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Review of an Environmental Impact Assessment Report for a Greek Aquaculture Operation in the Corinthian Gulf in Aquaculture Development Areas (PAY) B.3. (Erateini), B.4 (Galaxidi) and B.5 (Antikyra) of the Regional Units of Fokida and Boeotia.

Final Report for the Rauch Foundation




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Abbreviations and Acronyms

APC	Advance Planning Consultants S.A.
DEYA	Hellenic Union of Municipal Enterprises for Water Supply and Sewage
EAFRD	European Agricultural Fund for Rural Development
EIA	Environmental Impact Assessment
EMFF	European Maritime and Fisheries Fund
EPXSAA	Spatial Planning and Sustainable Development Framework for Aquaculture
ESYD	Hellenic Accreditation System
EU	European Union
EUSAIR	EU Strategy for the Adriatic and Ionian Sea Region
FCR	Food Conversion Ratio
g	Gram(s)
GDP	Gross Domestic Product
GIS	Geographic Information Systems
HPHSAAY	Special Spatial Planning and Sustainable Development Framework for Aquaculture
kg	Kilogram(s)
km	Kilometer(s)
km^2	Square kilometer(s)
m	Meter(s)
MAFSAP	Special Spatial Planning and Sustainable Development Framework for Tourism
MEP	MacAlister Elliott and Partners Ltd.
MERAMOD	Predictive model for aquaculture (see https://cordis.europa.eu/article/id/81735-meramod-a-predictive-model-for-aquaculture)
MoARDE	Ministry of Agriculture, Rural Development and Environment in Cyprus
MSP	Marine Spatial Planning

NAVIPE	Marine Industrial Complex
ODA	Organized Development of Aquaculture
OP	Operational Programme
OTE	Hellenic Telecommunications Organization
POAY	Area of Organized Development of Aquaculture
PAY	Aquaculture Development Area
ppt	Parts per thousand
RAS	Recirculating Aquaculture System
ROP	Regional Operation Programmes
SEIA	Strategic Environmental Impact Assessment
Stremma	1 stremma = 1,000 square meters, plural = stremmata
SPA	Special Protection Area
SWOT	Strengths, Weaknesses, Opportunities, Threats
SWSGPR	Surface Water and Groundwater and Groundwater Aquifers
t	Tonnes
WFD	Water Framework Directive
WUA	Water Use Agreement
XADA	Areas of Uncontrolled Waste Disposal
XYTA	Sanitary Waste Landfills

Disclaimer

This report is prepared from the original source reports in Greek. Every effort has been made to accurately provide English translations of the text from which these reviews are based. However, there may be some variations in the spelling of local names and differences in the acronyms and abbreviations used. Every effort has been made to standardize these throughout the reports.

Explanatory Notes

EIA report: The descriptions under the heading EIA report refer to the reported topic as described in the EIA report.

EIA analysis: The commentary described under the EIA analysis section is MEP's independent assessment of the reported section's quality and likely impact.

Assessment criteria

The following assessment categories have been used when considering various aspects of the EIA.

Critical weakness: A critical weakness refers to a significant flaw or deficiency in the EIA report that has the potential to substantially undermine the accuracy, comprehensiveness, or credibility of the assessment. This could include fundamental errors or omissions in data collection or analysis, failure to consider key environmental impacts, or lack of compliance with regulatory requirements. Critical weaknesses typically require urgent attention and correction to ensure the integrity of the assessment process and the validity of its conclusions.

Major weakness: A major weakness denotes a notable deficiency in the EIA report that, while not as severe as a critical weakness, still has a significant impact on the overall quality and reliability of the assessment. This may include inadequate documentation of methodologies, incomplete analysis of potential impacts, or insufficient consideration of alternative measures or mitigation strategies. Major weaknesses require substantial remediation to address deficiencies and improve the overall robustness of the assessment.

Weakness: A weakness refers to a less significant flaw or limitation in the EIA report that may detract from its effectiveness or thoroughness but does not severely compromise its overall validity or utility. This could include minor inconsistencies in data presentation, gaps in information, or shortcomings in the assessment of certain environmental factors. While weaknesses may not necessarily invalidate the assessment, they still warrant attention and corrective action to enhance the credibility and reliability of the findings.

Minor weakness: A minor weakness indicates a relatively minor or incidental flaw in the EIA report that has minimal impact on the overall quality or integrity of the assessment. This might include inconsistencies or minor omissions in documentation. While minor weaknesses may not significantly affect the substance of the assessment, they should still be addressed to ensure clarity, accuracy, and professionalism in the report.

Executive Summary

This report analyses the findings of the Strategic Environmental Impact Assessment (SEIA) conducted for the proposed expansion of marine fish cage farming in the Corinthian Gulf region. The SEIA was commissioned to evaluate the environmental implications, regulatory compliance, and sustainability considerations associated with the expansion project.

Greece has favorable environmental conditions for marine fish cage farming. However, the rapid expansion raises concerns about its potential impact on the natural environment, coastal communities, and existing land uses.

The primary objective of the SEIA is to assess the environmental, social, and economic implications of expanding marine fish cage farming in the Corinthian Gulf. The study examines various aspects such as spatial planning, natural environment, environmental impacts, and mitigation measures.

The SEIA was undertaken in 2024 by Advanced Planning Consulting (APC), an environmental consultancy firm with expertise in conducting impact assessments and was based on data collected and analyzed in 2015.

The Strategic Environmental Impact Study (SEIS) covers the Area of Organized Aquaculture Development (POAY) in Aquaculture Development Areas (PAY) B.3. (Erateini), B.4 (Galaxidi) and B.5 (Antikyra) of the Regional Units of Fokida and Boeotia.

The POAY consists of 11 zones: 3 zones are in the PAY B3 of Erateini, 5 zones in B4 Galaxidi and 3 zones in B5 Antikyra. The total area of the proposed POAY zones is 13,231,877 stremmata with a total production area of 1,110 stremmata and a total capacity of 37,810 tonnes (t) of fish.

The supporting infrastructure for aquaculture units is important, requiring facilities such as fish hatcheries, packing stations, warehouses, and staff accommodations. Currently, four fish hatcheries with an annual capacity of 147,000,000 juvenile fish and two packing plants with a capacity of 10,504 t support the operations. However, these facilities are deemed inadequate for the existing needs.

The study evaluates existing urban planning regimes and land use regulations to ensure compatibility with the proposed expansion of marine fish cage farming. It categorizes aquaculture development areas based on their suitability and outlines specific guidelines for sustainable development.

The SEIA provides an overview of the present aquaculture situation in the Corinthian Gulf, listing existing aquaculture activities, production levels, and infrastructure. It also details the proposed expansion plans.

The study assesses the natural environment, including sediment quality, water quality, benthic macrofauna and flora, zooplankton, and the presence of Posidonia meadows. The study evaluates baseline conditions and potential impacts of aquaculture activities on these environmental parameters.

The SEIA details the results of studies undertaken by the University of Patras on the environmental impacts of marine fish cage farming, including nutrient enrichment, habitat degradation, water quality degradation, and biodiversity loss. The study briefly identifies potential theoretical mitigation measures to minimize these impacts, such as improved waste management, site selection criteria, and environmental monitoring programs.

The SEIA identifies environmentally protected areas in the study area, including wildlife sanctuaries, Natura 2000 sites, and habitats of endangered species. It assesses the potential conflicts between aquaculture development and conservation objectives, proposing measures to mitigate adverse impacts on protected areas and species.

The SEIA includes the identification of sources of pollution in the study area, including point sources such as aquaculture farms, industrial discharges, and non-point sources such as agricultural runoff and urban runoff. The study evaluates the potential impacts of these pollution sources on water quality and ecosystem health.

The SEIA includes a climate risk analysis to assess the vulnerability of aquaculture operations to climate change impacts, such as sea level rise, increased storm frequency, and changes in water temperature and salinity. It identifies adaptation measures to enhance the resilience of aquaculture farms and minimize climate-related risks.

The SEIA discusses the challenges encountered during the study, including data availability, stakeholder engagement, regulatory complexities, and uncertainties associated with the prediction of environmental impact. It highlights the importance of addressing these challenges to ensure the credibility and robustness of the assessment findings.

The SEIA acknowledges the need for complementary studies to enhance the understanding of specific environmental issues and refine mitigation measures.

Analysis of weaknesses and gaps in the report analysis

The report on aquaculture expansion in the study area of Central Greece presents several critical gaps and weaknesses. These issues, if unaddressed, could undermine the sustainability and environmental health of the region. This analysis explores the key shortcomings in the report, providing a detailed analysis of each identified weakness.

Environmental Impact Assessment of nutrient output

The report identifies a potential increase in nutrient output due to the proposed aquaculture expansion but fails to provide detailed quantification of these impacts. Without specific data on the increased nutrient load and its potential effects on the marine environment, it is challenging to assess the severity and extent of the impacts. The absence of precise measurements and projections leaves a critical gap in understanding how expanded operations will influence water quality, sediment conditions, and overall ecosystem health. This omission hinders the development of effective mitigation strategies and long-term environmental management plans.

This is a **critical weakness** because the lack of detailed quantification of nutrient output undermines the accuracy and comprehensiveness of the SEIA. Without this information, it is

impossible to accurately predict or mitigate the environmental impacts of nutrient accumulation, such as eutrophication, on water quality and ecosystem health.

Recommendation. To improve the accuracy of the environmental impact assessment, it is essential to conduct a detailed quantification of nutrient outputs from proposed aquaculture operations. This includes.

- **Baseline data collection**. Gather baseline data on current nutrient levels in the water column and in the sediments under and close to the fish cages.
- **Quantify inputs**. Quantify the present and expanded level of fish production and calculate the average standing stock and daily feeding rates.
- **Analyze nutrient fate**. Using mass balance equations analyze the fate of the Phosphorus and Nitrogen from feed to dissolved nutrients in the water column and particulate nutrients to the sediment.
- **Predictive modelling**. Use predictive models (such as MERAMOD) to estimate the increase in nutrient loads due to the proposed new level of operations (present and expanded). Assess the potential effects of nutrient accumulation, dissolved nutrients on water quality and eutrophication and effects of particulate accumulation on sediment quality and benthic organisms.
- **Assess predicted impac**t. Analyze the predicted impact in terms of severity and extent and assess whether the impacts are within acceptable thresholds or not. Adjust the scale of expansion to ensure environmental sustainability.
- **Mitigation strategies**. Develop and implement effective mitigation strategies based on the quantified data to prevent adverse environmental impacts.

Inadequate supporting service analysis

While the need for additional services to support aquaculture operations is acknowledged, the report does not thoroughly analyze the adequacy of existing resources or the additional requirements. There is a notable absence of detailed evaluations regarding road and marine traffic capacities, electrical supply, freshwater availability, waste management systems, and effluent treatment facilities. This oversight could lead to operational inefficiencies, increased environmental degradation, and potential conflicts with local communities over resource allocation. Effective planning of services is essential to ensure the sustainable expansion of aquaculture activities.

This is a **major weakness** because the lack of detailed services analysis significantly impacts on the overall reliability of the assessment. Without understanding the existing resources and additional requirements, the expansion may face operational inefficiencies and increased conflict for the use of limited resources, hindering the sustainable development of aquaculture.

Recommendation. Undertake a detailed analysis of the existing resources and quantify the additional requirements for supporting services.

- **Capacity assessments**. Evaluate the capacities of road and marine traffic, electrical supply, freshwater availability, staff housing, waste management, and effluent treatment facilities.
- **Quantify additional service needs**. Quantify the service needs for the expanded production for road and marine traffic, electrical supply, freshwater availability, staff housing, waste management, and effluent treatment facilities.

- **Assess impact on availability of available services**. Analyze the predicted impact in terms of needs and availability, needs of other users of the services and assess whether service resource is sufficient or not and whether additional investment is required to provide additional services. Adjust scale of expansion to ensure service resource availability.
- **Stakeholder engagement**. Engage with local government and communities to understand resource allocation concerns and address potential conflicts proactively.

Limited scope of alternative analysis.

The analysis of alternative development possibilities is limited in scope, focusing primarily on existing conditions and locations. This narrow focus restricts the exploration of potentially more suitable or innovative locations that could offer better long-term benefits for aquaculture and other stakeholders. For example, offshore locations or areas with less environmental sensitivity could provide opportunities for sustainable expansion while minimizing conflicts and ecological impacts. The lack of a broader exploration of alternatives weakens the overall assessment, potentially missing out on more optimal solutions for sustainable aquaculture development.

This represents a **weakness** because it limits the exploration of potentially more sustainable and beneficial alternatives for aquaculture expansion. Without considering other locations or innovative approaches, the assessment may miss opportunities for minimizing environmental impacts and conflicts with other land uses.

Recommendation. Broaden the scope of alternative analysis to identify the most suitable locations for sustainable aquaculture expansion.

- **Site suitability studies**. Conduct comprehensive site suitability studies, including deeper offshore locations, locations with stronger currents and areas with lower environmental sensitivity.
- **Avoid environmentally protected areas**. Relocate existing fish farms that are located in environmentally protected areas and recommend additional regular environmental monitoring of farms located close to the boundaries of the environmentally protected areas.
- **Comparative analysis**. Use multi-criteria analysis to compare the environmental and operational benefits of various locations to select the most optimal sites for aquaculture expansion.

Lack of detailed monitoring framework.

The report recommends continued environmental assessments but lacks specifics on the mechanisms for regular monitoring, compliance, and enforcement. Effective management strategies, including clear guidelines for monitoring nutrient and pollutant levels, are essential to ensure that aquaculture operations adhere to environmental standards. The absence of a detailed monitoring framework raises concerns about the ability to detect and mitigate negative impacts promptly, potentially leading to long-term ecological damage. Continuous and systematic monitoring is important for adaptive management and environmental protection.

This is a **major weakness** as effective management strategies, including clear guidelines for monitoring and compliance, are essential to ensure that aquaculture operations adhere to environmental standards. The absence of a detailed monitoring framework raises concerns about the ability to promptly detect and mitigate negative impacts, potentially leading to long-term ecological damage.

Recommendations. Develop a detailed, science-based, environmental monitoring framework for adaptive management and environmental protection.

- **Monitoring plan**. Develop a comprehensive monitoring plan with regular monitoring frequency, parameters to be sampled and analyzed, and specific indicators for nutrient and impact levels.
- **Compliance mechanisms**. Establish agreed quality thresholds, ensure transparent monitoring reporting requirements, arrange for regular compliance checks and enforcement of environmental standards with dis-incentives for non-compliance.
- **Adaptive management**. Implement an adaptive management approach that allows for timely detection and mitigation of negative impacts.

Lack of detailed mapping and protection of sensitive areas

The report acknowledges the presence of *Posidonia oceanica* meadows, a priority habitat, but lacks detailed mapping of these sensitive areas, particularly in zones proposed for expansion. Protecting these habitats is essential for maintaining biodiversity and ecological balance. Regular monitoring and stringent protection measures should be implemented to prevent degradation due to aquaculture activities. The absence of a comprehensive mapping and monitoring plan for sensitive habitats is a significant oversight, risking harm to important marine ecosystems.

This represents a **critical weakness** because detailed mapping and protection of sensitive habitats like *P. oceanica* meadows are essential for maintaining biodiversity and ecological balance in protected zones. Without this information, the potential for significant habitat degradation increases, jeopardizing marine ecosystems.

Recommendations. Implement comprehensive mapping and protection measures for sensitive habitats. Protecting sensitive habitats like *P. oceanica* meadows requires detailed mapping and stringent protection measures.

- **Habitat mapping**. Conduct detailed mapping of sensitive habitats in the zones proposed for expansion.
- **Protection measures**. Implement stringent protection measures and regular monitoring to prevent habitat degradation.
- **Biodiversity conservation**. Develop conservation strategies to maintain biodiversity and ecological balance in these protected areas.

Inadequate consideration of cumulative impacts

There is a lack of comprehensive analysis of cumulative impacts from multiple aquaculture operations within the same region. This is particularly critical in areas where several fish farms operate in proximity, potentially leading to cumulative nutrient loading, habitat degradation, and other compounded environmental effects. Over time, the combined effects of multiple farms can lead to significant environmental stress, including hypoxia and harmful algal blooms, which are not evident when considering individual farms in isolation. A cumulative impact assessment is essential for holistic environmental management.

This is a **major weakness** because cumulative impacts, such as nutrient loading and habitat degradation, can lead to significant environmental stress over time. The absence of a cumulative impact assessment undermines the ability to understand and mitigate these compounded effects.

Recommendation. Conduct a Holistic Assessment of Cumulative Environmental Impacts to fully understand the environmental implications of multiple aquaculture operations, a comprehensive cumulative impact assessment is necessary.

- **Zonal impact studies**. Conduct studies to assess the combined effects of multiple farms operating in proximity.
- **Integrated modelling**. Use integrated modelling approaches to evaluate the cumulative impacts on nutrient loading to sediments and the water column, habitat degradation, and other environmental stressors.
- **Mitigation planning**. Develop and implement zonal mitigation plans to address cumulative impacts and ensure sustainable aquaculture practices.

Socio-economic impacts

The report does not fully cover what would be expected in an Environmental and Social Impact assessment study at the site level and the study is **insufficient** in:

- Quantifying planned new facilities (land and sea) and their requirement for infrastructure (roads, fresh water, sewage treatment), labor and the use of inputs (feed and fingerlings) - major weakness.
- Proposing social mitigation measures to reduce impact - **major weakness**.
- Quantification on the use of resources and how these will be addressed (road traffic, marine traffic, additional electricity supply, additional freshwater supply, etc.) - **major weakness**.
- Quantification, solutions and impact from the project outputs such as wastewater treatment, solid waste disposal, and organic waste disposal - **major weaknesses**.
- The study shows no evidence of stakeholder consultation and effort to find mutually agreed mitigation measures to reduce social impacts – a **critical weakness**.
- Marine tourism (yachts, pleasure vessels) could be impacted by the floating cage collars as well as the boating activity during the farm operation – **minor weakness**.

Lack of detailed socio-economic impact analysis.

The report lacks a comprehensive socio-economic impact analysis, which is important for understanding how the expansion will affect local communities, tourism, and other economic activities. The interaction between aquaculture operations and existing land uses, such as agriculture and tourism, needs to be comprehensively assessed to identify potential conflicts and develop mitigation strategies. Additionally, the impact on employment, housing, schools and local businesses, and the broader economic landscape should be examined to ensure a balanced and sustainable development approach. Without this analysis, the socio-economic implications of aquaculture expansion remain unclear, risking unintended negative consequences for local stakeholders.

This is a major weakness as it significantly affects the assessment's comprehensiveness. The socio-economic interactions between aquaculture operations and existing land uses need to be thoroughly assessed to identify potential conflicts and develop mitigation strategies. The absence

of this analysis leaves a significant gap in understanding the broader impacts on local economies and communities.

Insufficient community and stakeholder engagement. There is a notable gap in the analysis regarding the level of community and stakeholder engagement in the planning and implementation of aquaculture projects. Effective environmental management requires the involvement and support of local communities and other stakeholders. Engagement processes should include mechanisms for transparent communication, regular consultations, and participatory decision-making to address the concerns and interests of all affected parties.

This is a major weakness because effective environmental management requires the involvement and support of local communities and other stakeholders. The lack of engagement mechanisms can lead to a lack of accountability and missed opportunities for incorporating valuable local knowledge and views into decision-making processes.

Insufficient stakeholder engagement strategies and conflict resolution

The expansion plan does not sufficiently address potential conflicts with various stakeholders, including local communities, fishermen, environmental NGOs, and government authorities. Ensuring effective stakeholder engagement is important for gaining community support and addressing concerns related to land use, resource allocation, and environmental impacts. The report should include strategies for conflict resolution and mechanisms for involving stakeholders in the decision-making process to build consensus and foster sustainable development. Effective engagement can enhance transparency, accountability, and the incorporation of diverse perspectives into aquaculture planning.

This is a major weakness as effective stakeholder engagement is important for gaining community support and addressing concerns related to land use, resource allocation, and environmental impacts. The lack of strategies for conflict resolution and stakeholder involvement could hinder the project's acceptance and implementation.

In Summary

The overall quality of the current SEIA is generally poor with many weaknesses and gaps in the prediction of future environmental impacts; it is our recommendation therefore that the SEIA be revised to address critical weaknesses, quantify predicted impacts, fill data gaps and reassess their findings.

1. Introduction

1.1 Background

Environmental Impacts

The addition of nutrients into the marine environment, often referred to as "nutrient enrichment" or "pellet rain," involves the input of nutrients from uneaten fish feed and fish waste. These nutrients can stimulate the growth of natural prey organisms, such as plankton and benthic organisms, which are important in the marine food web. However, marine fish cage culture significantly impacts marine ecosystems. Nutrient-rich waste from fish, including nitrogen and phosphorus, leads to eutrophication, causing excessive algae growth, reduced water clarity, and decreased oxygen levels, which can harm aquatic life.

Particulate waste like faeces and uneaten food increases organic sediment, affecting benthic organisms and seagrass beds, essential for ecosystem health. Chemicals used in fish cages can contaminate the environment, impacting benthic health. Additionally, fish cages can spread diseases and parasites to wild fish, with high fish densities accelerating pathogen transmission. Escaped farmed fish may also genetically dilute wild populations. These farms can disrupt natural habitats, predator-prey dynamics, and create noise pollution, further stressing marine environments.

