MACALISTER ELLIOTT & PARTNERS LTD

Comparison of Six Environmental Impact Assessment Reports for Greek Aquaculture Operations

Final report for Rauch Foundation
POAY for the Region of Lesvos Island

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Abbreviations and Acronyms

AMBI	AZTI Marine Biotic Index - designed to establish the ecological quality of European coasts.
AMBIO	AMBIO S.A. Development Consultants
BENTIX	A biotic index - based on the relative percentages of three ecological groups of species grouped according to their sensitivity or tolerance to disturbance factors and weighted proportionately to obtain a formula rendering a five step numerical scale of ecological quality classification.
BOD	Biological Oxygen Demand
DE	Municipality
EAFRD	European Agricultural Fund for Rural Development
EIA	Environmental Impact Assessment
EMFF	European Maritime and Fisheries Fund
EPXSAAY	Special Planning and Sustainable Development Framework for Aquaculture
ESYD	Hellenic Accreditation System
EU	European Union
g	Gram(s)
GDP	Gross Domestic Product
HCMR	Hellenic Centre for Marine Research
HPHSAAY	Special Spatial Planning ND Sustainable Development Framework for Aquaculture
kg	Kilogram(s)
km	Kilometre(s)
km^2	Square kilometre(s)
m	Metre(s)
M-AMBI	An extension of the AZTI's Marine Biotic Index (AMBI) and combines AMBI BC (Biotic Condition) with Shannon diversity (H) and species richness (S)
MEP	MacAlister Elliot and Partners Ltd
MERAMOD	Predictive model for aquaculture (see https://cordis.europa.eu/article/id/81735-meramod-a-predictive-model-for-aquaculture)
ORP	Oxidation Reduction Potential

PAY	Aquaculture Development Area
PESSAU	Mult-year National Strategic Plan for the development of Aquaculture in Greece 2014-2020. General Directorate of Fisheries 2014.
POAY	Area of Organised Development of Aquaculture
ROP	Regional Operation Programme
SEIA	Strategic Environmental Impact Assessment
Stremma	1 stremma = 1000 square metres, plural = stremmata
SWOT	Strengths, Weaknesses, Opportunities and Threats
t	(metric) tonne (e.g. 1,000 kilograms)
USD	United States Dollar
WFD	Water Framework Directive
WWTP	Waste Water Treatment Plant
YPAAT	Ministry of Rural Development and Food
YPEXODE	Ministry of Environment, Physical Planning and Public Works

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.

Classification of MERAMOD prediction of impact severity

Light impact.	This refers to a low level of impact on the environment, typically caused by activities like fish farming or livestock production. It is detected using a specific measurement (1 gram (g) per square meter (m^2) per day), which is just slightly higher than natural background levels. Light impact is considered to be between 1 – 15 g/m^2/day (0.365-5.580 kg/m^2/year).
Moderate impact	At this level, the impact on the environment is a bit higher, but still manageable. It is measured at 15 g/m^2/day. While there is some effect on the sediment surface, the environment can handle this amount of organic matter. Moderate impact is classified between 15 – 45 g/m^2/day (5.48 – 16.425 kg/m^2/year).
High impact	Here, the impact becomes more significant. It's measured at 45 g/m^2/day (16.425 kg/m^2/year). This level of impact affects the sediment and the communities living within it. High impact is classified between 45 – 75 g/m^2/day (16.425 – 27.38 kg/m^2/year). In other environments, when the predicted impact exceeds 50 g/m^2/day (18 kg/m^2/year), it is generally not preferred by the industry.
Severe impact	The 75 g/m^2/day contour represents a severe impact and is expected to cause low or no oxygen conditions on the seabed resulting in severely degraded conditions, as well as significant black layer depth in sediments and high carbon content of sediments. Severe impact is classified as above 75 g/m^2/day (27.38 kg/m^2/year).

Classification of MERAMOD prediction of impact severity on benthic diversity

Quality regime	**Shannon index (*H'*)**
High	H' > 4
Good	$3 < H' \leq 4$
Medium	$2 < H' \leq 3$
Low	$1 < H' \leq 2$
Bad	$H' \leq 1$
Source: University of Crete, 2007.	

Range of Shannon-Weiner index values corresponding to the different ecological quality regimes as defined by the Water Framework Directive (Directive 2000/60/EC).

Executive Summary

The Strategic Environmental Impact Assessment (SEIA) study was undertaken in 2022 by AMBIO S.A. and was based on data collected and analysed in the 2017.

The study adequately describes the existing laws, regulations, and governmental framework for aquaculture development and theoretical potential environmental impacts. A detailed review of the Environmental and Socio-economic impacts, described below, demonstrates multiple insufficiencies ranging from major to minor weaknesses and two critical weaknesses.

Environmental impacts

The report does provide sufficient quantification of environment impact for individual farms. In the existing situation, the average estimated maximum impact for all the zones is 4.16kg/m^2/year for P1 and 7.3kg/m^2/year indicating light to moderate sediment impact. The benthic community in the area of the farm is 2.48 for P1 (Medium quality) and P2 1.4 (low impact). In the chosen scenario (Scenario 3), the average estimated maximum impact for P1 is 21.3kg/ m^2/year and 57.9 for P2 (severe impact). This is also reflected in the Shannon-Weiner index values for impact on the benthic community which is classified as bad impact for both sites. This indicates that the proposed increase in production is beyond the assimilative capacity of the environment to cope with the increase in nutrients and that the environment will be heavily impacted in the area of the farms. **This is a critical weakness**.

This indicates that the Scenario 3 level of production would be over the assimilative capacity of the local environment to deal with the additional nutrient inputs from the fish farms. These impacts can be mitigated by either a reduced level of fish production at the site of moving the cages into a deeper area so that the particulate matter is spread over a wider area (lower severity but higher extent)

Specifically, the study is **insufficient** in:

- Describing present farm activities and facilities e.g., the additional number, and size of cages, fish production at sea and the land-based facilities, vessels and trucks, etc. It does not provide summaries of regular environmental monitoring surveys presently undertaken that would verify the present level of impact and how this is validated with the MERAMOD model prediction. This is a major weakness.
- 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.
- The report does suggest that there is need for additional studies to map the location of *Posidonia* sea grass beds. The report notes that there are Mediterranean seals and sea turtles in the area. These are endangered species and there are risks of interaction between them and the farms. There is therefore a need for further studies to identify the locations of these species, assess the risks to them from farming operations and find ways to mitigate those risks. This is a major weakness.

Socio-economic impacts

The report does not fully cover what would be expected in an Environmental (and Social) Impact assessment study at site level. The study may have been sufficient to request increases in area and volume but the study is **insufficient** in:

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

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 Lesvos Island.

The main purpose of the environmental impacts of which are examined by the SEIA, is the spatial development of aquaculture activity in the coastal zone (marine and terrestrial) of the island of Lesvos Island.

Marine fish cage culture has become an increasingly important industry in Greece, contributing to both the economy and the food security of the country. However, the industry has also been associated with several 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 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

A series of feasibility studies and environmental impact assessments (EIAs) have been prepared for the designated Areas of Organised Aquaculture Development (POAY in Greek). The focus of this review is the Strategic Environmental Impact Assessment (SEIA) prepared by AMBIO in 2022 with environmental characteristics measured by the HCMR in 2017:

- Establishment of POAYs in the region of Lesvos. Strategic study of environmental impacts.

It should be noted that, according to the EPXSAAY, the study area is currently included in an area for the further development of aquaculture. The main objective of the General Spatial Planning Framework is the defining of a spatial zone for the development of aquaculture in Lesvos in which the aquaculture activity is supported in a sustainable manner and protected from incompatible activities in the same area.

The SEIA study is “Promoting areas of organised aquaculture development in areas with a large concentration of aquaculture, with the aim to their rational management and development, the achievement of economies of scale and the creation of modern support facilities (storage areas, packing stations, fish hatcheries, etc.)".

The coastal zone of Lesvos Island is also an area of capital importance for the country's economy and is subject to high competition due to the many activities that are developed in it. At the same time, the dependence of aquaculture development on high-quality water resources shapes the specificity of the sector and creates the need for special regulations for its location.

All the zones of the POAY are outside the Natura 2000 network as delimited according to the Ministry of Justice's Decree 50743/11-12-2017 (Government Gazette 4432/B/2017). There are no areas designated as Landscapes of Special Natural Beauty (Sites of Special Natural Beauty), Areas of Other Environmental Interest of the National List and Protected Island Wetlands in the land area included in the study area of the POAY.

2. AMBIO S.A. Development Consultants

The EIA for the Lesvos area was undertaken by AMBIO S.A. Development Consultants (AMBIO). AMBIO, based in Athens, Greece, is a consultancy company in the field of fisheries and aquaculture, with a history of completing EIAs for marine fish cages[1]. The company is active in over eight countries, demonstrating their international presence and reach.

AMBIO's services in the aquaculture sector are comprehensive, covering a wide range of areas from cage and land-based production units to hatcheries, packaging, and processing units. Their expertise also extends to logistics centres, waste processing units, and environmental monitoring systems. In EIAs, AMBIO employs over thirty years of experience, and can be considered to be at the forefront of consulting firms in this domain. Their use of the GIS technology and an extensive database for environmental information enables them to provide accurate analyses. The teams work closely with various stakeholders, including developers, architects, process engineers and planners, to deliver solutions for projects.

AMBIO's services in environmental impact assessment are varied, including strategic environmental assessments, environmental and social impact assessments, environmental due diligence, risk assessment, environmental planning and permitting, water management, and waste management and recycling. This breadth of services ensures a holistic approach to environmental impact studies, tailored to the specific needs of each project.

The company's involvement in major aquaculture projects in Greece and its expansion to other countries, including Cyprus, Egypt, Italy, the UK, Kenya, Oman, Saudi Arabia, and Turkey, provides evidence of their global position and track record. AMBIO's role in the significant acquisition and reorganization of aquaculture companies in the Mediterranean highlights their strategic and management capabilities in this sector.

Experience: AMBIO has been operating since 1993, indicating extensive experience in the broader field of environmental consulting. Their project portfolio includes a diverse range of environmental studies, encompassing renewable energy projects, infrastructure development, and aquaculture projects, suggesting their familiarity with the environmental considerations relevant to marine fish cage operations.

Expertise: AMBIO has a team of qualified environmental engineers, biologists, and other specialists with expertise in various environmental disciplines, including water quality, marine ecology, and EIA methodologies. This expertise aligns with the key areas of focus within marine fish cage EIAs, indicating their potential ability to address the specific environmental concerns associated with these projects. The company also mentions experience with obtaining environmental permits, suggesting their familiarity with the regulatory framework for marine fish cage operations in Greece.

