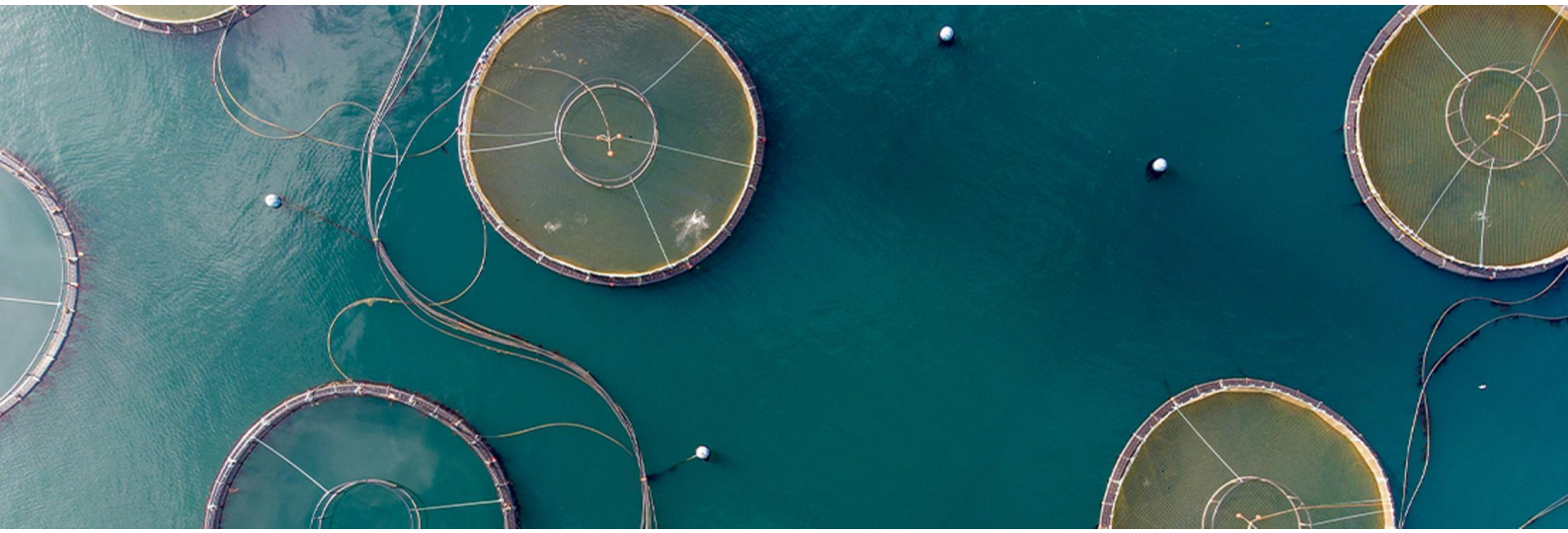
AZA4ICE | Interreg Euro-MED | Co-funded by the European Union



December 2024

Review on aquaculture legal/regulatory framework and licensing processes

https://aza4ice.interreg-euro-med.eu

Deliverable ID

Project acronym	AZA4ICE
Project title	Allocated Zones for circular to trigger the transition to an Inclusive and Circular Economy in the aquaculture sector fostering new business opportunities and eco consciousness society
Project mission	Strengthening an innovative sustainable economy
Project priority	Greener MED
Specific objective	RSO2.6 – Promoting the transition to a circular and resource efficient economy
Type of project	Test project (Thematic Project)
Project duration	01/01/2024 – 30/09/2026 (33 months)

Deliverable title	Review on aquaculture legal/regulatory framework and licensing processes
Deliverable number	D2.3.1
Deliverable type	Report
Work package number	2
Work package title	Living Responsible Research Innovation Ecosystems (LiRRIEs) for quintuple-helix engagement
Activity name	Analysis of the aquaculture legal/regulatory framework and licensing processes
Activity number	A2.3
Partner in charge (author)	Chamber of Economy of Montenegro
Partners involved	All Partners

Document history

Versions	Date	Document status	Delivered by
Version 0.1	02/12/2024	Draft	Chamber of Economy of Montenegro
Version 0.2	18/12/2024	Review	UPatras
Version 1.0	28/12/2024	Final	Chamber of Economy of Montenegro

Table of Contents

Executive Summary

This report analyzes the regulatory frameworks and licensing processes shaping the aquaculture sector across the Euro-MED region, emphasizing sustainability, innovation and economic development. The findings highlight a fragmented regulatory landscape, with each country adopting unique governance models and facing distinct challenges in fostering sustainable aquaculture practices.

In countries like Greece, Spain and France, decentralized governance allows for region-specific solutions but often leads to inefficiencies and regulatory overlaps. Conversely, Croatia and Montenegro have centralized systems, providing consistency but sometimes lacking flexibility to address local needs. Licensing processes universally present significant barriers, with lengthy and costly procedures which hinder the adoption of innovative systems such as Integrated Multi-Trophic Aquaculture (IMTA) and Recirculating Aquaculture Systems (RAS).

Several countries are integrating sustainability and innovation into their aquaculture policies. Portugal has made significant strides with its B-Mar digital licensing platform, which reduces administrative delays, while also promoting circular economy principles. Italy has focused on bioeconomy strategies and maritime spatial planning, though financial constraints and regulatory complexity remain challenges. Spain has simplified licensing processes in Andalusia, fostering growth while maintaining strict environmental standards. Meanwhile, Bulgaria and Montenegro prioritize alignment with EU directives and environmental sustainability, though both face operational and institutional hurdles.

Despite these challenges, the region showcases promising developments. France leads in sustainable feed practices, such as insect protein production, while Portugal and Italy are pioneering efforts in digital innovation and integrated aquaculture systems. Spain has developed an integrated tool to consolidate information on aquaculture activity across different regions. Lessons from other regions, including Norway and Scotland, underscore the value of harmonized regulations, streamlined processes and sustainability-focused practices.

To advance the aquaculture sector, the report recommends aligning national legal frameworks with EU directives, adopting digital licensing tools and providing financial incentives for innovation. Collaboration among stakeholders and the integration of circular economy principles will be crucial in overcoming existing barriers. These efforts will help create a resilient and inclusive aquaculture industry that balances economic growth with environmental stewardship across the Euro-MED region.

1 Overview of the Aquaculture Legal/Regulatory Framework

1.1 Introduction

1.1.1 Objective of the Analysis

The deliverable 2.3.1 "Review on aquaculture legal/regulatory framework and licensing processes" 2.3 focuses on analyzing the legal and regulatory context, as well as licensing processes, which influence aquaculture development and the adoption of innovative circular production systems, such as Integrated Multi-Trophic Aquaculture (IMTA) and Recirculating Aquaculture Systems (RAS), in participating Euro-MED countries. The legal framework governing aquaculture in this region is highly complex and fragmented, with activities regulated by various legislative bodies and authorities. This often results in overlapping responsibilities and a lack of clear regulatory hierarchy, posing challenges to the growth and sustainability of the sector.

The purpose of Activity 2.3 is threefold. First, it aims to enhance stakeholders' understanding of the current legal and regulatory landscape in their respective countries and to expose them to best practices from other regions. Second, it seeks to foster productive discussions among members of LiRRIEs (the project's local and regional regulatory and industry engagement stakeholders), promoting collaboration and knowledge-sharing. Lastly, it ensures that project outcomes align with existing legal, regulatory and licensing frameworks. Each project partner is tasked with conducting a country-specific analysis to identify common solutions, with input and feedback from LiRRIEs members to refine recommendations and encourage harmonized approaches across the region.

The aquaculture industry operates at the intersection of economic development, environmental sustainability and food security, making legal and regulatory frameworks and licensing processes critical to its success. These frameworks not only establish the rules for responsible aquaculture practices but also provide the structure within innovation can flourish. By governing aspects such as environmental protection, water resource management and biosecurity, regulatory systems ensure that aquaculture contributes positively to ecosystems while safeguarding public health and biodiversity.

Understanding these frameworks is essential for operators, policymakers, and stakeholders in navigating the complexities of the sector. Licensing processes, in particular, play a pivotal role in determining the viability of aquaculture projects, influencing everything from site selection and species management to compliance with sustainability standards. The clarity, efficiency and adaptability of these processes often dictate the pace of industry growth and the adoption of innovative production methods.

Consequently, a thorough understanding of regulatory requirements and licensing pathways is indispensable for advancing sustainable aquaculture practices and addressing the global challenges of resource conservation and food production.

1.1.2 Relevance to Aquaculture Development and Innovative Systems

Legal frameworks play a crucial role in shaping the development and sustainability of aquaculture, including innovative systems such as IMTA and RAS. These frameworks ensure that aquaculture activities comply with environmental protection, commercialization, animal welfare and health as well as public health standards. Regulations often dictate the siting, operation and monitoring of aquaculture farms, influencing the adoption and success of these innovative systems. For example, strict environmental regulations, such as water quality standards and habitat preservation requirements, can make it difficult for traditional aquaculture methods to expand without significant adjustments. In contrast, systems like IMTA and RAS, which recycle water and integrate multiple species, can be designed as Nature-Based Solutions (NbS) integrateing low-trophic species (e.g., macroalgae, bivalves, halophytes) to minimize environmental impact, reducing nutrient load and enhancing resource use efficiency and ecosystem services. Legal frameworks that incentivize such environmentally friendly farming technologies through simpler procedures, subsidies or tax breaks can facilitate their adoption and promote sustainable growth in the aquaculture sector.

