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2B-BLUE

Boosting the Blue Biotechnology community in the Mediterranean

2nd newsletter

2B-BLUE: Advancing Mediterranean Blue Biotechnology

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Albanian Center for Environmental Protection and Sustainable Development · CNR IRBIM ISTITUTO PER LE RISORSE BIOLOGICHE E LE BIOTECNOLOGIE MARINE · ALBANIAN DEVELOPMENT FUND · Ifremer · CTN centro tecnológico naval y del mar

Contents

1. Blue Biotechnology Hubs

Human health, food and energy security, and environmental sustainability are challenges that require innovative solutions. Many of these can be found in the study and exploitation of marine and freshwater resources, also known as Blue Biotechnologies. However, their development in Europe is still in its infancy. 2B-BLUE will foster them by establishing 5 interactive Blue Biotechnology Hubs (BBHubs) that will facilitate collaboration, know-how transfer and innovation. These will integrate partners across the Mediterranean in the areas of research, industry, governance, civil society, and the environment. 2B-BLUE supports public-public, public-private and private-private cooperation, training and scientific activities that will continue after the project's end.

1.1. Demonstration sites

2B-BLUE Demonstration Sites are specific tools of the BBHubs for scaling up technological solutions, support innovation and business development in the Mediterranean blue economy, and ensure cross-regional cooperation, stakeholder engagement, and knowledge transfer. Demonstration sites in the 2B-BLUE project are defined as designated areas where innovative BBt solutions, practices, and technologies are tested, validated, and showcased under real-life conditions.

These sites serve both as an extension tool and as a crucial bridge between research and commercial application of new technologies, facilitating the adaptation and evaluation of innovations under local field conditions at commercial scale. They provide the opportunity to conduct short-term, small-scale, pilot experiments to collect data and identify potential challenges. This process allows stakeholders to evaluate and assess the feasibility, efficiency, and effectiveness of new or innovative technologies and practices.

Figure 1. Location of demonstration sites in the 2B-BLUE project.

There are a total of 12 demonstration sites working on a wide range of marine organisms: macroalgae, microalgae, sea cucumbers, sea worms, shellfish, as well as total microbiomes. They are distributed as follows:

Table 1. Demonstration sites in the 2B-BLUE project. IMTA - Integrated multi-trophic aquaculture.

Country	Partner	Organisms	2B-BLUE application
Albania	Alb-Adriatico 2013	Fish, sea cucumbers, shellfish	IMTA
France	DareWin Evolution	Microalgae	Cultivation
	DIAG4ZOO	Microbiome	Analytics
	Greensea	Microalgae	Cultivation
	Insitu-o/Adict Solutions	Microbiome	Management
	POLYCHAETA	Polychaetes	Fishing
Greece	Mydia O Spyros	Sea cucumbers, shellfish	IMTA
Italy	CNR	Fish, sea cucumbers, shellfish	IMTA
Slovenia	AlgEN	Microalgae	Cosmetics
	MYTILUS	Sea cucumbers, shellfish	IMTA
	Okus morja	Fish	Aquaculture
Spain	Mediterranean Algae	Macroalgae	Bioremediation

1.1.1. Albania

The Albanian pilot focuses on strengthening sustainable aquaculture value chains through the development and implementation of Integrated multi-trophic aquaculture (IMTA) systems in the Bay of Vlora. By integrating species from different trophic levels, gilthead seabream, European seabass, mussels, oysters and sea cucumbers; the pilot promotes nutrient recycling, reduces environmental impact and improves water quality. This approach supports the production of high-value products for food, feed, and other bio-based sectors by transforming waste into valuable biomass. The Albanian Center for Environmental Protection and Sustainable Development (ACEPSD) has established a research collaboration with private company Alb-Adriatico 2013, located in the Vlora region, which accounts for 85% of Albania's marine fish farms. The rest of the marine farms are situated in the Saranda and Shengjin regions. Vlora and Saranda host fish-fattening units for gilthead seabream and European seabass, while mussel farming is exclusively localized in the Saranda and Shengjin regions.

Find more information about the Albanian demonstration site in section 2.

1.1.2. France

The objective of the French BBHub is to support SMEs in the blue biotechnology and aquaculture sectors. The French partners correspond to Pôle Mer Méditerranée (PMM) and Ifremer.

