafood MAP)
MESAT	Marine Ecosystem Services Assessment Tool
MSC	Marine Stewardship Council
NESEV	Name of a specific ecosystem services assessment platform
NSW	New South Wales (from the Department of Planning, Industry and Environment reference)
PBR	Photobioreactor
PDCA	Plan-Do-Check-Act (cycle for continuous improvement)
SBTi	Science-Based Targets initiative
SBTN	Science-Based Targets for Nature
SKAO	Stichting Klimaatvriendelijk Aanbesteden & Ondernemen (Foundation for Climate Friendly Procurement and Business)
SME	Small and Medium-sized Enterprises
SUMES	Sustainability assessment Methodology (referencing environmental handprint/footprint)
TCFD	Task Force on Climate-related Financial Disclosures
TESSA	Toolkit for Ecosystem Service Site-based Assessments
UN-REDD	United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation

Executive Summary

The **Ecosystem Approach (EA) Wheel** was conceptualised in 2021 by the Blue Cluster to support emerging blue growth sectors in Belgium and the EU, such as offshore energy (with the addition of nature-inclusive design and nature restoration) and aquaculture. This concept, published in a whitepaper, comprises three key elements:

1. A classification framework for marine ecosystems, segmenting them into domains or aspects that can be positively or negatively impacted by economic activities.
2. A five-level performance ladder to measure EA engagement.
3. A posteriori assessment of societal and policy impacts to evaluate the socioeconomic benefits of ecosystem-focused efforts.

Challenges in Development

Feedback from Belgian and other regional stakeholders, gathered during various project interactions, highlighted that the entry and processing steps in the EA Wheel were overly complex for companies to follow. Moreover, instead of fostering continuous improvement, the EA Wheel mainly served as a snapshot assessment. In contrast, other EA tools showed greater feasibility for application within Bluebio companies.

To address these challenges, the Blue Cluster partnered with Mantis Consulting to further develop the Ecosystem Approach Ladder—a practical evolution of the EA Wheel- tailored for the blue bioeconomy. This framework incentivizes and rewards companies for adopting nature-inclusive practices, aligning economic growth with environmental stewardship.

Key Activities

To enhance awareness and facilitate adoption of the EA by companies, the following initiatives were undertaken:

- **Workshops:** During the initial phase of the project, several partners introduced the EA Wheel to their stakeholders through regional workshops. A local workshop with Belgian stakeholders (Blue Session on Ecosystem Approach, February 2024) explored tools and strategies for advancing the EA in the Blue Economy. Insights from this workshop informed a subsequent session with project partners in Tartu, Estonia, to guide them in reaching out towards companies in their regions.

- **Conference Engagement:** A poster presentation "Can blue bio production be stimulated by the use of ecosystem approach?" at the World Aquaculture Society Congress "Aqua 2024" (Annex 1) highlighted the benefits and challenges of implementing the EA for Blue bioeconomy.
- **Policymaker Survey:** A survey targeted policymakers across Europe, from city level to national levels, to assess the integration of the EA into existing policies and how companies could or should be engaged in their regional implementation of EA.
- **Policy Framework Design:** Based on desk studies and stakeholder input (survey results, workshop conclusions, conference interactions…), a circular, iterative **Ecosystem Approach Policy Process Concept** (D6.5 *Guide for Use of EA Wheel at Regional Policy Level*) was developed as a guidance tool for policymakers. In this Concept, specific links are made to provide incentives for blue bioeconomy companies to introduce EA in their business plans.
- **Webinar:** A dedicated webinar highlighted how the EA can support the development of the blue bioeconomy and how it will play a pivotal role in enhancing regional policymaking and driving sustainable development. This webinar, especially oriented to policymakers, discussed the EA policy process concept and the EA Ladder and also the interaction policymakers should have with companies in order to support the adoption of an EA.
- **Presentation EA on the Flemish aquaculture symposium:** The symposium "Navigating Ecological Considerations and Sustainability in Mariculture Practices" (12/12/2024) brought together various stakeholders, including scientists, political, industrial and non-governmental parties. With a presentation on the work delivered in BBC, it was shown how EA can support businesses in integrating ecosystem services into novel ecology-driven business models and induce cross-sector collaborations along the value chain (Annex 2).
- **Online Awareness Tools:** The BlueBioClusters website (https://bluebioclusters.eu/ecosystem-approach-tool/) and the BlueBioMatch platform now feature an **online awareness tool** for companies to evaluate their current Ecosystem Approach activities. The companies will also have direct access to the list of available EA or ESV tools identified through the project (section 2.2.3 of this document).
- **Booklet** "Case Studies on the Ecosystem Approach in the Blue Bioeconomy". This booklet aims to illustrate through infographic case studies of companies within the blue bioeconomy applying the Ecosystem Approach or Ecosystem Services Valuation tools and how their EA efforts were translated into an internal decision or to gain benefits from external parties.

- **Case study as example:** The Ecosystem Approach (EA) Ladder is a framework that encourages Blue Economy companies to engage in an EA by assessing their level of commitment to improve their impacts on ecosystems and the services these ecosystems deliver, based on continuous improvement. ZENI, a French SME that specialises in cleaning industrial wastewater by applying natural processes through a nature-based solution, is testing the first, explorative Level of the Ladder to set up and strengthen their EA, and to showcase their positive contributions to nature. Section 4 describes the case study of ZENI and the steps they take to apply the EA Ladder.

Within the project, the Ecosystem Approach has been further clarified for Blue Bio Economy companies and tools are made available. By raising awareness at the policy level, the project also highlights potential pathways for supporting companies in the effective implementation of the Ecosystem Approach.

Introduction

The Atlantic, North Sea, and Baltic Sea regions hold significant potential for the blue bioeconomy, leveraging marine biodiversity for a wide range of products, including food, feed, fuels, cosmetics, pharmaceuticals, etc. However, the increasing demand for aquatic resources, coupled with environmental pressures, raises complex challenges for sustainability within the blue bioeconomy. Climate change intensifies the vulnerability of marine ecosystems, accelerating adverse effects like ocean acidification, habitat degradation, and resource scarcity. Such shifts place stress on species diversity, food webs, and water quality, impacting ecosystem resilience and services essential for both coastal and broader marine economies (Cooley et al., 2022; Mills et al., 2023). Conversely, unsustainable practices in the cultivation and harvest of aquaculture species can potentially lead to several negative impacts: increased use of fish meal/oil from depleted fishery sources to feed carnivorous species, eutrophication of water bodies, increased disease occurrence, release of exotic species, etc. (CINEA, 2022; James, 2009).

To prevent these adverse impacts, effective governance is essential. However, fragmented regulatory frameworks often delay adaptation to new standards and environmental needs. Additionally, decentralised governance structures may lack the capacity to address large-scale ecosystem management, while limited access to stable markets often restricts development, especially for smaller enterprises. A successful Blue Bioeconomy depends on robust, coordinated policies that address long-term environmental and socio-economic needs and involve diverse stakeholders, including researchers and industry representatives, in decision-making processes (Dietz, 2018).

When managed accordingly, Blue Bioeconomy activities can also have significant beneficial impacts on the natural environment through sustainable practices and strengthening ecosystem services. Ecosystem services are the numerous benefits that society derives from the natural environment. These services form the foundations of our economies, health, and general well-being. Within the Blue Bioeconomy, these services are critical. For example, mussels not only serve as a food source but also contribute to nutrient recovery and coastal protection. Similarly, oyster reefs provide coastal protection and serve as nurseries for marine life. These services are invaluable, not only for immediate benefits but for the long-term resilience of marine and coastal systems (Cooley et al., 2022).

Integrating ecosystem services into blue bioeconomy business models and regional planning offers both economic and environmental advantages. Locally produced, sustainably managed resources support regional economies, while nature-based solutions, such as oyster reefs for erosion control or macroalgae cultivation for enhancing biodiversity around offshore wind farms, illustrate how an approach focused on blue bioresources can align economic development with conservation. This economic and environmental alignment can create positive impacts that resonate

across sectors, creating value for tourism, retail, and other industries (European Commission, 2022; Buck et al., 2017).

To maximise these benefits, an Ecosystem Approach (EA) is essential, providing a framework that both assesses and mitigates the environmental impacts of activities while enhancing positive contributions to ecosystem services. Key elements of an EA include the evaluation of ecosystem services in the four dimensions, being ecological, economic, social and cultural terms, raising awareness about the value of these services, and fostering a willingness to protect them. Quantifying these services enables industry and policymakers to weigh trade-offs and make informed decisions. Adopting an EA can also significantly enhance public support, granting businesses and other stakeholders the social license to operate. This public backing is crucial for the sustainable success of any initiative (Smith and Maltby, 2003; UNEP, 2011).

The valuation of ecosystem services, however, comes with its challenges. The complexity of cumulative impacts, the need for comprehensive data, and specific monitoring requirements are significant hurdles. Awareness creation, robust tools, and regulatory frameworks are indispensable to ensure effective valuation and management within EA (Ruckelshaus et al., 2015; Liquete et al., 2013). The BlueBioClusters (BBC) project explores the concept of an Ecosystem Approach Ladder as a supporting tool for applying the EA in blue bio companies and addresses several of the existing challenges within the blue bioeconomy. The Ladder aims to incentivise and reward companies that are effectively adopting nature-inclusive practices within their business activities.

BlueBioClusters Project Deliverable 6.5 "*Guide for Use of EA Wheel at Regional Policy Level*" presents the opportunities for EA within policy on a regional or national scale, and provides recommendations on how policy can support blue bio companies in applying an EA. This document provides initial guidance for companies that want to adopt an EA and how EA implementation can stimulate more sustainable industries. While the main focus lies on how Blue Bioeconomy companies can improve their own ecosystem impacts, some Blue Bio companies can also offer opportunities to improve ES performance of other parties, e.g. through collaboration with other industries. In the SME guidance, some examples of how these companies can get involved in EA will be given.

1. The Ecosystem Approach

The Ecosystem Approach is defined by the Convention on Biological Diversity (CBD) as *"A strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way".* (Decision V/6 of the Conference of the Parties to the CBD, 2000). It was introduced to balance the objectives of the CBD: conservation, sustainable use, and the fair and equitable sharing of benefits arising from the utilisation of genetic resources. The EA recognises the complex interrelationships within ecosystems and aims to maintain their health, productivity, and resilience. Rather than adopting a narrow focus on a single species or environmental concern, the EA emphasises a holistic view of the entire ecosystem that includes human impacts and the interconnections among various ecosystem components (Smith and Maltby, 2003; Hassler et al., 2013). Originally centred on minimising human impact, the approach has evolved to incorporate regenerative practices that actively restore and enhance natural ecosystems and benefits provided by ecosystem services, with the understanding that economic activities can also positively impact nature (FAO, 2021).

Implementing an EA requires balancing positive and negative impacts, valuing ecosystem services beyond immediate economic gains, and learning how to handle the complexity of cumulative impacts. In essence, the EA tries to find a balance between ecological well-being and human well-being, ensuring that development sustains the natural resources upon which it depends without overprotecting resources to the point of hindering necessary economic growth. To achieve this balance, good governance is essential (Figure 1).

Figure 1. Main components of the EA (FAO, 2021)

Ecological well-being comprises many aspects. For aquatic systems, for example, this involves supporting biodiversity for ecosystem resilience, maintaining healthy habitats and food webs for maximising goods and services, and keeping critical ocean and coastal areas stable and functional. **Human well-being**, in turn, reflects the quality of life directly or indirectly tied to ecosystem health, encompassing material

living standards (income, food and wealth), health, education, social connections, governance, economic security, safety, etc. **Good governance** involves effective institutions and policies that ensure sustainable stewardship of ecosystems, with collaboration between individuals, organisations, communities and societies fostering resilience for present and future generations (FAO, 2021).

The EA is not a substitute for sectoral management but aims to integrate management across different interests within a sector and across sectors while accounting for externalities such as climate change.

1.1. EA and the Blue Bioeconomy

1.1.1 Ecosystem Services for Blue Bioeconomy

Ecosystem services (ES) are an important part of the EA and provide a wide array of benefits to humans, which are essential for human survival, well-being, and economic activities. They are typically classified into four categories:

1. **Provisioning Services**: Tangible products derived from ecosystems, such as food, water, timber, and medicinal resources.
2. **Regulating Services**: Natural processes like climate regulation, water purification, and flood control that help sustain stable environmental conditions.
3. **Cultural Services**: Non-material benefits, including recreation, aesthetic inspiration, educational opportunities, and cultural heritage values.
4. **Supporting Services**: These are foundational processes, such as soil formation and nutrient cycling, that underpin the other ecosystem services.

Living aquatic resources deliver a wide variety of products, processes and services. Table 1 provides a summary of ES relevant to the Blue Bioeconomy biomass value chains linked to the North and Baltic Sea regions, generated by deliverable 3.2 of the BBC project. Historically, ecosystemic services have been undervalued in policy and decision-making, as the focus has often been limited to market-traded goods and services (e.g., harvest yields), ignoring the indirect but potentially extensive benefits. This trend is now shifting towards the recognition that ES are key to sustainable development and conservation efforts. The economic valuation of ES is increasingly considered essential to capture their non-market contributions.

This is especially relevant for the blue bioeconomy, where certain activities can enhance several non-provisioning ES, including water filtration, coastal protection, and carbon storage. By recognising and assigning economic value to these services, such as through carbon, biodiversity, and nutrient credits, companies can generate additional revenue streams, providing incentives to adopt a wider EA (de Groot et al., 2012; Gowdy et al., 2010).

Table 1. List of ecosystem services provided by the Blue Bioeconomy from the BBC biomass value chains identified in the BBC project (Billing et al., 2024).

Ecosystem Services	**BBC value chain**					
	Bivalves	Crustaceans	Fish	Macroalgae	Marine bacteria	Microalgae
Provisioning						
Food						
Raw materials						
Medicinal resources						
Regulating						
Water filtration and nutrient assimilation						
Coastal protection						
Carbon sequestration and storage						
Biochemical cycling						
Biological control						
Supporting						
Habitat protection and maintenance						
Maintenance of genetic diversity						
Sediment creation						
Water cycling						
Oxygen production						
Cultural						
Recreational activities and mental and physical health						
Tourism and ecotourism						
Sense of place and spiritual connection						
Aesthetic and spiritual appreciation and inspiration for culture, art, and design						

Despite its potential, integrating ES into the blue bioeconomy faces several challenges. Although the concept of ES has gained traction within research and development, there is still minimal awareness of it in the business sector. Many companies do not recognise or evaluate ecosystem services within their operations, resulting in missed opportunities to integrate sustainable practices that could benefit both the environment and the economic sustainability of their activities. This limited awareness hinders the implementation of ES assessments and integration of ES in business activities and causes it to be often overlooked in cost-benefit analyses and corporate decision-making. In this way, companies may disregard practices that could support ES, such as habitat restoration or sustainable aquaculture, simply because the potential economic or ecological benefits are not fully understood or quantified (EC, 2020; EUMOFA, 2022).

Additionally, several knowledge gaps linked to the potential ES are relevant to the blue bioeconomy (Table 2). These knowledge gaps and the lack of valuation tools, however, should not prevent the adoption of the EA, as companies can still benefit from integrating ES considerations into their operations, even with incomplete valuation methods.

Another challenge is the limited presence of market mechanisms, such as carbon, biodiversity, or nutrient credits, that reward companies for supporting ecosystem services. Without established payment systems, companies have little financial motivation to invest in practices that enhance ES (GEF, 2023). Additionally, while some companies may assess their impact on ecosystem services, there is little evidence that these assessments have led to substantial behavioural changes, further underscoring the need for policies and incentives to encourage tangible commitments to ES stewardship (Billing et al., 2024).

To address these challenges and scale the benefits provided by Blue Bioeconomy activities, economic incentives and supportive frameworks are needed to encourage companies across sectors to adopt the EA and provide guidance on actions that can be taken despite existing knowledge gaps. For instance, non-bioeconomy industries, like offshore wind, could incorporate blue bioactivities (e.g., oyster or seaweed farming) to boost biodiversity and water quality in their operational zones. The Horizon Europe project ULTFARMS has pilots on the combination of low-trophic aquaculture in offshore wind farms. Government-backed incentives, tender opportunities, and regulatory support can motivate these sectors to invest in sustainable practices, thereby integrating blue bioactivities into broader economic activities for mutual ecological and economic gain.