Socio-economic Impacts

The marine fish cage farming industry plays a significant role in the economy and food security, offering substantial socio-economic benefits at both national and local levels. Nationally, it provides considerable job opportunities, contributes to foreign exchange earnings through exports, and supports economic diversification, especially in coastal regions where traditional fishing is declining. Locally, it generates employment in various sectors, aids in economic diversification, and contributes to community development through revenue that can be reinvested in projects like education and healthcare. Additionally, it supports local businesses by providing a reliable fish supply and stimulates skill development among workers.

However, the industry also presents socio-economic challenges. Environmentally, it can contribute to pollution, disease spread, and habitat destruction. Socially, it often leads to tensions between fish farmers, traditional fishers, and local communities due to resource competition, lack of transparency in decision-making, and uneven distribution of benefits. Locally, the visual impact of fish cages can affect coastal aesthetics, potentially deterring tourism, while increasing local marine and road traffic, straining freshwater resources, and impacting housing markets due to worker demand. Balancing these benefits and drawbacks depends on careful management and interaction with local communities, highlighting the complexity of assessing the overall impact of the fish cage farming industry in Greece.

1.2 Study Objective

A series of feasibility studies and Environmental Impact Assessments (EIAs) have been prepared for the designated POAY's. The focus of this report is the SEIA prepared by Advanced Planning Consultants S.A. (APC) in March 2024 in collaboration with the University of Patras and the Society of Environmental and Environmental Studies in Greece and for spatial studies with ENCON Consultants and Engineers SA. in 2015. Research from the Department of Geology, University of Patras research programme D.926 (Inventory of sedimentological and environmental parameters in aquaculture marine parks), 2015 is also presented in the study.

SEIA for the establishment of an POAY in PAY B.3 - Erateni, B.4 - Galaxidi and B.5 - Antikyra in the Regional Units of Fokida and Boeotia.

2. APC Advanced Planning - Consulting Consultants S.A. (APC S.A.)

The contractor of the study for the preparation of the project "Establishment of an Area of Organized Development of Aquaculture (POAY), Areas (PAY) B.3. (Erateini), B.4 (Galaxidi) and B.5 (Antikyra) of the Regional Units of Fokida and Boeotia.is the consultancy company Advanced Planning - Consulting Consultants S.A. (APC), which is engaged in the provision of services for development and spatial planning, environmental issues and the preparation of investment studies and programmes, the planning, management and evaluation of National and Community programmes.

For the preparation of the report. APC collaborated with the University of Patras and the Society of Environmental and Environmental Studies in Greece and for spatial studies with ENCON Consultants and Engineers SA.

APC, based in Athens, Greece, has expertise in the field of aquaculture, specifically in conducting EIAs for marine fish cages. The company specializes in various sectors, including fisheries and aquaculture, rural and regional development, and the marine environment.

APC has undertaken the coordination of the project titled “Monitoring and assessment of the conservation status of Community interest fish fauna species in Greece”. This project was assigned by the Greek Ministry of Environment, Energy and Climate Change and involved collaboration with research institutions.

APC's international certifications include ISO 9001:2015 and ISO 27001:2013.

Experience:

- APC has experience in environmental studies and consulting suggesting capabilities in this area.
- Their portfolio showcases a wide range of environmental projects, including studies for renewable energy, infrastructure development, and waste management, demonstrating their familiarity with complex environmental assessments.
- This experience, coupled with their understanding of Greek regulatory frameworks, indicates their potential to navigate the specific requirements of marine fish cage EIAs.

Expertise:

- APC has a team of professionals with expertise in environmental engineering, biology, ecology, and related fields.
- Their website describes expertise in water quality modelling, marine ecology assessments, and environmental impact assessment methodologies, all of which are components of marine fish cage EIAs.

3. Analysis of the Corinthian Gulf EIA

3.1. Scope of SEIA

EIA report: The project scope includes establishing multiple aquaculture zones across a large geographical area, with 11 zones spread over the coastal regions of several municipalities. The total area proposed for aquaculture development is 13,231.877 stremmata[1], with a production capacity of 37,810 t of fish.

The area under study for the creation of the POAY in the coastal area of the Municipalities of Tolofonos of the Municipality of Doris, Galaxidi and Desfinas of the Municipality of Delphi, as well as a small part of the Municipality of Antikyra of the Municipality of Distomo - Arachova - Antikyra of Boeotia. The largest part belongs administratively to the P.E. Fokida and is located in the southern part of the Gulf of Corinth.

The proposed MPA consists of 11 zones located in 3 zones

- (B.3.1, B.3.2, B.3.3, B.4.1, B.4.2, B.4.3, B.4.4, B.4.4, B.4.5, B.5.1, B.5.2 and B.5.3) for the farming of main fish, of which Zones B.3.1, B.3.2 and B.3.3 are located within the Eratini SAR,
- Zones B.4.1, B.4.2, B.4.3, B.4.4 and B.4.5 are located within the Galaxidi SAR and
- Zones B.5.1, B.5.2 and B.5.3 are located within the Eratini SAR. Antikyra.

The total area of the POAY zones is 13,231,877 stremma (total production area 1,110 stremma) and the total capacity is 37,810 t of fish.

3.2. Spatial planning and zoning aquaculture development

EIA report: The development of fish farming within the framework of an Organized Aquaculture Development Area (ODAA) is subject to numerous restrictions to ensure environmental sustainability, regulatory compliance, and the harmonious coexistence of different land and water uses. These restrictions are detailed within the Specific Framework for Aquaculture and related spatial planning documents.

Fish farming development is confined to designated Aquaculture Development Areas (ADAs), which are broader regions identified based on their suitability for aquaculture. These ADAs are classified into five categories (A to E), each with specific development guidelines.

- **Category A**. Highly developed areas requiring modernization, environmental protection, and infrastructure upgrades.
- **Category B**. Areas with significant potential for further development but currently have a limited concentration of units.
- **Category C**. Hard-to-reach areas with high potential for aquaculture that remain underutilized.

[1] *A unit of land area mainly used in Greece and Cyprus, equivalent to 1,000 m²*

- **Category D**. Sensitive areas where aquaculture operations must adapt to the specific environmental characteristics.
- **Category E**. Suitable areas for aquaculture that cannot support high concentrations of units or organized zones.

Fish farming zones within these categories must be defined by precise coordinates and can consist of one or more subzones.

Environmental protection. Environmental considerations impose strict limits on fish farming activities.

- **Water quality management.** Fish farming must not degrade water quality. This includes managing nutrient discharge, waste, and disease to prevent environmental harm.
- **Ecosystem preservation**. Aquaculture units must be sited away from sensitive habitats like wetlands to avoid ecological disruption. Specific species restrictions prevent the introduction of invasive species.
- **Biodiversity conservation**. Measures are in place to protect endangered species and maintain ecological balance. Regulations ensure that aquaculture does not harm local biodiversity.

Regulatory compliance. Compliance with a range of regulatory requirements is essential for fish farming development.

- **Permitting and licensing**. Obtaining necessary permits involves rigorous criteria, including environmental impact assessments and public consultations.
- **Operational and production standards**. Standards cover feed management, disease control, and waste disposal. Regular monitoring and reporting ensure ongoing compliance.
- **Coordination with other sectors**. Compatibility with tourism, residential developments, and port facilities is required. Aquaculture units must not interfere with these activities.

Infrastructure and resource constraints. Fish farming development also faces constraints related to infrastructure and resource availability.

- **Infrastructure development**. Adequate infrastructure, such as roads, water supply, and waste management facilities, is important. A lack of infrastructure can limit feasibility.
- **Resource availability**. Access to clean water and suitable land is essential. Competition for these resources with other sectors can impose restrictions.

Integration with other Spatial Planning Frameworks. Fish farming must align with broader spatial planning frameworks, including.

- **Tourism development**. Aquaculture must not conflict with tourism, and specific distances must be maintained from tourist facilities.
- **Industry and renewable energy**. Compatibility with industrial activities and renewable energy installations, such as wind farms, is required.
- **Regional plans**. The development must fit within regional spatial plans, considering local environmental and socio-economic contexts.

EIA analysis: The spatial planning for aquaculture development is regulated by the ODAA and ADA strategies but there are weaknesses in following these guidelines in terms of quantification and prediction of impact on the environment, risk assessment of cumulative impacts, weak SEIS reporting and lack of stakeholder engagement in the process.

3.3. Urban planning regime

EIA report: The urban planning regulations and land use regime in the wider area of the Planned Organized Aquaculture Development Area (POAY) play an important role in the development of aquaculture activities. The Specific Framework for Aquaculture provides detailed guidelines on how these areas are managed, ensuring that development is sustainable and compatible with existing land uses and settlement plans.

B.3 - The terrestrial area of PAY B.3 falls within the administrative boundaries of the Municipality of Tolofonos. The urban planning process for this area is still underway, with only Stage 1 of the "Plan of Spatial and Settlement Organization of the Open City" completed. Therefore, there are currently no specific land use and settlement zoning proposals affecting this study.

In most of the coastal areas of the Municipality of Tolofonos, off-plan building regulations apply, with specific conditions for settlements.

- **Eratini.** Governed by historical building decrees and conditions.
- **Paralia Tolofonos and Paralia Panormos.** Boundaries defined by various prefectural decisions.
- **Agios Spyridon and Agios Nikolaos.** Boundaries are also determined by prefectural decisions.

B.4 - The terrestrial area of PAY B.4 lies within the Municipality of Galaxidi, where the "Open City Spatial and Settlement Organization Plan" is in the consultation phase. Proposed zones in the onshore coastal area include.

- **MPA 6 - Area of Natural Beauty.** Includes regions declared as landscapes of outstanding natural beauty, with permitted uses like agriculture, educational establishments, and small-scale tourism facilities.
- **PEP 2B - Giannaki Peninsula.** A protected area within the Natura network, allowing activities such as traditional grazing and nature observation.
- **MAPD 4 - Area of Tourism and Organic Farming.** Allows for agricultural buildings, small tourist facilities, and certain utility structures.
- **MAPA 5A - Agricultural and Livestock Use with Alternative Tourism.** Permits farming buildings, educational institutions, and small-scale tourism facilities.
- **MIP 4 - Geo-environmentally Sensitive Area.** Prohibits any building and alteration of the soil.
- **Zone B of the Delphic Landscape Protection.** Allows traditional agriculture and beekeeping, prohibiting any alterations that could affect the landscape.

- **MAP 5 (AP) - Shoreline Protection Zone.** Prohibits permanent structures within 50 meters (m) of the shoreline, allowing only non-permanent structures for public convenience.

B.5 - The land area of PAY B.5 predominantly falls within the Municipal Unit of Desfinas, regulated by the "General Urban Plan." Key zoning regulations include.

- **Other rural Land.** Permits residential and small-scale alternative tourism accommodations, agricultural infrastructure, and processing units linked to on-site production.
- **Agricultural land for primary use.** Allows limited agricultural activities and prohibits non-agricultural uses.
- **Geologically unsuitable soils.** Prohibits building and allows infrastructure only after special geological surveys.
- **Coastal protection zone.** Prohibits permanent structures within 50 m of the shoreline, with specific guidelines for mobile beach equipment and road construction.

General provisions for aquaculture. Fish farming within these zones must comply with the Special Framework for Spatial Planning and Sustainable Development for Aquaculture. This includes adhering to specific environmental, operational, and land use regulations to ensure that aquaculture activities are sustainable and do not negatively impact other land uses or the natural environment.

Selection of the location. The selected location for the creation of the POAY is the result of accounting for a number of factors related to both the institutional framework and the character of the wider study area.

In principle, based on the existing institutional framework, as analyzed above, the development of the WFD is compatible with the guidelines of the overarching spatial planning, i.e. the Special Spatial Framework and the Regional Framework. Furthermore, it is compatible with the permitted uses of the currently established GAP of the Desfina Municipality.

EIA analysis: There are detailed guidelines on how the POAY are created and managed so that aquaculture development is compatible with existing land uses and settlement plans, but there is very little analysis and quantification in this EIA of the supporting infrastructure and services that will be required to support the increased fish production and their impacts on coastal development and local communities.

3.4. Present aquaculture situation

There are a total of 12 marine fish farming units are operating within the proposed zones of the PPA, with a total annual authorized capacity of 12,722.50 t of marine fish and a leased area of 434 stremmata. There are 2 fish packing plants, and 4 fish hatcheries are recorded, as shown in the table below.

Table 1: Fish Farming Units within PPAs B.3 - Eratini, B.4 - Galaxidi and B.5 - Antikyra

a/a	Institution	Location of the Unit	Marine area (stremma)	Eq. (t/year)
PAY B.3 (Eratini)				
1	Avramar Fish Farms S.R.O.	Vathia Lousa Bay, Municipality of Doris	42 (consisting of two sites)	1,624
2	Avramar Fish Farms S.R.O.	Ormos Xydia, Municipality Doris	10	225
3	Mediterranean Natural Seafood A.E.	Prasoudi, Municipality of Doris	10	150
4	Mediterranean Natural Seafood A.E.	Mavro Oros, Municipality of Doris	30	310
		TOTAL	**92**	**2,309.00**
PAY B.4 (Galaxidi)				
1	Mandrou Constance	Kontinova Bay, Municipality of Galaxidi	15	256.50
2	GALAXIDI Marine Farm SA	Cape Punta, Municipality of Delphi	60	1,650
3	GALAXIDI Marine Farm SA	Anemokambi Bay, Municipality of Delphi	40	877.50
4	GALAXIDI Marine Farm SA	Ormos Andromachi, Municipality of Delphi	100 (consisting of 2 sites)	4,700
		TOTAL	**215**	**7,484.00**
PAY B.5 (Antikyra)				
1	Fish Farms Antiquities S.R.O.	Rivers of Antikyra Bay, Municipality of Delphi	40	877.50
2	GALAXIDI Marine Farm SA	SouthCape Trachilos, Municipality of Delphi	67	1,352
3	GALAXIDI Marine Farm SA	West of Tsarouhi Island,	10	460
4	GALAXIDI Marine Farm SA	Municipality of Turk, Municipality of Delphi	10	240
		TOTAL	**127**	**2,929.50**

Source. Decentralized Administration of Thessaly & Thessaly and Sterea Ellada (Directorate of Rural Affairs of Sterea Ellada)

In addition to the above-mentioned farms, one (1) Mediterranean Marine Fish Farm is active in a marine area of 40 stremma with an approved capacity of 877.50 t (Table 2).

Table 2: Fish farms outside the zone

a/a	Institution	Location of the Unit	Marine area (stremmatas)	Eq. (t/year)
1	GALAXIDI Marine Farm SA	Vatheia Ports, Municipality of Doris	40	877.50

Source. Decentralized Administration of Thessaly & Thessaly and Sterea Ellada (Directorate of Rural Affairs of Sterea Ellada)

The above units (inside and outside the zones) operate in floating cages and are served by land-based supporting and accompanying facilities, which may include, where appropriate, hatcheries, packing stations, warehouses, staff buildings, etc.

In the Regional Unit of Fokida they also operate.

1. Four (4) fish hatcheries, with a total annual authorized capacity of 147.000.000 juvenile Mediterranean marine fish of an average weight of approximately 2 grams
2. Two (2) packaging facilities for fishery products, with a total annual licensed capacity of 10,504 t.

The above facilities are presented in detail in the table (Table 3) below.

Table 3: Land-based support facilities

a/a	Institution	Installation	Location of the Unit	Production
1	GALAXIDI Marine Farm SA	Fish hatchery	Tranos Aniforos, Municipality of Delphi	7,000,000 fish/year
2	GALAXIDI Marine Farm SA	Fish hatchery	Cape Trachilos, Municipality of Delphi	40,000,000 fish/year
3	Avramar Fish Farms S.R.O.	Fish hatchery	Chiliadou, Municipality of Doris	65,000,000 fish/year
4	Avramar Fish Farms S.R.O.	Fish hatchery	Lavria, Municipality Doris	35,000,000 fish/year
5	GALAXIDI Marine Farm SA	Packaging	Balathras, Municipality of Delphi	9,004 t per year
6	Avramar Fish Farms S.R.O.	Packaging	Wood, Municipality of Doris	1,500 t per year

Source. Decentralized Administration of Thessaly & Thessaly and Sterea Ellada (Directorate of Rural Affairs of Sterea Ellada)

3.5. Proposed expansion

EIA report:

Table 4: Summarised data provided for each zone, including the zone number, total area, existing farm sizes, areas, and proposed expansions.

Zone	Total Area (st)	Existing Farms Size (st)	Existing Annual Capacity (t/year)	Proposed Expansion (st)	Proposed Capacity (t/year)
B.3.1	884.49	42	1,849	80	2,400
		10		20	500
		Total. 52		Total. 100	Total. 2,900
B.3.2	200.00	10	150	20	500
B.3.3	1,131.37	30	310	100	3,000
B.4.1	128.03	15	256.50	20	500
B.4.2	387.58	60	1,650	60	1,650
B.4.3	304.15	40	877.50	40	880
B.4.4	1,475.62	100	4,700	170	7,700
B.4.5	1,045.83	0	0	100	3,300
B.5.1	2,062.07	40	877.5	140	4,380
B.5.2	3,785.48	77	1,812	200	7,000
B.5.3	1,827.25	10	240	160	6,000
Total	11,404.62	424	12,483	950	31,810

The expansion of fish farming in the ODAAs involves detailed planning and specific capacity limits for various zones. These expansions are designed to optimize production while maintaining environmental sustainability.

PAY B.3 (Eratini)

- **Zone B.3.1.** This zone currently operates one intensive fish farming unit with an annual capacity of 1,849 t. The proposed expansion includes:
  - Expanding the existing 42-stremmata plant to 80 stremmatas with a maximum capacity of 2,400 t/year.
  - Expanding the existing 10-stremmata plant to 20 stremmatas with a maximum capacity of 500 t/year.
  - Total proposed annual capacity. 2,900 t in a production area of 100 stremmata.
- **Zone B.3.2.** Currently has no aquaculture activity. The proposed expansion includes:
  - Establishing a plant of 20 stremmata with a maximum capacity of 500 t/year.
  - Total proposed annual capacity. 500 t in a production area of 20 stremmata.
- **Zone B.3.3.** Currently has no aquaculture activity. The proposed expansion includes:
  - Establishing a plant of 100 stremmata with a maximum capacity of 3,000 t/year.

- Total proposed annual capacity. 3,000 t in a production area of 100 stremmata.

PAY B.4 (Galaxidi)

- **Zone B.4.1.** This zone currently operates one fish farming unit with an annual capacity of 256.50 t. The proposed expansion includes:
  - Expanding the plant to 20 stremmata with a maximum capacity of 500 t/year.
  - Total proposed annual capacity. 500 t in a production area of 20 stremmata.

- **Zone B.4.2.** This zone currently operates one fish farming unit with an annual capacity of 1,650 t. No increase in capacity is proposed.
  - Total proposed annual capacity. 1,650 t in a production area of 60 stremmata.

- **Zone B.4.3.** This zone currently operates one fish farming unit with an annual capacity of 877.50 t. No increase in capacity is proposed.
  - Total proposed annual capacity. 880 t in a production area of 40 stremmata.

- **Zone B.4.4.** This zone currently operates one fish farming unit with an annual capacity of 4,700 t. The proposed expansion includes:
  - Continued operation of the existing 100-stremmata plant with a maximum capacity of 4,700 t/year.
  - Establishing a new plant on a leased area of 60 or 70 stremmata with a maximum capacity of 2,500 or 3,000 t/year respectively.
  - Total proposed annual capacity. 7,700 t in a production area of 170 stremmata.

- **Zone B.4.5.** Currently has no aquaculture activity. The proposed expansion includes.
  - Establishing a plant of 100 stremmata with a maximum capacity of 3,300 t/year.
  - Total proposed annual capacity. 3,300 t in a production area of 100 stremmata.

PAY B.5 (Antikyra)

- **Zone B.5.1.** This zone currently operates one fish farming unit with an annual capacity of 877.50 t. The proposed expansion includes:
  - Continued operation of the existing plant with a maximum capacity of 880 t/year.
  - Establishing new units with a total area of 100 stremmata and a capacity of up to 3,500 t/year.
  - Total proposed annual capacity. 4,380 t in a production area of 140 stremmata.

- **Zone B.5.2.** This zone currently operates one fish farming unit with an annual capacity of 1,812 t. The proposed expansion includes:
  - Expanding the existing plants to 100 stremmata with a maximum capacity of 3,500 t/year each.
  - Total proposed annual capacity. 7,000 t in a production area of 200 stremmata.

- **Zone B.5.3.** This zone currently operates one fish farming unit with an annual capacity of 240 t. The proposed expansion includes:

- Expanding the existing plant to 60 stremmata with a maximum capacity of 2,000 t/year.
- Establishing a new plant of 100 stremmata with a maximum capacity of 4,000 t/year.
- Total proposed annual capacity. 6,000 t in a production area of 160 stremmata.

The operation of floating fish farms and aquaculture units relies on the availability of onshore facilities and essential infrastructure. These components are critical for supporting the daily activities and long-term sustainability of aquaculture operations.

EIA analysis: The proposed expansion of aquaculture is from 12,483 to 31.810 t per annum (255%) and from an area of 424 stremmata to 950 stremmata (224%). This is a significant increase in production and production area that will have significant impact on nutrient output from the farms to the environment. These aspects are not quantified in the report and so it is very difficult to assess the severity and extent of the impacts of the proposed increases.