Competence: AMBIO appears to have a successful track record in delivering high-quality environmental studies for diverse projects suggests their competence in managing complex environmental assessments. They are accredited by the Hellenic Accreditation System (ESYD), demonstrating their adherence to international standards.

[1] *Information taken from company website, https://ambio.gr/industry/food/fisheries-aquaculture/*

3. Analysis of the Lesvos EIA

3.1 Scope of the SEIA

EIA report: The study notes that, in addition to the environmental requirements, that the Regional Operational Program (ROP) of the Northern Aegean Territorial Region (2014-2020) has formulated a vision and strategy for the region based on the requirement to effectively address structural weaknesses. This involves the "reversal of the declining development course of the islands of the Regional Operational Programme (ROP) and the pursuit of real economic and social convergence with the developed regions of the EU, ensuring the conditions of internal and external, spatial and social cohesion and maintaining the special insular character of each island".

The main developmental priorities are:

- Strengthening the spatial cohesion & upgrading the infrastructures in the direction of removing the isolation phenomena (internal & external) that the insular character that the ROP implies,
- Strengthening the attractiveness, competitiveness and extroversion of the islands and businesses, with an emphasis on the utilization of the local products and services available on the islands.
- Social support in the direction of dealing with the phenomena resulting from the crisis, as well as the support of vulnerable social groups,
- Upgrading the environment & culture & highlighting them as a local resource that will be transformed into a development mechanism.

Transforming the ROP economy into a competitive economy based on the use, promotion and adaptation of local production systems also has the following thematic objectives

- TS 1: "Strengthening research, technological development and innovation"
- TS 2: "Improving access, use and quality of information and communication technologies"
- TS 3: "Improving the competitiveness of small and medium enterprises and the agricultural sector (for the EAFRD) and the fisheries and aquaculture sector (for the EMFF)"
- TS 4: "Support the transition to a low-carbon economy in all sectors"
- TS 5: "Promoting adaptation to climate change, risk prevention and management"
- TA 6: "Preserving and protecting the environment and promoting resource efficiency"
- TS7: "Promoting sustainable transport and removing the problems in basic network infrastructures".
- TS8 "Promotion of sustainable and quality employment and its support of work force mobility".
- TS 9: "Promoting social inclusion and combating poverty".
- TS 10: "Investment in education, training and vocational training for skills acquisition and lifelong learning".

EIA analysis: The Regional Spatial Planning and Sustainable Framework Development of the North Aegean (Government Gazette 181D/2019) and the infrastructure and social requirements are outlined in the purpose and objectives of the ROP (Chapter 3). 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 concludes that the proposed scenario 3 contributes best to the objectives of the PESSAU 2014-2020 objectives for the development of aquaculture in Greece. Scenario 3 gives an annual production capacity of 13,806.25 tons in 3 production sites.

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 POAY on Lesvos Island and this is shown in the table below.

Strengths	**Weakness**
• Completion of spatial planning for aquaculture • Good status of surface water bodies • Important contribution to social cohesion • Significant contribution to the regional and national economy	• Complex legal framework • Competition with other activities • Limiting living space for the development of new units • It is in an isolated region • Absence of a complete restructuring plan for the sector
Opportunities	**Threats**
• Increase in production • Contributing to the protection of the marine environment • Minimize conflict with other users of the coastal zone • Simplification of the licensing of aquaculture units integrated in the POAY • Contribution to the formulation of an integrated plan for the reconstruction of the sector • Creating a friendly investment environment • Strengthening sectoral employment / Contribution to the reduction of unemployment	• Inadequate information to citizens with unsubstantiated negative publicity • Lack of experience on a national level • International financial crisis • Reduction of investment at a national level

EIA analysis: While the SWOT analysis considers many aspects of the study it does not reflect many of the social aspects such as the effect on local livelihoods and communities such as the impact on community infrastructure, services and resources that would be required to make this project sustainable.

3.3 Framework and objectives of the study

EIA report: Section 3.1 International, community and national environmental protection objectives relevant to the project

EU Policies and Regulations:

- **Integrated Maritime Policy and Blue Paper.** Aims for integrated decision-making in marine environments.
- **Marine Strategy Framework Directive (2008/56/EC).** Focuses on protecting and preserving marine environments through strategic assessments and cooperation among Member States.
- **Water Framework Directive 2000/60/EC.** Integrates qualitative, ecological, and quantitative objectives for aquatic ecosystems and water resources.

- **Blue Growth.** The Blue Growth Strategy [COM (2012) 494 final] addresses the necessary measures for an integrated maritime policy, guidelines for sea basin management and measures to promote sustainable development, and specific strategies for specific sectors such as aquaculture.
- **Common Fisheries Policy and Green Paper.** Develops fisheries policy considering social, economic, and environmental aspects.
- **Marine Spatial Planning.** Addresses cross-sectoral conflicts in European seas, including fisheries, shipping, and environmental concerns.
- **European Maritime and Fisheries Fund (EMFF).** Supports sustainable fisheries, coastal and marine conservation, and marine resource use.
- **Integrated Coastal Zone Management in the Mediterranean.** Establishes a framework for managing Mediterranean coastal zones.
- **Strategy for Sustainable Development of European Aquaculture.** Addresses challenges in aquaculture for competitiveness and sustainability.
- **Strategic Guidelines for Sustainable Aquaculture Development.** Aims to overcome EU aquaculture stagnation.
- **Guidelines for Aquaculture and Natura 2000.** Guides development and conservation in Natura 2000 sites.

Greek Policies and Regulations:

- **National Strategy for Sustainable Development.** Integrates environmental considerations into development processes.
- **National Strategy for Marine Environment Protection (Law 3983/2011).** Aligns Greek law with EU regulations for marine environment status by 2020.
- **Biodiversity Conservation Law (3937/2011).** Focuses on sustainable management and conservation of biodiversity.
- **National Strategic Plan for Aquaculture Development (2014-2020).** Aims for sustainable sector growth, increasing production, employment, and GDP.

Regional and Local Policies:

- **Regional Operational Programme (ROP) of the North Aegean Territorial Region (2014-2020).** Enhances competitiveness, innovation, and environmental protection.
- **Operational Programme of the Municipality of Lesvos 2015-2019.** Prioritises Environment and quality of life, Social care - Health - Education & lifelong learning - Culture – Sports, Economy – Employment and Internal development of the Municipality.

Objectives of the Proposed POAY:

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

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

Based on information available within the EIA report, the below project description provides a synopsis of developments in the Municipality of Lesvos. The POAY consists of three (3) production zones and two (2) fallowing zones. The study area also includes the single unit located at Paleolotros, Mytilene Municipality, Municipality of Lesvos, P.E. Lesvos, North Aegean Region, which is part of PAY 7 North Aegean Islands (P.E. Samos - Lesvos). The operation of this unit is controlled by the Management Entity of the POAY and the provisions of the HPHSAAY for the individual siting of existing units within PPAE applies.

For the modernisation and expansion of the existing facilities as well as the establishment of new onshore accompanying, supporting etc. facilities is required. However, the facilities are scattered and located according to the specific conditions applicable in each area and cannot be formed into a single zone. For the establishment of new facilities, wider areas are identified that are in principle considered suitable for the location of terrestrial supporting and accompanying aquaculture facilities. The new facilities are either public, managed by the POAY body, or private to meet the needs of each company. The management body supervises compliance with the operating conditions of both the existing and the new private land-based facilities.

In the chosen solution, the total proposed annual capacity of the POAY is 13,806.25 tonnes (t). The increase in the total proposed annual capacity of the POAY amounts to 12,326,25 t, of which 6,451,25 t relates to an increase in the capacity of existing units and 5,875 t to the establishment of new units.

In order to meet the needs of the total capacity of the POAY, new onshore accompanying, supporting, etc. facilities are required. The accompanying onshore infrastructure which, due to the nature and operational needs of the floating units, must be in relative proximity to the marine facilities, are the following:

- Berthing facilities (piers)
- Seawater pumping system (e.g. boreholes) and water run-off
- Feeding system (silos, pipes, etc.)
- Warehouses
- Guardhouses
- Net storage areas
- Incineration furnace
- Staff accommodation
- Access road termination and vehicle movement area
- facilities for the transhipment of shellfish from the farm support vessel to a refrigerated truck

In addition, it would be necessary to increase the total capacity of the packing plants and to establish new ones, to serve the production capacity of the breeding units of POAY.

3.5 Mandatory assessment of alternatives

EIA report: Three alternative scenarios were evaluated in this study. The MERAMOD prediction model was used to assess the impacts on the ecosystem and estimate carrying capacity.

- **Scenario 1 (Zero solution)**, in which no expansion of the leased areas is foreseen, while for the calculation of the capacity of the existing units the formula of the joint circular of YPEXODE and YPAAT (121570/1866/12-06-2009) is applied without counting the factors of distance from the coast, depth and speed of the currents. According to Scenario 1, the leased land in the whole of the POAY occupies an area of 50 (500

stremma[2]) with a total annual capacity of 610 t. This means that there is no increase in the total area of leased land, nor is there any increase in the total annual capacity.

- **Scenario 2,** in which the layout and the area of the leased areas of Scenario 1 are maintained, while the capacity of the units is calculated based on the formula of the joint circular of the Ministry of Environment and Natural Resources and the Ministry of Agriculture and Forestry of Greece (121570/1866/12-06-2009). According to Scenario 2, the total annual capacity of the PAY amounts to 2,643.75 t, which corresponds to an increase of 1,163.75 t on the existing capacity.
- **Scenario 3**, which provides for the rearrangement of existing units where this has been deemed appropriate due to the existence of *Posidonia*, other prohibitive uses or in accordance with the planned design and production restructuring plan prepared by the operators of the plants. In addition to the leased land in Scenarios 1 and 2 as reallocated, all the extensions required to implement the planning and production restructuring plan of the unit operators in the area are added. It also includes land for the installation of new units. The capacity is calculated in the manner described in Scenario 2.

EIA analysis: The report analyses 3 scenarios compared to the existing situation with Scenario 1 and 2 having the same area and a change in production of -58.8% and +78.6%, respectively. Scenario 3 has a significant increase in area from 500 to 3,000 stremmata (500%) and a major increase in production from 1,480 to 13,806,25 tonnes (833%). At this scale of expansion, the impact on the environment is significant.

	EXISTING UNITS	Scenario 1	Scenario 2	Scenario 3
Area (stremmata)	**500**	500	500	3,000
Production (t)	**1,480**	610	2,643.75	13,806.25

The proposed increase in production of 833% will have a significant increase in sediment impact.