Table 2. Knowledge gaps on ecosystem services were identified as relevant to the BBC value chains and obtained through an online survey (Billing et al., 2024).

Blue Bioeconomy knowledge gaps
Biosecurity of seeded lines/spat/inoculum/smolt
Assessment of services/processes
Impacts on local environment
Interactions between introduced/wild-caught species and biodiversity
Influence of climate change on food webs and habitats
Patterns of marine sediment carbon formation and stock
Stakeholder involvement and participation
Valuation of nature-based tourism, recreation, spiritual interactions
Linking cultural ecosystem services of the value chain to human wellbeing
Valuation strategies for specific products
Integration of valuation approaches/strategies
Heavy metal analysis for certain species for food
Life-cycle analysis of the value chain

1.1.2 EA for the Blue Bioeconomy

Companies can implement an EA to address some of the challenges surrounding ES in the blue bioeconomy, while others can be handled through effective EA policy. In this section, we will elaborate on what the EA comprises for the blue bioeconomy and what the potential benefits can entail. More insights into how policy can support companies in adopting an EA are provided in BlueBioClusters Deliverable 6.5 "*Guide for Use of EA Wheel at Regional Policy Level*".[1]

The FAO (2021) defines three principles for the EA for aquaculture management that can be generalised for the blue bioeconomy:

- **Principle 1:** Blue bioeconomy activities should be developed in the context of ecosystem functions and services with no degradation of these beyond their resilience capacity.
- **Principle 2:** Blue bioeconomy activities should improve human well-being and equity for all relevant stakeholders.
- **Principle 3:** Blue bioeconomy activities should be developed in the context of other sectors, policies and goals.

[1] Available from: https://bluebioclusters.eu/outcomes

The first two principles highlight the balance between ecological and human well-being, while the third emphasises the need for cross-sector collaboration and synergies. In addition to these principles, active stakeholder participation and integration are essential elements of the EA, as it does not offer direct solutions but rather aids stakeholders in identifying them.

An EA builds upon conventional management elements but enhances them through systems thinking and inclusive stakeholder participation. Traditional management tends to follow a top-down structure, usually focusing only on production as its primary objective. Decision-making is often limited to a single sector or on the scale of a single organisation (e.g. farm scale for aquaculture). This approach typically operates at a local or individual scale, uses prescriptive management tactics, and relies solely on scientific knowledge (FAO, 2024).

In contrast, the EA emphasises participation, encouraging collaboration with a wide range of stakeholders. Rather than pursuing a single objective, EA integrates multiple goals, such as biodiversity preservation, ecosystem health, and human well-being. It operates at multiple scales, from local sites to regional ecosystems, and encourages adaptive management, allowing for adjustments as new information becomes available. The EA also values diverse sources of knowledge, including traditional and community-based insights, moving away from rigid, prescriptive methods toward incentive-based management that motivates sustainable practices. The emphasis shifts from a primarily corporate focus to one that is transparent and publicly accountable, benefiting the broader community and environment (Hassler et al., 2013; FAO, 2024).

1.1.3 Benefits of EA for the Blue Bioeconomy

The EA offers substantial benefits to the blue bioeconomy by supporting sustainable and balanced resource management. EA facilitates trade-offs necessary to maintain both human and ecological well-being, allowing the integration of diverse stakeholder priorities while balancing production goals with the conservation of biodiversity and habitat protection. This approach enhances collaboration, enabling the blue bioeconomy to address resource-use conflicts and coordinate across different sectors (fisheries, aquaculture, coastal development, etc.).

EA's adaptability allows it to be applied even in data-limited situations, supporting more resilient and efficient resource planning. Adopting an adaptive management approach enables the Blue Bioeconomy to address long-term challenges, such as climate change, with the flexibility to adjust practices in response to environmental changes.

EA also prioritises increased equity and transparency, encouraging fair access to aquatic resources and recognising cultural values tied to marine ecosystems. It strengthens political and financial support for blue bioeconomy initiatives, often unlocking new funding streams and fostering active participation among stakeholders, including local communities, policymakers, and financial donors. Finally, the EA helps

blue bioeconomy activities to promote multifunctionality, as aquatic ecosystems can serve numerous purposes, such as food production, waste reuse, and habitat provision, resulting in a more efficient, holistic use of marine resources for both human and environmental benefit.

In addition to these overarching advantages, adopting an EA can benefit individual blue bioeconomy producers directly. By identifying and addressing threats from climate change and local environmental factors, producers can implement targeted measures to enhance resilience against future challenges. Simultaneously, reducing their own environmental impact helps mitigate their contribution to these changes. The greatest direct advantage, however, arises when producers positively influence the environment. Supportive economic frameworks, such as credit systems, certification programmes, or subsidies, can reward these beneficial impacts, creating incentives for sustainable practices while improving economic returns.

2. Current state of EA implementation

2.1 From single metrics to an integrated approach

Since the introduction of the concept of Sustainable Development in the Brundtland Report (World Commission on Environment and Development, 1987), many companies have made significant efforts in reducing their impacts on both climate and nature. Several approaches and frameworks have been adopted with the aim of integrating environmental and social considerations into corporate strategies and operations. While significant progress has been made in reducing environmental impacts across industries, several sustainability challenges still remain in current practices, to which an EA implementation can provide an answer.

In the next sections, some of the most prevalent sustainability concepts and approaches are further discussed, followed by their main shortcomings. Afterwards, some essential components of EA and the extent of their implementation are described.

2.1.1 Establishing sustainability concepts

Carbon Accounting

Carbon Accounting is by far the most established sustainability concept. Many companies now commit to reducing their greenhouse gas emissions, often by aligning with Science-Based Targets to achieve carbon neutrality. This focus has been greatly influenced by the Paris Agreement, which set global targets for limiting temperature rise and initiated the development of multiple carbon assessment standards and carbon reduction initiatives, including the GHG Protocol, the Science-Based Targets initiative (SBTi), ISO 14064 on GHG Accounting, the Task Force on Climate-related Financial Disclosures (TCFD), etc.

Circular Economy

Another widely adopted concept is the circular economy, which emphasises minimising waste, promoting recycling, and designing products for durability and longevity. Businesses across industries strive to close resource loops by reducing the use of raw materials and focusing on innovative ways to recover and reuse resources, applying the waste hierarchy (Figure 2). This approach not only reduces environmental impact but also presents economic opportunities through cost savings and resource efficiency.

Figure 2. Schematic of the concept of the circular economy and the original concept of waste hierarchy, where the highest priority is given to reducing waste. The new version of the waste hierarchy has additional steps (e.g. Refuse/Rethink/Redesign, Residuals management).

Environmental, Social, and Governance reporting

Environmental, Social, and Governance (ESG) reporting has become a standard framework for evaluating corporate sustainability performance, with investors, regulators, and stakeholders increasingly expecting transparent reporting on issues such as environmental impact, diversity, labour practices, and corporate governance. By integrating ESG considerations, companies aim to demonstrate accountability and build trust with their stakeholders.

Sustainable supply chain strategies

Sustainability is not limited to the operations of a company but extends to its entire value chain. Many businesses are working to ensure the traceability of their raw materials, reduce deforestation, and adopt ethical sourcing practices. Initiatives such as the Blue Carbon Initiative, certifications like MSC and ASC (Marine and Aquaculture Stewardship Council, respectively), and the integration of sustainability into procurement processes have helped companies reduce their indirect value chain impacts on ecosystems and communities.

While these concepts represent progress in sustainability, the heavy focus on carbon accounting has arguably overshadowed other important aspects of sustainability, such as biodiversity conservation, ecosystem restoration, and water management. This imbalance reflects the urgency created by global climate agreements like the Paris Accord, which have concentrated corporate attention on greenhouse gas emissions. However, achieving true sustainability requires businesses to adopt a more holistic approach that addresses broader ecosystem impacts, social equity, and the interconnections between climate, nature, and human well-being.

2.1.2 Shortcomings of current practices

One of the main challenges is the inherent complexity of ecosystems. Ecosystems are multidimensional, dynamic and interlinked, and often lack a clear spatial or biological

delimitation. Due to this complexity, sustainability is usually still approached in a siloed manner, with companies focusing on isolated metrics and initiatives and insufficient coordination between departments with different sustainability responsibilities (Langlet & Rayfuse, 2019). Another consequence of this approach is that trade-offs between different ecosystems are overlooked. For example, a company might introduce a measure to improve nutrient cycling and biodiversity in a river or coastal ecosystem, which might inadvertently increase the carbon emissions of the company. This problem is further exacerbated by rigid management structures that are still in place in many companies, as they are unable to provide a rapid response to new scientific data and changing environmental conditions (Tadesse Bogale & Debela, 2024).

Additionally, the value of cross-sectoral collaboration is often undervalued, resulting in missed opportunities to align efforts across industries. For instance, a fish farm might not account for how its nutrient discharge could intensify eutrophication in nearby waters, potentially affecting fish stocks that local fisheries rely on and undermining coastal conservation initiatives. Conversely, collaboration can help mitigate such negative impacts or even amplify positive ecosystem effects. For instance, microalgae cultivation can be integrated with wastewater treatment systems to reduce nutrient pollution, while partnerships between mussel farms and seaweed aquaculture can enhance water purification, improving ecosystem health and creating shared economic opportunities. Figure 3 highlights examples of collaboration opportunities for the Blue Bioeconomy with other sectors and industries. Collaboration, however, requires trust, which may take time to build and maintain and might be hampered by concerns about data security, intellectual property, or competition (Garnder, 2014; IEMA, 2020).

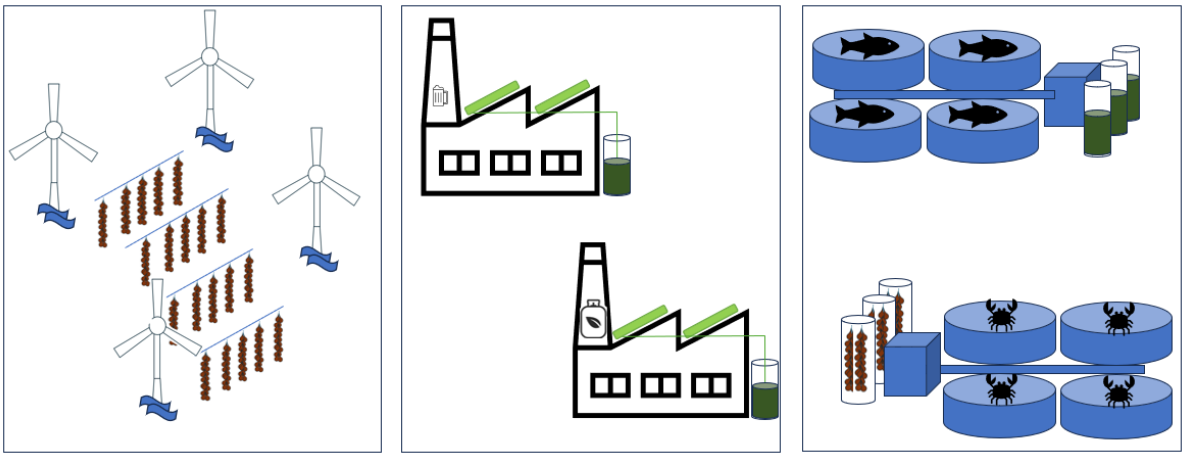

Figure 3. Examples of synergetic industrial and multi-use applications with the blue bioeconomy. (left) Macroalgae cultivation in wind farms, (middle) microalgae cultivation for industry side stream valorisation, (right) macro- and microalgae cultivation for aquaculture wastewater treatment.

Another significant barrier lies in inadequate understanding of ecosystems. Linked to this challenge is the lack of access to reliable data on biodiversity, natural resources, and ES. While there are still data limitations, especially on cumulative impacts, a lot

of data has already been acquired, especially in the heavily studied North and Baltic Seas. However, companies can often not access this data, or do not know where to obtain such data. Additionally, where data is available, it is often difficult to integrate data from different fields of scientific knowledge and translate this data into relevant knowledge for business operations and impacts (Langlet & Rayfuse, 2019). Without this information, businesses struggle to fully assess their environmental footprints or appreciate the value of the ES that support their operations.

Sustainability initiatives or projects by companies can also fail when stakeholders are insufficiently or ineffectively engaged. This engagement is essential to align sustainability goals with the priorities of key stakeholders. Lack of engagement can also lead to loss of trust or credibility and missed innovation opportunities. Stakeholders can often provide valuable perspectives or ideas that can improve sustainability performance or can identify risks and unrealistic targets (Ferrero-Ferrero et al., 2018; Institute of Education Sciences, 2013).

Another important subject to consider is greenwashing in the blue bioeconomy. Greenwashing refers to misleading claims or practices by companies, organisations, or governments that portray their marine-related economic activities as more environmentally sustainable or ocean-friendly than they actually are.

There are key aspects that could be performed, and so it is important to consider them when evaluating the real impact on the ecosystems. Below are some examples of these possible shortcomings.

False or Exaggerated Sustainability Claims: Companies may market fish, seaweed, or marine-derived products as “sustainable” without robust evidence (e.g., no independent certification or vague environmental standards). For instance, claiming aquaculture is “eco-friendly” without disclosing heavy antibiotic use, habitat destruction, or feed made from wild-caught fish.

Misuse of Certifications and Labels: Using eco-labels that are self-issued or lack rigorous verification. Exploiting terms like “blue”, “natural”, “carbon-neutral”, or “ocean-safe” in branding without third-party validation or full transparency.

Token Sustainability Efforts (Bluewashing): Making small, symbolic changes (like reducing plastic packaging) while continuing unsustainable practices in core operations (e.g., overfishing, illegal sourcing, marine habitat damage).

Selective Disclosure: Promoting isolated sustainability initiatives (like carbon offsets or seaweed farming) while obscuring harmful practices (e.g., bycatch in fishing operations or pollution from processing plants).

Co-opting Blue Economy Narratives: Aligning with “blue economy” or “blue growth” agendas as a form of legitimacy while lacking real ecological or social accountability,

especially in emerging sectors like marine biotechnology or ocean-based carbon capture.

Finally, market and consumer pressures complicate the adoption of ecosystem approaches. While consumer demand for sustainable products is growing, there is often an expectation for quick results. Implementing an ecosystem-based approach requires long-term investments and gradual improvements, which can conflict with the immediate expectations of consumers or investors. The pressure to meet consumer expectations quickly can lead some companies to engage in greenwashing, making exaggerated or false claims about their sustainability efforts (Economist Impact, 2022; The Conference Board, n.d.).

Note that these challenges are not uncoupled. A lack of collaboration and stakeholder engagement can limit the understanding of the complexity of ecosystems by not capitalising on the knowledge that resides in other organisations and local communities. Conversely, sufficient stakeholder integration can help in setting priorities and balancing short and long-term targets and impacts. It is important that these challenges are tackled coherently and that their environmental impact is mitigated, facilitating a responsible approach to ecosystem management. Standardised protocols for ES assessments can ensure consistent implementation, measurement, and reporting, helping industries to integrate EA in measurable ways. Note, however, that such protocols should also be adaptable to improved data and new insights.

2.1.3 State of play of EA implementation in business

A key concept within EA is **adaptive management**, a systematic, iterative approach to decision-making and resource management under conditions of uncertainty. While there are several variations on the different steps in a management cycle (see Figure 4 for an examples), it generally involves setting clear objectives and measurable performance indicators, implementing management actions based on current knowledge, continuous monitoring and evaluation of outcomes, and adjusting strategies and actions based on new information and lessons learned (NSW Department of Planning, Industry and Environment., n.d.). Adaptive management is particularly useful in complex or uncertain environments, allowing for ongoing refinement of strategies without requiring complete information at the outset, making it a highly suitable strategy to address ecosystem impacts (UN-REDD Programme, n.d.).