PMM provides support mechanisms tailored to the needs of companies operating in various markets, including nutrition, pharmaceuticals, and IMTA. The BBHub facilitates the identification of opportunities for public–private collaboration, with the goal of developing innovative solutions by connecting companies to research institutions specializing in blue biotechnologies and promoting networking. PMM also supports the identification of regional, national, and European funding opportunities. This includes funding monitoring, partner identification, and assistance in preparing applications.

IFREMER is a French public institute dedicated to the understanding, exploration, and preservation of the oceans. It conducts scientific research on marine ecosystems, climate, fisheries resources (fish and shellfish), aquaculture, marine technologies, and deep-sea environments. The institute also plays a key role in monitoring marine environments and preventing risks related to the ocean, such as pollution and extreme events. Beyond its research and monitoring missions, Ifremer actively drives maritime innovation by developing cutting-edge technologies such as underwater vehicles, oceanographic instruments, robotics, observation systems, and offshore platforms. These technological advances are not only essential for exploration but also for implementing sustainable practices in marine resource management.

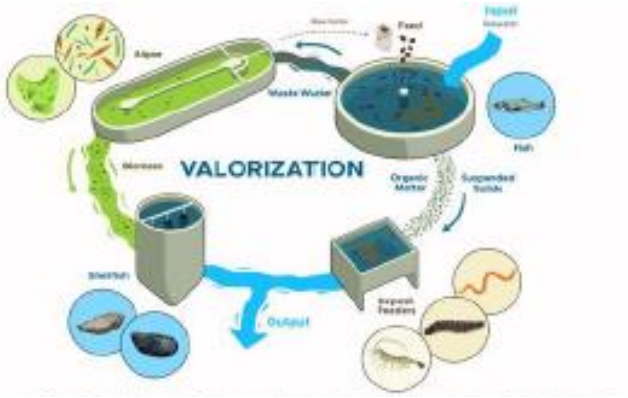

Figure 2. Principles of IMTA (Ifremer).

Find more information about the French demonstration sites in section 3.

1.1.3. Greece

The Hellenic Centre for Marine Research (HCMR) has chosen as a demonstration site the private partner Mydia O spyros, which operates a mussel farm near Thessaloniki. The demonstration site aims to evaluate the feasibility and effectiveness of integrating native sea cucumbers (*Holothuria tubulosa* and *H. mammata*) beneath mussel farms as a nature-based solution for remediating organically enriched sediments. Situated in the northwestern Thermaikos Gulf, the pilot system mimics natural seabed conditions using a stainless-steel farming frame and sediment-filled baskets, allowing for controlled monitoring of sediment quality, holothurian growth, and survival. This IMTA approach seeks to enhance the ecological sustainability of mussel farming by promoting nutrient recycling, improving sediment quality, and reducing the environmental footprint of aquaculture. The site also serves as a proof-of-concept for low-cost, scalable habitat restoration, supporting the development of monitoring protocols, fostering stakeholder engagement, and informing broader adoption of IMTA practices across Mediterranean aquaculture zones.

1.1.4. Italy

The designated demonstration site will integrate bivalve, fish and macroalgae aquaculture to reduce nutrient pollution and improve water quality. The National Research Council (CNR) will assess economic, environmental and social impacts, and translate the outcomes into new business models and policy recommendations, fostering innovation uptake.

1.1.5. Slovenia

In Slovenia the National Institute of Biology (NIB) has deployed three demonstration sites: AlgEn, (microalgae), Mytilus (IMTA), Okus morja, Prosub (valorization of fish waste).

- AlgEn aims to upscale microalgae cultivation to extract high-value compounds for cosmetic applications. AlgEn will optimize biomass production in large-scale bioreactors, while NIB will valorize the biomass by extracting valuable biocompounds and conducting safety, purity and functionality tests.

- Testing the feasibility of cultivating sea cucumbers together with mussels has never been attempted in the Gulf of Trieste. Mytilus and NIB are monitoring sea cucumber adaptability, growth and ecological interactions, while also exploring potential applications of its compounds in medicine, pharmaceuticals and sustainable biomaterials.
- Okus morja, Prosub specializes in fish aquaculture. Together with NIB, it is testing the management of a supply chain for fishery by-products such as fish skin, shells and crustacean exoskeletons, ensuring proper storage and transport. NIB will extract and analyze biopolymers such as collagen and chitin for biomedical and cosmetic uses, assess scalability and conduct pilot trials to optimize production for sustainable commercial applications.