Organic impact on the sediment:

- For location P1 will increase from 4.16 (light impact) to 21.3 kg/m^2/year (moderate impact)
- For location P2 will increase from 7.3 (moderate impact) to 57.9 kg/m^2/year (severe impact). Severe impact is defined at levels above 27.38 kg/m^2/year

Benthic diversity impact:

- For location P1 will change from a score 2.48 (medium quality) to 0.8 (bad quality)
- For location P2 will change from a score 1.4 (low quality) to 0.7 (bad quality).

	Original	**New**	**Change**	**%**
Area (stremma)	500.00	3,000	2,500	500%
Production (t)	1,480	13,806.25	12,326.25	833%
Organic impact P1 (kg/m^2/year)	4.16	21.3	17.14	412%
Benthic diversity P1	2.48	0.8	-1.68	-68%
Organic impact P2 (kg/m^2/year)	7.3	57.9	50.6	693%
Benthic diversity P2	1.4	0.7	-0.7	-50%

[2] A unit of land area mainly used in Greece and Cyrpus, equivalent to 1,000 m^2

These predictions of environmental impact that the increase in production will cause significant impact to the sediments and unacceptable impact in the case of the location P2.

3.6 Choice of Alternatives (Section 5.5)

EIA report: The main solution proposed in the text is the establishment of a POAY in Lesvos, implementing Scenario 3 for leased land area and capacity. The selection of this site considered several factors:

- **Suitable land area:** The ability to secure an appropriate and sufficient land area for aquaculture.
- **Absence of protected habitats:** No special conditions or restrictions due to protected habitats under Community and national legislation.
- **Coexistence of similar activities:** The potential for aquaculture activities to coexist, creating economies of scale without conflicting with established land uses or causing nuisances.
- **Economic and social benefits:** The potential for positive impacts on the economy and society.
- **Infrastructure availability:** The presence or possibility of developing necessary infrastructure like energy, roads, and telecommunications, ensuring technical adequacy, economic viability, and environmental protection.

EIA analysis: The chosen alternative (Scenario 3) will significantly increase the area farmed (up from 500 stremmata to 3,000 stremmata) and production volume (up from 1,480 to 13,806 t).

	EXISTING UNITS	Scenario 3	Increase (%)
Area (stremmata)	500	3,000	500%
Production (t)	1,480	13,806.25	880%

The report does quantify the organic loading on sediments, changes to benthic communities but does not quantify the positive or negative impacts of economic and social benefits at the local community level and impact on infrastructure and services at the local level.

4. Existing Environmental situation

Description of the existing environmental situation:

- Surface water and groundwater and groundwater aquifers
- Processing and assessment of physico-chemical parameters of marine waters
- Type of seabed – Ecological quality assessment
- Microbial load
- Inventory of pollution sources and data processing with analysis of zones of influence
- Habitat types – Flora and fauna of the study area
- Climatic characteristics
- Oceanographic data
- Coastal area

4.1 Surface water and groundwater

EIA report: The report provides a detailed overview of the surface water and groundwater features in the Aegean Islands Water Region (EL14), focusing on the island of Lesvos. The region, part of Greece, includes various island groups and is divided into three river basins: East Aegean, Cyclades, and Dodecanese Islands. The study details the different types of water bodies in the area, including rivers, lakes, transitional, and coastal waters, as well as groundwater bodies, following the classifications and guidelines of Directive 2000/60/EC.

EIA analysis: The information is given in sufficient detail but the report does not quantify the additional freshwater requirements for the expansion and estimate if freshwater water availability is sufficient.

4.2 Processing and assessment of physico-chemical parameters of marine waters

EIA report: The report covers an assessment of temperature and salinity through the water column based on a 2005 study. It describes the general seawater currents, dissolved oxygen levels, nitrate/nitrite/ammonia, phosphates, chlorophyll, transparency, pH, turbidity and suspended solids.

EIA analysis: The report comprehensively covers the existing seawater quality in the area but does not attempt to calculate the additional dissolved nutrient input from aquaculture and its potential impact to change the quality.

4.3 Type of seabed – ecological quality assessment

EIA report: The report describes the ecological status of sampling stations with the BENTIX consistently rated the ecological status as “High”, the M-AMBI index varied, sometimes rating it as “Good”. This variation is attributed to the different methodologies of the BENTIX and M-AMBI indicators, particularly how they incorporate biodiversity in their calculations.

The report highlights the complexity in using diversity indicators (like the Shannon diversity index) and biotic indicators that include diversity (like M-AMBI). This complexity arises due to the diverse responses of ecosystems to disturbances and the influence of various environmental factors, such as biotic interactions and the specific ecology of dominant species.

The report assesses the presence of healthy *P. oceanica* grasslands in the Strait of Mytilene and the Gulf of Gera, near the open Aegean Sea, suggests a high ecological status. This is in contrast to other coastal areas in the Greek sea.

EIA analysis: The report does identify the potential impact of aquaculture on the seabed and the use of models to predict the impact including MERAMOD. It also describes the Shannon – Weiner index to classify the diversity of the benthic community and ORP (Redox) to classify the seasonal variations related to the seasonal variation of sedimentation.

3.1 Point sources of pollution

EIA report: The report identifies various point and diffuse sources of pollution in the East Aegean area, including wastewater treatment plants, sewerage discharges, hotel and industrial units, livestock farms, aquaculture, and landfill leaks. These sources contribute to the annual loads of conventional pollutants like BOD (Biochemical Oxygen Demand), N, and P.

The report estimates that the total annual loads from point sources In the East Aegean LFA (EL1436) are estimated at 343 t of BOD, 243 t of N, and 60 t of P. Most of these pollutants come from wastewater treatment plants.

Diffuse sources include agricultural activities, urban wastewater not treated by WWTPs, livestock farming, and other sources. These contribute significantly to pollution, with annual loads estimated at 33,632 t of BOD, 21,488 t of N, and 5,089 t of P.

EIA analysis: The fish farm sites are located in relatively remote areas away from sources of industrial pollution. However, the level of production will cause a significant increase in nutrient input to the local area impacting water quality and sediment quality locally.

4.4 Habitat and flora/fauna in Lesvos

EIA report: The report also details the diverse habitats and species found in Lesvos. The island features different vegetation types, including Mediterranean pine forests, salt marshes, and various endemic species. Notable fauna includes amphibians, reptiles, mammals (including the rare Persian squirrel), and significant bird populations, particularly in the Gulf of Kalloni, which is a key site for migratory birds. The presence of endangered species like the Mediterranean seal (*Monachus monachus*) and the sea turtle (*Caretta caretta*) in the North Aegean waters is also highlighted.

EIA analysis: Fish cage culture in the North Aegean waters poses several risks to the Mediterranean seal and the sea turtles, two important species in the region. The key risks include:

- **Entanglement in fish nets.** Both the Mediterranean seal and the sea turtle can be attracted to fish cages due to the abundance of fish in the nets and are at risk of becoming entangled in the nets and structures associated with fish cages. This can lead to injuries, impaired mobility, and even death.
- **Increased human Interaction and disturbance.** The presence of fish farms can lead to increased boat traffic and human activity, which can disturb the natural behaviours of the Mediterranean seal and sea turtle.

4.5 Impact assessment based on the MERAMOD model

EIA report: To assess the impact of the expanded facilities' operation on the benthic ecosystem of the area, the MERAMOD forecasting model was used for each of the above scenarios.

In this study, the MERAMOD model was used for estimating;

- The dispersal of by-products of the rearing process (escaped food, fish faeces) on the bottom.
- The expected effects on benthic macrofauna by calculating the change of various indicators determining the biodiversity that meet the requirements of the Framework Directive 2000/60/EC for Waters such as the Shannon-Weiner index.
- The change in the redox potential of the sediment in the area.

The choice of environmental impact criteria to be assessed is good (organic deposition, Shannon-Weiner index and Redox potential). The MERAMOD model has been validated in the Mediterranean to predict the environmental impact of fish cage farms.

The MERAMOD model predicts the deposition of solids (organic nutrients) on the seabed and impact.

Organic deposition

To estimate a possible level of solid waste flux beyond which the area is considered polluted, a reference value of 1.5 kg/m^2/year is taken as a reference value, above which it has been observed that species considered to be indicators of pollution such as *Capitella capitata* and *Caulleriella oculata* occur, while species considered to be indicators of unpolluted areas, such as *Cirrophorus branchiatus, Cossura coasta* etc. are absent.

Benthic impact

Benthic impact tends to be local. However, nutrients also enter the water column from excretion and affect water quality by increasing the nutrient concentration in the water with high levels increasing the risk of triggering algal blooms.

To assess the impacts on the benthic biotic community, the MERAMOD prediction model provides the possibility to calculate the Shannon - Weiner index. The change in the Shannon - Weiner index determines the diversity of a biotic community.

The evolution of the index value gives a picture of the impact of solid waste on the benthic diversity of the area. It is expected that a high solid waste flux will result in a decrease in the number of species in the study area. Biomass and biodiversity are expected to increase to a point after which a sharp decline in values follows. This is due to the fact that polluted areas are dominated by a few species with very large numbers of individuals, which in turn collapse once a critical level of pollution is exceeded, resulting in a very limited number of pollution-resistant species being retained in the end. In general, the Shannon-Weiner index is expected to decrease with increasing solid waste flows in the area. The characterisation of the ecosystem status in relation to the values of the Shannon - Weiner index is presented in the table below.

