GUIDELINES

TO MARINE AQUACULTURE PLANNING, INTEGRATION AND MONITORING IN CROATIA

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to marine aquaculture planning, integration and monitoring in Croatia

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PROJECT

INTEGRATED COASTAL ZONE MANAGEMENT FOR CROATIA – WITH PARTICULAR FOCUS ON MARINE AQUACULTURE

GUIDELINES
TO MARINE AQUACULTURE PLANNING, INTEGRATION AND MONITORING IN CROATIA

Zagreb 2005

List of Acronyms

APN - Akvaplan NIVA
AZE - Allowable Zone of Effect
BATNEEC - Best Available Technology Not Entailing Excessive Cost
BMP - Best Management Practices
BOD - Biological Oxygen Demand
CBA - Cost-Benefit Analysis
CCRF - Code of Conduct for Responsible Fisheries
COD - Chemical Oxygen Demand
CZM - Coastal Zone Management
CZMP - Coastal Zone Management Plan
EC - European Commission
EIA - Environmental Impact Assessment
EQS - Environmental Quality Standards
FAO - Food and Agriculture Organization
GIS - Geographical Information System
GMO - Genetically Modified Organisms
ICZM - Integrated Coastal Zone Management
ICZMP - Integrated Coastal Zone Management Plan
IRB - Institute "Ruder Boškovic"
MAFWM - Ministry of Agriculture, Forestry and Water Management
MEPPP - Ministry of Environmental Protection, Physical Planning and Construction
MSTTD - Ministry of Sea, Tourism, Transport and Development
NIMBY - Not In My Back Yard
OG - Official Gazette
SEA - Strategic Environmental Assessment
SIA - Social Impact Analysis
TOC - Total Organic Carbon
UN - United Nations

ABSTRACT

It is well known that aquaculture may have impacts on the environment and the activities surrounding it. The issue of food supply is rising, as the world capture fisheries are declining. To be truly sustainable aquaculture has to find environmental more sound ways to feed its animals. Having solved that problem aquaculture will relieve the heavy tolls on the fisheries and at the same time be able to supply the humans with valuable fish protein. Aquaculture may have negative impact to tourism as well, through degradation of environment, bad smell or ruining the scenery. On the other hand aquaculture may also positively interact with tourism through supply of high-quality seafood, providing of seasonal employment, opening opportunities for eco-tourism and increasing of the offer.

Finding suitable sites for aquaculture in the marine and coastal environment is one of the most critical challenges facing this industry. The point is to integrate and merge all the concerns, issues and processes presented in the preceding chapters into a coastal plan to accommodate most of it, but nevertheless give special focus to marine aquaculture. Coastal Zone Management (CZM) and Environmental Impact Assessment (EIA) could represent a sound technical approach for the development of sustainable aquaculture management systems, and should be compulsory for all new aquaculture developments. The EIA is normally part of the feasibility study, and as such is essential in developing monitoring systems, in addition to mitigation measures as to prevent conflicts between coastal users, protect sensitive habitats and ensure sustainability of an individual project.

The project "Coastal Zone Management Plan for Croatia with particular focus on aquaculture" and the Guidelines as the final product of the project, integrate the rational and sustainable mix of users of coastal and marine resources and protection of natural eco-system. Among other issues, it formulates procedures for development of a coherent CZMP in Croatia focusing on marine aquaculture, and proposes solutions to release development potentials while reducing negative impact on environment.

Acknowledgements

This document was prepared based on the contributions to the project "Coastal Zone Management Plan in Croatia - with particular focus on aquaculture", of authors and project participants, both from the state administration bodies and from different scientific institutions worldwide. The integral versions of all contributions are available from the Directorate of Fisheries. References are rarely made throughout the document, and the list of the main contributors and their work as well as of other main references used is given at the end of each chapter.

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PREPARATION OF THIS DOCUMENT

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The project was conducted under the leadership of Ivan Katavić, assistant minister in the Ministry of Agriculture, Forestry and Water Management of the Republic of Croatia, through cooperation with Akvaplan-NIVA whose representative in the project, and coordinator of activities of the Norwegian partner, was Cand. Real. Tor-Jahn Herstad.

The main purpose of this document is to facilitate the planning and integration of marine aquaculture in coastal zone management processes. The procedures are outlined as well as the main elements for analysis and decision-making steps.

The principal targeted audience includes policy-makers, administrators and relevant stakeholders in the field of aquaculture, fisheries and the environment.

The document also provides the decision-makers with the basic orientation guide into the requirements and environmental concerns of marine aquaculture and provides basic checklists of possible integration effects.

It is hoped that the document will provide background information and reference sources for those involved in research in this field.

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FOREWORD

Croatia has a beautiful, unspoiled, clean and healthy marine environment whose development potential in not fully released yet. Tourism, fisheries and fish related activities as well as other branches of typical coastal economy are expected to grow in the near future. Therefore diminished biological diversity and landscape values in the coastal areas must not be overlooked. Coastal urbanization has in recent decades contributed to environment degradation and decline the quality of life, and bringing all the accompanying problems such as reduction of biodiversity, increase in waste, pollution, occupying coastline, land use conflicts, etc. It was obvious therefore that there was a need for a pro-active approach in releasing development potentials of coastal areas of Croatia to allow for better socioeconomic conditions for the local population. A balance must be achieved between the users of natural resources and their preservation where the use of natural resources by one sector should not diminish or degrade development potentials of the other sectors.

Even though "coastal management" appeared on the scene around 1990 as a new popular planning framework for the joint management of many coastal activities such as fisheries, aquaculture, tourism, environmental and habitat protection, pollution control, leisure activities, a true coastal zone management plan has not so far been ideally performed in any country. That is because the planning in sea requires more complex set of variables than planning on land. Also, a thorough knowledge of an area and its resources, a full understanding of interactions among coastal users, as well as possible impacts of the development on socio-economy and environment is fundamental for being able to balance intervention and to achieve integration among sectors. The competition for space and other resources among different users in the coastal zone requires integrated coastal zone management (ICZM), which is unavoidable means in solving conflicts. In this respect ICZM is continuous, proactive and adaptive process of resource management requiring multidisciplinary approach aiming to solve problems instead to transfer it. Good approach and planning tools are therefore crucial for good plans.

The project "Coastal Zone Management Plan for Croatia with particular focus on aquaculture" integrates the rational and sustainable mix of users of coastal and marine resources and protection of natural eco-system. The project among other issues, formulates procedures for development of a coherent CZMP in Croatia focusing on marine aquaculture, and proposes solutions to release development potentials while reducing negative impact on environment.

One important goal was to promote and harmonize development of marine aquaculture while avoiding any direct or indirect impacts on tourism and other complementary activities, assuming that development of a sustainable production of quality seafood will not conflict with tourist development and increase the social and economic well-being of the local communities and the country itself.

In order to ensure a successful aquaculture development and create a positive image of the industry, the proper siting of aquaculture installations was considered crucial. Conflicts with other interests in the use of coastal areas were considered, and the environmental impact from discharges that comes from the cages (nutrients, organic material, chemicals, parasites etc.) was proposed to be fully understood in order to size the aquaculture production and effluent release to the holding capacity of the recipient. The project also anticipated spatial conflicts with other interests at the coast, knowing that a stringent planning system with user's participation and democratic planning processes within a suitable legal framework should be in place.

The Project started with a small group of people from the relevant ministries as an "Inter-Ministry Team" with participation of representatives from Ministry of Agriculture, Forestry and Water Management in co-operation with Ministry of Environmental Protection, Physical Planning and Construction, Ministry of Sea, Tourism Transport and Development. Within the project we managed to summarise what was known about the issue, engaged experts from various disciplines to undertake research on the subjects that needed further clarification and then developed some principles and guidelines that would allow a professional to make suitable planning of an area. Stakeholder participation was secured, and it is hoped that we will manage to use our administrative positions to have the system implemented at broad scale.

Even though ICZM for Croatian coastal environment as a cooperative international project has been focussing on aquaculture, it will clearly establish the position of the Republic of Croatia towards the future management of the Adriatic resources with the intention to indicate a wide range of investment opportunities for local, national and international investors. I believe the same has a good chance to happen in tourism, as it is a sector so important in Croatia. I also believe that international network that is created through the realization of this project may assist in coastal area management plan of many developing countries in the world.

It is to be recognised that having opportunity to take advantage of experience gained in Norway and other countries privileged Croatia. Looking at the experiences from Norway we know that a similar situation concerning the administration of aquaculture existed about ten and more years ago. Greece lessons, USA and Australian achievements in aquaculture development were welcomed as to learn from good lessons and not to repeat mistakes that have happened already. By such an input, Croatia was able to consider and use the last achievements obtained internationally in development of ICZM, hoping to use it in preserving coastal environment and developing its economy in the most rational and sustainable way.

It is also to be remembered that seldom before such interactions among different ministries and integration among sectors, institutions and administrators were in place, and seldom before have scientists and experts from different countries and even continents, from different disciplines managed to create such a common ground for collaboration.

It is hoped that in the years to come, the relevant ministries will manage to agree upon an administrative system that helped aquaculture potentials in Croatia to be fully released, at the same time that the activity will be kept within the framework of sustainable use of nature resources. The administrative model is expected to involve all ministries and institutions of relevance, and thus provide support for a sustainable developement to most local communities on the island and other rural areas along the Croatian coastline.

HEAD OF THE PROJECT

Ivan Katavić, assistant minister
Fisheries Directorate
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Republic of Croatia

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BACKGROUND

Seafood is a product that is receiving increased attention and is under considerable focus from the industry side. As landings from capture fisheries are limited, a larger percentage will be obtained through controlled breeding in the future. Therefore, fishing and aquaculture are to be viewed as complementary activities – "where does fishing end, aquaculture start". Aquaculture, or the farming of aquatic organisms is achieved through "manipulation of an animal's life cycle and the control of the environmental variables that influence it". Manipulation means some sort of intervention as to enhance growth and production of the confined stock.

Aquaculture is a sector that is expanding rapidly. There is a firm belief that fish farming is a beneficial and more efficient way of exploitation of natural resources than meet production in agriculture. This explains aquaculture average annual expansion rate of 9.2% in the last 30 years compared to only 2.8% for terrestrial farmed meat production systems.

No doubt, fish are extremely effective in getting the maximum from their food. This is understandable, since fish by living in the water are practically weightless and don't need to spend energy to carry the weight of their own bodies, which is necessary for livestock on land. Fish utilize their feed better than land animals because they do not use the energy to keep warm and dispose of ammonia directly into the water. The result of this efficient use of energy is that it needs much less feed to produce a kilo of fish than it does for pork or broiler. While 1.2 kilos of dry feed produces one kilo of salmon, we need between 2.2 and 2.4 kilos of dry feed per kilo of pork or broiler. It is to be recognized that cattle or sheep feed mainly by grazing grass areas that humans don't have other uses for, while pigs and poultry live on concentrated feed of grain and soy, which in principle could have been utilized as food for humans. Given the over-fishing of wild stocks, if the growth is to continue it will be necessary to employ alternative raw material sources. One possibility is to utilize organisms further down the nutrition chain, as for example zooplankton (krill) whose annual production is 4-5 times the annual total production of fish. It is hoped that a moderate harvest of plankton (e.g. 100 million tones per year) would not have harmful effect to other fish and sea mammals, as well as for marine ecosystem in whole.

Components from by-products will without doubt be one of the ingredients in future fish feed industry. The search for the appropriate components in the global market is accelerating, and the tests are being carried out on a number of combinations and new components. But the most important factor is that fish have extremely efficient reproduction. While a hen can lay some 200 eggs in the course of a year, a salmon can produce 20,000 offspring and a single marine fish up to million. Thus the costs per fish offspring are minute.

Due to the increase in population and economic growth, one can expect increased demand for fish products across the entire globe. The major trend in developing countries is and will be to obtain enough food for everyone, while customers in industrialized countries are looking for nutritionally healthy food. Social and demographic trends may in the future increase consumers' preferences in developing countries towards more exclusive fisheries product. This is taking place through increased production on existing farms, but also through allocation of new sites to the aquaculture industry. It is obvious that environmental issues will be a central factor in the sector's planning, while further development will build on the control of a species life cycle. Marine species will without doubt take advantage of the improved knowledge in breeding, control of diseases, and finally, improvement in feed composition and feeding.

Coastal Zone Management, CZM

Environmental Impact Assessment EIA

FAO Code of Conduct for Responsible Fisheries, CCRF

It is also to be recognized that badly planned and uncontrolled fish farming may have an adverse effect to the environment. Enrichment and degradation of aquatic eco-systems in the vicinity of fish farm depend upon the intensity of fish culture activities (e.g. stocking density and feed inputs) and the characteristics of the culture sites. Due to the little data yet available, it is very difficult to have a complete perspective on the entire environmental and socio-economic consequences of farming industry.

Conflicts may be direct or indirect, affecting activities such as fishing operations, navigation or tourism. Many countries do not always take up their responsibilities to protect and manage fragile and endangered eco-systems such as *Possidonia* sea beds. The Code of conduct for responsible Fisheries (CCRF) stresses that ".. as regards the multipurpose usage of coastal areas, countries should secure that representatives from fisheries and fishing communities are consulted in the decision making process and other activities related to coastal zone planning and management plans." (FAO, 1995)

Farm installations themselves can be a source of conflict in coastal zones. CCRF emphasized that "States should consider aquaculture, including culture based fisheries, as means to promote the diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment and local communities are minimized". In other words it means sustainable development as to ensure the conservation of the marine environment for future generation and as well as bring both short-term and long-term benefits to the people.

Coastal Zone Management (CZM) and Environmental Impact Assessment (EIA) could represent a sound technical approach for the development of sustainable aquaculture management systems, and should be compulsory for all new aquaculture developments. The EIA is normally part of the feasibility study, and as such is essential in developing monitoring systems, in addition to mitigation measures as to prevent conflicts between coastal users, protect sensitive habitats and ensure sustainability of an individual project.

As the fish and shellfish in particular have the potential to introduce diseases and infections from polluted environment, it is therefore necesary to developed certification systems and secure traceability to guarantee safety and quality of aquaculture products. There is no evidence to confirm that farmed fish is less safe food than agriculture products. On the contrary, the most common diseases are widespread due to infection from food originated from warm-blooded animals. Many believe that farmed fish has a high level of antibiotics, which was the case at the end of the 1980's. Nowadays fish farming is practically antibiotics-free, while on the other hand considerable amounts of antibiotics are administered to livestock in agriculture. In spite of a global dynamic phase that is occurred in the recent aquaculture development, the sector still lacks the knowledge and experience to create an image of an environmentally friendly industry. Many species that have been commercialized have suffered from price declines, due to the negative consumer's perception of farmed fish and poor development of markets to absorb the new volumes now being produced. Good marketing strategies and response to consumer perceptions are the most important issues to continue rapid aquaculture growth. The industry must pay particular attention to environmental campaigns and issues, in order to avoid adverse reactions and impact.

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CHAPTER 1: INTRODUCTION

Integrated Coastal Zone Management, ICZM

In this Chapter, a brief introduction to Integrated Coastal Zone Management is given.

Population pressure, particularly the growth of urban areas, combined with rapid expansion of industry and tourism in coastal areas and extensive exploitation of marine resources have created a worldwide concern about sustainable development of these areas and the fate of their natural and environmental resources. To solve rising conflicts, and to plan marine aquaculture activities, is only possible using an integrated approach in which all interests and concerns are revealed and balanced through a democratic process at local and county level.

Particular attention is paid to sustainable development of marine aquaculture and the overall need to consider environmental impacts. This concern is crucial if needs of the sector are to be met, development potentials are to be realized and concerns and needs of local communities are to be taken into account at the same time.

A brief outline of present status of Croatian marine aquaculture is also presented. The recently brought National Strategy "Croatia in the 21st Century" brings the general outlines of possible goals. However, supplementary strategic goals and development guidelines are to be taken into account when planning and developing marine aquaculture.

1.1. INTRODUCTION TO ICZMP

ICZM is a commonly used acronym for "Integrated Coastal Zone Management". It is a continuous and dynamic development process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources. An Integrated Coastal Zone Management Plan is a complete set of suggestions how to manage the natural resources within a given part of a coastal area (zone) shown on a map. Around the world common problems in performing and setting up an ICZMP are the lack of institutional support and insufficient capacity of governmental offices to provide the right mechanisms and procedures, or to assess true needs and possibilities or drawbacks of the individual sectors.

Marine aquaculture in most cases represents a new activity in an area, and as such has to establish rights of access to coastal areas and its resources. Further challenges lie in the fact that its development has coincided with a large and timely increase in environmental awareness. Coastal areas all over the world are facing pressure from a wide array of activities, more or less lucrative and more or less environmentally friendly. Tourism, navigation, oil transport, forestry and agriculture are just some of them. Each of these activities tries to get the best available spot, which would secure its fast development and growth. User conflicts often emerge from such a situation. To integrate all these demands and concerns into a framework which provides both optimum utilization and proper protection of the resources is the goal. Integrated planning often represents the most viable solution. The process, however, should not be rushed, and will require skilful insight and a lot of common sense.

In the Republic of Croatia so far there have been several initiatives for coastal zone planning, which in most cases were limited to physical planning. An overall set of guidelines for planning and integration of any activity in coastal zone has not been developed or applied, mainly due to the lack of adequate databases, lack of compatibility with sector development plans, and in some cases lack of political commitment.

Croatia needs ICZM plans that will help combine all aspects of the human (socio-economic), physical and biological factors of the coastal areas within a single management framework.

One of the main aspects and goals of this project is to emphasize holistic and interdisciplinary approach in careful planning and management of all sectoral activities. Integrated approach should simultaneously result in greater overall benefits than just pursuing sectoral development plans independently of one another (e.g. agriculture, tourism, aquaculture, fisheries and education).

Efforts to integrate marine aquaculture into coastal management can contribute to improvements in selection, protection and allocation of sites and other resources for existing and future aquaculture developments.

1.2. Sustainable Marine Aquaculture Development and ICZM

Sustainability refers to the ability of a society, ecosystem, or any such on-going system to continue functioning into the indefinite future without being forced into decline through exhaustion or overloading of key resources on which that system depends. Sustainability can be attained when environmental conditions are appropriate and maintained, and this includes ecological, sociocultural and economic aspects of environment. In order to ensure sustainability, any activity, use or practice, in this case marine aquaculture development, should follow the next six general steps for resource management (Frankić, 2003)

1. Environmental Resource Assessment – Inventories of marine, coastal and islands natural and human resources are a necessary first step for successful management programs. To enhance resource development capabilities, a country or local community should acquire and maintain a comprehensive inventory of the physical and biological resources of the coastal area as well as their uses and users.

2. Environmental Impact Assessment (EIA) – Information about the impact marine aquaculture (or any other activity) will have on the environment, must be provided in a clear form to decision-makers and stakeholders. Impact assessments should be incorporated in each phase of aquaculture development projects. It also has to present clear options for the mitigation of impacts and for environmentally sound management. Impact assessment should be based on the best available knowledge and provide timely technical information to environmental decision makers, while acknowledging uncertainties.

3. Policy Framework – Formulation of a policy framework for coastal and marine management must address cross-sectoral issues that infringe on coastal resource management and national development planning. The basic approach is to review and analyze existing institutional and legal mechanisms (including regulations) for integrated coastal and marine management and aquaculture development potential. Based on this review, the country should propose a generic institutional and legislative framework to address coastal issues and encourage integrating aquaculture in the coastal zone management plan.

