COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 8.4.2009
SEC(2009) 453

COMMISSION STAFF WORKING DOCUMENT

accompanying the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

Building a sustainable future for aquaculture

A new impetus for the Strategy for the Sustainable Development of European Aquaculture

Impact Assessment

{COM(2009) 162 final}
{SEC(2009) 454}

TABLE OF CONTENTS

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Introduction

This Impact Assessment accompanies the Commission's communication for a "strategy for the sustainable development of European aquaculture". It assesses and compares different possible options for the framework under which public authorities in the EU could take to provide the best conditions for sustainable growth of aquaculture in Europe, ensuring both adequate supplies of healthy seafood and compliance with high European standards (especially environmental and health protection). This document is without prejudice to the final content of the Strategy to be adopted by the Commission.

It has to be highlighted that, given that the Commission Communication is a political initiative and envisages action for public authorities across a wide range of different policy areas, this document is mainly based on qualitative analyses. It cannot analyse the impacts of each individual action; nor can it foresee the evolution of the European aquaculture industry in the future, as this largely depends on the decisions and action economic operators. Any specific legislative proposals that may be presented subsequently to this Strategy for sustainable development of European aquaculture and that would normally require an impact assessment will be accompanied by separate specific impact assessments.

This initiative is referred to under item 2008/MARE/012 in the Commission 2008 Work Programme. This impact assessment is based on the results of a broad stakeholder consultation exercise and internal and external data and reports.

1.2. The consultation process

This initiative started in spring 2007 in the form of a broad consultation exercise conducted by the Commission (DG MARE, formerly DG FISH) on the opportunities for the development of Community aquaculture, with reference in particular to an earlier Communication of 2002 on an European aquaculture strategy (COM(2002)511 final).

The Commission's minimum standards for consultation have been met. The consultation phase lasted practically until the end of 2007 and was organised through three different types of consultation:

- An internet-wide consultation exercise was initiated on 10 May 2007 (through "Your Voice in Europe" and the DG FISH – now DG MARE – website). In order to provide guidance and facilitate the contribution from any interested party, DG MARE prepared a consultation document, together with other Commission DGs (ENV, SANCO, RDT), highlighting the mains issues where opinions were sought. This consultation document was accompanied by background facts and figures on European aquaculture.[1] This internet consultation exercise lasted until 16 July, but written contributions continued to be received later.

- In parallel with the consultation published on the internet, specific consultation meetings were organised with representatives and members of each of the main stakeholders and civil society

[1] The consultation documents can be found at the following address: http://ec.europa.eu/fisheries/cfp/governance/consultations/consultation_100507_en.htm.

groups, namely finfish producers, shellfish producers, the fish feed industry, NGOs, and social partners. A similar invitation for a specific consultation meeting was offered to the representatives of the aquatic food processing and marketing sector, but this invitation was declined.

- As a third step, the Commission organised a large stakeholder conference in Brussels on 15-16 November 2007 in order to discuss the main challenges to the sustainable development of aquaculture in Europe and in particular the role of public authorities in this context.[2]

An overarching follow-up and information exchange on this initiative was conducted in the framework of the Advisory Committee for Fisheries and Aquaculture (ACFA) and its Working Group 2, which is specifically dedicated to aquaculture. ACFA is the formal consultative body for the Common Fisheries Policy (CFP). Both the ACFA plenary session and its Working group 2 meet several times a year.[3]

The initiative and consultation process were accompanied by a number of events on aquaculture organised by the European Parliament (Special hearings by the Intergroup on Sustainable Development in October 2007[4] and by the Committee on Fisheries in March 2008). The Council of Fisheries Ministers also held an informal lunchtime debate on aquaculture at their June 2008 meeting (under the Slovenian Presidency). Very recently, the European Economic and Social Committee (EESC) also contributed to the organisation of an International Aquaculture Conference (Brussels, September 2008).[5]

1.3. General overview on feedback and contributions received from the consultation exercise

Participants at each of the specific stakeholder meetings welcomed this initiative and all expressed their satisfaction at being consulted. Generally, these meetings were held in "listening mode" and provided participants with the chance to air their concerns and problems. The choice of issue to be looked at and the extent of the discussion on each subject were left to the various parties concerned. Stakeholder representatives attending these meetings were also invited to submit their views in writing, preferably via the internet consultation process. Depending on their availability, other Commission DGs (notably DG SANCO and DG ENV) also participated in those consultation meetings.

Despite the official closure date for internet consultation of 16 July, a number of written contributions continued to be received until the end of July, and two additional submissions were received by DG FISH around mid-September.

In total, 46 written inputs had been submitted by 25 September 2007, which can be grouped into different categories of stakeholder:

– Aquaculture producer organisations or businesses (14)

– Feed industry (4)

---

2 See http://ec.europa.eu/fisheries/meetings_events/events/archives/events_2007/conference_151107_en.htm.
3 Minutes of the meetings are available at: http://ec.europa.eu/fisheries/cfp/governance/acfa/minutes_en.htm.
4 See http://www.ebcd.org/MeetingsEPISD2007-2007.htm.
5 See http://www.ebcd.org/.

– NGOs (4)

– Scientists or scientific bodies (9)

– Social partners (1)

– Public bodies or similar (11); at national level (3) and regional/local level (8)

– Regional interest groups (2)

– Others (1)

The contributions received were all rather substantial, most of them being presented in accordance with the main chapters and associated questions set out in the consultation document prepared by DG FISH, namely:

– The need for a Community strategy

– The economic outlook of aquaculture in Europe

– The environmental challenges faced by aquaculture, in terms of both the impact of aquaculture on the aquatic environment, and the strong dependency of aquaculture on an environment (water) of high quality

– The challenges of providing healthy food, while ensuring animal health and welfare

– The prospects of a new area of domestication (new species, feed limitations)

– The need to overcome space limitation through spatial planning and/or technological innovation

– The possibilities under the European Fisheries Fund

– The strategic importance of research.

The Conference on "European Aquaculture and its Opportunities for Development" held in Brussels in November 2007 crowned the consultation process. The event was attended by some 200 participants, including professionals from different sectors, representatives of national and regional authorities, scientists, non-governmental organisations and other stakeholders, and the debate centred on the main problems and challenges facing the sustainable development of aquaculture in Europe and in particular the role of the public authorities in this context. The Conference was also attended by representatives from several Commission DGs.

There was quasi-consensus during the whole consultation process in favour of a Community-wide Strategy for the sustainable development of aquaculture. The Conference ended on the conclusion, already expressed in numerous written contributions received, of the usefulness of developing a reviewed strategy to reflect evolving circumstances and challenges and to focus on the sustainable development of the sector through proactive measures, providing a level playing field and striking a better balance between environmental conservation and development of the aquaculture business.

1.4. Interservice Steering Group

Following this consultation exercise, an Interservice Steering Group was formally set up in January 2008. Given the importance of their respective policies with regard to the sustainable development of European aquaculture, DGs ENV, SANCO, RTD, TRADE, ENTR and the Secretariat-General were invited to participate in this Group.

The evaluation of the opportunities and challenges for European aquaculture, mainly conducted through the broad consultation process in 2007, identified a wide variety of different bottlenecks individually and collectively affecting the aquaculture sector. The Steering Group agreed that the overall objective of EU should be to help create a suitable business environment for the aquaculture industry that complies in full with the high EU level of consumer and environmental protection established by the Treaty.

In order to take account of the extensive and varied input received in the consultation, the Steering Group decided to set up thematic working groups (on topics such as environmental issues, animal health issues, market issues, research and innovation, etc.). These working groups brought together representatives from the main DGs concerned, under the lead DG for the policy issue at stake, with the task of providing the Steering Group with input on the respective themes of interest and identifying possible measures and their potential impact (environment, social, economic aspects). Each working group was asked to consider the challenges faced by the aquaculture sector under its respective theme of work and to envisage options to address these specific problems.

The working groups focused on action that may fall under the responsibility of the public authorities and on action that would benefit from an efficient and effective EU added value (vs. possible action that would fall under national competence by virtue of the principle of subsidiarity). The groups were also asked to consider possible action under the principle of proportionality and in the light of work undertaken or in preparation. These measures should not pre-empt possible horizontal or large-scale initiatives in the medium term (e.g. post-2012 EU financing policies and instruments), which would go well beyond this sector-specific initiative. Consequently, the working groups focused on concrete measures considered to be feasible within the next few years.

The Interservice Steering Group met four times between January and September 2008, but did not establish a specific or separate impact assessment. Moreover, considering that a Communication on a Strategy is primarily designed to establish general guidance principles, any specific action to be considered subsequently to this Strategy will be accompanied by an impact assessment.

1.5. Impact assessment – board opinion

A draft impact assessment report was submitted to the Impact Assessment Board on 29 October. Following a discussion between the Board and DG MARE on 19 November, the Impact Assessment Board presented its opinion on 24 November, in which it called for a number of important changes to the report, to which DG MARE had agreed.

The general opinion was as follows:

"The report should better present and integrate the changes to the strategy which have resulted from the impact assessment work. In this context, it should assess more fully the outcome of the strategy of 2002 and present the lessons learned. The reasons for providing support to this specific economic sector should be further justified. The sustainability criteria should be clarified. The definition and presentation of the options should be improved and the possible actions should be

linked clearly to the problems and objectives. The assessment should include a reasonable quantification of the impacts.

During the meeting with the Board, DG MARE agreed to revise the impact assessment on this basis. Given the nature of the recommendations, the Board would like to examine a revised draft IA report on which it will issue a new opinion".

Numerous changes were made as a result of the Board's opinion. Section 2 of the report has been significantly revised to give a fuller description of the evaluation of the 2002 strategy. The report also underscores the justification to refocus some of the strategic objectives compared to 2002, and reformulates some of the strategic and policy objectives (cf. section 3). The other sections have been adapted accordingly where necessary. It also clarifies the results of the assessment and the limits of the initiative as regards Community financial frameworks adopted by the Council and providing possible support to measures in aquaculture ("FIFG and EFF regulations") (see section 2), notably through a better presentation of the possibilities that had been envisaged under Option 2 (section 4 & 5.1). The actions planned under option 2 have been incorporated from the annexes directly in the main text (Section 5.2). Similarly, the numerous factors and drivers contributing to the situation (cf. section 2.5) are described in far more detail (by incorporating into the main body of this report, data from the annex of the earlier draft). The aim was to improve the readability of the report and to show a clear link between the specific problems identified, the possible measures envisaged and their contribution to the strategic and policy objectives. Further elaboration on overall quantitative estimates of impacts has been provided under section 5.4.

On 4 February 2009, the Impact Assessment Board submitted a new opinion on the revised draft IA report, where it recognised the positive aspects of the first changes made, but also considered that the report would benefit from making the criteria defining sustainability more explicit (monitoring indicators) and reworking the table of possible measures in section 5.2 to bring it more into line with the text. The IA Board also made a number of recommendations regarding presentation of the draft report.

This final report addresses the second sets of comments from the Board, while keeping the first set of comments in mind.

2. WHAT ISSUE/PROBLEM IS THE POLICY/PROPOSAL EXPECTED TO TACKLE?

The general issue, presented in more detail below, is that, while aquaculture in the EU guarantees the availability of products that are healthy, safe and of good quality, promotes high animal health and welfare standards, and is regulated and managed in an environmentally sound industry, the EU aquaculture industry is stagnating in terms of overall production, in direct contrast with the economic development and growth observed globally in this industry. Despite numerous assets, such as the high quality of aquaculture products, the high demand for aquatic food by EU citizens and top European research and technological innovation in this relatively new farming activity, the Community aquaculture sector faces a number of challenges that are preventing it from taking full advantage of development opportunities in this industry.

2.1. What is aquaculture?

Aquaculture consists of rearing or cultivating aquatic organisms (i.e. plants and animals) using techniques designed to increase the production of the organisms in question beyond the natural capacity of the environment. It also differs from capture fisheries by virtue of the fact that these

aquatic organisms remain the property of the natural or legal person throughout the rearing and cultivation stage, up to and including harvesting.

The European Aquaculture is a very varied industry. While cultivation of aquatic plants and algae is still marginal in Europe, farming of aquatic animals is mainly composed of three major sub-sectors: marine shellfish farming (e.g. oysters and mussels), marine finfish farming (salmon, sea bass and sea bream being the most important) and freshwater finfish farming (trout, carp, eel, etc.). Most of the EU production is made up of about ten major species, whereas data from FAO indicate that there are about one hundred different aquatic species farmed in Europe.[6] In addition, aquatic species can be farmed by a variety of different methods and with varied techniques: from fully open systems to totally closed and controlled recirculation systems, and from extensive to highly intensive production on land, in lakes, in ponds fed by rivers or even groundwater, at sea in lagoons, or near the shore or offshore, etc.

There are also a wide variety of types of enterprises, ranging from part-time subsistence activities among rural families (in particular for traditional fresh water fish species) to publicly traded international corporations (especially for marine fish species such as salmon, sea bass or sea bream). With very few exceptions (e.g. polychaete worms for bait, ornamental fish), all EU aquaculture production is intended as food for human consumption.

A more detailed description of the main sub-sectors of European aquaculture is given in Annex I of this report.

2.2. Aquaculture as an answer to increasing demand for aquatic food

The data referred to in this Impact Assessment Report have been extracted from different sources and may be subject to minor variation. However, this does not change the global analysis of trends and the overall evaluation.

At global level, aquaculture production is growing more rapidly than any other food sector. The contribution of world aquaculture to global supplies increased from 3.9% of total production by weight in 1970 to 27.1% in 2000 and to 34.0% in 2005.[7]

Projections of global trends observed since 1990 on fisheries and aquaculture production and on per-capita consumption levels indicate that if capture fisheries is kept at current levels, which may appear rather optimistic in view of the state of stocks or the possible consequences of climate change, global aquaculture production should rise to around 70 million tonnes by 2025 if current consumption levels are maintained or even 91 million tonnes if consumption levels increase, as is the case in many countries. The very important role that aquaculture is expected to play in satisfying the present and future demand for seafood is also confirmed by numerous recent prospective studies, such as:

– "Aquaculture 2020 – Transcending the Barriers – as long as…" (Foresight analysis, The Research Council of Norway, 2005)[8]

---

6 See http://www.fao.org/fishery/factsheets/en.

7 J. Nierentz: Overview of production and trade – the role of aquaculture fish supply; in the proceedings of "FAO Global Trade Conference on Aquaculture", China, May 2007.

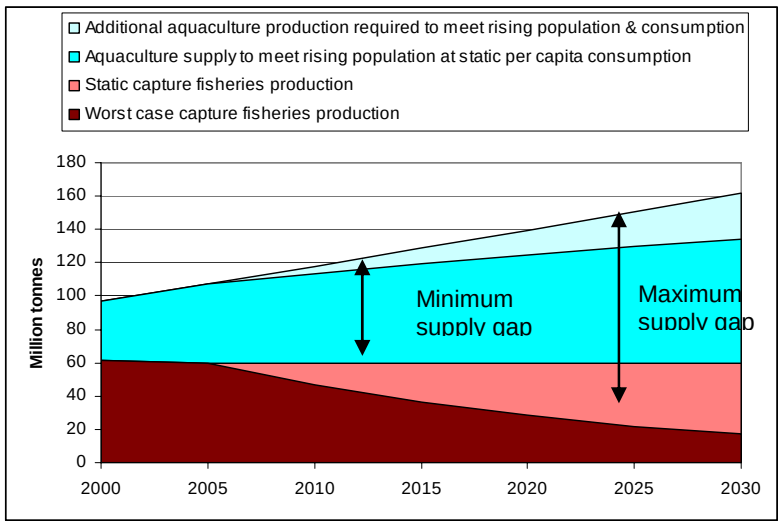
8 See: http://www.forskningsradet.no/CSStorage/Flex_attachment/Aquaculture_2020_eng.pdf.

– *"Driving forces for aquaculture – Different scenarios towards 2030"* (by Ms K. Gravningen in the proceedings of the FAO global trade Conference on aquaculture – China, 29-31, May 2007)[9]

– "Cinq scenarios pour la pisciculture française en 2021" (INRA – Septembre 2007)[10]

– "*Prospective analysis of the aquaculture sector in the EU"* (Joint Research Centre, IPTS Seville, September 2008)[11]

Projections of global demand for fish and seafood for human consumption



Source: JRC prospective analysis

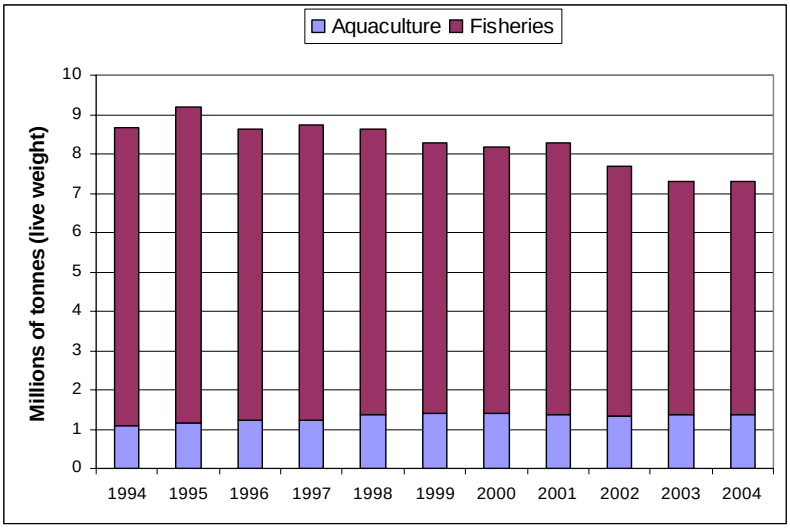
Total fish production in Europe is dominated by capture fisheries, and is on the decline. In 2004, the combined production from capture fisheries and aquaculture was 7.3 millions tonnes (live weight equivalent). The average production for 2002-2004 was 16% lower than the average for 1994-96. In 2005, aquaculture accounted for around 18% of Europe's aquatic food production. This proportion is gradually increasing, but mainly due to a trend of declining capture fisheries, as EU aquaculture production has not increased. Rising EU demand has so far been mainly met by rising fish imports (today, imports make up roughly 60-65% of total fish supply to the EU).

9 See: ftp://ftp.fao.org/docrep/fao/010/a1454e/a1454e00.pdf , pp. 19-26.

10 See: http://www.inra.fr/coordination_piscicole/content/download/3282/30855/version/1/file/prospective.pdf; The English version: Scenarios for French fish farming to 2021: http://www.inra.fr/coordination_piscicole/content/download/3350/31214/version/1/file/prospective_anglais.pdf .

11 Prospective analysis of the aquaculture sector in the EU Part 1: synthesis report and part 2: Characterisation of emerging aquaculture systems – cf. http://ipts.jrc.ec.europa.eu/publications.

Figure: European fish production
(aquaculture & capture fisheries – live fish equivalent – EU-25)



Source: JRC prospective analysis, based on Eurostat 2007

On the other hand, average per-capita consumption in Europe has risen substantially over the last 40 years (about 24 kg fish/person/year in 2005 – data for EU25) and could well continue to increase.[12]

2.3. Economic, social, and environmental dimensions of aquaculture

Total aquaculture production in the EU was close to 1.3 million tonnes, worth some €2.9 billion,[13] in 2005. Most of this production is destined for the EU market. Despite the constant increase, exports of EU aquaculture products remain limited (about 67 000 tonnes "live weight equivalent", worth €278 millions, in 2007[14]), while imports of fish into the EU continue to increase appreciably to fill the gap between demand and production (see above). Market challenges and production costs (fish fry, fish feed, labour, etc.) greatly influence the competitiveness of the EU aquaculture industry.

Direct employment in the EU aquaculture sector is, according to the data available, approximately 65 000 full-time jobs. In terms of the structure of the sector, the vast majority of enterprises are SMEs, although a small number of larger enterprises do play a significant role in some specific sub-sectors, particularly the salmon and sea bass/sea bream industries. More facts and figures on the EU aquaculture industry and its socio-economic dimensions are provided in Annex I.

Aquaculture plays an important role in wealth creation, in local and regional structuring and development and therefore in social cohesion. There are aquaculture production sites in most regions of the EU and they contribute to employment and wealth in every part of Europe, be they coastal areas (shellfish and marine fish farming) or inland areas (freshwater aquaculture). The

---

12 According to their Operational Programmes for the European Fisheries Fund, a number of Member States expect a further increase in national fish consumption levels (e.g. BG, RO, CZ, SI, MT, DK) over the period 2007-2013.

13 Source: Eurostat EU-27 (2005).

14 Source: AND International; see Annex I.

aquaculture industry contributes to the development of regions, be they peripheral and rural areas or more urbanised zones (e.g. with the development of closed recirculation systems).

The aquaculture sector also makes an active contribution to the conservation of the environment. As users of high quality water, fish and shellfish farmers actively ensure that water quality is maintained by the authorities responsible and other users. Extensive aquaculture in freshwater or along Europe's coastlines is also a major player in the conservation of wetlands and the preservation of the high biological diversity found in these somewhat fragile natural areas. The overall area of freshwater farming ponds in the EU-15 was about 60 000 ha, but since enlargement of the EU in 2004, this area for the EU-27 represents over 340 000 ha.[15]

2.4. What is the problem and why is action required?

2.4.1. The "2002 aquaculture strategy"

In 2002, the European Commission presented a Communication on a Strategy for the sustainable development of European aquaculture (COM(2002)511 final).

As part of its vision for the future, the 2002 Strategy aimed at aquaculture "*reaching the status of a stable industry, guaranteeing long-term secure employment, being able to cope with the main problems identified while ensuring health and environmental protection"*.

This vision also stated that "*Aquaculture in the EU had developed well in the last two decades, and this was partly allowed by the many Community initiatives that have been taken to support this sector. The Union had already a vast legal armoury on aquaculture, and activities to enhance the legal framework were progressing. However, there was still room for further improvement, and the recent slowdown of growth had to be addressed"*.

In this 2002 strategy, the Commission defined three objectives, namely:

– guaranteeing the availability of products that are healthy, safe and of good quality, while promoting high animal health and welfare standards;

– ensuring an environmentally sound industry;

– creating long-term secure employment, in particular in fisheries-dependent areas.

This latter objective was particularly important in political terms at the time of adoption of the 2002 Communication for a Strategy for EU aquaculture, as this period coincided with a major debate within the Council and the European Parliament on the Commission proposal tabled earlier in 2002 for a reform of the Common Fisheries Policy (COM(2002)185 final), and particularly its possible consequences on jobs losses in the fisheries sector.

The strategy recognised that the employment objective was ambitious and foresaw an increase of 8000 to 10000 Full Time Equivalent jobs in aquaculture over the 2003-2008 period. However, the 2002 Strategy also highlighted that the success of this objective would depend on four sub-objectives:

---

[15] Laszlo Varadi;"Extensive aquaculture in freshwater and its contribution to rural development"; November 2007. See: http://ec.europa.eu/fisheries/meetings_events/events/archives/events_2007/151107/varadi.pdf.

– Increasing the European Union's aquaculture production growth rate to 4% per year.

– Solving the conflicts for space that were hindering the development of aquaculture in some areas.

– Promoting market development.

– Improving governance in the aquaculture sector.

To address the main problems and challenges for this sector, this strategy proposed a number of measures to be taken at different levels by different parties: the Community, Member States and also economic operators.

2.4.2. Evaluation of the "2002 Aquaculture strategy" and lessons learned

General considerations

In essence, the EU-level measures identified in 2002 consisted of establishing (i.e. completing or reviewing) a regulatory context to ensure a high level of environmental, consumer and animal protection while creating a supportive framework to encourage the sustainable development of aquaculture (through fisheries structural funds in particular) and to stimulate research and innovation (through Community Research Programmes).

One of the major strengths of this strategy was certainly its political impact. This 2002 Communication was welcomed by the Council and the European Parliament and by all stakeholders in general. It was the first time that the aquaculture sector had been at the forefront of a debate at EU level.

However, as will be further expanded in this report, one of the prime weaknesses of this strategy may have been in defining social and economic growth targets at EU level for a relatively new economic sector with a variety of sub-sectors that was largely dependent on a fast changing market environment and a legal and administrative framework that relied on actions and decisions falling primarily within the responsibility of national or regional public authorities, and on decisions of economic operators, including consumers.

Main deliverables

At the beginning of 2007, a simplified mid-term assessment of the strategy allowed to draw the following main conclusions.

The actions identified in the 2002 Strategy as falling under EU responsibility had been launched. Initiatives of a legislative and financial nature that were put forward and in some cases implemented consisted of:

– amending the Financial Instrument for Fisheries Guidance (FIFG) in 2004 and providing additional support measures for a sustainable aquaculture sector. The FIFG thus allowed Member States to support a number of measures in line with the objectives of the Strategy, not only towards more production where there were good market prospects (e.g. measures to support investment or innovation in new aquatic species or species with interesting market prospects), but also towards increased environmental protection (e.g. development of techniques which substantially reduced environmental impacts; adhesion to Eco-Management and Audit System), plus measures relating to public health issues

(particularly in the shellfish sector in the case of toxic algal blooms) and projects promoted by the professional organisations, notably small-scale studies and research projects;

– adopting the European Fisheries Fund[16] for the 2007-2013 period. This builds on the same objectives and provides general support for the same type of measures (even additional support in some cases, such as aqua-environmental measures and animal health);

– establishing EU rules to prevent risks to the environment due to the use of "non-indigenous species" in aquaculture;[17]

– establishing EU rules on organic farming[18], including for aquatic farming;

– revising the EU "veterinary pharmaceutical package"[19] in 2004;

– revising the EU "animal health and disease control package" in aquatic animals[20] in 2006;

– revising and updating the "food hygiene package and consumer safety legislation" that also applies to aquatic food;

– pursuing a supportive research policy (under the 6th Framework Programme) followed by the launch of the 7th Framework Programme.

Other non-legislative initiatives of interest to aquaculture were also set in motion (notably the follow-up to the recommendation on integrated coastal zone management and the development of the new maritime policy). Further analysis – as announced in the 2002 strategy – did not prompt the Commission to consider that there was any need to develop any further specific legislation (notably in the case of GM fish or the risks of escape in aquaculture).

Contribution of theses deliverables to the objectives

The above deliverables all made a significant contribution to two of the strategy's objectives, namely:

– guaranteeing the availability of products that are healthy, safe and of good quality, while promoting high animal health and welfare standards;

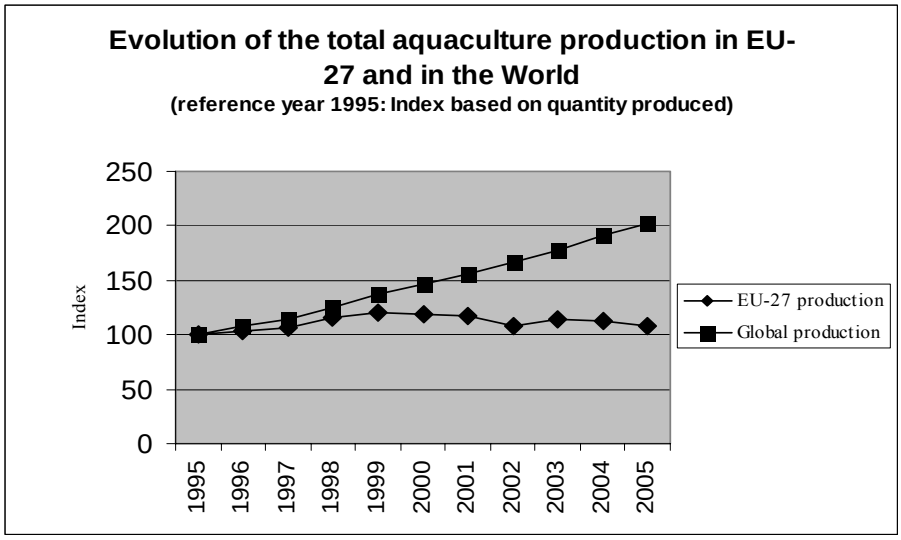
– ensuring an environmentally sound industry.

As stated above, these objectives were not only achieved through additional or reviewed legislative measures. The FIFG provided financial support for priority measures in aquaculture geared to environmental protection, animal health and welfare, consumer protection, as well as investment in innovation and production (notably for new species or production of species with good market prospects). Eligibility for FIFG support was to last until the end of 2008. Moreover, FIFG-supported research projects measures would only deliver several years after the financial framework had been put in place.

16 Regulation (EC) No 1198/2006.
17 Regulation (EC) No 708/2007.
18 Regulation (EC) No 834/2007.
19 Regulation (EC) No 726/2004 and Directive 2004/28/EC.
20 Directive 2006/88/EC.

As far as the 2002 objective of creating additional employment between 2002 and the end of 2008 was concerned, data on employment in aquaculture were not available on a regular basis. A first study was launched in 2004,[21] and a new assessment should have been made as from 2009 to assess employment trends during the period defined in the Strategy. In parallel, as regards a wider monitoring of the evolution of the sector at the EU level, the Commission presented proposals for improved monitoring of indicators in the aquaculture sector (new proposals for the collection of statistics and data on aquaculture[22]).

However, statistics on the volume of aquaculture production were, and continue to be, regularly available. As shown in the preceding chapter, monitoring of these data demonstrated that the prospects for average annual total growth of 4% in Community aquaculture production - identified as a necessary condition to increase the total number of jobs in this sector - had not materialised. At the same time, worldwide aquaculture production continued to grow at a rate of close to 7-9%, similar to the annual growth already observed between 1995 and 1999 (see figure below).[23]



This general stagnation of the overall EU production is not however reflected evenly across all the main aquaculture subsectors and in all Member States. Production of marine finfish species (notably sea bass and sea bream in some Mediterranean countries,) continued to increase in general (with some annual variations), while a general decline was observed in a number of freshwater finfish species and shellfish, which make up about half of total volume of EU production. Financial assistance provided by the Community to investment in aquaculture, designed to act as a catalyst for investment and start-up and to encourage European investors, has certainly stimulated growth in production, particularly in sea bass and sea bream. However, as required with Community funds, grants of this kind are only made available where there are good market prospects and should not be allocated where there is a threat of overproduction. Moreover, many of the measures eligible under the FIFG are for non-production support (i.e. to increase environmental protection, to develop organic production, to improve consumer protection, etc.) and do not necessarily convert into changes in the volume of production.

---

21 Employment in the fisheries sector: current situation (FISH/2004/4);
See http://ec.europa.eu/fisheries/publications/studies/employment_study_2006.pdf.

22 COM(2006)864 final and COM(2007)196 final**.**

23 According to recent communication from the FAO (in "fish-farmer" magazine; Nov/Dec 2008), there are already signs that the rapid growth in the sector at global level is also starting to slow down (6% a year from 2004-2006).

As a result of this overall stagnation, total EU aquaculture production made up a mere 2% of the worldwide aquaculture production in 2005, which is well below its 4% share in 1996 and far less than the EU's worldwide share of wild fish production (6.1%) in 2005.

In conclusion, a simplified mid-term evaluation of the 2002 Strategy for aquaculture indicated that one of its main objectives in terms of production growth prospects and job creation would not be achieved: overall EU aquaculture production does not benefit from the growth opportunities and economic prospects of this sector at a global level. As a consequence, the EU's dependence on fish and shellfish imports, much of it farmed, is on the increase.

In view of this general problem, the Commission initiated a broad consultation exercise in 2007 on the opportunities and challenges of European aquaculture. This tied in with the collection of additional information and figures, which made for a more thorough evaluation of the situation, its main influencing factors and the major drivers of the problem, which are further described in section 2.5.

2.5. Main factors influencing the development of the aquaculture industry and underlying drivers of the problem

One of the aims of the consultation exercise in 2007 was to provide an update of the main challenges facing the aquaculture industry. Annex II contains an overview of the outcome of this consultation exercise.

To sum up, the Community aquaculture sector still faces a series of obstacles and challenges which seriously affect production. The high Community standards put European aquaculture at the forefront of sustainable development in the world, in terms of both social and environmental impacts, but combined with other drivers, particularly economic and market ones, it makes it more difficult to compete price-wise with third-country producers (especially in Asia and South America where aquaculture production growth is the highest in the world). The consultation process emphasised the need to unlock the potential of European aquaculture and to make full use of its assets and innovative capacity. Farmers may leave the business if it is no longer sufficiently profitable or if it is not given due recognition of its values, notably in structuring rural areas and preserving their environmental features. Significant challenges also lie ahead for the aquaculture sector because of the intense competition for space and access to water it faces with other economic developments or societal demands. There is generally a need for better coordination of existing policies and for some challenges to be dealt with at EU, national and local levels.

As regard issues that are within the remits and responsibilities of public authorities, the various branches or sub-sectors of the Community aquaculture industry generally face the same challenges, although not necessarily to the same degree or under the same form depending on their specific needs. These challenges also depend to a large degree on the business environment established at national or local level.

In addition to the Community financial support framework (FIFG and EFF), which allows Member States to contribute to a number of policy objectives regarding aquaculture, as referred to earlier, there are many other factors and policies that influence the development of aquaculture in the EU. Although some are inherently interdisciplinary or cross-cutting in nature, these main factors and drivers are as follows:

2.5.1. The aquaculture industry in the EU needs to prove it is environmentally sustainable, while also being highly dependent on the availability of primary natural resources.

The **EU has put in place a wide range of legislative measures**, often of a horizontal nature, to ensure that the development of economic activities, including aquaculture, is sustainable from an environmental point of view. As announced in the 2002 Strategy, these provisions have been completed by specific rules on the use of "alien species" (i.e. non-indigenous aquatic species) in aquaculture,[24] in order to prevent any negative impact on the environment, and to ensure a level playing field in the EU regarding authorisation given in Member States for such use.

Addressing the environmental effects of aquaculture such as eutrophication, on-growing of wild-caught fish (tuna, eels), risks created by escapees, alien species or moved and restocked fish, is a considerable challenge for the aquaculture industry.

Numerous **EU-funded research projects** have already allowed experience to be gained and knowledge to be improved to address specific environmental problems and to reduce the environmental impact of aquaculture or to enhance the basis of an ecosystem approach. Major environmental impacts of aquaculture have been associated with uneaten feed, fish faeces or dead fish, and especially high-input/high-output intensive systems, the effects of which include discharge of suspended solids, and nutrient and organic enrichment of recipient waters resulting in the build-up of anoxic sediments, changes in benthic communities and eutrophication. However, the effects of fish farm effluents have been rather extensively studied and do not appear to be as far reaching as initially feared.[25] The ECASA research project,[26] for example, part of which was to develop a toolbox for marine aquaculture environmental impact assessments, studied the effects of fish farming in the Mediterranean and found that siting cages at a reasonable distance from *Posidonia beds,* a natural habitat type to be protected under the Natura 2000 network (Directive 92/43/EEC), could be compatible with the objective of conservation of this priority marine natural habitat.

Another environmental impact often mentioned in relation to aquaculture is escaped fish. There have been many research projects carried out on the potential impact (interbreeding with wild population; spread of diseases; competition for living space, etc.) of escaped farm fish.[27] Efforts are currently geared to minimising the number of escapees, especially through improved cage technology, through legal requirements for monitoring and reporting and through proper management and compliance with codes for practice for recapture of escapees.[28]

The aquaculture industry is also very active in limiting any negative impact on the environment, as demonstrated for example by the set-up of **Guidelines or codes of good practice** at European,[29] regional[30] and local level.[31]

---

24 COM(2006)154 final.

25 Institute of Aquaculture, Stirling University, UK: "response to the EU consultation document on the opportunities for the development of Community aquaculture".

26 See http://www.ecasa.org.uk/.

27 See, for example, FP6 research projects such as GENIMPACT (genetic impact of aquaculture on native populations) or IMPASSE (invasive alien species in aquaculture).

28 http://www.euraquaculture.info/files/consensus_brochure_web.pdf.

29 See, for example, the code of conduct developed by the Federation of European Aquaculture Producers (FEAP) *(http://www.aquamedia.org).*

30 See, for example, "Guides for sustainable development of Mediterranean aquaculture – interactions between aquaculture and environment"; BIOGES & IUCN workshop – Las Palmas, 26-28 October 2006.

31 See, for example, the "Association of Scottish shellfish growers Code of Good practice" - Oct 2005; or the "Code of Good practice for Scottish Finfish aquaculture"- Jan 2006.

Extensive aquaculture is also usually seen as an environmentally friendly way of producing fish, especially with regard to its role in wetlands and biodiversity conservation. However, extensive finfish or shellfish aquaculture can be subject to intense predation from protected birds[32] and there are often claims of insufficient management of such conflicts.

Aquaculture is an efficient user of water; land-based farms return nearly all of the water downstream of the abstraction point while sea water passes through cages. Technologies for cleaning water (removing wastes and contaminants) are already available, but the further development of new technologies to decrease effluent is also likely to be significant.

The farming of fish is also an efficient user of feed, which makes aquaculture rank highly when compared with traditional terrestrial animal farming. Aquaculture does not only provide high quality protein and other necessary dietary ingredients (e.g. unsaturated fatty acids), but farmed carnivorous fish convert manufactured feed into edible flesh with maximum efficiency. Farmed salmon convert approximately 1.2 kg of feed into 1 kg of fish, while, on a comparable basis, poultry converts between 3 to 5 kg of feed into 1 kg of flesh and pigs require approximately 8 kg of feed to make 1 kg of flesh.[33]

However, as a "new" industry, a major problem for aquaculture is that it also feels the **consequences of societal trends** more acutely (precautionary approach) and aquaculture may not always be seen as an equal player with other industries, including terrestrial animal farming.

In this context, **Member States may establish their own additional environmental protection rules** (provided that the EU environment level is not undermined and that the Treaty is respected). This "gold-plating" of environmental law may create additional obstacles or administrative burdens for the aquaculture industry. On organic discharge to waters, for example, some national environmental legislation is claimed to make it more and more difficult to obtain new licences for aquaculture farms, or even to renew licences for long established farms, in particular in certain northern Member States. On nature protection, for example, there is still an important debate going on in several Member States (particularly NL) on whether some aquaculture practices can continue to exist in Natura 2000 areas or on the excessive use of the precautionary principle.

At the opposite end of the scale, **aquaculture production is also highly dependent on a high quality environment**. This is not only valid for farming fish species such as Salmonids, which are very demanding in terms of water quality and oxygen, and have to face increased competition for scarce water resources (in particular from agriculture, urbanisation, etc.), it is an increasing concern for most aquaculture sectors, especially in view of the possible consequences of global warming. As such, fish producers have a strong interest in protecting and managing the water on which their activity depends. This is even more the case for shellfish producers, who are a very important interest group and advocate high sea water quality standards.

Because of possible changes in sea water conditions, shellfish farmers are already frequently faced with harmful algal blooms that cause severe economic damage (direct public health threats and also subsequent loss of image among consumers). Shellfish farming can also be excluded from the market because of microbiological risks, sometimes due to insufficient management and control of environmental pollution in production areas. The Directive on the quality of shellfish waters has been instrumental to shellfish producers in having Member States take the necessary measures to

---

32 Directive 79/409/EEC.

33 CONSENSUS project – see http://www.euraquaculture.info/index.php?option=com_frontpage&Itemid=1.

ensure that the sector benefits from access to the high quality water needed to produce safe food. In future, proper implementation of the Water Framework Directive and the Marine Strategy Directive should be instrumental in ensuring high quality water. However, the fact that the Water Framework Directive repeals the Directive on quality of shellfish waters in 2013 is creating some legal uncertainty on the protection of new shellfish growing areas, thus triggering significant concern among producers about their future prospects.

2.5.2. The aquaculture industry must produce safe and healthy aquatic food.

The aquaculture industry must produce **safe and healthy aquatic food for the consumer** and comply with all EU legislation to that end. This challenge is not only fully shared by the industry; it is seen as a sine qua non for their business and its image.

In this context, a number of remaining problems were raised during the consultation process, with specific differences between shellfish and finfish production, which are inherent in the biology of these groups of animals and in the production methods. However, all the aquaculture sub-sectors call for **measures that are science-based** and for **level playing field** to be ensured for all forms and sources of aquatic food.

The aquatic environment directly impacts on the potential safety for consumers of water-filtering molluscs, in particular as regards the risk of concentrating bacteria and viruses found in waters, or natural biotoxins produced by unforeseeable toxic algal blooms. To guarantee a high level of consumer protection, therefore, the competent authorities have an important responsibility for addressing such risks, not only by means of preventive measures and requirements to protect water quality, but also through surveillance and market prohibition where necessary. However, closing market access to products originating from a given shellfish growing area on the grounds of potential risks to consumers has significant economic consequences on the shellfish business. Scientifically solid identification and characterisation of these risks is therefore required, as is a level playing field.

Regarding microbiological risks, some producer organisations have developed risk assessment models and contingency plans to deal with pollution risks that often develop in coastal areas after heavy rainfall and flooding of inland waters, but, as already mentioned in the previous section, the repeal of the shellfish waters quality Directive by 2013 is cause for major concern. In addition, shellfish producers consider that changes introduced a few years ago in the mouse bioassay test to check for the presence of marine toxins in molluscs have led to an increasing number of "false positives", with significant subsequent economic losses, without increasing the apparent level of protection afforded to consumers. According to the producers, this also leads some national reference laboratories not applying the reference control methods the same way, leading not only to different ways of implementing EU law, but also to the absence of a level playing field for operators in the Member States.

Where finfish aquaculture is concerned, the **EU feed law package**, through restricting the use of animal by-products, assessing the safety of feed additives or preventing contaminants, helps to give full guarantees to consumers by addressing risks all along the food chain. However, this may create economic disincentives or the absence of a level playing field if some of these restrictions are not, and cannot be made compulsory outside the EU (e.g. some rules on feeding fish with fish products are not applied outside the EU, but the aquaculture products derived from fish fed under these different conditions can enter the EU market).

2.5.3. The aquaculture industry in the EU must comply with strict Community rules on animal health, while ensuring a high level of animal welfare.

