



Defining  
**sustainability indicators**  
for Mediterranean Aquaculture





Defining  
**sustainability indicators**  
for Mediterranean Aquaculture

The designation of geographical entities and the presentation of the material in this book does not imply the expression of any opinion on behalf of the Spanish Aquaculture Observatory Foundation (FOESA), the International Union for the Conservation of Nature (IUCN), or the Spanish Association of Marine Fish Farmers (APROMAR) regarding the legal condition of any country, territory or area, or of its authorities, with regards to the demarcation of its frontiers or boundaries.

The views expressed in this publication do not necessarily reflect those of FOESA, IUCN or APROMAR.

This publication has been made possible thanks to the **collaboration** of the Biodiversity Foundation and the Spanish Ministry for the Environment and Rural and Marine Affairs.



Fundación Biodiversidad



**Published by:** The Spanish Aquaculture Observatory Foundation (FOESA), Madrid, Spain, in partnership with the International Union for the Conservation of Nature (IUCN) and the Spanish Association of Marine Fish Farmers (APROMAR).



**Copyright:** ©2010 Spanish Aquaculture Observatory Foundation (FOESA)

Reproduction of this publication for educational and other non-commercial purposes is authorized without prior written permission from the copyright holder providing the source is fully acknowledged.

Reproduction of this publication for resale or other commercial purposes is expressly prohibited without prior written permission from the copyright holder.

**Citation:** FOESA (2010) Defining sustainability indicators for Mediterranean Aquaculture FOESA, Madrid, Spain 152 pages.

**ISBN:** 978-84-937611-2-7

**Legal Deposit:** NIPO: 770-10-293-6

**Design, editing and layout:** Arpa & Asociados

**Developed by:** Spanish Aquaculture Observatory Foundation (FOESA)

**Available from:** Spanish Aquaculture Observatory Foundation (FOESA)

c/ Fortuny, 47 1º 17

28010 Madrid

Tel: 91 310 75 46

[www.fundacionoesa.es](http://www.fundacionoesa.es) / [www.mediterraneo.es](http://www.mediterraneo.es)

**A catalogue of FOESA publications is also available at:**

[www.fundacionoesa.es/publicaciones](http://www.fundacionoesa.es/publicaciones)

The text of this book was printed on 100% recycled coated paper.



## INDEX

---

<b>FOREWORD</b>	<b>4</b>
<b>EXECUTIVE SUMMARY</b>	<b>8</b>
<b>GENERAL STATE OF AQUACULTURE</b>	<b>12</b>
1. State of World aquaculture	13
2. State of Mediterranean aquaculture	17
<b>SUSTAINABLE DEVELOPMENT OF AQUACULTURE</b>	<b>24</b>
<b>PROJECT MEDITERRANE-ON</b>	<b>28</b>
1. Approach	29
2. Background	32
3. Procedure	35
<b>PRINCIPLES, CRITERIA AND INDICATOR GUIDE</b>	<b>38</b>
1. Introduction	39
2. Indicators of sustainability at a farm/company level	43
3. Indicators of sustainability at a national level	69
4. Indicators of sustainability at a Mediterranean level	98
<b>APPENDICES</b>	<b>114</b>
APPENDIX 1. Records for Mediterranean countries	115
APPENDIX 2. Glossary	135
APPENDIX 3. Bibliography	139
APPENDIX 4. List of participants	141
APPENDIX 5. List of acronyms	145

An underwater photograph showing a vibrant marine ecosystem. The water is a clear, deep teal color. In the foreground, there are several translucent jellyfish with delicate, white tentacles. Some are larger and more prominent, while others are smaller and more distant. The background is filled with dark, branching seaweed or coral structures, creating a complex, almost abstract pattern. The overall scene is serene and captures the beauty of the underwater world.

## FOREWORD

*Our society faces new and formidable challenges in promoting and implementing more sustainable social and economic development in each and every socioeconomic activity and aspect that enable our civilization to progress. A firm commitment to this development model is forcing social agents to seek to adopt new interrelationship and coordination mechanisms, which contemplate the world in a global manner, as was reflected in recent international summits held to collectively make headway regarding sustainability.*

*The term “**sustainable development**” emerged in 1987, when it appeared for the first time in the Brundtland Report and it presented a new approach, which took future generations into account in the decision-making process, so that their development capabilities would not be compromised, allowing for environmental, economic and social aspects in this decision-making process, from a comprehensive perspective.*

*Today, the term 'sustainable' is attached to a great number of products, processes and activities. It has rapidly become an essential aspect for agents and consumers who associate its use with the incorporation of new features and qualities related to the conservation and preservation of the environment, the economic durability of a particular activity or the concern for social aspects in business management such as quality of employment and non-discrimination.*

*In this regard, the risk of sustainable development becoming just another marketing feature is high, hence the need to join forces so that this development does not simply remain a fad but can become a reality and be used in an effective and appropriate manner, responding to the new needs that society faces.*

*From an environmental point of view, the fight against climate change, global warming and the protection and conservation of biodiversity have become the core issues of a number of initiatives and actions, both public and private, taking up the main pages in the political agenda and the media, and instilling in society the importance of optimizing the use of natural resources which we have today, to ensure that future generations can enjoy them.*

*In this field, sustainable aquaculture is enabling the production of a high number of species that have been jeopardised in the wild such as eels, red tuna or common trout, this production contributing to the protection of biodiversity and the fight against their extinction in the wild. There is no doubt that research, technological development and innovation, which support aquaculture to a great extent, will enable the production of new species in the future, with the aim of improving biodiversity and the natural resources of our seas and rivers.*

*On a social basis, the fight against hunger, malnutrition and poverty is still, even today, one of the greatest challenges that we face. Recent initiatives, such as the United Nations Millennium Development Goals, have opened a window of hope, with the need to join forces if we want to live in a fairer, safer and more sustainable world by 2015.*

*Aquaculture will also play a key role in this fight, as highlighted by the FAO, given that it is already the main source of fish protein for the world's population, generating wealth and well-being as well as creating employment in rural and fishing areas, where often, development opportunities are limited.*

*From an economic point of view, there is no doubt that aquaculture is a booming and dynamic activity on a worldwide level. The 68.4 million tonnes produced in 2008 directly generated economic resources nearing 85.000 million euros, in addition to resources generated by auxiliary activities that support aquaculture. Today, society and market globalization is forcing our businesses to seek synergies and business concentration, aiming to improve their competitiveness in a very demanding context of economies of scale for small and medium producers. To meet this challenge they must aim for maximum product quality through certification, being ready to undergo transformation and to search for innovative presentations, which are increasingly sought after by a large part of society in a moment where, more than ever, time is money.*

*At the Spanish Aquaculture Observatory Foundation (FOESA) we understand that our society must follow this path, committing to research, technological development and innovation and apply this knowledge to improve sustainability in Spanish aquaculture, which is what we work towards on a daily basis.*

Alicia Villauriz

General Sea Secretary

President of the Spanish Aquaculture Observatory Foundation

Vice-President of the Biodiversity Foundation



Data were compiled and this document was drafted by Cristina García Díez (FOESA) and Sandra Simoes Rubiales (IUCN) under the general coordination of Javier Remiro Perlado (FOESA). The following mediterranean experts also took part in the reviews and comments:

- Abdelhafid Chalabi (Department of Fisheries and Aquaculture, Canada)
- Alistair Lane (EAS, Belgium)
- Dror Angel (Haifa University, Israel)
- Eduardo Chia (INRA, France)
- Fernando Torrent (UPM, Spain)
- Fernando Otero Lourido (APROMAR, Spain)
- François René (IFREMER, France)
- François Simard (IUCN, Switzerland)
- Güzel Yücel-Gier (Dokuz Eylül University, Turkey)
- Javier Ojeda González-Posada (APROMAR/FEAP, Spain)
- José Carlos Macías Rivero (D.a.p., Spain)
- Pablo Ávila Zaragoza (D.a.p., Spain)
- Philippos Papageorgiou (Fisheries and Aquaculture Consultant, Greece)
- Rosa Chapela Pérez (CETMAR, Spain)
- Shirra Freeman (Haifa University, Israel/EEUU)

This project has been co-funded by the Biodiversity Foundation.

*The photographs of the document have been given by the institutions and experts that collaborated in the development of the project or belong to the photo database of the OESA Foundation.*

# EXECUTIVE SUMMARY



Aquaculture has existed for more than 4.000 years in the various cultures and civilizations that have inhabited the earth. Nevertheless, the development process leading to its global importance today is relatively recent and has run side by side with the process of social awareness regarding the need to satisfy economic viability, social fairness and environmental conservation in all aspects of society, which are the three pillars that support the concept of sustainable development or sustainability. Nowadays, aquaculture is considered a consolidated and strategic practice that plays a key role in the growing demand for animal proteins on a worldwide scale and acting as a perfect complement to commercial fishing, which, as scientific studies have shown, has reached its highest level since the end of the 1980s. Aquaculture has to be able to face this challenge, by responding in a sustainable manner to society's expectations.

There is still strong potential for aquaculture development in the Mediterranean area, with the need to continue working together to guarantee that this development is sustainable, with fair and balanced rules that can be applied to all the countries within the region, thereby laying the foundations for Mediterranean aquaculture that are committed to biodiversity conservation and social and economic development in each of these countries, taking their current and future needs into account.

To date, one of the main documents that steers the sustainable development of the sector in the Mediterranean region, is “Guidelines for the Sustainable Development of Mediterranean Aquaculture” developed by the IUCN for the Spanish Ministry for the Environment and Rural and Marine Affairs (MARM) between 2006 and 2009. These guidelines offer a series of recommendations and principles to improve procedures and practices used in aquaculture from a sustainability point of view. Continuing with the work done, the MEDITERRANEON project: “Defining Sustainability Indicators for Mediterranean Aquaculture” has looked to design tools, in the form of indicators, which enable an analysis of the state of aquaculture in the region to be made with the aim of moving the various countries that make up the region towards an even more sustainable



aquaculture development. These tools aim to be of use to all the stakeholders involved in the sector; administrations, producing sectors, scientific communities, non-governmental organizations and other sectors and stakeholders, in order to obtain an initial assessment of Mediterranean aquaculture from a sustainability point of view.

This initial overview facilitates the adoption of new measures and initiatives to be agreed in the next few years, which contribute to the sustainable growth and development of a strategic sector and set to play a key role in the socioeconomic stimulus in a number of rural and coastal areas in the Mediterranean.



This initiative has been possible thanks to a number of stakeholders from various countries within the region and who, as researchers, producers or agents, have given their views and opinions regarding the real state of the sector, enriching the multi-cultural and multi-disciplined final result presented in this document and enabling sustainable aquaculture to be dealt with from three spatial approaches with very distinct requirements, which are: a local level, a national level and an international level. The interrelation of this whole matrix, with the three pillars that make up sustainable development, enables us to see the need to adopt different strategies based on the level we wish to look at, taking into account the various relationships that are established between aquaculture and the other activities that exist around it.

The principles, criteria and indicators in this guide are the result of an intense reflection and debate process in Mediterranean countries over the last few years and they aim to be sensitive to the existing characteristics and differences of the various species produced in the region, the production systems employed and the different degrees of aquaculture development in each Mediterranean country. It is for this reason that the indicators finally chosen can be relatively general. On the contrary are easily measured, lasting and relevant from a sustainability point of view.

The task of adapting the indicators to the different species and production processes that characterize the Mediterranean Sea, is yet to be completed, and this is one more step (surely not the last) in taking new and more solid advances in mediterranean and aquaculture sustainability.







## GENERAL STATE OF AQUACULTURE

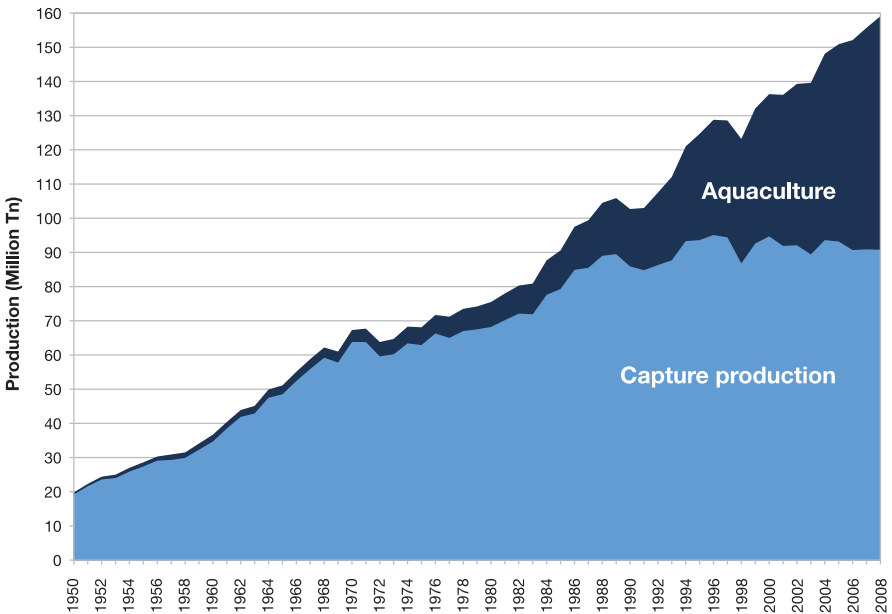
## 1. State of World aquaculture

Although aquaculture is more than 4.000 years old, it only started its industrial development on a worldwide level 50 years ago, and since then it has been considered an emergent practice with high growth and development prospects. Time has proved right those who proposed a rapid and sustained growth in this activity, which today, in productive terms, exceeds commercial fishing.

This growth is also due largely to the stagnation of commercial fishing towards the end of the 1980s; since then catches have remained stable at around 90-95 million tonnes. Improvements in the management of fishing resources will allow fishing levels in the following years to be maintained but probably not increased, so further increases in global seafood production will only be able to come from aquaculture activities.

According to the latest information available (*The State of World Fisheries and Aquaculture, FAO, 2008*), worldwide aquaculture now produces 68.4 million tonnes, compared to approximately 67.0 million tonnes of fishing products caught for human consumption by fishing. In reality, the total amount of fish catches exceeded 90.8 million tonnes but nearly 24 million tonnes of this goes towards other uses, mainly feeds for farm animals, fish and prawns.

FIGURE 1. EVOLUTION OF WORLDWIDE FISH PRODUCTION (CAPTURE PRODUCTION + AQUACULTURE) DURING THE PERIOD 1950-2008 (FAO, 2008)



Parallel to this growth in aquaculture, worldwide seafood consumption per capita has already exceeded 20 Kg/hab, which shows a strong increase compared to the 11 Kg/person/year consumed in 1970.

In this context of growth in the demand for fish products, aquaculture and fishing are two activities which must complement one another in order to face the challenge of providing the world's population with a top quality source of animal protein, especially given that aquatic products are currently the most important source of animal protein in the world, representing 28% of the total amount of protein consumed in developing countries and 14% in Europe and North America.

Hence, the contribution of aquaculture to the worldwide supply of fish, crustaceans, molluscs and other aquatic animals has risen from 3.9% of the total production by weight in 1970 to 36% in 2006.

During this same period, the growth in aquaculture production was faster than world population growth and than any other food production sector of animal origin, going from a per capita supply of 0.7 kg in 1970 to 7.8 kg in 2006 - an average annual growth rate of 7%.

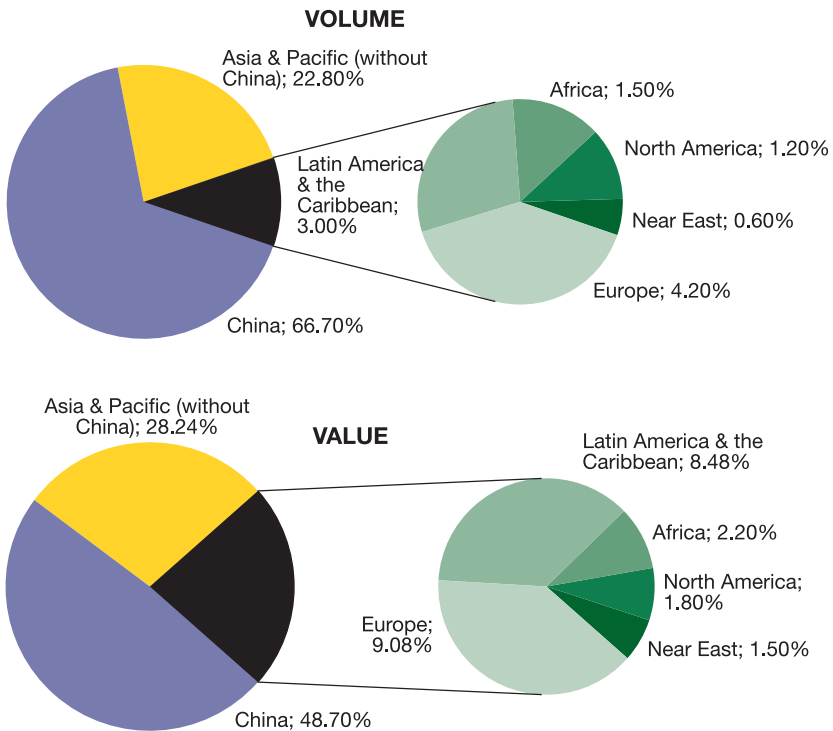


Aquaculture provided 47% of the worldwide fish supply for food in 2006 and this figure has increased further in the last few years. For example, in China, 90% of the fish production for food comes from aquaculture (2006). In the rest of the world aquaculture makes up 24% of the fish supply for food. (FAO, 2008).

This highlights the existing differences between the various regions regarding aquaculture development, both in terms of the species cultivated and production systems employed.

On a regional basis, 89% of the volume of aquaculture production comes from Asia (mainly China with 67%); the rest being split into 4.2% from Europe, 3% from South America and the Caribbean, 1.5% from Africa, 1.2% from North America and 0.6% from the Near East.

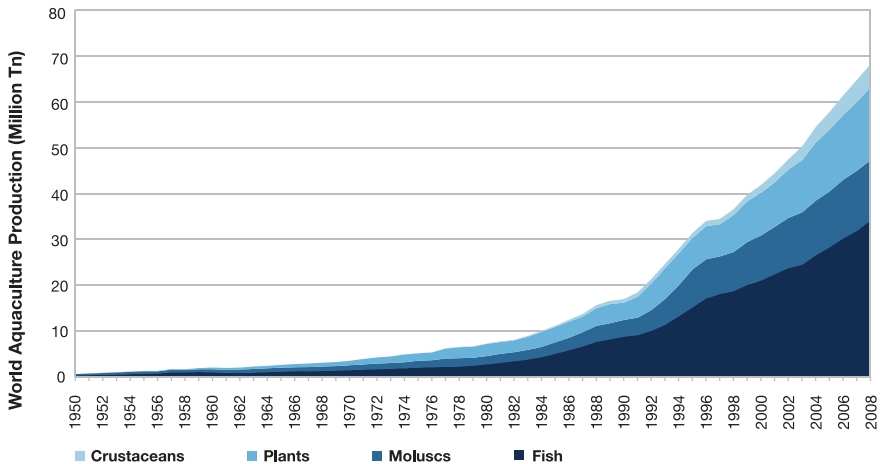
**FIGURE 2. WORLDWIDE AQUACULTURE PRODUCTION IN 2008 BY REGIONS, SEPARATING CHINA FROM THE REST OF ASIA (FAO, 2008)**



Compared with land farming systems, whereby the main part of the production is obtained from a reduced number of domesticated animals and plants, in 2008, 483 different aquaculture species were being produced in the world, including fish, molluscs, crustaceans, algae and others. Of these, there are more than 250 aquatic plant and animal species produced in significant quantities (>100t). This great diversity is due to the high number of aquatic organisms which can adapt to the conditions and systems of controlled production.

In terms of groups of cultivated species, in 2006, more than half the worldwide aquatic production was made up of freshwater fin fish at 76% (with 27.8 million tonnes), followed by molluscs with 14.1 million tonnes (27% of the total production) (FAO, 2008).

FIGURE 3. EVOLUTION OF THE WORLDWIDE AQUACULTURE PRODUCTION BY GROUPS DURING THE PERIOD 1950-2008 (FAO, 2008)



From a social and economic point of view, aquaculture has also made important progress over the last 30 years. It is an activity that generates wealth and economic resources, directly employing more than 9 million people worldwide in 2006 (FAO), within the 43.5 million people that are directly employed in the primary production of fish.

But aquaculture is not only about food production. Since the beginning - and even more so today - there are an important and growing number of activities directly related to its development, such as research, technological development and innovation, product assessment, design and elaboration of the equipment and infrastructures, commercialization, distribution or an important processing industry. On the assumption that for each aquaculture worker, another four workers are employed in activities directly related

to aquaculture production, then some 36 million people worldwide are generating an income from the breeding of aquatic species.

The success of modern aquaculture is based on the control of species reproduction, improved knowledge of their biology, technological innovations and the development of safe and good quality food products. In line with this approach, aquaculture is certainly an activity with an important development potential, capable of contributing to reducing poverty and malnutrition, providing society with foods rich in protein, oils, vitamins and minerals that improve health and quality of life, as well as improving economic incomes and generating new specialized job positions and hence promoting socioeconomic development in the regions where it continues to grow.

Over the last thirty years aquaculture has grown and diversified with very significant technological improvements. The contribution of these improvements for achieving socioeconomic wellbeing - both in developed and developing countries - for improved quality of life and better food safety has been recognised by the FAO in its Bangkok Declaration and Strategy (2000). This document highlights the need to back the potential development in aquaculture for the benefit of human beings. This growth will only be successful and lasting if it is done in a sustainable manner, respecting the environment, the creatures that live in it and by being sensitive and committed to the social and economic development of all persons.

## *2. State of Mediterranean aquaculture*

The Mediterranean is the largest inland sea in the world. Its waters, which surround the three southern European peninsulas (Iberian, Italian and Balkan) and one in Asia (Anatolian), connect with the Atlantic Ocean (via the Straits of Gibraltar), with the Black Sea (via the Bosphorous Straits and the Dardanelos Straits, and with the Red Sea (via the Suez Canal). It is a geographical, historical, cultural, political, and strategic area, with countries that have very different socioeconomic structures, development and growth perspectives.

The Mediterranean sea has the highest levels of hydrocarbon and contamination in the world (Linde, 2007) and it covers an approximate area of 2.5 million Km<sup>2</sup>, it has an average depth of 1.5 Km with a maximum of 5.1 Km and a volume of 3.7 million Km<sup>3</sup>. Its width is 3,860 Km from east to west and the maximum distance from N-S, between France and Algeria are 900 Km. More than 460 million people make up the population in the Mediterranean region.

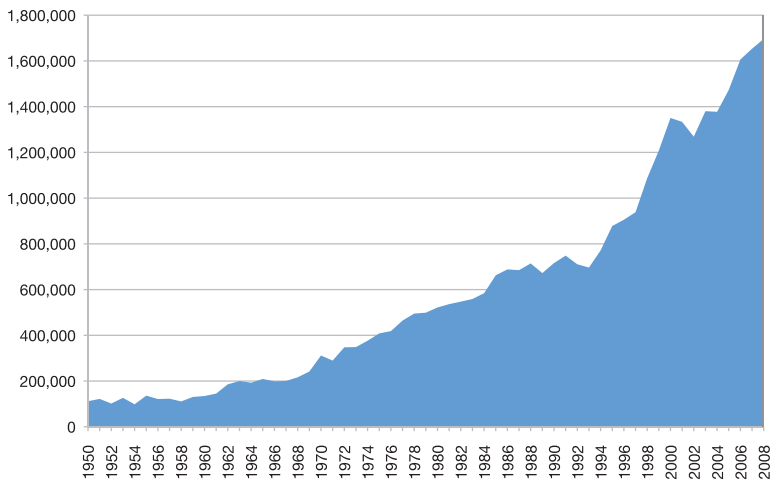
FIGURE 4. MEDITERRANEAN MAP. OWN ELABORATION



Since the beginning of the 1990s, Mediterranean aquaculture has experienced considerable growth, going from 700,000 to 1,700,000 tonnes produced in 2008 (FAO).

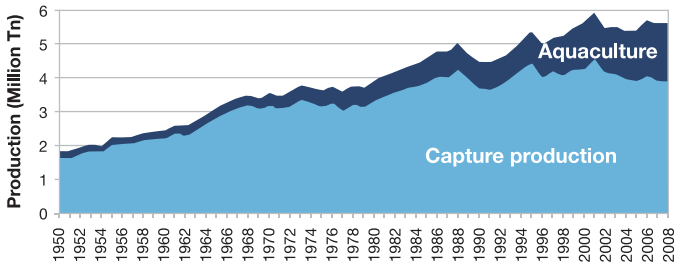
However, this growth has not been constant, with periods of flux in production such as those experienced in 2002 and affecting the sea bream and sea bass sectors.

