MACALISTER ELLIOTT & PARTNERS LTD

Comparison of Six Environmental Impact Assessment Reports for Greek Aquaculture Operations

Final report for Rauch Foundation Region of the Amvrakikos Gulf

March 2024




MacAlister Elliott & Partners Limited
56 High Street, Lymington, Hampshire, SO41 9AH, England
www.macalister-elliott.com

Table of Contents

Abbreviations and Acronyms

APE	Aquaculture Production Education
BOPE	Free Trade and Industrial Zone
BRC	British Retail Consortium
DEYA	Hellenic Union of Municipal Enterprises for Water Supply and Sewage
EAFRD	European Agricultural Fund for Rural Development
EIA	Environmental Impact Assessment
ELSTAT	Hellenic Statistical Authority
EMAS	European Eco-Management and Audit Scheme
EMFF	European Maritime and Fisheries Fund
EMS	Environmental Management Systems
EPXSAA	Special 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
GHP	Good Hygiene Practice
GMP	Good Manufacturing Practice
HRT	Hydraulic Retention Time
HPHSAAY	Special Spatial Planning and Sustainable Development Framework for Aquaculture
IFS	International Featured Standards
kg	Kilogram(s)

km	Kilometre(s)
km^2	Square kilometre(s)
m	Metre(s)
ml	Millilitre(s)
MEP	MacAlister Elliott and Partners Ltd.
MME	Small and Medium Enterprise
MSP	Marine Spatial Planning
NAVIPE	Marine Industrial Complex
ODA	Organized Development of Aquaculture
OTE	Hellenic Telecommunications Organization
POAY	Area of Organized Development of Aquaculture
PAY	Aquaculture Development Area
ppt	Parts per thousand
PSU	Practical Salinity Units
RAS	Recirculating Aquaculture System
ROP	Regional Operation Programmes
RT	Residence Time
SCA	Special Conservation Areas
SEIA	Strategic Environmental Impact Assessment
Stremma	1 stremma = 1000 square metres, plural = stremmata
SPA	Special Protected areas
SWOT	Strengths, Weaknesses, Opportunities, Threats
SWSGPR	Surface Water and Groundwater and Groundwater Aquifers
t	Tonnes
TEI	Technological and Educational Institute

TEE	Technical Chamber of Greece
WFD	Water Framework Directive
WUA	Water Use Agreement

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 standardise 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 are 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

The Strategic Environmental Impact study for the POAY in and around the Gulf of Amvrakikos was undertaken by NAYS Ltd in 2014 and was based on data collected and analysed in 2009 and published data from 1982 to 2010.

Much of the data concerning population demographics and infrastructures from the social aspect is from data more than 5 years old at the point when the initial report was prepared. The data is currently nearly 20 years old and considerable changes have occurred in the region with infrastructure projects and may also have occurred in the social aspects of the study.

However, the report does not fully cover what would be expected in an Environmental and Social Impact Assessment study at the site level.

Environmental impacts

The EIA report provides an overview of the potential environmental impacts of expanding fish farming in the Amvrakikos Gulf. The report concludes that the proposed development would have some environmental impacts, but that these impacts could be managed through mitigation measures.

This evaluation report is based on a thorough review of historical scientific literature and expert opinion and provides an assessment of the potential environmental impacts of the proposed development, identifies a number of mitigation measures that could be taken to minimise the impact of the development. The plan is for a considerable rise in marine species production, necessitating the relocation and establishment of new farming units as well as infrastructure improvements.

Specifically, the study is *insufficient* in:

The carrying capacity calculation uses the Greek formula that was developed for bays and open locations. The formula needs to be validated in the enclosed gulf conditions. This is a major weakness.

There is an absence of alternative, less impactful aquaculture methods in the EIA report, which focuses solely on the base case and the proposed production increase without exploring sustainable options. This approach neglects the potential for less environmentally damaging practices, undermining the assessment's comprehensiveness. This is a major weakness.

The EIA report does not adequately quantify the nutrient output of the individual farms (or collectively) to assess if the environment can assimilate these additional inputs or predict what impacts they would have locally around the farms and cumulatively in the Gulf. This is a major weakness.

The report does not adequately address the cumulative impacts of multiple fish farms in the same area in the sensitive ecosystem that is found in the Gulf. This is a major weakness, as the cumulative impact of multiple farms could be far greater than the impact of a single farm. For example, if multiple farms are located close to each other, the combined waste from these farms could have a significant impact on water quality.

The designation of Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) within the Gulf underscores its ecological value and necessitates protective measures. The report does not provide a detailed analysis of the potential impact on sensitive species such as *Posidonia oceanica* (seagrass) and dolphins. This is another major weakness, as these species are particularly vulnerable to the impacts of fish farming.

The EIA identifies some mitigation measures that could be taken to minimise the impact of fish farming. However, the report does not provide a detailed assessment of the effectiveness of these mitigation measures. To ensure that these measures are effective, the EIA report should provide a more thorough analysis of potential mitigation measures that can be undertaken by the farm operators. This is a major weakness.

In addition, there is a need for the following additional studies and surveys to be conducted (these are major weaknesses):

- A study to map the distribution of *P. oceanica* in the Amvrakikos Gulf and assess the potential impact of fish farming.
- A study to identify the location and range of sea turtles in the area and assess the potential impact of fish farming.
- A study to develop mitigation measures to reduce the interaction with birds.

While the planned aquaculture expansion in the Gulf of Amvrakikos aims to enhance production, it introduces significant environmental risks to a vulnerable ecosystem. This necessitates the quantification of outputs, prediction of impacts, consideration of cumulative impact effective farm management and mitigation measures to ensure the gulf's ecological integrity and the protection of valuable habitats and species for the future, highlighting a critical weakness in the current approach to safeguarding one of Greece's most important wetlands.

Socio-economic impacts

The study does not provide sufficient quantification of the social impacts or provide sufficient recommendations on mitigation measures. In addition, there appears to have been no stakeholder consultation during the study to be able to find mutually agreed solutions to avoid conflict with other users of the space (e.g. fisheries and tourism) in the regions surrounding the Amvrakikos Gulf.

Specifically, the study is *insufficient* in:

- Quantifying planned new facilities (land and sea), use of inputs (feed and fingerlings) and outputs (nutrients released to the water column). This detail is required to quantify the changes that might occur with the expansion of production and project area. This is a major weakness.
- Proposing environmental and social mitigation measures to reduce impact. This should be a key part of the study to identify and recommend areas of mitigation to minimise potential conflicts. This is a 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.) within the level of infrastructure and services available in the region. This is a major weakness.
- Quantification, solutions and impact from the project outputs such as wastewater treatment, solid waste disposal and organic waste disposal. A major increase in production will generate a large wastewater treatment requirement from sewage, facility and equipment washing, etc. This, as well as the other solid and organic waste disposal, needs to be quantified to assess and predict scale and potential solutions. This is a major weakness.
- The study shows no evidence of stakeholder consultation and effort to find mutually agreed mitigation measures to reduce social impacts. This is a critical weakness.

1. Introduction

1.1 Background

The Strategic Environmental Impact Assessment (SEIA) identifies, describes and evaluates the potential significant environmental impacts that will result from the implementation of the POAY Development Plan for the Amvrakikos Gulf.

The main purpose of the environmental impacts which are examined by the SEIA, is the spatial development of aquaculture activity in the coastal zone (marine and terrestrial) in and around the Gulf of Amvrakikos. It should be noted that while the aquaculture activities are focussed on the Gulf of Amvrakikos the study area includes the adjoining regions and municipalities of the Regional Units of Aitolokarnarnia, Preveza and Artas and the Districts of Western Greece and Epirus Greece.

The Amvrakikos Gulf is in northwest Greece. It is one of the largest semi-enclosed embayment's in Greece being about 40 km long and 15 km wide.

Amvrakikos attracts strong interest at the National and International levels, as one of the most important wetlands of Greece with high ecological value. Important habitats, and protected bird species, along with an abundance of plants, animals and fish compose an image of unique diversity and beauty[1].

Water renewal is made via a narrow channel which connects the Gulf with the Ionian Sea having a 3.0 km length, width ranging from 0.8 to 2.0 km and depth from 2.0 to 13.0 m. The hydraulic retention time (HRT) and residence time (RT) are terms that are used to indicate how fast the water of semi-enclosed coastal embayment's are renewed. A preliminary estimation of HRT was estimated[2] to be between 1.86 to 2.42 years however, the flow rates of the Louros and Arachthos rivers, which flow into the Gulf, reduce the HRT by 0.56 years. The theoretical RT is equal to 3.85 years.

Marine fish cage culture has become an increasingly important industry in Greece, contributing to both the economy and the food security of the country. In the Amvrakikos Gulf, fishing, aquaculture (traditional in lagoons, intensive finfish culture in floating cages and mussel farming in long-lines), and processing of fishery/aquaculture products are important activities related to the gulf. However, the industry has also been associated with a number of beneficial and detrimental environmental impacts.

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

[1] *https://necca.gov.gr/en/mdpp/management-unit-of-acheloos-valley-and-amvrakikos-gulf-protected-areas*

[2] *Modeling renewal times in Amvrakikos Gulf, Greece. (Stamou et al. 2012).*

significantly impacts marine ecosystems. Nutrient-rich waste from fish, including nitrogen (N), and phosphorus (P), 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 contributes 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

The present Strategic Impact Assessment (SIA) was prepared by the company "NAYS E.P.E." – in the context of the Strategic Environmental Assessment Strategy with a view to the adoption of a plan for the development of aquaculture areas (POAY in Greek) of the Amvrakikos Gulf (the responsibility of the Aitoloakarnania Region, the Region of Southern Greece and the Regions of Peloponnese and Apta, the Region of Epirus).

A series of feasibility studies and Environmental Impact Assessments (EIAs) have been prepared for the POAY. The focus of this review is the Strategic Environmental Impact Assessment (SEIA) prepared by NAYS Ltd in 2014 with environmental data collected in November and December in 2009 and using published data from 1982 to 2010.

- Drafting of the necessary study files and other supporting documents are for the zoning of the POAY in the Gulf of Amvrakikos (Jurisdiction of the Regional Unit of Aitolakarnia, Western Greece and the Regional Units of Preveza, Arta and Epirus)

It should be noted that the study area is currently included in an area for further aquaculture development. The main objective of the General Spatial Planning Framework is the identification of a spatial zone for the sustainable development of aquaculture in the Amvrakikos Gulf to enhance competitiveness, achieve economies of scale and the creation of modern support facilities (storage areas, packing stations, fish hatcheries, etc.) and maintain social and economic cohesion.

Consideration should also be given to other strategic objectives of the POAY which include: maintaining an ecological balance between aquatic resources such as existing rare fish stocks and aquaculture resources, safeguarding natural ecosystems, integration of other activities into the zoning plan while improving competitiveness of existing products and businesses. The maintenance, strengthening, and improvement of human capital in aquaculture and other supporting sectors (catering, hotels, housing, etc) through opportunities and improvement of the well-being of residents should also be considered.

2. NAYs EPE

The EIA for the Amvrakikos Gulf area was undertaken by NAYS Ltd, led by Ioanna Argyrou. It is a Greek company with expertise and experience in EIAs, particularly for marine fish cages in Greece. The company specialises in project planning and development consultancy, offering a range of services in various sectors. Among these, their proficiency in the aquaculture sector is particularly relevant.

NAYS Ltd has undertaken a number of EIA projects across Greece, specifically for marine fish farms. These assessments are carried out adhering to both National and European legislation. The company's portfolio includes projects such as the EIA and Specific Ecological Evaluation Study for marine fish farms in locations like Serifos Island in the South Aegean Sea, Gaidaros Island in the Amvrakikos Gulf, and others in the Epirus region and the Dodecanese Islands.

Their approach encompasses a wide range of environmental considerations, extending to ecological evaluations in areas under specific protection and management provisions, including those that are part of the Natura 2000 network.

NAYS Ltd has a diverse team including senior biologists, ichthyologists, chemical engineers, agro-economists, and technical advisors, indicating a multidisciplinary approach to their projects.

Experience:

- NAYS Ltd has been operating since 1996, indicating a significant amount of experience in the environmental field.
- The company's portfolio includes a diverse range of environmental projects, including fish farms, studies for wind farms, power plants, and infrastructure projects.
- They have a wide experience with complex environmental projects.

Expertise:

- NAYS LTD has a team of environmental engineers, biologists, and other specialists.
- They have expertise in water quality assessments, marine ecology, and environmental modelling.
- The company has experience with environmental permitting processes, and so has familiarity with relevant Greek regulations for marine fish cage operations.