Optimal health in farmed animals (disease and parasite control) is necessary to meet their welfare needs. However, good health and husbandry conditions suited to the physiological needs of farmed animals are also prerequisites for optimal growth and production performance. Animal health and welfare is therefore intrinsically linked to business performance. Guaranteeing the welfare of farmed fish also contributes to a better image for the aquaculture industry. Progress continues to be made and Community research programmes play an important role in numerous areas, such as seafood quality and safety, welfare of aquaculture animals, and disease control.[34]

The legislative framework for **disease control** in aquatic animals was subject to a full review in 2006[35] and is being developed through a number of implementing measures. This new package on the health control of aquatic animal was generally welcomed by the industry, but specific problems had arisen for some specific provisions because of the possible economic and operational consequences for given business sectors. These problems are usually of highly technical nature and relate in the main to the list of diseases covered by the Directive, the risk management to be applied for possible vector or susceptible species, and also specific measures taken at a national level. There is also a constant need to revise and update Community legislation on animal health in aquaculture to bring it into line with new situations and scientific progress. Some stakeholders feel that some of these problems come from the fact that diseases in aquatic animals are of less interest to and less dedication by the public authorities compared to diseases in terrestrial mammals or birds (e.g. BSE, avian flu, foot and mouth disease, bluetongue).

As far as **animal welfare** is concerned, the EU legal framework for the welfare of farmed animals may also cover farmed fish, but it does not provide specific standards. However, some existing provisions of a general nature are neither appropriate nor necessarily properly implemented because they have been developed on the basis of approaches taken for terrestrial animals. For example, the Regulation (EC No 1/2005) on transport provides that animals should be fed during transport, however feeding fish prior to or during transport quickly leads to poor welfare and death of the transported animals, mainly because of changes in water quality in transport tanks. As another example, some fish producers noted during the consultation process that some training courses on animal welfare, as required for drivers, do not address the specific needs of the transport of fish. An important factor surrounding this problem is the fact that the scientific knowledge in fish is still very poor and, for some species, even lacking, making it difficult to establish sound practice.

In terms of health, prevention is better than cure, and this is also the motto of the EU Animal Health Strategy. Vaccine developments have proved to be real success stories in some aquaculture sectors (e.g. salmon), significantly reducing fish mortalities while also lessening the need for drugs. However, health problems continue to be a real challenge for sustainable aquaculture, because of an **insufficient science base** and the **lack of veterinary medicinal products** authorised for use in a given fish species (notably for high value brood stock or for the early sensitive development stage in hatcheries and nurseries). Additional difficulties stem from the need, as a prerequisite to using any veterinary medicine, to ensure that products that derive from treated farmed animals do not contain any residue that may present a risk to consumers.

---

[34] See, for example, FP6 Research projects such as WEALTH (Welfare and health in sustainable aquaculture), AQUAFIRST (genetic and genomic approaches for stress and disease resistance), EUROCARP (disease and stress-resistant carp), PATHMEDA (pathogens and parasites in Mediterranean aquaculture), PIMAQUABI (pathogens and immune responses of molluscs).

[35] Directive 2006/88/EC.

As announced in the 2002 Strategy, the veterinary pharmaceutical legislation was reviewed in 2004,[36] but this has only partly allowed the problem of insufficiency of veterinary medicines that can be used by the animal heath professionals to be addressed. Member States also set up a specific task force to deal with this issue, with a specific recommendation in 2007 to address this issue.[37] The regulatory framework for setting maximum residue limits (MRLs) of active substances in food is currently also under review.[38]

Part of the problem of the unavailability of veterinary medicines is down to economics, as the costs of developing and marketing a specific drug for a given disease and a given fish species may not be profitable for a pharmaceutical company. But the consultation exercise also highlighted the fact that aquaculture producers and their professional organisations, and even some parts of the animal health professional sector, generally lacked sufficient knowledge of existing possibilities. On the other hand, nor did a number of competent public authorities appear to be sufficiently aware of the practical aspects and difficulties regarding treatments in aquatic animals as compared with terrestrial animals (including the use of disinfectants or biocides to clean farming equipment and facilities). Legal and administrative provisions (notably at MS level) may therefore make for additional obstacles.

2.5.4. The EU aquaculture industry has problems with access to space and water.

The European natural environment provides very suitable conditions for growing a number of high value aquaculture species. However, the increasing **competition for space** is a major challenge for the further development of freshwater fish farming and aquaculture production sites in coastal areas. **Public acceptance** of aquaculture development in an area is often inversely proportional to the population density and especially the tourist attractiveness of the area. Extensive aquaculture in inland ponds and wetlands or in coastal lagoons also faces increased competition from other economic developments (urbanisation, agriculture, industry, tourism, etc.).

In these circumstances, **technological innovations** in farming systems provide the means for the aquaculture industry to maximise the value added per unit of space and/or water used, and to do so in a way that reassures regulators and the general public that aquaculture activities are safe and well managed. Closed recirculation systems have been developed for some years now and these interesting developments may pave the way for further expansion in other locations, provided they are economically competitive (not only because of higher investment requirements, but also often higher running costs). Furthermore, as maritime activities continue to thrive, there will be increasing competition for the use of space while the needs of the local population and the protection and conservation requirements of the marine environment have to be respected. Moving aquaculture offshore is also seen as a possible way to avoid the conflict for space in coastal areas and reduce the environmental impact, but the promises of such technology will only be fulfilled through further research and technological improvement[39] and economic considerations.

The competition for space is holding back the development, or even the maintenance, of all forms of aquaculture. The uncertainty on possible siting and the lack of guidance and reliable data for the possible location of an economic activity and its continuity over time (because of the need to renew

---

36 Directive 2001/82/EC as amended by Directive 2004/28/EC.

37 http://www.hma.eu/203.html http://www.hma.eu/uploads/media/TF_Report_Availability_Vet_Medicines.pdf.

38 Cf. COM(2007)194 and its impact assessment, with the special focus on availability of veterinary medicines SEC(2007)484 & SEC(2007)485.

39 See, for example, FP6 Research projects such as GRRAS (growth retardation problem in recirculation aquaculture systems), SUBFISHCAGE (development of a cost effective submersible cage system)….

licences) creates uncertainty for investors, increases the risk of conflicts and means lost opportunities to benefit from synergy between aquaculture activities and protection of the aquatic environment.

2.5.5. The EU aquaculture industry operates within a highly competitive and market-driven business environment.

The aquaculture industry operates within **a highly competitive and market driven business environment**; to which the above factors contribute positively or negatively. In this context, the capacity of the sector to develop and be competitive on the EU and international markets depends on its ability to be cost-effective and to offer products that meet demand-side expectations in terms of quantity, time to market and quality. Consumer protection, animal welfare and environmental considerations are crucial for the image of aquaculture and possible demarcation of its products (labels) in the minds of European citizens and consumers, and also for the way this industry is seen by the public authorities.

In addition to the points described above, a number of other factors affect the economic performance of the aquaculture sector; these are illustrated in the paragraphs below (more detailed information is provided in Annex I).

Competition with imported fish

As referred to in section 2.2, the demand for aquatic food is on the increase. In the EU this demand is largely met by imports of fish, much of which is of farmed origin. As an illustration, EU imports of farmed fish and shellfish increased from about 351 000 tonnes in 1999 to about 1 272 000 tonnes in 2007 (while exports of the main species increased from approximately 30 000 to 67 000 tonnes over the same period). While farmed salmon accounts for most of this increase as regards marine species, the growth was even more spectacular in low-price freshwater farmed fish (imports of freshwater fish increased from about 2 100 tonnes in 1999 to over 393 000 tonnes in 2007, mainly due to imports of *pangasius* from Vietnam – see Annex I, Tables 6 and 7).

These low-price imports compete directly with EU fish production. Moreover, consumer awareness on these new imported products and their production methods (from a health or environmental viewpoint in particular) is very limited. Thus, the price factor remains the main driver of choice. In contrast, some European fish farming sectors have been facing repeated "bad press" in recent years, with the attendant damage to their image.

Structure of the EU aquaculture sector (size of firms, consolidation and vertical integration, access to finance and markets)

With the exception of salmon farming and to a lesser extent the sea bass and sea bream sector, the EU aquaculture industry is still largely dominated by SMEs. The total number of aquaculture firms in the EU was over 14 000 in 2005 (see Table 5 in Annex I); and EU aquaculture firms are not only small on average in terms of employees, but also in terms of turnover.

Horizontal consolidation and vertical integration (in particular hatcheries and fish feed production) has taken place and continues to take place mainly in marine fish production, the products of which are also by far the most widespread in terms of markets. Freshwater aquaculture and shellfish production are almost exclusively dominated by independent SMEs, probably due to the fact that these firms may have been established for a fairly long period, and that large-scale economies may not be as significant for the mass production of farmed marine fish.

The aquaculture production industry is still very fragmented and isolated from the other players in the marketing chain. This structure has also major consequences for the challenges faced by the industry. Aquaculture firms find it very difficult to access finance, possibly more difficult than SMEs in other economic sectors. Indeed, not only is aquaculture a relatively unknown sector to investors, like any new developing industry, early business failures may have given it a poor reputation in some Member States. Aquaculture also has a long production cycle (it generally takes at least 2-3 years to produce fish of marketable size), which means a significant time lag between a loan being taken out for site development and sufficient product sales to start making repayments.

In addition, a significant proportion of the assets of a traditional aquaculture enterprise lie in the value of the stock, which makes any disease or abnormal mortality in the fish stock a significant risk to the economic viability of an enterprise. The long production cycles also make it more difficult for producers to cope with market price fluctuations (because of the large amounts of imports or because of serious disruption in regional markets for some species due to the lack of a cohesive approach and insufficiently well planned production). The present credit crunch and financial crisis may certainly make these problems worse in the short and medium term.

Moreover, as for most SMEs, aquaculture SMEs have great difficulty in accessing markets, not only international or fast growing ones, but also large markets to which access is largely controlled by a very small number of powerful supermarket chains, especially where aquaculture producer organisations are not sufficiently established or efficient. Difficulties accessing the requisite information, complicated administrative procedures impossible to cope with by small aquaculture entrepreneurs, and problems of intergenerational transmission of small aquaculture enterprises were also highlighted during the consultation process.

Production costs and limits on fish feed

The problems the EU aquaculture sector has coping with lower labour or environmental protection costs in third countries (notably in South America or Asia) have already been mentioned. Similarly, high investment technologies and power-consuming production systems (e.g. indoor recirculation systems) push up overall production costs.

Shellfish farming has higher labour force needs than finfish farming. However, labour costs in finfish farming only make up about 10% of production costs, most of the operating costs being linked to feed (and depreciation of high investment production systems such as indoor farming systems) (see Table 8 in Annex I).

Regarding feed, the main aquaculture species wanted by the European market are carnivorous species. This raises the question of the possible non-sustainability of industrial fisheries that provide wild fish to produce the fishmeal and fish oil (FMFO) that is still indispensable for feeding carnivorous farmed fish and shrimps. But FMFO are available on the global market. While most of today's fish oil is used in aquaculture, fishmeal is also used to feed terrestrial farmed animals and pets.

The market price of FMFO in comparison with other types of feed raw material is a major factor influencing the final choice of animal feed manufacturers. The growth of aquaculture creates increased demand and higher prices for fishmeal and fish oil, as this resource is limited. The vast majority of aquaculture production on a global scale (herbivorous species such as carp and tilapia) uses feed with very little or no fishmeal. However, the increasing importance of omega 3 fatty acids content in aquatic food, which depend on the nutritional value of the feed given to the farmed animals, may also lead to an increase in the use of fish oil in this latter group of species.

In view of its important contribution to the image of aquaculture products, the fishmeal and fish oil producing industry is currently developing measures to demonstrate that their products are sustainable and originate from well and sustainably managed capture fisheries.

In addition, as FMFO are of limited availability, significant progress has been made in developing new feeding sources, new forms of proteins and omega-3 fatty acids, and in reducing the proportion of fishmeal and marine oils in the commercial diets of species such as salmonids and shrimp (although there are limits to these reductions because of the basic physiological needs of carnivorous species).

The pros and cons of using substitute fishmeal and fish oil in fish diets have to be addressed, given that consumer perception also drives the needs of the sectors. Krill is often quoted as one of the new marine resources that may become an alternative to fish as a source of marine oil and meal, but, in the light of its particular importance to the ecosystem, views differ as to whether it can provide a significant fraction of feeding material in the future. Vegetable protein concentrates have already made for significant reductions in the fraction of fish protein in the feed of some species (e.g. salmon, shrimps), but this should not just be seen in terms of physiological needs, production performance and environmental impacts (potentially increased effluents from fish farms). As regards the increasing share of GM plant protein on the market, consumer information and choices will be the drivers of whether the aquaculture industry and the fish feed industry consider of using GM plants as a substitute for fishmeal or fish oil.

Importance of R& D

Domestication of aquatic animals is far from being achieved and the aquaculture industry needs significant additional knowledge. The same goes for farming and production techniques. The need for continued research and technological development is crucial for the competitiveness of the EU industry, particularly in the context of competition with other parts of the world.

However, as the EU aquaculture sector is mainly composed of SMEs, it is very limited when it comes to undertaking sufficient research and development and putting innovation into practice off its bat. Since some companies tend to grow in size, there is also a trend towards company-led research. In 2008 industry leaders established a European Aquaculture Technology and Innovation Platform (EATIP), in a bid to maintain its world leadership, to provide a strategic vision and to define priorities for the European aquaculture sector with regard to research and technological development.

Community research programmes have been instrumental in putting EU aquaculture at the cutting edge of technological development. FP7 should also help to continue this trend. However, the consultation exercise in 2007 also highlighted a number of weaknesses that stopped the sector from maximising the benefits, these being insufficient coordination of national and Community efforts, insufficient involvement of economic operators in the setting of research priorities and a insufficient transfer and dissemination of RTD results.

2.5.6. The aquaculture industry has to operate within a governance framework that is still far from being optimal.

The sector is clearly in need of a **level playing field** and **improved governance** at EU, national and local level. In most member States, aquaculture producers have established professional organisations to represent the sector and certain subsectors (finfish vs. shellfish). A large part of the aquaculture industry is also well organised and represented at EU level, which allows it to dialogue

with the Community administration. The Advisory Committee for Fisheries and Aquaculture (ACFA), and in particular its working group II on aquaculture, has been a useful consultation body, but further improvements to consultation may be achieved and the Commission services are currently looking at how the ACFA works.

However, establishing the practicalities for the aquaculture business, such as **licensing** requirements and implementing general standards set at EU level, remains primarily a matter for national or even regional public authorities; but because of the varied dimensions of the aquaculture industry, and depending also on the administrative organisation of the Member States, it may also fall within the scope of a number of different administrations at different levels. National or regional gold-plating of environmental protection rules may create additional obstacles and administrative burdens for the aquaculture industry or may be used to justify a NIMBY ("Not In My Back Yard") policy at regional or local level. During the consultation process, some producers claimed that some Member States require more than 20 different licences and permits to open and run an aquaculture farm.

Better **awareness of the reality of this business** is part of this challenge, and the preparation of this strategy and the process leading to it may already have made a contribution in this respect.

A common denominator that emerged from the consultation exercise was the clear call for the Commission to renew the Strategy for aquaculture of 2002 and thus to take some form of political leadership.

2.6. Who is affected?

The first targets of this initiative are the Community and Member States public authorities, and other public administrations at regional and local level. The political leadership embodied in a strategy and the concrete measures identified to promote the sustainable development of European aquaculture make this initiative of high interest to all other key players, namely:

- Aquaculture producers are the most directly concerned by the above issues. They have to look for ways to farm aquatic animals to the high EU standards and market their products in a highly competitive environment. They need to be adaptable to rapid market changes – not only in the aquatic food they produce but also in feeding material on which they depend – and they need their business to remain profitable over time while coping with significant time factors (it takes several years to breed and growth aquatic animals) and depending on crucial external factors such as the quality of the water needed or climatic conditions.

- Aquaculture-related industries include technology or other material or service providing industries (e.g. pumps, aquaculture service vessels), but the most important is the fish feed manufacturing industry. While raw material for feed (fishmeal and fish oil, feed of plants origin) is available on the global market, the manufacturing of formulated fish feed is generally more regional and the fish feed industry usually develops close to the major aquaculture production areas.

- The final consumers and all European citizens (including NGOs and other associations representing civil society) have a legitimate interest in sustainable development. They demand high quality and healthy aquatic food products at the lowest price possible, while receiving all the information they need on these products to make informed choices.

- The intermediate and final players in the marketing chain (wholesalers, importers and processors of fish and other aquatic food products) are all important shapers of the market. Retailers,

especially supermarkets, are playing an increasing role in establishing the characteristics and prices of the aquatic food they sell. In this context, the capture fishing sector should not be omitted. As the aquaculture industry can guarantee a stable supply of standardised products in terms of size and quality, it can be seen as being in competition with or as a substitute for a declining fishing industry. However, in view of the ever increasing demand for aquatic food, aquaculture should first be seen as a necessary complement to capture fisheries to fill in the gap between supply and demand.

2.7. Does the EU have the right to act?

As illustrated in the previous sections, EU aquaculture is a business sector with multiple dimensions. It produces high quality and high value food. It plays an important role in wealth creation and in local and regional development, especially in rural and coastal areas. From a traditional and in some ways empirical activity, some fish farming sectors have developed into high-tech, cutting-edge industries, having the means when properly managed to cope with high levels of environmental protection.

The rationale for coordinated Community policy guidance stems from the multiplicity of EU policy areas, with their respective legal bases, which have an influence on the way aquaculture can develop and actually evolves:

- Aquaculture is first and foremost about farming of aquatic livestock: it therefore has to comply with the EU objectives of high productivity, equitable standard of living for farmers, stable markets, and security of supply (cf. Articles 32-38 of the Treaty). In concrete terms, aquaculture is part of the Common Fisheries Policy (Regulation (EC) No 2371/2002) and the Council decided in particular that specific EU support should be provided to aquaculture from the European Fisheries Fund (Regulation (EC) No 1168/2006).

- Aquaculture is about farming animals with the aim of producing food: the development of aquaculture therefore not only to meet the objective of ensuring a high level of protection of health and welfare of farmed animals (cf. Article 37 of the Treaty), it also has to be seen in terms of food policy; and aquaculture activities and products have thus to comply with the high EU food safety and consumer protection standards (cf. Articles 152 -153 the Treaty).

- The EU aims to ensure a high level of protection of the environment. Aquaculture is about the use of high quality natural resources, primarily water: it has to be sustainable and compatible with these high levels of environmental protection (cf. Articles 174-175 of the Treaty).

- Aquaculture is also about entrepreneurship and business development: it must therefore be seen as part of the Lisbon process. As an economic and commercial activity, aquaculture also has to abide by the rules of the internal market and trade and competition policies. It must also keep to the European objectives of economic and social cohesion, rural and regional development, employment, and education, etc. Aquaculture benefits from policy support instruments, particularly the European Fisheries Fund, and the Community Framework Programmes for Research and Technological Development.

- Finally, aquaculture is mostly about farming marine organisms: the development of aquaculture at sea and in coastal areas has to be on an equal footing with other activities, such as fishing, and also be seen in the context of the development of an integrated European maritime policy.

A Community Strategy should make for a common vision under which EU public authorities would take a consistent approach in the different policy domains, giving thereby also clearer perspectives to the sector as well to all citizens.

However, the factors shaping the aquaculture sector and the drivers described in previous sections also have a very clear dimension of subsidiarity. The development of aquaculture also fundamentally depends on the priorities and decisions taken at national and/or regional level, in accordance with the principle of subsidiarity. Issues such as setting stricter environmental rules, access to water and space, allocation or renewal of licences to operate an aquaculture farm remain fully within the remit of national and local authorities. Their standpoint and ways of governance, when implementing general EU approaches, are crucial to the economic prospects and actual development of aquaculture at regional and national, and hence at EU level.

3. WHAT IS THE OVERALL POLICY OBJECTIVE IN TERMS OF EXPECTED IMPACTS?

3.1. General objective

The overall objective of this initiative is to give political impetus and leadership at EU level, and thus to help unlock the potential for the sustainable development of European aquaculture. The aim is to identify the strategic principles that should drive the development of this sector. In this context it sets out a vision for this sector and the role of the public authorities in an effort to create the best environment in which the EU farming industry can make optimum use of its innovative capacities and further develop its contribution to the supply of healthy and high quality aquatic food to EU citizens, in full compliance with high environmental and public health standards. In this respect, it also aims to address a number of bottlenecks that the sector is facing today by way of possible action to be taken by the public authorities.

Given the primary role of entrepreneurs and markets in developing this sector and its diverse subsectors, however, and also the major role that national and local authorities play in shaping the development of aquaculture farms in the EU– notably licensing for production and access to space and water – the objective of this strategy is not to provide the aquaculture sector with advice on best economic choices, or to establish production or development targets for the sector at EU level.

3.2. Strategic and policy-orientated objectives

On the basis of the experience gained and the evaluation made of the 2002 Strategy, the strategic objectives for the sustainable development of EU aquaculture should be as follows:

* For the environmental pillar of sustainability: maintaining a high level of protection of the environment (in line with the 2002 Strategy).

* For the socio-economic pillar of sustainability: ensuring a high level of protection of consumers and of farmed animals, but moving away from the production-target-orientated objectives to give more focus to competitiveness in the sector and better governance.

As such, the strategic objectives of this initiative will contribute to both the **Lisbon agenda** and the agenda of the **Renewed EU Sustainable Development Strategy** (as adopted by the European Council on 15-16 June 2006),[40] in particular as regards the key challenges for sustainable production and consumption, conservation and management of natural resources and public health.

In view of the various challenges and problems facing the European aquaculture sector, as outlined in the previous sections, these strategic objectives should be met through a number of general policy-orientated objectives, in particular by:

– giving the highest priority to research and technological development;

– ensuring that aquaculture can compete on an equal footing for access to space;

– by contributing to the ability of the aquaculture business to cope with market demands;

– helping to ensure the presence of European aquaculture on the international scene;

[40] See http://register.consilium.europa.eu/pdf/en/06/st10/st10917.en06.pdf.

– ensuring that aquaculture has a low impact on the natural environment;

– providing the aquaculture industry with a high quality aquatic environment to match its needs;

– shaping an efficient animal farming industry, through securing animal health and animal welfare, addressing the need for specific veterinary medicines and providing high quality and sustainable feeding-stuffs for fish;

– ensuring consumer health protection and recognising the health benefits of aquatic food;

– improving governance in the design and implementation of policies and measures that influence the development of aquaculture, notably with the view to ensuring proper stakeholder participation, providing a level playing field and reducing the administrative burden.

Fixed time horizons to assess these strategic and policy objectives are not preset. However, the measures that may be identified as part of this initiative to address a number of bottlenecks facing the aquaculture sector relate to ongoing measures, some to new (mainly non-legislative) initiatives and some to medium-term initiatives, such as the review of EU financing instruments by 2012 and the reform of the CFP. All these measures should be delivered over a period of 3-4 years. If any of these measures requires the use of the budget, it would be within the present budget framework, and under the principle of "no new money".

In view of the governance-related dimension of these objectives and the major role of national and regional public authorities, the success of this strategy will first require it to be fully endorsed by the Member States (at all administrative levels).

Progress in delivering the various measures will be monitored, in particular within the framework of the Advisory Committee for Fisheries and Aquaculture, which provides a forum for regular consultation of all stakeholders. Monitoring will also cover the actual evolution of the aquaculture sector (mainly by way of the indicators established in 2008 within the new instruments on aquaculture statistics and data collection in the fisheries and aquaculture sector; see also chapter 7).

More specifically, the economic dimension of the sustainable development of aquaculture will be monitored by statistical production indicators (in terms of both the volume and the value of aquaculture production) and by the growth of this production vis-à-vis global production and its importance in terms of markets and trade.

The social dimension of aquaculture can be monitored through the level of employment in the sector, and through business structure indicators of aquaculture sub-sectors, notably in terms of the social roles of SMEs and the role of aquaculture in structuring coastal and rural areas. However, the collection of information on these indicators is primarily a national concern, and it needs to be recalled in this context that, in 2008, the Council did not include requirements for collecting data on freshwater aquaculture in the scope of the Regulation establishing an EU framework for the collection, management and use of data in the fisheries sector (Regulation (EC) No 2008/199).

Finally, as regards the environmental sustainability of aquaculture, Member States have to ensure that all appropriate legislation is complied with, including, where relevant, the monitoring of environmental quality indicators (e.g. water quality parameters in the case of water protection legislation). More generally, monitoring the increase in area dedicated to extensive aquaculture may provide a gross indicator of the positive role of extensive aquaculture in wetland conservation.

4. WHAT MAIN POLICY OPTIONS ARE AVAILABLE TO ACHIEVE THE OBJECTIVE?

This section focuses on the three broad policy options that were considered.

However, although the detailed drivers and challenges for the development of EU aquaculture cover a broad range of areas, this analysis does not scrutinise every specific option for measures to tackle each specific problem. It looks instead at the best approach for achieving the general policy objective. In addition, any individual legislative action that may be identified under this initiative would be subject to an own impact assessment as appropriate if subsequently taken by the Commission.

Option 1: Status quo (baseline option)

This option implies continuing with the current situation. This would mean developing a "business as before" approach, on the basis of the principles and overall policy objectives put forward in the 2002 Strategy for aquaculture. In other words, no new integrated initiative for European aquaculture would be taken at this stage, and no set of possible new measures would be identified.

Option 2: Developing a new Strategy for European aquaculture

This second policy option could reiterate the type of initiative taken by the Commission in 2002 and thus take the form of a document of a political nature setting out a Strategy for EU aquaculture (Communication from the Commission). This Strategy would provide a general vision on the prospects for this sector and set out the main principles and updated strategic objectives. In providing leadership in favour of the sustainable development of this industry, this political initiative would identify the need for action at EU, national and regional level, and call on the public authorities in the Member States to take action and help achieve those objectives. This Communication for a reviewed Strategy for Community aquaculture would serve as a basis for a continued debate with the other European institutions and the main players concerned from civil society. Endorsement of these principles and objectives would secure a high degree of political commitment and would give guidance to the Commission for possible further action.

Possible sub-options:

Sub-option 2.1: This would build on the existing strategy of 2002, keeping to the same principles and all its general objectives. It would mainly consist of complementing it by an updated set of measures to be taken by stakeholders in different policy areas to address the bottlenecks highlighted during the 2007 consultation and evaluation process.

Sub-option 2.2: This would be a renewed strategy, based on general principles but with reviewed and updated strategic objectives as identified under section 3 and based on the evaluation of the 2002 strategy. It would also include action to be taken by the public authorities in different fields to address both the bottlenecks highlighted during the 2007 consultation process and the general challenges that EU aquaculture may continue to face. In envisaging also some possible lines for future orientation of Community instruments, this option would allow sparking a debate with the other institutions and stakeholders on medium-term initiatives (e.g. possible priorities for Community financial support after 2013).

Sub-option 2.3: This would amount to developing a Strategy along the lines of sub-option 2.2, but include a parallel legislative proposal to amend the "aquaculture-related" aspects of the European Fisheries Fund, with the view to refocus and reprioritise the different possibilities to support

measures in the aquaculture sector to give it more leverage in one or the other of the environmental, social and economic facets of sustainable development.

Option 3: Developing a specific Community policy for aquaculture

The third option would be to develop the necessary provisions to allow for a fully fledged Community approach to managing EU aquaculture development.

This kind of "Community aquaculture policy" would concretise by taking the form of a single (but comprehensive) legal framework, to serve as an overall reference base, with legally binding objectives and principles to be implemented at EU and Member State levels to promote and manage the sustainable development of aquaculture in Europe. This could come somewhere between a Common Fisheries Policy (addressing only capture fisheries) and a Common Agriculture Policy (and its specific dimensions regarding the farming of terrestrial animals and products). It should include a comprehensive set of rules ranging from production-orientated objectives to market organisation, production standards, structural support, etc.

5. ANALYSIS OF IMPACTS

5.1. General considerations

Option 1: Status quo (baseline option)

The continuation of current EU policies and measures would continue to have an impact, with greater or lesser benefits to the aquaculture industry. As regards coordination, improved governance or implementation issues, it is difficult to anticipate what type of progress could be achieved over the long run at EU and Member State level, but the main impact of option 1 would be to lessen the pace of measures conducive to aquaculture development, and probably an increased risk of divergent approaches across Member States and regions.

Furthermore, as highlighted in earlier sections, this is compounded by several sub-problems afflicting the aquaculture industry in the current economic climate:

- problems of implementing and coordinating existing policies;
- gaps not properly addressed by established or planned measures; and
- need across the board for improved governance and a level playing field.

These problems will be left unattended. Therefore, one of the main negative impacts of option 1 would be not to address the remaining bottlenecks, which need action by the public powers and would mean that some of the barriers to EU aquaculture development would therefore remain. Another negative impact would be to keep with an objective that will not be achieved judging by how the sector has evolved since 2000 and considering that the market and business environment changes very fast.

Thus, by opting for Option 1, the Commission would be failing to respond to the quasi-consensus that emerged from the consultation exercise in 2007 for a review of the 2002 strategy; it would not therefore back up the political impetus given 6 years ago, which may have gradually slowed down since then.

This “inaction” may represent a missed political opportunity – or even a political failure – given the political support and EU leadership from the Commission called for repeatedly by a number of policy-makers (Members States, MEPs, etc.) and EU aquaculture stakeholders in the consultation process over the last 18 months.

Nor would maintaining the current situation make for a more consistent and coordinated approach to this sector at the Community level, including between the Commission‘s various Directorates-General with responsibility in this area. It could even give the false impression that no new legal or administrative burdens are being created or that no public money is currently available to steer development in this sector.

Option 2: developing a new Strategy for EU aquaculture

All European policies that apply directly or indirectly to aquaculture contribute to determine how Europe’s aquaculture business develops – or not. This alone is sufficient justification for defining a common vision for the sustainable development of EU aquaculture. Developing a new strategy will allow the underlining strategic objectives to be reviewed, and action to be identified to address some of the underlying problems highlighted above (cf. Section 2). This would make for a coherent approach, adapted to new and developing circumstances, and would address the present challenges facing the sector.

Reiterating a European initiative for aquaculture would also be of high political significance, especially in a sector where the principle of subsidiarity often prevails. The main added value of this option is to be found therefore in the political signal European Commission would be sending out to the other European institutions, to the industry and to the general public at large, namely, recognising the increasing importance of the aquaculture industry in providing the safe and healthy food that consumers want. The public authorities – particularly national and regional – should also recognise the economic value and socio-territorial importance of this sector.

In the light of experience with the 2002 Strategy and its assessment, however, the option of keeping the targets established in 2002 or setting new possible quantitative growth targets for EU aquaculture, as part of a new Strategy, was not regarded as right and has not be retained. This was not either called for during the consultation process. Indeed, aquaculture development also fundamentally depends on the priorities and decisions taken at national and regional level, according to subsidiarity principle. Issues such as access to water, competition for space, allocation or renewal of licences to run an aquaculture farm or the setting of stricter environmental rules are all within the remit of the national or local authorities, and their stance is crucial as regards the economic prospects for the overall aquaculture production at EU level. Moreover, the economic operators themselves have the prime role to play in the actual development of this industry, and hence on trends in terms of aquaculture production in the EU or competitiveness. Business structures and employment cannot be dictated by EU public authorities alone within such a Strategy. For all these reasons, sub-option 2.1 was rapidly discarded.

A general political initiative for a strategy for aquaculture could benefit from some "reinforcement" by a parallel proposal to change the current possibilities for EU financial support, in particular the fund designed to support the sustainable development of this sector, namely the European Fisheries Fund. If the new strategy is to review some of its objectives compared with 2002, the general aim of amending the EFF would be to review those provisions that have not sufficiently delivered or not contributed to the identified objectives in the past, or to amend the conditions for accessing EU funding to give more leverage to achieving some of the renewed objectives.

The rapid growth of seabass and seabream aquaculture in the Mediterranean, particularly in Greece, is certainly for an important part related to support made available by Member States using available Community funds. In other cases, financial support has gone into amplifying the environmental dimension of the aquaculture sector, without necessarily making significant changes to overall production. However, proposing to amend the EU financial support instrument specifically to review some of its provisions that may benefit the aquaculture sector would require a comprehensive evaluation of the results achieved to date and an assessment of the possible value and expected impacts of these changes. In this regard, the following additional considerations were made during this assessment:

– The use of the EU financing available for projects eligible under the FIFG was up to of 2008. Moreover, the amendments made to the FIFG in 2004 could not deliver immediately. A time for administrative adjustment was needed before new projects and measures could benefit from these provisions, and it would take several years for these projects to deliver. A full ex post evaluation of the FIFG was due to start as soon as possible after the end of implementation of the instrument, namely, in early 2009. It was thus felt neither proportionate nor cost-efficient to launch a detailed evaluation of the FIFG, already in 2007 or 2008 (or even only of the components that might have had an impact on aquaculture).

– Following the adoption of the new "European Fisheries Fund" at the end of 2006, the year 2007 and the beginning of 2008 was the period when the Member States only started to implement the first steps of EFF, namely, formulating national strategic plans and operational programmes. At such an early stage, it was not appropriate to change the conditions of the EFF. As a result, the "EFF aspects" of the broad stakeholder consultation exercise conducted in 2007 on EU aquaculture (see Section 1.2) focused mainly on the "governance aspects" of this first implementation phase by the Member states.

– Moreover, depending on the evaluation of the EU financial support instruments and their impact on a given objective, the option of refocusing EU support may be seen as being too ambitious and may not receive the backing of the Member States. Proposing this in parallel with a new Communication for a Strategy without sufficient consultation and debate would not be the right way forward.

In view of the above considerations, sub-option 2.3 was also rapidly discarded in the course of the assessment period, and sub-option 2.2 therefore remained the only valid sub-option to be further evaluated under Option 2.

It should be noted that the 2008 fuel crisis and the current economic crisis have not changed the above conclusions, which in any case are without prejudice to possible Commission initiative in the much wider and urgent context of addressing the economic crisis in all industrial sectors of the Community.

This option 2 for a new Strategy therefore focuses on the role of the public authorities, primarily at EU level, in designing their policies and shaping the way for sustainable development of European aquaculture. Option 2 sets out a vision, guiding principles and strategic objectives, as a framework in which the aquaculture industry should be able to develop in a sustainable manner, making it possible for its different branches to develop their full potential in the light of both their assets and their constraints. It identifies also possible action by the public authorities to address certain bottlenecks highlighted during the consultation and evaluation process.

Option 2 is expected to have a significant leverage effect in raising the importance and the strategic dimension of aquaculture at Member States and regional or local administration levels. Option 2 would accelerate the pace of EU and national action to establish the right framework conditions for aquaculture to fully develop its potential. By increasing the level of coordination and governance at EU and national level, by providing leadership, by recognising the value of EU aquaculture and by restoring confidence in the outlook for the aquaculture industry, Option 2 would give substantial added value to Community action, particularly in the following areas:

The cross-border dimension of the remaining specific problems of EU aquaculture: Section 2 above has highlighted a number of remaining problems that are hampering the development of EU aquaculture and clearly have a major cross-border EU dimension. The environmental challenge facing SMEs clearly also has, by definition, a cross-border dimension. Another example concerns market tools (e.g. labels) and recognition of the high value of aquaculture and its products, and the still rather low awareness of the public authorities and the public in general of this rather new, but very diverse industry. By virtue of its scale and scope, the EU level is best suited to fostering the three pillars of sustainability of this industry in these areas, be it from an environmental, economic and social point of view, and thus tackling negative cross-border externalities such as the lack of a level playing field.

Spill-over and synergy: For most of the issues mentioned above, the EU and the Member States each appear to have an important complementary role to play. In line with the Lisbon Strategy for Growth and Jobs, therefore, there is a strong case, for developing inter-linkages between national policies and coordinating their approaches to generate spill-over and synergy. Action taken by national public authorities in favour of – or against – their own aquaculture business has an impact on other countries' aquaculture development and affects the EU's internal and external markets. In such cases, purely regional and national views or strategies – or simply the absence of sufficient consideration of this sector by the public authorities – would be suboptimal: cross-border externalities and other prospects for the EU aquaculture business as a whole (and associated sectors, such as the fish feed industry or the technology-providing industry) would be largely overlooked. Aquaculture development is essentially interdisciplinary, and thus there is much potential for synergy between measures within or across policy domains, particularly within the new European Maritime policy and the European Research agenda. For example, better access to finance and innovation and skills, coupled with reduced administrative burden and increased entrepreneurship, is also intrinsically related to promoting the new "Small Business Act" for Europe.

Some issues clearly fall more within the remit of the Member States than others. This is typically the case of licensing procedures and allocation of access to space and water that influence aquaculture's growth potential. These problems are don national or regional legislation and are mainly outside the EU's jurisdiction. However, as stated above, Community leadership in promoting aquaculture may have significant leverage effects and can go a long way to unlocking such bottlenecks. Other useful action could consist of mutual learning and increased monitoring of the aquaculture industry and its various sub-sectors.

Finally, reviewing the strategy in the light of the present situation also means a renewed debate within the now expanded European Union. The 2002 Strategy for European aquaculture was discussed within the former EU-15 Members States and it was not part of the negotiations on the "*acquis communautaire*" that have since led to the two successive enlargements of the EU. A review of the EU strategy for aquaculture would now allow a debate at EU-27 level.

Option 3: Developing a specific Community policy for aquaculture

Option 3 basically embodies all the objectives of Option 2, but it builds further on Option 2 and establishes a comprehensive sector policy framework at EU level.

In relation to the objective of ensuring sustainable growth, the additional content of Option 3 is basically to set production targets at Community level.

Concerning the objective to increase competitiveness, many areas relevant to aquaculture development are mainly in the remit of the Member States, or even depend on regional and local authorities (e.g. space allocation and spatial planning, licensing and setting of associated requirements, regional development policy, etc.). Establishing an EU policy framework for aquaculture will require the EU assuming responsibility for a significant part of these areas. This would include setting market and production standards and rules, providing structural support, etc.)

On the objective of improving governance, Option 3 will require the EU to develop policies to promote harmonisation and a level playing field across the Member States.

Since business development in aquaculture in Europe also depends on the investment possibilities and willingness of entrepreneurs to invest, establishing a regulatory framework with principles, legally binding objectives and production targets to be met at EU and Member State level would appear to be in contradiction with the principle of subsidiarity.

In addition, the development of an integrated Community aquaculture policy initiated by the creation of a single legislative reference framework would require a fundamental review of the current EU legal architecture. Developing a single legal framework to encompass all the dimensions of this sector (production management, markets, financial support, environment, health, controls, etc.) would require a parallel comprehensive assessment and review of existing provisions relating to aquaculture under the Common Fisheries Policy set of legislation – and particularly the "basic CFP Regulation" ((EC) No 2371/2002). Such a fundamental change in approach to aquaculture at EU level would call for further parallel changes to the provisions developed under other EU Policies, e.g. the Common Agriculture Policy or the Animal Health Policy.

Moreover, developing a single legislative framework to encompass all the dimensions of aquaculture may also – logically – be accompanied by possible organisational changes in the internal structure and tasks of some Commission Directorate-Generals to ensure coordinated follow-up and best use of resources.

In the light of the above, Option 3 is not considered as being a viable alternative to tackling the problems identified at this stage. The fundamental questions raised in relation to the overall institutional set-up, including the consequences on subsidiarity, would have a negative impact that would outweigh any social, economic and environmental benefits resulting from this option. For these reasons, this option – which was only referred to in a few of the contributions received during the consultation process – is therefore discarded, before any more detailed analysis of impacts.

5.2. Possible action to contribute achieving the objectives and their incremental effect under Option 2

As described in Section 1.4, preparation of this initiative also looked at what could be done (or not) to address the main problems and challenges summarised in Sections 2.4 and 2.5. The table below provides an overview of possible action that would fall within the responsibility of the public authorities, and help achieve the different objectives identified in Section 3. These measures are all cumulative and complementary. Most of them are of non-legislative and could be implemented within 2 to 4 years.

Annex III of the report provides more detailed information about these possible measures and their incremental effect. It also provides information about possible action that was considered, but not pursued.