FIGURE 5. EVOLUTION OF MEDITERRANEAN AQUACULTURE PRODUCTION IN TONNES (FAO FISHPRO)



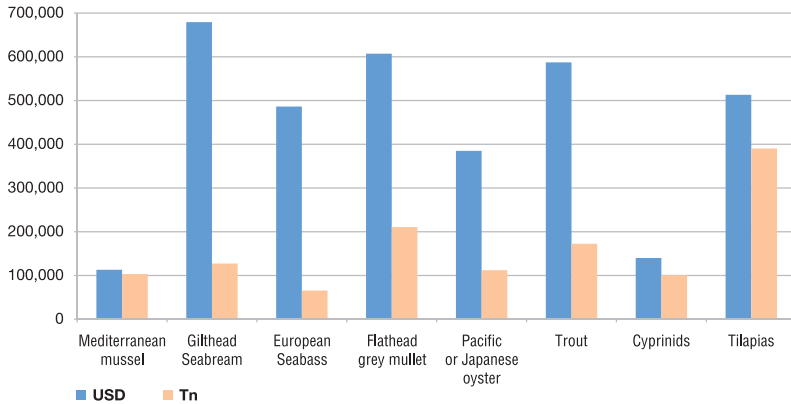
This information contrasts with the stability of fishing catches, which did not suffer great changes during this period.

FIGURE 6. PRODUCTION IN THE MEDITERRANEAN. CAPTURE PRODUCTION + AQUACULTURE (FAO, 2008)



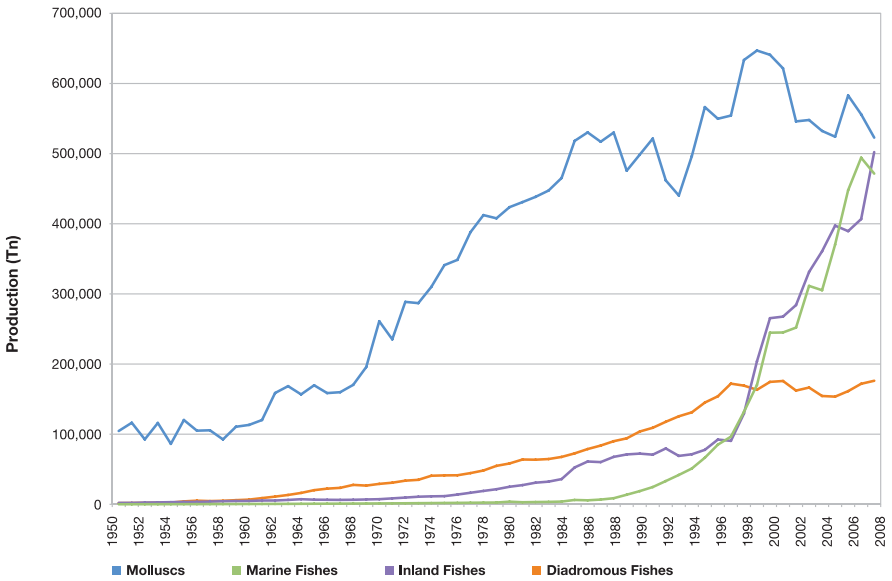
With regards to the economic value of the species farmed, there are also important differences where both extremes can be noted: Species with moderate production but a high economic value, such as sea bream and sea bass and species with a high production level but moderate economic value such as tilapia or mussels.

FIGURE 7. AQUACULTURE IN THE MEDITERRANEAN. PRODUCTION BY SPECIES (FAO, 2008)



Although Mediterranean aquaculture was based on the cultivation of molluscs in the 1990s the percentage of fish cultivation has experienced an exponential increase in the last few years and is still on the rise although at a lesser rate today. The trend is for further increases in fin fish production, with more moderate growth in the case of molluscs.

FIGURE 8. AQUACULTURE IN THE MEDITERRANEAN. PRODUCTION BY GROUPS (FAO, 2008)



This document shows Mediterranean countries with significant aquaculture production or those that promise to be significant and includes 19 countries: Albania, Algeria, Bosnia-Herzegovina, Cyprus, Croatia, Egypt, Slovenia, Spain, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Morocco, Syria, Tunisia and Turkey. A brief report on their aquaculture status is provided in Appendix I.

Table I shows information of a general nature about these 19 countries, with information such as area, population, research institutes, consumption and main species cultivated.

TABLE 1. MEDITERRANEAN COUNTRY RECORDS

COUNTRY	AREA (KM <sup>2</sup> )	MEDITERRA-NEAN COAST (KM)	INLAND WATERS	POPULATION <sup>1</sup>	GDP PER CAPITA <sup>2</sup> (USD)	N <sup>o</sup> TOTAL CENTERS RDI <sup>3</sup>	CONSUMPTION /KG/PER CA-PITA/2007 <sup>4,5</sup>	N <sup>o</sup> COMPANIES <sup>4</sup>	EMPLOY-MENT <sup>4,6</sup>	IMPORTS FISHERIES (TIV/2007) <sup>5</sup>	EXPORTS FISHERIES (TIV/2007) <sup>5</sup>	SPECIES <sup>4,6</sup>
Albania	28,000	418	10,000ha	3,660,000	6,859	1	2.9	25	2,500	17,746	25,086	Tr, BB, M
Algeria	2,381,743	1,280	-	34,586,000	6,698	9	5.17	-	300	25,515	12,164	C, Various, M
Bosnia-Herzegovina	51,129	20	-	4,622,000	7,611	0	1.5	-	662	34,071	10,462	Tr, C, BB
Cyprus	9,251	650	-	1,103,000	29,830	3	7.18	6	206	79,519	31,600	BB, T, Tr
Croatia	56,500	1,777	0.20%	4,487,000	18,545	31	9.2	38	606	126,954	152,580	T, BB, C
Egypt	1,001,450	950	0.80%	80,472,000	5,898	16	15	500	160,000	223,865	4,481	Ti, Mg, C
Slovenia	20,251	47	0.60%	2,003,000	29,472	23	5.5	-	215	73,614	19,010	Tr, C
Spain	504,782	2,580	1.04%	40,549,000	30,621	527	38	61	26,300	6,980,372	3,230,749	M, Tr, BB,
France	543,965	1,703	0.26%	64,768,000	34,208	888	33	-	20,000	5,366,203	1,926,920	M, Tr, BB
Greece	131,940	15,000	-	10,750,000	30,535	72	18.8	189	10,000	754,325	632,762	BB, M
Israel	22,145	160	2.00%	7,354,000	28,206	87	13.21	4	-	194,731	17,278	Ti, C, Mg
Italy	301,270	7,456	2.40%	58,091,000	30,581	215	22	715	7,764	5,143,834	765,841	M, Tr, BB
Lebanon	10,452	225	1.60%	4,125,000	13,032	8	4	1,506	-	73,877	2,737	Tr, Ti
Lybia	1,775,500	1,970	-	6,461,000	14,533	0	7	-	140	27,816	11,658	C, Ti, BB
Malta	320	140	-	407,000	23,760	1	4.4	4	184	40,699	49,822	T, BB
Morocco	446,600	550	-	31,627,000	4,349	9	10.4	9	607	61,737	1,371,079	BB, Tr, C
Syria	185,180	193	0.06%	22,198,000	4,749	1	2.6	-	10,000	42,411	268	C, Ti
Tunisia	163,610	1,300	-	10,589,000	7,963	10	11.45	25	1,000	52,749	184,062	T, BB, C
Turkey	779,452	5,191	1.30%	77,804,000	13,138	8	8.6	370	25,000	175,014	221,325	BB, Tr

**Legend:**

- T: Tuna;
- TR: Salmonids (trout);
- BB: Sea bream and Sea Bass;
- M: Mullusc;
- Various: Liza aurata, Solea vulgaris, Dicentrarchus labrax, Sparus aurata, Lithognathus mormyrus, Eel, Diploicus sargus, Scirpa salpa, Rudfispas decussatus, Crassostrea gigas, etc.

**TABLE REFERENCE INFORMATION:**

- <sup>1</sup>Countries by population: UN 2010 Wikipedia, [http://es.wikipedia.org/wiki/Lista\\_de\\_pa%C3%ADses\\_por\\_poblacion](http://es.wikipedia.org/wiki/Lista_de_pa%C3%ADses_por_poblacion)
- <sup>2</sup>Countries by GDP (PPA) per capita: FMI 2008 Wikipedia, [http://es.wikipedia.org/wiki/Anexo:Pa%C3%A9ses\\_por\\_PIB\\_\(PPA\)\\_per\\_capita](http://es.wikipedia.org/wiki/Anexo:Pa%C3%A9ses_por_PIB_(PPA)_per_capita)
- <sup>3</sup>Ranking of worldwide research centre webs, Cybermetric Laboratory Initiative (CSI), [http://research.webometrics.int/...\\_d\\_by\\_country\\_select\\_es.asp](http://research.webometrics.int/..._d_by_country_select_es.asp) Updated January 2010.
- <sup>4</sup>Baratz-Venulanos, L. Regional synthesis of the Mediterranean aquaculture (MedAquaMarket). Studies and reviews General Fisheries Commission for the Mediterranean. No. 88 Rome, FAO. 2010:195 pp.
- <sup>5</sup>FAO (2009). Aquaculture and fishing Statistics 2007 Rome, 75 pages.
- <sup>6</sup>FAO. Fisheries and Aquaculture Department for country profiles, <http://www.fao.org/fishery/countryprofiles/searches>

It is interesting to observe the relationships established between the area covered by the Mediterranean countries and the kilometres of Mediterranean coast, as well as analysing each ones existing production.

FIGURE 9. COUNTRY AREA/MEDITERRANEAN COASTLINE RELATIONSHIP

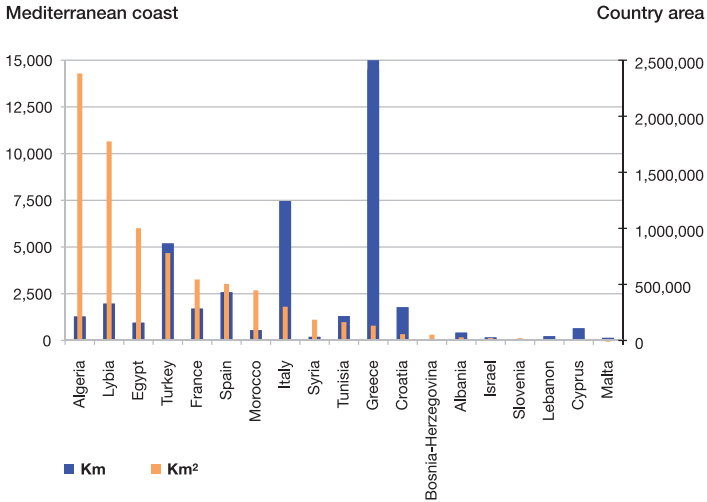


FIGURE 10. MOST PRODUCTIVE COUNTRIES IN THE MEDITERRANEAN (FAO, 2008)

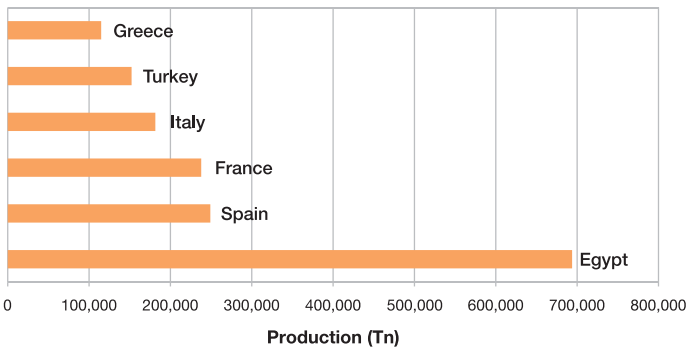
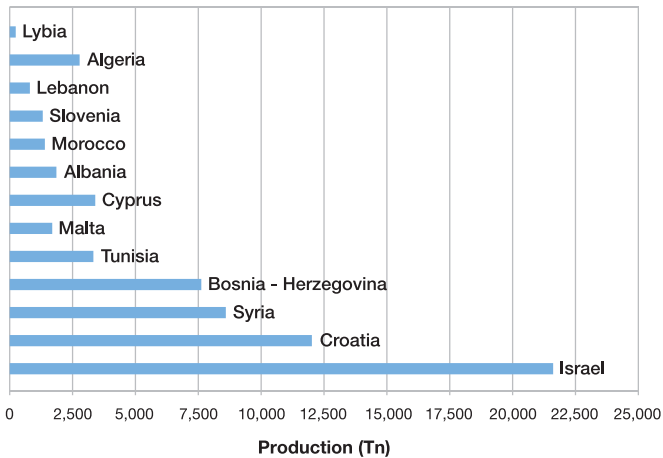




FIGURE 11. LEAST PRODUCTIVE COUNTRIES IN THE MEDITERRANEAN (FAO, 2008)



The growing population in the Mediterranean favours the need for both sustained and continuous growth in aquaculture in the region, providing the population with extremely healthy fish proteins, which are at reasonable and affordable prices for a large number of the population.

This growth requires cooperation at the regional level in the design and introduction of new tools that allow individual companies, national or regional administrative staff involved in the aquaculture industry and other stakeholders to adopt new strategies and good management skills which enable a more sustainable and transparent aquaculture sector and giving consumers a more positive impression of the industry and its activities.

All the information included in this chapter, diagrams, tables and the information included in each country's report in Appendix I has marked the beginning of the subsequent selection and definition of the indicators.

## SUSTAINABLE DEVELOPMENT IN AQUACULTURE



Towards the end of the 20th century, a new way of thinking appeared, known as **conservation**, as a result of the decisive change caused by the industrial revolution regarding the relationship between man and his environment. It promoted a development standard which was more humane and respectful towards the environment, compared to the existing development, based on economic growth. From then on, both society and the industry began to see the need to combine the concepts of production and development with environmental preservation, giving rise to the concept of the environmental unit, which states that a change to any system will inevitably cause changes to others which therefore force one to think globally.

With this in mind, The Club of Rome was formed in 1968, which reflected on global problems, with the aim of offering new alternatives and suggestions to national and international leaders. Its first study was published in 1972, highlighting the ecological dangers of the economic and demographic growth being experienced throughout the world at that point and which could lead to a catastrophic future if action was not taken. That same year the first Earth Summit took place in Stockholm (Sweden), where it was acknowledged that environmental protection and the efficient management of natural resources are crucial matters which affect the well-being of the population and economic development all over the world. The concept of **eco-development** flourished in this animated climate.

In 1984, nearly one year after the UN's General Assembly created it, the World Commission on Environment and Development's first meeting took place. A mandate was created for the first time which asked for the opinions and points of view of individuals, scientific institutions, non-governmental organizations, specialist organizations and other United Nation and Government organizations regarding the existing problems related to the environment and development. In 1987, the **Brundtland Report** also known as "Our Common Future" was published. The term "sustainable development" appeared for the first time in this report, defining it as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*". This document acted as the foundation for the second Earth Summit in Rio de Janeiro in 1992, which marked the start of new lines of action based on development that combined economic viability, social fairness and the conservation of the environment. This is how "sustainable development" acquired its current 3-pillared definition.

The aquaculture sector, which experienced unprecedented development in the 1980s, is also synonymous in the mid 1990s with creating the first tool for reaching a common and accepted understanding of sustainability by all interested parties, and also wider social acceptance. In the context of the third world summit for sustainable development in

Johannesburg (South Africa), the crisis suffered due to the badly controlled intensification of shrimp farming ultimately tarnished the image of aquaculture. Indeed, it started to be associated with the destruction of fragile ecosystems as well as with the negative impact on local towns. Generally speaking, aquaculture must, as a new emerging industry, in time, face up to global fears regarding both economic and social aspects as well as environmental ones. However, its development has also resulted in multiple actions that have led to the breeding of aquatic species in captivity moving towards a practice more in tune with *sustainable development*.

Various initiatives by a number of institutions such as; syndicates, international organizations, NGOs and research institutes have been applied at various geographical scales to promote sustainable development in aquaculture. Amongst them, and in particular, is the FAO's 1995 **"Code of Conduct for Responsible Fisheries"**, which was specifically applied to aquaculture in 1998 or the Federation of European Aquaculture Producers (FEAP)'s 2000 **"Code of Conduct for European Aquaculture"**. At the Mediterranean level, the three "Guides for the sustainable development of mediterranean aquaculture" published by the Spanish Ministry of the Environment and Rural and Marine Affairs and created by the IUCN between 2006 and 2009 are, to date, the only documents directed towards sustainable development of the sector in the region via the implementation of good practices in aquaculture. On the other hand, more than a dozen initiatives on a local, national or international level have been set up since the end of the 1990s with the aim of developing criteria and sustainability indicators. This is the case, for example, of the EU-funded CONSENSUS project which began in 2005 or the EVAD project. Information on these and other projects are provided in the next section.



In the same way, in the natural resources management policy, aquaculture has moved from a sectoral focus to an integrated management focus of the area, which considers all the activities and usage of the coast or the coastal areas for better integration of the sector. This management concept aims to balance the pillars of sustainable development via a process of co-construction, taking into consideration the opinions and interests of all those involved.

Sustainability has become, in a way, aquaculture's pet project. It is synonymous with knowledge and optimization of the interactions that aquaculture establishes with the environment in which it is done, tending towards the maintenance and/ or increase in biodiversity. Sustainability also contemplates socioeconomic development through the creation of jobs, wealth and social and cultural development, at the same time as promoting a harmonious integration with other activities in coastal and rural areas, generating synergies with these current and future activities and guaranteeing, ultimately, the viability and durability of aquaculture in the long term.

Despite considerable efforts, the social and environmental aspects of sustainable development do not carry the weight of the economic dimension. Aquaculture requires a better understanding of the dynamics that regulate the three dimensions and their interactions. Research and the application of new and improved technologies can contribute to better symmetry between the three pillars, as well as the definition and utilisation of sustainability indicators that allow those involved to measure and monitor, in a simple and timeless manner, the situation of aquaculture from a sustainability point of view.

This report takes the existing publications and reports on this subject as a starting point, with the main aim of identifying sustainability indicators in the field of Mediterranean aquaculture in the three dimensions; social, economic and environmental adapted to the three levels: local, national and Mediterranean.



# PROJECT MEDITERRANE-ON



## 1. Approach

The definition of sustainable indicators has become a necessary first stage in order to achieve sustainable development. Aquaculture producers are the first to be interested in promoting the sustainable development of their businesses, through the understanding that the final quality of their product depends largely on the actual sustainability of their business and an appropriate assessment of the existing interactions between aquaculture and the environment and social and economic aspects.

The MEDITERRANE-ON project, co-funded by the Biodiversity Foundation, is coordinated by the Spanish Aquaculture Observatory Foundation (FOESA), with the collaboration of the International Union for the Conservation of Nature (IUCN) and the Spanish Association of Marine Fish Farmers (APROMAR) and it aims to provide all those involved in the aquaculture industry: producers, central and regional administrations and international organizations with a series of measurable indicators applicable to the whole Mediterranean Basin, and allowing those involved to analyse and improve the sustainability of this strategic industry for socioeconomic development.

MEDITERRANE-ON's objectives are:

1. The definition and identification of indicators, capable of measuring sustainable aquaculture at a farm/ business, national and Mediterranean level.
2. To provide the decision makers and the aquaculture producers with a technical tool and advice on the processes of sustainable aquaculture development adapted to the Mediterranean context.
3. To increase awareness in the sustainable use and management of the social, economic and environmental resources available in order to obtain a sustainable balance in the management of the activity.



Fundación Biodiversidad

The **Biodiversity Foundation (BF)** is a public foundation of Spain's Ministry for the Environment and Rural and Marine Affairs. Its mission is to preserve natural heritage and promote biodiversity conservation, aiming to create jobs, wealth and well-being in society, with particular attention to rural areas. In order to do this, the Foundation collaborates with organizations which make up a large network which includes the public sector, civil society and the business sector.

The Biodiversity Foundation was founded by the Spanish Government in 1998 to contribute towards the conservation and the sustainable use of biodiversity. The council is the Biodiversity Foundation's main organ of government. Representatives of the General State Administration take part in it as well as well-known people in the field of nature conservation. To carry out its mission, the Biodiversity Foundation has a multi-disciplinary team made up of around 50 professionals, who respond to the demands of the job, the management and the social projection of the organization.

Web: [www.fundacion-biodiversidad.es/](http://www.fundacion-biodiversidad.es/)



**The Spanish Association of Marine Fish Farmers (APROMAR)** is a national organization with professional scope, recognized since 1986 as a Producer Organization (OP-30). It belongs to the Federation of European Aquaculture Producers.

APROMAR's main aim is to represent the business sector of Spanish marine aquaculture, to provide services that contribute to improving competitiveness amongst its members and encourage socially responsible behaviour for sustainable aquaculture.

APROMAR also supports food quality and food safety in fish rearing, while respecting the environment and the animal well-being.

*Web: [www.apromar.es](http://www.apromar.es) / [www.feap.es](http://www.feap.es)*



**The International Union for the Conservation of Nature, (IUCN)** helps the world find pragmatic solutions to our most pressing environment and development challenges. It supports scientific research, manages field projects all over the world and brings governments and non-government organizations, United Nations agencies, companies and local communities together to develop and implement policy, laws and best practice.

IUCN is the world's oldest and largest environmental network. IUCN is a democratic membership union with more than 1,000 government and NGO member organizations and almost 11,000 volunteer scientists in more than 160 countries.

IUCN's work is supported by more than 1,000 professional staff in 60 offices and hundreds of partners in public, NGO and private sectors around the world.

IUCN's Global Marine Project covers 8 subjects. The Global Marine Project's Fisheries and Aquaculture activities programme includes:

1. Governance
2. Certification
3. Sustainable Aquaculture
4. Illegal Unreported and Unregulated fishing (IUU)

*Web: [www.iucn.es](http://www.iucn.es)*

*Web: [www.iucnmed.org](http://www.iucnmed.org)*





**The Spanish Aquaculture Observatory Foundation (FOESA)**, set up in June 2008, is a public Foundation protected by the Spanish Ministry of the Environment and Rural and Marine Affairs (MARM), as well as Biodiversity Foundation. Its patrons are the Secretary General of the Sea, National Advisory board of Marine Aquaculture Farms (JACUMAR), Spanish Institute of Oceanography (IEO), Spanish National Research Council (CSIC), Spanish Science and Technology Foundation (FECYT) and Alfonso Martín Escudero Foundation (FUNDAME).

FOESA's priority is to bring together aquaculture and society, promote and popularize aquaculture, as well as to encourage the sustainability development of the sector.

To achieve this FOESA works on 5 working lines:

1. Bringing aquaculture closer to society and media
1. Strengthening the bond between I+D+i and producers
1. Publishing and training
1. Sustainable environment and development
1. International cooperation

Web: [www.fundacionoesa.es](http://www.fundacionoesa.es)

The project stems from the need to know and incorporate the different points of view of the stakeholders in the development of the Mediterranean aquaculture sector, with the absolute need to promote and favour dialogue and the participation of all. It is for this reason that the work schedule has been designed based on the various meetings and workshops with multi-disciplinary groups of experts who work in the Mediterranean region.

In these workshops the principles, criteria and subsequently the indicators have been identified and defined, which can best represent sustained aquaculture. These indicators must be easily obtained and audited, based on existing information or easily obtainable information, as well as allowing producers and aquaculture administrative staff to promote a more sustainable aquaculture, through the implementation of initiatives or improvement proposals.

The project will be communicated to all involved in the industry, so that the indicators can be adopted and introduced into the Mediterranean context in a gradual and continual manner which will require the implementation of various media initiatives and the circulation and promotion of the project and its results.

## 2. Background

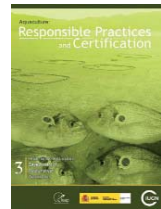
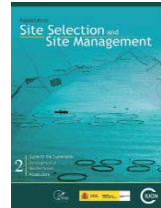
In 2006 the General Sea Secretariat (SGM), which belongs to the Spanish Ministry for the Environment and Rural and Marine Affairs (MARM), and the IUCN, signed a collaboration agreement with the IUCN's Centre for Mediterranean Cooperation, for the creation and establishment of guidelines for the sustainable development of mediterranean aquaculture. The result of this agreement is published in the first Guide for sustainable development in mediterranean aquaculture, which analyses the interactions between aquaculture and the environment.

