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Environmental impact of aquaculture in Turkey and its relationship to tourism, recreation and sites of special protection

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SUMMARY – With over 8,300 km of coastline and 25 million ha of useable sea, Turkey is a country with a great potential for further development of its aquaculture sector. The sector has grown rapidly into an important activity, which is considered by industry and government alike to have potential for increasing both domestic fish supplies and exports earnings. In 1999 total fishery production was 636,824 tonnes and total aquaculture production was 63,000 tonnes. There is a great potential for the development of marine aquaculture in Turkey. The first commercial ventures were set up in 1985 and the production has already increased from 35 tonnes in 1986 to 25,230 tonnes in 1999. Mariculture is a relatively recent industry in Turkey and it has not yet reached its full potential. In order to realise this potential, it is necessary to plan and implement a strategy to resolve the growing conflict between aquaculture and other coastal users in Turkey. At the beginning, marine farms were set up in the protected shallow bays due to lack of awareness of their environmental impact and technological and financial insufficiencies. As a result of this, they caused visual and organic pollution. Besides that, conflicts have erupted between aquaculture and other users. These conflicts have caused great harm to the aquaculture industry. In order to prevent such conflicts and minimise environmental impacts, offshore mariculture systems and eco-friendly technologies have to be adopted. In addition, integrated coastal zone management models must be developed and implemented.

Key words: Eco-friendly fish farming, environmental impact, tourism, special protected areas.

RESUME – *"L'impact de l'aquaculture sur l'environnement en Turquie en liaison avec le tourisme, les loisirs et les sites sous protection spéciale". Avec plus de 8 300 km de littoral et 25 millions ha de mer exploitable, la Turquie est un pays avec un potentiel énorme pour développer davantage le secteur aquacole. Ce secteur a prospéré rapidement et il est devenu une activité importante qui selon l'industrie et le gouvernement a le potentiel pour augmenter l'approvisionnement intérieur en poisson ainsi que les revenues des exportations. En 1999 la production totale de la pêche représentait 636 824 tonnes et la production aquacole totale était de 63 000 tonnes. Il y a un grand potentiel pour le développement de l'aquaculture marine en Turquie. Les premières entreprises commerciales furent fondées en 1985 et la production est déjà passée de 35 tonnes en 1986 à 25 230 tonnes en 1999. La mariculture est une industrie relativement récente en Turquie et elle n'a pas encore sa pleine puissance. Pour atteindre ce potentiel, il est nécessaire de planifier et appliquer une stratégie afin de résoudre le conflit grandissant entre l'aquaculture et les autres usages du littoral en Turquie. Au début, les exploitations marines étaient installées dans des baies peu profondes et protégées dûes à un manque de conscience de leurs effets sur l'environnement et des insuffisances technologiques et financières. En conséquence, elles ont provoqué une pollution visuelle et organique. D'ailleurs, des conflits entre l'aquaculture et d'autres usages sont apparus. Ces conflits ont pénalisé l'industrie aquacole. Pour éviter ceci et minimiser les impacts sur l'environnement il faut adopter des systèmes de mariculture en mer ouverte et des technologies éco-adaptées. En outre, des modèles de gestion intégrée des zones côtières doivent être développés et appliqués.*

Mots-clés : *Pisciculture éco-adaptée, impact sur l'environnement, tourisme, zones spéciales protégées.*

Aquaculture production in Turkey

With over 8,300 km of coastline and 25 million hectares of useable sea, Turkey is a country with a great potential for further development of its aquaculture sector. The sector has grown rapidly into an important activity, which is considered by industry and government alike to have potential for increasing both domestic fish supplies and exports earnings.

Established in the 1980s with the help of state support, aquaculture production has expanded rapidly, from around 16,000 tonnes in 1994 to over 63,000 tonnes in 1999 (MARA, 2000; SSI, 2000). Interest has centred on such species as trout, sea bream, sea bass, carp and salmon, and

more recently prawns and turbot. Government statistics show that over 300 fish farms have been established in the west and south of the country with many more operating on a semi-official basis. The aquaculture production of different regions and each sub-sector in 1999 is summarised in Tables 1 and 2.