Furthermore, the legal framework regulating licensing and permits directly impacts the feasibility to innovate and evolve current established production methods systems toward the more sustainable IMTA or RAS. In many countries, aquaculture operations must undergo rigorous environmental impact assessments (EIA), ensuring that the potential ecological effects of the project are carefully considered. IMTA and RAS systems, being resource-efficient and eco-friendly, often have an easier time meeting these requirements compared to traditional, more polluting methods. However, the complexity and cost of obtaining permits and lack of clear guidelines to assess sustainability of IMTA/RAS performance can still present significant barriers, particularly for smaller operations or new technologies. In jurisdictions where regulatory systems are fragmented or slow to adapt to new technologies, the lengthy licensing processes can delay or even prevent the deployment of innovative systems like IMTA and RAS, thus limiting their potential contributions to sustainable aquaculture.

In addition to environmental regulations, legal frameworks often encompass rules related to animal health and welfare, food safety, labelling and commercialización, transport and the management of invasive species. For instance, the use of specific targeted species in IMTA must comply with national and international biosecurity standards to prevent the spread of diseases, genetic drift in local strains or non-native species. Legal measures that

regulate the welfare of farmed species can also influence the design and operation of these systems, ensuring that they meet the ethical standards required for sustainable aquaculture practices. Clear legal guidance on how these systems can be integrated with traditional production methods, alongside clear criteria for operational safety and sustainability, is essential for fostering innovation in the sector.

Lastly, the broader policy environment, including the alignment with EU or national sustainability goals, can further shape the adoption of circular aquaculture practices. Legal frameworks that incentivize sustainable and circular production models are essential for ensuring long-term industry growth. Such frameworks might include support for research and development into new aquaculture technologies, subsidies for environmentally friendly practices or tax breaks for operations which meet high sustainability standards. In regions where legal frameworks prioritize sustainability, circular systems such as IMTA and RAS are more likely to thrive, driving both economic and environmental benefits for the aquaculture industry as a whole.

1.2 Current Legal and Regulatory Frameworks in Participating Countries

1.2.1 Overview of Legal Frameworks

The legal frameworks for aquaculture in Greece, Croatia, Italy, Portugal, France, Spain (Andalusia), Bulgaria and Montenegro are all designed to strike a balance between environmental sustainability and economic development. While these countries share common goals of promoting sustainable aquaculture practices, each has developed a distinct regulatory approach based on their local priorities, challenges and institutional structures.

A significant similarity among these countries is their alignment with European Union regulations, particularly the Common Fisheries Policy (CFP) and environmental standards. All the countries prioritize sustainability, focusing on environmental protection, biodiversity conservation and the responsible management of natural resources. Additionally, all have established regulatory bodies at both national and local levels to oversee licensing, environmental impact assessments and compliance with health and safety standards. These agencies frequently collaborate with regional and local authorities, ensuring effective management of aquaculture activities. Furthermore, each country has developed strategic plans or programs, such as Croatia's National Strategic Plan for Aquaculture Development, Spain's Contribution to the Strategic Guidelines for a More Sustainable and Competitive EU Aquaculture 2021 – 2030[1] or Italy's Bioeconomy Strategy, and regional plans such as the New strategy of Marine Aquaculture in Andalusia

1 *https://www.mapa.gob.es/es/pesca/temas/acuicultura/plan-estrategico/estrategia-2021-2030/*

2021-2030[2] which provide a roadmap for sector growth, enhanced productivity and competitiveness. These plans reflect a broader focus on innovation, climate resilience and addressing global market challenges.

Another shared characteristic is the widespread *requirement for environmental impact assessments* (EIAs), which ensure that aquaculture projects do not negatively affect the environment. Projects are classified according to their potential ecological impact, helping to minimize environmental risks and safeguard aquatic ecosystems.

However, the regulatory frameworks differ significantly in several aspects. One of the key differences is the **approach to governance**. In countries like Greece, Spain and France, aquaculture governance is more decentralized, with local and regional authorities playing a major role in managing aquaculture activities and overseeing environmental protection. This decentralization allows for region-specific solutions but often leads to challenges in coordination. In contrast, countries such as Croatia, Bulgaria and Montenegro have more centralized governance models, where national ministries such as the Ministry of Agriculture or the Directorate of Fisheries hold substantial authority in policy implementation and oversight. While this centralization ensures consistency across the sector, it can limit the flexibility needed to address localized issues.

Another major point of contrast is the ***complexity and fragmentation of regulatory systems***. Italy, Spain and France stand out for their highly fragmented and layered legal frameworks. In Italy, for example, regional regulations, such as those specific to Sardinia, create barriers to entry and delays in licensing. France's regulatory environment is similarly complex, with various national and regional laws governing different aspects of aquaculture. Similarly, in Spain, regulatory framework mostly depend on regional governments (a total of 17), which have their own regulations for managing and overseeing the activity, outlining the requirements for authorization, monitoring, and control. These results in a plethora of regulations focused on regional singularities[3]. All these regions are coordinated by Spanish Ministry that keeps the role as National coordinator for National strategic plans and interaction with EU and some regulatory issues such as the occupation and use of public domain. While this structure provides tailored solutions for local needs, it can create confusion and inefficiencies for industry operators. Conversely, countries like Portugal and Spain (Andalusia) have made efforts to simplify administrative processes. Portugal's B-Mar electronic platform and Andalusian Decree-Law 2/2020, on the Improvement and Simplification of Regulations to Promote Productive Activity[4] are innovations aimed at streamlining licensing procedures, reducing bureaucratic delays and increasing transparency in the sector.

Financial and operational support also varies. Most of the countries, including Spain,

2 *https://juntadeandalucia.es/sites/default/files/inline-files/2023/03/Estrategia_Acuicultura_2021_2030_0.pdf*
3 *https://www.mapa.gob.es/es/pesca/temas/acuicultura/normativa_acui_nov24_tcm30-628807.pdf*
4 *https://www.juntadeandalucia.es/boja/2020/504/1*

Greece and Italy face significant financial constraints, particularly for small-scale operators, and the complexity of their regulatory systems often exacerbates these challenges. The European Maritime, Fisheries and Aquaculture Fund (EMFAF[5]) is the core instrument for all countries to support aquaculture operations. Croatia has benefited from EU co-financing to support innovation and resilience in the aquaculture sector, helping to alleviate some financial burdens. Italy and France, however, focus more on fostering technological and sectoral innovation, integrating aquaculture into broader economic frameworks such as the bioeconomy and maritime spatial planning. In the Andalusian region (Spain), three main priorities were set: a) support of R&D&I strategic projects ensuring the participation of Andalusian stakeholders; b) support through EMFAF funds for sector companies considering key competitive aspects such as financing, return on investment, project types and knowledge transfer; c) enhance capacities for a competent aquaculture administration These efforts aim to improve the sustainability and competitiveness of the industry, albeit often at a higher cost.

The **challenges of institutional coordination and social dynamics** also differ across the countries. Greece and Bulgaria struggle with institutional conflicts and a lack of alignment between government entities and industry stakeholders. These issues can lead to delays and inefficiencies in the regulatory process. In Italy and Spain, fragmented laws and regional governance add complexity, often resulting in long delays and barriers to entry for stakeholders. Despite these challenges, these two countries make big efforts in coordinate, improve governance and integrate aquaculture into maritime spatial planning indicates an effort to streamline the sector's growth. Moreover, countries such as Portugal and Andalusian region in Spain have made strides to reduce bureaucratic obstacles, though Portugal still faces challenges with multi-tiered governance, which can complicate the regulatory process and slow sector growth.

Public health and ecosystem protection are also key focal points in the regulatory systems. A significant portion of aquaculture production in Europe is located within Natura 2000 protected areas, reflecting the sector's close interaction with ecosystems of high biodiversity value. This integration presents both challenges and opportunities for sustainable aquaculture development. Spain, France and Portugal, in particular, emphasize these areas through strict regulations governing water quality, species diversity and ecosystem health. This is especially relevant in coastal regions, where aquaculture may conflict with other industries, such as tourism. Montenegro, with its focus on both freshwater and marine aquaculture, is particularly concerned with aligning its practices with international sustainability guidelines and ensuring that aquaculture activities do not harm its aquatic ecosystems. Most of the aquaculture land operations in Andalusian region are in protected areas. This the case of the Bay of Cádiz, a natural park, recognized for its ecological value and biodiversity. The area is governed by specific

5 *https://oceans-and-fisheries.ec.europa.eu/funding/emfaf_en*

conservation and management plans, name Natural Resource Management Plan (NROP) and the Management and Use Master Plans (MUMP)[6] that clearly define strict environmental criteria for aquaculture facilities located in this area.

In conclusion, while all the participating countries strive to promote sustainable aquaculture, their legal frameworks vary in terms of governance structures, regulatory complexity, institutional coordination and financial support. Some countries, like Spain, Greece and France, adopt a more decentralized approach, which allows for region-specific solutions but can lead to coordination challenges. Others, like Croatia and Montenegro, have more centralized governance models that prioritize consistency but may lack the flexibility needed to address local issues. Financial support and innovation strategies also differ, with some countries prioritizing technological advancement and others focusing on simplifying administrative processes to reduce barriers to growth. Despite these differences, all countries share a commitment to balancing sector growth with environmental protection, though the success of each framework will depend on how effectively they address these diverse operational challenges.

1.2.2 National Legal Frameworks and Institutional Setup

1.2.2.1 Greece

The legal framework for aquaculture in Greece provides a structured approach to balancing environmental sustainability with economic development, aligning closely with European Union directives. The legislation covers critical aspects such as water resource management, administrative governance, licensing and environmental impact assessments. For example, Law 3199/2003 emphasizes integrated water management, establishing oversight bodies and monitoring programs to ensure sustainable resource use. Similarly, the "Kallikratis Plan" decentralizes governance, empowering local authorities to manage environmental protection and aquaculture activities more effectively. These measures aim to create a cohesive framework for sustainable aquaculture practices.