In 2007 a second agreement was signed between the two parties for the 2007-2008 period, providing continuity to the completed work and creating new reference documents for the sustainable development of the Mediterranean aquaculture sector. This agreement allowed the publication of new documents, analysing two subjects of great importance for the sustainable development of the industry - site selection and management for aquaculture use and the responsible practices and certification of aquaculture.

In 2009, the SGM, aware of the need to explore issues related to the sustainability of aquaculture, called a public tender for the elaboration of two new documents to analyse the aspects involved in continental aquaculture and its environmental interactions and diversification as a tool for sustainability. This is currently ongoing and the results should be available soon.

Through MEDITERRANE-ON, the OESA Foundation aims to give continuity to the work carried out by the IUCN, maintaining a participative and multi-cultural approach for the creation of guidelines, studying the established guidelines in depth and identifying and defining principles, criteria and ideal indicators that allow a numerical assessment of sustainable Mediterranean aquaculture on a local, national and Mediterranean level.


As well as the information and guidelines included in the "Guide for sustainable aquaculture in the Mediterranean", a thorough search of related reports, which could be of interest to this project, was made.




Therefore, the main projects related with MEDITERRANE-ON are:



**CONSENSUS:** is a platform for European sustainable aquaculture.  
 Funded by the European Commission under the 6th Framework Programme  
 It is an initiative that works towards a sustainable European aquaculture by building sustainable aquaculture protocols that are based on low environmental impact, high competitiveness and ethical responsibilities with regard to biodiversity and animal welfare.  
 Duration: 2005/2008  
 Scope: European marine and continental companies for fish and molluscs  
 Results: 78 indicators under 8 themes agreed by 120 stakeholders from 16 countries. Reduced to 25 indicators for code of practice for improvement at national level and of species  
 and 30 reference indicators for the industry, with potential use in European standards. Other outputs include information brochures for European consumer organisations and a collection of short films on sustainability by European fish and shellfish farmers and available on youtube.  
[Web: www.euraquaculture.info](http://www.euraquaculture.info)



**ECASA:** is a Ecosystematic Focus towards Sustainable Aquaculture  
 EU funded Framework 6 RTD project with 16 research partners from 13 member states  
 Duration: 2005/2007  
 Scope: Europe: Both fish farming and mollusc farming from all the European regions with around 10 field locations in various types of marine environments.  
 Dimensions: environmental  
 Results: 24 sediment and benthic indicators, 6 indicators of water quality, 8 environmental indicators, 15 socio-economic indicators, 4 genetic and 4 coastal area management indicators  
[Web: www.ecasa.org.uk](http://www.ecasa.org.uk)



**EVAD:** Assessment of the durability of the aquacultural systems. Elaboration of a method and implementation in different contexts of tropical and temperate areas.  
 Funded by the French National Investigation Agency  
 Duration: 11-2005/11-2008  
 Dimensions: technical-economic, institutional, environmental and social  
 Results: 13 principles, 81 criteria, 234 indicators on two levels: Sectoral and regional  
 Case study: France, Mediterranean, Cameroon, Philippines and Indonesia  
[Web: www.inra.fr/coordination\\_piscicole/groupe\\_de\\_travail/systeme\\_d\\_elevage/evad](http://www.inra.fr/coordination_piscicole/groupe_de_travail/systeme_d_elevage/evad)



**IDAqua:** Steps towards lasting aquaculture

Funded by Casdar + Feb/IFOP

Duration: 4-2006/2008

Objective: Tool for salmonid (trout) activity in France, voluntary and internal amongst the producers.

Results: 35 selected indicators from 110 tests: 11 economical, 9 socio-terrestrial and 15 environmental, spread between the various types of production.

Web: [www.sati.tv/spip.php?article1306](http://www.sati.tv/spip.php?article1306)



**SEACASE:** Provide an added value to the extensive and semi-intensive systems from southern Europe via the optimization of the systems and coverage of the differentiation of the product on the market from these low- impact production systems.

Funded by the European Commission under the 6th Framework Programme

Duration: 01-2007/01-2010

Web: [www.seacase.org](http://www.seacase.org)



**InDAM:** Indicators for the sustainable development of aquaculture and guidelines for their use in the Mediterranean

Funded by the EU DG Mare and developed by the Aquaculture Committee of the Sustainable Aquaculture Workgroup which belongs to the General Fisheries Commission for the Mediterranean (GFCM)

Dimensions: economic, institutional, environmental and social

Duration: 11-2008/2012

Objective: Provide the countries with a support tool for decisions in the development of sustainable marine aquaculture based on indicators, reference points and guidelines adapted to the Mediterranean region.

Pilot cases: Turkey and Tunisia

Results: 14 principles, 67 criteria, 156 indicators

Web: [http://www.faosipam.org/?pag=content/\\_ShowPortal&Portal=InDAM](http://www.faosipam.org/?pag=content/_ShowPortal&Portal=InDAM)

### 3. Procedure

The starting principle was that the selected and defined indicators could be used on any type of aquaculture farm in any Mediterranean country. In the first phase of the project, the identification of the most suitable indicators to assess the sustainability of aquaculture activity in the Mediterranean was made on the basis of ease of measurement and monitoring without further (administrative or other) burdens for producing companies.

The indicators may appear to be rather general but they can be used on any farm in any country, regardless of the type of water used (salt or fresh), the type of cultivation, intensive, semi-intensive or extensive, or the system or facilities employed, external tanks, floating hatcheries, etc. The indicators have also been defined for application to any of the 15 species or more that breed in the Mediterranean.

To ensure the correct definition and identification of the indicators the following three levels were established: farms and/or production companies, countries and Mediterranean region.

For each of these three levels, the pillars or dimensions of sustainability have been contemplated: Socio-territorial, economic, environmental aspects.

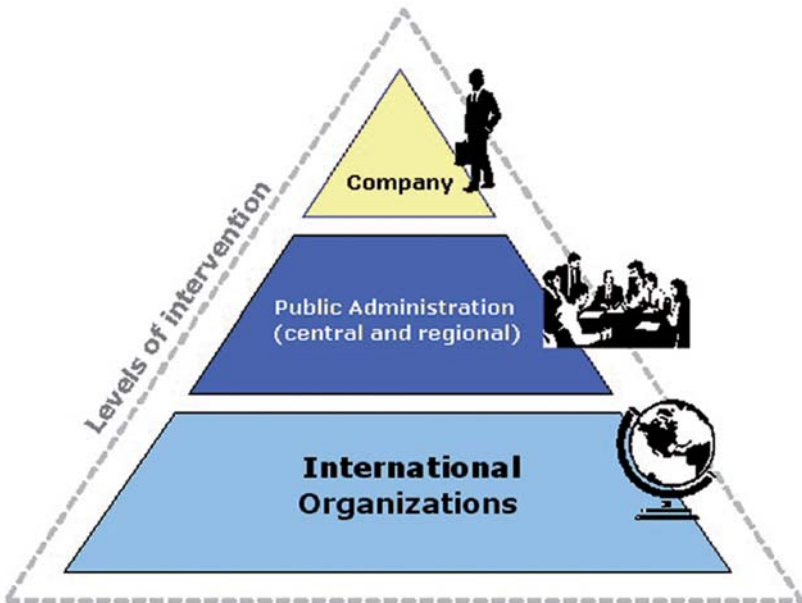


Diagram designed by José Carlos Macías

The key to sustainability and sustainable management is based on the balance between these three pillars.



Diagram designed by José Carlos Macías

With these levels and aspects in mind, a Principle-Criteria-Indicator (PCI) method was chosen as the essential and fundamental method to establish the relationship between indicators and principles within the corresponding framework. Also, the 'SMART' criteria were used in defining the indicators - i.e. being Specific, Measurable, Achievable, Relevant and Time Bound.

Each standard is based on impacts, principles, criteria and indicators, as defined below:

- Impact: Interaction
- Principle: The highest level objective which the impact is directed towards
- Criterion: The area that the impact is focused on
- Indicator: Measures the extent of the impact

The selection process of the indicators is critical, since it determines credibility, viability and the success of the standards. For this, a wide number of experts from the majority of Mediterranean producers were contacted, who also formed the workgroup that took part in the development of the IUCN guides (IUCN 2007, 2009, 2010). This process was multi-disciplinary and participatory. This group of Mediterranean experts allowed better

assessment of the complexity of aquaculture in the Mediterranean Basin, to analyse the industry's requirements and the challenges which must be faced in the next few years to demonstrate sustainability and become an even more consolidated, extended and well known activity in all countries that share the Mediterranean Sea.

In the workshops organised over the duration of the project, the participation of the experts was facilitated by a different work system, firstly according to the source language, for which three debate groups were held, in Spanish, English and French and secondly, according to the academic or professional specialization, for which three workgroups were formed for environment, social aspects and economic affairs.

This exercise allowed a better definition of the indicators and greater consensus regarding their selection, reinforced by the project team's work and coordination.

Some of the most interesting aspects discussed in the workshops with a view to future work, revolved around the importance or advisability of introducing governance as a fourth pillar for the sustainability or suitability, the convenience and current difficulties when it comes to defining sustainability indicators applicable to any type of species and cultivation system, which in the future will be able to be adopted on an international level, allowing comparisons to be made with aquaculture in different parts of the world.

The selection of suggested indicators in this document aims to support decision making for all stakeholders with a direct or indirect bearing on the development of the Mediterranean aquaculture sector, with tools that do not cause extra work on a day-to-day basis. The MEDITERRANE-ON project also aimed to increase awareness firstly amongst those involved in the activity but also in society, for the need to obtain a more sustainable management of our coastal and rural areas, which will allow future generations to make better use of them.

# PRINCIPLES, CRITERIA AND INDICATOR GUIDE





## 1. Introduction

Since the end of the 1990s, various initiatives have been completed on a local, national or international scale to identify sustainability indicators for aquaculture. However, these numerous proceedings and tasks have culminated in an accumulation of potential indicators which can no longer be used, given the complexity or difficulty in obtaining the information needed for a calculation and/or preventing subsequent tracking and analysis, thereby hindering the ability to adopt correct measures. The OESA Foundation started this project for the Mediterranean basin to get started and continue to broaden its search and promote greater sustainability in its activities, as well as diagnosing the state of aquaculture in this region, from a sustainability, social, environmental and economic point of view. This analysis also aimed to create a 'grade' of aquaculture sustainability for the different countries in the Mediterranean, thus enabling new initiatives and strategies for further progress to be initiated.

The indicators chosen for each of the three levels (local, national and Mediterranean) and for each of the three pillars of sustainability (environment, society and economy), will be validated in the next three months through a pilot project that will enable final improvement and approval.

The chosen indicators entail a simplification and summary of the existing information and a homogenization through its use as application standards for a wide spectrum of situations and cases. It is about qualitative and quantitative values which enable the state or evolution to be expressed in a significant way. According to Madec (2003), "indicators are communication tools which enable information to be quantified and simplified to make it understandable to a specific audience. They are monitoring, evaluation, indicative and decision making tools. They are defined in reference to previously set objectives; the confrontation of values taken by an indicator with the corresponding objective enables one to comment on the efficiency of an action".

The strength of the indicators lies in the fact that they report on a situation (state) or on the evolution of a variable and they are basically a measuring tool. They are, in other words, tools which provide synthetic information for a complex reality such as that which surrounds us. According to the Organization for Economic Co-operation and Development (OECD), the term indicator is defined as a "parameter or the value resulting from a set of parameters, which provides information about a phenomenon with a broader meaning than that directly associated with the parameter settings". On the other hand, all indicators express priority orders between variables and reveal important factors which have to be taken into account. It therefore responds to an inventory function pinpointing the variable, which amongst many others, is the object of this monitoring.

The indicator is also a tool which can be used at any time as a means of communication. It must be elaborated in a way that it is understandable to all those involved, easily measurable, financially affordable and sensitive enough to detect any changes in the management of the aquaculture sector as a whole against chosen references for sustainable development assessments; it constitutes a reference point with a threshold which synthetically determines the positive and negative situations assessed.

The elaboration of indicators must be perceived as an opportunity to include aquaculture in sustainable development, with the object of heading towards viability and sustainability in this sector. A good indicator is one which can be put into practice and for that it needs to have a precise meaning for the person who uses it. It is therefore vital that those involved can take part in the elaboration of these indicators in a collective manner, as well as the principles and criterion that regulate them.

In MEDITERRANE-ON, those involved are from the majority of Mediterranean countries and different fields of work, made up of producers, economic, social and environmental experts as well as representatives of institutional and environmental organizations. The approach is done in a transversal manner, taking three spatial scales into account: local, national and international and evaluating the three pillars which support sustainable development, giving the whole a more integrated identity.

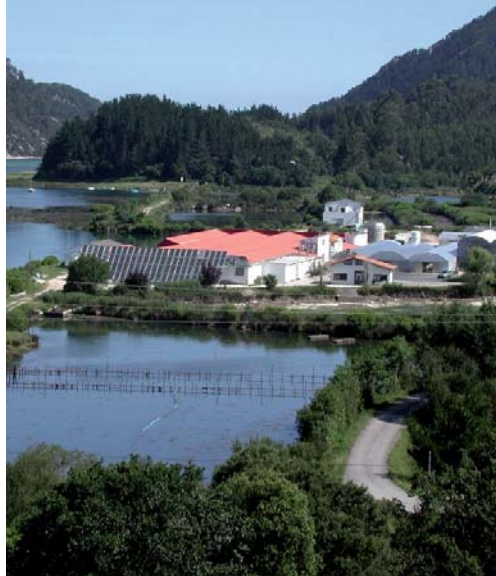
The indicator's approach is one of a cascading chain effect in which, firstly, the main principles of a context are defined whereby sustainability acquires a common meaning for the parties involved. The principles are devised from action verbs such as "contribute to", "ensure that", "improve", etc. and they are particular in that they are the founder element, the starting point from where reflections and actions in favour of sustainable aquaculture stem from. These principles then incline towards criterion, which are expressed in terms which show the state of a variable. Terms are used such as "importance of", "existence of", and "ability to" in order to break down the principle on the one hand, and on the other, to prefigure the indicators, which will enable them to be assessed. Lastly, the indicators culminate in the determination of threshold values by points of reference which are features of the availability of information, of the degree of implementation and the social acceptance of the rules they establish. By this hierarchical adjustment, territorial and/ or sectoral challenges are connected.

In this study, the indicators determined by the group of Mediterranean experts show aquaculture sustainability in the region from an environmental, economic and social point of view, setting a trend regarding improvement strategies which can be undertaken in each pillar with a view to obtaining a more sustainable development in the sector. Some of the aspects dealt with in the indicators shown below are related to food and conversion indexes, the activity's carbon footprint and the use of different sources of energy, environmental certifications, work generated or social acceptance of aquaculture.


The following indicators, as mentioned before, are addressed to companies or farms, for the improvement and unification of the regulation base, which the sector comes under and for the improvement in management on the part of the Mediterranean countries. All of them aim to offer a local, global, regional and national overview.

In this way, each of the selected indicators will be able to be used in time enabling one to observe improvements or a decline in sustainable management activities.

Below is a model template that shows the different elements, their definitions and objectives.



**LEVEL: FARM/COUNTRY/MEDITERRANEAN**

<p><b>INDICATOR DIMENSION:</b></p>	
<p><b>INDICATOR NUMBER:</b></p>	
<p><b>PRINCIPLE:</b></p>	<p>Establishes the basis and defines, selects and prioritizes the subsequent criterion and indicators. It is expressed in criterion and measured with the indicators.</p>
<p><b>CRITERION:</b></p>	<p>Homogeneous elements of the principles which lead to the indicators. A principle can be defined by various criteria. It expresses the degree or the state of the variable: Level of, existence of, etc.</p>
<p><b>INDICATOR:</b></p>	<p>It allows the criteria to be used. It simplifies the information to make it more understandable. They can lead to a rate or a group of indicators summarized in a single value.</p>
<p><b>EXPLANATION:</b></p>	<p>It explains why this indicator has been selected, its importance and contribution to aquaculture sustainability.</p>
<p><b>DATA SOURCE:</b></p>	<p>The information source is identified to work out the indicator: businessmen, producers, national and international statistic sources and/ or information in the public domain from contrasted sources.</p> <p>Measuring frequency: monthly, quarterly, half-yearly, annually.</p> <p>Calculation method and, if necessary, explanation.</p>
<p><b>FORMULA:</b></p>	<p>Unit: Euros, tonnes, units, etc.</p> <p>Scales: The scoring range is from 1 to 5:</p> <ul style="list-style-type: none"> <li>5 Sustainable</li> <li>4 Nearly sustainable</li> <li>3 Approaching sustainable</li> <li>2 Far from sustainable</li> <li>1 Unsustainable</li> </ul>

## 2. Indicators of sustainability at a farm/company level

### **Introduction**

The following indicators are aimed at farms or companies and they intend to provide with an idea of the level of awareness and implementation of aspects related to sustainability in business management. The indicators have therefore been defined and selected to strengthen certain actions which show this social, economic and of course, environmental awareness. Each of the selected indicators will be able to be used over time so as to observe improvements or a decline in sustainable management activities.

As shown in the summary table, 9 indicators have been chosen for this assessment, three for each dimension: economy, society and environment. A score for each of the indicators and dimensions contributes to the overall score for a farm or company.

All the indicators have a total of 5 points:

- 5** Sustainable
- 4** Nearly sustainable
- 3** Approaching sustainable
- 2** Far from sustainable
- 1** Unsustainable

Based on the score obtained in each of the indicators, design or propose improvement measures to be used, appointing someone responsible for this and establishing a deadline for monitoring and assessment.

This same assessment criterion must be applied to the three dimensions, remembering that sustainability is supported by sustainable practices in each of them. As a consequence, the farm/ company must, when implementing its final sustainability assessment, obtain a balanced score in the three dimensions, if one of the dimensions does not obtain sustainability level, it cannot be considered sustainable.

**SUMMARY TABLE FOR INDICATORS AT FARM/COMPANY LEVEL**

DIMENSION	PRINCIPLE	CRITERION	INDICATOR
ECONOMICS	Strengthen financial management enterprise	Level of economic performance	<b>Evolution of the ex-farm price per kg/total cost per kg produced</b>
		Level of debt	<b>Self-sufficiency</b>
	Increase adaptation capacity to cope with uncertainties and crises	Level of product diversification	<b>Number of products on sale</b>
ENVIRONMENT	Maintain ecosystem goods and services that are provided for aquaculture	Level of ecological footprint	<b>Inputs/Outputs</b>
		Level of carbon footprint	<b>Energy</b>
		Use of certification and good practices	<b>Fulfilment of environmental standards</b>
SOCIO-TERRITORIAL	Corporate social responsibility	Level of working conditions	<b>Existence of preventive policies</b>
	Strengthen the role of aquaculture in local development	Level of contribution to local employment	<b>Local employment</b>
	Strengthen the role of sectoral organizations in improving the social image, awareness and responsibilities	Image of aquaculture	<b>Existence of communication mechanisms</b>

## ECONOMIC INDICATORS

### ASSESSING THE ECONOMIC SUSTAINABILITY OF AQUACULTURE

**Philippos Papageorgiou**

Aquaculture & Fisheries Consultant  
Greece

*Aquaculture has become a truly global industry. Aquaculture companies, regardless of their size, level of -horizontal and/ or vertical- diversification, location of production unit(s) etc, compete for market shares against companies of the wider food producing sector, at the local, national and international markets. Equally, they compete for resources (environmental, human and financial) which often surpass local level and expand to national or even international levels.*

*While prospects for the future of aquaculture are generally positive, the industry faces various challenges which need to be promptly and adequately addressed. The dynamic intra- and interrelationships of aspects related to the environment, the society and the economics of aquaculture companies, and the efficient overcoming of the challenges associated with these relationships, form the basis of sustainability, a concept that has emerged as an important precondition for the future of the industry.*

*Taking for granted that, in the present era of ever-increasing environmental and social awareness, any company must strive for the lowest possible environmental impact, and that it must yearn for social acceptability, any such (private) company must also be profitable in order to justify its existence, and its purpose thereof, to its shareholders. In this respect, there are many elaborate ways to measure and evaluate economic performance of a company, based on various accounting rules and principles. However, in search of an easily applicable and commonly understood measurement of financial viability, the Gross Margin (the difference between the sales and the production costs) is probably the most simple and suitable indicator of the economic sustainability of the fish-farming operation of a company. Apart from the latter, various other economic indicators could also be complementary used, at a secondary level (i.e.: past the line of the company's 'existence'). Nonetheless, these would serve more as 'competitiveness' indicators, including the ratio of R&D and marketing expenditures over total company investments.*

*Given that aquaculture companies are profit making entities (when not state-subsidized for social or regional development reasons), it becomes apparent that economic sustainability can only be directly measured at company level (as means of returns over incurred costs and investments made). Measurements above that level (i.e. local, national), although they could provide a number of useful (relative and comparable) indicators, these would be more performance or impact related, rather than actual (absolute) indicators of sustainability.*

*Since aquaculture is often practiced in rural areas with little alternatives for development, the contribution of financially viable enterprises to local economies is of particular importance. It is not only whole or part of the income of the workers in the farm site that is spent in the area but also the maintenance and/or creation of complementary activities, directly or indirectly associated with the operation of the farm and the support of the workers and their families.*

*Equally, aquaculture may prove to be a development driver, of greater or lesser importance, for the national economy. In countries where there is a trade deficit in aquatic food products, national production reduces the dependence on imports and the outflow of exchange. Ideally, national production should aim to substitute for much of the imported quantities while at the same time trying to reverse the trade balance by exporting to other national markets (inflow of exchange).*





## ECONOMIC INDICATORS

## INDICATOR 1

**Principle:**

Strengthen the financial management of the business

**Criterion:**

Level of economic performance

**Indicator:**

***Evolution of the ex-farm price per kg/total cost per kg produced***

**Explanation:**

The intention of this indicator is to assess the economic efficiency of the farm on a medium-long term. The indicator analyses the evolution of the 1st sale price highlighting the importance of the profitability being stable on a short term (from one year to another) and a medium term (in the last three years).

The sustainability of diversified companies with temporary losses from one business unit (i.e. fish farming), being compensated by revenues of another (i.e. processing) is arguable in the long term, as possible competitors will overtake them making the most of the available niches.

**Data source:**

This indicator will assess profitability reached per kg produced. Firstly it carries out a short-term assessment, from one year to another, and then the long term, over the last three years, this way the trend and evolution of the company will be clear, always based on production costs and the ex-farm price of the product.

In the case of companies with various products, the ex-farm price is obtained from the average price of all of them.

The total cost refers to direct and indirect costs (packaging, marketing, selling, depreciation, insurances, general management costs, office costs, etc.). It should not include costs associated with other company activities, even if they are associated with the fish-farming activity (feed and/or fingerling production, etc.).

**Formulas:**

Profitability in 1 year (Formula 1)	Score	Profitability in 3 years (Formula 2)	Final Score
If >1	3	If it increases (+2)	5
		If it decreases (+0)	3
		If stable (+1)	4
If =1	2	If it increases (+2)	4
		If it decreases (+0)	2
		If stable (+1)	3
If <1	1	If it increases (+2)	3
		If it decreases (+0)	1
		If stable (+1)	2

Formula 1. Evolution of 1 year profitability assessment

*1st sale price per kg Year 1/total cost per kg produced Year 1/1st sale price per kg Year 0/total cost per kg produced Year 0*

Formula 2. Evolution of 3 year profitability assessment

*1st sale price per kg Year 3/total cost per kg produced Year 3/1st sale price per kg Year 0/total cost per kg produced Year 0*

## INDICATOR 2

**Principle:**

Strengthen the financial management of the business

**Criterion:**

Level of debt

**Indicator:*****Self-sufficiency*****Explanation:**

Borrowing is currently a common source of funding for business financing for the productive cycle and infrastructure assets as well as for diversification and growth. Borrowing, when sales are on the increase and interest rates are reasonable can be very profitable for companies, just as it can be damaging in hard times. The higher the borrowing the lower the solvency, but profitability can be greater.

**Data source:**

Data can be obtained from the Company Register asking for the aquaculture company's economic balance sheet.

Data will be gathered annually.

***Borrowing rate:*** It is the debt/asset ratio. It determines the company's debts.

Its optimum values range between 0.5 (50%) and 0.6 (60%).

**Formula:**

*Borrowing rate = Debt to Capital ratio*

Ratio	Score
0.5-0.6	5
>0.6	3
<0.5	1

### INDICATOR 3

**Principle:**

Increase ability to adapt to face crises and uncertainties

**Criterion:**

Level of product diversification

**Indicator:**

***Number of products on sale***

**Explanation:**

Species diversification, as well as the number of products taken to the market by a single company shows the ability to cope with uncertainties and crises and therefore the company will have more opportunities to guarantee its future when selling its products. Product diversification also increases the company's ability to adapt and to progress with regards to new markets.

