Environmental impact of aquaculture in Greece. Practical experiences

Klaoudatos S.D.

in

Uriarte A. (ed.), Basurco B. (ed.).
Environmental impact assessment of Mediterranean aquaculture farms

Zaragoza : CIHEAM
Cahiers Options Méditerranéennes; n. 55

2001
pages 109-127

Environmental impact of aquaculture in Greece. Practical experiences

S.D. Klaoudatos
National Centre for Marine Research, Aghios Kosmas, 16604 Athens, Greece

SUMMARY – The general background of the aquaculture activities in Greece with reference to the cultivated species, systems, production areas of fish farms operations, future tendencies and prospects are being presented. Also, there is a presentation concerning the legal/planning/management frame in which the aquaculture industry is being installed and operated. A view of the existing conflicts between aquaculture and other human activities in the same coastal area, in which the aquaculture farms operate, as well as the interaction of these activities and the influence of this particular situation on the development of the aquaculture industry are also being mentioned. The agencies (Governmental services) which are involved for the collection, analysis and estimation of the future results from the installation and operation of a fish farm in a given area, are also mentioned. Moreover, there is a presentation of the methods for the estimation of the interaction of the aquaculture activities and the sea environment, as well as the current area of research for the environmental impact assessment of the operating fish farms. Finally, the estimation of the present situation and the future trends of the aquaculture industry in Greece are presented.

Key words: Fish farming, environmental impact assessment, administrative framework, legislation.

RESUME – *"Séminaire sur l'évaluation de l'impact environnemental des fermes aquacoles en Méditerranée : Expériences pratiques en Grèce". Ce texte présente un aperçu général des activités aquacoles en Grèce en se référant aux espèces cultivées, aux systèmes, zones de production des fermes piscicoles opérationnelles, tendances futures et perspectives. Il y a également une présentation concernant le cadre légal, de planification et gestion dans lequel l'industrie aquacole est mise en place et opère. Une vision des conflits existants entre l'aquaculture et d'autres activités humaines dans la même zone côtière, dans laquelle opèrent les fermes aquacoles, ainsi que l'interaction de ces activités et l'influence de cette situation particulière sur le développement de l'industrie aquacole sont également mentionnés. Les agences, ou services gouvernementaux, qui interviennent dans la collecte, l'analyse et l'estimation des futurs résultats de l'installation et du fonctionnement d'une ferme piscicole dans une zone donnée, sont également cités ici. En outre, il y a une présentation des méthodes pour l'estimation de l'interaction entre les activités aquacoles et l'environnement marin, ainsi que le domaine actuel des recherches pour l'évaluation de l'impact environnemental des fermes piscicoles opérationnelles. Finalement, l'estimation de la situation présente et les tendances futures de l'industrie aquacole en Grèce figurent dans cet article.*

Mots-clés : *Elevage piscicole, évaluation de l'impact environnemental, cadre administratif, législation.*

The aquaculture activities, general background. Size of industry, cultivated species and systems

Greece has always had a long-standing tradition of aquaculture activity, which was limited to the extensive aquaculture exploitations of coastal lagoons though. The intensive form of aquaculture first took place in fresh waters, in the beginning of the 60's, with the introduction of the rainbow trout for culture. However, the notable development of the sector was noticed after 1985, when the country, relying on a European Union policy of motives, started developing marine culture, using the gilthead sea bream and the sea bass species. This development took place thanks to the successful introduction of the model of floating fish cages, which gave admirable results, due to the presence of many protected gulfs and bays, ideal sites for floating fish cages installation.

This marine fish farming development is clearly evident, if we consider that the total number of units of all sectors (Table 1), according to the annual report of the Aquaculture Directorate, Ministry of Agriculture, has risen in 1999 to 936, of which 711 were aquaculture farms in marine waters. Of all the above, 256 farms produced gilthead sea bream and the sea bass mainly in floating fish cages, as only four used land-based installations (cement reservoirs and earthen small marshes).

Table 1. Production from aquaculture activities, in marine and fresh waters, during 1999

Production sector	Number of units per activity and % ratio on the total	Production in tons and % ratio on the total	Value in million US$ (1$ = GRD 330 as at 1/12/99)
Marine aquacultures			
Hatcheries	30	156.5 million fry	42.50
Fish farms	681		
Gilthead sea bream/sea bass	256	41,500	194.00
Shellfish	425	31,000	12.14
Penaeus shrimps	1	6	0.06
Partial total	711 (76%)	72,506 (91.48%)	248.70 (92.45%)
Fresh water aquacultures			
Rainbow trout	95	2,600	7.48
Carp	12	150	0.41
European eel	12	570	3.63
Pacific salmon	3	10	0.08
Mixed aquacultures	9	100	0.35
Partial total	131 (14%)	3,430 (4.32%)	11.95 (4.44%)
Lake fishing	22 (2.3%)	1,750 (2.20%)	2.65 (0.98 %)
Coastal lagoons	72 (7.7%)	1,570 (2.00%)	5.71 (2.13 %)
Total	936 (100 %)	79,256 tons (100%)	269.01 (100%)

We should not omit in this impressive development the shellfish cultures, mostly those for Mediterranean mussels and European flat oysters, the production of which amounted in 1999 to 31,000 tons, from 425 units.

As it is apparent from the above, the increase in the production of the aquaculture activities mainly represents activities in marine waters, which are harmoniously combined with:

(i) The development of the local technology.

(ii) The increase in the demand of the products.

(iii) The creation of new employment posts, which contribute – among others – to holding the island population back in their homeland.

(iv) The improvement of the trade's balance, since approximately 70% of the aquaculture products is being exported to countries inside and outside the European Union.

Lakes, rivers and reservoirs (extensive aquaculture)

Inland fishery activities include 22 natural or artificial lakes, the production of which amounted to 1750 tons in 1999. Rivers and all other water formations (irrigation channels, canals, etc.) should be included in the lakes.

We could not say that a culture of the native species is being effected in the specific water environment; simply they're fishing exploitation. However, we should note that systematic enrichments have recently taken place, aiming at increasing the production by rearing species of high commercial value, such as the flathead grey mullet *(Mugil cephalus)* in selected lakes of the Western Greece (Trichonida and Amvrakia).

It is worth noticing that the selection of the species has been affected, while using as criteria the inability of their reproduction in fresh waters, so that a change in the structure of the native fish population could not be caused.

Intensive and semi-intensive inland aquaculture (fresh waters)

In 1999, trout (*Oncorhynchus mykiss*) culture units amounted to 95, having an annual production of 2600 tons. Apart from trout culture units, 36 units of other fresh water species are now in operation, such as: (i) three Pacific salmon *(Oncorhynchys kisutch*) culture units, with a production of 10 tons; (ii) twelve carp (*Cyprinus carpio*) culture units, with a production of 150 tons; (iii) twelve European eel culture units with a production of 570 tons; and (iv) nine mixed culture units (flathead grey mullet, tilapia and catfish), with a production of 100 tons.