Competence:

- NAYS Ltd is accredited by various international organizations, including TUV Hellas and the Hellenic Accreditation System (ESYD). These accreditations demonstrate their commitment to quality and adherence to international standards.
- The company's website showcases a range of environmental projects.

3. Analysis of Amvrakikos EIA

3.1 Scope of SEIA

EIA report: The management company of "POAY Amvrakikos AE" was established, to set up the POAY in the area of the Amvrakikos Gulf for the development of aquaculture areas. This company was established on 17/7/2014 and registered with the G.M.MH on 26/8/2014 and details of participants have been listed in the study. The main purpose of the SEIA is to investigate the impact of public procurement and the implementation of the POAY objectives. This was carried out by the implementing body "POAY Amvrakikos AE".

These objectives are:

- The status of the marine ecosystem of the Amvrakikos Gulf area (water column, bio-communities, seabed, etc.).
- The protection of sensitive and endangered species of flora and fauna.
- The integration of pollutant release into the marine and terrestrial environment.
- Supporting the population in disadvantaged areas by creating employment and living conditions
- Increasing employment in the fisheries sector (strengthening of sectoral employment due to the public procurement of the POAY) and improvement of fishing conditions.
- Ensuring the health and safety of fishing products.
- Improvement of the physical or associated environment which contributes to the promotion of alternative tourism and an integrated approach to sustainable development.
- Protection and enhancement of the cultural, architectural and archaeological heritage in the areas where the aquaculture sector is developing.
- Protection and improvement of the aesthetics of the landscape in the study zone.

In addition, the public service objectives of the company include:

- A public dialogue and exchange of views on common issues.
- The exchange and sharing of experience with similar players in other parts of the country or the world.
- The upgrading of the sector's workforce, to improve their wages and productivity, to boost the local economy.
- To inform the units and the public by publishing an information booklet or other for each unit and by organising or participating in events to promote the sector.

EIA analysis: The POAY strategy was in line with the National Strategy referred to in the Specific Plan for Economic Planning and Sustainable Development for the Region as outlined in Chapter 3 of the report.

The study notes that these priorities are considered in all individual parts of the design of the project. However, the description of the project (Chapter 4) does not mention that any stakeholder or community engagement and consultation was to be or had been undertaken during the study.

3.2 SWOT analysis

EIA report: The study area of the proposed POAY is divided into two area, the POAY of Southern Greece and the POAY of Epirus and concludes that 3 zones are suitable for the development of the aquaculture areas that will form the POAY. These have been developed to minimise any impact. of the establishment and operation of the aquaculture units, on the immediate and wider environment and they take account of their impact on other activities in the study area.

According to the models applied the total annual tonnage of the POAY, according to the physico-chemical characteristics and biological parameters of the area, is estimated at 7,080 tonnes (t) of Mediterranean marine fish, 3,692 t of shellfish, 650 t of eel, 15 t of mullet and 4.5 t of tilapia.

A SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) was used to identify the Strengths and Weaknesses, as well as the Opportunities and Threats for the definition of the PDOY in Amvrakikos Gulf and this is shown in the table below.

Growth potential

Strengths	Weaknesses
• An important physical and cultural resource for the development of alternative forms of tourism • Variety of aquatic systems- an important factor in a wide range of resources (aquaculture, irrigation etc.) • Important agriculture activities, capacity for expansion • Existing Aquaculture Production Education (APE) potential of existing budget and economic optimisation • Increasing demand for alternative forms of tourism • Existing Technological and Educational Institute (TEI) • Large traditional agriculture and livestock farming sector • Particularly assessed fishing areas	• Low level of APE • Insufficient business profitability • Insufficient small and medium enterprise (MME) networking • Micro, medium and technology intensive sectors. • Structural weaknesses in the tourism sector • Shortcomings in national infrastructure • Insufficient services to businesses and lack of business infrastructure • Structural weakness in the marketplace • Structural weakness in the manufacturing sector

Accessibility

Strengths	Weaknesses
• Major transport infrastructure largely completed (Ionian Road, Egnatia, Aktiou connection) and programmed planning of major projects to improve the transport system • Continued community funding for the new programming period • Proximity to Italy and the Balkans (Potential threat to the domestic market from competition and geopolitics)	• Shortcomings in the basic inter-urban road infrastructure and interconnection of transport nodes • Shortcomings in the marine transport system and air transport system • Improvement and growth of transport infrastructure resulting in an incomplete optimisation of the trans-European transport chains

Physical and sustainable environment

Strengths	Weaknesses
• Availability of specific physical resources • Existing habitats with international importance • Political heritage with development potential • Existing dynamic city regeneration	• Significant eutrophication problems in Amvrakikos Gulf • Shortcomings in social infrastructure • Shortcomings in the management of landfill and waste materials • Problems in the stability of residential areas due to no maintenance • Conflicts and weaknesses in land planning and spatial planning capacity but with the prospect of improvement • Weakness in urban planning • Weakness in the protection and management of specific natural resources and the safety of natural areas

Human resources and level of organisation

Strengths	Weaknesses
• The state of basic education is considered satisfactory • Availability of resources in growth programmes • Existence of the Technical Chamber of Greece (TEE) in the region	• Relatively low level of education in the population • Weaknesses in lifelong training • Shortages of advanced facilities in higher education • Reduced efficiency and problems in the organisation and administration of local government • Aged population and high unemployment rates especially in certain population groups (young people and women) • Social exclusion • Weakness in links between training and the requirement of the employment market

EIA analysis: The SWOT analysis considers many of the social aspects of the study and the impact on local livelihoods and communities with respect to educational requirements, community infrastructure, services and resources that would be required to make this project sustainable. The identification of basic technical, administrative and social infrastructure and equipment required for the effective operation of the POAY have been identified.

3.3 Framework and objectives of the study

EIA report: International, community and national environmental protection objectives relevant to the project include:

EU policy and regulations:

- **Barcelona Convention**: This convention is a collaboration between the EU and Mediterranean countries to protect the biodiversity, marine, and coastal environment in the Mediterranean Basin. It includes the adoption of the Protocol for Integrated Management of the Mediterranean Sea Area in response to climate change.
- **Community Marine Strategy Framework Directive** (2008/56/EC): This directive aims to protect and preserve the marine environment, promote biodiversity conservation, and address the impact of human activities on marine ecosystems.

- **European Parliament and Council Directive** 2000/60/EC on Water Framework Directive: This directive sets objectives for the protection of aquatic ecosystems and emphasizes integrated management of aquatic resources.
- **European Commission's Communication** COM (2000) 547: This communication focuses on the comprehensive management of specific zones, considering various environmental and human factors, and promoting an integrated participatory approach.
- **European Union's Strategy** for the Implementation of Policies: It recognizes the significance of Pacific zones, biodiversity, coastal risk due to climate change, population growth, and economic opportunities in shaping policies for sustainable management.
- **European Commission's Opinion** COM (2007): It emphasizes the need for region-specific solutions in coastal management, gathering and analyzing information, and promoting integrated zone management.
- **Renewal of the European Parliament's Position** (COM 2009) 162): This document addresses sustainability in water and agriculture, aiming to promote marine transport, technology, innovation, and sustainable practices.
- **Common Fisheries Policy** (Regulation No. 1380/2013): The objective of this policy is to ensure sustainable fisheries and aquaculture practices, contributing to economic, social, and environmental conditions and food availability.
- **Sustainable Water Strategy** for the EU (COM (2013) 229): This strategy supports sustainable aquaculture management, focusing on national objectives and sustainable practices.
- **Community Framework** for Maritime Spatial Planning: This framework aims to promote sustainable development of marine and maritime assets and resources through decentralized management and coordination of maritime spatial planning.

Greek policy and regulations:

Special Plan for Ecological Planning and Sustainable Development for the Pacific (2003-2018):

- Aims to promote integrated and balanced development of coastal areas while optimizing competitiveness and environmental protection.
- Promotes stakeholder involvement, information systems for the public, conservation of coastal resources, and strategic spatial planning.
- Defines the coastal zone, critical zone, and dynamic zone, each subject to different management approaches.
- Identifies eligible facilities for construction in coastal areas, including harbours, aquaculture sites, and more.
- Emphasizes the importance of scientific knowledge, sustainability, and participatory processes in integrated management.

National Biodiversity Strategy (2010):

- Focuses on protecting biodiversity and conservation of protected areas.
- Aligned with international commitments, including the Rio International Conference, Panama Convention, and EU's Biodiversity Strategy.
- Aims to reduce biodiversity loss in Greece over a six-year period.
- Addresses various threats to biodiversity and incorporates evidence-based sustainable management methods.
- Establishes Special Protection Areas (SPAs) and Special Conservation Areas (SCAs) for wildlife and habitat conservation.

Water Resource Management:

- Alignment with the Water Framework Directive through legislation.
- Emphasizes sustainable policies for water resource recovery and management.
- Addresses issues like water scarcity, flooding, and water-saving measures.
- Recognizes the importance of forests and their role in water management.
- Establishment of the National Water Authority for water management policy formulation.

Spatial Planning:

- Based on Law 2742/99, focuses on sustainable infrastructure development and protection of developed areas.
- Encourages spatially oriented projects in high-traffic areas and economic clusters.
- Law 4269/2014 introduces urban transformation and priority areas for development.
- Individual Plans (DPAS and PPAS) are considered within the spatial planning framework.

Specific Plan for Water Resources Planning and Management (2011):

- Adopted by the European Commission to improve water resource management.
- Aims to enhance environmental and sustainable development in the region.
- Focuses on strategic choices and interventions to improve water resource implementation.

Implementation of EU policy in Greece:

The European Water Framework Directive (Directive 2000/60/EC) is a comprehensive framework that lays out principles and measures for managing all types of waters, including rivers and lakes, with a focus on their ecological importance. Here's a summary of its key points:

Directive Objectives (Article 1):

- Prevent further deterioration and protect and improve the status of aquatic ecosystems and habitats affected by pollution.
- Promote sustainable water consumption while considering available financial resources.
- Encourage increased water supply and the enhancement of the water environment.
- Contribute to the necessary reduction in groundwater pumping.
- Help mitigate the effects of floods and flooding.

Implementation and Planning:

- The Directive involves a series of planning procedures leading to the adoption of measures included in the Clean Development Plan.
- It operates on an annual cycle, with multiple implementation cycles.
- The Directive was originally set to achieve its objectives by 2015 but has been extended to the end of 2027.

Water Management Plan:

- The Water Management Plan is a crucial component of Directive 2000/60/EC.
- It encompasses all steps and initiatives aimed at fulfilling the Directive's objectives.
- The plan specifies objectives for various water categories and outlines measures to attain good water status.
- It serves as a binding framework for activities related to water management and is a reference point for spatial planning in relevant catchment areas.
  Planning Authority:

- The Special Secretariat for Water under the Ministry of Environment, Nature, and Climate Change is responsible for drafting River Basin Management Plans for specific water regions.
- EGY serves as the National Competent Authority for implementing the Water Framework Directive.

Implementation Progress:

- Greece is completing the implementation of the Water Framework Directive for its river basins.
- Several River Basin Management Plans have been approved and published in the Government Gazette.
- A review of River Basin Management Plans was conducted in 2017, resulting in revisions and approvals.

Local policies:

The Thessaly - Central Greece - Epirus Operational Programme outlines its strategic objectives and plan for the period 2007-2013. The primary strategic objective is to enhance competitiveness, sustainability, and resilience of the ecosystem by focusing on spatial and environmental management and adopting sustainable production and management methods for the natural and built environment.

Key strategic objectives include:

- Improving the competitiveness, efficiency, quality, and individual capacity of enterprises.
- Enhancing accessibility through infrastructure construction and transport network improvements.
- Strengthening the domestic budget.
- Promoting sustainable management of natural and built environments and natural resources.
- Enhancing the economic and social environment.
- Promoting digital convergence.
- Integrating tourism and culture for sustainable development.

For the period 2014-2020, a sustainable grid of five strategies:

- Improvement of environmental performance through technology and environmentally sound technologies.
- Promotion of sustainable development.
- Introduction of measurement methods.
- Establishment of training, education, and training programs.
- Human resources analysis, social and economic intelligence, and crisis management.

These strategies aim to address environmental, economic, and social challenges in the region.

The program focuses on the sustainable development of the region. It emphasizes:

- Conservation and ecological balance
- Environmental management and protection.
- Waste management.
- Urban waste management.
- Ecosystem development.
- Regeneration of sites, settlements, and cultural monuments.
- Ecotourism, agro-ecotourism, and the conservation of local products and fisheries products.
- Improvement of geothermal energy and renewable energy sources.