Range of Shannon-Weiner index values corresponding to the different ecological quality regimes as defined by the Water Framework Directive (Directive 2000/60/EC).	
Quality regime	**Shannon index (*H'*)**
High	H' > 4
Good	3 < *H'* ≤ 4
Medium	2 < *H'* ≤ 3
Low	1 < *H'* ≤ 2
Bad	*H'* ≤ 1
Source: University of Crete, 2007[3]	

Scenarios

Scenario 1 (baseline scenario)	**Scenario 3 (chosen scenario)**
Scenario 1 (Null solution), in which no extension of the of leased areas while for the calculation of the capacity of the existing ones units, the formula of the joint circular is applied: 121570/1866/12-06-2009 YPEXODE and YPAAT without taking into account the coefficients of the distance from the coast, of the depth and speed of the currents. According to scenario 1, the leased lands in the whole of POAY occupy an area of 50 stremmata with a total annual capacity of 610 t. In other words, there is no increase in the total area of leased land, nor an increase in the total annual capacity. 610 t/yr	**Scenario 3,** the total area to be occupied by the proposed production zones amounts to 1,064,429 stremmata, within which the leased lands occupy an area of 300 stremmata. Suggested an increase of the total area of the leased lands by 250 stremmata of which 150 stremmata concern the extension of existing units and the 100 stremmata of new land. The total proposed annual capacity of POAY amounts to 13,806.25 t. the increase in the total proposed annual capacity of POAY amounts to 12,326.25 t, of which 6,451.25 t relate to the increase capacity of the existing units and 5,875 t concern the establishment of new units. 13,806.25 t/year

According to the results of the MERAMOD project, in the case of scenario 3, no cumulative effects are observed, as no interactions are observed both between fish farm units and production zones. The impact on the ecosystem in scenario 3 is greater than that in scenario 2 and occurs to a limited extent. The ecological situation under the cages is less than good but any phenomenon will be of limited duration and will be observed in a very limited area

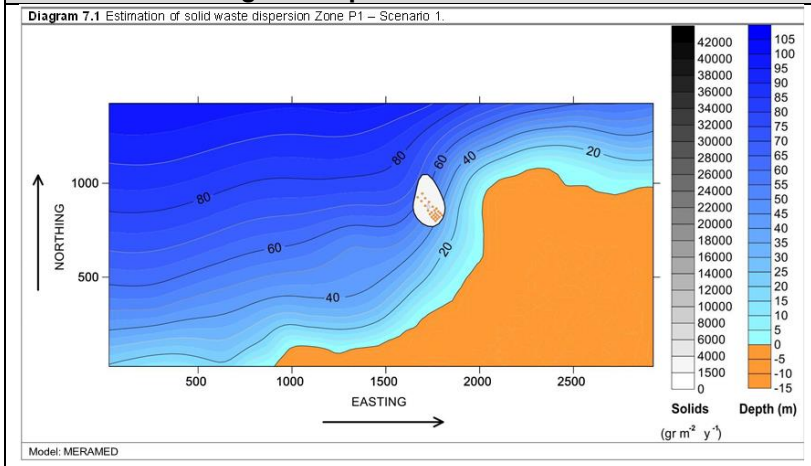
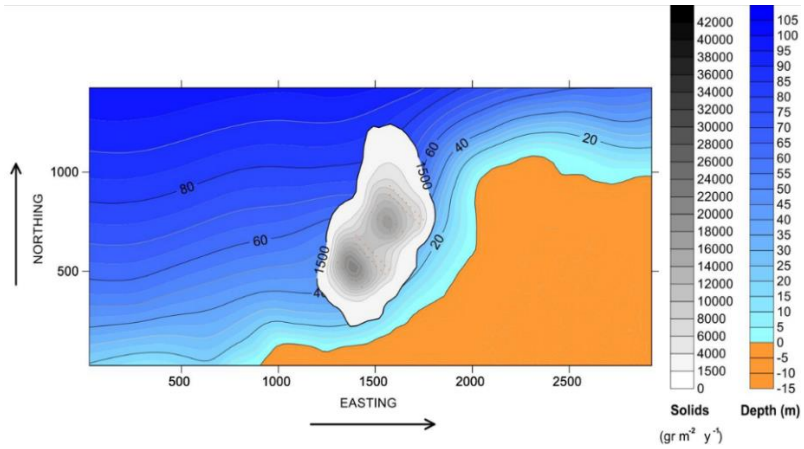
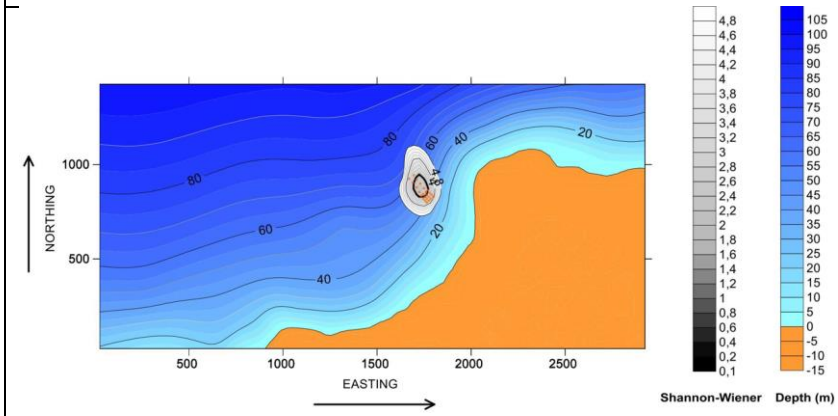
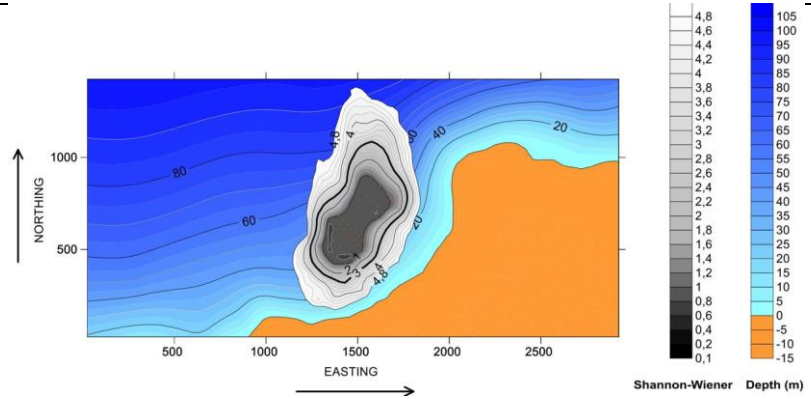
[3] *Karakasis, I., Sevastou, K., Koutsikopoulos, K,, 2007. Impact of fish farming on the marine environment and adaptation of production potential to the environmental characteristics of marine ecosystems. University of Crete, Laboratory of Marine Ecology*

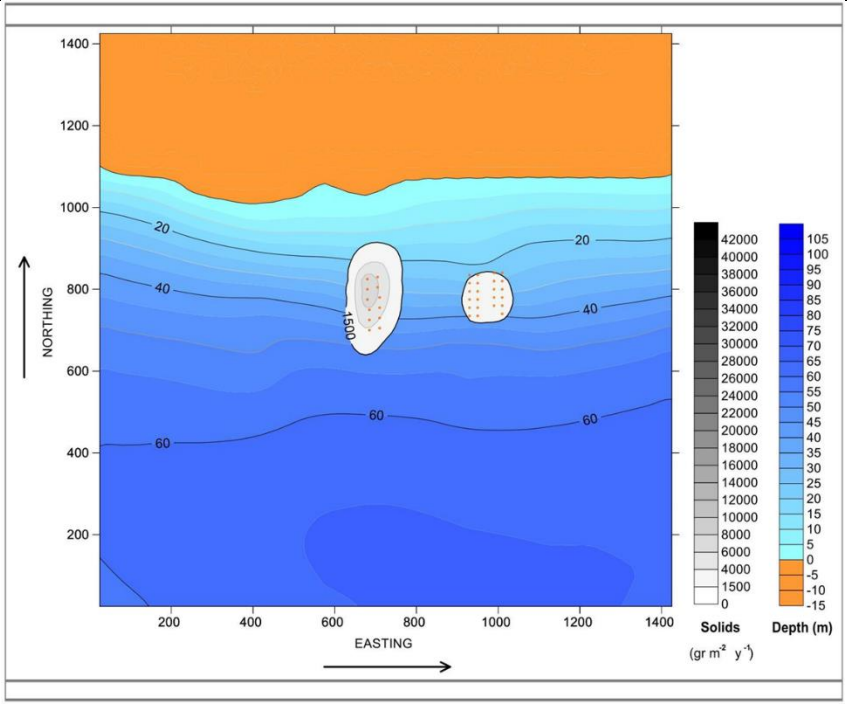
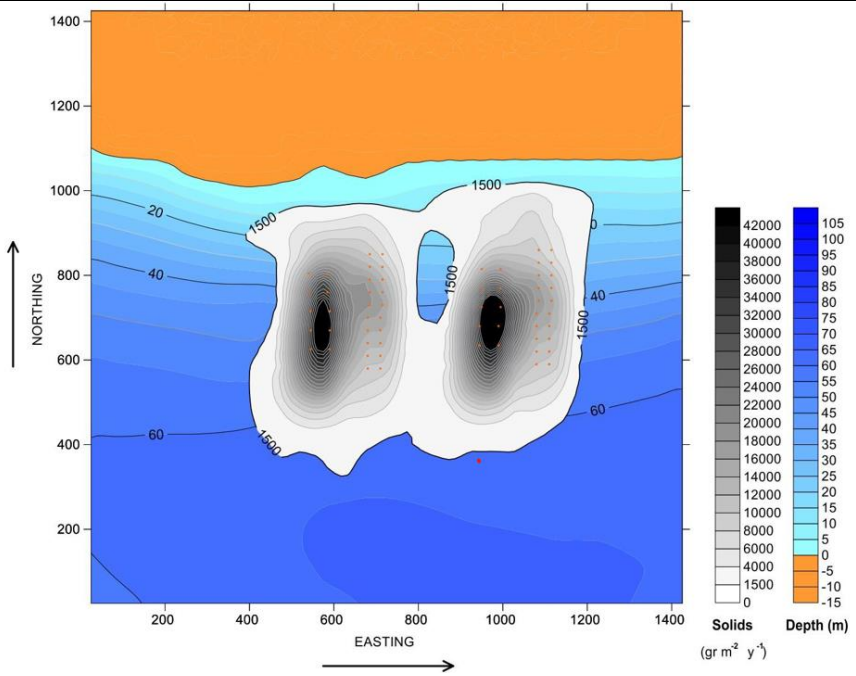
under the cages. At the same time, the quantities dispersed, due to the currents, are within the levels that the system itself can absorb.