Licensing processes, detailed in various Government Gazettes, underline the sector's rigorous regulatory standards. They include prerequisites for environmental impact assessments and specific criteria for floating and land-based units, ensuring compliance with environmental and veterinary standards. Environmental impact classification further enforces sustainability by categorizing projects based on their potential ecological effects. Protected zones and health measures also safeguard aquatic ecosystems and biodiversity, aligning with EU health directives.

6 *https://www.juntadeandalucia.es/medioambiente/portal/landing-page-planificacion/-/asset_publisher/Jw7AHImcvbx0/content/porn-y-prug-del-parque-natural-bah-c3-ada-de-c-c3-a1diz-incluye-los-parajes-naturales-isla-del-trocadero-y-marismas-de-sancti-petri-/20151*

Despite these comprehensive measures, Greece's aquaculture industry faces notable challenges, such as environmental concerns, financial constraints and social opposition. Institutional conflicts between government entities and the demands of major industry players add complexity to the regulatory landscape. However, the sector's efforts to streamline procedures and foster collaboration among stakeholders reflect a commitment to addressing these issues. Overall, Greece's legal framework positions the aquaculture industry for sustainable growth, even as it navigates operational and social hurdles.

1.2.2.2 Croatia

The Croatian legal framework for aquaculture, as defined by the Aquaculture Act and its amendments, establishes a comprehensive and EU-aligned regulatory system. The framework prioritizes sustainable aquaculture development under the Common Fisheries Policy and emphasizes economic, ecological and social objectives. Key strategic documents, such as the National Strategic Plan for Aquaculture Development and the Operational Fisheries Program (2021–2027), further outline priorities including climate resilience, sector competitiveness and innovation. These strategies, supported by European Maritime, Fisheries and Aquaculture Fund (EMFF) co-financing, aim to foster growth while enhancing rural and coastal livelihoods.

The implementation of this framework relies on detailed ordinances governing various aspects of aquaculture, from licensing and statistical data collection to professional training and species management. These regulations ensure standardization and traceability within the sector, particularly for high-value activities like bluefin tuna farming. The National Plan for Aquaculture Development (2021–2027) provides clear goals for sector expansion, promoting productivity, innovation and sustainability. This structured approach demonstrates Croatia's commitment to balancing environmental stewardship with economic recovery and growth.

Institutional oversight is centralized within the Ministry of Agriculture and its Directorate of Fisheries, which coordinates policy implementation, licensing and compliance. The ministry collaborates with environmental, spatial planning and maritime authorities, as well as local governments and advisory bodies. This multi-stakeholder approach enhances the regulatory framework's effectiveness while fostering partnerships between public and private sectors. Despite its robust structure, the framework's success will depend on addressing operational challenges and ensuring strategic alignment across institutions.

1.2.2.3 Italy

Italy's aquaculture sector operates under a detailed and evolving legal framework which aims to balance sectoral growth with environmental and social responsibilities. The foundational legislation includes D.Lgs. n. 154/2004, which establishes guidelines for sustainable aquaculture development and animal welfare and D.Lgs. n. 152/2006, which

addresses environmental and marine ecosystem protection. The "Implementation Action Plan (2020–2025) for the Italian Bioeconomy Strategy BIT II" underscores Italy's ambition to integrate aquaculture into maritime spatial planning through evidence-based licensing and innovative use of decommissioned offshore platforms. This strategic approach signals Italy's intent to foster sustainable and innovative aquaculture practices.

Regulatory responsibilities are distributed across national, regional and local authorities, with bodies such as the Ministry of Agriculture, Food Sovereignty and Forests (MASAF) and ISPRA playing central roles in project evaluation and authorization. Regional authorities, while critical to local oversight, face challenges due to fragmented laws and varying implementation. Sardinia, for example, has its own distinct regulatory framework. This complexity often translates into long and arduous licensing processes, creating barriers to entry and operational delays for stakeholders.

The sector's development is further constrained by competition from international imports, limited financial support for small-scale operators and concerns over biodiversity and ecosystem impacts. These challenges highlight the need for streamlined regulatory processes, enhanced financial accessibility and greater collaboration among stakeholders to address public concerns and foster sustainable growth. With coordinated efforts, Italy can position its aquaculture industry as a competitive and environmentally responsible sector within the broader bioeconomy.

1.2.2.4 Portugal

The regulatory framework for aquaculture in Portugal is robust and multifaceted, reflecting an effort to balance sustainable development with environmental protection and administrative efficiency. The foundation is laid by Decree-Law no. 40/2017, updated by Decree-Law no. 83/2023, which simplifies procedures and addresses administrative aspects of aquaculture licensing. This comprehensive legislation encompasses marine, transitional and inland waters and includes provisions for associated facilities on both public and private land. Key ministerial orders complement this framework, detailing procedural requirements, financial guarantees and fee structures for aquaculture operations. These measures demonstrate a structured approach to ensuring compliance with environmental standards, operational transparency and streamlined administrative processes.

Coordination of aquaculture licensing is distributed among multiple entities, with the Direção Geral de Recursos Naturais, Segurança e Serviços Marítimos (DGRM) and Instituto da Conservação da Natureza e das Florestas (ICNF) leading in marine and inland waters, respectively. The integration of B-Mar, an electronic platform, is a critical innovation, promoting procedural transparency, reducing administrative delays and facilitating stakeholder collaboration. The platform allows for consolidated analysis and decision-making, fostering efficiency and accountability. However, challenges persist, particularly concerning the administrative burden and multi-tiered governance, which can create

delays and complexities, impacting the sector's growth and its contribution to the blue economy.

Despite its challenges, Portugal's aquaculture regulatory system prioritizes sustainability and public interest, ensuring environmental and economic benefits. The implementation of the Plan for Aquaculture in Transitional Waters (PAqAT) exemplifies a forward-thinking approach, aligning aquaculture activities with spatial planning and ecological preservation. While the system is highly regulated due to the sector's environmental and public health implications, it also demonstrates flexibility, as seen in provisions for species diversity and adaptability to technological innovations. Nonetheless, the ICES reports highlight the need for continuous improvement to mitigate administrative hurdles and support the sector's potential for job creation and food security in coastal regions.

1.2.2.5 France

The regulatory framework for marine aquaculture in France is complex and multifaceted, involving both national and local legislation. At the national level, several key acts define the scope and structure of aquaculture activities, with the Rural and Maritime Fishing Code playing a central role by categorizing aquaculture as an agricultural activity and setting the framework for authorizations. Other significant acts, such as the Coastal Act and the Orientation Act of 1997, emphasize the importance of coastal protection, public access and the sustainable management of marine resources. These laws aim to balance economic activities, like aquaculture, with environmental considerations and public interests, particularly in relation to coastal zone planning and marine conservation. Additionally, the Agriculture and Fishery Modernization Act introduces regional planning schemes for aquaculture, aligning aquaculture development with broader coastal and environmental strategies.

At the regional and local levels, the regulatory framework becomes more detailed and tailored to specific geographic contexts. Various regional development schemes, like the Marine Aquaculture Development Regional Scheme (SRDAM), help identify suitable sites for aquaculture and manage spatial planning to minimize conflicts with other coastal activities. Local authorities, including interregional and regional directorates for the sea, food, agriculture and the environment, play a critical role in implementing and overseeing policies. These entities ensure compliance with health, environmental and planning regulations. For example, the French Office for Biodiversity (OFB) provides guidance on the environmental aspects of aquaculture operations, while local agencies handle day-to-day operations and enforcement. This decentralized approach allows for flexible responses to local needs and challenges but also creates a complex system of coordination among multiple agencies.

Overall, the French aquaculture regulatory framework reflects the importance of sustainable development, environmental protection and local governance. However, the

layered and extensive nature of these regulations may present challenges for industry operators, who must navigate multiple legal and administrative requirements. Coordination among national, regional and local authorities is essential to ensure the balanced growth of the aquaculture sector while safeguarding France's marine and coastal ecosystems.

1.2.2.6 Andalusian Region, Spain

The regulatory framework for circular aquaculture in Andalusia is comprehensive, aiming to foster sustainable development while ensuring environmental protection and economic viability. The core of this framework is based on several key legal documents that structure the authorization, management and monitoring processes for aquaculture operations. Central to these regulations is Law 1/2002[7], which provides the regulatory framework for the organization, promotion, and control marine fishing, shellfish harvesting and aquaculture, ensuring that these activities are carried out in a sustainable manner with an emphasis on ecosystem protection. Alongside this, Decree-Law 2/2020[8] focuses on simplifying bureaucratic processes, aiming to reduce barriers and enhance the competitiveness of the sector while maintaining strict adherence to environmental and safety standards. This regulatory shift supports business innovation and streamlines the acquisition of necessary permits for aquaculture activities, thus promoting growth in the region's marine-based industries.

Moreover, Andalusian Decree 58/2017[9] sets forth detailed guidelines for the sustainable development of marine aquaculture in Andalusia, including the procedures for obtaining necessary permits, environmental standards and public domain concessions. This decree ensures that aquaculture practices are aligned with regional goals for ecosystem protection and the preservation of marine biodiversity. In addition, Andalusian Decree 129/2021[10] introduces a dynamic approach to integrating fishing tourism and other diversification activities into the aquaculture sector. This supports economic diversification, enhances local communities and fosters awareness of sustainable aquaculture practices. By incorporating these diverse regulatory measures, Andalusia can promote the growth of circular aquaculture systems that are environmentally responsible, economically viable and socially inclusive, contributing to the region's long-term sustainability goals.