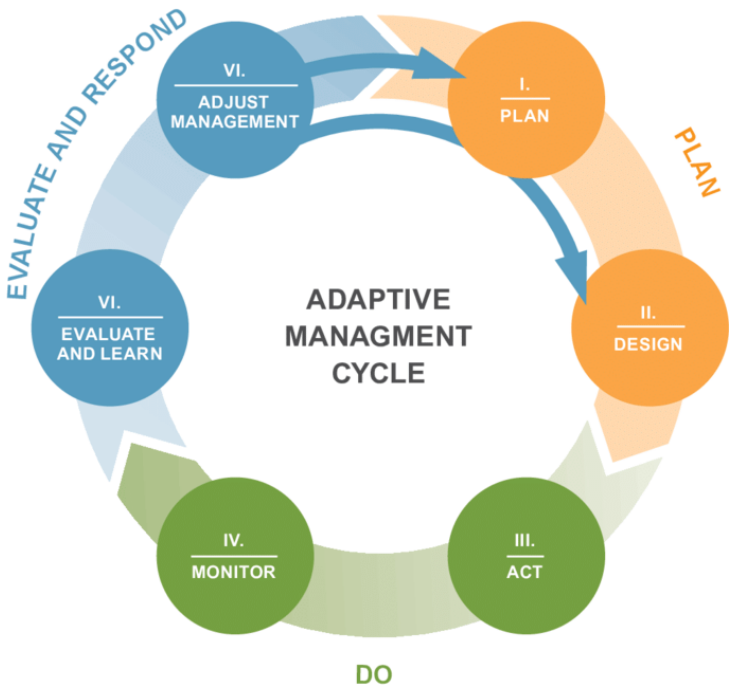

Figure 4. Example of an adaptive management cycle (CMS, 2014).

While adaptive management is already applied in the public sector in conservation initiatives and projects (Conservation Measures Partnership, 2020; Delta Stewardship Council, 2021), its implementation in business remains very limited.

A similar situation is present when assessing ES trade-offs and cumulative impacts. Many sustainability approaches and initiatives still focus on single issues, such as reducing carbon footprints or improving water efficiency, without considering how these efforts might affect other ES. Additionally, cumulative impacts might be overlooked when other industries operating in shared environments are not assessed. This lack of integrated impact assessment can be explained by the limited awareness of concepts like ES, considerable data and resource requirements for such assessments, difficulties in setting up stakeholder coordination and collaboration with other sectors, etc. (Deiser, 2020; Galparsoro et al., 2025). There are, however, methodologies and assessments already in place to simultaneously assess several impacts, e.g. ES assessments, life-cycle analyses (LCA), etc. ES assessments or reviews (ESR) are currently mostly applied by knowledge institutions. Examples include an ESR study of salmon aquaculture in Chile (Gallegos et al., 2016) and an ES assessment of the Prins Hendrik Zanddijk in the Netherlands (van der Wal, 2019). LCAs, however, are more prevalent in business, but usually have a different scope. Where ESR and ES assessments can give insights into the level of an organisation, LCA focuses on a specific product, process, or service. Additionally, LCA only assesses emissions to the environment, whereas ES assessments also address social and cultural aspects.

Assessing cumulative impacts is more difficult given that there are still several knowledge gaps related to cumulative impacts and the need for collaboration with other companies or organisations. There are, however, examples of how they can be addressed. An Australian study discusses several business strategies for addressing cumulative impacts and gives the example of how several mining companies are collaborating to reduce impact on water quality and manage water salinity in the Hunter Valley and Fitzroy Basin (Franks et al., 2009). An international study discusses how city-company collaborations can help in addressing cumulative impacts and provides an example of addressing cumulative impacts related to carbon emissions and water consumption.

Section 2.2 gives some examples of tools and initiatives that can help implement an ecosystem approach by establishing adaptive management, addressing trade-offs, etc.

2.1.4 Ecosystem Approach and credit systems

While the Ecosystem Approach and credit systems are both strategies aimed at improving environmental outcomes and sustainable resource management, there are important differences between the two strategies. When a company participates in a credit system, it does not automatically implement an EA. Where EA consists of a flexible and holistic strategy, credit systems focus on individual environmental aspects with specific measurable units (e.g. carbon or nutrient emissions), are more structured and standardised and less adaptable to changing environments and are market-based rather than system-based.

If companies want to use credit systems within a wider EA, they should be aware of the following risks and challenges:

- Credit systems may reduce complex ecological processes to simplified metrics, potentially overlooking important ecosystem functions and trade-offs (Squires et al. 2021). For instance, afforestation projects that focus on carbon sequestration but use non-native monocultures can harm biodiversity and water cycles.
- Corporate-controlled credit systems can lead to the displacement of local communities and limited access to natural resources for local communities. Additionally, there is the risk that benefits from credit systems are not equitably distributed among stakeholders. This does not align with the inclusive governance aspect of EA.
- Credit systems are vulnerable to market imperfections, potentially leading to unintended consequences (Federal Highway Administration, n.d.).
- Credit systems often allow for impact offsetting or compensation by companies. If this is not preceded by impact reduction measures, companies are at risk of greenwashing.
- Credit systems focus on short-term action and benefits and often lack long-term monitoring, raising concerns about whether the benefits they promise are sustained over time.

Despite these challenges, well-designed credit systems can be valuable assets for implementing an EA. They provide a means to quantify certain ecosystem services impacts, making these impacts more tangible for decision-makers; they offer a formal, transparent way to account for environmental impacts and benefits, and can encourage the development of new conservation and mitigation strategies (Squires et al. 2021). Additionally, they can drive investments in ecosystem conservation and restoration by providing financial incentives and encouraging cross-sectoral collaboration (Federal Highway Administration, n.d.). For example, blue carbon credits for seagrass and mangrove restoration can engage coastal communities, fisheries, and tourism sectors to ensure sustainable management.

2.2 Available tools and Frameworks

To support companies in the blue bioeconomy in implementing an ecosystem approach, several tools and frameworks are available that can help assess, manage, and communicate ecosystem service dependencies and impacts, as well as broader sustainability performance. The next sections discuss several of these tools and frameworks and indicate whether blue bioeconomy companies can directly apply them or have to rely on external consultants or university guidance.

2.2.1 ES assessment tools

MESAT

MESAT is a qualitative and semi-quantitative tool that evaluates the impact of marine projects on 9 different ecosystem services according to different international sustainability frameworks (SDGs, EU Taxonomy). MESAT links sustainability (through internationally used sustainability frameworks) and the relevant ecosystem services in the blue economy. MESAT is a living tool, i.e. there will be periodic updates so that MESAT always follows the latest legislation and sustainability principles. (https://emelia.be/advies-studies/duurzaamheid/mesat/).

NESEV

This cloud-based platform is designed to conceptualise and assess ecosystems as multi-layered networks depicting all their dimensions: natural, social, and economic. The model exhibits properties of self-organisation and scalability, similar to natural ecosystems. In this broad framework, all participants, actors, or organisms can engage in reciprocal interactions (services) (https://haedes.eu/tools/).

SUMES

The SUMES project developed a comprehensive environmental sustainability assessment methodology to quantify both the positive (handprint) and negative (footprint) impacts of blue economy activities across different geographical scales. This approach integrates Life Cycle Assessment (LCA) and Ecosystem Services assessment (ESA) to provide a holistic evaluation (https://sumesproject.be/en).

Sustainability Compass framework

The Sustainability Compass is a framework that promotes transdisciplinary social learning for sustainability, aiming to bridge the gaps between science, policy, and society in the pursuit of the SDGs. It uses multidimensional indicators to assess the social, economic, and environmental impacts of different sectors, focusing on human well-being within ecosystem limits. By fostering participatory, evidence-based decision-making, the Compass encourages stakeholders to engage in shared learning processes, ensuring more effective and integrated approaches to sustainability.

Blue Bio Sites

The Blue Bio Sites portal hosts multiple tools to support the sustainability of aquaculture and marine spatial planning. Among these, the Operational Decision Support System (ODSS) is a web-based platform designed to assist in the planning and implementation of low-trophic aquaculture activities, such as mussel and seaweed farming, particularly in the Baltic Sea region. By integrating environmental data, spatial analyses, and predictive models, the ODSS enables users, including spatial planners, policymakers, and aquaculture practitioners, to make informed decisions about site selection and management for sustainable aquaculture development (https://gis.sea.ee/bluebiosites/).

Toolkit for Ecosystem Service Site-based Assessments (TESSA)

TESSA offers a guided, step-by-step method to assess the value of ecosystem services at specific sites, such as aquaculture farms or marine installations. TESSA is qualitative and semi-quantitative, requiring minimal technical knowledge and no specialised software. This makes it ideal for small and medium-sized blue bio companies and cooperatives looking to evaluate services like water filtration or coastal protection without heavy reliance on consultants. However, companies aiming to use it for certification or funding purposes may still benefit from validation by sustainability advisors (https://www.birdlife.org/tessa-tools/).

Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST)

InVEST, developed by the Natural Capital Project, is a well-established modelling suite with some marine-specific modules. It includes modules specifically adapted to marine settings, such as the Marine InVEST models, and enables users to simulate and map changes in ecosystem service provision under different scenarios – such as comparing seaweed farm layouts or estimating nitrogen removal by shellfish beds. While InVEST is freely available, it requires GIS skills and ecological data inputs, meaning blue bio companies typically apply it through consultancy support or research partnerships. The investment in expertise is often justified for larger firms or clusters involved in coastal zone planning or impact monitoring. (https://naturalcapitalproject.stanford.edu/software/invest)

Artificial Intelligence for Ecosystem Services (ARIES)

ARIES offers a more automated, AI-driven modelling approach. It dynamically selects and connects models and datasets depending on user queries and location. While it reduces the modelling burden, it still demands a working understanding of ecological processes and benefits most from interpretation by academic or consulting partners. For companies involved in landscape- or seascape-scale planning, such as marine ingredient suppliers or multi-site aquaculture developers, ARIES can provide rich insights into ecosystem flows and cumulative impacts when applied in collaboration with experts (https://aries.integratedmodelling.org/).

EA Ladder

The Ecosystem Approach (EA) Ladder is a framework that encourages blue economy companies to engage in an EA by assessing their level of commitment to improving their impacts on ecosystems and the services these ecosystems deliver, based on continuous improvement. The ladder consists of four levels, with increasing requirements on insights into ecosystem impacts, setting targets, installing measures to improve impacts, and transparency. For each level, three dimensions are evaluated: insight, commitment and communication. As a company moves up the ladder, assessments and commitments move from qualitative to quantitative, and the targets to be achieved, as well as communication and collaboration, need to be intensified. Additionally, the focus shifts from one's own operations to the value chain. See also section 3 for a more detailed description. (https://www.mantisconsulting.be/diensten/blauwe-economie)

2.2.2 Other frameworks and initiatives

Science-Based Targets for Nature (SBTN)

SBTN is a framework under development that guides companies in setting measurable targets to reduce their natural impacts. While full marine sector guidance is still emerging, the structure is highly relevant to blue bio companies that aim to align with science-driven environmental commitments. Applying SBTN currently requires significant data and methodological input and is generally pursued in collaboration with expert groups, such as NGOs, academic partners, or sustainability certifiers (https://sciencebasedtargetsnetwork.org/).

Seafood Measurement and Accountability for Performance (MAP)

Seafood MAP, developed by the Global Sustainable Seafood Initiative, is specifically designed for seafood-producing companies. It provides a self-assessment platform and sustainability benchmarking tool that includes environmental impact areas relevant to ecosystem services. It is relatively user-friendly and structured for businesses, making it accessible to companies without advanced modelling skills. It

can also help companies move toward ESG or certification alignment while tracking progress toward biodiversity and ecosystem goals. (https://seafoodmap.org/)

EcoVadis

EcoVadis is a global sustainability rating platform that evaluates companies based on their environmental, social, and governance (ESG) performance. For blue bioeconomy companies, EcoVadis is particularly relevant for assessing and improving the overall sustainability of operations. It includes criteria such as environmental management, supply chain sustainability, and business ethics, all of which intersect with ecosystem services, particularly when considering the impacts of marine resource extraction or aquaculture practices. Although EcoVadis does not specifically focus on ecosystem services, its broad ESG evaluation process can be useful for companies looking to gain third-party recognition for their sustainability efforts, especially in their supply chains (https://ecovadis.com/).

B Corp

B Corp certification is awarded to companies that meet rigorous standards of social and environmental performance, accountability, and transparency. This certification can be valuable for blue bio businesses if they want to signal their commitment to sustainable practices and ethical operations. The B Corp certification evaluates a company's entire impact on stakeholders, including ecosystems, though its focus is broader than just ecosystem services. However, businesses in the blue bio sector can use this framework to demonstrate their commitment to sustainable marine and aquatic resource management, which is often crucial for securing funding (https://www.bcorporation.net/en-us/certification/).

CDP (formerly known as the Carbon Disclosure Project)

CDP is a global environmental disclosure platform that allows companies to report on their environmental impacts, including climate change, water security, and deforestation. For Blue Bio companies, participating in CDP can help track and disclose their environmental impact, particularly in relation to water use, carbon sequestration, and the impacts of marine-based activities. While CDP does not focus directly on ecosystem services, it plays a key role in driving transparency and accountability around environmental performance. For companies in the blue bioeconomy, CDP participation could be part of their broader sustainability reporting efforts and help improve their relationship with stakeholders who are increasingly concerned with environmental impacts (https://www.ibm.com/think/topics/carbon-disclosure-project).

2.2.3 Blue Bio examples

During the project, several blue bio and non-blue bio companies were identified as having used specific EA or ESV tools/frameworks. BBC Deliverable 3.4 "*Infographics*

Showing Results of Ecosystem Approach Wheel Tool", contains the booklet "*Case Studies on the Ecosystem Approach in the Blue Bioeconomy*". This booklet shows 10 case studies of companies within the blue bioeconomy applying the Ecosystem Approach or Ecosystem Services Valuation tools and how their EA efforts were translated into an internal decision or to gain benefits from external parties. A comparative assessment outlining the main specificities and trade-offs of the various EA tools is also included in the booklet. This should guide potential users in selecting the most appropriate approach for their context. Table 3 lists the companies and the tools they used in the various case studies.

Table 3. Overview of case studies showcased in BBC Deliverable 3.4 Infographics Showing Results of Ecosystem Approach Wheel Tool

Showcase study	Region	Framework/Tool used	Partners Involved
Offshore wind farm with mussel farm	Belgium	SUMES	Parkwind SUMES
Bivalves culture	Portugal	NESEV	Oceano Fresco Haedes
IMTA in Estonia	Estonia	BlueBioSites	Red Storm Aqua Verde
Bio-stabilisation through musselculture	Belgium	MESAT	Coastbusters Emelia Mantis Consulting
Oyster restoration in offshore wind park	Netherlands	Impact Platform	Go Ocean Orsted Van Oord
Nature-based wastewater treatment	France	EA Ladder	ZENI Mantis Consulting
Lobster ranching in Windmiil parks	UK	NSC	RWE Whitbey Lobster
Offshore musselculture	Belgium	MESAT	Colruyt Group Emelia Mantis Consulting
Mangrove restoration for seafood value	Ecuador	EA ladder	Jan de Nul Mantis Consulting
Oyster Reef	Belgium	Oyster Reef Digital Twin	Oyster Heaven

3. The Ecosystem Approach Ladder

3.1 From EA Wheel to EA Ladder

To support Blue Bioeconomy companies in adopting an EA, BlueBioClusters consider in its proposal phase using the EA Wheel to introduce the implementation of EA for Blue Bioeconomy. The white paper of the EA wheel was also a starting point for three Flemish projects (SUMES, MEsP, and WABESCO), each led by different consortia of academic and industrial partners, developing their own EA-based tools and frameworks for the emerging blue growth sectors.

Within BlueBioClusters, the goal was to adapt the EA Wheel specifically for the Blue Bioeconomy. At the project's kick-off meeting, the first exchange on Ecosystem Services Valorisation (ESV) took place, followed by a workshop during the second partner meeting in Porto. Partners received a presentation on the EA Wheel application process and participated in a try-out session, which also served as a guideline for engaging regional stakeholders in the project partners' regions with the EA Wheel concept.