1.1.6. Spain

The Spanish demonstration site investigates the integration of macroalgae cultivation for bioremediation of water quality in port areas, with a blockchain-enabled carbon-footprint tokenization system. Mediterranean Algae provides scientific and technical expertise, designing the bioremediation system and selecting suitable macroalgal species based on their nutrient-uptake efficiency and environmental resilience. The University of Murcia (UMU) manages data collection through Internet of Things sensors to track nutrient removal and system performance. It also oversees carbon tokenization by modelling CO_2 uptake and integrating results into a blockchain. The demonstration site aims to support the circular economy, and establish a scalable, algae-driven bioremediation business model with potential for replication in ports, in aquaculture, desalination, and wastewater treatment.

2. IMTA demonstration site in the Bay of Vlora

2.1. A pioneering step toward sustainable aquaculture in Albania

The IMTA demonstration site in the Bay of Vlora represents a milestone for the sustainable development of Albania's marine aquaculture sector. Implemented by the ACEPSD in collaboration with Alb-Adriatico 2013, this initiative, implemented in the frame of 2B-Blue project, aims to demonstrate how environmentally responsible aquaculture practices can generate economic value while preserving marine ecosystems.

The Bay of Vlora, known for its rich biodiversity and strategic coastal position between the Adriatic and Ionian Seas, offers ideal conditions for piloting integrated aquaculture systems. The IMTA concept brings together multiple species from different trophic levels — typically combining fish, shellfish, and sea cucumbers — in a balanced system that

Figure 3. Inspections, collection and monitoring activities by Joint Research Unit staff members in the Bay of Vlora, Albania (Rigers Bakiu, ACEPSD).

mimics natural marine ecosystems. This approach enhances resource efficiency, reduces waste, and improves overall environmental performance compared to traditional monoculture practices.

The IMTA system at the Vlora site integrates fish farming with shellfish and sea cucumber cultivation, where each species plays a unique role in maintaining ecological balance. Nutrients and organic matter released by fish are naturally absorbed by filter feeders (such as Mediterranean mussels and pearl oysters) and sea cucumbers (as deposit feeders), transforming potential pollutants into valuable biomass. The result is a more circular, low-impact production model that contributes to cleaner waters and diversified income opportunities for coastal communities.

The DS has been designed to serve as both a technical pilot and a learning platform, showcasing best practices to local aquaculture producers, researchers, and environmental managers. It offers hands-on experience in monitoring, data collection, and environmental impact assessment — essential components for replicating IMTA models across Albania's coastal areas.

2.2. Monitoring and field operations

Since its establishment, the IMTA demonstration site has been under continuous monitoring by ACEPSD's marine research staff in partnership with professional divers from Alb-Adriatico 2013. The monitoring program includes regular underwater inspections, sampling, and technical maintenance to ensure optimal system performance and species health.

The Alb-Adriatico 2013. diving team plays a crucial role in inspecting fish cages, shellfish and sea cucumber collectors, and respective cultivation structures. Their observations help identify biofouling levels, structural integrity, and potential environmental changes in the surrounding seabed. Meanwhile, ACEPSD researchers collect and analyze data on water quality, nutrient cycling, and biological interactions to assess the ecological balance and productivity of the IMTA system.

Preliminary findings show promising results — stable fish growth rates, good shellfish health, and significant nutrient uptake by the filter and deposit feeder organisms (known as IMTA organisms). These indicators suggest that IMTA could become a viable, environmentally friendly model for Albania's blue economy.

3. Microalgae cultivation and IMTA in France

Pôle Mer Méditerranée (PMM) and Ifremer aim to propose support mechanisms for SMEs located in the Provence-Alpes-Côte d'Azur and Occitanie regions to develop innovative pilot projects in the fields of blue biotechnology and innovative aquaculture.

After launching a call for expressions of interest, five SMEs were selected: Greensea, Institu-O, Diag4Zoo, Darwin Evolution, and Polychaeta. The objective of the French partners is to identify their needs in the development of their projects and to support them through various mechanisms:

- Identification of partners ;
- Assistance in accessing funding ;
- Access to research infrastructures, such as Ifremer and Celimer in Sète.

Figure 4. Holothurian growth tanks (Ifremer).

3.1. Microalgae for biosecurity and high-added value products

Among these SMEs, Diag4Zoo develops fast and accurate diagnostic tests that strengthen biosecurity and facilitate the management of aquaculture farms. Diag4Zoo has access to Celimer, the Coastal and Marine Center in Sète, a platform that fosters the development of links between economic stakeholders and the research community.