- Pilot innovative applications in the production process.
- Labelling of local products and quality assurance of agricultural products.

Spatial planning in Greece:

For the spatial planning of Aquaculture Activities in Greece, there exists today a National Prototype, The Special Spatial Framework for Aquaculture ('POAY')

The framework provides directions, criteria, compliance, rules and regulations of institutional, administrative and organizational nature, embodying various factors which should be discussed and which result in promoting multi-purpose activities and their complementarity.

The Special Spatial Framework for Aquaculture" further regulates matters of administrative actions concerning the spatial integration of aquaculture activities within:

- organized zones ('PAY'),
- small groups of clustered aquaculture units,
- single aquaculture units.

Special Spatial Framework (POAY):

POAY is a strategic plan that designates specific areas for the development of aquaculture activities in Greece.

The framework aims to promote sustainable development of aquaculture activities by considering environmental and ecological characteristics.

It considers factors like location, marine environment conditions, existing aquaculture units, and depths to ensure sustainable and efficient development.

POAY designates different sea surface areas for aquaculture activities, typically categorized as 10, 15, 20, or 25-stremmata[3] zones.

The framework specifies the annual production capacity for each designated area to ensure adherence to regulations and sustainability. Different areas have different capacity limits.

The implementation of POAY involves the allocation of specific sea areas for aquaculture activities based on the designated zones and capacity limits. Aquaculture operators must adhere to the regulations outlined in the framework to ensure responsible and sustainable aquaculture practices.

The Framework requires considering that areas hosting aquaculture units in an area greater than 100,000 m^2 from organized zones 'Areas of Organized Development of Aquaculture Activities', known as "POAY."

The issuing of a Presidential Decree instead of a Joint Ministerial Resolution for the establishment of "POAY." reinforces their institutional validity.

The planning of "POAY." has considered:

- the known scientific data concerning the area of interest,

[3] *A unit of land area mainly used in Greece and Cyprus, equivalent to 1000 m^2*

- the in-situ observations of the survey team as well as
- the directions and requirements as they currently apply in the national aquaculture legislation framework, together with the scope of the proposed Special Spatial Framework for Aquaculture

Objectives of the Proposed POAY.

- Reducing intensive aquaculture impacts.
- Promoting environmentally friendly aquaculture.
- Developing sector activities.
- Protecting human and public health.
- Reducing emissions.

The document discusses the establishment of land-based and exterior land areas for aquaculture units in the context of the POAY.

The key points are as follows:

I) Large Land-Based Zones:

- A green zone is proposed along the shore to facilitate the installation of infrastructure for floating units in the POAY project. This infrastructure includes boat sheds and facilities for mooring transport, final product handling, and personnel access.
- In the coastal zone (zones 2 to 6), additional measures may be allowed, such as the construction of small buildings (up to 25 to 30 m^2) for unit surveillance and storage of electrical equipment.
- Other facilities that may be placed in the coastal zone include feeding facilities, accommodation tanks, seawater pumping and drainage systems, boreholes, warehouses, net-keeping areas, waste treatment facilities, vehicle parking areas, pumping stations, sheds, engine rooms, and guest quarters.

II) Exterior Land Areas:

- On-site installations for aquaculture units are generally located outside the sea and in proximity to the units.
- These installations include small-scale industrial facilities, processing plants, offices for administrative staff, and ancillary premises.

III) Existing Land Situations:

- Existing ground support facilities and licensed building facilities that are operating legally are to be used for the POAY green zone.
- Greenfield sites with roads are proposed for establishing and operating on-site and off-site aquaculture facilities.
- The existing land use in the proposed green zones of the POAY is mainly agricultural.
- There are plans to build a processing plant - smokehouse in Zone X-1 in the future, where indoor space is available.
- The Centre of Administration is proposed to be located in Preveza.

EIA analysis: The report adequately describes the EU, Greek, Regional and Local policies and regulations. It covers the local policies that affect the local communities but does not relate (or quantify) the impacts of the expansion of cage culture to the regional and local objectives.

3.4 Project description

EIA Report: The document provides an overview of various marine aquaculture systems, including their evolution and characteristics. Here's a summary of the key points:

Evolution of marine aquaculture:

- Over the past 35 years, marine aquaculture in floating cages has seen rapid development.
- Initially, marine cages were three-water structures, but their expansion led to a need for a more advanced third generation of sea cages.
- Third-generation sea cages are designed for offshore areas and use large-volume net cages. Offshore waters are categorized as semi-exposed and exposed.

Technological advancements:

- Modern marine aquaculture systems utilize high-capacity feed barges and electronic computers to increase production efficiency.
- Long-range communication networks are used to transmit real-time data on production processes and marine ecosystem conditions.

Oyster cultivation:

- Oyster cultivation is non-intensive and depends on location, cost, and operation methods.
- Freshwater processes are used for feeding oysters, which are constantly filtered. The post-harvest period lasts one month.

Mussel cultivation:

- Mussel cultivation involves preparing for conception in autumn and spring, followed by harvesting.
- Mussels are grown for 12 months and reach commercial size by May of the following year.

Inland water aquaculture:

- Inland water aquaculture includes three types: extensive, semi-intensive, and intensive.
- Extensive aquaculture involves multiple species, low density, and minimal intervention.
- Semi-intensive aquaculture includes many species, moderate stocking density, and some intervention.
- Intensive aquaculture features high stocking density, monoculture, and control systems.

Tank systems:

- Tank systems come in various shapes and sizes, made of durable materials.
- Polystyrene, reinforced concrete, and concrete blocks are common materials used.
- Tank configurations are chosen based on factors like indoor/outdoor placement, species, and water supply.

Recirculation systems:

- Recirculation systems reuse water from culture tanks, reducing the need for fresh water.
- Water treatment systems purify and maintain water quality, allowing for high recirculation rates.
- Advantages include reduced water usage, easier waste treatment, and the ability to cultivate species with higher nutrient requirements.

Present fish production

Amvrakikos	Units	Total production (t)	Area (ha)
Marine Fish	20	4,998	408.8
Oysters	12	2,880	310

Hatcheries	Station stations	Fry production capacity
Paliovapka, W. Aktiou - Vonitsa	1	75,000,000
Pogonitsa, W. Preveza	1	2,000,000
Talia, Kapari Hermionis - Menidio, W. Amfilochia	1	7,200,000

Production of other species

Eels, mullet and tilapia are harvested there in closed and open water circuits.

Following the planning for the POAY, the cages were arranged in 15, 20, and 25 stremmata sea areas, considering factors such as location, marine environment conditions, existing units, and depths. The aim was to ensure efficiency, viability, and adherence to regulations for annual production capacity per unit.

The key points are as follows;

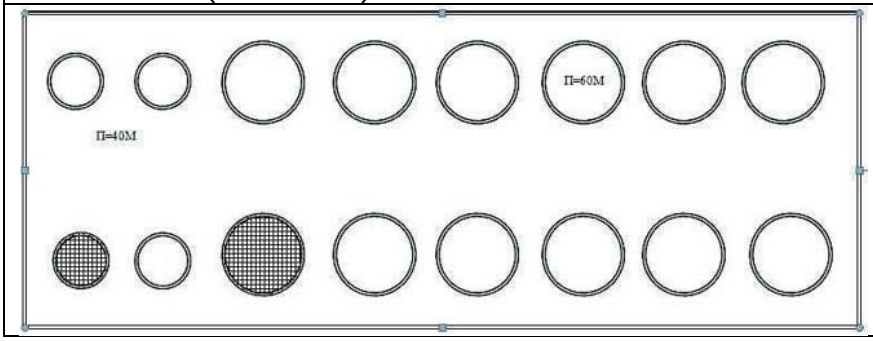
1. Capacity Planning:
    - 10 stremmata sea surface area: Not to exceed 200 t of Mediterranean marine fish per year.
    - 15 stremmata sea surface area: Not to exceed 250 t per year.
    - 20 stremmata sea surface area: Not to exceed 300 t per year.
    - 25 stremmata sea surface area: Not to exceed 340 t per year.

2. Specific Area Design:

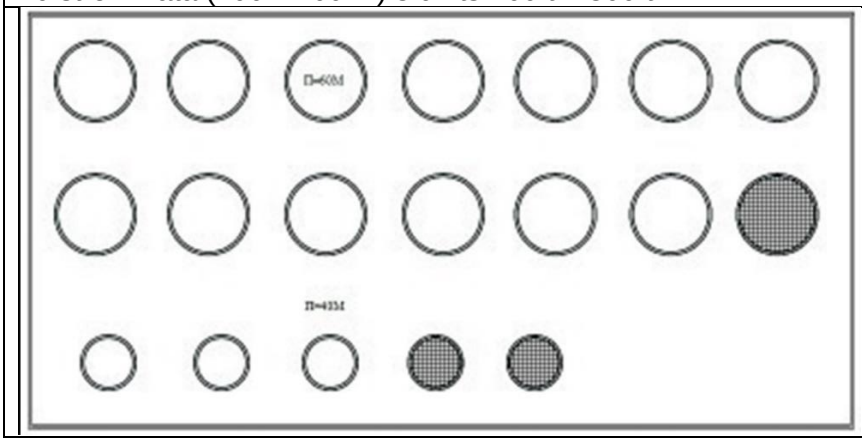
- The design of the theoretical model includes different dimensions for landings to accommodate necessary facilities:
    - 10 stremmata: 166.67 x 60 m
    - 15 stremmata: 200 x 75 m
    - 20 stremmata: 200 x 100 m
    - 25 stremmata: 208.33 x 120 m

3. Simplified Application of Common Rule:
    - Due to ecosystem and institutional framework specificities, a simplified application of the Common Rule for calculating dynamism per unit of area was proposed.
    - This approach resulted in lower annual activity compared to the full application of the formula in the Joint Decree.

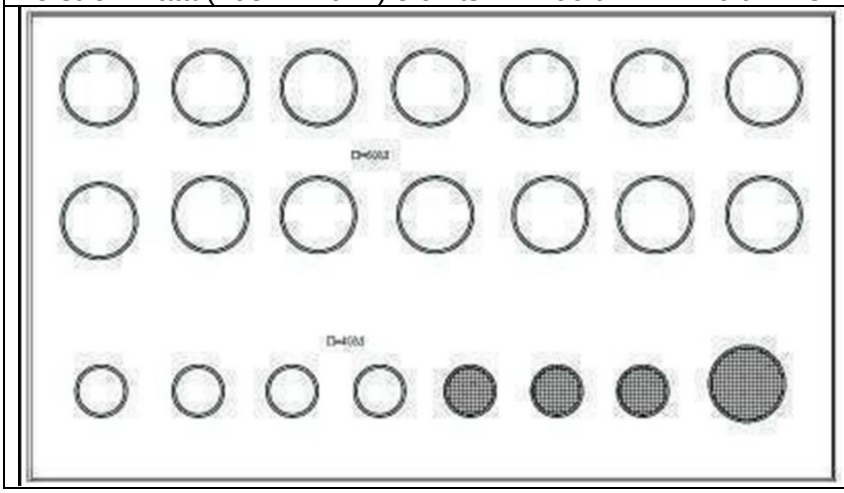
15 stremmata (200 x 75 m) 2 units 100t + 150 t = 250 t