Table 1. Aquaculture production in Turkey, by 1999 (source: Ministry of Agriculture and Rural Affairs)

Species	Production (tonne/year)
Trout (fresh water)	36,870
Trout (sea water)	1,700
Sea bream	11,000
Sea bass	12,000
Mussel	500
Carp	900
Shrimp	30
Total	63,000

Table 2. Distribution of aquaculture production in Turkey by regions, by 1999 (tonnes)

Regions	Marine	Freshwater	Total
Black Sea	2,040	7,310	9,350
Marmara	735	7,650	8,385
Aegean Sea	21,360	9,420	30,780
Mediterranean	1,095	4,490	5,585
Central Anatolia	–	5,330	5,330
East Anatolia	–	1,820	1,820
South-east Anatolia	–	1,750	1,750
Total	25,230	37,780	63,000

As for mariculture, the first commercial ventures were set up in 1985, production increasing rapidly since then, reaching almost 25,000 tonnes in 1999 (Fig. 1). Marine fish farming started with sea bream, followed by sea bass and salmon culture. There are 97 available sites for marine aquaculture in Turkey (MacAlister Elliot and Partners, 1996a).

Farms tend to be small (less than 30 tonnes production per annum). Accurate production levels in Turkey are not well known due to the existence of unlicensed farms and discrepancies between production capacity and actual production. The types of aquaculture practised include ponds for bass, bream and shrimp; tank culture for bass and bream; cage culture for bass, bream and trout; hatcheries for bass and bream; wild fry collection for bass and bream; and longlines or rafts for bivalve mollusc culture (Deniz, 1996, 2000).

At the beginning of the 1990s the Ministry of Agriculture and Rural Affairs (MARA)[1] identified different culture methods, potential sites, project profiles, viability, and possible species for a further development and long-term planning of the marine aquaculture sector. In order to develop the identified potentials, planning and development constraints were analysed and recommendations and guidelines on management techniques, planning and impact control

[1] Studies done in 1993 by the Ministry of Agriculture and Rural Affairs (MARA) with World Bank funding, Japanese grant aid and technical assistance from MacAlister Elliott and Partners Ltd, UK, Fisheries and Aquaculture specialists.

strategies were proposed.

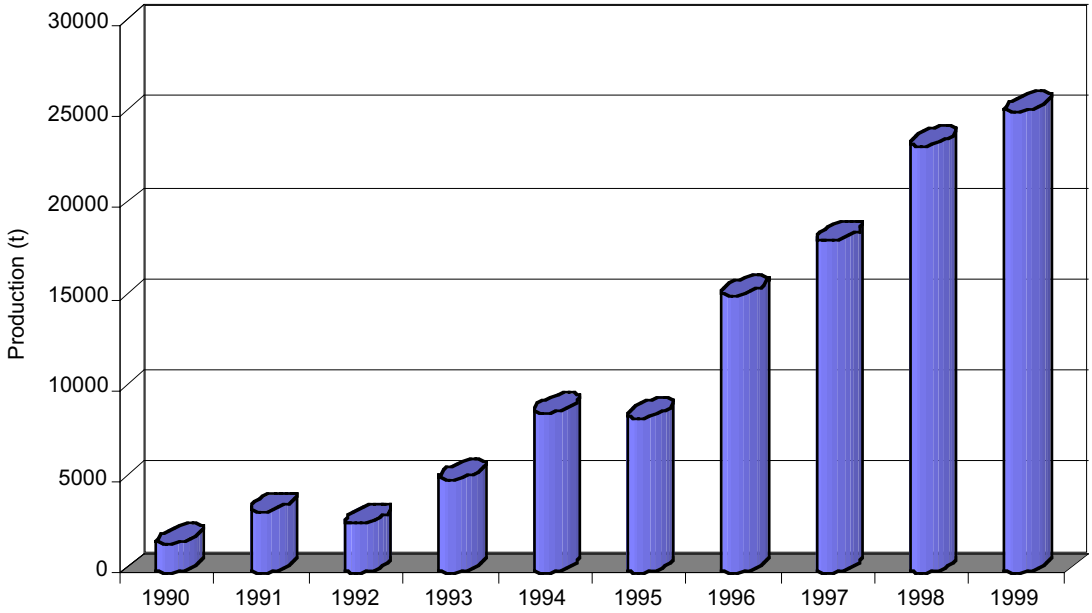

Fig. 1. Marine aquaculture production trend in Turkey, in 1990-1999.

Some of the identified constraints were:

(i) Some stretches of coastline having tourism, recreational and conservation potential, as well as being suitable for aquaculture.

(ii) The environmental impact of the aquaculture industry in Turkey is not well understood.

(iii) The current planning and regulatory system for aquaculture is weak with many authorities being involved. This results in poorly controlled development in coastal areas.

Coastal environment of Turkey

The coastline can be divided into four areas.

Black Sea

This is an inland sea of 413,360 km^2, between SE Europe and Asia, connected with the Mediterranean Sea through the Sea of Marmara. It has several rivers (e.g. Dniester and Danube) flowing into the northern part of the Black Sea which carry much silt and form deltas and lagoons. The generally low and sandy northern coast contrasts with the southern coast, which is steep and rocky.