3.6. Supporting infrastructure required for the functioning of POAY

EIA report: The supporting infrastructure and services for POAY requires a comprehensive range of facilities and equipment essential for efficient and sustainable aquaculture operations. This infrastructure is required to support daily operations, ensure compliance with environmental standards, and facilitates the smooth functioning of the aquaculture units. The implementation of these infrastructures is important for the success and sustainability of the aquaculture development in the region.

Additional infrastructure and support facilities. To support floating fish farms, a variety of onshore facilities are required. These include fish hatcheries, fish packing facilities, berthing facilities for docking vessels and feed handling systems to store and distribute feed efficiently. Warehouses and storage areas for equipment like nets, as well as incinerators for fish mortalities. Staff accommodation and access roads to facilitate movement and logistics are required.

In total there are four (4) fish hatcheries in the area, with an annual capacity of 147,000,000 fish and two (2) packing plants with an annual capacity of 10,504 t. It is clear that the supporting facilities of the floating units are inadequate for the needs of the existing units.

The POAY requires a range of supporting infrastructure and equipment to ensure its functioning and the well-being of its employees. This includes both accompanying facilities and supporting facilities, as well as other essential infrastructure.

These facilities are important for the daily operations and logistics of the aquaculture units.

- **Piers and jetties.** Essential for docking and loading operations.
- **Seawater pumping and drainage systems.** Required for maintaining water quality and supply.
- **Feeding systems.** To efficiently distribute feed to the fish.
- **Warehouses.** For storage of equipment and supplies.

- **Outposts.** For staff and operational control points.
- **Storage areas for nets.** To store nets used in fish farming.
- **Incinerators.** For the disposal of deceased fish.
- **Staff accommodation.** Housing facilities for employees.
- **Access roads, vehicle working areas and parking.** To ensure proper transportation and logistics.
- **Farm management facilities.** Offices, communication networks, and equipment to support operations.

Other supporting facilities. These facilities support the aquaculture units but are not integral parts of them.

- Fish Hatcheries (FSS)
- Land based fish nurseries
- Packaging Plants
- Cold stores

Existing support facilities include four fish hatcheries with a total capacity of 147,000,000 fish per year and two packaging plants with a combined annual capacity of 10,504 t. However, these are inadequate to meet current needs, especially for packaging. Therefore, it is proposed to establish five new packaging plants and expand the existing ones to achieve a total annual capacity of at least 27,300 t.

The current state of these facilities is generally inadequate, necessitating improvements, expansion and additions. Specifically, 16 berthing facilities (piers) are required across the zones, with various other terrestrial infrastructures to be enhanced or established.

- **New berthing facilities (Piers).**
  - 16 new piers
    - 3 near the zones of B.3
    - 6 near the zones of B.4
    - 7 near the zones of B.5

- **New sites for support infrastructure.**
  - **Existing sites to be upgraded.**
    - 3 near the B.3 zones
    - 2 near the B.4 zones
    - 1 near the B.5 zones
  - **New sites to be established.**
    - 1 near the B.3 zones
    - 5 near the B.4 zones
    - 4 near the B.5 zones

- **New packaging plants.**
  - 5 new packaging plants
  - Increase packaging capacity to at least 27,300 t/year

- **Expansion of existing packaging plants.**
  - **Current capacity.** 10,504 t/year
  - **Target capacity.** Additional capacity to meet the 27,300 t/year requirement

- **New fish hatchery.**
  - To meet the needs for fry of the floating units in the area

Other management infrastructure and equipment requirements

- **Management Entity Facilities.**
  - Office premises with necessary office equipment and computers
  - Creation of a communication network with the units of the POAY

- **Pollution Protection Equipment.**
  - Acquisition or contractual access to a floating vessel and other pollution control equipment

- **Environmental Monitoring Equipment.**
  - Either acquisition of necessary monitoring equipment or contracting specialized laboratories to conduct environmental parameter measurements

Additional services. For the PPA and its aquaculture units to function effectively, additional services will be required. This includes reliable access routes for road transportation, freshwater supplies, staff accommodation, solid waste disposal, farm effluent and domestic wastewater treatment. Additionally, consistent power supply and telecommunications networks are necessary to support the technological and logistical needs of the units.

The report states that the Management Entity will inventory existing facilities to ensure compliance with current legislation, relocating units if necessary. It will plan further development in each zone, prioritizing facilities based on their necessity for operations and employee services.

EIA analysis: These additional infrastructure and services are required to support daily operations, ensure compliance with environmental standards, and facilitate the smooth functioning of aquaculture units. Insufficient infrastructure can lead to operational inefficiencies, environmental degradation, and compromised product quality, ultimately affecting the sustainability of the aquaculture industry.

Establishing comprehensive onshore facilities can offer numerous potential benefits, including enhanced operational efficiency, cost reduction through shared resources, environmental sustainability through centralized waste management, economic development through job creation, improved quality control, and enhanced monitoring and management of aquaculture activities. Centralized infrastructure within a POAY promotes collaboration and resource optimization, supporting the growth and sustainability of the aquaculture industry.

However, there are potential disadvantages associated with the establishment of supporting facilities. Securing land for onshore facilities may lead to conflicts with existing land uses, such as agriculture, tourism, and residential areas. Infrastructure development requires substantial investment and can be disruptive, facing delays due to regulatory approvals and community opposition.

- **Local communities:** Local communities may resist the establishment of aquaculture facilities due to concerns about the loss of natural landscapes, increased pollution, and traffic. They may also fear negative impacts on existing industries like tourism and agriculture, which could lead to conflicts over land use and resource allocation.
- **Fishermen and fishing associations:** Traditional fishermen and fishery associations may fear competition for resources, such as fishing grounds and market share, leading to conflicts over access to marine areas and market opportunities.
- **Environmental NGOs:** Environmental non-governmental organizations (NGOs) may oppose aquaculture expansion due to concerns about its environmental impacts. They may advocate for stricter regulations, environmental assessments, and monitoring to ensure the protection of marine ecosystems and biodiversity, potentially leading to conflicts with aquaculture operators and regulatory authorities.
- **Government authorities:** Government authorities responsible for regulating and overseeing aquaculture activities may face conflicts between promoting economic development and ensuring environmental sustainability. Balancing these competing interests requires careful policy-making and enforcement to mitigate conflicts and address stakeholders' concerns effectively.

Additionally, the concentration of aquaculture activities in specific locations may lead to localized environmental impacts, including disturbance of local ecosystems, water quality degradation, and threats to biodiversity.

- **Ecosystem disturbance:** The construction and operation of supporting facilities, such as jetties, piers and their associated marine traffic, can disturb local ecosystems and marine life, altering natural landscapes and disrupting habitats for marine flora and fauna. This disturbance may lead to conflicts with environmental conservation efforts and concerns about habitat degradation and loss of biodiversity.
- **Pollution and waste management:** Aquaculture operations generate organic waste, excess nutrients, and chemical pollutants, which can accumulate in marine environments and degrade water quality. Inadequate waste management practices, such as improper disposal of dead fish and excess feed, can exacerbate pollution problems, leading to conflicts with regulatory authorities, environmental NGOs, and local communities over pollution control measures and environmental compliance.

The additional infrastructure required to support the increased production is quantified but the services required to support the additional infrastructure are not quantified. There needs to be further analysis of the road and marine traffic, electrical requirement freshwater supplies, staff accommodation, solid waste disposal, farm effluent and domestic wastewater treatment to better

understand the availability of resources, need for additional resources, and impact on local communities.

Managing such a vast and diverse project involves significant complexity and coordination. Coordination among multiple zones and municipalities can be challenging, potentially leading to administrative and logistical inefficiencies. Conflicts may arise over resource allocation, infrastructure development, and environmental management, requiring careful planning and stakeholder engagement to mitigate.

3.7. Alternative development possibilities

EIA report:

Zero Solution. The zero solution, which entails not establishing a POAY, was considered but ultimately rejected. This approach contradicts the guidelines of the Special Framework for Aquaculture, which emphasizes the need for structured and sustainable spatial organization of aquaculture activities. Continuing with the current scattershot placement of units would hinder effective environmental management and fail to optimize economic development. Establishing a POAY offers significant advantages in terms of integrated environmental monitoring and enhanced local economic growth through well-organized and sustainable aquaculture operations.

Alternative Number of Zones. Reducing the number of zones was another alternative that was evaluated. This approach was dismissed as it would exclude some existing aquaculture units, disrupting their operations. The current proposal includes all existing units to ensure their continued functionality and potential for expansion within a regulated framework. The integration of these units into the POAY is important for maintaining the viability and sustainability of the aquaculture sector in the region.

Alternative Locations. Several alternative locations within the designated areas were considered but ultimately rejected due to various constraints, as follows:

- **PAI B3 (Eratini)**.
  - **West of Paralia Sergoula beach to Spilia**. Rejected due to residential development and the presence of four bathing beaches (Sergoula-Platania, Glyfada, Chania, Spilia). Additionally, the area includes underwater power transmission cables, and the narrow sea area north of Trizonia lacks sufficient depth and space for fish farming units.
  - **West of Ormos Douvia to south of Ormos Vlonos**. Rejected because it falls within the 1,000 m exclusion zone from the settlement of Agios Spyridon and contains two bathing beaches.
  - **West of Agios Nikolaos Bay to Tolofonos beach**. Rejected due to residential development, inaccessible rocky formations, and the presence of underwater antiquities.

- **PAI B4 (Galaxidi)**.
  - **South of Cape Punta to South of Itea Bay**. Rejected because it fails to maintain the required distances from the outlet of the wastewater treatment plant of Galaxidi and includes areas within the 1,000 m exclusion zone from the settlement and bathing beaches.

- **PAI B5 (Antikyra)**.
  - **Veresé Bay Area**. Rejected due to residential activities, presence of swimming beaches, and unsuitable environmental conditions.

Differentiation in zone extent. The alternative of adjusting the size of the zones was considered but dismissed for several reasons.

- **Smaller zones** would not support the sustainable expansion of aquaculture, compromising the viability and productivity of the units.
- **Larger zones** were deemed unnecessary based on current technical and environmental data and would potentially interfere with other activities and navigation.

For instance, extending zones B.3.1, B.3.2, B.3.3, B.4.1, B.4.2, B.4.3, B.4.4, B.4.5, B.5.1, B.5.2, and B.5.3 either towards residential areas, bathing beaches, or the open sea would cause conflicts with existing land uses or obstruct maritime navigation.

Alternative capacity. Determining the capacity of the units took into account environmental suitability, technical feasibility, and regulatory guidelines. The alternative of setting a higher capacity without maximum limits was evaluated but rejected to protect the marine environment. Despite the area's current satisfactory ecological status, it was prudent to limit capacity and review it after the full implementation of the zones to avoid potential management and environmental issues.

Alternative Dewatering Sites. Alternative locations and smaller areas for water dewatering sites were also considered but ultimately rejected. The selected sites are important for supporting the aquaculture units, offering similar environmental conditions to the operating units and being located at manageable distances to minimize costs and logistical challenges.

EIA analysis: There is some analysis of alternative possibilities in terms of location, extent and capacities but there are some significant weaknesses in the analysis.

- **Narrow focus on existing conditions**. The study places significant emphasis on the current location of aquaculture units and existing land uses. While this is practical, it may limit the exploration of potentially more suitable or innovative locations (particularly further offshore) that could offer better long-term benefits for aquaculture and other stakeholders.
- **Lack of detailed socio-economic impact analysis**. Although the study considers compatibility with other uses, it lacks a detailed socio-economic impact analysis. Understanding how different location choices could affect local communities, tourism, and other economic activities is important for a holistic evaluation.

While the study provides an analysis of alternative possibilities, it reveals several weaknesses that need to be addressed. Expanding the scope of location and capacity alternatives, incorporating detailed socio-economic impact assessments, and implementing adaptive management strategies will strengthen the overall evaluation process. By addressing these weaknesses, the study can ensure a more sustainable and balanced approach to aquaculture development.

3.8. Assessment of the natural environment

EIA report: The environmental monitoring program mandated by the circular from the Secretary General of the Ministry of Environment and Natural Resources. The sediment and water samples were collected by the sedimentology laboratory of the University of Patras and the research staff of ELKEΘE across multiple locations associated with existing fish farming operations.

The results of the analyses from these sampling points provided a comprehensive assessment of the environmental quality at these sites. The study undertook a new analysis of existing fish farm impacts. The study reported on the methodology and findings of the sedimentological, geochemical, and biological study of bottom sediments conducted in various marine aquaculture zones from 2014 to 2015. The study aimed to assess the environmental quality of these zones to ensure sustainable aquaculture practices.

The main findings from the University of Patras and ELKEΘE are summarized as follows.

3.8.1 Sediment quality

EIA report: The sediment and water samples were collected from several key locations. Anemokampi Bay, Kontinova Bay, South Cape Trachilos, Martyra S1, Potamos, and Ormos Andromachi. The sampling was conducted using a Van-Veen grab for sediments and plastic bottles for water samples at a depth of 0.5 m. The samples were preserved and transported to laboratories under controlled conditions.

Sediment quality. The study measured total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and several heavy metals (Cd, Zn, Cu, Pb, Cr, Ni) to determine the environmental impact of fish farms.

- **Total Organic Carbon (TOC)**.
  - **Findings**. TOC levels were within normal ranges across all sites.
  - **Impact**. Acceptable. Normal TOC levels indicate that organic matter accumulation from fish farming is not excessively high.

- **Total Nitrogen (TN) and Total Phosphorus (TP)**.
  - **Findings**. Highest concentrations were found at the Kirfis site.
  - **Impact**. Moderately acceptable. While higher TN and TP levels can indicate nutrient enrichment, localized high values need continuous monitoring to prevent eutrophication.

- **Heavy metals**.
  - **Cadmium (Cd)**.
    - **Findings**. Values were below the 1.31 ppm limit at all sites.
    - **Impact**. Acceptable. Low levels of Cd suggest minimal heavy metal contamination.
  - **Zinc (Zn)**.
    - **Findings**. Slight enrichment at one site, exceeding the 123 ppm limit.
    - **Impact**. Slightly concerning. Elevated Zn levels at one site warrant monitoring to prevent bioaccumulation.
  - **Copper (Cu)**.
    - **Findings**. Below the 28.70 ppm limit at all sites.
    - **Impact**. Acceptable. Low Cu levels are unlikely to pose environmental risks.
  - **Lead (Pb)**.
    - **Findings**. Below the 35 ppm limit at all sites.
    - **Impact**. Acceptable. Low Pb levels indicate minimal pollution.
  - **Chromium (Cr)**.
    - **Findings**. Enriched at several sites, exceeding the 25 ppm limit.
    - **Impact**. Concerning. Elevated Cr levels suggest potential contamination, necessitating further investigation.
  - **Nickel (Ni)**.
    - **Findings**. Enriched at most sites, exceeding the 19.5 ppm limit.
    - **Impact**. Concerning. High Ni levels indicate significant contamination that requires attention.

Granulometric Analysis. The particle size analysis classified sediments as sandy gravel, gravelly sand, muddy sand, and gravelly muddy sand. The biogenic origin of a significant portion of the gravel was also noted.

Sand Content.

- **Findings**. 17.60% to 86.01%, with an average of 61.82%.
- **Impact**. Acceptable. Varied sand content is typical and not indicative of adverse effects.

Silt Content.

- **Findings**. 0.00% to 38.39%, with an average of 12.87%.
- **Impact**. Acceptable. Normal silt levels indicate stable sediment composition.

Gravel Content.

- **Findings**. 0.87% to 82.40%, with an average of 25.32%.
- **Impact**. Acceptable. High gravel content, particularly of biogenic origin, is typical in marine environments.

Sediment Quality.

- **Kontinova Bay.** The bottom within 50m downstream of the leased area consists of sandy silt. Heavy metal concentrations (Cu, Zn) and nutrient parameters (TOC, TN, TP) were within normal levels, indicating no significant enrichment compared to the reference site.
- **Vathia Lusa, Potamos, Andromachi, Pounda, Anemokabi, Trachilos, Turkos, Tsarouhi, and Cape Pagalos.** Across these locations, similar trends were observed with normal levels of heavy metals. The ecosystems were classified as "environmentally unimpaired."
- **Ormos Vereses.** Across these locations, similar trends were observed with normal levels of heavy metals. The ecosystems were classified as "environmentally unimpaired."

Most parameters, such as TOC, TN, TP, Cd, Cu, and Pb, were at acceptable levels, indicating minimal environmental harm. However, the elevated levels of Zn, Cr, and Ni at certain sites are concerning and require ongoing monitoring to prevent potential bioaccumulation and ecosystem damage.

The report concluded that normal levels of heavy metals and nutrients were observed across all sampling sites, indicating minimal impact from aquaculture activities and that environmental impact of fish farms on bottom sediments was within acceptable limits, with some exceptions.

EIA analysis: Continued environmental assessments are necessary to ensure sustainable aquaculture practices that do not harm marine ecosystems. Monitoring and managing nutrient and heavy metal levels will help maintain the ecological balance and support the long-term viability of fish farming operations.

The study conducted an extensive analysis of sediment quality across various sites to evaluate the environmental impact of fish farms. Parameters such as total organic carbon (TOC), total nitrogen (TN), total phosphorus (TP), and several heavy metals (Cd, Zn, Cu, Pb, Cr, Ni) were measured. Additionally, granulometric analysis was performed to classify sediment types and assess particle size distribution.

TOC levels were found to be within normal ranges at all sites. This indicates that the accumulation of organic matter from fish farming activities is not excessively high, suggesting a balanced organic input-output relationship in the sediment.

The highest concentrations of TN and TP were observed at the Kirfis site. Elevated levels of these nutrients can lead to nutrient enrichment, which might cause eutrophication if not monitored and managed. While the current levels are moderately acceptable, continuous monitoring is essential to prevent potential adverse ecological effects.

The study measured concentrations of cadmium (Cd), zinc (Zn), copper (Cu), lead (Pb), chromium (Cr), and nickel (Ni) to assess heavy metal contamination. Several sites exceeded limits including Zinc, Chromium and Nickel and ongoing monitoring is necessary to identify the source of the contamination, prevent bioaccumulation and associated risks.

The sediment particle size analysis revealed a range of classifications, including sandy gravel, gravelly sand, muddy sand, and gravelly muddy sand, with significant portions of gravel being of biogenic origin. The results indicated that particle sizes were within the normal range.

Site-Specific Observations.

- **Kontinova Bay**: The bottom within 50 m downstream of the leased area consists of sandy silt. Heavy metal concentrations (Cu, Zn) and nutrient parameters (TOC, TN, TP) were within normal levels, indicating no significant enrichment compared to the reference site.
- **Vathia Lusa, Potamos, Andromachi, Pounda, Anemokabi, Trachilos, Turkos, Tsarouhi, and Cape Pagalos**: These locations showed normal levels of heavy metals, classifying the ecosystems as "environmentally unimpaired."
- **Ormos Vereses**: Similar trends of normal heavy metal levels were observed, classifying these ecosystems as "environmentally unimpaired."

Overall, the sediment quality across the studied sites indicates generally acceptable conditions with specific areas requiring attention. While organic carbon levels are within normal ranges, nutrient enrichment at the Kirfis site and heavy metal contamination (specifically Zn, Cr, and Ni) at certain sites highlight the need for ongoing monitoring and management. Granulometric analysis suggests typical marine sediment composition, further supporting the interpretation that the present level of fish farming activities have not led to significant adverse sediment quality impacts.

3.8.2 Water quality

EIA report: The observed nutrient enrichment near fish farms, as indicated by elevated TOC, TN, and TP levels, suggests that fish farming contributes organic waste to the environment.

Water Quality.

- **Kontinova Bay.** Nutrient levels in the water were within normal ranges, the water column was well-oxygenated, and no signs of hypoxia or eutrophication were observed.
- **Vathia Lusa, Potamos, Andromachi, Pounda, Anemokabi, Trachilos, Turkos, Tsarouhi, and Cape Pagalos.** Across these locations, similar trends were observed with normal levels of nutrients. The ecosystems were classified as "environmentally unimpaired." Well-oxygenated water columns were observed with no hypoxia or eutrophication.

Ormos Vereses. Normal levels of nutrients were observed. The ecosystem was classified as "environmentally unimpaired." Well-oxygenated water columns with no signs of hypoxia or eutrophication.

EIA analysis: While water quality levels were generally within acceptable limits, continuous monitoring is essential to prevent eutrophication, which could lead to detrimental effects such as algal blooms and oxygen depletion

3.8.3 Benthic macrofauna

EIA report: The study of benthic fauna provides important insights into the ecological impacts of fish farming activities on the marine environment. The benthic fauna sampling was conducted in two phases, in 2014 and 2015. The sites selected for sampling included areas near existing fish farms and reference sites away from the influence of aquaculture activities.

The study found a relatively high diversity of zoobenthic macrofauna near existing fish farms. The presence of polychaetes was a consistent finding across all sites, indicating their adaptability to varying environmental conditions influenced by aquaculture activities. Predatory copepods and Tanaidacea were also significant in terms of their abundance, suggesting a complex benthic ecosystem capable of supporting a variety of species.

The study provided a comprehensive assessment of benthic fauna near existing fish farms, revealing significant spatial variation in macrofaunal abundance and diversity.

Key observations.

- **High abundance near farms.** Stations close to fish farms exhibited significantly higher abundance and biomass, particularly at South Cape Trachilos.
- **Dominance of polychaetes.** Polychaetes were the dominant group across all sites, indicating their resilience to environmental changes associated with fish farming.
- **Variability in diversity.** Sites further from farms (e.g., Reference-C1) showed lower diversity and abundance, highlighting localised impacts of aquaculture activities.