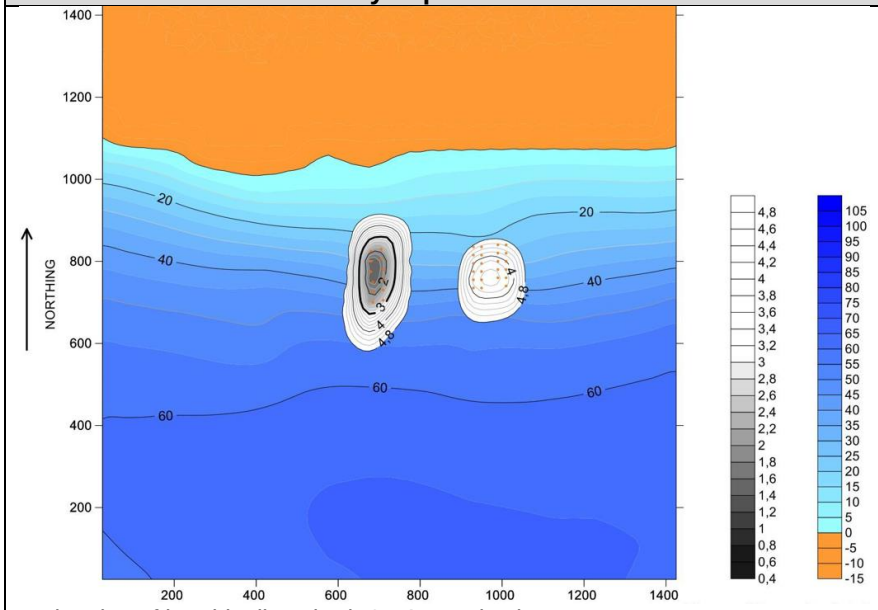
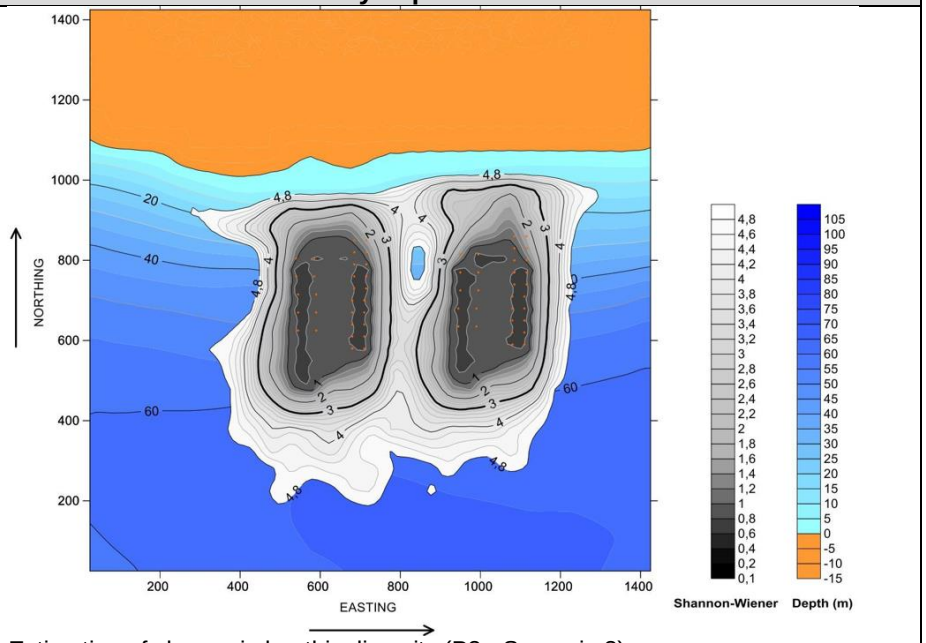
EIA analysis: The aquaculture production areas are located in relatively remote areas of the Island with the main areas in exposed locations that help to dissipate nutrient impacts.

Classification of severity of impact on the sediments.

Light impact.	This refers to a low level of impact on the environment, typically caused by activities like fish farming or livestock production. It is detected using a specific measurement (1 gram (g) per square meter (m^2) per day), which is just slightly higher than natural background levels. Light impact is considered to be between 1 – 15 g/m^2/day (0.365-5.580 kg/m^2/year).
Moderate impact	At this level, the impact on the environment is a bit higher, but still manageable. It is measured at 15 g/m^2/day. While there is some effect on the sediment surface, the environment can handle this amount of organic matter. Moderate impact is classified between 15 – 75 g/m^2/day (5.48 – 27.38 kg/m^2/year).
High impact	Here, the impact becomes more significant. It's measured at 45 g/m^2/day (16.425 kg/m^2/year). This level of impact affects the sediment and the communities living within it. In other environments, when the predicted impact exceeds 50 g/m^2/day (18 kg/m^2/year), it is generally not preferred by the industry.
Severe impact	The 75 g/m^2/day contour represents a severe impact and is expected to cause low or no oxygen conditions on the seabed resulting in severely degraded conditions, as well as significant black layer depth in sediments and high carbon content of sediments. Severe impact is classified as above 75 g/m^2/day (27.38 kg/m^2/year).

P1 Production Zone Ormos Agia Marina	
P1 Scenario 1. Organic impact	**P1 Scenario 3. Organic impact**
 Estimation of solid waste dispersion (P1 - Scenario 1).	 Estimation of solid waste dispersion (P1 - Scenario 3).
4.16 kg/m^2/yr Light impact	21.3 kg/m2/yr High impact (MERAMOD)
Scenario 1. Benthic diversity impact	**Scenario 3. Benthic diversity impact**
 Estimation of change in benthic diversity (P1 - Scenario 1).	 Estimation of change in benthic diversity (P1 - Scenario 3).
2.48 Medium impact (Shannon-Weiner)	0.8 Bad impact (Shannon-Weiner)

P2 Agrilia production zone	
Scenario 1. Organic impact	**Scenario 3. Organic impact**
 Estimation of solid waste dispersion (P2 - Scenario 1).	 Estimation of solid waste dispersion (P2 - Scenario 3).
7.3 kg/m^2/yr Moderate impact (MERAMOD)	57.9 kg/m^2/yr Severe impact (MERAMOD)

Scenario 1. Benthic diversity impact	Scenario 3. Benthic diversity impact
 Estimation of benthic diversity (P2 - Scenario 1).	 Estimation of change in benthic diversity (P2 - Scenario 3).
1.4 Low impact (Shannon-Weiner)	**0.7 Bad impact** (Shannon-Weiner)

EIA analysis: The consolidated sediment impact and the locations of the cage farms from Scenario 3 are shown in the figure below.

P1 Production Zone Ormos Agia Marina	
P1 Scenario 1	**P1 Scenario 3**
Estimation of solid waste dispersion 4.16 (kg/m^2/yr) Light impact	Estimation of solid waste dispersion 21.3 (kg/m^2/yr) High impact
Estimation of benthic diversity 2.48 Medium impact	Estimation of benthic diversity 0.8 Bad impact
P2 Agrilia production zone	
P2 Scenario 1	**P2 Scenario 3**
Estimation of solid waste dispersion 4.16 (kg/m^2/yr) Light impact	Estimation of solid waste dispersion 57.9 Severe impact
Estimation of benthic diversity 1.4 Low impact	Estimation of benthic diversity 0.7 Bad impact

The model predicts that for the present situation and Scenario 1, the impact on the sediment quality is light and that the benthic community is good quality. However, the prediction for Scenario 3 for both P1 and P2 sites is that there will be high impacts to sediment chemistry and the benthic community.

In the report no clear impact relationship of solid waste dispersion as expressed in kg/m^2/yr is given. The Shannon Weiner Index is used to express the diversity of a benthic community and the impact relationship is described in the report. This only gives an indicative insight into the impact of solid waste.

- **Sediment quality**. At this magnitude of impact, the sediment would have severely degraded conditions, as well as significant black layer depth in sediments and high carbon content of sediments.
- **Benthic community**. The impact of a classification less than 1 can be significant, as it may trigger the need for specific management actions and measures to improve the ecological status of the water body. These measures would include pollution control, reduction in nutrient loads from the fish farm aimed at restoring the health and diversity of the benthic community and, consequently, the overall ecological quality of the water body.

Parameter	Original	New	Change	% change
Area	300	550	250	83%
Production (t)	610	13,806.25	13,196.25	2163%
Organic impact P1 (kg/m^2/year)	4.16	21.3	+17.14	412%
Benthic diversity P2	2.48	0.8	-1.68	-68%
Organic impact P2 (kg/m^2/year)	7.3	57.9	+50.6	693%
Benthic diversity P2	1.4	0.7	-0.7	-50%

These impacts can be mitigated by a reduced level of fish production at the site or by moving the cages into a deeper area so that the particulate matter is spread over a wider area (lower severity but higher extent) so that the ecosystem has a better chance to assimilate the additional nutrients from the fish farm (see the consolidated executive summary recommendations and case studies examples).

There is a need to validate the Greek formula and the MERAMOD predictions against actual environmental Impact data from the regular environmental monitoring surveys that are conducted by the fish farms.

- Validate the Greek formula against the actual environmental impacts of existing farms with nominal carrying capacity estimation compared with actual impact on water quality and sediments
- Validate the model against MERAMOD predicted environmental impacts using modern impact thresholds

5. Proposed monitoring and mitigation measures

6.1 Proposed general measures

EIA report
- Operation and management by scientific staff
- Prevention of escapes
- Fish health specialist at each hatchery
- Correct food storage
- Disease treatment and responsible disposal of mortalities
- Waste disposed of at Municipal facilities
- After shutdown, the site will be restored

Construction phase
- Use of approved materials
- Correct mooring systems and 10 m from *Posidonia* beds
- Site demarcation

Operating phase
- Environmental protection
- Use of licensed vessels
- No fishing
- Net washing
- Lighting at sea
- Use of good quality feed
- Regular environmental monitoring
- Recording of waste and disposal

EIA analysis: The report does cover generic monitoring and mitigation measures for marine fish cage culture.

Greece has laws that cover environmental monitoring during construction and building works.

The Ministry of Environment and Energy has issued specific guidelines for the environmental monitoring of marine fish cage farms. These guidelines provide detailed recommendations on sampling protocols, data collection methods, and analytical procedures.

The Common Ministerial Decision No. 31722/2011, outlines the requirements for the licensing, operation, and control of marine aquaculture activities in Greece. The guidelines cover a wide range of topics, including:

- Site selection and planning. Farms should be located in suitable areas that are not likely to have a negative impact on the marine environment.
- Water quality management. Farms should have effective water quality management systems in place to minimize the discharge of pollutants into the water column.
- Feeding and nutrient management. Farms should use appropriate feeding strategies to reduce the amount of uneaten food that enters the water.
- Waste management. Farms should have effective waste management systems in place to collect and dispose of fish waste, dead fish, and other organic materials.

- Disease control. Farms should have effective disease control programs in place to prevent the spread of disease among fish.
- Monitoring and reporting. Farms should conduct regular monitoring of their environmental impact and report their findings to the relevant authorities.

6.2 Monitoring parameters

EIA report: The report covers the following:

- parameters to be monitored
  - Physiochemical
  - Nutrients
  - Sediment
  - Phyto and zoo benthos
- sampling frequency per parameter
- Responsible organisation

EIA analysis: The report provides sufficient information on the sampling type, frequency and analysis.