The Black Sea has two layers of water of different densities: a heavily saline bottom which has no marine life, and a top layer, much less saline and much richer in life. Recent studies have revealed a mesotrophic productive system with relatively high chlorophyll levels supporting a rich fishery (now in decline). Eutrophication and algal blooms occur at the western end of the Black Sea. The unique hydrography and enclosed status of the Black Sea has not only held fascination for marine scientists, but it also has high interest for other human activities, e.g. maritime shipping, oil, fisheries, tourism, etc. These activities, together with wastes (heavy metals and biochemical oxygen demand, BOD) coming from donor rivers and coastal cities have caused increasing levels of pollution and consequent reductions in fish populations.

Marmara Sea

The Marmara Sea (11,474 km^2), which is connected on the east with the Black Sea through the Bosphorus and on the west with the Aegean Sea through the Dardanelles, has no strong currents and the tidal range is minimal. Its main sources of pollution come from Istanbul and the Izmit Bay.

Aegean Sea

This sea, an arm of the Mediterranean Sea, is located between the Greek peninsula on the west and Turkey on the east and covers a total area of some 83,000 square miles with a heavily indented coastline and with many islands resulting in complex current systems. The Aegean Sea is characterised by low level background nutrient and chlorophyll levels resulting in low productivity with poor secondary production. High nutrient levels occasionally recorded in Greek waters have resulted in red tides but there have been no records to date in Turkish waters.

There are localised polluting inputs from certain industries or coastal communities, particularly Izmir, but there is no evidence of impact from pollution offshore. Lagoon systems, shallow coastal wetlands, areas of poor circulation or fragile ecosystems along this coast have not been studied in detail in comparison to similar habitats in Europe.

Mediterranean Sea

The Mediterranean waters are characterised by their high salinity, and high summer temperatures. The eastern Mediterranean is very oligotrophic with naturally very low primary and secondary production. As regards pollution, heavy industry contaminates the inshore waters near Mersin and Iskenderun and some sewage derived BOD arises from Alanya and Antalya.

Aquaculture policy, administration and legislation

Aquaculture policy

The Ministry of Agriculture and Rural Affairs (MARA) is the main state organisation responsible for aquaculture administration, regulation, protection, promotion and technical assistance. All activities in fisheries are based on the Fisheries Law No. 1380, enacted in 1971.

With this law, and its related bureaucracy, definitions were codified and regulations were prepared in order to control the stocks. Regulations concerning access to resources, which species would be applied by the courts were specified. After May 28, 1986 the Fisheries Law was updated. Thus Law No. 2338 replaces Law No. 1380. According to Laws 1380 and 2388 and Continental Waters Law No. 2674 which became effective on May 20, 1982, foreigners are not allowed to take part in fishing activities. The marine police have the authority to restrict activities, which are against Fisheries Laws No. 1380 and 2388. In accordance with Laws No. 1380 and 2388, every year a circular is published and announced in the national media about the restrictions for stock control. In these circulars, species whose fishing is restricted, mesh sizes that can be applied, protection areas, species size/gear restrictions and fishing seasons for species are all specified.

Aquaculture activities are coordinated under the Fishery Law No. 1380 (Article No. 13), later renewed by Law No. 3228. This law gives aquaculture investors the right to rent marine or land areas for the purpose of this activity. There is a coastal zone management plan, but aquaculture is excluded. Similarly, in the tourism plan, aquaculture is also excluded, as at that time there was no significant aquaculture activity.

Unofficially, MARA decides on the national aquaculture policies with information gathered from academic personnel and investors. Starting in 1998, however, Turkish Fisheries Foundation as well as the Aegean Aquaculture Producer Society has also been involved in decision making.

Administrative framework

The Turkish Constitution states that central administration practices are followed, yet local

authorities (Governor) hold the office as point of administration. Authority over aquaculture is divided between MARA, Ministry of Transportation (Department of Maritime, when applicable), Ministry of Health, Ministry of Forestry, Department of Water Works (where applicable), Ministry of Treasury by law, but involvement from Ministry of Tourism, Ministry of Environment, Ministry of Internal Affairs, and Ministry of Culture is also experienced.

MARA, General Directorate of Protection and Control has the administrative control on husbandry, agriculture and fisheries; but also Ministry of Commerce and Trade, Ministry of Finance, etc. are also involved.

Because aquaculture is new, absence of enough and well qualified personnel as well as absence of information from the local authorities are the limiting factor. Absence of at least a Fisheries General Directorate is the main constraint on responsible aquaculture. Also there is too much involvement from related Ministries.

