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REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT
6. WESTERN-EUROPEAN REGION – 2005

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REGIONAL REVIEW ON AQUACULTURE DEVELOPMENT
6. WESTERN-EUROPEAN REGION – 2005

by

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
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FOREWORD

The world population is on the rise, as is the demand for aquatic food products. Production from capture fisheries at the global level is levelling off and most of the main fishing areas have reached their maximum potential. Sustaining fish supplies from capture fisheries will, therefore, not be able to meet the growing global demand for aquatic food.

At present, the aquaculture sector contributes a little over 40 million tonnes (excluding aquatic plants) to the world aquatic food production. According to recent FAO predictions, in order to maintain the current level of per capita consumption at the minimum, global aquaculture production should reach 80 million tonnes by 2050. Aquaculture has great potential to meet this increasing demand for aquatic food in most regions of the world. However, in order to achieve this, the sector (and aqua-farmers) will face significant challenges.

A major task ahead for sustainable aquaculture production will be to develop approaches that will increase the contribution of aquaculture to the global food supply. These approaches must be realistic and achievable within the context of current social, economic, environmental and political circumstances. Accurate and timely information on the aquaculture sector is essential in order to evaluate the efficacy of these approaches and how they can be improved.

Under the FAO Fisheries and Aquaculture Department's current work programme, the Aquaculture Management and Conservation Service (FIMA) of the Fisheries and Aquaculture Management Division, using a wide-ranging consultative process, regularly conducts reviews on the status and trends in aquaculture development (FAO Fisheries Circular No. 886 – Review of the State of World Aquaculture and FAO Fisheries Circular No. 942 – Review of the State of World Inland Fisheries). The last review (both regional and global) was conducted in 1999/2000 and was published following the Global Conference on Aquaculture in the Third Millennium held in Bangkok, Thailand, in 2000 (NACA/FAO, 2001, Aquaculture in the Third Millennium). These reviews are seen as important milestones and the documents produced are recognized as significant reference materials for planning, implementing and managing responsible and sustainable aquaculture development worldwide.

As part of this continuing process and with the current objective of preparing a global aquaculture development status and trends review, FIMA had embarked on a series of activities. These are:

- National Aquaculture Sector Overviews and National Aquaculture Legal Overviews in selected countries;
- Prospective Analysis of Future Aquaculture Development – PAFADs in selected countries;
- five regional workshops to discuss the status and trends in aquaculture development in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, and sub-Saharan Africa; and
- seven regional aquaculture development status and trends reviews in Asia and the Pacific, Central and Eastern Europe, Latin America and the Caribbean, Near East and North Africa, North America, sub-Saharan Africa and Western-European region.

This document presents the regional synthesis for the Western-European region. This review is based in part on data and information compiled and synthesized by the author. Preparatory work for the review of aquaculture in the Western European region was undertaken by FIMA in consultation with experts of the European Aquaculture Society (EAS), the Federation of European Aquaculture Producers (FEAP), and the CONSENSUS Project. In 2005, the CONSENSUS project facilitated the preparation of six thematic status and overview papers on most recent issues and trends in European aquaculture. These six papers are made available in this report in the attached CD ROM which has been contributed by the CONSENSUS Project.

ACKNOWLEDGEMENTS

Appreciation is extended to the author, K. Rana, Institute of Aquaculture (University of Stirling, United Kingdom of Great Britain and Northern Ireland). We are particularly grateful to the following experts for thorough review of draft materials including text, data and presentation, and for their substantial contributions and improvements they provided in the course of finalization of this document: P. Christofilogiannis (AQUARK, Athens), A. D'Andrea (FAO Legal Office), K. Fisher (Danish Institute for Fisheries Research), B. Guillaumie (European Mollusc Producers Association), C. Hough (Federation of European Aquaculture Producers), A. Lane (European Aquaculture Society), K. Maroni and J.A Grottum (FHL Aquaculture, Trondheim), L. Varadi (HAKI, Szarvas), J. Verreth and C. Martins (Wageningen University and Research). For their interest, constructive suggestions and helpful contributions we thank especially A. Lane (EAS/CONSENSUS project coordinator) and the CONSENSUS project. Reference is made in particular to the contribution of six CONSENSUS "Existing knowledge/position papers" which were prepared in 2005 by the following CONSENSUS Working Groups:

- Semi-static freshwater systems – Chaired by Laszlo Varadi, Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), Hungary.
- Flow-through freshwater systems – Chaired by Benoît Fauconneau, Institut national de la recherche agronomique (INRA), France.
- Recirculation systems – Chaired by Johan Verreth, Wageningen University and Research (WUR), The Netherlands.
- Inter-tidal marine systems – Chaired by Douglas McLeod, Association of Scottish Shellfish Growers (ASSG), United Kingdom.
- Coastal systems – Chaired by Rosa Flos, Technical University of Catalonia (UPC), Spain.
- Post-harvest operations, processing & traceability – Chaired by Erling Larsen, Danish Institute for Fisheries Research (DIFRES), Denmark.

The finalization of the document required extensive work on presentation, layout and proofreading as well as technical editing and review, which was carried out respectively by Rine Sola and Uwe Barg, both staff of FAO's Fisheries and Aquaculture Department.

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ABSTRACT

FAO regularly conducts global and regional reviews of aquaculture status and trends, most recently during 2005 and 2006. The present regional synthesis for Western-Europe provides an overview of major issues and trends in the aquaculture sector. Stagnating capture fisheries and soaring demand for seafood products in Europe have spurred the expansion of aquaculture in this region. In 2003 farmed finfish accounted for 62 percent in volume and 79 percent of value while farmed molluscs accounted for 38 percent and 21 percent of volume and value, respectively. The expansion between 1994 and 2003 was dominated by marine finfish production particularly of Atlantic salmon in Norway (71 percent), United Kingdom (19 percent) and Faeroe Islands (10 percent). Seabass and seabream farming in Greece, Turkey, Spain, Italy and France in 2003 accounted for 95 percent of production. The increased production and supply of fish was accompanied by falling farmgate prices triggering restructuring of the industry, as well as substantial increases in volume of the key finfish species. The review confirms features of a maturing aquaculture industry including specialization, increasing skills and professionalism, diversification of technology and products, efficient production, vertical integration and market development. The growing environmental and social awareness and recognition of consumer and food safety preferences by the industry and the public sector are contributing to good farm management and governance measures which are enabling effective efforts towards sustainable development and responsible practices in aquaculture.

CONTENTS

CD ROM – Links to "Existing knowledge/position papers" by CONSENSUS Working Groups

A CD ROM is attached inside the back cover of this document to provide readers with the "Existing knowledge/position papers" on European aquaculture which were prepared in 2005 by the below CONSENSUS Working Groups:

WG 1 SEMI-STATIC FRESHWATER SYSTEMS - Chaired by Laszlo Varadi, Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), Hungary.

- D:\resources\papers\WG1_Semi-staticSystems.pdf

WG 2 FLOW-THROUGH FRESHWATER SYSTEMS - Chaired by Benoît Fauconneau, Institut national de la recherche agronomique (INRA), France.

- D:\resources\papers\WG2_Flow-throughSystems.pdf

WG 3 RECIRCULATION SYSTEMS - Chaired by Johan Verreth, Wageningen University and Research (WUR), The Netherlands.

- D:\resources\papers\WG3_RecirculationSystems.pdf

WG 4 INTER-TIDAL MARINE SYSTEMS - Chaired by Douglas McLeod, Association of Scottish Shellfish Growers (ASSG), United Kingdom.

- D:\resources\papers\WG4_ShellfishProduction.pdf

WG 5 COASTAL SYSTEMS - Chaired by Rosa Flos, Technical University of Catalonia (UPC), Spain.

- D:\resources\papers\WG5_CoastalSystems.pdf

WG 6 POST-HARVEST OPERATIONS, PROCESSING & TRACEABILITY – Chaired by Erling Larsen, Danish Institute for Fisheries Research (DIFRES), Denmark

- D:\resources\papers\WG6_PostHarvestOperations.pdf

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ABBREVIATIONS AND ACRONYMS

AQUAFLOW	European Network for the dissemination of Aquaculture RTD information
BSE	Bovine spongiform encephalopathy (mad cow disease)
CBD	Convention on Biological Diversity
CFP	Common Fisheries Policy
CORDIS	Community Research and Development Information Service
EAS	European Aquaculture Society
EFF	European Fisheries Fund
EIA	Environmental Impact Assessment
EMPA	European Mollusc Producers Association
EU-25	European Union with 25 Member States, as of 2005
FCR	Food Conversion Ratio
FEAP	Federation of European Aquaculture Producers
FIFG	Financial Instrument for Fisheries Guidance
FTEs	Full Time Equivalents
GDP	Gross Domestic Product
IHN	Infectious Haematopoietic Necrosis
ISO-EN	International Organization for Standardization – EN (European) Standards
MASMANAP	Methodology for seafood market studies with the aim of introducing new aquaculture products
MRS	Multiple Retail Stores
PPS	Purchasing Power Standards
R&D	Research and Development
RAS	Recirculatory Aquaculture Systems
VHS	Viral Haemorrhagic Septicaemia
W-ER	Western-European region

The Western-European region (W-ER)

For this review the target countries in the Western-European region (W-ER)[1] were: Austria, Belgium, Channel Islands, Cyprus, Denmark, Faeroe Islands, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey and United Kingdom (UK).

1. CHARACTERISTICS AND STRUCTURE OF THE SECTOR

1.1 Introduction

The impetus for the successful and sustainable aquaculture in the W-ER is based on two key linked drivers. The historically and traditionally established use of finfish and shellfish as integral components of a healthy diet by coastal as well as inland populations and declining wild fish stocks and consequent reduction in capture fisheries activities in Europe.

A broad assessment of recent aquaculture output may be divided into three market or consumer segments:

(a) one that is driven by historic and traditional consumption of aquatic products such as shellfish;
(b) another by economic affluence promoting consumption of high image marine finfish such as salmonids, tuna, turbot, seabass and seabreams, and
(c) another which is that fish is a healthy product to consume, an approach that covers all fish products from capture fisheries and aquaculture.

The rise in consumption across the W-ER is also sustained by the consistency of supply of assured quality products demanded by well-established multiple retail stores, including increasingly supermarkets.

Across the W-ER these incentives and opportunities for development and investment continue to occur against a backdrop of rising population, overall growth of economies, expanding European trading blocks and changing structural reforms. The rate of growth of the aquaculture sector will therefore in part be influenced by demographic changes, the economic health of the individual target countries in the W-ER and national priorities afforded to its expansion. The European Union is in third place worldwide in terms of population, and although it is in a clear distance behind the highly populated countries of China and India, it is ahead of the United States of America, Brazil and Japan, and is a major consumer of aquatic products from the W-ER.

1.2 Regional demographic dynamics

The population in the countries of the W-ER has grown at an average of 0.21 percent from 381 million in 1994 to 390 million in 2003. This, together with the expansion of the European Union (EU-25), has increased the potential market to around 460 million people in 2003 with the W-ER accounting for over 80 percent of the population.

[1] Western-European region: herewith after referred to as W-ER to facilitate reading

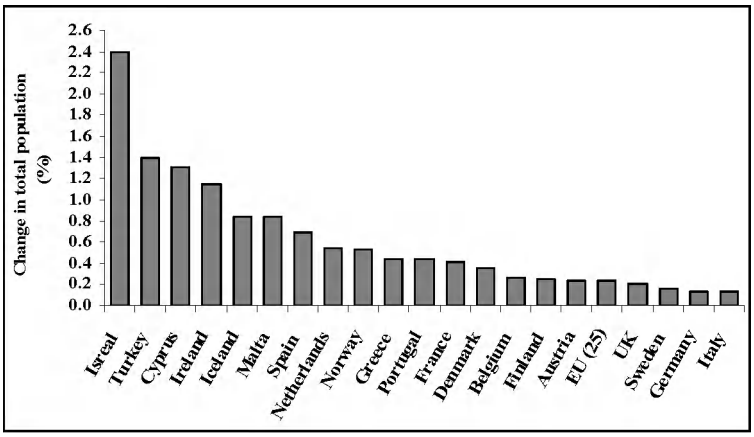

Figure 1. Rate of change in population in the W-ER, 1994-2003 (adapted from Eurostat, 2006)

In the last reporting decade (1994–2003) aquaculture has developed in the region where national populations were expanding albeit at heterogeneous rates (Figure 1). Using the EU-25 as a benchmark (0.3 percent/year) the rate of population increase in Israel was over 10 fold higher. This high rate, however, reflects Israel's unique migration pattern.

Of the 24 countries that make up the W-ER, Germany (82.5 million) has the most number of inhabitants and makes up more than 21 percent of the W-ER population, followed by France (60 million), UK (59.6 million) and Italy (57.6 million), with around 15 percent each. These four countries accounted for over two-thirds of the total number of inhabitants of the W-ER in 2003 and are likely to have a significant bearing on fish demand and consumption. In these countries however, total population has increased at a lower annual rate of 0.23, 0.4, 0.2 and 0.13 percent/year between 1994 and 2003, respectively, compared with countries such as Turkey (1.4 percent/year), Cyprus (1.3 percent/year) and Ireland (1.1 percent/year).

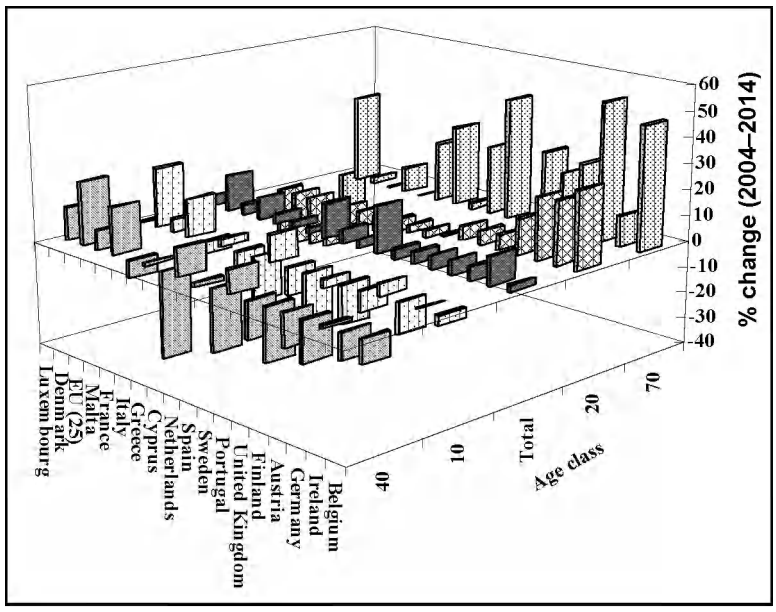

Figure 2. Predicted change in population structure in selected countries within the W-ER, 2004-2014 (adapted from Eurostat, 2006)

A striking feature of the population across the region is the decline in the proportion of young people and an increase in older age groups. The proportion of younger age groups is predicted to fall even further in the next decade (Figure 2). By 2014 the proportion of 20 year-old people in Luxembourg, Denmark and Malta are predicted to fall by around 18–21 percent whilst in UK, Cyprus, Sweden and Germany the age group of 10-year olds are likely to decrease by 15, 17, 26 and 12 percent, respectively. By contrast population of 60–70 year old people in countries such as Sweden, Belgium, Germany, UK and Cyprus will rise by as much as 47, 48, 57, 30 and 31 percent, respectively. This changing age structure could also influence consumer preference of aquatic products and product forms in the future which in turn may impact on the nature and direction of aquaculture development in W-ER. The capacity of aquaculture to be sustained and expanded in the region will also be influenced by current bullishness of economies and capacity of its inhabitants to consume farmed aquatic products.

1.3 Economic perspectives

The gross domestic product (GDP) of countries in the W-ER for 2003, based on current prices, was €10 283 billion (Eurostat, 2006).

Although the region achieved an actual GDP growth of 4.8 percent between 1994 and 2003, in 2003 it was considerably lower at 1.4 percent. The GDP, a measure of the strength of the economies, has increased in all countries in the W-ER at varying rates from a mean 20 percent/year for Ireland to just 2 percent/year for Germany between 1994 and 2003 (Figure 3).

The majority of countries in the W-ER grew at a higher rate than the EU-25 average of 4.8 percent. The GDP of countries such as Luxembourg, Norway Spain, Greece, UK, Iceland and Portugal increased by 8–9.5 percent/year (Figure 3). In 2002–2003, however, the growth of almost all national economies were sluggish and countries such as UK, Norway and Sweden decreased by 4, 2.6 and 2.7 percent, respectively.

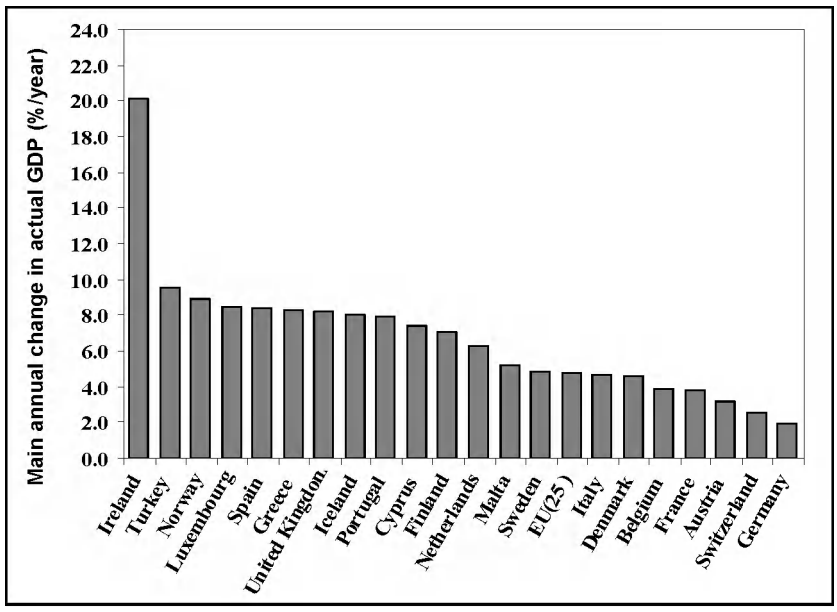

Figure 3. Relative strengths of economies as changes in GDP in selected countries in the W-ER, 1994–2003 (adapted from Eurostat, 2006)

It is more appropriate to consider GDP per capita for comparing national economies due to the heterogeneous circumstances in the countries with different price levels. Throughout the region the per capita GDP adjusted for purchasing power standards (PPS) had risen between 1994 and 2003 by 2–10 percent/year. In terms of GDP per capita (as PPS), Luxembourg took the leading position in 2003 with €47 400. Norway (€31 800), Ireland (€29 100), Switzerland (€28 300), the Netherlands (€27 100) and Austria (€26 300) follow as second to fifth, respectively. These countries are significantly ahead of Germany (€23 600) and clearly show a higher level of economic development based on the EU average (EU-25: €21 700: see Figure 4). Overall, all the nations in the region have increased their wealth. As the region is also the main market, the capacity

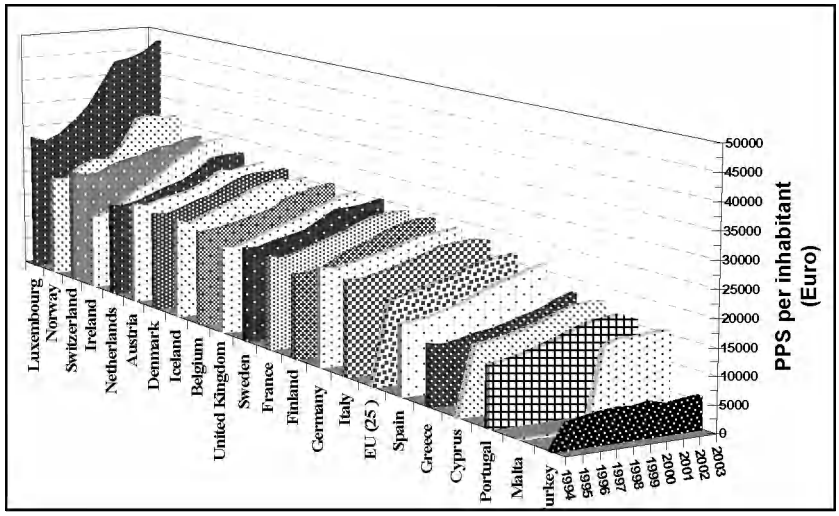

Figure 4. Temporal changes in net per capita (as PPS in €) disposable income in selected countries in the W-ER (adapted from Eurostat, 2006)

of its inhabitants to consume aquatic products will also be dictated by their disposable income and targeted marketing.

The disposable income in all the major countries in the region has increased in recent years (Figure 5). From the 24 countries in the region the UK, Austria, Germany, France and Belgium lead the way with the highest net disposable incomes in 2003 of €16 700, €15 400, €14 900 and €16 900, respectively. The fastest growing disposable incomes for 1994–2002 were recorded in France (5.8 percent/year), Netherlands (5.7 percent/year), Austria (5.6 percent/year) and Ireland (5.2 percent) whilst the slowest rise was in Denmark (2.7 percent/year) and Germany (2.9 percent/year).