6.3 Sampling stations

EIA report: Under the responsibility of the Management Entity of the POAY, sampling will be carried out at designated stations at selected points to monitor impact of the activity. The locations of the stations were determined considering the zones of impact from the operation of the plants as estimated by the MERAMOD model for the proposed capacity of the production system. At least one sampling station has been identified in each proposed production zone, and has been located so that the minimum distance between stations is at least 3 km.

EIA analysis: The report provides sufficient information on the number and location of sampling stations.

6.4 Floating installations

EIA report: Section 8.1 outlines regulations for marine fish cage farms in a specific study area.

- All of the units in the study area are located within the boundaries of the production zones as defined in the table in this plan. An exception is the unit for which the terms and conditions of the EPXSAAY apply for individual placement in PAY E at Paleolotros, Mytilene Municipality, Lesvos Municipality, Lesvos P.E., North Aegean Region.
- Operations are governed by Law 4282/2014, with special conditions including set leased areas and capacities, possible adjustments in leased land dimensions, and specific rules for relocating units within or beyond 250 m, subject to distance and environmental checks.
- New sites for new or relocated units, with leasing based on specific criteria favouring smaller, single-unit entities with investment plans.
- Experimental rearing is permitted under certain conditions, avoiding species with disease risks.
- Fishing near these farms is allowed beyond 50 m, following relevant fishing regulations.

EIA analysis: The Law 4282/2014 consists of four Chapters divided into 35 articles and establishes the Basic Law on Aquaculture development. It defines the institutional framework for the development of the aquaculture sector in the context of its sustainable operation as regards the use of marine waters for the installation of an intensive aquaculture activity and the authorisation procedure for the establishment and operation of aquaculture units, which can be installed on water or land.

6.5 Onshore installations

EIA report: Section 8.2 outlines guidelines for land-based facilities supporting aquaculture.

- Facilities must adhere to the Aquaculture EPXSAAY (Special Planning Framework for Aquaculture), including necessary accompanying and supporting facilities like hatcheries and packaging units.
- These facilities should ideally be located near the seashore for water access, with location and construction following specific legal provisions and promoting modern facilities in designated areas.
- Facility placement will consider the area's topography and physical condition, requiring individual authorization.
- Integration into the natural environment is emphasised, with a focus on preserving local characteristics and avoiding environmental damage, verified during the authorization process.
- Concealment and integration of facilities into the landscape using plantings and other techniques are encouraged.
- Building conditions and restrictions will align with existing legislation for areas outside urban plans.
- Traffic access to facilities will primarily use existing roads, with new roads following natural terrain and requiring specific studies.
- Watercourse protection measures include restrictions on construction that hinder water flow and infrastructure design to handle significant flood events.

EIA analysis: There will be an increase in the shore-based facilities to support the increase in production including feed stores, net cleaning, repairing and net stores, offices, repairs and maintenance workshops, fish packing facilities and fish hatcheries. The report states that these facilities must adhere to the Special Planning Framework for Aquaculture and outlines some of the measures.

However, there is no quantification of the additional facilities that will be required (expansion or new) and how these will impact local infrastructure and demand for local services.

6.6 Monitoring of environmental parameters

EIA report: The Management Entity of the WFD (Water Framework Directive) and unit operators within it must monitor environmental parameters as per the plan, which can be updated based on regulatory changes and scientific advancements.

The WFD Management Entity oversees inspections outside the leased land boundaries.

Unit operators within the PAY are responsible for checks within their leased land, reporting results to the WFD Management Entity. However, inspections are not mandatory for operations with an annual capacity under 500 t.

EIA analysis: In Greece, the Law 4447/2016 regulates aquaculture activities and mandates environmental monitoring programs for marine fish cage farms. The scope of monitoring should include parameters such as:

- Water quality: Temperature, salinity, dissolved oxygen, pH, nutrients, and suspended solids
- Sediment quality: Organic matter content, nutrient levels, metal concentrations, and bacterial communities
- Benthic fauna: Macrofauna, meiofauna, and benthic microalgae
- Fish populations: Species composition, abundance, and health status

The Ministry of Environment and Energy has issued specific guidelines for the environmental monitoring of marine fish cage farms. These guidelines provide detailed recommendations on sampling protocols, data collection methods, and analytical procedures.

The frequency and duration of environmental monitoring depend on the size and location of the fish farm, the species cultured, and the farming practices employed. However, most farms are required to conduct monitoring at least once a month, and the monitoring period should extend throughout the entire production cycle.

Fish farm operators are responsible for documenting and reporting their monitoring data to the relevant authorities. This data is used to evaluate the environmental performance of the farms and identify potential areas of concern. Authorities may also conduct site inspections to verify the accuracy of monitoring data and ensure compliance with regulations.

6.7 Management measures

EIA report: The report recommends that if environmental degradation is detected, the following measures are proposed.

- Suspension of capacity increase if not yet at proposed levels.
- Reduction of production capacity to levels set by specific Ministry circulars if relocation isn't possible.
- Suspension of the unit if it cannot be relocated.
- Relocation of the unit to a better location.
- In production zones, temporary relocation from production zones is planned if ecosystem degradation is detected. Specific relocation zones are outlined for different units.
- Production sites maintain their original area and capacity and must comply with distance regulations from neighbouring units.
- The relocation process follows the relevant Law 4282/2014.
- Units can return to their original locations if, after inspection, the ecosystem is found to have recovered.

EIA analysis: 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.

6.8 Solid waste - animal by-products

EIA report:

- Disposal of solid waste and animal by-products through a contract with an approved treatment operator.
- Maintenance of detailed records on waste quantities, characteristics, origin, destination, collection, and transport.
- Removal of abandoned aquaculture facilities within the POAY within one year of cessation of operations.
- Issuance of a certificate by the POAY Management Body for units ceasing operations or relocating, confirming removal and environmental restoration.
- Submission of detailed removal and absorption plans to obtain the certificate, with these documents kept in the specified record.

EIA analysis: Increased fish production will also result in increased solid waste disposal, particularly the responsible disposal of fish mortalities. Dead fish will need to be transported to designated disposal facilities which employ appropriate methods to minimize environmental harm, such as incineration or specialized composting systems. There is no quantification or description for this in the report.

6.9 Main additional studies and surveys required

EIA report: The report recommends *Posidonia* seagrass mapping.

- *Posidonia* meadows, important under Directive 92/43/EEC, are prevalent in the study area, forming dense underwater habitats.
- These meadows are typically found from the coastline to 45-50 m depth, especially between 10 and 30 m depth, near the steep island coasts.
- The Ministry of Development and Food is conducting a comprehensive study to map these meadows across Greece, relevant to aquaculture development, but results are pending.
- Over forty potential aquaculture sites were examined by the Hellenic Centre for Marine Research (HCMR) for the presence of *Posidonia* grasslands, with findings detailed in an appendix.
- It is recommended that detailed mapping of these meadows follows to identify areas unsuitable for aquaculture.

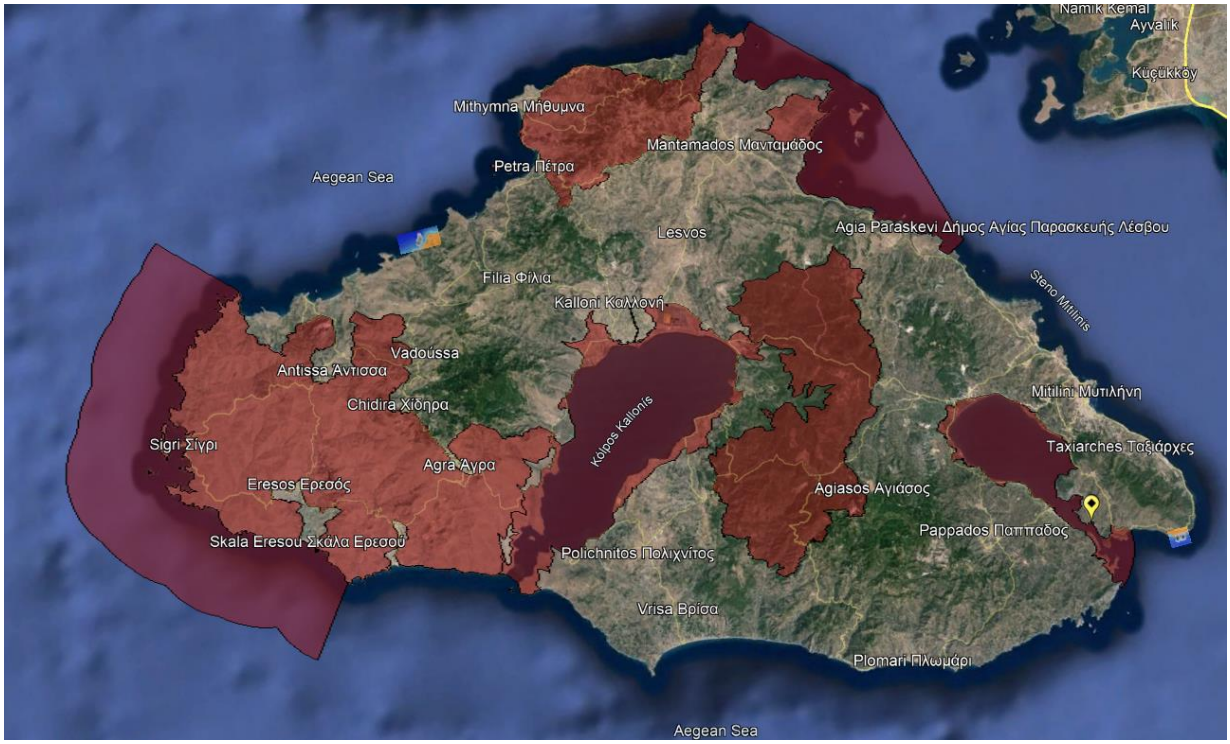
EIA analysis: The report acknowledges that there is insufficient mapping of *Posidonia* seagrass beds in the area. This means that there is a risk that farms that are expanding (together with their increase footprint impact) as well as new farms could impact *Posidonia* beds that are close by.

Marine fish cages can have a significant impact on *Posidonia oceanica* seagrass beds due to:

- **Increased organic loading**: Particulate organic matter can settle on seagrass meadows, increasing nutrient levels and reducing light availability.
- **Sediment smothering**: Fish cages can also smother seagrass meadows by trapping sediments and debris. This can block light penetration and prevent the exchange of gases, which are essential for seagrass survival.

- **Anoxia**: The organic matter from fish cages can decompose anaerobically, which deduces oxygen levels in the sediment and can even produce hydrogen sulphide and other toxic substances. These substances can impact and even kill seagrasses and other organisms.