Benthic Macrofauna.

- **Kontinova Bay.** The Benthic Quality Index (BQI) indicated a "Good" ecological status, consistent with the reference site.
- **Vathia Lusa, Potamos, Andromachi, Pounda, Anemokabi, Trachilos, Turkos, Tsarouhi, and Cape Pagalos.** Consistently classified as "Good" ecological status based on the BQI.
- **Ormos Vereses.** Classified as "Good" ecological status based on the BQI.

The report states that the results of the analysis showed that the zoobenthic biotic community in the Gulf of Itea does not exhibit characteristics of severe degradation. The relative homogeneity observed in both quantitative (abundance, biomass) and qualitative characteristics (group composition) between the sampling stations and the reference station indicates the limited influence of fish farming activity on the benthic macrofauna of the area. At the location south of Cape Trachilos, in the Gulf of Antiquity, the effect appeared to be relatively stronger. However, the composition of the macrobenthic fauna at this site does not show characteristics of prolonged anoxia and azoic conditions, such as those found under conditions of intense stress.

EIA analysis: The methodology employed for sampling and analysing benthic fauna near fish farms in the Corinthian Gulf was thorough, providing data on the ecological impact of aquaculture. While the diversity and abundance of benthic organisms indicate a functioning ecosystem, the dominance of certain taxa suggests localised environmental changes and impacts.

The study's findings indicate that while the diversity of benthic macrofauna remains high near fish farms, there are notable changes in the composition of these communities. The dominance of polychaetes and the increased presence of predatory copepods near fish farms suggest nutrient enrichment likely due to organic waste from the farms. Despite these changes, the benthic environment near the fish farms maintains its ecological functions.

However, the enrichment of certain taxa near fish farms points to localised environmental impacts, highlighting the need for ongoing monitoring and effective management practices to ensure the sustainability of aquaculture activities and the health of the marine ecosystem.

The observed levels of zoobenthic macrofauna and the presence of diverse taxa suggest that the benthic environment near fish farms is maintaining ecological functions. However, the elevated abundance of certain taxa like polychaetes and predatory copepods near farm sites indicates local nutrient enrichment, likely due to organic waste from the farms.

3.8.4 Benthic flora

EIA report: A comprehensive study was conducted to assess the phytobenthic biota and the ecological quality of four sites near existing fish farms in the Corinthian Gulf. These sites included Anemokabi Bay, Kontinova Bay, South Cape Trachilos, and a reference site, S1. The study aimed to evaluate the impact of fish farming on the local benthic ecosystems by examining macroalgal species and their coverage.

Species Composition.

- **Macroalgae.** Nine genera of macroalgae were identified, with 1 chlorophyte, 3 phaeophytes, and 5 rhodophytes. Three genera were classified in ESG-I and six in ESG-II.
- **Dominance of calcareous rose algae.** Across all sites, calcareous rose algae (*Corallinaceae*) dominated the rocky substrate, which was either bare or sparsely covered by small, low height macroalgae.
- **Sea urchins and sponges.** A significant presence of sea urchins (*Paracentrotus lividus* and *Sphaerechinus granularis*) and various sponge species was noted.

Ecological Status.

- **Coverage.** The percentage coverage of species varied across sites, with notable differences in the abundance of chlorophytes, phaeophytes, and rhodophytes.
- **EEI Classification.** All sites were classified as having "Good" ecological status due to the dominance of ESG-I species and the limited presence of ESG-II species.

Evaluation of Results.

- **Good ecological status.** The overall ecological quality status was determined to be "Good" across all sites. This was attributed to the strong presence of calcareous rose algae and the limited opportunistic species.

- **Impact of sea urchins.** The high abundance of sea urchins, which strip rocky substrates of vegetation, indicated an ecological issue unrelated to aquaculture activities. This pattern was consistent across both impacted and reference sites.
- **Predation and overfishing.** The absence of top predators, likely due to overfishing, has led to an increase in sea urchin populations and altered their behavior, resulting in significant predation on macroalgae.

Benthic flora.

- **Kontinova Bay.** The area was characterized by stripped phytobenthic biotic communities due to sea urchin predation, not associated with aquaculture activities.
- **Vathia Lusa, Potamos, Andromachi, Pounda, Anemokabi, Trachilos, Turkos, Tsarouhi, and Cape Pagalos.** Seagrass beds were observed within the bays at varying depths, indicating healthy benthic conditions.
- **Ormos Vereses.** Benthic Macrofauna as classified as "Good" ecological status based on the BQI. The presence of seagrass beds was noted, indicating healthy benthic conditions.

The study concluded that the ecological quality of the phytobenthic biota in the study area is "Good," primarily due to the dominance of calcareous rose algae. However, the extensive predation by sea urchins, resulting in the stripping of the rocky substrate, indicates system degradation not directly related to fish farming activities. This issue appears to be more widespread and likely linked to overfishing of top predators, which has altered the balance of the ecosystem. The findings suggest that while fish farming does not significantly degrade the benthic biological communities, broader ecological issues need to be addressed to improve the overall health of the marine environment.

EIA analysis: The results indicate that the overall impact of fish farming activities on the benthic biota in the study area is moderate and within acceptable levels. The ecological quality of the areas near the fish farms was found to be "Good," with strong dominance of ESG-I species and limited presence of ESG-II species. The findings suggest that.

- **Moderate impact from fish farms.** While some impact on benthic macrofauna was noted, particularly at the site south of Cape Trachilos, the levels of impact are not severe. The presence of a diverse range of benthic organisms and the similarity to reference sites indicate that fish farming activities do not significantly degrade the benthic environment.
- **Predation by sea urchins.** The primary ecological issue identified was the high level of predation by sea urchins, leading to the stripping of rocky substrates. This issue appears to be more related to the absence of top predators, likely due to overfishing, rather than fish farming activities.
- **Comparison with literature.** The observed abundance and biomass of organisms are consistent with values reported in the literature for areas close to fish farms. The BFI values also suggest that the organic load from fish farms is not creating adverse conditions for benthic organisms.

The impact of fish farming activities on the benthic flora in the study area is acceptable and within the range of impacts reported in similar studies. However, broader ecological issues, such as the

impact of sea urchins due to overfishing of predators, need to be addressed to maintain and improve the ecological quality of these marine environments.

3.8.5 Zooplankton

EIA report: Mesozooplankton were sampled in 2014 and 2015 at four sites, matching the locations of the zoobenthic sampling.

2014 Sampling.

- **Abundance.** Total zooplankton abundance varied significantly between sites, with 4031 individuals/m³ at Rivers-IXTH/S ANTIKYRA S.E. and 1659 individuals/m³ at Martyr-S2.
- **Dominant groups.** Copepods were the most abundant group, constituting around 70% of the zooplankton at both sites. The dominant genera included *Temora, Centropages, Clausocalanus, Oithona, Oncaea, Corycaeus*, and *Farranula*.
- **Other Groups.** Cladocerans, chaetognaths, and siphonophores were also present, though in lower numbers. Meroplankton (larval stages of benthic organisms) were found in low abundance.

2015 Sampling.

- **Abundance.** Zooplankton abundance ranged from 1223 to 3139 individuals/m³, with the highest at Anemokambi Bay and the lowest at the site south of Cape Trachilos.
- **Dominant groups.** Copepods dominated all sites, with Acartia sp. being the most prevalent in the Gulf of Itea and Clausocalanus sp. dominating south of Cape Trachilos.
- **Holoplankton and meroplankton.** Other holoplankton groups like euphausiids and chaetognaths were present in low abundance. Meroplankton were generally rare, except at Anemokambi Bay where they were absent.

The study highlighted a clear distinction in zooplankton composition between the Gulf of Itea and the site south of Cape Trachilos in the Gulf of Antikyra. The Gulf of Itea showed higher overall abundance and was dominated by the copepod Acartia sp., an opportunistic species typical of mesotrophic and temperate coastal areas. This suggests that the Gulf of Itea is a more fertile ecosystem favoring the development of such species, particularly in the spring season.
In contrast, the site south of Cape Trachilos exhibited more diversity in zooplankton species, indicative of the characteristics of more open waters in the Corinthian Gulf. The presence of various copepod species along with other groups like ostracods points to a different ecological structure compared to the Gulf of Itea.

Impact of Fish Farms.

- **Localized impact.** The study indicates that the impact of fish farms on mesozooplankton biota is localized and relatively minor. Nutrient enrichment from fish farms, primarily through fish excretion and feed, is rapidly diluted or absorbed by the microbial food web, limiting its impact on mesozooplankton.
- **Zooplankton adaptation.** Given their longer life cycle, mesozooplankton do not directly exploit nutrients from fish farms, suggesting that any impact is indirect and minimal.

The analysis of mesozooplankton samples reveals a division of the study area into two distinct ecological sub-areas. The Gulf of Itea is characterized by higher fertility and a dominance of opportunistic zooplankton species, while the area south of Cape Trachilos in the Gulf of Antikyra shows characteristics more typical of open waters with a greater diversity of zooplankton species.

EIA analysis: The results suggest a localized and minor impact of fish farms on the mesozooplankton biota.

- **Nutrient enrichment.** Nutrients from fish farms (mainly through excretion and feed) are quickly diluted or absorbed by the microbial food web, limiting their impact on zooplankton.
- **Zooplankton adaptation.** Due to their longer life cycles, mesozooplankton do not directly exploit these nutrients, suggesting minimal direct impact from fish farms.

Given the findings, the levels of impact observed are considered acceptable.

- **Localized impact.** The effects of fish farms are confined to a small radius around the farms, typically less than 200 m.
- **Minimal disruption.** The relatively low levels of zooplankton biomass and abundance near the fish farms indicate that the farms are not causing significant environmental degradation.
- **Comparable conditions.** The similarity in zooplankton composition and abundance between the sampling sites near fish farms and reference sites suggests that the overall ecological impact of the farms is minimal.

The study indicates that fish farming activities in the Gulf of Itea and the Gulf of Antikyra have a localized impact on the mesozooplankton community. The observed impacts are within acceptable limits. Further systematic monitoring is recommended to ensure continued environmental compliance and to detect any long-term changes.

3.8.6 Posidonia

The study undertook to locate and assess the presence of the marine plant *P. oceanica* in areas with existing fish farms. Four sites were investigated. Anemokambi Bay, Kontinova Bay, and South Cape Trachilos, all affiliated with GALAXIDI FISH FARMING S.A. and KIRFIS S.A. Divers conducted underwater videography using scuba diving. Dive profiles were recorded with a Suunto Vyper dive computer, which logged temperature and depth data.

P. oceanica was found in specific sites at depths of 7 – 17 m. Its limited distribution was likely due to water clarity, topography (steep slope), and substrate type.

Anemokambi Bay.

- **Findings.** Sparse stands of *P. oceanica* were identified at depths between 11 – 17.4 m. Below 17.4 m, the seabed was sandy, extending to 31.4 m depth. The seagrass meadows were approximately 150 m from the fish farm cages.
- **Visual Evidence.** Images showed the seagrass meadows at their shallow and deep boundaries.

Kontinova Bay.

- **Findings.** Beds of *P. oceanica* were present at depths between 8 – 14 m. No seagrass was found directly under the fish farm cages.
- **Visual Evidence.** Photos depicted the seagrass meadows at their shallow and deep boundaries.

South Cape Trachilos.

- **Findings.** *P. oceanica* was absent. The seabed was sandy from 5 m depth extending below the fish farm cages to 30 m depth.
- **Visual Evidence.** The dive profile and seabed images showed a sandy bottom.

EIA analysis: *P. oceanica* meadows are typical of the Mediterranean submarine zone, found at depths up to 30-40 m. These meadows grow on soft substrates and are considered one of the main-scale societies. *P. oceanica* can withstand significant fluctuations in temperature and water movement but is sensitive to decreases in water clarity and salinity, requiring salinity levels between 36 and 39‰.

The depth and density of Posidonia meadows depend on light availability and hydrodynamics. Most meadows occur between the isobaths of 5 – 35 m. The vegetation form of *P. oceanica* varies due to changes in light conditions, hydrodynamics, and substrate type, which can be rock, sand, or mud.

The mapping of habitat 1120 has categorized Posidonia meadows into:

- Pure *P. oceanica* meadows on sandy substrates with high density and uniform distribution.
- *P. oceanica* meadows coexisting with reefs, where the distribution of reefs influences hydrodynamic conditions suitable for meadow establishment.

P. oceanica meadows are listed as a priority habitat type in Annex I of Directive 92/43/EEC due to their ecological importance. These meadows are characteristic of the Mediterranean coastline and are absent only in conditions of low salinity, poor water renewal, or pollution. The habitat is important for biodiversity conservation and reducing coastal hydrodynamics.

Under Law 3937/2011, the establishment and operation of fish farms over Posidonia meadows is prohibited. According to the Commission's Communication 31722/04-11-2011, the siting of marine aquaculture units on seabeds with marine vegetation, including *P. oceanica* , is subject to specific conditions and restrictions established by Community and national legislation. Specifically, within protected areas of the European Ecological Network Natura 2000, the placement of marine aquaculture units over Posidonia meadows is not allowed.

Posidonia is strongly impacted by fish cage farms and so it would be expected that there are remaining Posidonia meadows located close to existing fish farms. However, there needs to be mapping of Posidonia beds in the proposed areas that will be expanded to ensure that the increased production in the increased area of production does not impact any Posidonia beds

located in those areas. In environmentally protected areas this mapping should be mandatory with regular monitoring of nearby Posidonia quality and health.

3.9. Comparison of survey results

EIA analysis: The marine environmental quality measurements were conducted as part of an ongoing environmental monitoring program mandated by the circular from the Secretary General of the Ministry of Environment and Natural Resources.

From 2020 to 2023, sediment and water sampling were conducted at various fish farm sites to evaluate their environmental impact. The University of Patras and ELKEΘE performed these analyses according to the Directive 2000/60/EU and the guidelines set by the Ministry of Environment and Natural Resources. The sampling involved geochemical, nutrient, and benthic macrofauna analyses, with sediment samples collected at 50 m downstream of the fish farms and reference sites.

The results of the analyses from these sampling points provided a comprehensive assessment of the environmental quality at these sites. The main findings from the University of Patras and ELKEΘE are summarized as follows:

Evaluation of environmental impact

- **Ecological status.** The overall ecological status of the study areas was classified as "Good" according to the Community Water Directive (WFD) (2000/60/EC) and "Good" ecological status based on the Benthic Quality Index (BQI) and Ecological Evaluation Index (EEI).
- **Geochemical parameters.** Normal levels of heavy metals and nutrients were observed across all sampling sites, indicating minimal impact from aquaculture activities.
- **Sediment and water quality.** Across all sites, heavy metals and nutrient levels were within normal ranges, indicating minimal pollution and eutrophication.
- **Benthic and phytobenthic communities.** The presence of stripped phytobenthic communities due to sea urchin predation was noted, but this was not associated with aquaculture activities. The absence of significant nutrient loading and the presence of stable phytobenthic communities suggest that the fish farms are not causing severe degradation to the benthic and phytobenthic communities.
- **Seagrass beds.** Healthy seagrass beds were present at various locations, further indicating minimal impact on benthic communities from aquaculture operations.

The findings suggest that the environmental impacts from the existing fish farms are minimal and localized. The "Good" ecological status across multiple parameters indicates that the current aquaculture practices are sustainable and within acceptable environmental impact levels. Continuous monitoring and adherence to environmental management plans are important to maintaining this status and ensuring long-term sustainability of the marine environment.

EIA analysis:

Table 5: Results for each of the ten fish farms

Location	Sediment Type	Heavy Metals	Nutrients	Ecological Status	Phytobenthic Community	Posidonia Meadows
Kontinova Bay. Mrs K. Mandrou	Sandy silt	Normal	Normal	Good	Stripped by sea urchins	Present at depths 4-14m
Vathia Lusa, Nireus	Silt	Normal	Normal	Good	Good	Not found
Antikyra Fish Farms	Sandy silt	Normal	Normal	Good	Not assessed	Not found
Galaxidi	Sandy clay	Normal	Normal	Good	Good	Not found
Punta, Galaxidi	Loamy sand	Normal	Normal	Good	Stripped by sea urchins	Not found
Anemokabi, Galaxidi	Sandy silt	Normal	Normal	Good	Not assessed	Not found
Trachilos, Galaxidi	Loamy sand	Normal	Normal	Good	Not assessed	Not found
Turkos, Galaxidi	Sandy silt	Normal	Normal	Good	Good	Not found
Tsarouhi, Galaxidi	Sand	Normal	Normal	Good	Not assessed	Not found
Cape Pangalos, Galaxidi	Rocky-sandy, limestone	Normal	Normal	Good	Good	Not found

The impacts observed at each fish farm are considered medium to good given that:

- Heavy metal and nutrient levels remain within normal limits but with some exceptions.
- The ecological status remains "Good" across all sites.
- The observed sea urchin predation is a broader ecological issue not directly linked to fish farming.
- The stability of conditions over multiple years (2014-2015 and 2019-2022) indicates that fish farming activities are sustainable and do not significantly disrupt the marine environment.

However, there has been very little analysis of the potential impact on the environment due to the proposed expansion of the farms. There needs to be a quantification of the expected particulate and dissolved nutrient output from the expanded farms and an assessment made of the potential individual and cumulative impact of the farms.

Continuous monitoring and adherence to best practices will be essential to maintain these standards.

3.10. Environmental impact of aquaculture

EIA report: The environmental impacts of aquaculture activities in Greece, particularly those associated with the installation and operation of marine and terrestrial facilities, are multifaceted. These impacts can be categorized based on their effects on the aquatic and terrestrial environments.

- **Aquatic Environment Impacts.** Marine aquaculture, primarily involving floating installations such as fish and shellfish cages, exerts several pressures on the aquatic environment. The visual impact on the coastal landscape is immediately apparent and often criticized, although it is reversible and non-permanent. Despite concerns about visual aesthetics, substantial environmental damage from aquaculture operations has not been evidenced in recent studies.
- **Terrestrial Environment Impacts.** Land-based facilities, including hatcheries, pre-fattening plants, packaging units, and oyster purification centers, also impact the environment. The most significant concerns relate to visual alterations and restricted coastal access due to infrastructure. However, these impacts are mitigated by stringent environmental regulations that govern the construction and operation of these facilities.

Aquaculture is often perceived as an environmentally friendly activity. From a scientific standpoint, intensive aquaculture represents a linear flow of energy—from exogenous food supply to cultivated organisms and ultimately to the environment. This process suggests that the environmental impact of aquaculture is additive. However, research findings from Greece and the European Union indicate that the environmental impact of aquaculture is minimal compared to agriculture and urban development. This impact is geographically limited, generally extending no more than 100 m from the farm site.

Major Impacts of Marine Fish Farming:

Bio-geochemical Impacts. Marine aquaculture primarily affects the bio-geochemical parameters of the marine environment. The introduction of nutrients such as nitrogen and phosphorus, originating from fish faeces and food losses, leads to a localized increase in nutrient concentration and a reduction in dissolved oxygen levels near the seabed. However, these effects are temporary; areas show significant recovery within six months after farm operations cease or relocate.

Landscape and visual impacts. Aquaculture installations can alter the landscape and views, potentially causing a nuisance to local residents. While this issue is not universal, it highlights the need for careful site selection. Successful coexistence examples include highly developed tourist areas like the coast of Nice in France and Monaco, as well as areas in Greece like Galaxidi, where aquaculture and local communities live together.

Specific environmental impacts. The table below summarizes the environmental impacts of aquaculture, particularly in the context of the establishment of POAYs.

Environmental Parameter	Impact
Biodiversity (flora and fauna)	Concentrated aquaculture activities minimize negative impacts on biodiversity compared to scattered units and facilitate integrated environmental monitoring.
Population	Establishment of POAY enhances local economic development by creating new job opportunities.
Human Health	POAY promotes monitoring of environmental impacts, ensuring a healthy aquatic environment and safe aquaculture products for consumers.
Land	Placement of units in organized receptors and creation of supportive onshore infrastructure contribute positively to soil protection.
Water	Strengthened mechanisms for water quality monitoring in breeding areas.
Pollution	Environmental protection is achievable through collective waste recycling and management agreements.
Cultural Heritage and Landscape	Organized placement of units enhances the landscape character.

Recent research in Greece has significantly advanced the understanding of aquaculture's environmental interactions. Studies have examined various parameters, such as nutrient concentration, plankton dynamics, macrophyte meadows, benthic organisms, and fish populations. Key findings from these studies include.

- **Nutrient concentrations**. Dissolved waste from fish farms, such as ammonia and phosphate, show minimal effects on nutrient concentrations in surrounding waters. Solid waste, however, leads to detectable changes in sediment characteristics beneath the cages, but these effects are confined to a small radius (10-25 m) from the cages.
- **Plankton**. Studies indicate no significant differences in plankton abundance and diversity near fish farms compared to control sites. Grazing by microplankton helps prevent phytoplankton blooms despite continuous nutrient supply.
- **Benthic fauna**. The deposition of particulate matter affects benthic organisms under the cages, reducing diversity and favoring small opportunistic species. However, these effects are limited to a small area and vary with environmental conditions such as bathymetry and hydrodynamics.
- **Fish fauna**. Fish farms increase local fish abundance and biomass, particularly in oligotrophic environments like the Aegean Sea. This enhancement does not occur as markedly in more nutrient-rich environments like the North Atlantic.
- **Biodiversity**. While aquaculture affects certain species and reduces biodiversity under the cages, it does not pose a significant threat to overall biodiversity. The impact on *P. oceanica* meadows; however, is notable and warrants careful management.
- **Water quality degradation:** Aquaculture activities introduce nutrients like nitrogen and phosphorus into the water, which can lead to eutrophication and algal blooms if not properly managed. Increased nutrient levels can degrade water quality, harm marine life, and threaten the health of coastal ecosystems, potentially leading to conflicts with environmental regulators and conservationists.