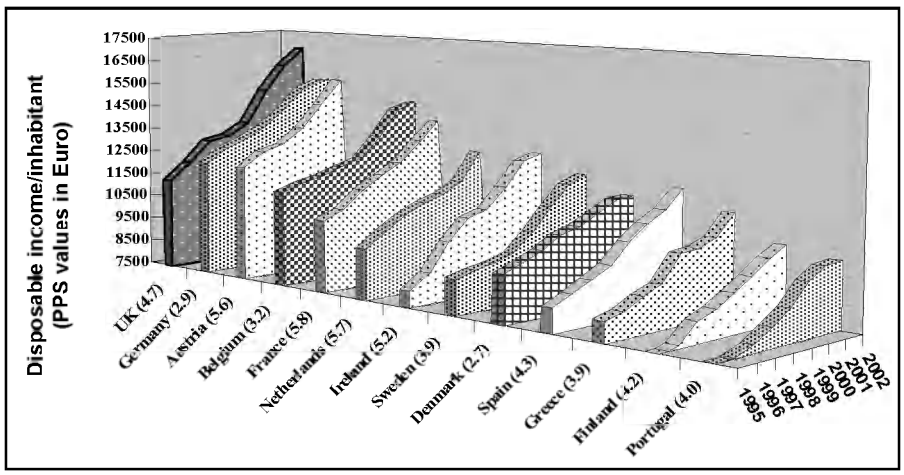

Figure 5. Recent trends in the buying power of inhabitants (PPS in €) in selected countries in the W-ER. (Values in parenthesis on X axis give mean rate of change-%/year, 1994-2002) (adapted from Eurostat, 2006)

1.1 History and background of aquaculture practice

The practice of fish rearing in both freshwater and marine environments in the W-ER dates back to biblical and Roman times. In the Etruscan culture (Italy) the earliest extensive marine farms date back to the sixth century BC. In Greece shellfish rearing was practised in the fifth century BC (Basurco and Lovatelli, 2003) and carp rearing in earthen ponds in Germany dates back to the eleventh century.

In recent times, aquaculture in the W-ER covers:

- family owned and operated units (mainly shellfish and freshwater fish farms);
- limited companies (mainly freshwater fish farms and small-medium size marine fish farms), and
- publicly-listed and multinational companies (mainly salmon, tout and seabass/seabream farming).

Prior to 1950 most aquacultural activities (85 percent) were undertaken in traditional intertidal coastal systems in the Mediterranean region producing shellfish and by 1950 around 145 000 tonnes of mussels were being produced in the region. Modern aquaculture practices since the 1950s brought about dramatic increases in production from both freshwater and marine culture environments in the W-ER (Figure 6A).

Such changes in the utilization of these environments for aquaculture in the W-ER have occurred in three main phases. An initial phase between 1950 and 1965 is characterized by the doubling of shellfish output and by the rapid transition of freshwater farming technologies from an experimental to commercial phase which saw freshwater production increase five-fold from 8 000 to nearly 40 000 tonnes. This emphasis on freshwater aquaculture development resulted in the doubling of its

contribution to total production from 5.5 to 12 percent. During the same period output from the marine environment declined from 95 to 87 percent (Figure 6B). The second phase between 1965 and 1990–1992 was characterized by a continued but marked expansion in freshwater culture during which output increased to its maximum of 100 000 tonnes or 20–22 percent. This increase was almost entirely due to emphasis on trout production predominantly in France, Italy, Spain, Denmark, Germany and UK. These increases also resulted in the continued fall of proportional production from marine environment to 70 percent. The third phase was dominated by rapid expansion in marine finfish culture in northern Europe, in particular around 600 000 tonnes of Atlantic salmon, mainly in Norway and UK and 105 000 tonnes of seabass and seabream in southern Europe notably in Greece, Italy, Spain and France. This dramatic rise also increased the contribution of mariculture from 70 percent in 1990 to 86 percent in 2003 at the expense of freshwater production (Figure 6).

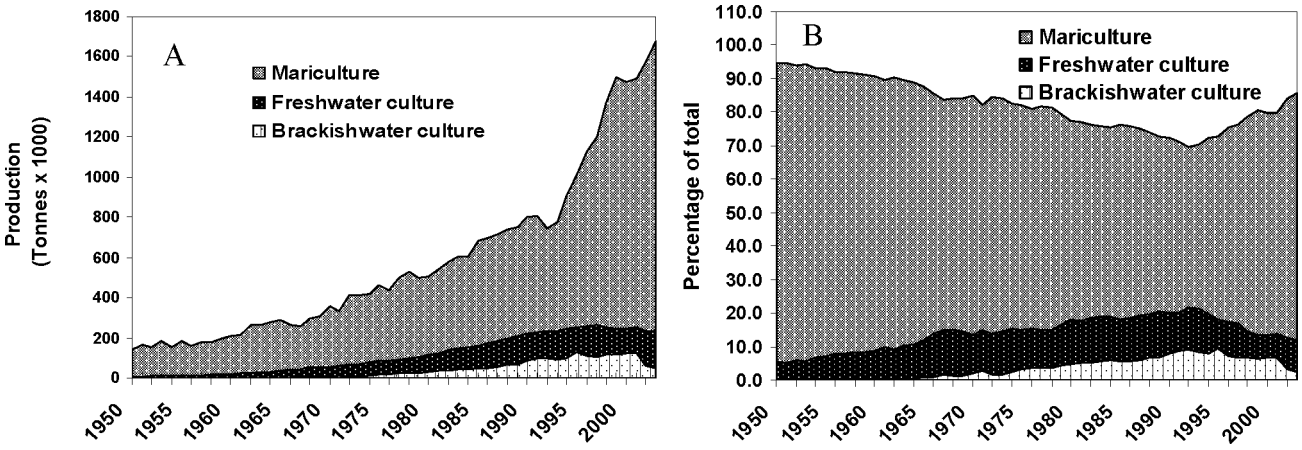

Figure 6. Evolution in the use of culture environments expressed as (A) total production and (B) percentage change since 1950 (data adapted from FAO FISHSTAT Plus, 2005)

The major production systems in these three environment types have also evolved with the changing demands placed on aquaculture in the region. This evolution in system types has progressed from extensive intertidal systems in Greece, Spain, Italy and France, through to land based semi-static systems using earthen ponds and closed recirculating systems, and cages in coastal offshore systems. Such recent developments and key dynamics of aquaculture practice in the W-ER are presented in Table 1 by milestones and in Table 2 by species groups.

Two major species groups, the salmonids and molluscs, continue to dominate aquaculture development in the region. Atlantic salmon accounted 35 and 37 percent of the production and value, respectively in 2003, while the rainbow trout represented 14 and 16 percent. Mussels, which are lower-valued, accounted for 30 percent of regional production. Although the cupped oyster and clam are exotic species, they like rainbow trout are well established in the region and together in 2003 accounted for 11 and 7 percent of quantity and value, respectively. Although collectively seabass and seabream accounted for only 6 percent of production they represented 16.5 percent of regional value. There is also evidence in the region of producers responding to market intelligence and producers are diversifying through production of new farmed candidates (Table 2). These include Atlantic cod and Arctic char in northern Europe and turbot, sturgeons, tuna and prawns in southern Europe. Although tilapia production is not new in Israel and Belgium its introduction in Spain is new. Other exotic introductions such as the African catfish into the Netherlands and Belgium for intensive culture in recirculation aquaculture systems (RAS) have also seen their production double in five years (Table 2).

Table 1. Major aquaculture developments in selected countries in the W-ER giving key historical aquaculture landmarks and milestones

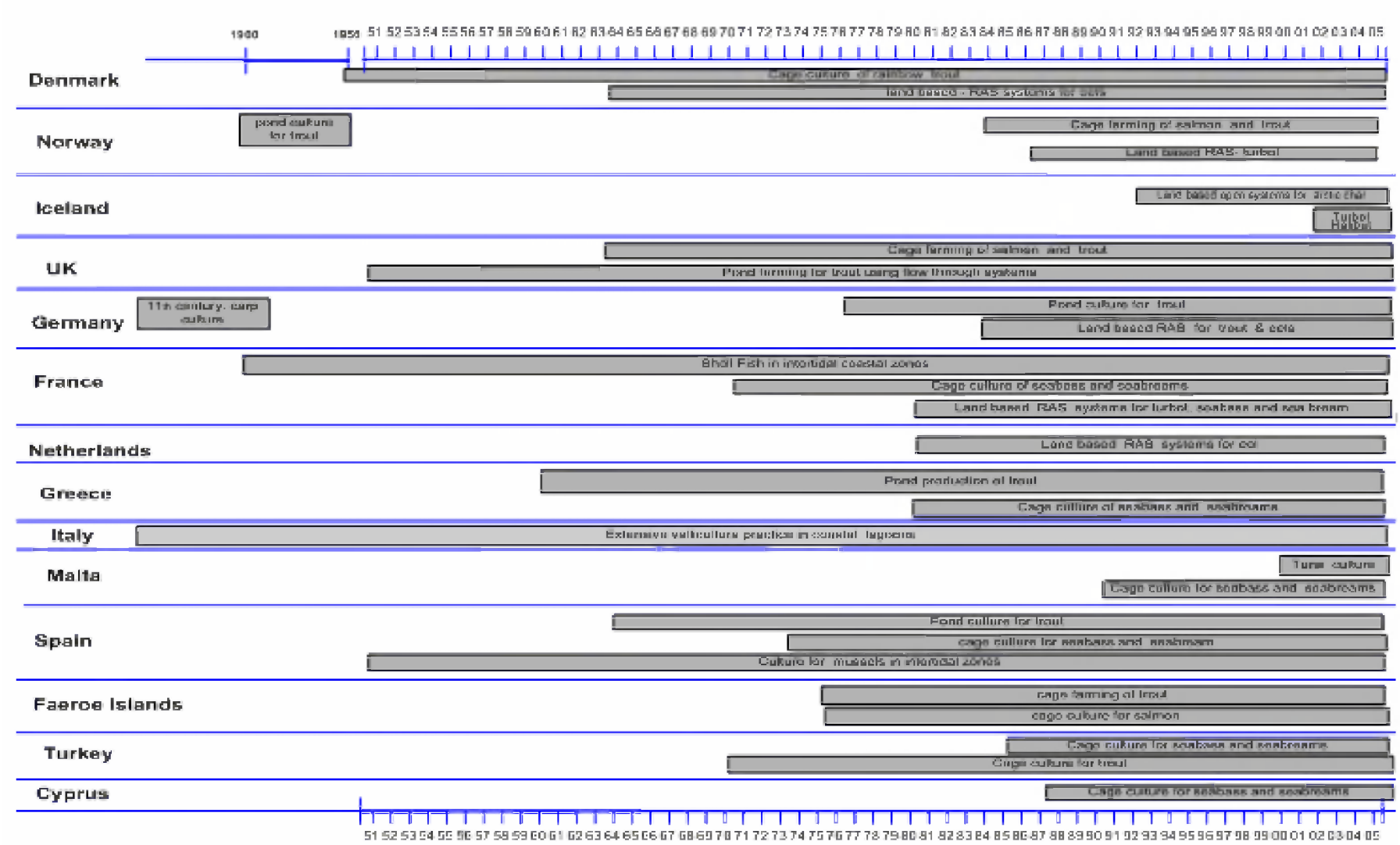

Table 2. Production and structural characteristic matrix of major groups of species farmed in the W-ER (data from FAO FISHSTAT Plus, 2005)

Species groups: key species (tonnes in 2003)	Major centres of production (tonnes in 2003)	System for production	Method of production	Total production of group (tonnes)		Significance in 2003 (% total)		Major markets for products	Major issues for further development	Drivers
				1999	2003	Quantity	Value			
FINFISH			**FINFISH**						**FINFISH**	
Salmon *Salmo salar*	Norway (507 000) Scotland (146 000) Faeroe Is (56 000)	Coastal in shore and off shore systems	Cages	612 000	730 000	35.4	37	France, Sweden Denmark and, Russia and far east	(i) Bio security (ii) Environmental sustainability (iii) Fish welfare (iv) Waste disposal (v) Genetic interactions of wild stocks (vi) Conflict with tourism (vii) Poor media coverage	Established & expanding markets
Rainbow trout *Oncorhynchus mykiss*	Norway (69 000) France (39 000) Italy (38 000) Spain (33 000) Denmark (30 000) Germany (23 000) UK (15 000)	Flow through and coastal near shore system	Earthen ponds, raceways, tanks and cages	275 000	282 000	13.6	16	Mainly home markets but export made to Germany and some other minor national markets	(i) Regulations and discharge (ii) Supply of water (iii) Fish welfare (iv) Rising costs (v) Waste disposal	(i) Regular and traditional demand in mass and niche local& export market (ii) Good valorization potential (iii) Best management practices
Seabass *Dicentrarchus labrax*	Greece (25 000) Spain (10 000) Italy (4 000) France (4 000)	Coastal in shore systems	Mainly Cages but some onshore units s	49 000	66 000	2.2	8.0	Italy France and Spain	(i) Declining prices (ii Limited supply of quality seed (iii) Competition for sites (iv) Fish welfare	(i) National and EU Investment incentives (ii) Buoyant export markets (iii) Market expansion
Gilthead seabream *Sparus aurata*	Greece (38 000) Spain (13 000) Italy (9 000)	Coastal in shore systems	Mainly Cages but some onshore units	63 000	84 000	4.1	8.5	Italy France and Spain		
Common Carp *Cyprinus carpio*	Germany (16 000) France (4 700) Italy (700)	Semi static systems	Ponds/lakes	23 000	26 000	1.5	1.5	Often local but also to Germany, Austria, eastern & central Europe	(i) Rapidly rising production costs threatening economic viability (ii) Lower value species (iii) Shift in consumer preferences	Traditional established market
Eel *Anguilla anguilla*	Netherlands (4 200) Denmark (2 000) Italy (1 600)	RAS[1] except in southern Europe	Tanks and raceways RAS in north	10 438	8 814	0.4	1.4	Netherlands Germany and Italy	(i) Declining supplies of wild glass eels (exported to Asia) (ii) Stable but small market (iii) Rising glass-eel, production and feeding costs (iv) Fish welfare (v) Cheap imports from Asia	Use of RAS and therefore non–dependence on environmental regulations due to RAS

Species groups: key species (tonnes in 2003)	Major centres of production (tonnes in 2003)	System for production	Method of production	Total production of group (tonnes)		Significance in 2003 (% total)		Major markets for products	Major issues for further development	Drivers
				1999	2003	Quantity	Value			
SHELLFISH				**SHELLFISH**					**SHELLFISH**	
Mussels *Mytilus edulis* (450 000) *Mytilus galloprovincialis* (145 000)	Spain (250 000) Italy (100 000) France (68 000) Ireland (39 000) British Is (19 200) Netherlands (56 000) Germany (29 000) Greece (32 000)	Intertidal systems	bottom extensive culture, suspended culture and bouchot culture	604 000	606 000	28.9	7.0	Italy, France, Spain and Netherlands	Negative impact of external factors - microbiological loading, Industrial pollutants, harmful algal blooms (ii) Further development: ▪ Available sites ▪ Water quality ▪ Food safety ▪ Disease/pests ▪ New markets (iii) Food safety	(i) Low inputs. (ii) Well established historic and traditional markets. (iii) Historic economic importance - Rural employment, public health (iv) Offset job losses from capture fisheries
Oysters *Crassostrea gigas* (123 000) *Ostrea edulis* (5 000)	France (117 000) Ireland (5 000) Netherlands (3 000) Spain (3 000) British Is (1 200)	Intertidal systems	mesh trays or bags	156 000	131 000	8.0	6.3	France and Spain		
Clam *Ruditapes philippinarum* (27 000)	Italy (25 000) Spain (1 500) France (750) Ireland (150)	Intertidal systems	Beds	52 000	28 000	3.0	0.7	Italy		
NEW FARMING CANDIDATES				**NEW FARMING CANDIDATES**					**NEW FARMING CANDIDATES**	
Tilapias nei *Oreochromis* spp.	Israel (l6 800) Belgium (200E) Spain (127)	RAS[1/], semi-static systems	Tanks, ponds	6 650	7 400	0.4		Israel, Belgium, UK, France, Belgium, Germany, Netherlands	(i) Cost of production, marketing (ii) Valorization of products (iii) Competition from catfish	(i) Shortage of whitefish in Europe (ii) Increased awareness of fish by consumers
Turbot *Psetta maxima* (5 300)	Spain (3 800) France (900) Portugal (310)	RAS[1]	Tanks	4 100	5 300	0.4	0.85	France, Spain and Italy	Niche markets	Established niche and national markets– popular high quality product
Catfish *Clarias gariepinus* (3 600)	Netherlands (3 200) Belgium (200E)	RAS[1]	Tanks	1 750	3 590	0.2	0.07	Germany, Italy, Netherlands and UK	(i) Limited and under-developed market (ii) Low prices (iii) Fish welfare	(i) High productivity (ii) Low production costs (iii) Reasonable market acceptance (iv) Rising national market
Atlantic cod *Gadus morhua* (2 600)	Norway (2 180) Iceland (380) UK (50)	Coastal in shore systems	Cages	157	2 600	0.1	0.05	Norway, UK	(i) Quality supply of fingerling (ii) Production systems and technology	(i) Decline in wild catches (ii) Well known and appreciated product (iii) Economical production costs (iv) Diversification (v) Market acceptability
Arctic char (1700) *Salvelinus alpinus*		Coastal in shore and onshore systems	Cages	1 000	1 670	0.08	0.12	Iceland, Finland, Norway and Sweden	Niche markets and value adding	Domestic niche markets

Species groups: key species (tonnes in 2003)	Major centres of production (tonnes in 2003)	System for production	Method of production	Total production of group (tonnes)		Significance in 2003 (% total)		Major markets for products	Major issues for further development	Drivers
				1999	2003	Quantity	Value			
Sturgeons (1 340) *Acipenseridae*	Italy (1 000) Spain (225) France (115)	Semi static systems	Ponds/tanks	550	1 250	0.07	0.16	France, Italy	Market acceptability of meat and caviar	Declining wild stocks for caviar
Prawns: Kuruma (85) Indian white (80)	France (40) Spain (21) Italy (8)	RAS[1]	Tanks	125	160	0.08	0.07	Japan	Insignificant production levels Competition from non EU regions	Highly priced products
Koi (value in US$ million)	Israel	Semi static systems	ponds		4			UK, France, Germany, Spain	Bio security issues KHV	Good market, need to diversify markets & farming

[1]RAS = recirculating aquaculture systems

2. PRODUCTION, SPECIES AND VALUES OF MAJOR SPECIES

2.1 Contribution of regional aquaculture production to global production

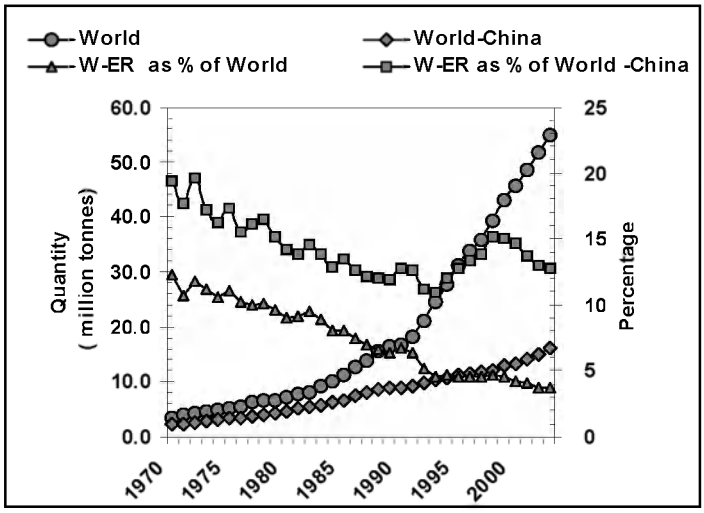

Figure 7. Temporal changes in the significance of regional aquaculture to global output since 1970 (adapted from FAO FISHSTAT Plus, 2005)

Aquaculture within the W-ER has grown by 8 percent in absolute terms; however its contribution to world aquaculture production has declined due to the higher rate of growth in the Asian region. In the 1970s aquaculture from the W-ER accounted for 12 percent of world production and since then its global share has declined to 4 percent in 2003 (Figure 7). However, when aquaculture production in China is excluded (World minus China, in Figure 7), the region's significance shows the same negative trend but its contribution is considerably higher. In fact it has declined from 19 percent in 1970 to 13 percent in 2003 (Figure 7). The trend in contribution of the total value (US$) produced by the region to total value of global aquaculture production was also similar and by 2003 the region accounted for 7 percent of global value. Excluding China's production increased the region's contribution to 16 percent.

2.2 Contribution of aquaculture to regional fish production

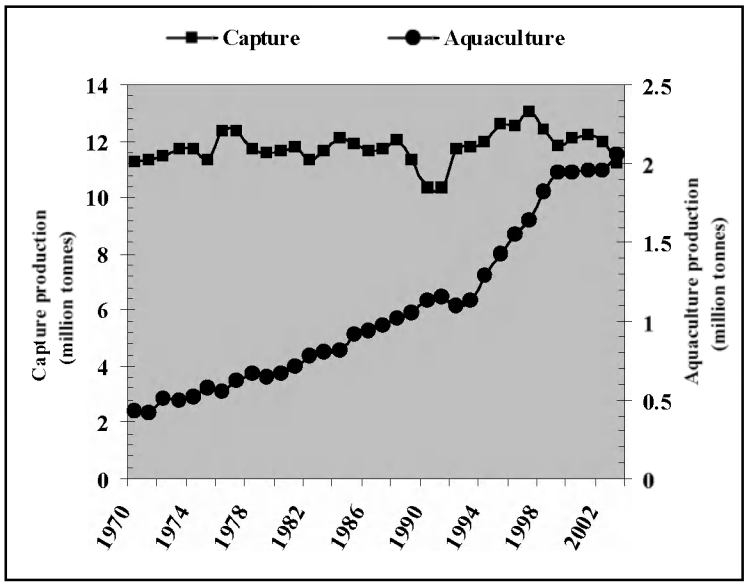

Figure 8. Contribution of aquaculture and capture fisheries in the W-ER to fisheries output since 1970 (adapted from FAO FISHSTAT Plus, 2005)

Since the 1970s aquaculture production has continued to make an increasing contribution to the fisheries sector in the W-ER when compared to capture fisheries production which has been stagnant (Figure 8). This rapid increase in contribution resulted in aquaculture increasing its share of fisheries output nearly four fold from 4 percent in 1970 to 16 percent in 2003. Given the population rise in the region and stagnation of capture fisheries the increase in per capita fish supply can be attributed to a combination of aquaculture production and increased imports. The per capita fish supply for the region has risen from 22 kg in 1984 to 31 kg in 2001, representing an increase of 34 percent (Eurostat, 2006).