4. Economic evaluation and regulatory measures – Economic evaluation is an important component of a systematic assessment of coastal resources and potential aquaculture development. It provides an economic framework from which differing adaptation strategies (solutions) can be studied.

5. Implementation – The success of a coastal resource management program is based on the country's ability to understand how an effectively established program manages natural and human coastal resources. It is necessary to establish monitoring and evaluation of land and marine use decisions and changes in coastal resources, as well as in their integral uses.

6. Monitoring and evaluation – The purpose for monitoring of marine aquaculture practices is to assure that the major policies are properly implemented. Environmental Quality Standards (EQS) should be part of such major policy whether it is

Environmental Quality Standards, EQS

Aquaculture production statistics

at national, or at county levels. Monitoring will assess the cumulative effects of changes and assure that management program elements for aquaculture are adjusted to accommodate the environmental demands set. It will provide multidisciplinary data for a "feedback loop" evaluation of our activities and their impacts on natural and human resources.

1.3. Aquaculture - a Rising Industry That Needs Planning

Aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants. According to FAO statistics, aquaculture's contribution to global supplies of fish, crustaceans and molluscs continues to grow, increasing from 3.9% of total production by weight in 1970 to 27.3% in 2000. Aquaculture is growing more rapidly than all other animal food producing sectors. Worldwide, the sector has increased at an average compounded rate of 9.2% per year since 1970, compared with only 1.4% for capture. Landings from worldwide aquaculture have been increasing rapidly in the last decade, approximately 10 to 15% per year depending on the reference sources. According to FAO 2002, total aquaculture in 1996 was 26.7 million tonnes, and in 2001 increased to 37.5 million t. The world fisheries have stagnated at around 100 million tonnes and the world's need for seafood in 2030 is calculated to be 150 to160 million t. This means that the aquaculture production will likely double by 2030, reaching 50-60 million t.

Around the world, sustainable aquaculture has proved in a number of cases to be a revitalizing economic force in rural and coastal communities. Aquaculture development will, however, influence its environment and will therefore be subjected to various constraints. These include limited suitable sites, concerns regarding negative environmental impacts, and multi-use conflicts. Without proper management of all components within the ecosystem, the viability of the ecosystem is threatened.

The sustainable development of aquaculture requires adequate consideration of interactions among environmental, social, and economic factors that accompany any development. At every stage of the production cycle, intensive aquaculture has to manage the risks associated with water and with all the physical effects of nature. In a climate of competition of different coastal users, selection of sites for aquaculture is of vital importance, since quality and characteristics of the site are essential for both farming performances and reduction of negative impact on the environment. Conflicts are expected in a situation when basic biological knowledge is missing, or/and when siting of an aquaculture farm is done without using a multidisciplinary territorial approach involving all interest parties. Uncontrolled development and bad management of intensive aquaculture can increase pollution of surrounding environment, and thus affect the culture operation itself, reducing profitability and, ultimately, resulting in its closure. Hence, adequate and timely planning seems to be the only viable solution for the future of this industry.

Table 1. Trends in World Auaculture Production for different species groups in million tones, FAO 2004

	1990	1994	1998	2002
Finfish	*8*	*12,5*	*20*	*21*
Molluscs	*4*	*7*	*10*	*12*
Aquatic plants	*4*	*7*	*9*	*12*
Crustaceans	*1*	*1,5*	*2*	*3*

1.4. Croatian Marine Aquaculture - a Brief Overview

Croatian marine aquaculture predominantly includes production of Mediterranean sea bass (*Dicentrarchus labrax*), Gilthead sea bream (*Sparus aurata*) and bluefin tuna (*Thunnus thynnus*). Shellfish production is mostly composed of black mussel (*Mytilus galloprovincialis*) and European flat oysters (*Ostrea edulis*).

Table 2. Marine aquaculture production in Croatia (in tonnes)

	1998	1999	2000	2001	2002
Tuna	400	690	1167	3045	3971
Bass and bream	1747	1750	2100	2500	2500
Mussel and oyster	900	1100	1111	3000	2500
TOTAL	3047	3540	4378	8545	8971

Sea bass and sea bream

Sea bass and sea bream are grown in floating cages. There are 40 bass and bream farms divided in two types: big farms with yearly production of 200-800 tonnes and small family farms with production 50-100 tonnes.
Production was continuously increasing and has stopped at 2 500 tonnes in 2002, staying at the same level in 2003. The main market for these products is the EU, although revitalization of tourism has made the domestic market more and more attractive.
There are three hatcheries in operation with total production of about 6 million of fry per year (Table 3). This fry production is not meeting the present requirements of domestic needs, so almost 10 million of fry are imported every year.

Table 3. Production of fry in Croatia (in pieces)

	1999	2000	2001	2002
Bass	3.003.000	4.645.000	5.114.000	5.007.000
Bream	285.000	0	113.000	353.000

1.5. Strategic Framework for Development of the Republic of Croatia (Focusing on Marine Aquaculture)

Government of Croatia has, during 2002 and 2003, adopted several development strategies, including the ones for nature and environment protection, tourism and fisheries ("Croatia in the 21st Century"). Applicable measures based on these strategies should be developed in the near future, in order to enable each sector to develop as well as to integrate the needs into a common goal. Despite the differences and different points of view, all sectors agree in one – that the lack of integral management and planning is the key "missing link" in the development of Croatia, and particularly its coastal zone.

Marine aquaculture strategy forms an integral part of the Fisheries Strategy of Croatia. Its main features are the increase of production and the development of the sector. During the next 10 years, marine aquaculture finfish production is planned to increase to 10 000 t/year, shellfish production to 20 000 t/year and all this is to be achieved by respecting the highest ecological standards of production. Main determinants in achieving these goals are farming of indigenous species, increasing environmental standards, reduction of production costs, and product quality.

"Croatia in the 21st Century", development strategy

Bluefin tuna

Tuna is grown in semi-offshore floating cages. All production is concentrated on the middle coast islands. There are six tuna farms, producing 500-1.000 tonnes each. This is the most rapid growing marine aquaculture activity, which in seven-years from total production of 40 tonnes has reached over 4.000 tonnes in 2003. One of the limiting factors for its future increase is a catching quota, which Croatia has to follow as a member of International Commission for the Conservation of Atlantic Tunas (ICCAT).

When considering integral planning of coastal zones, two other important strategies have to be taken into account – Environmental and nature protection strategy and Tourism development strategy. The first one sets the overall environmental framework for all economic activities in the Republic of Croatia, stressing the importance of careful consideration of environmental protection and preservation. The second one provides a framework and sets the goals for the development of tourism activity, which often presents the main conflicting activity to marine aquaculture and at the same time presents the main development orientation of the Republic of Croatia.

Environmental and nature protection strategy states that the present situation is already alarming, indicating that the coastal pressures are rising and that an integrated approach is badly needed. Strategy foresees integral management of coastal areas.

Tourism development strategy identifies an overall physical plan of Croatian tourism as a priority in development, including strengthening of intersectoral cooperation and taking into account of environmental requirements and constraints to the maximum possible extent.

Two other relevant strategies are the Strategy for biological and landscape diversity and the Strategy of Physical Planning. The Program of Physical Planning and the County Physical Plans provide an important strategic framework for future planning and development of coastal areas.

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CHAPTER 2: MARINE AQUACULTURE – A SHORT INTRODUCTION TO THE INDUSTRY

In this Chapter a general presentation of marine aquaculture is provided. Major considerations in marine aquaculture are the species and the technologies applied, which in turn require different parameters from the environment.

2.1. General Considerations

According to FAO definition, aquaculture is the farming of aquatic organisms, including fish, molluscs, crustaceans and aquatic plants

There is a great diversity in the number of aquaculture systems available (open, closed, semi-closed, land based) and the degree of intensity of the operation – extensive, semi-intensive, intensive, and super-intensive.

Aquaculture relies heavily on natural resources – land/space, energy and water. The technology should be linked to both biology of the cultured animal and to the culture systems itself.

A clear relationship exists between these main elements whose cost and availability are main determinants to match species and the type of the system (Fig. 1). In considering methods (intensive, semi-intensive extensive) and culturing techniques (lagoon system or enclosures, land based production, cage culture) in a given zone, there would be need to assess the availability and cost of the individual resource. Thus, if land is scarce and costly, a cage system that requires less area may be a proper solution.

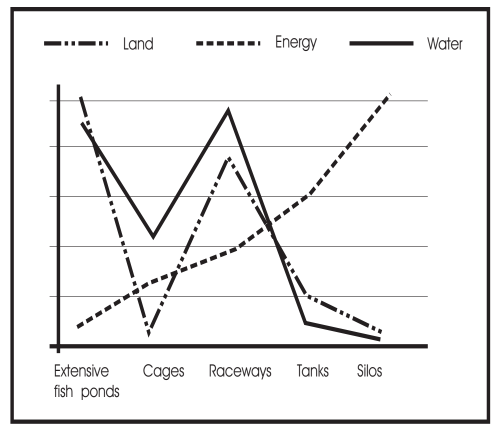


Figure 1: Cost of the main resources (land, water, energy) as related to various culturing systems.

2.2. Classification of Aquaculture

BY LEVEL OF CONTROL

Extensive Aquaculture

Any culture system that does not require supplemental feeding to support or grow the species may be characterized as extensive aquaculture. Two types of extensive aquaculture are commonly practiced:

- fish culture in brackish lagoons or enclosures refers to the culture of the organisms in a habitat similar to their natural environment, where no additional food is used; compared to the intensive techniques, rearing densities tend to be low.
- filter feeding (like mussel farming) culture, which uses the water column's natural productivity. Food such as phytoplankton may be a limiting resource for many extensively cultured species such as mussels. Dense

cultivation may reduce the quantity of suspended and re-suspended material available.

INTENSIVE CULTURE

This covers the wide variety of technologies that involve different degree of control over the environment and the culture species themselves. It is commonly practiced in containers, tanks or enclosures, where the organisms rely on added feed for their food supply. This type of production strategy may be divided according to location (sea based or land based) and the degree of water movement (reuse of water and flow-through systems).

The most common system currently used in fish farming of Croatia consists of intensive land-based hatcheries for fry production and on-growing of the juvenile fish in tanks, and transfer to sea cages for growth up to marketable size. Sea bass and sea bream are cultured mostly using this technology.

BY AREA

LAND BASED CULTURE

The primary advantage of a system where the facilities are based on land is that the culturist has a significant amount of control over fish and the culture environment. They provide the possibility for treatment of the effluent and trap escaping fish. The disadvantages normally include higher construction and operating costs, and in some cases lack of land-area.

SEA BASED SYSTEMS

Cages may be placed in-shore and offshore. The advantage of cages over other systems is the low capital investment compared with land-based flow through or recycling systems. Some comparisons between the in-shore and offshore are given in Table 4. In-shore systems are mainly used for rearing of sea bass and sea bream, while offshore technology applies for tuna farming. The difference between in-shore and offshore is in the level of exposure. Semi-offshore system can be used for all species, and represents an intermediate category between the two. The most expensive technology is offshore.

Table 4. General relationships between in-shore and off-shore aquaculture practices

in-shore	VS.	offshore
+	VULNERABILITY	–
+	OPERATIONAL COSTS	–
+	ACCESSIBILITY	–
+	CAPITAL INVESTMENT	–
–	RISK OF SELF-POLLUTION	+
–	REDUCED WATER QUALITY	+
–	PARASITES	+
–	FOULING	+
–	USER CONFLICTS	+
–	SURVIVAL	+

Legend: + indicates positive relationship
- indicates negative relationship

BY TECHNOLOGY

HATCHERIES

Hatcheries are installations where rearing of fish from spawning until pre-growing size or transfer to the cages takes place. They are all land-based in which good control over operations is established.

Intensive hatcheries are most commonly used by industrial scale production. Broodstock are kept in hatcheries under specific and completely controlled conditions. Hatcheries for shellfish differ in construction from those for finfish.

There are two main types of technologies applied in hatcheries – flow-through and recirculation systems. In a flow-through system water usually passes through only once. Recirculation systems are predominantly used in the hatcheries of marine finfish. In these systems a certain portion of water is re-used. This system offers some advantages over flow-through systems in terms of management of production, water and heat conservation and freedom from site limitations. Disease control, biological performance and production management tend to be limited when compared to flow through systems. Other disadvantages are high capital and operational costs involved, but production costs per produced fish need not necessary be higher.

Tanks are used for pre-growing of finfish prior to transfer to cages. For some species and some areas the total production cycle is undertaken in tanks. In terms of technology, tanks employ either flow-through or recirculation systems.

Cage culture

There are three main types of cage technology applied today – submersed, semi-submersed and floating cages. Submersed cages are not used in the Republic of Croatia. Floating cages are kept on the surface by a system of buoys or other type of a floating device/frame. The netting is suspended from the frame. The size of the netting depends on the species and site. The shape of the cages is usually rectangular for fry keeping, and circular for larger fish sizes. This system may interact with the environment, depending on the natural characteristics of the water where it is placed. Possibilities of environmental control are virtually non-existent.

Parks

Park rearing technology is applied for shellfish farming. Parks may be fixed or floating. Oysters spat (*Crassostrea gigas*, *Ostrea edulis*) is collected from the wild by suspending plastic nets or tree branches deposited in spawning areas. They can also be collected naturally after settlement from spawning adults kept in small tanks and raceways or from more intensive hatcheries. Adults are kept in suspended culture cemented on rafts or long lines. Mussels spat (*Mytilus galloprovincialis*) are also collected from the wild from suspended rope placed into the upper layer of water column (from surface to thermocline - epilimnion) of mussel farm. Adults are on-grown by means of plastic perforated nettings hanged from rafts or floating long lines. Future growth of mussel culture would be oriented towards modern long-line culture with significant mechanization of culture process.

2.3. Species and Environmental Requirements

Apart from species currently reared in the Republic of Croatia, there are several other species of interest for marine aquaculture (Table 5).

REQUIREMENTS

All species reared are affected by the hydrographical and biological characteristics of the environment. Knowledge of the tolerance of certain factors is particularly important for implementing aquaculture operations and assessing both the success and maximum capacity of an environment. Farmed fish, particularly the ones reared in floating cages, interact with their environment, and therefore environment itself can significantly affect the economics of the culturing operations. Although at present the sheltered coastal zones are often used as technology progresses, the future developments are likely to take place in the more offshore areas. Fish have more or less specific environmental requirements, which change depending on life stage. For optimal farmed fish performance (survival, growth, reproduction) rearing environment should correspond as closely as possible to the biological needs of the certain

Table 5. Existing and potential species of interest for marine aquaculture in Croatia

SPECIES	Cages	Land based	Cages in-shore	Cages offshore
Sea bass	+	+	+	+
Sea bream	+	+	+	+
Rainbow trout	+		+	+
Salmon	+	+	+	+
Turbot	+	+		
Plaice		+		
European eel		+		
Bluefin tuna			+	+
Bivalves		(+)	Long-lines	
Gastropods		(+)	Long-lines	
Cephalopods		(+)	Enclo-sures	

species (Table 6, 7, 8, Fig 2). The main parameters are: temperature, salinity, pH, oxygen saturation, ammonia, waves and depth.

Table 6. Maximum levels of ammonia for long duration exposure without affecting growth and conversion index

SPECIES	Ammonia level in weight of nitrogen N-NH_3 (mg/ml)
Oncorhynchus mykiss	0,4-0,14 (after acclimatization)
Dicentrarchus labrax	0,2
Sparus aurata	0,2
Thunnus thynnus	0,11
Pleuronecte platessa	0,06
Hommarus sp.	0,14

Table 7. Optimum and lethal temperature for some farmed fish species

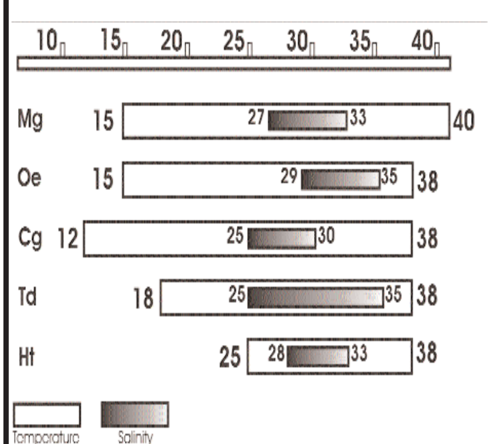
***Rainbow trout: parameters differ in fresh and marine water. In marine water** *Max °C 30°-32° Min °C 0-1, in fresh water Max °C 24°-25° Min °C 0.*

SPECIES	Optimum growth (°C)	Optimum food conversion (°C)	Max °C L_t50	Min °C L_t50
Rainbow trout*	14°-16°	15°	25,5°	
Atlantic salmon	13°-15°	14°	25°	-0,8°
Sea bass	22°-23°	22°	30°-32°	1°
Gilthead sea bream	25°-26°	24°	32°-34°	5°
Turbot	19°	16°	28°-30°	2°
Plaice	15°	16-18°		
European eel	22°-26°		33°	9°-11°
Mullet *Mugil cephalus*	28°		34°	4°
Bluefin tuna	23°-25°			

Table 8. Biophysical limits for several species of bivalves, *Haliotilis tuberculata* (gastropods) and *Sepia officinalis* (cephalopods)

SPECIES	Min °C L_t50	Max °C L_t50	Min ‰ Sl50	Max ‰ Sl50	Depth (m)
Mussel	5°	26°-27°	17	39	40
Oyster	2°	24°-25°	15	38	30
Crasostrea gigas	0°	27°	12	39	10
Tapes decussatus	1°-2°	27°	18	38	50?
Tapes philippinarum	2°-3°	28°	18	38	50?
scallop	5°-6°	25°	23	38	120
GASTROPOD					
Haliotilis tuberculata	5°	23°	25	38	20
CEPHALOPOD					
Sepia officinialis	6°	27°	25	38	50

Figure 2: Preferred temperature (°C) and salinity (ppt) under which gametogenesis occurs in several species of molluscs related to Adriatic conditions.
***Mg**-Mytilus galloprovincialis; **Oe**-Ostrea edulis; **Cg**-Crassostrea gigas; **Td**-Tapes decussatus; **Ht**-Haliotis tuberculata*



BOX 1: KEY PARAMETERS IN REARING OF MARINE SPECIES

SEA BASS (*DICENTRARCHUS LABRAX*)

- larval temperature 18-20°C, survival 40 to 50%
- on growing at 20-25°C with optimum of 22 to 23°C
- salinity range from 3 to 40 ppt, with an optimum of 27-28 ppt
- reaching 300 to 400 g within 20 months with 80 to 85% survival and stocking density from 10 to 20 kg /m³

SEA BREAM (*SPARUS AURATA*)

- larval temperature 18 to 21°C
- on-growing at 22 to 26°C, with an optimum of 24°C
- reaching 300 to 400 grams within 18 months

Both species shall be kept in water with sufficient oxygen concentration. The optimal oxygen levels vary depending on both abiotic factors such as temperature, salinity, carbon dioxide concentration, ammonia, and Ph; 70 % of oxygen saturation is a minimum to support good growth. The maximum level of CO_2 should not exceed 35 mg/l. Stocking density in the cages is from 12-15 kg/m³

COMMON DENTEX (*DENTEX DENTEX*)

- larval temperature 20 to 23°C
- on growing at 22 to 26°C
- reaches 500 g after 20 months with survival at 60%

WHITE SEA BREAM (*DIPLODUS SARGUS*)

- slow-growing sparids
- in about 20 months reach 200 to 250 g with survival 60 to 70%
- larval survival is up to 20% at 20 to 22°C

COMMON SEA BREAM (*PAGRUS PAGRUS*)

- larval temperature from 18-20°C
- on-growing at 19 to 24°C
- gives 600 to 700 grams fish after two years with 70% survival.