**Data source:**

Companies must provide or obtain this data annually.

The greater the number of species or products the farm or company produces, the higher the score.

Number of species produced: 1, >1

Number of products (fresh whole, fillets, frozen, smoked, gutted, sizes): 1, >1

**Formula:**

N° species	N° products	Score
1	N° of products = N° of species	1
	N° of products > N° of species	2
>1	N° of products = N° of species	3
	N° of products > N° of species	4
	N° of products > 2 x N° of species	5

## ENVIRONMENTAL INDICATORS

## SUSTAINABILITY INDICATORS FOR AQUACULTURE

**Fernando Torrent**

Polytechnic University of Madrid  
Spain

*Aquaculture is a very new industry and in the beginning it was particularly fragile, which went hand in hand with the low social and economic effect it had on the Mediterranean coast. Particularly with regards to marine fish farming, which began in the 1980s and is only just gaining importance, but also inland aquaculture, which have to be carried out in areas of high environmental quality, which are increasingly scarce in our society. From the beginning, aquaculture has been competing for areas with other industries, which are much stronger and more established.*

*The Mediterranean area and particularly the European coast, have modern economic and cultural populations, which are characterized for their important, consolidated and socially accepted industries associated with the coast.*

*Obviously any activity we carry out has an impact. It may be big or small, but it evidently always has an impact on the location. What greater impact than the destruction of woodland to create fields for grazing or grain fields or any traditional activities which increase the biomass required by mankind within the terrestrial environment? The origin of aquaculture as an industry has to initially be associated with not knowing the effects of the activity on the environment, and therefore, until we know more about the activity, we must go through a learning process. Fortunately, this learning period is becoming easier as there are more examples of important developments in aquaculture in the world and what must and must not be done in the various economic, social and environment aspects to develop aquaculture in a sustainable manner, . We need to have the right balance between these aspects in order to reach modern society's required sustainability, which protects this development and foreseeable growth.*

*The reality is that the lack of knowledge in this field and in particular the effects of industrial development in aquaculture have created scientific information which has been poorly understood and negatively publicised by today's powerful media, distorting the image of aquaculture. What was an idyllic image of marine farming only a few years ago now portrays and image of aquaculture being a contaminating activity.*

*All this information, which is generated during the monitoring process, is used in abundance by other coast and sea users, in legitimate defence of their own interests, to magnify the negative effects of aquaculture by using any argument in the conflicts generated by the industry.*

*This is why the aquaculture industry and the scientific community that surrounds it are studying these impacts closely to control them and keep them at acceptable levels for today's society. Particularly the European Aquaculture Technology and Innovation Platform (EATIP), seems to be the tool which will channel the priorities of future research by the EU which will enable better control of the activity.*

*The most consolidated aquacultural industries in our cultural environment are mussels in Galicia, which are fully accepted and which are one of the economic driving forces of the Galician coast. The same occurs with the Norwegian aquaculture industry, which is now worth more than fishing and which is accepted by society as the coast's main economic force. This is achieved over time and with the general social acceptance of the activity.*

*Aquaculture's sustainability indicators are going to be essential tools in channelling the characteristics of the industry to society. There is no better tool than the knowledge and control of aquaculture's development, which will help society accept the expected huge growth of aquaculture's producers in the Mediterranean. The elaboration of appropriate simple and easy sustainability indicators, in environmental, economic and social aspects have to be the most suitable tool to convey to society the harmlessness of these practices if they are planned correctly. We cannot let small pieces of information, which have been magnified by other coastal industries with a conflict of interest in aquaculture and broadcast to the media, often with no knowledge of the subject, become "de facto" of the aquaculture industry in society.*

*Mediterranean aquaculture is set to become a much more efficient food producer than the current farming industries. And in order for society to accept the idea, that a consolidated aquaculture industry on our coasts will guarantee the quality of the coastal waters, we need to find, introduce and set up some reliable and socially acceptable indicators which clearly contribute to guaranteeing continual and sustainable growth on our coasts the same as the rest of the world is doing.*

## ENVIRONMENTAL INDICATORS

## INDICATOR 1

**Principle:**

Maintain the goods and services that the ecosystem provides to aquaculture

**Criterion:**

Level of ecological footprint

**Indicator:**

***Input (feed kg or n°. of individuals)/Output (produced kg or n°. of individuals)***

**Data source:**

The calculation of the indicator depends on whether the species produced is fed, in which case the conversion index refers to each growth cycle, sowing season, and if they do not receive supplementary feed, it is based on the collection of individuals in the natural environment for subsequent fattening.

Companies can provide data.

**For farms using fodder****Explanation:**

The Feed Conversion Ratio (FCR) is the amount of food needed for an animal to gain 1 kg. This indicator is aimed at using food in an efficient manner that optimizes the transfer of resources into fish flesh for consumption, besides contributing to reduce adverse marine environmental impact.

Finally the FCR was considered alone with no other related factors such as the impact of the water column, which was first taken as water turbidity before and after feeding, but due to numerous other factors affecting turbidity (currents, land effluents, spills, fluvial effluents, etc.), it was decided to consider only feed input (uneaten or remains) scoring higher in the proximity of 1.

To complete this indicator it would be useful to consider the interaction on the feeding process with the benthic environment, which is complex due to measurement high costs (commercial divers needed, sampling gear, sample analysis in the lab, etc.) and the unavailability of mandatory legislation nowadays. However, in order to obtain a more specific ecological footprint of the farm, it is highly recommendable that farmers analyse the evolution of temperature, dissolved oxygen, pH, not forgetting interactions in the benthic community.

**Formula:**

*Input (kg food)/Output (kg fish)*

Feed Conversion Ratio (FCR)	Score
≤1	5
>1<1.6	4
≥1.6<2	3
≥2<2.5	2
≥2.5	1

**For farms that do not provide supplementary feed for their stock:**

**Explanation:**

For filter feeding molluscs that grow in small areas, estuaries, bays, etc. the main environmental factors to consider are: plankton and biodeposits under the floating devices (batea, a flat-bottomed boat). As mentioned above for the benthos, it is hard to make an assessment and the same applies to plankton, especially given temporal variation, weather factors, sea conditions, water movement, etc. The analysis of the evolution of chlorophyll, as an environmental indicator, is difficult to measure due to high variability in time.

Therefore, it is advisable to carry out, at least once a year, an assessment of the state of the benthic conditions below the floating device, either with a visual assessment or a specific technique for this ecosystem. As well as assessing the load bearing capacity of the seabed below the device.

Based on these considerations, the relation between the initial and final number of individuals has been selected due to its simplicity and direct relation with the adoption of good farming practices, which do not harm the environment.

The indicator also establishes the seed origin: production in hatcheries or wild capture.

**Measurement:**

Number of individuals = Kg mollusc per rope or basket\*number of ropes or baskets/average weight of individual (kg)

**Recommendation:**

*\*Seed production in hatcheries should have a number of guidelines: Sterile seeds, local seeds, seed rotation in reproduction years and between years, etc.*



**Formula:**

---

*N°. of final individuals/n°. of initial individuals*

If =1 the ideal situation is achieved (4)

If <1

Between  $\geq 0.8 < 1$  (3)

Between  $\geq 0.4 < 0.8$  (2)

<0.4 (1)

---

**Plus:** Seed origin

Hatchery (+1)\*

Wild capture (+0)

---

INDICATOR 2

**Principle:**

Maintain the goods and services that the ecosystem offers to aquaculture

**Criterion:**

Level of carbon footprint

**Indicator:**

***Energy***

**Explanation:**

Climate change perhaps represents the biggest environmental challenge faced by current and future generations. Because of this, energy consumption used in food production has become a major source of concern. This indicator recognizes the importance of efficient and responsible energy use, besides making the producer ensure minimal adverse impact. Those farms or companies that adopt renewable energy strategies in terms of production or consumption will be awarded the highest score.

**Data source:**

Data will be gathered annually.

**Formula:**

***Step 1.***

Do you produce your own renewable energy on your farm (solar, wind, etc.)?

**No.** Do you buy and consume renewable energy from another company?

No (1)

Yes  $\geq 50\%$  (3)

Yes  $< 50\%$  (2)

**Yes.** What % do you produce and what type of energy?

$\geq 50\%$  (2)

$< 50\%$  (1)

***Step 2.***

Do you analyse the carbon footprint produced by your farm or company?

**Yes** (+1)

**No** (+0)

**Plus:**

Has your farm/company a strategy or planning or other mitigation measures\*?

**Yes** (+1)

**No** (+0)

\*Reducing/mitigation measures:

1. Use of renewable energies
  2. Use of energy saving light bulbs
  3. Use of low octane diesel
  4. Composting
  5. Planting native trees
  6. Installation of habitat enhancing structures (artificial reefs...)
  7. Other measures
-

### INDICATOR 3

**Principle:**

Maintain the goods and services that the ecosystem offers to aquaculture

**Criterion:**

Use of certification and best practices

**Indicator:**

***Fulfilment of environmental standards***

**Explanation:**

A farm or company committed to any environmental standard (not necessarily to obtain a seal or certificate) shows a certain interest and motivation in improving the final quality of the product, giving it an added value with environmental implications. Given the difficulty in determining the efficiency or degree of reliability of each standard or existing certification at an international level, and more specifically at a national level, it has been decided that an evaluation will be made of the certificates which fulfil the three levels (the company which creates the certificate is independent of the one which authorizes it and which certifies it) starting with the lowest level and obtaining the highest score if they have been involved in creating standards.

**Data source:**

The company itself should be interested in showing its adherence to and fulfilment of the standards which it has already committed to in its last written statement to the authorized body (corresponding to the given year) or through the acquired stamp.

Data will be gathered annually.

**Formula:**

***Step 1.***

Do you have and use a Best Practices Code (e.g. Best Aquaculture Practices Certified)?

**Yes (2)**

**No (1)**

**Step 2.**

Do you have any eco-labels which guarantee the farm or company's involvement in environmental issues? (e.g. ASC, Gold Standard)?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Do you have any environmental standards (ISO, EMAS)?

**Yes** (+1)

**No** (+0)

---

**Plus:**

Have you taken part in the design and definition of aquaculture environmental standards (e.g. WWF Dialogues)?

**Yes** (+1)

**No** (+0)

---

## SOCIOTERRITORIAL INDICATORS

### SOME ANGLES ON THE SOCIAL DIMENSION OF AQUACULTURE

**Güzel Yücel Gier**

Institute of Marine Science and Technology  
Dokuz Eylül University  
Turkey

*It is essential that the full range of knowledge connected with aquaculture is passed on to the public at large. Knowledge has always been critically important to the development of aquaculture. Knowledge management will become increasingly critical to the sustainable development of aquaculture and its movement towards attaining the desired social outputs. Networks such as the farmers associations, the ministries and the municipalities, need to pass on information about, say, the way aquaculture successfully interacts with the environment and how this is being effectively monitored. Knowledge networks and the use of knowledge platforms should be aimed at the effective dissemination and adoption of aquaculture. Marine Aquaculture is relatively new to the Mediterranean, whereas fishery activities are extremely ancient. The exchange of information between professionals and the setting up of support and communications networks, with know-how as to their effective political implementation, are essential. But they must be very professional in how they operate in connection with local, national and supranational (EU) politics. These professional organizations are essential for the effective circulation of information. The social acceptability of aquaculture and the conflicts between stakeholders are reflected in extensive, and often one sided, media coverage. As a useful indicator it would be informative to compare, with reasons, relative amounts of positive and negative news about aquaculture. More documentary films and TV programs focusing on aquaculture would help develop a favourable image.*

*The social dimensions of aquacultural often seem to be more complex than environmental and economic ones. Farmed fish production is the concern of the people directly involved in marine aquaculture and who live and work near the sea. But it is also the concern of the public at large who may never have seen a fish farm but who like the good nutritional results and the social ambience connected with eating fish. Moreover, many people who complain about fish farms seem to be the very ones who want to cover our coastline with cities and, at the same time, to eat the farmed fish at restaurants. These people are often unaware the way their new summer homes look to a fish farmer who set up in business when the coastline was empty. On the other hand, the layout of a fish farming installation must be carefully planned so as to enhance the landscape in terms of visibility. The architectural quality of buildings and cages must be carefully selected with regard to overall spatial integration with surroundings.*

*Successful social integration of aquaculture activities with those of other local people and their livelihoods, and especially other stakeholders, is an important matter. Not only should farm installations enhance the landscape, but also the potential of activating direct sales of their products is important for the community. Opportunities for sport fishing, for on-site restaurants, for touristic visits to the aquaculture establishments and so on, can augment the social integration of site into the locality. The indicator of how many people visit the site is a strong convincing argument in favour of aquaculture. The owner and staff of the marine farm should play a full part in local social activities so as to become well known and respected.*

*The social dimensions of aquaculture are also indicated by how many people work all year round on the farm or do other sectoral work full time. For example many people are connected with transporting fish products, or supplying a huge range of farm equipment. Many workers manufacture food pellets. Others process the fish as smoked fish, fish cakes, fish fingers and so on. Other people supply scientific, legal and financial advice, work in training schools and provide veterinary services. Yet other people in the sector advertise the large companies that make aquacultural machinery and other technological products on an international scale. Just examine the “Future Fish Eurasia” trade fair newsletter to see how big the fish farming sector is as an employer and as a money-spinner. And in such a catalogue we have many other indicators of the importance of the social dimension in the appraisal of aquaculture.*

*Good pay and congenial working conditions for personnel are necessary to encourage the development of social status and high quality staffing. For example working hours and shifts, health and safety, both preparatory and in-service training and length of holiday must be considered in attracting able and professional people to work in aquaculture.*

*At global level future prospects for aquaculture are generally positive. But there are various challenges to be faced, promptly and effectively. The social and the economic faces of businesses associated with aquaculture, and the overcoming of the challenges of environmental interaction, form the basis of sustainability at company level. Company manager must strive for the lowest possible environmental impact. But they must also yearn for social acceptability whilst pleasing their shareholders.*



## SOCIO-TERRITORIAL INDICATORS

### INDICATOR 1

**Principle:**

Corporative social responsibility

---

**Criterion:**

Level of working conditions

---

**Indicator:**

***Existence of preventive policies***

---

**Explanation:**

As not all countries have legislation that require the company to assume responsibility for job-related accidents and injuries and not all employees will be covered under such laws, when not covered under national law, employers must prove they are insured to cover 100% of employee costs in a job related accident or injury. They will obtain a higher score if the employee receives health and safety training and the frequency of this training will influence this score.

This indicator is essential for protecting workers, since it guarantees health and safety in the work place. When an accident, injury or infraction occurs, the company must record it and take corrective action to identify the root causes of the incident, rectify them and take steps to prevent future occurrences.

---

**Data source:**

The companies will voluntarily make this information available either to the relevant administration through periodic surveys or to authorized bodies and they will aim to improve the company management, ideally by making the information available online.

Data will be gathered annually.

---

**Formula:**

---

**Step 1.**

Does the company have preventive safety policies?

**No** (1)

**Yes** (2) Does the company have an insurance which covers 100% of the costs incurred by employees?

**No** (+0)

**Yes** (+1)

---

**Step 2.**

Do the employees receive health and safety training?

**No** (+0)

**Yes** (+1) How often? More or once a year (+1)

Less than once a year (+0)

---

## INDICATOR 2

**Principle:**

Strengthen the role of aquaculture in local development

---

**Criterion:**

Level of contribution to local employment

---

**Indicator:**

***Local employment***

---

**Explanation:**

The aim is to promote employment of local employees. It is considered positive for the company if there is a balance between the number of non-local employees that bring knowledge and new experiences to the company and local employees. In cases where there is a very low or non-existent population, all or nearly all of the employees will have to come from elsewhere which will generate wealth in the area. However, the job offers will have to first be offered to the local community.

Aquaculture also generates indirect jobs which have not been taken into account in this indicator given the difficulties in obtaining this information. However, according to the FAO, for each direct job created, 4 more indirect jobs are generated (FAO 2008).

---

**Data source:**

The company will have to provide this information as a % of local, national or foreign employees.

Data will be gathered annually.

To measure the suggested indicator first the percentage of local employees will be considered, the more local employees the farm or company has, the higher it will score, then the average length of time the employee has been in that job is considered, the longer the employee has been there, the higher the score as it shows good working conditions, staff consolidation, etc.

---

**Formula:**

---

*(N°. of local employees / n°. of total employees farm) \* 100*

**Step 1.**

What% of employees is local?

**If** ≥70% (3)

**If** 30-70% (2)

**If** ≤30% (1)

---

**Step 2.**

Turnover of employees or time in the company?

**If** ≤1 year (+0)

**If** 1-3 years (+1)

**If** ≥3 years (+2)

---

### INDICATOR 3

**Principle:**

Strengthen the role of sectoral organizations in improving the image, social awareness and responsibilities

---

**Criterion:**

Image of aquaculture

---

**Indicator:**

***Existence of communication mechanisms***

---

**Explanation:**

Transparency and public communication in aquaculture developed in a given locality is considered one of the most important aspects which should place particular emphasis and effort. It is well known that for a good part of society aquaculture is an unknown activity that causes a rejection. The indicator seeks to promote the adoption and implementation of awareness raising and communication to enable a greater understanding of the image.

---

**Data source:**

Data will be gathered annually.

The indicator is measured in 3 steps plus one extra point with a total of 5. Communication actions to improve the image and understanding on the part of the company, hence avoiding legal proceedings against the industry, will score higher. This makes the company take the residents into account, allowing them to visit the farms, taking part in fairs, or through corporate responsibility plans, the farm will be well respected in the community.

---

**Formula:**

---

**Step 1.**

Were any transparency and communication plans put in place before setting up the farm?

**Yes** (2)

**No** (1)

---

**Step 2.**

Are there any communication plans in place promoting the transparency of the farm/ company (e.g. farm visits, pamphlets, talks, participation in fairs, etc.)?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Does it comply with Corporate Social Responsibility (e.g. sponsorship, beach cleaning, etc.)?

**Yes** (+1)

**No** (+0)

---

**Plus:**

What do you think the local community thinks of your farm/ company?

**Positive** (+1)

**Negative** (+0)

---

SCORE TABLE FOR FARM/COMPANY LEVEL INDICATORS			
DIMENSION	INDICATOR	SCORE	ASSESSMENT
ECONOMICS	Evolution of the ex-farm price per kg/total cost per kg produced		
	Self-sufficiency		
	Number of products on sale		
<b>TOTAL</b>			
ENVIRONMENT	Inputs/Outputs		
	Energy		
	Fulfilment of environmental standards		
<b>TOTAL</b>			
SOCIO-TERRITORIAL	Existence of preventive policies		
	Local employment		
	Existence of communication mechanisms		
<b>TOTAL</b>			
<b>TOTAL SCORE</b>			
Final assessment		45-40 Sustainable 40-35 Nearly sustainable 35-25 Approaching sustainable 25-20 Far from sustainable <20 Unsustainable	



### 3. *Indicators of sustainability at a National level*

#### **Introduction**

The indicators defined in this section have been designed for use in the 19 Mediterranean countries included in this study as previously described. However, the pilot projects carried out in specific countries will enable assessment and improvement.

The aspects which provoked the most debate and discussion when selecting these national indicators are the definition and use of the terms “development” and “growth” in relation to the following issues: “Is it really sustainable to increase farm food production without setting a limit? Should the relevant administrations set or put these limits in place?” The biggest difference in opinions can be seen in the answers voiced by the producers and conservation organizations. According to them, development is most suitable in finite systems because it stretches itself to its full extent until it reaches a balanced state. As a result of this approach, the use of indicators relative to aquaculture's contribution to GDP or the number of direct or indirect employees against the total number of employees in the country has been dismissed, favouring the selection of indicators more in line with this developmental approach.

It should also be mentioned that some of these indicators selected on a national level come from already defined farm/ company level indicators, even extrapolating to a Mediterranean level. An example of this type of indicator could be the use of environmental standards. Such an indicator enables one to easily obtain information through an extrapolation of results obtained on a local level by linking them and making them more consistent.

As with the farm indicators, the first part of the sustainability assessment should be economic, since, if this area is not sustainable, the company will obviously have to cease operation in the future. However, this does not mean that this is going to be more important in the final appraisal than environmental and socio-territorial aspects.

All the indicators have a total number of points, with 5 Sustainable, 4 Nearly sustainable, 3 Approaching sustainable, 2 Far from sustainable and 1 Unsustainable.

The calculation of some indicators are made up of various steps and/ or may require more than one formula, so the final score is calculated by the addition of or by obtaining bonuses which allow the maximum score to be obtained.

**SUMMARY TABLE FOR INDICATORS AT NATIONAL LEVEL**

DIMENSION	PRINCIPLE	CRITERION	INDICATOR
ECONOMICS	Promote an economy directed towards aquaculture	Aquaculture contribution to the national economy	<b>Percentage of foreign capital in the country's aquaculture sector</b>
	Increase ability to adapt to face crises and uncertainties	Level of national research competence	<b>Investment in RTD</b>
	To plan the sustainable development of the sector	Level of commitment with sustainability	<b>Evolution in the number of licences</b>
ENVIRONMENTAL	Maintain the goods and services that the ecosystem provides to aquaculture	Level of ecological footprint	<b>Regulation of feed supply and the capture of seeds</b>
	To contribute to the improvement of the activity's ecological footprint	Use of certification and best practices	<b>Existence of EIA</b> <b>Fulfilment of environmental standards</b>
SOCIO-TERRITORIAL	Contribute to national development	Employment in the aquaculture sector	<b>Quality of employment in aquaculture</b>
	Strengthen the role of sectoral organizations in improving the image, social awareness and responsibilities	Level of sectoral transparency	<b>Degree of associationism</b> <b>Existence of unions</b>

## ECONOMIC INDICATORS

### ECONOMIC INDICATORS FOR DOWNSTREAM EFFECTS AND ENVIRONMENTAL SPILLOVERS

**Shirra Freeman**

University of Haifa (Israel) / Harvard School of Public Health (USA)

*Economic indicators for the enterprise and sector are essential to the sustainability of aquaculture. No entrepreneur or investor would undertake the risks of establishing and operating a fish farm without the expectations of profits and returns on investment. Thus, from the perspective of the business community, performance indicators such as those above are existential.*

*The economic dimension of sustainable aquaculture goes beyond firm, industry and macro-economic concerns; however and in order to represent the economic dimension more completely, one must consider downstream effects and environmental spillovers. Although some of these effects are commonly placed in either of the environmental or social pillars of sustainability, they're full contribution to human welfare can only be captured through the use of economic indicators together with social and environmental indicators. Thus, for example though employment may fall within the social pillar, it should also be measured in terms of contributions in monetary terms to household incomes and the local tax base. Similarly, the interaction between aquaculture and the environment can be measured in terms of the monetary costs of cleaning up a polluted environment and lost livelihoods.*

#### **Economic Indicators at the company and/or local level:**

*Indicators stemming from environmental impacts: The main impacts at these levels stem from interaction with other uses/users of the ecosystem. They include the monetary value of damage caused by pollution. In the case of farm effluent, the appropriate indicators are the costs of clean up and the costs of damages of self pollution to the farm and impairment of non-farm users (e.g.: recreation, tourism, drinking water).*

*Indicators stemming from stakeholder interactions: Where there is competition for space, there are trade-offs between fish farms and other users. Trade-offs can be measure as the enterprise income foregone (opportunity cost) by other potential users.*

*Indicators stemming from economic spillovers: Often, the off-farm opportunities created by fish farms are greater than the on-farm potential. Downstream industries such as processing, transport, marketing and maintenance all have measurable monetary values.*

### **Economic Indicators at the industry or sectoral level**

*The primary economic indicator at this level measures the monetary value of the wider-range environmental effects of many aquaculture enterprises over a large geographic area. Here there may be measurable pollution effects and impacts on wild stocks. For example, large collectivities of farms may substantially increase local wildstocks and commercial fish landings. The indicator in this case would be the estimated value of these increased landings.*

*Many of the same stakeholder interactions and economic spillovers that exist at the local level can be aggregated up to the sectoral level, but do not require a separate indicator.*

### **Economic indicators at the national level**

*The national level indicators are essentially an aggregation of those at the enterprise/local and industry/sectoral level.*

### **Non-monetary indicators of risk**

*The risk of most enterprises and industries is directly proportional to the level of diversification. For aquaculture, diversification indicators include the number of species farmed, the range of culture techniques used and the level of vertical or horizontal integration. The higher the level of diversification is, the lower the risk is.*

*The indicator for species diversity is the proportional distribution of species.*

*The indicator for the range of culture techniques is the proportional distribution of techniques.*

*The indicator for integration is the proportion of enterprises engaged in the culture of more than one species and the number of farms that engage in activities other than fish culture (e.g.: processing and marketing)*

## ECONOMIC INDICATORS

## INDICATOR 1

**Principle:**

Promote an economy directed towards aquaculture

**Criterion:**

Potential of national aquaculture

**Indicator:**

***Percentage of foreign capital in the country's aquaculture sector***

**Explanation:**

The analysis of foreign investment in a sector such as aquaculture could be interesting. It could be the symptom of the existence of favourable conditions for its development. However this foreign investment has to be stable in time, enabling economic sustainability in the activity. In some countries, a certain limit of foreign investment is set which is another way of protecting national aquaculture.