1.2.2.7 Bulgaria

The regulatory framework governing aquaculture in Bulgaria is complex and multi-layered, involving numerous legislative acts, regulations and authorities responsible for

7 *https://www.boe.es/eli/es-an/l/2002/04/04/1*
8 *https://www.juntadeandalucia.es/boja/2020/504/1*

9 *https://www.juntadeandalucia.es/boja/2017/76/6*
10 *https://www.juntadeandalucia.es/boja/2021/63/2*

enforcing them. The Fisheries and Aquaculture Act (FAA) is the cornerstone of this framework, defining aquaculture activities and outlining the regulatory processes for licensing, water use, environmental protection and hygiene standards. The various authorities involved, including the Executive Agency for Fisheries and Aquaculture (EAFA), the Bulgarian Agency for Food Safety (BAFS) and the River Basin Directorate, play critical roles in overseeing aquaculture operations. These agencies are tasked with ensuring compliance with national and European Union regulations, including environmental impact assessments and biodiversity protection measures, to promote sustainable aquaculture practices. Key regulations such as Regulation No. 37, which governs aquaculture in state-owned water bodies and Regulation No. 4, which sets water quality standards for aquaculture, help ensure that the sector operates within the bounds of environmental protection laws.

Despite the comprehensive legislative and regulatory framework, several challenges persist that hinder the development of Bulgaria's aquaculture industry. One major issue is the need for legislative updates to align the regulatory environment with the sector's evolving needs. While Bulgaria's laws are in line with EU policies, further amendments are needed to create a more predictable and efficient regulatory system. The current framework could benefit from simplifying administrative processes and integrating services to reduce bureaucratic burdens. Additionally, the lack of differentiation between commercial and non-commercial aquaculture activities in the FAA complicates the licensing and regulatory processes, as does the absence of clear guidelines for the registration of commercial entities in aquatic farming. To foster industry growth, it is suggested that fees for water use and wastewater discharge be reconsidered, with a focus on incentivizing environmentally friendly practices while maintaining stringent water quality standards. Addressing these barriers through thoughtful regulatory reforms and digitalization of services could significantly enhance the efficiency and sustainability of Bulgaria's aquaculture sector.

1.2.2.8 Montenegro

Montenegro’s aquaculture sector is governed by a robust legal framework consisting of key laws that address both freshwater and marine aquaculture. The Law on Freshwater Fisheries and Aquaculture and the Law on Marine Fisheries and Mariculture outline the regulatory landscape, with distinctions in spatial planning for mariculture and construction for freshwater aquaculture. Additional laws cover food safety, animal welfare, environmental impact assessments and water management, ensuring that aquaculture activities align with broader environmental and health regulations. These laws are complemented by numerous by-laws that further define the operational aspects of fisheries, aquaculture and related activities.

The management and regulation of aquaculture are handled by several governmental bodies, with the Ministry of Agriculture, Forestry and Water Management overseeing

policy formulation. The Directorate for Fisheries ensures sustainable resource use, while the Environmental Protection Agency and the Veterinary and Phytosanitary Directorate monitor environmental and animal health standards. Scientific research institutions like the Institute of Marine Biology provide valuable data for resource management and the Statistical Office of Montenegro collects essential fisheries statistics. Montenegro's aquaculture practices are also shaped by international commitments, including alignment with FAO guidelines, EU directives and regional agreements, ensuring sustainability and the protection of aquatic ecosystems.

This combination of national legislation, institutional oversight and international cooperation aims to promote sustainable aquaculture practices while safeguarding the environment and public health. Through effective management and adherence to global standards, Montenegro seeks to balance economic development in aquaculture with the preservation of its aquatic ecosystems.

1.3 Analysis of Licensing Processes

1.3.1 Commonalities and Differences Among Participating Countries

The legal and regulatory frameworks governing aquaculture in European countries exhibit significant commonalities and differences, reflecting shared commitments to sustainability and local adaptations to national contexts. A prominent feature of these frameworks is their alignment with European Union regulations, particularly the Common Fisheries Policy, ensuring compliance with sustainability goals and harmonized operational standards across the region. Environmental sustainability is a key priority, with all countries mandating EIAs and implementing measures to protect aquatic ecosystems. This includes emphasizing sustainable water resource management as a cornerstone of regulatory strategies.

Comprehensive regulatory structures are a shared characteristic, with each country establishing laws and ordinances that govern aquaculture practices, licensing procedures and operational requirements. National and regional authorities play critical roles in overseeing these activities, relying on dedicated ministries or directorates for fisheries, agriculture and environmental management. However, challenges persist, especially in the form of bureaucratic inefficiencies, such as lengthy licensing procedures, high administrative burdens and fragmented regulatory frameworks. Despite these hurdles, aquaculture is universally recognized for its potential to drive economic and social benefits, contributing to rural development, job creation and food security.

Amid these commonalities, significant differences arise in the complexity and implementation of regulatory systems. Countries like Italy and Spain face considerable

regulatory fragmentation across regions, whereas Croatia and Portugal have adopted digital platforms, such as B-Mar, to streamline licensing processes and improve efficiency. Institutional setups also vary; Montenegro depends heavily on specialized entities like the Institute of Marine Biology, while Portugal centralizes tasks within fewer agencies to simplify governance. Licensing policies further highlight contrasts, with Portugal's Blue Licensing System offering up to 50-year licenses, a notable departure from the shorter durations typical in countries like Bulgaria.

Innovative approaches to aquaculture development also differ across countries. Portugal has pioneered initiatives such as the Blue Licensing System and permits the production of exotic species under strict conditions, whereas Bulgaria maintains stricter biodiversity rules focused on native species. Greece, on the other hand, emphasizes repurposing decommissioned platforms for aquaculture expansion. In Andalusia, a single window approach is available that integrates all authorization procedures for activity registration, environmental procedures adjusted specifically to the characteristics of aquaculture facility, and allocation of space for aquaculture operations.

Public and industry challenges also vary, with Greece and Spain encountering local opposition due to tourism impacts, while Montenegro grapples with balancing traditional fishing practices with modern aquaculture growth. The pace of digital transformation further distinguishes countries, with Croatia and Portugal advancing digital licensing systems while others continue to rely on traditional, paper-based processes. These variations reflect the diverse strategies adopted to navigate regulatory, environmental, and economic complexities in aquaculture.

1.3.2 Key Barriers in Licensing and Regulatory Compliance

Analysis of major barriers to aquaculture development, including administrative, procedural, and legal challenges.

Aquaculture in Europe faces a range of challenges stemming from administrative, procedural, legal, financial, social, environmental and technical barriers, each of which significantly impacts the industry's growth and development. Administrative inefficiencies, such as fragmented and complex governance frameworks in Italy and Spain, result in confusion and delays due to regional variations in regulations. Similarly, high administrative burdens, as seen in Bulgaria and Montenegro, involve lengthy and complex processes that require the involvement of multiple authorities, leading to inefficiencies. While nations like Portugal have adopted digital tools like the B-Mar platform to streamline administrative processes, others still rely on traditional, paper-based systems, further slowing progress.

Procedural hurdles exacerbate the delays caused by administrative inefficiencies. Licensing processes often take years due to redundant bureaucracy and poor inter-

agency coordination, as observed in Italy. In Spain, licenses competences are hold by multiple regulatory bodies, sometimes within the same administration, which further prolongs approval processes. Similarly inconsistent enforcement of regulations by regional authorities, such as in Spain and Greece, creating inefficiencies and unpredictability for investors. The need for multiple permits and approvals, particularly in countries like Bulgaria and Montenegro, adds to the procedural complexity, further discouraging potential entrants to the aquaculture industry.

Legal challenges also present significant obstacles. Regulatory overlaps between national, regional, local and environmental authorities, as seen in Greece and Spain, create jurisdictional conflicts and complexity that undermine clarity and efficiency. Frequent legislative amendments in most regulatory frameworks including animal health, environment and water quality or zoo sanitary production make continuous adjustments required. In some countries like Croatia and Bulgaria further complicate compliance, making it difficult for businesses to plan long-term investments. Strict environmental and conservation laws in nations such as Greece and Montenegro, while essential for sustainability, can limit site availability and raise compliance costs, adding another layer of difficulty for operators.

Financial and market barriers amplify these challenges. High costs associated with compliance, including environmental studies and licensing fees, pose significant financial strain, particularly in countries like Italy and Portugal. Competition from cheaper imports further discourages investment in domestic aquaculture, as seen in Spain, Italy and Bulgaria. Compounding these issues, small-scale operators often lack awareness of financial aid and support programs, leaving them without access to critical resources that could help them overcome these financial hurdles.

Social and environmental challenges, including public opposition and conflicting land use, also impede aquaculture development. In Greece and Spain, local communities often resist aquaculture projects due to perceived environmental and aesthetic impacts, particularly in tourism-heavy regions. Similarly, urbanization and competing coastal activities in France and Portugal create zoning conflicts that delay project approvals. In Andalusia, aquaculture along the South-Atlantic coast is widely accepted, unlike the Mediterranean area, as it is recognized as a compatible activity within wetlands that are subject to strict environmental regulations. Technical barriers, such as the lack of harmonized standards and capacity gaps within regulatory authorities, further hinder the industry's progress by complicating compliance and decision-making processes.

Collectively, these barriers result in prolonged project approval timelines, increased costs for operators, and reduced growth of the aquaculture industry. Addressing these issues will require harmonized regulations, streamlined processes, digital transformation, and enhanced coordination among authorities. By overcoming these challenges, countries can pave the way for innovative circular production systems IMTA-RAS, enabling

sustainable growth and resilience in the aquaculture sector.