The system applying for rearing the above species in these units differs significantly and European eel culture, for example, is being produced under intensive/super-intensive system, while carp culture follows the traditional extensive system. The remaining cultured species are being reared, while using the intensive farming system.

The perspectives of aquaculture development in fresh waters also differ.

Trout culture, although it overcame those problems related to trading in the fresh product, which it faced in the past, does not seem to have notable increasing possibilities, mostly because of the limited possibility of using inland spring waters, either due to their decrease or due to their use for other activities, in which priority is being given in certain regions.

Carp culture is not considered to be a growing sector as well, mainly because of the applying extensive rearing system, which requires large land areas.

On the contrary, the intensive production of European eel culture seems to promise a lot more, despite the direct dependence of the production on the imports of the glass eel population required.

Aquaculture inside coastal lagoons

Many travellers (Tselempis, 1660) mention the traditional exploitation of coastal lagoons by local fishermen, based on the migratory movements of the euryhaline species, already from the beginning of the 16th century. The country has 72 coastal lagoon exploitations, occupying a total area of 45,000 hectares, the production of which amounted, in 1999, to 1570 tons.

The structure of the fish captured – per species – and the percentage ratio of the various species in 1999, in relation with the total number of exploitations, was: (i) flathead grey mullet, 783 tons or 49.8%; (ii) European eel, 298 tons or 19.0%; (iii) gilthead seabream, 233 tons or 14.9%; (iv) seabass, 178 tons or 11.4%; and (v) annular seabream, 78 tons or 4.9%.

The output, on an annual basis, of the coastal lagoons is not invariable and fluctuates from 50 to 300 kg/hectare. It mostly depends on the weather conditions prevailing during the previous year and the exploitation method used which, in many instances, could not be described as rational.

Approximately 1500 people have been employed in these coastal lagoons, most of them in co-operatives.

Land-based coastal aquaculture

Hatcheries

30 hatcheries operated in 1999, one of which was state-owned (in Pogonitsa, Epirus) as for the remaining ones, those were privately-owned. Their production amounted to 156.5 million fry, of which 4.5 million were fry of new species (common sea bream, sharpsnout sea bream, common dentex and common pandora) and the remaining ones, sea bass and gilthead sea bream.

Fish farms

Out of the total 256 fish farms, as mentioned above, only four reared sea bass and gilthead sea bream species in land-based units (cement reservoirs and earthen small ponds) while the remaining ones reared in floating fish cages. Out of these units, 25 were of combined production, namely they had a hatchery and a fish farm, while the others reared the fry produced exclusively from the average weight of 1.5 g/individual up to the marketable size of 350-500 g/individual.

The total useful farming areas amounted in 1999 to 4,500,000 m^3, of which only 50,000 m^3 were in land-based units and the remaining ones in floating fish cages. The total productive capacity of the aquaculture units, on an annual basis, amounted in 1999 to 41,500 tons, of which only 1000 up to 1500 tons originated from land-based units.

As evident from the above, there is not a favourable climate in Greece for rearing the sea bass and gilthead sea bream euryhaline fish in land-based units for multiple reasons, the most important of which are: (i) land-based aquaculture relies upon the use of coastal areas, which are available at a higher cost, than that of the low renting price of the marine area used for fish cages; (ii) water needs to be pumped up when rearing fish, something that causes a significant surcharge over the company's operating costs; and (iii) the total cost for the administration of land-based installations is significantly higher, than the respective one for floating fish cages.

Culture of crustaceans

Aquaculture developed in land-based installations includes cultures of crustaceans. The crustaceans mostly preferred for cultures are the sea shrimps of the *Penaeus* species and, in particular, *Marsupenaeus japonicus*.

One unit now operates in Greece, which applies the semi-intensive farming system. The climatic conditions allow a full production during the summer season (20-25 g) and one having less average weight (12-15 g) during the winter season. In 1999, the unit produced 6 tons of shrimps.

Integrated aquaculture

Integrated forms of aquaculture are of a limited range in Greece, when the water discharged from the small marshes is used for irrigation purposes and not for aquaculture activities. The form of integrated aquaculture, associating finfish culture and molluscs in seawater has not applied either in Greece. This form has its own problems as, the poor water quality of effluent from the fin fish culture, the presence of pathogenic micro-organisms, which may be concentrated by the molluscs and the broad spectrum antibiotics used to prevent infectious diseases that interfere with feeding in the molluscs. Also exploitation of the warm water discharges has not been realized yet, e.g. that discharged when cooling power-generating engines, nor the use of processed waste waters by tourist or other installations for aquaculture purposes.

Shellfish cultures

87 shellfish cultures operated in 1990, the production of that reached 3800 tons, out of which 1800 tons was European flat oysters (*Ostrea edulis*) and the remaining ones Mediterranean mussels (*Mytilus galloprovincialis*). Later on, the growth in the culture of bivalve's molluscs was impressive and, in 1999, total production reached 31,000 tons, from 425 units. The distribution of the units is restricted to the coasts of the Pieria, Thessaloniki and Imathia Prefectures. The main product was Mediterranean mussels (*Mytilus galloprovincialis*), while the production of European flat oysters (*Ostrea edulis*), scallops (*Chlamys glaber*) and carpet shells (*Venus verrucosa*) is limited and is being effected mainly in its traditional extensive form or by fishing natural reserves.

On the contrary, the Mediterranean mussel culture units apply modern rearing methods, something that results to the vertical increase of their performance.

Aquaculture in floating fish cages

A special development was noted during the last years in the culture of the euryhaline species of gilthead sea bream and sea bass in floating fish cages, the production of which, from 1,600 tons in 1990, reached 41,500 tons in 1999. This development is also apparent in the increase of the number of operating units, which although they were only 100 in 1990, reached 256 in 1999.

Due to the fact that the over production of sea bass and sea bream created trading problems, no more licenses are issued for the installation and operation of gilthead sea bream and sea bass units, a fact which orientating the new fish farmers compulsorily to rearing new species, such as the common sea bream (*Pagrus pagrus*), the sharpsnout sea bream (*Puntazzo puntazzo*), the common dentex (*Dentex dentex*), the sand steenbras (*Lithognathus mormyrus*) and the common pandora (*Pagellus erythrinus)*.

This in fact causes problems, given that much research effort is still needed for the successful culture of these species. The old units are being financially supported with the purpose of their modernization and the exploitation of the initially leased marine area in its entirety. The above activities take place in well-protected gulfs, as the offshore aquaculture in open areas is not applied in Greece.

In Table 1, the total activity of the aquaculture sector is being tabulated, according to the Aquaculture Directorate of the Ministry of Agriculture.