**Data source:**

Companies will make the data available either to the administration or to assigned bodies through periodic surveys.

The calculation of the indicator consists of three steps.

**Formula:**

---

**Step 1.**

Percentage of foreign capital in the country's aquaculture sector

**If** 30-60% (3)

**If** > 60% (1)

**If** < 30% (2)

---

**Step 2.**

(Number of companies with foreign capital/ total no. of companies)\*100

**If** <60% (+1)

**If** ≥60% (+0)

---

**Step 3.**

Is there some sort of in foreign investment limit in the country's aquaculture sector?

**Yes** (+1)

**No** (+0)

---

## INDICATOR 2

**Principle:**

Increase ability to adapt to face crises and uncertainties

**Criterion:**

Level of national research competence

**Indicator:**

***Investment in RTD***

**Explanation:**

In an ever developing environment, characterized by a fast, deep and an often unpredictable change, aquaculture must develop and maintain strategies in order to adapt and survive in a dynamic system. In this way, a reliable strategy can be developed which will rely not so much on external stimuli but on intuition. Research, technological development and quality innovation (RTD) will provide new information and knowledge which will enable both companies and the rest of the agents in the sector to have a bearing on the improvement of sustainability in the activity. This progress will also help the sector adapt easier to specific changes or future crises which may occur, reducing management struggles and uncertainties.

The indicator intends to analyse the spending progress destined to RTD in aquaculture, without taking into account its specific weight in the RTD National Budget, considering this increase in time expenditure as a positive thing for the sector's sustainability.

The indicator also considers the need for a specific programme and structure for RTD carried out in aquaculture, which prioritizes work to be carried out and channels the financing and project monitoring on a public level, working towards a balance between company RTD investment and public funding.

**Data source:**

Data will be collected annually from the research centres, the companies and the relevant administrations.

The indicator will be calculated according to the following formulas:

***Total national cost in aquaculture RTD activities*** = Private funds + public (state + international) funds.



**Formula:**

---

**Step 1.**

Total national cost in aquaculture RTD activities (€) Year 1. Total national cost in aquaculture R&D activities (€) Year 0:

If  $C_1/C_0 > 1$  (3)

If  $C_1/C_0 = 1$  (2)

If  $C_1/C_0 < 1$  (1)

---

**Step 2.**

Is there a national RTD plan or program specifically for aquaculture?

**Yes** (+1)

**No** (+0)

---

**Plus:**

Fund source comparison = private funds/state funds (national)

If [0.90-1.10] (+1)

---

## INDICATOR 3

**Principle:**

To promote sustainable development in the sector

**Criterion:**

Level of commitment with sustainability

**Indicator:**

***Evolution in the number of licences***

**Explanation:**

The development of a business sector is active and therefore very dynamic and changeable. Hence there are companies starting up whilst others are closing down completely or partly.

This process of granting licences and authorizations is heavily controlled in the Mediterranean by each country's relevant authorities for the development of a sustainable aquaculture sector. It is essential that these relevant authorities carry out an analysis of their potential and put in place a strategic plan enabling this medium to long term sustainable sectoral development which is environmentally, socially and economically friendly and do so in a transparent and participative manner.

By monitoring the number of new licences granted and analysing the procedure employed to obtain them, this indicator aims to see the level of commitment of the authorities towards sustainable development as well as highlighting each country's entrepreneurship.

Nevertheless, the characteristics of each Mediterranean country regarding the level of development in the aquaculture sector will have to be taken into account, as well as the variety of species and farming systems employed in the region, in order to assess the effect of the indicator on a global scale.

**Data source:**

The relevant authority in each Mediterranean country will provide the information annually.

The number of licences granted will include both licences for new farms/ facilities as well as for extensions to existing ones.

Calculation consists of 3 steps.

**Formula:**

---

**Step 1.**

Licence progress: No. of licences (administrative authorizations) granted year 1 /  
No. of licences (administrative authorizations) granted year 0

**If** >1 (3)

**If** = 1 (2)

**If** < 1 (1)

---

**Step 2**

Does the country have a strategic plan for sustainable aquaculture development which is environmentally, socially and economically friendly?

**Yes** (+1)

**No** (0)

---

**Step 3.**

Is the procedure for granting licences carried out in a transparent manner encouraging the participation and contribution of the various agents involved in coastal and/ or rural development?

**Yes** (+1)

**No** (0)

---

## ENVIRONMENTAL INDICATORS

REFLECTIONS ON THE ENVIRONMENTAL ASPECTS OF  
THE SUSTAINABILITY OF AQUACULTURE**Dror L. Angel**

Recanati Institute of Maritime Studies & Dept of Maritime Civilizations  
University of Haifa  
Israel

*The intense growth in marine aquaculture that has occurred over the past 30 years is the result of a number of remarkable changes in the marine environment. Foremost among these was the drop in capture fishery landings which made the supply of marine products to the market less reliable at a time that the market had actually increased its demand for this commodity. The decrease in commercial fishery landings was the result of several factors, including overfishing (Pauly et al. 1998), marine pollution and deterioration of water quality (FAO 1997), destruction of marine habitats and climate change (Cochrane et al. 2009). The drop in supply of wild-captured fish paved the way for marine aquaculture (mariculture) development. Mariculture was heralded as a sustainable way to obtain food from the sea, i.e. with minimal impact to marine resources.*

*In its early years, mariculture production levels were small relative to capture fisheries and the sector did not attract a lot of attention. This changed dramatically following the massive growth in tropical shrimp-farming during the 1980s (Chua et al. 1989, Primavera 1998). In coastal areas mangroves were cut down to make room for shrimp farms, thereby reducing biodiversity, increasing coastal erosion and destroying crucial coastal habitat. In addition, discharged pond effluents added large organic loads, toxic chemicals, e.g. pesticides and antibiotics and disease agents, such as viruses to the coastal marine environment. The media provided wide coverage to the destructive impacts of shrimp farming and helped establish a generally negative public attitude toward aquaculture on the basis of the environmental impacts of this industry.*

*Another sector that grew at a tremendous rate during the 1980s was salmon farming. In the early years of this industry, salmon farmers used high levels of antibiotics to combat the diseases that afflicted the fish, thereby reinforcing the harmful impact on the environment and the human consumers. High feed conversion factors and inappropriate husbandry led to heavy organic loads on the seafloor; benthic anoxia (and sulfidic sediments) and severe impacts to the benthos, i.e. additional negative environmental effects.*

*Although shrimp and salmon farming are only two examples of marine aquaculture and there are other less-problematic practices, e.g. bivalve and seaweed farming, the damage was done and public opinion in many countries was stacked against aquaculture, largely on the basis of environmental impacts (Dierberg and Kiattisimkul 1996, Primavera 1998). Public surveys to assess the basis for public opinion regarding aquaculture revealed that it was the result of a largely un-informed public and a strong media campaign against aquaculture (Barraclough and Finger-Stich 1996).*

*If we use an environmental ruler to measure the sustainability of mariculture, it is essential to separate among different types of practices on the basis of how they affect their surroundings. Among the issues at stake we may consider the following: feed footprint, impact on the water column and impact on the benthic community. The feed footprint relates to the effect that aquaculture has on an ecosystem level. If the preparation of finfish food, for example, involves increased pressure on natural fisheries or other resources, the sustainability of this practice is low and the footprint will be large. If the food is obtained locally and its harvest or production have limited effects on the food web and on marine resources, the feed footprint will be small. With respect to aquaculture impacts on the water column and benthos, there is a variety of possibilities. On one end of the spectrum, pond or tank-based mariculture may have minimal impacts on the water column and the benthos if nutrients and contaminants are removed from effluents before discharge. However, land-based mariculture (e.g. shrimp or fish ponds) often draws criticism because it is limited to the coastal zone which is the focus of conflicts between the numerous stakeholders there. Farming of organisms in the sea may have small or large effects, depending on whether they are fed or extractive and on the husbandry and management of the farm. Aquaculture is “fed”, when the farmed organisms, e.g. finfish or shrimp receive formulated feeds that contain components that do not originate in natural food from their surroundings (allochthonous). Fed aquaculture is usually intensive in order to be economically sustainable and the wastes from such farms often create a benthic footprint, though the water column is seldom affected. In extractive aquaculture the farmed organisms extract their natural (autochthonous) food from the surrounding water, e.g. bivalves or seaweeds that feed on phytoplankton and inorganic nutrients, respectively. In eutrophic environments where there is an excess of phytoplankton and nutrients (mainly N & P) conversion of these into biomass that is then harvested at a profit is a win-win situation. Marine farmers clearly have an incentive to rear profitable extractive crops and environmental loads are reduced, thereby averting ecological disasters such as dead zones.*

*Multi-trophic integrated aquaculture (IMTA) combines fed and extractive aquaculture in one system, thereby enabling the rearing of fish or other animals that release large amounts of particulate and dissolved nutrients (which may cause environmental impacts) with suspension feeders and algae that thrive on these effluents (Chopin et al. 2001). The operation of IMTA systems is more demanding than traditional monoculture because it requires coordination between the various components, and although the concept is slowly spreading among practitioners, it is still not a common aquaculture practice. In the coming years it is likely that industries will be required to pay for the nutrients that they release into the environment (the “polluters pay” concept) as the world becomes more diligent about the state of our oceans (WFD) and IMTA is one option that will enable aquaculture to maintain and increase production to supply demand while caring for the environment.*



## ENVIRONMENTAL INDICATORS

### INDICATOR 1

**Principle:**

Contribute to the maintenance of the ecosystem goods and services that are provided to aquaculture

---

**Criterion:**

Level of ecological footprint

---

**Indicator:**

***Regulation and control of feed supply and the capture of seeds***

---

**Explanation:**

Both feed use and the collection of seeds in the wild must be controlled and monitored by the relevant authorities. This is the only way to better understand the natural processes taking place in the marine environment and, in some ways it helps to avoid possible future environmental impacts.

This indicator offers an estimate of the administration's involvement and commitment in improving food management on the farms that use compound feeds, by promoting good management practices such as incentives for correct food management processes.

In the case of molluscs, environmental sustainability is linked to managing and obtaining live resources from the wild.

---

**Data source:**

Information will be provided directly by the farms through specific surveys carried out by the administration. This information can later be included in an ecological footprint categorization system for each farm.

---

## Formula for farms using supplementary feed

---

### Step 1.

Does the current licence process include a regulation which requires the producers to optimize the feed (e.g. Use of a more digestible feed, type of components, sustainable source, etc.)?

**Yes** (2)

**No** (1)

---

### Step 2.

Is there a management and monitoring policy for the food process (improvement in management practices, operational standardization practices, guidelines, thorough monitoring of parameters to optimize use of food, etc.)?

**Yes** (+1)

**No** (+0)

---

### Step 3.

Do the competent authorities monitor the use of feed and its interactions with the environment?

**Yes** (+1)

**No** (+0)

---

### Plus:

Are there incentives for a well-managed farm?

**Yes** (+1)

**No** (+0)

---



**Formula for farms which harvest seeds in the wild (e.g. molluscs):**

---

**Step 1.**

Is there a regulation regarding the harvest of wild seed?

**Yes** (2)

**No** (1)

---

**Step 2.**

Are there measures to regulate collection of wild seeds?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Does the country have to import wild seed?

**Yes** (+0)

**No** (+1)

---

**Plus:**

Are there any measures to preserve natural resources?

**Yes** (+1)

**No** (+0)

---

## INDICATOR 2

**Principle:**

Contribute to the maintenance of the ecosystem goods and services that are provided to aquaculture

**Criterion:**

Level of ecological footprint

**Indicator:*****Existence of Environmental Impact Assessment (EIA)*****Explanation:**

The Environmental Impact Assessment (EIA) is a tool which consists in identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of the development proposals prior to the important decision making and to assume commitments to reduce the impacts on the environment caused by human activities. With regards to the sustainable development and placement of aquaculture and the existing concepts of Integrated Marine and Coastal Management (IMCAM) and an Ecosystem Based Management (EBM) for an integrated management system in mind, EIA provides an optimum framework to structure the projects in a consistent and consequent manner in compliance with the environmental, social, political and economic requirements.

The EIA is mandatory in a number of Mediterranean countries. However, harmonization of the rules regarding these environmental impact assessments is still required.

**Data source:**

The data will be collected annually by the relevant authorities.

The indicator consists of three steps and a bonus, which enables a total score of 5 to be obtained. The indicator is based on issues related to the EIA, such as requirements, the framework surrounding it, the duration of the process and the correct documentation to ensure that all this is carried out correctly.

**Formula:**

---

**Step 1.**

Does the law require an EIA to be carried out in aquaculture activities?

**Yes** (2)

**No** (1)

---

**Step 2.**

Does this EIA come under an integrated management model such as ICZM or EBM?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Duration of the EIA elaboration process

> 6 months (+0)

< 6 months (+1)

---

**Plus:**

Is a legitimate Surveillance Environmental Plan carried out?

**Yes** (+1)

**No** (+0)

---

## INDICATOR 3

**Principle:**

To contribute towards the improvement of the activity's ecological footprint

**Criterion:**

Use of certification and best practices

**Indicator:**

***Fulfilment of environmental standards***

**Explanation:**

A country which encourages companies to obtain licences of an environmental nature within aquaculture shows an interest from the relevant authorities in promoting good environmental practices in this field. This will ultimately benefit the end product with an added environmental value, which is increasingly popular and sought after by a number of consumers.

In order to establish the reliability and confidence generated by these national and international environmental certifications, special attention should be paid to the certification process. It must consist of three steps: i) An entity has to exist which will be in charge of the creation process of this regulation and which will develop and supervise the selection and definition of the standards which the certification will consist of ii) another entity will exist which verifies that the company complies with the certification standards and iii) a third entity will grant a certification stamp or label, which physically credits the product.

**Data source:**

This information will be collected annually by the relevant authorities from the companies, which must show full compliance with the certification process.

The calculation of the indicator consists of three steps.

**Formula:**

---

**Step 1.**

Nº. of farms/ companies in the country which adhere to a specific aquaculture eco-label (e.g. Friend of the Sea, ASC, etc.)?

≥ 80% (2)

< 80% (1)

---

**Step 2.**

Nº. of farms/ companies in the country adhered to an international environmental certification (e.g. ISO, EMAS, ISEAL, etc.)?

≥ 80% (+2)

< 80% (+1)

---

**Step 3.**

Are there any government incentives for implementation of these environmental certifications?

**Yes** (+1)

**No** (+0)

---

## SOCIO-TERRITORIAL INDICATORS

## ROLE OF THE CREATION OF SOCIAL INDICATORS IN ESTABLISHING SUSTAINABLE DEVELOPMENT

**Eduardo Chia**

INRA/CIRAD

France

*Sustainable development, as a general principle of public action, is increasingly present in development projects on a local and regional level. However, the creation of the projects and their implementation does not happen naturally. On a territorial level, the implementation of sustainable development is everybody's responsibility: private and public parties, aquaculturists, agriculturists, salespersons, etc. The scheduled actions may cause antagonism amongst those involved who feel they are isolated and not involved enough. This antagonism can sometimes turn into conflicts and endanger the execution of the projects. Solving these conflicts will involve large economic and operational costs which should be avoided. A way of reducing and eliminating these conflicts is by establishing agreement and negotiation mechanisms to start community action.*

*The indicators which assess the effects and impacts of actions of sustainable development can play an important part in the structuring of community action, which is essential for territorial level projects, so long as they are co-produced, that they make sense to those committed to action and enable external communication.*

*The indicators are not just measuring tools for progress or a specific situation. They are also inventories which enable a variable to be defined, amongst several others, which will be monitored. The variables can be arranged in order of importance to form a sort of control panel. But an indicator is also an internal and external communication vector. The indicator becomes a standard once it is accepted and its limitations are identified. It becomes the signal which can eventually entail penalties for situations which, beyond the aforementioned threshold, are considered negative.*

*This group of functions lead the indicators to be considered as both technical and social mechanisms, which report social construction and commitment.*

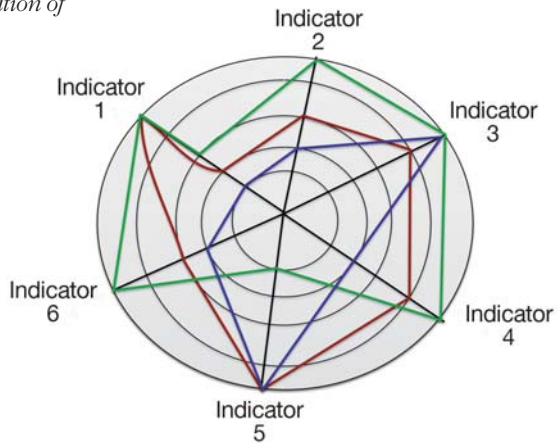
*Sustainable development has the environment and the human being at the top of its agenda, so it requires a change in mentality and practices of those involved, hence the need to establish learning mechanisms and processes. Learning to create common projects defining synergies between the individual logics; learning to establish actions; learning to work together; learning to communicate and assess the changes. In this way, the*

construction of sustainable development indicators has to be considered as an opportunity to define the focus of sustainable development for aquaculture in a collective way and on different scales. Based on the principle that a good indicator is one which is used.

Creating these indicators entails: i) considering the whole construction process as a reciprocal and mandatory learning process in the creation of a common language, a common project, of running actions and regulations; ii) taking into account the representations that the aquaculturists have in the industry and that of those involved in the placement of aquaculture in the local or regional development to create them; iii) being aware that every indicator is, at first, incomplete and cannot report on its own on a complex situation.

The social scale of sustainable development does not only involve solidarity amongst generations but it also means that we must reconsider the benefits that the current generation obtains with regards to health, employment, lifestyle, education, work, etc

In short, to elaborate indicators for the impact of sustainable development socially, we must agree on a small number of indicators, such as the number of unemployed in the region, the number of development groups or the number of conflicts regarding the space, the number of illiterate people, the number of doctors per 1,000 inhabitants, the regional budget percentage for the protection of natural resources, the culture, etc. A number of those involved use a graphic representation of their election (see figure).



## SOCIO-TERRITORIAL INDICATORS

## INDICATOR 1

**Principle:**

Contribute to national development

---

**Criterion:**

Employment in the aquaculture sector

---

**Indicator:**

***Quality of employment in aquaculture***

---

**Explanation:**

The quality of employment in the aquaculture sector through specific training methods for aquaculture within the country is vital when offering professionals to companies which will guarantee good business management. A team of correctly trained and specialized employees will considerably improve the day to day running of the company.

Specialized training as well as continuous training by the administration and the business owners is considered to be essential for promoting a more sustainable development in social terms within the aquaculture sector.

---

**Data source:**

The relevant authorities will obtain this information from the companies on a yearly basis.

The calculation of the indicator consists of three steps. The highest score can be obtained by a bonus related to the type of contracts provided by the companies. This bonus encourages permanent contracts rather than temporary contracts as these contribute to greater sustainability.

---



**Formula:**

---

**Step 1.**

Existence of recognized higher education training in aquaculture (e.g.: Degree, Master's degree, post graduate)?

**Yes** (2)

**No** (1)

---

**Step 2.**

Existence of officially recognized training courses in aquaculture (e.g.: Operators, technicians, etc.)?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Do farms/ companies develop training schemes for their employees?

**Yes** (+1)

**No** (+0)

---

**Plus:**

Types of contracts in aquaculture

**If** permanent contracts > temporary contracts (+1)

**If** permanent contracts ≤ temporary contracts (+0)

---

## INDICATOR 2

**Principle:**

Strengthen the role of sectoral organizations in improving the image, social awareness and responsibilities

---

**Criterion:**

Level of sectoral transparency

---

**Indicator:*****Degree of associationism***

---

**Explanation:**

Business organization through associations or producer federations in the case of aquaculture, contributes to a better representation and a better defence of its interests and proposals and lastly, to better unity when facing the challenges ahead. Associationism can therefore contribute towards better sustainability of the activity through mechanisms which enable the participation of all the companies when making decisions and a greater connection with vitally important subjects for sustainable development within the sector.

Therefore, the existence of one or various producer associations that represent the majority of the companies is essential, as well as a single national association that unites the sector's interests. If there is more than one association, a channel of communication between them will have to be established.

---

**Data source:**

The companies will voluntarily provide this information to the relevant administration through periodic surveys.

Data will be gathered annually.

The calculation process consists of three steps, with the aim of encouraging companies to join an association, creating unity amongst them and there being a national association or entity which unites and represents the aquaculture sector.

---

**Formula:**

---

**Step 1.**

Nº. of companies associated/ total nº. of companies	Score
= 1	2
< 1	1

---

**Step 2.**

Are there any meeting mechanisms or communication and coordination sectoral priorities within the various associations, which benefit the companies within the sector?

**Yes (+1)**

**No (+0)**

---

**Step 3.**

Is there a representative on the association map of the country, who makes important decisions within the association according to the different species cultivated in terms of production and/ or economic value?

**Yes (+1)**

**No (+0)**

---

**Plus:**

A bonus is obtained if there is a national association or organization that represents all the associations and aquaculture companies in the country and is recognised by national authorities.

National association (1)/ Nº. of national associations	Score
= 1	+1
< 1	+0

---

## INDICATOR 3

**Principle:**

Strengthen the role of sectoral organizations in improving the image, social awareness and responsibilities

---

**Criterion:**

Level of sectoral transparency

---

**Indicator:*****Existence of unions***

---

**Explanation:**

Syndicates, unions or collective agreements can regulate a number of aspects with regards to the work relationship between the company owner and the employees such as wages, work hours, training, health and safety in the workplace, extra hours or the right to take part in company affairs. It is a basic human right as well as the employee's essential right. These can be company agreements, national agreements for each species, even employee, producer, national or international syndicates, etc. The sector should be organized with regards to labour rights and improving them.

---

**Data source:**

Companies will provide this information to the relevant administration on a yearly basis.

The calculation of the indicator consists of three steps: Representation of the worker's rights, the existence of collective agreements, to see if they are sufficient or not.

---

**Formula:**

---

**Step 1.**

Are there figures which enable the representation of the worker's rights within the country's aquaculture sector?

**Yes** (2)

**No** (1)

---

**Step 2.**

Are there any national collective agreements for the aquaculture sector which represent all the species or groups of species that are cultivated in the country?

**Yes** (+2)

**No.** Are there any collective agreements for the species or groups of species that are cultivated in the country?

**Yes** (+1)

**No** (+0)

---

**Step 3.**

Are there enough existing syndicates to represent the national aquaculture sector?

**Yes** (+1)

**No** (+0)

---

SCORE TABLE FOR NATIONAL LEVEL INDICATORS			
DIMENSION	INDICATOR	SCORE	ASSESSMENT
ECONOMICS	Percentage of foreign capital in the country's aquaculture sector		
	Investment in RTD		
	Development in the number of licences		
TOTAL			
ENVIRONMENT	Regulation of feed supply and the capture of seeds		
	Existence of EIA		
	Fulfilment of environmental standards		
TOTAL			
SOCIO-TERRITORIAL	Quality of employment in aquaculture		
	Degree of associationism		
	Existence of unions		
TOTAL			
TOTAL SCORE			
Final assessment		45-40 Sustainable	
		40-35 Nearly sustainable	
		35-25 Approaching sustainable	
		25-20 Far from sustainable	
		<20 Unsustainable	

## 4 *Indicators of sustainability at a Mediterranean level*

### **Introduction**

The identification and definition of the indicators on a Mediterranean level has been very challenging due to the particular complexity of the region and high diversity of species, which are cultivated in it.

A number of similar practices and activities merge in the Mediterranean, also sharing a number of problems which affect aquaculture. Despite this, there is a big difference in the level of development of aquaculture in the different countries. In this study and more so in key aspects of that development such as administrative and legislative activity regulation, or access to contrasted and updated information related to the sector.