Box 1 Continued: Key Parameters in Rearing of Marine Species

Dusky grouper (*Epinephelus marginatus*)

- development of appropriate hatchery technology has proved extremely difficult
- survival after metamorphosis is exceeding 90%, but from hatching until day 80 when the individuals weighing around 2 grams is as low as 10-12%
- on-growing at 24 to 28°C may produce 1 kg fish after two years

Yellow tailed amberjack (*Seriola dumerili*)

- it is still difficult to obtain fertilized eggs and larval survival is still low (<5%)
- larval temperature is 20 to 22°C
- on-growing at 20 to 22°C gives 1 kg after 1 year, 3 kg after 2 years and 6 kg after 3 years with 90% survival.

Sole (*Solea solea*)

- at 18°C larval survival through metamorphosis reaches up to 70%
- on-growing at 16 to 18°C brings fish up to 250 g in two years with survival above 90% at stocking density 20 to 30 kg/m^2
- optimal temperature for the early stages is around 20°C
- juveniles can reach size of 24 cm (approximately 125 g) in less than 1 year

Other flatfish species

Flatfish may also have an important role to play in land-based aquaculture. Flounder (*Pleuronectes platessa*) and turbot (*Schophthalmus maximus*) are potentially interesting species. Such species are predominantly reared in re-circulating systems.

Adults are very robust and in a case of turbot they can be kept at densities higher than 25 kg/m^2. In areas where temperatures exceed 22°C the adults my have reduced growth and are more susceptible to disease problems with consequent lower yields.

Lobster (*Hommarus* sp., *Palinurus* sp.)

Lobster juveniles can be reared for restocking or artificial propagations. At present, prospect for commercial lobster farming are poor. Some experimental trials in on-growing small lobsters collected from their natural habitat are going on in Croatia (VIP project, Ministry of Agriculture, Forestry and Water Management).

Bluefin tuna (*Thunnus thynnus*)

Tuna farming is based on the harvesting of live wild juvenile fish, and their subsequent rearing in the floating cages. Large specimens are captured and fed during short periods of time (4 to 6 months) aimed mostly to increase the fat content of the fish, which strongly influences the prices of tuna meat on the Japanese sushi market. Such a practice can also be referred to as "tuna fattening". However, small individuals are reared through standard fish farming practice during few years aiming to increase fish weight and change fat content of the flesh.

A suitable rearing site must have good exchange of water, high transparency, and high dissolved oxygen. In most cases in Croatia, the stocking density is not exceeding 3kg/m^3.

*Short list of stressors and mitigation options in marine cage aquacultu*re

Aquaculture is subjected to a variety of negative impacts from the environment. Below follows a list (Table 9) of some of them and how to avoid the perils:

Table 9. Some threats and mitigations in marine aquaculture

THREAT	MITIGATION
DISCHARGE OF SEWAGE, OR MUNICIPAL RUN-OFF Microbial and viral loading; (hyper) eutrophication; stimulate algal growth (blooms)	The recommended distance from the outlet will depend of the diluting capacity. Monitoring of oxygen levels in the cages is recommended
RUN OFF FROM INDUSTRIES AND MINING ACTIVITIES (INDUSTRIAL POLLUTION) Chemical industry and Mining industry; risk of contamination by toxic substances; release of sandy or muddy (turbid) water	Avoid the contaminated area
RELEASE OF COOLING WATER FROM E.G. POWER PLANTS Changing (periodically) the temperature regime: stressing factor	Either avoid the area or take advantage of the elevated temperature designing the farm, choice of species and production
RUN-OFFS FROM LAND FILLS (uncontrolled or not), other waste disposal systems, toxic effects, eutrophication	Avoid the area or apply more frequent monitoring.
OIL SPILLS Can cause large scale fish kills; absorption of hydrocarbons by shell fish	As for other accidents – contact relevant authority; Move cages to other sites
RELEASE OF PESTICIDES, FERTILIZERS, ANTI-FOULING AGENTS Can severely contamine fish and shellfish meat	Avoid such areas, map the prevailing currents, get information on when the danger of release is imminent
RELEASE OF UNFORESEEN HAZARDOUS SUBSTANCES FROM PORTS All kind of contamination depending on substances drifting into the cages	Avoid farming close to such areas
RELEASE OF VARIOUS SUBSTANCES FROM OTHER MARINE AQUACULTURE FARMS Increased rate of contamination.	Keep a safety distance from the other farms; look at the current pattern; co-operate with neighbouring farms; (e.g.: synchronize the medication); establish an information network between the farms in the area

2.4. Diseases and Disorders

The main infectious diseases in sea bass and sea bream farms are parasitic infestations, bacterial diseases and viral diseases.

Table 10: Most common diseases of sea bass and sea bream

Parasites	Bacterial diseases	Viral diseases
Tricodina sp	*Vibrio anguillarum*	Lymphocystis
Diplectanum sp	*Vibrio damsela*	Viral Nervous Necrosis (VNN)
Calligus	*Pasteurella piscicida*	Distended gut syndrome (DGS)
Microzoa	*Pseudomonas anguilliseptica*	
Myxozoa		

Box 2 Disease prevention at different stages of fish life cycle

Eggs & Larvae

The immune system of marine fish species is undeveloped at this stage and protection strategies must therefore concentrate upon high quality eggs being kept in the cleanest possible environment. Disinfection and environmental control are the primary methods of keeping the stock disease free.

- Disinfection
- Environmental Controls

Fry

Marine fish fry are susceptible to a wide range of viral, bacterial and parasitic secondary infections. Sea bream are especially prone to acute mortalities due to Pasteurellosis. This can be minimised by careful husbandry and the quality and cleanliness of live feed. Immunostimulants should be mixed with the dry feed.

- Immunostimulants
- Careful husbandry/Management

Box 2 Continued: Disease prevention at different stages of fish life cycle

Juveniles

Juveniles are normally transferred to ongrowing sites at 1 to 2 grams. A minimum size of 1 gram is recommended for immersion vaccination, which should be carried out 2 weeks before transfer. Immunostimulants can be used to help boost the response to the vaccine and to enhance the resistance of juveniles to the stress of the move. Detailed, accurate diagnosis, swift intervention and good planning will minimise the disease risk in hatcheries and ongrowing sites. It is preferable to vaccinate sea bass and sea bream juveniles against Pasteurellosis at the ongrowing site although this is also possible at the hatchery. Vaccination is recommended 4 to 5 weeks prior to the period of risk.

Ongrowers

Ongrowers will be exposed to a number of disease problems. The most significant of these are Pasteurellosis, Vibriosis, Myxobacteriosis and Viral Nervous Necrosis (VNN). Pasteurellosis and Vibriosis can be prevented and controlled using vaccines, which should be targeted to the periods of greatest risk. These will vary from site to site depending on seasonal temperature cycles. Vibriosis is often associated with the temperature fluctuations in spring and autumn. It may however, become endemic in constant temperature systems. Pasteurellosis is usually associated with high summer temperatures. Ergosan has been shown to help control losses and enhance recovery in infected fish. It can also be used to reduce mortalities due to VNN.

General health monitoring and investigation will ensure that correct preventive measures are taken and that in the case of treatments being administered the correct choice of product is made at all stages! Concurrent parasitic infections have been shown to increase the levels of mortality caused by bacterial and viral infections.

- Oral vaccines
- Injectable vaccines
- Immunostimulants

BOX 2 CONTINUED: DISEASE PREVENTION AT DIFFERENT STAGES OF FISH LIFE CYCLE

BROODSTOCK

Broodstock are one of the keys to the future success of the farming operation and great care should be taken in selecting the correct fish. Production quality and performance characteristics are the most important traits for which fish are selected. The fish must be kept free from disease and in a stress-free environment and be provided with high quality feed.

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OSPAR convention

Barcelona convention

Helsinki convention

Ministry of Agriculture, Forestry and Water Management, MAFWM

Ministry of Environmental Protection, Physical Planning and Construction, MEPPP

Ministry of Sea, Tourism, Transport and Development, MSTTD

CHAPTER 3: LEGISLATION, PLANNING AND LICENSE OBTAINING PROCEDURES

In this Chapter, a brief outline of legislation framework related to marine aquaculture is given. Particular attention is paid to European legislation and Directives. National legislation framework in the Republic of Croatia is briefly provided. Planning procedures are outlined, and current practice is described. License obtaining procedure is described; identifying the steps for farmers and users. Key gaps and problems are identified and some suggestions for improvements are provided.

3.1. Overall International Framework

There are currently three international Conventions on marine pollution covering the coastal waters of EU states. All may have some influence on the management and regulation of marine aquaculture in the EU. These are:

- The **OSPAR** Convention formed by the recent amalgamation of the general fields of activity of Oslo and Paris Conventions, and covering the northeast Atlantic north of Gibraltar, and west to Greenland and the mid-Atlantic Ridge. For details see www.ospar.org.
- The **Helsinki** Convention covering the Baltic Sea. For details see www.helcom.fi
- The **Barcelona** Convention covering the Mediterranean Sea. For details see www.rempec.org/barcelona.html. The **Barcelona** Convention has been ratified by the Republic of Croatia and is of interest for planners, decision makers and farmers in the Adriatic Sea.

BARCELONA CONVENTION

In 1975. all coastal Mediterranean states and the EU signed the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution. The Convention would allow the identification of priority environmental issues (causes and effects) through coordinated monitoring activities, and sought to harmonize and assist Contracting Parties to raise the standards and objectives of national legislation. So far, there has been no specific action within the Barcelona Convention directly concerning marine aquaculture. Amended text of the Conference has still not entered into force in the Republic of Croatia.

The list of international conventions signed by the Republic of Croatia, which are of interest for marine aquaculture, is provided at the end of this Chapter.

3.2. EU Regulations Relevant for Marine Aquaculture

Joining the EU is a strategic goal of the Republic of Croatia. Following the application for membership in 2002 and the *avis* and candidature in 2003, the Republic of Croatia has undertaken to harmonize its national legislation with the one of the EU. Hence, different EU regulations have already been incorporated into the national framework, or shall be in near future.

EU Directives set up environmental protection measures at three levels in the aquaculture sector: i) general policy, ii) specific measures, and iii) regulations which control specific local conditions. Some of the main directives affecting aquaculture are:

- *Dangerous Substances Directive (76/464/EEC)*: lists of substances which are toxic, persistent and which bio-accumulate and those, which have a deleterious effect.

- *Directive 76/160/EEC* concerning the quality of Bathing Water

- *Directive 75/440/EEC* concerning the quality required of surface water intended for the abstraction of drinking water in the Member States

- *Habitats and Species Directive (97/62/EC)* on the coastal and estuarine activity of aquaculture

- *Environmental Impact Assessment Directive (Council Directive 97/11/EC of 3 March 1997 amending Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment)* as an Annex 2 activity, i.e. one where the conditions regarding the carrying out of a mandatory environmental impact assessment (EIA) is at the discretion of the member state

In the context of aquaculture, the Freshwater Fish Water Directive, the Shellfish Water Directive and the Dangerous Substances Directive will be integrated into the Water Framework Directive, and repealed by 31 December 2007 when all the obligations established under these existing Directives will be put into a more coherent framework covering all waters. In regulating marine cage fish farming, competent authorities in Member States will be required to ensure that areas comply with the Dangerous Substances Directive and the Shellfish Directive throughout coastal and territorial waters by ensuring that both Environmental Quality Standards (EQS) and a BATNEEC-based (Best Available Technology Not Entailing Excessive Cost) approach are utilized. These provisions include the establishment of a combined approach, which permits the use of both EQSs and fixed Emission Limit Values.

Dangerous Substances Directive 76/464/EEC

Directive 76/160/EEC

Directive 75/440/EEC

Habitats Directive 97/62/EC

EIA Directive 97/11/EC

Enviromental Quality Standards, EQS

Best Available Technology Not Entailing Excessive Cost, BATNEEC

3.3. National Framework

Planning and zoning of aquaculture in the Republic of Croatia is governed by a long list of regulations, which supplement and/or take into account different international regulation and provide a good, albeit somewhat complex and often confusing, national framework for siting of marine aquaculture.

Concession for usage of a section of maritime estate is issued by the Assembly of the County where the farm is planned. The Ministry directly responsible for providing the legislation governing concession-obtaining procedure is the Ministry in charge of naval transportation and maritime affairs (Ministry of Sea, Tourism, Transport and Development). Basic national legal framework for this segment of marine aquaculture is Act on Maritime Estate and Sea Port (OG 158/03) and the subsequent Ordinances (in particular the Ordinance on the procedure of issuing of the concession for usage of a section of maritime estate – OG 23/04, 101/04).

Basic regulation of interest for marine aquaculture under the jurisdiction of the Ministry of Environmental Protection, Physical Planning and Construction is the Environment Protection Act (OG 82/94, 128/99) and its subsequent regulations, ordinances and by-laws. Environment Protection

Act on Maritime Estate and Sea Port OG 158/03

Ordinance on concessions OG 23/04, 101/04

Environment Protection Act OG 82/94, 128/99

Regulation on EIA OG 59/00

Act on Physical Planning OG 30/94, 68/98, 61/00

Nature Protection Act OG 162/03

Marine Fisheries Act OG 46/97

Regulation on suitability for marine aquaculture OG 8/99, 56/02

Veterinary Act OG 70/97

Water Act OG 107/95

Food Law OG 23/03

Act stipulates the provision on requirements for EIA, which are then further elaborated in the **Regulation on Environmental Impact Assessment (OG 59/00)**. It also provides the basic provisions on monitoring of environmental impact of an activity (including marine aquaculture) and stipulates the penalty provisions as well. Physical planning is governed by the main **Act on Physical Planning (OG 30/94, 68/98, 61/00, 32/02)** which is supplemented by a wide set of regulations. These regulations provide for location and construction permit, physical planning procedures, requirements for local government when preparing a physical plan and so forth.

Nature Protection Act (OG 162/03) is another basic regulation with impact on marine aquaculture planning and zoning procedures and possibilities. The implementation of this act and its subsequent regulations is under the jurisdiction of the Ministry of Culture.

Basic regulation for marine aquaculture under the jurisdiction of the Ministry of Agriculture, Forestry and Water Management is the **Marine Fisheries Act (OG 46/97)**. This act provides a basic set of definitions and requirements, and foresees additional set of regulations for commercial fish farming activities. Perhaps the most important legislation coming from this act governing marine aquaculture is the **Regulation on suitability of a section of marine estate for marine aquaculture (OG 8/99, 56/02)**. This regulation sets the framework of relevant parameters, which should be checked for if successful marine aquaculture is to be achieved (see chapter 7 of this document).

Veterinary legislation framework covers veterinary regulations for farmed fish and other organisms. Basic regulation is the **Veterinary Act (OG 70/97)**.

Government of the Republic of Croatia has also brought the **Water Act (OG 107/95)**, which fostered the **Ordinance on water classification (OG 77/98)**. Data gathered in the framework of these regulations as well as standards set for water classifications are of particular importance for inshore aquaculture and for shellfish culture. Another act of high relevance for aquaculture and food industry in general is the **Food Law (OG 23/03)**, which sets the main propositions and standards for all food articles placed on the market in the Republic of Croatia. There are other regulations of indirect relevance for marine aquaculture.

3.4. Coastal Planning Procedures and Physical Plans in Croatia

There are two main documents, which provide a framework for all physical plans in the country. These are the **Strategy of Physical Planning of Croatia** and the **Program of Physical Planning of Croatia (OG 50/99)**. Both the Strategy and the Program are produced by Institute of Physical Planning of the Republic of Croatia. Both the strategy and the program are brought by the relevant ministry (MEPPP) and are then brought by the Parliament. The Strategy stipulates in general the elements of physical planning in Croatia. Based on these provisions, the Program of Physical Planning was brought.

Physical plans of Counties are brought by County Assemblies upon consent from the MEPPP. Municipalities bring their physical plans, which are brought by Municipality or City Council upon consent from the County. Act on Physical Planning stipulates the requirements of each plan.

All Counties of Republic of Croatia have already brought their physical plans by the end of year 2002. However, as the Program foresees auditing of plans in intervals of 2 years, some counties are in the process of bringing new and changed physical plans. Available physical plans may be seen on the official web-site of the Ministry of Environmental Protection, Physical Planning and

Construction (www.mzopu.hr). Different Counties have in their physical plans included marine aquaculture locations based on present regulation and known and available information.

Several Counties (Zadar and Primorsko-Goranska) have included more elaborate requirements into their plans and have done precise zoning for species reared in marine aquaculture. This particularly applies to Zadar County, where the new plan includes zones for bream and bass, zones for shellfish farming and zones for tuna farming.

3.5. License Obtaining Procedures in Croatia

License obtaining procedure in Republic of Croatia starts with the request for concession. Concession depends on the usage of the section of maritime estate and the duration. Concessions of up to 20 years are given by the County, up to 50 years by the Government and for longer time by the Croatian Parliament. Most concessions for marine aquaculture are sought for less than 20 years, and are given by the County.

Any interested party may start the procedure, by submitting the request (letter of interest) either to the responsible administrative body in the County where the concession is sought or to the Ministry in charge of sea affairs directly. The ***responsible administrative body*** is usually the County or field office for maritime affairs or physical planning. The letter of interest has to contain the information on the section of the maritime estate (or ***demesne***) where the concession is sought and on the intended activity.

Once the letter is sent, responsible authorities have 30 days to check if the area is delimitated and inscribed in cadastre books and if the usage stated in the letter is in line with the overall documents of the physical plan of the County. If so, the responsible authority suggests to the County to actually call for proposals and open a public tender.

The County then brings the Decision on public tender, and this decision determines for which type of activity the concession tender is being opened, which data should be presented in feasibility study, minimum concession fee, duration of the concession, duration of the public tender and other different provisions. The minimum concession fee is determined as a sum of the fixed amount, which is equal to the result of the multiplication of the surface area (in square meters) with 0,5 kn per square meter (for fish farming) or with 0,2 kn per square meter (for shellfish farming), and a variable part which is equal to 0,3% of the turnover of the applicant. Once the tender is out, all interested parties submit the full documentation to the responsible authority, which includes:

- proof on financial capabilities of the applicant (certified copies from Trade Court Register, financial report for the past year, revision reports);
- offered amount for concession fee (fixed and variable);
- feasibility study which includes information on the present status of the location for which the concession is sought, detailed plan of investment for the entire duration of the concession, planned amount of investment for environmental protection purposes, amount of investment, sources of investment, feasibility of the project, certificate on technical and human capacities, and the written bank guarantee. This part will tell the County how the applicant will fund the project, how much will it all cost, will it be profitable and what will be the profit margin. It is important to notice that this part foresees the investment into the environment – funds should be set aside for mitigation measures and measures to minimize damages. When applying for a marine aquaculture concession, this might be a rather important element;

Required documents for application

- suggestion on type and scope of usage of maritime estate;
- excerpt from the County physical plan which can ask for the detailed plan (in the process of location permit issuing) or the location permit. Very few Counties have their detailed plans, so location permit will be required. The requirement for a location permit is an EIA. If the applicant already has the farm, he/she will also need an EIA for any upsizing over 50 tonnes.