Problem/issue identified	**Possible action by public authorities**	**Actors**		**Objective being contributed to.**
		Commission	Member States	
• Not properly managed, aquaculture => negative **impact on the environment**	- **Monitor** developments regarding the problem of **escapees**	X	(X)	• Ensuring a high level of protection of the environment.
	- Pursue supporting **research** on interactions between environment and aquaculture.	X	X	
• **Aquaculture** is highly **dependent on water** resources of high quality • **Legal uncertainty** on guarantying shellfish waters quality after 2013	- **Ensure** that the level of **protection of shellfish waters is maintained** (2009 and onwards).	X	X	• Ensuring a high level of protection of the environment and a high level of public health. • Improving competitiveness and governance
	- **Enhance information** to ensure proper implementation of the Water Framework Directive (WFD) and of the Marine Strategy Framework Directive as regards aquaculture activities; Develop guidelines (possibly 2009-2012).	X		
	- **Assess** the need to review some parts of the **EU water protection legal framework** (possibly 2009-2010)	X		
	- Recognise the importance of fish and shellfish farmers in contributing to environment priorities; ensure **fair treatment to the aquaculture industry** and consider it an **equal player** with other economic activities.		X	
• **Aquatic environment**	- **Re-examine the situation** once EFSA has completed a full review of marine biotoxin related issues (2009-2010)	X		• Ensuring consumer health protection

directly **impacts on safety** for consumers • "**False positive"** safety **tests** lead to economic losses	- Support the **development of alternative methods** and standards for these detection methods.	X	X	• Improving competitiveness
	- Evaluate how to make **more widespread use of risk assessment and risk prevention tools**	X	X	
• **Scientific opinions** are addressing **only one policy issue** (related risks)	- **Continue to base** evaluation and assessments **on scientific advice** - Request **scientific advice to provide for a more integrated assessment** of fish related issues (including health benefits related to the consumption of aquatic food)	X		• Recognising health benefit of aquatic food contributes to both the competitiveness objective and the consumer protection agenda
• Specific problems related to some parts of the **aquatic animal health Directive** (2006/88) • Diseases in aquatic animals attract **low level of attention.**	- Keep under **review** (by 2011) the **list of important diseases for aquatic animals**.	X		• Securing animal health • Contributing to shaping a performing animal industry, thereby improving competitiveness.
	- **Assess additional guarantees** for some diseases taken at Member State level (2009-2010)	X		
	- **Pursue assessment of preventative measures** in relation to vector and susceptible species, on the basis of scientific advice and research.	X		
	- **Assess the present financial instruments available** to support measures dedicated to the health of aquatic animals (by 2011, as part of the action plan on animal health).	X		
• **Scientific knowledge in fish welfare** is still very poor. • Some EU welfare **legislation is not perfectly suited** to aquatic animals	- **Seek advice** on fish welfare **on a species-dependent basis**, and further promote animal welfare research	X		• Ensuring animal welfare • Contributing to shaping a performing animal industry, thereby improving competitiveness.
	- **Promote the need** for a species-dependent approach **in international fora** addressing fish welfare	X		
	- **Assess fish welfare issues in aquaculture** (by 2011) in order to evaluate the value of non-legislative or possible legislative measures, (2009).	X		
	- Propose **revision of some provisions of the "animal transport Regulation"**[41]	X		

[41] Regulation (EC) No 1/2005 on the protection of animals during transport and related operations

• **Lack of veterinary medical products** for fish • **Insufficient knowledge on practicalities and needs** (between stakeholders and public authorities)	- Adopt the proposal for a new **regulation on Maximum Residue Limits** (while seeking to ensure provisions of particular interest to aquaculture).		Council and EP	• Ensuring a high level of animal health and welfare • Contributing to the competitiveness objective
	- **Implement the recommendations made by the "Availability Task Force"** (2009-2010).	X	X	
	- **Improve information exchanges** between the competent authorities and the different stakeholders of fish health (2009-2010).	X	X	
• Increasing **competition for space and water** (and "gold-plating" of environmental protection rules) => creates **uncertainty for investors.**	- Promote **Integrated Coastal Zone Management** and launch action as foreseen within the **roadmap for maritime spatial planning**[42] (2009).	X	X	• Improving competitiveness and governance • Optimising environmental performance by means of appropriate assessments and optimal location of farms.
	- **Develop marine spatial planning systems**		X	
	- Ensure that **"inland" spatial planning** fully integrates the needs and values of freshwater aquaculture.		X	
• The aquaculture **industry remains very fragmented** and isolated from the other players in the marketing chain. • The aquaculture industry is facing **business challenges** and is **competing within a global market**	- Assess and address **needs of the aquaculture** sector within the context of the **review of the market policy** of fisheries and aquaculture products (2009).	X		• Improving competitiveness and governance (enabling the aquaculture business to cope with market demands)
	- Assess and develop the **value of labelling possibilities** (to allow the aquaculture sector to benefit from compliance with high environmental standards).	X		
	- Envisage a **possible simplification and review of the custom nomenclature** (2009-2011).	X		
	- Continue **international cooperation on labelling and aquaculture certification** issues, notably with the FAO.	X		
	- Make **full use of the possibilities available under the European Fisheries Fund** to support market initiatives, promotions campaigns, etc.		X	

[42] COM(2008)791 final.

• Numerous **red tape and administrative challenges** => creates uncertainty and discourages investment	- **Raise awareness** in the aquaculture sector of the "**Small Business Act for Europe"**[43] and **implement** it (e.g. simplify licensing procedures for aquaculture operations through e-government and one-stop-shop solutions (2009-2012).	X	X	• Improving governance (and thereby also competitiveness).
	- **Member States** to ensure that licences are allocated for reasonable periods of time compatible with the specificity and the needs of aquatic farming, and with clear conditions for renewal, clear procedures and established time limits to decision.		X	
• Aquaculture still has a rather **negative image**	- **C**ontribute to meeting the need for information (in particular under the possibilities available in European Fisheries Fund).		X	• Contributing to the objective of better governance, and improving competitiveness.
	- **M**ake sure that information (e.g. outcome of studies supported by public bodies) is made publicly available (Internet).	X	X	
• **Availability of fish meal and fish oil** is limited • **Absence of level playing field** if EU restrictions on feed cannot be applied outside the EU	- **Promote research** for feed substitution and for optimisation of feeding regimes	X	X	• Ensuring that feeding-stuffs for fish are both from sustainably managed sources and of high quality, thereby contributing to both the competitiveness objective and the sustainable development agenda.
	- Ensure that EU feed law is developed in a way that allows **maximising the use of high value raw material while preventing food-borne risks** and act towards **increasing the availability of necessary feed additives** for fish.	X		
	- **Contribute to adequate information** on feeding behaviour and needs of fish to ensure that EU legislation adequately covers the needs for aquaculture development	X	X	
• Sill **very limited science base** of aquaculture • **Insufficiency of coordination,** of **involvement** of economic operators and **low level of transfer and dissemination** of	- Make a special **effort on RDT priorities** for aquaculture (2009-2013).	X	X	• Giving highest priority to research and technological development, thereby contributing to the competitiveness objective.
	- Ensure that public funded projects benefit the EU industry through **greater involvement of EU business.**	X	X	
	- Promote optimisation of key research infrastructures, **reinforce networks and integration into broader science networks** (in the context of the new Maritime Policy and its strategic research agenda (2009-2013).	X		
	- Better **promote the exploitation and dissemination** of EU funded aquaculture research **projects** (2009-2013).	X		

[43] COM(2008)394 – see *http://ec.europa.eu/enterprise/entrepreneurship/sba_en.htm*.

RTD results • **Risks of neglecting** the importance of **extensive and traditional aquaculture.**	- **C**onsider, with the Member States and the European Technology Platform for Aquaculture, the future opportunity for launching a Joint Technology Initiative (JTI)[44] in aquaculture (possibly by 2011).	X		
	- **Recall the value** and importance of traditional and extensive forms of aquaculture	X		
• **EU leadership in R&D** is **not always best exploited** to the benefit of the EU industry **on the international scene**.	- Assess if EU aquaculture industries have an interest in joining working groups established to develop market access partnerships.	X		• Contributing to Europe being a reference on the international scene and to the competitiveness objective • Promoting environmental sustainability outside EU
	- **Promote** the need for **sustainability** in aquaculture when participating **in international fora** as well as at regional and bilateral level.	X	X	
	- **Develop, in the context of its new animal health action plan, an export Strategy** in order to strengthen the Community role in negotiating exports conditions related with animal and public health issues under the SPS agreement (2009-2011)	X		
• MS may decide to allocate a **low share of EFF funds to aquaculture projects**.	- Ensure that **support for aquaculture is continued within the Operational programmes** (e.g. priorities such as supporting innovation or environmental values in aquaculture) (2009).		X	• Contributing through EFF to the social, economic and environmental dimensions of aquaculture.
	- **Begin exploring possible future direction** of Community support)	X	X	
• Uneven situation because of different interpretation and implementation of EU legislation	- **Contribute to better mutual understanding** of the scope and aims of EU environmental legislation	X	X	• Ensuring a level playing field among operators and among Member States, thereby contributing to the objective of better governance
	- Facilitate a level playing field by **developing guidance documents and organising specific workshops** with stakeholders and national authorities (2009-2011).	X		

[44] Joint Technology Initiatives are proposed as a means of implementing the Strategic Research Agendas (SRAs) of a limited number of European Technology Platforms (ETPs). The dedicated structures implementing the JTIs will be independent legal entities that will manage research projects in an integrated way, with industry joining forces with other stakeholders.

• Gold plating of environmental rules and NIMBY policy ("Not In My Back Yard") at regional level.	- Ensure that EU animal health and public health law is properly implemented and in a comparable way (with additional guidance or with FVO inspection "on the spot").	X		
• Aquaculture industry has **limited means to provide input to public authorities or to dialogue with scientists**	- Assess the need to revise the place and role of the aquaculture industry in the **Advisory Committee for Fisheries and Aquaculture** (by 2011)	X		• Contributing through the involvement of stakeholders in policy development to better governance.
	- **Improve the consultation process** with the aquaculture sector **in the framework of the research agenda**	X	X	
• The **collection** of reliable **indicators on aquaculture is difficult** or not considered worthwhile by public authorities.	- **Ensure that the new instruments for statistics and data collection are implemented** to deliver the necessary indicators (cf. section 7)	X	X	• Ensuring regular monitoring of the aquaculture industry, thereby making for better governance and public action based on facts.
	- Actively **participate in international fora** (notably the FAO) for the development and collection of global and harmonised indicators	X	X	
	- Establish a **price monitoring system** for fish and aquaculture products throughout the marketing chain.	X		

5.3. Likely economic, social and environmental impacts[45]

5.3.1. Impacts of Option 1 (Baseline option)

As stated above, under a "status quo" situation, EU policies will continue to deliver on the policy objectives identified above though several key measures focusing on some of the main determinants of growth, in particular support for R&D and innovation, support for sustainable development investment and access to finance. In parallel, the EU's environmental protection policy will continue to ensure a high level of protection of the environment, but the way environmental protection is implemented at national level and the insufficient consideration of aquaculture stakeholders and their needs may through up serious challenges to the sector, as was clearly expressed during the consultation process.

5.3.1.1. Economic impacts

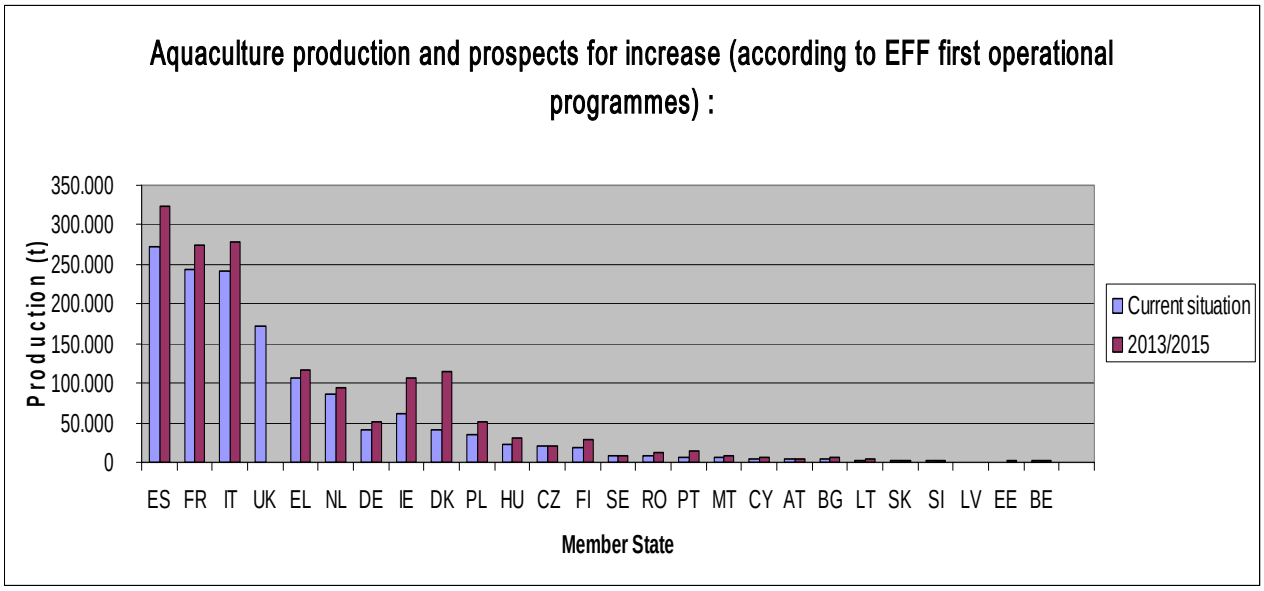
A number of initiatives are already ongoing under this first option and will result in support for R&D, public funding of some measures in the aquaculture sector, notably through the EFF, and other action that may contribute to the objectives identified earlier.

For instance, the previous Framework Programme for Research (FP6) had been highly successful in contributing to research projects in support of aquaculture (75 aquaculture projects were co-financed for a total of €98 million, of which about half, making up about a third of the budget, were funded under the FP6 programme dedicated to SMEs). The projects have not yet all been completed, and they will continue to deliver an increased knowledge base for aquaculture. The Seventh Framework Programme for Research and Technological Development (FP7) is operational and it also includes a number of incentives for aquaculture-orientated research and for SME participation.

As regards another source of public funding, the European Fisheries Fund (EFF) is the largest Community funding instrument benefiting the aquaculture development. Around 29% of the total EFF allocation, an amount of about €1 275 million for the 2007-2013 period, is initially planned to be spent under the so-called "Axis 2", which covers measures for both the aquaculture and the fish processing sectors. According to the Operational Programmes available from the Member States at the time of this assessment, a total investment of about €2.15 billion of public money (national + EU money) would be made available over the 2007-2013 period under Axis 2 to support aquaculture and processing.

Total aquaculture production in the EU is currently in the order of about 1.3 million tonnes (cf. more detailed data in previous sections and in Annex I). According to the information and data provided by the Member States in their first national Operational Programmes (OPs), the figure below illustrates the estimated increase in national production levels by 2013/2015 (depending on MS data). These figures are provisional and may change with possible modification of the OPs and actual use of EFF.

[45] See Annex IV.



It needs to be stressed, however, that these figures may not reflect actual developments as they depend on a number of caveats:

– The European Fisheries Fund (EFF) Regulation adopted in 2006 provides numerous possibilities for financial support for the sustainable development of aquaculture (e.g. not only productive investment and innovation, but also measures dealing with environmental protection, health issues, etc.). However, as the EFF provides the possibility within the same chapter (namely priority Axis 2) of support for both the aquaculture and the processing sectors, it is not possible to say exactly what the specific prospects are for the aquaculture sector from the EFF and national budgets.

– Notwithstanding the uncertainty surrounding some of the indicators used by the Member States and the possible limits of comparability of data, all the objectives and indicators for future prospects available in the Member States Operational Programmes are probably based on optimal development and support scenarios. Real developments and funding will not only depend on the priority measures that Member States decide to support using EFF contributions, but also on the need for operators to tender for such support and to co-invest in those measures. This would mean at least that business prospects are favourable for this sector, and that aquaculture producers can actually expect to cope with the problems and challenges identified above. Without Member States implementing parallel measures called for under a new Strategy (e.g. addressing aquaculture licensing difficulties, simplifying administrative burdens, ensuring a level playing field, etc.), funding opportunities in favour of innovation and productive investment may not deliver their full potential.

– Moreover, in the context of the fuel crisis of 2008 and its significant impact on operating costs for capture fisheries, the Council adopted of a "Fuel crisis package"[46] in July 2008. This package creates additional incentives for possible support for the capture fisheries sector and the restructuring and adjustment of the fishing fleet. This may lead in the coming months to reprogramming by Member States. However, within an overall unchanged total EFF budget allocation, increasing possibilities to the restructuring of the

[46] Regulation (EC) No 744/2008

national fishing fleets can only be done by reducing the budget allocation under the other EFF axis, including priority Axis 2 dedicated to aquaculture and processing. Consequently, not only may the overall contribution to aquaculture be reduced it may also lead to support for the different types of measures (e.g. "productive investments vs. environmentally supportive measures) being reprioritised.

Finally, from a market perspective, EU aquatic food production has been slowly decreasing over the last ten years. In the years to come, assuming a constant increase in demand for fish and further assuming that EU capture fisheries will not be able to satisfy an increasing proportion of that demand, there should be increasing room for EU aquaculture products. Large EU retailers would be ready to offer more EU aquaculture products if sufficient quantities were available and competitive.

Whether EU producers will be able to cover at least part of this gap will depend on whether public policies are effective in reducing bottlenecks and EU producers can retain their cutting edge vis-à-vis competitors in other parts of the world (e.g. Asia and South America). If so, EU production could enter into a virtuous circle. Otherwise, the unsatisfied demand will most likely be covered by increased imports of aquaculture (or even capture) products.

The lack of further coordination and renewed EU political support and leadership inherent in Option 1 do not guarantee that the bottlenecks will be eliminated. Progress is likely to be modest and slow.

5.3.1.2. Social impacts

The lack of reliable data makes it difficult to predict how employment in the sector will evolve. For Option 1, even available EFF operational programmes from the Member States do not include any projections regarding the evolution of employment.

However, as emerged from the evaluation of the 2002 objective concerning job creation, stagnation in overall aquaculture production is very unlikely to be accompanied by an increase in the number of jobs – on the contrary. Option 1 may lead to a slow increase in production if not to a continuation of the current stagnation even, with significant differences across sub-sectors. Further production increases in marine fish aquaculture would normally not translate into significant increases in employment figures, given the capital-intensive nature of that sub-sector, in particular in the most globalised sectors (salmon, sea bass/sea bream). To the extent that the increase in size of firms takes place through mergers and acquisitions it can even be said that the net result for employment will be negative. The other two sub-sectors are more labour-intensive. The continued decline of fresh water aquaculture could have negative consequences on employment. As regards molluscs and crustaceans, which are by far the most important source of jobs, employment figures should not change dramatically.

The overall impact on employment could then be neutral or even negative. The same will also apply to jobs in the sectors upstream and downstream of aquaculture (e.g. fish feed).

5.3.1.3. Environmental impacts

The Community is committed to a high level of environmental protection and EU regulation is based on the precautionary principle to ensure that the development of industries, including aquaculture, is sustainable from an environmental point of view.

As a consequence, the environmental status of the EU aquaculture industry is generally good and this will be maintained or even improved under Option 1, particularly in the light of the points made in Section 2.5.1.

However, as highlighted in the consultation process, knowledge of actual aquaculture impacts, the importance of good management and best practices and the possibilities offered by technologies are not yet taken fully into account. Under Option 1, this situation would probably continue, benefiting from progress made would probably be slow and the benefit to both aquaculture and the environment would be suboptimal.

In addition, the aquaculture industry still suffers from a rather negative image at certain levels and Member States may establish their own additional environmental protection rules, provided that EU levels of protection are not undermined. This sometimes makes it practically impossible for aquaculture to develop, or simply to continue to exist (even for extensive sectors like shellfish farming or pond farming). Progress on these issues would probably continue under Option 1, albeit at a slower pace. At first sight, such situation could be seen as having additional positive effects for the environment in the EU, as it prevents aquaculture from expanding and therefore adding to the overall impact of human activities on the environment in MS. However, this might actually lead to other negative environmental effects, especially if some of the aquaculture sectors were to gradually disappear from the European landscape, with the attendant loss of the environmental services these sectors were providing (conservation of wetlands, contribution to surveillance of water quality, etc.).

5.3.2. Impacts of option 2

5.3.2.1. Economic impacts

The same reasoning as for Option 1 can be made from a market perspective: whether EU aquaculture develops or not will largely depend on whether bottlenecks for aquaculture are properly addressed by the parties responsible over the next few years.

The framework created under Option 2 aims precisely to give fresh political impetus, and, if shared and endorsed by Member States, to address the bottlenecks identified by the sector that fall under the responsibility of the public authorities, at EU and also at national and local levels.

Option 2 is expected to facilitate investment decisions in aquaculture by creating conditions for a more stable and predictable framework and by ensuring a level playing field for aquaculture. Option 2 is expected to help increase competitiveness, for example through action in R&D and know-how which are expected to increase productive efficiency; and in the areas of image and markets (labels), which could contribute to increasing demand for EU aquaculture products.

A combination of all the impacts expected from Option 2 increase the likelihood of the EU aquaculture sector being more successful in the future.

Option 2 is expected to raise the profile and strategic dimension of aquaculture in the Member States and with regional and local administrations. EU leadership should have a generally positive impact on business development though improved recognition of the industry and supportive action from the public authorities. Moreover, according to some aquaculture representatives during the consultation process, aquaculture remains a rather unknown business in some regions compared to well-established industries. This Option may have an important leverage effect and therefore act as a facilitator for entrepreneurs in search of investment funds when negotiating with credit institutes.

Option 2 will provide positive support on the whole for the development of the sector. Specific measures addressing some of the bottlenecks are also expected to have a direct effect, such as measures to improve return on investment from publicly funded R&D on EU business. Measures to

improve the association of the business to the definition of research priorities eligible for public support (particularly in conjunction with the European Aquaculture Technology & Innovation Platform[47] and its strategic research agenda) or measures to facilitate and improve the feedback from research projects to EU business will also boost the economic performance and development of aquaculture.

Even if Option 2 is more conducive to developing the aquaculture industry in the EU, and overall EU production actually increases as predicted in Member States' Operational programmes (cf. 5.3.11) or even by an optimistic factor of 1.5 by 2015 (see Section 5.4 below), the impact on third countries would be marginal, given that EU production currently accounts for a mere 2% of global production and that production levels in third countries continue to increase much faster than in the EU.

5.3.2.2. Social impact

From a social point of view, to the extent that bottlenecks, in particular the issue of access to sites, will be largely or completely eliminated at national and regional level, production should increase. Option 2 would thus have an incremental effect compared to Option 1. Jobs would be created in fresh water and molluscs and crustacean aquaculture, which will remain more labour intensive. Marine fish aquaculture will also make a positive contribution to employment. The scope for this will largely depend on the degree of globalisation of species other than salmon, sea bass and sea bream and the development of new production technologies, in particular off-shore aquaculture and recirculation, the latter also being of relevance for fresh water aquaculture.

The overall contribution to employment will thus be clearly positive, particularly in areas and regions where aquaculture is already significant and where there is still potential for further development of aquaculture production.

The impact on jobs upstream and downstream of aquaculture will also be positive and greater than in Option 1.

5.3.2.3. Environmental impacts

As already highlighted above, ensuring that aquaculture does not adversely impact on the environment is of major importance to the sustainability of farmed fish and shellfish industries. Aquaculture production is also highly dependent on an aquatic environment of high quality.

Overall, compared with Option 1, Option 2 would have a more positive impact on the environment. One of the main impacts would be to highlight the efforts already made to ensure that aquaculture is compatible with the environment when well managed and facilitating the promotion of best practices. Option 2 would also offset a number of possible drawbacks in Option 1 (see end of Section 5.3.1.3), by generating more synergy between environmental priorities and aquaculture. Extensive aquaculture practices contribute to the maintenance and preservation of wetlands, which are areas of high biodiversity and high importance for nature conservation. Because of their dependence on high quality water, and because fish are often very good biological indicators of water quality and allow thereby early detection of any degradation in water quality, fish producers play an active role in the daily surveillance of water pollution. Similarly, aquaculture producers have every interest in ensuring the quality of the water on which they depend. Shellfish farmers in particular have demonstrated their active role in ensuring that water quality rules (e.g. in cases of

[47] http://www.eatpnet.eu.

persistent failure of water treatment plants) are duly enforced by the respective parties, both private and public.

Possible measures under Option 2 would have different levels of positive impact on the environment, some direct positive, others indirect impact.

As mentioned above, national measures can create additional obstacles and administrative burdens for the aquaculture industry. Without questioning the need to meet the objectives of environmental protection, there may be scope for Member States to examine whether measures implemented at national or local levels are best suited to providing sustainable aquaculture growth. A broader partnership approach between the EU and the Member States by way of a reviewed strategy for aquaculture could improve the situation for aquaculture operators, on the one hand by making sure that legislation is conceived from the start in a way that ensures a high level of protection of the environment, while taking account of the specific needs of aquaculture, and on the other by avoiding a situation whereby the terms of Community directives are exceeded significantly when implemented in national law (so-called gold-plating issue). Option 2 will contribute to a better understanding of EU environmental legislation. Measures such as the organisation of information workshops and the development of guide documents should help to achieve this objective while ensuring proper implementation of European legislation (especially the water quality legislative package and the Natura 2000 network of protected areas). Exchange of information, best practices in the use of veterinary medicines in aquatic animals and guidelines for limits on the release of certain chemical substances into the aquatic environment are other examples of possible action that would help to ensure animal health and welfare while limiting the possible impact of fish farming on the environment. Action of this kind will guarantee continued protection of Europe's environment and will make for better mutual understanding of the scope and aims of these legislative instruments. This approach could therefore help to prevent negative cross-border externalities such as pollution.

As also already highlighted, the aquaculture sector is often not taken into account during planning and decision-making processes, and may even be stifled by other activities. Reviewing the strategy is expected to help address this problem and to stress the importance of spatial planning (especially marine spatial planning). The proper siting of aquaculture facilities should help this sector to integrate into the environment and to avoid conflicts with other activities. Planning tools will help to pre-empt the risks of climate change, floods, drought, erosion, etc., and to underscore the role of aquaculture facilities (e.g. freshwater ponds) in landscape water management. Spatial planning and integrated coastal zone management would doubtlessly have a positive effect on the environment and on the facilitation of aquaculture development.

Innovation and technological development play an important role in minimising the impact of aquaculture on the environment. The reviewed strategy will add value by addressing these aspects and the need for investment in RTD (e.g. for offshore aquaculture developments or recirculation systems) and by helping to create networks of aquaculture science and to apply scientific results to aquaculture practices. The development and transfer of eco-efficient technologies would also help other countries to make efficient use of their resources.

The European Fisheries Fund provides possibilities, among numerous others, for support for aqua-environmental measures and can help aquaculture to substantially reduce any negative impact and enhance the positive effects on the environment. A reviewed strategy would provide leadership and thus encourage Member States to prioritise the aquaculture sector sufficiently, notably in the case they would redefine their Operational Programmes to increase the scope for restructuring the capture fishing fleets.

Rules on organic aquaculture, development of eco-labels for aquaculture products and international cooperation on aquaculture certification are other areas of measures where the industry can expect to improve its environment record.

5.4. Overall estimates of possible environmental and socio-economic impacts depending on aquaculture growth scenarios

Potential measures proposed in Option 2 focus on the role of public authorities to establish a framework for European aquaculture to address some of its bottlenecks while remaining sustainable from an environmental point of view. By providing more political leadership than in Option 1 this could lead to more production. Taking a simplistic approach, increased production could mean more extensive use of natural resources and increased output of pollutants. However, this needs to be assessed in each specific case. Increased impacts from increased production in a given aquaculture facility can either be fully mitigated (notably through technological progress and proper management), or remain within acceptable limits for local environmental conservation, especially as regards water quality requirements. These impacts, or the level of mitigation required, should be put in balance with the social and economic consequences.

As mentioned in previous sections, in September 2008 the JRC published a "*Prospective analysis of the aquaculture sector in the EU*", which concurs on a number of issues with the assessment made during the preparation of this initiative. One of the chapters in this prospective analysis sets out different theoretical scenarios of development of European aquaculture and provides quantitative estimates of indicators in terms their environmental output and jobs and wealth creation.

These scenarios, hypotheses and projections of this specific chapter of the JRC prospective analysis[48] are copied in full in Annex IV. These figures cannot be considered in themselves as Commission targets, but rather as an aid to illustrate impacts from the different options. It needs to be said in this context that this JRC prospective study was launched already in 2006, and was not intended to serve as a basis for this impact assessment. Thus, there is no direct link - and no such link shall be made - between the scenarios developed by the JRC and the policy options assessed above.

Growth modelling scenarios developed by the JRC

The models used by the JRC explore the potential for increased aquaculture production in EU Member States (EU-25). They firstly identify potential market demand for fish and seafood products and compare this with supply from the capture fisheries sector. The shortfall in supply is then expected to be met through aquaculture and net imports from third countries. The implications of only part of the shortfall being met through aquaculture, or virtually all the shortfall being met through aquaculture, are explored. The JRC models are not intended to be predictive, but rather to indicate the development levels needed and the implications of the different options.

Four main aquaculture production scenarios were considered by the JRC:

(i) Minimal development: current trend of decline continues for remainder of this decade, before reversing as the gap between production and demand rises.

---

[48] The JRC prospective analysis also includes further detailed assessments of the aquaculture industry and its sub-sectors, notably on the prospects and characterisation of new aquaculture technologies (offshore aquaculture, recirculation systems, integrated systems) and emerging aquaculture species (e.g. meagre, turbot, octopus, tuna, cod, halibut, sturgeon, etc.).

(ii) To meet output targets of 4% annual increase in aquaculture production as envisaged in the 2002 Strategy (according to JRC calculation, the EU 4% growth target would now require an 8.4% per annum average growth rate to reach the same production level by 2025 as would have been achieved by a 4% annual increase from 2000 onwards).

(iii) EU aquaculture develops to fill the gap left by capture fisheries declining at 2% per year.

(iv) EU aquaculture develops to fill the entire gap between capture fisheries supply and expected demand.[49]

Within each modelling scenario, 12 categories of aquaculture products were considered (e.g. salmon and trout; carp, tilapia and catfish, mussels, etc.), and how these might develop in order to achieve the target production levels. As the prospective study also focused on emerging aquaculture systems, particular attention was given to the role these systems play in these scenarios.

Nitrogen, phosphorus and organic carbon were used as relevant and amenable emissions to estimate the environmental impact. Use of natural resources (space, water, energy) was also assessed.

JRC quantitative models with regard to the expected outcome of Options 1 and 2

When putting the production scenarios modelled by the JRC in correspondence with Options 1 and 2 in this impact assessment, we can reasonably consider that:

– the consequences of Option 1 (status quo) roughly correspond to JRC scenario 1 (minimal development);

– the consequences of Option 2 (a new strategy, fresh impetus for aquaculture accompanied by action by public authorities to address bottlenecks, at both EU and national level) would be somewhere between the output modelled for scenario 1 and the output modelled for JRC scenario 2 (4% growth since 2000), which is already an unachieved scenario. JRC scenario 3 illustrates this intermediate situation (aquaculture filling the gap left by capture fisheries declining at 2% a year);

– the 4th scenario modelled by JRC (maximum aquaculture development) seems highly unlikely, given the drivers and challenges facing the EU aquaculture sector and considering its development over the last 5-10 years.

The table below summarises the key indicators for the 3 first scenarios modelled by the JRC by 2010 and 2015, with the reference data used by the JRC for the year 2005.

[49] The 4th scenario modelled by the JRC (maximum aquaculture development) seems rather unlikely given the drivers and challenges of this sector at EU level, and its development over last 5-10 years.

JRC Modelling scenarios		Minimal development (scenario 1)		Intermediate development: compensate fisheries (scenario 3)		Higher development: 4% production growth since 2000 (scenario 2)	
		IA Option 1 roughly ⇔ JRC scenario 1		IA Option 2 probably somewhere between JRC scenarios 1 & 3		Expected but unachieved development since 2000	
Indicator	**2005 value (< JRC)**	**2010 estimate**	**2015 estimate**	**2010 estimate**	**2015 estimate**	**2010 estimate**	**2015 estimate**
Aquaculture production (Mt)	1.26	1.17	1.20	1.57	1.94	1.84	2.44
Aquaculture value (€ billion)	2.83	2.79	2.86	3.65	5.18	4.31	6.58
Direct jobs (x 10^3)	75.8	72.8	74.9	88.0	101.7	94.9	122.5
Land / water area required (10^3 ha)	200	224	237	208	215	230	301
Water use (billion m^3)	2 960	2 720	2 760	3 600	4 270	4 340	5 460
Industrial energy used (M MJ)	150	142	146	195	257	255	359
Nitrogen output (t)	34 070	35 060	36 790	45 860	65 640	56 500	97 160
Phosphorus output (t)	5 100	5 360	5 790	7 500	12 240	8 580	16 150
Carbon output (10^3 t)	180	170	174	230	295	209	391

In JRC model scenario 1, overall EU production would first continue to decline (1.17 Mt in 2010 and 1.20 Mt by 2015), and production would only slightly increase in the longer term, by about 20-30% in 2025. The other two scenarios anticipate more of a contribution from aquaculture to

projected EU consumption demands. As a result, by 2015 forecast production could be around 1.5 to maximum 1.9 times higher than current production.

If aquaculture development is minimal the number of jobs may slightly decrease or stagnate in the next 5 to 10 years.[50] Using constant multipliers, employment would have multiplied by 1.6 in 2015 (and would have more than doubled by 2025) if output had matched the target growth rate of 4% per annum for aquaculture development since 2000. However, price competition and market demand are likely to result in major increases in production volume through new marine fish production, especially in offshore systems with higher efficiency. Employment per tonne of production however is greatest for small-scale artisanal and family-run farms, which might increasingly need to address niche markets to survive.

As regards the effects on the environment and the need for resources, the JRC calculations suggest that raising aquaculture output in line with the projections in the 2002 Strategy (4% growth a year from 2000) would multiply the land and water area used by aquaculture by 1.5 in 2015. Even if continued until 2025, an annual increase in production of this kind would be something less than double the total land and water area required by 2025. However, even in this maximum (and unachieved) target, the overall area needed would be very small compared with agriculture (less than 0.5 million ha estimated, compared with over 6 million ha of land used for organic agriculture, which is itself only 4% of total agriculture). Output of nutrients should see a 2.8-fold increase in nitrogen output by 2015 (and 3.8 by 2025). However, this should be seen in the wider context. In comparison with the terrestrial livestock sector, for example, the additional nitrogen maximum output in 2025 under the JRC scenario 2 would be equivalent to increasing European cattle population by around 0.7%. More important would be how and where the nutrients are released and treated. Offshore aquaculture would have very high waste dispersion characteristics, whilst recirculated systems provide greater means of control and removal for further processing or use. An increase in human consumption of fish could also imply some compensatory reduction in overall consumption of meat produced by terrestrial farmed animals, with indirect consequences on the overall environmental impact from terrestrial farming.

The estimated direct usage of industrial energy (based on a selected mix of systems) would multiply by 2.4 by 2015 and triple by 2025 if aquaculture were to develop along the 4% projection since 2002 compared to the minimal development scenario. This maximum increase is equivalent to the average annual energy usage of 4 600 European homes, or 10 500 people. In terms of power generation it equates to a wind farm of about 15 turbines of 2.5 MW capacity each.

[50] The JRC report, however, takes a different baseline of about 75 000 jobs in the aquaculture sector in 2005.

6. COMPARING OPTIONS

6.1. Comparing options

The following tables provide a comparison of the three options in terms of contributing to meeting objectives, possible advantages and drawbacks and environmental, economic and social impacts.

Strategic objective identified	Option 1	Option 2	Option 3
Establishing conditions for aquaculture in line with the EU sustainable development agenda	Continues horizontal policies development, without any new specific approach or any updated vision for aquaculture. Ensures a high level of protection of the environment through numerous areas of action (pollution, water quality, nature protection...) Ensures a high level of consumer health protection. Ensures a high level of animal health and welfare, in particular through the new animal health strategy.	Ensures the same high level of protection of the environment, of consumer protection and of animal health and welfare. Also promotes an environmentally friendly aquaculture development while recognising the aquaculture industry as an equal right competitor in access to space/water and develops integrated spatial planning. Gives the new animal health strategy a specific "aquatic dimension" to shape an efficient aquatic animal farming industry, addressing also the need for specific veterinary medicines and high quality and sustainable feeding-stuffs for fish. Highlights the health benefits of aquatic food. Promotes a level playing field for this sector.	Comparable to Option 2.

Promoting competitiveness of EU aquaculture branches	Does not provide sufficient stimulus to address, in a coordinated manner, the bottlenecks faced by the industry for sustainable development. Keeps with an objective of job creation that is known not to be achieved.	Improves coordination and interpretation of all EU policies with the aim of eliminating bottlenecks and developing sustainable EU. Aquaculture. Develops new opportunities to increase the competitiveness of the EU aquaculture products (notably through technological development and innovation as a means of addressing competition for space, giving highest priority to research, prioritising support for innovative action and environmental benefits, contributing to the ability of the aquaculture business to cope with market demands, and promoting European know-how in the international arena).	Establishes ad hoc instruments for the aquaculture sector (production management, markets, financial support, environment, health, control, etc.), at EU level by assuming responsibilities currently within the remit of MS (e.g. space allocation and spatial planning, licensing and setting of associated requirements, structural policies, etc.)
Improving governance in designing policies and measures which influence the development of aquaculture	Dilution over time of the supportive stance that surrounded the 2002 Strategy, which was also only debated within the former EU-15. Maintains the same "administrative difficulties", or does not raise sufficient awareness of non-specific initiatives (e.g. the Small Business Act) within the aquaculture industry. Does not sufficiently address the specific needs of aquaculture within horizontal policies.	Brings stakeholders together to seek solutions to current problems in a coherent and consistent manner for the EU-27. Provides leadership and gives a stronger political signal regarding the strategic importance of EU aquaculture. Aims to provide a level playing field and reduce the administrative burden for the aquaculture industry. Improves the image and provides factual information on aquaculture. Ensures increased stakeholder participation.	Comparable to Option 2. Establishes further action to ensure harmonisation of production and a level playing field across MS.

Advantages and drawbacks of each policy option	Advantages	Drawbacks
Option 1 **Status quo (baseline option)**	Continues to deliver several key measures (e.g. support for R&D and innovation; support for sustainable development investment). Does not require a specific initiative for a new framework for the development of EU aquaculture.	Keeps within a background of an objective established in 2002 and that will not be achieved. The outcome of the consultation process is not taken into account, particularly regarding the consensus in favour of reviewing the strategy. The bottlenecks of EU aquaculture development are not addressed; the sector is not boosted by political impetus. Slower pace of measures conducive to aquaculture development. Increased risk of divergent approaches across Member States and regions.
Option 2 **Developing a new Strategy for EU aquaculture**	By recognising the strategic importance of aquaculture as a provider of healthy and safe food, as well as its economic, social and environmental assets, the Strategy sends out a political signal from the Commission to the public authorities at national and regional level, and to the public at large. Establishes a framework for sustainable development of EU aquaculture, by identifying strategic objectives and reviewing the problems and their underlying drivers (as developed in Section 2). Addressing the main challenges and bottlenecks will make it possible for the different branches to develop their full potential. Increases coordination and governance at EU and national level. Brings specific added value to Community action (including the cross-border dimension of the remaining specific problems of EU aquaculture).	Some bottlenecks to aquaculture development are within the jurisdiction of Member States (e.g. licensing procedures; allocation of access to space and water); Option 2 does not guarantee achieving all objectives without parallel and additional action being taken by national / regional authorities. This strategy therefore requires full endorsement by Member States and a significant contribution from their part into concrete action. Meeting the set objectives also depends on the investment possibilities and willingness of entrepreneurs to invest in Europe.

	Extends the debate to EU-27 (the 2002 strategy was discussed with 15 MS only)	
Option 3 **Developing a specific Community policy for aquaculture**	Basically covers the objectives of option 2. Builds on it by setting up a comprehensive sector-specific policy framework.	The development of an integrated Community aquaculture policy initiated by the creation of a single legislative reference framework requires a fundamental review of the present EU legal architecture. Developing a single framework legal instrument encompassing possibly all dimensions of this sector (production management, markets, financial support, environment, health, controls, etc.) also requires a comprehensive review of the existing provisions and references to aquaculture under the Common Fisheries Policy – and particularly its "basic" Regulation (EC) No 2371/2002. This fundamental change in approach to aquaculture at the EU level would require additional parallel changes of provisions under the present Common Agriculture Policy (or possibly others, like the animal health policy)). Addressing at EU level some of the present bottlenecks faced by the EU aquaculture sector through legally binding objectives and principles **appears to be in contradiction with the subsidiarity principle**.

In the light of the above, Option 3 is not considered as being a viable alternative for tackling the problems identified at this stage. The fundamental questions raised in relation to the overall institutional setup, including the consequences on subsidiarity, would generate negative consequences, which would outweigh any incremental social, economic and environmental benefits resulting from this option. For these reasons, this option is discarded.

Possible impacts	Option 1 Status quo (baseline option)	Option 2 Developing a new Strategy for EU aquaculture based on a new political Communication from the Commission
Environmental impacts	The environmental status of the EU aquaculture industry is generally good and this will be maintained or even improved under Option 1.	The environmental status will be maintained or even improved under Option 2. The protection of Europe's environment successfully continues and makes for a better mutual understanding of the scope and aims of these legislative instruments. This approach helps to prevent negative cross-border externalities such as pollution. Stresses the importance of spatial planning to make for better integration of this sector to its environment and help avoid conflicts with other activities while optimising its compatibility with the environment, and to pre-empt also the risks of climate change, floods, drought, erosion etc. Adds value by addressing the role of innovation and technological development and minimising the impact of aquaculture on the environment.
Economic impacts	A number of initiatives are already ongoing and will result in support for R&D, public funding for some measures in the aquaculture sector (e.g. FP7 or EFF) and other action to help reduce some of the bottlenecks. The information and data available in the current national Operational Programmes allow to make an approximate estimate of an overall increase of EU aquaculture production of about 318 000 tonnes over the programming period by 2013/2015. This figure appears subject to a number of caveats, however, and will probably not be realised if bottlenecks are not properly addressed.	Addressing aquaculture bottlenecks is expected to have a positive economic impact overall. Decisions to invest in aquaculture should be facilitated by creating a more stable, predictable framework and by ensuring a level playing field for aquaculture. Several measures are expected to help to increase competitiveness, e.g. in the areas of R&D and know-how, which are expected to increase productive efficiency, and in the fields of image and marketing, which could help to increase demand for EU aquaculture products. The importance and the strategic dimension of aquaculture should be raised at Member State, regional and local administration levels. Facilitation for entrepreneurs in search of investment funds when negotiating with credit institutes (probably limited in view of the recent credit crunch and severe economic crisis).
Social impacts	The overall impact on employment could be neutral or even	The overall economic benefit of Option 2 should also lead to more positive impacts

	negative. The same applies to jobs in EU sectors upstream and downstream of aquaculture. Present trends in some sub-sectors (e.g. consolidation, or disappearance of some businesses) may lead to enterprises that survive being stronger, but also lead to some job losses.	in terms of employment in the aquaculture sector (and of related business activities, such as technology providers, fish feed industry, etc.).

6.2. Preferred option

The analysis of the state of play in Section 2 shows the principal economic and social magnitudes of EU aquaculture in the period 1996-2005. These figures clearly show the lack of overall growth of EU aquaculture in this period, and the increase in imports, particularly farmed fish, over the same period. Option 2 thus corrects an objective set in 2002 that will clearly not be achieved. By urging Member States to act and proposing action to remove obstacles more quickly and efficiently than Option 1, it is more likely to help unlock the potential for sustainable development in the sector. Option 2 would also lead to more extensive use of natural resources and to an increase in pollutant output, but this increase in pollution has to be balanced again the pollution (and other aspects) of other forms of production of high value proteins and food for human consumption. Any negative impacts resulting from using natural resources appear to be less significant than the overall positive impacts resulting from Option 2. In the light of this, Option 2 should be the preferred option.