Figure 5 :EA workshop at partner meeting in Porto

Feedback from these regional workshops and stakeholder interactions revealed that, while conceptually strong, the EA Wheel was too complex for practical application in the blue bioeconomy. In fact, SMEs and startups found it challenging to adopt such a detailed tool while focusing on core business priorities, especially without any formal requirement or incentive to use it. Many stakeholders also lacked familiarity with ecosystem service concepts, making the tool difficult to understand and apply. In some regions, the absence of policy linkage or industry mandates further reduced understanding and interest in the tool, with participants needing simpler alternatives for initiating ecosystem-based discussions.

Similar challenges emerged in interactions outside the BlueBioClusters regions, such as at the 1st Mission Arena (November 2023), where the EA Wheel was presented during the workshop "Co-creating the Blue Bioeconomy in Regions through Valorisation." Discussions during the workshop confirmed the complexity of valorising ecosystem services. Further, findings from two deliverables in the first project period

highlighted key barriers to ecosystem valorisation, including the need for expanded monitoring efforts, more tailored data for different end-users, and the fact that although many Blue Bioeconomy actors were aware of ecosystem services, few had developed valuation strategies or methods. When combined with additional stakeholder feedback from various interactions, these findings raised the question of whether the EA Wheel could be effectively implemented in practice.

On 01/02/2024, at the start of the BBC second project period, the "*Blue Session on Ecosystem Approach*" was held in Belgium, bringing together stakeholders from across the Blue Economy. The session presented progress on EA-related projects in Flanders (EA Wheel for BlueBio, SUMES, MEsP, and WABESCO) and included interactive discussions on their respective approaches. Their tools had evolved significantly, while the BlueBioClusters team faced difficulties further developing and implementing the EA Wheel. The EA tools, where academic partners were involved, such as SUMES, had stronger expertise in modelling and quantitative assessment, enabling faster methodological development. Consultancy-led initiatives, by contrast, often operated with larger and more flexible budgets, allowing them to dedicate more effort to communication design, user experience, and company engagement. These consultancies were also more successful in attracting larger industry partners to share data and participate actively. Together, these factors made it more challenging for the EA Wheel to achieve the same level of practical testing and co-development as some of the other EA or ESV tools.

Feedback from Belgian and other regional stakeholders confirmed that the entry and processing steps in the EA Wheel were too complex. The EA Wheel functioned mainly as a snapshot assessment rather than supporting continuous improvement, and its multi-dimensional visualisation proved difficult to operationalise. Therefore, to stay aligned with the project's objectives—showing real cases of EA uptake in the blue bioeconomy, DBC, in agreement with the Consortium decided to shift toward another framework for ecosystem assessment: the EA Ladder.

The EA Ladder, inspired by the EA Wheel, offers a simpler and more accessible structure with clearer progress steps. Like the EA Wheel, the EA Ladder helps organisations assess their relationship with nature by evaluating their impacts and dependencies on ecosystem services, identifying which services are most material to their operations, and determining their current level of performance in applying ecosystem-based practices.

At the 4th BBC partner meeting (23/04/2024), a workshop introduced the EA Ladder and applied the GPS-brainstorm kit, using roleplay with different Blue Bio stakeholder roles, to identify actions that could facilitate EA Ladder implementation in both policy and business contexts. These discussions provided input for developing a Policy Process Concept for EA implementation and for adapting the EA Ladder to blue bio companies. The workshop also explored how SMEs could move forward with the approach, leading to a more tailored procedure for the EA Ladder application

described later in this deliverable. A key principle was ensuring a low threshold for engagement with EA, allowing companies to gradually increase their commitment through continuous improvement.

At the World Aquaculture Society Congress "*Aqua 2024" (Copenhagen,* 27-30/08/2024), BlueBioClusters presented a poster on how the EA can stimulate sustainable Blue Bio production, leading to further discussion on opportunities and challenges. To better understand the policy landscape, a European-wide survey was conducted among policymakers to assess how EA principles are reflected in their strategies and how businesses could be more actively involved. Results from this survey, combined with workshop outcomes and stakeholder interactions, shaped the Policy Process Concept—an iterative framework guiding policymakers on how to integrate EA principles while providing incentives for companies (Deliverable 6.5). The concept was further discussed during a webinar, with registrations from 12 European countries, focusing on how policymakers and businesses can collaborate to make the EA operational. In Flanders, the Flemish Aquaculture Symposium 2024 (Ostend, 12/12/2024) provided another platform to present how the EA can help companies embed ecosystem services into their business models, generating synergies between ecological and economic value. To reach a broader audience, online EA awareness tools were launched via the BlueBioClusters website and the BlueBioMatch platform, allowing companies and policymakers to self-assess their EA readiness and access a list of available EA and ESV tools. These resources were complemented by a booklet of infographics and case examples illustrating how companies apply EA tools and framework in practice.

Outreach was carried out among various Blue Bioeconomy companies—both directly by the Blue Cluster and through the BlueBioClusters project partners—to identify which Ecosystem Approach (EA) or Ecosystem Services (ES) valorisation tools they currently use and to explore their interest in testing the EA Ladder. Most companies indicated that applying any EA tool was too time-consuming relative to the immediate benefits it could deliver. This perception also applied to the EA Ladder and was earlier in the project also noticed in our workshops on the EA Wheel.

However, companies recognised that the EA Ladder offers a more simplified and structured process, helping them understand where they stand, what steps to take next, and how to gradually improve their ecosystem performance. Its continuous improvement logic aligns better with business realities, allowing incremental progress rather than a one-off, resource-intensive exercise.

Still, despite this simplification compared to the EA Wheel, many firms—especially SMEs—saw limited short-term value and preferred to allocate their time and resources to activities with clearer business returns, such as product development, certification, or functional claims. While they acknowledged the long-term potential of the EA Ladder, its practical uptake remains limited until more tangible incentives or market advantages emerge.

Nevertheless, the EA Ladder was piloted through a real case study with ZENI, a French company using nature-based solutions for industrial wastewater treatment. ZENI applied the first exploratory level of the Ladder to strengthen its ecosystem-oriented strategy and demonstrate measurable contributions to nature. This case serves as proof of concept for how Blue Bio SME can use the Ladder to monitor progress and communicate sustainability performance.

3.2 General Concept

The Ecosystem Approach Ladder, a concept from Mantis Consulting, draws inspiration from two other frameworks and concepts: the CO_2 performance ladder (SKAO, n.d.) and the EA Wheel (Blue Cluster, 2021). The former is a CO_2 management system for assessing commitment to and progress towards CO_2 emission reduction, while the latter serves as a sustainability instrument and growth framework for the blue economy companies to improve and showcase their performance regarding EA. The EA Ladder utilises essential elements from both frameworks to arrive at a structured and stepwise approach for EA implementation in companies.

The ladder consists of four levels, with increasing requirements on insights into ecosystem impacts, setting targets, implementing measures to improve impacts, and transparency. While the first two levels focus on the companies' own impact, the last two levels extend the scope to influencing their value chain and sector. For each level, three dimensions are evaluated: insight, commitment, and communication. The general goals of the different levels and dimensions are discussed further below. Figure 6 provides a schematic overview of the Ladder concept.

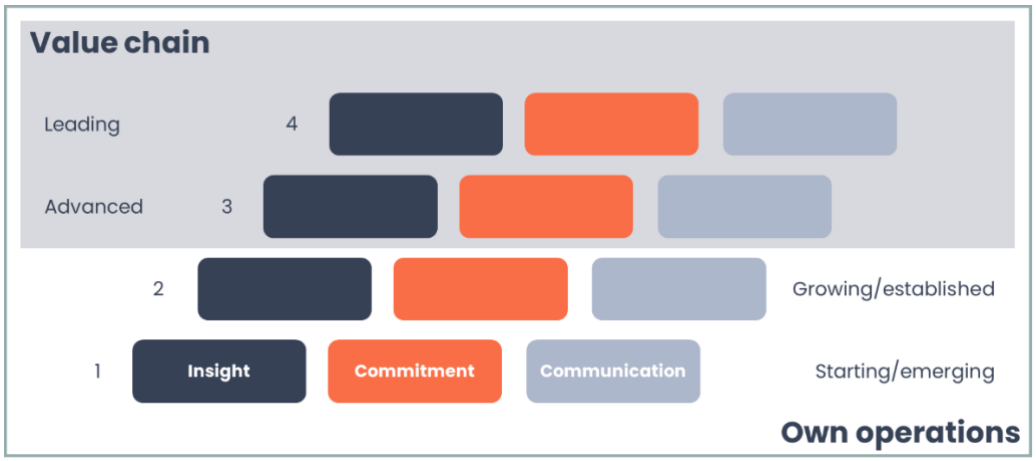

Figure 6. Overview of the EA Ladder concept.

The ladder is based on the following underlying principles:

- The Ladder is independent of specific ES assessment tools or impact quantification methods. Companies can choose which assessment tool and method they use to obtain insights into their ES impact.
- The Ladder is based on the concept of continuous improvement. Companies are encouraged to keep improving their impacts. In this respect, each level on the ladder includes and builds further on underlying levels.
- The levels are dynamic, and the requirements to achieve a certain level can change over time based on new insights and knowledge on ES and ecosystem functioning.
- The Ladder seeks to build upon other sustainability frameworks and initiatives for mutual reinforcement. For example, companies setting targets through the Science Based Targets Network (SBTN) can automatically fulfil requirements on setting commitments, while requirements on communication can be coupled to reporting and disclosure directives and frameworks for companies.

Dimensions and levels

The first dimension is the **insight** dimension. The goal of this dimension is for a company to gather knowledge on their ecosystem impacts and identify risks and opportunities based on this knowledge. This dimension requires companies to identify and assess their dependencies and impact on ES, and prioritise which ES measures should be installed. Additionally, a company needs to identify its area of influence and prioritise operational processes for improvement. Furthermore, companies should monitor their impacts and the effectiveness of installed measures to improve their impacts. The insight dimension is linked to the other dimensions as it provides information for target setting and collaboration, and leverages the content for communication.

After gathering insights, a company needs to make a **commitment**. This dimension has the goal of facilitating opportunities for companies to reduce their impact and strengthen their positive contribution to ecosystems. Additionally, it aims to establish effective collaboration with other companies and organisations to address cumulative impacts. This dimension requires companies to set both long-term ambitions and short-term targets to achieve these ambitions. Companies need to identify key performance indicators to measure their progress in achieving their goals and to create accountability. Additionally, they need to identify measures to improve their impact and assign responsibilities for effective implementation.

The final dimension entails **communication**. The goal of this dimension is to engage employees and stakeholders in a company's EA, to showcase the progress that a company is making to improve its impacts and to hold companies accountable for their impacts. Additionally, communication can be used to foster collaboration and knowledge sharing, both in-house and externally. This dimension requires companies to communicate their ecosystem impact, targets for improvement, and actions to

improve their impact. Companies also need to engage their stakeholders and participate in initiatives related to their prioritised ES.

Table 4 provides a summary of the requirements for the three dimensions for each level of the EA Ladder.

Continuous improvement

The EA Ladder, as a management framework, has the goal to facilitate continuous improvement. An organisation that aims to use the Ladder has to implement iterative processes to improve both their ES performance and their ES management system. Such processes generally follow a "Plan-Do-Check-Act" (PDCA) or "Deming" cycle (Figure 7). Continuous improvement is incorporated in the Ladder in two ways:

- By tightening criteria and requirements to achieve higher levels on the Ladder; and
- By specifically requiring verifiable improvements in biannual Ladder assessments to maintain a certain level on the Ladder.

Similar to other sustainability management frameworks and rating tools, achieving a level on the EA Ladder is valid for 2 years. When an organisation wants to **maintain a certain level** after this period, they will have to **fulfil the continuous improvement requirements of that level**.

An exception to this rule is the first level. Given the complexity of EA and ES impacts, this level mainly serves as an exploratory phase of EA. Organisations that have achieved level 1 and reapply for the EA Ladder are expected to aim for level 2.

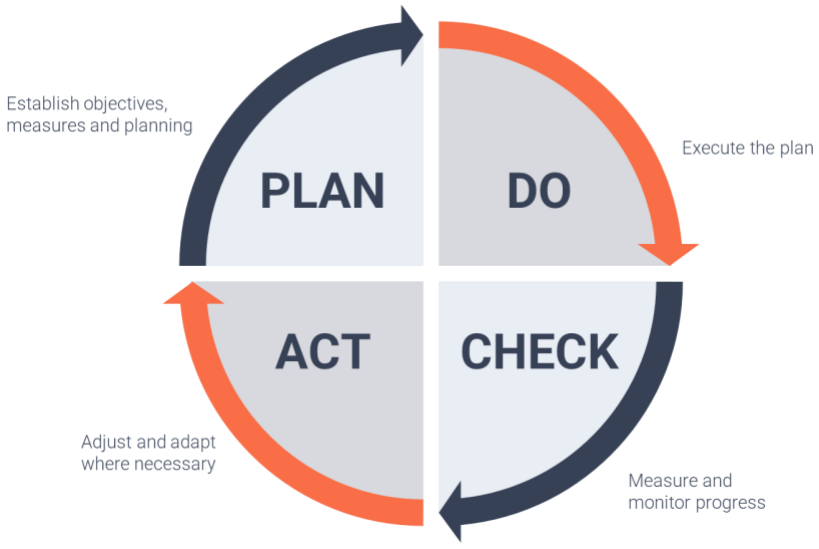

Figure 7. Plan-Do-Check-Act cycle. Adapted from SKAO (2020).

Table 4. Overview of the requirements for 'Insight', 'Commitment', and 'Communication' for each level on the EA Ladder.

	Insight	Commitment	Communication
Level 1: Emerging	Identify relevant ES; explore ES assessments; gather basic ES insights for one test project	Define long-term objectives; identify opportunities to mitigate and improve ES impacts	Communicate ES impact policy internally, including long-term objectives and opportunities for improvement; identify relevant stakeholders
Level 2: Established	Gather quantitative insights on ES impacts; assess ES impacts for a limited number of projects; set up a monitoring system	Define quantified objectives; define measures to improve ES impacts of own operations	Structurally communicate ES impacts, targets and measures for improvement; set up a steering cycle and assign responsibilities
Level 3: Advanced	Gather ES impacts in the value chain; assess ES impacts of all major projects; set up a quality management plan	Define targets to improve value chain ES impacts, including a plan of approach and identified measures; set up an impact management plan for own operations	Set up an internal and external communication plan with clear tasks, responsibilities and modes of communication; organise regular stakeholder dialogues, at least including government and/or NGO representatives
Level 4: Leading	Gather quantitative insights of ES impacts in the value chain; analyse opportunities to influence and identify strategies to reduce these impacts	Define clear, quantified and time-bound value chain targets; achieve objectives for improvement or demonstrate that the organisation is on track to timely achieve the targets	Structurally communicate value chain ES impacts, targets and measures for improvement

3.3 Initial guidance

This section dives deeper into the first two levels of the EA Ladder and provides stepwise guidance on how to achieve these levels. The plan of approach is further illustrated by using fictitious examples.

3.3.1 Plan of approach for achieving level 1

The plan of approach to achieve level 1 of the EA Ladder contains the following steps:

- Step 1: ES materiality
- Step 2a: ES assessment
- Step 2b: Commitment
- Step 3: Internal communication
- Step 4: Stakeholder identification

Figure 8 schematically represents the workflow for this plan. Note that while steps 2a and 2b can be addressed in parallel, there is room for interaction between them. While the ES assessment is not required to formulate a commitment, it can give additional insights into important services to address in the EA. Vice versa, the ES assessment can already target opportunities identified in the commitment step.