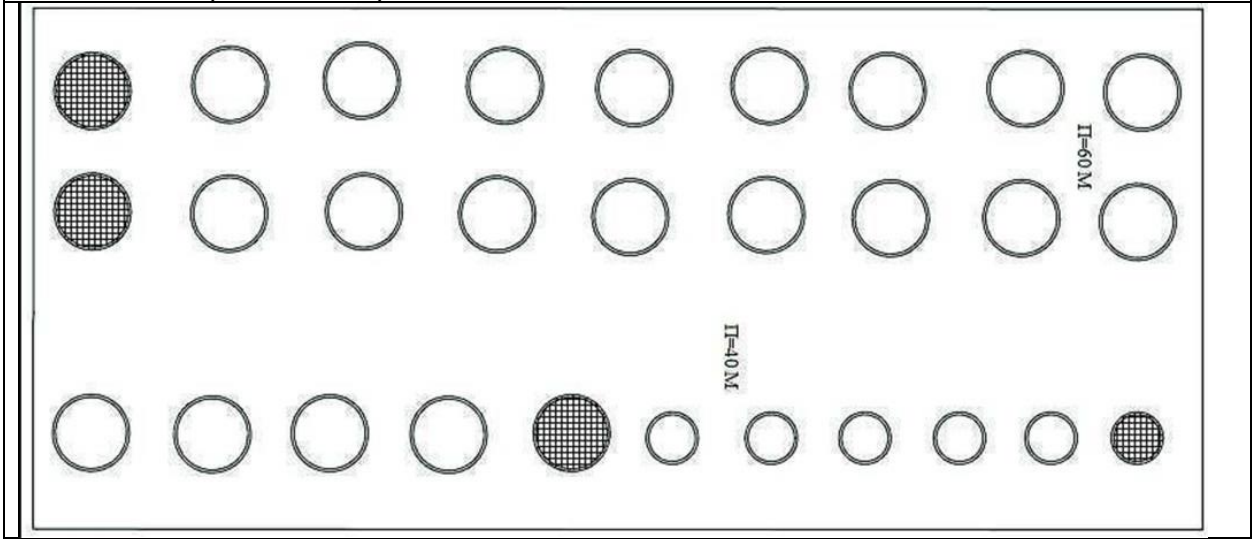


20 stremmata (200 x 100 m) 3 units 100 t = 300 t



25 stremmata (208 x 120 m) 3 units 2 x 100 t + 1 x 140 t = = 340 t



40 stremmata (300 x 134 m) 3 units 1 x 150 t + 1 x 180 t = 480 t


Finfish	2 – 15 g	15 – 50g	50 – 180g	180 – 380g
Initial Stock	2 g	15g	50g	180g
Cages	40 m diameter, 6 m deep	60 m diameter, 10 m deep	60 m diameter, 10 m deep	
Mortality Rate	6%	5%	4%	2%
Duration	2 months	4 months	5 months	6 months
End density	2.91 kg/m³	3.66	6.33	11.7

Oysters	0.3 – 300g
Initial Stock	0.3 g
longlines	40 m diameter, 6 m deep
Mortality Rate	11%
Duration	12 months
size	250 m x 120m
capacity	284 t
End density	15 kg/m

Eels	2 – 35 g
Initial Stock	2 g
Tanks	
Mortality Rate	
Duration	24 months
capacity	250 t

3.5 Assessment of alternatives

EIA report and analysis: There is no assessment of alternatives. The report provides details of the base case (existing situation) and the proposed increase in production. This a major weakness.

3.6 Choice of alternatives

EIA report: The report quantifies the new planned increase in aquaculture production for the different aquaculture zones.

Zone	Zone	Total volume (t)	Stremmata	New plans
Saint Thomas	1.1.Y	150	10	
	1.2.Y.	230	20	300 t
Pogonitsa	2.1.Y.	230	20	
	2.2.Y.	230	20	300 t
Laskaras	3.1.Y.	460	40	100 strem. / 1,380 t
	3.2.Y.	230	20	
	3.3.Y.	230	20	
	3.4	none	none	
Myrtave	4.1.Y.	230	20	30 strem. / 380 t
Gaidaros	5.1.Y	340	40	80 strem. / 760 t
Sogono	6.1	none	none	120 strem. / 1,136 t
	6.2	none	none	
	6.3	none	none	
	6.4	none	none	
Agia Tpiada - Voreia	7.1	none	none	40 strem. / 600 t
	7.2	none	none	
Agia Tpiada - Ditika	8.1.Y	230	20	90 strem. / 852 t
Mathoma	9.1.Y	284	30	90 strem. / 852 t
	9.2.Y	284	30	
	9.3	none	none	
Lofos	10.1.Y	100	15	75 strem. / 590 t
	10.2.Y	150	10	
	10.3.Y	310	30	
Kakovragos	11.1.Y.	150	10	60 strem. / 760 t
	11.2.Y.	190	15	
Gelada	12.1.Y.	150	10	30 strem. / 500 t
	12.2.Y.	150	10	
Chaliki	13.1.Y.	300	20	80 strem. / 920 t
	13.2.Y.	408	33.8	
Menithi	14.1.Y.	530	40	75 strem. / 590 t
	14.2.Y.		10	
	14.3.Y.		10	
	14.4.Y.		10	
Koronisia	15.1.Y	0	20	90 strem. / 852 t
	15.2.Y	0	30	
Preveza	X-1-Y	123 t eels	30.2	250 t
Arta	X-2-Y	400 t eels, 15 t mullet, 4.5 t tilapia	125.9	

The total annual tonnage is estimated at 7,080 t of Mediterranean marine fish, 3,692 t of shellfish, 650 t of eel, 15 t of mullet and 4.5 t of tilapia.

In the new plans, for marine fish, the following can be undertaken:

- Relocation - change of EXISTING units,
    - change of existing units which *are* located in the POAY zones,
    - replacement from another POAY site in accordance with the provisions of the 'Special Plan of design and Aspectual Design'
- The establishment of a new site by a LICENSED or UNLICENSED establishment
    - the installation of new facilities.

Oysters: It is recommended that the sea area is 30 stremmata (250 x 120 m) with a production of 284 t.

Eels: Maximum production of 250 t/unit.

Mixed species: 400 t of seabass or seabream, 15 t of mullet and 4.5 t of tilapia.

	Existing		**Plan**	
	t	Stremmata	t	Stremmata
Zone 1	380	30	300	20
Zone 2	460	40	300	20
Zone 3	920	80	1,380	100
Zone 4	230	20	380	30
Zone 5	340	40	760	80
Zone 6	0	0	1,136	120
Zone 7	0	0	600	40
Zone 8	230	20	852	90
Zone 9	0	0	852	90
Zone 10	560	55	590	75
Zone 11	340	25	760	60
Zone 12	300	20	500	60
Zone 13	708	53,8	920	115
Zone 14	530	40	590	75
Zone 15	0	0	852	90
Zone X1	123	30.209	250	30.21
Zone X2	400 + 15 + 4.5	125.933	400 + 15 + 1.5	125.93
Total	**4,998**	**423.8**	**5,774**	**1,065**
Expansion			**641**	**5,774**

Description of the existing support facilities

Packing stations	**Present situation**	**New situation**
Existing production	4,998	10,772
Number of units	10	11
Existing capacity	7,920	7,920
Excess capacity	2,922	-2,852

Hatcheries	Present situation	New situation
Existing production (million)	14.994	21.24
Number of units	3	3
Existing capacity	13.73	
Excess capacity	-1.264	-7.51

Additional necessary building facilities and equipment for the operation of the units (both in terms of production and after-sales services).

- Cold chambers, dispatch, de-misting, decontamination, cleaning, cleaning facilities (post-contact),
- Workshops - processing plants, premises housing offices for administrative staff, ancillary premises for auxiliary staff, etc. (others),
- Warehouses, 3-hourly waste management facilities, waste treatment facilities, vehicle parking areas, pumping station, sheds, sheds, engine rooms, guest rooms (sheds).

Piers

For zones 1 and 2, access will be from an existing port infrastructure near Preveza. For Zones 3 and 4, three (3) existing piers and two (2) new piers are planned, as shown on the site layout, from which access to the units in Zones 3, 4 and 5 will be provided. Access to Zone 5 will be from a new pier in Zone 3, which will - jointly - also serve a Zone 3 unit. Access to Zone 10 will be from an existing pier in the Zone area, while access to the Zone 11 units may be provided from two (2) new piers in the area of the Zone 11 on-site facilities. For access to the units in Zones 6 to 9, access is proposed to be from an existing port infrastructure in the vicinity of the P.E. converter. Preveza (near Zone 9). In the area of Zone 12 there is existing port infrastructure which is proposed to be improved for the passage of the units under the POAY. Zone 13 is proposed to be served by the existing harbour infrastructure at the location of Aki Haliki. Zone 14 can be served by the existing infrastructure of the operating unit.

4. Existing Environmental Situation

EIA report: Due to the ecological importance of the Amvrakikos Gulf, there have been a large number of scientific studies on the area. The report draws on the results of these studies particularly data from a thesis written in 1996 by Dr. Tsavou and other studies undertaken between 1983 to 2014.

- Seabed type and chemistry
- Zoobenthos
- Phyto benthos
- Water quality, temperature, salinity, oxygen, pH, water currents, nutrients
- Climate wind speed,
- Plankton
- Wildlife mammals, fish, birds
- Water sources rivers, lakes, groundwater

4.1 Seabed type and chemistry

Sediment. The sediment composition is predominantly uniform silt, except for sandy silt in the Preveza riverbed. Soil samples show low sand concentrations (<3%) and high silica content. The sediment has high CaCO3 contents in certain areas suggesting favourable conditions for benthic organisms. The sedimentary sediments show varying levels of total organic carbon, N, and P, indicating diverse environmental conditions across different stations. For the organic carbon, the region near Preveza shows maximum organic carbon values (up to 5.52%).

Zoobenthos. The benthic zoobenthos species diversity and biomass are generally poor in both aspects, especially in deeper parts of the bay. The benthos suffers from eutrophication and persistent layering. The low rate of water renewal and eutrophication, along with other factors, contribute to qualitative and quantitative deterioration. There have been notable changes in species like *Corbula gibba* and *Cerastoderma glauc*um in certain areas, indicating ecological shifts.

Phyto benthos. There are extensive areas with sandy or silty substrate in the Gulf of Ambakikos which support marine seagrass meadows. Species like *Zostera noltii* and *Cymodocea nodosa* are prevalent, while *P. oceanica* is absent, indicating rapid water evolution. The phytobenthos composition is influenced by various factors including salinity, water clarity, and eutrophication.

4.2 Water resources

River Basins and Characteristics:

- The Arachthos River has a basin area of 2000 km²
- The Acheron River, with a 705 km² basin area, originates from the Kokotos and Dala rivers.
- The Loupos River, with a 961 km² basin area, is characterized by stable flow due to its course through calcareous limestone.
- The Achelous River, the largest in the region, extends over 220 km with various sub-basins and freshwater lakes.

Local water reservoirs: There are small-scale projects for environmental, educational, and animal husbandry needs.

Management: The region generally meets its water needs satisfactorily, with most supply derived from wells and geothermal sources. However, there are issues with physical fouling and overfilling in some systems.

Water Supply and Distribution: The region has a network of pipelines and open canals, some of which suffer from significant water losses and deterioration. The lack of free-flowing water from surface bodies creates pressure on subsurface bodies, leading to the opening of geothermal vents and reduced discharge.

Water Column Stratification: The Gulf of Ambrosa exhibits intense stratification with a surface layer (up to 10 m depth) showing varying salinity (23.9 to 33.0 psu[4]) and a deeper layer with a salinity of 35.5 psu. This stratification is influenced by the depth of the water communication channel and water exchange.

Currents and Tides: The currents in the Gulf of Amvrakikos, surface currents are generally slow (< 3 cm/sec) but can reach up to 100 cm/sec near the Ionian Sea. In the Strait of Preveza, currents have average velocities of 9.3 - 13.9 cm/sec. In the port of Preveza, tides are weak, with a maximum range of 0.28 m.

4.3 Environmental parameters

The Gulf's main freshwater sources are the Loupos and Arachthos rivers, contributing to its classification as a sub-basin with significant sulphate (SO_4^{2-}) concentrations.

There is no significant disturbance in the ecological balance from heavy metals, but some accumulation is noted near certain areas.

Temperature: The winter surface temperatures range from 10.7°C to 13.8°C, varying across different parts of the Gulf. The summer night temperatures are between 8°C and 9°C. Surface temperatures average 28.4°C to 29.9°C, decreasing to 16°C to 20.5°C in autumn.

Salinity: The winter salinity values range from 26.4 psu to 37.5 psu, with the lowest values in the estuaries. In other seasons, the salinity ranges from 19.0 psu to 38.0 psu, with variations across different areas and seasons. Salinity decreased in the upper water column from November to December. Variations in salinity were observed at different depths and locations, influenced by river inflows and sea mixing.

Oxygen Concentration: Dissolved oxygen concentrations vary seasonally, higher in spring and winter (6.0 - 7.0 ml/L) and lower in summer and autumn (4.0 - 5.0 ml/L). Oxygen levels decrease with depth due to stratification and consumption for decomposition. A decrease in dissolved oxygen concentration was noted from November to December in the upper parts of the water column.

Turbidity: Turbidity levels varied across different stations and months, with some stations showing greater water column differences in July compared to March.

pH Levels: pH values were close to 8, with slight variations due to river influx or stagnation. Alkaline pH levels were observed in specific lagoons.