7. MONITORING AND EVALUATION

Development of the EU aquaculture industry requires the full commitment of both the Community and the Member States. The Commission therefore expects the Council, with the support of the European Parliament and the other EU institutions, to endorse the Strategy and thereby recognise the role played by the aquaculture industry and the need to unlock its potential.

This will require closer monitoring of the industry, and the indicators for doing so have been rather limited so far, in terms of both the data available and the quality. However, the European legal framework was updated in 2008 to make for better monitoring of this industry.

– A new Regulation on aquaculture statistics (Regulation (EC) No 762/2008) was adopted by the European Parliament and the Council in July 2008. It requires Member States to collect and submit data on annual production (volume and value), annual input to capture-based aquaculture, annual production of hatcheries and nurseries and data on the structure of the aquaculture sector. This Regulation (which repeals the former Regulation (EC) No 788/96) not only significantly extends the scope of data to be monitored, compared to the previous regulation, it also provides additional guarantees regarding quality.

– In February 2008, the Council adopted a Regulation establishing an EU framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the CFP (Regulation (EC) No 2008/199). This new data regulation has been extended to cover additional data concerning the marine aquaculture industry. The Commission implementing Regulation ((EC) No 665/2008) was adopted in July 2008 and provides for the collection of the following economic variables: income, personnel costs, energy costs, raw material costs, investment, employment and number of enterprises.

These new tools will be implemented in the coming year, and they should help to improve the monitoring of the economic, social and environmental components of the aquaculture industry (cf. chapter 3).

Lessons from the past – based on the experience of the 2002 strategy – have shown that setting fixed timetables with quantitative objectives is not best suited to an overall initiative of this kind, which covers numerous horizontal and wide-ranging policies. However, monitoring the aquaculture industry and its sub-sectors will show whether growth opportunities are emerging for this industry over time. In addition, permanent dialogue with stakeholders will allow in the coming years to evaluate whether the different measures identified have been taken and have delivered, and bottlenecks are gradually being eliminated.

ANNEX I

BACKGROUND INFORMATION: FACTS AND FIGURES

The data and tables referred to in this Annex have been extracted from different sources and may be subject to some variability. However, this does not change the global analysis of trends and the overall evaluation.

1. EU AQUACULTURE – DESCRIPTION OF THE MAIN SUB-SECTORS

European aquaculture is mainly composed of 3 large sub-sectors, with different characteristics: shellfish, fresh water fish and marine fish farming. Crustaceans and algae are also grown in the EU, but their production is marginal so far.

1.1. Shellfish farming

1.1.1. Oyster farming

The bulk of oyster production is the cupped or Pacific oyster, *Crassostrea gigas*, which was introduced into Europe in the past 50 years. Native European flat oysters are now produced only in small quantities, since the introduction from the Americas of a protozoan parasite in the late 1970s which significantly affected most flat oyster growing regions of Europe, including France, Spain, the Netherlands, Ireland and the UK.

Juvenile oysters are either collected in the wild or are grown in hatcheries and production takes place via bottom culture on inshore beds with firm substrates or via rack culture where oysters are grown in plastic mesh containers on metal trestles or racks. In France a special treatment (*"affinage"*) may be carried out in ponds *("claires"*) for the supply of top quality oysters.

Total oyster production for EU27 was in the order of 132 000 tonnes in 2005 valued at about €300 million. Largely dominated by France, which is also the largest market for oysters, the Community production of cupped oysters peaked at over 160 000 tonnes in mid 90's but subsequently significantly decreased. In some part of the Community, for example Ireland, cupped oyster production is smaller but registered an increase in production to 12,089 tonnes in 2005 (nearly six times the 1995 level). Irish production of flat oysters was 1708 tonnes in 2005 compared with 1412 tonnes in 1995[51]. The native oyster obtains a higher price on the market and many producers mourn the fact that stocks have been decimated.

Very high mortalities of juvenile oysters has been reported in France during the summer 2008, and this will certainly have important repercussion on overall production within the coming years.

[51] Source BIM: Status of Irish Aquaculture 2005

1.1.2. Mussel farming

In the Community today there are three types of mussel farming. The largest volume is cultured on ropes suspended from rafts or long lines as in Galicia in Spain and on the east coast of Italy and to a lesser extent in France, the West of Ireland and the UK (West of Scotland). Bottom culture, where vessels are used to relay seed mussels in suitable grow out sites, is used in the Netherlands, Ireland and in the UK (Wales). "Bouchot" culture is a method used in France using a series of wooden poles as supports. Young mussels are transplanted onto these poles for on-growing.

Total Community mussel production (EU-27) increased from about 367 000 tonnes (valued at €210 million) in 1993 to a peak over 600 000 tonnes and the end of the 90's. Since production fluctuated, but generally decreased. The top producers are Spain, Italy, the Netherlands and France. The level of production has declined in the last ten years in the Netherlands due to a shortage of seed supplies. Access to wild seed for cultivation has been restricted over concerns regarding the impact of seed mussel collection on the availability of food for wild birds. There is also competition for access to collection grounds due to hydrocarbon extraction in the northern part of the Netherlands. New mussel industries have developed in recent years in Greece, Ireland, the UK and Sweden. The oyster and mussel production sectors have been affected by increasingly frequent biotoxin closures linked to algal blooms. For shellfish farming, there is also an ongoing problem of access to waters free from microbiological contamination of human or animal origin.

1.1.3. Other shellfish

The "other shellfish" sector is made up of clams, scallops, abalone and sea urchins. The Japanese or Manila clam *Ruditapes philippinarum*, is now the lead species in the Community. Total clam production in 1997 was 49670 tonnes, valued at €149 million, of which Italy accounted for 80%, Spain 11% and Portugal 7% with smaller quantities grown in France, Ireland and the UK[52]. Italian production grew to 50000 tonnes in 1999 but had dropped to 27737 tonnes by 2003,[53] (Facts and figures on the CFP). The clams are grown in the open in shallow areas with fine sediments in the Po Delta area principally. In other Member States cultivation generally takes place in the inter-tidal zone under mesh covering to protect from birds. Growth of the clam cultivation using this method has been slower than anticipated. Production of other shellfish in this category is very small at the present time but there are some hopes that production can grow in future as there is a good market for these species.

1.2. Fresh-water-fish farming in lakes, ponds or basins

European aquaculture production is dominated by farming of trout, carp, and some other species in smaller amounts.

1.2.1. Trout: an intensive but high quality water demanding production.

Trout production is spread throughout Europe and fresh trout can be bought everywhere. Because of its growth requirements and production performance, rainbow trout

---

52 Source: Forward study of Community Aquaculture, MacAlister Elliot and Partners Ltd, Sept 99.

53 Source: Facts and figures on the CFP- Basic data on the Common Fishereis Policy- Edition 2006

(*Oncorhynchus mykiss*) largely dominates European trout production (approximately 95% of the total production).

Almost every Member State has trout farms. Most of them are near to rivers, and use concrete basins or ponds. Some lake cages are also in use. Approximately 200 000 tonnes of portion-size trout are produced within Europe each year. The main producers are Italy and France, followed by Denmark, Germany and Spain. Turkey is also a big producer of portion trout outside the EU. Trout remains the first farmed fish in Europe. After many years of slow but steady increase, in the period 2000-2005 the production of portion trout showed a slow declining trend (approximately minus 0.6% per year)[54], but prices remained good.

Larger size trout over 1 kg are mostly destined for filleting or smoking, but there is also a market for the whole fish, fresh and gutted. Most large trout are portion-size trout spawned and grown in fresh water, then transferred to sea-cages to become large trout. However in some countries the entire cycle to Large Trout is carried out in fresh water. The production of Large Trout in Europe grew regularly from 1998 (where it was 94 000 tonnes) to 2002 when it reached 144 000 tonnes. The EU produces approximately 40% of total European production of Large Trout. However, Norway alone produces more than the whole EU. Norwegian and Faroese production collapsed after 2003 (following the imposition of a 20% duty on imports of this fish into the EU). In 2005, production was approximately 100 000 tonnes.

1.2.2. Extensive or semi-extensive aquaculture: carp and associated species.

The total EU production of carps, which is estimated at 72000 tonnes in 2006[55] is largely dominated by the Common carp (*Cyprinus carpio*) (over 90%). The main areas for EU production are in Central Europe (Czech Republic, Poland, Hungary, and Germany being the biggest producers) where the fish is mostly produced in ponds using traditional extensive or semi-intensive techniques.

In addition, the extensive polyculture techniques practised in carp ponds also allow simultaneous production of other freshwater species such as pike, pike-perch, perch, eels, tench and other small Cyprinids.

Statistics on carp production may not be fully reliable, but the trend over the last six years in the EU is towards a fall in total volumes, in particular in Austria and Poland, but good results in terms of prices with a certain tendency to the increase. On the European continent, non EU "carp" production is almost 145 000 tonnes/year, the common carp and the silver carp being by for the most frequently famed species. The main producers are the Russian Federation and Ukraine.

The carp group is far and away the largest fish production in aquaculture on a world scale. 2005 world production was around 19, 5 million tonnes, mostly in Asia[56].

---

54 Source: FEAP - Aquaculture Production. AQUAMEDIA 2007

55 Source: FEAP - Aquaculture Production. AQUAMEDIA 2007

56 Source: FAO Fishstat.

1.2.3. Intensive aquaculture in closed systems with water recirculation: Eels and other species

Eel is farmed in intensive systems in the Netherlands, Denmark and Italy. Dutch and Danish farmers use closed water recirculation systems, while in Italy farms are more traditional, with concrete basins and flow-through of water. The ancient form of extensive farming in Italian lagoons has almost completely disappeared.

EU production was around 11 000 tonnes/years until 2001, and then it went down to approximately 8 500 tonnes/year from 2002 and has stabilized overall since. But this figure hides major shifts among the main producers; Italian production (once the biggest EU producer) is on a constant downward trend since the late 90's, and Danish production also went down after 2001. These losses have been partially compensated by some increase in Dutch production. However, because of the uncertain supply of young eels, some eel farmers switch production to other species or simply abandon the sector.

Non-European fresh water species, such as Tilapia, catfish and sturgeon are also being produced. Although production amounts are yet minor compared to trout or carp, the high technology and innovation level of these farms appears highly attractive.

1.3. Marine finfish farming

1.3.1. Atlantic salmon[57]

The expansion in output from Atlantic salmon farming has continued over the past 30 years. The Community industry began to develop from the late 1970s onwards. The UK (West of Scotland) and Ireland (West coast) are the main EU producers. Estimated 2006 production was 128 000 tonnes in the UK and 15 000 tonnes in Ireland (although their production peaked in 2003 and 2002 respectively).

Norway remains the dominant world player in salmon farming, with an overall production of over 600 000 tonnes, whereas other producers of Atlantic salmon in Europe are Iceland and the Faroe Islands. Outside Europe, the species has seen spectacular growth in production in Chile (estimated about 400 000 tonnes in 2006), but which faced a severe disease outbreak since, and to a lesser extend in Canada, Australia and USA.

The industry cycle is now regarded as mature and salmon is the sector of European aquaculture which is most subject to globalisation and concentration of ownership. The top seven companies are responsible for 38% of Norwegian production. The top six companies, four of which feature in the Norwegian list, are responsible for 66% of UK production. Several European companies are also significant producers in Chile and Canada. Production has tended to surge ahead of market demand periodically.

There are still important environmental bottlenecks for salmon farming to deal with (if managing sea-lice seems less a problem than in earlier times, reducing the escape of farmed salmon is an important priority in salmon producing countries on the European continent).

---

[57] All statistics from Kontali Monthly Salmon Report, January 07.

1.3.2. Sea bass and sea bream

The development of sea bream and sea bass aquaculture in Greece was probably the biggest success story of the entire EU aquaculture sector; in the decade 1990-99 the average yearly increase in production was nearly 70%, bringing Greek output from 3,550 tonnes in 1990 to 57 250 tonnes in 1999[58].

The production of both species continued to increase in the following years almost everywhere, to reach 181 000 tonnes in 2002. Greece was by far the most significant producer accounting for 57% of all production in 2002, with 44 000 tonnes of sea bass and 59 000 tonnes of sea bream[59].

The high production volumes reached by 2001-2002 led to a major confusion in EU markets for sea bass and sea bream, with a collapse in prices. The main cause of the price crisis was the imbalance between supply and demand caused by rapid and uncontrolled production growth, without proper planning, market support or promotion, particularly in Greece where some Greek enterprises went bankrupt. Since then, sea bream and sea bass production has remained stable overall during 2003 and 2004 in Greece, while it restarted moderate growth in most other countries. By 2005, production again took off strongly almost everywhere. Spain is an interesting example; with its moderate but regular yearly increase, this Member State is the only European producer which has constantly increased production since 1990.

Despite some ups and downs, average prices for these species have risen during recent years, with good price levels in 2006. Production is still on an increasing trend today, but a fall in first sale prices is been reported again by the sector, particularly for sea-bream.

1.3.3. Tuna farming

The activity of blue tin tuna fattening started in the early 1990s in the Mediterranean and the market opportunities opened up by this practice has led to its continued increase ever since (EU, Turkey, Tunisia, Libya, Croatia, Morocco…). Although there have been some recent positive research results on tuna reproduction[60], this new sector of aquaculture is still only based on the capture of wild fish, including juveniles. Moreover, it has not yet been possible to adapt these caught wild fish to industrial pellet feeding, and fattening is performed using raw wild fish as feed. In the EU the number and capacity of tuna cages increased from 25 farms in 2003 to 37 farms in 2007 (Spain, Malta, Cyprus, Italy, Greece, and Portugal).

The development of tuna fattening has been an additional driver to excessive fishing pressure on wild stocks. Faced with this situation, the International Commission on the Conservation of Atlantic Tuna (ICCAT) adopted measures aimed at better control of these fattening activities[61] and in view of the level of capture, the Commission had to anticipate the closing of this fishery in 2008. The reduction in catches foreseen in the blue-fin tuna recovery plan might have a consequence on farming, as there will be less fish available for farming activities.

---

58 FAO Fishstat.

59 University of Stirling - "Study of the market for aquaculture produced seabass and seabream". Stirling 2004.

60 Cf FP5 Research project REPRODOT for example

61 Source ICCAT. See also ICCAT recommendation 06-07 on blue-fin tuna farming and ICCAT recommendation 06-05to establish a Multi-annual Recovery plan for blue-fin tuna

Significant research and technological progress are still necessary and high investment is needed to make tuna farming becoming a "fully-domesticated fish" aquaculture activity.

1.3.4. Other marine fish

Intensive water recirculation systems have been used for a number of years now to produce high value species like turbot (or other flat fish). Farms are usually located close to markets. Overall production in Europe remains proportionally limited, but the planned or on-going of construction of new farms (notably in Portugal and Spain) should lead to increased production.

2. EU AQUACULTURE – MAJOR SOCIO-ECONOMIC FEATURES

This chapter and the two subsequent ones summarise the main magnitudes of the EU aquaculture sector[62].

2.1. Overall production

In 2005, total aquaculture production in the EU was close to 1.3 million tonnes, worth about € 3.5 billion.

As can be seen in the Table1a, the production in 2005 was a mere 3.4 % larger than what it was in 1996. Furthermore, production in 2005 was close to 12% less than the maximum of 1999. Decline in production has been broadly speaking steady since then, with the exception of 2003 and 2004.

As already referred to earlier, there are quite different trends between marine fish on the one hand and fresh water fish and molluscs & crustacean, on the other.

Fresh water production has slowly decreased from some 360 000 tons, worth little less than €1 billion in 1996, to 313 000 tons and € 0.8 billion. This implies an annual decrease of the volume by 1.4% and of the value by 1.1%.

As regards molluscs & crustaceans, production in 2005 was 5% lower than that in 1996, but close to 20% lower than the maximum achieved in 1999.

---

[62] Data come from the following studies:
- Etude des Performances Économiques et de la Compétitivité de l'Aquaculture de l'Union Européenne. Etude 3 dans le cadre du contrat cadre Lot 3 - études relatives à la mise en œuvre du FEP. AND International. September 2008. This analysis will be further referred to as the "AND 2008".
- Review of the EU Aquaculture Sector. Task 1 of the study on the Definition of Data Collection Needs for Aquaculture. FISH/2006/15 – lot 6. Interim Report, December 2007. Framian. "Framian 2007", hereinafter.
- FUTURE PROSPECTS FOR FISH AND FISHERY PRODUCTS 4. Fish consumption in the European Union in 2015 and 2030 Part 1. European overview by Pierre Failler, with the collaboration of Gilles Van de Walle, Nicolas Lecrivain, Amber Himbes and Roger Lewins. Centre for the Economics and Management of Aquatic Resources Portsmouth, United Kingdom of Great Britain and Northern Ireland. FAO, 2007. p.51. "FAO 2007", hereinafter.
- *Prospective analysis of the Aquaculture sector in the EU* - JRC scientific and Technical reports, September 2008. See http://ipts.jrc.ec.europa.eu/publications - This analysis will be further referred to as the "JRC prospective analysis" or "JRC 2008".

The production volume of marine fish farming has been growing for nearly the entire period, with the exception of 2005. Production in that year was anyway 88% larger than that of 1996.

The production volume of marine farming (marine fish together with molluscs and crustaceans) shows quite a distinct growth of 8% per year from 1993 till 1999 (mainly due to important growth in shellfish farming), after which the production has levelled off at approximately 1 million tons (but with a general negative trend in shellfish production, while marine fish farming continued to increase). Overall marine farming has grown from 720,000 tons in 1990 to 980,000 tons in 2005, representing an average growth rate of 2% per year. The value of the production has grown quite regularly by some 5% per year from €1.3 billion in 1990 to €2.7 billion in 2005.

As can be seen in Table 2, the five most important producers (France Spain, Italy, United Kingdom and Greece) account for about 75% of the total value and volume. The next 7 countries account for a further 20%.

2.2. Production per species

Table 3 and 4 show the volume and value of production for a 13 species, as referred to in AND 2008 and Framian 2007.

In terms of volume, mussels are the most important species (38.2%), followed by trout (16.49%), salmon (11.77%), oysters (10.71%) and sea bream/sea bass (9.81%). In terms of value the most important today is farming of sea bream and sea bass (19% of total), followed by trout and salmon (each 17%), mussels (14%) and oysters (10.11%). These (groups of) species represent 78% of the total value of production and more than 86% of the total volume.

The most important increases in aquaculture production have been in higher unit value fish species, largely dominated by sea bass and sea bream, and Atlantic salmon. Mollusc production has remained fairly constant for the last ten years, dominated by mussels and oysters.

As can be seen in the Table 3, the most important producers of carp in 2006 were Poland, the Czech Republic, Germany, Hungary and France, which produce close to 90% of the EU carp production. Nearly all EU Member States produce significant amounts of trout. The major EU producers of trout in 2006 were Denmark, France, Italy, Spain and Germany with a 72% share in total EU volume (worth around €600 million).

Most EU salmon production is concentrated in Scotland (almost 90%) and the rest in Ireland, with marginal production volumes in France.

The production of sea bream and sea bass is dominated by Greece (56%), followed by Spain and Italy with 15-16% each. France, Portugal and Cyprus are the other Member States having a significant production.

The most important producers of mussels are Spain, France, Italy, the Netherlands, and the United Kingdom with a share of 85% in the total EU volume (worth close to €350 million).

Looking at the trends of individual species it is apparent that the only species with a consistent growth in value and volume are salmon and sea bass/sea bream, although the produced volumes of these two latter species are much lower, as well as the growth rate of the

volume. In 2005 the group "sea bass / sea bream" became economically the most important one farmed in the EU.

2.3. Employment

Employment figures in aquaculture are scarce and not very reliable. They vary significantly depending on the sources and the definitions used. According to what can be compiled and extrapolated from diverse available data, including most recently from the Member States Operational Programs for the EFF[63], aquaculture firms employed around 65 000 full-time jobs in 2005-2006. According to the European Federation of shellfish farmers (EMPA/AEPM), the European shellfish farming industry generates about 37 000 direct jobs. This shows that shellfish farming is generally more human resources demanding than finfish farming. According to JRC2008, labour requirements per tonne of production in mollusc and crustaceans are 6 to 7 times larger than for salmon, but broadly the same than for carps or tilapia.

Table 5 shows employment and firms by Member State. According to data from Framian, close to 70% of employees are men and a bit less than 30% women. This is a very different repartition than that in capture fisheries (96% men) and from that in processing (56% women). Spain is the country with more women employed in the sector (44%), followed by France (42%), the 3 Baltic States and Poland (40%). The Czech Republic, the Netherlands and Malta represent the other extreme (5, 2 and 1% of women, respectively). There are no data available regarding their level of education, although it can be presumed that particularly as regards molluscs and crustaceans, most of employments are not highly qualified ones. The most globalised sectors (salmon and sea bass/sea bream) are also the more capital-intensive ones; Production technologies used for these species also offer fewer employments but require a higher level of qualification.

Spain (27.4%), France (19.2%), Germany (10.3%), Italy (9%), Greece (7.8%) and Portugal (6.3%) account together for 80% of total employment. In terms of firms, France (26%), Spain (16%), Portugal (10.2%), Germany (7.35%) and Greece (6.5%) represent two thirds of firms.

In terms of geographic area, close to two thirds of aquaculture employments are in the Atlantic area, close to 20% in the Mediterranean and the rest in the Baltic and North seas.

In terms of region, Galicia (Spain), Poitou-Charente (France) and Algarve (Portugal), are those which concentrate most of the employment. All are located in the Atlantic area.

As regards firms, according to Framian 2007, there were some 14,400 firms in the EU. Most firms are SMEs. According to the Table 5, the average number of employees per firm is 4.47, with many variations across Member States. As an example, in France which is the second biggest EU aquaculture producing countries (in volume), the number of shellfish farming enterprises in 2005 was 3 317, representing 9 933 full-time equivalent jobs[64]; 36 marine fish farming enterprises generating 493 jobs, and 306 freshwater fish farms for 1 070 jobs[65].

---

63 However, specific data on the total employment in the aquaculture sector have not been provided by all Member States (aggregates with the capture fisheries and/or the fish processing activities).

64 Source OFIMER, les chiffres clés de la filière pêche et aquaculture en France – édition 2008.

65 Extensive aquaculture in ponds not included

2.4. External trade

EU imports of all fish and fish products from the rest of the world have increased from €11.7 billion in 2000 to €15.8 billion in 2006; i.e. almost 5% per year. On the other hand EU exports of all fish and fish products have grown from €1.8 to 2.4 billion, i.e. a little more than 4% per year.

2.4.1. Imports

As the table 6 shows, imports of aquaculture products have grown significantly, with the exception of carps. The total value of imports was € 2.8 billion in 2007 (approximately 2.2 times higher than the corresponding figure of 1999). Imports represent about 75 % of the value of the internal aquaculture production.

It can be observed that among the species traditionally farmed in Europe, the imports of mussels have increased the most. The most of this increase is due to imports of canned mussels (about 30 000 tonnes in 2007, representing 120 000 tonnes of live weight of mussels, 90 % of which are from Chile).

Sea bass and sea bream imports are also growing rapidly, coming mainly from Turkey and Croatia.

As regards salmon, which is by far the most important imported species both in volume and value, imports from Norway represent close to 85 % of all imported salmon. Although whole salmon is still the most important product, imports of salmon fillets and other processed salmon products are growing faster.

Another important group of species imported to the EU are bivalves, originating largely from Chile (23% of the value) and USA (20%). Approximately 50% of these imports are scallops and about 38% are mussels in different product forms.

It has to be noted that imports from fresh water species have increased in the period 1999-2007 by more than 187 times (from 2 100 tonnes to about 394 000 tonnes). Imports in 2007 were nearly four times as big as these of 2005, which clearly shows the great importance these imports have now. Imports come almost exclusively from Southeast Asian countries. Figures are shown on Table 7.

According to a study carried out by the EU Fish Processors' Association in October 2007, Vietnamese imports into the EU (and Norway) are nearly exclusively made of pangasius (126 000 tonnes in 2006).

2.4.2. Exports

Total exports of the main aquaculture species' products amounted to 67 000 tonnes "live weight equivalent" in 2007 (see table 8), worth € 278 million. Generally speaking, exports have grown significantly during the period 1999-2007, at a rate very close to that of imports, in volume terms (volume multiplied by 2 - 2.5), for most species.

It has to be noted however that total exports of EU aquaculture products remain limited when compared to the total EU production or to the imports of aquatic food in the EU (the volume of exports was around 5 % of imported volume and 10 % in value in 2007).

Exports of sea bream are growing quickly. The volume of exports has multiplied by 30 since 1999, in particular to Russia, the US, and Switzerland (see Table 9). These three countries are the most important destinations for most EU aquaculture products, followed by Vietnam, Japan and Thailand, in particular for salmon.

Exports of salmon and mussels are increasing since 2005, particularly salmon, after having lost significant ground in the period 2003-2005. Regarding salmon, even if exports of whole fish are still the most important export product (close to 60% of volume), exports of smoked salmon, salmon fillets and other transformed products are outgrowing those of whole salmons.

Exports of mussels have multiplied by approximately 2 during the period 1999-2007. As regards fresh mussels, Russia and Croatia are the most important destinations. The US is the most important destination for canned mussels.

Exports of trout and oysters are also important. Russia is the main destination for both.

3. STRUCTURE OF THE EU AQUACULTURE SECTOR

3.1. Size of EU aquaculture production firms

AND 2008 has been looking into the accounts of a sample of close to 750 EU aquaculture firms for which financial information for 2006 was complete[66]. These firms represent around two thirds of the total turnover of the EU aquaculture sector.

The average turnover of firms in the sample is around €2.69 million. However, a mere 2% have a turnover exceeding €20 million; a further 2.6% have a turnover between €10 and €20 million, and a further 4% have a turnover between €5 and €10 million. In total, 8.5% of the firms have a turnover of €5 million or larger. However, firms exceeding €20 million, account for 42.1% of the turnover of all firms in the sample. These which have a turnover between €10 and €20 million account for a further 13.4% of the total turnover of the sample and these between €5 and €10 million for a further 10.4%. Overall, 8.5% of firms account for close to 66% of the total turnover of firms in the sample.

Contrary to that, 62% of firms have a turnover of less than €1 million. Together they account for 9.5% of the total turnover of firms in the sample.

The majority of the largest firms are Greek, and specialise in sea bream and/or sea bass. Several other companies are from the UK and produce salmon. In fact, most of the UK firms are owned or controlled by Norwegian capital. A few large companies are Spanish, mostly specialised in turbot. Pescanova, the largest EU aquaculture producer, shows the peculiarity that 90% of its aquaculture activities are outside Spain (and the EU). An Italian producer of caviar and sturgeon is also listed among the large EU companies.

The largest firms represent close to 80% of the total turnover of UK firms and 60% of the Greek firms in the sample.

[66] These firms are included on the AMADEUS database of EU firms.

It has to be noted finally that Norway has 3 times as many firms larger than €20 million as the entire EU. The largest EU producer (leaving aside Pescanova) is 4 times smaller than the largest Norwegian producer.

In conclusion, EU aquaculture firms are not only small in terms of employees, but also in terms of turnover. However, next to thousands of SMEs, there is a small but significant number of larger firms. Nearly all of the latter produce salmon or sea bass/sea bream. These three products are by far the most globalised ones.

3.2. Consolidation and vertical integration

Different trends and paths are taking place for different species, regarding consolidation and vertical integration.

As regards salmon, intense horizontal consolidation has taken place. The number of Scottish firms was reduced from 131 in 1994 to mere 41 in 2005, of which 14 firms produce 86% of the total output. Most of EU producers are controlled by Norwegian interests. It appears that firms form the Netherlands also have major interests in the main competing production areas as Norway and Chile. This trend results basically from pressures on selling prices. Horizontal consolidation is an answer to the need to gain scale of production so as to benefit from economies of scale. Horizontal concentration is already quite significant and barriers to entry are high in view of the scale of production required and the scarcity of new sites.

This trend has been sometimes complemented by the externalisation of upstream activities (in particular hatcheries and fish meal), as means to get further cost reductions, and by a certain trend to move into processing and marketing as ways to counter the buying power of bid retail chains. However, the externalisation of upstream activities is by no means the rule.

Trends regarding sea bass/sea bream are somewhat similar: horizontal concentration is taking place combined with vertical integration into processing and marketing and into hatcheries and also fishmeal. This time, EU firms, mainly Greek, are taking positions in other EU producers in the Mediterranean and expanding into adjacent non-EU countries, particularly Turkey and Croatia, partially at least as a way to overcome increasing constraints within the EU. The upstream integration can be explained as a mean to compensate for the lower labour costs, in particularly in Turkey. This labour cost disadvantage does not exist as regards salmon, where competing producers face also high labour costs.

Horizontal concentration is significant although not as marked as in salmon. Nevertheless, barriers to entry are also significant in particular as far as the availability of new sites is concerned. This horizontal consolidation is accompanied by some diversification into other aquaculture producers: salmon producers into trout and sea bass/sea bream producers into salmon. In both cases, diversification is always by means of merger or acquisitions.

Producers of new high value species, in particular turbot and sturgeon are normally quite vertically integrated both upstream and downstream.

Consolidation is not significant for mussels and oysters, where softer links between producers (e.g. cooperatives) are preferred. Perhaps that was a reflection of the fact that mussels were less exposed to international competition. This can be changing now, as significant imports – in particular from Chile- are taking place. Nevertheless, it is probable also that scale economies are not as significant as in respect of fish, which could limit the potential for

consolidation. Lack of room for scale economies, combined with the decline in demand, could also be an explanation for the lack of consolidation of carp's producers (and to a lesser extent as regards trout).

3.3. Production cost factors

Aquaculture productivity has to date been improved through increased use of mechanisation and scale of production effects (e.g. through consolidation) that are lowering the labour and overhead costs per unit of production. These have combined with biological efficiency gains associated with better quality seedstock, feeds and feed utilisation, and with better management of (though still troublesome) risks associated with aquatic diseases. However, rising input costs (feeds, energy, water, etc.) and environmental charges (waste disposal costs or increasing barriers to environmental resource use), combined with potential technical limits to further biological performance gains (excluding possible options available through genetically modified –GM- technology) may make it increasingly difficult to break further production cost and price barriers.

Globalisation is increasing competition in national markets, but also improving opportunities for exports. By the nature of food markets, much of the larger scale aquaculture output is increasingly at commodity level, where the most important competition is on price. Achieving a lower cost of production is therefore a key factor in successful competition and any regional factors that add to production costs (either directly such as higher labour costs, or site licensing costs) or indirectly (e.g. increased administrative costs due to regulatory requirements) could affect business investment decisions. The alternative competition strategy is niche marketing, where producers are able to differentiate their product e.g. on the basis of quality, locality, service or brand.

As can be seen in Table 10, there are wide variations in the cost of production of different species, depending on system type and other inherent characteristics. Estimated costs range from €2.33 to €10.50 per kg for the species presented therein. It can be added that, at least for salmon, EU producers are at a competitive disadvantage.[67]

The major components of production costs are *seed, feed, labour, and in the case of recirculated systems, power*. The proportion spent on seed is highest for those systems relying on wild sources, especially tuna, eel and currently octopus. Feed is a higher component of costs in cage systems (mostly due to other costs being lower) whilst labour costs are a higher proportion in systems with lower output (char and organic salmon in these examples). Depreciation is not cash cost, but is usually included in comparative operating costs to indicate the financial burden of different capital cost structures.

Feed is an increasing matter of concern for most farmers for two main reasons, first because of the dependence of fish meal and fish oil on capture fisheries and second because of the oligopolistic nature of the sector. Four firms account for close to 75% of total world wide production of fish meal and fish oil. The combination of these two elements implies that prices for fish meal and oil will continue growing in the future.

---

[67] According to a big farmed salmon producer (Cermaq), production costs are in 2006: Chile: 1.29€/kg; Norway: 1.87€/kg; Canada: 2.07€/kg; Scotland: 2.54€/kg

Transport costs can be significant. In the case of salmon for instance, depending on the distance they can vary between €0.195/kg (from Canada to US) to €1.95/kg (Chile to Europe). Transport costs from Norway to the EU are around €0.4/kg. The transport of frozen salmon costs around €0.2/kg.

Access to finance is another important issue. On the one hand aquaculture is characterised by a relatively long production cycle, which implies a significant time lag between a loan being taken out for site development, and sufficient product sales to start making repayments. On the other hand, it seems that obtaining bank loans for aquaculture had been difficult in many countries, as the sector had earned an uncertain reputation from earlier levels of business failure. The fact that loan servicing is hardly visible in the table, could mean that financing has been mainly through internal resources, or that companies use other means than loans to get finance. For instance, some big groups are quoted in stock exchanges. It seems also that farmers are getting credit from feed and oil sellers and that there are farmers which produce for bigger groups which take the financial risk themselves.

The price of licenses is not generally a very important production cost factor, however, the access to space and to licenses represent a crucial limiting factor to aquaculture development.

The same goes for *waste disposal*. Capacity limitations on assimilating these wastes are therefore key constraints. For freshwater fish farming in Europe, this has limited the size and clustering of individual units and discouraged the type of expansion and consolidation seen in the salmon sector. Marine farms have been less constrained, allowing higher levels of production from individual sites, and greater opportunities for consolidating central services and facilities. It is however difficult to reflect access to water as a separate cost component.

R&D effort is another factor worth mentioning here, although not directly visible in the table. EU aquaculture producers are said to have a competitive advantage in this field.

4. ECONOMIC PERFORMANCE OF THE EU AQUACULTURE SECTOR

The economic performance of the EU aquaculture sector appears to differ in many different aspects – not only species and on-growing technologies, but also country and size of the company.

As mentioned above, the most important factors affecting economic performance are, at the moment:

- Heavy (global) competition with imports of farmed species from other parts of the world. Imports are putting pressure on prices of EU produced species;
- Strong demand for fish in Europe and worldwide;
- As stated above, supermarkets require constant supply of constant quality, with guarantee of environmentally friendly production chains;
- Increasing costs of fish meal; and
- Access to sites, licences and waste disposal.

4.1. Economic performance of the sector in general

AND 2008 has approached this issue by making a rough comparison of the largest aquaculture and poultry producers in the EU. The preliminary conclusions are that the EU aquaculture largest producers are dynamic, young firms showing high yearly rates of turnover increase (close to +30% in 2006 over 2005) and profitability ratios (well above 10% of turnover), active in a sector where concentration is low. Contrary to that, most poultry producers show very small progression of their turnover (less than 5%) and profitability ratios very close to zero or even negative. The sector is heavily concentrated.

There is a big difference between sizes of firms in both sectors. The largest EU aquaculture producer (not counting Pescanova) is 17 times smaller than the largest EU poultry producer.

4.2. Economic performance by species produced[68]

In general the following impression of the main segments of the EU aquaculture sector can be given.

4.2.1. Fresh water culture – carp and trout

Fresh water fish farming is for many producers only a supplementary source of income. Small producers manage to integrate their farming activities in for example agro-tourism or sports fishing to be less dependent on sale of food fish.

The economic situation in the carp farming is in general rather weak for the following reasons:

- Stagnating prices of carp and rising prices of input, mainly feeds, labour and energy;
- Market preference for sea fish rather than fresh water fish;
- Low investment levels lead to stagnation of productivity, caused by the relatively small size of most carp producers.

Total production value of common carp was in 2006 at a similar level to 1996, thanks to relatively constant volume and a price which has significantly recovered since 2000.

The economic performance of trout farmers depends significantly on the firm size. Small producers have difficulty to maintain sufficient growth of productivity and must focus on local niche markets as they are not able to offer regularly sufficient quantities to sell to supermarket chains. Over the past years a consolidation process has been going on and the numbers of small producers have been falling.

Lack of new suitable locations, environmental restriction and dependence on animal feed stuff are among the main problems faced by this industry.

[68] Conclusions in this section are largely taken from Framiam 2007 and AND2008.

Total EU value of production of rainbow trout has decreased by more than 15% between 1996 and 2005 (almost 30% in real terms). This was mainly caused by the fall in volumes, while the price has remained relatively constant.

4.2.2. Marine farming of salmon and sea bass / sea bream

The economic performance of salmon has recently recovered, after difficult years between 2001 and 2004. A major consolidation process has taken place. The number of Scottish firms was reduced from 131 in 1994 to mere 41 in 2005, of which 14 firms produce 86% of the total output. Salmon farming is a globalised activity. Some 85% of the Scottish farms are in the hands of Norwegian or Dutch companies, which also have major interests in the main competing production areas as Norway and Chile.

Firms in this sector are quite large for EU standards. They show also acceptable profitability, which exceeds that of most other sectors, apart from sturgeon.

The main problems of the EU salmon farming appear to be:

- Increased price of fishmeal, as feed represents a significant share of the production costs. In this respect Scotland, not being a fish meal producer, is in relative disadvantage compared to the main competitors.

- Negative publicity about health and environmental impact of salmon farming.

- As many other species, competition for space with other users and consequent difficulties to obtain new permits.

The value of EU salmon production has steadily increased over the period 1996-2005 thanks to both higher prices and greater volumes.

The sea bass/sea bream sector shows similar trends to salmon – consolidation into a small number of internationally operating (Greek) companies which account for a significant share of the total production. Because of increasing constraints on growth within the EU, new production facilities are built in non-EU Mediterranean countries. After a crisis of this sector in 2001 and 2002 due to over supply which resulted in low prices, there has been a general recovery and profitability is illustrated by on-going new investments. The sector enjoys strong demand. The leading companies are vertically integrated, from hatcheries through on-growing to processing and wholesale trade. The most important constraint seems to be the lack of new licenses.

The value of EU production of sea bream and sea bass shows steady growth over the period 1996-2005 thanks to higher volumes. The prices were in 2005 significantly below the 1996 level.

Firms are much smaller than those active in salmon production.

4.2.3. Bivalve farming – blue mussels, oysters

Regarding mussels, the available information does not allow an even indicative assessment of the economic performance of the mussel sector, as the required information is not available for most major producers.

Overall value of the EU mussel production has increased by 50% between 1996 and 2005, mainly due to steady rise of the prices, while the volume has remained relatively constant.

As for oysters, there are a large number of small producers whose profitability appears to be significantly determined by their regional location. The location determines the suitability of on-growing conditions but also specific profitable specializations / activities such as the purification.

The value of the EU production of Pacific cupped oysters has increased since 2001, exclusively due to the continuous increase in price. The volume was in 2005 about 20% below the 1996 level.

Table 1a: Volume of EU aquaculture production

Aquaculture production in the European Union (EU-27) - Quantities (tonnes live weight)												
EU-27	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Total aquaculture products	1.104.786	1.183.643	1.230.362	1.254.243	1.377.943	1.431.738	1.401.751	1.389.009	1.276.561	1.346.744	1.332.337	1.272.455
Crustaceans and molluscs	634.502	691.757	714.860	709.367	817.648	825.264	779.742	741.607	661.066	703.033	705.280	679.679
Molluscs	634.249	691.511	714.535	708.974	817.357	825.013	779.487	741.345	660.788	702.742	705.072	679.419
Mussels	422.964	457.822	498.038	491.971	600.448	603.408	562.516	548.827	480.401	541.347	538.964	470.197
Oysters	157.323	156.178	163.336	160.067	152.134	155.529	148.772	123.960	130.837	129.344	131.250	132.053
Clams & arkshells	52.654	75.945	51.075	54.243	62.630	64.516	67.063	67.377	49.411	31.898	34.679	76.996
Finfish*	465.197	486.786	510.440	539.814	557.235	603.439	618.977	647.359	615.457	643.674	627.016	592.731
Freshwater fishes **	356.036	361.813	361.549	361.802	352.396	356.408	357.848	365.223	334.059	345.181	331.229	312.846
Rainbow trout	231.986	243.085	245.178	247.784	244.055	236.766	237.817	246.264	221.389	221.791	214.786	202.900
Carps + other cyprinids	98.160	96.436	88.447	88.153	82.326	88.576	89.997	89.954	83.254	89.433	83.919	80.912
River eels	7.943	6.819	8.503	8.605	9.686	10.439	10.658	10.151	7.953	8.997	9.024	8.202
Tilapias + other cichlids	200	320	320	200	200	246	180	200	186	507	473	521
Marine fishes**	109.161	124.973	148.891	178.012	204.839	247.031	261.129	282.136	281.398	298.493	295.787	279.885
Atlantic salmon	77.728	83.748	98.920	116.926	127.346	146.139	146.952	162.267	169.478	162.552	172.939	144.801
Gilthead seabream	12.779	17.487	23.751	29.868	37.858	50.137	58.747	63.605	59.798	71.524	64.004	71.475
European seabass	12.753	16.999	19.253	23.739	29.209	37.198	40.849	41.443	39.256	46.632	42.030	49.202
Atlantic bluefin tuna	NA	15	77	NA	1.959	3.346	3.682	4.446	5.185	5.194	6.546	3.858

* Finfish is the aggregate for Freshwater, Diadromous and Marine fish

** Considering the main production methods for diadromous species farmed in the EU, data on Atlantic Salmon has been considered under "Marine" fish, while data for all other diadromous species, in particular the most important such as rainbow trout and eels, have been included under "Freshwater" fish". - NA: not available

(Source Eurostat datasets)

Table 1b: Volume of world aquaculture production

Global aquaculture production - Quantities (tonnes live weight)

WORLD	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total fishery products	27.775.597	31.195.904	33.796.137	35.841.852	39.085.697	43.005.040	45.660.666	48.583.977	51.966.012	55.210.620	59.869.723	62.959.046
Crustaceans and molluscs	7.723.000	9.332.038	9.606.363	9.777.353	10.505.074	11.665.675	12.591.664	13.533.204	14.453.837	15.859.100	16.799.480	17.409.949
Molluscs	6.717.944	8.230.344	8.488.940	8.558.604	9.143.865	10.154.093	10.771.464	11.396.652	12.059.601	12.606.086	13.145.358	13.448.749
Mussels	985.248	1.108.617	1.095.360	1.115.189	1.337.772	1.446.032	1.370.957	1.445.001	1.634.280	1.712.635	1.770.356	1.795.779
Oysters	2.648.545	3.048.915	3.035.834	3.080.176	3.541.913	3.722.944	3.998.513	4.211.531	4.332.420	4.472.773	4.607.566	4.615.400
Clams & arkshells	1.679.724	1.766.090	1.781.326	1.941.474	2.261.843	2.760.246	2.633.454	3.145.415	3.458.226	3.813.086	4.109.653	4.175.907
Finfish*	13.051.113	14.994.371	16.923.211	18.746.417	19.871.935	21.582.078	22.748.462	24.255.719	25.778.107	26.491.494	28.743.909	30.301.498
Freshwater fishes **	11.719.387	13.493.450	15.267.765	16.876.274	17.832.345	19.275.070	20.149.533	21.365.950	22.723.392	23.133.385	25.174.426	26.507.213
Rainbow trout	334.727	365.240	384.180	427.329	437.816	416.238	447.313	511.595	509.376	495.953	499.262	486.928
Carps + other cyprinids	8.767.159	10.406.173	11.999.125	13.236.957	13.930.188	14.948.553	15.452.156	16.316.354	16.727.667	17.448.303	18.702.802	19.541.921
River eels	187.529	187.822	233.981	233.589	226.120	218.713	232.957	231.006	231.874	232.084	248.274	242.067
Tilapias + other cichlids	593.065	703.086	810.399	931.389	950.698	1.103.784	1.269.964	1.386.274	1.490.573	1.683.637	1.899.000	2.025.560
Marine fishes**	823.429	998.263	1.120.217	1.330.676	1.465.437	1.657.405	1.897.883	2.116.221	2.287.712	2.523.637	2.708.433	2.879.097
Atlantic salmon	374.931	465.245	551.906	646.516	688.227	805.616	895.808	1.030.005	1.084.934	1.130.784	1.253.047	1.235.972
Gilthead seabream	20.570	24.466	33.198	41.472	54.388	67.204	87.288	82.152	77.495	96.305	92.718	110.705
European seabass	14.863	19.475	21.095	27.517	35.129	41.883	52.802	44.824	43.779	52.374	47.767	57.550
Atlantic bluefin tuna	NA	15	77	NA	1.959	3.346	3.682	4.446	5.185	5.448	10.608	7.583

* Finfish is the aggregate for Freshwater, Marine and Diadromous fish

** For better comparison purpose with EU data sets above, data on rainbow trout and "river eels" have been added to the "Freshwater fish" aggregate and Atlantic Salmon has been considered under "Marine fish". Other Diadromous species not farmed in Europe are not included in total fresh water fish neither under Marine fish.