Legal framework

Basic legislative climate for aquaculture

The fisheries law of MARA governs access to the public land by aquaculture investors and the Treasury who owns the public lands regulates rental. Law No.1380 guarantees issue of a license to aquaculture in public areas (fresh water, seawater and land).

Licenses for freshwater usage are issued by MARA, after approval from Department of Water Works of Ministry of Energy and Natural Resources, Ministry of Forestry, or local authorities. Accesses to marine waters are regulated under Law No. 1380 and consequently, by legislation, however, clashes between authorities (such as tourism, maritime, environment, etc.) exists.

A multidisciplinary advisory committee is in the process of being established as a result of decisions taken on the First Fisheries Assembly and the First Agriculture Assembly gathered in 1997. Fishery experts are expected to participate in this advisory committee

Specific legislation applicable to aquaculture

General Fisheries Law No. 1380, Article No. 13 (*Cultivating ponds)*: those who wish to cultivate aquatic products by building rearing ponds on land for commercial purposes are obliged to apply to MARA by informing the Ministry about the location, characteristics and management of the facilities, and submit the enterprise's project and plans. Permission is issued by MARA if there are no adverse effects in terms of public health, the state economy, navigation or science and technology. Propagation ponds to be constructed in the sea and inland waters are also subject to the provision of the article mentioned above. Nevertheless, before permission is given for the establishment of such ponds, the approval of the Ministry of Transportation, conforming that there is no adverse effect on navigation, must be taken. As for the propagation ponds which will be established in the sea and inland waters, provisions of the last paragraph of *Article 4* is applied.

Legislation and directives are based on the fisheries law but many problems exist due to the presence of a vacuum and thus privileges and responsibilities of aquaculture producers are not specific nor are they well-defined and protected.

Both legal provisions and tendencies create overlaps between aquaculture, tourism, environment, commerce and industry, water works, forestry and culture.

By law, an investor applies to MARA with a draft project and, after preliminary approval should obtain permits from Ministry of Health, Ministry of Transportation, Ministry of Forestry, Department of Water Works-Ministry of Energy and Natural Resources (if applicable); after submission of these permits MARA grants permission and the area is rented through the Treasury.

Permits need not be obtained from the Ministry of Forestry for marine investments, nor is permission required from the Navigation and Oceanographic Directory for inland aquaculture, and only aquaculture in dams needs permits from the Department of Water Works of the Ministry of Energy and Natural Resources.

To be eligible for aquaculture permits, the project feasibility, soundness, environmental impact analysis, public health concerns, cultural and tourism restraints and access limitations have to be evaluated.

Mechanisms to control environmental impacts of and on aquaculture

General Fisheries Law No. 1380 article No. 20 deals with environmental aspects of aquaculture and revisions are being made in accordance with code for responsible fisheries. Both rural MARA divisions and Ministry of Environment monitor discharges to the environment but they are neither efficient nor effective.

Article 20 (Discharging Hazardous Materials Into The Waters): it is prohibited to dump materials detrimental to the health of aquatic products, to people who produce or consume them and to the equipment, processing gears and materials, into or around the inland waters or the production areas in the seas; and it is also prohibited to establish facilities that will discharge waste into the waters. The waste materials prohibited are shown in the regulation.

Legislations of Special Environment Protection Agency Department of National Parks and Ministry of Culture prohibits or restricts aquaculture in certain areas that are designated as protection areas, for natural beauty or antiquity.

All coastal areas were designated as aquaculture production areas in 1986, but specific areas are to be defined as this procedure is not applicable.

Conflicts of aquaculture with tourism and recreation in the coastal zone

Since aquaculture, tourism and recreation all require similar standards of water and environmental quality, it is inevitable that conflicts of interest will arise. Conflicts have arisen in many countries. There is no straightforward solution but careful planning and control mechanisms, taken before the aquaculture industry becomes too large, may be appropriate.

In Turkey tourism is generally associated with hotels and second home areas. To be successful these require surroundings that are aesthetically pleasing and peaceful. Conflicts with aquaculture are associated with the infrastructure that is directly related to the operation of the aquaculture site (Deniz and Kilic, 1998). Ponds, tanks, cages, waste-processing plants, store sheds and construction materials are not considered aesthetic and would therefore have a deleterious effect upon the environmental quality of the hotels and second home areas. The effects of aquaculture infrastructure can be mitigated by careful planning and thoughtful construction.

In terms of aquaculture and recreation, the conflicts, while perhaps not so apparent, must be considered. Recreational interests arise from yachts and pleasure boats, divers, snorkellers, windsurfers and swimmers and sports fishermen. All of these activities require good water quality and large areas of uncluttered water surface. The effects of aquaculture can be deleterious to these by increasing turbidity through over-feeding and poor waste management. Aquaculture can conflict with yachting by causing navigational hazards.