- **Biodiversity Threats:** The concentration of aquaculture activities in specific locations may lead to localized biodiversity loss and ecosystem imbalances. The introduction of non-native species, disease outbreaks, and genetic contamination from escaped farmed fish pose significant risks to native biodiversity and ecosystem functioning, raising concerns among environmental stakeholders and conservationists.

EIA analysis: The study identifies the main environmental impact of aquaculture development and highlights the positive aspects of aquaculture, such as lower impact compared to agriculture and urban development, and the potential for landscape enhancement. However, it tends to downplay or insufficiently detail the negative consequences, potentially leading to a biased perspective that might not fully represent the environmental risks and challenges.

The study has a number of gaps and weaknesses in the environmental analysis.

- **Insufficient long-term impact assessment.** The analysis predominantly focuses on short-term impacts and their immediate remediation. While it acknowledges that the seabed can recover within six months, it lacks a detailed examination of potential long-term ecological impacts, such as chronic nutrient accumulation, persistent chemical residues, or long-lasting changes in local biodiversity.
- **Limited geographical scope.** The study's scope is largely confined to the immediate surroundings of the fish farms, typically within a 100-meter radius. This narrow focus overlooks potential broader environmental impacts on the larger marine ecosystem, such as changes in water currents, sediment transport, and wider marine life distribution patterns that might be influenced over time.
- **Inadequate consideration of cumulative impacts.** There is a lack of comprehensive analysis of cumulative impacts from multiple aquaculture operations within the same region. This is particularly critical in areas where several fish farms operate in proximity, which might lead to cumulative nutrient loading, habitat degradation, and other compounded environmental effects that are not addressed individually.

The study has a number of gaps and weaknesses in the socio-economic and governance analysis.

- **Insufficient analysis of socio-economic impacts.** While the study mentions the potential for job creation and economic benefits to local communities, it does not thoroughly analyze the socio-economic impacts. This includes potential conflicts with other coastal activities such as tourism and fishing, changes in property values, or the social dynamics within local communities impacted by the visual and environmental changes brought by aquaculture operations.
- **Lack of detailed regulatory and monitoring framework.** The study mentions the importance of regulatory frameworks and monitoring but lacks detailed recommendations or descriptions of the specific regulatory measures and monitoring protocols necessary to ensure compliance and mitigate environmental impacts. The analysis would benefit from a clearer outline of the roles and responsibilities of various stakeholders, including government agencies, local authorities, and the aquaculture industry.

- **Community and stakeholder engagement.** There is a notable gap in the analysis regarding the level of community and stakeholder engagement in the planning and implementation of aquaculture projects. Effective environmental management requires the involvement and support of local communities and other stakeholders, which is not adequately addressed in the analysis.

While the analysis provides a foundational understanding of the environmental impacts of marine fish farming in Greece, addressing these identified gaps and weaknesses is important for a more comprehensive and balanced assessment. Enhanced focus on long-term impacts, cumulative effects, socio-economic considerations, regulatory frameworks, and stakeholder engagement will contribute to more sustainable and environmentally responsible aquaculture practices.

3.10.1 Environmental mitigation measures

EIA report: The report states that significant progress has been made in minimizing aquaculture's environmental impacts through improved management practices and technological advances. These include:

- Development of optimized feeding protocols to improve food conversion ratios (FCR).
- Implementation of automated feeding systems to reduce feed waste.
- Genetic selection of faster-growing, disease-resistant fish.
- Monitoring of water quality parameters and adapting feeding protocols accordingly.
- Use of new net technologies to reduce fouling and minimize the use of antifouling substances.
- Improved waste management and recycling systems for land-based facilities.

The aquaculture sector in Greece operates under a stringent regulatory framework that ensures environmental protection. This includes regulations on the use of therapeutic substances, fish feed ingredients, and the management of aquaculture of non-native species. Compliance with the HACCP principles for food safety further ensures that production processes minimize environmental impacts.

Aquaculture also offers positive environmental benefits by reducing pressure on wild fish stocks and providing an alternative to more harmful coastal activities such as intensive agriculture and mass tourism. It supports the sustainable management of natural and biological resources, contributing to environmental conservation.

The report concludes that aquaculture in Greece, when conducted within the established regulatory framework and with best practices, does not cause substantial or irreversible environmental damage. Instead, it can be a sustainable alternative to other coastal activities. The industry's historical issues have largely been addressed through technological advancements and stricter regulations, ensuring that modern aquaculture practices are environmentally responsible. As such, aquaculture should be integrated into national strategies for coastal zone management to support sustainable development and environmental protection.

To minimize environmental impacts, specific strategies were employed in the selection of POAY zones B.3 (Eratini), B.4 (Galaxidi), and B.5 (Antikyra) in Fokida and Boeotia. Key considerations include:

- **Local nutrient increase**. Nutrient increase is inherent in aquaculture but can be controlled. Establishing aquaculture units in areas with strong hydrodynamics—at least 18 m deep and open to strong currents—helps disperse nutrients and prevent local trophic level imbalances.
- **View and landscape alteration**. Visual impact is unavoidable due to the visibility of coastal aquaculture facilities. However, most proposed POAY zones are in areas with minimal existing development, reducing potential land use conflicts.

The development of marine fish farming in Greece presents manageable environmental impacts. Through strategic planning and site selection, negative effects on the bio-geochemical parameters, landscape, and biodiversity can be minimized. The establishment of POAY facilitates effective environmental monitoring and management, ensuring sustainable development and coexistence with local communities.

EIA analysis: The SEIA emphasizes the importance of mitigation and remediation measures to minimize environmental impacts. However, the effectiveness of these measures depends on rigorous implementation and monitoring. There is a need for more detailed and specific guidelines on mitigation practices, including waste management, habitat protection, and emergency response plans to address potential environmental hazards promptly.

To reduce impacts of aquaculture on the coastline and the environment, aquaculture facilities to be located in areas with strong hydrodynamics, suitable depths (at least 30 m), and exposure to open sea currents. These conditions help disperse nutrients and waste, preventing localized nutrient overload and anoxia. The recommended mitigation actions include:

- **Hydrodynamic modelling.** Use advanced hydrodynamic models to select optimal sites that ensure efficient dispersal of nutrients and waste.
- **Avoid sensitive habitats.** Ensure that aquaculture units are not placed over sensitive habitats like *P. oceanica* meadows and reefs, as these are important for biodiversity and ecosystem health.
- **Zoning and buffer zones.** Establish clear zoning regulations and buffer zones to separate aquaculture activities from critical habitats and other marine uses.

Nutrient management is essential to prevent eutrophication and maintain water quality. The release of nitrogen and phosphorus from fish waste and uneaten food can significantly impact the marine environment if not properly managed. The recommended mitigation actions include:

- **Optimized feeding practices.** Implement automated feeding systems and feeding protocols to minimize feed wastage and ensure optimal food conversion ratios (FCR).
- **Regular environmental monitoring.** Continuously monitor nutrient levels in the water and sediments to detect any signs of nutrient overload early.
- **Feed formulation.** Develop and use feeds that are specifically designed to meet the nutritional needs of farmed species, use ingredients that have high digestibility thereby reducing waste.

Effective management of both solid and liquid waste is important to minimizing the environmental footprint of aquaculture operations. The recommended mitigation actions include:

- **Solid waste recycling.** Establish systems for the recycling of solid waste, including feed bags, packaging materials, and farm equipment.
- **Effluent treatment.** Implement advanced effluent treatment systems, such as sedimentation tanks, mechanical and biological filters, and the use of Integrated Multi Tropic Aquaculture (IMTA) on which biofiltration of nutrients occurs, using organisms like mussels.
- **Waste collection and disposal.** Ensure proper collection and disposal of organic waste, including fish faeces and uneaten feed, to prevent accumulation and degradation of the seabed.

Protecting marine biodiversity involves both direct conservation efforts and measures to reduce the broader ecological footprint of aquaculture. The recommended mitigation actions include:

- **Anti-predator measures.** Use non-lethal deterrents, such as anti-snare nets and acoustic devices, to protect fish farms from predators without harming wildlife.
- **Responsible stocking practices.** Avoid the introduction of non-native species and genetically selected strains to prevent genetic pollution and preserve local biodiversity.
- **Monitoring and research.** Conduct regular biodiversity assessments to monitor the health of marine ecosystems and adapt management practices based on scientific findings.

Engaging local communities and stakeholders is essential for the sustainable management of aquaculture operations. The recommended mitigation actions include:

- **Stakeholder involvement.** Involve local communities, environmental groups, and other stakeholders in decision-making processes to ensure that their concerns and knowledge are integrated into management practices.
- **Public information.** Inform the public about the environmental impacts of aquaculture and the measures being taken to mitigate them, fostering greater understanding and support.

Strengthening the legal and regulatory framework is essential for ensuring compliance with environmental standards and promoting sustainable aquaculture practices. The recommended mitigation actions include:

- **Enhanced enforcement.** Strengthen the enforcement of environmental regulations through regular inspections, penalties for non-compliance, and incentives for best practices.
- **Updated regulations.** Continuously update regulations to incorporate the latest scientific knowledge and technological advancements in aquaculture.
- **Transparent reporting.** Mandate transparent reporting of environmental data by aquaculture operators to ensure accountability and facilitate public oversight.

The dynamic nature of marine environments and the evolving state of aquaculture technology necessitate a commitment to continuous improvement and adaptation.

By implementing these additional monitoring and mitigation measures, fish farms can minimize their environmental impact and operate more sustainably in environmentally protected areas.

These precautions not only help preserve the ecological integrity of protected areas but also ensure the long-term viability and social acceptance of aquaculture operations.

3.10.2 Environmentally protected areas

The report undertakes an analysis of environmentally protected areas and the development of aquaculture in those areas.

3.10.3 Register of protected areas

EIA report: Directive 2000/60/EC mandates that Member States establish a Register of Protected Areas (RPA) to ensure the protection of water bodies requiring special conservation measures. This register includes areas identified under various specific Community legislation provisions aimed at safeguarding surface water, groundwater, habitats, and water-dependent species. This essay assesses and summarizes the methodology and results related to the identification and delimitation of Protected Areas of Aquatic Species of Economic Importance within the Water Departments of Western and Eastern Central Greece.

The identification and delimitation of Protected Areas of Aquatic Species of Economic Importance were conducted within the framework of the River Basin Management Plans. The process involved several steps.

- **Data collection**. Information was gathered on the location, capacity, and type of existing aquaculture activities.
- **Register compilation**. The Register of Protected Areas (RPA) was compiled to include all water bodies identified by Annex V of Decree 51/2007.
- **Designation of areas**. The areas were categorized into several types, such as those for water abstraction for human consumption, protection of aquatic species of economic importance, recreational waters, nutrient-sensitive areas, and habitats or species protection zones.
- **Consideration of aquaculture facilities**. The size and type of existing aquaculture facilities were taken into account when establishing the list of Protected Areas of Aquatic Species of Economic Importance.

The compilation of the RPA involved both Western and Eastern Central Greece Water Departments, utilizing the first revision of their respective River Basin Management Plans.

The results of this methodological process led to the identification of specific protected areas within the Eastern and Western Central Greece regions. These areas were documented and tabulated in the respective River Basin Management Plans.

Eastern Central Greece.

- The protected area with the code EL0725C0019N "Corinthian Gulf - Boeotia" includes the marine areas of PAs B.3, B.4, and B.5.

Western Central Greece.

- The protected area with the code EL0421C0001N "Corinthian Gulf - Aitoloakarnania coast" also encompasses the marine areas of PAs B.3, B.4, and B.5.

These protected areas are important for the conservation of aquatic species of economic importance, ensuring sustainable aquaculture practices and the protection of vital marine habitats.

The establishment of the Register of Protected Areas is a significant step towards the comprehensive management of water resources and the protection of biodiversity. By considering the size and type of existing aquaculture facilities, the methodology tries to ensure that economic activities are balanced with environmental conservation. The inclusion of diverse types of protected areas, such as those for human consumption, recreational waters, and habitats, reflects a holistic approach to water management.

The report states that the findings indicate that the designated protected areas in both regions are adequately covering the necessary zones for conservation. The alignment with the provisions of the Water Framework Directive (WFD) and Decree 51/2007 ensures that the management plans are in accordance with European standards for environmental protection.

EIA analysis: Aquaculture units in protected areas must navigate a complex array of environmental, regulatory, and socio-economic issues to operate sustainably. Key challenges include managing environmental impacts such as habitat degradation and water quality, ensuring biodiversity conservation, complying with regulatory frameworks, maintaining economic viability, addressing socio-economic conflicts, and ensuring effective monitoring and enforcement.

- **Environmental impact.** Aquaculture activities can lead to the degradation of marine habitats, particularly seagrass beds and coral reefs, which help maintain biodiversity. The discharge of nutrients, chemicals, and organic waste from aquaculture units can deteriorate water quality, leading to eutrophication and hypoxia, which negatively affect marine life. Organic matter from feed and fish waste can accumulate on the seabed, altering the sediment composition and impacting benthic organisms.
- **Biodiversity conservation.** The presence of aquaculture cages and associated activities can disturb or even displace native species and alter local biodiversity. Farmed fish species attract wild predators with farms taking preventative measures to exclude them. Escaped farmed fish can become competitors to wild species, potentially disrupting local ecosystems and can interbreed with wild populations, leading to genetic pollution and reduced fitness of wild species.
- **Regulatory compliance.** Aquaculture units must comply with various directives, such as Directive 2000/60/EC and specific national legislation, which may impose restrictions and require regular monitoring. Operating within protected areas often entails stricter regulations to ensure that aquaculture practices do not compromise the conservation objectives of these areas.
- **Economic viability.** Compliance with stringent environmental regulations can increase operational costs for aquaculture units affecting their economic viability.
- **Socio-Economic Conflicts.** Local communities may have concerns about the environmental impact of aquaculture on fishing grounds and tourism. There may be competition for marine

space and resources between aquaculture operators and other marine users such as fishers and recreational activities.

- **Monitoring and enforcement.** Continuous and effective monitoring of environmental parameters is important to ensure compliance with environmental standards and to mitigate potential impacts. Ensuring adherence to regulations and taking corrective actions in case of non-compliance can be challenging due to resource constraints and enforcement capacities.

Continuous stakeholder dialogue and engagement, innovative sustainable production and management practices, strong regular environmental monitoring and robust regulatory frameworks are essential to addressing these challenges and promoting the long-term sustainability of aquaculture in protected areas.

3.10.3.1 Natura 2000 network

EIA report: The Natura 2000 network is a key strategy for European countries to preserve biodiversity through the protection of critical natural habitats and species habitats. This extensive ecological network is composed of two principal types of sites: Special Protection Areas (SPAs) and Sites of Community Importance (SCIs).

- **Special Protection Areas (SPAs):** SPAs are designated for the conservation of bird species as mandated by Directive 79/409/EEC, which has been codified by Directive 2009/147/EC. These areas are specifically selected to protect bird populations of European significance. Once member states designate these areas, they are automatically integrated into the Natura 2000 network. Greece has designated 202 SPAs, thereby contributing to the broader effort to safeguard avian habitats across Europe.
- **Sites of Community Importance (SCIs):** SCIs are defined under Directive 92/43/EEC, focusing on the conservation of natural habitats and wild fauna and flora. After member states finalize the list of SCIs, they are required to declare these sites as Special Areas of Conservation (SACs). This designation entails setting conservation priorities to maintain the habitats and species in a favorable state. To date, Greece has designated 241 SACs, reflecting its commitment to preserving these critical natural environments.

Under Greek law, particularly Law 3937/2011 on the conservation of biodiversity, several provisions ensure the integration and protection of these designated areas:

- **Special Protection Zones (SPAs):** Areas classified as SPAs in Greece, listed in Annexes B and C of Article 14 of Decree H.P. 37338/1807/E.103/1-9-2010, are part of the Natura 2000 network. The list of SPAs can be updated with new sites following the procedure outlined in Article 4 of the decree.
- **Special Areas of Conservation (SACs):** Areas included in the list of SCIs from Annex 1 of Decision 2006/613/EC are now designated as SACs. This reclassification underscores their importance and provides a framework for their protection.

The national list of sites included in the Natura 2000 network was revised by Decree No. 50743/11.12.2017, ensuring that the network remains comprehensive and up to date. According

to Law 3937/2011 (Articles 4 and 5), both SACs and SPAs are incorporated into the National System of Protected Areas. This legal integration ensures that these areas receive the necessary protection and management to conserve their biodiversity effectively.

In the study area there are the areas "Coastal zone from Nafpaktos to Itea - Chiliado Springs Area" and "Greater Galaxidi area", which have been included in the Natura 2000 network and include the entire coastal area of the Municipalities of Tolofonos and Galaxidi. Similarly, the marine area of the study area and specifically the Corinthian Gulf is included in the Natura 2000 network.

There are areas of the NATURA 2000 network, which are located in the wider study area of B.3, B.4 and B.5 and which are briefly as follows.

P.E. Fokida.

- GR2450005 - area 18,663.57 stremmata
- GR2450001 - area 19,373.53 stremmata
- GR2450002 - rea 21,879.82 stremmata
- GR2450007 - area 10,399.14 stremmata
- GR2450008 area 24,789.15 stremmata

P.E. Boeotia.

- GR2410001 area 12,131.5 stremmata
- GR2410002 34,384 stremmata

More specifically, the protected areas in the immediate area of the planned POAY are the following.

Table 6: Protected areas in the study area

Code	Area	Habitat
GR2450004	Coastal zone from Nafpaktos to Itea - Chiliado Springs area	Natura - site of the SPA - πΤΚΣ
GR2450009	Greater area of Galaxidi	Natura - SPA site
GR2530007	Gulf of Corinth	Natura - site of the CBC

Source:. http://natura2000.eea.europa.eu/#

GR2450004 - "Coastal Zone from Nafpaktos to Itea - Chiliado Springs Area"
Location and Habitat Description.

- The area spans 10,604.34 stremmata along the coastal zone from Nafpaktos to Itea.
- Dominated by habitats such as Mediterranean salt marshes, thermo-Mediterranean hills, and oak forests.
- Contains important species such as the seal *Monachus monachus* and fish species like *Valencia robertae*.

Impact of Aquaculture.

- The area is highly sensitive due to its ecological importance, including the presence of unique and vulnerable species.
- Activities in this zone need to be managed carefully to avoid habitat degradation and water quality deterioration.

Conservation Status.

- Habitats like Mediterranean salt marshes (1410) and thermo-Atlantic alophila (1420) are rated as Unsatisfactory-Inadequate (U1).
- Other habitats like tree formations with Juniperus spp. (5210) are rated as Satisfactory (FV).

GR2450009 - "Greater Galaxidi Area"

Location and Habitat Description.

- Spanning 12,207.42 stremmata, it includes the town of Galaxidi and nearby settlements.
- Designated for the conservation of wild birds as per Directive 2009/147/EC.

Impact of Aquaculture.

- Potential impacts on bird populations due to habitat disturbance and changes in water quality.
- Specific bird species such as *Alcedo atthis* and *Buteo buteo* are protected and require careful monitoring.

Conservation Status.

- Several bird species are classified under varying degrees of abundance and preservation, from common to rare.
- The overall conservation status of bird species ranges from sufficient to good, requiring targeted management actions.

Aquaculture activities in Natura 2000 areas. The assessment of aquaculture activities within Natura 2000 protected areas involves a detailed analysis of the environmental impact of these activities on local habitats and species. This process is governed by the guidelines set forth in Directive 2000/60/EC and involves several key steps.

- **Identification and mapping**. Mapping the precise locations of aquaculture units and the boundaries of the Natura 2000 protected areas.
- **Habitat and species assessment**. Conducting field surveys and collecting data on the presence and health of habitats and species listed in Annex I of Directive 92/43/EEC and Annex II of Directive 2009/147/EC.
- **Environmental monitoring**. Regular monitoring of water quality, sediment composition, and the health of benthic and phytobenthic communities.
- **Impact analysis**. Comparing data from areas close to aquaculture units with reference sites to assess the impact of aquaculture activities on the environment.
- **Regulatory compliance**. Ensuring that aquaculture activities comply with national and EU regulations aimed at protecting water bodies, habitats, and species.

Monitoring and mitigation of aquaculture in Natura 2000 areas. Marine fish farming in Greece, while generally considered environmentally friendly, must undergo thorough assessment and evaluation to ensure sustainable development. The analysis of environmental impacts, particularly concerning the Natura 2000 site GR2530007 - Gulf of Corinth, follows a rigorous methodology based on the precautionary principle outlined in Directive 92/43/EEC. This essay summarizes the due diligence process, the stages of impact assessment, and the monitoring systems proposed to manage environmental impacts effectively.

Precautionary Principle and Due Diligence. The due diligence process aims to assess the potential impacts of marine fish farming on Natura 2000 sites and implement mitigation measures to avoid compromising the site's integrity. This process includes procedural and substantive safeguards to ensure compliance with environmental standards.

Stages of Impact Assessment. The impact assessment follows a structured, step-by-step approach as outlined in Article 6 of Directive 92/43/EEC.