The relative changes within the fisheries sector in the region, however, were not uniform (Figure 9). For example, between 1994 and 2003 in the Faeroe Islands capture fisheries expanded by an annual average of 16 percent whilst the Cypriot and Maltese capture fisheries production declined by 11 and 5 percent/year, respectively (Figure 9). In sharp contrast to capture fisheries, aquaculture output from countries such as Faeroe and Channel Islands, Turkey and Cyprus which had a small production base increased respectively by 25, 74, 54 and 60 percent/year.

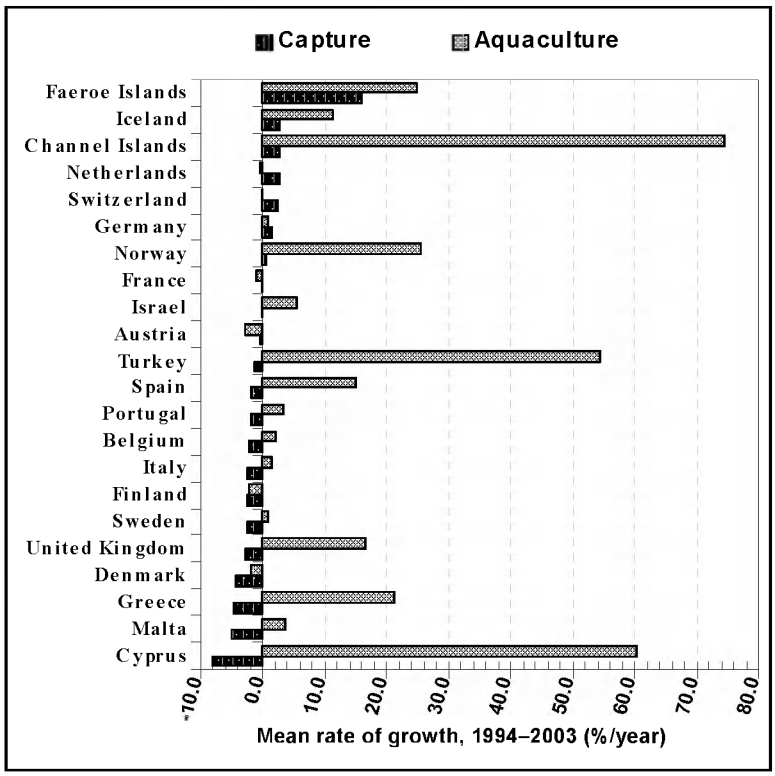

Figure 9. Relative growth rate of aquaculture and capture fisheries production in the W-ER, 1994-2003 (adapted from FAO FISHSTAT Plus, 2005)

Unlike capture fisheries which showed near zero growth the total aquaculture production in the last two decades in this region has increased since 1984 by 8 percent/year and 15 percent/year in volume and value, respectively, to reach 2.1 million tonnes and US$4.9 billion in 2003 (Figure 10). The continual increase in production was interrupted in the late-1980s to mid-1990s by several different events. There was a sharp decline in blue mussel production due to increasing occurrence of red tides and market saturation; salmonid (salmon and trout) production had continued to increase while seabass and seabream were emerging in the Mediterranean. In global terms production from the W-ER in 2003 represented a modest 4 and 7 percent/year increase in volume and value, respectively, when compared with global increases of 23 and 24 percent/year in the same period. If aquaculture production in China is excluded, however, the regional share for quantity and value is higher at 6 percent and 16 percent, respectively; compared with global (minus production in China) rises of 8 and 16 percent, respectively.

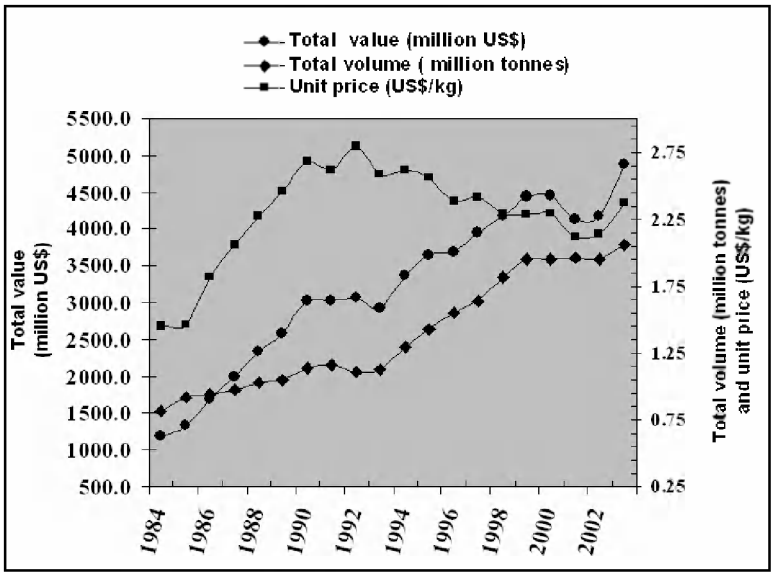

Figure 10. Temporal changes in value, quantity and unit value of aquaculture production in the W-ER (adaped from FAO FISHSTAT Plus, 2005)

During the period 1984–2002 the average unit value of aquaculture products in the region rose from US$1.45/kg to its maximum of US$2.75/kg in 1990 reflecting the contribution of the higher market

prices of salmon, seabass and seabream. The average value dropped to US$2.25/kg by 2003, reflecting the market difficulties encountered by all sectors at that time (Figure 10).

The historical use of aquatic environments for aquaculture production was presented in Figure 6 above. Typically much of the aquaculture production comes from marine environment and in 2003 this accounted for 86 percent of volume (1.7 million tonnes) and 80 percent of value (US$3.6 billion). The total value of production from the marine environment grew at a remarkable mean annual rate of 47 percent since 1994 compared with 17 percent and 6 percent from brackish and freshwater, respectively. Most of the expansion in the marine environment was attributable to Atlantic salmon, blue Mediterranean mussel, rainbow trout, seabass and seabream. The production of these and other species in the region was heterogeneous with two main regional centres of development in the W-ER *viz.* northern and southern Europe.

Although all but one (Luxembourg) of the 24 countries in the region have reported production data to FAO in 2003 well over 90 percent of production originates from the top ten countries listed in Table 3. Norway leads the region, accounting for 28 percent of production by volume and value. Although Spain is ranked second in production, its ranking in value slips to sixth place due to lower values of mussels compared with finfishes. The achievements in the region in 2003 mask the efforts made by countries, especially those with a lower production base (Figure 11a and b), to expand aquaculture in recent years.

Table 3. Quantity and value of aquaculture production in top ten countries in the W-ER in 2003 (adapted from FAO FISHSTAT Plus, 2005)

	Quantity		Value	
	Tonnes	**% of total in 2003**	**US$ (million)**	**% of total in 2003**
Norway	582 016	28.3	1 338.8	27.5
Spain	313 288	15.2	361.5	7.4
France	245 846	11.9	595.2	12.2
Italy	191 662	9.3	519.4	10.7
United Kingdom	181 837	8.8	517.4	10.6
Greece	101 209	4.9	357.5	7.3
Turkey	79 943	3.9	278.6	5.7
Germany	74 280	3.6	161.4	3.3
Netherlands	67 025	3.3	123.5	2.5
Faeroe Islands	65 517	3.2	187.8	3.9
Others	157 005	7.6	196.8	8.9
Total	**2 059 628**		**4 875.3**	

Amongst the top producing countries, Norway by far has had the greatest impact on aquaculture development in the region. This success was predominately attributable to increases in production and productivity of Atlantic salmon in the 1990s and driven by significant improvements in feed and improved technologies and farm management, genetic selection and biosecurity (Aslesen, 2004). Strong growth was also exhibited by Greece (21 percent/year), UK (16 percent/year) and Spain (15 percent/year).

FAO statistics (FAO FISHSTAT Plus, 2005) report seabass and seabream production at 64 700 tonnes in 2002 whilst estimates from other sources suggest that as much as 103 000 tonnes were potentially produced in Greece in 2003 (Stirling Aquaculture, 2004). The expansion of seabass and seabream could be attributed to a significant increase in the number of farms entering the activity from around 100 in 1990 to around 269 in 2000. This increase was facilitated by major EU grant funding, adoption of the cage-farming technologies from the salmon industry, the increasing market demands for these

species and favourable environmental conditions offered by Greece's climate and extensive shoreline. The expansion ceased in 2003 and a consolidation period was evident until 2005 due to a significant market crisis that lead to the closure of farms and companies as well as significant integration through mergers and acquisitions effected by the large groups (Christofilogiannis, 2005). In 2002 the number of companies actively engaged in aquaculture has dropped to 169.

Aquaculture development in France has been stagnant since the 1980s (Figure 11a) and declined by 1 percent/year between 1994 and 2003. French aquaculture is dominated by the Pacific cupped oyster (*Crassostrea gigas)* which has limited potential for growth and is at high risk from detrimental changes in water quality and climate change. Perhaps more importantly the competitive uses of coastal resources for fishing activities, recreation, tourism and nature conservation provide strong opposition to long-term aquaculture development (Lacroix, 2005). In Spain the recovery of mussel farming from severe red tides in the early 1990s had spurred growth in mussel output from 91 000 tonnes in 1991 to 250 000 tonnes in 2003 (Stirling Aquaculture, 2004).

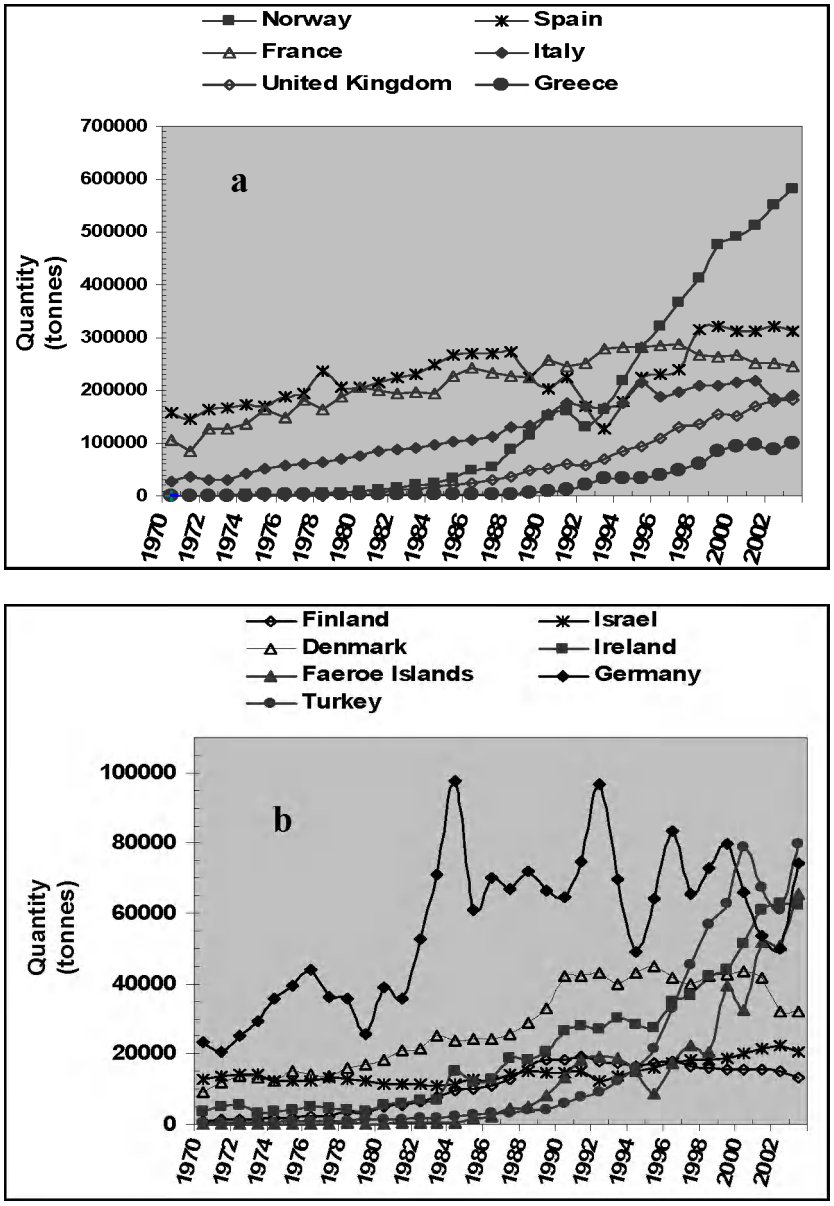

Figure 11. Evolution of aquaculture production in (a) Major and (b) Minor contributing countries in the W-ER (adapted from FAO FISHSTAT Plus, 2005)

Amongst the smaller producing countries, a few have begun to emerge as significant players in regional aquaculture (Figure 11b). The Faeroe Islands recognized the unsaturated markets for Atlantic salmon and increased its production by 25 percent/year since 1994 from 15 000 tonnes to 66 000 in 2003. Fish farming provides virtually the only alternative to wild fisheries as a major activity. The continued expansion, however, may be in doubt due to poor quality of currently available smolts and lack of venture capital (Reyni, in preparation). In the south, aquaculture production in Turkey has expanded at a phenomenal rate of 75 percent/year since 1994 increasing from 16 000 tonnes to 70 000 tonnes by 2003. This increase was largely due to the expansion of freshwater trout production from 7 000 tonnes in 1994 to 35 000 tonnes from around 1 300 farms in 2002 and seabream and seabass from 8 000 to 31 000 tonnes from 219 farms in the same period (OECD, 2003).

2.3 Production of major species

European aquaculture is diverse; in 2003 the production data of over 75 species were reported to FAO. Of these, the production of 30 species exceeded 1 000 tonnes and of these the top ten species accounted for over 90 percent of production (Table 4). The contribution of these major species to the growth and development of aquaculture in the region, however, has not been uniform and has varied between species and with time. The rates of production growth between the decades given in Table 5 illustrate the main phases of increase of production for the various species since the 1970s. The highest rate of growth for Atlantic salmon (373 percent/year) in the region was attained from 1980 to 1990 but slowed considerably since 2000 to 6 percent/year (Table 5). The rapid expansion phase for seabass and seabream followed salmon between 1990 and 2000.

Table 4. Expansion in production of top ten species cultured in the W-ER (adapted from FAO FISHSTAT Plus, 2005)

	Volume		Value	
	Tonnes (x 1 000)	Mean rate of growth in 1994–2003 (%/year)	US$ (million)	Mean rate of growth in 1994–2003 (%/year)
Atlantic salmon	730.02	16.1	1 825.40	4.7
Blue mussel	450.32	4.0	338.12	8.0
Rainbow trout	281.06	1.7	777.91	0.5
Mediterranean mussel	145.34	4.6	109.27	5.7
Pacific cupped oyster	122.54	-2.1	304.55	-0.5
Gilthead seabream	84.02	38.2	413.79	17.2
Gilhead seabass	65.85	36.9	273.37	14.6
Trouts nei	40.87	48.6	100.13	15.9
Common carp	30.10	1.5	70.85	2.3
Japanese carpet shell	27.41	-3.2	145.48	4.6
Others	82.10	3.1	348.84	3.0

Table 5. Heterogeneity in growth of key species/groups produced in the region since 1970 (adapted from FAO FISHSTAT Plus, 2005)

Major species/group	Mean annual rate of increase in production (%/year) between				
	1970–1980	1980–1990	1990–2000	2000–2003	1994–2003
Atlantic salmon	169.0	373.0	20.3	5.8	16.1
Gilthead seabream	247.0	157.3	168.4	2.4	38.2
Seabass	171.4	255.5	160.5	3.0	36.9
Mediterranean mussel	21.2	9.6	2.2	5.2	4.6
Pacific cupped oyster	15.1	3.8	-0.2	-4.3	-2.1
Rainbow trout	13.5	10.3	3.3	0.8	1.8
Blue mussel	2.6	0.3	2.1	1.0	4.5
Sector	5.4	6.9	7.3	1.5	6.7

Although aquaculture production has expanded by 7 percent/year between 1994 and 2003, its growth slowed to 1.5 percent/year from 2000 to 2003.

The most important species groups farmed in the W-ER in 2003 were finfishes accounting for 62 percent in volume and 79 percent of value while molluscs accounted for 38 percent and 21 percent of volume and value, respectively. In marked contrast to finfish, mollusc output was almost stagnant. The trends in the contribution of the major species annual share to aquaculture production are shown in Table 6.

Table 6. Temporal changes in the relative importance (as percent of annual quantity) of key cultured aquatic species in the W-ER (adapted from FAO FISHSTAT Plus, 2005)

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Atlantic salmon	28.8	24.3	26.2	28.2	27.4	30.5	31.1	32.2	33.6	34.4
Blue mussel	31.0	23.6	24.9	23.1	26.0	23.9	21.9	20.4	21.1	21.2
Trout	23.8	17.5	16.9	16.7	15.5	14.0	14.0	15.6	15.4	13.5
Mediterranean mussel	9.9	7.5	6.5	6.3	6.3	6.2	6.3	6.8	6.3	6.8
Pacific cupped oyster	14.5	10.1	9.8	9.1	7.7	7.3	7.0	5.7	6.0	5.8
Gilthead seabream	1.8	1.5	1.9	2.3	2.7	3.2	3.8	3.9	3.7	4.0
Seabass	1.5	1.4	1.5	1.8	2.0	2.5	2.9	2.8	2.7	3.1
Common carp	2.5	1.9	1.7	1.7	1.4	1.3	1.2	1.2	1.3	1.4
Japanese carpet shell	3.9	4.1	2.5	2.4	2.7	2.6	2.8	2.8	2.1	1.3
European eel	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4

Salmon and trout

Salmon and trout accounted for 51 percent of aquaculture production in volume and 55 percent of value in the W-ER in 2003. This reflects a notable change since 1994 when this group accounted for 42 percent of volume and 60 percent of value indicating a decline in unit price of salmon and trout over this period. Unit prices for salmon and trout fell by 43 and 20 percent since 1994 from US$4.15 and US$3.13 to US$2.40 and US$2.50/kg, respectively in 2003.

Salmon

Despite this sharp fall in prices the Atlantic salmon was by far the most important species farmed in the W-ER and the only major species that contributed a significant increase in production to the region. Salmon output increased at a rate of 15 percent/year since 1994 reaching 703 000 tonnes in 2003, valued at US$1.82 billion. By 2003 it accounted for 35 percent of aquaculture output, an increase in 6 percentage points since 1994 (Table 6). These production gains were achieved primarily through technological improvements, especially feed management, use of vaccines, improved performance of selected species strains, automation, higher productivity as well as improved site selection. In the UK the number of fish vaccinated increased from 25 to 42 million in 10 years. Such measures in Norway have reduced overall losses through diseases from 8.3 percent in 1998 to 4.9 percent in 2002. It is important to note that the structure of this sector changed considerably. Corporate consolidation and the increased vertical integration of aquaculture companies (i.e. feed and production companies) have become evident, especially in Scotland and Norway.

Trout

Although the output of trout in absolute terms showed a modest increase of three percent between 1994 and 2003, its overall share of annual production in the same period declined from 24 to 14 percent (Table 6). The main production base remains table-sized fish from freshwater installations (ponds, raceways, tanks). This segment showed a decline in production from 200 000 to 180 000 tonnes between 1994 and 2003 in favour of production in sea cages. In 1994, 84 percent of production originated from freshwater and only 10 percent from marine waters. By 2003 production

from freshwater dropped to 65 percent while that from marine waters increased nearly four fold from 25 000 to 89 000 tonnes, especially in Norway, Denmark, Sweden and Finland. Much of this shift was due to production of larger rainbow trout (>1 kg) which is preferred for the smoking and filleting markets, and also provides eggs for the roe market. This shift was also encouraged by the establishment of feed quota for salmon production, a system used to stem uncontrolled production growth.

Seabass and seabream

The European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) are the major seabass and seabream species farmed in the W-ER, with the production centred in the Mediterranean. Over 80 percent of all seabass and seabream production are grown in sea cages moored near to the seashore in depths less than 40 m. In Greece alone there are 377 cage sites capable of producing over 100 000 tonnes (virtually all of national production) and in Turkey there are 219 registered sites producing 47 000 tonnes annually in cages (97 percent of national production) (FAO FISHSTAT Plus, 2005; Stirling Aquaculture, 2004).