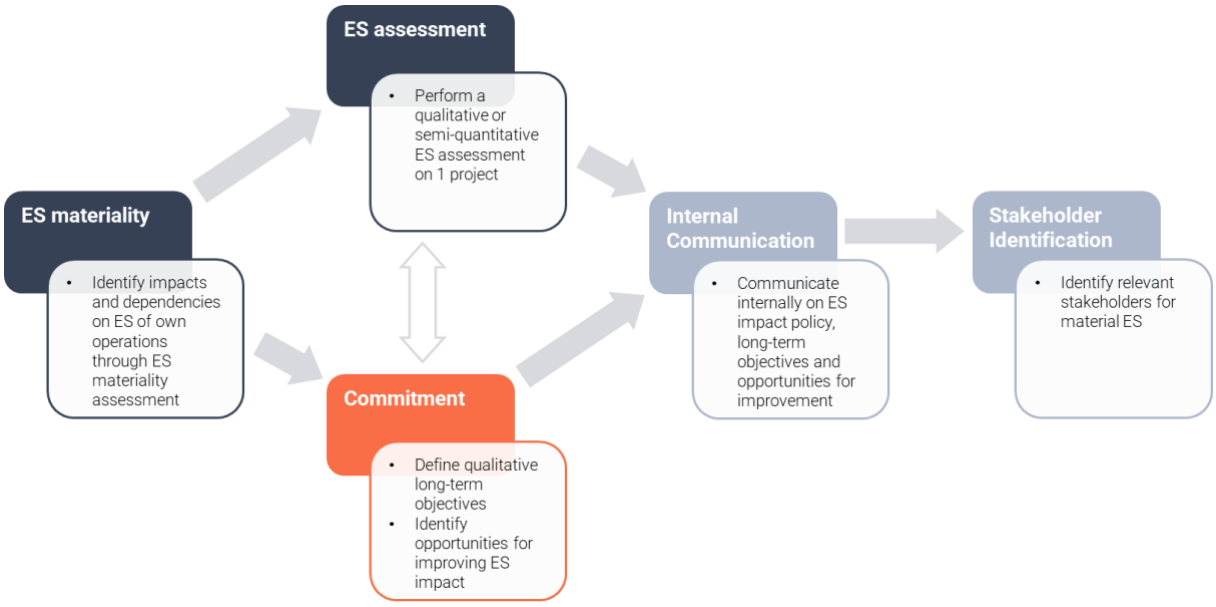

Figure 8. Schematic of the different steps to achieve level 1 of the EA Ladder.

Fictive Blue Bio example

To further explain the plan of approach for level 1, the following fictional example will be presented:

A new Portuguese fishery cooperative from the Setúbal region, Cooperativa Pesqueira SadoMar (CPS), wants to enrol on the Ladder at level 1 to reduce its impact on the ecosystems within its fishing territory and safeguard the ecosystem services that it depends on. The cooperative has a fleet of 8 vessels consisting of a mixture of smaller coastal boats (for day fishing) and larger vessels (for multi-day trips). The

cooperative targets the following species for food consumption: European hake (Merluccius merluccius), common sole (Solea solea), and Cuttlefish (Sepia officinalis). The vessels apply bottom trawling for hake and sole, and traps and pots for cuttlefish.

Step 1: Ecosystem services materiality

In this first step, a company identifies which ecosystem services can be related to its operations and prioritises those services on which its operations have the highest dependencies and impacts.

Firstly, a list of potential ES linked to the business operations is created. The Ladder does not require the use of a specific ES classification system. However, the longlist of ES used for this assessment should be based on an official classification system (e.g., CICES, Millenium Ecosystem Assessment, IPBES classification, etc.). The services listed in Table 1 are a good example of such a longlist.

In a classic materiality assessment, both the importance to business and to stakeholders are considered. In the EA Ladder, this stakeholder involvement is moved to the second level to limit the complexity of achieving the first level. The ES materiality assessment does, however, use the concept of double materiality, where both the **dependencies and impacts of business on ES** are included. Double materiality is a combination of financial materiality and impact materiality. Financial materiality reflects which sustainability topics can have financial impacts on business (dependencies), while impact materiality indicates how business affects the environment and society (impacts). A visual representation of double materiality is provided in Figure 9.

In the first level of the EA Ladder, the dependency and impact are qualitatively scored for each ES (e.g., low, medium, high, very high). When the dependency or impact is high for a specific ES, it is identified as 'material' and prioritised for setting targets and objectives and installing measures for improving impacts.

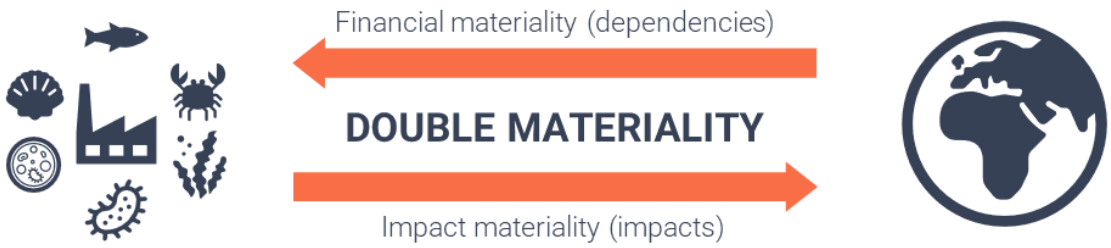

Figure 9. The concept of double materiality.

For the ES materiality assessment, CPS has identified the following ES on which their operations depend and/or have an impact on:

1. *Provisioning services:*
    - *food (wild fish stocks): The fishery cooperative depends on the abundance of healthy fish populations and influences the abundance and size of fish stocks through its operations.*
2. *Regulating services:*

- *Water quality regulation: Healthy marine ecosystems can filter pollutant and excessive nutrients out of the water which ensures that fish stocks are not affected by contaminants.*
- *Habitat maintenance: Healthy fish stocks need sufficient areas for spawning and juvenile growth, trawling and lost fishing gear can damage these habitats.*
- *Climate regulation: Fishing activities can disturb marine carbon sinks (e.g. seagrass beds, salt marshes and shelf sea sediments) and indirectly contribute to emissions. Additionally, fishing vessels contribute to climate change through carbon emissions.*
- *Maintenance of genetic diversity: A diverse gene pool ensures resilience to disease, climate change, and overfishing pressures.*

3. *Cultural services:*
   - *Cultural identity and heritage: The cooperative is part of a regional fishing tradition and depends on its reputation for economic viability.*
   - *Recreational fishing & ecotourism: Competition with or synergies between commercial and recreational fisheries may influence local economic activities.*
   - *Employment and coastal livelihoods: Fishing provides jobs & supports local economies and can provide stable employment in coastal communities when fish stocks are managed sustainably.*

The dependency and impact score, and resulting materiality are summarised in Table 5. The prioritised ES are food provisioning, water quality regulation, habitat maintenance, and cultural heritage.

Table 5. ES materiality of a fictive French fishery cooperative.

Ecosystem Service	***Dependency***	***Impact***		***Materiality***
Food (Wild fish stocks)	*High*	*Medium*	*0/-**	*High*
Water quality regulation	*High*	*Low*	*-*	*High*
Habitat maintenance (spawning grounds, reefs)	*High*	*High*	*-*	*High*
Climate regulation (carbon sequestration and emissions)	*Low*	*Medium*	*-*	*Medium*
Genetic diversity maintenance	*High*	*High*	*0/-**	*High*
Cultural heritage (fishing identity)	*High*	*Low*	*+*	*High*
Recreational fishing/ecotourism	*Low*	*Medium*	*+/-***	*Medium*
Employment and coastal livelihoods	*High*	*High*	*+*	*High*

**Depends on (sustainable) fishing practices. Fisheries can contribute to overfishing, but if seafood is sustainably managed, it does not necessarily inhibit the food provisioning service of marine ecosystems. CPS will have to perform a quantitative assessment to determine the impact. Similarly, for genetic diversity, depending on the health of the targeted species stocks, the impact can be detrimental or neutral.*

***This impact on ecotourism depends on CPS's public image. The impact on recreational fishing is negative if the same fishing ground and species are targeted.*

Step 2a: ES assessment of a test project

This step requires the organisation to perform a qualitative or semi-quantitative ES assessment on one project. ES assessments can be used to compare different alternatives for a project, identify the potential ES outcomes of new ideas, or assess the outcomes of a project that has already been completed. Qualitative assessments are based on information from scientific literature, expert opinions and/or stakeholder workshops, and do not apply any scoring or ranking system. In a semi-quantitative assessment, ES are ranked relative to each other or relative to other scenarios and technology options. In quantitative assessments, all relevant ES are quantified, where possible, using ecological models or economic valuation.

The organisation is free to choose the assessment type (qualitative versus semi-quantitative, scenario analysis versus assessment of completed project). In a qualitative assessment, the ecosystem services impacts and dependencies should be described as beneficial or detrimental; in a semi-quantitative assessment, this should be accompanied by a scoring system (e.g. 1 to 5 for highly detrimental to highly beneficial impacts or -/0/+ indicators). It is highly important that the outcomes are substantiated by available sources and that these sources are cited in the assessment. Where quantitative information is readily available (e.g. from previous monitoring campaigns or measurements), the organisation is free to use this information to substantiate the ES assessment results.

CPS wants to test new gear for hake fishing. They are looking to apply gillnets or demersal longlines instead of bottom trawling and will be performing a 3-month trial. Before the project is implemented, they perform a comparative semi-quantitative ES assessment to assess the potential ES benefits and/or disadvantages of the new gear alternatives.

<u>Baseline scenario (current practice):</u>

- ***Bottom trawling** is widely used but **has bycatch risks** (marine mammals, seabirds, non-target fish).*
- *Bottom trawls are dragged over the seabed, **disrupting benthic habitats.***
- ***Fuel consumption** is relatively high due to the higher engine capacity needed for trawling.*

<u>Alternative practices:</u>

- ***Demersal longlines** and **gillnets** are trialled to assess:*
    - ***Selectivity:** Does this gear reduce bycatch?*
    - ***Habitat impact:** Is seabed disturbance lower than with bottom trawling?*
    - ***Carbon footprint:** Does it use less fuel per kg of catch?*

While the focus lies on food provisioning, habitat maintenance, and carbon footprint, other ES are assessed as well. The results of the assessment are summarised in Table 6. This ES assessment already explores one of the opportunities identified in the commitment step (2b), i.e. using selective gear.

Table 6. Results of a comparative semi-quantitative ES assessment for alternative hake fishing gear.

Ecosystem Service	***Bottom trawling (baseline)***	***Gillnets (alternative 1)***	***Impact vs. baseline***	***Longlines (alternative 2)***	***Impact vs. baseline***
Food (Wild fish stocks)	*High fish yield but risk of stock depletion by overfishing*	*More selective, bycatch risk of undersized fish*	+	*Highly selective, minimizing stock depletion*	+
Habitat maintenance (spawning grounds, reefs)	*High damage to benthic habitats*	*No seafloor contact, no habitat impact*	++	*Light seafloor contact but minimal impact, as longlines rest lightly on seabed*	+
Water quality regulation	*Increases turbidity by disturbing sediments*	*No sediment disturbance*	++	*No sediment disturbance*	++
Climate regulation (carbon sequestration and emissions)	*High fuel consumption, increasing CO_2 emissions, risk of disturbing seabed carbon sinks*	*Lower fuel use, likely more fuel-intensive than longlines due to net retrieval & soaking time*	+	*Lower fuel use expected due to targeted effort*	+/++
Genetic diversity maintenance	*High bycatch risk*	*High bycatch risk; Lost nets continue to trap marine life (ghost fishing)*	+	*Reduced bycatch expected; No or less ghost fishing expected*	++
Economic & cultural sustainability	*Supports trawler crews but requires high fuel costs*	*Lower crew demand, but improved profitability due to selectivity*	*0*	*Labor-intensive but stable employment opportunities*	*0*

Data Sources for Semi-Quantitative ES Assessment:

1. ***Catch & Bycatch Data*** *(ICES reports, observer logs, cooperative records): Comparison of species composition (target vs. bycatch) in both methods.*
2. ***Fuel Use & Carbon Footprint*** *(Vessel logbooks, engine fuel rates): Comparison of fuel use per trip/kg catch for gillnets vs. longlines.*
3. ***Gear Loss Records*** *(Cooperative incident reports, fishermen feedback): Estimation of the probability of ghost fishing for each method.*
4. ***Existing Literature on Gear Impact*** *(ICES reports, gear trials in similar fisheries): Knowledge from prior studies on habitat disturbance from nets vs. hooks.*

Expected Outcome:

- *If the* ***longline method shows environmental benefits*** *(lower bycatch, reduced habitat impact, lower CO_2 emissions), CPS may consider gradually* ***scaling up*** *the practice.*
- *If the trial shows* ***unexpected challenges*** *(e.g., lower catch efficiency, operational difficulties), adjustments can be made.*

Step 2b: First commitment

When an organisation knows where its impacts and dependencies lie, it can start to define its long-term objectives. Since the first level of the EA Ladder does not require quantitative insights, the commitment of this level can take the form of a qualitative long-term objective or a pledge. It is important that this objective relates to the material ES as identified in the first step.

Additionally, the organisation has to identify opportunities to improve its impacts and safeguard its dependencies on material ES. It can be helpful to indicate whether the opportunity relates to impacts or dependencies.

Based on the materiality assessment, CPS has set the following long-term qualitative objective to improve its ES impacts:

" Cooperativa Pesqueira SadoMar commits to continuously improving its fishing practices to minimise negative environmental impacts while ensuring the long-term sustainability of fish stocks, marine habitats, and biodiversity in the Sado River and the connected marine ecosystems. We recognise our responsibility in maintaining a balance between economic viability and ecosystem health, and we strive to safeguard the natural services that support our fisheries and coastal communities. Therefore, we will improve our efforts to

- ***Ensure sustainable fish stock management*** *by avoiding overfishing and supporting scientific stock assessments.*

- ***Protect marine habitats and biodiversity,*** *by avoiding key nurseries and spawning areas, exploring alternative fishing techniques and minimizing bycatch.*
- ***Reduce our environmental footprint*** *by investigating fuel efficiency measures to reduce carbon emissions and promoting responsible waste management.*
- ***Strengthen positive socioeconomic contributions from fishing activities,*** *by balancing local fishing traditions with sustainable innovations, enhancing market access for sustainably caught seafood and engaging with stakeholders for responsible resource use."*

CPS's commitment already reflects the opportunities they have identified. Table 7 provides more details on these opportunities. The opportunity to use more selective gear has already been explored in the ES assessment (step 2a).

Table 7. Opportunities to improve CPS's impact and dependencies on their material ecosystem services.

Ecosystem Service/ impacts	***Opportunities***	***Type***
Food (Wild fish stocks)	*Explore ways to gradually transition towards **more selective gear** to reduce bycatch of non-target species.* *Consider strategies to **reduce fishing pressure** during critical periods (e.g., spawning season closures).*	*Mitigation,* *Safeguarding*
Habitat maintenance (spawning grounds, reefs)	*Improve **fishing zone planning** to avoid areas with sensitive habitats (e.g., spawning grounds, seagrass meadows).* *Explore **alternatives for bottom disturbing fishing techniques** to prevent destruction of valuable habitats.*	*Mitigation,* *safeguarding*
Climate regulation (carbon sequestration and emissions)	*Evaluate potential fuel efficiency measures (route optimization, alternative propulsion) to further reduce emissions.*	*Mitigation*
Genetic diversity maintenance	*Explore ways to gradually transition towards **more selective gear** to reduce bycatch of non-target species.*	*Mitigation, safeguarding*
Economic & Social Resilience	*Strengthen cooperative **collaboration with research institutes** and fisheries scientists to improve data-driven decision-making.*	*Enhancement*

Knowledge Sharing & Fisher Engagement	*Launch awareness initiatives within CPS to involve fishermen in ES-related discussions and best practices.*	*Enhancement*

Step 3: Internal communication

At this stage, the organisation communicates internally about its commitment to the EA. The main goal is to engage employees and ensure that the organisation's EA policy is understood and supported at all levels. Internal communication helps to create awareness of EA and engage employees by explaining why ecosystem services matter to the organisation. It creates a shared responsibility to improve the ES impacts and identifies employees as key actors in implementing measures.

The EA Ladder does not postulate specific communication methods as long as it is effective in reaching the employees. Different methods might be favourable depending on the size and structure of the organisation. Some examples include company meetings and workshops, internal newsletters or emails, infographics and posters, internal reports, etc. However, the communication should cover the EA policy, long-term objectives, envisioned opportunities for improvement and the results from the materiality assessment. If deemed relevant, the ES assessment results should also be communicated.

As the target audience might be diverse, it is important to use clear, simple language and avoid overly technical terms. Additionally, to ensure engagement, the content of the communication should be relevant to the context of employees and show how ES impacts relate to employees' daily work. Make sure to acknowledge contributions from teams or individuals working on the EA and create a space where employees can provide feedback and share concerns and ideas on the EA.