1.4 Innovative Circular Production Systems (IMTA/RAS) and Products

1.4.1 Integration of IMTA and RAS in Legal/Regulatory Contexts

The findings from the document reveal a significant variation in the legal and regulatory frameworks across countries for implementing Integrated IMTA-RAS.

Some regulations, like the Andalusian region (Decree 58/2017), include specific definitions concerning trophic relationships defining *Multitrophic Culture or IMTA as the cultivation of multiple species from different trophic levels, either in the same or different technical cultivation units.* While some other regulation, such as is the case in Greece, have made explicit references to these systems within their regulatory texts, challenges persist due to outdated frameworks and jurisdictional overlaps.

Countries like France and Italy face unique barriers such as the Novel Food classification and fragmented regulatory approaches, complicating the adoption of innovative aquaculture practices. Meanwhile, nations like Portugal and Bulgaria lack specific legislation, relying on general aquaculture laws that do not adequately address the distinct needs of IMTA and RAS. Common challenges include high costs, technical expertise gaps and limited financial incentives, highlighting the need for harmonized approaches to regulatory updates and incentive structures. From a regulatory point of view, it is a priority for most of the countries to set well-established technical criteria IMTA as a production model beyond the mere relationships between species. The term IMTA is basically defined on the participation of different trophic levels, however, licensing and regulatory bodies should have technical criteria to clearly assess this connectivity and circularity.

A recurring theme across the findings is the alignment —or lack thereof—with EU directives and sustainability goals. While initiatives such as the National Bioeconomy Strategy in Italy, the Multi-Annual Aquaculture Plan in Bulgaria or the Spanish Contribution to the Strategic Guidelines for a More Sustainable and Competitive EU Aquaculture 2021-2030 and Andalusian Strategy of Marine Aquaculture 2021-2030 aim to foster innovation, implementation is often hindered by unclear classifications and administrative burdens. Encouragingly, the integration of circular economy principles, particularly in Italy and Montenegro, demonstrates a growing recognition of IMTA and RAS's potential to enhance resource efficiency and environmental sustainability. Overall, the findings suggest that to fully realize the potential of these systems, countries must address fragmented regulations, streamline licensing processes and invest in research

and capacity-building efforts.

1.4.1.1 Legal Barriers for Innovative Techniques

The growth of the European aquaculture industry has driven a transition toward innovative techniques that emphasize sustainability and environmental stewardship. Methods such as IMTA-RAS present significant opportunities to enhance resource efficiency and reduce ecological impacts. However, these advancements face numerous legal and regulatory challenges that hinder their widespread adoption. This analysis explores the key legal barriers confronting innovative aquaculture techniques and highlights potential solutions to address these impediments effectively.

1. Fragmented Jurisdiction and Overlapping Regulations

One significant barrier to implementing innovative aquaculture techniques lies in fragmented regulatory frameworks. Multiple agencies often oversee aquaculture, creating jurisdictional overlaps. For example, while fish farming may fall under the Ministry of Agriculture, algae production—a component of IMTA—might be regulated by the Ministry of Environment due to its influence on water quality. This fragmentation leads to conflicting priorities and unclear authority over integrated systems, hindering the adoption of advanced methods.

2. Outdated Environmental and Zoning Laws

Environmental protection rules originally designed for traditional aquaculture often fail to align with the eco-efficiency and circularity goals of innovative systems. RAS, which recycles water and sludge, minimizing use of water and nutrient discharges represents a viable pathway toward zero-waste aquaculture. However, this model still needs to comply with discharge standards intended for conventional methods and SANDACH regulations constraints creating unnecessary hurdles. Similarly, coastal zoning restrictions that aim to preserve natural resources may inadvertently obstruct the development of IMTA farms, despite their reduced environmental impact and sustainability benefits.

3. Complexity in Licensing and Permits

The licensing process for aquaculture is rigorous, involving multiple stages of approval, from environmental impact assessments to compliance with coastal regulations. In regions such as Andalusia, Spain, the licensing procedure includes detailed project submissions, public consultations and zone planing checking compatibility with existing land-use plans. This complexity is magnified for innovative systems that lack explicit inclusion in current frameworks, delaying approvals and increasing costs for operators.

4. Lack of Tailored Guidelines for Innovation

Reluctance to update regulations to align with emerging technologies imposes significant barriers to innovation and implementation. While the European Green Deal and Blue

Economy Strategies emphasize the importance of circular and sustainable aquaculture, national regulations in most of the countries like Greece and France lag behind. This delay impedes the integration of innovative methods into policy objectives and fails to incentivize their adoption.

5. Challenges in Classification and Market Entry

For techniques involving novel food sources, such as algae and haloplyte plant species in IMTA, regulatory frameworks like the EU's Novel Food Regulation (EU 2015/2283) add layers of complexity. The classification of certain outputs as "novel" can lead to costly and lengthy approval processes. Mixed outputs in IMTA systems, where secondary species are fed using waste from primary species, further complicate compliance due to safety and contamination concerns.

6. Regional and National Discrepancies

Countries like Portugal exhibit minimal legal barriers, fostering a more supportive environment for innovative aquaculture. Conversely, regions like France, with frameworks tailored to single-species or traditional methods, face significant obstacles in permitting integrated or multitrophic systems. These inconsistencies create uneven development opportunities across Europe.

To address these barriers, policymakers must harmonize regulatory frameworks across jurisdictions to clarify criteria, responsibilities and reduce conflicts. They should update environmental and zoning laws to reflect the reduced impact of innovative systems and simplify licensing processes by providing clear provisions for advanced techniques. Additionally, tailored guidelines and incentives should be established to promote sustainable aquaculture practices. Enhancing regional coordination is also essential to ensure uniformity in fostering innovation across member states. These changes will enable the aquaculture sector to align with sustainability goals and leverage innovative techniques to address environmental and economic challenges.

1.4.2 Integration of Innovative Aquaculture Products in Legal/Regulatory Contexts

The integration of innovative aquaculture products, such as algae-based foods and other novel marine resources, into existing legal and regulatory frameworks faces numerous challenges across different jurisdictions. These challenges arise from outdated or ambiguous regulations, conflicting authorities and a lack of technical expertise, which collectively hinder the development and commercialization of these products.

In Greece, the absence of specific legal provisions for innovative aquaculture products, including algae cultivation, complicates the permitting process. Regulatory frameworks are primarily designed for conventional fish farming, which do not adequately address

the unique requirements of algae-based production. Conflicts between regional and central authorities, as well as between national and EU regulations, further exacerbate the issue, leading to delays and uncertainty for operators. Similarly, in France, the integration of new species into aquaculture is managed on a case-by-case basis, with rigorous procedures for classification and safety validation that often slow down the commercialization process.

In Italy, the regulatory landscape is marked by complexity and fragmentation. Operators must navigate multiple levels of authority for permits related to land use, water extraction and health and safety. The lack of clear legal definitions for innovative products, particularly algae, poses additional barriers, as regulations are either underdeveloped or scattered across various domains. This regulatory ambiguity is further compounded by conflicts among authorities, such as differing priorities between environmental agencies and health ministries.

Other countries, such as Montenegro and Bulgaria, also face significant barriers due to a lack of specific regulatory frameworks and limited technical expertise. In Montenegro, the absence of dedicated regulations for algae farming creates uncertainty for investors, while stringent environmental compliance requirements discourage potential projects. Similarly, Bulgaria's reliance on general aquaculture laws and the absence of state funding or targeted guidelines limits opportunities for innovation in this sector.

Addressing these challenges requires a coordinated approach to harmonize regulatory frameworks, streamline licensing processes and provide clear guidelines tailored to innovative aquaculture products. Enhanced collaboration between stakeholders and increased investment in technical expertise and consumer awareness are also crucial to overcoming these barriers. By fostering an enabling environment, countries can support the growth of sustainable and innovative aquaculture practices.

1.4.2.1 Legal Barriers for Innovative Aquaculture Products (e.g., Algae)

The legal status of innovative aquaculture products such as algae-based foods presents numerous challenges across the examined countries, primarily due to regulatory ambiguity and jurisdictional conflicts. Most nations lack specific frameworks to address the unique production processes and characteristics of these products. Instead, operators must navigate generalized laws that are often unsuitable for innovative aquaculture. This creates significant uncertainty for businesses and hinders the growth of the sector.

Conflicts between authorities are a common issue, as seen in Greece, Italy and Montenegro. Jurisdictional overlaps and differing priorities among local, regional and national regulatory bodies often lead to delays and inconsistencies. For example, in Greece, regional authorities may approve an aquaculture operation only for central bodies like EFET to later find violations of national or EU standards. Similarly, in Italy,

ministries prioritize different aspects of aquaculture, complicating approvals for algae farming projects. Such conflicts not only slow down the regulatory process but also discourage investment in innovative practices.

Environmental and market entry barriers further complicate the integration of new aquaculture products. Strict environmental compliance requirements, including lengthy EIAs, add to the cost and time needed to launch projects. Market acceptance is another hurdle, as novel products including algae or halophyte-based foods or holothurians require additional certifications and scientific validation to meet EU standards. These processes delay commercialization and make it harder for producers to establish a foothold in the market.

Country-specific challenges exacerbate the situation. In France, for instance, the case-by-case evaluation of new species through the Marine Culture Commission (CMC) slows innovation. In Bulgaria and Montenegro, limited technical expertise and knowledge gaps in algae farming create further obstacles. Moreover, smaller enterprises in countries like Bulgaria struggle to access funding due to complex application processes. The high initial investment costs associated with innovative aquaculture also deter businesses from entering the field.

To address these challenges, countries need to develop clear regulatory frameworks tailored to innovative aquaculture products. Harmonizing the roles of conflicting authorities and simplifying permitting processes are essential for fostering growth in this sector. Investment in technical expertise and research will also help close knowledge gaps and support sustainable practices. Finally, efforts to educate consumers and align national regulations with EU standards can improve market acceptance and facilitate exports, enabling the aquaculture sector to thrive.