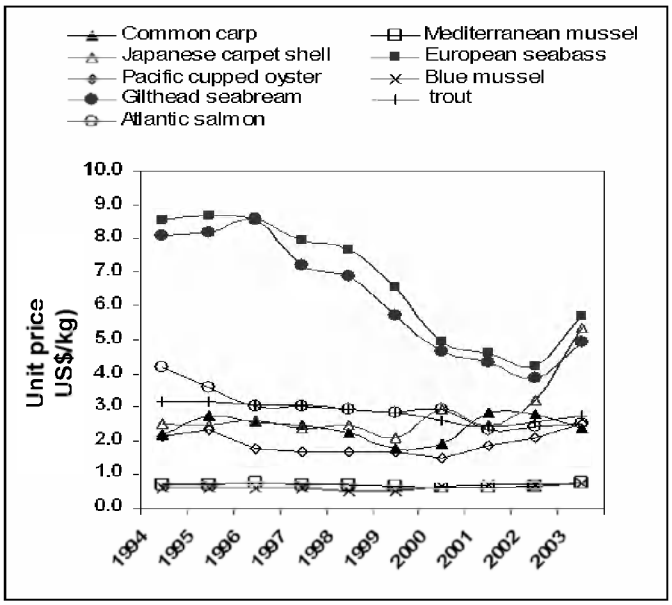

Figure 12. Chronological changes in unit prices of major farmed finfish and shellfish species in the W-ER (adapted from FAO FISHSTAT Plus, 2005)

The species are farmed semi intensively to intensively in cages (up to 20–25 kg/m^3) and most farms produce both species. The seabass and seabream have a lower production than the salmonids (7 percent of regional output in 2003) but are still relatively higher valued species. Between 1994 and 2003 seabass and seabream production increased by 38 and 37 percent/year in volume, respectively and 17 and 15 percent/year in value (Table 4). This sector had developed rapidly but then faltered against an environment of rapidly falling prices although a small recovery in prices occurred since 2001 (Figure 12). Between 1994 and 2003 the unit price of seabass and seabream was basically halved from around US$8.00/kg in 1994 to US$4.00/kg in 2001 (Figure 12).

Carps

Carps were the second most important freshwater finfish species after rainbow trout and much of the 30 000 tonnes valued at US$71 million in 2003. Production originated from pond based farming in Israel and Germany. At the regional level its importance has decreased mainly due to changes in consumer preferences and eating habits. Since 1994 its contribution to annual share has declined from 2.5 percent to 1.4 percent (Table 6).

Molluscs

In contrast to major finfish species, even though the absolute production of mussels increased, its relative contribution to annual production continued to decline from 31 percent in 1994 to 21 percent in 2003 (Table 6). Two main species dominated production; the blue mussel (*Mytilus edulis)* and Mediterranean mussel (*Mytilus galloprovincialis)*, which between them accounted for 600 000 tonnes

of production in 2003. Mussels are farmed extensively using three main methods; spat are attached to either poles or "bouchots" staked to the sea bed for around 15 months. Alternatively spat may be attached to ropes or placed in bags and suspended in water or spread on specially prepared sea beds.

Oysters

Although two native species of oysters (*Ostrea edulis)*, the European flat oyster and the Portuguese cupped oyster (*Crassostrea angulata*) are available, the bulk of reported production is exotic Pacific cupped oyster (*C. gigas*), which comes from the Pacific Ocean. The development of oyster farming was at its optimum between 1970 and 1980 when production grew at 14 percent/year followed by a sharp decline in growth rate (Table 5). Thereafter the growth of the sector was in continual decline. Since 1994 the production of the Pacific cupped oyster declined from 150 000 tonnes (valued at US$322 million) to 123 000 tonnes (valued at US$305 million) in 2003. This decrease was accompanied by a drop in unit price from US$2.15/kg in 1994 to US$1.50 in 2000. The price has shown some gain since then and by 2003 reached US$2.50 (Figure 12).

Oyster-growing techniques in the region had been modified to generate new higher priced markets. Top quality oysters may undergo the process of "affinage", where feeding on blue algae (*Navicula* sp.) gives a green tinge to the oyster, which is duly called a "fine de claire". Cultivation is usually a three-year process that starts with the collection of small oysters on a support from which they can be easily removed after six to eight months. During the second year of culture, oysters are spread out in the intertidal range, either directly on the ground (bottom culture), or in bags on trestles, or suspended (McLeod *et al.*, 2006).

3. ECONOMICS AND TRADE

3.1 Fisheries trade in the region

All 24 countries in the W-ER have a high dependence on fisheries products and in 2003 the region was a net importer of fisheries products to the value of US$6.23 billion. The high capacity to add value to fish products and the huge diversity of possible types and forms of fisheries products has enabled producing and non-producing countries in the W-ER to engage in fisheries sector. Unfortunately, it is not possible to separate aquaculture products from capture fisheries except for those species where it is known that the vast majority of production originates from aquaculture.

The total trade in fisheries products in the region is presented in Figure 13. Within the major trading nations the Scandinavian countries, the Netherlands and Ireland show a net positive trade balance. Norway had the highest trade surplus of US$3.1 billion. Iceland and Denmark were second and third with surpluses of US$1.43 and US$1.04 billion, respectively. In contrast to these lowly populated countries, Italy, Spain, France, Germany and UK reported trading deficits of US$3.11, US$2.68, US$2.46, US$1.37 and US$0.85 billion, respectively. The ability of aquaculture to offset this deficit in the region will depend on whether farmed products can be transformed from highly priced products to main stream commodities for mass markets. In the case of salmon and trout this status has been fast achieved with falling prices and wider distribution through chains such as hyper and supermarkets. Although the gate prices of key farmed finfish have decreased, this decrease does not appear to be entirely passed on to consumers.

The priority which the countries in the region place on aquaculture may also depend on the significance of aquaculture to national economies. As shown in Figure 14 the contribution of aquaculture to GDP for most countries is low (EU-25=0.04 percent of GDP) but significant. Aquaculture is of greatest national economic importance in Norway. In 2003 it contributed 0.6 percent to GDP, down to 0.2 percent from its maximum of 0.83 percent in 2000. The significance of aquaculture in Iceland, Greece and Turkey was similar between 1994 and 2003 and its contribution in 2003 was 0.25, 0.21 and 0.17 percent, respectively (Figure 14). Aquaculture is of lesser importance

in the rest of the region contributing 0.001–0.007 percent of GDP in Belgium, Switzerland, Austria, Sweden and Germany and 0.02–0.04 percent in the Netherlands, Finland, Portugal, France, United Kingdom, Italy and Denmark. The level of contribution has not changed in the last reporting decade (Figure 14).

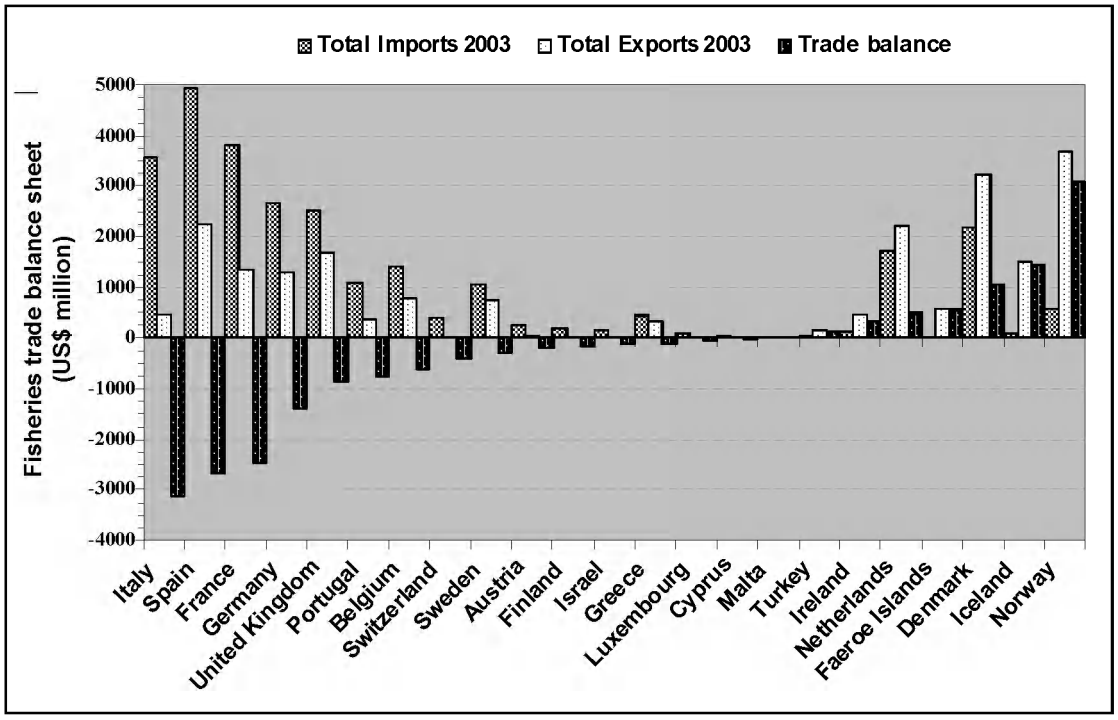

Figure 13. Regional trade in fisheries products in 2003 (adapted from Eurostsat, 2006)

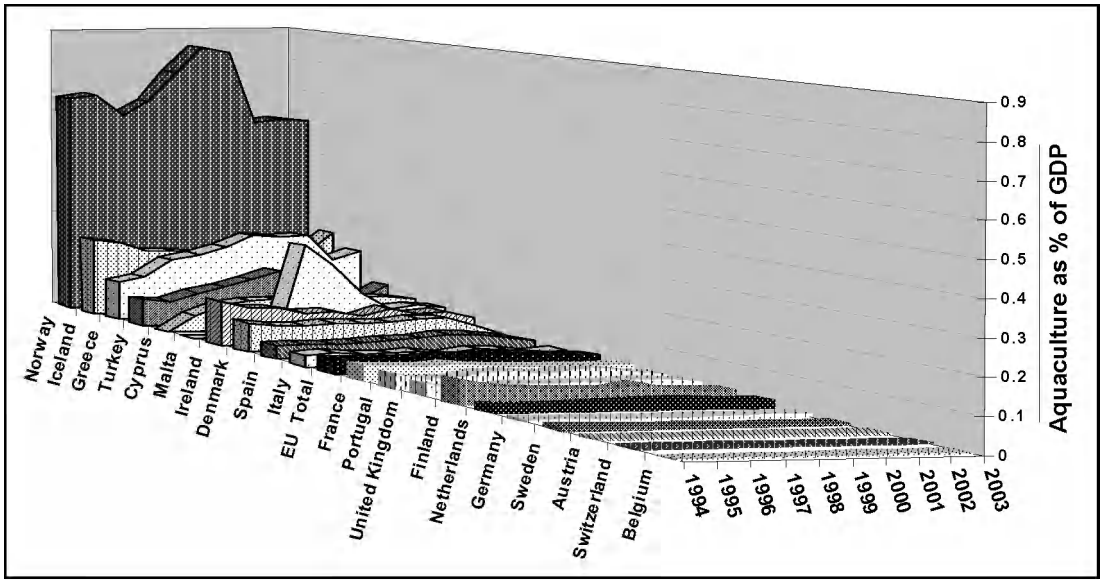

Figure 14. Changes in the contribution of aquaculture to national GDP of countries in the W-ER (adapted from Eurostat, 2006)

3.2 Comparison of aquaculture with regional agriculture and meat production

The value of aquaculture compared with agriculture or meat production is small at €4.9 billion in 2003. In the same period, the value of total agricultural and meat output at producer prices was €255 and €107 billion, respectively, representing a mean annual growth of only 0.7 percent for agriculture and a decline of 0.3 percent for the value of meat between 1994 and 2003. In contrast aquaculture showed an annual increase of 4.5 percent. This stagnation in the former sectors resulted in aquaculture increasing its share. Between 1994 and 2003 values of aquaculture as a percentage of total agricultural value increased from 1.4 to 1.9 percent. Similarly aquaculture output as a percentage of total meat value increased from 3.1 percent to 4.6 percent (Figure 15).

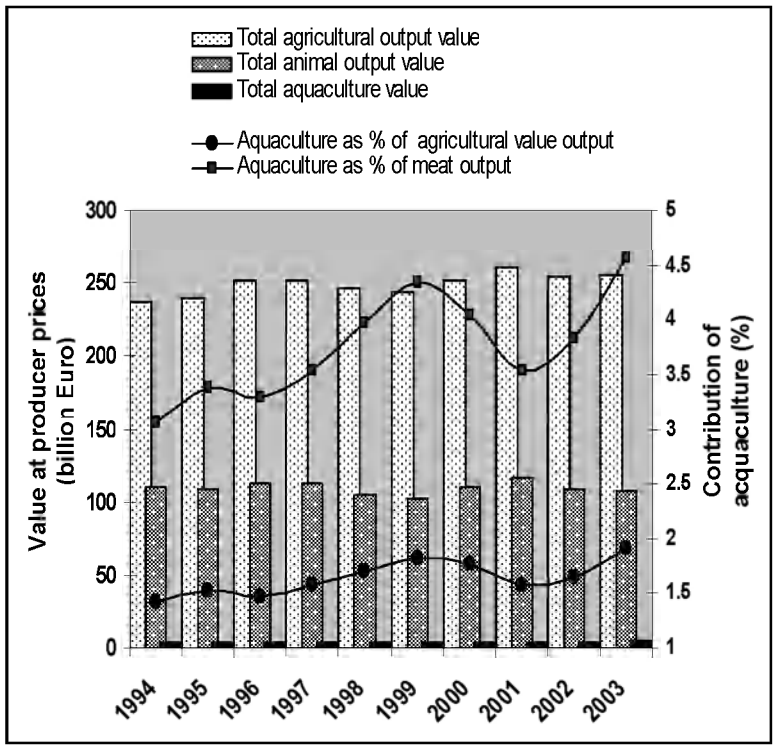

Figure 15. Recent changes in the relative value of aquaculture to agriculture and meat in the W-ER (adapted from Eurostat, 2006)

In the W-ER fish will have to compete with other animal proteins and food items and although health benefits are recognized by the consumer, consumption remains price sensitive. The cost and affordability of major food items has changed markedly in the region and in particular the rise in fish and seafood prices in the region was amongst the highest of key food types (Figure 16). Although the data here is for the EU-25 countries it is indicative of the W-ER as the major consumer countries are common to both.

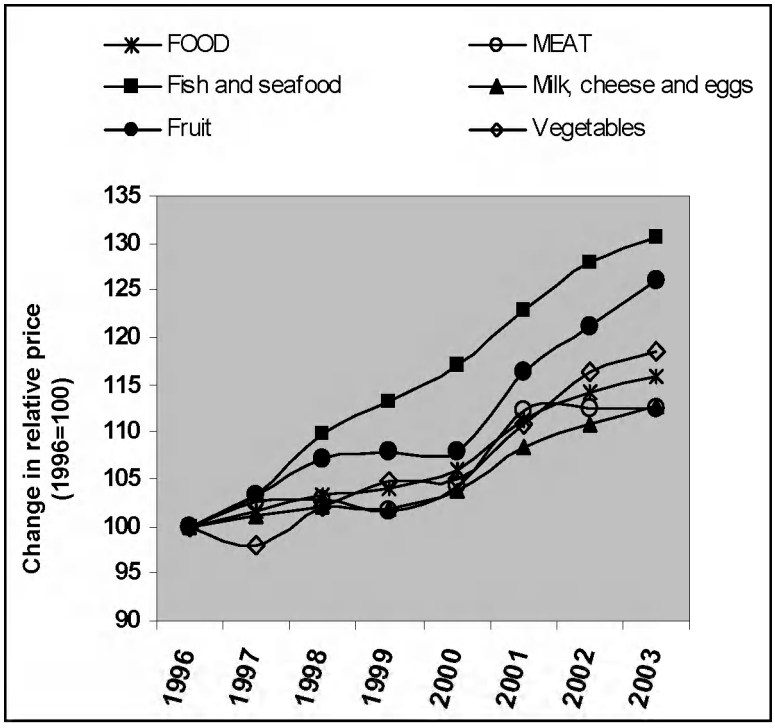

Figure 16. Comparison of recent changes in average price index of major food items in major Western-European markets (adapted from Eurostat, 2006)

Since 1996 (=100 percent) the relative cost of fish and fish food has risen by 30 points, almost by 2.5 times that of meat (112 percent). Also, the relative price of meat has remained unchanged since 2000. These higher prices for fish and fish products are also

probably indicative of higher and rising demand and falling supplies of these products. Consequently farmed fish is likely to be considered a non-essential commodity by consumers and its contribution as a food item to food security for poorer households within the W-ER is likely to decrease or at best remain unchanged.

It is not possible to establish the contribution of aquaculture to annual fish consumption in the region as in many countries aquaculture products are exported and post harvest production cannot be disaggregated from capture. Since landings from capture fisheries are stagnant and population has risen, the share of aquaculture to annual per capita supplies is likely to have increased. The importance of fish and shellfish within the region, however, is markedly varied ranging from Turkey where the annual per capita supply from 1993 to 2001 ranged between 7 and 8 kg/year to Iceland at around 90 kg/year (Figure 17). In most countries per capita fish supply has not changed in recent years. The highest increase was noted for Malta where per capita supply increased by 122 percent between 1993 and 2001, followed by the Netherlands (75 percent), Spain (16 percent) and Norway (16 percent).

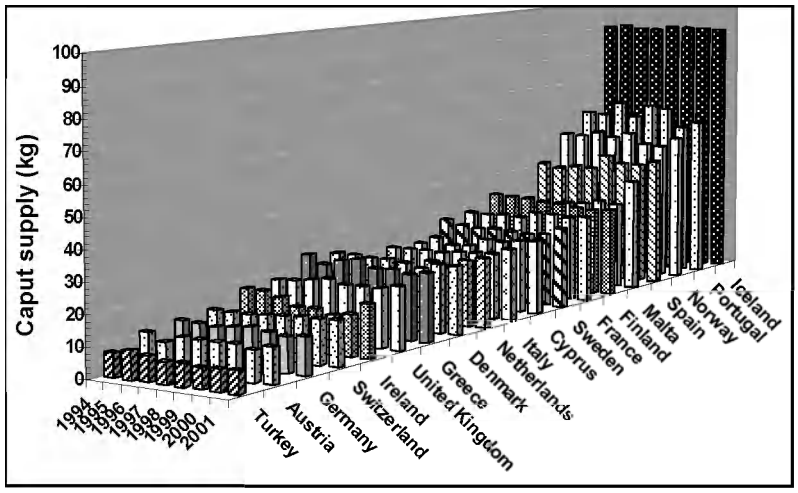

Figure 17. Regional and temporal trends in the annual per capita supply of fisheries products in the W-ER (adapted from Eurostat, 2006)

3.3 Social significance of aquaculture

The main recent developments in finfish aquaculture were undertaken by commercial companies some of which are public, who have made large capital investments in the activity, especially in main centres of production such as Norway, UK, Ireland, Greece, Spain and Turkey. Restructuring of the sector and subsectors has followed a regular pattern – production growth accompanied by price instability. Consequently, many small and family owned businesses have either consolidated, through mergers or sale in favour of national and international companies. As a result social participation in aquaculture is increasingly in the form of employment as opposed to investment.

As pressure on prices inevitably leads to required increases in productivity, automation is needed. Nonetheless, there has been a significant rise in specialized services, leading to subcontracting of tasks that would otherwise have been delegated to employees. Furthermore, the increased supplies to the processing sector also support employees in this sector. Consequently, while on-farm production-linked jobs have stabilized, even though production has increased, aquaculture supports many upstream and downstream activities (C. Hough, pers. comm.).

Shellfish farming remains traditional and many farms are still small family run businesses.

3.4 Main regional trade in fish commodities

Once aquaculture products leave the sites of production it is difficult to disaggregate data from capture fisheries products. Since the bulk of some species entering the market chain originate from aquaculture, however, they are considered sufficiently discrete to analyse.

Three finfish and two shellfish species groups dominate trade in farmed aquatic products in the region. In 2003 salmon, trout, seabass and seabream accounted for 92 percent of regional export and 90 percent import trade of farmed products. For finfish the most dominant product forms were fresh chilled whole fish on ice. In the case of salmon and trout there was a significant market for fresh fillets and smoked products. The vast majority of shellfish were sold live on ice (Table 7).

The major regional markets for farmed species are given in Table 2 and the trade by product form in specific commodities within the region is shown in Table 7.

Table 7. Main fish and shellfish commodities and product types traded in the W-ER (adapted from FAO FISHSTAT Plus, 2005)

	Commodity of fish and shellfish by species groups				
	Salmon	**Trout**	**Seabass and seabream**	**Mussels**	**Oysters**
Product form	fresh or chilled	fillets, fresh and chilled	fresh or chilled	fresh or chilled	fresh or chilled
	frozen	fillets, frozen	frozen	shelled frozen and canned	in shell, fresh or chilled
	smoked	smoked			
	fillets fresh or chilled				
	fillets, frozen				
	salmon sides, salted or in brine				

Although the main centres of production for salmon in the region are Norway, UK and Faeroe Islands various forms of salmon products are exported in varying amounts from all but three countries in the region, Channel Islands, Israel and Malta (Table 8). With an estimated consumption of about 13 000 tonnes, farmed salmon imported from Norway has substituted cod as the number one fish species being consumed in Denmark. This change in consumption is due to rising prices of cod and lower prices of salmon from Norway (K. Fischer, pers. comm.).

Trade in Atlantic salmon between the Scandinavian countries is high. In 2003 Norway exported US$1.4 billion worth of Atlantic salmon mainly in the fresh or chilled form, while Denmark, Sweden and Germany imported US$620 and US$320 million and US$144 million of salmon, respectively. Apart from Germany much of this salmon was processed and re-exported thereby generating further economic activity and employment opportunities in these countries. Denmark imported large amounts (50 000–100 000 tonnes) of fresh whole salmon from Norway, much of which were filleted and smoked for re-export (K. Fischer, pers. comm.). In 2003 Denmark and Sweden exported US$740 and US$280 million of fresh and chilled salmon. In Germany a significant amount was consumed nationally leading to US$133 million in exports. Other major consumers of salmon in 2003 were Belgium (US$107 million), France (US$413 million) and Italy (US$93 million).