Conversely, tourism developments on land impact on existing and potential aquaculture through the discharge of sewage to the sea and general disturbance. Recreation may also interfere with aquaculture through noise, disturbance, and accidental collision with sea-based installations and poaching.

This study has recommended a series of minimum distances to be allowed between various types of aquaculture installation and tourism development.

The Ministry of Reconstruction has recently drawn up a coastal zone master plan, which has not catered for the aquaculture industry. Most of the problems of conflict with aquaculture would be resolved with the production of a revised plan that caters for aquaculture development in the areas identified as suitable in the recent report to MARA providing that the siting of aquaculture complies with the guidelines set out regarding separation distances.

These conflicts must be addressed and resolved by increased communication between the General Directorate of Agricultural Production and Development, an arm of MARA, the Ministry of

Environment, the Ministry of Tourism and the Navigation and Oceanographic Directorate.

Conflicts of aquaculture in environmentally protected areas

The Authority for Special Protected Areas (ASPA) was established in 1988. Special Protected Areas (SPA's) were designated due to the presence of unique habitats and/or very productive ecosystems. A site that has been designated as a SPA has the greatest protection under existing Turkish legislation from pollution and/or habitat loss. At present there are nine SPA's that affect the Turkish coastline. Of these, seven are located on the Aegean coastline and two are located on the Mediterranean coastline. Within each SPA there may be inner, especially sensitive zones with habitats that are considered to be of special importance.

In addition the SPA's formed under APSA, the Ministry of Forestry is responsible for the designation of National Parks and Reserve Areas. The National Parks Department, an arm of the Ministry of Forestry, is empowered to designate areas as Nature Parks, Natural Protected areas, Natural Monument areas and also recreational hunting and fishing areas. Six of the National Parks have coastal interests. The Ministry of Culture also has three categories of protected areas either for reasons of archaeological, natural beauty or heritage importance. Currently, aquaculture activities in these areas are restricted. Within each category different restrictions are applied to aquaculture. Basically, the approach is sound but the current ban on aquaculture in diving areas is too restrictive and wastes significant aquaculture production potential. It is recommended that aquaculture is permitted in non-diving areas provided that it is no less than 500 metres from known wrecks and archaeological sites. Diving to service cages should be strictly regulated (MacAlister Elliot and Partners, 1996b).

The regime of aquaculture control between MARA and ASPA restricts land-based aquaculture in the nine Special Protected Areas and prohibits sea-based aquaculture in four of the nine areas. It is recommended that these restrictions are not relaxed as any land-based operations risk causing environmental degradation on shore and may lead to unofficial secondary development.

The Ministry of Forestry controls large areas of coastal land and allows aquaculture development with discretionary restrictions for shore-based activity. In considering agreement of licences on their land, the Ministry of Forestry should consider allowing land-based installations to support cages that can be practically accessed by boat rather than building new roads and electricity supply lines through the forests. There is significant public awareness of the need to protect the coastal environment in Turkey. Same areas have international importance in terms of conservation. It is important that the success of the industry is not seen to be damaging the coastal environment.

Controls and regulatory measures

Environmental management is dependent on a controlled development and controlled impacts, and is achieved through practical guidelines, legislation, planning protocols, disincentives and punitive measures.

The changes proposed to establish a separate Directorate of Fisheries within MARA to be responsible for both development and control of the aquaculture sub-sector is seen as a positive change by this study. The major tools available to MARA and other institutions involved in the control of aquaculture are explained below.

Legislation

Legislative measures are required to protect the aquatic and shoreline environment from the impact of tourism development, poor aquaculture practices, and to protect habitat and sensitive species. Although the basis of aquaculture law is in force it still does not cover all areas. For example disease control and wild fry capture. A separate study to modernise legislation is under way.

Environmental Impact Assessment (EIA)

The principle of EIA can be used in project planning, including aquaculture and tourism development. It is a highly complex and detailed procedure requiring expertise in interpretation and application. It is recommended that any new application over a threshold of 50 tonnes per annum production should submit an environmental impact assessment. EIA must be undertaken by an independent government approved/licensed specialist entity. The project proposer should follow the recommendations of the EIA.

Coastal area management

This must be executed through the principles of ICAM (Integrated Coastal Area Management). Water quality objectives must be employed to protect the interests of priority users. ICAM guidelines should also be used to formulate planning strategies particularly where there are conflicts of interest between users.

Siting policies

MARA must have internal siting strategies so that the siting of aquaculture developments take environmental data into account. These should include information on bottom type, hydrography, farm size, and environmental capacity and separation distances.