Key coastal habitat used/involved, their essential characteristics

The culture of the Mediterranean euryhaline species *Sparus aurata* and *Dicentrarchus labrax* in floating cages in Greece started at the beginning of the 80's. Through the years the majority of fish farms in Greece has been installed in protected areas, as the technology of netcages' construction, which was transferred from the protective close areas of Scottish lakes or the Norwegians fords, did not allow a direct exposure to the height waves of the open sea. The majority of these areas was near seashore and well protected, but with satisfactory seawater currents, which permitted the aquaculture wastes to disperse in the sea environment and not to be accumulated in the sea bottom of the area, in which the fish farm was being operated. However, in some cases the high density of the cultivated fish, the small depth of the sea bottom, and the morphology of the bottom settlement (muddy sand) caused pollution problems, which forced the fish farmers to change site.

Later on, as the technology of the cages' construction was being developed and more resistant materials were used, the majority of fish farms were installed in less protected areas. In these places, the deeper waters, the stronger sea currents and the higher waves permitted an operation without causing any significant pollution problem. The main problem is the pollution created by the other sources (agriculture, urban and industry waste, etc.) which are affecting more seriously the aquaculture operation.

We should however, bear in mind that at the beginning of the aquacultural development, the governmental policy was focused on encouraging investors to turn in euryhaline fish culture in floating cages. Later on, as the number of fish farms increased, disputes with other users of natural resources and the producers appeared in certain regions, mostly among those pursuing a housing or tourist development of regions or its use for fishery purposes. In this case, the concerns about possible pollution from aquaculture became a strong weapon in the hands of other coastal user competitors (owners of tourist installations, industries, boarding houses, fishermen, etc.) for the control of the coastal area influencing on the public opinion. It is important to note that the large and scientifically self-sufficient non-governmental bodies and organizations do not have an opposite point of view, for the establishment and operation of fish farms. There were local ecological groups which, based on narrow local assessments, appeared sometimes – and in specific regions – to oppose the establishment of units, without this attitude documenting an overall opposition. The majority of these groups have included the protection of the nature and the environment, in general to the bread-winning professions.

However, it is common knowledge that the pollution was caused not only by the fish farms'

installation and operation, but also from other human activities such as agriculture activities, industry, urban waste, etc. Each of the above mentioned activities has its own share of responsibility for the sea water pollution, and that corresponding to the fish farmers is probably the smallest one, taking into consideration that the sea pollution has proved to be more dangerous for the living cultivated animals than for other human activity. This may well mean that the state should find a way to separate and measure the sources of pollution of the seawater environment and both analyse and count the pollution from each source.

It should be recognized, however that, as the cultivation of marine organisms is being completed in the water environment, no possible method to control the effluences before entering the environment exists. Intensive aquaculture method requires the provision of all needed substances, and especially feeds, by man; therefore sustainable, exploitation of aquaculture should aim to minimize the offered food waste and on the other hand exploit the water movements in the area for maximum dispersion of the fish metabolic waste (Gowen and Bradbury, 1987; Gowen *et al.*, 1990; Pillay, 1992; Beveridge, 1996) in order not to increase water eutrophication (Ryther and Dunstan, 1971; Taft and Taylor, 1976; Porter *et al.,* 1987).

On the other hand, the waste from a fish farm mainly consists of biological substances (proteins, lipids, carbohydrates), nutrients, ammonia and particulate matter, all of which either are dispersed by the water movement or directly enter the local food chain (fish, bacteria, benthic organisms) (Klaoudatos *et al.*, 1995, 1996; Koussouris *et al.*, 1995). Theoretically, the only existing danger to the environment is being attributed to the different rates of both the outflow and utilization of these substances. In such cases, anoxic conditions are evident mainly near the bottom, so that the local food chain collapses, as many of the organisms that are unable to move (benthic bacteria, polychaetes, bivalves, etc.) die. The problem is being enhanced then with the appearance of anaerobic organisms (bacteria), which produce by-products toxic to all organisms, such as H_2S, NH_3 and CH_4.

In further studies carried out in Greece in which the environmental impact of sea bass and sea bream floating cage fish farm were examined, the occurring levels of pollution from a 200 ton-cage fish farm were very low and found an average of: proteins 6.811 kg/day, lipids 0.357 kg/day, carbohydrates 6.483 kg/day, and particulate matter (ash) 9.309 kg/day. From the same studies it has found that the participation of a 200 ton-cage fish farm to the total area pollution was less than the 1/5 of the whole (Klaoudatos *et al.,* 1996; Conides and Klaoudatos, 1998).

Prior to analyse and summarize these results, we should mention the legal/planning/management context, the specific provisions concerning the site selection and monitoring, in which site the aquaculture industry is being installed and operated.

Aquaculture policy, administration and legislation

Aquaculture policy

The development of the aquaculture sector, by determining goals and priorities, etc., is being provided by the multiannual or annual action projects of the Ministry of Agriculture.

The most essential points of the policy in the aquaculture sector refer to the: (i) increase in the supply of products having high nutritional value and quality, at satisfactory prices; (ii) rational fishing administration of inland waters, within the framework of a viable development; (iii) reduction of the fishery product imports and the increase of exports; (iv) increase of the number of employment posts and the non-removal of the population from their homeland; and (v) differentiation of the primary fishery production by adopting new technologies.

The determination of the sector's national policy pertains to the Minister of Agriculture, who takes into account the recommendations of the competent Fishery Services at the General Fishery Directorate, the proposals of the scientific bodies (universities, research institutes), producers, local authorities, prefectural councils, etc.

Furthermore, an Agricultural Policy Council (APC) operates at the Ministry of Agriculture, as a

consultative body on the policy to be followed by the particular sectors of the Ministry of Agriculture. There officials from the Ministry of Agriculture and other competent Ministries, scientific bodies, producers, collective producer bodies, representatives of universities, etc. participate.

We point out that the aquaculture sector of our country operates within the framework of the Common Fishery Policy, applies the national and community legislative provisions for its development and is subject to the commitments of the Community Support Framework.

Administrative framework

The country's administrative system is divided into: (i) the central administration (Ministries); (ii) the regional administration (13 regions); (iii) the prefectural authorities (52 prefectural authorities); and (iv) the local authorities (923 municipalities-communities).

The aquaculture sector operates at a central administrative and prefectural authority level, in a direct connection with the local Fishery Services.

The fishery production in marine and fresh waters, the administration and management of fishery waters, the supervision and administration of Fishery Services, are all exercised by the Minister of Agriculture. Part of these competencies have been decentralized and exercised at a prefectural level, by the respective Prefects and the corresponding Fishery Services.

The planning and design in a policy measures in the aquaculture sector (law drafts, presidential decrees, administrative acts), consist a responsibility of the Central Administration, either exclusively of the Ministry of Agriculture or within the joint competence framework of other Ministries as: (i) the Ministry of Environment, Land Planning and Public Works, which is competent for the sectors Public works, Environment and Nature; (ii) the Ministry of Development that is competent for the sectors Commerce, Industry, Surface waters, Tourism, Research and Salt-pits; and (iii) the Ministry of Culture, which is competent for the sector Antiquities.