Some general observations in this analysis can be made; to the north of the Mediterranean region aquaculture is subjected to a complex and sometimes excessive legislative system, which is mainly because these countries belong to the EU. In the South, as there is no body or entity to unite the different countries which make up this area, there are multiple legislative frameworks for each country which prevent or hinder the identification of development requirements within the sector as well as the adoption of sustainable development strategies in the sector. This imbalance in socio-economic and environmental development makes it difficult to find common indicators which enable a sustainable assessment of aquaculture in the region.

Despite this, three indicators have been defined and developed for this level: one for each dimension. In order to try to complete this list, a second table has been included at the end of this appendix with indicators which have been defined but because of the aforementioned factors have not been completely developed.

The results obtained in the proposed indicators will be able to be used both as a comparison with other parts of the world (Caribbean, Southeast Asia, etc.), following a situation report on the regions through calculation or by obtaining the indicators and as a starting point to assess the situation and development of aquaculture sustainability in the Mediterranean region. The results obtained from the indicators on a country level can be used in many ways -not only as a comparison with other countries but also with regions, north-south and east-west.

All the indicators have a total number of 5 points, with 5 Sustainable, 4 Nearly sustainable, 3 Approaching sustainable, 2 Far from sustainable and 1 Unsustainable.

**SUMMARY TABLE FOR INDICATORS AT MEDITERRANEAN LEVEL**

DIMENSION	PRINCIPLE	CRITERION	INDICATOR
ECONOMICS	To have a market oriented towards aquaculture	Market approach	<b>Assessment of the economic value of Mediterranean aquaculture products</b>
ENVIRONMENT	Promote environmental sustainability	Use of certification and best practices	<b>Environmental standards</b>
SOCIO-TERRITORIAL	Strengthen the role of sectoral organizations in improving the social image, awareness and responsibilities	Level of sectoral participation	<b>Degree of associationism</b>



## INTRODUCTION TO THE NEED FOR GOVERNANCE INDICATORS IN AQUACULTURE

**Rosa Chapela Pérez**

Marine Technology Centre (CETMAR)  
Spain

*Establishing governance indicators in aquaculture management and, specifically, in the selection and planning processes of areas for the activity, will help in determining a legal safety level which will enable promoters to start their aquaculture businesses, as well as determining a level of good aquaculture governance or regulation as an economic, social and environmental regulation authority. The indicators will contribute to the monitoring and validation mechanisms of public policies which affect aquaculture, with the help of public and private agents in the framework of good governance.*

*Governance and governability go hand in hand. There has been much research and analysis in the sociology and politics field which has differentiated them in the 1970s. The term “governability” refers to the government processes and systems within the State framework and its institutions in decision making and outlining public policies in the framework of a vertical scheme in a state/ citizen relationship. Meanwhile, the “Governance” concept involves a horizontal relationship between diversity of public and private actors to improve public policy decision making, management and development processes, bearing in mind negotiation, integration and interrelation processes.<sup>1</sup>*

*Governance defined as the establishment of public and private interaction which is created to resolve social problems and create social opportunities, would aid the institutions' governability and make it more effective.*

*Since its first years of development, aquaculture has been better identified with the “governability” concept, as it has been regulated by public administrations, establishing procedures and adopting public policies for aquaculture without the participation of agents or private organizations. Good governability has for years been limited to determining a level of elaboration of regulations in an institutional or State field and guaranteeing legal safety for any aquaculture promoter and other coastal interests.*

*But technical and technological progress and a greater complexity of social processes have made traditional systems of public management insufficient or inoperable. This is where the need for governance backup comes in. Over time, aquaculture has become a technically,*

---

<sup>1</sup> Vid. Elkin Velásquez *Governability and governance of citizen security. Towards a functional proposal, local government consolidation international seminar for citizen security, training and experience, Florence 2006.*

*socially and environmentally complex activity, creating a series of conditions for its development which traditional public management would struggle to deal with alone. We need to bring in social agents to participate who are directly or indirectly related to aquaculture: Entrust the management to participating social agents (companies, associations, interest groups...) and to public institutions with aquaculture abilities which, by clearly defining their interactions and relations, will enable their conflicts to be resolved in a more efficient and versatile manner.*

*In short, the hierarchical management systems must be replaced by new forms of regulation based on negotiation, participation and coordination, even auto regulation - as seen in the sector's adoption of codes of conduct, UNE, ISO, etc., - in which those responsible for the policies try to manage public and private agents. The legal-administrative system tends to get divided and generate participation networks as a result of society's transformations. So aquaculture must let private agents, public organizations, NGOs, pressure groups, etc. participate as they have a lot to say in this sector. Governance constitutes a new policy strategy aimed at guaranteeing society governability and to maintain legitimacy within the institutions in exchange for the transfer of political authority to the economic and social authors.<sup>2</sup>*

*This goal can only be reached with the implementation of good governance in aquaculture which includes all agents involved - companies, producer organizations (POs), auxiliary companies, NGOs- in making decisions, elaborating processes or procedures, in selecting and planning spaces, etc. By participating they could have a bearing on the definition and implementation of politics which have an impact on aquaculture; collectively decide what the main and common problems are for aquaculture development and how they should be dealt with; and, finally, that these public and private agents jointly monitor and assess the impact of these policies on aquaculture.*

*Previously, the Administration established these social and economic aspects. Companies adapted to them. Now it is society and the market who establish their own requirements and these have to be contemplated in the regulation. Both local and national politics are more demanding with social and environmental aspects. Since 2002 there has been a need to strengthen governance in Europe. The White Paper on European Governance (2001) confirms this, "open up the Union's decision making procedures to allow citizens to participate in making decisions which concern them, which would translate into greater transparency and greater accountability". This would show citizens how governments are able to efficiently respond to their concerns.*

<sup>2</sup> Frances Morata "Multilevel Governance in the EU", VII International congress of CLAD on State and Public Administration Reform Lisbon 8-11 October 2002.

*And specifically in aquaculture, the Strategy for Sustainable Aquaculture Development in Europe [(COM2002) 501final], has expressed the need to “improve governance” in aquaculture through “greater participation in decision making by the agents involved. Likewise, self-regulation and voluntary agreements should be encouraged, as a code of best practice and good conduct. The same could be said of the introduction of community management and environmental audit schemes (EMAS) to the aquaculture system”. More recently the European Commission's “Building a sustainable future for aquaculture. New impetus to the sustainable development of European aquaculture” insists on the need to improve “governance conditions” in aquaculture, with special emphasis on “consulting with stakeholders for an enhanced image of the companies within the sector”. Although it does highlight that it is the national authorities, “who will have an essential role in designing aquaculture development in their area”.<sup>3</sup>*

*This new document aims at:*

- *Improving the implementation of EU legislation*
- *Reducing the administrative burden*
- *Ensuring that both fishermen and national administrators have access to the information they need in a clear and understandable manner*
- *Guaranteeing suitable monitoring of the aquaculture sector*

*Finally, the state and development of aquaculture in a specific area can be improved if its legislation works efficiently, if it is balanced.*

---

<sup>3</sup> Communication from the Commission to the European Council and European Parliament [COM (2009) 162 final], 8th April 2009.

## THE IMPORTANCE OF LEGISLATION AND GOVERNANCE IN AQUACULTURE DEVELOPMENT

**Fernando Otero Lourido**

Spanish Association of Marine Fish Farmers (APROMAR)  
Spain

*It is common knowledge that aquaculture has to occupy a public domain and areas of restricted use, competing with other activities which also interact with the environment; it is subjected to complex license restrictions; it produces and sells fresh products; and operates in a very structured market, coveted by countries with negligible legislation and costs. It is therefore a vulnerable activity in need of legislation.*

*However, this is unsatisfactory and counterproductive: an abundance of confusing, vague, illogical and void laws; slow and uncertain administrative processes; renunciation of the principle of equal opportunities with non-EU countries - and some EU ones- which sometimes benefit from unfairly favourable production conditions and public aid; and consequent annulment of the basis of competition law (so well protected in other aspects of the native marine industry).*

*And that is not all. Such legislative magma has to be implemented by undefined authorities reluctant to commit to an industry which has its development blocked when it comes to the need for consistent legislation in key aspects - suitable sites, an efficient market organization and 'level playing field'.*

*Unsatisfactory legislation, indecisive administrations. Result: Confinement to inadequate infrastructures (which disheartens the more dynamic sub-sectors and leads them to outsource some excellent projects), and the perpetuation of a chronic crisis for those less fortunate, which is in part due to weak legislation relating to certain imports.*

*Therefore, good planning and solid development are essential. In exchange we offer environmental, economic and social sustainability. A two way street, marked by consecutive milestones: 1) an initial, realistic estimate of the size of the sector (current strength and the medium/ long term growth possibilities); 2) eco-systematic selection of suitable sites, prior to assessment of surrounding ecosystem's carrying capacity; 3) implementation of the necessary legislation for its development - according to the three sustainable aspects- and 4) decisive implementation without hesitation. - This is the key to the future of this sector.*

*Planning is, therefore, the first step. It must start with a good outlook for the future as a base for the subsequent and proportional granting of ideal aquaculture sites through precise localization research and legislative coverage, which takes us from coastal legislation to specific sectoral planning and projects. But it is not the only step: It will be of little use if it is not followed up with secure and decisive development.*

*Therefore, in order to face up to the sector's bigger problems, European aquaculture needs two things: Constructive legislation which aids reasonable development and a direction for the process, based on a well-founded and objective knowledge of the activity, in agreement with the sector with a view to a society without complexes or false prejudices. This also implies clarity of ideas and policies and efficient administrative management. In other words, good governance.*

*A coordinated, transversal and efficient public management in aquaculture is a basic supposition for an encouraging future. Because from a business perspective, governance is just that, a symbol of confidence: Confidence in the 'administrative viability' of investment, as the first step towards legislation which is globally inclined towards the viable and efficient development of the European aquaculture sector.*

*And this is decisive: it determines everything from the beginning. When you think that with some species, the engineering project alone can cost one hundred thousand Euros; and with all of them, the resulting investment and employment depend on separate decisions made by various agencies that know nothing about aquaculture. This is why we must appeal for the coordination of three terms (laws, political decisions, bureaucracy) and the clarification of ideas on the administration side: The investor needs to know beforehand if his project is going to be authorized, when, with what environmental requirements and at what cost and repayment period. And he also needs to be able to decisively take part in the process, as an ever more essential supplier of a fundamental product in society and not as an uncomfortable participant.*

*This is not possible without good governance: it is important that the administrations assess the sector and join us in planning for our space, but it is even more important that they put the means in place for its development, which solidly supports a coordinated and transversal course of action in quality administration, in support of the business initiative. A course which concerns each project, each body, each report and each paper. Which gives or withdraws safety and therefore investment and development which is being ever so evasive.*

*In its absence it is obvious that this sector "...is not developing its creative wealth and employment potential..., the national authorities must become aware of this and establish their own appropriate framework" <sup>(1)</sup>, which should "...include specific conditions for aquaculture, with environmental legislation specifically for aquaculture..., designating a fisheries authority to act as the relevant entity for environmental assessment issues" <sup>(2)</sup>. In this context, "the main challenge for the legislators is the development of an administrative and legal environment for the development of aquaculture which contributes to the expansion of this activity to its full potential" <sup>(3)</sup>.*

*It is not us saying it: The three citations that define governance under the coordination of fishery authorities and the need for an ideal legislative framework for the development of aquaculture, come from recent documents from, none other than, the European Economic and Social Committee <sup>(1)</sup>, the European Parliament <sup>(2)</sup> and from the FAO <sup>(3)</sup>.*

*With such respectable company, it is amazing that we are still stuck in an inefficient legal framework and prisoners of the administration's indecisiveness. The necessary governance must know and understand aquaculture, take it as its own and guarantee its deserved right to the responsible co-use of public marine resources and establish the foundations which bring about the consolidation of a solid and viable national European aquaculture sector. Without further delay, as we are in injury time.*

---

<sup>(1)</sup> Report n° 445 European Social and Economic Committee EESC, "Building a sustainable future for European aquaculture" - NAT Commission, Section for Agriculture, Rural Development and Environment, Vigo. -Brussels 28/04/2010 [available at [www.eesc.europa.eu/index\\_es.asp](http://www.eesc.europa.eu/index_es.asp)].-

<sup>(2)</sup> "Regulatory and Legal Constraints for European Aquaculture" Study, Directorate General for Internal Policies, European Parliament.-Brussels, 2009 [at <http://www.europarl.europa.eu/studies/>].-

<sup>(3)</sup> FAO/Fisheries: "The state of world Fisheries and Aquaculture" (Sofia - 2008).

## ECONOMIC INDICATOR

### INDICATOR 1

**Principle:**

To promote a market oriented towards aquaculture

---

**Criterion:**

Market approach

---

**Indicator:**

***Assessment of the economic value of aquaculture products***

---

**Explanation:**

From the economic value of the first sale of aquaculture products we can get an idea of the progress of economic aspects which affect aquaculture. That is why we suggest co-relating the total production progress of the Mediterranean with the economic value progress. This way we can study different scenarios: If production increases but the economic value does not, it would mean that the sale price and consumption of these products decreased. On the other hand, if the production remained the same or even dropped a little but its economic value increased or remained the same it would be a good sign of economic sustainability, which may reflect on the increase in the quality of the product, increase in the diversification and decrease in the production costs, etc.

---

**Data source:**

The information will be collected annually, preferably from a computer programme.

The statistics published periodically by the FAO will also be obtained.

---

**Formula:**

**Evolution of the economic value in 1 year** = Sum of EV of the Mediterranean production for the current year / Sum of EV for the Mediterranean production for previous year.

**Evolution of the economic value in 3 years** = Sum of EV of the Mediterranean countries for the current year / Average of the sum of EV of the last three years in Mediterranean countries.

**EV** = Economic value

Profitability in 1 year	Score	Profitability in 3 years	Final score
If it increases	3	If it increases (+2)	5
		If it decreases (+0)	3
		If stable (+1)	4
If it remains stable	2	If it increases (+2)	4
		If it decreases (+0)	2
		If stable (+1)	3
If it decreases	1	If it increases (+2)	3
		If it decreases (+0)	1
		If stable (+1)	2



## ENVIRONMENTAL INDICATOR

### INDICATOR 1

**Principle:**

Promote environmental sustainability

---

**Criterion:**

Use of certification and best practices

---

**Indicator:**

***Environmental standards***

---

**Explanation:**

In the Mediterranean region there are a growing number of international, national, regional and local environmental nature standards, many of which are implemented in Mediterranean aquaculture, even though they were not designed specifically for this activity. These certifications are thought to be necessary for companies to use in a participative approach which could bring together the various agents that contribute to the sector's development in order to improve sustainability.

The support of the administrations involved in the adherence to and incorporation of these standards in business management through incentives and communication measures is also important.

---

**Data source:**

Directly from the companies participating in this assessment.

Data will be gathered annually.

The calculation of the indicator consists of three steps:

---

**Formula:**

---

**Step 1.**

Percentage of companies with environmental certification (ISO, EMAS)

≥ 80% (2)

< 80% (1)

---

**Step 2.**

Percentage of companies attached to a specific aquaculture eco-label (Friend of the Sea, ASC, etc.)

≥ 80% (+2)

30-80% (+1)

---

**Step 3.**

Percentage of countries that promote the implementation of these standards with incentives such as reduced fees.

≥ 80% (+1)

< 80% (+0)

---

## SOCIO-TERRITORIAL INDICATOR

### INDICATOR 1

**Principle:**

Strengthen the role of professional organizations

---

**Criterion:**

Level of sectoral participation

---

**Explanation:**

***Degree of associationism***

---

**Explanation:**

Sometimes there are too many associations which are decentralized and scattered in the territory. This stops producers and company owners having a more active role in the decision making process. That is why a pyramid organization is necessary in these associations favouring the existence of at least one national association which is capable of representing the whole sector in the country, which in turn can be included in an association of a supra-national or Mediterranean nature.

---

**Data source:**

Annually from the associations or producers participating in this assessment of Mediterranean aquaculture sustainability.

The calculation of the indicator consists of three steps. The first one analyzes the number of associated or organized companies in the 19 Mediterranean countries selected for this project, a higher score will be obtained when more than 80% of the companies are associated. The second step assesses the number of associations per country. Ideally 1 association will represent the whole of aquaculture in the country. Therefore the number of associations must be the same as the number of Mediterranean countries with a significant aquaculture production. In this project 19 countries have been counted and taken into account.

---

**Formula:**

---

**Step 1.**

N° of companies associated/ total n° of companies	Score
If $\geq 80\%$	2
If $< 80\%$	1

---

**Step 2.**

N° national associations/ total n° of countries (19)	Score
= 100%	+2
If $\geq 80\%$	+1

---

**Step 3.**

Existence of discussion forums amongst private producer associations in the Mediterranean?

**Yes (+1)**

**No (+0)**

---

**SCORE TABLE FOR MEDITERRANEAN  
LEVEL INDICATORS**

DIMENSION	INDICATOR	SCORE	ASSESSMENT
ECONOMICS	Assessment of the economic value of Mediterranean aquaculture products		
TOTAL			
ENVIRONMENT	Environmental standards		
TOTAL			
SOCIO-TERRITORIAL	Degree of associationism		
TOTAL			
<b>TOTAL SCORE</b>			
Final assessment		12-15 Sustainable 9-11 Nearly sustainable 8-10 Approaching sustainable 4-7 Far from sustainable <4 Unsustainable	

<b>OTHER POTENTIAL INDICATORS</b>			
<b>DIMENSION</b>	<b>PRINCIPLE</b>	<b>CRITERION</b>	<b>INDICATOR</b>
<b>ECONOMICS</b>	To promote a market oriented towards aquaculture	Market approach	<b>Total production/ Consumption per capita/Mediterranean population</b>
	Increase ability to adapt to face crises and uncertainties	Level of research competence	<b>Investment in RTD</b>
<b>ENVIRONMENT</b>	Strengthen institutional capacities in relation to sustainable development	Trends in the existence of regulations	<b>Percentage of countries with environmental regulations</b>
<b>SOCIO-TERRITORIAL</b>	Contribute to Mediterranean development	Social integration	<b>No. of people linked to aquaculture / Mediterranean population</b>
	Promote participation in decision making	Importance of initiative development	<b>Existence of environmental discussion forums</b>
		Level of planning and aquaculture development	<b>Existence of ICZM</b>
	Strengthen the role of sectoral organizations in improving the image, social awareness and responsibilities	Level of aquaculture acceptance	<b>Existence of public funds for public awareness campaigns</b>

## APPENDICES



## *Records for Mediterranean countries*

The information included in these reports has been developed using public information available in the databases of the United Nation's Fisheries and Aquaculture Department for Food and Agriculture (FAO). This information has been updated and contrasted with the report: Regional synthesis of the Mediterranean aquaculture (MedAquaMarket). Barazi-Yeroulanos, Developed by the General Fisheries Commission for the Mediterranean.

For more information please visit:

<http://www.fao.org/fishery/naso/search/es>





**HISTORY**

Albania is a country rich in water resources with the largest lakes in the Balkan Peninsula. The Albanian experience in aquaculture using semi-intensive practices began in the 1960s. Until the 1990s it involved the production of carp family species, and it had a total of 25 hatcheries covering an area of 800 ha. **Extensive** aquaculture in coastal lagoons such as Butrinti in Saranda



where more than 80 farms were built where they cultivated the Mediterranean mussel during the 1980s, with an average production of 2,000 tonnes per year and a maximum of 5,000 tonnes in 1990.

The first **intensive** aquaculture of marine species began in the mid 1990s, with the growing of shrimps, sea bream and sea bass in floating cages. Other species cultivated in Albania are cold water salmonids, mainly rainbow trout and ohrid trout.

Lake Ohrid is stocked through the Lini hatchery, where artificial reproduction of *Salmo letnica* has been carried out since 1965 and which stocks millions of larvae and fingerlings every year.

**EMPLOYMENT**

An estimated 2,500 fish farmers are employed in aquaculture, in marine aquaculture and mollusc cultivation there are 250 fish farmers 50 of whom work part-time. Fish farmers employed in inland aquaculture number 2,250 and are involved in shrimp and trout cultivation, in agricultural reservoirs as well as natural and artificial lakes.

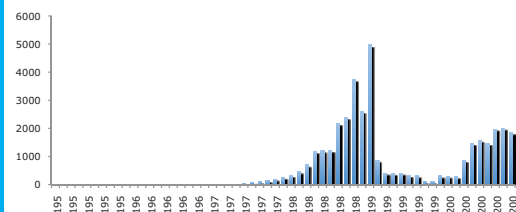
**BIODIVERSITY**

The main species cultivated in Albania are as follows: Rainbow trout, Sea bass, Sea bream, Common carp, Silver carp, Bighead carp, Grass carp, Kuruma prawn, European mussel and Ohrid trout.

**CONSUMPTION**

Albania imports products from Greece, mainly sea bass and sea bream and the demand for these products has created the need to increase investment in cage fish farming cage systems and trout cultivation. The **high prices** of fresh products and the **lack of wholesale markets** create problems for the farmers in selling their products.

Reported aquaculture production in Albania (FAO Fishery Statistic)



## HISTORY

Aquaculture in Algeria is experiencing a boom period with regards to production. Since 1920 it has been capitalized by four stages:

- Freshwater fish and shrimp breeding trials,
- Experimental shellfish production together with the development of brackish and freshwater lagoon fisheries,
- Development of restocking in impoundments and commercial development of inland fisheries,
- Recently the establishment of the Fisheries Ministry and Fish Resources and the intervention of the private sector to set up aquaculture businesses.



Aquaculture production currently comes from:

- Brackish and freshwater lake fisheries in the East of the country. A variety of fish are caught: Sea bream, mussel, eel, sole, sea bass, European bass, clams, oysters, sand steenbras, Caramote prawns, Chinese and common carp.
- Inland impoundment fisheries such as the common carp, Chinese carp and the barbell.
- Shellfish cultivation by one private business operator, producing several dozen tonnes of Mediterranean mussels and Japanese oysters.

## BIODIVERSITY

As well as the lagoon fisheries for endemic species (e.g. loach, sole, sea bass, sea bream, sand steenbras, eels, European bass, grouper, tuna, pagrus, barbus), until the beginning of the 1990s aquaculture activities involved stocking natural and artificial water bodies with the introduced species, these are: Common carp, tilapia, rainbow trout, tench, bass, mussels, Japanese oyster, bighead carp, herbivorous carp, silver carp, perch and silure. Over 90% of the production in inland impoundment fisheries is common, silver and herbivorous and bighead carp.

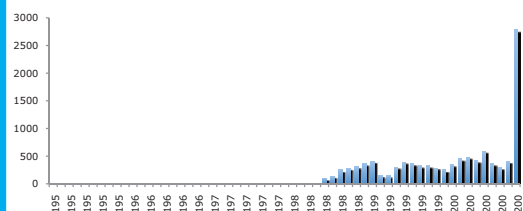
## PRODUCTION SYSTEMS

The majority of aquaculture in Algeria is extensive, based on stocking and restocking inland water bodies. In marine aquaculture there is only one private company which is farming Mediterranean mussels and Japanese oysters.

## EMPLOYMENT

Inland fisheries in impoundments are run by 14 fish farmers (between 1 and 4 people per impoundment) working full-time on 9 impoundments. Eel farms employ 66 people. The mollusc company currently in production employs 17 workers. Private companies which have received financial support within the framework of the economic recovery support programmes which started at the end of 2006 will help create 303 jobs.

Reported aquaculture production in Algeria (FAO Fishery Statistic)





## HISTORY

Bosnia and Herzegovina have more than a century-long tradition in aquaculture of salmonid and syprinid species. The current situation in relation to aquaculture production has been significantly influenced by the war, when a large number of fish farms were destroyed or severely damaged.



The introduction of modern fish culture in Bosnia and Herzegovina is associated with the establishment of the fish farm 'Vrelo Bosne' near Ilidza in 1894. In 1898 a new, large hatchery was built with a capacity of 600,000 larvae; it was the largest and most modern hatchery in the region.

Between 1946 and 1982, intensive aquaculture was developed; a system of floating cages in lakes and reservoirs with dense populations and higher production. In 1964, Bosnia and Herzegovina had 13 salmonid fish farms with a total surface area of 38,000m<sup>2</sup>.

In 1990, Bosnia and Herzegovina produced approximately 3,000 tonnes of fish for consumption. During the war, the majority of the production capacity was devastated and experts and workers abandoned aquaculture. After the war, in 1996, aquaculture resumed with a major deficit.

## EMPLOYMENT

In 2004, 562 full-time workers and approximately 100 part-time workers were directly employed in the aquaculture sector in cyprinid fish farms.