Monitoring and policing

Licensing of sites is the principle mechanism of aquaculture operations by MARA. Successful monitoring and policing is essential to implement licence conditions. MARA scientists should monitor conditions at representative aquaculture sites, before, during and after implementing a project. This data can then be used to review and if necessary, alter the licensed production capacity, up or down as required, in the future. Policing is an obvious requirement to control unlicensed sites and activities. Policing should be regular and be seen to be effective by all.

Recommendations

Aquaculture, tourism, recreation, wildlife and conservation interests have many common environmental needs. All benefit from good water quality, low disturbance, good management policy and resources. Conflict between aquaculture and other coastal users should therefore be manageable. Some appropriate strategies, practical guidelines, known technologies and some developmental strategies are recommended.

Governmental policy recommendations

Database of aquaculture installations

MARA in conjunction with the General Directorate of Protection and Control (GDPC) should monitor and record existing coastal aquaculture installations in Turkey. It is essential that location, the type of process (cage, hatchery, tank or pond, etc.) size and licence status is reviewed regularly by General Directorate of Agricultural Production and Development (GDAPD) preferably each year. Aerial surveillance may be useful for rapidly compiling information on number and laceration of installations. This information should be held on a database and made available for use by the appropriate authorities, consultative committees and inter-ministerial working parties.

It is important to increase awareness, within the aquaculture industry and other interested users, of impact and benefits of different types of aquaculture upon the coastal environment. It is also important to encourage awareness of environmental protection at such events as aquaculture conferences and encourage the aquaculture industry to promote itself as being environmentally responsible through the trade literature.

Aquaculture registration must be streamlined and tailored to operate within each relevant

ministry and between ministries. Environmental issues demanding legislation and enforcement include the control of disease, transfer of species to new or different sites, control of chemicals, siting and waste disposal. The issues are complex and is the subject of a separate study being undertaken on improvement of registration to central aquaculture.

The development of a siting strategy should take into account at least: (i) depth; (ii) location; (iii) farm size and type; (iv) proximity to other developments; and (v) species of fish to be farmed.

Strengthen licensing system with liaison between GDAPD and GDPC

A licence should be compulsory for every operator. The licence is a legal document and should be a vital part of the control mechanism. Standard application processes should include environmental management data: feed type and method, type of aquaculture, size and number of structures or tanks, sketches of onshore buildings, location, proposed stocking density, species, volume and type of discharge and volume, chemicals to be used and method of application, and maximum production tonnage. Plans for fallowing or rotation of cage sites should also be presented. EIA should also be submitted for proposed operations over 30 tonnes per annum production. Licences should be reviewed every 2 years by monitoring the farm and assessing its impact on the environment. Licences should not be automatically renewed without environmental data and should be withdrawn if the environmental quality standards are exceeded. All licences should be held on a database and reviewed as necessary.

Important decision criteria for applications include: (i) the degree of enclosure of the water body; (ii) the presence of special ecosystems; (iii) the number of other aquaculture ventures already there; (iv) the holding capacity of the environment; and (v) the type of proposal.

A system of punitive measures for transgression of license conditions in order of severity may be implemented as follows: (i) monetary fine; (ii) withdrawal of licence; and (iii) withdrawal of licence and fine.

Each application should be considered within the guidelines but also on its own merit and in the light of new technology in other countries.

Monitoring

A monitoring strategy can be developed regarding the impact of aquaculture and environmental protection. This should be carried out on a regular basis, at least every 2 years near large farms and also in the light of new technology in other countries.

Monitoring is useful at several stages in planning and control: (i) to evaluate new site applications and renewal or increase of licensed production; (ii) for ongoing impact assessment; and (iii) for determining compliance with licence conditions.

Monitoring could be carried out by an independent, apolitical body such as the Institute of Fisheries Research and based on scientific judgement and criteria. The findings should be reported to MARA.

Whether monitoring is carried out by MARA or external staff, expertise will need to be developed in either organisation so that a core of specialists can continually collect and interpret environmental data. This expertise could be through overseas training and several MSc courses are available, as is funding assistance in some countries.

Licensing of chemicals

A list of chemicals to be controlled should be drawn up by MARA. It should include antibiotics and other treatments used against fungi, parasites, etc. Farms should be made to keep records of all purchases and usage. Antibiotics should be available only on prescription from a qualified veterinarian. MARA should monitor literature on aquaculture treatments and ban or limit the use of those shown to be environmentally damaging. Manufacturers operating and application guidelines should be strictly followed and disposal of dosed water should be carefully monitored and controlled.