Upon receiving all the offers, the County compiles a committee to evaluate the offers and brings the Decision on concession issuing. The Committee shall then assess all offers and shall calculate the overall grade through application of a set of criteria. Roughly, the concession fee offered contributes for the 40% of the overall grade. Further 40% are contributed by the overall investment amount. The remaining 20% is validated according to the social criteria (how many people will be employed) and environmental concern (what will be invested into the environmental protection).

The County Assembly is the administrative body in the County that actually brings this decision. When the decision is brought, the last step in this procedure is the signing of the Contract on Concession. This document is needed to apply for the License for fish farming. Note that the Contract may ask for the EIA, or for the monitoring, or give the experimental concession for a period of 1 year. This is the prerogative of the County.

Commercial fish farming license is issued by the Field office of the Ministry of agriculture, forestry and water management. It contains data on the holder (name), area or zone for which it's issued, legal foundation, and the quantity and species of marine organisms you are going to farm.

When applying for the license, the applicant needs the following documents:

- proof of register from Trade register or Commercial Court
- concession contract
- statement on list and quantity of farmed species
- title/name of the farm location
- position (ϕ, λ)
- farm area (m^2)

The license will be valid until it either expires or is revoked (see *Marine Fisheries Act* for details).

The important element in legislation and procedures around the marine farming licensing is the location permit. The Act on sea ports and maritime estate does ask for either the location permit or the copy of the Detail plan, but as the Detail plan is mostly lacking, the applicant will eventually be obtaining the location permit as well.

The location permit issuing is under the jurisdiction of the ministry in charge of physical planning and environmental protection. To obtain the location permit one must apply to the responsible authority at the level of the County. One of the requirements of the location permit is the Environmental Impact Assessment Study. The EIA is not requested for production of less than 50 tonnes per year or 500 000 juveniles in a hatchery, but is for larger farms. Even if the application is for production of less than 50 t in a cage farm or for less than 500 000 juveniles in a hatchery, the County may ask for an EIA within a year, according to the stipulation in the County physical plan.

3.6. PROCEDURES IN EU

All EU countries require state authorization of some sort to set up and to engage in aquaculture activities, i.e., authorization, permit, license, lease, and concession. The competent authorities whose consent is required for the granting of the license vary considerably, from one to several different government departments, regional authorities and other interested parties.

Directives are legal instruments, which are binding on Member states as to the result to be achieved, but leaving them free to choose the form and the methods to be used. As part of the application and licensing procedures, Directive 85/33 7/EEC on Water Quality, updated by Directive 92/43/EEC, includes an "assessment of the effects of certain public and private projects on the environment which embodies the "preventive approach" to environmental protection by requiring that, before a development consent is given, certain projects likely to have significant effects on the environment by virtue of their nature, size or location are subjected to an assessment of possible environmental impacts". One of the categories covered by this Directive is "intensive fish farming" and a further amending Directive 97/11/EC extended its provision to cover intensive farming of all marine finfish, effective from March 1999.

An EIA must be carried out for a project falling into this class where a Member State considers that the project's characteristics require it. The EIA is not simple and involves a number of stages: the developer must submit certain information, and the public concerned together with other consultees are then given an opportunity to express an opinion; all the information thus obtained must be taken into consideration in the development consent procedure. Procedures involved in an EIA are set down in impressive and exhaustive detail (the size, design and scale of the proposed development, methods of operation, the use of natural resources, the types and qualities of any emissions or residues, existing land use, assimilative capacity, the geographic extent of the possible impact, the magnitude and complexity, the duration, frequency and reversibility of the impact, including the methods used to predict possible effects on the environment such as models or surveys).

3.7. Identification of Weak Points and Suggestions for Improvements

Generally speaking, the regulations governing marine aquaculture in the Republic of Croatia are satisfactory – starting from the provisions on request for environmental impact assessment, through requirements of water quality and concession requirements up to the regulations on environmental suitability for marine aquaculture. Overall, it might be said that the set of regulations is actually in some cases more elaborate than in many other countries. However, there are lacks and problems, which need to be identified, and in some cases the procedures are complicated.

3.7.1. CO-ORDINATION, IMPLEMENTATION OF THE REGULATIONS AND INSPECTION

Starting from license obtaining procedure to the control and surveillance of activity, there is an overall lack of communication and coordination among different administration bodies.

Given that several different bodies govern marine aquaculture, implementation of a huge set of acts is cumbersome and difficult. The situation is further aggravated by the fact that the acts are not integrated. This will allow for certain loopholes, as well as for difficulties in starting up of the production.

With the problems of overlapping of regulation on one hand, and gaps in regulation on the other, there are difficulties in inspection activities and implementation of regulations. Environmental inspection checks if the investor has the Decision on intervention, location permit and if he performs monitoring according to the requirements laid down in the EIA, (if there is an EIA). When there is no EIA obligation, the inspection checks if investor has the location permit and the status of the environment. In such cases there is no monitoring. Nature inspection controls the terms of nature protection in protected areas, fishery and commercial inspection check for the license and the production levels, and veterinary inspection checks for veterinary quality. And still, with all these inspections, problems occur and integration is difficult.

Present penalty provisions of different acts are also either inadequate, or inefficient. This problem is directly linked with the problem of control and implementation of legislation, as most offences go either undiscovered or not penalized.

3.7.2. ENVIRONMENTAL IMPACT ASSESSMENT AND STRATEGIC ENVIRONMENTAL ASSESSMENT

There is a need to strengthen the EIA procedure, The EIA very rarely contains the baseline study, and the regulation does not set environmental standards, which should be either monitored or not exceeded.

Strategic environmental assessment SEA

With the present legal framework, the scope and the quality of the EIA study often depends on the institution performing the study, as the regulation provide for a loose set of requirements. Due to the lack of both communication and coordination, it is often the case that different ministries in charge of different steps in the procedure do not have the "right" relevant information on the activities planned. This then further burdens the EIA evaluation committees. Some of the problems presently tackled through the EIA might be solved through the development of a Strategic environmental assessment (SEA) for the Republic of Croatia, which is not yet defined through regulations. The intention is to include this segment in the changes of the Environment Protection Act. The idea is to make the SEA mandatory for certain strategies and programs, as well as for plans for development of certain initiatives prior to their confirmation.

Different interests are met through SEA, but it is not regulated completely in national legislation. The EIA, on the other hand, is conducted for individual activities. The problem in implementing EIA regulation on marine aquaculture is that aquaculture has, at least so far, rarely been viewed as an integral part of coastal activities and initiatives, but rather as an individual enterprise/activity. This has often resulted in invalid or inadequate results, and has – unfortunately – generated an overall negative perception of the activity, both among the decision makers and among the general public.

3.7.3. MONITORING

In the current setup in the Republic of Croatia, the monitoring and mitigation measures are foreseen in the EIA study prepared for any individual activity. This introduces a wide array of different methods and requirements set forth in individual monitoring procedures. These are rarely, if ever, co-related with monitoring measures prescribed for other similar activities, and the data obtained through the monitoring are not adequately used for mitigation or other management measures. There is no clear set of monitoring procedures suggested for any type of activity, including marine aquaculture. County level administration in charge of physical planning sometimes also lacks both the capacity (human and financial) and the will to retrieve and process the data obtained through the monitoring. With the monitoring on an individual basis, it is difficult to control and enforce the measures set. Although the monitoring measures set in the EIA become binding once the EIA is approved, these are often disobeyed. This is partially due to the high costs and partially to the lack of information the farmer would need. The costs are often projected at levels higher than those possibly sustainable by the small size farms, and the farmers still do not truly understand the implications a bad-monitoring result may have on the quality of the fish and the level of production in the future. Another problem is that often several small size farms operating in the vicinity do not have any monitoring procedures set, since they do not require an EIA for their enterprise. This could be remedied by setting either the minimum distances or the minimum level of production per area for which a monitoring procedure could then be set. An education program should also be put in place, where the farmers would be educated into, among other things, the best management practices (BMPs), monitoring importance, environmental implications and interactions etc. It could be a suggestion that a Committee is set at the level of the County, which would consist of the representatives of relevant ministries (in the case of marine aquaculture, for example such a Committee could consist of the representatives from the ministries in charge of fisheries, physical planning, environmental protection tourism and sea affairs). The task of the committee would be to retrieve the monitoring reports, ask for clarifications and implications, and to, according to the input, suggest further measures. The reports and the monitoring procedures should thus be comparable, leading back to the need for a set of standardized monitoring procedures.

3.7.4. ENVIRONMENTAL QUALITY STANDARDS (EQS)

EQS are needed to manage the monitoring of aquaculture properly. Standards are defined for a set of substances. In terms of marine aquaculture they are limited to some toxic substances and water quality limits. These limits and standards are the same ones as set in the EU regulations, but even the EU has admitted the lack of adequate EQS for marine environment as a whole. EQS should be developed at a national level for the Republic of Croatia.

3.7.5 PLANNING AND ZONING PROCEDURE

Although there are extensive and numerous regulation covering planning procedures in general, marine aquaculture planning is still viewed as another individual activity, which is rarely given priority or even deserved attention in physical plans. This is partially due to the high importance of tourism, which is still inadequately linked with the possibilities of marine aquaculture. Part of the reason is also the "bad image" often attributed to marine aquaculture activities, which is caused by accidents and behaviour of some irresponsible farmers rather than by the sector as a whole. The negative public perception is often the reason why in planning and zoning activities marine aquaculture does not get the proper attention.

The planning and zoning procedures currently in place lack the basic tools of integration, implementation, proper management, monitoring and evaluation of the results. They are rather streamlined, and with very few feedback possibilities.

A good set of guidelines for zoning, integration and planning of marine aquaculture could be useful both for the planners structuring the physical plans at County levels, as well as for the decision makers and the farmers. The planners and the decision makers would benefit from an integration chart which would help them in assessing the true benefits and drawbacks of different activities competing or co-existing at a given area, and for the farmers they would present a clearer procedure and would facilitate the initial steps (cutting the initial costs in location permits and EIA, as well as in subsequent monitoring activities)- These guidelines would attempt to address some of these issues.

Environmental Quality Standards, EQS

3.7.6. OFFICIAL STATISTICS

Official marine aquaculture data gathering was initiated in 2003. Without a proper system of data

Best Management Practices, BMP

gathering, it is impossible to assess the needs of the industry (as no assessment of the status can be made), it is impossible to monitor the activity (as no certified database is available to compare the values with), and it is overall impossible to achieve sustainable development in a healthy environment.

3.8. Best Management Practices

To ensure proper development of aquaculture, science should be applied and **best management practices** (**BMPs**) should be implemented. Comprehensive BMPs should become a "living document", open to revisions and expansion. Established BMPs provide consistent national standards and practices for implementation of different types of aquaculture in the coastal areas, as well as standards for monitoring and control of these activities. Aquaculture and other coastal industries, agencies, and environmental organizations have recognized the need for BMPs. BMPs for site planning and for ICZM provide opportunities for early intervention and collaborative review of new activities. By publishing public standards and goals in advance of the submission of plans by a private developer, for example, one can provide guidance before major investments are made in site development. BMPs should be developed for all different species and technologies. This is the next step in aquaculture planning, and should be an object of separate study.

3.9. General Remarks

In creating a sustainable aquaculture and coastal zone management plan, it is essential to strike a balance between the need for aquaculture development and the need for natural resources conservation within the same management plan. In this context it is necessary to recognize and deal with the increasing competition for resources.

Croatia has a certain advantage of still having undeveloped and pristine islands, as well as some parts of the coast and sea. However, no one is responsible for being 'awarded' with such a beautiful treasure, but we are certainly responsible and obligated to do everything in our power to preserve the natural and cultural values for generations to come.

Sustainable use of Croatia's coastal and aquatic resource base requires an appropriate and enabling regulatory framework that is supported by clearly delineated national, county and local roles and responsibilities and transparent accountability agreements. At all levels, the roles of agencies involved with aquaculture should be clarified. Central themes should include site access, property rights, food safety, productivity, competitiveness and environmental sustainability. Incorporating a planned approach to resource use and management, a streamlined and inclusive review process would provide a practical mechanism for timely conflict resolution. Moreover, such a framework would be conducive to the development of a balanced and objective public service culture with respect to aquaculture and other users of the islands, marine and coastal resource base, such as fisheries, tourism, nature conservation and agriculture.

Some of these issues may be solved on a national level, but some need to be taken down to local communities and local authorities. The development of indicators, environmental quality standards and codes of conduct should be left to governmental level, while actual implementation and mechanisms of monitoring and follow-up, together with planning should be left to local communities. Development of codes and EQS should be a task all responsible ministries should work together on. Creation of a National Network of Experts, including representatives from ministries, science and industry (in this case marine aquaculture) should be a priority, as it is this body that should ultimately bring the suggestions for national standards. Whether this body is institutionalized or not, depends on the national strategies identified and overall development plans.

INTERNATIONAL CONVENTIONS RATIFIED BY THE REPUBLIC OF CROATIA POSSIBLY AFFECTING MARINE AQUACULTURE

Here follows a list (not exhaustive) of several international conventions ratified by the Republic of Croatia, which might affect marine aquaculture. Detailed information on the conventions may be obtained from these two sites: www.mzopu.hr and the www.nn.hr

- Protocol on Strategic Environmental Assessment. Signed by the Republic of Croatia in Kiev, 23 May 2003.

- Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona 1976); Pursuant the notification on succession, the Republic of Croatia became a party to the Convention on 8 October 1991 (OG-IT 12/93).

- Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft (Barcelona 1976);Pursuant the notification on succession, the Republic of Croatia became a party to the Convention on 8 October 1991 (OG-IT 12/93).

- Amendments to the Convention for the Protection of the Mediterranean Sea against Pollution (Barcelona, 1995); Published in OG–IT, No. 17/98, came into force with respect to the Republic of Croatia on 9 July 2004, and the effective date was published in OG-IT 11/04.

- Amendments to the Protocol for the Prevention of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea (Barcelona 1995); Published in OG–IT, No. 17/98, came into force with respect to the Republic of Croatia on 9 July 2004.

- Protocol Concerning Cooperation on Preventing Pollution from Ships and, in Cases of Emergency, Combating Pollution of the Mediterranean Sea (Malta 2002); Published in OG–IT, No. 12/03, came into force with respect to the Republic of Croatia on 17 March 2004, and the effective date was published in OG-IT 4/04.

- Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean. (Barcelona 1994 and Monaco 1995); Published in OG–IT, No. 11/01, came into force with respect to the Republic of Croatia on 12 May 2002, and the effective date was published in OG-IT 11/04.

- Protocol for the Protection of the Mediterranean Sea against Pollution from Land-Based Sources (Athens 1980); Pursuant the notification on succession, the Republic of Croatia became a party to the Convention on 8 October 1991 (OG-IT 12/93).

- Protocol for the Protection of the Mediterranean Sea against Pollution From Land-Based Sources and Activities (Syracuse 1996); Republic of Croatia signed the Protocol.

- Protocol for the Protection of the Mediterranean Sea against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and its Sub-Soil (Madrid 1994); Republic of Croatia signed the Protocol.

- Protocol on the Protection of the Mediterranean Sea by Transboundary Movements of Hazardous Wastes and their Disposal (Izmir 1996); Republic of Croatia has not signed the Protocol.

- United Nation Convention on Biological Diversity (OG – International Treaties 1/6/96) Entry into force in the Republic of Croatia: 5 January 1997.

- Bio-safety Protocol under the Convention on Biological Diversity (Official Gazette –

guidelines 26062006.qxp 5.7.2005 0:50 Page 40

International Treaties No 7/02) Entry into force in the Republic of Croatia: 29 September 2003.

- Convention on Conservation of European Wildlife and Natural Habitats (Official Gazette – International Treaties 6/00). Entry into force in the Republic of Croatia: 3 July 2000.

- Convention on the Conservation of Migratory Species of Wild Animals (CMS) (Official Gazette – International Treaties 6/00) Entry into force in the Republic of Croatia: 1 October 2000.

- European Landscape Convention (Official Gazette – International Treaties – No 12/02) Entry into force in the Republic of Croatia: 15 April 2003.

- Convention on Environmental Impact Assessment in a Transboundary Context (Official gazette 16/96). Entry into force in the Republic of Croatia: 10. October 1997.

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European Commission - Common Fisheries Policy and Environmental policy, http://europa.eu.int/

Frankic, Anamarija: Coastal Management & Sustainable Aquaculture Development in the Republic of Croatia- Contribution to the project: ICZMP; Center for Coastal Resource management, Virginia Institute of Marine Science, College of William and Mary, USA, 2003

Guidelines for Integrated Management of Coastal and Marine Areas with Special Reference to the Mediterranean Basin, Split, Croatia, PAP/RAC (MAP-UNEP), 1994, pp iii+80.

Meramed Project: www.meramed.com

Ministry of Agriculture, Forestry and Water Management, www.mps.hr

Ministry of Environmental protection, Physical Planning and Construction, www.mzopu.hr

Official Gazzete, www.nn.hr

Planning and Management for Sustainable Coastal Aquaculture Development; GESAMP No.68, FAO, 2001

CHAPTER 4: SOCIO-ECONOMIC ASPECT

In this Chapter basic information on the need for social and economical assessment are provided. Also, guidelines have been suggested for County or investor level as to how to proceed in assessing social and socio-economical impact to the community in brief guidelines. Importance of public participation in any activity introduced in an area is stressed. The procedures outlined here may be used in assessing the social and economical consequences of marine aquaculture on a general (planning) level, as well as on particular (site) level. Depending on the scope of the activity, the suggested guidelines may be adapted.

4.1. GENERAL

Planning for sustainable uses of coastal resources must be a process that comprehensibly and holistically analyses islands, marine and coastal systems: natural resources conditions, and human uses and socio-economic aspects. Site suitability assessment and implementation must incorporate physical, biological as well as socio-economic and cultural factors.

4.2. COST-BENEFIT ANALYSIS (CBA)

Cost-Benefit Analysis (CBA) is needed if proper socio-economic analysis is to be prepared. Although an important planning and development tool, it has not been used much in planning of marine aquaculture. There are five main stages of a CBA:

- *DEFINITION OF THE SCOPE OF THE PROJECT (NATIONAL, REGIONAL, LOCAL)*
- *IDENTIFICATION OF COSTS AND BENEFITS*
- *FINANCIAL EVALUATION*
- *ECONOMIC EVALUATION*
- *COMPARISON OF ECONOMIC COSTS AND BENEFITS OVER TIME UNDER VARIOUS SCENARIOS.*

The benefit of a CBA is that it provides valuable insight into economical side of the project (costs and benefits of development of a certain project in terms of revenues, employment, concession fees).

The weak side is that there are costs and benefits that may not be easily estimated. Leaving CBA to be the only mechanism of assessment in discussing different options of development is not a good idea. The decision makers should be well aware of its limitations. Social assessment is usually the best complement to a CBA, as it provides the insight into the general opinion and may be better in assessing the intangible costs and benefits.

Ideally, both a CBA and a Social Impact Assessment (SIA) should be performed, complementing one another. In the course of the procedure, general public should be made aware of all possible costs and benefits, including real, environmental and social. Both assessments could be used in general planning procedures as well as on local level. The scale of the assessment would vary according to the scope, but the general input data should be the same.

4.3. SOCIAL IMPACT ASSESSMENT (SIA)

By definition, SIA runs parallel with environmental impact assessment (EIA), risk and hazard assessment, technology assessment, project, program and policy monitoring and evaluation and a number of other planning and management fields. It also includes the cultural assessment, and policy evaluation. In another words, this assessment could provide the decision-makers with effective tools how to organize and implement certain economic incentive.