In addition, the SME is supported by PMM and Ifremer, who connected them with a research organisation, a potential partner for their project. The 2B-BLUE project also enables Diag4Zoo to take part in a technical visit to the Spanish demo site, aimed at strengthening collaboration among partners on macro- and microalgae applications and the implementation of Marine Nature-Based Solutions (NBS).

A second SME, Greensea, specializes in the industrial production of microalgae in photobioreactors, particularly polysaccharides for various sectors such as nutrition, cosmetics, and healthcare. In addition to participating in events organised by PMM, the French partners facilitate networking between Greensea and identified potential partners. Greensea has also expressed a need for support in identifying European funding opportunities. Support for the SME is therefore complemented by targeted monitoring of calls for projects in Greensea's field of activity.

Another important activity carried out by PMM and Ifremer within the framework of the project is the development of a comprehensive mapping of the blue biotechnology and innovative aquaculture sectors. Following a call for expressions of interest, Le Paysan Marin was selected to develop an analytical map of public–private cooperation mechanisms and platforms, support schemes, stakeholders, and funding opportunities in the fields of aquaculture and blue biotechnology.

The objective of PMM and Ifremer is to centralize this information in a document to support project leaders in these sectors.

3.2. O'Gallo project, Ifremer Marbec

Fish farming, a valuable source of protein in the face of global population growth, has been constantly evolving for decades. However, this type of farming is not without consequences for the environment. The release of dissolved nitrogen and phosphorus compounds linked to fish metabolism can cause harmful eutrophication. IMTA is a way of treating and valorizing waste by associating species at different trophic levels. Primary producers such as phytoplankton are good candidates for association with fish due to their ability to consume dissolved waste. Moreover, certain strains of microalgae are of great interest and represent a significant cost for some aquaculture sectors such as shellfish production.

This project aims to assess the feasibility of cultivating *Skeletonema marinoi* in a recirculating IMTA system (RAS-IMTA) using effluents from *Dicentrarchus labrax* aquaculture in high-productivity algal lagoons. To achieve this objective, several experiments were conducted using an innovative experimental setup in order to:

- analyze algal growth using a semi-batch cultivation method,
- assess nutrient uptake during the growth phase and evaluate the algal bioremediation capacity,
- characterize algal development (growth rate, doubling rate),
- identify environmental factors influencing algal growth,
- optimize the algal cultivation protocol.

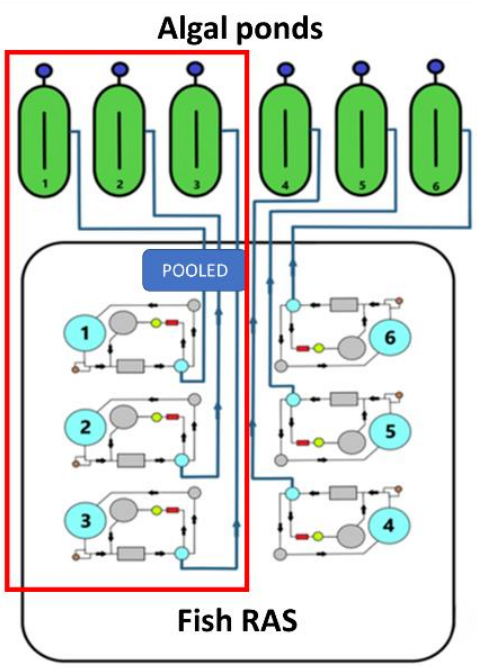

Figure 5. Principles of Recirculating Integrated Multi-Trophic Aquaculture (RAS-IMTA) (Ifremer).

We used six independent RAS-IMTA systems, each of them combining a 4-m^3 fish tank with a 1,000-L microalgae raceway.

The results demonstrated that *Skeletonema marinoi* is well-suited for cultivation using fish farm effluents. The culture was sustained over a 12-day period, starting from an inoculum and undergoing multiple harvests. The maximum observed specific growth rate was 1.12 doublings per hour, with cell concentrations reaching 10^6 cells / mL. Moreover, the bioremediation potential of this system was confirmed, with reductions in nitrate and phosphate concentrations to levels below detection limits. These results suggest that the integration of fish RAS represents a promising approach for the sustainable development of aquaculture.

Find a printable version of 2B-BLUE's Catalogue of Demonstration sites here.

Stay tuned to learn about the results of 2B-BLUE of work groups & co-creation activities!