[4] *Practical salinity unit, equal to 1 part per thousand (ppt) (i.e., 1 g of salt in 1 litre of water)*

Chemical Parameters: High levels of ammonia were noted in estuaries, indicating pollution from organic matter or agricultural runoff. Variations in nitrate (NO_3-), ammonium nitrate (NH_4NO_3), phosphate (PO_4^{3-}), and other chemical parameters were observed, reflecting different sources of pollution and natural processes. Significant differences in P concentrations were observed between different months and depths. The distribution of total P varied, with some stations showing higher concentrations at greater depths.

Chlorophyll Concentrations: High concentrations of chlorophyll are found, indicating high levels of pollution in the Gulf. These are attributed to P carriers from rivers and P in the Gulf, as well as effluents from settlements and pig farms lacking biological treatment. The chlorophyll concentrations vary seasonally. In March, concentrations increase with depth up to a certain point and then decrease, while in July, they decrease up to a depth of 5 m and then increase. The distribution of chlorophyll at different stations shows variations, with some similarities in patterns observed between different months.

Zooplankton populations: There is a noticeable change in the abundance and diversity of zooplankton species from November to December across various stations. *Acartia clausi* (a marine copepod) is identified as the predominant species in most stations during these months. Each area of the gulf exhibits unique trends in zooplankton populations, with some showing an increase and others a decrease in the number and abundance of species.

EIA analysis: The results given in the report all come from previous studies.

The overall ecological status of the Gulf is not optimal, with indications of ecological degradation due to anthropogenic activities like agricultural runoff and pollution.

The region's water resources are managed through a combination of surface water bodies, river basins, and groundwater systems. While there are challenges like localized overexploitation and infrastructure issues, the overall management appears to meet the region's needs. The focus on local projects and the proposed improvements in water supply infrastructure indicate ongoing efforts to maintain and enhance water resource management.

Overall, the Gulf region's marine waters show significant seasonal and spatial variations in temperature, salinity, and dissolved oxygen, influenced by river inflows, stratification, and geomorphology. The currents and tides also vary, with generally weak tides and varying current speeds. The ecological balance appears stable, although there are concerns about heavy metal accumulation in specific areas.

Environmental Implications

- **Eutrophication**: The high levels of chlorophyll and variations in zooplankton populations suggest a state of eutrophication in the Gulf, particularly near the mouths of the Arachthos and Loupos rivers.
- **Pollution Indicators**: The presence of high chlorophyll levels and changes in zooplankton communities are indicative of pollution, likely influenced by agricultural runoff and lack of effective waste management.

The Special Areas of Conservation (SACs) and Special Protection Areas (SPAs) within the study area are described in the following table and figure:

Code	Category	Description of place	Area (ha)
GR2110001	ΕΖΔ (SCI)	Amvrakikos Gulf, Delta areas of Louros and Arachthos rivers (Petra, Mytikas, and wider area)	28,787.56
GR2110004	ΖΕΠ (SPA)	Amvrakikos Gulf, Lagoons of Katafoupko and Koronisia	23,010.75

Sources of pollution

- Farming and livestock production
- Fisheries

Sources of pollution from farming and livestock production

The report discusses the environmental impact of agricultural practices, particularly focusing on pollution and biodiversity in specific geographic areas. Key points include:

- **Pollution concerns**: The report highlights the excessive use of fertilizers in agriculture, contributing to environmental degradation. This includes the pollution of surface waters with N

and P, leading to risks for sensitive aquatic organisms and the potential carcinogenic effects of NO_3- in drinking water.

- **Biodiversity and ecosystems**: The area has a high potential for biodiversity but faces threats from biocidal activities and pollution. The impact on fruit trees and the introduction of chemicals into plant surfaces are noted concerns.
- **Economic and structural aspects**: The region's economic division and reliance on agriculture, despite technological advancements, contribute to environmental challenges. The use of large quantities of medication for agricultural efficiency is mentioned.
- **River basin management**: The text references the SEIA of river basin management plans in Greece and Epirus, focusing on the pollution from sulphur (S), N, and P due to fertilization.
- **Livestock production**: The impact of livestock enterprises (animal and bird species) on the environment is discussed, including issues related to waste management and the concentration of volatile compounds.
- **Environmental management**: The SEIA (2010) is mentioned, focusing on the environmental management of specific areas like Arta and Preveza. The report also discusses the distribution of livestock in various sub-basins and the impact of livestock units on the environment.
- **Animal welfare**: The text briefly touches on animal welfare teams in the region.

Fisheries

The report provides an overview of the fisheries and aquaculture sectors in the region and southeastern Greece, focusing on environmental impacts and biodiversity:

- **Fish stocks and fishing grounds**: The region has well-developed saltwater fish stocks, with fishing grounds divided into marine fish and inland water areas. These grounds are primarily located in the northern and southern areas of the Gulf.
- **Aquaculture development**: The aquaculture sector has seen rapid growth, particularly in the Epirus sub-region, which hosts numerous fish farms. These farms exert significant pressure on the local environment.
- **Fishing Grounds in Epirus (EL05)**: The Epirus sub-region contains over a hundred fishing grounds, mainly along certain rivers and coastal areas. There are 113 units established in the area, with a total estimated production of 15,000 t per year for marine fish and over 5,000 t per year for internal water farms.

5. Impact assessment

EIA Report: The report lists the potential impacts of aquaculture.

Physical Impacts

1. **Spatial Impact Management:**
   - Activities are planned in defined areas after consultation with competent authorities, ensuring integration with existing and foreseeable plans.
   - This approach minimizes negative spatial impacts.
2. **Land Use and Industrial Activities**:
   - The proposed zones will not affect land currently used or likely to be used for other industrial activities.
   - Areas of natural beauty and ecological importance are not impacted.
   - Existing reception facilities remain unaffected.
3. **Impact on Coastal Fishing**:
   - The occupation of marine areas may reduce areas available for coastal fishing due to alterations in fish habitats.
   - However, proximity to fish farms may increase the quantity of catches in nearby free fishing grounds, offsetting some impacts.
4. **Urban and Greenfield Sites**:
   - The construction of POAY units is not expected to affect existing urban concentrations.
   - No new greenfield sites are primarily envisaged; instead, the emphasis is on improving existing sites.
   - If new on-site facilities are required, they will meet all siting criteria.
5. **Coastline Characteristics**:
   - In proposed marine zones, coastlines are typically rocky and steep, unsuitable for installations or activities like swimming.
6. **Impact on Local Settlements**:
   - The establishment of POAY is expected to positively impact the spatial character of nearby settlements.
   - It may contribute to economic growth by maintaining and creating recreational areas and through the development and integration of the site.
7. **Infrastructure Impact**:
   - The development of the zones is not expected to increase requirements for fresh or drinking water.
   - Waste management will comply with existing regulations.
   - No significant additional operational requirements are anticipated in the infrastructure sector.
8. **Regulatory Compliance**:

- The operation of existing and any future installations will be subject to all necessary licensing procedures and regulations.

Environmental impacts

1. **Geochemical Interactions**:
    - Aquaculture farms interact with marine geochemical processes, affecting the environment at various spatial and chronological scales.
    - Impacts vary based on regional characteristics, population distribution, and mobility of affected biota.
2. **Environmental Sustainability Studies**:
    - Studies in Greece have focused on the environmental impact of floating aquaculture units.
    - These studies indicate that ecological alterations near aquaculture sites are generally reversible and confined within 100 m of the cage perimeter.
3. **Impact on Local Ecosystems**:
    - Aquaculture operations do not significantly impact water quality, local communities, or soil.
    - The design of aquaculture zones considers physico-chemical parameters to minimize pollutant accumulation.
    - There is no expected reduction in habitats for rare or endangered species in the proposed zones.
4. **Impact on Planktonic Communities**:
    - Studies show no significant difference in planktonic communities near fish farms compared to control areas.
    - Grazing on phytoplankton cells by invertebrates helps prevent phytoplankton blooms despite nutrient release from fish farms.
5. **Filtration capacity of shellfish**:
    - Mussels have a significant filtration capacity, which can reduce the oncogenic load in the water.
6. **Impact on Biodiversity**:
    - There is no expected change in species diversity or abundance of fish and algae due to the introduction of endemic species.
7. **Benthic Biodiversity**:
    - Some changes in benthic communities have been observed below cages, but these are not significant at larger spatial scales.

Specifically, the report concludes;

- **Impact on benthic communities:** Changes in benthic communities have been observed below aquaculture cages, but these changes are not significant beyond 25 m from the plumes. Larger

scale studies did not show significant differences in abundance or distribution of bacterial populations.

- **Impact on wild birds:** The operation of the POAY is not expected to impact wild birds.
- **Impact on local fishery:** Studies show that while the abundance of native fish species is high near aquaculture facilities, biomass is reduced and biodiversity quality is increased within a 1-20 km vicinity, impacting local fisheries.
- **Cultivation units and endemic species:** The species cultivated (e.g., *Mytilus galloprovincialis*) is endemic and not expected to impact local populations.
- **Eel production plants:** Eels are contained within tanks, and their impact on the environment is unlikely due to specific containment measures.
- **Overall Impact on biodiversity:** While there is a reduction in diversity under the cages, it does not necessarily indicate a danger to overall biodiversity. Threats to biodiversity are more significant when they affect rare, endemic, or key species over large spatial scales, or when species with low reproductive rates are reduced below viable levels.
- **Potential Impact on seagrass beds:** The most concerning potential impact is the degradation of seagrass beds, particularly *P. oceanica*. Analysis of environmental data suggests that no *P. oceanica* meadows or protected species were found in the proposed POAY zones.

In summary, while there are some localized impacts on benthic communities and potential effects on local fisheries, the overall operation of the POAY is not expected to significantly impact biodiversity, wild birds, or protected species. Measures are in place to contain and manage species within aquaculture facilities, minimizing their environmental impact.

Nutrient impact

In addition, in the literature (Karakassis, 2004), the percentages of N and P released into the environment from the environment by plant cultivation have been measured.

In all cases, the amount of fertilisers released through harvesting is less than 1/3 of the amount released through harvesting, but there is significant variability in estimates of the proportion of the biennial phase of losses to the environment. The variability in terms of the rate of harvesting is mainly due to local conditions (such as e.g. the availability of oxygen), whereas the variability in terms of the rate of harvesting is due to both biological factors related to the species and the level and quality of treatment.

To calculate the impact of nutrients from fish farms on the marine environment, the following figures shall be used:

- The N concentration of the formulation in water is equal to 8%.
- The P content of the feed was considered to be 1.2%.
- The Feed Conversion Ratio (FCR) of 1.8:1.

The report lists some expected impacts;

- **Benthic impact**: A significant effect of aquaculture is the accumulation of organic matter under cages. This layer is typically anoxic, with high concentrations of carbon, N, and P compounds. The extent of waste accumulation varies depending on the type of seabed, with depth and vegetated areas showing less accumulation.
- **Spatial impact**: The affected zone extends to a maximum of 10-25 m from the cages. Beyond 100 m from the cages, the impact significantly diminishes, and no effect is observed within 250 m.

- **Seasonal variations**: Signs of sediment impact beneath cages vary seasonally, being less severe in winter due to reduced levels of feeding and water currents.
- **Organic material deposition**: The C/N ratio in samples remains unchanged, indicating full absorption of organic material deposited. The impact is confined to leased sea areas and is not significant in shallower waters.
- **Environmental factors**: Environmental factors like wind speed and direction influence the dispersion of the nutrients. In areas with faster winds, pollutants are more effectively dispersed.
- **Sediment monitoring**: Studies have shown no significant changes in the geochemical characteristics of water at distances of 1-10 km from aquaculture sites.
- **Impact on phytoplankton and algae**: Despite high production of organic matter, there is no significant increase in chlorophyll-a, indicating rapid degradation and limited capacity for phytoplankton to utilize these nutrients.
- **Utilization of organic matter**: Rapid degradation of organic matter prevents significant accumulation, limiting the impact on the environment.

It is estimated that, for the Mediterranean as a whole, the increase in the total marine inputs to the aquaculture sector is between 0.3% and 1.0% for N and between 0.4% and 1.4% for P. For Greece, the main producer of bass and bream, these values are 1.9% to 7.7% for N and 2.9% to 10.4% for P.

However, it must be stressed that the increase in terms of the universal generation of nutrients is far less than that, as neither 'fresh' river inputs nor freshwater inputs of pollutants to seawater are included in the river input (ΕΠΕΤ ΙΙ, 1998).