Trout was the second most valuable export commodity totalling US$525 million in 2003. Most of the product was traded in the frozen form (US$200 million). Norway was the leading producer and exporter, exporting US$178 million followed by Denmark (US$80 million). The Faeroe Islands (US$24 million), Spain (US$20 million) and Germany (US$11 million) also showed notable exports in 2003 all exporting frozen trout. Trout was the preferred fish in Germany with imports of US$58 million in 2003.

The Mediterranean countries in the region were the major exporters and consumers of fresh or chilled seabass and seabream. Greece was by far the largest exporter at US$181 million. France (US$41 million), Turkey (US$30 million) and Spain (US$29 million) were in third to sixth places. In 2003, Italy was the largest consumer of seabass and seabream importing US$149 million followed by Spain (US$82 million). Although France was the second largest exporter, they also imported US$34 million of fresh seabass and seabream.

Fresh chilled mussels were the most popular form of mussel sales and consumption. In addition mussels are processed mainly in Spain for meat and are sold frozen or canned. Such products are mainly used by the expanding food services sector and retailers (McLeod *et al.*, 2006). The Netherlands were the leading traders in mussels exporting over US$121 million in 2003 followed by UK (US$35 million), Spain (US$27 million) and Italy (US$23 million). The region is also a high consumer of mussels with Belgium, France, Spain and Italy spending US$85, US$54, US$63 and US$35 million, respectively, on importing fresh mussels.

The intraregional trade in oysters is relatively small at US$16 million and is mainly centred in France where oysters are sold with quality marks to sophisticated consumers. France is the centre of production in the region and most of the production is consumed nationally. The vast majority of oysters are traded in the live chilled form and traded in France through a variety of marketing chains from on-farm sales directly to public to large merchants who have centralized purification and transport facilities (McLeod *et al.*, 2006).

Table 8. Total export and import value (US$ million) matrix for key species groups traded by countries in the W-ER in 2003 (adapted from FAO FISHSTAT Plus, 2005) (Major producing countries are given in italics)

Countries	Salmon		Trout		Seabass and seabream		Mussels		Oysters		TOTAL	
	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import
Austria	0.72	18.27	0.41	2.91	2.60	3.94	0.06	0.74	0.00	0.11	**3.79**	**25.97**
Belgium	32.17	107.17	2.29	9.11	2.34	5.78	1.65	84.96	0.37	7.68	**0.37**	**214.70**
Channel Islands	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**	**0.00**
Cyprus	0.16	0.72	0.00	0.00	1.38	0.25	0.00	0.00	0.00	0.08	**1.54**	**1.05**
Denmark	739.86	620.59	80.00	5.22	0.38	0.32	9.71	0.71	4.63	0.50	**834.58**	**627.34**
Faeroe Islands	87.32	0.09	24.26	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**111.58**	**0.09**
Finland	0.69	2.52	1.28	21.53	0.03	0.07	0.01	0.29	0.12	0.13	**2.13**	**24.52**
France	58.39	413.54	5.49	5.89	41.21	34.39	9.18	53.61	0.00	0.00	**114.27**	**507.43**
Germany	133.02	400.47	10.75	58.23	0.38	10.58	10.50	14.26	0.12	1.93	**154.77**	**485.47**
Greece	28.69	7.84	0.61	0.36	181.12	14.87	9.72	1.73	0.01	0.02	**220.15**	**24.82**
Iceland	8.47	0.05	5.17	0.00	0.46	0.00	0.17	0.02	0.00	0.00	**14.27**	**0.07**
Ireland	9.63	2.18	1.85	0.60	1.66	0.83	17.24	0.76	2.54	0.01	**32.92**	**4.38**
Israel	0.00	13.79	0.00	0.00	1.65	0.00	0.00	0.00	0.00	0.41	**1.65**	**14.20**
Luxembourg	0.25	4.99	0.09	0.69	0.82	0.88	0.83	2.21	0.02	0.38	**2.01**	**9.15**
Italy	0.49	93.37	5.70	1.49	11.69	148.82	23.41	34.64	0.58	12.48	**41.87**	**290.80**
Malta	0.00	0.96	0.00	0.11	3.96	0.03	0.00	0.04	0.00	0.03	**3.96**	**1.17**
Netherlands	18.93	45.55	7.10	9.42	2.36	6.95	121.91	29.32	6.82	1.22	**157.12**	**92.46**
Norway	1 400.08	2.85	177.83	17.71	0.00	0.08	0.88	0.25	0.09	0.00	**1578.88**	**20.89**
Portugal	0.83	12.07	0.01	10.75	1.57	16.41	1.93	1.10	0.07	0.05	**4.41**	**40.38**
Spain	4.54	20.00	18.64	2.17	27.29	81.21	27.12	62.88	0.00	0.00	**77.59**	**166.26**
Sweden	290.71	377.51	180.61	18.13	0.00	0.12	0.63	0.53	0.00	0.26	**471.95**	**396.55**
Switzerland	1.82	37.70	0.00	2.72	0.00	0.06	0.00	4.41	0.00	0.00	**1.82**	**44.89**
Turkey	0.01	1.50	0.00	0.00	29.86	0.02	0.00	0.00	0.42	0.00	**30.29**	**1.52**
United Kingdom	103.93	16.58	2.47	1.57	2.11	22.72	34.55	5.41	0.00	0.00	**143.06**	**46.28**
Total	**2 920.71**	**2 200.31**	**524.56**	**168.61**	**312.87**	**348.33**	**269.50**	**297.87**	**15.79**	**25.29**	**4 043.42**	**3 040.41**

4. CONTRIBUTION TO FOOD SECURITY; ACCESS TO FOOD, NUTRITION AND FOOD SAFETY

4.1 Contribution of fish supply compared with other sources of meat protein in the region

The inhabitants, especially those living away from coastlines have historically relied on many sources of proteins. These include protein from meat from cattle, pigs, sheep and goats and poultry and fish.

Although comprehensive data on unit meat supplies across the region are poor, available data suggest that the relative importance of each of these sources of protein, estimated as per capita supply, varies across the region (Table 9, Figure 18). Apart from two countries pig meat was the most important available source of protein, especially in Denmark and Spain where capita supplies exceeded 60 kg/person/year (Table 9). The apparent consumption of cattle, poultry and fish were similar across the region in 2001. Consumers, however, have a high apparent preference for fish. In 2001, fish supply was ranked second highest in most countries signifying its high importance in the region (Table 9 and Figure 18). For Portugal, the available data suggest that fish provided the highest per capita supply of protein meat. In Iceland the availability of fish is even higher at 91 kg/person/year. More detailed trends in apparent fish consumption are presented in Figure 19.

Table 9. Supply of meat and fish for human consumption in the W-ER in 2001 (adapted from Eurostat, 2006)

	Per capita supply in 2001 (kg/person/year)[1]					Ranking	
	Cattle	Pigs	Sheep/goats	Poultry	Fish	Pigs	Fish
Belgium	NA	NA	NA	NA	NA	-	-
Denmark	22.5	63.1	1.3	19.1	23.2	1	2
Germany	10.0	54.1	1.1	16.0	12.3	1	3
Greece	18.7	32.3	13.5	19.7	23.1	1	2
Spain	13.1	65.4	5.9	29.3	45.0	1	2
France	25.6	36.6	4.3	24.8	29.9	1	2
Ireland	17.3	40.1	4.5	33.6	17.6	1	3
Italy	22.8	37.9	1.6	19.0	24.6	1	2
Luxembourg	28.2	43.4	2.1	13.1	NA	1	-
Malta	NA	NA	NA	NA	39.2		-
Netherlands	19.0	42.6	1.4	21.6	23.8	1	2
Austria	18.3	56.4	1.2	17.2	11.7	1	4
Portugal	15.4	43.6	3.5	30.3	56.5	2	1
Finland	17.9	32.0	0.3	13.3	30.5	1	2
Sweden	20.5	34.7	1.0	12.5	27.7	1	2
United Kingdom	18.6	25.1	5.7	28.8	21.1	2	3
Iceland	NA	NA	NA	NA	91.3	-	-
Norway	NA	NA	NA	NA	52.0	-	-
Switzerland	NA	NA	NA	NA	14.8	-	-

[1] NA = not available

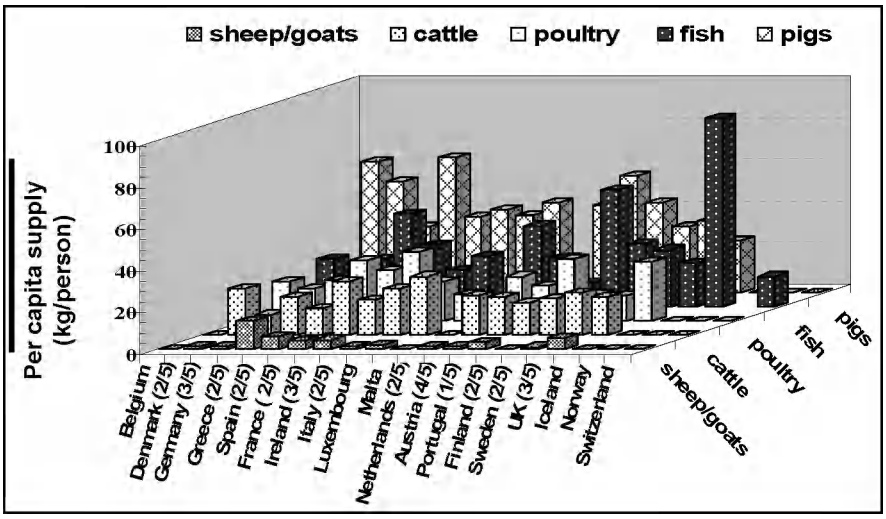

Figure 18. Per capita supply of fish and various meats in selected countries in the W-ER in 2002. Values in brackets given with country names refer to ranking of fish in relation to other meats (adapted from Eurostat, 2006)

4.2 Trends in fish prices – capture versus farmed

The differential between prices for major farmed and wild caught fish has narrowed considerably in recent years and in the last few years farmed products were cheaper than wild caught. The price of fresh Atlantic salmon for example is now about the same (approx. €4) when compared with frozen blocks of cod fillets (Figure 19) which are accessible to the mass consumer markets. With these falling prices salmon has become more accessible to the consumers in the region and in recent years is a regularly traded commodity.

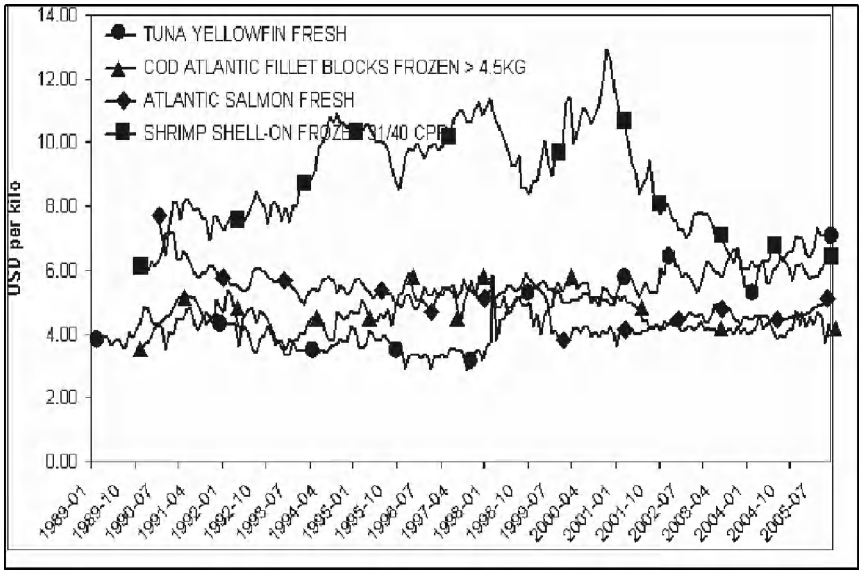

Figure 19. Comparison of prices of fish from capture and aquaculture (GLOBEFISH)

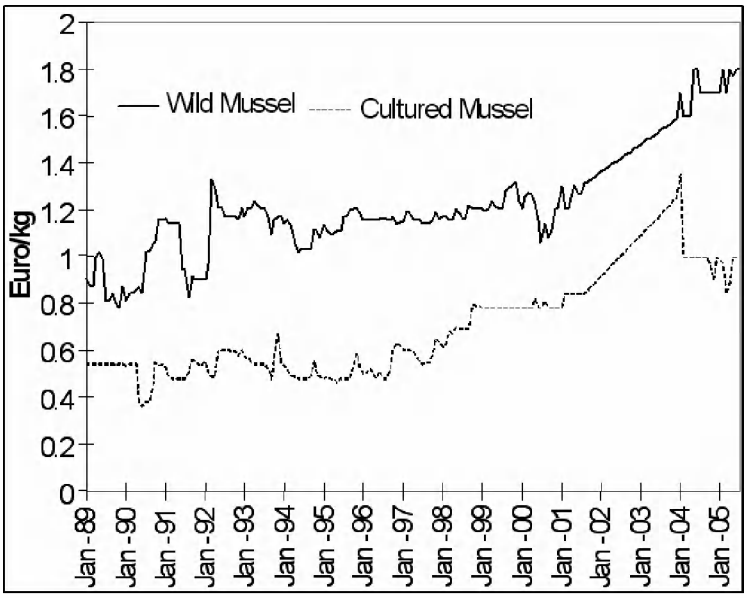

Figure 20. Comparison of prices of mussels from capture and aquaculture (GLOBEFISH)

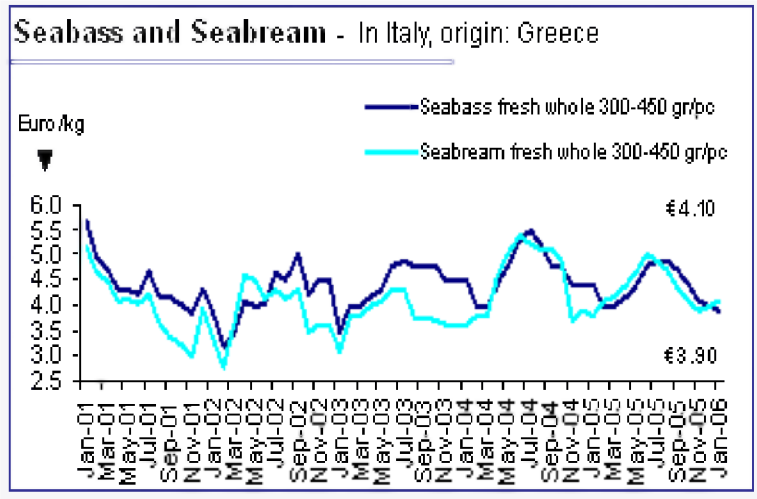

Figure 21. Comparison of prices of seabass and seabream from capture and aquaculture 2001–2005 (FISH INFOnetwork Market Report, 2006)

Recent price trends for mussels in Spain suggest that wild mussels consistently fetch a higher price than their cultured counterparts and those prices for both have been steadily rising (Figure 20). It is noteworthy that discerning consumers in traditional markets such as France, Spain and Italy have indepth knowledge of product quality and prefer wild products for which they are prepared to pay higher prices. Wild mussels only constitute 10 percent of total production therefore the bulk of the lower priced cultured mussels are more affordable and accessible to the wider inhabitants in the region and contributing to a healthier diet and local food security.

Almost all the seabass and seabream traded originate from aquaculture and prices in the main producer countries have been continuously falling. Since 2001 the price of seabass and seabream has dropped from €5.50 and €5/kg to around €4/kg (Figure 21). The prices of trout were lower and had fallen below €2/kg. In Germany and France where production costs may be higher, farmers are selling directly to the retailers to maintain acceptable profit margins.

5. ENVIRONMENT AND RESOURCES

5.1 Impacts of aquaculture on environment

The expansion of aquaculture in the region continued to be affected by extra-sectoral and intra-sectoral environmental factors. These influences can be broadly separated by reference to intensity of farming and species, with finfi sh being increasingly challenged by internal factors while shellfish being predominantly affected by the external environment. Aquaculture operators in inland and coastal environments are working to meet increasingly stringent regulations and legal enforcements that govern the impact of their activity on the environment. The industry has taken the lead in adopting mitigating measures to minimize impact of farming activity on the environment but in recent years this has also been driven primarily by the market place.

In the last decade the intensive farming practices have been challenged with a number of issues affecting the broader environment. Expansion and intensification of production has increased the nutrient loading and affected benthic life in the immediate vicinity of the farming activity, increased the risk of escapees of cultured fish with potential undesirable interactions with wild populations and raised concerns on animal welfare issues.

Rapid expansion of intensive finfish production in marine waters, in particular salmon, and trout in freshwater environments in the recent years has generated increased awareness of pressures on the environment. Even though the number of companies operating farms has sharply decreased in all major finfish producing countries in the region, the number of sites have remained largely unchanged or have decreased only marginally. Under these conditions the 2.5 fold increase in salmon production (298 000 to 730 000 tonnes) between 1994 and 2003 for example was attained largely from a similar number of sites with consequent use of substantially more feed at the same sites thus increasing pressure on the environment in these localities. Such concentrated farming activity especially within aquatic systems such as fjords and sea lochs which are most suited to aquaculture, but have long retention times, has resulted in an increase in organic and inorganic discharge of nutrients. Consequently one major challenge faced by the salmon industry is to militate against impact of local discharge of nutrients, organic matter, and chemicals from intensive cultivation.

The level of nutrient loading, especially of nitrogen (N) and phosphorus (P) would appear to be associated with known intensities of coastal finfish aquaculture activity in the region (Figure 22). However, there is no clear evidence that this loading has resulted in significant undesirable changes in the wider coastal environment (EEA, 2005). The discharges, although only indicative, also contribute to the overall load from inland and coastal areas together with discharges from agriculture, forestry, industry and domestic waste (EEA, 2005).

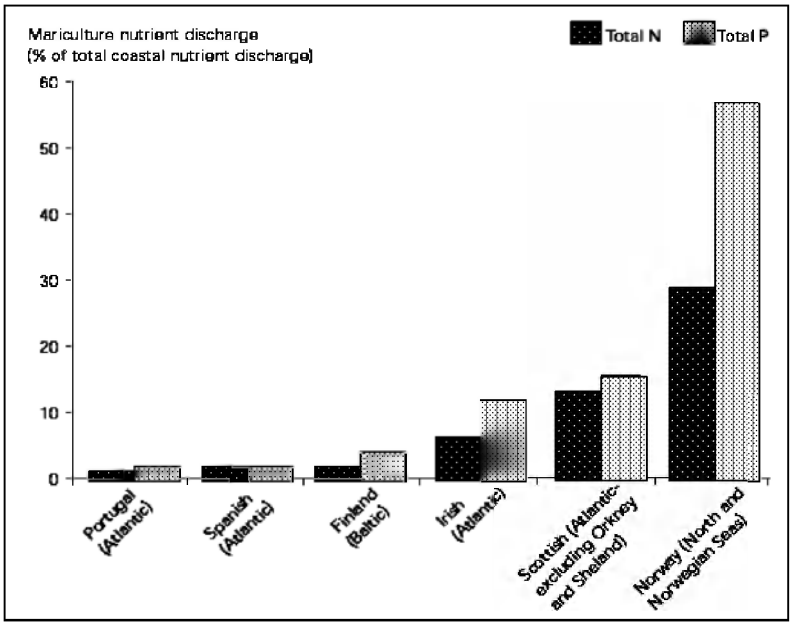

Figure 22. Indicative contribution of marine and brackish water finfish culture to total coastal nutrient discharges in selected countries (EEA, 2005)

The rapid increase in number of fish stocked in intensive units can increase the probability of unintentional fish escapees and disease outbreaks and consequent potential impacts on wild stocks through genetic change in populations, competition for food and diseases. Improved cage technology and management however, has reduced the escapees to a very small percent of total production although they can represent a large absolute number (EEA, 2005).

5.2 Environmental management

To mitigate against such pressures on the environment actions have been taken at farm level and at the institutional levels. Key trends at the farm level have been the increasing practice of fallowing (production site rotation), improved cage design to minimize escapees and reduced use of antibiotics. At the institutional level there is an increase in the enforcement of regulations although these measures are targeted at farm level activity rather than at local or regional level. The uptake of regulations is strong in many countries often where the growth of aquaculture has been rapid, suggesting that many governments have taken a view to ensure sustainability of the sector. The industry, however, has taken the lead to respond to environmental concerns and many of these have been driven by market forces.

Mitigation at farm level

In the last decade the reduction of the number of companies and acquisitions has resulted in companies having multiple sites, which facilitated the practice of fallowing. This practice has enabled sites to recover and has proved successful in mitigating against the now well-understood effects of feed wastes in the immediate vicinity of cages or pond discharges. In 2003, 231 of the 326 salmon sites in Scotland were fallowed for varying periods between 4 and 52 weeks to allow the sites to recover and to break any disease cycles. The practice of fallowing was introduced by many Norwegian farmers some 15–20 years ago (K. Maroni, pers. comm.) and is also built into Norwegian licensing regulation whereby companies can only farm if they have licences to farm several sites. Only one stocking cycle is allowed and upon harvest the sites must be fallowed for at least 6 months (Venvik, 2005). The consolidation of farms in the Faeroe Islands has also made it possible for each company or group of companies to have at least three farming sites at sea. This will make it possible to harvest year round and practice fallow periods between each production cycle, which is now a legislative requirement. The slide in fish price has also provided an incentive for such farms to reduce waste. The efficiency of nutrient utilization in intensive salmonid aquaculture has increased steadily. The quantity of nitrogen discharged per tonne of production has decreased from almost 180 kg/tonne of production in the late 1970s to less than 40 kg/tonne in the mid-1990s (EEA, 2005). Further improvements in the last decade have come mainly from improved feed quality and from improved automated feed management systems.