Now that CPS has set a long-term commitment and identified opportunities for ES improvement, the cooperative needs to internally communicate its EA policy. The goal is to engage fishermen, employees, and cooperative members by explaining why CPS is adopting an EA approach, what the long-term objective is, how CPS' activities impact ecosystem services (ES), and what opportunities exist to improve ES performance.

Due to the relatively small size of the organisation, CPS has identified the following communication methods:

- *A dedicated internal meeting and presentation with the cooperative members*
- *A brief internal document*
- *Ad hoc updates (e.g., in cooperative meetings, via digital channels) to notify employees of advancements in the EA*

The CPS EA team has set up and shared a form in which employees can give feedback, and they have allocated time for updates and feedback during upcoming cooperative meetings.

Step 4: Stakeholder identification

The final step in the first level of the EA framework is to identify key stakeholders who are relevant to the organisation ES impacts and dependencies. The purpose of this stakeholder identification is to understand what external expectations and concerns about ES impacts are, recognize who may be positively or negatively affected by the organisation's EA, and identify potential partnerships and collaboration for improving ES management.

Stakeholders can be grouped in four main categories:

- **Directly affected stakeholders**: employees, internal teams, and local communities.
- **Industry and business**: suppliers and service providers, customers and buyers, and industry associations.
- **Environmental and regulatory stakeholders**: governments, certification bodies and standard organisations, and NGOs or other environmental organisations.
- **Scientific and knowledge-based stakeholders**: research institutions, universities, consultants, and sustainability advisors.

When a list of potential stakeholders has been drafted, the organisation should assess which stakeholders can influence the organisation's decision making and which stakeholders are directly affected by the organisation's ES impact. In the following stage of the EA Ladder, these stakeholders will have to be well-informed about advancements in the organisation's EA.

In the final step to achieve the first level of the EA Ladder, CPS has identified the stakeholders that are relevant to its ES impacts and dependencies. They have summarised their stakeholder mapping in Table 8.

Table 8. CPS stakeholder mapping.

Stakeholder	***Group***	***Relevance to PBD's EA***	***Influence level***	***Impact exposure***
Fishery cooperative members (Fishers)	*Direct (Employees & Internal Teams)*	*They directly implement sustainable fishing practices and experience ES changes firsthand.*	*High*	*High*
Local fishing communities	*Direct (Local Communities)*	*Depend on healthy marine ecosystems for their livelihoods.*	*Medium*	*High*
Port authorities (Setúbal region)	*Industry & Business*	*Regulate port infrastructure and could influence waste management and sustainable practices.*	*Medium*	*Medium*

Seafood buyers & distributors (Docapesca, Frip, Luís Silvério & Filhos, …)	*Industry & Business*	*Influence demand for sustainably sourced seafood and impact market incentives.*	*Medium*	*Medium*
Certification bodies (MSC Portugal, Denominação de Origem Protegida)	*Regulatory (Certification & Standards)*	*Set sustainability criteria, providing credibility and market benefits for CPS.*	*High*	*Medium*
Government & Regulatory Authorities (DGRM, ICNF, APA, EU Common Fisheries Policy, …)	*Regulatory*	*Define legal requirements for sustainable fishing, quotas, and ES-related policies.*	*High*	*High*
Environmental NGOs (Sciaena, ANP/WWF Portugal, Ocean Alive)	*Environmental*	*Monitor fisheries' ES impact and could be partners in conservation initiatives.*	*Medium*	*High*
Marine researchers & universities (CCMAR, IPMA, MARE, …)	*Research & Knowledge*	*Provide data and methodologies to assess CPS' ES impact and improvement strategies.*	*Medium*	*Medium*
Local tourism sector (restaurants, seafood markets, eco-tourism operators)	*Industry & Business*	*Dependent on the perception of sustainable and high-quality seafood from CPS' fisheries.*	*Low*	*Medium*

3.4 Additional guidance for SMEs

Small and medium-sized enterprises (SMEs) form a vital part of the Blue Bioeconomy. However, they often face limitations in terms of time, capacity, and financial resources to conduct comprehensive sustainability assessments or implement extensive environmental management systems. For this reason, the EA Ladder offers a 'light version' tailored to the realities and constraints of SMEs, while still encouraging meaningful steps toward adopting an Ecosystem Approach (EA).

In this light version, the requirements across the different levels of the EA Ladder are deliberately reduced in complexity and intensity. For Level 1, the general design of the Ladder already minimises workload by focusing on qualitative assessments. The first step of this first level – conducting a materiality assessment of ES – remains essential for any organisation that wishes to participate in the Ladder. However, for all other assessments, particularly those required at higher levels, SMEs are only expected to consider the most material ES, meaning those where the company has a high dependency on or impact upon the service.

When it comes to disclosure and communication, SMEs are not held to the same standards as larger companies. They are only expected to communicate the essential elements of their EA engagement, and they have the flexibility to select communication channels that are appropriate and manageable within their context.

For example, in Level 1, internal communication can remain informal to avoid unnecessary administrative burden. Similarly, stakeholder engagement may be limited to those directly involved with the SME's operations or those who can support the SME's EA journey.

At the higher levels of the Ladder, large companies are expected to take on a more prominent 'ambassador' role – actively participating in or leading ecosystem-related initiatives. This expectation does not apply to SMEs. Any ambassadorial function for SMEs will be entirely voluntary and tailored to their capacity and available resources.

Throughout the EA Ladder, the pathway for SMEs remains flexible and adaptive. The purpose is not to meet all criteria at once but to adopt a mindset of gradual engagement with ecosystem services and sustainability. SMEs can progress at their own pace, guided by their individual circumstances, ambition, and available resources. The light version of the Ladder is designed to build confidence, visibility, and momentum, supporting SMEs in gradually expanding their positive contributions to ecosystems.

For SMEs with limited capacity or resources to independently engage with the EA Ladder, alternative options for participation are available. For instance, SMEs can join a cooperative that applies the EA Ladder collectively. In such arrangements, the administrative responsibilities are distributed across members, while each SME still contributes to and benefits from the cooperative's ecosystem-related efforts. Alternatively, SMEs can partner with larger companies to engage indirectly with the EA Ladder. This is especially valuable for SMEs offering products or services with clear ecosystem benefits. In such partnerships, the larger company can integrate the SME's solution into its EA implementation, while the SME benefits from financial returns and increased visibility.

4. Case study - ZENI

4.1 Description of ZENI technology

4.1.1 General Description

ZENI is a French company that specialises in cleaning industrial wastewater by applying natural processes through a nature-based solution. The technology is designed to address wastewater from the food processing industry and aquaculture, both of which typically contain high concentrations of nitrogen (N) and phosphorus (P).

Effluents from food processing and aquaculture contain high levels of N and P, which contribute to **eutrophication** when discharged into natural water bodies (e.g., lakes, rivers, and seas). Eutrophication leads to excessive algal blooms that consume available nutrients and create **environmental issues** such as oxygen depletion, fish mortality, and degraded water quality. Conventional nutrient treatment systems require **large spatial footprints**, which may not be feasible in all industrial settings.

ZENI mimics the process of eutrophication but in a **controlled environment and using "good" microalgae strains** (i.e. non-toxic strains of algae). A **microalgae-based photobioreactor (PBR)** is used to remove excess N and P from wastewater while occupying a **limited spatial footprint**. Additionally, ZENI contributes to a circular economy through a '**zero waste**' approach by allowing for both the reuse of treated water and the valorisation in various applications of the grown algal biomass.

4.1.2 Process description

Preliminary Treatment

ZENI's bioreactor functions as a modular component / tertiary process within a broader wastewater treatment system. The preliminary treatment, or 'first treatment', is a standard practice in wastewater treatment plants and is not part of ZENI's technology. It is, however, a necessary step before the water can be treated by the bioreactor. In this first treatment, suspended solids and large particles are removed from the wastewater. The resulting effluent still contains high nutrient loads, making it ideal for microalgae cultivation.

Microalgae-Based Photobioreactor

The core of ZENI's wastewater treatment technology is the **microalgae Photobioreactor (PBR)**, which facilitates the biological uptake of nutrients.

The bioreactor requires the input of (pre-treated) wastewater from the first treatment, CO_2 for pH regulation and as a carbon source for microalgae growth, and light energy for photosynthesis. Depending on the industrial setup for which the wastewater treatment system is required, CO_2 can be captured from the industrial process and fed to the bioreactor. Light energy is provided by an artificial lighting system using low-energy-consuming LEDs.

The effluent of the bioreactor consists of water with a highly reduced nutrient load and the grown algal biomass (below the regulatory constraint if they are rejected in the natural environment).

The main system components of the PBR include a bioreactor tank – designed for wastewater treatment at a capacity of 1 – 100 m^3/day, the lighting system, and a patented agitation anti-biofilm coating system used to prevent biofouling on the inside tank wall and to provide an even light distribution.

Separation & Reuse of Outputs

When the algal biomass is separated from the cleaned water, the biomass can be repurposed for:

- **Fertiliser** in agriculture (rich in essential nutrients),
- **Animal feed** (high protein content),
- **Methanation** for bioenergy production (note that this can lead to greenhouse gas emissions),
- **Bioplastics** as a sustainable raw material alternative, or
- Any other additional valuable valorisation depending on the clients' possible needs.

The cleaned water can be reused in the connected industrial process (food industry, aquaculture) **after sterilisation**.

4.2 Ecosystem services materiality

4.2.1 Ecosystem services

Ecosystem services (ES) are the services that ecosystems provide to humanity. They are a pivotal part of the Ecosystem Approach and provide a wide array of benefits to humans, essential for human survival, well-being, and economic activities. They are typically classified into four categories:

1. **Provisioning Services**: Tangible products derived from ecosystems, such as food, water, timber, and medicinal resources.
2. **Regulating Services**: Natural processes like climate regulation, water purification, and flood control that help sustain stable environmental conditions.
3. **Cultural Services**: Non-material benefits, including recreation, aesthetic inspiration, educational opportunities, and cultural heritage values.
4. **Supporting Services**: These are foundational processes, such as soil formation and nutrient cycling, that underpin the other services.

In the next section, the following services will be discussed:

- Provisioning services:
  - Food provisioning
  - (Clean) water provisioning
  - Energy provisioning
  - Raw abiotic materials

    - Biotic materials
- Regulating services:
    - Water quality regulation
    - Coastal protection
    - Climate regulation
    - Biological control
- Cultural services
    - Recreational activities
    - Eco-tourism
    - Aesthetic appreciation and inspiration for culture, art, and design
- Supporting services
    - Habitat protection and maintenance
    - Maintenance of genetic diversity
    - Sediment creation
    - Nutrient cycling
    - Oxygen production

4.2.2 Ecosystem services Materiality

In the next sections, the materiality of ES relevant to ZENI's technology is evaluated. For each ES, ZENI's dependency and potential impact on the service are qualitatively assessed. Dependency and impact are here defined by:

- Dependency: The extent to which the technology relies on a specific ecosystem service to function.
- Impact: How the technology inhibits or supports an ecosystem service, or provides an alternative that reduces dependency on ES for other processes. The impact on the service can be positive or negative.

The dependencies and impacts of ZENI's technology are always described relative to the scale of the system. When comparing results with other technologies, the system's scale should be accounted for by, for example, comparing results per treated m^3 of water.

Note that the impacts and mitigation measures (section **Error! Reference source not found.**) are mainly described in the context of the industrial sectors that are targeted by ZENI, i.e. the food (processing) industry and aquaculture. While most impacts are generally applicable to ZENI's technology, some impacts and mitigation measures might not apply when other sectors are targeted.

4.2.2.1 Provisioning services

Food provisioning

While the wastewater treatment system does not rely directly on food provisioning, it has a limited, indirect dependency, as it supports industries that strongly depend on food provisioning. The impact on food provisioning is negligible, except if the algal biomass is repurposed as fertiliser or animal feed.

Clean water provisioning

Like food provisioning, the treatment system does not depend directly on clean water. However, the wastewater that constitutes the main input of the system stems from an industrial process that strongly relies on the availability of clean water, making the dependency on water stronger than on food. The impact on water provisioning is high, as the treatment system provides a way to reuse water in industrial operations, reducing the need for additional freshwater input.

Energy provisioning

The system has some dependency on energy provisioning, as it requires artificial light energy for photosynthesis. However, this energy is not sourced directly from an ecosystem service but from external energy inputs. The impact on energy provisioning is negligible unless the algal biomass is repurposed as biofuel.

Raw abiotic materials

For construction of the bioreactor and other necessary components, raw abiotic material may have been used. During operation there is no need for additional raw materials. While the system's scale remains relatively small, it may still lead to a limited increase in demand for non-renewable resources.

Biotic materials

There is no direct dependency on biotic materials for the wastewater treatment system. It relies on controlled conditions to cultivate microalgae without needing external biological input. However, the impact is high, as the system produces algal biomass, which can be repurposed for various applications, such as fertilisers, animal feed, biofuels, or bioplastics.

4.2.2.2 Regulating services

Water Quality Regulation

The system strongly depends on water quality regulation, as it mimics and relies on natural purification processes. Given that removing excess nutrients from industrial wastewater is the main goal of ZENI's technology, the system's impact on water quality regulation is also high. By improving nutrient removal from wastewater, ZENI aids in preventing eutrophication and harmful algal blooms in riverine and coastal systems.

Coastal protection

No dependency or impact on coastal protection.

Climate regulation

The dependency on climate regulation is mainly caused by the requirement of CO_2 input for microalgal photosynthesis and temperature regulation for optimal algal growth. Since CO_2 can often be captured from the connected industrial process, this dependency is limited. Regarding the impact on climate regulation, there are

counteracting effects. Microalgae contribute to carbon sequestration through the process of photosynthesis. Additionally, the required CO_2 input can reduce the emissions of the connected industry. On the other hand, there are still energy requirements, mainly by the lighting system, that can lead to indirect carbon emissions. The system is expected to have a net positive effect on climate regulations. There is, however, a need for a quantitative analysis to verify this effect and determine its strength.

Biological Control

There is no direct dependency on biological control for the system. There is no significant impact expected since the inflowing wastewater comes from a highly regulated industry regarding biological security. There is some limited impact from the sterilisation process if water is to be reused, but this process is not part of the ZENI technology. The operational process may have some influence on microbial communities within the bioreactor, but given that this is a closed system, the impact is low, and there will be no significant effect on broader biological regulation processes.

4.2.2.3 Cultural services

Recreational Activities

The wastewater treatment system does not directly depend on recreational activities. Some limited impact is expected if the system is integrated into green infrastructure or eco-awareness initiatives that encourage outdoor activities.

Eco-Tourism

There is no direct dependency on eco-tourism for the system. The system could have an impact if the wastewater treatment plant can be visited as part of a larger tour to the industrial plant of the hosting industry, potentially raising awareness about sustainable technologies. Additionally, ZENI's technology can contribute to (eco)tourism by applying their solution in the tourism sector for wastewater treatment.

Aesthetic Appreciation and Inspiration for Culture, Art, and Design

The system does not rely on aesthetic services. However, it could have a limited impact, potentially serving as an example of sustainability and offering inspiration for art, design, or other cultural projects that focus on environmental innovation.

Educational values

ZENI's technology has no direct dependency on educational values. The system can have an impact on this service by providing opportunities for public awareness and education on sustainable solutions, circularity, and environmental engineering. The level of impact depends on how active the technology is integrated into educational programs or made accessible for demonstrations (e.g. through public exhibitions), guided visits, or collaboration with academia.

4.2.2.4 Supporting services

Habitat Protection and Maintenance

There is no direct dependency on habitat protection and maintenance for the system. The potential impact of the system is limited to influencing microbial habitats within the bioreactor, but it does not significantly alter natural habitats. Additionally, ZENI has some impact on protection of riverine and coastal habitats by reducing the pressure on other water treatment installations.

Maintenance of Genetic Diversity

There is no dependency on maintaining genetic diversity. However, there might be some limited impact if the operational process influences microbial diversity. Additionally, if the process leads to a monoculture of microalgae, there can be a limited reduction in genetic diversity in further applications of the biomass. On the other hand, ZENI contributes to reducing the risk of oxygen depletion by harmful algal blooms, potentially leading to a reduction in genetic diversity. All these impacts are, however, limited and mostly indirect.