In summary, while aquaculture has a localised impact on the benthic environment under cages, particularly in terms of organic matter deposition and anoxic conditions, its effects are generally confined to a small area around the cages. Seasonal variations and environmental factors like wind play a role in the dispersion and impact of these effects. Overall, the broader marine environment, including phytoplankton and algae, does not seem to be significantly affected by these localized impacts.

The report concludes that no change is expected from the operation of the POAY vessels where marine fish, eels, eels, mullet, tilapia and shellfish will be fed/cultivated in the water quality and in such a way as to prevent other uses of the coastal area.

EIA analysis: The fish and shellfish production will increase from 5,541 t to 11,439 t (106% increase) and the farmed area will increase from 579.9 to 1,221 stremmata (111% increase). Although individual farms are relatively small the fragile and sensitive ecosystem will be impacted by this doubling of production.

Although each individual zone will be low or moderately impacted, the impact of many farms in the same area can have cumulative impacts at the far field (Gulf scale) that can affect water quality, farming operations and local communities.

The carrying capacity calculation uses the Greek formula that was developed for bays and open locations. The formula needs to be validated in the enclosed gulf conditions.

The cumulative impact of multiple fish cage farms in a water body can significantly affect the ecosystem, particularly concerning eutrophication, the spread of fish diseases and parasites.

- **Eutrophication**: Fish farms release nutrients such as N and P into the water through fish excrement and uneaten feed. These nutrients can accumulate due to limited water exchange. High nutrient levels can lead to eutrophication, characterized by increased algae levels in the

water and, in extreme cases, can cause algal blooms. These blooms can deplete oxygen in the water (hypoxia), harm marine life, disrupt the ecological balance and sometimes cause fish kills.

- **Spread of fish diseases and parasites**: The Gulf of Amvrakikos is an enclosed bay with an estimated residence time of 3.85 years. Cage farms that are close to each other can facilitate the rapid spread of diseases and parasites, such as sea lice and isopods. These pathogens can affect not only farmed fish but also wild populations if they escape or interact with wild fish. The very-enclosed nature of the Amvrakikos area could exacerbate this issue by limiting the dispersal of pathogens and parasites.

These impacts can affect water quality, fish farm operations, and local coastal communities.

- **Impact on water quality**: The accumulation of dissolved nutrients from fish waste and uneaten feed can deteriorate water quality. This degradation can manifest as increased turbidity, reduced oxygen levels, and altered chemical composition of the water.
- **Fish farm operation**: The cumulative impacts of multiple farms can lead to a decline in the health and productivity of the fish stocks. Over time, farms may face increased costs due to the need for more disease treatments and potentially lower yields due to disease outbreaks or environmental stressors.
- **Effect on local coastal communities**: Local communities may experience both direct and indirect impacts. Directly, poor water quality can affect recreational activities, tourism, and the health of local fisheries. Indirectly, the community might face economic challenges if the sustainability of the aquaculture industry is compromised. Additionally, conflicts can arise between fish farmers and other stakeholders, such as local fishermen or conservation groups, over resource use and environmental concerns.

6. Proposed Monitoring and Mitigation Measures

6.1 Proposed general measures

EIA report: The report assumes that the mitigation of any impact will be managed by the POAY and the certification of farms.

POAY administration and management:
- Managed by "POAY AMBROKIKOY A.E."
- Financed by its members and potentially supplemented by public bodies, public agencies, and private bodies.
- Companies in the POAY benefit from subsidies and have obligations under the operating agreement.

Objectives:
- To adapt to the evolving aquaculture sector in a competitive international environment.
- Develop common positions and policies on production, environmental protection, and disposal of organisms.
- Facilitate public dialogue, meetings, and communication among members and other management bodies.
- Engage in innovative projects and promote knowledge.

Key concerns:
- Processing, transformation, and packaging of products using traditional and new technologies.
- Adherence to ISO standards for quality assurance and product hygiene.
- Management of waste from aquaculture activities.
- Development of distribution networks and promotion strategies for products.
- Exploration of consumer diversity at local and national levels.

Administration structure:
- Managed by a Board composed of representatives from fishing enterprises.

Design:
- Specific objectives set for the POAY implemented by the managing body.
- Provision of necessary facilities and equipment for operation.
- Ensuring all necessary permits and planning are in place.

Operating rules:
- Clear definition of responsibilities and coordination mechanisms.
- Comprehensive organization for control, inspection, and strategy implementation.
- Possibility for the operator to conduct its own operations in the future.

Responsibilities of the managing body:
- Ensuring compliance with permit procedures and operational requirements.
- Maintenance of infrastructure and equipment.
- Monitoring financial engineering projects and compliance with environmental regulations.
- Annual reporting on environmental and production states.
- Ecological use of infrastructure and maintenance of cleanliness and safety standards.

Additional services:

- Provision of various services to members, including ichthyologist services, security, environmental monitoring, and management of resources.

Future considerations:

- Embracing new technologies and projects.
- Collaborations with various entities and focus on environmental protection.

Financial aspects:

- Utilization of national and Community funds for sustainable development.
- Potential exploration of organic aquaculture and innovative approaches.

Certifications:

ISO 22000:2005:

- An international standard for Food Safety Management, replacing the Greek standard ΕΛΟΤ 1416.
- Ensures the safety of food products and applies to businesses of all sizes and types.
- Incorporates Good Manufacturing Practice (GMP) and Good Hygiene Practice (GHP) for an integrated system of food quality and safety management.

BRC & IFS:

- BRC (British Retail Consortium) and IFS (International Featured Standards) are standards issued by major retailer associations.
- Aim to certify the safety of food products within an internationally recognized framework.
- Focus on a wide range of requirements for certification, some of which extend beyond ISO 22000:2005.

ISO 14001:

- An international standard for Environmental Management Systems (EMS).
- Helps companies systematically reduce their environmental impact and improve performance.

European Eco-Management and Audit Scheme (EMAS):

- A European Union mechanism for recognizing organizations that sustainably improve their environmental performance.
- Based on Regulation (EC) 761/2001 and incorporates EN ISO 14001:2004 standard.

Friends of the Sea:

- An international certification scheme for sustainable fisheries and aquaculture.
- Ensures products are from sustainable stocks and meet strict sustainability criteria.
- Requires no impact on critical habitats, reduction of bycatch, no use of harmful substances, and social responsibility.

GLOBALGAP:

- A global standard set by the Euro Retail Produce Working Group.
- Focuses on minimising the environmental impacts of farming, reducing chemical inputs, and ensuring the health and safety of products and animal welfare.
- Covers the entire process from inputs to product release from the farm.

AGRO Quality Marks (AGRO 4-1 and AGRO 4-2):

- Greek certification for quality assurance of aquaculture products.
- Focuses on production unit requirements, feed selection, facility design, and compliance with health and safety standards.

Organic Aquaculture:

- Regulated by EC regulations (710/2009 and 271/2010) for organic production of aquaculture animals and seafood.
- Focuses on sustainable management, high animal welfare standards, and high-quality product production.

The summarised points from the literature regarding the impact of aquaculture on the environment are as follows:

- Limited impact around cages: Effects can be detected within a range of 25 to 100 m around the cages of aquaculture units.
- No unforeseen impacts in POAY zones: Operation of landfill sites within the PAY zones does not have unforeseen impacts, particularly in terms of depth and benthic regions.
- Ecosystem's waste absorption capacity: Studies indicate that the ecosystem's capacity to absorb waste is not exceeded in the studied areas.
- Variability of impact: The intensity and extent of environmental effects vary based on depth, size of units, and nature of events. Seasonal variations are significant, with less impact observed during winter.
- Oxygen levels: Oxygen levels in and around the cages are within normal ranges, preventing fish death due to lack of oxygen.
- Recovery from impact: Any impact on the seabed under the cages is reversible, with complete recovery observed within 6 months, faster than in some other regions like Norway.
- Minimal effect on gravel substrates: Gravel substrates under the cages show minimal geochemical and chemical impact.
- Water quality classification: Waters in the Amvrakikos area range from lower middle to upper middle quality. Various indicators classify these waters as low-volume or oligotrophic.
- Rapid dispersion of waste: Waste from aquaculture disperses quickly (within 3-5 hours after feeding), minimizing impact.

Report recommendations

The introduction of good practices and innovative techniques and the evaluation of their effectiveness in Greek waters, such as the cultivation of clams in combination with fish farming, as a means of reducing the release of inorganic SO_4^{2-}, or the cultivation of shellfish (especially molluscs) in combination with fish farming, as a means of reducing (or converting to a more biodegradable form) particulate matter.

The installation of seawater monitoring systems locally at the floating units to ensure the re-diagnosis of the waters where the discharged populations live in the event that this is deemed necessary on the basis of the monitoring systems of the units.

EIA analysis: The report does cover general measures by the POAY to minimise environmental impact, certification of farms for responsible environmental management and environmental monitoring. However, this assumes that the POAY will be effective and that farms will become certified. Environmental monitoring will assess the impact of the individual farms on the local

environment but there needs to be ecosystem monitoring at the Gulf scale to ensure that the cumulative impact is not detrimentally impacting the Gulf.

6.2 Monitoring parameters

EIA report: The report lists the type and frequency for monitoring:

1. **Daily Monitoring**:
    - Abiotic parameters like temperature, oxygen, and pH.
    - Water treatment and dissolved oxygen levels at different depths.
2. **Monthly Monitoring**:
    - Suspended strains, water clarity (using Secchi disk), and pH levels.
3. **Biannual Monitoring**:
    - Every six months, mineral salts (including various forms of N and PO_4^{3-}) and chlorophyll levels are to be assessed.
4. **Hourly and Bi-hourly Monitoring**:
    - REDOX (reduction-oxidation) dynamics and other specific parameters like fauna and flora assessments, along with video recording of the sea state.
    - Grassland mowing of open-grown plants every two hours.
5. **Additional Monitoring**:
    - Maritime traffic monitoring, following specific guidelines.
    - Microbiological analyses of seawater samples for bacteria and total microbial flora annually.
6. **Pre-Installation Monitoring**:
    - Measurements are to be carried out before the installation of units, including the detection of heavy metals in the seabed.
7. **Perimetric Zone Monitoring**:
    - Monitoring of organic bathing areas within a 100 m perimeter around fish farms.
8. **Diversity Assessment**:
    - Use of SPI (Sediment Profile Imaging) scales to assess fauna diversity and water quality.
9. **Sampling and Analysis Protocol**:
    - Samples for testing the POAY's buffer stock are to be analysed according to established protocols in certified laboratories.

10. **Annual Reporting**:

- Compilation of an annual report based on measurement results, to be submitted to competent authorities.

11. **Station Selection for Monitoring**:

- Monitoring stations are to be strategically located in each zone, with at least two stations per zone – one at the entrance and one at the centre.

12. **System Evaluation**:

- Monitoring production systems and production, road traffic,
- Regular evaluation of the management systems for the aquaculture units in the POAY zones to assess changes in the water column and environment.

This monitoring strategy is designed to ensure the sustainable operation of aquaculture units within the POAY, with a focus on minimizing environmental impact and maintaining ecosystem health.

Recommended emergency response plan for fish kills.

The emergency response plan for fish kills in the context of the POAY includes several key steps and measures:

1. **Preparation and collaboration**:

- Collaborate with fisheries, veterinary departments, and scientific bodies for effective operation and emergency management.

2. **Immediate response to mortality events**:

- In case of accidental fish mortality, immediate steps are taken in consultation with competent authorities to manage the situation and protect water quality.

3. **Specific emergency response plan**:

- A detailed plan is established for handling emergencies, adaptable to evolving community needs and implemented by the POAY Forum members.

4. **Contingency plan steps**:

- Regular monitoring of fish population health.
- Immediate reporting of non-physiological mortality to POAY authorities.
- Implementation of measures in case of high mortality rates, including notifying authorities and taking samples for analysis.
- If necessary, use floating debris or special nets to contain and collect dead fish.
- Sanitary collection of mortalities in compliance with legislation.

5. **Notification and coordination**:

    - Neighbouring units within a 1 km radius are informed of incidents.
    - In case of significant or uncontrolled mortality, immediate notification from local authorities is required.

6. **Mortality management**:

    - Coordination of inland management and disposal of mortalities, minimizing environmental risks.

7. **Spatial distribution of mortality rates**:

    - Dead fish are transferred to designated companies for proper management, following legal requirements.

8. **Disinfection of Equipment and Instruments**:

    - Post-event cleaning and decontamination of equipment and areas used in the units.

9. **Restoration and Accessibility**:

    - Ensure availability of contact information for emergency teams, veterinary authorities, fisheries departments, etc.

10. **Regular Updates and Compliance**:

    - The plan is subject to regular updates and compliance with relevant legislation and recommendations from authorities.