- **Initial Screening.** The initial screening aims to determine whether the proposed project is likely to affect protected areas. This involves collecting detailed information about the protected objects within the Natura 2000 site and the proposed intervention. In the case of GR2530007, the assessment incorporated literature reviews, field research, and data from previous Environmental Impact Assessments (EIA).
- **Dedicated Impact Assessment.** This stage evaluates the significance of potential impacts on the conservation objectives of the protected area. The assessment focuses on habitats and species listed in Annexes I and II of Directive 92/43/EEC. If significant impacts are anticipated, alternative project implementations are considered to minimize adverse effects.
- **Consideration of Public Interest and Remedial Measures.** If significant impacts are identified, this stage involves examining overriding reasons of substantial public interest for the project's implementation and ensuring compensatory measures to maintain the coherence of the Natura 2000 network.

Key environmental parameters. The assessment identifies key environmental parameters that may be impacted by marine fish farming.

- **Sandbanks (Habitat 1110).** The proposed project is not expected to affect sandbanks due to its location more than 50 m from the shoreline and beyond the 18 m isobath, ensuring minimal disruption to hydrodynamics.
- **Posidonia Meadows (Habitat 1120).** The priority habitat of *P. oceanica* is safeguarded by ensuring that aquaculture units are not installed over these meadows, as per regulatory guidelines.
- **Reefs (Habitat 1170).** Measures are in place to protect reefs during the environmental licensing process, ensuring compliance with relevant legislation.
- **Avifauna and Marine Fauna.** Temporary disturbances to avifauna during installation are expected, but these are mitigated by measures such as anti-snare nets and acoustic deterrents. The presence of sea turtles and dolphins is monitored, with protocols to minimize disturbances from operational activities.

Conservation status and synergistic effects. The small scale of the proposed project, compared to the overall area of the Gulf of Corinth, indicates minimal cumulative environmental impacts. The existing licensed activities around the Gulf, combined with the environmentally friendly nature of aquaculture, suggest no significant synergistic effects with other projects.

Proposed Monitoring System. A robust monitoring system is essential to protect the aquatic environment and ensure the sustainable operation of aquaculture units. Continuous monitoring is mandated by Law 3199/2003 and Decree 51/2007, aligning with Directive 2008/56/EC (Marine Strategy Framework Directive). Key aspects of the monitoring system include.

- **Water quality monitoring.** Regular assessments of water and sediment parameters ensure compliance with environmental standards.
- **Measurement points and parameters.** The monitoring parameters are categorized based on the stage of the project (establishment, operation, etc.) and are aligned with EU guidelines on permitted mixing zones.

EIA analysis: Theoretically, there are strong due diligence and impact assessment processes for marine fish farming in Natura 2000 designated areas that are designed to ensure minimal environmental impacts on protected areas. However, the planning of new or expansion of aquaculture in Natura 200 areas continues and the environmental monitoring and production and management guidelines for fish farms are weak.

There are number of potential impacts of aquaculture in environmentally sensitive areas.

- **Habitat degradation**. In both protected areas, certain habitats are already rated as Unsatisfactory-Inadequate (U1), indicating existing environmental stress that could be exacerbated by increased aquaculture activities. Specific management plans are essential to mitigate additional degradation from aquaculture.
  - **Seagrass beds.** The placement of aquaculture facilities over *P. oceanica* meadows and other seagrass beds can lead to their destruction. These habitats are important for maintaining marine biodiversity, providing nursery grounds for various marine species, and stabilizing the seabed.
  - **Reef Systems.** Physical structures and increased sedimentation from aquaculture operations can smother coral and rocky reefs, reducing their structural complexity and the diversity of species they support.

- **Water quality**. Monitoring data shows that water quality parameters are generally within normal levels, with no significant hypoxia or eutrophication observed. This suggests that current aquaculture practices are not severely impacting water quality. Although current nutrient levels are within normal ranges, there is a potential risk of nutrient enrichment from fish farm effluents, leading to eutrophication.
  - **Eutrophication.** Excessive nutrients can lead to eutrophication, causing harmful algal blooms that deplete oxygen in the water and create dead zones, which are detrimental to marine life.

  - **Chemical pollution.** The use of chemicals and antibiotics in aquaculture can lead to the contamination of water and sediments, affecting non-target species and potentially entering the food web.
- **Species protection**. The presence of protected species such as *Monachus monachus* and various bird species necessitates stringent monitoring and management to ensure that aquaculture does not lead to population declines or habitat loss. Fish farming units can introduce or increase populations of competitive species, such as the alien species *Gambusia holbrooki*, which can outcompete native species like *Valencia robertae*. This threatens the survival of native species and disrupts the local ecosystem. Aquaculture operations can disturb breeding and feeding grounds for protected species, including birds listed under Directive 2009/147/EC and fish species protected under Directive 92/43/EEC. This can lead to population declines and loss of biodiversity.
- **Visual and acoustic disturbance**. Noise, light pollution, and human activity associated with aquaculture can disturb wildlife, leading to the displacement of species and affecting the behavior and distribution of sensitive species, particularly marine mammals and birds.
- **Regulatory compliance**. Both areas comply with the environmental standards set by the EU Water Framework Directive and national legislation, indicating that the impacts are managed within acceptable limits.

Aquaculture activities in the Natura 2000 areas of GR2450004 and GR2450009 present environmental challenges related to habitat degradation and species protection. However, current monitoring and management practices appear to mitigate these impacts effectively, maintaining water quality and the overall ecological status as "Good." Continued compliance with regulatory frameworks and targeted conservation actions are essential to ensure that these impacts remain within acceptable levels, thereby balancing economic activities with environmental sustainability.

Expanding aquaculture production in Natura 2000 sites poses significant risks to biodiversity, water quality, habitat integrity, and overall environmental health. To mitigate these risks, rigorous environmental assessments, strict regulatory frameworks, and best management practices are essential. Continuous monitoring and adaptive management strategies are necessary to ensure that aquaculture expansion does not compromise conservation objectives. Through careful planning and responsible practices, it is possible to balance the growth of the aquaculture industry with the need to preserve and protect valuable natural ecosystems.

Expanding fish farms in environmentally protected areas requires comprehensive and proactive monitoring and mitigation measures to ensure minimal impact on the environment. The following sections list additional precautions that should be implemented.

3.10.3.2 Wildlife sanctuaries

EIA report: According to Law 3937/2011 on the conservation of biodiversity, natural areas (terrestrial, wetland or marine), which are of particular importance as important sites for the development of wild flora or as habitats for the reproduction, feeding and wintering of wildlife species, or as areas for fish breeding and fry aggregation, or as important marine habitats, are

designated as Wildlife Sanctuaries (WSA). Ecological corridors among other categories of protected areas under Article 5 of Law 3937/2011 may also be designated as wildlife sanctuaries.

Wildlife Refuges, together with Special Conservation Zones (SPAs) and Special Protection Areas (SPAs) constitute Habitat and Species Protection Areas (Articles 4 and 5 of Law 3937/2011) and are part of the National System of Protected Areas.

There are the following statutory Wildlife Refuges in the land area of the immediate and wider study area.

Of the above Wildlife Refuges, the closest to the land area of the study area are.

- The Xirovouni shelter (Kallithea-Dafnochori-Elaia-Makrini), which is approximately 2.1 km from the boundary of Zone B.3.1
- The Xirotiri-Paleopournara-Karvelas (Galaxidi-Pedeorion) shelter, which is approximately 2.6km from the boundary of Zone B.4.1
- The sanctuary of Agioi Pantes (Delphi-Desfina-Grysos), which is approximately 5.2km from the boundary of Zone B.4.1

According to Law 3937/2011, as amended by Law 4492/2017, the establishment of aquaculture units within wildlife refuges is allowed after environmental licensing, in accordance with the provisions of Law 3937/2011. 4014/2011 (A'209), as in force.

The remaining Sanctuaries are located at a distance of more than 10 km from the POAY zones.

EIA analysis: As there are aquaculture units located in Wildlife Refuges, there should be stronger baseline surveys undertaken for new or expanding units, mandatory good aquaculture practices followed and strong environmental monitoring of the units.

3.10.3.3 Endangered species

EIA report: The Gulf of Corinth is home to several endangered species, as outlined in Article 4 of Directive 2009/147/EU and Annex II to Directive 92/43/EEC. The key species include:

- **Loggerhead Turtle** (*Caretta caretta*). This species is migratory and undergoes two ecological phases. the "oceanic" phase in open sea and the "insular" phase in coastal waters. Loggerhead turtles nest mainly in Zakynthos, the Peloponnese, and Crete. They face threats from coastal development, tourist activities, fishing gear, and predation. Conservation efforts focus on protecting nesting beaches and reducing fishing-related injuries.
    - **Threats.** Entanglement in fish cage netting, coastal construction, tourist disturbances, fishing gear injuries, and predation (especially of eggs by foxes).
    - **Conservation measures.** Protect nesting beaches, reduce fishing-related injuries, and manage tourist activities to minimize disturbances.
- **Green Turtle** (*Chelonia mydas*). Another migratory species, *Chelonia mydas*, shows a high fidelity to nesting and feeding areas. It nests primarily in Turkey, Cyprus, and Syria, with significant juvenile populations in the Laconian Gulf, Greece. The primary threats include

fishing gear entanglement and degradation of marine angiosperm beds. Conservation measures aim to protect nesting sites and reduce accidental captures.
    - **Threats.** Entanglement in fishing gear, degradation of feeding grounds (marine angiosperm beds), and occasional deliberate killings.
    - **Conservation measures.** Protect breeding areas, reduce mortality from accidental captures, and safeguard feeding habitats in the Gulf of Laconia.
- **Bottlenose Dolphin** (*Tursiops truncatus*). The Bottlenose Dolphin is a resident species in the Gulf of Corinth. The population is permanent but details on their abundance and distribution within the Gulf are limited. The main threats to dolphins include habitat degradation and human activities such as shipping and fishing.
    - **Threats**. Habitat degradation from human activities, including shipping and fishing.
    - **Conservation measures**. Implement measures to reduce habitat disturbances and regulate activities that threaten their populations.

EIA analysis: The presence of endangered species like *Caretta caretta, Chelonia mydas*, and *Tursiops truncatus* in the Gulf of Corinth underscores the ecological importance of this area. For *Caretta caretta*, major nesting sites like Zakynthos and Kyparissia Gulf are critical, while for *Chelonia mydas*, the focus is on protecting juvenile foraging grounds in the Laconian Gulf. For *Tursiops truncatus*, ensuring a healthy marine environment and mitigating human impacts are essential.

The construction and operation of fish cage farms and associated coastal infrastructure can lead to habitat loss and degradation. Turtles, particularly species such as the loggerhead (*Caretta caretta*) and green turtle (*Chelonia mydas*), use these coastal areas for nesting and foraging. Disruption of these habitats can reduce nesting success and foraging efficiency, threatening turtle populations.

Turtles can become entangled in the nets and other structures used in fish farming. This entanglement can lead to injury or death, as turtles may struggle to free themselves or drown if they are unable to reach the surface to breathe. Additionally, turtles may be attracted to fish farms due to the availability of food, increasing the risk of interaction in aquaculture operations. Therefore, there is a need for effective mitigation strategies in operating the farms

The Gulf of Corinth hosts a unique and isolated ecosystem for dolphins, including both coastal and pelagic species. The Ionian bottlenose dolphins reside in the shallow coastal areas of the northwest, while the deeper waters are home to a unique community of common, striped, and Risso's dolphins. These populations are significantly isolated due to the natural geographical barriers of the Gulf, which contribute to the area's fragility and ecological uniqueness. The limited exchange with other cetacean populations underscores the importance of preserving this distinctive marine habitat.

Fish farming operations generate underwater noise from machinery, boat traffic, and other activities. Dolphins rely on echolocation and acute hearing for navigation, communication, and hunting. Increased noise levels can interfere with these essential behaviors, leading to disorientation, stress, and decreased feeding efficiency. Fish farms attract wild fish, creating a

concentrated food source that can attract dolphins increasing the risk of interaction in aquaculture operations.

3.11. Sources of pollution in the study area

EIA report: The study area faces multiple pollution challenges from various sources, including urban wastewater, agriculture, livestock, industry, and mining. Each source contributes uniquely to the overall environmental impact, affecting both surface and groundwater quality.

The environment in the study area faces pollution from both point and diffuse sources. These sources impact surface and groundwater quality, influencing the overall ecological balance of the region. The primary contributors to pollution are urban wastewater, agricultural and livestock activities, industrial operations, mining and quarrying, and groundwater overmining.

Point sources of pollution

- **Urban wastewater.** Urban wastewater significantly contributes to pollution, primarily from settlements using cesspools or sewerage networks and centralized wastewater treatment plants (WWTPs). The region hosts five WWTPs located in Galaxidi, Itea, Aspron Homes, Eratini, and Desfinas. All except Desfinas discharge into coastal waters. These treatment plants manage urban wastewater, yet the adequacy and efficiency of these facilities are important for controlling pollution levels.
- **Agriculture and livestock.** Agricultural activities, particularly olive and fruit cultivation, contribute to organic pollution through the runoff of nutrients such as nitrogen and phosphate from fertilizers, pesticides, and biocides. Livestock farming, especially in the mountainous regions of Galaxidi and Tolofonos, adds to the pollution load with waste from poultry, pig, and cattle farms. Poorly managed livestock waste disposal exacerbates environmental issues, notably in Glyfada and Eratini, where livestock concentration is high.
- **Industrial activities.** Central Greece has significant industrial activity, with major industrial parks in Lamia and Thisvi and smaller BIO.PAs in Amfissa and Chalkida. Industries in the food sector and chemical production are prevalent. Oil mills, particularly during the olive harvest season, contribute organic loads due to inadequate waste treatment. Industrial pollution, while generally low, can cause serious environmental problems when waste from food processing plants, slaughterhouses, and mills is not properly managed.
- **Mines and quarries.** Mining activities, particularly bauxite extraction in Fokida, cause notable environmental degradation. Surface mining affects vegetation, disrupts habitats, and increases erosion and sedimentation. The port in Itea, used for bauxite transport, is a significant pollution source for the coastal system. The mining runoff contains suspended solids and potentially heavy metals, especially impacting the bay of Itea.

Diffuse sources of pollution

- **Agriculture and livestock.** Apart from point sources, diffuse pollution arises from agricultural runoff carrying nutrients and pesticides, affecting surface water quality. This type of pollution is harder to control and can spread over a wide area, impacting various water bodies.

- **Groundwater over-extraction.** Groundwater overextraction, particularly in the Amfissa plain, presents significant challenges. Intensive pumping combined with marine intrusion affects the chemical status of groundwater, causing contamination in coastal zones. This over-extraction leads to waterlogging, impacting water quality and the broader ecological system. However, areas like Tolofonos district do not experience waterlogging from seawater intrusion, highlighting regional variations in groundwater impacts.

Effective management of these pollution sources is important to maintaining the ecological balance and ensuring the sustainability of water resources in the region. Addressing these issues requires coordinated efforts across sectors, emphasizing improved wastewater treatment, better management of agricultural and industrial waste, and sustainable groundwater use practices.

EIA analysis: Together with other sources of pollution, aquaculture activities introduce nutrients such as nitrogen and phosphorus into the sediments and the water column, which can lead to eutrophication if not properly managed. This risk is heightened with the proposed increase in production capacity, potentially impacting water quality and marine life.

3.12. Climate risk analysis

EIA report: Climate change poses significant risks to various sectors and activities in Central Greece, including aquaculture, agriculture, water resources, and tourism. This assessment, based on a Strategic Environmental Impact Assessment (SEIA), evaluates the vulnerability and potential impacts of climate change on these sectors, using specific climate scenarios and timeframes.

The methodology for assessing climate vulnerability involves:

- Defining reference changes in climate parameters.
- Identifying business processes affected by these changes.
- Establishing impact scales based on operational parameters.
- Estimating vulnerability based on these changes.
- Assessing potential reductions in vulnerability due to adaptive capacities.
- Estimating the magnitude of expected changes over two periods (2021-2050 and 2071-2100) and under two scenarios (RCP4.5 and RCP8.5).

The parameters considered include temperature, drought, wind, heat waves, cold invasions, rainfall, snowfall, sea level rise, and wave activity.

- **Aquaculture and Fisheries.** Aquaculture and fisheries in Central Greece show moderate vulnerability to rising water temperatures and sea levels. Higher water temperatures can accelerate the growth of aquatic life but may not increase fishery yields due to overfishing. The increased frequency and intensity of extreme weather events, such as tornadoes, can cause significant economic damage to fishing vessels and aquaculture infrastructure. Sea

level rise threatens wetlands essential for fish reproduction and development, potentially altering fish migration patterns and affecting biodiversity.

- **Socio-economic analysis.** An important parameter for the successful completion of the project is the participation of all stakeholders, both from the administration and from civil society, in order to ensure effective cooperation at various levels in order, on the one hand, to propose appropriate actions with emphasis on the integration of low-cost adaptation options and, on the other hand, to ensure a solid long-term political commitment for the implementation of the action plan and the integration of the climate change adaptation dimension in all sectoral policies.

EIA analysis: The SEIA's assessment of climate change impacts on marine fish cage farming in Central Greece highlights both vulnerabilities and opportunities for adaptation.

Fish cage culture in Central Greece is assessed to be moderately vulnerable to specific climate change impacts. Rising water temperatures, for instance, can potentially accelerate the growth rate and so there can be increased production in the winter months but also increased temperature in the peak summer months causing stress to the fish, particularly seabream.

The heightened frequency and intensity of extreme weather events such as storms could pose significant economic risks, potentially damaging fish cages and aquaculture infrastructure.

3.13. Monitoring the implementation of the POAY

EIA report: A monitoring system will be designed for the implementation of the POAY, with specific objectives for each environmental sector.

Biodiversity, Flora, Fauna, and Protected Areas.

- Minimize the impact of aquaculture on the environment.
- Protect marine species and habitats.
- Organize systematic monitoring of the quality of the marine environment.
- Manage and dispose of residues in both marine and terrestrial environments effectively.

Water, air, soil, and climate factors.

- Systematically monitor the quality of the marine environment.
- Minimize the environmental impact of aquaculture activities.
- Reduce the amount of liquid, solid, and gaseous waste produced.
- Protect and improve the quality of the water environment.
- Reduce air pollutant emissions and limit climate change impacts.

Population, human health, physical assets, cultural, architectural, archaeological heritage and landscape.

- Ensure the hygiene and safety of fishery products.
- Retain the population in disadvantaged areas by creating jobs and improving living conditions.

- Improve working conditions for employees.
- Protect and enhance the aesthetics of the landscape in the coastal zone.

Proposed monitoring measures. The establishment of the Water Framework Directive (WFD) in the region aims to seamlessly integrate environmental considerations into aquaculture practices by ensuring the responsible and systematic monitoring of water quality. This continuous assessment helps gauge the environmental impact of aquaculture units. The measures outlined in Chapter 7 detail the implementation of existing environmental laws and the specific water parameters that need to be monitored to maintain water quality. Key monitoring measures include:

- **Water quality monitoring.** Regular checks on various water parameters to ensure compliance with environmental standards.
- **Environmental permits (EIA).** All measures and parameters will be included in the decisions for environmental permits at each site.
- **Legal framework.** The current legislation supports the measures for mitigating the environmental impacts of aquaculture. The approval of the present Decision, in accordance with Law 3889/2010, provides a strong legal foundation for implementing these measures within the PPA.

EIA analysis: The study relies on a monitoring system that will be designed for the implementation of the POAY. It is weak in describing specific monitoring guidelines to ensure effective planning, sustainable production and minimizing environmental and social impact. The monitoring measures should also include:

- **Baseline Environmental Assessment.** Conduct thorough baseline studies of the existing environmental conditions, including water quality, sediment quality, benthic habitats, and biodiversity, before any expansion activities commence. Establish reference sites in similar but unaffected areas to compare against sites with aquaculture operations.
- **Continuous Water Quality Monitoring.** Install automated water quality monitoring systems (buoys) to continuously measure parameters such as dissolved oxygen, nitrogen, phosphorus, chlorophyll-a, and temperature. Regularly monitor sediment quality for organic carbon, nitrogen, phosphorus, and heavy metals to detect any changes due to fish farming activities.
- **Biodiversity Monitoring.** Conduct regular surveys of local flora and fauna, focusing on key indicator species and habitats such as seagrass beds, coral reefs, and mangroves. Implement fish escape monitoring programs to track and mitigate any escapes of farmed fish into the wild.
- **Disease and parasite monitoring.** Regularly inspect fish for diseases and parasites and maintain detailed records of health checks and treatments. Monitor wild fish populations in the vicinity for any signs of disease transmission from farmed fish.
- **Impact Assessment Reporting.** Submit regular environmental impact assessment reports to relevant authorities, detailing monitoring results and any observed impacts. Use adaptive management practices to adjust operations based on monitoring data and mitigate any negative effects promptly.

3.14. Challenges in undertaking the study

EIA report: The preparation of the SEIA for establishing the POAY faced several significant challenges.

- **Lack of experience.** There is a general lack of sufficient experience with projects of this nature, even after the adoption of the National Planning for Aquaculture Development. This inexperience posed difficulties in anticipating and addressing specific project requirements effectively.
- **Inadequate maritime spatial planning.** The absence of an integrated spatial plan for maritime areas complicates the establishment of Marine Protected Areas (MPAs). The combination of maritime spatial planning and the adoption of the National Coastal and Marine Spatial Development Framework (NCPCSD) would provide a clearer framework for setting up MPAs.
- **Insufficient data.** There was a notable lack of comprehensive data on the aquatic environment. This deficiency necessitated additional time to conduct measurements of certain water parameters important for the SEA.
- **Existing location constraints.** The existing point location regime, under which current aquaculture units operate, limited the options for selecting the optimal spatial organization of aquaculture activities in the area.