(Source Eurostat datasets)

Table 2- EU Aquaculture production in EU Member State (EU-27)

Member State	Value of production in 2005 (Euro million)	Volume of production in 2005 (1000 tons)	Average production 94-98 (1000 tons)	Change 2005 over average 94-98	% of aquaculture over total aquatic food production in 2005
Austria)	10.9	2.4	2.954	-25.62%	87%
Belgium	3.5	1.2	0.865	+38.73%	5%
Bulgaria	9.6	3.1	5.024	-38.3%	37%
Cyprus	na	na	0.731	na	55%
Czech Republic	38.9	20.5	18.061	+13.5%	83%
Denmark	98.3	39.0	42.064	-7.19%	4%
Estonia	2.6	0.6	0.298	+101.34%	1%
Finland	44.1	14.3	16.827	-15.01%	10%
France	537.0	239.3	281.739	-15.06%	30%
Germany	171.2	52.3	60.427	-13.45%	14%
Greece	341.3	105.2	42.886	+145.3%	54%
Hungary	26.3	19.1	9.376	+103.71%	64%
Ireland	107.8	62.9	33.609	+87.15%	19%
Italy	562.0	234.1	224.572	+4.24%	38%
Latvia	1.0	0.5	0.444	+12.61%	0.5%
Lithuania	4.2	2.0	1.631	+22.62%	1%
Luxemburg	na	na	na	-	na
Malta	5.4	0.7	1.42	-50.7%	36%
Netherlands	108.4	67.9	102.284	-33.62%	11%
Poland	77.2	36.4	27.156	+34.05%	19%
Portugal	28.4	6.5	6.3	+3.17%	3%

Romania	16.2	7.3	14.948	-51.16%	55%
Slovakia	2.1	1.0	1.258	-20.51%	36%
Slovenia	4.1	1.5	0.831	+80.5%	56%
Spain	318.3	279.8	237.22	+17.95%	21%
Sweden	20.9	5.9	7.09	-16.78%	2%
United Kingdom	619.3	172.8	111.302	+55,25%	21%
Total	**3,159.0**	**1,376.3**	**1.451**	**-5.15%**	**18%**

(Source: Framian 2007)

Table 3 –EU-27 Aquaculture productions per species

MS	Trout	Carp	Eel	Tila-pia	Cat-fish	Salmon	Sea bream	Sea bass	Turbot	Cod	Mussels	Oyster	Clam	Total
BE	400	400		150										950
BG	1151	926			26						171			2274
CZ	597	17814	1		69									18481
DK	36587		1673			18			8		280			38566
DE	19343	11999	329		149			25	68		9470	85		41468
ET	451	44	40											535
EL	2446	107	372			6	43829	30959			26048	3		103770
ES	25959	2	427	1			15433	5713	5572		158059	4861	1143	217170
FR	32412	4230			200	1190	1778	3913	791		84775	119400	1810	250499
IE	1614		1132			13764			6		38265	6153	161	59963
IT	30558	263		20			6914	6262			63577		69678	178404
CY	70						1465	583						2118
LV	2	514												516
LT	46	1932												1978
LU														0
HU	28	9739	5		141									9913
MT							540	196						736
NL	50		4000	350					75		59500			63975
AT	1729	321			2									2052
PL	15700	18600												34300
PT	844		1				1514	1526	214			331	1491	5921
RO	815	2256			124									3195
SI	995	241					2	25			201			1464
SK	742	169												911
FI	13693													13693
SV	4210		222								1069			5501
UK	12458					129823			58	69	28506	964	5	171883
EU 27	202900	69557	8202	521	711	144801	71475	49202	6792	69	469921	131797	74288	1230236

(Source: Framian 2007)

Table 4 - Value of EU aquaculture production by species, 2005

Species	**Value (Euro million)**
Rainbow trout	601.6
Atlantic salmon	593.5
Gilthead sea bream	369.8
Pacific cupped oyster	358.8
Blue mussel	350.1
European sea bass	315.1
Japanese carpet shell	272.1
Common carp	166.8
Mediterranean mussel	133.2
European eel	87.7
Atlantic bluefin tuna	54.4
Turbot	52.5
Other species	190.6
Total	**3,546.2**

(Source: Framian 2007)

Table 5- EU aquaculture sector: employment and firms (2005)

Country	Employment	Number of firms	Average employees
Austria	500	400	1.25
Belgium	84	na	na
Bulgaria	na	na	na
Cyprus	127	na	na
Czech Republic	1,693	690	2.45
Denmark	674	205	3.29
Estonia	42	96	0.44
Finland	332	187	1.78
France	12,374	3,720	3.33
Germany	6,609	1,058	6.25
Greece	4,975	937	5.31
Hungary	1,518	349	4.35
Ireland	1,144	253	4.52
Italy	5,771	725	7.96
Latvia	426	na	na
Lithuania	333	18	18.5
Luxemburg	na	na	na
Malta	105	na	na
Netherlands	194	155	1.25
Poland	2,610	900	2.9
Portugal	4,051	1,471	2.75
Romania	na	na	na
Slovakia	233	na	na
Slovenia	254	na	na
Spain	17,619	2,306	7.64
Sweden	200	325	0.61
United Kingdom	2,430	589	4.13
Total	**64,298**	**14,384**	**4.47**

(Source: Framian 2007)

Table 6 - Evolution of EU- 25 imports (in "live weight equivalent" tonnes)

Species	1999	2000	2001	2002	2003	2004	2005	2006	2007
Eel*	3 092	2 076	4 025	2 286	2 620	2 707	3 436	2 368	4281
Sea bass	3 990	3 403	4 250	7 424	7 976	9 894	12 061	12 569	15 425
Carp	424	405	424	380	285	222	133	1 101	446
Sea bream	1 075	444	533	862	1 159	1 416	2 512	2 244	3 450
Oyster	85	48	102	115	118	225	405	221	229
Mussel	9 235	15 863	19 216	33 493	48 329	63 643	71 771	99 465	134 580
Salmon	329 976	339 970	347 261	390 603	447 640	484 631	537 858	571 538	714 458
Trout	584	578	3214	6 542	9156	3 564	1 304	3131	5 103
Other fresh water fish	2 109	2 998	7 092	9 744	22 070	57 362	107 467	287 754	393 538
Total	**350 571**	**365 784**	**386 115**	**451 449**	**539 352**	**623 663**	**736 947**	**980 390**	**1 271 512**

Source: AND-International (based on data from Eurostat/COMEXT; conversion factors: OFIMER

Table 7 - Evolution of EU imports of fresh water fish from some Asian countries (tonnes)

Origin	1999	2000	2001	2002	2003	2004	2005	2006	2007
Vietnam	572	848	2 106	3 290	7 627	20 023	38 016	103 151	140 187
China	58	90	293	110	1	53	1 211	4 157	7 233
Indonesia	81	58	68	35	217	1 021	835	1 228	1 230
Thailand	90	144	231	270	546	714	799	876	984
Total	**802**	**1 140**	**2 697**	**3 705**	**8 392**	**21 811**	**40 862**	**109 412**	**149 634**

Source: AND-International (based on data from Eurostat/COMEXT)

Table 8 - Evolution of exports (in "live weight equivalent" tonnes)

Species	1999	2000	2001	2002	2003	2004	2005	2006	2007
Eels	190	242	128	190	147	191	126	131	124
Sea bass	615	717	894	1083	954	1194	1406	1732	2228
Carp	666	707	773	593	718	412	164	458	184
Sea bream	65	213	257	333	250	295	438	852	1839
Oysters	731	1041	833	673	700	785	805	840	1180
Mussels	6063	8313	10450	11849	12936	13252	8996	10840	11988
Salmon	19602	14909	14944	18170	33336	30326	23849	36408	46011
Trout	1890	1215	2506	2593	871	1633	2618	3040	3634
Total	**29823**	**27357**	**30783**	**35484**	**49912**	**48088**	**38401**	**54301**	**67188**

Source: AND-International (based on data Eurostat/COMEXT); conversion factors: OFIMER

Table 9 – Exports per country of destination in 2007 (tonnes)

Destination	Salmon	Trout	Sea bass	Sea bream	Eels	Mussel	Oysters
USA	16 060	0	653	171	0	1 036	2
Russia	7 054	1 485	586	508	48	825	365
Switzerland	2 487	461	301	163	5	585	214
Japan	1 084	341			0	32	0
Norway	762	169	6	4	0	205	41
Vietnam	826	182				0	1
Ukraine	659	12	30	48	1	218	67
Australia	985	10				14	
Canada	556		45	21		12	3
Croatia	254	99	4	2	0	329	
Thailand	587	0				7	7
Lebanon	531		0	0		24	4
Tunis	66	1	194	294		28	2
China	247	139	37		56	0	5
Hong-Kong	184	0	1		4	5	248
Israel	175		7	245		9	2
Serbia	213		41	35		29	0
Kuwait	338	0			0	0	0
United Arab Emirates	173	1	4		0	15	53
Bosnia	54			0	0	56	0
Total	**36 669**	**3 461**	**2 122**	**1 751**	**118**	**4 190**	**1 180**

Source: AND-International d'après Eurostat/COMEXT

Table 10 - Comparative operating cost profiles of different aquaculture systems (percent of total operating cost)

Breakdown of operating costs	**Offshore salmon**	**Organic salmon**	**Sea bream cages**	**Tuna cages**	**Turbot re-circulated**	**Turbot flow through**	**Eel re-circulated**	**Octopus on-growing**	**Arctic charr cages**	**African catfish**
Feed	46	45.6	54	27	15	18	29	13	43	58.7
Selling costs/Packing	17	7.1								
Seed stock (fry or smolts)	8	13.5	20	48	10	11	29	42	21	7.9
Wages/salaries	7	10	9	6	7	8	9	11	19	7.2
Misc./other operating costs – inc. consumables & contingency	6	0.4		14	10	10	1			9.6
Depreciation	5	7.1	13		35	33	20	11	12	5
Maintenance					4	1		3		2.2
Vet/medicines	3				2	2				1.1
Administration/ Overhead costs	3	9.3			4	4	1			2.2
Transport		2.5								
Harvest expenses		4.6								
Stock & general Insurance	3		1	2	2	2	2	15	2	2.2
Legal & professional fees					1	1				0.7
Licensing/lease/ discharge costs			0				1	1		
Power and fuel	2		2		11	9	9	3	2	3.3
Loan servicing				3						
Total	100	100	100	100	100	100	100	100	100	100
Cost €/kg	2.33	4.15	4.04	10.50	4.58	3.98	4.88	5.53	2.54	3.61

(Source: JRC2008)

ANNEX II

OUTCOME OF THE CONSULTATION

Report on the results of the open consultation on the

"Opportunities for the development of Community aquaculture"

This overview of the main points raised in the consultation process is primarily based on the written submissions received with additional references – where necessary – to indications provided in specific meetings. This document is provided as background information only. It is not a formal report by the Commission nor should it be interpreted as such.

As most of the contributions received were presented according to the main chapters and associated questions developed in the consultation document prepared by DG FISH Services when launching the consultation[69], this overview is presented and structured in the same way.

1. AQUACULTURE: A CHANCE FOR EUROPE

1. Do you consider it justified for the Community to develop a specific strategy for aquaculture and why?

2. Do you share the vision for a sustainable development of European aquaculture as set out in the 2002 Strategy? Would you consider that it needs to be adapted to evolving circumstances?

There is a unanimous view and often strong support in all contributions in favour of a Community wide Strategy on Aquaculture. Most of the reasons that are outlined in the consultation document are referred to by contributors when highlighting their justification and views on what they consider should be the scope, the vision and the objectives of such a strategy, although views diverge on one or the other specific domain that should be addressed[70].

Differences in both the functions of, and the approaches to, fisheries and aquaculture are seen to entirely justify a specific strategy for aquaculture and its different components. Some producers organisations have even expressed the views for "*the need for a Common Aquaculture Policy*" (Finnish fish farmers association) or have invited the Commission to take a less ""hesitant" approach, with reference to a "*European Fisheries and Aquaculture Funds*" (French Aquaculture Federation).

---

69 See at http://ec.europa.eu/fisheries/cfp/governance/consultations/consultation_100507_en.htm

70 As, an example, the Finnish Fish Farmers Association is strongly advocating for a "common and binding European approach to the development of industry", but considers that "fish welfare is not a challenge that should be addressed at Community level", while "Eurogroup for Animals" believes that it is of utmost importance that the Community develops a specific strategy for aquaculture, including the welfare of fish. As another example, the House of Dutch Provinces "agrees that the sustainable development of European aquaculture is imperative, with the exception of the specific link with employment", while the European Transports Workers Federation considers that aquaculture is a strategic sector in terms of job creations.

Generally, the vision and objectives of the 2002 strategy are fully supported and are considered being still valid, but several arguments are put forward to justify the need for a revision (young and fast moving industry, evolving circumstances, effect of passage of time, etc). However the most frequent reasons put forward refer to the fact that the objectives of the strategy have not been reached in terms of production growth. Some even argue that a strategy is needed not only for developing aquaculture, but also for sustaining "*some aquaculture sectors that are at risk of losing ground and may otherwise be abandoned*" (Committee of professional Agricultural Organisations in the EU : COPA-COGECA).

Contributors with an interest in environmental or animal welfare issues insist on the need to include these dimensions as part of the sustainability of aquaculture. The social dimension of sustainability in aquaculture is also seen as being insufficiently addressed (e.g. European Transport Workers' Federation). However, the most numerous contributors (from business and others) consider that more emphasis should be given to striving for strong growth of this activity, and focusing on the role of aquaculture in providing Europeans with healthy and nutritious food.

According to a number of views, the Strategy should be adapted to new and developing circumstances, with a sharper focus on encouraging successful sectoral development of the business through positive proactive actions, level playing field and a better balance between business development and environment conservation. Several contributions refer to the importance that should be given to aquaculture and to giving it similar support to other sectors (notably to allow an aquaculture strategy to contribute significantly to European Food Policy or to form a significant part of the process to develop a European marine/maritime strategy). However, most contributors do not give any indication of possible targets for the development of aquaculture, and quantitative objectives can be found in two contributions only (one advocating for an EU objective of doubling production over five years, while another one even mentions that the objective for Europe should be self-sufficiency).

2. ECONOMIC OUTLOOK FOR EU AQUACULTURE

3. What effect is globalisation having on the EU aquaculture sector and what are the main factors affecting its competitiveness?

4. How do you see the future of the market for Community aquaculture (niche markets, mass production …)?

5. How can the image problem of aquaculture be addressed to increase consumer acceptance of farmed products?

All those that have expressed their views on the above issues recognise that lower **labour** and ancillary **costs** and lower **environmental protection requirements** in a number of non-EU countries allow them to produce large amounts of aquaculture products that are increasingly present on the EU market. Low labour cost also contribute to increasing outsourcing of seafood processing, while processed products represent the highest growth area and consumer preferences. Difficulties in succession - handover of enterprises have also been referred to (Brittany Region).

Several contributors argue either on the need for some forms of "Community preference", or on the fact that trade policy does not allow a level playing field. They contest the fact that fish

produced under different and less stringent conditions can easily enter the European Market. As an example, some "traditional" European products (trout and salmon) are now produced in industrial quantities at highly competitive prices outside the Community (e.g. Chile), while some "health measures" (e.g. rules on the use of animal by-products in fish feed) are not applicable in those countries. Another example refers to the trade disputes and the time involved in taking anti-dumping measures while damage is done in the meantime. Some contributors envisage the potential for a permanent and real time monitoring of markets, or the creation of an observatory of European Aquaculture.

Despite the above challenge in a global market, some contributions also highlight the **strengths of Europe** in the aquaculture sector (such as technological advance, know-how, quality products, research…) or weaknesses of non EU production (unacceptable standards for EU consumers, consequences of food-miles).

There is a wide consensus which considers that the European Market allows for the **growth of both mass production and niche products**, and that they are not mutually exclusive in a composite European market. However, there appears to be some different views on the relative importance to be given to mass products vs. niche products, depending on the background or the main field of interest of the stakeholder.

There seems on the contrary to be more diverse, not to say opposed, views among contributors regarding the existence of an **image problem** for aquaculture, as well as the "public" concerned and the nature and the intensity of such a problem. While generally most contributions received from public bodies, the scientific Community or NGOs highlight the importance of transparency and better communication on aquaculture, some producers do not consider that there is a problem in consumer acceptance of farmed fish (Finnish and several Scottish associations, mollusc producers…), argued in particular on the basis of continuous consumer demand and growing market. However, they express concerns about the image problem they face primarily with policy makers and public authorities - notably the Commission - because of some intensive lobbies or bad and misleading press.

Despite the controversy on the nature and depth of an image problem, there is rather a strong common denominator among the contributors for better public education and for promotion campaigns at different levels and with different aims (tackling industry credibility and production method, promotion and marketing of products, highlighting the health benefit of fish…). The CONSENSUS project has been quoted several times as a good example of a pro-active European initiative in this context. Among the different proposals, one calls on the Commission "*to set up a stakeholder forum to produce user-friendly information*" (European Aquaculture Society- EAS), while another even considers that "*a Europe-wide communication strategy for aquaculture should be developed and provide a promotional base for the acceptance of aquaculture as a valid stakeholder within a sustainable food supply sector*" (Federation of European Aquaculture producers - FEAP).

Product demarcations and labelling considerations (aquaculture logo, eco-labelling, organic aquaculture, sustainable aquaculture label …) are very often referred to in this context, but usually in general terms and principles. The need to set and harmonise standards at EU level is often mentioned (and in line with work developed at the global level, notably FAO), but the views on the way forward do not necessarily coincide (e.g. on roles and limits of private and public bodies). Some contributors however give precise input such as their own very detailed principles and criteria for sustainable fish farming (e.g. Marine Conservation

Society) or their views for detailed legislation changes (e.g. Federation of Greek Maricultures regarding Reg. 2065/2001 on consumer information). The future reform of the common organisation of the markets for fishery products is also mentioned in this context.

3. ENVIRONMENTALLY - FRIENDLY AQUACULTURE GROWTH

3.1. Environmental impact of aquaculture

6.	***What are the most important environmental challenges faced by aquaculture and what are the appropriate avenues to address them?***
7.	***Can you identify, within the framework of Community environmental legislation, business-friendly options to regulate aquaculture activities?***

Although it can be noted that contributions from environmental bodies in the consultation process have been rather limited, environmental aspects of aquaculture are confirmed to be very important issues addressed by most contributors.

A very **wide range of environmental challenges** has been cited. The main or most frequent issues refer to:

– Organic waste, discharge of effluents and siting of farm

– Quality of water and efficient use of water resources

– Fish escapes and genetic impact

– Predation by wild animals

– Use of wild stocks

– Sustainable feed sources

– Diseases and infections[71]…

Classifying them by importance may be subjective; however it is clear that there are different views on the importance of these threats/impacts of aquaculture activity to the environment. As an illustration, organic discharge or escaped fish are often referred to, or seen as, major threats and problems. However, Stirling University states for example that "*the effects of fish farms effluents have be extensively studied and do not appear to be as far reaching as initially feared*", or the Scottish Salmon Producers Organisation refers to the potential genetic impact of escaped fish" as a "*perceived environmental impact that is being given more prominence-particularly in the media*".

In the contributions received from **public bodies**, protecting the environment from aquaculture impacts seems to be generally of high importance. As an example, the Åland

[71] Other challenges (such as competition for space, the need for a healthy environment for aquaculture.) have been sometimes evoked under this section on environmental challenges by contributors, but these are dealt with in further sections of in this note.

provincial government indicates that its environmental action programme adopted in autumn 2005 aims at "*reducing the load from aquaculture by 80% by 2015 compared to average level for 2001-2003*". The Dutch Department for Fisheries sees the way forward in reducing dependence on nature, or the comments received from Ministry of Agriculture of Slovakia also illustrate possible divergent views and approaches among public authorities.

There is widespread general view among **producers** that environmental considerations / requirements are important challenges hampering growth or, even, leading existing business to shut down (e.g. problems with licence renewals). Generally, contributions from the aquaculture sector express the view summarised by FEAP when stating that "*there is little in the way of business-friendly environmentally legislation, since the latter tends to assume negative rather than positive impacts of aquaculture and impose associate restrictive actions*". Some contributions also insist on the fact that environmental services provided by aquaculture to the environment should be recognised and compensated (e.g. fish predators, wetland and habitat conservation…).

Numerous contributors refer to **EU environmental law and its implementation**. Scottish Producers for example consider that a comprehensive retrospective investigation into the additional regulatory burden placed on EU aquaculture over the last decade should be commissioned. However, the most frequent and important concerns refer to legal instruments in two main policy domains, namely water quality and nature conservation.

For example, the contribution from the Brittany region reports "*that –according to the producers- the strengthening of regulations such as the Water Framework Directive WFD) risks making 50% of the French businesses disappear when applied*." Some producers express important concerns about the classification of water bodies or the definition of "fresh pristine conditions" in this context. Other refer also to national Environment Quality Standards Limits set at very strict levels (e.g. for use of bath treatment medicines) because of fear of EU action (court challenge). The planned repeal of the shellfish-waters Directive is also of significant concerns to shellfish producers.

In terms on nature conservation, many producers see the implementation of Natura 2000 (by some Member States) as a major limiting factor for development and access to space. They also refer to the disproportionate use of the "precautionary principle" by authorities, even at renewal of the existing operating licences. Increased consultation and discussion among stakeholders and authorities (rather than imposed measures) are also called for.

The need for better **level playing field** for aquaculture development appears to be an important common denominator to numerous contributions and comments in this regard. Referring to different levels of imbalance – between MS, between environmental and socio-economic considerations, but also between different competing or comparable activities - several contributions see benefits from increased forms of harmonisation between Member States. The development of interpretation or guidance documents on EU environmental legislation, of common estimators of "carrying capacity", of scientific evaluations and impact assessment guidelines on the basis of common predictive models, are often quoted as ways forward. Some insist however for such common guidelines to address the need for species and regional specific sets of environmental indicators and critical range values. Other contributors however are more in favour of self regulation and promoting codes of practices developed by the sector rather than at EU level.

The difficulty of conciliating an increasing level playing field at EU level while keeping the possibility to decide on "higher" environmental protection requirement at region or Member States level is illustrated in the contribution from Åland Provincial Government. They considers that detailed regulation should be set according to the subsidiarity principle, while cautioning against possible shifting of aquaculture production to in regions or member States with "more lenient environmental requirements".

In addition to voices for an increased level playing field regarding environmental requirements, for the promotion of best practices and sound management, or for a more reasonable application of the precautionary principle, the aquaculture producers would also see benefit in respecting principles of Better Regulation, such as a more streamlined and business-friendly authorisation process (e.g. concerns regarding the multiplicity and diversity of current approval procedures and numerous licences required to run a business, the various counterpart administrations to work with, etc).

Numerous contributors considers that an important part of impacts of aquaculture on the environment can be managed and minimised through effective siting of farms and understanding of processes involved. Environmental challenges are therefore also viewed in **relation to spatial planning** or development of an integrated European Maritime Policy. (See chapter 6.2).

Finally, the need for **research** on environment aspects of aquaculture appears as a main common point in the contributions received. Some advocate for precise evidence based research (notably for knowledge gaps when assessing specific production sites), but numerous contributors also consider the need for research on horizontal and wider issues, such as the effect of climate change on aquaculture.

3.2. Dependency of Aquaculture on the Environment

8.	***In a context of increasing scarcity of pure water, what are the main avenues to ensure that aquaculture producers continue to get access to water of the best possible quality for aquaculture development?***

All forms of water pollution (including algal blooms and introduction of alien species, highlighted as particularly important risks to shellfish aquaculture) and climate change are the issues most commonly taken up by the concerned stakeholders.

In addressing the issue of the strong dependency of aquaculture on an aquatic environment of high quality, contributors develop their views around two different types of "concepts", namely ensuring that aquaculture is treated as an equal rights user of water resources or developing less water-dependent / water-consuming systems (close recirculation systems, new water technologies, etc). The importance given to one or the other option varies according to the contributors, even within the same group of stakeholders. Comments made in regard to the availability of water of good quality for aquaculture are also often close, or complementary to, the one made on subsequent questions raised in the consultation document in regard to limits or competition for space.

Aquaculture is presented by a number of contributors as an efficient user of water (often by comparison to agriculture in respect of water consumption to produce high quality food). Aquaculture (notably shellfish) also plays a role as an indicator of water quality. Numerous

contributors consider that the aquaculture sector should be seen as an equal rights user of water resources, and insist on its need to be closely associated to the implementation of the Water Framework Directive (WFD) and the EU Maritime Policy in this regard. Several contributions call for actions to be concentrated on the principal sources of pollution or recommend effective regulation and enforcement of other water users whose activities can impinge on aquaculture water quality.

In this context also, some support the development and application of (marine) spatial planning or integrated coastal zone management (ICZM) to facilitate the allocation of appropriate sites - with the correct water quality - for aquaculture applications.

Specific needs are also expressed for shellfish production, especially the necessity to amend the WFD to incorporate the specific microbiological standards contained in the shellfish waters' directive, or to develop some forms of crisis management approach to better anticipate the phycotoxines problems (a problem which is not restricted to coastal areas and could also affect offshore sites).

4. AN AQUACULTURE INDUSTRY PROVIDING HEALTHY FOOD WHILE ENSURING ANIMAL HEALTH AND WELFARE

9. What are the most important challenges related to animal health and welfare and how should they be addressed, in view of the different constraints faced by the aquaculture sector?

The aspects related to aquaculture and animal health, public health and food safety have been commented on in most contributions received, demonstrating the importance of these domains as a key component of a sustainable, well managed and economically viable aquaculture industry. If some contributions can be seen as providing only general views, a number of other contributions dedicate rather long and precise comments to very specific health and welfare issues (e.g. from the Federation of Greek maricultures). A few contributions to the consultation are even practically entirely dedicated to specific aspects of these domains, such as for example those received from some NGOs, particularly those interested in animal welfare.

These latter generally consider that fish welfare is insufficiently addressed at EU level and plead for strong and enforced legislation. They provide very detailed views on an extensive list of practices or issues (such as stocking density, poor health conditions, crowding, handling and grading, transport, starvation, tagging, sea lice, algal blooms and jellyfish threatening farmed fish, mortality, biotechnology, genetic engineering, artificial lighting and photoperiod manipulation, slaughtering…). Animal disease or high stocking densities are also seen as exacerbating environmental impact (such as interaction with wild predators and water pollution). Fish slaughtering and fish transport are also two priorities issues referred to in the contributions from the Dutch Department of Fisheries.

Fish producers are generally supportive for fish welfare, but to be placed in the context of promoting and maintaining the optimum conditions for species. Some consider that the challenge is to resist the temptation of applying pseudo-anthropomorphic suggestions for best practices (FEAP), or that there are many opinions but few facts (Danish aquaculture), or that any Policy on these issues should avoid being exaggerated and counterproductive (French

producers). The need to look for robust welfare indicators based on science, but also allowing adaptation to fast developing techniques has been put forward several times. Best practices and codes of conducts for stocking density are given as examples (e.g. SSPO) or as the preferred option by several contributors. The Directive on live transport of vertebrates is also criticised regarding its present scope and provisions applicable to fish.

However, there is a consensus on the need for low stress in animals to contribute to good health status, in association with good water quality, proper risk assessment, and prevention rather than treatment.

The new EU aquatic animal disease legislation (Dir. 2006/88/EC) is generally seen by producers as providing an improved framework to address health issues for finfish, although specific concerns are expressed by some groups (Greek Federation, Austrian carp producers, COPA-COGECA). Shellfish producers however consider that this new directive on "animal health" does not sufficiently take into account the specific characters of shellfish farming that takes place in a very open environment, and that it gives a to strong dimension to trade facilitation in comparison to protecting shellfish production from possible diseases.

Genetic selection (resistant brood stock) and the development of vaccines are often mentioned as solutions to fish health problems. However, in regard to the number of potential diseases and species to be used in aquaculture, vaccine specificity makes development very slow (and mainly for major species, as observed in salmon aquaculture for example). More generally, availability of and access to veterinary medicines is seen as a major difficulty by numerous contributors, who often express concerns regarding the absence of authorised medicines, the cost and length of approval of new medicines, the disparities among MS, the difficulties of addressing health issues in new species (markets without interest for the pharmaceutical industry)… In a comparable manner, the European Feed Manufacturers Federation (FEFAC) consider that the authorisation procedures for feed additives are tailored made for land animals and do not specifically address characteristics of aquatics animals, limiting thereby the possibilities to address specific nutritional needs for some fish species.

Healthy food from fish aquaculture is also often referred to in relation to feeding and the high value of unsaturated fatty acids (see question 11 below). For shellfish producers however, the main concerns regarding public health relate to microbiological testing and biotoxin monitoring. They consider being severely constrained by the "hygiene" package, and the continuous trend on an always stricter approach of legislation on public health and too frequent changes in this domain. The shellfish producers appear critical of the EU health legislation on biotoxins, criticizing sharply in particular the relevance and validity of the "mouse" test and the discrepancies in its implementation among MS. They consider this subject of major concern as they see it as a threat to the viability of their companies in the short-term. The role of the European Food Safety Authority, the position of national reference laboratories and some form of "abuse" of the precautionary principle are also questioned.

Finally, there is a common trend in all contributions received to highlight or illustrate the importance of research in terms of public health and animal health and welfare. There is unanimous call for continuing research on keys animal health issues and basic scientific knowledge on fish health and welfare.

5. AQUATIC FARMING: A NEW ERA IN ANIMAL DOMESTICATION

10. What do you see as the most promising avenues in fish or shellfish domestication to provide opportunities for aquaculture growth in the EU?

Some contributors recognise that developing new alternative species could be a promising avenue, but do so only in general terms.

However, the majority of contributions received provide some detailed views on "domestication" of fish and shellfish. A number of contributions from producers identify the "new" aquaculture species that they would see an interest in. For example, recognising climatic differences in the Community, FEAP sees cod and sole to be well placed to succeed in "cold water" aquaculture, while cobia and faster growing sea-bass and sea-breams would look more promising for the Mediterranean area. For fresh water fish, choices seem less obvious, although percid fish or sturgeons are regularly suggested as options. In closed recirculation systems with a controlled environment, the range of option appears wider (eels, catfish, tilapia, barramundi…).

Some contributors, notably NGOs, also insist on domestication as a mean to address specific concerns: improved quality of sterile fish is seen as a way to prevent problems of escapes (EBCD); development of integrated systems of aquaculture associating several species (finfish and shellfish) might reduce environmental impact from aquaculture; shellfish production or development of herbivorous or omnivorous species should be favoured and capture-based aquaculture (e.g. tuna, eels) is not seen as a viable alternative (MCS); new species should only be used for farming when there is sufficient knowledge about their needs (Eurogroup For Animals).

However, if "new" aquaculture species are seen by some as providing possible opportunities for European aquaculture, there is also a strong tendency in a number of contributions received to insist on the need to improve possibilities for "existing" species. Highlighting the successful farming in Europe of salmon, trout, sea-bass, sea-bream, oysters and mussels, a number of producers (generally from the shellfish sector, but also in the finfish sector) consider that, with the exception of cod and a few "newcomers in niche markets", the main route forward lies with producing more of the same species[72], produced even more efficiently and also processed with more efficiency. Improved domestication of local indigenous species is also seen as important by Dutch national authorities.

It must also be noted also that timescales in relation to domestication are not necessarily perceived in the same manner depending on the main groups of stakeholders. The EAS board of Directors for example considers that "*EU aquaculture is based only on new species, except for the common carp which has undergone a significant period of domestication*". This views is somewhat echoed by SK republic in its contribution when referring to traditional pond farming and to the fact that they do not yet expect an increase of aquaculture in (other) new species.

However, despite possible differences in considering what is a new species or not, there is a common and unanimous view that domestication is necessary to ensure sustainable and

[72] The need for lifting some intra-EU trade restrictions (e.g. on mussels seeds) has been referred to in this context.

economically viable industry, and that domestication still requires extensive and coordinated research and dissemination to realise its full potential. Numerous challenges, gaps and opportunities are mentioned with associated needs for research and development, such as: reproduction control and efficiency, disease resistance, feed source and nutritional needs, food conversion efficiency, brood stock management, selective breeding (including use of genomic tools)…

According to most comments, domestication goes largely beyond issues directly related to animal breeding and management, as it also includes aspects such as effect of the environment, or market considerations (negative appreciation of genetic modification, commercial and financial sustainability issues, etc). Insisting on the fact that farmers will produce what the market demands and that the EU aquaculture will probably develop more on a "product basis" (i.e. easy cooking fillet or added value products) rather that on a "new species" basis, market consideration are viewed sometimes as a main criteria to the orientation of research in terms of "animal domestication". Others also plead for the need to look for innovative products and new market opportunities.

11. To what extent do you consider that fish oil and fish meal would represent a limiting factor to aquaculture growth in the European Community? Which option would you favour to reduce limitations from such feed?

For carnivorous fish - the preferred species of EU consumers - fish meal is seen by many as the ideal product for the major components of feeds, since:

– It is the most natural products for naturally carnivorous species

– It contains a high nutrients concentration whose composition is perfect for effective nutrition, and it does not contain anti-nutritional factors (vs. vegetable proteins) that decrease growth

– It is highly palatable (vs. substitute diets) to fish leading to less feed wastage, and consequently also less environmental discharge.

For fish oil, the objective is to have the best content of omega 3 fatty acids, for the benefit of the consumer.

With very few exception (e.g. Seafood Shetland), common general statements can be found in most contributions to agree that fish meal and fish oil (or FMFO) represent a limiting factor to finfish aquaculture growth. However, the type of limits identified may vary depending on the views of contributors, and these limits are generally not seen or perceived as "insurmountable" as there is a common view that there is capacity for substitution and improvements, in view in particular of the amount of research done and progress already made to providing alternatives for FMFO.

The International Fishmeal and Oil Organisation (IFFO) considers even that statements on fish meal and fish oil limitations look "*unnecessarily alarmist*" in the Community 2002 Strategy on aquaculture or in the Consultation document, and they provide an extensive set of information and data to support their views. They recognise however that fishmeal and fish oil, "*once commodities, will increasingly become strategic dietary ingredients and that their ideal nutritional profile will make them the ingredients of choice in many aquaculture situations, particularly carnivorous fish*". The use of FMFO will also increasingly be targeted

at critical stages in the life-cycle such as starter diets, brood-stock diets, or finisher diets. They consider therefore that production (at a global level) of both aquaculture feed and seafood products will increase, but the feed and farming cost will be controlled.

On the contrary, increasing costs represent a common concern for fish-feed manufacturers and primarily European fish producers. Meal and oil are global products with a transparent market, and their prices fluctuate and reflect global production and demand. Both FEAP and COPA-COGECA consider that what is preventing aquaculture from expanding is not the lack of meal, but its price, and that it could seriously affect production costs of European fish farming, compared to imports from other countries where labour and other costs are much lower. Fish oil availability could be a more serious limiting factor in the future, considering that global fish oil production is already practically totally used for aquaculture purposes, but partial substitution by vegetable oils (e.g. rape seed oil) is already current practice (e.g. for salmon). However, some argue that the increase in rape seed oil, related to the increased demand for bio-fuels, is now the determining process of oil prices (In this regard, Scottish aquaculture producers for example oppose the idea of using rape seed oil as bio fuel, and indicate their preference for exclusive use in feeds).

The fish feed industry agrees that it must reduce the inclusion of FMFO in its formulations in order to be able to support a sustainable aquaculture development. Any further growth in finfish aquaculture has to be based on fishmeal replacement and higher FMFO prices will accelerate substitution rates.

A number of NGOs, public authorities but also economic operators associate their contribution on FMFO availability with concerns about the need to ensure sustainability of industrial fisheries or other environmental aspects of feeding FMFO to farmed fish (e.g. competition with prey stocks of natural predators).

The general current position is seen as one of demonstrating that the industry still requires FMFO for its sustainable development, but alternative raw material will be used more once a better understanding of formulation and nutritional know-how has been achieved. The importance and need for continued research in this area is therefore a common feature in all contributions, although the views on the role to be played by different actors may vary. As an illustration, the Finnish Fish Farmers' Association is of the view that the feed industry is well performing in research and, except for some basic research, there is no need to target this question in an EU strategy, while the Federation of Greek Maricultures considers that research in this area must become a strategic priority, asking also for some particular quantified targets.

Notwithstanding zoo-technical work such as species selection, breed improvements, physiology knowledge, the most quoted key replacements options of FMFO in feed are vegetable protein concentrates or vegetable oil (including GM derived feed materials), land animal by-products (e.g. blood meal) or krill. Some more "anecdotal options" are also foreseen in a few contributions, such as exploring possibilities of bacterial and algal culture (IMARES), producing marine lipids from natural gas (SINTEF) or even using insects (House of the Dutch provinces).

In addition to promoting research, several contributors also call for more immediate political or legal changes. Several contributions refer to a better use of by-catch and discards as a raw material for fish, although FEAP indicates that a practical, logistical, and economic

assessment would have to be made whether this portion of discards could make a significant contribution to providing an alternative resource to traditional fish meal and fish oil supplies. The Federation of Greek Maricultures calls for a mandatory gradual reduction of FMFO used to feed land terrestrial animals towards an ultimate prohibition of such use within a decade, arguing that aquaculture is by far the best and most efficient user of FMFO, – a fact that has been highlighted in several contributions from producers or researchers. Some present limitations in EU legislation on fish feed availability are also highlighted. The Austrian producer *Alpenlachs* considers that the intra-species feed ban in respect to fresh water fish should be lifted urgently. The European Fat Processors and Renderers Association calls for an amendment to the TSE regulation as soon as possible to allow terrestrial-non-ruminants-processed animal proteins to be used in feeds for aquatics species, estimating that about 150.000 to 200.000 tonnes of these proteins could be made available per year to the aquaculture industry, position generally also supported by the fish-feed sector .

However, the acceptance by the public and consumers of the possible options for FMFO substitution and alternative sources is recognised by numerous contributors as a very important element, influencing their individual input to the consultation. The British Trout Association, for example, claims that a high level of FMFO is still needed because of the attitude of some retailers who insist on the need of feed fish with FMFO. Comparable issues are expressed by the French aquaculture association which insists on the importance of associating distribution channels and the media to inform consumers on the present evolution (on issues such as for example the re-introduction of blood meal) or by FEFAC which highlights the need to address fish farmer and consumer perception, with regard to omega 3 fatty acids contents of fish and risks and benefits associated with substitution of FMFO. The need for public information and communication is also put forward by some scientists (e.g. EAS board).

Finally, despite the fact that they are not concerned by fish-feed related challenges, the shellfish producers refer to the fact that they are faced with other forms of possible limits on feeds, in the sense that they need to have access to the natural environment that provides the optimal nutrients possibilities for growth of oysters and mussels (cf. water quality or access to space). They see a need for major research in the field of biological carrying capacity and potentially beneficial results from integrated multi-trophic (i.e. multi species) aquaculture.

6. OVERCOMING SPACE LIMITATIONS: THE IMPORTANCE OF TECHNOLOGICAL DEVELOMENTS AND SPATIAL PLANNING

6.1. Technological innovation

12. What technological innovation would you consider most promising to allow aquaculture development in a limited space context? What are the main obstacles to their development and how could they be overcome?

On-land "recirculation aquaculture systems" and offshore technologies are the main possible innovations referred to by all groups of contributors, with the exception of the feed sector who did not express a view on these questions, and the welfare NGOs who only express some general concerns. These latter consider that technological innovation may lead to a further intensifying of fish farming and higher stocking density, and techniques to increase production, such as biotech and genetic engineering risk being introduced.