The emergency response plan for fish kills in the POAY involves proactive measures, immediate response, coordination with authorities, and strict adherence to environmental and safety protocols to manage and mitigate the impact of such events effectively.

EIA analysis: The report provides sufficient information on the sampling type, frequency and analysis and gives details for an emergency response plan for fish kills. However, it does not provide sufficient information on the location of the sampling stations.

6.3 Management measures

EIA report: The report states that mitigation of impact from aquaculture will be undertaken by;

- Shellfish filtering
- Water treatment in onshore service facilities
- Feed quality, improved digestibility, feeder control systems

EIA analysis: Although these mitigation measures will help reduce the impact of aquaculture and there are regulations covering the management of farms in terms of level of production, suspension or relocation if farms are found to significantly impact the environment, there is still a

need for planners and farm operators to take strong mitigation measures to protect the rich and sensitive ecosystem that is found in the Gulf. This includes:

- Siting farms away from sensitive flora (e.g. *Posidonia* bed) and fauna (e.g. turtle nesting area)
- Taking measures to reduce interaction with birds
- Minimising nutrient input to the gulf by reducing Feed Conversion Rates.

6.4 Main additional studies and surveys required

EIA report: The report lists the necessary studies and plans required for the construction of the POAY:

- Carrying out studies for the licensing and construction of the POAY's common facilities if this is deemed necessary.
- Studies for the determination of the 3 zones - if required, which will be provided for the issuance of a permit for the execution of works, for the use of the units of the 3 zones of the POAY.
- Studies for the construction of port infrastructure and improvement of existing port infrastructure to support the operation of the POAY (quays - piers).
- Studies to improve the existing road network and the access network to the facilities, where necessary.
- Studies to improve the telecommunications network of the region, where necessary.
- Capacity building and preparation of studies on the integration of issues and capacities in the framework of national and Community financial programmes.
- Demonstration of the ability to install and maintain an independent monitoring system covering the whole of the POAY units and zones.

EIA analysis: The Amvrakikos Gulf attracts strong interest at National and International levels, as one of the most important wetlands of Greece with high ecological value and important habitats, protected bird species, along with an abundance of plants, animals and fish. More than 295 bird species have been recorded in Amvrakikos, out of a total of about 450 species of the Hellenic avifauna. Moreover, the bottlenose dolphins well known as "dolphins of Amvrakikos" and the sea turtle, are examples of rare and endangered fauna[5].

Therefore, there is a need for studies on the species that might be impacted by fish farming development, these include;

- ***P. oceanica* (seagrass):** This seagrass provides habitat for a variety of marine organisms and helps to reduce coastal erosion. It is also a foundation species, meaning that it plays a key role in maintaining the health of the ecosystem.
- **Sea turtles:** Sea turtles play a role in seed dispersal and nutrient cycling. They are also an important tourist attraction.
- **Dolphins:** Dolphins play a key role in maintaining the health of the marine ecosystem. They are also a popular tourist attraction.

[5] *https://necca.gov.gr/en/mdpp/management-unit-of-acheloos-valley-and-amvrakikos-gulf-protected-areas/*

Studies are needed to assess the location and range of these species about the fish farms and find mitigation measures that can be taken by the farms to minimise impacts.

5.5 Environmental impact conclusions

The EIA report provides an overview of the potential environmental impacts of expanding fish farming in the Amvrakikos Gulf. The report concludes that the proposed development would have some environmental impacts, but that these impacts could be managed through mitigation measures.

The report is based on a thorough review of scientific literature and expert opinion and provides a comprehensive assessment of the potential environmental impacts of the proposed development identifies several mitigation measures that could be taken to minimize the impact of the development.

However, the EIA report does not adequately address the cumulative impacts of multiple fish farms in the same area in the sensitive ecosystem that is found in the Gulf. This is a significant weakness, as the cumulative impact of multiple farms could be far greater than the impact of a single farm. For example, if multiple farms are in close proximity to each other, the combined waste from these farms could have a significant impact on water quality.

The report does not provide a detailed analysis of the potential impact on sensitive species such as seagrass and dolphins. This is another significant weakness, as these species are particularly vulnerable to the impacts of fish farming.

The report identifies a number of mitigation measures that could be taken to minimise the impact of fish farming. However, the report does not provide a detailed assessment of the effectiveness of these mitigation measures. To ensure that these measures are effective, the EIA report should provide a more thorough analysis of potential mitigation measures that can be undertaken by the farm operators.

In addition, there is a need for the following additional studies and surveys to be conducted:

- A study to map the distribution of *P. oceanica* in the Amvrakikos Gulf and assess the potential impact of fish farming.
- A study to identify the location and range of sea turtles in the area and assess the potential impact of fish farming.
- A study to develop mitigation measures to reduce the interaction with birds.

7. Social Analysis of the EIA

In Greece, fish cage culture, with its associated hatcheries and processing units, has become an important industry, contributing to both the economy and the food security of the country. However, social tensions between fish farmers, the traditional fishing industry, and local communities are a common occurrence in regions where fish cage culture is practised. These tensions arise from a variety of concerns, including the environmental impact of fish farms, the distribution of benefits from the industry, and the potential for conflict over resources.

7.1 Socio-economic benefits

7.1.1 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 ~~o~~Organisation (2021) the industry ~~in 2021~~ directly employs 3,871 people and it is estimated directly and indirectly employs about 12,000 people[6].

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.

7.1.2 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.

7.1.3 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.

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

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

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.

7.2 Socio-economic drawbacks

7.2.1 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.

7.2.2 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.

7.2.3 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 byproducts. 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 labour to operate efficiently. This can put pressure on local housing markets and can lead to higher housing costs such as rents.

7.2.4 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 8.1 and 8.2, depends on how the industry is managed and how it interacts with local communities.

7.3 Social status

EIA Report: The study assessed the present (2014) social status:

- Demographics
- Employment and unemployment
- Tourism
- Infrastructure and services
- Land use
- Cultural heritage

This was based on literature studies available at the time of preparation of the study.

7.3.1 Demographics

EIA study: The study notes that a third of Greece's population lives in areas close to the sea. ELSTAT census data (1991-2011) show that the population of Western Greece at the end of 2011 was 682,604 persons, (i.e. 6.24% of the country's population) while the population of the Epirus Region at the end of 2011 was 339 721 persons (i.e. 3.11% of the country's population).

During the 20-year period (1991 to 2011) the population of Western Greece decreased by 3.5% while there was no change in Epirus during the same period. No information on the age distribution or educational attainment of the population of the regions is included in the study.

EIA analysis: The EIA study considers the creation of the POAY will strengthen and develop entrepreneurship, increase income and safeguard employment in the study area due to the proposed development and its indirectly linked activities both locally and nationally. This is expected to increase due to the growing demand for fish products globally 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. fisheries).
The EIA study evaluates the potential number of jobs that can be created by the fish hatcheries, farms, and processing units and this makes it possible to consider the effect on local communities and local infrastructure (roads, fresh water and sewage, healthcare and schools) due to the effect of increased economic activity.

7.3.2 Employment - unemployment

EIA study: In the study, a detailed analysis of employment in all the municipal units of the Region was examined using census data from 1991-2011. In 2001, the economically active population of both the Epirus and the Western Greece regions accounted for 39% of the total population of these regions.

In general, there is a marked shift in employment from the primary sector to the tertiary sector, with the result that the sectoral breakdown of employment in Epirus in 2001 was 23%, 21% and 56% for the primary, secondary and tertiary sectors respectively. In the Region of Western Greece the corresponding percentages are 27%, 19%, 54% and a significant deviation from that of Greece (15%, 22% and 62% in 2001). In the study regions employment is concentrated in the primary sector and lags behind that in the secondary sector.

In the period 2005-2011, the rate of increase of the per capita ΑΕΠ of the Regional Units is much lower than the rate of increase of the corresponding national rate. There is a decrease in the per capita AEP both in Greece and in the region from 2008-2011.

Unemployment rates in these regions are lower than the national figure of (18.73%), varying from 11.65 % to 12.83% of the population.

EIA analysis: The study concludes and demonstrates that the POAY in the Amvrakikos Gulf will safeguard existing employment while increased employment will result through increased production in the hatcheries, farms and processing units. This will also increase income and the value added and competitiveness of the economy.

The study calculates the number of permanent staff required in the on-site facilities based on the number of juveniles, and the volume of fish produced and processed. The breakdown of the existing and foreseen employment from these calculations is reported.

7.3.3 Tourism

EIA study: The importance of the tertiary sector in Greece's economy is obvious given that 80.35% of the gross value added is generated by this productive sector. In the study, it is noted that the Port of Preveza plays a significant role in marine tourism and as a result, tourism development is prominent. Data is presented on the tourist industry and the levels of accommodation available with occupancy rates. It is noted that tourist development needs to be planned so that there is no risk to the protection of protected areas, forests, land and archaeological sites etc.

EIA analysis: The spatial structure attempted through the organization of the aquaculture units into 3 areas attempts to solve several problems that have so far hampered their operation and, consequently, their further development. Through the creation of these spatial zones 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). This will also facilitate the permitting procedures for the plants and reduce the bureaucratic burden on investors.

Further development in the tourist industry or alternative forms of tourism will most likely increase the tourist development in the area. Implications on the social aspects and cost of living due to this increase in tourism need to be investigated. Further prediction of the touristic development may impact the locals' openness to such a project.

7.3.4 Infrastructure

EIA study: In the study area, the transport of goods and people is almost entirely dependent on road transport due to a lack of a rail network and the small amount of traffic handled by the ports. The regions are well served nationally and intra-regionally with the Egnatio Odos, European Road 55 and the Ionian Road and several other axis are planned. In the coastal zones of the Amvrakikos Gulf there are several national axis roads including the EO42, EO 55 and the proposed Ionian Road which are interconnected with medium-grade roads.

The project summary concludes that the project is not going to change population density, existing housing, means of transport, available resources and public utility sectors.

- **Road transport** – In the 3 zones of the POAY there has been significant improvement in the main road arteries and medium-grade roads that ensure access to the coast. Suggestions are made and comments are proposed to improve the existing access infrastructure of the units.

- **Air transport** - There is one commercial airport at Ioannina in the Epirus region.

- **Ports -** There are 2 ports in the Epirus region: Igoumenitsa is the main national port which has been upgraded and is also planned as a free trade zone and a BOPE site. The secondary port of Preveza, at the entrance to Amvrakikos Gulf, has significant commercial traffic and has an important tourist role. Patras is the main “Gateway” port of the Region of Southern Greece. In strategic terms, the 'gateway' is complemented by the new commercial port at Plattiyali in Astakou, where a free zone port is planned. In many places along the coastline of the Amvrakikos Gulf, there are small anchorages, either for fishing boats and yachts or for the use of existing fishing units.

EIA analysis: A detailed analysis of how the current infrastructure will affect the development of the project, moorings and the way goods are transferred have been considered in the study. Suggestions and comments are made on improving the existing access infrastructure of the units.

The economic impact study also includes the costs of moving the landing sites of the floating units within the proposed POAY zones allowing access to cage units from piers on the shore. In addition, in the proposed aquaculture areas, zones have been identified for the installation of on-site renewable energy installations to meet the energy needs of the installations.

7.3.5 Freshwater supply and sewage

EIA study: In the study, a description of the freshwater resources from water springs, boreholes, dams and reservoirs is made for both domestic supply and agricultural use. The infrastructure of the area is not expected to be affected, as the development of the zones will not increase the requirements for inputs of fresh water or drinking water. It is reported that waste will be managed in accordance with existing regulations.

In the study area, most of the settlements above 2,000 inhabitants do not conform with the requirements of Greek and Community legislation, neither in terms of sewage treatment plants (STPs) nor in terms of wastewater treatment plants (WWTPs). The management and disposal of urban wastewater is largely the responsibility of the inhabitants themselves.

The large settlements of the regional units have a functioning wastewater supply and biological treatment system, with the need to extend it to parts of the settlements that are not currently connected to the water supply system (Ag. Thomas, Mytikas, etc.). Vonitsa is at an advanced stage in the construction of a sewerage and biological treatment network, which will require substantial financing, while facilities are also being completed for Amphilochia. In Menidi, on the other hand, the process is at the design stage, while all the settlements in the prefecture of Apta have no plans for dealing with their urban waste.