The realization and control of the above is being primarily exercised at a prefectural level. Among the services of the above Ministries many time difficulties confronted refer to the lack of co-ordination among them, the overlapping of competencies, the existence of too many laws, the different approach-concept as it concerns the common issues, and the lack of demarcation zones for the various activities. In Table 2, the joint competencies of the aquaculture sector are recorded.

Specific legislation applicable to aquaculture

The fishery legislation in the aquaculture sector is being incorporated in the Fishery Code (Legislative Decree 420/70) as well as the subsequent additions or amendments of its articles; in particular, Laws 1740/87, 2040/92 and 2130/93. The decrees or resolutions (either Ministerial or Prefectural ones), specifying the articles of the previous laws (Royal Decree 142/71, Presidential Decree 227/87).

Prior to promulgating presidential decrees – for which the Ministry of Agriculture is the competent one – providing for regulations in the aquaculture sector, an opinion taken by the Fishery Council (operating within the administration of the Ministry of Agriculture) is required. Participants in the Fishery Council are representatives from the Government, legal services, officials of the sector, scientific bodies, as well as collective bodies.

The Community Directives have also harmonized with the national legislation for the protection of the environment, the trade of the aquaculture products, the hygienic rules of products quality during the production, transportation and manufacture. For example the Community Directive CE/90/220/ECU, which is in connection with the international release of genetically modified organisms in the environment.

The legislative framework of the aquaculture sector refers to fishery exploitation only (administration-management of fishery and water resources) and does not cover the complete administration of the coastal regions, land or water areas, which appertain to other Ministries.

Table 2. The joint competencies of the aquaculture sector

Activities	Ministries
Professional fishing in coastal lagoons	Ministry of Agriculture; Ministry of Merchant Marine
Professional fishing in lakes-rivers	Ministry of Agriculture; Ministry of Public Order
Use of fresh, spring, surface waters	Ministry of Agriculture; Ministry of Development; Ministry of Environment; Land Planning and Public Works
Use of marine water	Ministry of Agriculture; Ministry of Finance
Aquaculture	Ministry of Agriculture; Ministry of Environment, Land Planning and Public Works; Ministry of Finance; Ministry of Merchant Marine; Ministry of Culture; Ministry of Development; Ministry of National Defence (General Navy Staff – GNS)
Water quality	Ministry of Agriculture; Ministry of Environment, Land Planning and Public Works; Ministry of Health and Welfare Public Health; Ministry of Agriculture (Fishery – Veterinary Science Sector); Ministry of Health; Ministry of Development
Trade	Ministry of Agriculture; Ministry of Development; Ministry of Finance
Land home	Ministry of Agriculture; Ministry of Finance; Ministry of Affairs (Local Authorities – Municipalities, Communities)
Research, education	Ministry of Agriculture; Ministry of Education; Ministry of Development
Endangered species	Ministry of Agriculture (Fishery – Forest Sector), Ministry of Environment, Land Planning and Public Works

The existence of regulations per Ministry, providing for the possibility of individual use of the various areas for the purposes of each Ministry, without necessarily revealing a conflict in legislation, in conjunction with the lack of complete land planning of the areas and the lack of priorities in the use of common resources, caused a problem of delay or rejection of applications, in connection with the operation of aquaculture sector units.

On the other hand as the licenses or accordant opinions of the jointly competent bodies are required for the establishment of aquaculture units, the priority, the use of common resources should regulate from the beginning and disputes or problems should be avoided.

In many instances, the problems were discussed at a prefectural level, with the participation of local communities, which have a possibility to participate in the local or prefectural councils, and express their opinions about the development planning of a region where several activities, agriculture, aquaculture, tourism, etc., are being discussed.

Finally, the licenses or opinions offer all possibilities and ensure the proper operation of the unit (maximum water quantity, method of outflow, limits of leased area, non-obstruction of fishing, shipping, etc.). The problems arising are due to the non-application, on the part of the individuals, of the operational rules and procedures, as they are provided by the relevant resolutions concerning all activities using common resources. In this particular circumstance, when examining issues or problems of the aquaculture sector are being faced, informal (ad hoc) committees are being set up by the Ministry of Agriculture, in which participate aquaculture experts from the state (ministries, institutes, universities) and private sectors, which solved the arising problems.

Procedure followed for leasing a marine area and issuing a license for the establishment of an aquaculture unit

As we have mentioned before, the legislative framework governing aquaculture has been

exercised at a central level (planning design, legislation) and could be specified (realization control) at a prefectural level. So the issuance of the establishment and operation license for an extensive, semi-intensive or intensive culture unit appertains to the Fishery Services of the prefectural authorities under all circumstances, both in fresh and marine or brackish waters.

Local restrictions, which are effective for the sector, have been specified at a prefectural level, and refer to an authorization to practice the specific competence, within the framework of the legislation in force. The existing disagreements can be located in the opinions or accordant opinions of the jointly competent services only without necessarily revealing a conflict in legislation, in conjunction with the lack of complete land planning of the areas and the lack of priorities in the use of common resources. The duties and obligations of aquaculture producers are clearly recorded both in the establishment and operation license of the aquaculture unit (land or water area), as well as in the resolution – lease contract for the public space and the resolution approving the environmental terms for the operation of the unit.

These (duties-obligations) refer to administrative (body, articles of association, management, representative, etc.) and technical issues: species, production capacity, installations, construction methods, materials, rearing time, protective zone, trade, transport methods, use and distribution of fish feed, use of chemicals (antibiotics, probiotics, vaccines, anaesthetics, antifoulings), monitoring water quality, etc.

For leasing or sell a public land for aquaculture purposes

The legislation of the particular Ministries currently in force, to which the ownership or administration and management of the public land appertain, offer a possibility to lease or sell it only in very few cases. For this reason the highest percentage of the land-based aquaculture units operating in Greece has been built in privately owned areas, in particular:

(i) For areas of public use (land/water), it is provided that they may exclusively be leased for a period of up to 10 years and, afterwards, there is a lease renewal option.

(ii) For public areas, which belong to the private property of the State, it is provided that they may be leased or sold, on bidding.

(iii) For public areas, transferred to the Ministry of Agriculture, so that it develops agricultural activities, it is provided that they may be leased (for 10 years) or assigned by ownership, on a nominal consideration.

For the use of water resources

A special license needs to be issued for the use of fresh waters (spring/surface/underground), as it concerns land-based fresh water aquaculture units.

This license, which is issued free of charge and is valid for a period of 10 years, with a renewal option, determines the quality, quantity and method of water acquisition and is granted on conditions, e.g. the legislation in force determines the priorities of using waters in the following order: water supply, environment, agricultural activities, industry, etc.