There is a consensual trend to consider that **on-land aquaculture systems using recirculation** (and possibly heating) provide most promise where space is the limiting factor for fresh water but also coastal sites. Water recirculation and treatment technology is also seen as an excellent way to address impacts of aquaculture on the environment and for optimal control of environmental parameters most suitable to fish. However, higher skill levels are required in the workforce (system monitoring and surveillance) and task automation is almost a prerequisite.

There is also a general recognition that such technological uptake and development has been limited so far primarily because of costs considerations. Economic expenses (investments and operations, in particular energy costs) combined with market uncertainty have restricted development so far. Except for very sensitive phases in the farming process, such as for hatcheries and nurseries, technology take up has not been greater because productions costs are not the same in open and closed systems. Some contributors strongly advocating for development of recirculation systems consider that the "sustainability" criteria should attract for a premium price and allow therefore positive developments (e.g. Marine Conservation Society).

However, there appears to be still some need for technological development and some zootechnical issues have not yet been completely resolved for an optimal management of recirculation systems. Contributions received highlight the need for innovation in managing and monitoring recycling processes, efficient water treatment (marine and fresh water), optimised energy use, disease prevention and treatment, addressing growth limits for certain species, paying close attention to the quality of the final product (muscle tone and quality, absence of off-flavour)…

Moreover, since many recirculation systems use species that support a high farming density (notably to reduce costs per unit produced), several contributors refer to the importance that should be given on the societal acceptability of this approach and on the need to inform consumers ("chicken-cage- like syndrome").

Offshore fish and shell fish farming is often quoted as another technological innovation for aquaculture but there is also a general and common view among contributors that there are many issues that remain to be resolved in the technical, managerial and financial spheres, which makes FEAP qualifying offshore fish farming as "*appearing to provide a lot of instant solutions*". Similarly, the Aquaculture section of the Irish farmers' association for example considers that "*offshore farming in the strictest sense … while widely promoted, has yet to be proven in terms of safety and welfare of both stocks and farmers, suitability of sites and equipments, and availability of appropriate plankton food for shellfish. Much more research and developments needs to be carried out in this area before it becomes a reality*". Environmental NGOs express some more cautious position about possible promises of offshore aquaculture, notably regarding experience of escapes in marine fish farming and the need for technology to be able to cope with worst conditions forecast (while safeguarding farmed species from excessive currents).

Notwithstanding the technological challenge, a number of contributors highlight the financial dimension of engaging into offshore innovation. According to FEAP, it seems probable that major investments could take place in this type of aquaculture, but that these may be limited to the bigger companies active in marine aquaculture. The Federation of Scottish Aquaculture Producers see a major challenge in finding investors that are willing to risk large sums of

money on pilot scale ventures that are of sufficient scope to be able to reassure future full scale investment. The Federation of Greek Maricultures is of the view that the size of the Mediterranean fish farming industry seems to lack the critical mass for industry-financed research on the topic. The two latter organisations also refer to the need to address legal and regulatory challenges associated with off-shore aquaculture (e.g. licensing).

There are therefore numerous common views that technological innovation should be encouraged trough efficient **EU cooperation in research and investments**. Some contributors recall also that, if offshore aquaculture is to be developed, equipments and boats will have to be modified for such sites and complementary inshore sites for harvesting or over-wintering of stocks will be required. Possibilities of linking with other industries (renewable energy for example) where aquaculture can take advantage of structures that have the potential to alleviate stress on containments are mentioned. Promoting recirculation aquaculture systems by subsidising energy costs is also an option put forward by some contributors (Finnish Fish Farmers' association).

It is worth noting that several contributors (from various categories of stakeholders) also consider important to mention that, if Europe is a world leader in technology, there must however not always be a presumption that aquaculture production needs to be high-tech. The positive role of extensive aquaculture is highlighted, and traditional aquaculture should be able to continue and to benefit from support. The existence of new technology should not wipe out existing ones. Further development of current production systems (increase in size and production level) is seen by several as a way to significantly contribute to overall production.

6.2. Spatial planning

13.	***What are the main obstacles to access to marine or fresh water space for aquaculture activities? Would you consider that there is a need for public decision maker to set aside specific locations dedicated to the development of aquaculture?***
14.	***How could marine/maritime spatial planning be developed to provide appropriate conditions for the sustainable growth of aquaculture sectors in coastal and offshore waters?***

Obtaining access to farming depends on the procedures to get an approval of licences to operate. In numerous contributions, there is quite an overlap of concerns and views between the two questions above and those related to the links between aquaculture development and environment related issues. Good governance related issues and the current "low" status of aquaculture as a stakeholder in marine and freshwater policies appear also at the heart of this debate. There are unanimous voices for a full stakeholder involvement in any such process.

A number of producers consider that current policies and legal frameworks are unsuited to the sector's needs, specifically at Member State, regional or at local level, which impedes the issuing of licences and/or other control procedures and leads to an effective blocking of aquaculture development.

Very frequent concerns refer to:

– Bureaucratic delays in procedures, costs of registration, and uncertainty of the outcome in absence of specific [supportive] legislation (can imply years of effort and many different authorisations to obtain the necessary licences to operate).

– Licence validity periods are too short which does not stimulate investment, but creates uncertainty and confusion for the producer and investor.

– Differing interpretation of European legislation at national level, combined with a frequently reported tendency for local authorities and organisations to be more radical (under the 'precautionary principle'). In this context some fish or shellfish producers even consider that the overall challenge is some Member States is not to get new licences to develop aquaculture, but first to succeed in having the old ones renewed.

Review of the processes is urgently called for by the sector if development is to occur. Clear and simplified procedures, with established time limits for decision, for obtaining aquaculture operating licences should be provided in each Member State. Licences should also be accorded for reasonable periods of time with clear conditions for renewal in order to bring about longer term investments. These conditions are seen by the sector as symptomatic that it remains poorly understood and reflecting its low status as a stakeholder in freshwater and maritime activities. The need for better communication is often reiterated, with the EU - or the European Commission- being seen an important player in raising the profile of aquaculture as an equal right user of water and land space.

Some contributors put forward benefits of some forms of identifying and mapping of most suitable sites for aquaculture production. Support for spatial planning comes from most quarters and relates to their wish to see aquaculture and its economic dimension and environmental protection treated on an equal footing. However, as far as the possible need for public decision makers **to set aside specific locations dedicated** to the development of aquaculture, there are rather different views among contributors, even within a given category of the main stakeholders, thus reflecting probably different levels of difficulty already faced by operators in terms of access to space and licensing.

As an illustration, the Danish aquaculture organisation considers that it "*is imperative that specific locations are dedicated to aquaculture, otherwise the local authorities will apply the "NIMBY (Not In My Back Yard) principle*". The need for designation of specific aquaculture sites –including supporting the existing ones- is also seen as necessary by the French Aquaculture Association, which considers that such planning should also have legal force, and they insist that this is only possible if there is a real political will. The EAS board is of the view that reserved specific locations are probably crucial for the sustainability of shellfish sector as well as for artisanal finfish production in riverside and coastal zones. The Greek producers report that their central administration has decided to move towards the creation of designated aquaculture zones, or Areas of Organised aquaculture development, in response to the need for better control, collective managements within a flexible business environment, but also with respect to natural resources. The Dutch department of fisheries, recognising inconsistent legislation at different government levels, considers that the establishment of specific locations for aquaculture development could prevent the damaging of vulnerable ecosystems.

Other stakeholders have more mitigated views. COPA-COGECA does not consider it useful in every case to designate areas potentially suitable for aquaculture. Conditions and

requirements as well as insight into site-specific needs may change over time (due to environmental change, for example, or new species entering the aquaculture scene). It could be helpful to have dedicated areas for aquaculture where it is easier to get approval to establish a farm and receive subsidies, but it would be counterproductive if that would also mean excluding aquaculture in other areas. The Irish producers also recognised there are differing opinions on giving specific zones to specific sectors (uncertainty involved in specialisation and expertise on those who may draw up the zones, need to cope with possible increasing demand in the future, unforeseen environmental impact on the industry, possible impacts on the rights to explore new areas or apply for new areas of production, or simply to continue to operate in exiting areas if not selected…). Some contributors from the scientific community would also see a need to examine each individual case (e.g. SINTEF). Austrian producers do not see the need for reserved aquaculture sites in rural areas, neither do the Slovakian authorities (although recognising that access to aquaculture is limited because of a great number and space of protected areas).

Public bodies or similar, although supportive of some general principles, such as participation processes, often appear to have more of a precautionary stance regarding dedicated allocation of space to aquaculture. There are nevertheless a few more pro-active views, such as for example the Fisheries and Aquaculture Strategic Group that advises the Welsh assembly which supports the creation a public body in charge of setting aside specific location for aquaculture.

More broadly, sharing space between different and competing users is often referred to by contributors in relation to the initiative for a Maritime Policy, which is seen as a positive stimulus to marine spatial planning development. The position expressed in the corresponding report of the European Parliament that states '*within the context of an integrated coastal zone management (ICZM) approach, clearly defined areas where fish farms may be clustered should be promoted and that this should be linked to a simplified regulatory regime encouraging entrepreneurship and sustainability*' has been quoted and supported by both FEAP and the EAS board.

Numerous contributions make references to ICZM and the development, use and application of spatial planning procedures are seen as contributing to the resolution of conflicts for space and support the overall recognition of fish farming as a key stakeholder in the maritime sector. Several contributors refer to the usefulness of a mapping exercise, for a clear identification -by Member States- of potential, available and sustainable sites for coastal and offshore aquaculture, and the possible development of guidelines for optimising site locations for different sectors within the Aquaculture industry. For some also, flexibility among planners is needed to allow fish farms to consolidate on fewer but larger sites to maintain production on a competitive scale (British Trout Association). The Federation of Greek Maricultures is of the view that there is an urgent need for an EU directive or Regulation for marine spatial planning and the designation by MS of areas for aquaculture development, while the Irish producers indicate that IE has already a system very close to terrestrial based planning, but the deficiencies in the system have not come from the legal text but rather from the interpretation of scale, lack of knowledge on carrying capacity, non-implementation of biomass limits... The Norwegian Ministry of Fisheries indicates that spatial planning and management is the main tool in coastal management, and its implementation relies on local authorities. They also indicate that there is a need for science based knowledge of environmental impact of farms on a local scale. However, the central authorities (regional

office of the Directorate of Fisheries) may raise objections if sufficient areas for aquaculture are not set aside by the municipality.

The scientific community appears generally supportive of spatial planning initiatives, but highlight also the need for research to develop methodologies for comprehensive and multidimensional approaches. Some NGOs (MCS) also express their support of the principle, subject to strategic environmental impact assessment. They consider that it will increase certainty for industry as government licensing bodies will abide by the Marine Plan unless significant impacts revealed by environmental impact assessments.

7. PROVIDING SUPPORT FOR SUSTAINABILITY

15. How can we ensure that EFF implementation will contribute to sustainable aquaculture growth in the EU?

16. Are there already some lessons to be drawn from the preparation of your National Strategic Plan and Operational Programme regarding aquaculture?

There is generally very little input on the questions related to the European Fisheries Fund (EFF). Some concerns (producers from UK, IE, FI) have been expressed regarding the uncertainty of the outcome of National Strategic Plans and Operational Programmes under elaboration, the insufficient allocation of money compared to previous structural funds or the too- restrictive measures of the new EFF Regulation. Other producers insist on the need for a national dynamic process and a general political, with a better coordination between national authorities and industry (e.g. French and Greek associations). However, the Danish aquaculture association expresses its satisfaction on the collaboration with national authorities and the general consensus about industry development, which they consider will appear important in relation to local decision making.

As far as contributions from national authorities are concerned, the Ministry of Agriculture of the Slovak Republic indicates that the preparation of their national programme allowed them to note that there was an increased interest in building of new production capacity, but considering that they had not enough money for such action, they intend to focus their efforts into existing farming capacity. The Dutch authorities (Department of Fisheries) are of the view that the involvement of the stakeholders has been an effective way for the identification of measures and objectives that are the most promising.

8. RESEARCH: A POWERFUL DEVELOPMENT TOOL

17.	***How can research policy be set in a strategic context to enhance its benefits, specifically for European aquaculture and/or European technology and know-how?***
18.	***How can the transfer of research results be optimised so as to maximise the benefit to European business?***
19.	***Which cross-cutting areas in marine research would you consider most important for aquaculture?***

There is a clear common view among contributors to see research as a fundamental element to sustainable development of Aquaculture in Europe, although views vary on the facets of sustainability to be more developed. The views on (marine) research for aquaculture are often focused or referring to the conclusions provided in several workshops and seminars made in recent months, such as the "Aberdeen Declaration" of June 2007 for example", as well as in relation to the development of the Maritime Policy. Several contributors consider it important to recall that the high profile given at EU level to Maritimes issues should not leave freshwater aquaculture out of European RTD efforts.

In practice, it is difficult to identify only a few themes that would be seen as most important for aquaculture as the need for further research –being specific or crosscutting- has been raised for all issues covered under the previous questions, such as for example:

– New technologies (materials and management systems offshore aquaculture, marine biotechnology

– (alternate feed)

– Environmental issues, efficient and optimal use of aquatic resource, Climate change effects

– Health monitoring and maintenance, improved hatchery performance for the production of marine juveniles (reduced malformations, better growth), alternate feeds

– Spatial planning and modelling for improved ICZM, potential for integrated aquaculture activities.

Several contributors insist therefore on the fact that the research policy should reflect the overall strategy or that it should be directed by objectives. Providing a specific research policy for European aquaculture would have visible benefits but would need to be better adapted to the needs (immediate, medium and long-term) of the sector if it is to assist its sustainable development. In parallel to this approach, support work on basic research (e.g. lifecycle, basic biology) and wider issues (for example, on environmental interactions, effects of climate change…) need to be continued. Some also see the use of foresight studies, combined with established European and national aquaculture strategies, as a mean to help to give a clearer focus on sectoral priorities. Nonetheless, the industry will need to accommodate how it can provide financial support for such research work.

While supportive of the need for research, some stakeholders express concerns regarding the present state of research. For example, the Federation of Greek Maricultures is of the view that there is an apparent lack of strategic guidance and support in the research field. The Danish Aquaculture Organisation expresses some rising concern that even though the EU is investing heavily in R&D, production is stagnating. The House of Dutch Provinces even states that in an open economy, it seems inevitable that supporting know-how and innovation will spill over to non-EU Member States and "will capitalise only there", and considers therefore crucial the need for a good picture on the focus points and chances in Europe beforehand. A number of stakeholders also express concerns regarding the bureaucratic procedures for EU RTD projects, which represent a major limiting factor for joining in.

Quite a number of contributors also indicate that European aquaculture research remains dispersed with duplication of effort, particularly between the National Programmes. Some would see benefits in the creation of a central database for future aquaculture research or in a regular appraisal by relevant stakeholders – including industry representatives of RTD progress, based on definite benchmarks to measure progress.

A closer involvement of economic operators in the definition of research priorities at Community level also appears as a frequent request from the sector. The importance of the development of a Technology Platform for European Aquaculture –EATP- has been mentioned several times in this regard, as it should allow providing a strong industry-led view on its future development and research requirements.

Finally, an improvement in RTD transfer is a central concern of the producers (and a number of researchers). However, the willingness to publish and transfer results differs depending partially on the objectives of the research and the owner of the intellectual property or of the competitive advantage gained. A structured effort to optimise the dissemination and availability of information, and training should help bridging the gap that exists between the research and professional sectors. Positive experiences are often used as examples[73] to support numerous proposals in this regard, such as:

– The assistance of strong professional associations of inter-professional organisations with personnel who are responsible for RTD actions for efficient communication and transfer to the industry

– The development of accessible RTD project summaries, explaining why the RTD work is done, how it can benefit the sector and debating progress and/ or direction (in conferences, regional workshops)

– The need for improved networking between research institutes and European business, and improved training in new technologies.

[73] such as 'PROFET Policy' or the WAVE projects (see *www.profetpolicy.info* or *www.waveproject.com*)

ANNEX III

POSSIBLE ACTIONS TO CONTRIBUTE REACHING THE OBJECTIVES AND THEIR INCREMENTAL EFFECT UNDER OPTION 2

The table below provides additional information on possible actions referred to under section 5.2.

Problems/issues identified	**Possible actions by public authorities**	**Objective being contributed to and incremental effect**
• When inadequately assessed, and not properly managed, aquaculture practices may affect the quality of the natural environment (water pollution, abuse of chemicals…) or create risks for nature (introduction of exotic invasive species, transfers of diseases to wild animals…).	Background: cf. section 2.5.1 • Potential actions (non-legislative) - The Commission **to monitor developments** regarding the **problem of escapees**, notably in view of measures taken by the sector and by competent authorities at Member States level (as well as in Norway) and if necessary, assess the added value for possible action at the EU level - The Commission and the Member States to **pursue supporting research** on interactions between environment and aquaculture. • Potential actions not retained - Revision of the EU environmental legislation with the view to reduce the level of protection (not proportionate, neither in line with the Treaty). - Decision on the need to develop new specific legislation to address a specific environmental problem of aquaculture (extensive environmental legislation already in place, no evidence for additional one).	• Ensuring a high level of protection of the environment. • Incremental effects Primarily of political nature, by recognising that well managed aquaculture is an environmentally compatible activity, but also restating the general political commitment to continue, when developing policies and actions, to placing emphasis in ensuring environmentally sustainable development of aquaculture. Highlight also the readiness of the Commission to take additional measures if this would prove necessary.

• Aquaculture is highly dependent on quality water so as to guarantee safe and high quality products, while also facilitating health and welfare of farmed animals. The aquaculture industry heavily depends therefore on water resources that are under management and control by public bodies. • The changes in the Community legal framework for water protection (Water Framework Directive) and the repeal of the Directive on quality of shellfish waters creates some legal uncertainty as to how the quality of the shellfish waters will be guarantied in the future and as to how the shellfish producers will continue to benefit from access to the water quality they need.	• <u>Potential actions (non-legislative)</u> - The Commission and the Member States **to ensure that the level of protection of shellfish waters** under the first river basin management plans established under the Water Framework Directive (WFD) is maintained (2009 and onwards). - The Commission to enhance information targeting national competent authorities and the industry **to ensure a proper implementation of the WFD** and **of the Marine Strategy Framework Directive** as regards aquaculture activities, including by developing guidelines on the application of the WFD to shellfish areas, in order to ensure a certain degree of harmonisation in the implementation of environmental requirements (possibly 2009-2012). - The Commission to assess the need **to review some elements of the EU water protection legal framework** in view of the repeal of the Directive on shellfish waters quality (possibly 2009-2010) - The Member States **to recognise the importance of fish and shellfish farmers** in contributing to ensuring water quality on which they depend and the importance of these actors in the preservation of the environment and to ensure a fair treatment to the aquaculture industry and consider it an equal player with other economic activities • <u>Potential actions not retained</u> - Immediate decision on a revision of some elements of the EU water protection to possibly increase water quality requirements for the protection of shellfish growing areas (prior deeper assessment required)	• Ensuring a high level of protection of the environment and a high level of public health. • Improving competitiveness and governance by providing the aquaculture industry with an environment of high quality compatible with its needs • <u>Incremental effects</u> These actions should facilitate the development of aquaculture with the associated economic and societal benefits. The importance of the effects will directly depend on the level of protection afforded by public authorities to the water quality, the access given to the fish and shellfish farmers to high quality water resources, and the legitimate recognition of these stakeholders among all other actors.

• The aquatic environment directly impacts on the potential safety for consumers of water-filtering molluscs, in particular regarding the risk of concentrating bacteria or viruses that would be present in waters, or natural biotoxins produced by unforeseeable toxic algal blooms. Shellfish producers consider that changes introduced in the mouse bioassay test to check for presence of toxins in molluscs have lead to an increasing number "false positive" with important subsequent economic losses, without increasing the apparent level of protection afforded to the consumers.	Background: cf. section 2.5.2: • <u>Potential actions (non-legislative)</u> - The Commission **to re-examine** the situation once EFSA has achieved a full review of **marine biotoxin related issues** (2009-2010, as the opinion from EFSA is awaited by mid 2009) - The Commission and the Member States **to support the development of alternative methods** and standards for these detection methods. - The Commission and the Member States **to evaluate** how to make more widespread use of **risk assessment and risk prevention tools** such as the SUMO project ("Mollusc Surveillance") initiated by the European shellfish industry in order to complement existing surveillance requirements for pathogens in live molluscs (2009-2010). • <u>Potential actions not retained</u> - To review immediately the provisions of the mouse biological assay test and modify the observation period to 5 hours, without any new scientific basis and assessment of the consequences.	• Ensuring consumer health protection and recognising health benefit of aquatic food contributes to both the competitiveness objective and the sustainable development agenda. • <u>Incremental effects</u> All these actions are expected to have positive effects for the consumers as well as for the development of the sector. They will result in an increased level of consumer protection based on new scientific development. In addition, they will provide better monitoring and risk prevention tools which will help to a better management limiting possible economic losses for market prohibition.
• Aquatic food has high nutritional values that contribute to the health of citizen (Omega 3 fatty acids for example). EFSA is usually providing specific one-sided scientific opinion on a given issue, such as the one on given health risks associated to aquatic food or on fish welfare consideration. Scientific opinion often fails in providing a more comprehensive assessment of both the benefits and the risks with reference to the overall public health related aspects.	• <u>Potential actions (non-legislative)</u> The Commission **to continue** to base its **evaluation and its assessments** on scientific advice, but to request such scientific advice to provide for a more integrated assessment of fish related issues by including health benefits related to the consumption of aquatic food, taking into account also the possible significant differences in the content of high value nutrients (e.g. omega 3 fatty acids, protein content) depending on the origin and species concerned.	• Recognising health benefit of aquatic food contributes to both the competitiveness objective and the sustainable development agenda. • <u>Incremental effects</u> Such more integrated assessment of both risks but also benefits of eating aquatic food, is expected to provide a more balanced and factual view on aquaculture products, with positive impacts on both the sector and the consumers. Consideration of health potential benefits depending on the type and nature of aquatic food will provide the society with a more precise and useful knowledge on the value of consuming a given fish species.

• Specific problems arise as regard some elements of the new animal health law (Directive 2006/88), notably the list of diseases covered, risks and measures related to vector species, possible sources of financial support, or specific national measures. There is also a continuous need to revise and update the aquaculture animal health Community legislation to adapt it in a proportionate manner to new situations and scientific progress. • Diseases in aquatic animals attract lower level of attention compared to more disease of significant importance in terrestrial animals (recent crisis on avian flu, foot and mouth disease, blue tongue).	Background: cf. section 2.5.3: • <u>Potential specific actions (primarily non-legislative but could lead to legislative proposals)</u> - The Commission **to keep under review** (by 2011) the list of important **diseases** for aquatic animals (Spring Viremia of Carp was recently de-listed after reassessment the impact of the diseases with regard to the proportionality and efficiency of measures that were required under the Directive). - The Commission **to assess** (2009-2010) the current provisions regarding **additional guaranties for some diseases** taken at Member State level, in order to ensure that these measures do not represent unjustified barriers to economic operators and movements of aquaculture animals and products thereof. - The Commission to pursue **assessment of preventative measures** in relation to vector and susceptible species, on the basis of scientific advice and promote scientific research. - The Commission **to assess** (by 2011), as part of its action plan on animal health, the present **financial instruments** available to support measures dedicated to **the health of animals**, including aquatic animals (in particular regarding the promotion of on-farm bio-security measures and training).	• Securing animal health contributes to shaping a performing animal industry and improving thereby competitiveness. It also contributes to the objectives of the Strategy for sustainable development. • <u>Incremental effects</u> These actions should ensure that the health needs of aquatic animals and their specificities are fully taken into account as part of the follow-up of the new animal health policy strategy.

• The EU legal framework in relation to welfare developed for farmed animals also generally covers farmed fish. However, it is not the most appropriate because either it is based on terrestrial animals (regulation on transport) and/or the specific standards are lacking at all (directives on protection of animals kept for farming purposes, or on slaughter or killing). One of the main problem drivers is that the scientific knowledge in fish is still very poor.	• <u>Potential specific actions</u> (non-legislative and legislative) - The Commission to seek for advice on **fish welfare on a species dependent basis**, and further promote animal welfare research to develop relevant welfare indicators in fish species - The Commission to promote also the need for **a species-dependent approach** in the **international fora** presently addressing fish welfare (in particular the World Organisation for Animal Health / OIE). - The Commission **to assess fish welfare issues** in aquaculture (by 2011) in order to evaluate the value of non-legislative or possible legislative measures, but in the mean-time the Commission to propose for a timely revision of some present but inadequate provisions in the "animal transport Regulation"[74] (2009).	• Securing animal welfare contributes to the objectives of the Strategy for Sustainable Development. • <u>Incremental effects</u> These actions should ensure that specificities of aquatic animal welfare are taken into account, beyond measures of the Community action plan 2006-2010 for animal welfare, and that proportionate measures are developed in close collaboration between all stakeholders.

[74] Regulation (EC)N° 1/2005 on the protection of animals during transport and related operations.

• There is a lack of authorised veterinary medical products for fish - because of economic considerations (absence of profitability of developing drugs for a given disease in a given fish species by the pharmaceutical industry), legal and administrative provisions (notably at Member Sates level). In addition, there is insufficient knowledge by the stakeholders on the existing pharmaceutical framework, as well as insufficient awareness from public authorities on the needs and specificities related to the treatment of aquatic animals.	• <u>Potential actions (legislative and non-legislative)</u> - The Council and the European Parliament **to adopt the new MRL regulation** proposal while seeking to ensure provisions of particular interest to aquaculture. - The Commission and the Member States **to implement the recommendations** made by the **"Availability Task Force"** (2009-2010). - The Commission and the Member States to act as a facilitator **to improve information exchanges** between the competent authorities and the different actors of fish health, in particular by convening experts and stakeholders meetings aimed at addressing the specificities related to the treatments in farmed aquatic animals and the practical problems to overcome to ensure an adequate and reasoned use of veterinary treatments in fish (2009-2010). • <u>Potential actions not retained</u> - Immediate commitment to a revision of the basics of the pharmaceutical law, notably to facilitate or create a true internal market for veterinary medicinal products for minor species /minor uses (new Directive adopted only back in 2004). Such a review may be considered in a medium or longer term (full assessment required before).	• Addressing the need for specific veterinary treatments in aquatics animals contributes to a high level of animal health and welfare, and therefore to both the competitiveness objective and the sustainable development agenda. • <u>Incremental effects</u> Will ensure, in particular through better exchange of information that the needs and specificities of aquatic animal health are fully taken into account to unlock this major bottleneck for development, but also to promote wise use of drugs and provide factual information on this industry (e.g. often wrong perception/image on antibiotic use).

• Aquaculture is hampered by an always increasing competition for space and water in coastal areas, but also along fresh water courses. Gold plating of environmental protection rules can create additional obstacles for the aquaculture industry, which feels often not being taken on an equal footing with other activities. • The uncertainty on siting and the absence of appropriate guidance and reliable data for the possible location of economic activity create uncertainty for investors, increase risks of conflicts and represent lost opportunities to use synergies between aquaculture activities and protection of the aquatic environment.	Background: cf. section 2.5.4 • <u>Potential actions (non-legislative)</u> - The Commission **to promote Integrated Coastal Zone Management** (e.g. better exploitation and dissemination of knowledge on aquaculture siting) and to launch actions as foreseen within the roadmap for maritime spatial plannnig[75] developed in the framework of the new EU Maritime Policy (2009). - The Member States **to develop marine spatial planning systems**, in which they fully recognise the strategic importance of aquaculture. The Member States to undertaking an inventory and mapping of most suitable sites for aquaculture needs, including offshore, in order to facilitating such planning. These planning tools should also facilitate anticipating risks from, for instance, climate change effects, floods or coastal erosion that may affect aquaculture sites. - The Member State**s** to ensure that "**inland" spatial planning** fully integrates the needs and values of freshwater aquaculture. - (*see also other actions contributing to an improved governance)*	• Improving competitiveness and governance by ensuring that aquaculture is an equal right competitor in access to water and space • <u>Incremental effects</u> Highlighting the importance of aquaculture while developing EU leadership in promoting spatial planning should allow this activity to develop much better at EU level, while also optimising it environmental performance by appropriate assessment of optimal location of farms.

[75] COM(2008)791 final

• The aquaculture production industry still remains very fragmented and isolated from the other actors in the marketing chain. • The aquaculture industry is facing business challenges and is competing within a global market. Lower production costs and lower environment protection requirements in certain non-EU countries allow them to produce aquaculture products that are increasingly present on the EU market at low prices.	• <u>Potential actions (non- legislative and legislative)</u> - The Commission to assess and address needs of the aquaculture sector within the context of the **review of the market policy of fisheries and aquaculture products** in 2009 (in particular regarding producer's organisations, inter-professions, consumer information and marketing instruments such as labelling of aquatic food products). Several studies have been launched to prepare this exercise, including one on price forming mechanisms in the seafood marketing chain. - The Commission to assess, besides the possibilities for organic labelling, **the value of labelling possibilities** that would promote the sustainability aspects of EU aquaculture products (in full respect of international obligations). The Member States to adopt the Commission's proposal for a revised Community Eco-labelling scheme[76] to allow the aquaculture sector to benefit from compliance with high environmental standards. - The Commission to envisage a possible **simplification and review and of the custom nomenclature**, and if appropriate, will look to differentiate aquaculture products from those from capture fisheries, as a tool to improve information on trade flows (2009-2011). - The Commission **to continue international cooperation** on labelling and aquaculture certification issues, notably with the FAO. - The Member States to make full use of the possibilities available under **the EFF to support** market initiatives, promotions campaigns, etc. • <u>Potential actions not retained</u> - Actions that would consist in reviewing and softening present state aid rules, or developing sector specific aids support to operational costs and that cannot lead to a self sustained indutry (would be inefficient in terms of competitiveness, disproportionate and not creating a level playing field with other economic sectors) - Establishing non-tariff trade restrictions or other measures that would contradict the international trade rules.	• The aquaculture industry has to cope with market principles, to answer the market demands and to remain competitive. However, public authorities can give guidance and contribute to this adaptation, and where necessary take control measures. Enabling the aquaculture business to cope with market demands is fundamental to the competitiveness objective. • <u>Incremental effects</u> The implementation of these actions will contribute to provide a favourable market environment for the EU aquaculture products. They may be developed in parallel to an increasing awareness of the consumers on the high standards of EU aquaculture products. Moreover, promotion of high quality (including also issues such as environmental impacts, welfare considerations, sustainability, etc.) products and labels based on certification schemes should contribute to satisfy the increasing consumer demand for this kind of products and allow commanding higher prices.

[76] COM(2008)401 final

• Aquaculture enterprises face a number of administrative challenges. Particular problems lie in difficulties to obtain licences to run an aquaculture farm, bureaucratic delays and complex bureaucratic procedures, costs of registration, uncertainty of the outcome, short licence validity, different administration involved, etc. This all creates uncertainty and confusion, which does not stimulate investment in aquaculture.	• <u>Potential actions (non- legislative, administrative)</u> - The Commission and the Member States **to raise awareness** in the aquaculture sector **on the "Small Business Act for Europe"**[77], and implement it notably with the view to improve and simplify licensing procedures for aquaculture operations through e-government and one-stop-shop solutions (2009-2012) - the Member States to ensure that **licenses** are allocated for reasonable periods of time compatible with the specificity and the needs of aquatic farming, and with clear conditions for renewal, clear procedures and established time limits to decision.	• The Commission and Member States are committed to facilitate business development and reduce the administrative burden to contribute to the objective of better governance. • <u>Incremental effects</u> - Many advantages for both the sector and the competent authorities would arise from a clearer and well organised system of licenses. It would facilitate business development and possibly stimulate new investments. Moreover, establishing clear procedures for the renewal of the licenses would reduce uncertainty and would encourage longer term investments. For the competent authorities it would contribute to reduce the administrative burden and to rationalise procedures.

[77] COM(2008)394 – see *http://ec.europa.eu/enterprise/entrepreneurship/sba_en.htm*

• The aquaculture industry is still facing a rather negative image at some level (particularly in certain public bodies or with some policy makers). This image may derive from past practices, or because of misleading press and lobbying. There is a need to develop and disseminate scientifically sound facts about aquaculture.	• Potential actions (non- legislative) - The Member States to contribute to meeting **the need for information** (in particular under the possibilities available in European Fisheries Fund) - The Commission and the Member States to make sure that relevant **information**, in particular the outcome of studies or research supported by public bodies is made **publicly available** (notably on the Internet). • Potential actions not retained - The Commission to launch information/promotion campaigns at EU level (no present legal basis and no budget dedicated to this by the EU budgetary authorities. Moreover, even before envisaging a possible initiative that may lead to establishing a legal basis with an associated budget, a deeper assessment should be made on the efficiency and proportionality of public authorities interfering with private business operations, notably the type of message and the nature of the information that could be given by public authorities without creating discriminate treatments between sectors, products, etc.).	• Giving the right image of an industry to citizens means communication and full transparency by providing factual information. Improving the image of aquaculture contributes to the objective of better governance. • Incremental effects Producing and disseminating sound information on aquaculture will have very positive effects as this will enlarge the knowledge base of citizens and policy makers and allow them to make a fully informed opinion before making their decision as consumers or as public powers.

• The main aquaculture fish species demanded by the European market are carnivorous species, the feeding of which still largely depends on the availability of fish meal and fish oil (FMFO). The limited availability of these resources creates an increased demand and higher prices for fish meal and fish oil. • Producing fish meal and fish oil from industrial fisheries gives also rise to a debate on the sustainability of such fisheries. • Other constraints on feeds relate to the whole set of EU feed legislation aimed at ensuring high quality and safety of feed and food derived from farmed animals. Restrictions in the use of animal-by products, feed additives or feed contaminants, provide additional guaranties to consumers, but may create economic disincentive or absence of level playing field if these restrictions are not, and cannot be applied to aquaculture practices outside the EU (e.g. rules on feeding fish with fish products).	• <u>Potential actions</u> (non-legislative) - The Commission and the Member States **to promote research** for **feed** substitution, for optimisation of feeding regimes, and for keeping high nutritional value of fish presently produced in the EU - The Commission **to ensure** that EU **feed law** is developed in a way that allows maximising the use of high value raw material while preventing food-borne risks, and The Commission to act towards increasing the availability of necessary feed additives for fish. - The Commission and the Member States to contribute to adequate **information of feeding behaviour and ne**eds of fish (most of EU produced fish are carnivorous) to ensure that the EU legislation adequately covers the needs for aquaculture development • <u>Potential actions discarded</u> - to envisage legislation to reserve the use of FMFO to feed aquatic animals only, by prohibiting the use of such raw material to feed pets, poultry or pigs for example (disproportionate, and inefficient if only applied in the EU, notably when considering that such feeding raw material is available on a global market)	• Ensuring that feeding-stuff for fish is both from sustainably managed sources and of high quality contributes to both the competitiveness objective and the sustainable development agenda. • <u>Incremental effects of option 2</u> All these actions are expected to have very positive effects for the sector as well as for the consumers.

• Many of the problems or challenges for aquaculture have not yet fully benefited from optimal solutions as the science base of such a young industry, despite fast developing, is still very limited. Many solutions are expected to be found through science but also technological development. Further research efforts are needed in many key areas (environmental issues, health and welfare, innovative technologies, spatial planning, climate change, etc.). • Insufficient coordination of national & Community efforts, insufficient involvement of economic operators and low level of transfer and dissemination of RTD results did not allow to maximise benefits for the aquaculture industry. • Focus on innovation and new technology may lead to forget the importance of extensive and traditional forms of aquaculture.	Background: cf. section 2.5.5: • <u>Potential actions (non-legislative)</u> - The Commission and the Member States to make a special effort on **RDT priorities for aquaculture** and ensure appropriate budget is allocated to aquaculture projects to further develop all dimensions of the knowledge-base for sustainable and competitive aquaculture practices (2009-2013). - The Commission and the Member States to ensure that public funded projects benefit to the EU industry by **a greater involvement of EU business**. - The Commission to promote **optimisation and development of key research infrastructure** reinforce networks in aquaculture science and promote further integration into broader science networks to address global challenges such as climate change especially in the context of the new Maritime Policy and its strategic research agenda (COM-2008-543) (2009-2013). - The Commission to better promote the **exploitation and dissemination** of EU funded aquaculture **research** projects (e.g. like PROFET-policy) and create specific mechanisms to this end (2009-2013). - The Commission to consider, with the Member States and the European Technology Platform for Aquaculture, the future opportunity for launching **a Joint Technology Initiative (JTI)[78] in aquaculture** (possibly by 2011). - The Commission to recall **the value and importance of traditional and extensive forms** of aquaculture (within the strategy).	• Giving highest priority to research and technological development is fundamental to the competitiveness objective. • <u>Incremental effects</u> By highlighting the value of aquaculture and ensuring it is fully taken into the broad picture of EU RTD, all these actions should contribute to increase scientific knowledge and new technology for the development of aquaculture activities in a more coordinated and integrated way. Very positive impacts can be expected such as a better economic performance of the aquaculture industry which should allow it to be more competitive in the international market. Recalling the value and importance of extensive aquaculture in parallel will give impetus to MS in considering also possibilities of developing production in existing sites and facilities.

[78] Joint Technology Initiatives are proposed as a means to implement the Strategic Research Agendas (SRAs) of a limited number of European Technology Platforms (ETPs). The dedicated structures implementing the JTIs will be independent legal entities that will manage research projects in an integrated way, with industry joining forces with other stakeholders

• The EU leadership in R&D and innovation is not always best exploited to the benefit of the EU industry on the international scene. It is only seldom that it serves as a basis to allow EU industry to invest abroad and benefit from the growth observed in certain regions of the world, while also exporting "EU values" about the social and environmental dimensions of sustainability.	• <u>Potential actions (non- legislative)</u> - When setting up working groups to develop market access partnerships, **the Commission** to assess whether EU aquaculture (either the farming sector or the associated technology providing industry) may have an interest in joining these groups. - The Commission and the Member States to promote the need for sustainability in aquaculture when participating in international fora as well as at regional and bilateral level, in particular with the view to improve the environmental record of some present practices and improve the level playing field for this sector at a global level. - The Commission to develop, in the context of its new animal health action plan, an export Strategy at Community level in order to strengthen the Community role in negotiating exports conditions related with animal and public health issues under the SPS agreement (2009-2011). This may open new opportunities for high quality products, in particular from aquaculture hatcheries and nurseries.	• Contributing to Europe being a reference on the international scene is fundamental in contribution to the competitiveness objective • <u>Incremental effects</u> Such possible actions are expected to increase the role of EU aquaculture business on the global scene. This may not be easily achievable for some sub-sectors which remain yet very fragmented, but such initiatives may be beneficial for some "high tech" segments (e.g. output from EU hatcheries and nurseries), or aquaculture technology providers (off-shore cages, net manufacturers, recirculation system designers …), or already big consolidated EU companies. High quality EU aquaculture products may found outside of the EU new niche markets and result in positive effects on the aquaculture trade balance. The promotion of sustainable aquaculture development in international fora, if successful, would certainly contribute to a fairer global competition with benefits for EU production.

• The recent "fuel crisis package" adopted by the Council in mid 2008 may lead to reprogramming by Member States with the view to increase the contribution to restructuring of the fishing fleet (despite fuel prices significantly lowered since). In such re-prioritising, MS may decide during 2009 to allocate a lower share of EFF available funds to aquaculture projects.	• <u>Potential actions (non- legislative)</u> - The Commission to use the Communication on a Strategy to begin exploring some possibilities for future **orientation of Community support** (such as linking for example the allocation of EU financial support with a requirement for spatial planning to address the conflict on space). - The Commission to collaborate with Member **States to facilitate reprogramming** where so considered, and Member States to ensure that allocating some support to aquaculture is continued within their Operational programmes (e.g. to priority such as supporting innovation or environmental values in aquaculture) (2009). • <u>Potential actions not retained</u> - In parallel to the Communication for a strategy, present an immediate proposal to amend the EFF with a sole "aquaculture" perspective. (Priority needs for sustainable aquaculture development will be assessed as part of the reflection and preparation for the proposals for the EU financial frameworks after 2013).	• Support available under the European Fisheries Fund allows contributing both to the Sustainable Development Agenda and to the objective of competitiveness and improved governance. • <u>Incremental effects</u> Option 2 for a Strategy is also timely, as without a political EU leadership on aquaculture and its prospects, some Member States may not necessarily give sufficient attention to this industry in their OP, and may be tempted in allocating most of the money in actions benefiting the fishing industry only. In addition, better targeted priorities are expected to result in a more efficient use of the limited financial resources.