1.5 Best Practices and Comparative Analysis

1.5.1 Case Studies of Best Practices

In the evolving landscape of aquaculture, regulatory frameworks and licensing approaches play a pivotal role in ensuring sustainable growth, environmental stewardship and economic viability. This presentation brings forward successful case studies from the Euro-MED region and beyond, showcasing innovative and effective regulatory practices tailored to the diverse needs of aquaculture stakeholders.

By exploring these best practices, we aim to provide actionable insights that can inspire improvements in policy design, enhance stakeholder collaboration and address challenges such as resource management, environmental impact and social acceptance. These examples serve not only as benchmarks but also as catalysts for discussions on adopting adaptable and region-specific strategies to advance the aquaculture sector.

Let us delve into these case studies to uncover valuable lessons and pave the way for more resilient and forward-thinking aquaculture governance.

1.5.1.1 Spain:

The **Acuivisor** initiative is a cutting-edge monitoring tool for aquaculture in Spain that aims to increase information access and openness in the industry. Its objective is to gather and arrange aquaculture-related data, including the locations of facilities, the kinds of species raised and output levels. This application helps public authorities make decisions and enhances public communication by making it easier to monitor aquaculture operations.

Figure 1. Acuivisor program. https://servicio.pesca.mapama.es/acuivisor/

This platform, created by Spain's Ministry of Agriculture, Fisheries and Food in collaboration with the regions promotes ocean conservation and sustainable use in line with the 2030 Sustainable Development Goals of the UN. By making important information available to scientists, businesspeople, legislators and the general public, it seeks to increase the transparency of the aquaculture industry.

It is highly relevant the Andalusian best practices **for identification of**

AZAs and implementing circular aquaculture. The Regional regulatory authority in Andalusia has developed a long and intense work for the mapping and identification of AZAs including assessment of marine cultures developed in the maritime-terrestrial zone, location of uses, activities and occupations, identification of potential areas for marine farming as study zones and conflicts of use setting indicators to monitor activity and a cartographic overview

available in the Andalusian Aquaculture Geographic Information System viewer[11]. This best practice was identified by the commission staff in the working document SWD(2024) 107 about Planning of space and access to water for marine aquaculture. This spatial planning allows Andalusia harmonizes aquaculture with other coastal activities, ensuring environmental sustainability and social acceptance.

In addition to maritime planning, Andalusia is pioneers in the modelling and implementation of innovative practices combining traditional extensive farming in salt marshes with the most advance IMTA and RAS production methods. Currently, several RAS facilities producing sole and amberjack were authorized in this region. More significantly, a highly innovative IMRAS combining IMTA and RAS was recently authorized (https://solee-gourmet.com). This production model combine flatfish farming in RAS with cultivation of oysters, halophytes in aquaponics and algae. This model was awarded twice National Prize for Research in aquaculture (JACUMAR) for technological development advances in 2021 (in collaboration with University Cádiz) and in 2023 (in collaboration with IFAPA). This model implements the best practices to efficiently manage effluents in marine aquaculture to produce novel marine biomass in aquaponics and microalgae.

Figure 2. IMTA-RAS system (CUPIMAR) in Andalusia.cuivisor program.

11 *https://www.juntadeandalucia.es/agriculturaypesca/sia/index.jsf. https://www.juntadeandalucia.es/organismos/agriculturapescaaguaydesarrollorural/areas/pesca-acuicultura/acuicultura/paginas/ZIA.html*

Italy

3

AWARE project

The **AWARE** project (Aquaponics Integrated with Wastewater Recovery) is an innovative best practice from Italy that seeks to create the first aquaculture facility in Europe that is integrated with a wastewater treatment plant. This project, which will be carried out in Castellana Grotte, aims to demonstrate how sustainable methods may be used to raise fish using reclaimed water.

The Horizon Europe program provides funding for the AWARE project, which is managed by Innova EU.

https://www.aware-eu.eu/the-project/

1.5.1.2 France

InnovaFeed and insect production

The largest insect protein production facility in the world has been set up in Nesle, northern France, by the French business **InnovaFeed**. Fish and poultry are fed with 15,000 tons of protein and 5,000 tons of insect oil produced by this company each year.

By using an "industrial symbiosis" concept, the production process lowers its carbon footprint by 80%. AI and automated procedures are used to do this, improving sustainability and efficiency. By substituting traditional animal feed with products obtained from insects, overfishing is lessened and the food chain is made more sustainable. In a similar way, the French business **Ÿnsect** uses cutting-edge technology to turn insects into premium proteins. In Amiens, the largest vertical insect farm in the world is built, a carbon-negative project. It

optimizes productivity through the use of cutting-edge data analysis.

https://innovafeed.com/

https://www.ynsect.com/

https://www.globalseafood.org/advocate/france-has-become-innovation-nation-for-insect-production/

1.5.1.3 *Greece:*

i.Kastelorizo Aquaculture S.A. and Environmental Monitoring

Wings ICT Solutions, a Greek tech business, has supplied Kastelorizo Aquaculture, which operates in the Saronic Gulf, with an advanced monitoring platform called AQUAWINGS. The system, which uses cameras and sensors to maximize farming conditions and reduce environmental effect, demonstrates how technology may improve aquaculture operations' sustainability and efficiency. Using cutting-edge equipment, this strategy not only supports ecological preservation initiatives but also highlights aquaculture's versatility.

https://www.wings-ict-solutions.eu/aquawings/

Figure 4.AQUAWINGS device

ii. AVRAMAR: A fresh way forward in Mediterranean aquaculture

By using electric stunning to decrease fish stress during harvest, Avramar is promoting moral behavior. By 2027, they want to apply this technique to all of their farms in Spain and more than half of their facilities in Greece. Additionally, they use feed that is sourced sustainably and they calculate and cut their carbon emissions in an effort to lessen their environmental impact. Avramar is also increasing the number of Aquaculture Stewardship Council certifications it holds, demonstrating its dedication to ethical farming methods.

https://www.preprints.org/manuscript/202402.1338/v1/download

Examples of innovative projects related to sustainable and circular production

systems, such as RAS and IMTA, include:

National and European Research Programs:

- AQUAEXCEL2020 and AQUAEXCEL3.0: Implemented with the participation of HCMR, this project focused on improving sustainable production through advanced aquaculture technologies.

https://www.aquaexcel2020.eu/

https://aquaexcel.eu/

Pilot Projects:

- Facilities combining RAS with algae or shellfish farming, leveraging fish waste products, such as EnAlgae Project in Europe.

https://repository.oceanbestpractices.org/bitstream/handle/11329/1550/WP1A6.01%20enalgae_bp_report_v6_5_Final.pdf?sequence=1

- IMTA applications in coastal areas aimed at improving water quality and increasing production capacity, such as IMPAQT project.

https://impaqtproject.eu/

Actions by Private Aquaculture Companies:

- Development of closed-loop systems (RAS) to minimize water use and enable fully controlled production, applied in species like sea bream and sea bass by Nireus and Philosofish. For instance, a well known action by Nireus is their ASC-certified production of sea bream and sea bass. This project integrates sustainable aquaculture practices, including advanced water management and efficient resource use, while ensuring high-quality fish production.

https://www.esmmagazine.com/fresh-produce/nireus-becomes-first-asc-certified-sea-bream-and-sea-bass-producer-in-europe-76252

These initiatives are often funded through European programs such as **Horizon Europe** or national development programs, aiming to promote sustainable production and minimize environmental impact.

1.5.1.4 France

The best practice that will be presented below is a good example of how the aquaculture industry succeeded in the implementation of a new innovative aquaculture production, without any support of a legal framework for IMTA or circular aquaculture.

Barba Group is conducting a series of ambitious projects to develop a seafood sector in France around the holothurian aquaculture (*Holoturia tubulosa*), mixing innovative

technologies, ecosystem preservation and a sustainable and structured economy.

The first project, HOLOSUD (2019-2021), laid the foundations of a fruitful collaboration between Ifremer, Cépralmar and CRCM, with an Occitanie Region and national funding from the Plan Littoral 21. It aimed to secure the supplying in holothurians, while preserving natural resources thanks to aquaculture. HOLONURS (2022), funded by the Occitanie EMFAF, then validated the hatchery and nursery production steps, towards a pilot scale deployment. Since 2023, HOLOPROD, funded through the national EMFAF, is carrying on its works with an objective of growing-out in natural environment and elaboration of zootechnical paths transferable to fishermen and shellfish farmers. Between 2024 and 2026, juveniles from the Palavas hatchery will be sown in three different lagoons in Occitanie Region (Prévost, Thau and Salins de Gruissan) and in the sea in SUD PACA Region (Baie de Tamaris in Var) and some tests will be done in Nouvelle-Aquitaine Region (Marais Oléron and in the sea) in association with other species (IMTA). These experiments will assess the growth and survival performances as well as the holothurian effects on sediments bioremediation.

Authorizations that were given in the project framework are only valid for experimental tests. There is no precise regulatory framework for the production phase.

Structuring regulation process for the growing-out in natural environment:

- Natura 2000: implementation of administrative and legal process for the targeted growing-out sites (Thau and Prévost), with an estimated period of one month.
- Marine culture permission (*Autorisation de culture marine*): request submitted to the Hérault departmental commission, with some periods between commissions (commissions are held each semester).
- For some site (Toulon, in department of Var), a public inquiry and a setting up of a specific sanitary protocol has been done.

These projects have been implemented trough a participatory approach. Presentations to local players and discussions on site have supported the project steps, leading to a commitment and an awareness of all stakeholders.