The 2 fish farming zones are not in the Natura 2000 designated area.



However, the report notes that there are Mediterranean seals and sea turtles in the area. These are endangered species and there are risks of interaction between them and the farms. There is therefore a need for further studies to identify the locations of these species, assess the risks to them from farming operations and find ways to mitigate those risks.

Mediterranean seals

As an apex predator, the Mediterranean seal plays an important role in the marine ecosystem. However, fish cage farming can disrupt seal populations by reducing their access to prey and increasing their exposure to human activities. For example, a study conducted in the Aegean Sea found that the presence of fish farms significantly reduced seal foraging activity and prey abundance. This is likely due to the fact that fish farms attract fish species that seals also prey on, reducing the availability of food for seals. Additionally, fish farms can increase noise and light pollution, which can disrupt seal behaviours and make it more difficult for them to hunt for prey.

The Mediterranean seal is at risk of entanglement in fish cage netting and fishing gear, which can cause injuries, drowning, and even death. Entanglement can occur in nets, ropes, and other fishing equipment that is left unattended or discarded in the water. It is estimated that approximately 40% of Mediterranean seals have been entangled in fish farming or fishing gear at some point in their lives (see references). The presence of seals in the vicinity of the fish farms and the risk of entanglement for seals that live near fish farms needs to be assessed more thoroughly.

Sea turtles

Sea turtles are also vulnerable to entanglement in fish cage nets and fishing gear, including nets, lines, and hooks. Like seals, entanglement can cause injuries, drowning, and even death. It is estimated that over 60% of sea turtles have encountered fish cage nets or fishing gear at some point in their lives (see references). The presence of turtles in the vicinity of the fish farms and the risk of entanglement for turtles that live near fish farms needs to be assessed more thoroughly.

6. Socio-economic benefits and drawbacks of marine fish cage culture in Greece

The section below is an analysis of the EIA from a socio-economic perspective, providing an overview of the possible benefits and drawbacks associated with marine fish cage culture in Greece. This section is intended to highlight what the sector offers at the regional, country and local level and is an independent overview from the report authors.

6.1 Socio-economic benefits

6.1.1 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 Organisation (2021) the industry directly employs 3,871 people and it is estimated directly and indirectly employs about 12,000 people[4].

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.

6.1.2 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.

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

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.

6.1.3 Food security benefits at the country level

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

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

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.

6.2 Socio-economic drawbacks

6.2.1 Drawbacks at the regional 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.

6.2.2 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.

6.2.3 Drawbacks at the local level

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

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

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

Local road traffic. The construction and operation of fish farms can also increase local road traffic, as trucks are needed to transport materials and supplies to the farms, and to carry away waste and by-products. This increased traffic can put a strain on local infrastructure and can also contribute to air pollution.

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

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

6.3 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 6.1 and 6.2, depends on how the industry is managed and how it interacts with local communities.

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 Social status

EIA report of content

The study assessed the present (2017) social status.

- Demographics
- Employment and unemployment
- Tourism
- Infrastructure and services
- Economic conditions
- Land use
- Cultural heritage
- Protection of human and public health

7.1.1 Demographics

EIA report: Census results in the period 1991-2011, show that the population growth for all of Greece is 5.80% however a slight reduction is observed in the Region of North Aegean (1.08%). The Municipality of Lesvos shows a small population decrease (-0.82%) in the same period 1991-2011. In the period 2001-2011, the population of the North Aegean decreased (-2.93%) and in the Regional Unit of Lesvos (-4.42%)

The age distribution of the North Aegean Region and the Lesvos Regional Unit is similar to that of the entire country. The Northern Aegean Region shows slightly lower percentages in the age groups of 60 years and over (28.54%) compared to the Regional Unit of Lesvos for which this percentage is 29.68%.

The educational level of all the country's residents is considered satisfactory, as more than 65% of the population of Greece and 68.21% of the North Aegean Region area are graduates of primary, secondary and post-secondary education.

EIA analysis: The EIA study considers that the creation of the POAY will strengthen entrepreneurship, 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. fishermen) whose income has declined considerably in recent years.

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

7.1.2 Employment -Unemployment

EIA report: In the region of Northern Aegean and in the island of Lesvos the economically active population in 2011 was 38.46% and 37.86%, respectively. Unemployment rates in these regions are slightly lower that the national figure of (18.73%), namely 13.99% and 14.71%, respectively.

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

7.1.3 Tourism

EIA report: 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 (2014) and as a result, tourism development is prominent. The study mentions that the North Aegean Region and the Lesvos and Limno Regional units have a high percentage of workers in the tertiary sector.

From the given data only hotel accommodations is recorded in the study area with an observation that in the Regional Unit of Lesvos & Lemnos a decrease of bed number of -1.92% was observed from 2013 to 2015. However, looking at arrivals at hotel accommodations for the years 2013-2015 there is an increase of (19.11%) with an increasing occupancy rate of 39.8% in the Regional Unit of Lesvos.

EIA analysis: The spatial structure attempted through the organisation of the aquaculture units into 3 production and 2 fallowing zones 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.

There is a significant increase in the touristic popularity of the island which is evident by the increase of arrival at the hotels. Further development in the tourist industry such as the rise of popularity of AIRBNB will most likely increase this number. Implications on the social aspects and cost of living due to this increase need to be investigated. Further prediction of the touristic development may impact the locals' openness to such a project.

7.1.4 Infrastructure

EIA report: 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 municipality of Lesvos there has been significant improvement in the main road arteries however significant improvements remain to be carried out in the national and provincial road networks, to reduce travel times and mitigate the dangers of the roads.

- **Air transport** - There is one commercial airport in the Municipality of Lesvos at Mytilene, one military airport which is non-operational and a municipal heliport in Skala Eresos for emergency transport and some tours.

- There are 2 main ports on the island of Lesvos, one local port in Sigri located on the west side of the island and the other in Mytilene on the east which is the main port of international interest and regional Importance. Two marinas and infrastructure is in place to accommodate sailing vessels, fishing boats, and other nautical sports such as rowing.

EIA analysis: There will be significant road traffic due to the expansion of the supply of feed, live fry, packing boxes, harvested fish, and packed fish for distribution within Greece and for export. This is not quantified, and no attempts have been made to analyse the impact of this additional traffic on the rural road network.

There will be a significant increase in the use of port facilities for the transport of, feed, fry, nets, people, harvested fish, etc. This use of the ports will compete with normal use by fishermen, ferries, and recreation. This is not quantified, and no attempts have been made to analyse the impact of this additional use of port facilities.

A detailed analysis of how the current infrastructure will affect the development of the project, the way goods are transferred, boats stored and moored seems to be very weak. The understanding is that a lot of work would need to be carried out to have a truly functional road network and port that would cover the needs of such a project. Time frames are not discussed also leaving the matter open to discussion.

7.1.5 Freshwater supply and sewage

EIA report: In the study, a description of the water supply from water springs, boreholes and reservoirs is made for both supply and irrigation. Part of the network, using asbestos pipes, supplying the city of Mytilene has been upgraded and replaced with polyethylene pipes, However, many areas still require to be modernised and new water supply networks are proposed in these areas. Rainwater drainage and sewage systems are also described, and many are in good condition. Again, several areas require further work and are in different stages of planning and construction.

Water supplies and infrastructure for the municipal sections of:

- Mytilene - The network within the old city was built in 1930 and has been upgraded however the areas of Varia, Taxiarches, Neapoli, Agia Marina, Kratigou, Pligoni need replacing.
- Kallonis - The condition of the water supply is good and further expansion is being planned.
- Geras – The general condition is good however some sections need replacing because they still have asbestos pipes. In the area many springs could provide the quantity of water for irrigation networks, but their high iron content has prevented their exploitation.

Sewage for the municipal section is described for the following areas:

- Mytilene - The newly constructed network transports the city's wastewater up to the area of Acleidi to the Wastewater Treatment and Disposal Unit (MEL of Mytilene), which is located at the "Kara Tepe" location.)
- Kalloni and Geras have a good sewage system in place however certain areas still need to be connected.

EIA analysis: The EIA study does not quantify the freshwater requirement for the population or for irrigation and whether the supplies can meet the requirement or any additional requirement of the new proposed facilities.

There will be a requirement for the following:

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

7.1.6 Telecommunications and network infrastructures

EIA report: In the study section 6.1.15 Water supply, sewage and telecommunication network infrastructures no mention of the current telecommunication network infrastructures on Lesvos could be found.

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

7.1.7 Electricity supply

EIA report: The study concludes that in the study area all the necessary infrastructures (energy, roadwork telecommunications) are present, and these can be improved to advance the technology used, be more economic and protect the environment.

EIA analysis: The study does not consider the supply capacity, the distribution network, or the requirement for electricity in the Region or Island of Lesvos. Without any detailed information, it is not possible to assess whether the electrical generation and distribution infrastructure can meet the island of Lesvos's demands and satisfy the requirements for this project. The EIA does not quantify the electrical demands of the proposed new facilities.

7.2 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 in these areas as the production zones where the aquaculture units will be located are in isolated areas.

EIA analysis: See detailed responses below.

7.2.1 Impacts of noise and light pollution

EIA report: The SEIA study states that sources of noise pollution will generally be limited to the construction and maintenance of facilities. **i**n general, the movement of vehicles, which is necessary for the transport of feed and other equipment to the premises, will take place via the roads connecting the onshore premises to the main road network and may cause noise.

The SEIA study stated that **l**ow-intensity lighting is used to protect the units, and to avoid stress to fish populations during storms, which is not expected to affect animal behaviour, as it is limited within the boundaries of leased land.

EIA analysis:

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

The SEI does not consider the noise impact from fish hatchery production facilities. The SEI does not consider the noise from reversing forklift vehicles around the packing stations which may impact nearby residential sites.

The SEIA 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, esp. in terms of nesting.

7.2.2 Impacts on the landscape

EIA report: The EIA study recognises that the coastal zone is important for vacation and leisure and are an important national asset. The study concludes that no adverse aesthetic effects are envisaged as the units are located in isolated areas without visual contact with other anthropogenic activities. In any case, when building new land or sea infrastructure, it will be a priority to find ways to integrate it into the surrounding landscape.

EIA analysis: The EIA study does not quantify the number or size of additional land-based facilities that are expected to be constructed or location[5]. This is a major omission as it does not take into consideration the necessary land services and infrastructure requirements that are needed to support the expansion, road traffic increase, freshwater requirement, electricity requirement, housing requirement, sewage and water treatment, etc. Without quantification of these facilities and their locations, it is not possible to make an informed judgment on impact on the landscape. The SEIA study does not take into consideration the visual seascape and impact on yachting in the area and the use of sheltered space and bays.