Consultation processes

Development of a rapid and regular consultation process is needed to assess applications for aquaculture licences with input from statutory consultees including MARA, Ministries of Environment, Reconstruction, Culture and Tourism, navigation and military interests. This should be achieved through regular meetings (every three months) and adherence to a coastal planning policy that has been agreed by all parties in advance. A system must also be in place for public participation/objection to developments prior to building. Much of the practical aspects of such a policy could include such considerations as shown in Table 3.

Table 3. Options for agricultural activities depending on environmental characteristics

Environmental Characteristics	Options
Special ecosystems Fragile communities Rare/endangered species sites Areas of exceptional scenic beauty	No aquaculture
Very touristic areas Polluted bays, beaches, harbours Coastal fringes and resort areas	No aquaculture
Major shipping or boating routes Commercial fishing areas	No aquaculture
Areas of poor water circulation Areas conflicting with siting guidelines	No aquaculture
Steep shelving of shores with deep waters Within SPA's but outside Buffer Zone, Areas of moderate scenic beauty	Cage culture of low tonnage (30-50 t)
Areas of occasional/moderate recreational use Areas of limited tourism Deep waters outside SPA'S all together	Shore facilities screened no share facilities serviced by boat from nearby. Land based operations or submergent or ocean going cages
Low lying coastal land suitable for building and pumping, outside sensitive zones or grade 1 culture sites	Tank farms and hatcheries. Roads and buildings screened. Erosion minimised Tanks and pumps to be hidden. Outfalls to be buried and to discharge below low water
Back margins of swamps, bogs salt marsh	Pond culture. Retain natural habitat in front. Ponds to have irregular margins and planted with shrubs, etc. Outlets to treatment ponds or deep waters
Tourist areas	Associated with appropriate aquaculture: fish restaurants, recreational fishing, educational centres, tours, boat trips, fish sales, aquaria
Shallow sites	Hatcheries with long intakes and outfalls. No cages, on-growing tanks or shellfish rafts.

All the above are subject to individual consideration and merit evaluation. Guidelines should be flexible and based on changing environmental and technical knowledge.

MARA should liaise with the Ministry of Tourism to determine the number of existing aquaculture operations sited illegally in tourism areas, their impact on the environment and aesthetics and, should they be acceptable, ensure that they rapidly apply for and receive a licence to operate. If such existing operations are unacceptable then they should be forced to cease operation and remove all equipment.

Shellfish aquaculture should be at least 1 km from tourist hotels and secondary housing development to reduce the risk of disease and faecal contamination. Cage aquaculture, hatchery and tank farms should be at least 1 km from tourist centres. In scenic areas, distances of 0.5 km,

0.75 km and 1 km respectively, should be adopted.

These distances are dependent on topography, concealment and screening. Hatcheries, ponds and tank farms should be screened from view with trees and shrubs:

(i) Cage and raft culture should be restricted in heavily used recreational waters as a safety precaution but should be permitted in waters with light, irregular traffic. This requires liaison between GDAIPD and the Navigation and Oceanic Directorate. All installations should have marker lights.

(ii) Fish farms should be encouraged to mark boundaries of sites clearly. Hatcheries should have their intakes and outfalls clearly buoyed. Tourists should not be permitted within these areas.

(iii) Tourism development must be subject to the same controls relating to pollution of the sea as other industries. Sewage discharges should be properly sited and treated, MARA and the Ministry of Tourism should liaise to enforce these legislations and regulations. Septic tanks must be closed and waste-tankered away for land disposal.

(iv) Increase availability of resources in terms of funds, suitably qualified personnel, equipment and literature to enable scientific investigations and research relating to aquaculture, monitoring, conservation issues, pollution central strategies and other coastal developments to be carried out effectively.

(v) Develop incentive schemes to favour good management and aesthetically designed facilities particularly land-based.

(vi) Aquaculture in sensitive areas. Large areas of the western Mediterranean and Aegean are enclosed within National Parks or have Special Protected Area status.

Some of these locations are also ideally suited to certain types of aquaculture and very significant production potential is being lost. Co-operation between MARA and the Ministries of Environment and Culture in the form of a working plan could allow aquaculture to be developed sensitively without significant impact. Such a working plan could be as follows:

(i) Special ecosystems, delicate habitats and very sensitive zones, endangered species, poor sites (too shallow, poor circulation) are identified within these areas, where aquaculture or any other development should not take place under any circumstances, e.g. primary turtle nesting sites, protected bird-nesting sites.

(ii) Less sensitive areas outside this in the form of a buffer zone 1 km wide where no aquaculture can take place.