In the cases of rearing euryhaline species on land-based units, a license for the execution of the project is required, with the purpose of pumping up sea water and, in this case, the license is granted free of charge and is valid for several years, with a possibility to renew the right of using sea waters.

In the cases of establishing intensive aquaculture units at an aquatic region (sea or lake) and, given the fact that these regions have been classified as regions of public use, the State:

(i) Leases their use for intensive culture, against a rent, for a period of up to 10 years, with a renewal option.

(ii) The lease may be effected through an auction or by a direct lease to individuals or legal entities, which are active in the sector.

(iii) Assigns their use, for an experimentally establishing model aquaculture units, for two years and, following the success of the experimental culture, it leases the area for up to 15 years.

As long as fish rearing waters are being leased with the purpose of establishing intensive aquaculture units, the lessee has the exclusive exploitation of the area and third parties are forbidden to practice free (capture) fishing.

Common law occasionally applies to the exploitation of coastal lagoons and lakes, allowing – in certain seasons – non-lessees to practise capture fishing in those circumstances. Some examples of applicable customary law could be found; they concern the exercise of amateur or professional fishing in leased areas of lakes or coastal lagoons, by residents of neighbouring communities or municipalities

We should point out at this point that, as it concerns the lakes and coastal lagoons of the country, which are located as a whole in coastal regions or wetland regions, no license or approval is required for their fishery exploitation (extensive aquaculture). In this case, fishery legislation provides the possibility of leasing the exploitation, either through an auction or through a direct agreement, to fishery co-operatives.

For establishment and operation of a fish farm

In order for an intensive aquaculture unit to operate, a license for its establishment and operation is required, issued by the prefecture fishery services and initially valid for 10 years, with a renewal option.

The most essential eligibility criteria for granting an establishment and operation license for an aquaculture unit are: (i) the existence of a suitable area; (ii) the quality and quantity of water (land-based units); (iii) the environmental parameters (Study for Environmental Impact Assessment – SEI); (iv) the depth (for fish farms operated in floating cages); and (v) the viability.

In the cases where land use plans have been drawn up at a regional or national level, providing for the use of land by determining the activities and wherever the activity of the aquaculture sector is mentioned, no special license or approval for the activity are required. However, it is required that a license for building and operating a specific aquaculture unit (method of operation, capacity, etc.) is being issued.

In all other cases an approval for the activity is required, following the submission of an application, a feasibility study for the operation of the aquaculture, a study for the environmental impact, as well as the accordant opinions of the jointly competent Services.

The supporting documents required, as well as the competent authorities for the establishment of units in fresh (Appendix A) and in marine waters (Appendix B) are being recorded.

Current practice of site selection and monitoring of cage units installation

The exploitation of the biological resources, whether through aquaculture or the operation of fisheries, is concentrated in the narrow coastal zone which is subject to natural environment fluctuations brought about by mixing of water from the land with that in the sea. This coastal zone is delicately balanced and limited in size affected also by human activities (sea traffic, industries, urban development, tourism, swimming, etc.) which affect water quality (Barnabe, 1990).

Water quality also depends on the capacity to integrate waste from urban, industrial and agricultural sources into biological and geochemical cycles. When the volume of waste material becomes too great to be assimilated in these cycles, the fundamental balance of the ecosystem is disturbed and marine life is threatened. Pollution arrives.

UNESCO has defined pollution as "The introduction made by man into the marine environment, directly or indirectly, of substances or energy which cause deleterious effects towards living resources and threaten human health, hinder activities in the sea such as, fishing and reduce its beauty".

Pollution may result from long-term phenomena or from short-term accidental ones. In consequence, the effects on living organisms may be long-standing or only temporary.

As a general rule so as to protect aquaculture operations against effects of long-term pollution we select sites away from industrial or urban waste outfalls. However, accidental pollution is much harder to avoid. The productive process is being influenced and narrowly confined by the physical, chemical and biological characteristics of the seawater, which influence the reproduction and growth of the cultured species. The quality of the water, which is the medium of aquaculture, is being carefully examined before installing the fish farm.

Physical parameters (temperature, density, ionic, colour, turbidity, suspended solids), as well as chemical parameters (salinity, ionic composition, dissolved gases salts and molecules, dissolved and particulate organic matter) of the seawater are being measured before and during the operation of a fish farm.

As we have already mentioned above, the culture of the Mediterranean euryhaline species *Sparus aurata* and *Dicentrarchus labrax* in floating cages in Greece started at the beginning of the 80's. At that time little was known about pollution and the problems caused by the fish farm's operation (autopollution), and for this reason an Impact Assessment Study was not necessary. Later on, as the majority of fish farms in Greece has been installed in closed, well-protected areas near seashore, autopollution problems arose; something which, forced some of the fish farmers to change site and move towards less protected areas where deeper waters, stronger sea currents and higher waves permitted an operation without causing any significant pollution problem.

At the same time, the State forced those fish farms, already operating, to carry out an Impact Assessment Study while it adopted the precautionary approach of the Greek legislation (Law 1650/86) for all activities (Environmental Control Units, land planning, operational regulations, conflicts of use, estimation of the future influences into the sea environment, etc.). Also among the duties of fish farmers written in their issued license, it added the obligation of providing statistical data, either concerning the operating process of their fish farms or the physicochemical parameters of the seawater and generally the impact, which this operation create to the sea environment.

However, long-term pollution by the fish farms' are less dangerous for the cultivated species, than the pollution caused by other human activities, such as agriculture, urban, or industry water-waste. These pollution sources are, not only a danger for the cultivated fish, but they also affect the quality of the aquaculture product by deleterious factors, such as various toxic substances, which are dissolved in the sea environment.

Pollution of the sea environment affects aquaculture operations in the following ways:

(i) Alteration of the hydrobiological characteristics of the water (temperature, dissolved oxygen, dissolved salt content) which encourage phenomena such as water coloration, algal bloom which initially caused eutrophication and distrophication (anoxia) later on to the sea environment, endangering the lives of cultured species.

(ii) Direct toxic action of biocides causing physiological breakdown and/or mass mortality.

(iii) Contamination of animal tissues with toxins, pathogenic micro-organisms, and various chemical substances, which make them unfit for human consumption.

These phenomena made the producers realise, either that the protection of the farming environment is, first of all, beneficial for the business itself, since the health of the fish population depends on it, as well as a constant monitoring of the sea environment is necessary.

Generally those strategies, which are being followed by the Greek State so as to promote awareness about the importance of a sustainable use of the environment and particularly of the sea environment, are:

(i) To create mechanisms in order to control environmental impact assessment (EIA) of and on aquaculture.

(ii) To encourage co-operation between aquaculture producers and National Research Centres so as to carry out research studies.

(iii) To improve responsibility among all the users of the sea water environment.

(iv) To install systems permanently recording the abiotic water parameters.