POSSIBLE SOCIO-ECONOMICAL IMPACT OF AQUACULTURE

In the case of potential introduction of aquaculture, it should be clear that:

- *It has its physical characteristics;*
- *It has its social impacts due to the impact on physical environment;*
- *It also has a social impact due to the change it introduces in the local social environment*.

This change and impact could be operationalized in the following way:

- *AQUACULTURE CAN INFLUENCE AND CHANGE THE PERCEPTION OF THE PLACE* – the place used to be known as a place for, say, vacation, holidays, traffic, commerce, etc., but after the introduction of something new (aquaculture), the same place will be mostly identified with this "new" thing. This may be a positive or a negative perception.
- *IT CAN INFLUENCE AND CHANGE THE EMPLOYMENT PATTERNS* – aquaculture can bring about to the new ways of development, and thus also of employment, which is definitely favourable, especially for the economically depressed areas.
- *IT CAN INFLUENCE AND CHANGE THE EXISTING ECONOMIC AND SOCIAL PATTERNS OF LIFE* – the place (a town, an area) and the way of life could be positively changed in the sense that new activities are to be open, provided, and that the existing inhabitants can participate in these new opportunities. This, in turn could have positive long-term effect for the development of the area in general, and in that sense, overturn the negative demographic and employment trends.
- *IT COULD HAVE A SHORT AND/OR LONG TERM IMPACT ON THE CHANGES OF PERCEPTION* of the overall picture of a place, city, and area.
- *DIRECT AND INDIRECT BENEFITS FROM THE ACTIVITY CAN BE FELT.* In this sense, the population in a certain area could have a better standard of life and can attract other activities, people, and industries into the area. These direct benefits could be supplemented by some indirect benefits, which, in most of the cases, could not be predicted in advance with full precision. These more indirect ("fringe") benefits usually are felt in a longer run, and could influence the overall change of the image of the place (to the better), placing new standards for economics and social environments, etc.

4.4. SIA - SUGGESTIONS FOR PROCEDURE

SCOPING

There is a need to identify the potential impacted people and their concerns, and the actors involved. Community problems should be determined as well as present plans of initiatives and aspirations of local population.

PROBLEM IDENTIFICATION

Usually there are many interrelated problems, and the goals of the assessment study must be also a) to clearly define what are the problems, b) how many of them at the moment could be enumerated, c) in what ways are they inter-correlated, and d) what problems current study is to address.

FORMULATING OF ALTERNATIVES

Reasonable alternatives should be developed on the basis of the needs of the community, people involved, taking into consideration their aspirations and attitudes. A wide range of techniques could be used – public meetings, questionnaires, interviews, advisory groups, public data, etc.

PROFILING

Determination of what is likely to be affected impact. Describe social units to be affected, with appropriate indicators for measuring. A clear social profile of the affected should be identified – a baseline study is necessary.

PROJECTION

With the respective data, an assessor is doing projections of what is likely to happen and who is affected or will be affected and in which sense. Cause-effect linkages should be also assessed. Develop several scenarios to identify possible course of actions

ASSESSMENT

The primary task is to assess the magnitude of impacts and changes that are likely to occur in the local environment

EVALUATION

Evaluation takes into account the major trade-offs and tries to determine the losers and the gainers. It should provide answers to the following question: What are preferable alternatives to be implemented?

The results of the evaluation should be presented to the advisory groups and/or at the meeting at the level of community. In most of the cases a simple document to show the basic results should be prepared.

ONGOING MONITORING

Observation of effects in their implementation and measuring potential difference with the predicted ones is necessary. Develop plans for continuous monitoring. Today there is a wide variety of monitoring options for social and socio-economical analysis.

PARTICIPATION OF THE PUBLIC IN ASSESSMENT PROCESS

Public participation is one of the tools of overall methodology of social assessment. It means that all stakeholders have the (same) right and different possibilities to participate in deciding about alternatives.

Participation is realized in the way that one must take into account existing views and preferences of affected population and other stakeholders so as to improve design of the project, as well as to establish a participatory process for project implementation and monitoring. Participation is a continuous procedure, an integral part of the whole assessment and it does not end at the moment when the assessment is done – participation is expected in the process of monitoring as well.

Participation usually must include the following representatives or layers of the population in a certain area:

- *Key informants (experts, representatives of local community on the political level);*
- *Advisory groups;*
- *Community forum representatives;*
- *"Ordinary citizens";*
- *Representatives of potential investors;*
- *Citizen committees;*

Ways of dissemination of results, or how to get a feedback on the ongoing process of social assessment are usually the following: public hearings; referendum; workshops; newsletters and public display of information.

ENGAGEMENT TOOLS

In many occasions *local public* have reacted against new initiatives, following the *"not in my back yard" syndrome (NIMBY)*. In this sense it is questionable whether the local residents would be able to see any potential benefits for them through the introduction of aquaculture in their environments. Possible benefits (employment of local residents in the aquaculture activities) could be of great help as a major facilitator for the whole initiative. The whole strategy should be build very carefully, with full awareness on potential dangers if and when local residents are overlooked and ignored.

So, when planning any actions concerning social assessment, several aspects must be organized as follows:

- *Involvement of general public and decide on participation tools;*
- *Develop negotiation and conflict resolution tools;*
- *Develop adequate information and education tools;*
- *Develop adequate methods for stakeholder analysis and social profiling tools;*
- *Develop survey and methodology tools;*
- *Develop participatory action research tools;*
- *Develop monitoring and evaluation tools.*

One of the final results of this analysis is a conviction that careful planning and analysis of all dimensions concerning aquaculture represent a necessary step that must be taken seriously into account if the whole initiative should be a success.

Main References:

Caldarovic, Ognjen: Socio-economic Aspects of Marine Aquaculture in Velebit Channel - A Contribution to the project ICZM; University of Zagreb, Croatia, 2003

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CHAPTER 5: ENVIRONMENTAL IMPACT ASSESSMENT AND CONCERNS

In this Chapter a brief outline of Environmental Impact Assessment (EIA) is provided, with reference to current practices in the Republic of Croatia and general considerations of environmental impact. The importance of environmental impact is stressed, and some suggestions for improvements are provided.

5.1. General Considerations

EIA is a formal and structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process. This information consists, basically, of predictions of how the environment, human health and welfare are expected to change if certain alternative actions are implemented and advice on how best to manage environmental changes if one alternative is selected and implemented. The 'environment' includes biological and physical environment as well as the socio-economic environment.

Today, EIAs are a legal requirement for major development projects with significant environmental impacts in most industrialized countries and in many developing countries. Benefits of an EIA are numerous, and include, among other, improved environmental protection, the long-term lowering of the project costs, facilitating of the investment, identification of mitigation actions and the increase of project acceptance by the public.

5.2. EIA in Croatia

In the Republic of Croatia EIA is not required for farms producing less than 50t/year and hatcheries producing less than 500 000 juveniles per year unless the County plan stipulates anything different. However, it has been shown in practice that this system may have some shortcomings, which in the long run may result in the deterioration of the environment larger than expected. This is in some cases due to the fact that the production exceeds the limit listed in the license (e.g. lack of enforcement) and more often may be attributed to bad management and husbandry practices.

Monitoring procedures are provided in EIA studies, and the study itself assesses the amount of fish, which may be farmed in a given area. In Croatia, a committee comprising experts from different fields assesses each EIA study. Once the EIA has been given a green light, the license obtaining procedure may be initialized. However, it is a general consensus that EIA studies lack some uniform criteria for assessment and that, very often, it is the EIA that makes the license obtaining procedure difficult.

Without proper planning and legislation, the findings of any EIA will have little meaning, decision criteria will be inconsistent, and mechanisms for ensuring compliance with any recommendations will be lacking. In particular, there will be no mechanism for addressing cumulative and incremental environmental issues, which are a basic characteristic of aquaculture developments.

ENVIRONMENTAL QUALITY STANDARDS

Agreed environmental quality standards are a precondition for effective environmental assessment and integrated coastal management. This is because the significance of any impact (a key issue addressed in EIA) cannot be assessed without some environmental standard to measure the impact against. Ideally environmental quality standards should be developed and agreed prior to any form of EIA or integrated coastal management.

PUBLIC INVOLVEMENT

Public involvement is a fundamental principle of the EIA process. Timely, well-planned and appropriately implemented public involvement programmes will contribute to EIA studies and to the successful design, implementation, operation and management of proposals.

5.3. EIA – Requirements and Procedures

Ideally, the EIA process should include: screening; scoping; impact analysis; mitigation; reporting; review; decision-making; follow up and public involvement.

SCREENING

Screening is the first and simplest stage of considering the environmental impacts of an activity. Based on the general characteristics of the project, screening determines the type of environmental review the project will require. The screening process results in one of three outcomes:

- *The nature of the project demands a full EIA.*
- *By its nature, the project is unlikely to have any significant environmental impacts*
- *The project may or may not require a full EIA; further inquiry is indicated.*

SCOPING

Once a decision to conduct an EIA is made, the scoping process is initiated to determine the key issues and choices of alternatives to be examined in the full EIA.

ASSESSING

Once the important impacts have been identified, their potential size and character can be predicted.

The impact prediction utilises physical, biological, socio-economic and cultural data to estimate the likely characteristics and parameters of an impact. Typical parameters are:

Nature (positive, negative, direct, indirect, cumulative, synergistic with others). Many of the impacts associated with the aquaculture are cumulative in nature

Magnitude (severe, moderate, low). The complexity to estimate the magnitude of an impact varies as a function of the impact considered.

Extent/location (area/volume covered, distribution). Considering the cumulative nature of the agricultural impact the extent/location varies over time

Timing (during construction, operation, immediate, delayed, rate of change)

Duration (short term, long term, intermittent, continuous)

Reversibility/irreversibility – The release of phosphorus and nitrogen is likely to cause effects, which could be rapidly reversible, depending on environment.

Likelihood (probability, uncertainty or confidence to the prediction). If the probability of particular impact is known, than the associated risk is quantifiable. However if the probability of an impact is unknown, we are dealing with uncertainty, which is far more difficult to quantify

Significance (local, regional, global)

Methods used to predict impact include:

Professional judgement

Quantitative mathematical models

Experiments, physical models

Once impacts have been identified and analysed, their significance must be addressed. An impact can be measured against accepted standards or criteria. It may also be measured against more fundamental concept such as environmental sustainability. Public involvement plays a critical role in this process.

5.4. Possible Impact of Marine Aquaculture to Environment

All kinds of marine aquaculture activities will have the potential to exercise some environmental influence or interaction upon the surroundings. This may be by release of various kinds of substances or organisms, or because it may create specific disturbances towards neighbouring activities.

Some of these impacts are related to poor management and can be avoided or reduced by adopting alternative management options, improved technologies or other mitigation measures. On the other hand, there are impacts such as the release of nutrients and faeces, which is difficult to avoid since they are part of the physiology of the farmed species.

The severity of some of the above effects are related to site-specific environmental attributes, such as depth, hydrographic conditions, quality of ambient water, sediment type and presence of other pressures in the area. Both the planner of coastal activities and the fish-farmer have to be aware of the most common kind of the environmental concerns and nuisances.

Keeping the damage to the receiving environment to a minimum will protect the industry itself, favour better fish health an growth, improve the reputation and market opportunities and, not the least, cause less harm to the natural resources in the vicinity.

PARTICULATE MATTER AND DISSOLVED NUTRIENTS

Fish farming in net cages affects the environment by releasing certain amounts of organic waste from uneaten food and faeces. Sedimentary inputs can have a marked impact on benthic communities resulting in successional changes in response to increasing inputs, which can be modelled.

The release of nutrients by fish farms and the effect of water quality is perhaps one of the most widely used arguments against aquaculture. A badly operated farm sited in shallow waters with weak water dinamism might cause overloading of nutrients and nutrient enrichment. Settling of organic material at the bottom, burst of local algal blooms and polluted waters and in some cases even eutrophication problems, can be the case. Feeding techniques are important. Improper feeding or overfeeding may result in unwanted pollution at the seabed as well as in the water column. In addition, poor feed quality, with ingestible solids and excess insoluble and low quality carbohydrates will increase the amount of waste.

In addition to the organic load from feeding and faeces, considerable loads might also be transported to the recipient by the handling of waste such as dead fish, offal, surplus feed etc. Throwing wastes overboard adds to the loading in the vicinity, and should not be done.

RELEASE OF CHEMICALS, MEDICINES AND DISINFECTANTS

Whenever chemicals are used or applied, residual amounts of the substance may enter the aquatic environment. Chemical releases to the environment through routine inputs of feed and faeces containing various additives are likely to occur continuously at low concentrations. An understanding of the persistence of chemicals in the aquatic environment, potential toxicity to non-target species, and inhibition of microbial activity in the aquatic environment are key to assessing potential impacts.

Such chemicals may be used as treatment for diseases, disinfection and cleaning of gear, nets and various equipment. Detergents are used to disinfect gear and equipment. Tanks are sterilized with hypochlorite of formalin. Peroxides may also be appropriate. The most common antifouling agents for nets are copper and TriButylTin (TBT). In many countries the use of TBT as antifouling agent for nets is banned.

There is currently insufficient information available to determine the long-term effects of medicine and antifoulants use. Such research is required particularly where multiple sources enter the same marine area. In the short term, the environmental risk is considered to be low and very much dependant of the magnitude of the use of it. However, in the case of antifoulants, research on alternative anti-fouling strategies needs to be intensified.

The EC requires toxicity testing for new chemicals intended for use. This can take up to 2 years. Pollution control authorities in the UK are compiling registers of usage of chemicals from data supplied by the aquaculture operators.

PARASITES AND DISEASES

Cages, densely populated by fish, may be excellent breeding grounds for parasites. Therefore fish farms can impact the environment through transfer of diseases.

Pathogens and parasites can be spread horizontally (between fish in the same generation) or vertically (between parents and progeny). Infectious diseases are not transmitted, only their agents are.

The transmission of an infectious agent does not insure that disease will occur in the recipient. Whether a disease will occur or not depends on the nature of the exposure and susceptibility of the host.

VERTICAL TRANSMISSION

Vertical transmission of pathogens between wild and farmed fish requires that a sufficient number of infected brood-stock or their progeny successfully reproduce and encounter wild fishes.

HORIZONTAL TRANSMISSION

Diseases can be spread horizontally through direct contact, through vectors, through contaminated equipment and through environmental media such as air and water. Bacterial or viral pathogens do not have active host seeking mechanisms. Most are spread through direct contact with susceptible fish or through opportunistic contact through environmental sources.

THROUGH THE ENVIRONMENT

Fish that remain in a net cage can shed pathogens into the environment through a variety of routes including mucous, faeces and decaying dead fish. Shed pathogens or parasites can enter the water column or the sediments below the pens.

WILD AND FARMED FISH INTERACTION

In general, aquaculture operations attract both pelagic and benthic organisms. Increased biomass around farms can partly be explained by the presence of escaped fish that remain to exploit feed wastes and partly by wild fish attracted to the cages by shelter and available waste feed. Another mechanism for disease transfer is through escaped fish. It is unlikely that a sick fish will travel far after it escapes. In addition, it is unlikely that a sick fish will behave normally, particularly in its attempts to meet social demands. However, for some diseases, asymptomatic carrier states can occur.

ESCAPEES AND GENETIC EFFECTS

It has been suggested that farmed fish have been selected for traits, which make them suitable for farming (for example, rapid growth, placid behaviour, disease resistance), but less well adapted to the natural ecosystem. Thus, escaped fish could initially out-compete native stocks, but then decline, or the progeny resulting from inter- breeding could be poorly adapted to the ecosystem.

It has been disputed within the scientific community whether the interaction discussed above is a serious ecological impact. Based on a 10 year investigation (funded by EU) researchers at the Queens University Belfast demonstrated that farmed fish escapes and hatchery-reared fish are having such an impact that wild salmon stocks are precipitating into an "extinction vortex".

Establishing a large number of fish farms in a certain area may present a risk for genetic dilution of wild populations due to potential accidental release.

NON-INDIGENOUS SPECIES

As in agriculture and ornamental horticulture, alien aquatic species have contributed to an improvement of the human condition in many areas.

While recent attention has focused on the adverse impacts of introduced species - also known as alien species and alien genotypes - species introductions can be a valid means to improve production and economic benefit from fisheries and aquaculture.

Introduced species may have environmental as well as social and economic impacts. Aquatic ecosystems may be affected by the introduced species through predation, competition, mixing of exotic genes, habitat modification and the introduction of pathogens. Human communities may also be impacted through change in fishing patterns due to a newly-established fishery or through changes in land use and resource access when high valued species are introduced into an area.

To ensure that aquaculture development is undertaken in a responsible manner, the international community and many national governments are advocating that a precautionary approach should be adopted. Risk assessment will require information from a number of sources on a number of areas such as the biology, ecology, and genetics of the alien species. The information will need to be readily available and understandable to those performing the risk assessment and to policy makers. Risk assessment must also include an accurate accounting of the benefits derived from the introduced species.

The decision on inclusion of a non-indigenous or allochthonous species is a decision that the Government should bring on a strategic level. The decision should not, by rule, be negative, but general practice indicates that prevention of inclusion of allochthonous species is the best precautionary approach. This problem on a national level raises again the question of definition of non indigenous species, which is in some case still ambiguous and difficult to answer.

An accurate assessment of the impact of an alien species will only be possible if an accurate assessment of the "pre-introduction" ecological and socio-economic environments already exists.

VULNERABLE AREAS

Some areas are particularly sensitive to any form of pollution, regardless of the source. Given the specificities of the marine environment, possible areas that may be influenced by the pollution of marine aquaculture are nature parks and reserves, sanctuaries, breeding grounds and particularly sensitive areas identified through national strategies or international conventions.

INTERACTION WITH WILDLIFE

Interactions with and conflicts between aquaculture operations and wildlife species have become significant management issues for proponents and regulatory agencies. In general, the expanding aquaculture industry is increasingly using more coastal migratory bird habitat important for feeding, staging, wintering, and nesting. Also, at the same time, concentrations of

BOX 3 AREAS OF UNCERTAINTY IN THE USE OF INTRODUCED AND NEWLY DOMESTICATED SPECIES

GENETIC UNCERTAINTIES ON:
- the long-term effects of interbreeding between hatchery and wild stocks;
- the long-term effects of potential inter-species breeding between introduced and wild stocks;
- the significance of genetic variation;

FISH HEALTH UNCERTAINTIES ON
- emerging new diseases and how to screen for them;
mode of transmission of diseases;
- host specificities;

ECOLOGICAL UNCERTAINTIES ON:
- the level of environmental impact, i.e. how an aquatic community will change;
- the resilience, resistance and productivity of ecosystems as influenced by diversity

easily accessible fish are a tempting food source for a variety of migratory birds and mammals. Avoidance of any area where migratory birds and species at risk may be impacted by the construction and operation of an aquaculture project is the preferred approach. Breeding grounds of different fish species should also be identified, as putting a cage above a breeding or nursery ground for valuable fisheries species is not wise and should be avoided.

MANAGEMENT OPTIONS FOR WILDLIFE INTERACTIONS

Even when all feasible avoidance and design features have been incorporated, the concentration of potential food within a fish farm remains an obvious attraction to predators. This can result in a number of problems for the operator including:

- THE DIRECT LOSS OF FISH FROM CONSUMPTION, INJURY, OR STRESS;

- DAMAGE TO HOLDING FACILITIES BY PREDATORS AND A POSSIBLE INCREASE IN FISH ESCAPES;

- INTERFERENCE WITH FEEDING (PREDATORS CONSUMING FOOD OR DISTURBING THE FEEDING PROCESS)

The presence and activities of migratory birds in the vicinity of the operation should be regularly monitored. The species, approximate numbers, behaviour, and time of year should be documented and proponents are encouraged to report information to the responsible agency and seek advice as appropriate. It is important that measures be implemented as soon as the presence of birds begins to interfere with the operation of the aquaculture site. Opportunities for improving feeding and husbandry practices that will reduce the attraction of birds to the site should be considered. Scare techniques should also be considered on a contingency basis.