## GEOGRAPHICAL DISTRIBUTION

In Bosnia and Herzegovina, fish farms are generally distributed in three regions. In the North of Bosnia, in the Republic of Srpska, there are 5 cyprinid fish farms with a total surface area of 3,276 ha. In the River Neretva and the River Vrbas there are 40 concrete salmonid fish farms of 8.5 ha and 14 floating cage fish farms of 8.1 ha. Marine aquaculture is practised in two cage farms situated in Neum, with a total area of 3.6 ha.

(FAO, <http://www.fao.org/fishery/naso/search/en>).

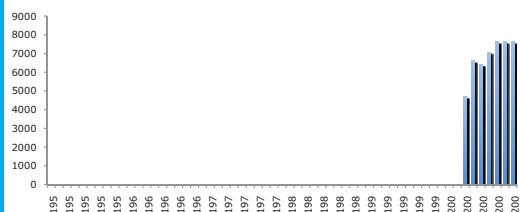
## BIODIVERSITY

The most important fish species are: Salmonids (rainbow trout, brown trout, brook trout), cyprinids (common carp, herbivorous carp, silver carp and wels catfish), marine species (sea bass, sea bream and common dentex), molluscs (Mediterranean mussel and European oyster).

## CONSUMPTION

Current consumption of fish and fish products is estimated at 1.5 kg per capita annually. It could be higher, but it is not given the difficult economic situation, with high levels of unemployment.

Reported aquaculture production in Bosnia and Herzegovina (FAO Fishery Statistic)





### HISTORY

Cyprus is the third largest island in the Mediterranean, situated in the eastern part of the Basin and it joined the EU in May of 2004.



The main type of aquaculture carried out in Cyprus is marine aquaculture with 3,500 tonnes in 2008, showing favourable expansion prospects. Marine culture is carried out exclusively on the country's southern coasts, mainly using cage capture in open sea. Commercial production of sea bream and sea bass began in 1986 with one hatchery. In 2008 there were 3 impoundments, along with 1 shrimp impoundment operating on 6 private fish farms with cages in open seas and 3 for tuna fattening, which has been running since 2004.

### EMPLOYMENT

The total number of people employed in the aquaculture sector in 2004 was 206 (78 men and 28 women). The majority work in the marine aquaculture sector (179) and a smaller number in the freshwater sector (27). Employment is both full-time and part-time and it includes production, administration and sales.

### BIODIVERSITY

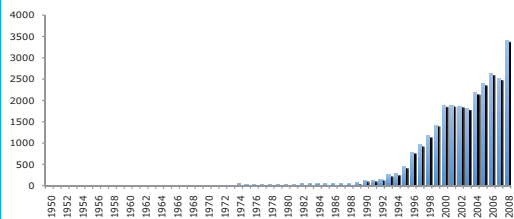
In 2004 the main marine species which were commercially farmed were sea bream, sea bass, and Bluefin tuna from the North. The following species are also produced in much lower quantities (2%): Gilthead bream, *Umbrina cirrosa*, Japanese snapper (*Pagrus major*), snapper, and Indian white shrimp (*Penaeus indicus*).

The only freshwater fish which is commercially produced is the rainbow trout. There are 6 small trout farms and 2 small ornamental freshwater farms.

### CONSUMPTION

In terms of volume, aquaculture contributes to the Cypriot fish production with approximately 70%. It also contributes significantly to the fish and fish product supply consumed in Cyprus. The average annual consumption of 18 kg per capita of fish and fish products, aquaculture contributes 2.5 kg.

Reported aquaculture production in Cyprus (FAO Fishery Statistic)





**HISTORY**

Croatia is a new independent state, but aquaculture dates back more than a thousand years. Both freshwater and marine aquaculture have been developed in Croatia. The main species farmed are tuna, grouper, red bream, carp, rainbow trout and mussels. Freshwater aquaculture is carried out in both warm waters (for cyprinids) and cold waters (for salmonids). The first trout farm was established in Croatia in 1883 and 14 years later the first carp farm was established and in 1894 the rainbow trout was introduced. The first attempts at intensive marine culture in Croatia began in 1980. Farming (fat-tening) of blue fin tuna started in 1996.



**PRODUCTION SYSTEMS**

Carp production is based on the use of all available feeds for polyculture. As well as common carp, the species farmed are, tench, Chinese carp, bighead carp, silver carp and silurus.

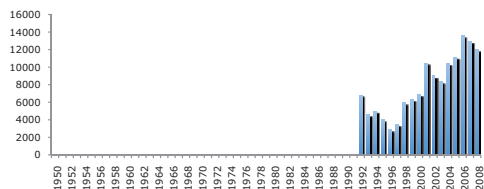
**EMPLOYMENT**

There has been a decline in the number of people employed in salmonid and carp farms for freshwater aquaculture, from 644 in 1995 to 606 in 2000. Of those, 486 worked on carp farms and 120 in salmonid farms. Since then there has been an increase in the number of people employed in salmonid farms. A good number of positions in freshwater aquaculture are seasonal and 11.8% are part-time workers.

**CONSUMPTION**

Croatia's fish consumption per capita is relatively low at 9-10 kg/year. Of this, only 0.4-0.5 kg is freshwater fish, with a clear preference for marine products. Fish production only represents a small sector of Croatia's economy; in value terms it corresponds to 0.2-0.3 of the Gross National Product.

Reported aquaculture production in Croatia (FAO Fishery Statistic)



## HISTORY

Aquaculture has been known in Egypt since the beginning of history; tomb friezes date back to 2,500 B.C. and illustrate the harvest of tilapia in ponds. The development and expansion of modern aquaculture began in Egypt two decades ago.



With the exception of a small number of isolated cases, the majority of aquaculture activities are located in the Nile Delta region. So far, the majority of farmed fish are freshwater species or those that can grow in brackish water. The majority of fish farms in Egypt can be classified as semi-intensive brackish water pond farms.

The farming of marine species such as sea bass, sea bream, sole, meagre and shrimp began at the end of the 1980s and beginning of the 1990s. They are produced in limited quantities in marine fish farms.

## BIODIVERSITY

Currently, 14 different types of fish and two species of crustacean are farmed in Egypt, ten are native and six introduced. The native species are: Nile tilapia, blue tilapia, North African catfish, flathead grey mullet, thinlip mullet, bluespot mullet, sea bass, sea bream, meagre and penaeid shrimp. The introduced species are: Common carp, herbivorous carp, silver carp, bighead carp, black carp and giant river freshwater prawn.

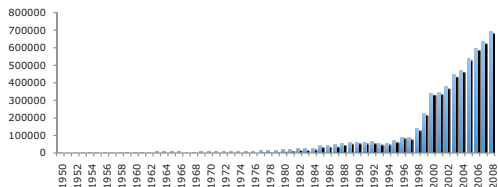
Integrated aquaculture, together with rice production is considered, by the government as an indirect subsidy in the consumption of animal protein amongst the poorest rural population. The government buys approximately 20 million fish fingerlings per year from private hatcheries to be distributed free of charge to rice farmers. This ensures that the farmers get a supply of animal protein since they do not sell the fish, they eat it themselves.

## CONSUMPTION

Aquaculture is considered to be the only solution to increasing the fish production in Egypt. In its development strategy, the Ministry of Agriculture and Land Reclamation, plans to increase the total fish production in Egypt to 1.5 million tonnes in 2017 and is targeting a harvest of 1 million tonnes from aquaculture.

Aquaculture is currently the main fish supply in Egypt; it covers 65% of the total fish consumption, of which 98% is produced on private farms. Nearly half its production is grey mullet whose seeds come from the wild and the other half is tilapia and carp. The annual consumption per capita in Egypt is 15 kg.

Reported aquaculture production in Egypt (FAO Fishery Statistic)





## HISTORY

The history of Slovenian freshwater aquaculture dates back to the sixteenth and seventeenth centuries when fish farming was monitored by churches and monasteries. In 1870, the first fish farm for artificial carp breeding was established. Slovenian aquaculture comprises freshwater farming (cold water fish farming of salmonids, warm water fish farming of cyprinids) and marine farming (fish and shellfish farming).



## BIODIVERSITY

The main freshwater species which contribute to aquaculture production are the rainbow trout and carp, whilst in mariculture it is the Mediterranean mussel, sea bass and sea bream. As well as the aforementioned species, other cold-water species are farmed such as: Grayling (*Thymallus thymallus*), lake trout (*Salmo trutta lacustris*) and char (*Salvelinus alpinus*). The non-indigenous species like rainbow trout and brook trout are bred mainly for the market and recreational fishing, whilst the native species are bred to restock the natural waters. Warm-water fish farming consists of the breeding of many cyprinid species, but economically important is the semi-intensive or intensive polyculture breeding of carp, Chinese carp, silver carp, bighead carp, pike, silurus, pike perch and tench.

## EMPLOYMENT

In 2003, 215 people worked in aquaculture activities in Slovenia. Of these, 203 were employed on freshwater farms and 12 in marine fish and mollusc farms. The aquaculture sector is characterized by small family farms, the majority of which only have one employee and are based on the labour of family members free of charge.

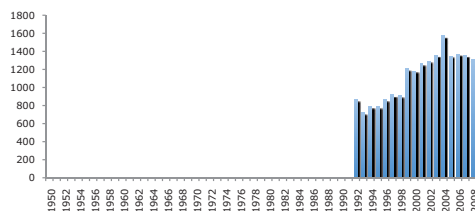
## PRODUCTION SYSTEMS

In 2003, the total aquaculture production was 1,354 tonnes. Fish farms produced 1,065 tonnes of fish. In mariculture, the total amount of fish and molluscs farmed was 206 tonnes. Nearly two thirds came from intensive breeding (cold-water fish and marine fish farming), a tenth from semi-intensive breeding (warm-water fish farming), and a quarter from extensive breeding (warm water and mussel farming).

## CONSUMPTION

Slovenia is a net importer of fish and fish products. There is a constant importing of freshly farmed species: Sea bass, Sea bream and salmon. Live fish imports mainly consists of fingerlings and eggs for breeding. The average consumption per capita was between 5.0 and 5.5 kg/year.

Reported aquaculture production in Slovenia (FAO Fishery Statistic)



## HISTORY

The first written reference on inland fish production in Spain dates back to 1129. However, industrial aquaculture began its development in 1961. In 1964 it reached an annual production of 25,000 kg of trout which still exists today despite suffering serious ups and downs. The beginning of modern marine aquaculture in Spain can be traced back to 1973, with the establishment of two private companies, Finisterre Mar y Tinamenor, S.A., which started farming molluscs. Truly productive industrial activity is only 20 years old.



## BIODIVERSITY

The main species which are currently bred in Spain on a commercial level are: Sea bream, sea bass, turbot, eel, red bream, meagre and sole. Other species that are in an advanced research stage include snapper, red snapper, tilapia and octopus. The most important species cultivated in Spain in terms of their economic value are: tunids, turbot, clams, (*Ruditapes philippinarum* and *Ruditapes decussatus*), sea bass, sea bream and sole. As for inland and brackish water fish, the most important species is the rainbow trout, constituting 11% of the total aquaculture production and 99% of the inland aquaculture production.

## EMPLOYMENT

With regards to employment in aquaculture, according to a study carried out for the General Secretariat for Maritime Fisheries in 2008, it concluded that 26,300 people were employed. In 2007 there were 61 companies divided almost equally into small, medium and large companies according to production volume (Barazi-Yeroulanos, 2010).

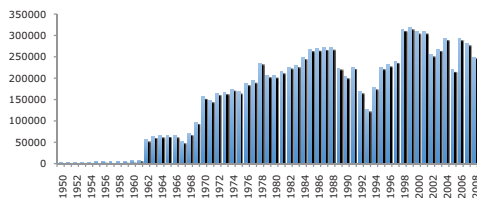
## PRODUCTION

Aquaculture production in Spain reached more than 250,000 tonnes in 2008, of which some 230,000 corresponded to the farming of marine species (molluscs, fish) and the rest to inland farming. In that year, the farming of Mediterranean mussels constituted 74% of the total production and 92% of main production, with Spain becoming the sixth producer of molluscs in the world, but despite this, mussel farming is not the most important in terms of economic value. In 2008 it only constituted 24% of the total value of production and 27% of the marine production value. Spain is also the third producer of sea bream and sea bass in the Mediterranean, with a combined annual production of 37,530 tonnes in 2009 (APROMAR 2010).

## CONSUMPTION

Approximately 70% of the Spanish mussel production is consumed internally and the remaining 30% is exported, mainly to Italy and France. 80% of marine fish goes to national market and 45% of fingerlings produced in Spain are exported to European markets. Fish consumption per capita in Spain is some 40 kg.

Reported aquaculture production in Spain (FAO Fishery Statistic)





## HISTORY

French aquaculture is an ancient and deep-rooted activity, mainly in the production of molluscs and trout farming. With the exception of salmonids, fresh-water species (carp - 4,230 tonnes, roach and tench - 2,790 tonnes) have been farmed since the Middle Ages in the Southwest and Central and Eastern regions of France. During the seventies, the biological cycle of sea bass and sea bream was completed by French scientists who were experimenting in the South of France.



## BIODIVERSITY

There is a large diversity in production systems:

- Marine and freshwater fish: These are bred in raceways or fast-flowing channels, ponds, tanks and cages, except for carp and cyprinids which are produced in dams, lakes and reservoirs.
- Crustacean (tropical shrimp) is farmed in earthen ponds.
- Molluscs are reared along the coast in bays, estuaries and lagoons, either on suspended longlines, racks, posts or directly on the seabed.

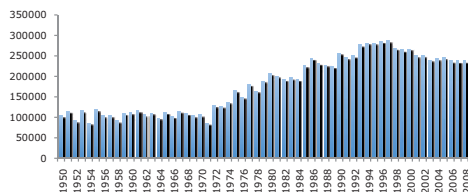
## EMPLOYMENT

The most important production sector is mollusc farming; there are 55,000 registered concessions for 3,700 farms which employ 20,000 people. Trout farming employs 2,000 people in the 500 farms; only 3% are large companies producing more than 500 tonnes each, whilst small companies, which produce less than 100 tonnes each, represent 84% of the total production. Farming of other freshwater fish species is represented by 6,000 multi-activity farmers. Marine fish farming is carried out in 40 individual companies in 46 farms, including hatcheries, and/or fattening farms (Barazi-Yeroulanos, 2010).

## PRODUCTION

The main farming species in terms of volume in France is the Japanese oyster, the second most important in terms of economic value in Europe. Also, France is the third biggest trout producer after Chile and Norway. Sea bass, sea bream and turbot still dominate the marine aquaculture sector. France has a good level of juvenile production; as a consequence, France exports between 60 and 70% of its production to Greece and Spain and also China. Fish consumption per capita in 2003 was 33 kg/year.

Reported aquaculture production in France (FAO Fishery Statistic)



## HISTORY

Although the farming of aquatic animals has existed in Greece since ancient times, the main farmed species which make up the aquaculture sector today, sea bass and sea bream have only been farmed since the beginning of the 1980s. Some freshwater species are farmed such as trout, eel and carp (source: FEAP). There is also some mollusc farming, such as mussels, but of comparatively little economic value. Sea bream and sea bass production reached a total of 145 thousand tonnes in 2008 (Barazi-Yeroulanos, 2010) equivalent to 48% of the global aquaculture production of these species.



## EMPLOYMENT

In Greece there are 189 producing companies, although in the last 10 years the industry has focused on 6 companies which control 60% of the national production and 16 companies or business groups which control 70-75% of production. The Greek industry is vertically integrated with 16 companies as well as large impoundment owners and 3 companies who own feed production plants. (Barazi-Yeroulanos, 2010).

## BIODIVERSITY

The main fish species farmed today are shown below, in order of importance in terms of tonnage produced: Sea bream and sea bass, mussels and oysters, trout, other marine species and eels. The first two species made up 70% of the total production in Greece and the second group represented 24% in 2007.

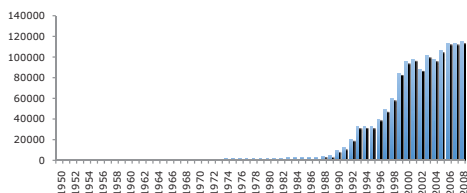
## CONSUMPTION

In recent years the Greek market has expanded into other countries, mainly Turkey and Spain, through the participation and investment of Spanish and Turkish companies.

Fish, mainly sea bass and sea bream account for a significant fraction of agricultural export, after olive oil and tobacco, and therefore the Greek government considers it to be a strategic product. The success of the Greek market stems from the production costs which are amongst the lowest in Europe. Production sites are all along the Greek coast, but they are mainly in more central regions closer to improved infrastructure and export routes.

The consumption per capita in Greece is approximately 25 kg per year (FAO) of which 21 kg is sea bass and sea bream. This means that the annual total consumption in Greece is approximately 250,000 tonnes for a population of around 10 million and aquaculture contributes with less than 10%.

Reported aquaculture production in Greece (FAO Fishery Statistic)



## HISTORY

Aquaculture in Israel began with the importing of carp during 1927-28. An experimental farm was established in 1934 on the South coast of Acre. Nir David's cooperative farm (kibbutz) in the Bet Shean Valley began farming common carp in 1937-38 and by 1939 commercial carp farming had extended all through the valley.



Water is a major concern for fish farmers. Israel suffered droughts through the 1980s and 1990s which seriously affected aquaculture. Lack of water has generated research efforts to increase production using as little water as possible.

One of the main pond methods currently being developed and which is rapidly increasing in volume is the use of covered oxygenated ponds, with water circulating via a reservoir or biofilter.

## BIODIVERSITY

The majority of Israel's farmed species are imported. Rainbow trout was imported from Switzerland. Common carp is the most important species and Chinese, silver and bighead carp are also farmed. Other species are being farmed on a lower scale such as striped bass (*Morone saxatilis*), The Red Drum (*Sciaenops ocellatus*), tilapia hybrid, barramundi (*Lates calcarifer*), Australian crab (*Cherax*) and silver perch (*Bidyanus bidyanus*). Although the most commonly produced species are tilapia, grey mullet and carp.

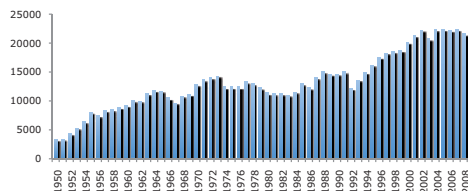
## PRODUCTION SYSTEMS

Aquaculture in the Galilee, Gilboa and Jordan Valleys are characterized by freshwater polyculture using intensive fish ponds, reservoirs for extensive freshwater aquaculture and in the northern regions raceways are used for farming rainbow trout. Along the coastal plains, freshwater polyculture is carried out in intensive ponds, as well as in salt water ponds to produce a variety of marine species. Along the Mediterranean sea coast a variety of freshwater and marine species are produced in ponds as well as floating cages. The Negeve and Arava valleys have freshwater ponds producing salt tolerant exotic species (e.g. barramundi and turbot) whilst in Elat sea bream is farmed in cages and ponds.

## CONSUMPTION

Aquaculture in Israel has been and continues to be based on cooperative farms. Between 1995 and 2003, aquaculture contributed approximately 4.7% of fish production in the country with 4% of its total value.

Reported aquaculture production in Israel (FAO Fishery Statistic)



## HISTORY

More than 2,000 years ago the people used to breed sea fish, in particular sea bass and sea bream which were considered very valuable. The fall of the Roman Empire led to the disappearance of this type of aquaculture and it was not until the twelfth century that a resurgence of freshwater aquaculture was seen in central Europe, especially in Italy. Large-scale extensive aquaculture began in the fifteenth century mainly on the Adriatic lagoons: *Valliculture* (aquaculture carried out on coastal lagoons). These activities were promoted by the religious practice of not being allowed to eat meat on Fridays.



Modern marine aquaculture production began in Italy about 25 years ago. The Italian aquaculture tradition was conceived in inland areas, in lagoons and ponds and currently the main production is represented by freshwater species, mainly trout, carp, sturgeon and eel.

Modern marine aquaculture production began in Italy about 25 years ago. The Italian aquaculture tradition was conceived in inland areas, in lagoons and ponds and currently the main production is represented by freshwater species, mainly trout, carp, sturgeon and eel.

## EMPLOYMENT

In 2006 there were a total of 715 aquaculture companies (including freshwater, marine and mollusc production companies) employing 7,764 people (Barazi-yeroulanos, 2010). Of this total, 130 companies produce mainly sea bream and sea bass (96%) employing 926 people on a full-time basis.

## PRODUCTION SYSTEMS

Farms are spread throughout the Italian territory, mainly in the southern regions. The system of production used is marine cages, but there are some difficulties in finding suitable areas which do not interfere with other economic interests or activities (e.g. tourism).

Italian aquaculture can be divided into four farming systems: Extensive (inland farms), semi-extensive (inland farms), intensive farming (inland and sea farms) and mussel farming (strings or longlines).

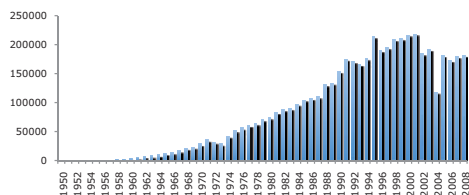
## BIODIVERSITY

The majority of fish farming is made up of freshwater species, mainly trout, catfish and sturgeon. Of euryhaline species, the most important are sea bass and sea bream, followed by eel and sharpnose sea bream. The Italian production of mussels and clams is also relatively important. Tuna farming has stretched into the Mediterranean in recent years, including Italy.

## CONSUMPTION

With regard to seafood per capita consumption, fish and shellfish registered a positive trend in the last 10 years, reaching an approximate value of 21.5 kg in about 2004. Italian aquaculture has experienced a stable growth over the years. Italian aquaculture contributes 43% of the national fish production which constitutes 29% of the income.

Reported aquaculture production in Italy (FAO Fishery Statistic)





**HISTORY**

Inland aquaculture has been practiced in Lebanon since 1930 (El-Zein, 1997). The first farm was created in 1965 in the area of Hermel, nearly all the farms (41%) were established between 1985-1990, mainly in the areas of Anjar and Hermel and a few in Zahle.



More than 90% of Lebanese fish farming production is rainbow trout. They are farmed in semi-intensive systems introduced in 1958. Today there are 150 fish farms or concessions. Tilapia farms have recently been established through private initiatives. There is only one marine aquaculture farm and it produces shrimp, it belongs to a private company and it is situated in the north of Lebanon.

**BIODIVERSITY**

The following species are farmed in Lebanon: rainbow trout, tilapia and shrimp.

**GEOGRAPHICAL DISTRIBUTION AND PRODUCTION SYSTEMS**

Aquaculture is practiced in the following areas: Bekaa, Akkar in the North of Lebanon and in the South of Lebanon.

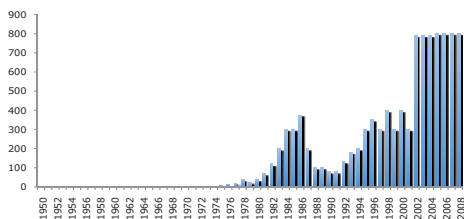
The production system mainly used is semi-intensive. The average annual production of rainbow trout is 600 tonnes, which is produced in 150 farms, of which 80% are in the northern area of Hermel and Bekaa, the value of this production is US\$ 2 million and with an average yield of 10-12 tonnes (approximately 1.5 kg/litre/minute).

**CONSUMPTION**

The total fish production (capture and aquaculture) accounts for less than 27% of local consumption. Aquaculture contributes 10% of local production and 3% of local fish production.

Compared to other Mediterranean countries fish consumption in Lebanon is still limited, with 4 kg/person/year. Domestic consumption is estimated at 25,000t/year.

Reported aquaculture production in Lebanon (FAO Fishery Statistic)



## HISTORY

Aquaculture is a new activity in the Libyan Arab Republic, which started with farming a variety of freshwater species in the 1970s. Due to the limited freshwater resources, dams and small lakes have been used for semi-intensive farming of a variety of species of carp (common, Chinese, bighead, silver carp) imported from China as well as catfish. Farming tests have been successful and have suitable growth rates in the majority of the species. However, freshwater fish farming has not been consolidated given the low level of acceptance on behalf of the local consumers.



Nile tilapia (*Oreochromis niloticus*) was introduced in the beginning of the 1990s. This species was accepted locally thanks to its physical aspect and taste, helping a rapid increase in production using water from the irrigation canals used in agriculture.