Although the installation of systems permanently recording the changes of physico-chemical parameters in fresh or salt waters has not been completed yet, such systems have been installed for certain cultures' (shellfish, cyprinids, salmonids) systems, in many coastal lagoons and rivers, whereas a plan to place such systems in the sea, as well, is in progress. With those systems' aid the aquaculture farmers are being informed of the latest developments.

We should also notice that the Greek legislation protects the water resources and not the environment in particular in which, aquaculture units operate. Emphasis also is being given before licensing the operation of aquaculture activities; no conflicts concerning both uses and interactions should be noted.

There are specific regulations governing water quality in fresh water fish farms. The control of physicochemical parameters is necessary throughout the production process, and the water quality limits (Morou, 1996) are shown in Table 3.

Table 3. Water quality limits

Dissolved oxygen	5-9 mg/l
Saturation level	50-100%
BOD_5	3-6
Suspended solids	25
Ammonia	0.1 mg NH_3-N/l
Nitrites	0.1 mg NO_2-N/l
Nitrates	100 mg NO_3-N/l

For the floating cages units there are not specific regulations governing water quality.

It is necessary also to clarify that, in case we refer in this presentation to EIA, we mean studies which concern the floating cage units on the sea environment and not the land base installations, on which it is possible the total purification of the outflow water-waste. On the contrary, the fish farms in floating cages, as it can be easily found, have not the ability to purify the biological sub-products of the cultivated fish or the remaining food substances, which are inserted directly into the sea environment.

For the protection of the sea environment, in which net cages will be installed and operated, and in order to maintain a balance between the aquaculture activities and the sea environment, the Greek State asked the investors to submit a preliminary environmental impact study for the approval of the activity, and before the respective aquaculture license is issued.

This study applies to the Environmental Planning Directorate of the Ministry of Environment, Land Planning and Public Works and to the Aquaculture and Inland Waters Directorate of the Ministry of Agriculture. Consequently, this study forwards the local administrations in which the fish farm will be installed and operated. In a public meeting the study is being both presented and evaluated by the local authorities.

In case that the final decision of the local authorities is positive the future fish farmer should submit a full Environmental Impact Study (EIS) to these same authorities of the above Ministries. The study

is necessary to contain all the data, which prove that the operation of the fish farm does not create any pollution problem to the sea environment or damage to the coastal ecosystem. In case of potential damage to the coastal ecosystem, the fish farmer will be fined.

The contents of these studies are not yet clarified, however they include: the measurements of the physicochemical parameters of the sea environment; the suspended solids; the height of the waves; the direction and speed of the wind; the direction and speed of sea currents; the depth and the substrate of the seabed; the structure of the macro benthic community; etc.

These studies are in conjunction with the productive capacity of the aquaculture farm and as it is obvious the collected data can serve as a control indicator for a future environmental impact assessment.

It is also one of the major contractual obligation of the fish farmer to change site or stop cultivating fish, in case that accumulation is being noted at the bottom of the sea bed behind the fish farms installation, moreover restore the environment to its original state after its use.

The above studies have been carried out mainly by private companies, but the evaluation of the degree of impact, which the human activities have on the water environment, is being carried out by various services and research centres, the co-operation among which could be characterized as satisfactory.

As we have already mentioned, a number of fish farms in floating cages have been installed in the marine environment without a preliminary study of the EIA. Consequently, the methodology applied for the EIA estimation in a given area is not the same, and for the additional reason that neither in Greek nor international bibliography is this process quantitative, up to now, in the open systems of culture and even more in the floating cages units.

For this reason, most of the research groups adopted one of the following methods:

(i) The comparative study of the marine environment before and after the installation of the floating cage unit.

(ii) The comparative study of the area in which the fish farm has been installed and operated and the simultaneous study to an adjacent marine area.

(iii) The study of the present situation of the marine ecosystem within the operating fish farm.

From the above mentioned methods, the first one only could be said to have the statistical precision necessary to estimate the real influence of the aquaculture activities on the sea environment and vice versa; because of the fact that only in this case those changes, which took place in the marine environment after both the installation and operation of the fish farm, are clear. However, this method is not feasible in many cases, for reasons already explained above.

The second method, the most common among the research groups, for the EIA estimation, should have the ability to be scientifically acceptable if the two selected areas have the same ecological conditions, although to the best of my knowledge, such ecological conditions were never presented in the already carried out EIA studies. The third method, which is being followed by our research group (Conides *et al.,* 1993; Klaoudatos *et al.,* 1995, 1996; Conides and Klaoudatos, 1998), permits the separation between the impacts of the fish farm on the sea environment and the influences of the sea environment on the fish farm in a satisfactory precise way. However, it has the ability to estimate the real situation of the ecosystem bearing in mind that the fish farm is a part of it and not an initiated problem. At the same time, the measurements have the ability to describe and isolate the different arising problems, as well as foretell the maximum productive capability of a fish farm in a given area for a sustainable use of the marine ecosystem.

Mechanisms controlling environmental impact

It is an unquestionable fact that lack of respect for the rules of the protection of the environment

causes a disorder in the ecosystems developed with direct impact on the units themselves. Aiming at maintaining a balance between the productive activities of aquaculture units and the sea environment in which fish farms are being installed and operated, the national and community legislation applies. Responsible services of the Ministries of Agriculture and of Environment, Land Planning and Public Works, the services of the prefectural authorities and the research centres of Greece keep a continuous monitoring and recording of the environmental impacts. Systems, which the State has installed, for certain cultures (shellfish, cyprinids, salmonids), permanently record the abiotic water parameters, so that the aquaculture farmers can be informed and absolutely compliant with the limits enacted by the legislation for the protection of the environment. At the same time, the Ministry of Environment monitors through specialized laboratories, the waters of all coastal areas of the country (based on the Directives of the European Union).

In the case of dangerous situations for the public health, the competent Veterinary Service of the Ministry of Agriculture takes measures, in co-operation with the Ministry of Health, and the results are immediately applicable and are abided by the producers.

When the above services indicate situations being dangerous for the sea environment, prior to providing penalties, the aquaculture farmer is imposed to finance a research project (an EIA study), carried out by research centres aiming at the evaluation of the degree of pollution caused.

Based on the results of the study, the fish farmer is obliged to change either the initial installation place of his unit or periodically, the mooring place (fallow), often reducing the environmental impact of the aquaculture farm.

Many times also the State or the local authorities finance EIA studies when pollution problems arise from the fish farms operation along the coast of their specific region. The cost of these research projects ranges from 40 to 100 thousands Euro and the time needed between 1.5 to 3 years.

Strict control is being imposed in order to import non-endemic species to Greece, especially for productive or enrichment purposes. Any import of non-endemic species from third countries is subject to control, which covers the issues of environmental integration. However, the opening of the EU frontiers has caused certain problems, which, although limited, are still alarming. The danger exists, given that the import of non-endemic species cannot be controlled. As a result, strict controls must be instituted in every EU country, upon the first import of products from third countries. However, certain incidents of importing and releasing non-endemic species to lakes have not caused any problems to the endemic ones.