HABITATS AND SPECIES AT RISK IN REPUBLIC OF CROATIA

Marine habitats identified by the international conventions (Bern, Barcelona) as vulnerable or endangered ones may be found in Republic of Croatia. These include infralitoral and circalitoral habitats on sediment and rocky bottoms, caves, sea grasses meadows, estuaries and coastal lagoons. As some of these habitats such as *Possidonia* beds are considered globally endangered, the cages should not be placed above or near them. Republic of Croatia still does not have the fully completed charting of marine habitats, although certain steps have been made in that direction. Once the full charting of habitats is made, it will be easier to assess the level of their vulnerability and the extent to which they are endangered.

Some species listed in the international conventions as endangered marine species may be found in Republic of Croatia as well. These primarily include whales, dolphins and turtles. Thus far there has been no record of any of these species entangling in the cage nets. *Pinna nobilis*, a protected shellfish species, may sometimes be found beneath the cages. However, it should be noted that should the regulation currently in place be fully complied with and fully enforced, the cages would be pushed further off the coast (above 30m depth), which would in most cases protect both the *Possidonia* beds as well as the endangered shellfish species.

VISUAL

In pristine, beautiful surroundings the sight of a fish farm might be considered a nuisance. In areas with summer-cabins this is often the case. Avoid such sitings for the farms. If this is not possible, make the farm tidy and pleasant! Less prominent colours should be used (black, blue or grey). Installations in these colours are hardly visible from more than 1km distance.

SMELL

If not properly operated unpleasant smell might stem from a fish farm. It could be the storage of feed, sloppy handling of dead fish and offal etc. This may cause irritation for the neighbourhood. It should be easily solved: take properly care of the waste material and operate the farm in a tidy way.

THE FEED PROBLEM

The issues concerning the use of industrial fishmeal and fish oils in artificial pelleted diets in the fish farming industry are wide-ranging and complex. In a world where the most of the important capture fisheries are in jeopardy, aquaculture's need for fishmeal and fish oil is of great concern because it's impact on the capture fisheries sector. In order to reduce the amount of fishmeal in food for marine aquaculture the search for fish feed substitutes has been initialized.

NATURAL STOCKS

The catch/use of juvenile fish for on-growing could jeopardize natural stocks (such as for tuna). This is the reason why quota systems for different species have already been introduced. Fortunately, most finfish species nowadays are fully reared in captivity.

BOX 4: CERTAIN STEPS TO BE CARRIED OUT TO REDUCE THE NEGATIVE IMPACT FROM ORGANIC MATERIAL AND NUTRIENTS FROM FISH-FARMS (CAGES):

SITING:

– Ensure sufficient depths under the cages (at least 25 meters)

– Ensure sufficient current speed

– Check the bottom composition

– Avoid enclosed areas and closeness to bays where organic waste could drift/float in and be trapped

– Avoid recipients, which already have an excessive organic/nutrient load

– Use robust cages to take advantage of deeper and more exposed sites

FEEDING:

– Carefully adjust the amount of feed to the amount of fish in the farms (fish size, feed type and formulation). Keep a thorough record of the amount of fish-biomass in the pens. Do not overfeed!

– Adjust the feeding and feeding rates to temperature and other relevant external factors; use high energy, low sinking feed with favourable fat to carbon/protein ratio utilizing feeds with low nitrogen and phosphorous content, which achieves a higher feed conversion efficiency ratio, could be considered

– Site rotation could be advised, but careful, considerate and attentive operation to maintain the good conditions at the site given might/will be more sustainable

– Careful monitoring of the effect of the farm-operation at the site should be instituted

– Adjust the operation of the farm according to the results of the monitoring

– Dispose the waste and dead fish in designated silage facilities (closed tanks with formic acid), onshore in lime pits or by burning.

Main References:

Approaches for Zoning of Coastal Areas with Reference to Mediterranean Aquaculture; PAP/RAC, 1996

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Box 5: Possible suggestions for EIA study contents (adapted from PAP/RAC, 1996)

1. Introduction

The EIA should contain a short description of the site, description of the planned activities and importance of the project.

2. Description of the proposed project

The proposed plan of the project should be shown on the appropriate bathymetric map (Scale 1:1000 or 1:2500) together with site plan that presents the location of buildings, land based installations and other structures. The description should include:

a) Details of methods of construction (materials used, transport suitability of roads);

b) Detailed description of the farming operations proposed at the site (methods, species, initial and future production capacity, expected patterns of stock weight and feed input);

c) An estimation of the quality and quantity of waste loads produced by the farm's operations, disposal of wastes, mortalities, disease and other treatments.

3. Reasons for selecting the proposed site and technologies

The reasons for selecting the proposed site, including a short description of alternatives, which have been considered, should be given.

Box 5 continued: Possible suggestions for EIA study contents

4. Site description and environment

a) Physical characterization of the local aquatic environment should include information on the following:

- *an onshore topographic and offshore bathymetric map of the site at least 1 km beyond the*
- *culturing location;*
- *details of any existing underwater banks, which could impact water, mass movement, channels and their communication with the sea;*
- *description of shore, bottom type.*

b) Meteorological, hydrographic and hydrological information:

- *predoimnant wind direction, wind velocity and intensity (wind roses, extreme events);*
- *tidal conditions, the seiches and the probability of extreme conditions;*
- *wave conditions and currents;*
- *hydrological conditions of natural or artificial water channels and outlets to the sea;*
- *temperature/oxygen profiles.*

c) Typical water chemistry based on the mean of four replicate samples collected at each of three depths (0.5m, 5m and 1m of the bottom) which must include determinations of:

- *salinity (ppt)*
- *pH (units)*
- *total phosphorus (µg/l)*
- *orthophosphate (µg/l)*
- *total nitrogen (µg/l)*
- *ammonia (µg/l)*
- *nitrate (µg/l)*
- *nitrite (µg/l)*
- *suspended solids/turbidity*

d) Sediment chemistry, based on the mean of four replicate, grab samples taken below the location of the water samples (see above) which include determination of:

- *sediment type on the site and its surroundings;*
- *redox potential (at 4 cm depth in sediment);*
- *sediment organic carbon and nitrogen content.*

e) Biological characterization of the local aquatic environment:

- *phytoplankton community; seasonal changes in composition; occurrence of algal blooms;*
- *mean summer chlorophyll a levels;*
- *survey of the benthic community;*
- *fishing areas and species important to commercial fishing.*

f) Biological characterization of the local terrestrial environment - existence of particularly sensitive and/or protected species or communities.

g) Present land and sea uses on site and in surroundings:

- *location and size of other farming operations;*
- *location and size of nearby settlements;*
- *navigation routes;*
- *location and size of tourism activity nearby the site;*
- *location and size of nearby marinas;*
- *proximity of other point sources of nutrient/effluent, including intensity of agriculture.*

Box 5 continued: Possible suggestions for EIA study contents

5. Identification of possible impacts

An assessment of anticipated or forecasted positive or negative impact, using accepted standards wherever possible, should be given, including the following:

a) Topographic and bathymetric changes and the occurrence of changes during and after construction;

b) Changes in water circulation due to aquaculture construction;

c) Sand movements and where increased sand accumulation and coastal erosion is likely to occur;

d) Hypernutrification/eutrophication – expected response of local biological communities;

e) Physical accumulation and organic enrichment of aquatic sediments – expected response;

f) Impact on bottom flora and fauna, the risk of loss of a habitat, changes likely to occur;

g) Disposal of stock mortalities;

h) Aesthetic impacts of buildings and other structures;

i) Impact on the quality of bathing water and on the cleanliness of beach sand, if any;

j) Interaction with local fishermen;

k) Impact on navigation routes and other activities in the sea.

6. Measures to reduce or prevent negative impacts

This section should describe all measures - whether technical, legal, social, economic or other - to prevent, reduce or mitigate the negative effects of the proposed aquaculture activities.

7. Monitoring

Measures to be used to monitor the effects on a long-term basis, including the collection of data, the analysis of data, and the enforcement procedures, which are available to ensure implementation of the measures should be given. See Chapter 6 for additional suggestions.

8. Bibliography

A list of source materials that are used or consulted in the preparation of the EIA studies should be given.

CHAPTER 6: MONITORING OF MARINE AQUACULTURE

In this Chapter brief outline of monitoring procedures is provided. Modelling may be a useful tool in EIA and monitoring procedures, but a decision should be made on the type and the scope of a model (or models) to be used. This decision should be based on specific conditions and types of productions, as these differ in organic load, impact to environment and requirements. Regardless of the model developing procedure, it is suggested that all fish farms in Croatia should regularly monitor the impact on the environment. Suggested monitoring procedures are simple and should be cost-effective. Data gathered from the monitoring should be supplied to the central database in the County, and there should be an expert body at the level of the County, which would assess the data and provide advice to the planners and farmers alike on future management options or changes. If linked to a good planning and licensing procedure, and a good EIA procedure, this system could assist the farmers and the planners in managing the system in a sustainable way. It is also suggested that two or more small farms of less than 100t if located in close proximity (shellfish farms usually) should be monitored as one larger production farm.

6.1. General Considerations

All fish farms release some effluents, which give an environmental response in the vicinity of the farms. The purpose of monitoring is to assess this impact and to provide a base for options to improve performance.

The process of monitoring is in principle as follows: the impact of a certain production at an operational farm is modelled and then checked at the site and in its surroundings. The results are compared to the EQS or any agreed upon standard, and the level of production and future monitoring frequency and thoroughness is adjusted according to the findings. The cycle is then repeated after a certain interval.

An example of this principle is given below (The MOM – Modelling-Ongrowing fish farms-monitoring – system which the Norwegian standard is based upon).

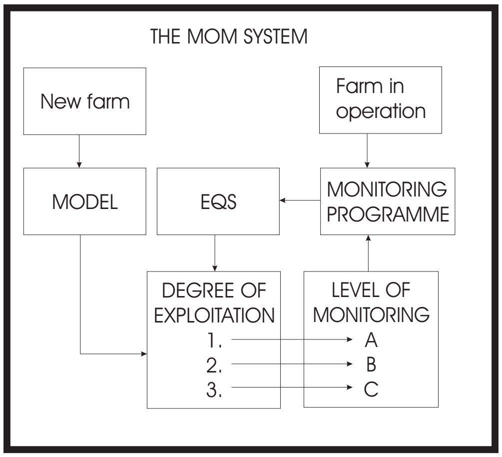

Figure 3. MOM system (Modelling-Ongrowing-Monitoring), a Norwegian system

Environmental conditions and associated tolerance levels are extremely variable in marine waters. Therefore, it is more important to monitor environmental impact using critical effect parameters rather than measuring the actual effluent from the fish farm. An essential aspect of monitoring survey strategy is to ensure that the methodologies used are uniform and that they are applied to the same standards in all surveys.

Thus there have to be standardised protocols for all methods used and a system for ensuring that these are adhered to by all survey operators (Quality Assurance/Quality Control).

6.2. EIA and Monitoring

EIA and monitoring are inter-related: monitoring is the mean to assess the environmental impact. Hence, each monitoring should be linked to the EIA, or rather to the results of the prediction model used in EIA. Data and model predictions from EIA are needed to design efficient and cost-effective monitoring programmes. The pre-requisites for a sound monitoring are to have both a good baseline study and basic EQS set, or at least main indicator values identified.

6.3. Monitoring in the Republic of Croatia

The Environmental Protection Act regulates monitoring of marine aquaculture in Republic of Croatia. It is done in accordance with the EIA study, as this document then states what kind of monitoring should be conducted.

Although there is a legal basis for monitoring, several problems have been observed in practice. First of all, monitoring system is not unified – there is no clear and defined set of parameters to be universally monitored on one type of fish farm. Also, baseline values are lacking in some case, and prediction models differ significantly, if and when are used. Finally, no standards are set in terms of indicator impact parameters, which would signal the need for some management options and future decisions.

6.4. Monitoring Criteria

Overloading of sites and accumulation of organic material in the form of waste feed pellets and excrement can be a fundamental cause of stress, poor growth and disease, with the associated spread of infectious agents and need for medication. Organic material can therefore be influential for several types of environmental impact, even if the effect is greatest on the bottom under the cages. The present standard focuses on methods for determination of bottom conditions at and in the vicinity of fish farms.

Repeated and systematic monitoring provides an overview of the possible changes in bottom conditions both under and around the site. The environmental effects are monitored regularly and any undesirable developments are corrected.

6.4.1 TERMINOLOGY – SOME DEFINITIONS

6.4.1.1 Holding Capacity

The holding capacity as related to auculture is a measure of the biomass of cultured species that can be supported without detriment to either cultured species themselves or to the environment, generally depends on effects that occur on a larger spatial scale. Accordingly the long-term sustainable production of aquaculture is largely related to the holding capacity of the environment it is associated with. In the case of aquaculture the holding capacity (or environmental capacity) may be:

– *THE RATE AT WHICH NUTRIENTS CAN BE ADDED WITHOUT TRIGGERING EUTROPHICATION;*

– *THE RATE OF ORGANIC FLUX TO THE BENTHOS WITHOUT MAJOR DISRUPTION TO NATURAL BENTHIC PROCESSES;*

– *THE RATE OF DISSOLVED OXYGEN DEPLETION THAT CAN BE ACCOMMODATED WITHOUT MORTALITY OF THE INDIGENOUS BIOTA.*

6.4.1.2 Allowable Zone of Effect (AZE)

The use of AZE accepts that aquaculture will have an impact restricted to a defined area. Establishing an AZE around a cage or cage set provides a degree of flexibility in the regulation of farms effects. This practice recognises that it is difficult to cause no environmental effects from intensive fish production in the immediate vicinity of

Box 6: Variables often used to monitor the ecological effects of coastal aquaculture wastes (GESAMP)

Variable	Usage	Cost	Value
Sediment Chemistry			
Redox potential (Eh)	M	L	H
Depth of visual Eh discontinuity	L	L	L
Total Organic Carbon (TOC)	H	M	M
Total Kjeldahl Nitrogen (TKN)			
Total Nitrogen (TN)	L	M	M
Benthic Biota			
Visual presence of *Beggiatoa*	H	L	M
Microfaunal Community			
Structure	H	H	H
Visual survey	H	L	L
Water Chemistry			
Dissolved Oxygen	H	L	H
Biochemical Oxygen Demand (BOD)	H	L	H
Suspended Solids (SS)	H	L	M
pH	L	L	L
Transparency (Secchi disk, NTU)	L	L	L
Dissolved Inorganic Nutrients	H	H	M
Phytoplankton Biomass			
Chlorophyll	L	M	H

Legend:
L - low
M - medium
H - high

the cages. In Mediterranean practice regulators have tended to specify a maximum AZE, typically a radius of 25 or 50 m from the cages or the licensed surface area.

6.4.1.3 Reference Sites

It is an essential aspect of any survey strategy that a suitable reference sampling station(s) is selected as a comparator against which changes at stations influenced by fish farm discharges can be assessed.

Reference stations should be located far enough from the cages to be well beyond any cage related influence but in an area having similar depth, sedimentary and hydrographic characteristics. In practice it is usually found that a position upstream of the predominant current through the cage site at a distance of between 500 and 1000 m is suitable.

However this can vary if local circumstances dictate another position. If the local conditions are very variable in the vicinity of the cage site it may be necessary to select more than one reference station in order to have undisturbed comparators for all conditions observed at the stations along the chosen sampling transect.

6.4.1.4 Impact Zones

Fish farm effluent consists of large particles (wasted feed pellets and intact faecal pellets), smaller suspended particles (feed dust and broken faecal pellets) and dissolved material (nutrients, organic compounds etc.).

These types of effluents have different potential dispersal kinetics, and affect the water column and sea floor at varying distances from the fish farm.

A greater impact is accepted under a fish farm than further out into the recipient. Around a fish farm, various zones are formed, which are affected to different degrees (see Table 11), and where different environmental standards are used. The table gives information on the dominant source, and potential source of impact.

Table 11. Overview of impact zones

	Local Impact Zone	Intermediate Impact Zone	Regional Zone
Definition	Area under and near a fish farm where most of the larger particles are deposited. This does not normally extend beyond 15m from the fish farm	Area between the local impact zone and the remote zone, where sedimentation of smaller particles occurs	Area beyond transitional zone
Source of Impact	Fish farm	The fish farm is a source of impact, but other factors contribute	The fish farm is one of several sources of impact
Potential Impact	Marked changes in benthic faunal communities and chemical conditions at the sea floor. Fouling of the cage group, reduced oxygen levels in the cages	Gradually less impact	Increased primary production and oxygen consumption in deeper water

Box 7: Overview of aquaculture-specific monitoring parameters and characteristics for which data may be collected

– Hydrographic and topographic conditions of coastal water bodies in terms of current

– Directions and speeds, tide dynamics, wave actions, winds, retention times of water

Box 7 continued: Overview of aquaculture-specific monitoring parameters and characteristics for which data may be collected

– Masses in embayment, stratification patterns, estuarine mixing of marine and fresh water masses, fluctuations in river flows;

– Depths, slopes, seabed types, sedimen tation and erosion patterns, etc.;

– Ecological characteristics of "undisturbed" benthic and pelagic communities as well as of littoral/riparian fauna and flora;

– Patterns, extent and consequences of aquatic contamination and physical degradation by coastal activities other than aquaculture;

– Location, lifetime and layout of the aquaculture farm, including size, design or construction of holding units, water supply channels, tubing, pre- and post- water treatment facilities,

– Quality of water supply, water exchange requirements (salt water/fresh water), properties of pond soils, etc.;

– Cultured organisms, including type and number of species/strains, size/age, stocking density, growth, yield per production cycle; time of stocking and harvesting; disease problems (type, onset, duration), losses;

– Inputs, including feeds, fertilizers, chemicals, in terms of type, quantity, composition (if possible, content of water, inorganic and organic carbon, nitrogen, phosphorus) consistency, food particle size; methods, schedule and frequency of feeding, fertilizing and chemical usage;

– Spatial and temporal changes in the water column within and/or around the farm, in terms of water circulation/current speeds, salinity, turbidity, colour, temperature, pH, dissolved oxygen, dissolved inorganic nutrients, total carbon, total nitrogen, total phosphorus, suspended and settled particulate matter, BOD, etc.;

Box 7 continued: Overview of aquaculture-specific monitoring parameters and characteristics for which data may be collected

– Spatial and temporal changes in and on the seabed (and pond bottoms) in terms of sediment colour, thickness, consistency, pH, redox potential, organic matter content, BOD, COD, total carbon, total nitrogen, total phosphorus, dissolved inorganic nutrients, dissolved oxygen, hydrogen sulphide, methane, drug residuals, etc.

– Spatial and temporal changes in benthic and pelagic organisms (partly including cultured organisms) in terms of responses at biochemical and cellular level, responses at the level of individual organisms (morphological anomalies, reduced reproduction, growth and survival, accumulation of chemicals in tissues), responses at population and community level (abundance of indicator species, species richness, abundance, biomass, diversity), energy flow in food webs, etc

6.4.2 MEASUREMENT PARAMETERS

Monitoring programs are composed of a scheme for measurements of certain parameters.