This project is a good illustration of an approach which is technologically innovative, ecologically and regulatory compliant, while involving professionals for a concrete and sustainable implementation.

1.5.1.5 Portugal

The development of good practices is an important part of the European strategic guidelines for more sustainable and competitive aquaculture in the EU.

Portugal in its Strategic Plan for Aquaculture, aims to disseminate the good practices for aquaculture production identified by the Commission among the aquaculture producers.

The implementation of these good practices aims to ensure that aquaculture operations are managed in such a way as to maintain the quality of farmed water, improve production efficiency through feed management and contribute to ensuring animal welfare. This set of measures results in healthier animals, reflected in the final quality of the product, while protecting ecosystems and maintaining economically viable resources for local communities. The implementation of good practices not only improves production efficiency but also adds value to the product and the confidence of more demanding markets (national or international).

Recently, European Union as published a report on "Good husbandry practices for aquaculture" (EU, 2024), to support member states in implementing the Strategic Guidelines for EU aquaculture.

The existence of a Maritime Spatial Plan (PSOEM, https://webgis.dgrm.mm.gov.pt/), which defines areas with potential for aquaculture, Aquaculture Production Areas (APA) for the cultivation of fish, shellfish and algae, as well areas for other sectors of the Blue Economy, is a good practice by identifying areas adequate for aquaculture, minimizing conflicts and environmental impacts.

Some good practices manuals or basic guides, have been developed by public entities, some within research projects, to provide information to aqua culturist on how to optimize rearing protocols envision higher growth efficiency and welfare promotion of the organisms, to achieve better quality products.

In The Code of Good Practice on fish welfare in aquaculture, drawn up by the Aquaculture Advisory Council (AAC), has been approved and sent to the European Commission and the Member States.

Title	Good Practices in Oyster Farming – Algarve, 2017
Editor	APA – Agência Portuguesa do Ambiente
link	https://apambiente.pt/sites/default/files/_SNIAMB_A_APA/Publicacoes/Guias_Manuais/Boas_Praticas_Cultivo_Ostra.pdf
Title	Basic guide on integrated multi-trophic aquaculture system in earthen ponds, 2023
Editor	AquaAmbi - INTERREG-POCTEP Espanha-Portugal, FEDER
Link	https://www.ipma.pt/resources.www/docs/publicacoes.site/eppo/AquaAmbi-Aquacultura_Sistema_Multi-trofico_Integrado_Tanques_Terra.pdf
Title	Guia básico Boas Práticas na Produção de Ostras, 2023

Edit or	AquaAmbi - INTERREG-POCTEP Espanha-Portugal, FEDER
Link	https://www.ipma.pt/resources.www/docs/publicacoes.site/eppo/AquaAmbi-Guia_basico_Boas_Praticas_Producao_Ostras.pdf
Title	The Code of Good Practice on fish welfare in aquaculture, drawn up by the Aquaculture Advisory Council (AAC), has been approved and sent to the European Commission and the Member States.

1.5.1.6 Italy

From a regulatory point of view, the case of the Positioning document of the Sardinia Region in the field of Maritime Space Planning is reported as a best practice. The document was approved on March 24, 2021 by the Regional Council and, following the European directives on the Blue Economy and Sustainable Blue Growth, it has acquired the value of a long-term strategic act. This document represents the first act of strategic direction on the Blue economy. With this document, the Autonomous Region of Sardinia recognizes crucial importance to the Blue Economy and its sustainable development (Sustainable Blue Growth). The Sardinia Region also recognizes as necessary the adoption of an overall development strategy for all the traditional sectors of the regional blue economy, in order to address the critical issues of conflicts of use and the challenges of climate change, while ensuring environmental protection. In addition, the need for integrated support policies for emerging sectors with a high rate of innovation (energy from marine renewable sources, the circular economy linked to the recovery of waste at sea and blue biotechnology) was mentioned.

The maritime governance activities were identified by an interdepartmental table (of which the IMC Foundation was a member during the BLUEfasma project), coordinated by the Department of Local Authorities, Finance and Urban Planning. Among the specific objectives of this key document, the following within the general objective “Contribute to the achievement of the objectives of the National Strategy for Sustainable Development, in harmony and in compliance with the United Nations 2030 Agenda and the Regional Strategy for Sustainable Development (SRSvS)” constituted a potential fertile ground for the activities of AZA4ICE in the Sardinian territory:

Sector 2 – Fishery and Aquaculture

SO 2.b - Ensure the development of existing marine and lagoon aquaculture activities, encouraging the diversification of production, the sustainable use of resources and technological innovation; identify, through spatial planning, the most suitable areas for this purpose (AZA) in order to reduce possible conflicts with other uses of the sea and ensure the protection of marine habitats.

SO 2.c - Promote aquaculture that follows an ecosystem-based approach and is in line with the principles of Blue Growth, the Green Deal and the Circular Economy.

SO 2.d - Promote multitrophic farming practices (i.e.: IMTA- Integrated Multi-Trophic Aquaculture) and low FFDR (Fish Feed Dependency Rate) and ecologically sustainable species, aiming at market diversification and favouring innovative and economically relevant species.

1.5.1.7 Croatia

In most counties in Croatia, aquaculture zones have been designated through the implementation of Integrated Coastal Management (ICM), which also envisages integrated fish farming. In these zones, the carrying capacity of shellfish production and health monitoring are primarily determined.

Applicable Legislation (in Croatian):

Studija korištenja i zaštite mora i podmorja na području Splitsko-dalmatinske županije, s naglaskom na djelatnost marikultrure, u multisketorskom kontekstu Integralnog upravljanja obalnim područjem (2012.)

Zona marikulture Z1 - Košara - Žižanj. Studija utjecaja na okoliš (2009)

Obalni plan Šibensko-kninske županije (2016.)

Applicable Legislation (in English):

Study of the use and protection of the sea and underwater areas in the area of Split-Dalmatia County, with an emphasis on mariculture activities, in the multi-sectoral context of integrated coastal zone management (2012)

Mariculture Zone Z1 - Košara - Žižanj. Environmental Impact Study (2009)

Coastal plan of the Šibenik-Knin region (2016.)

1. Public Consultation on the Draft Regulation for the Implementation of Measure IV.1 "Production and Marketing Plans" - This Ordinance determines the implementation of the award of support under measure IV.1. "Production and marketing plans" within Priority 2 of the European Union "Encouraging sustainable aquaculture activities and the processing and marketing of fishery and aquaculture products contributing to the security of food supply in the Union"

2. Project TAPAS (Tools for Assessment and Planning of Aquaculture Sustainability“) - Guidance for Aquaculture Licences and Permits (https://www.aquaculturetoolbox.eu/media/1256/00-tapas-guidance-document-aquaculture-licences-and-permits.pdf)

1.5.1.8 Norway

Norway's aquaculture sector operates under stringent environmental and health regulations, emphasizing sustainable practices such as RAS. Licenses are granted through a rigorous assessment process that evaluates environmental impact, operational plans and fish health management. Specific frameworks for RAS focus on water quality management and energy efficiency, ensuring sustainability at every operational level. Norway's success in aquaculture is bolstered by a strong emphasis on research and innovation, which drives the development of sustainable technologies. Collaborative efforts between government, industry and research institutions further strengthen the regulatory environment, making it robust and forward-looking.

EXPOSED Aquaculture Operations Centre

> An important aquaculture best practice from Norway is the "EXPOSED Aquaculture Operations Centre", which was created by SINTEF, one of the biggest independent research organizations in Europe. The goal of this program is to develop technology that will allow for the safe and sustainable production of seafood in "exposed" coastal and marine areas—that is, places subject to more powerful natural influences.
>
> https://www.sintef.no/
>
> https://www.globalseafood.org/advocate/norway-project-combines-offshore-wind-power-with-aquaculture/

1.5.1.9 Scotland

Scotland has established a well-defined regulatory system for aquaculture, supporting both RAS and Integrated Multi-Trophic Aquaculture (IMTA). The regulatory framework prioritizes sustainability, biosecurity and environmental protection. Licensing responsibilities are divided between the Marine Scotland Licensing Operations Team (MS-LOT), which handles marine licensing, and local authorities, which oversee planning permissions. RAS systems benefit from specific guidance aimed at mitigating environmental impacts and optimizing resource use. Scotland's success is attributed to clear guidelines on biosecurity and environmental monitoring, which ensure compliance and sustainability. Regular stakeholder engagement fosters adaptive management, allowing for the integration of new technologies and practices into the aquaculture sector.

1.5.2 Lessons Learned for Stakeholders

1) Harmonization of Regulatory Frameworks

A key lesson emerging from the analysis is the critical importance of harmonizing regulatory frameworks across participating countries to foster a cohesive aquaculture industry. Diverse legal and institutional arrangements create significant barriers to

efficient licensing and compliance, particularly for IMTA-RAS. Stakeholders must prioritize aligning national regulations with broader EU directives, such as the Common Fisheries Policy, to streamline licensing processes and reduce jurisdictional conflicts. Collaborative efforts to develop shared standards and guidelines can enhance cross-border cooperation and improve the overall regulatory environment.

2) Importance of Decentralized and Streamlined Governance

Decentralized governance models, as observed in Greece, Spain and France, provide opportunities for localized solutions but often result in fragmentation and inefficiencies. Conversely, centralized systems, such as those in Croatia and Montenegro, offer consistency but lack the flexibility to address region-specific needs. A balanced approach that combines the strengths of both models can help stakeholders design governance structures that are efficient, adaptable and conducive to innovation. Digital platforms such as Portugal's B-Mar system demonstrate the potential for technology to reduce bureaucratic delays and increase transparency in aquaculture licensing processes.