The imports of breeder or fry of aquatic organisms from third countries, presupposes – under any circumstances – a health certificate issued by the country of origin, certifying the absence of infectious diseases, the operation of the fish farm under veterinarian control, etc.

The State and the producers oppose the import and rearing of genetically modified fish and organisms and the legislation has already set bars to this.

Hormone preparations are not used; the marine fish species reared originate, as a rule, from native breeders which spawn eggs spontaneously during the natural spawning season or under photoperiod control.

In the case of a disease outbreak or a viral infection, the cultivated fish population is accompanied by the application of treatment methods by the aquaculture farmers themselves with the assistance of a private ichthyopathologist or that of a State laboratory, which determine, after performing an antibiogram, the treatment. Antibiotics and other therapeutants are used, according to the kind and seriousness of each case. If the disease does not retreat, the research centres and the local hygienic directorates are informed and, further to that, a series of prohibitive Directives are being issued, aiming at restricting the disease from spreading. The usual prohibitive measures are the prohibition to transport eggs, fry, young and marketable individuals.

Concerning shellfish, when the values of various parameters, received through continuous samplings on individuals, exceed the permissible limit, their fishing and sale is prohibited.

Dangerous for man chemicals are not being used in aquaculture. The plant derivative chemical Rotenone has a limited use, only in extensive or semi-intensive cultures in earthen ponds, a form of aquaculture limited in Greece.

Furthermore penalties are provided for those causing, with their practices, environmental aggravation, by violating the legislation enacted and controlled by the Minister of Environment, the local port authorities and the prefectural authority services.

As soon as the adverse impacts or damages to the marine environment have been verified, fines and several other sanctions are imposed. The eventual enforcement of the sanctions will depend on the final outcome of the appeals at the competent courts.

The monitoring mechanisms used by the Greek government are not considered to fully meet the controls requested, nevertheless an upgrade of the control system is in progress. However, the compliance of aquaculture farmers with the provisions of the above resolutions requires, apart from the risk of sanctions being imposed, a conscientious adoption of the necessity for the protection of the environment.

Future aims in these directions. Future trends and prospects

In general, we are far away from the activation of inherent human trends towards the protection of the environment. The environment is protected, since its probable degradation or destruction would harm the producers themselves.

The future plans and strategies for the perpetual use of natural resources constitute firm goals, which require a deep knowledge and a good and concordant co-operation of all users of marine and coastal ecosystems. This ideal picture is not considered to be achievable in the near future, for many reasons different in each country. In Greece for example the determination of zones for agricultural, industrial, touristic or aquacultural use has not been concluded. This creates problems as the procedure of determining zones of use, will give another dimension to the confrontation of the entire issue, and will solve a lot of existing problems.

Activities such as: (i) the choice of the location, which takes into account the parameter of avoiding the cause of any environmental burden; (ii) the adoption of prevention methods (vaccines), instead of treatment, by continuously more and more producers; (iii) the use of environmentally friendly aquafeed, despite its higher cost; (iv) the reduction of disinfectants used; and (v) the use of approved preparation, namely – in total – the application of friendly for the environment and the consumers administration methods, are in the right way and show that the producers adopt in practice the fundamental principles for a sustainable use of the marine environment.

Such general principles should essentially be cultured and communicated to the businessmen within the bounds of scientific congresses held, at the conclusions of which, the particular reference to the environmental dimension of the aquaculture and the protection of the marine environment should be done.

The Greek aquaculture farmers are adequately aware of the impacts that other activities may cause to the marine environment. The common intention is to identify possible adverse impacts of an aquaculture farm, prior to its construction and granting of operational license.

The Greek aquaculture farmers are also aware of the impacts the establishment and deficient operation of their units could cause to the marine environment, taking into account the often-hostile attitude of the local communities in the first stages of their operation.

Aquaculture initially was not accepted by the population as a whole, despite the undeniable offer of the sector to the Greek economy, as long as not only the biggest part of the production is being exported, whereas it offers, at the same time, employment posts to a large part of the population and, in particular, that of the frontier insular regions of the country. The main reason was the initial misinformation that their operation causes a significant pollution in the water environment. Even today, a large part of the local population continues to believe that the operation of aquaculture units

and the entire productive process of fish farming cause a significant pollution to the marine environment.

The research centres and the organisations of fish farmers have directly shouldered the defence of aquaculture, through publications, booklets, speeches in problematic regions, television appearances, seminars and exhibitions promoting the sector and making known the point of view of the bodies supporting the development of the sector, as an alternative proposal to offer fish catch in a way which does not oppose to the permanent logic of development.

As the time passes by, this picture radically changes and a large part of the population understands the real dimensions of the impacts caused in the marine environment while, at the same time, they realise the benefits they return to the local societies and the national economy, in general.

The sector should adopt more drastic measures in order to prove either that it can reduce the pollution from the fish farm operation to the sea environment, as well as to ensure that the quality of the producing fish and selfish is equal to that of the wild ones.

For the first direction the most conscientiously aware fish farmers have already chosen high quality aquafeeds, achieving faster growth rates for the reared fish, ignoring their higher cost. Apart from the faster growth rates achieved from the high quality fish feeds used, the discharge of suspended solids to the water column is limited thus causing fewer burdens to the marine environment and extend to the reared organisms. For the second one the sector should adopt the quality assurance systems (ISO, HACCP, EMAS, eco labelling).

In Greece, it should be noted that the sector appears to have a very advanced point of view, in comparison with others, much more traditional sectors of the agricultural economy. There are already units which have made much progress and are even at the final stage for the award of an ISO certification. Certainly, there is still much to do, concerning the establishment of project for the award of an ISO certification to aquaculture products. Many units have also made substantial progress for the construction of packaging installations according to the national legislation, which has incorporated the Community Regulations for the transportation and hygienic conditions of fishery products.

Extensive promotion campaigns for the fish and selfish produced from aquaculture should take place seriously. An effort is made the last few years towards improving the public opinion for the cultivated fish, throughout publications, television, radio advertising, tasty tests, etc.

On the other hand the producers all around the Mediterranean region must provide statistical data either for the production process of their fish farms as well as for the physicochemical parameters of the sea environment. At a national level, there is an obligation of the producers to provide statistical data, but problems arise in many instances, in connection with the collection and codification of these data, a fact true, for many countries. These data should be collected and codified through a network so as to be available to all users. A network that will work for covering the benefit of the same sector and not for the people involved.

The dissemination of the research results is not considered satisfactory due to the lack of co-ordination and non-operation of a relevant information network. The sector needs more seminars, meetings, aquaculture exhibitions to be held, as well as special publications and booklets referring to the methods for administering aquaculture units. The aquaculture farmers should have a continuous information about the new technological applications and the risks, which the thoughtless use of the marine environment could cause.