EIA analysis: The study acknowledges the challenges in undertaking the study and establishing the POAY.

3.15. Other studies

EIA report: In view of the stated challenges, additional studies are required covering:

- Accompanying and supporting onshore facilities that will be required under the responsibility of the Management Entity. The first stage will concern the precise identification of the projects by category, number and size (e.g. surface area, volume, capacity, etc.).
- Construction studies and therefore their costing will follow at a later stage.
- For the infrastructure projects, the preparation of studies concerns port facilities and road network improvement projects that serve the needs of POAY.

The studies will be carried out by competent bodies of Local Authorities and the State, as appropriate, after the relevant actions of the Management Body of the POAY, in the framework of its cooperation with the bodies concerned.

With regard to the actions required, after the adoption of the WFD, it is of primary importance to establish a monitoring programme for the aquatic environment, the data of which will form the basis for the assessment of water quality over time, for possible medium-term adaptation.

EIA analysis: Recommended additional studies include:

Assessment of nutrient output. To improve the accuracy of the environmental impact assessment, it is essential to conduct a detailed quantification of nutrient outputs from proposed aquaculture operations. Understanding the dynamics of nutrient release from fish farming operations into the surrounding marine environment is crucial for predicting and mitigating potential impacts. This involves gathering baseline data on current nutrient levels, quantifying inputs from fish production, analyzing the fate of nutrients, and utilizing predictive modelling to estimate future nutrient loads. By assessing the severity and extent of predicted impacts, appropriate mitigation strategies can be developed to prevent adverse environmental consequences.

Supporting service analysis. Undertake a detailed analysis of the existing resources and quantify the additional requirements for supporting services. Assessing the capacities of transportation, electricity, freshwater supply, housing, waste management, and effluent treatment facilities is essential to determine additional needs and assess potential impacts on service availability. Adjusting expansion plans accordingly ensures that infrastructure development aligns with environmental sustainability goals and minimizes strain on existing resources.

Comprehensive mapping and protection measures for sensitive habitats. Protecting sensitive habitats like *Posidonia oceanica* meadows requires detailed mapping and stringent protection measures. Assessing the capacities of transportation, electricity, freshwater supply, housing, waste management, and effluent treatment facilities is essential to determine additional needs and assess potential impacts on service availability. Adjusting expansion plans accordingly ensures that infrastructure development aligns with environmental sustainability goals and minimizes strain on existing resources.

Assessment of cumulative impacts. Holistic assessment of cumulative environmental Impacts to fully understand the environmental implications of multiple aquaculture operations. Regional impact studies and integrated modelling approaches help evaluate the cumulative impacts on nutrient loading, habitat degradation, and other environmental stressors. Developing and implementing regional mitigation plans based on these assessments ensures that aquaculture practices remain sustainable and minimize their ecological footprint.

3.16. Environmental conclusions

EIA analysis:

- **Nutrient enrichment.** The introduction of nitrogen and phosphorus from fish faeces and uneaten food can lead to localized nutrient enrichment, reducing dissolved oxygen levels and potentially causing eutrophication. However, there is no quantification of this additional nutrient load entering the environment to allow an accurate prediction of potential impact on the environment and no assessment of the cumulative impact of multiple farms located in the same area
- **Coastal development.** The presence of additional aquaculture support facilities on land can alter the natural coastal landscape, affecting the aesthetic value and potentially impacting tourism and local communities. The additional services required also compete with other users and need to be quantified to assess the requirements.

- **Protected zones.** Aquaculture units located in environmentally protected areas need careful planning, additional background studies strong monitoring and control of the impacts on marine biodiversity, including benthic communities and key habitats like *P. oceanica* meadows.
- **Insufficient regulatory and monitoring framework.** Although the SEIA outlines necessary monitoring measures and legal frameworks, there are weaknesses in the existing regulatory mechanisms to address environmental impacts effectively. The need for continuous, organized monitoring of water quality and other environmental parameters is critical. However, the current legislative provisions may not be robust enough to enforce comprehensive and proactive environmental management practices across all aquaculture sites.
- **Inadequate enforcement of environmental regulations.** The strategic environmental assessment (SEA) indicates that while there are existing regulations intended to mitigate the environmental impacts of aquaculture, the enforcement of these regulations is often lacking. The legal provisions for environmental monitoring and impact mitigation are theoretically sound but are not always effectively implemented. This discrepancy between regulation and practice can result in unaddressed environmental degradation and insufficient protection for sensitive ecosystems.
- **Gaps in continuous monitoring.** Continuous monitoring of environmental parameters is important for understanding and managing the impacts of aquaculture. However, the current regulatory framework does not sufficiently mandate or facilitate this level of monitoring. Regular and systematic data collection on water quality, sediment composition, and biodiversity is essential to detect changes and trends over time. The lack of a robust monitoring system means that potential negative impacts may go unnoticed until they become significant problems, complicating remediation efforts.
- **Limited Scope.** The existing regulatory framework tends to focus on specific aspects of environmental impact, such as water quality, while potentially overlooking other critical factors like the cumulative impacts of multiple aquaculture operations or the broader ecosystem effects. This limited scope can result in fragmented and ineffective environmental management. A more holistic approach is needed, encompassing all aspects of environmental health, including land-based impacts, waste management, and socio-economic factors.
- **Weak penalties and incentives.** The penalties for non-compliance with environmental regulations are often not stringent enough to deter harmful practices. Conversely, there are insufficient incentives for operators to adopt more sustainable and environmentally friendly practices. Strengthening penalties for violations and providing incentives for compliance can encourage better adherence to environmental standards.
- **Inadequate public and stakeholder engagement.** Effective environmental management requires the involvement of various stakeholders, including local communities, environmental groups, and scientific experts. The current framework often lacks mechanisms for meaningful public and stakeholder engagement. This exclusion can lead to a lack of accountability and missed opportunities for incorporating valuable local and scientific knowledge into decision-making processes.

Recommendations for improvement. To address these regulatory and monitoring framework deficiencies, several measures are recommended.

- **Strengthening enforcement mechanisms**. Ensure that environmental regulations are strictly enforced, with regular inspections and penalties for non-compliance.
- **Enhancing monitoring systems**. Develop and implement comprehensive monitoring systems that provide real-time data on key environmental parameters, enabling timely interventions.
- **Detailed implementation guidelines**. Provide clear, detailed guidelines for implementing environmental safeguards, ensuring consistent application across all aquaculture operations.
- **Integrating scientific and technological advances**. Regularly update regulatory practices based on the latest scientific research and technological advancements.
- **Holistic regulatory approach**. Expand the scope of regulatory oversight to include cumulative impacts and broader ecosystem considerations.
- **Incentivizing compliance**. Introduce incentives for sustainable practices and impose stricter penalties for environmental violations.
- **Stakeholder engagement**. Establish mechanisms for regular and meaningful engagement with stakeholders, ensuring transparency and accountability in environmental management.

By addressing these gaps, the regulatory framework can more effectively mitigate the environmental impacts of aquaculture, promoting sustainable practices that protect the Gulf of Corinth's delicate marine ecosystems.

4. Social analysis of the EIA

4.1. Socio-economic benefits

4.1.1. Socio-economic benefits at the country level

Job creation. Fish cage culture employs a significant number of people in Greece, from farm workers to fish farmers to technicians and managers. According to the Hellenic Aquaculture Producers Organization (2021) the industry directly employs 3,871 people and is estimated to directly and indirectly employ about 12,000 people[2].

Export earnings. Greece is a major exporter of farmed fish, with exports of over €300 million per year. This contributes significantly to the country's foreign exchange earnings.

Economic diversification. Fish cage culture provides an important source of income for coastal communities, particularly in areas where traditional fishing has declined. This helps to diversify the economy and reduce reliance on a single industry.

4.1.2. Socio-economic benefits at the local community level

Job creation. Fish cage culture can create jobs in construction, operation, maintenance, and processing. This can be a major benefit for local communities, particularly in areas where employment opportunities are limited.

Economic diversification. Fish cage culture can provide an additional source of income for local communities, which can help to diversify the economy and reduce dependence on a single industry.

Community development. Fish cage culture can generate revenue that can be reinvested in community development projects, such as education, healthcare, and infrastructure.

Increased local demand for goods and services. Fish cage culture can increase the demand for goods and services provided by local businesses, such as transportation, construction, maintenance, and supplies. This can stimulate economic activity and create jobs in the local community.

Fish supply for local businesses. Fish cage culture can provide a reliable source of fresh fish for local businesses, such as restaurants, hotels, and fishmongers. This can help to reduce reliance on imported fish and support local food systems.

Skill development. Fish farms can provide training and education to local workers in aquaculture, marine biology, and other relevant fields. This can enhance their skills and employability, making them more competitive in the job market.

4.1.3. Food security benefits at the country level

Increased fish production. Fish cage culture has helped to increase the production of fish in Greece, making it a more self-sufficient country in terms of fish supplies.

Supplementing wild fisheries. Fish cage culture can help to supplement wild fisheries, which have been under pressure due to overfishing and environmental degradation.

[2] *https://fishfromgreece.com/wp-content/uploads/2023/10/HAPO_AR23_WEB-NEW.pdf*

Reducing reliance on imports. Fish cage culture helps to reduce Greece's reliance on imported fish, which can be expensive and can contribute to food insecurity.

4.2. Socio-economic drawbacks

4.2.1. Drawbacks at the country level

Environmental impact. Fish cage culture can have a negative impact on the environment, including pollution from fish waste, the spread of diseases and parasites, and habitat destruction.

Conflict with traditional fisheries. Fish cage culture can conflict with traditional fishing practices, leading to competition for resources and disruption of fishing grounds.

4.2.2. Drawbacks at the country level

Social tensions. Fish cage culture can lead to social tensions between fish farmers, traditional fishers, and local communities, as there may be concerns about the environmental impact and the distribution of benefits.

Competition for resources. Fish farms compete with traditional fishers for resources, such as fishing grounds. This competition can disrupt traditional fishing practices and reduce the livelihood opportunities for traditional fishers.

Lack of transparency and participation. The decision-making process for fish cage culture projects is often opaque, and traditional fishers and local communities may not have a say in the size of farms and where the farms are located. This lack of transparency can lead to resentment and distrust.

Lack of benefits sharing. Traditionally, the profits from the fishing industry have been shared among the fishers and the local communities. With fish cage culture, the profits often flow to the fish farmers and the companies that own the farms, with little benefit to the local communities.

4.2.3. Drawbacks at the local level

Visual impacts on seascape. The presence of fish cages can alter the natural beauty of coastal areas, affecting the aesthetics of the seascape. The large floating structures of fish cages and feeding barges can be visually unappealing, disrupting the natural views and creating an industrial feel to the shoreline. This can be particularly noticeable in areas with pristine coastlines or with significant tourism value.

Impacts on coastal tourism and yachting. Fish cages can potentially deter tourists and yachters from visiting coastal areas, negatively impacting the local tourism industry. The sight of fish cages can diminish the perceived natural beauty of the coastal landscape, reducing the appeal for recreation and relaxation. This can be particularly detrimental for tourist destinations that rely on the pristine beauty of their coastlines.

Local marine traffic. Fish cage culture operations can increase local marine traffic, as vessels are required to transport fish, feed, and supplies to the farms, and to collect and transport fish away from the farms. This increased traffic can disrupt the movement of other vessels, such as fishing boats and pleasure craft, and can also increase the risk of collisions and accidents.

Local road traffic. The construction and operation of fish farms can also increase local road traffic, as trucks are needed to transport materials and supplies to the farms, and to carry away

waste and by-products. This increased traffic can put a strain on local infrastructure and can also contribute to air pollution.

Freshwater resources. Fish cage culture operations can consume large amounts of freshwater, which is used for cleaning fish tanks, diluting waste, and maintaining optimal water quality. This can place stress on freshwater resources, particularly in areas where freshwater is already scarce.

Housing for workers. The expansion of fish cage culture can lead to an increase in the demand for housing for workers, as fish farms need a steady supply of labor to operate efficiently. This can put pressure on local housing markets and can lead to higher housing costs such as rents.

4.2.4. Assessing the balance of benefits and drawbacks

The socio-economic impacts of marine fish cage culture in Greece are complex and there is no easy answer to whether the benefits outweigh the drawbacks. The industry has the potential to provide significant economic and food security benefits, however, it is important to manage the environmental and social impacts carefully.

The overall balance of benefits and drawbacks, as outlined in Sections 4.1 and 4.2, depends on how the industry is managed and how it interacts with local communities.

4.3. Social assessment

4.3.1. Demographics

EIA report: The study area is located in the coastal area of 4 municipalities: Galaxidi, Tolofonos and Desfinas in the Regional Unit of Fokida and Antikyra in the Regional Unit of Boeotia.

Census results (EL. STAT 1991-2011) show that the neighbouring districts of Galaxidi and Tolofonos have almost the same population and show the same population development in the 20-year period 1991-2011. In 2011 the population of Galaxidi and Tolofonos was 3,240 and 3,247 persons, respectively. A population increase of 6.9% is recorded for the municipality of Galaxidi and 5.7% for the municipality of Tolofonos from 1991 to 2011.

However, the census results show that the municipality of Desfinas has shown a population decrease of 17.3% in the 20 years from 1991 to 2011, down to 2,011. The same is true for the municipality of Antikyra, which recorded a large population decrease from 1991 to 2011 of 46.5% to a population of 1,596 in 2011.

EIA analysis: The SEIA study considers that the creation of the POAY will strengthen the economy and the development of the local communities as long as new jobs are created. This is expected to increase due to the growing demand for fish products at the global level which in turn will increase the volume of production of aquaculture products at the national level, giving Greece a higher position in the export sector. At the local level, it will create new jobs while maintaining existing ones, thus retaining the local population, and increasing social cohesion. It will also provide employment opportunities for people employed in related sectors (e.g. fishermen) whose income has declined considerably in recent years.

The SEIA study mentions a cage labor requirement of 1 person per 40-50 t of production per year. The proposed POAY will have a 24,210-tonne increase in production from that currently licensed and this indicates that there will be an increased employment requirement of between 485 to 605

people. This is indicative of the cage farm and there will be a corresponding increase in hatchery and processing personnel.

The SEIA study, however, does not evaluate the existing and potential number of jobs that can be created by the fish farms, their quality and whether the potential recruitment can be met by local recruitment. Without a detailed evaluation of the potential number of jobs, it is not possible to explore the potential disruption to traditional ways of life and community dynamics. Without analysis of the number of potential jobs and new facilities required it is impossible to analyze the strain the proposal will make on local infrastructure (roads, fresh water and sewage, healthcare, and schools) due to population influx and the effect of increased economic activity.

4.3.2. Employment - Unemployment

EIA report: According to the available census data of 2011 the permanent population of the 3 municipalities in the study area was reported as 9,296 persons of which 27.5% (2,560) were employed, 6.5% were unemployed and 63.8% were economically inactive. This percentage of economically inactive people was considered high.

In 2011, in the whole of the study area, 54.7% of the economically active population was employed in the tertiary sector. In the coastal regions of Galaxidi and Tolofonos with easy access, the catering and leisure services predominates with a developed tourism activity. In Desfinas and Antikyra the wholesale and retail trade and public administration services dominate. “Aluminium of Greece” in Boeotia with its exploitation of Bauxite employs a significant percentage of employees, 30.9% and 40.1% respectively in Desfinas and Antikyra.

EIA analysis: Without analysis of the number of potential jobs and new facilities required it is impossible to consider the effect of the proposal on the unemployment rate or economically inactive people in the region.

4.3.3 Tourism

EIA report: The report mentions that the proposed aquaculture zones take into account residential developments in areas of the municipalities where holiday homes and tourism exist. The study does not consider tourism as an important activity in the area, and it is only mentioned as a competing industry and potential holiday homes in the Erateini PAY.

EIA analysis: The spatial structure attempted through the organization of individual aquaculture units into PAYs, attempts to solve several problems that have so far hampered their operation and, consequently, their further development in other areas. Through the creation of the PAY, negative spatial impacts are avoided, while at the same time, emphasis is placed on any planned new uses to avoid future conflicts due to competing uses (e.g. aquaculture and tourism). It will also facilitate the permitting procedures for the plants and reduce the bureaucratic burden on investors.

4.3.4 Infrastructure

EIA report: The existing infrastructure of the study area is described and summarized:

Port infrastructure – In the area where the POAY is planned there is a basic port infrastructure that serve the residents, tourists and professionals. There are, in particular, fishing harbours and

two marinas at Galaxidi and Trizonia. Private port facilities operate at the factory complex "Aluminium of Greece" in Agios Nikolaos, Boeotia.

All other piers in the study areas have arisen to expedite the existing aquaculture activities.

Maritime transport could play an important role in the region if it is effectively integrated into the overall national and regional system.

Road transport – Road transport dominates the wider region. The roads that cross the study area include the Itea-Nafpaktos road which is part of the inter-regional road axis Lamia-Amfissa-Antirio-Patras which connects Central Greece with Western Greece.

Regarding the local road network of the study area, it is considered in many places to be inadequate as it presents erosion and subsidence problems, which make accessibility to some of the settlements difficult.

Rail transport: This is non-existent in the study areas.

Air transport: The Regional Unit of Fokida does not have any airports and the main service remains the International Airport in Athens. However, there is a military airport Tanagra and a small civilian airport for light commercial air transport in Lamia.

EIA analysis: A detailed analysis of how the current infrastructure will affect the development of the POAY, the way goods are transferred, boats stored and moored seems to be very weak. The understanding is that a lot of work would need to be carried out to have a truly functional road network and ports that would cover the needs of such a project.

4.3.5 Freshwater supply and sewage

EIA report: The municipality of Galaxidi is supplied with water from the artificial lake of Mornos, and from older boreholes whose water supply is brackish. The district has a complete water supply network, in good condition, consisting of hard PVC plastic pipes, up to a 160mm diameter. However larger pipes from 200mm diameter and above are made of asbestos.

The municipalities of Desfinas and Tolofonos are reported to have deficiencies in their water supply network, and it is necessary to complete the water supply system to meet the water supply requirements of all the settlements.

The municipality of Galaxidi has a separate sewage system, and studies are reported to be underway to extend this to areas where cesspits cannot be constructed due to soil characteristics. In the municipality of Desfinas only the town of Desfinas has a sewage network, the remaining villages rely on cesspits. In Tolofonos there is sewage treatment plant and additional drainage studies are being undertaken for wastewater to be discharged to the Erateini Wastewater treatment Plant (WWTP)

EIA analysis: The EIA study does not quantify the freshwater requirement for the population or irrigation and what volume of water can be supplied from the artificial lake of Mornos. It is unclear whether additional boreholes will be required and can meet the requirement or any additional requirement of the newly proposed facilities. There will be a requirement for the following:

- Worker drinking water

- Cleaning water (tanks, packing facility, etc.)
- Domestic toilet water
- Water for ice (harvesting, packing)

4.3.6 Communications

EIA report: It is reported that there are no specific problems with the telecommunication network of the region. The quality of communications regarding fixed voice and internet use is considered sufficient. In the municipality of Galaxidi there are optic fiber networks and upgraded digital services. Further modernization of the network in Desfinas and Tolofonos will be based on the construction of optic fiber networks.

EIA analysis: Without detailed information, it is not possible to fully assess whether the telecommunication infrastructure is capable of meeting modern demands.

4.3.7 Electricity supply

EIA report: The study area is supplied by the national electricity distribution network of energy that extends throughout the Central Region of Greece with North-South 400kV and 150KV transmission lines. The local network consists of a high, medium and low voltage network and the energy requirements of the area are reported to be easily covered by the existing generation. The local electricity supply network (PPC) is aerial. In addition, there are several wind farms in the study area and more are planned.

EIA analysis: The study does not consider the requirement for electricity in the study area. The EIA does not quantify the electrical demands of the proposed new land-based facilities of the POAY.

4.4 Impacts related to aesthetics

4.4.1 Impacts of noise and light pollution

EIA report: The study does not consider the impact of any noise and light pollution on the human population from the facilities in the proposed areas of the POAY.

EIA analysis:

- **Light -** Artificial light used at night can have several negative impacts on marine life as it disturbs the natural light cycle of marine organisms. Many marine organisms rely on the natural light cycle to regulate their behavior and physiology. Artificial light at night can disrupt this cycle, leading to disorientation, reduced reproduction, and changes in feeding behavior. Lights at night can also cause visual disturbance for coastal communities.
- **Noise** - Fish farms can generate noise pollution from boat traffic, feeding operations, and other activities. This can disturb marine life and make it difficult for some species to communicate and reproduce.

4.4.2 Impacts on the landscape

EIA report: The report states that the visual distortion of aquaculture activities on the natural coastal landscape is certainly a basis for criticism and that it is not permanent as it is immediately

reversible. However, it must be considered for the land-based facilities and infrastructures. The report states that substantial environmental damage has been shown through a series of studies to be non-existent.

The report also notes that in terms of conservation of natural resources, aquaculture as a development activity can be significantly milder than many other competing or conflicting uses of the coastal zone (e.g. industry, intensive agriculture, mass tourism, holiday homes, port projects/marinas, etc.).