## BIODIVERSITY

Marine culture also began in the beginning of the 1990s, today sea bass, sea bream and red tuna from the Atlantic are farmed. Freshwater farming includes various types of carp: Common, bighead, silver and Chinese carp as well as catfish. Nile tilapia and red tilapia are the main types of freshwater fish which are farmed and they are widely distributed in irrigation ponds on agriculture farms along the coast, as well as in rural areas in the south of the country. As a result of the good growth rates, a large production plant has been developed in the south of the country. This farm has a large hatchery and 78 concrete tanks.

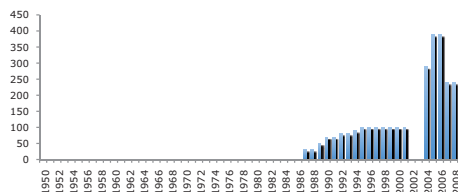
## EMPLOYMENT

There are no historical statistics, currently the number of people employed full-time in this sector is approximately 140, and this figure is based on research carried out in 2004 by the Marine Biology Research Centre.

## CONSUMPTION

Given that there have not been great changes in the demand for aquaculture products and there is a very low consumption per capita (around 7 kg in 2001), the producers prefer to export all of their produce. The main aquaculture products are sea bass and sea bream of between 350 and 500 g labelling and certification of aquaculture products does not exist in the Libyan Arab Republic. Aquaculture's current contribution to the economy is insignificant.

Reported aquaculture production in Libya (FAO Fishery Statistic)





## HISTORY

Aquaculture was introduced into Malta following the establishment of the National Aquaculture Centre (NAC) in 1988, when basic farming techniques were demonstrated for tilapia in seawater. At the beginning of the 1990s, commercial fish farms started to produce sea bass and sea bream. NAC developed its own pilot marine hatchery for the production of sea bream and sea bass fingerlings in 1992.



Maltese aquaculture is mainly marine based and consists in the fattening of the Atlantic Bluefin Tuna caught in the wild, as well as sea bass and sea bream farming. The Atlantic Bluefin tuna is mainly exported to Japan, whilst sea bass and sea bream are exported to Europe, especially Italy. All fish farmed in Malta are reared on floating cages, approximately 1 km from the coast, through intensive production systems.

There is strong competition for resources and space given Malta's size. The government is very aware of the environmental costs, which is why an environmental assessment is necessary before aquaculture development can begin. An area specifically for aquaculture is being created close to the coast in order to take tuna farming away from the direct coast which is conflicting with tourism.

## BIODIVERSITY

Malta farms sea bass, sea bream and fattens Bluefin tuna. Sea bream and sea bass fingerling are imported from Italy, Spain or France. Meagre production is also being researched.

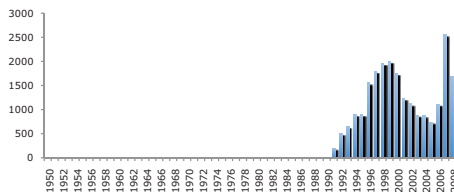
## EMPLOYMENT

There are two sea bass and sea bream farms operating in three different areas. In 2005 there were approximately 120 people employed full-time and 64 people part-time in aquaculture. These include directors, office personnel, established fishermen or part-time fishermen, workers and divers. The majority are men; women are only employed in processing activities.

## CONSUMPTION

Local captured fish consumption is strongly complimented with farmed fish and imported, fresh, frozen and processed products. Fish consumption per capita (excluding tinned products and other processed products) is 6.58 kg/year.

Reported aquaculture production in Malta (FAO Fishery Statistic)





### HISTORY

Marine aquaculture began 50 years ago in Morocco when oysters were first bred south of Casablanca, producing approximately 200 tonnes. The first intensive sea fish breeding farms were established in the 1980s on the Mediterranean coast. In 2004 the industry was dominated by two companies: Marost and Aqua M'diq. Inland aquaculture began in 1924 with the establishment of the Azrou fish farming station. The purpose of this station was to promote angling as a sport by breeding and releasing fingerlings with a high nutritional and economic value in the Atlas Lakes, dams and other impoundments.



### BIODIVERSITY

The production of inland fish in 2004 was 685 tonnes. The most important species is the common carp, which makes up 88% of the production. The entire production was used for restocking the impoundments and dams. The production of rainbow trout was 50 tonnes, produced by a company with a semi-intensive system and in natural and artificial impoundments. Tialpia, silver, Chinese and bighead carp, perch, barbell and eel are also farmed.

Since mollusc farming appeared in 1950, the production has been stable, at around 200 tonnes. In 2004, six companies produced 160 tonnes, mainly oysters for the local market.

### EMPLOYMENT

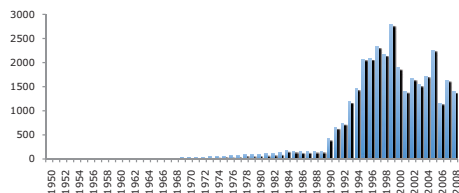
In 2005 there were 9 companies which employed 607 people in the country, 454 full-time, 112 part-time and 41 directly or indirectly related to aquaculture.

### CONSUMPTION

In 2004 Moroccan production was 1690 tonnes, which meant 0.19% of the total national fish production. Marine aquaculture production was 788 tonnes, which was mainly sea bass and sea bream (91%). These two species are intensively farmed in floating cages in both lagoons and open sea. The production is nearly all exported to Italy, Spain and France. Also, Bluefin tuna which are caught in tuna nets are fattened on the Mediterranean coast.

Fish products contribute to food nutrition given its protein content, although the estimated consumption per capita is 9 kg.

Reported aquaculture production in Morocco (FAO Fishery Statistic)







## HISTORY

Due to geographic, natural, economic and technical factors, Syrian aquaculture is practised exclusively in freshwater. It is also restricted to fish breeding, more specifically warm freshwater fish farming. The main species of freshwater fish produced commercially are tilapia and common carp. The main production systems are ponds, cages and dams.



## BIODIVERSITY

Until now commercial aquaculture had been restricted to two freshwater species: Common carp and tilapia, which are thought to be hybrids of *Oreochromis aureus* and *Oreochromis niloticus*. There are also three more species of lesser importance farmed in ponds: African catfish (*Clarias gariepinus*), herbivorous and silver carp.

## PRODUCTION SYSTEMS

Three production systems prevail: Ponds, cages and dams. Of the total number of existing farms in 2004, 80.78% were ponds, 12.44% cages and 6.78% dams.

With respect to the standardization of feed allocation, productivity of fish pond farms is classified in three categories:

- Extensive fish pond culture with a productivity of up to 4 tonnes/ha.
- Semi-intensive fish pond culture with a productivity between 4 and 8 tonnes/ha.
- Intensive fish pond culture in tanks with a productivity between 8 and 12 tonnes/ha.

## EMPLOYMENT

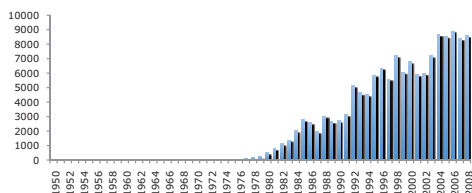
Approximately 1760 families or 10,000 people currently work full-time on fish farms. If the production in fisheries and surface water retention lakes are taken into account, another 300 families or 2,000 people would be added to these figures.

## PRODUCTION

Annual freshwater aquaculture yields are approximately 50% of the total production (8682 tonnes of 17,210 total tonnes in 2004), with an estimated economic value of US\$ 12 million.

Syrian aquaculture is still considered small scale.

Reported aquaculture production in Syria (FAO Fishery Statistic)



## HISTORY

The first steps in aquaculture in Tunisia began in 1960 when a mollusc farm was set up in Lake Bizerte (in the north of the country) for the National Fisheries Office.



These trials were followed by scientific experiments and the establishment of two experimental stations (freshwater fish raising in the south of Tunisia in 1974 and marine fish breeding in the north of Tunisia in 1975), later, the National Aquaculture Centre was set up in Monastir in the eastern-central part of the country. This centre was established to manage the breeding and rearing of marine fish (sea bream and sea bass) and to provide assistance to private producers.

It was not until 1985 that the first industrial operations began in this field, with the establishment of three private industrial farms in southern Tunisia.

Today, there are around 13 aquaculture projects in production, as well as 23 inland farms in private ponds in the interior of the country.

Total aquaculture production rose from 140 tonnes in 1987 to 3,700 tonnes in 2004, which was about 3% of the total output in the fisheries sector in 2005.

## EMPLOYMENT

Approximately 1,000 people are directly or permanently employed in aquaculture.

## BIODIVERSITY

The most important species in terms of breeding value are basically sea bream and sea bass, along with Bluefin tuna fattening caught in the wild. Freshwater species farmed in Tunisia are zander, black sea bass, Chinese, silver and bighead carp and Nile tilapia. With regards to molluscs, the Japanese oyster is farmed.

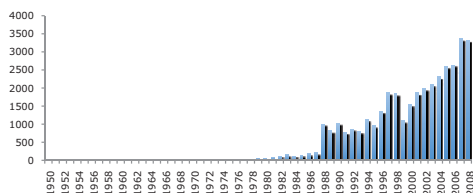
## PRODUCTION SYSTEMS

Intensive farming techniques are used in marine aquaculture. Inland aquaculture consists of extensive techniques, stocking with mullet fingerlings which will then be fished in ponds. The Mediterranean mussel and the Japanese oyster are farmed using breeding tables or floating lines.

## CONSUMPTION

The annual consumption per capita presents a very unbalanced regional division, given that the annual consumption per capita in inland areas is less than 1.5 kg, with 11.45 kg/year.

Reported aquaculture production in Tunisia (FAO Fishery Statistic)



## HISTORY

Aquaculture in the Mediterranean is an activity which began centuries ago, with a form of extensive aquaculture known as 'daylan fisheries' practised in the Mediterranean lagoons of Turkey. Modern aquaculture began in the late 1960s, the first species cultivated was the rainbow trout and common carp and later on sea bream and sea bass farming were developed in the 1980s. The production of the three species, especially rainbow trout, sea bream and sea bass increased rapidly during the 1990s. Rainbow trout, sea bass, sea bream, common carp and mussel production reached 80,000 tonnes/year in 2003, in 1,659 farms.



Trout farms are spread throughout the country, the main sea bream and sea bass farms are located on the southern coast of the Aegean Sea where the conventional floating cages are protected.

## EMPLOYMENT

The Turkish aquaculture sector employs approximately 25,000 people (directly or indirectly), mainly in rural areas, in a total of 1,781 fish farms which produced 118,000 tonnes of fish in 2008. Secondary support activities are also developing rapidly, generating more job opportunities, such as: Feed production, equipment and consultancy. There are approximately 350 marine companies and 20 sea bass and sea bream hatcheries (Barazieroulanos, 2010).

## BIODIVERSITY

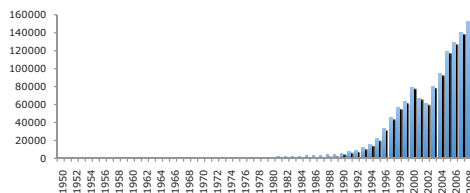
Turkish aquaculture is based mainly on intensive farming of sea bream, sea bass and tuna in floating cages, there are also sea bass and sea bream farms which use earthen ponds and there is only one farm with high technology (including re-circulation). Extensive and semi-intensive farming are limited to mussel and common carp cultivation, but only around 1,500 tonnes/year. Rainbow trout is the main species cultured and it is farmed in both land-based raceways and some more modern farms use circular concrete tanks. Semi-intensive use of earthen ponds is the most common system used for carp farming.

Important efforts have been made to develop new species such as the Black Sea turbot (*Scophthalmus maeoticus*) and some Mediterranean species such as sharpnose sea bream, common sea bream, common dentrex and groupers (*Epinephelus spp.*). Fattening of the Atlantic red tuna, which began at the start of the new millennium, has constituted the latest development in terms of diversification of the farming species.

## CONSUMPTION

The consumption per capita of Turkish fishery products is approximately 8.6 kg/year. Today aquaculture's participation in the total fish production is 22% in volume and around 25% in value. The majority of the production (almost 98%) is generated in intensive farming systems; rainbow trout consumption is mainly local, whilst approximately 75% of sea bream and sea bass are exported to EU countries. Nearly all aquaculture products are sold whole and fresh.

Reported aquaculture production in Turkey (FAO Fishery Statistic)



## Glossary

### Aquaculture

According to FAO, in the Technical Guidelines for Responsible Fisheries (1997), “Aquaculture is the farming of aquatic organisms: fish, molluscs, crustaceans or aquatic plants. Farming implies some sort of intervention in the rearing process to enhance production, such as regular stocking, feeding, protection from predators, etc. Farming also implies individual or corporate ownership of the stock being cultivated. For statistical purposes, aquatic organisms which are harvested by an individual or corporate body which has owned them during their rearing period contribute to aquaculture”

### Biodiversity

Biodiversity (abbreviation of “*biological diversity*”) is an idea - a complex representation of the complexity or the tree of life in all its forms. The Convention on Biological Diversity defines biodiversity as “*The variability amongst living organisms from all sources including, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: This includes diversity within species, between species and of ecosystems*”.



Signed at the Earth Summit (Río Summit) in 1992 by 150 government leaders, the Convention on Biological Diversity is dedicated to promoting sustainable development. Conceived as a practical tool for translating the principles of Agenda 21 into reality, the Convention recognizes that biological diversity is about more than plants, animals and microorganisms and their ecosystems - it is about people and our need for food security, medicines, fresh air and water, shelter and a clean and healthy environment in which to live.

### Certification

Certification proves that a product or a process conform to requirements. This confirmation is added to the information provided by the producer on the tickets and is generally, although not always, by external assessment.

## **Production cycle**

The time required to breed any aquaculture species until it reaches commercial size.

## **Code of conduct**

Codes of conduct are a set of written principles and expectations, which although voluntary, are considered binding on any person who is a member of a particular group that adopts the code.

## **Intensive farming**

According to FAO *“Intensive farming is a culture system characterized by production rates of up to 200t/ha/year; a high degree of control; high initial costs; high level of technology and high productive efficiency; a tendency towards increased independence of local climate and water quality and use of man-made culture systems”*.



## **Coastal area management**

Coastal area Management could be defined as *“the management of marine and coastal areas and resources to obtain sustainable use, development and protection”*.

## **Indicator**

Tell us what to measure to determine the extent of the impact. It simplifies the information to make it more understandable. They can lead to a rate or a group of indicators summarized in a single value.

## **Aquaculture licence**

A legal document which gives official authorization to carry out aquaculture. It comes in different forms: An aquaculture permit, which allows the actual activity to be carried out, or an



authorization or concession, which allows the occupation of a public domain, providing the applicant complies with the environmental and aquaculture legislation.

### **Interested party or actors**

A person, group or organization that has a direct or indirect interest in an organization because it can affect or be affected by its actions, objectives and policies.

### **Polyculture**

According to the FAO, polyculture is “the rearing or growing of more than one species on the same area of land at the same time”. They do not compete for food or space, but neither is there trophic benefit from this interaction.

### **Person responsible for decisions**

A person, group or organization whose judgements can be translated into binding responsibilities.

### **Certification system**

A collection of processes, procedures and activities which lead to certification. A believable system of certification is based on three steps: Elaboration of rules, credentials and certification.

### **Sustainability**

The three pillars of sustainability are economic, environmental and social. According to Harwood (1990) “sustainable aquaculture is a system that can evolve indefinitely toward greater human utility, greater efficiency of resource use and a balance with the environment which is favourable to humans and most other species”.



## Tanks

According to the FAO, “*tanks are structures containing water or fish, commonly built on the ground, generally with a high level of water renovation; highly controlled environment*”.

## Hatchery

According to the FAO “*Hatcheries are structures used for breeding, closed at the bottom and the sides with either wood or mesh. They allow the exchange of natural water either through the sides or in the majority of cases from the base of the hatcheries*”.



## Bibliography

- Aprumar. 2010. Spanish Association of Marine Fish Farmers. 74 pages.
- Barracough, S. and Finger-Stich, A. 1996. *Some Ecological and Social Implications of Commercial Shrimp Farming in Asia*. United Nations Research Institute for Social Development (UNRISD) Discussion Paper #74.
- Chopin, T., Buschmann, A.H., Halling, C., Troell, M., Kautsky, N., Neori, A., Kraemer, G., Zertuche-Gonzalez, J., Yarish, C., Neefus, C. 2001. Integrating seaweeds into aquaculture systems: a key towards sustainability. *Journal of Phycology* 37:975-986.
- Chua, T., Paw, J. and Guarin. 1989. The environmental impact of aquaculture and the effects of pollution on coastal aquaculture development. *Marine Pollution Bulletin* 20: 335-343.
- Cochrane, K.; De Young, C.; Soto, D.; Bahri, T. (eds). 2009. Climate change implications for fisheries and aquaculture: overview of current scientific knowledge. *FAO Fisheries and Aquaculture Technical Paper*. No. 530. Rome, FAO. 212p.
- Dierberg, F. and Kiattisimkul, W. 1996. Issues, impacts, and implications of shrimp aquaculture in Thailand. *Environmental Management* 20: 649-666.





- El Zein, G. 1997. Development Actuel de la peche et l'aquaculture au Liban. La pisciculture Francaise d'eau vive et d'etang saumatre et marine. Numero 130 - 4eme trimestre 1997 revue trimestrielle - 80F, pp. 13-27.
- FAO. 1997. Fisheries management. FAO Technical Guidelines for Responsible Fisheries. No. 4. FAO, Rome 82 p.
- Food and Agriculture Organization of the United Nations. 2008. State of world aquaculture: 2008. FAO Fisheries technical paper No. 500, 197pp.
- Madec P. 2003. Les indicateurs de développement durable. INRA-Université de Montpellier II. 118 p.
- Linde, P. 2007. El mar más sucio del mundo. El País 23/07/2007, [http://www.elpais.com/articulo/sociedad/mar/sucio/mundo/elpepusoc/20070723elpepisoc\\_1/Tes](http://www.elpais.com/articulo/sociedad/mar/sucio/mundo/elpepusoc/20070723elpepisoc_1/Tes).
- Pauly, D., V. Christensen, J. Dalsgaard, R. Froese and F.C. Torres Jr. 1998. Fishing down marine food webs. *Science* 279: 860-863.
- Primavera, J.H. 1998. Tropical shrimp farming and its sustainability. In: *Tropical Mariculture*. De Silva, S. (ed), Academic Press, New York, pp. 257-289.
- IUCN, 2007. *Guide for the Sustainable Development of Mediterranean Aquaculture 1. Interaction between Aquaculture and the Environment*. IUCN, Gland, Switzerland and Malaga, Spain. 107 pages.
- IUCN, 2009. *Guide for the Sustainable Development of Mediterranean Aquaculture 2. Aquaculture Site Selection and Site Management*, IUCN, Gland, Switzerland and Malaga, Spain. VIII + 303 pages.
- IUCN, 2009. *Guide for the Sustainable Development of Mediterranean Aquaculture 3. Aquaculture Responsible Practices and Certification*. Gland, Switzerland and Malaga, Spain: IUCN. VI+70 pp.

## List of participants

### “MEDITERRANE-ON”



The workshop was held in Madrid on the 10th and the 11th of June 2010 in the headquarters of the GSM. The main objective was to discuss principles, criterion and indicators in terms of farm, country and the Mediterranean region.

#### **Abdelhafid Chalabi**

FAERM Team Leader

Aquaculture Management Directorate AMD / Department of Fisheries and Oceans DFO

Canada

[abdelhafid.chalabi@dfo-mpo.gc.ca](mailto:abdelhafid.chalabi@dfo-mpo.gc.ca)

#### **Alistair Lane**

Executive Director

European Aquaculture Society (EAS)

[a.lane@aquaculture.cc](mailto:a.lane@aquaculture.cc)

#### **Chedly Rais**

Okeanos

Tunisia

[chedly.rais@okianos.org](mailto:chedly.rais@okianos.org)

**Cristina García Díez**

Spanish Aquaculture Observatory Foundation (FOESA).  
Spain  
*cgarcia@fundacionoesa.es*

**Eduardo Chia**

CIRAD, UMR Innovation, Montpellier  
France  
*eduardo.chia@cirad.fr*

**Fabio Massa**

FAO  
Italy  
*fabio.massa@fao.org*

**Fernando Torrent**

Polytechnic University of Madrid  
Spain  
*fernando.torrent@upm.es*

**François René**

IFREMER, Montpellier  
France  
*francois.rene@ifremer.fr*

**Francois Simard**

Global Marine Programme, IUCN  
Switzerland  
*francois.simard@iucn.org*

**Güzel Yücel-Gier**

Institute of Marine Sciences and Technology  
Univeristy Izmir, Turkey  
*yucel.gier@deu.edu.tr*

**Javier Ojeda González-Posada**

APROMAR  
Spain  
*ojeda@apromar.es*

**Javier Remiro Perlado**

Spanish Aquaculture Observatory Foundation (FOESA)  
Spain  
*jremiro@fundacionoesa.es*

**José Carlos Macías Rivero**

Public Enterprise for Agriculture and Fisheries Development (D.a.p.)  
Spain  
*jcmacias@dap.es*

**Joseph Borg**

University of Malta  
Malta  
*joseph.a.borg@um.edu.mt*

**Julian Le Viol**

IUCN, Málaga  
Spain  
*julian.leviol@iucn.org*

**Maria Teresa Dinis**

SEACASE  
Portugal  
*mtdinis@ualg.pt*

**Pablo Ávila Zaragoza**

Public Enterprise for Agriculture and Fisheries Development (D.a.p.)  
Spain  
*pavila@dap.es*

**Pablo Sánchez Jerez**

University of Alicante  
Spain  
*psanchez@ua.es*

**Paco Padilla**

Brotherhood of Fishermen of Conil  
Spain  
*pacopadilla@dydmar.com*

**Panos Christofilogiannis**

Management Solutions for Aquatic Resources (AQUARK)  
Greece  
*panosvet@otenet.gr*

**Philippos Papageorgiou**

Consultant on Fisheries and Aquaculture Greece  
*f\_papageorgiou@tellas.gr*

**Rosa Chapela Pérez**

Marine Technology Centre (CETMAR), Galicia  
Spain  
*rchapela@cetmar.org*

**Sandra Simoes Rubiales**

Global Marine Programme, IUCN  
Switzerland  
*sandra.simoes@iucn.org*

**Sherif Sadek**

Aquaculture Consultant Office (ACO)  
Egypt  
*aco\_egypt@yahoo.com*

**Shirra Freeman**

University of Haifa/Harvard School of Public Health  
Israel / USA  
*freeman@hsph.harvard.edu*

**Other collaborators:**

**Fernando Otero Lourido**

APROMAR  
Spain  
*fernando@oterolourido.com*

**Dror Angel**

University of Haifa  
Israel  
*adrdr@research.haifa.ac.il*

**Jose Ramón Texeira**

Public Enterprise for Agriculture and Fisheries Development (D.a.p.)  
Spain  
*jrtexeira@dap.es*

## List of acronyms

**ACO:**

---

*Aquaculture Consultant Office*

**APROMAR:**

---

*Spanish Association of Marine Fish Farmers*

**CAQ:**

---

*CGPM's Aquaculture Committee*

**CETMAR:**

---

*Marine Technology Centre (Vigo)*

**CGPM:**

---

*FAO's General Fisheries Commission for the Mediterranean*

**DAP:**

---

*Agriculture and Fisheries Development of Andalucía*

**EBM:**

---

*Ecosystem Based Management*

**EC:**

---

*European Commission*

**EMAS:**

---

*Eco-Management and Audit Scheme*

**EU:**

---

*European Union*

**FAO:**

---

*Food and Agriculture Organization of the United Nations*

**FEAP:**

---

*Federation of European Aquaculture Producers*

**FOESA:**

---

*Spanish Aquaculture Observatory Foundation*

**ICZM:**

---

*Integrated Coastal Zone Management*

**IEO:**

---

*Spanish Institute of Oceanography*

**INRA:**

---

*French National Institute for Agricultural Research*

**ISO:**

---

*International Organization for Standardization*

**IUCN:**

---

*International Union for the Conservation of Nature*

**MARM:**

---

*Spanish Ministry for the Environment and Rural and Marine Affairs.*

**JACUMAR:**

---

*National Advisory Board of Marine Aquaculture Farms*

**OP:**

---

*Producers Organization*

**SEP:**

---

*Surveillance Environmental Plan*

# NOTES

A series of horizontal dotted lines for writing notes.





# NOTES

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....











[www.mediterraneon.es](http://www.mediterraneon.es)

Developed by:



In partnership with:



Fundación Biodiversidad



MINISTERIO  
DE MEDIOAMBIENTE  
Y ACCIÓN CLIMÁTICA

SECRETARÍA GENERAL  
DEL MAR