Last but certainly not the least, they should clarify the methodology for an EIA study in order to have comparable results. As you know it is extremely difficult to monitor the effects of the aquaculture industry to the various marine ecosystems as either the ecosystems or the management differs from one farm to another. It is therefore extremely important to assign indicators in the various ecosystems and to continuously monitor them in order to intervene in the case of environmental degradation.

References

Barnabe, G. (1990). *Aquaculture*. Series in Aquaculture and Fisheries. Ellis Horwood, New York.

Beveridge, M.C.M. (1996). *Cage Aquaculture*. Fishing News Books. Blackwell, Oxford.

Conides, A., Anastasopoulou, K. and Fotis, G. (1993). Application of standard procedure for forecasting the maximum possible environmental impact of sea bream cage culture in Greece. *Envir. Educ. Inform*., 12(1): 49-58.

Conides, A. and Klaoudatos, S. (1998). Effects of fish farming on coastal water quality: The case study of Aghios Panteleimon, western Greece. *Aquaculture Europe 98*, Eur. Aquac. Soc. France.

Gowen, R.J. and Bradbury, N.B. (1987). The ecological impact of salmonid farming in coastal waters: A review. In: *Oceanography and Marine Biology: An Annual Review,* Vol. 25, Barnes, M. (ed.). Aberdeen University Press, Aberdeen, pp. 563-575.

Gowen, R.J., Rosenthal, H., Makinen, T. and Ezzi, I. (1990). Environmental impact of aquaculture activities. In: *Aquaculture Europe '89-Bussiness Joins Science,* de Paw, N. and Billard, R. (eds). EAS, Sp. Publ. No 12, Belgium, pp. 257-283.

Klaoudatos, S., Conides, A. and Chatziefstathiou, M. (1995). Modern methods of the estimation of the environmental impact of fish farms. In: *2nd Panhellenic Congress on Aquaculture: Research and Production*. Federation of Greek Maricultures, pp. 16.

Klaoudatos, S., Conides, A. and Hatziefstathiou, M. (1996). Environmental Impact Assessment (EIA) studies in floating cage culture system in Greece. In: *Partnership in Coastal Zone Management*, Taussik, J. and Mitchell, J. (eds). Samara Publishing, Ltd., Cardican, pp. 525-532.

Koussouris, Th., Fotis, G. and Conides, A. (1995). *Aquaculture and the Environment*. Agricultural Bank of Greece editions, pp. 187.

Morou, Z. (1996). *The Incorporated Community Directives into the Greek Legislation, Concerning the Fresh and Marine Environment*. Institute of Environmental Policy, Athens.

Pillay, T.V.M. (1992). *Aquaculture and the Environment*. Fishing News Books. Blackwell, Oxford, p. 323.

Porter, C.B., Krom, M.D., Robbins, M.G., Brickell, L. and Davidson, A. (1987). Ammonia excretion and total-N budget for gilthead sea bream (*Sparus aurata*) and its effects on water quality conditions. *Aquaculture*, 66: 287-297.

Ryther, J.H. and Dunstan, W.M. (1971). Fish farm effluents. *Science,* 171: 1008-1013.

Taft, J.L. and Taylor, W.R. (1976). Uses, stresses and adaptation to the estuary. In: *Estuarine and Processes*, Vol. 1, Wiley, M. (ed.). Academic Press, London, pp. 76-89.

Appendix A: Issuance of an establishment and installation license for aquaculture units in inland waters (Ministry of Agriculture, Aquaculture and Inland waters Directorate Section II).

Legislation

Royal Decree 142/71 (State Gazette vol. A' 49/71)
Presidential Decree 332/83 (State Gazette vol. A' 119/83)
Presidential Decree 915/81 (State Gazette vol. A' 232/81)

Supporting documents

1. Application submitted by the person concerned or the legal representative of the company, having the company's articles of association attached (State Gazette vol. where it has been promulgated).
2. Ownership tittles or leases contract for the site.
3. a. A chart of the greater area at a 1:200.000 scale, where the location for the installation of the unit will be noted.
   b. A topographical drawing at a 1:500 or 1:1000 scale, depicting the required – proposed works and installations.
4. Technical-economic study-report, with full details as it concerns the culture of the proposed species (ichthyological, constructive, economic).
5. License to use fresh water (issued by the Prefecture).
6. a. Resolution determining the recipient of the outflows.
   b. Approval of the study on waste disposal (issued by the Hygienic Directorate of the Prefecture)
7. Resolution approving the demarcation of the installation site (issued by the Regional Services of the Ministry of Environment, Land Planning and Public Works or the Land Planning Directorate, depending on the potential of the unit).
8. Joint resolution approving the environmental terms for the operation of the unit (issued by the Environmental Planning Directorate of the Ministry of Environment, Land Planning and Public Works and the Aquaculture and Inland Waters Directorate of the Ministry of Agriculture).
9. Certificate in connection with the possibility of constructing the proposed installations, according to the effective construction terms (issued by the Technical Services Directorate of the Prefecture).
10. Accordant opinion or opinion of the jointly competent Services or Bodies, depending on the case:
    – Ministry of Culture – Antiquities Services
    – National Tourism Organization
    – Local Authorities (optionally)
    – etc.

As long as the units under establishment require the incorporation of the plan in a developmental project of financial aid, the supporting documents provided by it are also being required.

Appendix B: Procedure followed for leasing a marine area & issuing a license for the establishment of an aquaculture unit (Ministry of Agriculture, Aquaculture and Inland waters Directorate Section II).

- Application to the regional Fishery Service (Fishery Supervision) accompanied by:
  a. Chart of the greater area (with longitude and latitude of the site)
  b. Topographical drawing, at a 1:1000 – 1:5000 scale
  c. Technical-economic preliminary study

- Accordant opinions from
  a. General Navy Staff
  b. Ministry of Merchant Marine
  c. National Tourist Organization

d. Archaeological Service
e. Local Authority (optionally)
f. Hygienic Directorate (cases of land installations)
g. Lease resolution from the prefecture

- Application for a preliminary demarcation approval by the Ministry of Environment, Land Planning and Public Works (Land Planning Directorate) accompanied by:
  a. Topographical drawing of the greater area, at a 1:50,000 – 1:20,000 scale, with a particular marking of the site
  b. Topographical drawing, at a 1:1000 – 1:200 scale
  c. Photographs, with a particular marking of the site
  d. Questionnaire
  e. Technical-economic preliminary study

- Application accompanied to the Ministry of Environment, Land Planning and Public Works (Environmental Directorate) by:
  a. Environmental Impact Study
  b. Preliminary approval of demarcation

When the above process finishes they receive the Establishment and Operation License, from the Prefecture in which the fish farm will establish and operate.