Box 8: Indicators commonly used in the water quality monitoring programs

Physical

Temperature and salinity profiles are used to determine ambient stratification, which in turn can control vertical exchange of heat and food. Sudden and excessive changes in temperature, e.g. as a result of the cooling water discharge, can have detrimental effects on the aquatic environment.

Box 8 continued: Indicators commonly used in the water quality monitoring programs

Nutrients

Nitrogen (Organic, Nitrate plus nitrite, Ammonia, Total)

Phosphorus (Filterable reactive, Total)

The nutrients nitrogen and phosphorus are essential for plant growth. High concen trations indicate potential for excessive weed and algal growth. Total nutrients are made up of a dissolved component (e.g. nitrate plus nitrite, ammonia and filterable reactive phosphorus) and an organic component, which is bound to carbon (e.g. organic nitrogen). Nutrients in the dissolved state can be readily used by plants. FRP is a measure of the level of phosphorus that is readily recycled through organic biomass; TP includes FRP together with phosphorus bound to the organic matter. Ratio of total phosphorus to total nitrogen can be used as an indicator of likelihood of cyanobacterial blooms.

Microalgal Growth

Chlorophyll-a – An indicator of algal biomass in the water. An increase in chlorophyll-a indicates potential eutrophication of the system. Consistently high or variable chlorophyll-a concentrations indicate the occurrence of algal blooms, which can be harmful to other aquatic organisms.

Water Clarity

Suspended solids – Small particles (soil, plankton, organic debris) suspended in water. High concentrations of suspended solids limit light penetration through water, and cause silting of the benthic (bottom) environment. Suspended solids in concentrations as low as 200 mg/L can kill susceptible fish species by abrasive action on their gill tissues.

BOX 8 CONTINUED: INDICATORS COMMONLY USED IN THE WATER QUALITY MONITORING PROGRAMS

TURBIDITY – A measure of light scattering by suspended particles in the water column. Altered light climate might affect productivity and predator-pray relationships.

SECCHI DEPTH – The depth to which the black and white markings on a Secchi disc can be clearly seen from the surface of the water provides an indication of light penetration.

OXYGEN

DISSOLVED OXYGEN – Essential for life processes of most aquatic organisms. Low concentrations of dissolved oxygen usually indicate the presence of excessive organic loads in the system, while high values can indicate excessive plant production (i.e. eutrophication). Many aquatic organisms will suffocate if there is insufficient volume of dissolved oxygen in the water.

OXYGEN DEMAND – The oxygen demand is a measure of the level of organic matter present in the water body (both particulate and dissolved). BOD (biological oxygen demand) is a measure of the actual amount of oxygen that wild be consumed from the water mass over some period of time (usually 5 days) when the existing bacterial population break down what organic matter they can. COD (chemical oxygen demand) is a measure of oxygen required for the breakdown of all the organic matter present in the water. Less realistic indicator than BOD, it is much quicker to measure, and it is often used for this reason.

pH

pH – A measure of the acidity or alkalinity of the water. Changes to pH can be caused by a range of potential water quality problems (e.g. low values due to acid sulphate runoff). Extremes of pH (less than 6.5 or greater than 9) can be toxic to aquatic organisms.

SALINITY

CONDUCTIVITY – A measure of the amount of dissolved salts in the water, and therefore an indicator of salinity. In fresh water, low conductivity indicates suitability for agricultural use. In salt waters low conductivity indicates of freshwater inflows such as storm runoff.

TOXICANTS IN SEDIMENTS

TRACE ELEMENTS IN SEDIMENTS

Trace elements, such as fluoride, are present in the environment naturally and derive principally from weathering of rocks and soils. Many elements are essential for aquatic organisms. However, high concentrations of some elements in sediments can be toxic to aquatic organisms and may indicate contamination from domestic or industrial sources.

ORGANIC CHEMICALS IN SEDIMENTS

Commonly used pesticides can accumulate in the sediments of aquatic environments and may reach concentrations toxic to aquatic organisms.

DISEASE ORGANISMS

BACTERIA; FEACAL COLIFORM

Disease causing microorganisms enter marine ecosystem via sewage, animal faeces or in urban runoff. Human pathogens can endanger people in direct contact with the water (e.g. swimmers) or those eating contaminated filter-feeders, which can concentrate bacteria and viruses. Introduced pathogens can affect flora and fauna.

HEAVY METALS

COPPER, LEAD, ZINC, CALCIUM, TIN, MERCURY

Heavy metals can be acutely toxic to aquatic organisms. Even when present in sub-lethal levels, heavy metals can have a number of debilitating effects that reduce the health and growth of aquatic organisms. Heavy metals tend to accumulate in fish and shellfish. If sufficiently high, accumulated heavy metals in fish and shellfish are of public health concern and may lead to the closure of fisheries.

6.4.3 MONITORING RECOMMENDATIONS

The following monitoring recommendations describe methods for measuring bottom impacts from marine fish farms, and gives detailed procedures for how environmental impacts from individual fish farm sites shall be monitored.

The monitoring encompasses three types of survey (A, B and C survey), which vary in the intensity of the monitoring program and with the life cycle of the farming operation.

6.4.3.1 Pre-License (Baseline) Survey

At all new sites, especially in zones not designated for marine aquaculture a fully quantitative survey should be undertaken before the introduction of stock to provide baseline data with which future survey data will be compared The main aims of such pre-license environmental survey are:

– To conduct a baseline study of natural conditions in the area. This allows comparison with future developments at the site;

– To assess local variations in topography and hydrography;

– To predict the likely impact of the proposed production project;

– To provide information on management procedures.

An environmental survey will include most of the following aspects, depending on objectives and local circumstances:

– Sediment analyses;

– Semi-quantitative visual and sensory analyses;

– Physical properties (temperature, depth, sediment structure, etc);

– Chemical properties (salinity, pollutants, nutrients, chlorophyll a, etc)

– Biological properties (including bacterial quality);

– Hydrography (currents, wave heights, etc);

– Benthic communities.

6.4.3.2 Timing and Frequency

Baseline surveys should preferably be taken at the time of the year when maximum biomass is expected to occur or did occur. Once monitoring is established, each survey should be timed to the same season in order to allow for easy comparison of the survey data over time.

6.4.3.3 Application to Various Conditions

In view of the variability in geographical, environmental and managerial circumstances, monitoring practices may have to be adapted to the local conditions. Thus the level, number and frequency of the surveys undertaken might vary in response to economic or other factors.

The regulators define the frequency of the survey. Generally, annual monitoring of large farms is recommended, whereas smaller farms may be investigated less frequently or less intensively. It is important, however, that any variations should be with the agreement of the regulators and that, once accepted, the methodologies are strictly adhered to and that quality control is not compromised in any way.

6.4.4 REGULAR MONITORING SURVEYS

6.4.4.1 General

All existing sites should be surveyed at the time of peak biomass. At existing sites carrying a low biomass (<100 tonnes) a descriptive survey is recommended (*Type A*). However should there be any local sensitivity to for example conservation or heritage issues a higher level of survey might be considered. It is also suggested that if several farms are situated close to one another, they should be considered as intermediate or high-level biomass production.

At existing sites with intermediate biomass levels (100-500 tonnes) a semi-quantitative survey is recommended (*TYPE B*).

At existing sites with high levels of biomass (>500 tonnes) a fully quantitative survey is recommended (*TYPE C*).

Table 12. Monitoring according to farm size

	DESCRIPTIVE SURVEY	SEMI-QUANTITATIVE	QUANTITATIVE SURVEY
PURPOSE	Monitoring of small farms, <100 t	Monitoring of medium-sized farms, 100-500 t	Baseline and monitoring of large farms >500 t
SEDIMENT CONDITION	Colour, smell, *Beggiatoa*	Grain size, Total Organic Carbon	Full chemical analysis
BENTHIC FAUNA	Visul indicator species	Semi-quantitative analysis	Quantitative analysis

6.4.4.2 DESCRIPTIVE SURVEY – TYPE A

A simple and cheap descriptive qualitative survey is suggested for sites where production levels are less than 100 tonnes.

This survey level should provide sufficient information to warn of the development of adverse conditions attributable to farm activities. In the event of such developments the results from such a survey would be a trigger for more extensive quantitative surveys to be undertaken.

STATION SELECTION
Two transects of stations, originating at the cages, should be established. Transect 1 should take the direction of the residual current through the site and Transect 2 should take the reciprocal direction. Three sampling stations should be established along each transect at distances of 0, 25 and 50 m from the cages. In addition two reference stations should be established at points between 500–1000 m from the cages. These should have similar depths, sediment type and exposure to those found at the farm site.

PARAMETERS
The following parameters should be measured at each sampling station:

Water depth; degree of turbidity in bottom water; degree of disturbance of surface sediments; colour smell and appearance of the sediments; presence or absence of organic waste at surface; type of sediment (clay-gravel); sediment texture and colour; number of organisms, tubes and burrows visible on surface; number of organisms, tubes and burrows visible down sediment column; presence or absence of indicator fish species, with the list of fish species seen at different seasons.

ANALYSIS AND REPORTING
Presentation of observations should be entered onto a standardised form issued by regulating authority.

6.4.4.3 SEMI-QUANTITATIVE SURVEY / RAPID ASSESSMENT TECHNIQUES - TYPE B

This type of survey is recommended for sites with intermediate levels of production (100-500 t).

STATION SELECTION
Same as for type A surveys.

PARAMETERS
In addition to parameters identified in Type A survey, this survey should also include:

depth measured by echo sounder;
sediment characteristics (sand, silt, clay etc.); description of the sediment profile

and thickness of surface layer, if visible; colour; smell (eventual presence and severity of H_2S is recorded); main groups of large, easily visible animals present; other particular characteristics, for example, presence of fish food pellets, stones, dead shells, terrestrial material etc.; sediment samples for semi quantitative macrofaunal analysis, granulometry and total organic carbon (TOC) analysis.

Analysis and Reporting

Biological and chemical samples should be analysed in authorised laboratory. Full results of survey and analysis should be entered onto a standardised form issued by regulating authority.

6.4.4.4 Full Quantitative Survey – Type C

A full quantitative survey is recommended for sites with high levels of produced biomass (>500 t). In this type of survey a comprehensive statistical analysis is made of fully worked up biological and chemical data from all samples collected.

Station selection

Same as for Type A and Type B survey.

Parameters

In addition to parameters sampled in Type B survey the following parameters should be measured:

grain size analysis of sediments in sediment column; redox potential profile down sediment column; TOC in sediments; abundance and number of species of organisms in sediment samples; presence or absence of indicator fish species; quantitative analysis of fish species.

Analysis and Reporting

Same as for Type B.

6.4.4.5 Monitoring Frequency

Should the conditions under the fish farm be unacceptable (Condition 4), an extended B-survey may be carried out to ensure a correct evaluation of the site. This primarily encompasses a larger number of samples, but may also be extended to include additional parameters such as total organic carbon (TOC), medication (antiparasitic and antibiotic compounds), total nitrogen, phosphorous, zinc and copper.

Before a recipient is used for fish farming, a C-survey should be carried out. This survey provides a documentation of the environmental conditions which, when compared with subsequent surveys, will reveal the extent to which the fish farm affects the recipient. Follow-up surveys should be carried out after establishment of the fish farm as per Table 13. The monitoring frequency for new recipients and for those already in use for fish farming is determined by the relevant authorities, based on the principle that monitoring intensity increases proportional to impact.

Table 13. Frequency of A-, B- and C-survey depending on farm production size

Farm size	A-survey	B-survey	C-survey
0-100 t	Annually	Annually, if unacceptable conditions found outside AZE	
100-500 t		Annually	Annually, if unacceptable conditions found outside AZE
>500 t		Annually	Annually, if unacceptable conditions found outside AZE

Table 14. Frequency of A- and B-survey at the site (local impact zone) in relation to impacts at the site (site conditions).

	Monitoring level	
Site condition	A-survey	B-survey
1- Good	every 3 months	every 2 years
2 - Acceptable	every 3 months	annually
3 - Increased Disturbance	monthly	every 6 months
4 - Not Accept-able		eventual extended B-survey

The monitoring programme is assessed regularly and adjusted as necessary according to the results obtained.

6.4.6 MAPS AND CHARTS

The following maps and charts should be made available upon start-up of the monitoring programme:

Chart (1:50 000) and topological chart showing the site and position of the fish farm. In addition, an original hydrographic map should be made available, covering the site and surrounding area;

Chart (1:5 000) showing the site and position of the fish farm;

Topological map of the sea floor. The map covers the site and at least 10 m of the surrounding sea floor in all directions (local impact zone). If the fish farm comprises dispersed cages, the entire area containing cages is covered;

Map showing the form and dimensions of the fish farm, comprising number, length, breadth and diameter of the cages and distance between eventual dispersed cages. Depth contours are shown.

Table 15. Frequency of A-, B- and C-survey to be undertaken depending on farm cycle

	Monitoring level		
Farm Life Cycle	A-survey	B-survey	C-survey
Pre-consent for license			In advance of consent
During production	As per table 12 and 13	As per table 12 and 13	As per table 12 and 13
Increasing production		If under 100 tonnes	If over 100 tonnes
Close down of farm		If under 100 tonnes	If over 100 tonnes

6.4.7 REPORTING

A report is compiled which contains all original data and a concluding assessment. If results are available from a comparable survey carried out before the fish farm was established, these are compared with the new results using multivariate analyses. The report shall include all the necessary information required in order to carry out the survey in an identical manner at a later time, such that trends may be assessed.

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CHAPTER 7: PLANNING OF MARINE AQUACULTURE AND INTEGRATION WITH OTHER INTERESTS

Finding suitable sites for aquaculture in the marine and coastal environment is one of the most critical challenges facing this industry. The point is to integrate and merge all the concerns, issues and processes presented in the preceding chapters into a coastal plan to accommodate most of it, but nevertheless give special focus to marine aquaculture. In this chapter a procedure for such integration is suggested.

7.1. National Planning and Development Policy

The planning procedure should be in line with the National Strategy for Physical Planning and other strategic determinants. Clear structure is called for, including appointments of executive authorities, governmental agencies and experts at all levels, and establishment of funding possibilities.

Planning agencies and responsible administrative bodies at all levels should have defined terms of responsibilities and capacities. These planning prerequisites are at national level, and are not industry-specific. Adequate bodies and guiding principles should be set up at national and County levels, responsible for both planning,

Box 9: Overview list of Environmental indicators that should be considered but are not limited for aquaculture planning, zoning and site suitability selection

– Species types

– Salinity

– Exposure

– Depth (bathymetry)

– Currents (velocity, direction, surface, tides and water column movements)

– Wind (fetch, speed and direction)

– Coastal topography (slope, geology, pedology)

– Substrate (benthic type and quality)

– Suspended matter

– Trophic status

– Water quality (% oxygen, temp, salinity, coliforms, heavy metals, nitrate, phosphate, chlorophyll, etc.)

– Land use/land cover

– Fouling

– Predators (e.g. birds, other marine species, etc)

– Threatened and endangered species, habitats (e.g. SAV), migratory pathways

– Protected areas

– Buffer zone for aquaculture sites (related to pollution, protected species, use conflicts, etc)

– Accessibility and infrastructure (related to transportation, roads, etc)

– Site carrying capacity or environmental capacity

– Finfish feed quality and quantity (e.g. strict regulation of GMOs)

BOX 10: SUGGESTED DATABASE REQUIREMENTS (FROM: PAP/RAC, 1996)

NATURAL ENVIRONMENT:
- cultivated area
- forest area
- topography
- hydrology (tides, waves)
- climate (winds, temperature)
- sensitive or protected areas

EXISTING USERS
- land users
- sea users
- demographic data
- infrastructure
- activities and economy
- social structure

integration, implementation and evaluation processes. This part of the suggested procedure will require additional financial and human resources, if compared to the present situation in Republic of Croatia, but is deemed necessary if the sustainable development and integrated management of coastal zones is to be achieved.

It is recommended that the planning process for marine aquaculture should start with a policy statement, having as long-term goals sustainable development of the industry respecting all environmental constrains and other social and economical elements. Policy statement should identify the priorities, assign the responsibilities, and state the objectives and the time-frame. This policy statement should be brought by the Counties, and in line with the development strategies at the national level.

The County Assemblies could at this point also identify its implementing agency with the task of integrated planning. The list of authorized bodies or implementing agencies should be determined at the national level.

7.2. ASSESSMENT OF MAIN CONDITIONS

Having the administrative fundament in place the main objective for the next step is to map environmental indicators required for potential aquaculture areas.

Aquaculture has requirements for space on water and land. Determination of suitability involves an evaluation of limitations of a certain area in order to decide if the locality can support the activity. The initial phase of a suitability evaluation includes classification of current environmental conditions, identification of existing and possible future constraints, and assessment of compatibilities and incompatibilities between resources and human activities.

The most important step when starting the planning and zoning procedure at the County level is to identify the main environmental conditions and existing spatial limitations. Setting up such database should be done in a way to enable the usage of a GIS system and GIS tools (i.e. all data should be geographically-coded). This step will include collecting data on the natural environment, supporting infrastructure, existing and planned usage and other considerations of relevance.

Developed aquaculture protocols are a prerequisite in the process of selecting environmentally suitable aquaculture areas. This initial database in most cases already exists in Physical Planning Offices at the level of the County and is still not industry-specific. All data to be gathered at this stage are generally classified as planning data. These should be strengthened with the more detailed data on the marine environment. In this aspect, bathymetry is crucial, followed with data on temperature, salinity, currents regime and sediments. Data on sediments should be as precise as possible since this factor has a strong integration value (indicates the currents regime as well).

Data must be checked for quality, and gaps should be identified.

The results of this phase are supposed to be the definition of different management zones within the County and the completion of the database by inclusion of a better set of environmental data.

7.3. Elimination Process

Once the database is set, and has the main layers, the next step is to eliminate obvious unsuitable areas. The following set is suggested as a basic eliminating criteria list for marine aquaculture:

POLLUTION

- AREAS CLOSE TO PORTS, URBAN SETTLEMENTS, POINT SOURCES OF POLLUTION, HARBOURS, MARINAS SHOULD BE LEFT OUT.

- MINIMUM DISTANCE FROM SOURCES OF POLLUTION ARE DIFFICULT TO SET, AND SHOULD BE FINALLY DETERMINED BY EIA FOR INDIVIDUAL SITE.

- CLOSED BAYS OR AREAS OF HEAVY URBANIZATION SHOULD BE AVOIDED AS WELL AS AREAS IN THE VICINITY OF OIL PUMPS OR RIGS.

- WHETHER AQUACULTURE SHOULD BE CLOSE TO THERMAL SOURCES (SAY FROM A POWER PLANT) IS STILL AN ISSUE, BUT THIS IS NOT CONSIDERED TO BE AN ELIMINATING CRITERIA.

SHELLFISH DETERMINING HYGIENIC CRITERIA

- THESE ARE SET BY RELEVANT REGULATIONS, SO MEASUREMENTS OF BACTERIOLOGY IS A MUST IF SHELLFISH FARMS ARE IN THE AREA.

EUTROPHIC AREAS

- THESE SHOULD BE AVOIDED AS WELL AS ALGAL BLOOMS MAY BE TOXIC OR HARMFUL .

SHIPPING ACTIVITIES

- KEEP AWAY FROM UNDERWATER CABLES, SEA ROUTES, COMMON SAILING ROUTES AND SIMILAR AREAS.