EIA analysis: The EIA study recognizes that in the regulations the coastal landscape and environment must be respected. Descriptions of the landscape and protected environments in the study area are described and areas of outstanding natural beauty are considered. The study considers that the visual alteration of the natural coastal landscape, by the installation of land and sea infrastructures, is a basis for criticism. However, the operation of some fish farming units in the past have caused significant impacts on the landscape and the view can create a nuisance for residents in some areas. The studies mentioned in the report that substantial environmental damage in this aspect is non-existent have not been referenced.

4.4.3 Impact on cultural heritage

EIA report: The EIA considered in each of the aquaculture development zones the sitting of the aquaculture units in relation to other users in the areas and this includes cultural heritage sites. In the entire Regional Unit of Fokida there are several remarkable cultural elements, some of which are protected according to the provisions of Law 3028/2002 "For the protection of Antiquities and Cultural Heritage in general". These include coastal and marine archaeological sites such as the lighthouse building at Cape Psaomits and the islets of Apsifa, Agios Geogios and Panagia of Galaxidi. All these coastal and marine archaeological sites are located outside of the proposed POAY zones.

EIA analysis: The proposed aquaculture areas appear to be free of important historical cultural heritage and all relevant regulations would have to be followed before the construction of any facilities.

4.5. Impacts related to Infrastructure

EIA report: The purpose of the creation of POAY is the concentration of aquaculture activity in areas where organized units already exist, and this will minimize any negative effects of the POAY in the spatial organization of the wider region.

EIA analysis: Both floating and land units will require the existence of road infrastructure for the distribution of products.

The SEIS study does not estimate the increase in road traffic. The expansion of production will cause significantly higher levels of road traffic on the existing road infrastructure. Road traffic might include:

- Feed deliveries to the feed store
- Deliveries of fry from hatcheries to the onshore nursery unit

- Harvested fish delivered to the packing facilities and from the packing facilities to the main markets
- It is estimated that there will be a need for an additional 300 workers and these workers will have to travel to the farms and back home daily.

The study does not estimate the increase in marine traffic. There will also be a significant increase in marine vessel traffic, e.g.,

- Changes of nets (nets taken to shore to be washed, nets taken out)
- Feed supply to each cage
- Fish harvesting
- Cage servicing
- Diver inspection of each cage
- Cage security at night.

4.6 Social impact

EIA report:

Population: The aquaculture sector in Greece, primarily located in arid and remote areas, significantly contributes to local employment and economic development. According to the SEIA written in 2024, it directly employs around 4,000-5,000 people in the sector while the number of people indirectly employed has been around 5,000-6,000 (data from the General Directorate of Fisheries). This helps maintain the local population and social structure. Aquaculture farms also economically support local communities through leasing agreements. The proposed Water Use Agreement (WUA) is expected to further boost employment and stimulate related industries, enhancing overall economic growth in these areas.

Human health: Aquaculture's impact on human health is mainly associated with the use of antibiotics and the potential for developing antibiotic-resistant bacteria. In Europe and North America, vaccines have largely replaced antibiotics in salmonid farming, reducing the need for their use. The risk of antibiotic resistance transferring to humans is currently low, but it remains a concern, especially in the development of new aquaculture species and in ornamental fish, which are often in close contact with humans.

Efforts are needed to prevent antimicrobial resistance due to the extensive use of antibiotics in aquaculture. Consuming fishery products from polluted areas or those not fully cooked can pose health risks, highlighting the importance of good farm management and consumer education.

In the specific country context, the impact of aquaculture on public health is considered low due to strict regulations and practices that minimize disease and antibiotic use. Farms are required to comply with environmental laws, and any medicinal substances used are approved and prescribed by veterinarians. Overall, aquaculture does not pose significant health risks to the population in this context.

Material assets: The aquaculture sector can impact physical assets in several ways. It can lead to the development or improvement of road and sea transport infrastructure for efficient product transportation. The sector also involves financial transactions such as leasing sea areas from municipalities and renting or purchasing coastal land for establishing land-based units. Additionally, the creation of new jobs in the aquaculture sector can indirectly affect physical assets, as workers may invest in their local areas, potentially leading to further development.

Cultural heritage: The establishment and operation of the POAY are not expected to have any impact on cultural heritage, as the units are located at a distance from any archaeological site and always after the agreement of the competent authorities.

Regarding the areas declared as Ancient Archaeological Sites (Law 3028/2002 "For the protection of Antiquities and Cultural Heritage in general"), there are no such sites in the study area.

The study concludes that the proposal will reduce unemployment and activate local potential, providing significant growth and employment opportunities. The assembly operations of the fish cages are not expected to cause any risk of harm to human health, provided that all necessary measures for the safety of personnel as required by applicable legislation are taken.

EIA analysis: No quantification of the personnel required for the increased production is provided and without analysis, it is difficult to assess the effect on the unemployment rate.

4.6.1 Population

EIA report: Aquaculture farms are usually located in arid and/or remote areas. It is well known that in Greece such areas face problems, mainly due to the absence of development structures to retain the new population.

EIA analysis: The SEIA study does not estimate the increase in workers and skilled personnel required for the proposed increase in production and without analysis it is difficult to assess the effect on the unemployment rate. Given that many of these areas are remote and the SEIA study states that developmental structures (housing, schools, healthcare) are absent no proposals are made as to how these can be addressed.

4.6.2 Human health

EIA report: The assembly operations of the fish cages are not expected to cause any risk of harm to human health, provided that all necessary measures for the safety of personnel as required by applicable legislation are taken.

EIA analysis: The establishment of the POAY creates conditions for monitoring the impact of the activity on the environment ensuring the good environmental conditions and the welfare of the farmed animals. At the same time this ensures the public health of consumers of aquaculture products.

4.6.3 Solid waste disposal

EIA report: The study notes that older practices such as the improper collection and management of solid waste (food bags, packaging materials of all kinds, dead fish/shellfish shells, parts of damaged cages, anchors, nets, etc.) are being replaced by modern practices.

It is noted that in May 2021 the co-funded project "Solid Waste Treatment Plant (composting plant) and landfill" was completed in the location "Vartos" in the Municipality of Amfissa of Fokida, through which the two Municipalities of Fokida , Delphi and Dorida, are served in terms of waste management. In addition, the upgrading of the Composting Unit is foreseen to transform into a Waste Treatment Plant for the management of all waste streams, as well as the expansion of the Amfissa Waste Treatment Plant.

EIA analysis: The SEIA report however does not estimate the scale, or type of solid waste that will be generated or give any details on how and where the solid waste will be disposed of. The report does not mention the main sources of solid waste which include

- Feed bags
- Discarded nets
- Fish mortalities
- Net washer sludge and shells

Other waste streams (such as lubricating oils, accumulators, batteries, waste electrical and electronic equipment including light bulbs, tires, end-of-life vehicles) are not mentioned and should be collected and delivered to licensed collectors or approved alternative management systems.

4.6.4 Housing

EIA report: No mention of the housing requirements for the additional staff required for the aquaculture development is made.

EIA analysis: There will be a need for additional housing for technicians and managers who will be brought in from outside the region. An increase in additional workers will put pressure on availability (and rental price) for year-round accommodation. This needs to be quantified.

4.7 Stakeholder consultation

EIA report: Good spatial planning will help to separate the uses of marine and coastal space, avoiding disputes and conflicts between stakeholders and finding synergies between the activities and the respective environment in which they are carried out.

- Ensure proper involvement of stakeholders and appropriate information to the public.
- Ensure adequate monitoring of the aquaculture sector.

All the above were considered when formulating the proposed plan, as well as the objectives and priority areas given by the EU.

EIA analysis: No details of any stakeholder consultation are given in the report even though the SEIA report states that the involvement of all stakeholders in decision-making is a central element in the planning and operation of the expanded facilities. If this is the case. then there is a serious omission in a SEIA study. There is no mention of social responsibility measures for the local community.

5. Conclusions

The report provides a comprehensive analysis of the SEIA conducted for the expansion of marine fish cage farming in the Corinthian Gulf region undertaken by APC. The objective of the SEIA is to assess the environmental, social, and economic implications of expanding marine fish cage farming in the Corinthian Gulf, covering various aspects such as spatial planning, natural environment assessment, environmental impacts, and mitigation measures. The SEIA undertaken by APC covers the objectives and scope in various degrees of quality and extent. While the SEIA covers some of the environmental implications of the proposed expansion, there are weaknesses (several critical) and gaps that require further elaboration and action.

One of the key weaknesses identified in the SEIA is the lack of detailed quantification of nutrient outputs from the proposed aquaculture operations. Nutrient enrichment can have significant impacts on water quality, sediment conditions, and overall ecosystem health. Without precise measurements and projections of nutrient loads, it is challenging to assess the severity and extent of these impacts accurately. Therefore, conducting baseline data collection, quantifying inputs and outputs, analyzing nutrient fate, and utilizing predictive modelling are essential steps to address this gap. Implementing these measures will enable stakeholders to develop effective mitigation strategies and ensure the environmental sustainability of the expansion project.

Another critical aspect that requires further attention is the inadequate analysis of supporting services for aquaculture operations. While the SEIA acknowledges the need for additional services such as road and marine traffic capacities, electrical supply, and waste management systems, it fails to provide a thorough evaluation of existing resources and additional requirements. Without a comprehensive understanding of service needs and availability, the expansion may face operational inefficiencies, environmental degradation, and conflicts with local communities. Therefore, conducting capacity assessments, quantifying additional service needs, and engaging with stakeholders are crucial steps to ensure the sustainable development of aquaculture activities.

The SEIA demonstrates a limited scope of alternative analysis, focusing primarily on existing conditions and locations. This narrow focus restricts the exploration of potentially more sustainable and beneficial alternatives for aquaculture expansion. To address this gap, stakeholders should broaden the scope of alternative analysis to identify the most suitable locations for sustainable aquaculture development. Conducting site suitability studies, avoiding environmentally protected areas, and using comparative analysis techniques are essential steps to identify optimal sites for expansion while minimizing environmental impacts and conflicts with other land uses.

The SEIA lacks a detailed monitoring framework for environmental assessment and compliance. Effective management strategies, including regular monitoring and enforcement of environmental standards, are essential to prevent and mitigate negative impacts from aquaculture operations. Therefore, developing a comprehensive monitoring plan, establishing compliance mechanisms, and implementing adaptive management approaches are critical steps to ensure environmental protection and long-term sustainability.

The SEIA overlooks the detailed mapping and protection of sensitive habitats, such *as P. oceanica* meadows, in the proposed expansion zones. Protecting these habitats is crucial for maintaining biodiversity and ecological balance in the region. Therefore, implementing comprehensive mapping and protection measures, conducting regular monitoring, and

developing conservation strategies are essential steps to safeguard sensitive habitats and preserve marine ecosystems.

The SEIA fails to address the cumulative impacts of multiple aquaculture operations within the same region. Cumulative impacts, such as nutrient loading and habitat degradation, can have significant environmental consequences over time. Therefore, conducting holistic assessments of cumulative environmental impacts, conducting zonal impact studies, using integrated modelling approaches, and developing zonal mitigation plans are essential steps to ensure sustainable aquaculture practices and minimize environmental stressors.

The SEIA should address the identified weaknesses and gaps in the SEIA to ensure the sustainability and environmental health of aquaculture expansion in the Corinthian Gulf region. By implementing the recommended actions and incorporating stakeholder feedback, policymakers, regulators, and industry stakeholders can enhance the accuracy, reliability, and effectiveness of aquaculture development planning and environmental management processes, thereby promoting sustainable aquaculture development and protecting marine ecosystems for future generations.

The socio-economic impacts of marine fish cage culture in Greece are complex and there is no easy answer to whether the benefits outweigh the drawbacks. The industry has the potential to provide significant economic and food security benefits, however, it is important to manage the environmental and social impacts carefully. The SEIA study considers that the creation of the POAY will strengthen the economy and the development of the local communities if new jobs are created. However, the results depend on how the industry is managed and its interactions with local communities.

The spatial structure attempted through the organization of individual aquaculture units into PAYs, attempts to solve several problems that have so far hampered their operation and, consequently, their further development in other areas. Through the creation of the PAY, negative spatial impacts are avoided, and emphasis is placed on any planned new uses to avoid future conflicts due to competing uses (e.g. aquaculture and tourism). The SEIA notes that it will also facilitate the permitting procedures for the plants and reduce the bureaucratic burden on investors.

The SEIA study, however, does not quantify and evaluate the existing and potential number of jobs that can be created by the fish farms, their quality and whether the potential recruitment can be met by the local population. The effect of an increased demand for workers on the unemployment rate or economically inactive people in the region has not been considered. Without a detailed evaluation of the potential number of jobs, it is not possible to explore the potential disruption to traditional ways of life and community dynamics. Without analysis it is impossible to analyze the strain the proposal will make on local infrastructure (roads, fresh water and sewage, healthcare, and schools) due to population influx and the effect of increased economic activity.

A detailed analysis of how the current infrastructure will affect the development of the POAY seems to be very weak. The SEIA study does not consider and quantify the increase in road traffic, the way goods are transferred, boats stored and moored. The expansion of production will cause significantly higher levels of marine traffic and road traffic on the existing road infrastructure. The understanding is that a lot of work would need to be carried out to have a truly functional road network and ports that would cover the needs of such a project.

The SEIA report, however, does not estimate the scale, or type of solid waste that will be generated or give any details on how and where the solid waste will be disposed of. The report does not mention the main sources of solid waste which include:

- Feed bags
- Discarded nets
- Fish mortalities
- Net washer sludge and shells

Other waste streams (such as lubricating oils, accumulators, batteries, waste electrical and electronic equipment including light bulbs, tires, end-of-life vehicles) are not mentioned and should be collected and delivered to licensed collectors or approved alternative management systems.

The SEIA considers that the electrical supply and telecommunication networks can meet the demands of the existing and proposed new land-based facilities of the POAY however these have not been quantified.

The SEIA study recognizes that in the regulations the coastal landscape and environment must be respected and the location of the units in POAYs contributes positively to strengthening the character of the landscape. Descriptions of the landscape and protected environments in the study area are described and areas of outstanding natural beauty are considered. The study considers that the visual alteration of the natural coastal landscape, by the installation of land and sea infrastructures, is a basis for criticism. However, the operation of some fish farming units in the past has caused significant impacts on the landscape and the view can create a nuisance for residents in some areas. The studies mentioned in the report substantiating the claim that substantial environmental damage in this aspect is non-existent have not been referenced.

The proposed aquaculture areas appear to be free of important historical cultural heritage and all relevant regulations would have to be followed before the construction of any facilities.

No details of any stakeholder consultation are given in the report even though the SEIA report states that the involvement of all stakeholders in decision-making is a central element in the planning and operation of the expanded facilities. If this is the case. then there is a serious omission in a SEIA study. There is no mention of social responsibility measures for the local community.

In Summary

The overall quality of the current SEIA is generally poor with many weaknesses and gaps in the prediction of future environmental impacts; it is our recommendation therefore that the SEIA be revised to address critical weaknesses, quantify predicted impacts, fill data gaps and reassess their findings.

References

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Annexes

Annex 1. EIA Assessment classification

EIA Assessment classification	Assessment description
Critical weakness	A critical weakness refers to a significant flaw or deficiency in the EIA report states that has the potential to substantially undermine the accuracy, comprehensiveness, or credibility of the assessment. This could include fundamental errors in data collection or analysis, failure to consider key environmental impacts, or lack of compliance with regulatory requirements. Critical weaknesses typically require urgent attention and correction to ensure the integrity of the assessment process and the validity of its conclusions.
Major weakness	A major weakness denotes a notable deficiency in the EIA report states that, while not as severe as a critical weakness, still has a significant impact on the overall quality and reliability of the assessment. This may include inadequate documentation of methodologies, incomplete analysis of potential impacts, or insufficient consideration of alternative measures or mitigation strategies. Major weaknesses require substantial remediation to address deficiencies and improve the overall robustness of the assessment.
Weakness	A weakness refers to a less significant flaw or limitation in the EIA report states that may detract from its effectiveness or thoroughness but does not severely compromise its overall validity or utility. This could include minor inconsistencies in data presentation, gaps in information, or shortcomings in the assessment of certain environmental factors. While weaknesses may not necessarily invalidate the assessment, they still warrant attention and corrective action to enhance the credibility and reliability of the findings.
Minor weakness	A minor weakness indicates a relatively minor or incidental flaw in the EIA report states that has minimal impact on the overall quality or integrity of the assessment. This might include inconsistencies or minor omissions in documentation. While minor weaknesses may not significantly affect the substance of the assessment, they should still be addressed to ensure clarity, accuracy, and professionalism in the report.

Annex 2. Guidance document on Aquaculture and Natura 2000

The Natura 2000 network supports the principle of sustainable development. Its aim is not to ban human activities but rather to ensure that these are undertaken in a way that still allows to reach the conservation objectives, which have been set for the Natura 2000 site (in function of the species and habitat types of European interest present). This principle is underpinned by Article 6 of the Habitats Directive which states that within each Natura 2000 site Member States must:

- take appropriate conservation measures which correspond to the ecological requirements of the protected habitat types and species present on the sites (Art. 6.1),
- avoid damaging activities that could significantly disturb these species or deteriorate the habitats of the protected species or habitat types (Art. 6.2),
- follow the procedure laid down in Art. 6.3 and 6.4 when planning new developments that might affect a Natura 2000 site.

Different aquaculture systems may exert different impacts and cause diverse effects on the natural environment, which may include habitat loss or deterioration, species disturbance and the displacement of species as well as changes in local communities. The effects of different aquaculture systems depend on several factors, including the hydrographic conditions of the farm's location, the type of cultured organisms and the production method, management practices, etc. These factors must be accounted for when assessing possible risks, together with the sensitivity or vulnerability of the ecosystem to possible pressures from aquaculture activities.

For marine fish cage farms, the following key issues that need to be addressed are

- Sedimentation
- Biogeochemical change in water
- Chemical input
- Disturbance
- Predator control
- Interbreeding (escapes)
- Pathogen transmission
- Alien species

A case-by-case approach is needed to identify the actual potential impacts, which depend on the environmental and rearing conditions and on the mitigation measures and appropriate management practices that must be applied to avoid or minimize such effects. The guidelines provide a number of specific suggestions on mitigation measures to be adopted for all aquaculture systems. For marine cage culture, control and limitation of the stock density can reduce the possible impacts caused by particulate organic waste, while the improvement of feed digestibility, as well as systems to reduce food waste, can also mitigate these impacts;

The procedure for aquaculture projects within a Natura 2000 site Articles 6.3 and 6.4 of the Habitats Directive lay down the procedure to be followed when planning new developments that might affect a Natura 2000 site. The procedure involves three stages: screening, Appropriate Assessment (AA) and, in exceptional circumstances, derogation. Every stage determines whether a further step in the process is required.

The **screening stage** is to determine whether a plan or project is '...likely to have a significant effect...' on the Natura 2000 site, implying that the Appropriate Assessment will be required. It applies to plans or projects either individually or in combination with other plans or projects. It may be that one aquaculture project alone might not have a significant effect but, if taken in combination with other plans or projects (other fish farms or other developments) within the area, the cumulative effects may turn out to be significant.

The **Appropriate Assessment** (AA) should address the potential effects on the conservation objectives of the Natura 2000 site from all the aspects of the plan or project, and cover all the stages of the aquaculture project, for instance: site preparation, building or installation of infrastructure and facilities, operation and maintenance activities, decommissioning, etc. All the potential pressures from the planned aquaculture activities, either through direct overlap (e.g. sedimentation on seabed areas) or induced at a larger scale (e.g. nutrient enrichment), that might have significant effects on the conservation objectives of the Natura 2000 site should be identified and the sensitivity and vulnerability of the relevant species and habitats to those pressures should be considered to assess the risk of significant effects.

Mitigation measures are an integral part of the specifications of a plan or project and should be considered during the AA. In the aquaculture context, they should be understood as technically feasible solutions that are the least damaging for habitats and species and the integrity of the Natura 2000 site as a whole, especially if alternative locations are not feasible.

Once the potential effects of the plan or project have been assessed, it needs to be determined whether it will adversely affect the integrity of the Natura 2000 site, either alone or in combination with other plans or projects.

This decision-making process is underpinned by the precautionary principle. The emphasis should be on objectively demonstrating, with reliable supporting evidence, that there will be no adverse effects on the integrity of Natura 2000 sites. For this reason, the lack of scientific data or information on the potential risk or significance of impacts cannot be a reason to proceed with the plan or project.

The third stage of the process applies in case the lack of adverse effects on the integrity of the Natura 2000 site concerned cannot be ascertained. Article 6.4 of the Habitats Directive establishes **a set of conditions which must be met for the competent authority to authorize such a plan or project in exceptional circumstances**. These conditions relate to the absence of alternatives, the presence of imperative reasons for overriding public interest and the adoption of all necessary compensatory measures. The latter constitute the "last resort" and are used only when the decision has been taken to proceed with a plan or project that could have an adverse effect on the integrity of the Natura 2000 site

By properly implementing relevant EU and national legislation most of the potential pressures and impacts from aquaculture can be prevented or minimized. In addition, the aquaculture operators are voluntarily making significant efforts to apply good management practices (e.g. codes of conduct, monitoring, certification) and organic aquaculture is promoted by the EU.

https://op.europa.eu/en/publication-detail/-/publication/5a1b8512-df3e-11e9-9c4e-01aa75ed71a1/language-en/format-PDF/source-search