Sediment Creation

There is no direct dependency on sediment creation. If algal biomass is applied to sediments, it could potentially contribute to organic enrichment, but the impact is limited.

Nutrient Cycling

The system has a high dependency on nutrient cycling, specifically nitrogen and phosphorus inputs, which are key nutrients for algae growth. The impact is also high, as the system significantly contributes to nutrient cycling by absorbing and removing excess nutrients, thus supporting the natural nutrient balance.

Oxygen Production

The system has no dependency on oxygen production, as it does not require external oxygen. However, it might have a limited impact, since algae generate oxygen through photosynthesis, which may enhance local oxygen levels in the vicinity of the system.

4.2.2.5 Summary of ES materiality

Table 9 summarises ZENI's dependencies and impacts on ecosystem services. Where the technology has a potential impact, it is indicated if this impact supports (+) or inhibits (-) the services. Based on the dependency and impact, each service's materiality is also indicated.

Table 9. Summary of the dependencies and impacts of ZENI's technology on ecosystem services.

Ecosystem service	Dependency	Impact		Materiality
Provisioning				
Food provisioning	Low	Medium*	+	Low/Medium
(Clean) water provisioning	Low	High	+	High
Energy provisioning	Low	Medium*	+	Low/Medium
Raw abiotic materials	Low/Medium	Low	-	Low/Medium
Biotic materials	Low	High	+	Medium/High
Regulating				
Water quality regulation	High	High	+	High
Coastal protection	/	/	0	/
Climate regulation	Low/Medium	Medium/High	-/+	Medium/High
Biological control	/	Low	-/+	Low
Cultural				
Recreational activities	/	Low	+	Low
(Eco)tourism	/	Low/Medium	+	Low/Medium
Aesthetic appreciation and inspiration for culture, art, and design	/	Low	+	Low
Educational values	/	Low/Medium	+	Low/Medium
Supporting				
Habitat protection and maintenance	/	Low	-/+	Low
Maintenance of genetic diversity	/	Low	-/+	Low
Sediment creation	/	Low*	0/+	Low
Nutrient cycling	High	High	+	High
Oxygen production	/	Low *	+	Low

4.2.2.6 Mitigating detrimental impacts

The above discussion does not include all potential detrimental impacts of wastewater treatment by applying microalgae cultivation, since these have been mitigated by the design and operational process of ZENI's technology. These mitigated impacts are summarised below.

See also the note at the start of section **Error! Reference source not found.**.

Table 10. Overview of mitigated potential detrimental ecosystem services impacts of wastewater treatment by applying microalgae cultivation.

Ecosystem service	Detrimental impact	Mitigation
Provisioning		
Food provisioning	Risk of contamination with heavy metals, pathogens, or residual pollutants when biomass is used in food or as feed.	ZENI targets specific sectors that have high nutrient concentrations in the waste water but no or very low risk for any other pollutants.
Raw abiotic materials	If the treatment systems relies on synthetic fertilizers or additives to optimize algal growth, it could increase the demand for non-renewable resources or require additional treatment steps before the water and/or biomass can be (re)used.	The technology is designed such that no other components need to be added to the bioreactor to allow for algal growth.
Regulating		
Water quality regulation	If not managed properly, algal blooms could occur, leading to oxygen depletion and water quality degradation in surrounding ecosystems.	The treatment system is part of a closed cycle reducing the risk for detrimental impacts on surrounding ecosystems. The bioreactor is designed such that algal biomass can be timely collected to prevent oxygen depletion within the tank.
Biological control	Changes in microbial communities could lead to unintended shits in wastewater ecosystem dynamics, potentially favouring bacteria.	This risk is not directly mitigated by ZENI, but by the requirement for a sterilization process before the cleaned water is reused.
Supporting		

Habitat protection and maintenance	If wastewater discharge still contains excess nutrients or toxins, it may negatively affect aquatic habitats downstream.	The closed wastewater treatment system reduces the risk for discharge into aquatic habitats before proper treatment. Risk for toxins is mitigated by targeting specific industries that generally have no harmful chemicals in their wastewater. ZENI has demonstrated that their technology is able to reduce nutrients below regulatory standards.
	Wastewater treatment plants can have a significant footprint. Potentially inhibiting the reach of valuable habitats.	ZENI uses a bioreactor tank with a limited spatial footprint.
Nutrient cycling	If nutrient removal efficiency is inconsistent, there could be unintended nutrient imbalances, affecting downstream ecosystems.	ZENI has demonstrated that their technology is able to reduce nutrients below regulatory standards. Additionally, ZENI ensures consistent efficiency through thoroughly testing whenever a new industry is targeted.
Oxygen production	In high-density algal cultures, oxygen production could be offset by excessive microbial respiration at night, leading to localized oxygen depletion.	ZENI applies a closed bioreactor tank with an artificial lighting system to ensure continues photosynthesis.

4.2.2.7 Conclusion materiality assessment

ZENI has no strong dependencies on ES besides nutrient cycling and water quality regulation, which serve as inspiration and provide the baseline for ZENI's technology. Most of ZENI's impacts on ES are positive, mainly attributed to the nature-based solutions they provide and the design and operational process that mitigates several detrimental impacts that can be related to nutrient removal from wastewater by facilitating microalgae growth. ZENI's most material impacts are clean water provisioning, water quality regulation, and nutrient cycling, followed by provisioning of biotic material and climate regulation. Materiality is spread among the provisioning, regulating and supporting categories. Cultural services are generally the least material for ZENI.

4.3 Next Steps

4.3.1. EA Ladder Level 1

With the ES materiality, discussed in the previous section, ZENI has completed the first step for Level 1 on the EA Ladder. To fully achieve the first level, ZENI still needs to:

- Perform a qualitative or semi-quantitative ES assessment of one of their projects
- Set qualitative long-term objectives, based on their material ES and identify opportunities to improve their ES impact
- Communicate internally on their EA, including material ES, objectives and opportunities
- Identify relevant stakeholders for their EA

For the ES assessment, some additional guidance is provided in the next section.

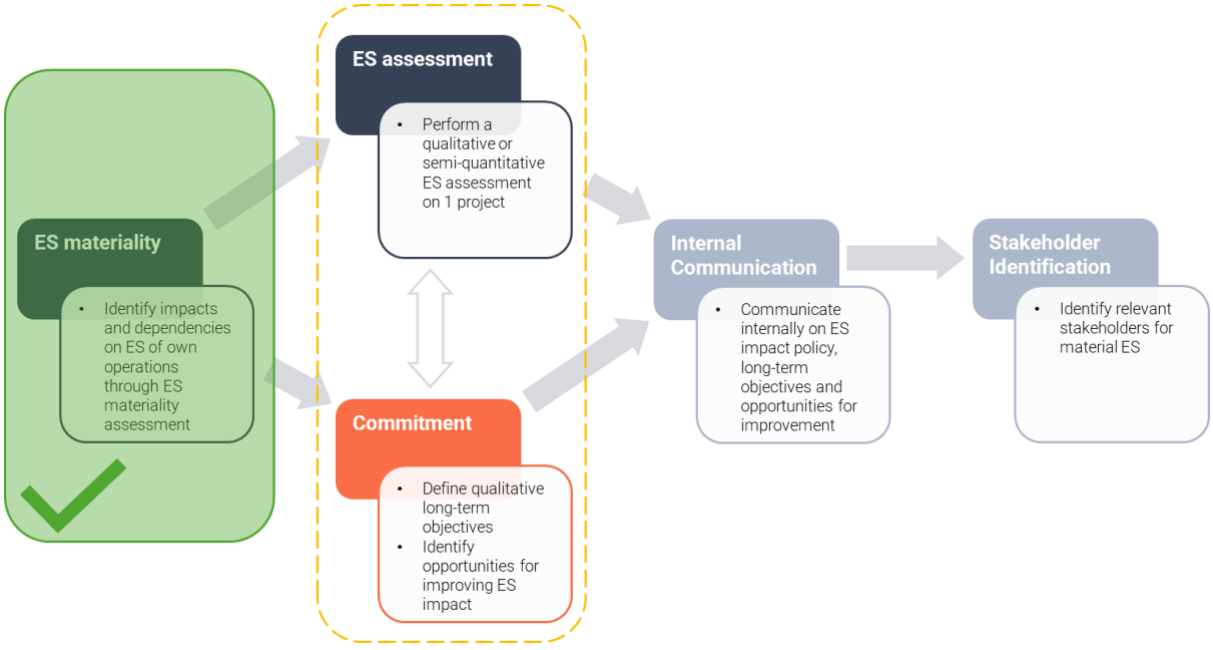

Figure 10. Schematic of the different steps for achieving Level 1 on the EA Ladder and the progress tracking of ZENI.

4.3.1.1 Ecosystem services assessment

A suitable project for the ES assessment would be to compare the ES impact of their own solutions with that of a standard nutrient treatment component of a larger wastewater treatment system. In such a comparative analysis, each material ES is scored based on the impact that the technologies have on the respective service. By comparing the results, ZENI can use this to showcase in their communication where its technology performs better than standard wastewater treatment solutions. An additional benefit of such an analysis is that it can indicate opportunities for further improvement for ZENI.

As ZENI is an SME, they are only required to include ES with high materiality in the ES assessment. They are, however, free to include any other ES in their analysis.

The discussion in the previous section already indicated certain services in which ZENI is performing better or is expected to perform better than standard wastewater treatment systems. We provide here some additional comparisons that can function as a baseline for a more in-depth ES assessment:

- The ZENI technology simplifies the treatment process as it replaces several treatment units of a standard wastewater system. Primary treatment is still required, but secondary treatment and biological nutrient removal are entirely replaced by the Zeni bioreactor when the right conditions are met.
- ZENI provides an alternative for P treatment systems that:
    - Are costly and energy-intensive (reverse osmosis),
    - Have a large spatial footprint (biological P removal by bacteria or microalgae in ponds), or
    - Use chemical precipitation that results in a sludge that requires further treatment (landfill, incineration, P retrieval),

  where the technology of ZENI results in a directly usable by-product.
- The technology of ZENI requires no artificial aeration, which is needed in treatment systems that rely on aerobic bacteria.

4.3.2. EA Ladder Level 2

A major step for achieving Level 2 is to obtain quantitative insights into the ES impact of the company. The most preferred option to obtain these insights is to perform a quantitative ES assessment. However, such an assessment is usually performed in view of land use and habitat changes, and results are often expressed in impact per area. Given that ZENI's technology will usually not lead to habitat changes, this approach is less favourable. A suitable alternative for ZENI would be to perform an LCA, especially since most of their material ES is related to LCA impact categories.

Since an LCA goes beyond its own operations, this assessment can already function as a good baseline for achieving higher levels on the EA Ladder.

5 Conclusions

The implementation of the Ecosystem Approach within the blue bioeconomy presents both a complex challenge and a promising opportunity. Despite the clear environmental and socio-economic benefits that EA can deliver—such as enhanced sustainability, stakeholder collaboration, and long-term ecosystem resilience—its adoption remains difficult for several reasons.

First, the inherent complexity of ecosystems, involving interconnected biological, chemical, and social dimensions, makes designing, monitoring, and managing EA initiatives challenging. Many companies still operate with a siloed mindset, lacking integrated management systems and access to comprehensive environmental data. This limits their ability to assess cumulative impacts or trade-offs between ecosystem services. Current sustainability efforts often focus narrowly on carbon accounting, neglecting broader biodiversity and ecosystem health goals. Market mechanisms and incentives to reward ecosystem-positive practices are still in their infancy, offering little immediate return on investment for nature-inclusive actions. These structural and institutional barriers are compounded by limited awareness and technical capacity, especially among small and medium-sized enterprises. There is also a clear lack of straightforward methodologies to assess impact, given the complexity of environmental, social, economic, and scientific domains and the challenges of developing evaluation methods and indicators.

Interactions with large companies confirm these barriers: despite general support for sustainability goals, few tangible incentives exist to invest in environmental assessment tools or initiatives that contribute to positive ecosystem impact. Monitoring and certification of ecosystem services are still perceived as not cost-efficient, and many companies feel that the current economic climate in Europe is not conducive to making such investments. As a result, most businesses focus on basic compliance rather than proactive engagement. On the policy side, interest in EA tools is growing, but the complexity of establishing a comprehensive EA framework often deters progress. Policymakers cite limited technical capacity and insufficient funding as major barriers. This mismatch—between companies needing incentives or mandates to adopt EA practices and the lack of policy structures to provide that guidance—slows down the rollout of the Ecosystem Approach and makes it difficult for EA tools under development to find practical applications.

These challenges also became evident during the BlueBioClusters project. While the EA Wheel provided a strong conceptual foundation, stakeholder feedback and project deliverables highlighted its complexity and limited usability, particularly for SMEs. The EA Wheel functioned mainly as a snapshot assessment rather than supporting continuous improvement, and its multi-dimensional visualisation proved difficult to operationalise. Consequently, the consortium decided to shift toward a simpler, more accessible framework: the EA Ladder. This tool offers a progressive model with self-assessment levels that allow companies to gradually increase their internal and

external commitments, while enabling policymakers to monitor progress and align incentives.

New frameworks and initiatives like the EA Ladder offer practical pathways for overcoming these challenges. They help companies build capacity, set actionable goals, and engage stakeholders effectively. Promising collaborations—such as integrated aquaculture in offshore wind farms and partnerships between fisheries and conservation groups—demonstrate how EA can unlock synergies between environmental protection and economic development. Nevertheless, challenges persist: many tools still lack clear use cases and pilot testing, and awareness among blue bioeconomy actors remains low. Implementing EA requires not only technical tools but also cultural and institutional shifts toward inclusive governance, cross-sector collaboration, and long-term thinking. Incentivising sustainable behaviour through credits, certifications, and policy support remains crucial. Continuous learning, stakeholder engagement, and refinement of assessment methodologies will be key to scaling the ecosystem approach across the blue bioeconomy.

Governments should take the lead by establishing clear policy frameworks that require companies to incorporate EA principles into their planning processes, while providing transitional support such as technical assistance, funding schemes, and flexible timelines to ensure these requirements do not threaten business viability. In sum, while the path to full EA integration is neither simple nor linear, the growing availability of tools, incentives, and collaborative models—combined with practical frameworks like the EA Ladder—offers a window of opportunity. If harnessed strategically, these developments can help transition the blue bioeconomy toward a more regenerative, resilient, and inclusive future.

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Annex 1 Poster presentation "Can blue bio production be stimulated by the use of ecosystem approach?" at the World Aquaculture Society Congress "Aqua 2024"

Jurgen Adriaen, Kristien Veys *(Blue Cluster)*
Suzi Billing *(SAMS)*
Liisi Lees *(UTartu)*

Can Blue bio production be stimulated by the use of Ecosystem Approach ?

Living aquatic resources deliver a wide variety of products and processes. These **ecosystem services** can be provided **directly or indirectly** by Blue bio economic activities and are essential for human survival and well-being, and they encompass a wide range of natural processes and functions for which it is of upmost importance to consider the entire ecosystem, including human impacts, rather than focusing on a single species or environmental issue. The ecosystem approach is **a strategy** for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way (CBD, 2000[1]). It recognizes the complex interrelationships within ecosystems and aims to maintain their health, productivity, and resilience. Within the BlueBioCluster project, the aim is to develop tools for supporting businesses in **integrating ecosystem services** into novel ecology-driven business models and induce cross-sector collaborations along the value chain. This should give Blue bio producers **more production area** (Multi-Use) as well as **a larger return** for their activity due to the ecosystem services they provide.

Blue bio production

- **-Direct monetisation of Blue bio products or their components**
- **-Indirect valorisation**
  - ***Tender criteria (multiuse,...)**
  - ***Social license (wellbeing,...)**
  - ***Compliance requirements**
  - ***....**

WORK FLOW

Workshops — Quick Scope Review — Survey — Data Collection

Blue Bio Value Chains

CURRENT STATUS

-Significant knowledge gaps in ecosystem services of certain Blue Bio value chains

-Tools exist to help valuing certain ecosystem services

-Opportunity for non-blue bio companies to engage with blue bio companies to positively impact ecosystem services by combining them in the primary activity of the non-blue bio company

(Ex. macroalgae cultivation between offshore windmills)

NEXT STEPS:

-Set up of an Ecosystem Approach performance ladder, in analogy with CO_2 Performance Ladder[2], as a procurement tool, tender obligation or other instrument to incentivizes companies to apply Ecosystem approach

-Increased Ecosystem Approach Awareness through workshops

-Find the drivers (big companies, innovative technology, government,...)