In several European countries such as the Netherlands, France, Belgium and Denmark, recirculatory aquaculture systems are being increasingly used to mitigate against effluent discharge, as well as to provide the circumstances required for products desired by local or regional markets (e.g. eels). Some sectors of the industry have also responded to consumer concern by initiating codes of practice and joining quality management and organic certification schemes.

Mitigation at institution level

An overview of regulatory instruments governing aquaculture is provided in Section 6. These are supported by local laws that are more stringent in those countries where aquaculture has high economic significance, a position that suggests that governments have taken a view to ensure higher levels of control to support the sustainability of the sector. However, an appraisal (see Section 6) of these regulations suggests that, like industry and agriculture, these directives are targeted at micro-

impacts of organic matter in the immediate vicinity of farms but not the wider environment. The latter can only be addressed through comprehensive monitoring and integrated management of aquatic systems, taking account of the pressures from aquaculture and other economic activities perhaps through pragmatic zonation. In the last five years the EU and some individual countries, including Spain and UK, have developed strategies for the sustainable development of aquaculture. Such a strategy was developed and implemented in Norway in the 1985 Aquaculture Act.

5.3 Feed resources and efficiency

The sustainable farming of carnivorous species such as salmonids, seabass and seabream in the W-ER (and the world) appears to be inextricably linked with the supply of fishmeal and fish oils. In the last decade aquaculture has surpassed livestock into becoming the largest user of fishmeal for fish feed in 2003 consuming 46 percent of world fishmeal (Figure 23) and 81 percent of fish oil.

The major users of fishmeal in the W-ER are members of the EU and therefore consumption of fishmeal in the EU is also reflective on the W-ER. In the EU the average consumption of fishmeal for aquaculture purposes has increased from 21 percent since 1998 to 33 percent in 2002 and has overtaken pigs as the largest consumer of fishmeal (Table 10).

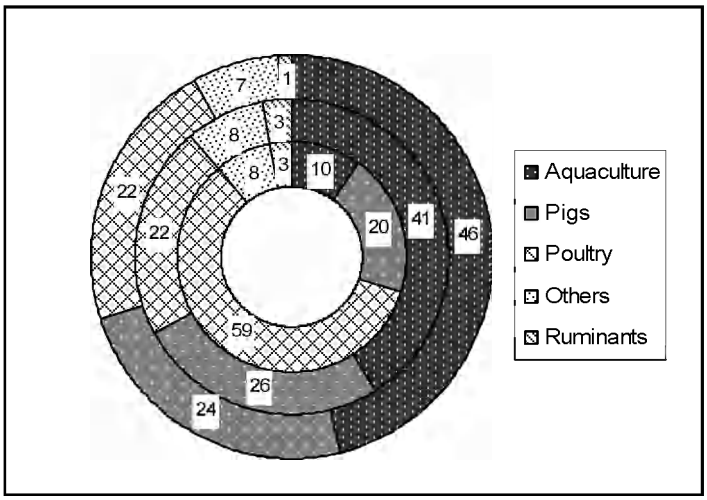

Figure 23. Utilization of fishmeal for fish and meat production in the EU (adapted from Fishmeal Information Network, 2006)

Table 10. Average fishmeal consumption in the EU by different uses in 1998 and 2002. Relative shares given as percentages.

Uses of fishmeal in EU region	Annual consumption (tonnes x 1 000)			
	1998	%	2002	%
Use in aquaculture	214	21	254	33
Use in pigs	310	31	252	32
Use in poultry	280	28	225	29
Use in ruminants	152	15	-	-
Other uses including pet feeds	39	4	50	6
Total EU consumption	**995**	**100**	**781**	**100**

Source: Huntington *et al.*, 2004

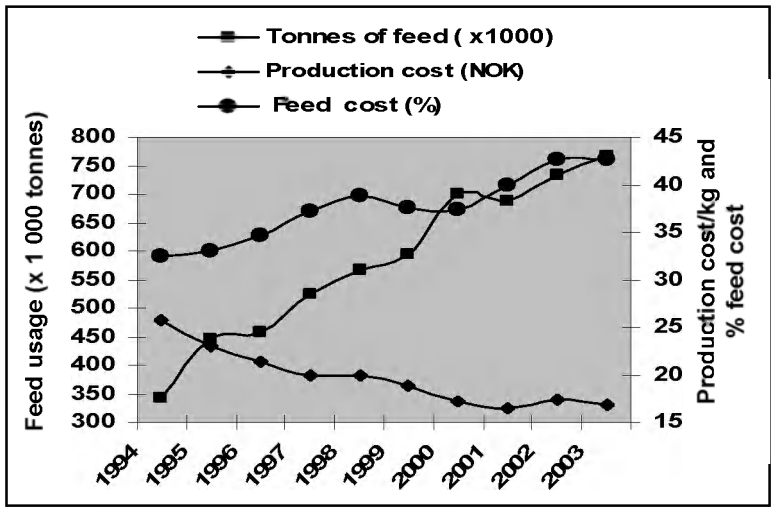

Figure 24. Changing relationship between feed usage, cost of feed and production costs for Atlantic salmon and trout in Norway (Statistics Norway, 2006)

Aquaculture in Norway increased its consumption of fish oil 1.5 fold between 1996 and 2004 from 149 000 to 215 000 tonnes and fishmeal from 232 000 to 309 000 tonnes in the same period (FIN, 2006). Salmon, trout, seabass and seabream production have placed the greatest demand for fishmeal. In Norway alone the use of complete diets has increased 12 percent/year from 342 000 tonnes in 1994 to 768 000 tonnes in 2003 (Figure 24). The dynamics of feed usage in Norway, its impact and rising costs in the light of rising fishmeal prices on the open market shown in Figure 24 apply equally to trends for seabass and seabream industry. As the production costs in Norway were reduced by 35 percent since 1994, the proportional cost of feed to total production costs rose by 10 percentage points from 1994 to 43 percent (Figure 24). During this period the economical food conversion ratio (FCR) was similar at 1.2–1.3. In seabass and seabream producing countries feed comprised 35 percent of production costs in 2002 (Stirling Aquaculture, 2004).

The greater reliance on and demand for fishmeal in the last decade has placed upward pressure on prices, and this has generated greater incentive to improve diet formulation and manufacture and to find alternative feed ingredients. Since the early 1990s gains have been achieved by switching to high energy extruded diets resulting in better economical FCRs. The industry has also responded by exploring replacements of dietary marine proteins and oils. In W-ER, Norway has lead the way in terms of dietary fish protein and marine lipid substitution at 55 and 50 percent respectively. Similarly, in the UK substitution levels at 45 and 10 percent have been achieved with no apparent loss in fish growth or the nutritional quality of the fish carcass.

6. LEGAL, INSTITUTIONAL AND MANAGEMENT ASPECTS OF THE AQUACULTURE SECTOR

6.1 Managing the aquaculture sector

With the exception of Norway and Turkey, the countries in the W-ER with major aquaculture production are members of the EU-25 and therefore the development of the sector is managed through a series of interrelated statutory instruments and regulations at both EU level and national level. These instruments address both the management of the fisheries sector as a whole and the establishment of aquaculture practices and codes. In view of the significance of the EU as a trading block, however, non-EU members often follow and attempt to comply with these instruments as well. This reflects what is known as the *Acquis Communautaire*, where trading countries adopt EU Regulations to assure common rulings. In the last five years the increasing influence of EU legislation has superseded related national legal instruments used to regulate aquaculture to the extent that many national regulations are devoid of aquaculture definitions instead of relying increasingly on harmonized definitions and provisions originating from the EU. Surprisingly, with the exception of Norway, none of the countries in the region have a specific Aquaculture Act. In most cases, provisions in the national Fisheries Acts and/or Environmental Acts are invoked to enforce necessary regulations.

Often legislation and regulations used for aquaculture are not formulated specifically for aquaculture as an activity. Instead aspects of many existing legislations are invoked based on the impact of aquaculture as an activity on the broader environment.

The principle legislation used to regulate aquaculture can be categorized as those pertaining to aquaculture in fresh water and sea water. Examples from selected countries in the region are given in Table 11.

The legislations and regulations governing aquaculture activities in the region as a whole are becoming more centred on the protection and improvement of the environment, food safety, and transboundary aquatic animal movement with special reference to biosecurity. Conducting an environmental impact assessment (EIA) is an integral part of the process of determining most applications for marine, brackish and freshwater aquaculture. This is influenced by the EU Water Framework Directive (2000/60/EC) that introduces the environmental objective of good ecological and chemical status for surface and underground waters. This Directive is supported by other Directives, such as the Habitats and Birds Directives. Restoration of waters adversely impacted by aquaculture would have to achieve this target by 2015. The Member States of the EU are required to ensure that all aquaculture enterprises operate within the rules and regulations set by the legislation and to integrate environmental protection requirements into the approving process of aquaculture. The integration of the EIA process is in accordance with the Council Directive on the assessment of the effects of certain public and private projects on the environment (85/337/EC as amended by Council Directive 97/11/EC) and seeks to ensure that where a development is likely to have significant effects on the environment, the potential effects are systematically addressed in a formal environmental statement. This includes changes or extensions to existing developments that may have significant adverse effects on the environment even where the original development was not subject to an EIA. The regulations also apply to renewal of existing leases. The authorization process includes EIA followed by granting a licence or permit. When there are no specific authorizations required to engage in and set up inland aquaculture farms, as in the case of Netherlands, obtaining a number of permits under various environmental laws is mandatory.

Therefore in the absence of an Act specific to aquaculture the most commonly observed sector management approach by countries in the region is to apply various EU and/or EC legislations and communications which have significant implications for the establishment and operation of aquaculture practices. There is a long list of EU and EC Directives, council decisions and convention texts that are relevant for those working in the aquaculture sector. The EU and/or European Council Directives which have significant implications for the development of the aquaculture sector and management are given in Table 12.

Table 11. Examples of sector governing categories of legislation by environment in selected countries

Environments	Denmark	France	Netherlands	Norway	UK
Freshwater	Environment Protection Act (2004)				
Marine water	Fisheries Act (2004)	Law No.97-1051 on Maritime Fisheries and Maiculture	See all environments	Act Relative to Sea Ranching (2000)	Crown Estate Act (1961) Coastal Protection Act (1949) The Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations (1999)
All environments	Environment protection act (2000) Act relative to animal keeping (2004) Foodstuffs Act (1998)	Law No.76-629 on the Protection of Nature Environmental Code, Book 1, 2, 4, & 5 Law No.83-630 environment	The Fisheries Act (1963) The Regulation on Aquaculture (1993) Animal Health and Welfare Act (1992) The Environmental Management Act (1993) The Food and Commodities Act (1935)	The Aquaculture Act (1985) The Food Safety Act (2003) Prevention of Cruelty to Animals (1974)	Environmental Protection Act (1990) Control of Pollution Act (1974) Registration of Fish Farming and Shellfish Farming Businesses Amendment (Scotland) Order (2002) The Fish Health Regulations (1997) Natural Heritage (Scotland) Act 1991
Reference	Skonhoft, 2005	D'Andrea, 2005	Spreij, 2005a	Skonhoft, 2004	Spreij, 2005b

Table 12. EU legislation influencing establishment and management of aquaculture sector in the European Union (adapted from Siriwardena, 2005)

Section 1: EU and/or European Council legislation concerning *siting* of aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Council Directive 79/409/EEC on the conservation of wild birds	To provide a framework for the conservation and management of, and human interactions with wild birds	www.europa.eu/scadplus/leg/en/lvb/l28046.htm
Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora	To ensure the water quality of surroundings areas where aquaculture activities are sited	http://europa.eu/scadplus/leg/en/lvb/l28076.htm
Council Directive 76/160/EEC concerning the quality of bathing water	To ensure quality of bathing water	http://europa.eu/scadplus/leg/en/lvb/l28007.htm
Council Directive 75/440/EEC concerning the quality of surface water intended for drinking water	To ensure quality required of surface water intended for the abstraction of drinking water	http://europa.eu/scadplus/leg/en/lvb/l28006a.htm

Section 2: EU and/or European Council legislation concerning procedural formalities and authorization of aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
EIA Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment)	Preventive approach to protect the environment by assessing the likelihood of any significant impacts projects may have on the environment	http://www.europa.eu/scadplus/leg/en/lvb/l28137.htm
Council Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment	To include intensive farming	http://europa.eu/scadplus/leg/en/lvb/l28163.htm
The Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	To create a framework to control the introduction of certain dangerous substances released into the aquatic environment	http://ec.europa.eu/environment/water/water-dangersub/76_464.htm
Council Directive 96/61/EC concerning integrated pollution prevention and control	To achieve integrated prevention and control of pollution with measures designed to prevent or, where that is not practicable, to reduce emissions including measures concerning waste, in order to achieve a high level of protection of the environment taken as a whole.	http://ec.europa.eu/environment/ippc/index.htm

Section 3: EU and/or European Council legislation and communications concerning *water quality* with implications on aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Water Framework Directive 2000/60/EC	The Directive aims at maintaining and improving the aquatic environment in the Community. By protecting water resources and ensuring that these water bodies do not deviate from its "normal condition".	http://europa.eu.int/eur-lex/en/search/search_lif.html
Directive 76/464/EEC on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community	Member States shall set up a system of emission standards and authorizations for all discharges into the waters which are liable to contain such substances.	http://ec.europa.eu/environment/water/water-dangersub/76_464.htm
Council Directive 79/923/EEC on the quality required of shellfish waters	Production of high quality of shellfish products for human consumption	http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_190/l_19020060712en00990099.pdf
Community guidelines 2001C/37/03 on state aid for environmental protection	"Polluter pays" principle apply to aid protect the environment in all sectors governed by the EC Treaty, including those subject to specific Community rules on state aid including fisheries and aquaculture	http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/c_037/c_03720010203en00030015.pdf

Section 4: EU and/or European Council legislation and communications with implications on aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora	To promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. Activities capable of affecting such habitats are to be subject to various controls.	http://europa.eu/scadplus/leg/en/lvb/l28076.htm
Council Directive 79/409/EEC on the conservation of wild birds	To protect, manage, and control of all naturally occurring birds in the wild state of the European territory.	www.europa.eu/scadplus/leg/en/lvb/l28046.htm
Council Directive 90/220/EEC on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC	To protect human health and the environment when carrying out the deliberate release into the environment of genetically modified organisms for any other purposes than placing on the market within the Community, and when placing	http://ec.europa.eu/environment/biotechnology/index_en.htm

	on the market genetically modified organisms as or in products within the Community.	
Commission Communication (2001) to the Council and the European Parliament: Biodiversity Action Plan for Fisheries (Volume IV).	Establish an action plan to improve or maintain bio-diversity status and prevent bio-diversity loss due to fisheries and aquaculture activities	http://europa.eu/scadplus/leg/en/lvb/l28025.htm

Section 5: EU and/or European Council legislation concerning *aquatic animal diseases and health* with implications on aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Council Directive 91/67/EEC concerning the animal health conditions governing the placing on the market of aquaculture animals and products	To avoid the spread of contagious diseases, by introducing the concept of approved zone (disease free areas for a certain disease) and limiting the movement of live animals between zones of different disease status. The directive also applies to imports of aquaculture animals and products from third countries.	http://europa.eu/scadplus/leg/en/lvb/l12008.htm
Commission Decision 2002/300/EC establishing the list of approved zones with regard to Bonamia ostreae and/or Marteilia refringens	The molluscs must be accompanied by a movement document certifying that the molluscs originate from an area where there has been no history of bonamiosis (*Bonamia ostreae*) or marteiliosis (*Marteilia refringens*) in the previous two years	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Commission Decision 95/352/EC laying down the animal health conditions and the certification requirements for the importation from third countries of Crassostrea gigas for relaying in Community waters	Guide to authorize imports of molluscs belonging to the species *Carassostrea gigas* for relaying in Community waters, or for re-immersion in purification centres in contact with Community waters, from the listed countries	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Commission Decision 2002/308/EC establishing lists of approved zones and approved farms with regard to one or more of the fish diseases viral haemorrhagic septicaemia (VHS) and infectious haematopoietic necrosis (IHN)	Restrict fish movement and prevent spread of infectious diseases	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Commission Decision 2002/304/EC approving programmes with a view to	To obtain approved zone and farm status with regard to one or more of the fish diseases	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html

obtaining the status of approved zones and of approved farms in non-approved zones with regard to one or more of the fish diseases viral haemorrhagic septicaemia (VHS) and infectious haematopoietic necrosis (IHN)	viral haemorrhagic septicemia (VHS) and infectious haematopoietic necrosis (IHN)	
Council Directive 82/894/EEC on the notification of animal diseases within the Community Amendments – 2002/788/EC; Council Regulation No. 3768/85; Council Regulation No. 807/2003	Notification of outbreaks of any of the listed diseases	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Council Directive 93/53/EEC introducing minimum Community measures for the control of certain fish diseases Amendments – 200/27/EC; 2001/288/EC	To define the minimum Community measures for the control of the fish diseases referred to in Annex A, lists I and II, to Directive 91/67/EEC	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Council Directive 95/70/EC introducing minimum Community measures for the control of certain diseases affecting bivalve molluscs Amendments – 2001/293/EC; 2003/83/EC	Establishes at Community level the measures to be taken in the event of outbreaks of mollusc disease referred to in Annex A, list II, to Council Directive 91/67/EEC.	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Council decision 92/532/EEC Laying down the sampling and diagnostic methods for the detection and confirmation of certain fish diseases and repealing the	Sampling and diagnostic methods for the detection and confirmation of viral haemorrhagic septicemia (VHS) and infectious haemophoietic necrosis (IHN)	http://ec.europa.eu/comm/fisheries/doc_et_publ/factsheets/legal_texts/sani_en.htm
Commission Decision 2002/878/EC Laying down the sampling and diagnostic methods for the detection and confirmation of the presence of molluscs diseases Bonamiosis (*Bonamia ostreae*) and Marteiliosis (*Marteilia refringens*)	Sampling and diagnostic methods for the detection and confirmation of Bonamiosis (*Bonamia ostreae*) and Marteiliosis (*Marteilia refringens*) of molluscs in the case of abnormal mortality and for the recognition of approved zones and farms	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Commission Decision 2001/494/EC Approving the schemes submitted by UK and Ireland to withdraw all fish in farms infected with salmon anaemia (ISA) virus and repealing decision	remove and destroy fish from infected farms with the aim to eradicate the disease and to prevent further spread of the disease to other farms as well as to the wild population susceptible to this infection.	http://forum.europa.eu.int/irc/sanco/vets/info/data/oj/01494ec.pdf
Commission Decision 96/490/EC on Certain protective measures with	To prevent the spread of the disease from regions in the Community possibly infected	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html

respect to *Gyrodactylus salaries* in salmonids	with *Gyrodactylus salaris*, and the introduction of the parasite into regions with salmon stocks which are highly susceptible to *Gyrodactylus salaries*	
Council Decision (1999/313/EC) on reference laboratories for monitoring bacteriological and viral contamination of bivalve molluscs	Designate a national reference laboratory for monitoring viral and bacteriological contamina-tions of bivalve molluscs.	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html
Commission Regulation (EC) No 2722/2000 for establishing the conditions under which the Financial Instrument for Fisheries Guidance (FIFG) may make a contribution towards the eradication of pathological risks in aquaculture	This regulation permits Community assistance from the Financial Instrument for Fisheries Guidance (FIFG) for the eradication. It may therefore be possible to compensate producers for the slaughter of aquaculture animals	http://europa.eu.int/eur-lex/lex/LexUriServ/LexUriServ.do?uri=CELEX:32000R2722:EN:NOT
Council Decision 93/383/EEC on reference laboratories for the monitoring of marine biotoxins	To monitor marine biotoxins to ensure shellfish are free from them for the placing on the market of live bivalve molluscs	http://europa.eu/eur-lex/en/lif/reg/en_register_035030.html

Section 6: EU and/or European Council legislation concerning *feed additives* with implications on aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Commission Directive 2003/7/EC on Amended the conditions for authorization of use of canthaxanthin in feeding-stuffs (2003/7/EC) in accordance with Council Directive (70/524/EEC)	To provide greater protection for consumer health	http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_022/l_02220030125en00280030.pdf

Section 7: EU and/or European Council legislation concerning *coastal zone management* with implications on aquaculture

EU and/or European Council legislation	Purpose of the instrument	Further information on the instruments see:
Recommendation of the European Parliament and of the Council 2002/413/EC on the Implementation of the integrated coastal zone management in Europe	To take a strategic approach to the management of coastal zones	http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_148/l_14820020606en00240027.pdf

In addition to the above legislative instruments of the EU, the significance of certain international environmental and wildlife conventions should also be noted in the sector governing process. For example, the EU is party to the Convention on the Conservation of European Wildlife and Natural Habitats and the Convention on Biological Diversity. These conventions commit parties to avoiding or minimizing damage to wildlife sites, to protect fauna and flora, to safeguard the biodiversity and integrating the principles of sustainable use into development policies. Such commitments may be

relevant when examining whether the proposed use of Community finance for particular aquaculture activities is compatible with Community environmental policy. Most countries have ratified the following international and appropriate regional conventions:

International and regional Conventions	Further information on Conventions see:
Rio de Janeiro Convention on Biological Diversity (CBD) (1992)	http://www.biodiv.org/default.shtml
Bern Convention on Conservation of European Wildlife and Natural Habitats (1997)	www.coe.int/T/E/Cultural_Co-operation/Environment/Nature_and_biological_diversity/Nature_protection/
Bonn Convention on the Conservation of Migratory Species of Wild Animals (1979)	http://www.cms.int/documents/index.htm
MARPOL International Convention for the Prevention of Pollution from Ships	http://www.imo.org/Conventions/contents.asp?doc_id=678&topic_id=258
UN/ECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (1996)	http://www.unece.org/env/water/text/text.htm
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1992; accession)	http://www.basel.int/text/text.html
Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat (1995 into force).	http://www.ramsar.org/key_conv_e.htm
OSPAR Commission on guiding international cooperation on the protection of the marine environment of the North-East Atlantic	http://www.ospar.org/eng/html/welcome.html
Helsinki Convention to protect the marine environment of the Baltic Sea from all sources of pollution	http://www.helcom.fi/
Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean	http://www.unep.ch/regionalseas/regions/med/t_barcel.htm

6.2 Envisaged shortcoming in national and EU regulations for sustainable management of aquaculture

In most countries in the region aquaculture is a relatively new economic activity when compared with agriculture and capture fisheries. Consequently many of the national and EU legal instruments and their regulations predominantly focus on these activities and consequently aquaculture is not specifically defined and its development and regulations are diluted in these instruments. For aquaculture to develop sustainably and attract meaningful support, the activity may need to be recognized as a legal entity in its own right, e.g. the Aquaculture Act (1985) in Norway.