• Different ways of interpretation and implementation of EU environment legislation at national level lead to an uneven situation within the EU. Moreover, as Member States may establish their own additional environmental protection rules, the environment legislation may be used to justify a NIMBY ("Not In My Back Yard") policy at regional or local level. • Implementation of EU public health and animal health policies may also lead to possible disparities. Concerns have been expressed in particular regarding the present application of the tests for biotoxins (mouse test). Some EU rules applied along the food-production chain cannot be imposed in a same manner to non-EU producers (e.g. by-products or feed law).	• <u>Potential actions (non- legislative)</u> - The Commission and the Member States to contribute to **better mutual under**standing on the scope and aims of **EU environmental legislation**, and to identify limitations that derive from EU legislation and additional limitations depending on stricter rules to protect the environment, that may have been taken at Member States level. - The Commission to contribute to an **improved level playing field** to the benefit of the aquaculture industry by developing guidance documents and organising specific workshop with stakeholders and national authorities (2009-2011). Priority actions should focus on nature protection - illustrating how a sustainable well managed aquaculture development can be compatible with Natura 2000, pollution related aspects - e.g. use of treatments in aquaculture-, or environmental impact assessment processes. - The Commission to ensure that **EU animal health and public health law** is properly implemented and in a comparable way (with additional guidance developed where needed, such as risk based surveillance for aquatic animal disease taking into account the variety of the aquaculture industry in the EU, and with FVO inspection "on the spot", e.g. for tests for biotoxins in shellfish).	• Public authorities have a fundamental responsibility in ensuring a level playing field among operators, among Member States, but also at the international level. Improving the level playing field is necessary to the objective of better governance • <u>Incremental effects</u> Very positive effects can be expected from the implementation of these possible actions. They will contribute to reduce or avoid distortion of situations among Member States. A better understanding and implementation of the environmental legislation aimed to make compatible aquaculture and nature conservation will facilitate the development of aquaculture production in a sustainable manner.
• The aquaculture industry and its numerous sub-sectors remain of limited economic importance which does not always allow it to be aware and contribute to all policy initiatives that may affect its development, and public authorities do not always sufficiently address the needs of this industry. • RTD does not sufficiently contribute to aquaculture development in the EU, because of insufficient dialogue between industry and scientists when designing research priorities needs. The industry also lacks sufficient return on the outcome of such research projects.	• <u>Potential actions (non- legislative, and possibly legislative)</u> - The Commission to assess the need to revise and raise **the profile of the aquaculture** industry and the possibilities to **reinforce** the role of aquaculture representatives in **AFCA** (by 2011) (cf. section 2.5.6) - The Commission and the Member States **to improve the consultation process** with the aquaculture sector for non legislative action, in particular in the framework of the EU research agenda (e.g. establishing a forum for dialogue with the European Aquaculture Technology and Innovation Platform, assessing the value of international multi-stakeholder platforms in close association with the EU aquaculture producers) (cf. section 2.5.5)	• Involvement of stakeholders in policy development is essential to better governance. • <u>Incremental effects</u> These actions will raise the profile of the aquaculture industry allowing it to better participate in broader initiatives. This would contribute to better regulation and increased involvement and responsibility of the industry in the development and application of the Community rules. Improved dialogue and consultation would allow improved coordination and better use of research resources and structures.

• The development, implementation and evaluation of policies need to be based on reliable information. However, because of the size of the aquaculture industry and its numerous sub-sectors the collection of reliable indicators is difficult or not considered worthy by public authorities.	• <u>Potential actions (non- legislative)</u> - The Commission and the Member States to ensure that **the new instruments for statistics and indicators** deliver the necessary data (cf. section 7) and to monitor progress and evolution of this sector on this basis. The Commission to broaden its information base with other sources (e.g. data available from aquaculture producer organisations, from associated sector such as the feed industry). - The Commission and the Member States **to actively participate in international fora** (notably the FAO) for the development and collection of global and harmonised indicators for this growing industry. - The Commission to **establish a price monitoring system for fish and aquaculture products** throughout the marketing chain. (Several studies are going on. The first consolidated results and recommendations should be shared and discussed with stakeholders during 2009.)	• Ensuring an adequate and regular monitoring of the aquaculture industry is key to better governance, to allow public action based on facts. • <u>Incremental effects</u> The effects of these actions are expected to be positive for both the competent authorities and the sector if they achieve to develop and establish a EU/international framework for statistics which associates high quality of data at a reasonable cost. The price monitoring system will also lead to developing a tool for analysis and decision making aiming at improving knowledge on price setting and understanding how added value is generated from the first sale. It is also expected that improved information on markets mechanisms should enable producers to adapt their production and supply to get better value for their products.

ANNEX IV

DEVELOPMENT SCENARIOS FOR AQUACULTURE AND THEIR SOCIAL, ECONOMIC AND ENVIRONMENTAL IMPACTS

Extracted from the "Prospective Analysis of the Aquaculture sector in the EU"

Part 1 : Synthesis report

JRC – September 2008

Preliminary remark:

All text, figures and table have been reproduced from the JRC analysis report. The numbering of chapters, tables and figures below shall not therefore be read in conjunction with the main body of the present impact assessment report. For readability reasons and not to alter the content of this extract, the presentation of the text below and all cross referencing refers to the original report from with this section has been reproduced.

[….

[6] SCENARIO ANALYSIS

[6.1] Summary prospective analysis and scenario definition

The factors outlined in [section 2] set out the expected upper and lower limits for development of the aquaculture sector in Europe up to 2025. The objective for the analysis in this section is to examine the identified drivers with respect to the strength of their influence on development, possible interactions between drivers, how the drivers might be modified through policy or other interventions, and the composite impact on the aquaculture development trajectories. Of those identified earlier, only the most significant ones are included at this point, to avoid over-complication. These are:

- Consumer purchasing behaviour – taking into account price changes, actions of campaign groups and responses of the multiple retailers etc.
- Site availability and cost – taking into consideration physical availability, lease costs, environmental costs, and competition with other users
- Support for innovation – taking into account government and business investment in R&D, education and training, and the support of government and financial institutions for commercial (technology-based) risk takers

Species are grouped with respect to culture and market characteristics into:

- Salmon, trout, charr and other salmonids
- Sea bass, bream and similar species

- Halibut, turbot, sole and other flatfish
- Cod, haddock, hake and other quality marine whitefish
- Carp, tilapia, catfish and other low to medium value freshwater fish
- Eels, perch, sturgeon, zander and other higher value freshwater fish
- Tuna and other high value pelagic fish
- Mussels
- Oysters, scallops and higher value shellfish
- Clams, cockles and other lower value shellfish
- Potential new aquaculture species not covered above (squid, cuttlefish, octopus, lobster, crab, shrimp, abalone, echinoderms etc.)
- Aquatic plants (seaweeds)

Previous growth rates for these species groups provide some guidance, but future factors such as technology break-throughs and changes in the marketplace are likely to have greater impact, so more emphasis is placed on foresight rather than hindsight in the scenarios and discussions which follow. It is also important to consider trends with respect to the final products that might be marketed rather just output volumes from aquaculture, as value addition can be more significant in economic terms, than primary production. Other changes in aquaculture practice may also occur in response to market demands. For instance demand for larger-size trout, and to some extent sea bass and bream, suitable for processing (e.g. fillets) has been increasing in recent years. In responding to this, the French rainbow trout production fell from 46,462 tonnes in 2001 to 32,412 tonnes in 2005, although value per kg increased by approximately 12%[79]

Aquaculture production projections for the four scenarios are set out in the next sections. The purpose is not to predict how aquaculture might develop over the next 20 years in Europe, but to use these different projections to reflect on their implications with respect to resource use, economic and environmental impacts, and what changes would be necessary within the sector to achieve differing levels of output. From this, consideration might then be given to which scenario appears more likely in relation to larger external trends that may impact on development.

The first scenario reflects minimal development, but continuation of trends that can already be seen in the industry. The other three scenarios are essentially target-based. The overall growth in aquaculture is set by the target growth assumptions. Which sub-sectors develop and at what rate is then determined with reference to discussed drivers and barriers, but the actual rate is calculated to deliver the target production levels, based on 5-year intervals

[79] Calculated from FAO Fishstat database, 2007, with US dollar values converted to Euro using annual average rates for 2001 and 2005 respectively.

In all scenarios it is assumed that a proportion of the aquaculture production will be exported, but that an equivalent or greater quantity of other seafood products will be imported. [Table 12] summarises the main drivers that were considered in constructing the models.

[Table 12]: Summary of driver effects by sub-sector

Species group	Consumer trends and issues	Resource constraints and sustainability	Policy and investment issues
Salmon, trout & other salmonids	Lower prices and improved range of products are expanding markets. As the highest profile farmed fish in Europe, salmon has been subjected to considerable bad publicity on contaminants, welfare and environmental impacts. However, consumption has also been encouraged by positive health messages. Good potential for further expansion if comparative value continues to improve.	The industry is moving towards using a smaller number of large sites for reasons of operational efficiency. Environmental regulation is constraining this trend, at least in the UK. Other sustainability issues are being addressed through innovations and new guidelines for best practice.	Low prices throughout the first half of the current decade slowed expansion and encouraged further consolidation. The majority of European production is in the hands of a decreasing number of international businesses, which should bring greater stability and provide access to investment finance as needed.
Sea bass, bream & similar	The whole fish format is popular in Southern Europe, but even here, trends have been towards easier to prepare and convenient fish products. Market expansion is therefore somewhat constrained, although further substitution is likely if capture fisheries decline.	There are significant constraints on further inshore sheltered sites, but further expansion at more exposed sites is feasible.	The sea bass and bream industry is only moderately consolidated and suffered low prices in the early part of the decade. Further restructuring is emergent and more is expected.
Halibut, turbot, sole etc	Popular, but nevertheless premium fish species. Prospects for steady growth within limits defined by price. Reasonably versatile fillets/steaks for value addition. Market prices have been comparatively stable.	Most turbot and sole are produced in tank-based systems, sometimes recirculated. Halibut also produced in cage systems. Relatively unconstrained.	Likely to witness only modest expansion given comparatively high production costs and desire to maintain high unit value status of products.
Cod, haddock, hake etc	Traditionally high volume whitefish species. Considerable substitution in lower-value products from other marine species. Some evidence that aquaculture produce may be able to compete on quality and environmental credentials given increasing concerns about overfishing of wild stocks.	Industry still very small and not resource constrained. Possible competition with salmon etc. for resources as expansion occurs.	Further research needed to improve production processes and encourage investment
Carp, tilapia, catfish	The carp market has been declining, although there are some indications that market image and new products can be developed to raise value. Tilapia and catfish are relatively under-represented in the European market, with good prospects for expansion as versatile meat suitable for	Land based systems for tilapia and catfish feasible. Established processing technology-based solutions for carp and changing market could see expanded interest in carp.	Emergent interest more evident in tilapia with a number of emergent investments seeking to exploit growing market in imported products with those locally based. Competitive advantage remains to be proven

Species group	Consumer trends and issues	Resource constraints and sustainability	Policy and investment issues
	incorporation in a range of products.		for mass market.
Eels, sturgeon, perch, zander etc.	Carnivorous freshwater fish are well known and valued in East and Central Europe with some prospects for expansion as prosperity rises and perhaps as the species are introduced to other markets. The main interest in sturgeon is for caviar, although markets exist for sturgeon meat in Central Europe.	Wild stock are likely to be increasingly protected. Intensive culture in ponds and recirculated tank systems are emerging with few immediate resource constraints. Eel production is currently highly constrained by wild elver supplies.	Generally niche products that have not had substantial R&D or structural funding support. Primarily of interest to small and medium scale businesses with relatively limited investment resources.
Tuna	Most tuna produced in Europe is exported to Japan. There would be few obstacles for expansion of European markets if prices fall and sustainability issues can be addressed.	Current reliance on wild seed stock is a major constraint, as is the use of baitfish for feed and associated environmental impacts.	Substantial R&D investment is required to close the tuna production cycle and allow for the development of commercial hatchery/nursery operations. Early weaning of fish onto dry diets would also reduce environmental impacts.
Mussels	Reasonable prospects for market expansion with improved quality, processing and packing technologies.	Traditional production sites are increasingly constrained, but new developments in offshore farming are opening up new opportunities.	Mussel farming is likely to be a central part of IMTAS
Oysters & scallops	Premium shellfish species with potential for market expansion, especially if prices were reduced	Traditional near-shore sites are highly constrained.	These shellfish might form part of IMTAS. The industry is mostly small-scale private producers with limited means for investment.
Clams, cockles etc.	Lower value shellfish commonly incorporated into a range of dishes.		
New non-fish aquaculture sp.	Prospects for octopus, cuttlefish and perhaps squid if economic production technology is developed Some prospects for premium echinoderms and molluscs (e.g. abalone), initially for export or ethnic	New species, sharing only general aquaculture constraints	Substantial R&D required for most species, as well as support for pilot and early commercial projects.

Species group	Consumer trends and issues	Resource constraints and sustainability	Policy and investment issues
	markets.		
Aquatic plants	There is scope for developing the market for seaweed as food in Europe, given the very low base. Industrial uses exist, but are not high value. Potential for biopharmaceuticals	Potential near-shore space constraints.	Likely to be central to IMTAS development. Difficult for production in Europe to be competitive with other regions at present. Potential for biopharmaceuticals requires substantial R&D funding for development.

[6.2] Emerging technologies, practices and systems

[6.2.1] Emerging systems

The particular focus of our analysis is to discern the prospects for emerging aquaculture systems, as defined and characterised in more detail in the Part 2 report, in the context of overall prospects for aquaculture development (partly because it is where most development/growth, if occurred, would be based). The emerging systems that were identified, and the anticipated prospects are as follows:

Production technology driven

Recirculated aquaculture systems - The number and scale of commercial recirculated aquaculture systems continues to grow and units capable of an annual output of up to 1000 t are foreseen within the next 5 years. The technology is still only moderately standardised and key components effectively custom built for each development. Expansion of this sector will depend on continued improvements to design and optimisation of both build and operating costs.

Offshore aquaculture systems - The salmon industry in particular is increasing production scale at individual sites, and developing the handling and harvesting systems that would be required for true offshore aquaculture. Support for further R&D is being given by the governments of Ireland and Norway. It is also notable that the USA have prioritised this type of development both investing in R&D and introducing a bill to bring in the regulatory changes required to allow for offshore aquaculture developments in designated zones (http://www.nmfs.noaa.gov/aquaculture/offshore.htm).

Integrated systems - IMTA systems have potential for reducing environmental impacts whilst optimising overall production through making best use of ecological processes to assimilate wastes. However, there are numerous challenges to making such systems work in practice due to commercial and operational factors. Research is ongoing in Canada and Scotland using seaweeds and bivalve mollusc in conjunction with salmon culture. Seaweeds mitigate waste by removing dissolved inorganic wastes such as ammonia, whereas the molluscs are used to remove solids waste (Chopin *et al* 2006). Currently the seaweeds have the least value in the system as they are not widely consumed in the West, despite the reported nutritional value of some species. However they have a wide range of industrial uses, and are increasingly noted as sources for new biopharmaceutical products such as anti-cancer and anti-viral drugs. They may also have potential use for production of biofuel, though the economics of doing so would have to be more specifically defined.

Market driven

Organic and other labels – the market (and supporting legislation) is increasingly demanding assurances of product safety, transparency concerning production and processing, and many consumers are also seeking products that clearly embody ethical and environmental values or quality concepts. Where labels seek to differentiate a product from other similar offerings in the marketplace, the production and/or distribution process must indeed be different. For labelled products to have credibility, it is essential to have a robust and independent certification process that checks that the production and distribution systems do meet the claims made for the label. As the number of participants in any scheme increases so too does

the risk of brand degradation through the rogue actions of individual producers. This adds cost and the proliferation of standards, organisations and labels, whilst providing a wider range of consumer choice, is sometimes regarded as potentially confusing, diluting the value individual labels may have. In recognition of this, the European Commission DG Fisheries conducted a survey on certification of aquaculture products during the first half of 2007. This concluded that action at EU level would be helpful, and this is now receiving closer scruitiny[80]. Supermarket chains across Europe seem set to continue their increasingly receptive view of standards which reinforce their 'green' credentials; undoubtedly there may be a cost-based constraint on any unbridled enthusiasm, especially if the consumer proves more resistant to its price implications.

New aquaculture species – Interest in producing a wider range of species from aquaculture is driven partly by declining prices for established species as production levels rise. It may also be stimulated through rising demand for greater variety, or increasing prices for some traditional high value or high volume capture fisheries species. Concerns about over fishing also promote interest in a more diverse aquaculture production base among policy makers. This study identified around 50 species that are either produced at small scale or research levels, with potential for expansion. Some species are clearly constrained by technical barriers, such as the reproduction and early rearing of bluefin tuna. For other species, it is usually a combination of technical and market factors which lead to an assessment that production would not be economically viable (or sufficiently attractive for investment given other available alternatives). As technologies and markets develop, it might be expected that new aquaculture species will emerge from time to time as both technically feasible and commercially attractive. However as the range of species expands it might be expected that there will be greater concentration upon a much smaller number of core species satisfying the common determinants of the market.

[6.2.2] Emerging technologies and practices

In discerning emerging aquaculture systems, it was also noted that there is continued evolutionary development of technologies and management practices within the mainstream aquaculture systems. Those with greatest impact include:

Breeding technology – Closing the lifecycle has been the single most important technical advance for many aquaculture species, especially marine fin fish. This has required a combination of technologies – maintenance of correct environmental conditions, adequate maturation of broodstock with quality gametes, initiation of spawning behaviour; successful fertilisation and hatching of eggs; nursing of larvae and fry through early developmental stages until weaning on artificial diets etc. The Mediterranean sea bass and bream industry effectively started once commercial hatchery production of fry became feasible in the 1980s. Since then, production efficiencies have improved and cost per fry reduced. In 1987, prices quoted for sea bass were approximately €0.34 - €0.40 for 1 g fry and €0.67 to €0.88 for sea bream[81] (Berg & Cittolin, 1987). Survival rates from egg to fry were often less than 5%. One

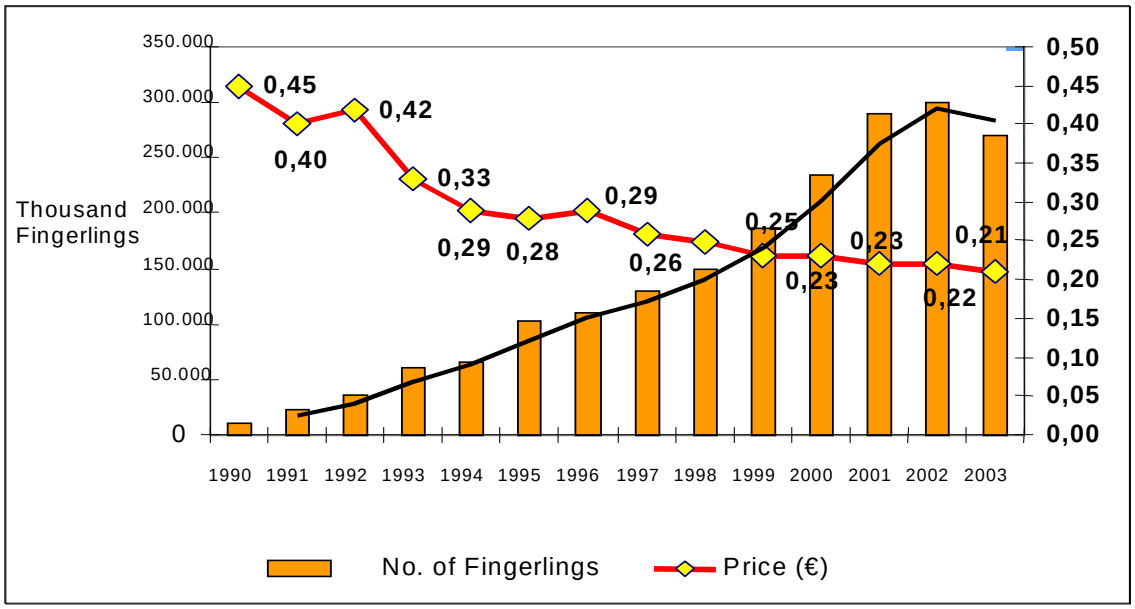
---

80 http://www.ec.europa.eu/fisheries/cfp/governance/consultations/consultation_240407_conclusions_en.htm

81 Prices quoted in Greek Drachma were GRC 50-60 for sea bass and GRC 100-130 for sea bream. At a fixed exchange rate of GRC 340.75 per Euro, this equates to € 0.15 – 0.18 per fry for seabass and €0.29 to 0.38 for sea bream. The given values have been calculated by comparing the US$ - GRC rate for

of the most important advances was the introduction of enrichment media for live feed, but there have been many incremental developments such that survival rates are now commonly over 30% from egg to first feeding fry. These improvements have lowered the cost of production (in both real and relative terms) as shown in [Figure 62], based on data from Greece. Fry prices reduced from €0.45 from 1991 to €0.21 in 2003, allowing the total cost of bass and bream production to be reduced and markets expanded. Although the industry now has over 20 years experience, further gains in productivity and quality are possible, with consistency still a problem. Such gains might not necessarily lead to further price reductions however, as input costs such as feed ingredients, labour and power are rising.

[Figure 62]: Evolution of seabass and seabream fingerling production and prices 1990-2003



Source: ICAP 2003 (reported in University of Stirling, 2004)

The status of breeding and reproduction for other marine species is quite varied. Hatcheries for colder water species such as cod and halibut have not yet reached the levels of survival achieved in the bass and bream industry, but have become financially viable for high value end product. The spawning and rearing of bluefin tuna in captivity is still at the research level.

With control over reproduction achieved, the next step is greater control over the genetics of farmed populations. As discussed in [Section 5], this is being achieved through selective breeding programmes using a combination of traditional stock rearing approaches and the use of genetic markers and statistical techniques. Ongoing research to identify quantitative trait loci (QTL) and ultimately full genome mapping is likely to allow further advances[82]. This assumes that the "domestication" or improvement of wild species remains ethically

1987 with the average extrapolated Euro to dollar value calculated from the DEM-US$ and FRF-US$ rates and adjusting accordingly.

82 The breeding company "Landcatch Natural Selection" has recently announced the introduction of QTL technology into their salmon breeding programmes, allowing selection of broodstock with identified genes with disease resistance or faster growth rather than only on the basis of pedigree performance. http://www.fishupdate.com/news/fullstory.php/aid/8347/_Quantum_leap__in_salmon_breeding_.html

acceptable (as it has done in most other branches of livestock, agriculture and horticulture). This may not be a safe assumption, as concerns over the technology of genetic modification appear to have made many consumers more suspicious of any technologies that are seen to artificially interfere with the genetics of farmed species. This may be particularly the case with fish, which are hard to contain securely in open culture systems, and which may then interbreed with wild populations. The comparative recency of farmed fish as a mainstream source of food supply is likely to exacerbate this initial disposition, which may recede over time as familiarity and acceptance increases.

Selective breeding programmes have proved to be a fundamental tool in lowering the cost of production for terrestrial livestock, and are having an increased impact on aquaculture. By only breeding from broodstock that have shown the best performance with respect to desired characteristics (usually growth rate, feed conversion efficiency and disease resistance, although flesh fat content and colour or other qualities are increasingly included), average performance can be improved incrementally each generation by up to 20%.

[Table 13]: Example genetic gain from selective breeding programmes

Species	% gain per generation
Channel catfish	12-20
Pacific salmon	10
Atlantic salmon	11-14
Rainbow trout	13
Tilapia	14-23

Source: Akvaforsk (quoted in Mortensen et. al. 2005)

The main challenge for traditional breeding programmes is that improving one characteristic (e.g. growth rate) can have a negative impact on other characteristics. A multi-trait breeding programme is more complex, but possible using more sophisticated statistical analysis. Traits also vary with respect to heritability. This is often linked with the number of genes (usually unknown) that influence the trait. For traits with relatively low heritability, discerning the genetic effect from environmental influences is more difficult. QTL and genome mapping approaches should ultimately provide much greater levels of information and hence control.

There have been substantial productivity gains in the Atlantic salmon industry over the past twenty five years, partly due to strain and family selection processes. According to Scottish industry records[83], in 1980 the average weight of a two sea-winter salmon at harvest was 3 kg. This had risen to 4.3 kg by 1995 and to 4.4 kg by 2005. Similarly the percentage of salmon harvested as grilse (early maturing fish) was around 30% in 1980, down to 18% in 2005. Again, the use of low-grilsing strains is only part of the reason as photoperiod management has also played a role. The total yield per smolt rose from 1.67 kg for 1990 year class smolts to 3.43 kg for 2003 year class smolts. Again, this also reflects both genetic and other management gains. Studies on the genetic gain of breeding programmes in Norway have shown gains of 4.6% per generation in feed efficiency ratios (Thodesen *et al* 1999), and 8-

[83] Various annual Scottish fish farming surveys – most recent at http://www.marlab.ac.uk/

10% per generation for growth rate, age at maturity and flesh pigmentation (Cited in Gjøen & Bentsen, 1997). Studies on selective breeding programmes for Pacific salmon in Canada found that 55% of the improvement in growth rate was due to genetic selection and 45% from improved animal husbandry (Peterson & Swift, 1999). The same authors quantified the economic benefits of improvements to an Atlantic salmon stock as US$1.43 per fish marketed, or $1.23 per smolt entry if sold early at the equivalent weight of non-selected stock, or $3.66 per fish marketed and $3.07 per smolt entry if grown for the same period to a greater weight.

When considered on an annual basis, species with shorter breeding cycles can be advanced at a faster rate than those with long breeding cycles. The time between generations for Atlantic salmon is approximately 4 years. The time between generations for tilapia can be as little as 9 months; the Norwegian company GenoMar claim a 15% annual genetic gain for growth rate (GIFT-strain)[84]. The rate of improvement possible for species such as sturgeon, which have relatively long breeding cycles is therefore more limited.

The breeding and hatchery phase is the most technically complex of the full aquaculture production process and is the key component in the development of any new aquaculture species. Improvements in efficiency and performance achieved through breeding can have substantial economic benefits throughout the production process and hence on market price and volume.

Feed technology – Feed is one of the primary production inputs and therefore of great importance with respect to determining production efficiency and cost. Feed also has a significant effect on the amount and type of waste output from the system. Advances in hatchery feeds have been mentioned above, and include nutrient enrichment of live feeds (expecially rotifers and artemia), development of microalgae and copepod production techniques, progress towards reducing labour requirements through the use of commercially available algal paste, manufactured artemia systems and automated feed delivery systems. Artemia replacement diets also reduce reliance on fluctuating and limited stocks of this creature.

Compounded diets used in growout have been gradually improved throughout the last 20 years. Significant advances include improvements to fishmeal quality through lower-temperature processing, finer milling and the use of extrusion technology, better tuning of diet formulation to meet particular species and life stage requirements, or achieve lower environmental impacts. Further improvements are often constrained by cost considerations, but current issues include the potential for reducing the fishmeal and fish oil components derived from capture fisheries and their substitution with vegetable proteins and oils to enhance sustainability. However, this raises concerns about welfare, especially for carnivorous fish species, and doubts have also been expressed about the acceptability of using supplementary industrially produced amino acids. For the immediate future, modest improvements to utilisation efficiency will allow aquaculture to continue to expand whilst relying on feeds derived from marine proteins and oils. Longer-term, more innovative solutions will undoubtedly be required.

[84] http://www.genomar.no/text.cfm?SID=12&ID=57

Health management – Disease problems continue to impose serious risk and costs to many aquaculture producers. Only a limited range of therapeutants is licensed for use in Europe. Most development in recent years has focused on anti-parasitics and anti-fungal agents. Due to environmental and residue concerns, prevention of disease through good husbandry, proactive diagnostics and the use of vaccines and immunostimulants is often the preferred approach.

The most successful fish vaccines have been those against gram negative bacteria, although there are a limited number of products for gram positive bacteria and some viral diseases. Vaccines against parasites are under research, but so far no commercial products are available. Vaccines are administered as a bath treatment, e.g. in the hatchery, orally (with feed), or by injection. The latter is the least favoured but currently most effective. The duration of immunity is limited, and booster vaccinations are sometimes required. It appears that the specific immune response in fish is not well developed until they are at least a gram in weight. Shrimp never appear to develop a specific immune system. For these groups, and for providing additional protection for larger fish, immunostimulants are available that boost the non-specific defence mechanisms. A variety of compounds are used, perhaps most commonly beta-glucans derived from yeast, although others are under development. Vaccine development is at the leading edge of biotechnology and several new approaches are under serious development or trial. These include the use of recombinant DNA technology for vaccine and adjuvant production and more revolutionary, vaccines based on direct injection of DNA into the muscle, the cells of which take up the DNA and produce antigenic proteins over a longer period, directly stimulating the immune system.

The use of biotechnology in disease diagnostics is also important, with increasing use being made of molecular (e.g. PCR, RT-PCR) and immunological (immunohistochemistry, immunofluorescence, immunochromatography etc.) techniques for health screening at critical points (e.g. broodstock selection, or seedstock prior to purchase).

Product handling, packaging and distribution – Overall trends in Europe have been for processed fish products that require little or no preparation and are easy to store and cook, preferably skinless and boneless (fish). Freshness is one of the most important product qualities, so minimising the time and temperature control between harvest and final sale has proved important, as have advances in packaging designed to enhance shelf life (e.g. MAP). Improved monitoring of product condition during logistics distribution has been another important element, along with product management and restocking.

For an internationally traded product such as salmon, it is worth noting that farm costs only constitute around 30% of total production and distribution costs (Dempster, 2007), so efficiency gains in processing or distribution can potentially have a greater impact than efficiency gains in the farming phase. As consumers become more accepting of added value products this margin on non-raw material costs can be expected to increase further still. For the foreseeable future, a key issue will be the cost of energy and changes in policy and market environments as greater action is taken to minimise climate change.

Integration into zonal planning – With increasing pressure on coastal zones throughout many parts of Europe aquaculture is increasingly included in coastal zone planning, in some cases with proposed or actual development of aquaculture zones, where existing operations are afforded greater protection, or new developments encouraged. Examples of similar

approaches may be found inland, such as the protection of aquaculture activities in traditional ponds in the Czech Republic, or the development of aquaculture parks in France.

As discussed in [Section 5], the primary driver for commercial development is ultimately the opportunity to make a favourable return on investments, such that the key issue for any emerging system, technology or practice will be whether it improves sales prices or volumes, or reduces production costs. [Table 14] summarises cost of production data from the Part 2 report with some comparison of market prices.

[Table 14]: Comparative operating cost profiles of different aquaculture systems (percent of total operating cost)

Breakdown of operating costs	**Offshore salmon**	**Organic salmon**	**Sea bream cages**	**Tuna cages**	**Turbot re-circulated**	**Turbot flow through**	**Eel re-circulated**	**Octopus on-growing**	**Arctic charr cages**	African catfish
Feed	46	45.6	54	27	15	18	29	13	43	58.7
Selling costs/Packing	17	7.1								
Seed stock (fry or smolts)	8	13.5	20	48	10	11	29	42	21	7.9
Wages/salaries	7	10	9	6	7	8	9	11	19	7.2
Misc./other operating costs – inc. consumables & contingency	6	0.4		14	10	10	1			9.6
Depreciation	5	7.1	13		35	33	20	11	12	5
Maintenance					4	1		3		2.2
Vet/medicines	3				2	2				1.1
Administration/Overhead costs	3	9.3			4	4	1			2.2
Transport		2.5								
Harvest expenses		4.6								
Stock & general Insurance	3		1	2	2	2	2	15	2	2.2
Legal & professional fees					1	1				0.7
Licensing/lease/discharge costs			0				1	1		
Power and fuel	2		2		11	9	9	3	2	3.3

Loan servicing				3						
Total	100	100	100	100	100	100	100	100	100	100
Cost €/kg	2.33	4.15	4.04	10.50	4.58	3.98	4.88	5.53	2.54	3.61
NB excludes finance costs										
Comparison – average unit value at first sale, 2005 - €/kg	2.20 – 2.93		3.53 – 8.82	6.78*	8.99	8.99	8.17 -8.78	3.97*	5.10	1.10

Source: Part 2 report. Note these figures are included to illustrate the diversity of cost structures and are not directly comparable due to different analytical approaches used. They also reflect current systems rather than future potential. Average price data from FEAP - http://www.feap.info/Production/euproduction/pricespecieseu_en.asp except values indicated (*) which were calculated from FAO Fishstat commodity trade database.

As illustrated by [Table 14], there are wide variations in the cost of production of different species, depending on system type and other inherent characteristics. Estimated costs range from €2.33 to $10.50 per kg for the systems presented in [Table 14]. Assuming moderate substitution effects, particularly within seafood groups, systems and products with the lower production costs will tend to achieve higher market shares. The major components of production costs are seed, feed, labour, and in the case of recirculated systems, power. The proportion spent on seed is highest for those systems relying on wild sources, especially tuna, eel and currently octopus. Feed is a higher component of costs in cage systems (mostly due to other costs being lower) whilst labour costs are a higher proportion in systems with lower output (charr and organic salmon in these examples). Depreciation is not a cash cost, but is usually included in comparative operating costs to indicate the financial burden of different capital cost structures.

The proportion of costs allocated to different items is a useful indicator of sensitivity. For instance, small increases in feed prices will affect cage salmon farms proportionately more than recirculated turbot farms with respect to impact on overall production cost. On the other hand, recirculated systems are more sensitive to power and capital (depreciation) costs.

[6.3] Aquaculture production projections to 2025

[6.3.1.] Scenario 1: Baseline – minimal development of aquaculture

Our baseline scenario, introduced in [Section 3], assumes that capture fisheries will continue to decline over the 15 year time horizon at a rate of 2% per year, aquaculture will not develop substantially, and that the balance of trade will meet the remaining demand. Overall demand estimates are based on apparent per capita supply assuming declining, static or rising per capita consumption levels, based on available Eurostat data.

Consideration of the constraints and drivers discussed in previous sections allows estimates to be made for each of the aquaculture sub-sectors previously identified. These are summarised in [Table 15], and discussed in greater detail following presentation of the production projections. Overall, the projections lead to a decline in the EU-25 aquaculture production from 1.26 million tonnes in 2005 to 1.17 million t in 2010, rising again to 1.2 million t in 2015 and 1.48 million t by 2025. The initial decline is based on the most recent statistics, which at least in part reflect the poor producer prices experienced in the early half of this decade. The subsequent recovery and expansion is assumed as fish supplies become more constrained and newer technologies become financially viable. Growth generally remains within historical limits and no brand new technology developments are assumed (e.g. closing of the tuna life cycle).

[Table 15]: Baseline scenario for aquaculture development - summary assumptions:

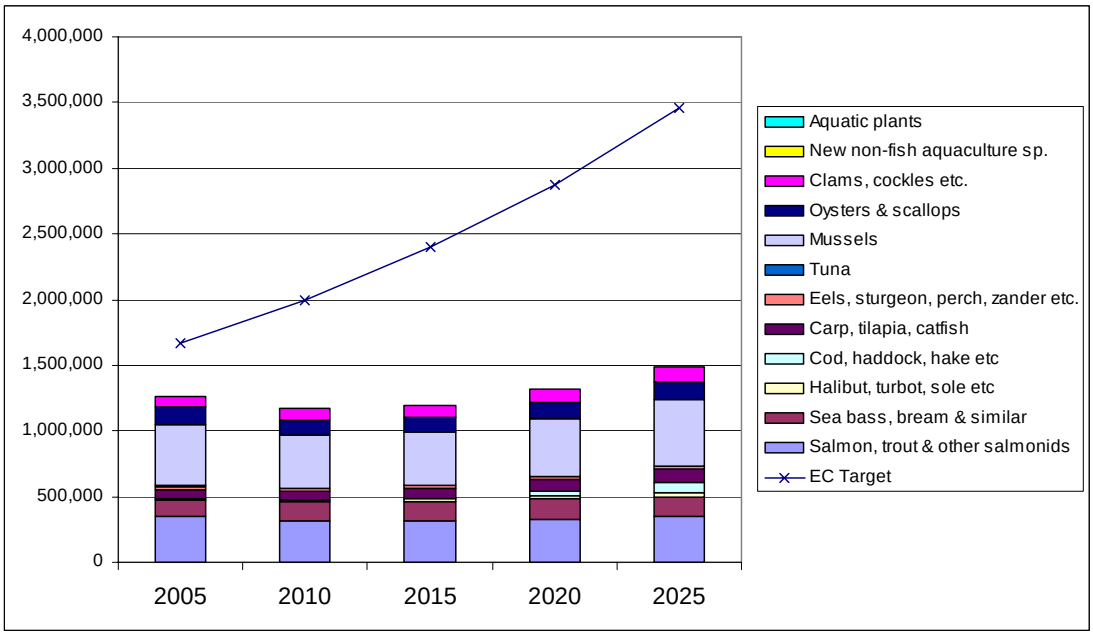
Salmon, trout & other salmonids	Negative growth until 2010 due to increasing regulatory constraints and moderate markets. Expanding slightly after 2015 with rising demand.
Sea bass, bream & similar	Modest growth continues until 2015, in part driven by market expansion through widening size and product range, and thereafter affected by environmental constraints
Halibut, turbot, sole etc	Reasonable growth but from low levels driven by improving recycle systems etc.
Cod, haddock, hake etc	Assumes cod farming in particular is developed as a significant aquaculture species, probably utilising redundant salmon sites.
Carp, tilapia, catfish	Assumes modest growth in low-cost recirculated systems – mainly catfish and some tilapia
Eels, sturgeon, perch, zander etc.	Assumes decline until 2015, then some growth as technologies are refined
Tuna	Assumes no development of hatcheries so production limited by declining wild stocks
Mussels	Initially declining and then assumes some further growth as greater industrialisation and offshore culture is introduced, especially from 2015
Oysters & scallops	Currently declining, but small modest growth from 2015, perhaps as part of integrated or offshore projects
Clams, cockles etc.	Small modest growth perhaps as part of integrated projects
New non-fish aquaculture sp.	Currently declining, but some modest development from 2015
Aquatic plants	Currently declining, but small increase associated with integrated projects from 2015.

[Table 16]: Baseline scenario – EU-25 aquaculture production projections to 2025

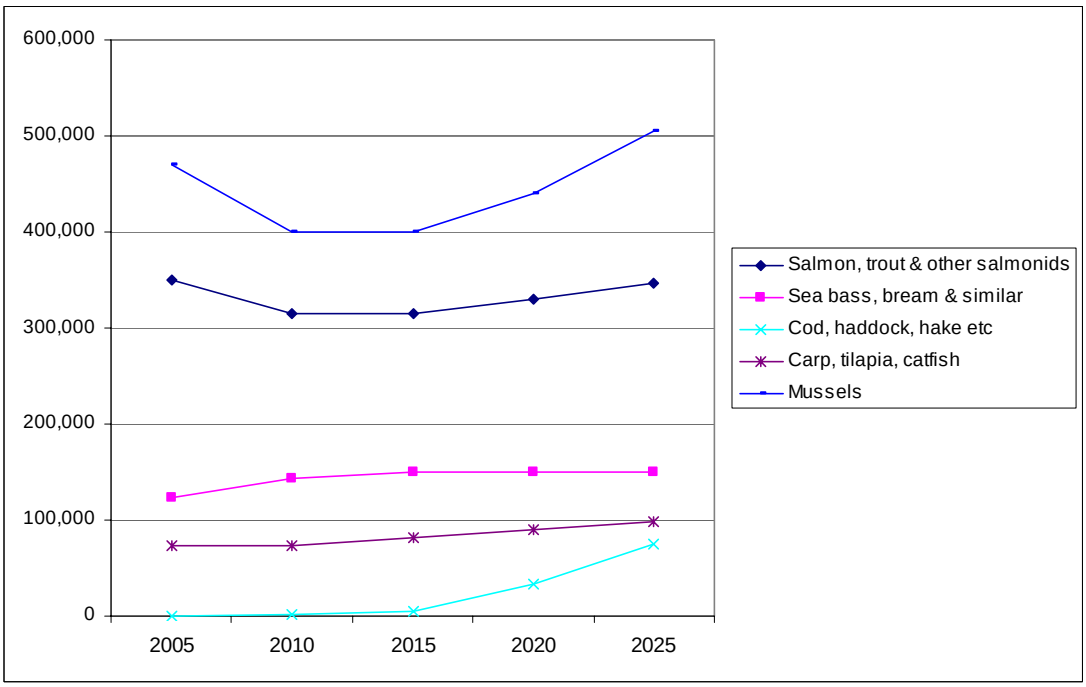
	Group growth rate			Production (tonnes)			
Group name	**5 year rate**	**10 year rate**	**Projected rates***	**2005**	**2010**	**2015**	**2025**
Salmon, trout & other salmonids	-1.97%	0.63%	1--2%	350,019	315,017	315,017	347,306
Sea bass, bream & similar	3.47%	22.47%	3-0%	124,046	142,653	149,786	149,786
Halibut, turbot, sole etc	9.57%	13.64%	10%	7,111	10,667	16,000	35,999
Cod, haddock, hake etc			250-10%	69	932	5,589	75,452
Carp, tilapia, catfish	-1.08%	0.06%	2-0%	74,086	74,086	81,495	98,608
Eels, sturgeon, perch, zander etc.	-1.63%	2.29%	2--1.5%	21,858	20,219	20,219	23,353
Tuna	0.96%	2401.25%	0--20%	3,858	3,858	0	0
Mussels	-3.29%	0.27%	3--3%	470,026	399,522	399,522	505,395
Oysters & scallops	-2.25%	-1.55%	2--2%	132,210	118,989	118,989	143,977
Clams, cockles etc.	2.96%	0.14%	2-0%	76,996	88,545	92,973	102,502
New non-fish aquaculture sp.	-15.43%	-8.27%	10--10%	273	137	137	256
Aquatic plants	-19.70%	-9.91%	10--15 %	45	11	8	11
Total			0.88%	1,260,597	1,174,635	1,199,733	1,482,645
EU Target			4%	1,665,600	1,998,720	2,398,464	3,453,788

* * The 5-year growth rate is from 2000-2005 whilst the 10-year growth rate is 1995-2005. Future growth rates are projected in 5-year intervals with the highest and lowest rates used indicated in the table.

[Figure 63]: Scenario 1 aquaculture projections – minimal aquaculture development (EU-25)



[Figure 64]: Scenario 1 aquaculture projections – development of major aquaculture species



These projections take account of commercial developments already in progress, such as further investment in cod farming and some recirculated systems. However, it is assumed that increasing constraints through environmental regulation will lead to decreased production

from other sub-sectors, especially freshwater ponds and cages, and will severely limit further coastal developments.

[6.3.2] Scenario 2: Aquaculture expands to meet output derived from EU target of 4% per annum growth to 2025

Our second scenario, introduced in [Section 3], also assumes that capture fisheries will continue to decline over the 15 year time horizon at a rate of 2% per year, aquaculture will develop to meet the output required by assuming the EU target of 4% annual growth in production tonnage was met from 2000, and that balance of trade will meet the remaining demand. Overall demand estimates are determined in the same way for all scenarios.

Consideration of the constraints and drivers discussed in previous sections allows estimates to be made for each of the aquaculture sub-sectors previously identified. These are summarised in [Table 17], and discussed in greater detail following presentation of the production projections. Overall, the projections raise EU-25 aquaculture production from 1.26 million tonnes in 2005 to 1.84 mt in 2010, 2.44 mt in 2015 and 3.37 mt by 2025.