PROTECTED AREAS

- ACCORDING TO NATIONAL LEGISLATION, IT IS NOT ALLOWED TO PLACE THE FARMS IN PROTECTED AREAS.

MILITARY ZONES AND OTHER RESTRICTED AREAS

- THESE ARE ALSO CLOSED FOR ANY OTHER ACTIVITY, SO MUST BE AVOIDED.

EXPOSED AREAS

- TOO ROUGH WAVE EXPOSURES COULD DAMAGE THE INSTALATIONS.

Once the eliminating criteria are applied, the remaining marine areas are all at least in theory possible zones for aquaculture. More extensive data gathering activities should by applying this suggested rocedure be limited only to areas where aquaculture is possible.

As mentioned, using integrated GIS analysis and modelling provides managers with a tool for recording and viewing environmental data over space and time. This includes spatial analysis that is useful in overlaying possible zoning schemes onto current land use and land cover.

7.4. Potentially Suitable

Allocating zones and areas for aquaculture should be assessed based on the suitability criteria. However, prior to the initiation of a zoning procedure, the coastal area should be partitioned into logical areas. These could be geographically, socially, culturally, economically or politically determined. Although it has been shown in many studies that geographical and biophysical units would present the best solution for integrated planning procedures, in the present situation in Republic of Croatia it is suggested that the initial partitioning is done accord-

Table 16. List of suitable criteria for semi-offshore and in-shore finfish farming (sea bass, sea bream)

FACTOR	GOOD	MEDIUM	POOR
Exposure	Partially	Sheltered	Exposed
Waves	1-3m	1m	>3m
Depth	>30m	30-15m	>15m
Dynamism - Flushing	High	Medium	Low
Water Quality - Pollution	Low	Medium	High
Temperature (°C)			
Max	22°-24°	24°-27°	>27°
Min	12°	10°	<8°
Salinity (‰)			
Average	25-35	15-25	<15
Fluctuation	<5	5-10	>10
Dissolved Oxygen (%)	100	70-100	<70
Topography (slope)	>30	10-30	<10
Substrate	Sand or gravel	Mixed rock	Mud
Trophic status	Oligotrophic	Mesotrophic	Eutrophic
Fouling	Low	Moderate	High
Predators	No	Some	Abundant

Table 17. List of suitable criteria for offshore tuna farming

FACTOR	GOOD	POOR
Exposure to open sea	exposed/partially exposed	bays/gulfs
Depth	>50m	<50m
Currents	$>10cms^{-1}$	$<10cms^{-1}$
Pollution	1	>1
Salinity (‰)	36-39	<36 i >39
Dissolved oxygen (%)	>90	<90
Trophic status	oligotrophic	eutrophic
Phytobenthos (*Possidonia* beds)	no Possidonia or on safe dstance determined by EIA	Possidonia in the vicinity of the location

Table 18. List of parameters for shellfish farming (by A. Frankic as presented in Frankic, Guidelines for sustainable aquaculture development, CZMP project contribution, following Spencer)

SUSTAINABILITY INDICATOR	GENERAL	OYSTERS	MUSSELS	HARD CLAMS
pH	6,0-8,5	6,75	7,0-8,5	6,75-8,75
Temp (°C)	18-28	15-25		21-31
Salinity (‰)	20-35	25-35	20-35	18-20
Suspended sediment (mg/l)	<10	10-20		
Dissolved oxygen (ppm)	>5			>3,64
Chlorophyll (mg/l)	2-8		4-8	
Bathymetry (m)	>1			>2
Bottom (habitat) type		solid, firm substrate	solid substrate	softer sediment, sand, mud
Exposure (cm/s)	sheltered areas with tidal flow	50-100	20-50	
Accesibility (nearest boat or road)	500-5000 meters			
Fecal coliforms (Cfu/100 ml)	14			
Nitrate mg/l	0,8			
Phosphate mg/l	0,08			
Dissolved oxygen (ppm)	>5			
Heavy metals (mg/kg flesh)	mercury 0,5; cadmium 2; lead 2			

ing to the present division at County levels. This would, in the initial procedure in Republic of Croatia, give 7 zoning regions.

While zoning one should be careful to apply criteria, which are species and technology specific. Additional data will be required at this phase. The

Table 19. Water quality for shellfish farming (by A. Frankic as presented in Frankic, Guidelines for sustainable aquaculture development, CZMP project contribution, following Spencer)

Coastal area	Allowed FK/100 ml	Shellfish from	
		Rearing	Wild
A - healthy	<300	allowed for direct sales	allowed for direct sales
B - unhealthy	300-6000	allowed for sales after purification or transfer to zone A	allowed for sales after purification or transfer to zone A
C - conditional	6000-60000	forbidden, except under special cases	allowed for sales after purification or transfer to zone A
forbidden	>60000	unconditional prohibition	unconditional prohibition

best strategy is to follow aquaculture protocols (suitability criteria) defined for each species and each technology. Suitability criteria will give good guideline as to which variables are needed to evaluate the industry. This approach will allow integration of GIS coverage (data layers) for e.g. temperature, salinity, bathymetry, exposure (also considering wind effects in bays), water quality data, circulation pattern, slope, substrate types, accessibility, available infrastructure, etc.

Based on available environmental suitability indicators, identified aquaculture areas can be ranked as desirable, desirable with limitations and undesirable; or just as good, medium and poor. For finfish tables 16 and 17 apply. For shellfish examples of criteria are given in table 18 and 19.

Similar criteria should be developed for all other competing activities. There is also the issue of the importance of any given criteria for selection of a site or a zone for aquaculture. Different studies have shown that this question may not be easily answered and should be considered on case-by-case basis. It is suggested that the main parameters and criteria (depth, exposure, wave height, currents, flushing, temperature) are ranked on a scale from 1 to 3. The net sum will aid in selection of a "better" zone or site. However, this may only be used as an aiding principle in planning and zoning. An example is given on the CD (available on request from MAFWM) by grading the impact of individual parameter in planning. Modifying the "weight" of individual parameter shall give less or more restrictive results.

Having in mind all the environmental requirements, as well as the benefit of the farmer and the best conditions for the farmed animals, it is suggested that, when zoning and siting the farms possible distances between different types of activities are considered as well. Suggested distances are given in Box 11.

Box 11. Suggested distances between marine aquaculture activities

Between two farms	2 km
Between fish and shellfish farm	2 km
Between two shellfish farms	0,5-1 km
Fish farm and settlement	3 km
Shellfish farm and tourist area	1 km
Shellfish farm and settlement	0,5-1 km
Fish farm and bird colony	0,5 km
Shellfish farm and bird colony	0,5 km

7.5. Integration, Conflict Analysis and Evaluation

After selecting suitable areas based on environmental indicators, scoped and revealed all other interests, the next step is to integrate the requirements for all the activities. Integration is directly linked with planning, as it is the decision-makers that, based on inputs from criteria, EIA, monitoring, and a socio-economic assessment will choose between different options and scenarios. The use of conflict analysis will facilitate this process.

CONFLICT ANALYSIS:

In this process all the existing and potential uses have to be identified and mapped. The purpose of this analysis is to identify areas that, although suitable for aquaculture on the basis of environmental conditions, may be less desirable because incompatible uses (tourism, recreation, fishing, boating, navigation etc.) that may be present or planned. GIS algorithms have to be developed in order to analyze and model criteria, and create indices of suitability related to aquaculture siting. For a suggestion and illustration of a possible usage of GIS in integrating marine aquaculture in County physical planning and zoning procedures, refer to CD material. The use of suitability and conflict analyses will support the interdisciplinary aspects of ICZM planning and decision making processes. The easiest possible way of conducting this analysis is to apply some check-box characteristics of possibilities of integration of several activities. Example of a conflict matrix is given in Table 21.

The decision to allocate various activities to specific areas is left to the County Assembly. This of course should be subject to the public hearing. Management choices will be required when certain activities can appear in the same locations based on suitability analysis of the area (e.g. aquaculture and tourist beach area, or marina). In these instances, choice has to be based on environmental requirements for the activity and the activity's interaction with the environmental resources (impact assessment, EIA).

Involving the community in the planning and decision-making process is an important step toward acceptability and success of the coastal management project. In Chapter 4 suggestions for adequate procedures are given for the stakeholders to be involved and to participate in the process. In this process the element of high environmental suitability and low impact on the respective land/water system will be of high relevance.

ZONES FOR DIFFERENT ACTIVITIES:

It is suggested that the zones for aquaculture be categorized as exclusive for marine aquaculture, primarily for marine aquaculture, zones of equal importance and zones where aquaculture is subdued to other activities. The zones reserved exclusively for aquaculture would be planned for aquaculture development and should be

Table 20. Example of management issues, options and outcomes in aquaculture suitability siting

Aquaculture suitability siting			
Adjacent coastal activity	*Management issue*	*Management options*	*Outcomes*
Terrestrial Residential	*Water quality (urban runoff, wastewater runoff); Socio-economic issue - aesthetics, smell*	*Zoning and buffers: - exclusive use zones - zoning with multile uses*	*Suitable if buffers exist; Socio-economic cost benefit analysis*
Agriculture commondity	*Water quality (afeiculture runoff, pesticides, nutrient, erosion, sedimentation)*		*Environ-mental and socio-economic assessment*
Industry	*Water quality (wastewater discharges, contamination)*	*Zoning, buffers, priority user*	*Suitable outside buffer, but depending on water quality*
Marina	*Water quality (wastewater discharges)*	*Buffer, zoning*	*suitabl outside buffer*
Piers	*Recreational fishing and boating; water quality*	*Buffer?*	*suitable outside buffer*
Beaches (public) and bare areas as potentials	*Water quality (pathogen contamination)*	*Buffer, zoning and EIA*	*Suitable or optimal with adequate facilities and water quality*

protected by legislation. Zones primary for aquaculture should be those where this activity has priority over others. Zones of equal importance allow for all activities equally, and the last type says that aquaculture has to wait until other needs are met. In all zones where possibilities for development of marine aquaculture are determined and entered into the plans, further mechanisms of promotion of marine aquaculture should be applied. These would include training for management practices, monitoring, strengthening of the regulation etc.

Criteria for zoning of different activities (marinas, tourism) have been developed (see Frankic 2003) as a checklist of possible requirements. These are not exhaustive, but should help decision-makers as guides. Using each particular set of requirements would provide good zoning for individual activity, but the integration process would require additional parameters.

When assessing the possibilities of integration of different activities, Table 21 may serve as a simple checklist of positive and negative effects of different activities on each other.

It is suggested that baseline surveys or zero-state surveys are conducted by Counties in the zones, which are selected exclusively for marine aquaculture and for zones where aquaculture has priority. The agencies or institutions authorized by the State and hired or employed by the Counties should make the initial measurements on (suggested list):

- *DEPTH*
- *TEMPERATURE*
- *SALINITY*
- *CURRENTS*
- *WAVE HEIGHT*
- *BACTERIAL QUALITY*
- *CHLOROPHYLL A*
- *SEDIMENT STRUCTURE*
- *BENTHIC COMMUNITIES*

If this is done by Counties in those areas, the EIA procedure will be facilitated and the process of license obtaining will be more streamlined. Then the County will have good insight into the situation of the environment prior to introducing a new activity.

The full scale EIA should be made for aquaculture sites in other zones, although all counties would benefit from a general baseline study in different zones of their interest. It needs not only be for marine aquaculture, but for other activities as well.

IMPACTS FROM AQUACULTURE:

It is well known that aquaculture may have impacts on the environment and the activities surrounding it.

The issue of food supply is rising, as the world capture fisheries are declining. To be truly sustainable aquaculture has to find more environmentaly sound ways to feed its animals. Having solved that problem aquaculture will relieve the heavy tolls on the fisheries and at the same time be able to supply the humans with valuable fish protein. Aquaculture may have negative impact to tourism as well, through degradation of environment, bad smell or ruining the scenery. On the other hand aquaculture may also positively interact with tourism through supply of high-quality seafood, providing of seasonal employment, opening opportunities for eco-tourism and increasing of the offer.

In addition, a well-operated local fish farm may provide a good destination for organized tours and visits, thus enriching the tourist offer. Distances between tourist facilities and beaches may be determined based on EIA or possible national regulations, which would prevent visual deterioration of a tourist area, but these two activities could never-the-less be well integrated if planned and managed well.

7.6. Monitoring and Implementation

Having undertaken the previous steps,tThe County would then be able to set up monitoring measures, and would be able to continuously gather and compare the data. The models, which should be applied, should be developed, and commonly agreed, thus setting some standard options.

Implementation:

It is suggested that a body is formed on a County level, whose task would be to implement and follow up the implementation of the plans in full. This body would comprise of different experts and officials, and would facilitate the full implementation of the plan. The final idea is that the body may then suggest changes, mitigation measures and management options – meaning stopping further concession issuing or requiring additional studies or other.

Siting – EIA:

Issues of individual site locations should be easier once an overall study has been done. However, this doesn't mean it's going to be less strict. EIA should still be done, but for zones of particular interest it will contain mainly the prediction of impact and mitigation measures. In zones where marine aquaculture is not a priority, EIA should be more encompassing and more elaborate. However, even there the baseline study should be done at some point. Hence it is suggested that the EIA for the sites in zones where marine aquaculture is not a priority consist of baseline study which should be well-defined in scope and requirements.

Main References:

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Table 21. Relation between aquaculture and other users of coastal areas

Activity	Industry and Harbour	Urbanization	Tourism and Recreation	Intensive Agriculture	Extensive Agriculture	Fisheries
Spatial resources	- land reclaiming (-) - shipping traffic (-) - military zones (-) - dredging (-)	- land use - land reclaiming (-)	- land reclaiming (-) - harbours (-) - sailing, bathing (-) - fishing (-) - historical sites (-)	- coastal land (-)	- coastal land (-)	- spawning areas (-) - nurseries (-) - artificial reefs (-) - fishing zones (-)
Quality of environment	- pollutants (-) - ballast waters (-) - warmed water (-)	- sewage (-) - organic matter (-) - bacteria and viruses (-) - nutrients (-)	- sewage (-) - antifouling paints (-)	- fertilizers (-) - pesticides (-) - organic matter (-) - suspended solids (-) - freshwater management (-)	- nutrients (-) - organic matter (-) - freshwater managemet (-)	- disease transmission (-) - genetic escape (-)
economy	- linfrastructure (+) - attraction of investment (+)	- market (+) - infrastructure (+)	- attraction of investment (+/-) - seasonal employment (+/-) - local market (+) - infrastructure (+)	- infrastructure (+)	- infrastructure (+)	- attraction of investment (+) - market (+) - infrastructure (+) - fish meal for aquafeeds (+)
Social resources		- living habbits (-)	- eco tourism (+) - seascape (-) - wildllife (-)			- internal competition (-) - employment (+) - education (+)
Regulation	- areas around (-) - harbours reserved (-) - military zones (-)	- municipality (-) - lpolicy (+/-)	- protected areas (-) - wild fauna and flora (-) - environmental standards (+)			- sanctuaries for fisheries (+/-)

Recommended Reading:

Doody J.P., Pamplin C.F., Gilbert C. and Bridge L. 1998. Information required for Integrated Coastal Zone Management. Thematic Study for EU Demonstration Program on ICZM

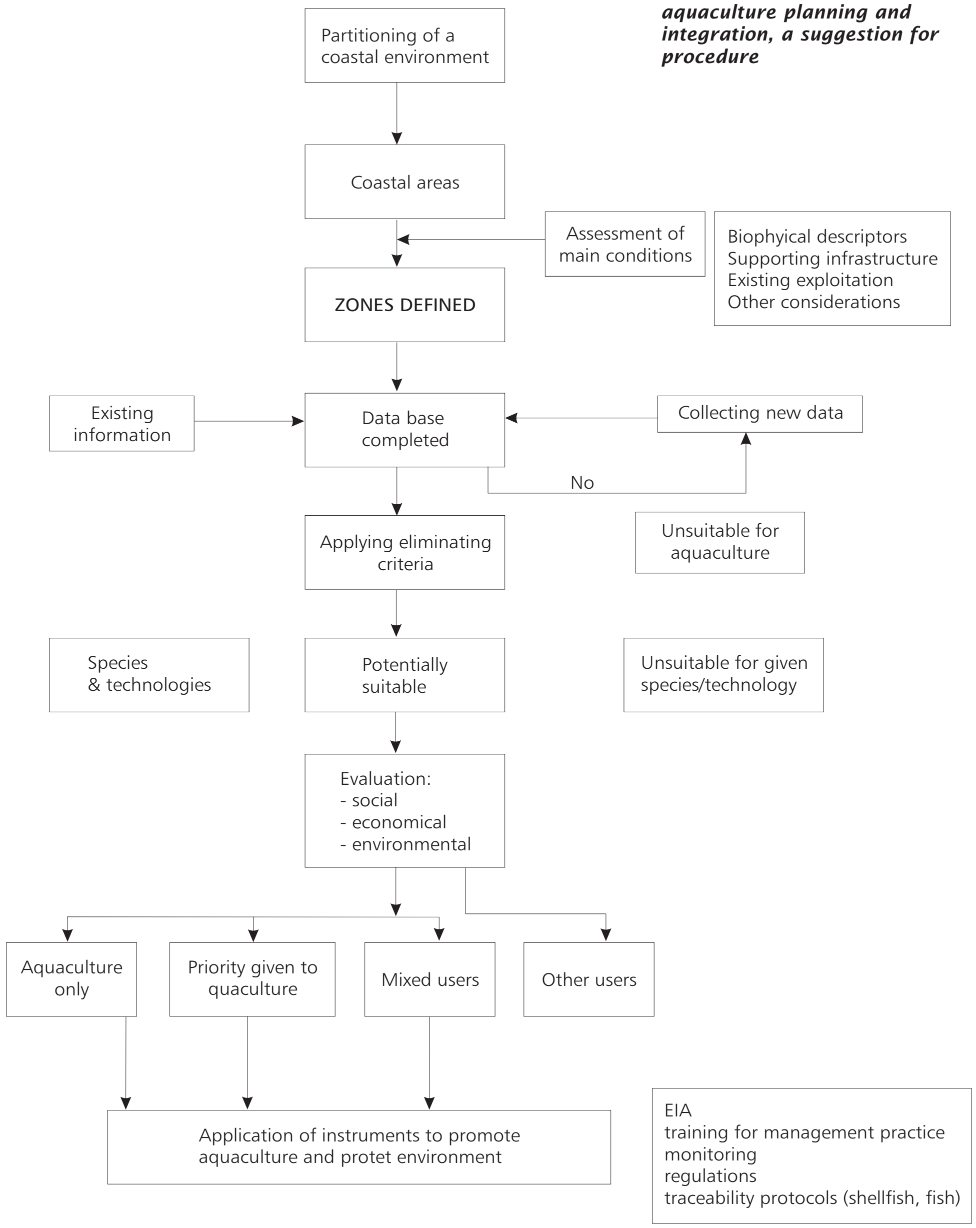
King G. 1999. Participation in the ICZM Process: mechanisms and procedures needed. Thematic Study for EU Demonstration Program on ICZM. Hyder Consulting

METAP 1998. Assessment of Integrated Coastal Area Management Initiatives in the Mediterranean: Experiences from METAP and MAP (1988-1996), METAP-PAP

Towards a European Integrated Coastal Zone Management (ICZM) Strategy: General Principles and Policy Options, EC 1999

UNEP/MAP/PAP: Good Practices Guidelines for Integrated Coastal Area Management in the Mediterranean. Split, Priority Actions Programme, 2001

Figure 4: Flowchart for aquaculture planning and integration, a suggestion for procedure



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