Join the discussion on the BlueBioMatch platform ⇨ Blue Bio Match — The Blue Bioeconomy Hub

BLUE CLUSTER · BLUEBIO ALLIANCE · Klaipeda University · SAMS · innovatum science park · NCE Blue Legasea

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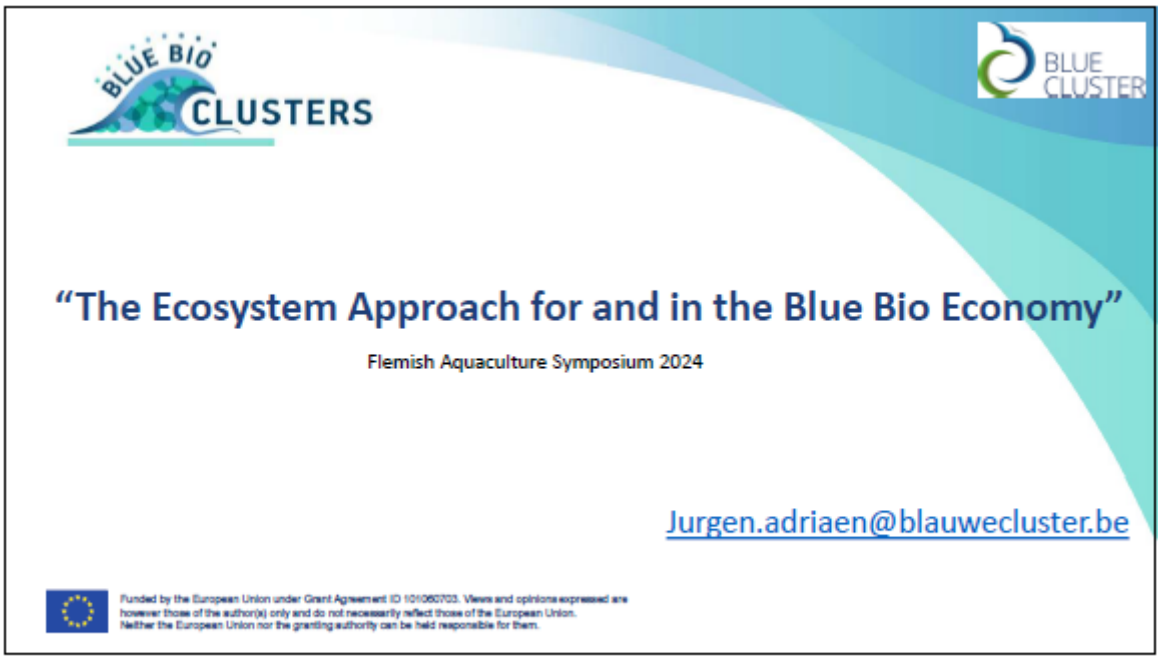
[1] Convention on Biological Diversity (2000). [2] CO_2 Performance Ladder, SKAO (2023)

Annex 2 Presentation on the Flemish aquaculture symposium "Navigating Ecological Considerations and Sustainability in Mariculture Practices" (12/12/2024)



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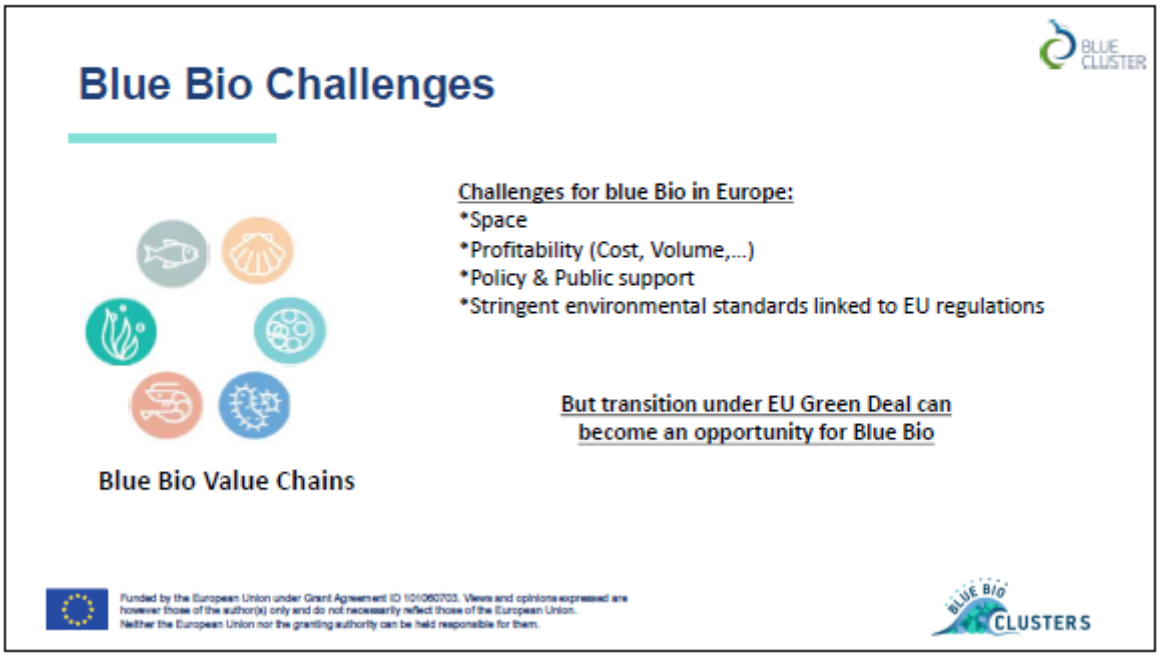

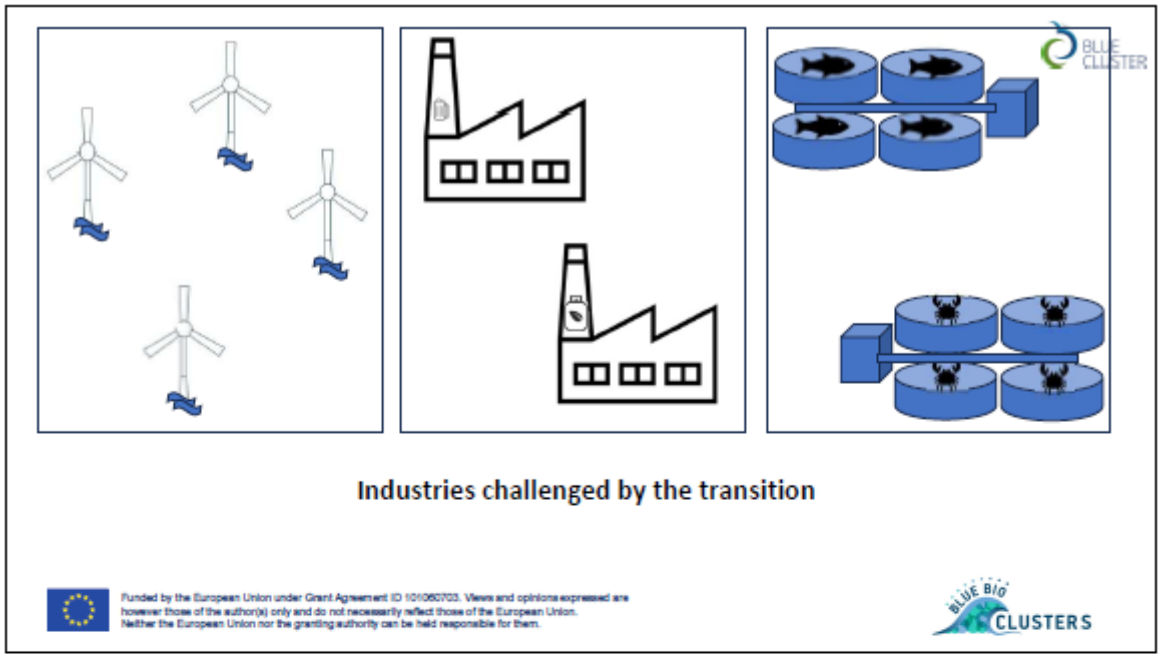
Industries challenged by the transition
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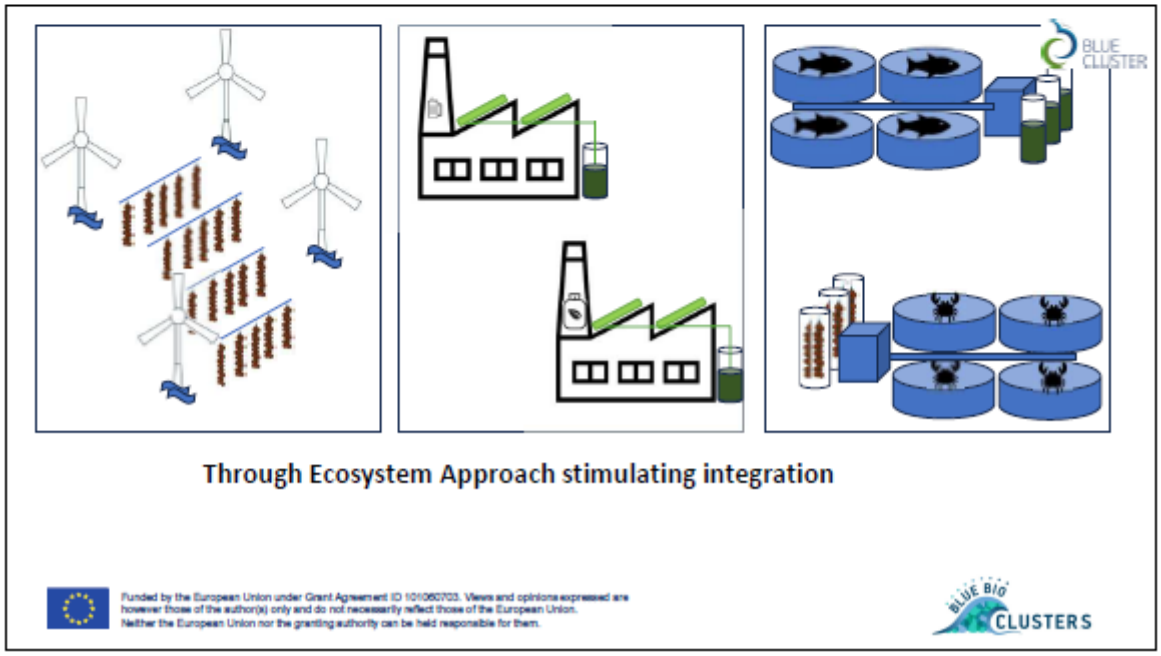
Through Ecosystem Approach stimulating integration
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What is Ecosystem Approach?

" An ecosystem approach for a region focuses on managing natural resources by considering the entire ecosystem, including human and environmental interactions, to promote sustainable development. This method aims to balance ecological health with economic and social needs, ensuring long-term resilience. It involves collaboration across sectors, local communities and stakeholders to maintain biodiversity, support livelihoods and mitigate environmental impacts."

Adding targets in order to move from philosophy towards a true practice

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Ecosystem Approach in/for Blue Bio

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-Direct monetisation of Blue bio products or their components (credits for Ecosystem Services)

-Indirect valorisation
- *Tender criteria (multiuse,...)
- *Social license (wellbeing,...)
- *Compliance requirements
- *....

→ Increased EU Blue bio production

CURRENT STATUS

-Significant knowledge gaps in ecosystem services of certain Blue Bio value chains

-Tools exist to help valuing certain ecosystem services

-Are non-blue bio companies aware that engaging with blue bio companies can positively impact ecosystem services by combining them with the primary activity of the non-blue bio company?

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Why implement Ecosystem Approach?

Policy

- Promoting sustainable development
- Balancing ecological health with economic and social goals
- Fostering stakeholder collaboration

Industry

- Reduces resource and energy expenses through efficient, nature-inspired practices.
- Minimizes risks of penalties and ensures compliance with evolving environmental laws.
- Attracts investors who prioritize sustainable and ESG-compliant businesses.

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How implement Ecosystem Approach?

Policy

- Awareness creation
- Incentive for companies?
- Obligation for companies?

Industry

- Internal process?
- External audit?
- Throughout Supply Chain?

Need for a clear, widely supported and recognised EA framework with targets qualifications?

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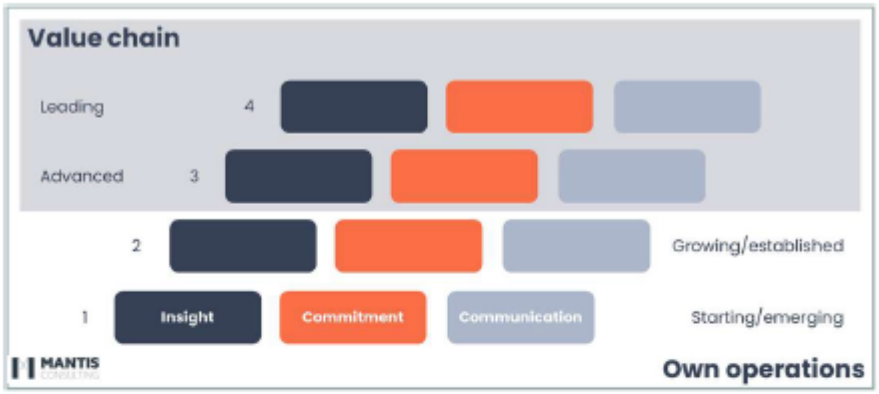
EA ladder – management tool



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EA ladder – management tool

Categories

MANTIS CONSULTING

	INSIGHT	COMMITMENT	COMMUNICATION
Level 1	• Basic ES insight • 1 test project	• Qualitative ambition • Identify opportunities for improvement	• Internal communication on ES policy
Level 4	• Profound quantitative ES insight of value chain • All project	• Integrate EA in business models & strategies • Maximise ES benefits	• Complete and transparent communication

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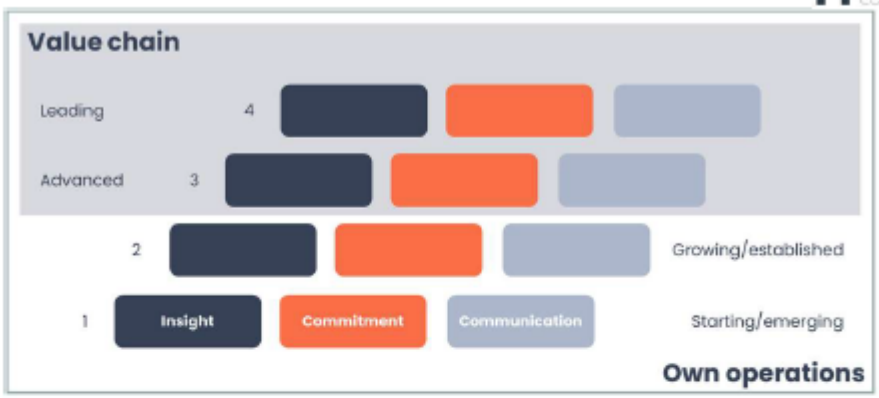
EA ladder – management tool



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Steps to Ecosystem Approach

Policy

- Survey
- Webinar
- Policy Brief + Guide (Januari 2025)
- Online awareness check (Januari 2025)

Industry

- Survey (please PARTICPATE)
- Webinar (February 2025)
- Handbook (June 2025)

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slido
Please download and install the Slido app on all computers you use
What actions of policy makers (regional-(inter)national) could support blue bio companies in choosing to implement EA?
Start presenting to display the poll results on this slide.

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Thank you!
BLUE CLUSTERS
BLUE BIO CLUSTERS
BlueBioClusters Tech Matchmaking Webinar #1
Addressing Technology Needs in Cultivation and Harvesting of Marine and Aquatic Biomass
Monday, 16 December 2024
14:00-15:30 (CET)
Join our matchmaking webinar to connect technology suppliers with users addressing critical needs in the BlueBio value chains
Jurgen.adriaen@blauwecluster.be
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