3) Overcoming Barriers to Innovation

Legal and administrative challenges remain a significant hindrance to adopting innovative aquaculture systems. Outdated environmental regulations and complex licensing requirements often impede the deployment of eco-friendly techniques. Stakeholders need to advocate for regulatory updates that explicitly address these systems, providing clarity and incentives for their implementation. Additionally, fostering research and capacity-building initiatives can equip regulators and operators with the expertise necessary to navigate the technical complexities of these innovative systems.

4) Integrating Sustainability and Circular Economy Principles

Sustainability is at the heart of successful aquaculture practices. Legal frameworks that integrate circular economy principles, such as those observed in Italy's bioeconomy strategies, demonstrate the potential for aquaculture to align with broader environmental goals. Stakeholders should emphasize policies that promote resource efficiency, waste reduction and the use of renewable inputs in aquaculture operations. Supporting pilot projects and best practices—such as Andalusian's focus on RAS and IMTA, Norway's focus on RAS and France's initiatives in insect-based protein production—can help build a case for scaling up sustainable aquaculture systems.

5) Addressing Financial and Market Barriers

Financial constraints and market competition pose significant challenges, particularly for small-scale operators. High compliance costs and limited access to funding often restrict opportunities for growth and innovation. Stakeholders can work to identify and promote funding mechanisms, including subsidies and EU co-financing programs, that support sustainable aquaculture practices. Ensuring equitable access to these resources will be

vital for fostering inclusive growth within the industry.

6) Enhancing Stakeholder Collaboration

The complexity of aquaculture governance underscores the need for robust collaboration among stakeholders. Effective communication and coordination between regulatory authorities, industry operators and research institutions are essential for overcoming institutional conflicts and aligning objectives. Initiatives such as stakeholder workshops and participatory governance models can facilitate knowledge sharing and build trust among diverse groups. Moreover, integrating public consultation processes can help address social resistance and align aquaculture projects with community needs and values.

7) Leveraging Best Practices and Innovations

Case studies from participating countries highlight the value of adopting best practices to enhance regulatory frameworks and operational efficiency. Programs like Spain's Acuivisor and regional Andalusian's SIG as well as Italy's AWARE project provide actionable insights into leveraging technology and innovation to support sustainable aquaculture development. Sharing these experiences across borders can inspire new approaches and accelerate the adoption of proven solutions.

The lessons outlined above provide a roadmap for stakeholders to address the challenges and opportunities within the aquaculture sector. By focusing on harmonization, sustainability, innovation and collaboration, stakeholders can contribute to creating a regulatory and operational environment that supports the growth of a resilient, inclusive and eco-conscious aquaculture industry. These insights should serve as a foundation for discussions among LiRRIEs members, fostering a shared vision for the future of aquaculture in the Euro-MED region.

1.6 Recommendations for Legal/Regulatory Harmonization

1.6.1 Proposed Common Solutions for Participating Countries

a) Streamlining Licensing Processes

A unified approach to licensing across participating countries is crucial to reducing delays and increasing transparency. Countries should adopt digital tools like Portugal's B-Mar system to consolidate applications, streamline approvals and provide real-time updates to applicants. Harmonizing licensing criteria across the region, including clear definitions and indicatorsfor innovative systems IMTA- RAS, can further simplify the process and foster collaboration.

b) Aligning National Regulations with EU Directives

Participating countries must ensure their legal frameworks are in alignment with EU directives such as the Common Fisheries Policy and the European Green Deal. Standardizing key aspects like environmental impact assessments and operational monitoring can help create a level playing field, reduce jurisdictional conflicts and facilitate cross-border investments.

c) Promoting Research and Capacity Building

Investments in research and capacity-building programs are essential for regulators and operators to stay informed about innovative technologies and best practices. Establishing regional research hubs and knowledge-sharing platforms can enable stakeholders to address technical challenges and adopt advanced aquaculture more effectively.

d) Financial Incentives for Sustainable Practices

Financial support mechanisms, including subsidies and tax incentives, should be designed to encourage sustainable aquaculture practices. Participating countries can leverage EU funding programs to support small-scale operators and projects that demonstrate innovative and environmentally friendly methods. Enhanced financial accessibility will enable broader participation in the sector.

e) Encouraging Public-Private Partnerships

Building partnerships between public institutions and private operators can drive innovation and reduce administrative bottlenecks. Collaborative frameworks can also foster transparency and accountability while ensuring that aquaculture projects align with both national goals and local community interests.

f) Integrating Circular Economy Principles

Countries should adopt policies that emphasize the integration of circular economy principles into aquaculture operations. Encouraging the use of renewable inputs, recycling waste, and developing closed-loop systems can enhance resource efficiency and align the sector with global sustainability objectives.

g) Enhancing Stakeholder Engagement

Proactive engagement with stakeholders, including local communities, industry players, and environmental groups, is critical for building trust and addressing resistance to aquaculture projects. Structured consultation processes and participatory decision-making models can ensure that regulatory reforms are inclusive and reflective of diverse perspectives.

By implementing these solutions, participating countries can create cohesive and forward-thinking aquaculture sector that balances economic growth with environmental

sustainability and social inclusivity.

1.6.2 Enhancing Compliance with Project Results

a) Alignment with Legal Requirements

Ensuring that aquaculture project outcomes align with existing legal and regulatory frameworks is pivotal to their success and long-term sustainability. This alignment guarantees that innovative practices and outputs, such as those proposed in AZA4ICE, integrate seamlessly into existing legal structures, fostering smoother adoption and scaling of project outcomes.

b) Legal Framework Awareness and Integration

A comprehensive understanding of the legal and regulatory landscape is fundamental. The aquaculture sector operates within a multifaceted framework that encompasses environmental protection, public health standards and licensing procedures. Ensuring compliance begins with a thorough review of these frameworks at national and regional levels. For instance, the AZA4ICE project's methodology, which involves spatial planning and innovative production systems, must conform to national laws on water use, environmental impact assessments and biodiversity conservation

c) Stakeholder Engagement and Legal Synergy

Effective stakeholder engagement is instrumental in bridging project innovations with regulatory requirements. By involving public authorities, legal experts and industry players, projects like AZA4ICE can identify potential legal challenges early in the development phase. This collaborative approach not only facilitates compliance but also supports the co-creation of actionable solutions that are legally viable. For example, through the LiRRIE framework, stakeholders can collaboratively address barriers to implementing innovative aquaculture systems, fostering legal harmonization across regions

d) Capacity Building and Licensing Streamlining

Building institutional and operational capacity among stakeholders ensures that they are well-equipped to navigate the legal intricacies of aquaculture projects. Training initiatives and knowledge-sharing platforms can demystify complex licensing procedures, enabling stakeholders to adhere to regulatory requirements efficiently. The integration of digital tools like B-Mar in Portugal demonstrates how streamlining administrative processes can enhance compliance while reducing delays in licensing and implementation

e) Recommendations for Legal Harmonization

To enhance compliance, it is recommended to pursue harmonized legal frameworks that align across regions while respecting local nuances. Initiatives should focus on reducing

regulatory fragmentation by creating standardized guidelines for innovative practices. These guidelines should address common barriers like the high cost of permits and the lengthy approval timelines, particularly for small-scale operators

f) Monitoring and Adaptive Feedback

Continuous monitoring of project activities against legal benchmarks ensures sustained compliance. Establishing adaptive feedback mechanisms allows projects to remain responsive to changes in the legal landscape, safeguarding long-term viability. AZA4ICE's use of geospatial platforms and data-driven methodologies exemplifies how real-time monitoring can enhance alignment with regulatory standards.

By embedding compliance measures into the core project design and fostering partnerships with regulatory bodies, aquaculture initiatives can effectively navigate legal complexities while advancing sustainable and innovative practices.

1.7 Conclusion

The analysis of aquaculture regulatory frameworks in participating Euro-MED countries highlights a complex and fragmented legal landscape, with significant variations in governance structures. Some countries, like Montenegro and Croatia, employ centralized systems that offer consistency but lack flexibility, while others, such as Spainm Greece and France, rely on decentralized models that enable localized solutions but often lead to inefficiencies. Licensing processes are another critical barrier, with lengthy and costly procedures impeding industry growth and innovation. These challenges are particularly pronounced for advanced systems IMTA-RAS, which face outdated laws and a lack of tailored regulatory support.

Despite these challenges, there is a growing momentum toward integrating sustainability and circular economy principles into the sector. Countries like Italy and Portugal are adopting innovative practices, such as digital licensing systems, integrated bioeconomy strategies and maritime spatial planning, to enhance regulatory efficiency and environmental stewardship. Best practices from these nations demonstrate how technology, innovation and participatory approaches can address institutional inefficiencies and foster sustainable growth. However, high compliance costs and limited financial accessibility remain significant hurdles, particularly for small-scale operators, exacerbated by market competition from imports.

To address these issues, stakeholders should prioritize harmonizing legal frameworks across the region in alignment with EU directives, such as the Common Fisheries Policy and the European Green Deal. Streamlining licensing processes through digital platforms, fostering stakeholder collaboration and expanding capacity-building initiatives are crucial for promoting innovation and sustainability. Financial incentives, such as subsidies and EU funding, can further support small-scale operators and incentivize environmentally friendly practices. Scaling best practices, such as Portugal's digital tools and Norway's focus on sustainable systems, offers a clear pathway for advancing aquaculture in the Euro-MED region.

By implementing these measures, stakeholders can address existing barriers, foster collaboration and ensure the growth of a resilient, inclusive and eco-conscious aquaculture sector that aligns with global sustainability goals.

AZA4ICE

Interreg
Euro-MED

Co-funded by
the European Union