At the EU level this shortcoming has also been recently recognized and for the first time the Financial Instrument for Fisheries Guidance regulation (FIFG) (Council regulation. 2792/99EC) was modified to include a definition for aquaculture to help better, the implementation of the Strategy for the Sustainable Development of European Aquaculture (COM (2002)511 final) (Commission of the

European Communities, 2002). In so doing it has clarified aquaculture as an economic entity in its own right and eligible for 30–80 percent public investment aid.

Legal definitions of aquaculture

There is no legal definition of aquaculture provided in most of the national sector governing principle Acts in most countries. Instead terms such as "aquaculture animals", "aquaculture products" and "farm" have been defined in relevant regulations. Including a legal definition for aquaculture in the principle governing Acts will strengthen the national importance of aquaculture as an economic sector. The regulations related to diseases in aquaculture directly refer to the definitions of Council Directive 91/67/EEC concerning animal health, and conditions governing the placing on the market of aquaculture animals and products. This Directive contains definitions of, *inter alia*, "aquaculture animals", "aquaculture products" and "farm".

In the UK these terms are defined in Fish Health Regulations. In Germany "aquaculture animals" are defined in the Fish Hygiene Ordinance. In the Netherlands these definitions are found in regulations pertaining to fisheries products, snails and frog legs and health requirements for live bivalve molluscs. These regulations are more concerned with product safety than with aquaculture practices. In Denmark the regulations pertaining to the establishment and operation of marine (or ocean) aquaculture farms, adopted under the Fisheries Act (1994), have defined marine/ocean aquaculture farms as "fish farms consisting of cages and similar structures, installed in marine waters which require the use of feed for its operation". The land-based marine/coastal aquaculture is defined in the regulations pertaining to marine water aquaculture (1990), adopted under the Environment Protection Act (1998) as "fish farm placed on land that has an intake of marine water, including cooling water from power plants or similar sources, which requires the use of feed for its operation". Both definitions do not encompass the non-fed aquaculture practices such as seaweed culture and most mollusc cultures not utilizing rafts. The inclusion of the practice of feeding in the definition may be due to its potential to pollute the environment. Nevertheless, this is not reflected in the definition of freshwater aquaculture. The regulations on freshwater fish farms, adopted under the Danish Environment Protection Act (1998) defines freshwater aquaculture practices as fish farms that exclusively take in fresh water and which has a water outlet to water ways, lakes or the ocean. This implies that the definition of aquaculture varies according to the environment within the same country.

Further complexity in the definition of aquaculture is seen in France. Legal definition varies with the relevant decree or regulation. For instance, regulations on the authorization of establishments for marine aquaculture define mariculture as practices aimed at production, which includes capture, cultivation, processing, storage, conditioning and shipping of marine products. In contrast a functional definition is found in the Environmental Code, where fish farming is the raising of fish for consumption or stock enhancement, or for scientific, experimental or recreational/tourism purposes. A third definition exists in the French Rural Code under rural activities. This is the consequence of direct application of a set of regulations originally designed for the agriculture sector, particularly in relation to public funding, financial benefits and labour rights. This approach of defining aquaculture is influenced by the Common Agriculture Policy and the Common Fisheries Policy EU directives which are not activity specific.

Policy and codes

There are few clear stipulated national policies on aquaculture, with the exception of the recent strategies published in Spain, Norway and the UK. This has weakened the recognition of aquaculture as an independent economic sector of importance at both the European and national levels. This position also reflects the growing influence of EU legislation and policies on both capture fisheries and aquaculture, through the Common Fisheries Policy (CFP) as per Article 14 of Council Regulation (EEC) 3760/92 established by the *Community Framework.* The Common Fisheries Policy tends, as its name implies, to be dominated by capture fisheries issues, particularly those concerning stock

management, the protection of specific stocks and the reduction of the overcapacity of the European fleet in the face of what can actually be fished in European waters. Sustainable development and responsible management are the key issues for the present and the immediate future of the CFP. Therefore clear national aquaculture policies need to be formulated to supplement the CFP.

In 2004 the European Commission produced a European Code for Sustainable and Responsible Fisheries Practices under its CFP (Commission of the European Communities, 2004). The Code was prepared with the participation of the Advisory Committee for Fisheries and Aquaculture. With regards to aquaculture it provides only two guiding principles refering to:

(i) assured quality of the consumer product and animal welfare of farmed fish, and
(ii) planning and managing fish farming to avoid negative interaction with the environment and resources.

This again is centred on product safety and environment protection. Therefore the policies need to be broadened to encompass areas such as diversification of sustainable aquaculture systems and practices at national level.

Since 2002 the EC has also produced a Strategy for the Sustainable Development of European Aquaculture outlined in text COM(2002)511 final (Commission of the European Communities, 2002). The Strategy contains proposed actions in the following fields:

(i) increasing production
(ii) competition for space
(iii) market development, marketing and information
(iv) training
(v) governance
(vi) safety of aquaculture products
(vii) public health issues
(viii) animal welfare issues
(ix) environmental aspects
(x) research

This Strategy provides important guidance for the sector. It is also fairly general in scope presumably to accommodate the issues from many EC member countries. Therefore, some aspects presented in the Strategy are not of importance for a particular country's aquaculture sector in the short- and mid-term, and alternatively, some specific country issues are not addressed in the EC Strategy (such as, for example, the links between recreational fishing/angling and aquaculture). Nevertheless, this Strategy is being implemented to assist aquaculture development through the FIFG (Council regulation 2792/99EC). Such assistance and its scope was made possible by defining aquaculture in a manner that allows for targeted assistance (Commission of the European Communities, 1999).

The relatively low attention given to aquaculture development by national and regional institutions compared with other food production sectors has necessitated trade organizations representing the aquaculture industry to take a more proactive role in managing and promoting aquaculture. In recent years their activities have been reprioritizing to meet the challenges accompanying a rapidly expanding sector in a price conscious market that is increasingly sensitive to environmental and health issues. For example, the Federation of European Aquaculture Producers (FEAP), in collaboration with several stakeholders, produced a Code of Conduct for European Aquaculture (FEAP, 2000). In addition, marketing information tools have also been developed with financial assistance from the EU and the private sector. National trade associations in major producing countries have also shown the same level of self-monitoring. In Scotland, the Scottish Salmon Producers Organisation took the lead with several other principal stakeholders and recently produced a Code of Good Practice for Scottish finfish culture to ensure that farmers, who wish to join the Association following a successful independent audit, are compliant and implement best management practices therein (SSPO, 2006).

Similar examples exist in Italy (Vade Mecum for trout, seabass and seabream: Association of Italian Fish Farmers 2006) and France (Quality Charters: French Federation of Aquaculture 2004–2005) and are being followed by several other associations in Europe (C. Hough, pers. comm.).

Significant recent changes in the management of the aquaculture sector

The overall effectiveness of a legal system for the management of the aquaculture sector depends to a large extent on an effective government administration of the aquaculture sector. In attempting to identify the current trends in the institutional settings of different countries, it is important to note that most of the countries do not have a well defined aquaculture policy. However, Norway has recognized aquaculture as an important independent economic sector by enacting the Aquaculture Act (1985) to regulate the management, control and development of fish farming in fresh water, brackish water and marine water. In most of the countries in the region, administration is centralized and policies related to aquaculture are developed either by Ministries in charge of agriculture, fisheries and environment or combination thereof. In some countries however, fisheries including aquaculture is devolved to provincial or regional levels. Centralized regulations to ensure the equitable allocation and sustainable management of resources might be desirable, in order to establish the "level playing field" that is required within a "free-trade scenario" (Varadi *et al.*, 2001). With the recognition of aquaculture as a natural-resource base sector within the EU, there is a tendency that aquaculture will be a more important component within future fisheries policies.

Significant changes have taken place in aquaculture management at the national level through the formulation of legislation to regulate aquaculture. Such regulations are largely influenced by EU and Council Regulations and Directives aimed at minimizing or preventing environmental impacts, ensuring food safety and preventing transboundary infectious diseases. One advantage of adopting regulations in different countries based on common influence (EU/Council directives/regulations) is the harmonization of regulations across the region.

Prevention of natural water quality deterioration is influenced by the Directive related to water policy (2000/60/EC; known as Water Framework Directive). As per the Directive many countries have adopted the "polluter pays"' principle to safeguard natural water quality from the impacts of aquaculture effluents. This will encourage adoption of mitigatory measures by farmers to reduce environmental impacts which may result from aquaculture effluents. The development of recirculation aquaculture systems is influenced by this "principle" (as can be seen in Denmark or the Netherlands). Licensing systems adopted by all countries allow the controlled expansion of the industry. One implication of this licensing system is the allocation of feed or tonnage quota for various aquaculture practices in a zone (as practiced in Norway). However, the allocation of quota will only be meaningful when it is coupled with the environmental carrying capacity of the zone concerned. Influenced by the EU and/or Council directives and regulations, all countries have adopted the Environmental Impact Assessment (EIA) process. Nevertheless, the need for an EIA is often size-limited. Aquaculture enterprises below a certain size and production output are exempted from the EIA process. One drawback in such EIA implementation policy is that the potential cumulative effect of aquaculture development is overlooked. To address this issue, integrated EIA for aquaculture zones has been proposed against individual EIA for each aquaculture enterprise.

7. SOCIAL IMPACTS, EMPLOYMENT AND POVERTY REDUCTION

7.1 Dynamics of the structure of the aquaculture sector

The absolute number of businesses engaged in aquaculture of key species has declined across the region, while production has increased significantly. Several factors are driving this change, the most important being falling fish prices, market restructuring where the multiple retail stores increasingly dominate access to the consumer, environmental pressures and competition for space. More often the

maturation of the industry, with more professional businesses, more efficient production, vertical integration and market development are considered very significant drivers (K. Maroni, pers. comm.).

In all salmon, seabass and seabream producing countries these challenges were accompanied by a reduction in the number of companies and through acquisitions, consolidation and vertical and horizontal integration to maintain profitability. In most cases however, the number of licensed sites for production of major species has not decreased and in some instances showed small rises.

In addition the expansions of such farms are also severely curbed due to environmental concerns. In Denmark, no new licences have been approved in the last decade for freshwater farms and only one was allowed for a marine farm. Therefore the growth of companies has been through acquisitions and about 40 percent of farms were also closed to protect rivers and streams. In all cases, however, such reduction has been accompanied by the increase in production and productivity (Larsen, 2005).

In Scotland the number of companies farming rainbow trout (portion-size) in fresh water has decreased from 56 in 1994 to 37 in 2003, while productivity has more than doubled from 20 to 48 tonnes/person/year. Similarly in the same period the number of salmon companies declined from 131 to 81 (Fisheries Research Services, 2005). In Greece the price crisis of 2000–2001 also resulted in consolidation and the number of companies reduced from 269 in 2000 to 167 in 2002 through either closures or mergers and a vertical integration of production (Christofilogiannis, 2005).

In Norway many firms have filed for bankruptcy in recent years. Increased international competition, toll barriers, price pressure and differentiated and strict customer demands are factors challenging industry and innovation (Aslesen, 2004). This has resulted in significant restructuring of the aquaculture sector in Norway in recent years. Two components can be identified to illustrate this trend, the number of farm licences or permits and the ownership of these licences. In 1981, 52 farm licences were issued which increased to 150 at its peak in 1982 before falling to 40 by 2002.

In Norway the proportion of salmon and trout farm licences owned by limited liability companies has increased from 86.3 percent in 1992 to 97.3 percent in 2001. In contrast the share of salmon and trout licences owned by sole proprietorships has declined from 6.7 percent to only 1.2 percent in the same period. The impact of this acquisition is also evident by the influence of the large limited companies on Norwegian output of salmonids. In 1990 the ten largest companies accounted for 8 percent of total production. By 2001 their share had risen to 46 percent, reflecting sectoral consolidation and restructuring.

Malta is a relatively new entrant in aquaculture in the region and despite this shifts in farming operations and systems are already evident. In 1999 there were four companies for seabass and seabream. Following the price crisis of 2001 only two seabass and seabream companies were operational and the focus in the last couple of years was diverted to the more profitable blue fin tuna which could be classed as partly farmed. By 2003 three companies fattened 3 350 tonnes of tuna (Vasallo-Agius, 2005).

In France, Spain, and Italy the shellfish industry continues to be represented by small family and cooperative run farms which have not changed significantly over time. In recent years as many as 55 000 leases were made available to around 3 700 companies in France; the most significant changes have been in the consolidation of sales efforts, primarily through cooperative ventures. Lack of government support and environmental pressure meant that no new fish farms were allowed in the last 10 years in France. Italy has witnessed a yearly fall in the number of trout farms and there remain around 500 farms.

7.2 Trends in ownership

Most of the farms in the region are privately owned and the type of businesses range from small family run business to multinational public companies. The dichotomy of business types can be linked to the type of species group farmed, the scale of production and type of production system, and even the location, reflecting local or regional economic circumstances.

Most shellfish in Spain, France, Denmark, and the Netherlands continues to be traditionally cultured in an extensive manner and the majority of these operations are run by small family owned enterprises and cooperatives. Freshwater trout farming is often semi-intensively produced in open flow through systems and many of these businesses are also family owned enterprises.

The salmon and seabass/seabream sectors which farm more intensively and on a much larger scale have witnessed the greatest changes in ownership. This has been an increasing trend in the last decade resulting in reduction in the number of production-related employment, through improvement in productivity and the subcontracting of certain services.

7.3 Contribution of aquaculture to employment

Data on employment in aquaculture in the region are poorly documented and where available are largely incomplete. In addition available national data cited by various authors vary widely. A key issue is the estimation of upstream and downstream employment; for example, within the supply and service sectors, through to logistics (transport), processing and retail. Education and training are also vital in supporting the development of the sector.

As the aquaculture sector provides more and more fish and shellfish to the markets, such service sectors whose reliance was on fisheries are increasingly supported by aquaculture. For example, in 2004 more than 70 percent of all shellfish produced in the EU originated from aquaculture (B. Guillaumie – European Mollusc Producers Association, pers. comm.).

In 1998 the number of people employed in aquaculture in the EU-25 was estimated at 80 000 full or part-time jobs representing 57 000 full time equivalents (European Commission, 2006). The socio-economic importance of aquaculture in creating sustainable employment would appear to be related to the type of aquaculture practice. In intensive operations direct employment has evidently decreased in recent years. Most of these jobs are in the marine sector with shellfish farming providing the bulk of the employment (Goulding *et al.*, 2000). Overall however, the socio-economic importance of aquaculture in creating sustainable jobs is linked inevitably to the core criteria of economic sustainability.

Where more traditional aquaculture methods and systems are used they tend to be more labour intensive employing a greater number of persons. Furthermore, in many parts of inland Europe that use such systems, products such as carps are losing ground in consumer preferences and the market place. Where the "consumer is king", and where the EU expands its single market, pressure will increase on the traditional sectors to adapt or diversify or develop products for specialized niche markets, for example, for organic aquaculture products. Failure to do so will inevitably result in activity reductions and decline in aquaculture-related jobs.

The numbers employed in higher profile aquaculture subsectors are more comprehensively documented. The seabass and seabream sector provides jobs equivalent to around 7 600 full time equivalents (FTEs) in the region (Stirling Aquaculture, 2004). For salmonids, the major producer countries such as Norway, Denmark, UK, France, Italy and Spain provided full or part-time jobs equating to around 9 100 FTEs. In addition to these jobs the sectors also provide indirect job opportunities in support services as well as in education and training.

Italy

In Italy the marine and shellfish industry engaged around 6 100 persons in full time employment in 2001, 1 800 persons in coastal aquaculture mainly in the seabass and seabream sector and 4 300 persons in the shellfish sector. In addition these sectors employed 400 seasonal workers and 250 in managerial or expert capacity (Cozzolino, in prep.). A recent study however suggests that the seabass and seabream sector employees 2 150 FTEs (Stirling Aquaculture, 2004).

Denmark

In 2003 the Danish aquaculture industry directly employed 819 persons on 414 farms, mainly in the inshore and onshore trout industry. The majority (666) of these employees worked on the land based trout farms on a full time basis and an additional 148 were part time. The industry is male dominated with only 7 percent of all employees being female (Larsen, 2005).

Norway

The number of people directly employed in the Norwegian aquaculture sector has fallen in recent years due to automation and rising labour costs. Since 1995 the number of persons directly employed in salmon and trout production sector has declined by 26 percent in eight years from 4 500 to 3 300 in 2003. This decline mainly affected unskilled production staff while administrative staff and staff with higher education have increased. The immediate service support industries are also significant providers of employment. In 2003 feed industry, marketing and transport supported an additional 2 700 full time jobs (Venvik, 2005).

Spain

In Galicia, Spain, where mussel farming predominates, the industry directly supports around 13 500 jobs. In addition the seabass and seabream sector provides 800 full time jobs. There is increasing activity (seabass/seabream) also in the Canary Islands (McLeod *et al.*, 2006).

7.4 Benefits to the wider community

The primary immediate benefits of aquaculture to the economies in the region are derived from indirect employment generated through support services and added value of aquaculture products. The extent and significance of these contributions especially to rural economies vary within the region.

In Scotland the salmon industry is regarded as the most important economic development in the Highlands and Islands injecting around US$3.5 million every week in wages into the rural communities. In terms of value, the gate price of salmon (US$525 million) is greater than the combined value of beef and lamb and represented 40 percent (US$265 million) of total Scottish food exports in 1999. In Scotland, UK, the salmon farming industry directly employs an equivalent of 1 600 full time staff. For shellfish 137 full time and 230 part-time and casual staff are employed. When the processing and ancillary industries are considered the salmon industry alone supported a total of around 6 500 people.

Norway shows a similar trend in indirect benefits of the salmonid industry. In 2003 around 3 550 persons were directly employed in the salmon aquaculture production sector, plus some 400 persons were employed in aquaculture production of fish species other than salmon and trout (Statistics Norway, 2006). Some additional 3 500 persons were employed in slaughtering and filleting. In total the aquaculture industry provided some 19 500 jobs directly and indirectly (K. Maroni, pers. comm.). Given the rural distribution of these farms these jobs serve a crucial role in social cohesion in these communities.

The increase in the number of public companies in Greece and Norway in particular, has increased the opportunity of the general public to share the risk and profits of these companies. Such distribution of benefits is unlikely to reduce poverty in the region. The main benefit to communities therefore would be income generation through direct and indirect employment.

8. TRENDS, ISSUES AND DEVELOPMENT

8.1 Trends influencing direction of aquaculture development in the region

The continuing stagnation of capture fisheries and soaring demand for seafood products in the W-ER has stimulated the expansion of the aquaculture sector in the W-ER since the 1970s. The rate of growth over the last decades, however, has not been consistent and shows characteristics of a new agro-food industry that is showing signs of slowing down in the last decade (Table 5). Although aquaculture production has expanded by 7 percent/year between 1994 and 2003 its growth slowed to 1.5 percent/year between 2000 and 2003. This expansion between 1994 and 2003 was about half that of the world average (11 percent/year) but is similar when the respective growth rate of aquaculture production in China is excluded (5.6 percent/year).

The sector comprises diverse production systems in freshwater and coastal environments for farming a variety of finfish and shellfish species using both traditional and intensive production methods and is wholly reliant on natural resources. Its sustainability is therefore intrinsically linked to the sustainable use and management of these resources. In recent years this increasing recognition focused national and regional efforts on regulating the industry to ensure that the socio-economic benefits to the region are sustainable.

The dramatic increase in finfish production especially that of salmonids and seabass and seabream was accompanied by a sharp fall in prices. To meet these challenges the sector had undergone structural adjustment through consolidation and vertical integration. Such changes were also accompanied by dramatic improvements in productivity.

The increased productivity in key producing countries in the region especially within the EU has been accompanied by transboundary marketing initiatives and greater cooperation between farmers and their trade associations. While the industry has invested heavily to address these challenges, the EU has provided strategic information and assistance to the aquaculture industry through the European Community's regional cohesion policy under the Community Research and Technological Development Framework programme. Such support included initiatives such as MASMANAP (Methodology for seafood market studies with the aim of introducing new aquaculture products), AQUAFLOW and the first phase of the Aqua-Media project to improve marketing, research, technology, development and promotional information (Arnal-Monreal, 2002; Hough, 2002). Such targeted support will continue under the new European Fisheries Fund (EFF for the period 2007–2013) for aquaculture, and processing and marketing of fisheries and aquaculture products (European Commission, 2004).