[5] With similar scale cage farms, the onshore facilities would typically include: (i) tank based fish nursery facilities, (ii) offices & accommodation for key staff, (iii) net washing, net repair & net stores; (iv) feed stores, (v) jetty & cranes, (vi) fish packing facility with fish box storage, (vii) maintenance workshop with stores, (vii) spare materials area (cage pipes and stanchions) and (viii) parking area for trucks live fish tanks, etc.

7.2.3 Impact on cultural heritage

EIA report: The EIA concluded that no impact on cultural heritage is expected during the construction phases of facilities, as the units are located at a distance from archaeological sites which could be affected by these works. In addition, in the marine study area there are no declared underwater archaeological sites, while the land facilities would not be located near cultural monuments and their operation will not have any impact on cultural heritage.

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

7.3 Identification of residential /spatial impacts

EIA report: The EIA concluded that no impacts on the residential areas are expected to occur, given that the zoning and the radius of influence would be 1000 m from the aquaculture sites. The study areas only have residential areas at much greater distances than 1000 m. Therefore, there are no direct effects on the residential areas of the DEs of the Kallikratiko Municipality of Lesvos.

EIA analysis: The EIA study does not estimate the additional land-based facilities that will be required or provide the area or location of the facilities. The EIA does not attempt to quantify the amount and type of land use change.

The support facilities will include coastal installations such as jetties, net washing facilities including net washing effluents (organic and solid waste). Without quantification of such facilities the impact cannot be assessed. The net washing process creates high nutrient effluent that needs treatment before being released back to the sea. Net washer effluent is small volume but high nutrient loading and inorganic particle loading (mussel shells). This requires a high level of treatment as well as sludge and solid waste disposal.

7.3.1 Impacts related to Infrastructure

EIA report: The EIA notes that there are no waste management facilities in the allocated aquaculture sites and that the POAY of Lesvos is not spatially related to the military shooting ranges of the N. Aegean. It is also noted that the POAY is expected to contribute to the construction of new roads, and the improvement and completion of the incomplete road network.

The purpose of the creation of POAY is the concentration of aquaculture activity in areas where organised units already exist. This will minimise any negative effects of POAY in the spatial organisation of the wider region.

EIA analysis: Under infrastructure, the study does not state where a freshwater supply will come from. In addition, it does not mention any electrical supply requirements and whether these can be covered either by the local grid or by generators.

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

The SEIA 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 home on a daily basis

The SEIA 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 net washer, nets taken out Changes washing
- Feed supply to each cage
- Fish harvesting
- Cage servicing
- Diver inspection of each cage
- Cage security at night

7.4 Social impact

- Population
- Human health

EIA Report: The study states that the proposal will reduce unemployment and activate local potential, providing significant growth and employment opportunities. The assembly operations of the fish cages are not expected to cause any risk of harm to human health, provided that all necessary measures for the safety of personnel as required by applicable legislation are taken. Regarding the areas declared as Ancient Archaeological Sites (Law 3028/2002 "For the protection of Antiquities and Cultural Heritage in general"), there are no such sites in the study area.

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

7.4.1 Population

EIA Report: 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.

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

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

7.4.2 Human health

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

EIA Analysis: Only antimicrobials and vaccines are mentioned. There is no mention of anaesthetics used on farm.

7.5 Economic impact

EIA Report: The EIA study states that the aquaculture sector currently employs directly and indirectly about 10,000 workers, mainly in the periphery of the country. It should be stressed that aquaculture complements rather than replaces fishing activity, thereby contributing to the conservation of natural fish populations, and can provide alternative employment for workers from the fishing sector.

Further the report states the comparative advantages of the Greek seas creates positive environmental prospects for the future development of the fish farming sector and the maintenance of its leading position at Mediterranean and European level. At the same time, according to international experience and corresponding successful practices, the development of aquaculture has a positive impact on the economies of local communities. This is reinforced by the potential for developing alternative forms of tourism (fishing tourism, fish tourism, diving tourism) in combination with productive activities, boosting the income of producers, and diversifying and enriching the tourist product of a region.

EIA analysis: No stakeholder engagement has been made to determine current employment levels and gauge the potential employment levels required with proposed levels of production.

7.6 Solid waste disposal

EIA report: The EIA study states that all solid waste and animal by-products will be disposed of through an approved management body.

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 Housing

EIA report: The SEIA study does not mention the additional housing needs for the workers.

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

7.8 Stakeholder consultation

EIA report: The EIA report states that the participation of stakeholders in decision-making is a central element in planning and operation of the expanded facilities of the POAY, esp. in the following:

- Good spatial planning will help to separate the uses of marine and coastal space, avoiding disputes and conflicts between stakeholders and finding synergies between the activities and the respective environment in which they are carried out.
- Ensure proper involvement of stakeholders and appropriate information to the public.
- Ensure adequate monitoring of the aquaculture sector.

All the above were taken into account when formulating the proposed plan, as well as the objectives and priority areas given by the EU

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

7.9 Socio-economic assessment summary

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 and the neighbouring communities and tourist trade on the island.

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.
- 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.
- 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 on the island.
- 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.
- The study shows no evidence of stakeholder consultation and effort to find mutually agreed mitigation measures to reduce social impacts.
- The SWOT indicates that one of the strengths of aquaculture development in Lesvos would be a significant contribution to the regional and national economy. However, a financial analysis of sustainability using current market data and prices to indicate the impact of remote aquaculture units like those proposed for the Island of Lesvos is not covered. Specific questions as to the additional cost per kilo of fish produced compared to the mainland should be considered.

8. Conclusions

8.1 Environmental impacts

The existing environmental situation, including water bodies, seabed quality, and biodiversity, is well-documented. However, the assessment lacks specific details on the additional freshwater needs for aquaculture expansion and the potential impact of nutrient input from aquaculture on water quality.

The ecological quality of the seabed, particularly the presence of *P. oceanica* grasslands, indicates a high ecological status as defined by the EU Water Framework Directive. However, there are concerns about the potential impact of aquaculture on seabed quality and biodiversity, as indicated by various ecological models and indices. Lesvos hosts diverse habitats and species, including endangered species like the Mediterranean seal and sea turtle. The report highlights risks to these species from fish cage culture, such as entanglement and increased human interaction.

The report identifies various pollution sources but does not fully analyse the specific contribution of aquaculture expansion to this pollution.

The MERAMOD Model predicts the impact of organic deposition on the seabed and water quality, indicating potential local benthic impacts and risks of algal blooms. The model also predicts indicators like the Shannon-Weiner index to assess biodiversity changes in the benthic community. Scenarios show varying degrees of impact, with Scenario 3 (proposed expansion) indicating very large increases in organic impact and large reductions in benthic diversity.

The MERAMOD model predicts:

- the organic loading is increased by 412 – 693% (from light/moderate impact to high/severe organic impact on the sediment)
- The benthic diversity impact is from –50 to –68% (from low/medium impact to bad impact)

The report lists measures for the management and monitoring of environmental impacts, adhering to Greek laws and guidelines. These include strategies for waste management, disease control, and regular environmental monitoring.

The report highlights the need for further studies, particularly in mapping *Posidonia* seagrass beds, to better understand and mitigate potential impacts of aquaculture expansion. However additional studies are needed to assess the risks and mitigation measures that can be taken to reduce interaction with the endangered species Mediterranean seal and sea turtle.

The EIA provides a thorough overview of the potential environmental impacts of expanding marine fish cage farms in Lesvos Island. While it demonstrates a comprehensive understanding of the current environmental status and outlines detailed monitoring and mitigation strategies, it falls short in quantifying certain impacts, particularly those related to additional nutrient inputs and freshwater requirements.

8.2 Socio-economic impacts.

The report notes that there has been a slight population decrease in Lesvos and the North Aegean region, with an aging demographic profile like the national average. High educational attainment noted in the region. Unemployment rates in Lesvos and the North Aegean are slightly lower than

the national average. The EIA lacks a detailed analysis of the potential job creation from the project, making it difficult to assess its impact on local employment and community dynamics.

Tourism is a significant economic sector, with increasing hotel arrivals in Lesvos. The EIA suggests spatial zoning to avoid conflicts between aquaculture and tourism, but does not fully explore the implications of increased tourism on social aspects and cost of living. The report acknowledges that there is a nee d for some improvements in road and port infrastructure for the increase fish production, but the EIA lacks a comprehensive analysis of the impact of increased traffic and usage due to the aquaculture expansion.

The report describes the existing water supply and sewage systems, but the EIA does not quantify the additional requirements or capacity for the proposed expansion. There is a lack of detailed information on telecommunications infrastructure and its capacity. Similarly, the EIA does not address the electricity supply capacity and requirements for the project.

Potential impacts from noise, light pollution, and landscape changes are acknowledged but not thoroughly assessed. The EIA does not quantify the number or size of additional facilities and their visual impact. No direct impacts on residential areas expected due to distance from aquaculture sites. However, the EIA does not provide detailed analysis on the land use change and infrastructure requirements for support facilities. There are plans for disposal of solid waste through an approved management body, but no specifics on the scale, type of waste, or disposal methods.

The report notes that there is an anticipated increase in road and marine traffic, but these are not quantified. Lack of details on freshwater and electricity supply requirements for the expansion.

There is a potential for reduced unemployment and local economic growth, but without quantification of required personnel, the impact on unemployment rate and local development structures remains unclear. There will be need for additional housing needs for workers not addressed, which could pressure the local housing market. There are positive prospects for local economies and potential for alternative tourism forms, but lack of stakeholder engagement to gauge potential employment levels and community acceptance.

Despite being stated as central to planning, the EIA lacks detailed documentation of stakeholder consultations, raising concerns about the inclusiveness and comprehensiveness of the assessment.

The socio-economic impact assessment for the marine fish cage farm development in Lesvos Island identifies several potential benefits, such as job creation and economic growth. However, it falls short in providing detailed analyses and quantifications in key areas, including employment potential, infrastructure capacity, and housing needs. The assessment also lacks comprehensive evaluations of potential conflicts between aquaculture and tourism, as well as the environmental impacts of increased traffic and waste generation. Insufficient stakeholder engagement and documentation further limit the assessment's effectiveness in capturing the full range of socio-economic impacts, necessitating a more thorough and inclusive approach to planning and decision-making.

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10. Annexes

Annex 1. EIA assessment classification

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

Annex 2. Guidance document on aquaculture and Natura 2000

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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