(iii) Aquaculture projects, which can take place under conditional circumstances in the outer zone, are then identified. Assessment of licence applications and of EIA's for larger schemes should be more rigorous in these outer zones than in normal coastal areas. Such applications and EIA's should pay particular respect to the original requirement of the zone.

It is necessary to: (i) establish the degree of impact on wild fry populations and other fish populations due to the practice of netting of wild bass and bream; (ii) follow guidelines to control the practice until research is completed; and (iii) simplify but enforce leasing procedures to prevent operators reclaiming stretches of shoreline for building. This requires direct liaison between GADP, Ministry of Forestry and the Ministry of Tourism.

Recommendations relating to aquaculture

(i) Manage impacts from aquaculture at source. Follow guidelines for minimising impact to the aquatic environment. The control of disease to animal and man has driven many of the good practices found in aquaculture today.

(ii) Improvement waste disposal strategies from land based sites by treatment of suspended solids, by disinfection during recycling of waters and prior to discharge. The siting of outfalls should take dilution into consideration.

(iii) Minimise the impact of organic waste to the seabed by operating rotation or fallowing regimes and using floating low phosphate feeds. This will require guidance from the Institute of Fisheries at Bodrum, Trabzon and Kepez. Advice should be freely available on request.

(iv) Use "all in-all out" stocks husbandry policy where possible and disinfect land based installations between generations to minimise disease and the need for chemical treatments.

(v) Operation of management agreements between different farms in the event of persistent disease problems in certain areas of sea. This has proved effective in other countries.

(vi) Use non-destructive techniques such as nets or scarers to main predators such as birds and mammals, to reduce the destruction of wildlife at farms.

(vii) Dispose of dead fish and waste by incineration or burial with lime.

(viii) Develop an aquaculture fraternity through producer associations to identify needs and priorities within the industry.

(ix) Increase industry-funded research into disease problems, transmission and treatments.

(x) Strengthen legislation to protect sensitive habitats, ecosystems and special sites that are related to the coastal environment. It is recommended that SPA and National Park formation be used as the central mechanism in this context.

(xi) Reduce smell, litter, rubbish and unsightly building materials and pollution to inshore waters by operating good site management.

(xii) Develop a relationship between tourism and aquaculture to promote tourist interest in the industry and the marine environment. For example promote visits to some fish farms: ponds, cages and tank farms. Hatcheries are not suited to this. Allow fish restaurants to be built on site using the cultured species for speciality dishes. Encourage bird watching at farms with large bird problems and recreational fishing at pond farms using sacrificial ponds. Fish can also be sold direct. The development of marine aquaria, exhibition and education areas for school trips and visitors can be built in suitable areas.

Recommended research topics

Areas of research in aquaculture and effects on the marine environment that could be undertaken at academic institutes active in marine environmental topics are listed below. Funding for such research could be sought from Central Government, supply industries, international funding agencies, and, in the longer term, producer organisations themselves.

Chemicals

A critical evaluation of the impact of the wider use of chemicals is necessary. Registers of the amounts and types used and the usage per kilogram of fish. The pathways of any persistent chemicals through the ecosystem and their fate and distribution in the receiving environment. The effects of these chemicals on marine fauna and flora are virtually unknown.

Nutrients

Evaluation of the interaction of nutrients with aquaculture and the receiving environment and their relationship to primary production, the stimulation of algal blooms or the modification of algal community composition. The development of suitable models for determining the distribution of nutrients and risk of hypernutrification in Turkish waters, The development of more nutritious and better converted feeds to reduce wastage and excess nutrients entering the environment.

Disease

The pathology of disease in Mediterranean waters, infective pathways and the effects of aquaculture on microorganisms are not always clearly understood. The resistance of disease

organisms to antibiotics and this relationship to human disease. The stimulation of bacteria such as *Vibrio* spp. by aquaculture. This is an area that requires considerable research. Adequate funds and suitably qualified personnel should be available to enable this research to be carried out.

Wild stocks

The impact of aquaculture on wild fish populations through disease as well as through wild fry collection must be monitored by MARA in conjunction with Fisheries Institutes.

Benthic impact in Mediterranean waters

The development of appropriate techniques for minimising solid deposition on the sea bed. The development of models to predict potential pollution scenarios and the fate of sediments arises from the day to day operation of aquaculture operations. The investigation into "zonation" patterns around cage culture in Mediterranean waters. The development of control criteria. Data on the recovery times of impacted sediments and waters in the Mediterranean.

Hydrography

Detailed hydrographic measurements should be collected in areas assigned for aquaculture in order to apply models and effect better planning regulations and central strategies.

Predators/conservation

The behaviour of predators in relation to season, breeding, distribution and ecology of conserved or predatory species.

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