8.2 Impacts of regulatory environment on development

With the exception of Norway that introduced an Aquaculture Act in 1985, countries in the region regulate the sector through a series of interrelated statutory instruments and regulations which address the management of fisheries sector as a whole and establishment of aquaculture operations. In the last five years, however the increasing influence of the EU has superseded related national legal instruments to the extent that national acts can be devoid of aquaculture definitions, instead relying on harmonized definitions and directions originating from the EU. Since the target countries in the W-ER are members or trade with the EU, all nations are likely to be impacted by its legislation and regulatory developments. The legislations and regulations in the region as a whole are becoming more centred on the well-being of the environment, food safety, and transboundary aquatic animal

movement with special reference to biosecurity (see Table 12 for a list of EU legislative instruments concerning aquaculture).

8.3 Status and contribution of aquaculture

In the last decade the rate of development has shown high intraregional variation with southern countries exhibiting higher growth and northern countries in the W-ER exhibiting medium growth. Between 1994 and 2003 aquaculture production in Cyprus, Turkey and Greece expanded at an average annual rate of 53, 40 and 21 percent, respectively, compared with 17 and 11 percent for Norway and UK. These differences reflect the varying phases of maturity of the production of these species. Overall, the rate of increase in value has trailed behind the increase in volume indicating a fall in unit prices between 1994 and 2000 following which prices showed some recovery (Figure 10).

The major expansion in aquaculture between 1994 and 2003 was overwhelmingly dominated by the marine finfish production particularly that of Atlantic salmon in northern Europe, and seabass and seabream in the Mediterranean region. Over 70 percent of the increase in tonnage since 1994 was contributed by Atlantic salmon, mussels, trout, seabass and seabream. Atlantic salmon alone contributed 44 percent of the total increase in volume during this period in the W-ER while mussels, trout, seabass and seabream contributed 13, 7.6 and 6.5 percent of the increase, respectively.

Norway (71 percent), UK (19 percent) and Faeroe Islands (10 percent) were the major players driving the soaring increases in Atlantic salmon production and accounting for almost all the increase in salmon production since 1994. Production and productivity from predominantly inshore intensive cage farming systems in these countries has increased following improved feed quality, feed management, husbandry and overall farm management. As a consequence of automation (especially for feeding) the number of people engaged directly in the industry has reduced. Such changes have had the highest impact on unskilled labour market in rural areas. In all three countries, salmon is a major contributor to the economy as a whole and to the rural economy in particular. It is also a significant export earner. In Norway, the export of sea food is second after oil and gas and was valued at US$3.5 billion in 2003. Farmed salmon and trout accounted for 40 percent (US$1.4 billion) of this value (Ludvigsen, 2004) and the industry directly employed around 3 500 jobs in 2003 mainly in rural areas. More specifically, according to K. Maroni (pers. comm.) the Norwegian aquaculture industry supports 3 500 FTE jobs in the primary production, 3 500 in slaughtering and some 12 000–13 000 in downstream supporting activities. In Scotland, the significance of salmon farming is equally high, producing over US$437 million of salmon (gate prices) and supporting over 6 500 people in production and processing often in remote rural areas. In 1999 farmed salmon accounted for around 40 percent (US$262 million) of total food exports from Scotland. Similarly, in the Faeroe Islands, salmon accounted for 25 percent of the country's exports. In view of the economic importance of this activity, the sustainability of salmon farming in these countries is a high priority. Norway is the only country in the region to enact an Aquaculture Act and Scotland has recently developed a strategic aquaculture plan within their coastal zone strategy.

In southern regions of western Europe seabass and seabream farming has similar significance for Greece, Turkey, Spain, Italy and France, which together in 2003 accounted for 95 percent of production mainly from sea cages. In Greece, fish, mainly farmed seabass and seabream is the third largest agricultural export after olive oil and tobacco, and is regarded as a strategic product by the Greek Government. In 2003, Greeks engaged around 3 200 full time staff to produce 63 250 tonnes of seabass and seabream, accounting for 43 percent of the production in the W-ER. In most countries the number of employees directly employed in the sector has declined following restructuring of the industry since 2000.

The increased production and supply of farmed fish species notably salmon, trout, seabass and seabream was accompanied by a steady fall in gate prices triggering restructuring of the industry farming the major species. In Norway, such restructuring resulted in the number of sole proprietors

declining from 47 in 1994 to just eight in 2003 and concomitant decline in number of employed people in salmon and trout farming by 18 percent of 2001 numbers in 2004. Greece was no exception with number of farms declining from a peak of around 250 in 1998 prior to the price crisis to 167 in 2003. Such restructuring was also accompanied by decline in unit production cost by 34 percent between 1994 and 2003. In the UK a similar trend is evident with the number of salmon farms halving from 131 in 1994 to 63 in 2003. The falling prices have also stimulated productivity and innovation especially in the salmon industry. In the UK productivity has more than trebled in 10 years from 40 tonnes/person in 1994 to 140 tonnes/person in 2003.

These challenges have not had a negative impact on production and falling prices were accompanied by substantial increases in volume of the key finfish species which in the last reporting decade saw production of salmon rise by an average of 15 percent/year and seabass and seabream by 37–38 percent/year. The demand for farmed fish is also being driven by falling supplies of fish from capture fisheries as well as the market requirement for assured quality, traceability as well as the stability and reliability of the supply chain.

The region produced around 750 000 tonnes of shellfish in 2003 (FAO FISHSTAT Plus, 2005). Production was dominated by three countries, Spain (34 percent), France (24 percent) and Italy (17 percent) accounting for 75 percent of regional production. In the last reporting decade, however, shellfish production only increased by two percent/year but this masks the large heterogeneity in output in the region. Whilst shellfish production in countries such as France, Netherlands and Sweden declined by 2–5 percent/year between 1994 and 2003 output in Ireland, Norway, UK and Germany increased by 21–53 percent/year in the same period, albeit from a relatively low production base.

All present data suggest that the total shellfish production is unlikely to grow significantly although some countries in the region such as Norway have increased the number of licences granted for shellfish production. The production in traditional producing countries such as Spain, France and Italy continues to be influenced by external factors such as deteriorating water quality and algal blooms, competition for space by recreation and leisure sectors, food safety issues and unstable markets, cheaper imports as well as internal factors relating to stocking density and seed availability (McLeod *et al.*, 2006).

There has been a continued increase in interest in the farming of new species such as cod, turbot and halibut and these areas saw some increase in employment and number of companies investing in these species.

8.4 Trends in diversification

The aquaculture sector in the region has been market driven and therefore its sustainability is intrinsically linked with the balance between production and demand and the maintenance of profitability. This together with the recognition of the narrow product base has focused some producers, research institutions and regional institutions such as the EU on giving priority to diversification and securing a sustainable aquaculture sector (Commission of the European Communities, 2002). This process has gained momentum in the last five years with financial aid and human resources, notably in Norway, being channelled to develop new species for culture. Species such as cod, sole and halibut have been targeted for expansion with increasing number of companies, approved sites, and employment. The recent production and rate of expansion of new species are presented in Table 13. The improvements in cod fingerling supply have facilitated expansion by a phenomenal 354 percent/year between 2000 and 2003. Similarly halibut production rose by 176 percent/year in the same period. Nonetheless, specific technical issues for seed supply remain to be resolved and none of these species has yet attained a significant position in the European aquaculture production profile. Niche markets for exotic species continue to provide a stable market for some producers but show signs of saturation under current marketing efforts, e.g. tilapias (Table 13).

Table 13. Trends in diversification: production and growth rate of new aquaculture candidates and exotics (FAO FISHSTAT Plus, 2005)

Exotics[1] and new farm candidates	Annual rate of increase (%/year) between				Production (tonnes)	
	1970–80	1980–89	1990–99	2000–03	2000	2003
Tilapias	9	8.6	3.3	0.6	*7 239*	*7 403*
Turbot	-	-	52.5	2.8	4 785	5 321
North African catfish	-	-	24.9	5.4	*3 000*	*3 650*
Atlantic cod	-	-	-7.17	353.8	169	2 561
Arctic char	-	-	133.5	15.6	1 028	1 671
Atlantic halibut	-	-	107.1	176.4	35	282
Siberian sturgeon	-	-	99.0	6.9	90	115
Kuruma prawn	-	-	0.4	15.1	*53*	*85*
Indian white prawn	-	-	341.0	4.6	*65*	*77*
Haddock	-		-	-	*0*	*65*
European whitefish	-	-	-	76.9	79	322

[1] Exotic species groups are given in italics

The likely impact these new species compared with established species, however, is difficult to ascertain at present and will probably be dictated by national regulatory authorities rather than technical constraints. The diversification initiatives are occurring against a backdrop of limited production sites being allowed for fish farming, increasing environmental challenges, and a highly competitive marketplace. Many available inshore production sites in these countries are used for currently farmed species, and production sites in UK, Norway and Denmark are regulated through capping of tonnage, feed quota and feed efficiencies, respectively. Clearly, as total fish output in near-shore and land sites may approach allowable capacity, and if new sites are not made available, companies may have to diversify production within current total production limits set for available sites. The use of offshore cages to address environmental concerns is in its initial phase and technical and investment constraints are yet to be overcome.

To develop new markets creative marketing is an emerging strategy for diversification. In the last decade quality labels such as "Tartan Quality Mark Label", "le Label Rouge" for salmon, "Truite Qualité charte" for trout and "Charte Qualité" for aquaculture in France for marine fish and sturgeon have been promoted to attract sales and more recently organic labels have been introduced to create higher priced niche markets (Monfort, 2006).

Countries in the region have varying rules for organic production but as yet there are no European or internationally harmonized standards. The multiplicity of the different organic schemes, ecolabels and third-party labels (supermarkets) appears to be creating a degree of confusion and the production sector supports the idea of common European standards for such approaches.

Whilst these strategies may have been thought to provide increased price margin opportunities, both the mass appeal and degrees of market share remain uncertainties and their impact on increased production is unclear.

The desire for organic, bio and ecolabels has been forwarded from the original organic agriculture movement; however, the absence of general and species-specific guidelines for aquaculture has created a void in the direction of this approach. When compared to organic agriculture, it seems unlikely that, apart from certain niche markets, that organic or ecolabels will displace mainstream production, where costs and guaranteed quality remain the primary decisions of purchase.

8.5 Food safety and biosecurity

In the last decade much greater emphasis has been placed on food safety following public concerns and reports of contaminants in fish products, and the incidences of bovine spongiform encephalopathy (BSE also known as mad cow disease), salmonella, dioxin contamination and avian flu. Public concerns, echoed by the legislator, have been extended into a zero tolerance regime on food contamination, a position extended to fisheries and aquaculture supplies. These initiatives have been taken by the EU to ensure that the benefits are translated in a harmonized manner across the W-ER and beyond; although the legislation is based on risks rather than a risk/benefit analysis; for example, the risks of dioxin contamination versus the benefits of consuming Omega-3 fatty acid rich fish products. New and more stringent EU directives setting maximum dioxin levels in feeds have been established.

The use of antibiotics has declined significantly in the last decade accompanying the widespread use of vaccines in the salmon and seabass and seabream sectors. This aspect, leading to the most significant drop in the use of antibiotics, demonstrated the adaptability of the sector to be able to respond to critical issues.

8.6 Environment

Aquaculture has continued to attract largely unsubstantiated negative publicity as an environmental polluter. The output of nitrates and phosphates from aquaculture to regional nutrient loading is considered insignificant compared to the releases from agriculture and urban agglomerations but may have local impacts on eutrophication and algal blooms. Great strides have been made in the last decade to mitigate against nutrient inputs by improving feed delivery systems to redress uneaten feed. Notable advances and innovation in automated feeding technology has significantly reduced feed input whilst maintaining productivity. These developments were strengthened by the increased practice of fallowing made possible through increased site availability but, more often, by increased site access through acquisitions and mergers.

The number of escapees into the wild in major salmon producing countries in the region has stabilized and is evidently declining. Improved cage and surveillance technology has been largely responsible for these improvements.

Factors external to the shellfish farming industry have continued to dominate its sustainability in the last decade. Algal blooms and strong competition for space especially with tourism and recreation is affecting production and expansion.

9. OPPORTUNITIES AND CONSTRAINTS

Aquaculture in the W-ER has developed in a socio-economic environment of traditionally high demand for aquatic products concomitant with declining wild fish supplies from European waters, a rising urban population and increasing disposable income. This combination of factors together with the need to stabilize rural economies provided the initial set of drivers and opportunities for development.

The opportunities available for developing and transforming aquaculture in W-ER have varied over the different phases of its development and between countries within the region. These opportunities have been recognized at regional, national and enterprise levels.

Although these opportunities across the region are market driven in the first instance, developments were also facilitated through incentives geared to support developed and underdeveloped European regions. In the EU, this refers to funding for research and development (R&D) and training through

instruments such as CORDIS and the Structural Funding mechanisms which were often applied to rural and coastal areas within the EU.

At both the regional and national level aquaculture has provided an opportunity to increase export earnings, stabilize rural economies through economic regeneration and job opportunities especially in localities affected by declining fishing and agricultural activities. Reducing urban migration and providing local employment was a prime consideration in aquaculture development in many areas of Europe. The recognition of this opportunity continues to be reinforced through the European Commission in the recent strategy for sustainable development of European aquaculture (COM, 2002, 511 final) (Commission of the European Communities, 2002).

The European mechanism served originally to stimulate investment in aquaculture in the poorer areas of Europe, providing partial interventions (relative contribution depending on the region and the activity) towards capital investment. As such developments became mature and the legislative pressure, principally environmental, increased, such financial support has been applied to ensure that farms are able to comply with the increasingly restrictive legislation that is in force.

Generally, these development opportunities have stimulated innovative processes towards a skilled, professional culture technology, adapted to the modern market and consumer demands. None of this would have happened without the development of highly skilled hatcheries and associate technologies, who supply the core seed stock to the ongrowing sector. Developments in first feeding, strain selection and improved performance in the stock produced for ongrowing comes primarily from this subsector of the European aquaculture "industry".

The rapid expansion of aquaculture production (Figure 25), primarily as small or family businesses, came at a time of political European expansion and consolidation, reflected by expansion of the EU to now include 25 Member States and thus the Single European Market as well. It was also based primarily on the production of high value finfish species (salmon, seabass, seabream, turbot, eel, etc.).

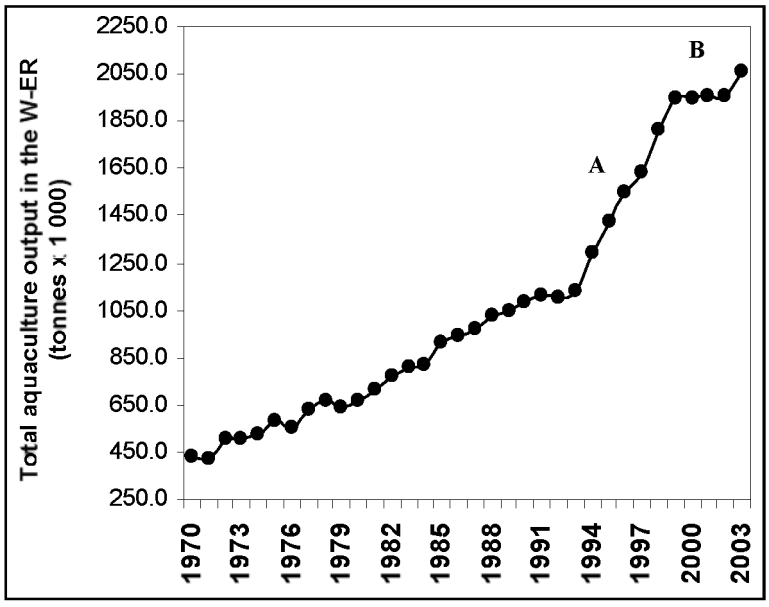

Figure 25. Profile of annual total aquaculture production showing (A) exponential and (B) maturing phase of development (adapted from FAO FISHSTAT Plus, 2005)

At the same time, the European retail sector underwent significant changes. The multiple retail stores (super and hypermarkets) looked to increase their product ranges and to decrease purchase costs, reducing the number of players in the fisheries and seafood supply chains. The result was a reduction in the influence of public auctions for fishery products and a virtual elimination of the middlemen and fishmongers (especially in northern Europe). The domination of Multiple Retail Stores (MRS) and the changes in the conditions of purchase (6-month contracts with pre-determined prices versus auction daily prices) has meant that market conditions have changed. Some 85 percent of all fish sold in France go through five major MRS chains. This condition means that a small family farm is generally excluded from the major retail markets and that marketing efforts are no longer in the hands of the production sector.

As prices decreased – additionally, a result of poor marketing and production controls within a highly dispersed production sector – many producers opted to increase production and productivity. Production increases without marketing inevitably give rise to price reductions and the conundrum of the need to increase productivity. The decline in prices affected principal aquaculture products such as salmon, trout, seabass and seabream (Section 4).

Declining profitability and saturating markets for the principal farmed species have also resulted in some companies and national research institutions exploring production of new cultured species and also resulted in some companies seeking alternative opportunities to diversify into niche markets.

Quality labels such as "Tartan Quality Mark", " the "Label Rouge" for salmon and turbot, "Truite Qualité charte" for trout and "Charte Qualité" have been developed (see Section 8) as a means of diversification into niche markets. Organic production is also developing albeit slowly and remains a marginal activity. The existence of different national schemes, combined with the costs of certification, have contributed to confusion in the development of this niche market. Similarly, uncertainties as to the difference between organic and ecolabelled products – which are not necessarily produced to the same quality levels as ISO/EN certification – has limited their development.

For a dispersed industry that faces a remarkable concentration of the buying power of the MRS, the lack of concentrated selling in the different subsectors of European aquaculture is seen as a limiting factor. The increased use of cooperative structures or producer organizations to counter this has to be foreseen. Such efforts would also answer the lack of concerted marketing for the promotion of value-added and new products which is an issue that is of great concern to the sector, particularly when production is geared to export to other European and non-European countries.

Scope for further immediate expansion of aquaculture production in the region, may well be constrained by the reduced availability of new sites (competition of space) and the capping of production at existing sites through new or existing regulations. Production increases on existing sites will require the mitigation of detrimental environmental effects. The availability of adequate fish feed supplies may also prove to be a limiting factor in the future, although much development work is being applied to this issue.

Therefore to sustain expansion and to maintain adequate production levels and profitability, new sites will have to be licensed and effective alternatives to fishmeal and fish oil be identified. These constraints however, do offer opportunities to develop new and efficient production technologies and effective fishmeal replacements. Technologies for offshore cages and more efficient recirculatory aquaculture systems (RAS) are being developed. The use of RAS has been promoted, particularly for warmwater species such as tilapia, African catfish and eel, but their total contribution to European production remains limited. Pre-treatment of fresh water and partial waste treatment and water recirculation may provide a viable option for more intensive freshwater farms (i.e. trout), while waste recovery systems for cage culture are also increasingly under investigation. In Israel 500-tonne RAS units have been recently developed to commercially farm Barramundi and stripped seabass. These systems however, have been developed with State grants to the value of around US$10 million (Yarkov, pers. comm.).

Compromises in farm biosecurity has resulted in significant production losses due to disease outbreaks and affected some farming activities. In addition such pressures on production losses have been compounded by the absence of licenCes for new and some traditional therapeutic agents. The development and increasing use of vaccines has been encouraged in some countries, but the sector remains very concerned about the long-term availability of effective veterinary medicines. Unpredictable weather, water quality problems (algal blooms and pollution), particularly from urban or agricultural run-off, are also factors providing negative external effects.

On the social front, negative media coverage, and food scare stories have been at the forefront for negating the image of European aquaculture, imposing higher levels of transparency and communication between the producers and end users.

In summary, there are several aspects that provide both opportunities and constraints, each being linked to the concept of sustainable development, and which need to be addressed in consultation with stakeholders involved, particularly by the regional, national and local authorities as well as the professional sectors:

- Rising fish and seafood imports, significant reductions in supplies from capture fisheries and rising populations in the region provide the prime encouragement for sectoral growth in Europe.

- Harmonization of rules and regulations within the region provides a level playing field for European producers; however, there are major differences in the interpretation and uptake of core legislation that discourage this.

- A realistic and practical approach to integrated coastal site management, particularly for marine fish farming, is needed which provides more opportunities than constraints given new knowledge generated through Environmental Impact Assessments (EIAs), the benefits of fallowing and improved feeds, and the socio-economic contribution of aquaculture to local coastal communities especially in rural areas .

- Freshwater fish farming may be hindered on two fronts, the competitive use of freshwater and the acceptability of some products, particularly in Central European areas. Improved water use, recent developments in recirculating aquaculture systems (RAS) drastically reducing water use and reduced effluent levels provide opportunities for sectoral consolidation and growth. Product and even activity diversification towards restocking, sport fishing, and agro/ecotourism may provide further opportunities.

- The development of genuine offshore fish farming activities (a concept which should be encouraged) must be seen as a medium to long-term objective, since their viability is uncertain and neither the structures nor their management systems exist as yet for this activity.

- Production increases and price decreases have encouraged market diversification and productivity. Niche market development through quality and local origin labels, organic production etc., is increasing. The dominance of Multiple Retail Stores (MRS) may dictate the scope for such diversification. Future expansion of traditional species may depend on successful transnational marketing efforts and more proactive role by trade organizations.

- Competitiveness is being addressed by using a trained workforce whose skills are being routinely upgraded. Skill development should be encouraged within the sector to ensure higher competence levels.

- The fishmeal and fish oil supply line is frequently suggested as a limiting factor for the continued development of aquaculture. The reduced availability of these ingredients and those from fish recycling activities has reduced the availability to compound feed manufacturers. Significant progress had been made on replacement materials.

- On farm and national biosecurity measures need to be better disseminated, understood and implemented, reducing escapes and mitigating potential impacts.

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