EIA analysis: The EIA study does not quantify the freshwater availability and requirements for the population or agriculture. There will be a requirement for the following in the proposed facilities:

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

7.3.6 Telecommunications and network infrastructure

EIA study: The EIA study notes that there have been significant improvements in the telecommunications infrastructure of the Region however the region is likely to remain disadvantaged when compared to the EU. It is noted that there are still many opportunities for the deployment of new fibre-optic networks, which are currently operating to a limited extent.

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

7.3.7 Electricity supply

EIA study: The study considers the freshwater sources and notes that several dams have been constructed on rivers to create artificial lakes that can supply both freshwater and generate electricity for the surrounding areas. The electrical transmission infrastructure of the region was upgraded in the decade before 2011 to integrate the Greek grid into the European integrated system and appears to be in a satisfactory condition. The study also notes that future mitigating strategies are mentioned such as the construction of a new dam.

EIA analysis: The study considers the supply capacity and the distribution network however the EIA does not quantify the electrical demands of the proposed new facilities.

7.3.8 Health and welfare infrastructures

EIA study: The study indicates the health facilities of the regions around the Amvrakikos Gulf and notes that there is a shortage of medical staff in important specialities.

EIA analysis: The study indicates that the provision of health care from local services is inadequate for the area due to staff shortages. This will be further compounded by an increase in personnel for the aquaculture facilities and the expected increases in tourism. No indication as to the availability of increased resources to this sector is mentioned other than the development of

the Greek health sector is a strategic objective in the 2007-2013 Community Agriculture Programme and the programme for the period 2014-2020.

7.4 Impacts related to aesthetics

EIA report

1. Noise and light pollution
2. Landscape
3. Cultural heritage

The study concludes that there will not be any significant impacts.

7.4.1 Impacts of noise and light pollution

EIA study: The EIA study does not mention noise or light pollution for the units of the proposed POAY.

EIA analysis: The study does not consider the noise impact from the different fish production facilities or from the processing facilities. This includes the movement of vehicles for the transport of feed and harvested fish. The study does not consider the noise from reversing forklift vehicles around the packing stations which may impact nearby residential sites.

The study does not consider the perimeter mooring warning lights at night and land security lighting at night. It is prudent to have flashing warning lights at night at the perimeter of the sea cage sites together with radar reflectors to prevent collision of boats with the cages at night. The flashing lights can be designed to be shielded from the light penetrating the water and causing light pollution. Unshielded lights might affect sea turtle behaviour, especially in terms of nesting.

No mention is made of the use of **l**ow-intensity lighting used to protect the cage units and to avoid stress to fish populations during storms.

7.4.2 Impacts on the landscape

EIA review: The study only considers landscape in relation to the process for the establishment of a buffer zone against which the impact of the POAY will be considered for the protection and improvement of the aesthetics of the landscape. The study states that the locations of the proposed units have been chosen in such a way that they do not compete with other developments, do not adversely affect the natural environment and landscape, and do not conflict with existing planning and any protection regimes.

EIA analysis: The study while quantifying the number and size of the additional land-based facilities that are expected to be constructed they do not consider their impact or mitigation on the landscape. The SEIA study does not take into consideration the visual seascape and its impact on yachting and fisheries in the area and the use of sheltered space and bays.

7.4.3 Impact on cultural heritage

EIA review: No information was found on cultural and land or underwater archaeological sites in the study area. The study stated that the aquaculture facilities constructed would be simple and compatible with the surrounding landscape and following the specifications of the competent authorities and the applicable legislation.

EIA analysis: The environmental impact of cultural and architectural heritage is one of the objectives of the environmental study of the POAY and they would be protected and enhanced where the aquaculture sector is developing. Without any detailed information on the cultural and archaeological sites (land and marine), it is not possible to understand if any archaeological sites would be affected by the POAY works.

7.5 Identification of residential /spatial impacts

EIA review: The study does not mention any residential/spatial impacts.

EIA analysis: The EIA study does not state the radius of influence considered around the additional land-based facilities that will be required to assess whether there are any residential or spatial impacts.

7.5.1 Impacts related to Infrastructure

EIA review: The study details the infrastructure of the surrounding regions of the Amvrakikos Gulf and states what impacts were expected without giving any data to support this. For example:

- Sewage facilities: Drainage facilities were only available in the large settlements in the study area and only the sewage from Apta which is discharged into the river Apachtos was treated. It was noted that the drains of the small settlements were discharged into the ground without any particular environmental problems.
- Freshwater supply: The water supply network was described and noted that the infrastructure was not expected to be impacted.

EIA analysis: Under infrastructure, the study does not quantify the freshwater availability and requirement for the population or for agriculture. The study considers the electrical supply capacity and the distribution network however the EIA does not quantify the electrical demands of the proposed new facilities.

Both floating and land units require the existence of road infrastructure for the distribution of products.

The EIA study does not estimate the increase in road traffic. The expansion of production will cause significantly higher levels of road traffic on the existing poor 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 to home daily.

The EIA 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

7.6 Social impact

7.6.1 Population

EIA review: The EIA study expects the proposed POAY to enhance the employment intensity of the aquaculture sector in the study area, reducing unemployment and activating local potential, providing significant growth and employment opportunities.

EIA analysis: The EIA study estimates the increase in workers and skilled personnel required for the proposed increase in production. Many of these areas are remote but the study does not state the effect on developmental structures such as housing, schools and healthcare.

7.6.2 Human health

EIA review: The 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: There is no mention of the risks of harm to personnel such as the use of antimicrobials, vaccines and anaesthetics on farm.

7.6.3 Solid waste disposal

EIA review: The EIA study states that all solid waste and animal by-products will be disposed of through an approved management body. However, the study notes that there were no modern facilities for the final disposal of landfill waste (landfills, etc.) at the time of the study. The disposal of landfill waste has created pollution problems both for the soil and the surface water network. However, studies and projects were being carried out to construct landfill sites for the disposal of urban waste and surplus geological waste.

EIA analysis: The EIA report 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, tyres, end-of-life vehicles) are not mentioned and should be collected and delivered to licensed collectors or approved alternative management systems.

7.7 Stakeholder consultation

EIA review: The EIA report states that the participation of stakeholders in decision-making is a strategic future objective of the POAY's administrative unit. In addition, the study states that consultations with all stakeholders (scientists, fishermen, fishery management, environmental managers, local communities etc) are one of the measures that could be taken to address potential problems in the fisheries sector.

EIA analysis: No details of any stakeholder consultations are given in the report even though the EIA 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 the EIA study.

8. Conclusions

The SEIA conducted by NAYS Ltd, while comprehensive in certain aspects, reveals significant shortcomings in addressing the full spectrum of environmental and socio-economic impacts associated with aquaculture expansion that would be expected in a SEIA. The study effectively outlines existing legal frameworks and potential environmental impacts, facilitating the process of increasing production licenses and establishing new farms. However, its analysis of environmental impacts, particularly in quantifying and assessing cumulative effects, is inadequate.

The evaluation of the environmental impact of marine fish cage farming in the Gulf of Amvrakikos, Greece, identifies significant gaps and concerns in the current approach to aquaculture development in ecologically sensitive areas. A major weakness highlighted is the lack of assessment of alternatives in the Environmental Impact Assessment (EIA) report, focusing only on the base case and proposed increase in production without considering other sustainable or less impactful options. The choice of alternatives presented quantifies a significant planned increase in aquaculture production across various zones without adequately addressing the potential cumulative environmental impacts.

The report estimates substantial increases in the annual production of different marine species, proposing both the relocation of existing units and the establishment of new sites. It also outlines the necessary infrastructure improvements to support this expansion. However, the ecological status of the Gulf, already compromised by anthropogenic activities such as agricultural runoff and pollution, raises concerns about further degradation from increased aquaculture activities. Key environmental implications include eutrophication, indicated by high chlorophyll levels and variations in zooplankton populations, and pollution, largely due to ineffective waste management and agricultural runoff. The lack of quantification of additional nutrient output from the expanded aquaculture production and the predicted increase in impact in the Gulf is a major weakness.

SACs and SPAs within the Gulf underscore the region's ecological value and the critical need for protective measures. The report's recommendations for good practices and innovative techniques, such as combining fish farming with shellfish cultivation, aim to mitigate environmental impacts. However, the effectiveness of these measures depends on their implementation and the efficacy of local and gulf-wide environmental monitoring systems to manage cumulative impacts. Management measures suggested in the EIA analysis, such as siting farms away from sensitive habitats and minimising nutrient input, are steps in the right direction. However, these measures require rigorous enforcement and a commitment to ecological preservation to be effective. In this sensitive ecosystem, lack of defined management and mitigation measures is a major weakness.

The necessity for additional studies on species potentially impacted by fish farming highlights the need for a comprehensive understanding of the ecosystem and the formulation of strategies to protect key species such as *P. oceanica*, sea turtles, and dolphins. This is major weakness.

While the planned expansion of aquaculture in the Gulf of Amvrakikos aims to boost production, it presents significant environmental risks to an already vulnerable ecosystem. The effectiveness of proposed mitigation measures and monitoring systems is crucial to safeguarding the ecological integrity of the Gulf. There is a pressing need for a holistic approach that balances economic development with environmental sustainability, ensuring the protection of valuable habitats and species for future generations.

Furthermore, the SEIA's treatment of socio-economic impacts is notably deficient. The absence of a thorough social impact assessment, coupled with a lack of stakeholder consultation, raises concerns about the study's ability to identify and mitigate potential conflicts with local communities

and other space users, such as the tourism sector. The insufficient quantification of the impacts of new facilities on infrastructure, labour, and resource use, including the management of waste and wastewater, indicates a major oversight in understanding the full scope of socio-economic challenges.

The study's failure to propose adequate social mitigation measures, alongside its lack of engagement with stakeholders, is a critical weakness. This could lead to social conflicts potentially undermining the sustainability of the aquaculture expansion. Additionally, the impact on marine tourism, a minor but notable concern, has not been adequately addressed.

In conclusion, while the SEIA by NAYS Ltd provides a foundational understanding of the legal and theoretical environmental aspects of aquaculture expansion, it falls short in thoroughly assessing and mitigating the cumulative environmental and socio-economic impacts. This gap highlights the need for a more holistic and inclusive approach to aquaculture governance and planning, one that encompasses the full range of environmental, social, and economic considerations.

The EIA's treatment of socio-economic impacts is notably deficient with several shortcomings:

- The EIA study considers the electrical supply capacity and the distribution network, but it does not quantify the electrical demands of the proposed new facilities. This is another significant omission, as the proposed POAY is likely to have a significant impact on the electricity demand in the area. The study should have estimated the electricity requirements of the POAY and assessed whether there is enough electricity available to meet these requirements without overloading the existing infrastructure.

- The EIA study does not estimate the increase in road traffic or marine traffic that will be caused by the proposed POAY. This is another significant omission, as the POAY is likely to increase traffic in the area, which could have negative impacts on the environment and public health. The study should have estimated the traffic impacts of the POAY and developed mitigation measures to minimise these impacts.

- The EIA study does not estimate the scale, or type of solid waste that will be generated by the proposed POAY. The study also does not give any details on how and where the solid waste will be disposed of. This is a significant omission, as the POAY is likely to generate a large amount of solid waste. The study should have estimated the solid waste generation of the POAY and developed a plan for managing and disposing of this waste.

- The EIA report does not mention the main sources of solid waste that will be generated by the POAY, such as feed bags, discarded nets, fish mortalities, net washer sludge, and shells. The EIA report also does not mention other waste streams, such as lubricating oils, accumulators, batteries, waste electrical and electronic equipment including light bulbs, tyres, and end-of-life vehicles. This is another important omission, as these waste streams could have negative impacts on the environment if they are not properly managed. The study should have identified all potential waste streams and developed a plan for managing and disposing of these wastes.

- The EIA report does not provide any details of any stakeholder consultations that were conducted. This is a significant omission, as stakeholder consultation is an important part of the environmental impact assessment process. The EIA study should have documented the stakeholder consultations that were conducted and outlined how the views of stakeholders were taken into account.

9. References

- Greece - National Aquaculture Legislation Overview. https://www.fao.org/fishery/en/legalframework/gr/en?lang=en
- Διαφάνεια 1 - Gov.il (Presentation on Greek Aquaculture Legislation). https://www.gov.il/en/departments/units/fishery_and_aquaculture
- Environmental impact of aquaculture in Greece. Practical experiences. https://link.springer.com/article/10.1007/s41742-020-00289-8
- Stamou, A., Loverdou, L., Matsoukis, C., Triantafyllos, A., Gkesouli, A. (2012). Modeling renewal times in Amvrakikos Gulf, Greece. Global Nest Journal. 14. 386-392.