[Table 17]: Scenario 2 - summary assumptions:

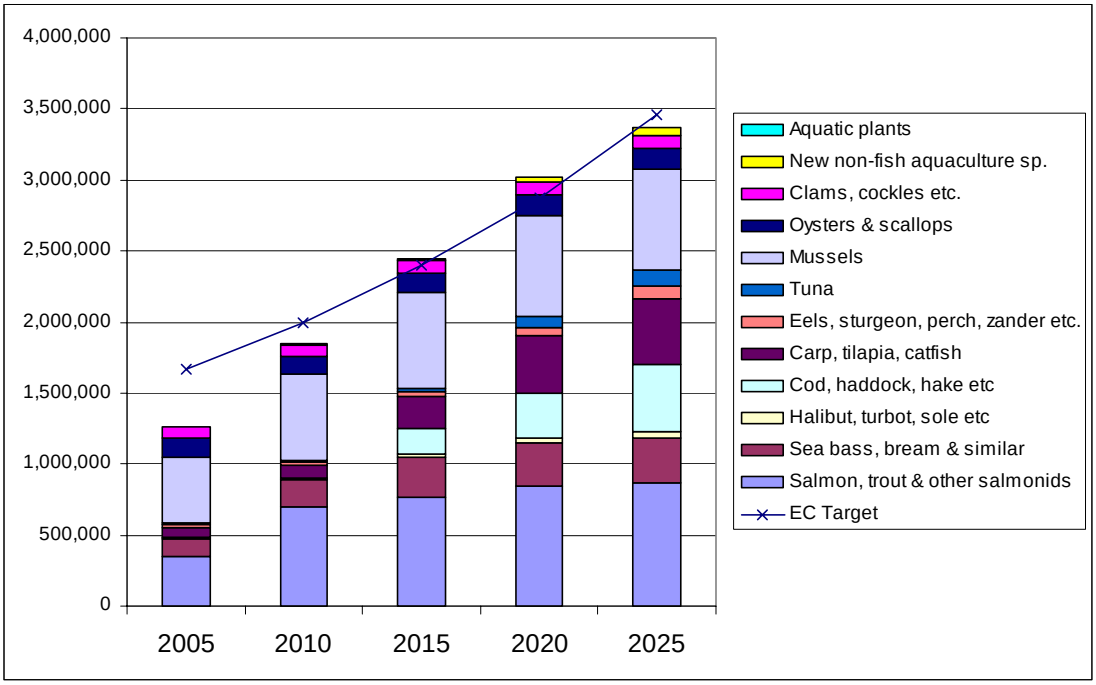
Salmon, trout & other salmonids	Increasing move offshore, triggered by continuing high demand. High growth rate as offshore aquaculture takes off, but levelling off as other species come online later and increase variety
Sea bass, bream & similar	Similarly stimulated to increasingly move offshore and expand, but not as dramatically as salmon – levelling off again as supply equilibrates
Halibut, turbot, sole etc	Reasonable growth facilitated by improving recycle systems etc.
Cod, haddock, hake etc	Assumes cod farming in particular is developed as a major aquaculture species, probably utilising redundant salmon sites initially, but possibly moving offshore with the salmon industry in due course.
Carp, tilapia, catfish	Assumes all growth facilitated by low-cost recirculated systems – mainly tilapia and perhaps catfish
Eels, sturgeon, perch, zander etc.	Assumes all growth to be facilitated by recirculated aquaculture systems
Tuna	Assumes hatchery/nursery technology is developed in next 10 years and continued high market demand
Mussels	Assumes some further growth as greater industrialisation and offshore culture iis introduced
Oysters & scallops	Small modest growth perhaps as part of integrated projects
Clams, cockles etc.	Small modest growth perhaps as part of integrated projects
New non-fish aquaculture sp.	Small number of successful projects to help enhance diversity but not a major contributor to volume (developments of cephalopod culture may alter this assessment)
Aquatic plants	Small increase associated with integrated projects, but otherwise difficult to compete with lower-cost regions

[Table 18]: Scenario 2 – EU-25 aquaculture production projections to 2025

	Group growth rate			Production (tonnes)			
Group name	**5 year rate**	**10 year rate**	**Projected rates***	**2005**	**2010**	**2015**	**2025**
Salmon, trout & other salmonids	-1.97%	0.63%	20-2%	350,019	700,038	770,042	868,222
Sea bass, bream & similar	3.47%	22.47%	10-0.5 %	124,046	186,069	279,104	314,689
Halibut, turbot, sole etc	9.57%	13.64%	20-5%	7,111	8,889	17,778	46,666
Cod, haddock, hake etc			1000-5%	69	3,519	91,494	471,106
Carp, tilapia, catfish	-1.08%	0.06%	30-2%	74,086	92,608	231,519	465,931
Eels, sturgeon, perch, zander etc.	-1.63%	2.29%	10-2.5%	21,858	24,590	36,885	82,992
Tuna	0.96%	2401.25%	75-2%	3,858	4,823	22,907	120,261
Mussels	-3.29%	0.27%	6- 0%	470,026	611,034	672,137	705,744
Oysters & scallops	-2.25%	-1.55%	2- -1%	132,210	125,600	138,159	151,975
Clams, cockles etc.	2.96%	0.14%	2-0%	76,996	84,696	84,696	84,696
New non-fish aquaculture sp.	-15.43%	-8.27%	500-5%	273	410	10,647	55,897
Aquatic plants	-19.70%	-9.91%	100-1%	45	68	405	2,126
Total			8.37%	1,260,597	1,842,341	2,443,747	3,370,306
EU Target			4%	1,665,600	1,998,720	2,398,464	3,453,788

* The 5-year growth rate is from 2000-2005 whilst the 10-year growth rate is 1995-2005. Future growth rates are projected in 5-year intervals with the highest and lowest rates used indicated in the table.

[Figure 65]: Scenario 2 aquaculture projections –based on output derived from EU target of 4% per annum growth to 2025

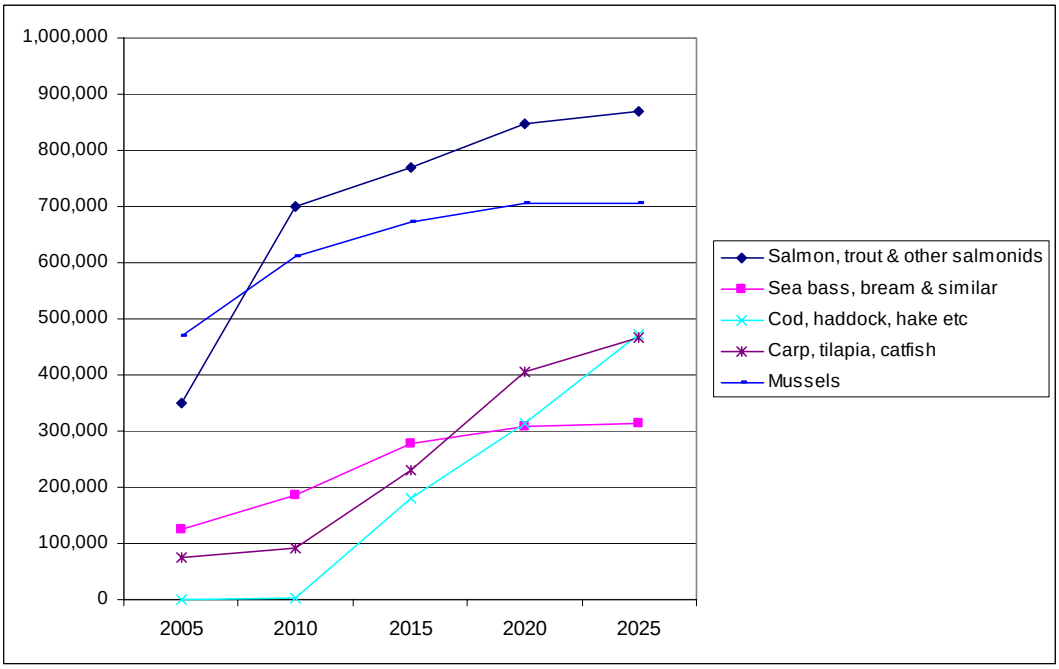


The growth rate of aquaculture between 2002 (publication of the EU aquaculture strategy) and 2005 has not met the 4% target, therefore future growth rates would need to be significantly higher now to meet the output targets predicted by a 4% growth rate commencing in 2000. The scenario assumes an overall growth rate of 8.37% between 2005 and 2025, with the highest growth rate (9.23%) between 2005 and 2010 to compensate for earlier lag. This could most likely be achieved through species and systems that are relatively well established, although some change with respect to market, policy or technology is likely be required as trigger. In many respects, salmon is best placed for rapid expansion. Further use of large cages in more offshore locations would be technically feasible and smolt production capacity could also be increased through further use of recirculated water systems. However, the annual growth rate would need to be increased from almost -2% over the 5 years 2000-2005, to 20% per annum up to 2010, effectively doubling production of salmonids from 350,000 tonnes to 700,000 tonnes. Since it is unlikely that the internal market for salmonids will double over that period without a significant fall in prices (or rapid rise in price of other fish species), much of the expansion in production would have to be export oriented (e.g. the Russian market has been strengthening recently). However, as most of the EU salmon industry is owned by Norwegian based companies with larger interests and lower costs in Norway and Chile, it seems unlikely that they would chose the EU as the production base for market expansion elsewhere unless there were significant incentives to do so.

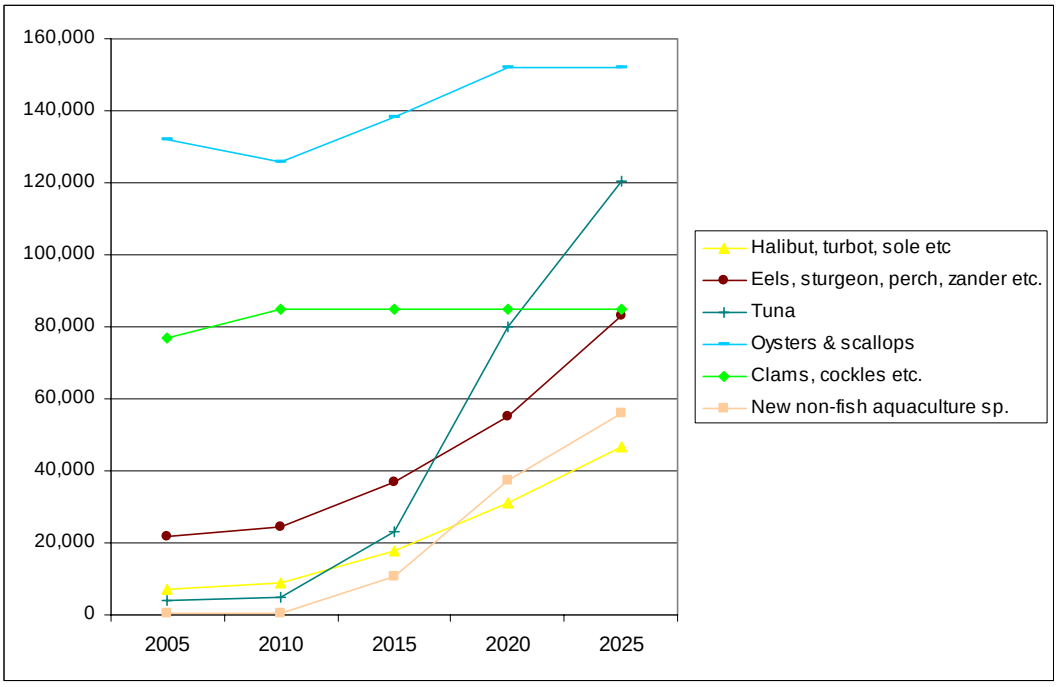
To achieve the target growth rate, the Mediterranean sea bream and sea bass industry would have to similarly expand. This would take production from a recorded 124,000 tonnes in 2005 to 186,000 tonnes in 2010. The major challenge here would be the development of Northern European markets through the provision of more added value products (most likely chilled MAP fillets based on a wider range of fish sizes), although declining capture fisheries supply might also drive market growth.

Early expansion of production should also be possible through shellfish aquaculture, most notably mussel farming, where technologies are developing for larger-scale culture in more exposed conditions. Potential expansion here is projected from 470,000 t in 2005 to 611,000 t in 2010, with the greatest expansion of sales most likely through prepared products of more consistent quality for home consumption.

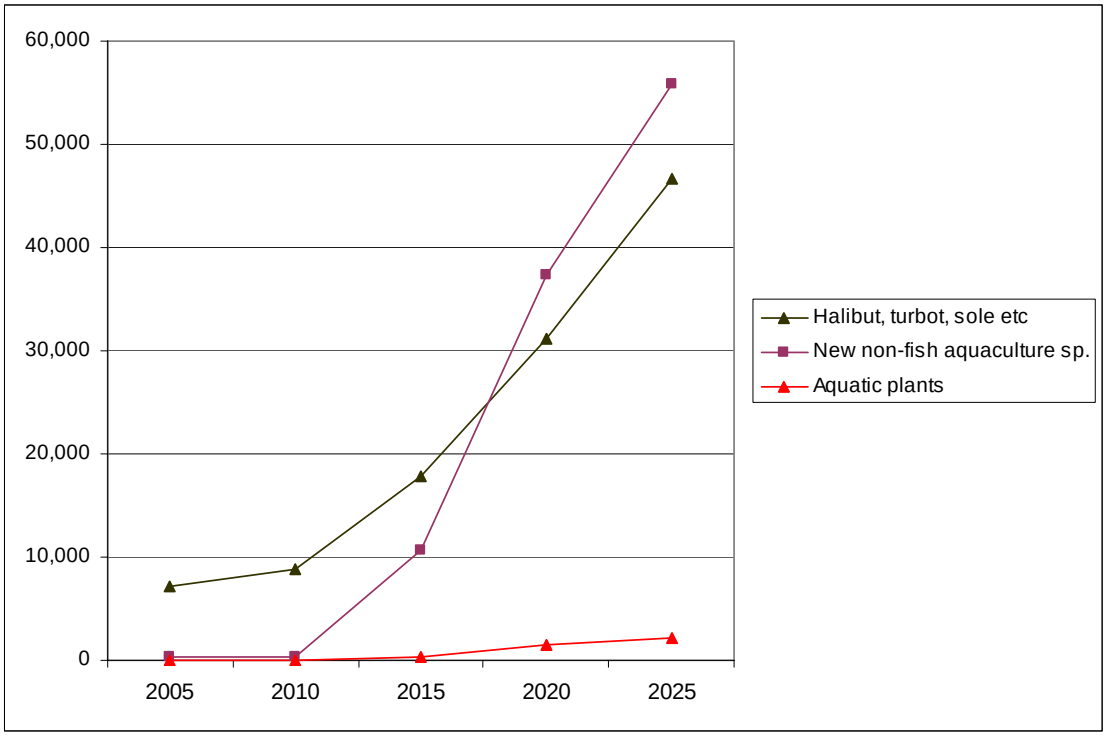
[Figure 66]: Scenario 2 – EU target production- Projections for highest volume aquaculture sub-sectors



[Figure 67]: Scenario 2 – EU target production - Projections for medium volume aquaculture sectors



[Figure 68]: Scenario 2 – EU target production – Projections for low volume aquaculture sub-sectors



For most other species groups, it is assumed that it will take longer to develop production capacity, and that growth rates will be highest between 2010 and 2015. This could be due to the need to develop hatchery systems (especially marine fin fish species), or through the time required for markets to respond substantially to projected falling capture fisheries supplies. It is also assumed that investment costs for recirculated aquaculture systems will fall in real terms between 2010 and 2020 as the market for system manufacturers expands and more efficient production methods can be introduced. Modest growth in aquatic plant and higher-value bivalves are projected as integrated multitrophic aquaculture systems are increasingly developed.

Some growth in the freshwater sector may be facilitated through increased linkages between conservation, recreation and fish production providing continued access to freshwaters for aquaculture. This could be supported by greater emphasis on local or regional food production or low environmental impact food production and eco-labelled and quality certification. Under the alternate scenario where a 4% target growth is achieved and maintained from 2005, output would reach 1.513 mt in 2010, 1.814 mt in 2015 and 2.614 mt by 2025. This 2025 figure is 77.5% of the output calculated under assumptions of an early "catch-up" high growth rate.

[6.3.3] Scenario 3: Aquaculture develops to fill the supply gap caused by declining capture fisheries

In this scenario it is assumed that aquaculture grows at a rate needed to make up the losses from a declining capture fisheries (at EU25). It is assumed that most of the growth in Europe is in the higher value species, with rising exports of these and increasing imports of lower value species.

[Table 19]: Scenario 3 - summary assumptions for aquaculture development (EU-25):

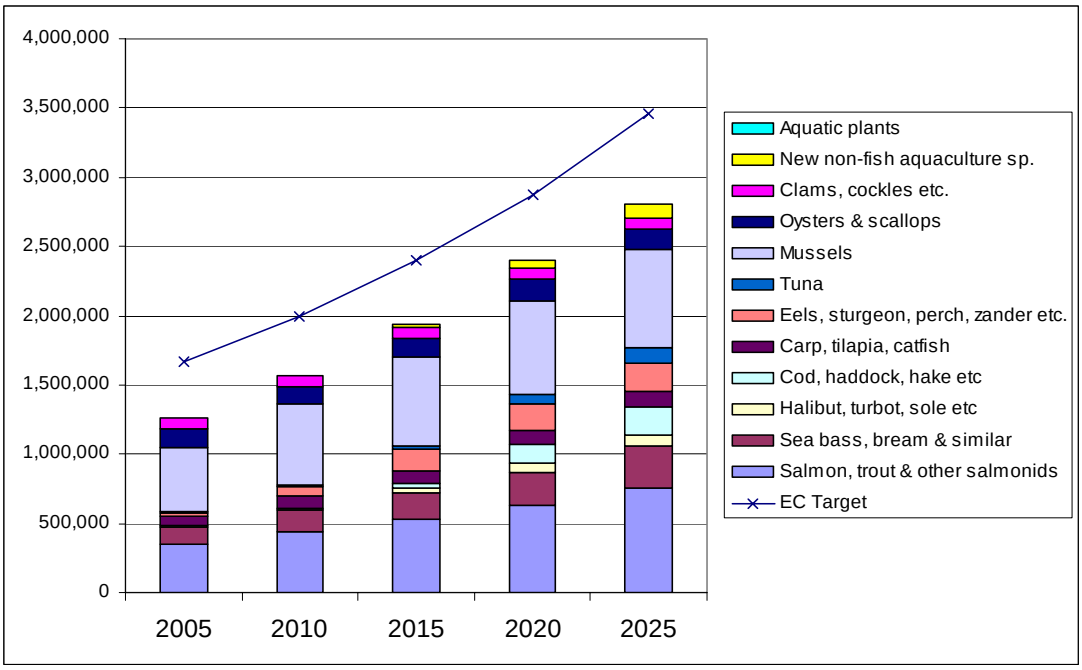
Salmon, trout & other salmonids	Increasing move offshore, triggered by continuing high demand. High growth rate as offshore aquaculture takes off, but levelling off as other species come online later and increase variety
Sea bass, bream & similar	Similarly stimulated to increasingly move offshore and expand, but not as dramatically as salmon – levelling off again as supply equilibrates
Halibut, turbot, sole etc	Reasonable growth driven by improving recycle systems etc.
Cod, haddock, hake etc	Assumes cod farming in particular takes off and probably utilises smaller salmon sites initially, but perhaps move offshore with salmon industry in due course
Carp, tilapia, catfish	Modest development of low-cost recirculated systems – mainly tilapia and perhaps catfish
Eels, sturgeon, perch, zander etc.	Assumes reasonable growth in these species to meet strengthening demand in East and Central Europe. All growth in recirculated aquaculture systems
Tuna	Assumes hatchery/nursery technology is developed in next 10 years and continued high market demand
Mussels	Assumes some further growth as greater industrialisation (and perhaps offshore production) is introduced
Oysters & scallops	Small modest growth perhaps as part of integrated projects
Clams, cockles etc.	Small modest growth perhaps as part of integrated projects
New non-fish aquaculture sp.	Small number of successful projects to help enhance diversity but not a major contributor to volume
Aquatic plants	Small increase associated with integrated projects

[Table 20]: Scenario 3 – EU-25 aquaculture production projections to 2025

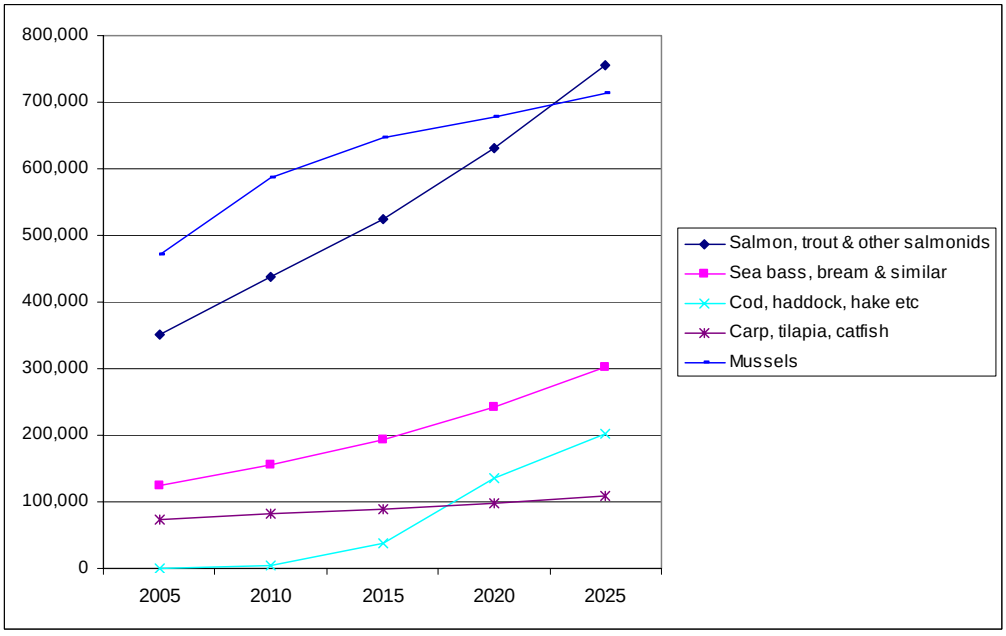
	Group growth rate			Production (tonnes)			
Group name	**5 year rate**	**10 year rate**	**Projected rates***	**2005**	**2010**	**2015**	**2025**
Salmon, trout & other salmonids	-1.97%	0.63%	20-0.5%	350,019	437,524	525,029	756,041
Sea bass, bream & similar	3.47%	22.47%	10-0.5%	124,046	155,058	193,822	302,847
Halibut, turbot, sole etc	9.57%	13.64%	20-5%	7,111	16,000	35,999	78,749
Cod, haddock, hake etc			1000-5%	69	3,519	38,709	203,222
Carp, tilapia, catfish	-1.08%	0.06%	30-2%	74,086	81,495	89,644	108,469
Eels, sturgeon, perch, zander etc.	-1.63%	2.29%	10-2.5%	21,858	76,503	153,006	210,383
Tuna	0.96%	2401.25%	75-2%	3,858	4,244	20,158	105,830
Mussels	-3.29%	0.27%	6- 0%	470,026	587,533	646,286	712,530
Oysters & scallops	-2.25%	-1.55%	2--1 %	132,210	125,600	138,159	151,975
Clams, cockles etc.	2.96%	0.14%	0-2%	76,996	76,996	76,996	76,996
New non-fish aquaculture sp.	-15.43%	-8.27%	500-5%	273	1,638	18,018	94,595
Aquatic plants	-19.70%	-9.91%	100-1%	45	68	405	2,126
Total			6.12%	1,260,597	1,566,175	1,936,231	2,803,763
EU Target			4%	1,665,600	1,998,720	2,398,464	3,453,788

* The 5-year growth rate is from 2000-2005 whilst the 10-year growth rate is 1995-2005. Future growth rates are projected in 5-year intervals with the highest and lowest rates used indicated in the table.

[Figure 69]: Scenario 3 – aquaculture fills fisheries gap - aquaculture development by species group (t)



[Figure 70]: Scenario 3 – aquaculture fills fisheries gap - aquaculture development of highest volume species (t)



[6.3.4] Scenario 4: Aquaculture expands to fill the supply gap between capture fisheries and static demand

In this scenario it is assumed that aquaculture grows at a rate needed to meet all of the gap between declining capture fisheries and static projected demand. It assumes that growth occurs in both low-value and higher value species, although the greatest volume growths are likely to be in lower-value species.

[Table 21]: Scenario 4 - Aquaculture grows to fill the static-demand supply gap - summary assumptions for aquaculture development:

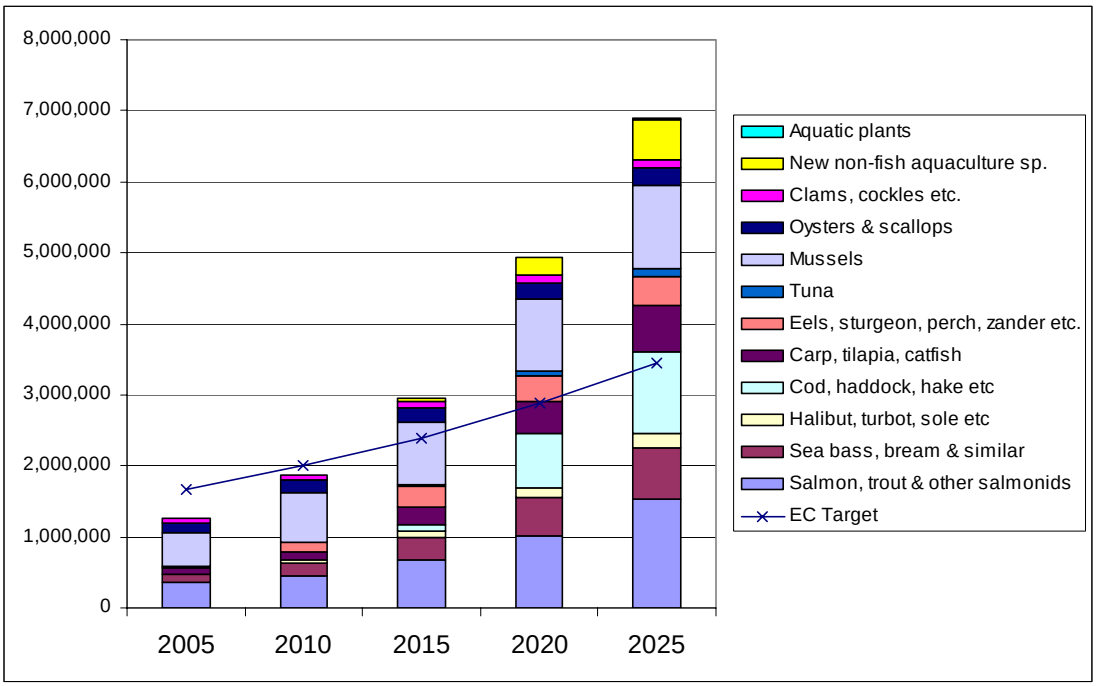
Salmon, trout & other salmonids	Increasing move offshore, triggered by continuing high demand. High growth rate as offshore aquaculture takes off, but levelling off as other species come online later and increase variety
Sea bass, bream & similar	Similarly stimulated to increasingly move offshore and expand, but not as dramatically as salmon – levelling off again as supply equilibrates
Halibut, turbot, sole etc	Reasonable growth driven by improving recycle systems etc.
Cod, haddock, hake etc	Assumes cod farming in particular takes off and probably utilises smaller salmon sites initially, but perhaps move offshore with salmon industry in due course
Carp, tilapia, catfish	Strong growth due to introduction of low-cost recirculated systems – mainly tilapia and perhaps catfish
Eels, sturgeon, perch, zander etc.	Assumes reasonable growth in these species to meet strengthening demand in East and Central Europe. All growth in recirculated aquaculture systems
Tuna	Assumes hatchery/nursery technology is developed in next 10 years and continued high market demand
Mussels	Assumes some further growth as greater industrialisation is introduced
Oysters & scallops	Small modest growth perhaps as part of integrated projects
Clams, cockles etc.	Small modest growth perhaps as part of integrated projects
New non-fish aquaculture sp.	Cephalopod farming is successfully commercialised within 5-10 years
Aquatic plants	Moderate increase associated with integrated projects

[Table 22]: Scenario 4 – Aquaculture grows to fill the static-demand supply gap - aquaculture production projections to 2025

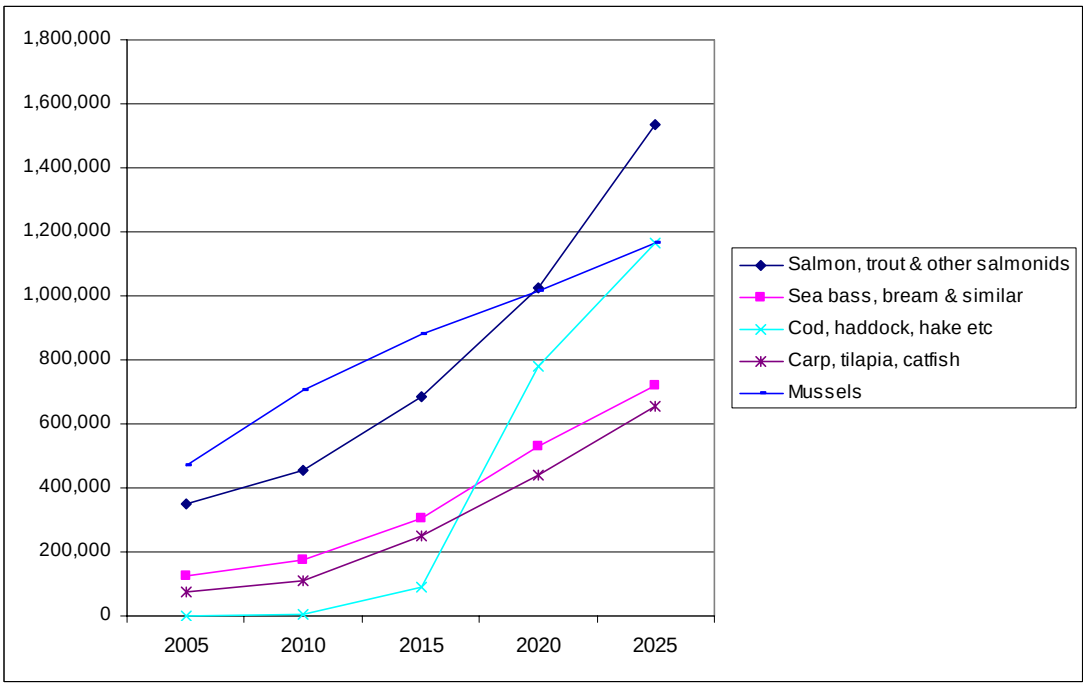
	Group growth rate			Production (tonnes)			
Group name	**5 year rate**	**10 year rate**	**Projected rates***	**2005**	**2010**	**2015**	**2025**
Salmon, trout & other salmonids	-1.97%	0.63%	10-2%	350,019	455,025	682,537	1,535,708
Sea bass, bream & similar	3.47%	22.47%	15-2 %	124,046	173,664	303,913	717,994
Halibut, turbot, sole etc	9.57%	13.64%	100-10%	7,111	42,666	85,332	191,997
Cod, haddock, hake etc			1000-2%	69	3,519	91,494	1,166,549
Carp, tilapia, catfish	-1.08%	0.06%	25-2%	74,086	111,129	250,040	656,356
Eels, sturgeon, perch, zander etc.	-1.63%	2.29%	100-2%	21,858	131,148	295,083	405,739
Tuna	0.96%	2401.25%	75-2%	3,858	4,244	20,158	105,830
Mussels	-3.29%	0.27%	10- 0%	470,026	705,039	881,299	1,165,518
Oysters & scallops	-2.25%	-1.55%	5 -0%	132,210	165,263	206,578	249,960
Clams, cockles etc.	2.96%	0.14%	2-0%	76,996	84,696	93,165	112,730
New non-fish aquaculture sp.	-15.43%	-8.27%	500-10%	273	1,638	42,588	574,938
Aquatic plants	-19.70%	-9.91%	100-10%	45	68	405	1,367
Total			22.31%	1,260,597	1.878.098	2.952.592	6.884.684
EU Target			4%	1,665,600	1,998,720	2,398,464	3,453,788

* The 5-year growth rate is from 2000-2005 whilst the 10-year growth rate is 1995-2005. Future growth rates are projected in 5-year intervals with the highest and lowest rates used indicated in the table.

[Figure 71]: Scenario 4 – Aquaculture grows to fill the static-demand supply gap - aquaculture production projections to 2025 (t)



[Figure 72]: Scenario 4 – Aquaculture grows to fill the static-demand supply gap - highest volume aquaculture products (t)



[6.4] Assumptions on regional development

The regional location of aquaculture is primarily determined by where the necessary natural resources exist (sufficient water of the correct temperature, sheltered coastal areas or land adjacent to rivers etc). A secondary consideration is costs, such that locations that are closer to market, or that have cheaper labour rates, are more likely to be utilised. For conventional (incremental) development, it is not anticipated that there will be any major changes in location.

Offshore aquaculture, if it develops as assumed in the above scenarios, will most likely start in countries that already have cage aquaculture industries but where inshore sites are most highly constrained. This includes Ireland, Spain, Italy and Malta, where farming in higher energy sites is already common. Subsequent development however could involve most countries with substantial coastlines.

The decoupling of recirculated aquaculture system from the environment creates opportunities for these systems to be located in areas not previously considered for aquaculture. If these develop for fish production as assumed in later scenarios, proximity, or accessibility, to market may be their key advantage. Locations close to major cities, or distribution hubs could be favoured, with peripheral regions at a competitive disadvantage.

[Table 23]: Regional considerations by species group

Salmon, trout & other salmonids	North Atlantic for salmon and most European countries for trout
Sea bass, bream & similar	Mediterranean coast
Halibut, turbot, sole etc	Halibut and turbot in Atlantic coasts, Sole and Turbot in Mediterranean
Cod, haddock, hake etc	North Atlantic countries, such as UK
Carp, tilapia, catfish	East and Central European countries with some development of recirculated systems in other countries
Eels, sturgeon, perch, zander etc.	East and Central European countries with some development of recirculated systems in other countries
Tuna	Mediterranean basin countries
Mussels	Blue mussels in North Atlantic and North Sea countries and Mediterranean Mussels further south
Oysters & scallops	Atlantic and Mediterranean coasts
Clams, cockles etc.	Atlantic and Mediterranean coasts
New non-fish aquaculture sp.	Atlantic and Mediterranean coasts
Aquatic plants	Atlantic and Mediterranean coasts

The competitive landscape within the European Union is expected to change over time. Countries that have joined recently have a potential advantage in lower labour costs, which in some cases is taking both production and processing from higher cost countries (e.g. the trout industry and associated processing has increased in Poland whilst contracting in Germany and France). On the other hand, fish consumption in Central and Eastern European countries is

well below that of Western Europe, and is expected to increase with expanded market opportunities for all producers.

[6.5] Impact of defined scenarios

Sustainability is an increasingly important criteria for guiding policy, as well as an emerging driver for consumer food retailing. It is usually considered in relation to social, economic and environmental goals. Indicators are typically used to measure performance and these can be aggregated at a high level (i.e. to compare performance across different sectors) or at a low-level and highly specific to a particular activity.

[6.5.1] Economic and social impacts of farming

Financial turnover is used as the simplest indicator of economic sustainability, giving a direct measure of the scale of economic activity. Similarly, an estimate of the number of jobs (total employment) is used as an indicator of social sustainability. In order to provide a flexible approach to modelling, these indicators are linked directly to production tonnages. In the case of turnover, the link is price per unit (e.g. Euro/kg) based on approximate current farmgate prices for whole fish. This is clearly a crude indicator, as prices are not static, particularly when volumes change substantially within a relatively short period of time. However robust data on demand elasticity does not exist, particularly for longer-term projections where prices may also be affected by broader changes within the food market. Similarly, turnover will vary according to the stage within the value chain and the various activities undertaken thereto.

Labour requirements per tonne of production can be calculated from employment data for a particular industry divided by the production tonnage. The availability and quality of employment data varies considerably between industries and countries. In many cases, only total employment is recorded. We have therefore used this, both as the most widely available indicator, but also because it is a better indicator of social sustainability than full time equivalent (FTE) jobs, which is a better indicator of productivity. Trends such as industrialisation and consolidation tend to reduce the labour requirement per tonne of production, although there may be an increase in employment in downstream processing, as a greater proportion of the output is processed.

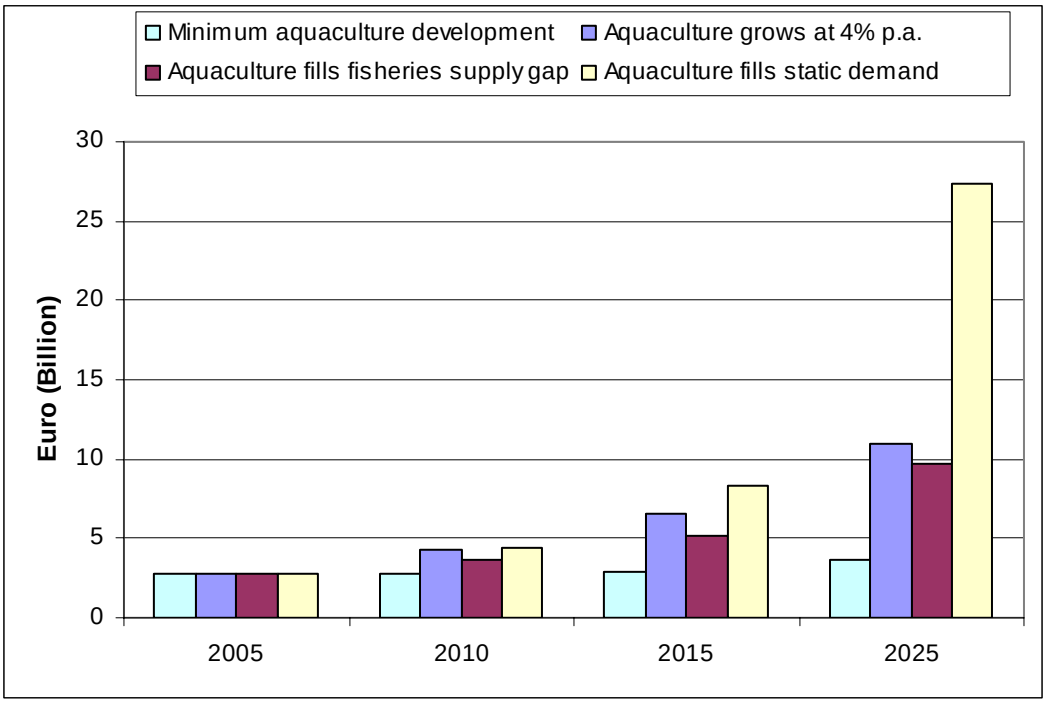
Due to the aggregation used in this analysis, some of the species groups combine several different types of production systems with different employment characteristics. For instance salmonids includes large companies with outputs up to 300 tonnes per person, down to small farms which produce less than 10 tonnes per person. Once again, there may be related employment in recreational fisheries, or small-scale processing. For the purposes of this indicative calculation, a mean figure is used for each group. Consideration should also be given to the quality of the jobs created within each sub-sector. and the impact that these may have in encouraging or retaining economic activity elsewhere within the region.

[Table 24]: Multipliers used for calculation of economic and social sustainability indicators

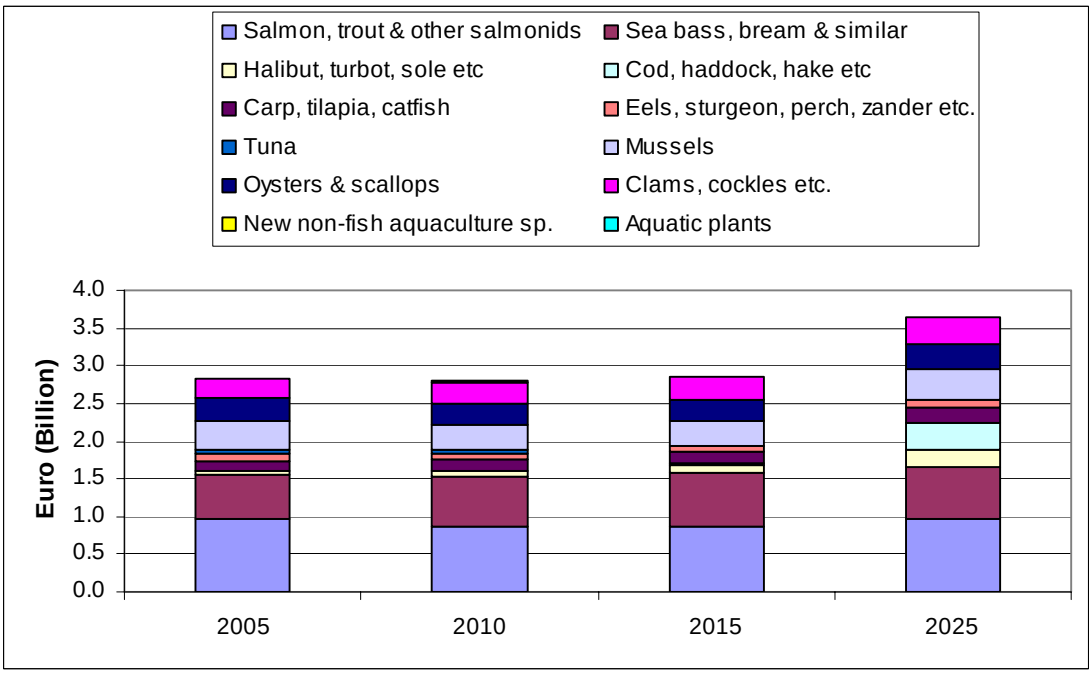
	Turnover **Euro/kg**	**Labour** **t/person**
Salmon, trout & other salmonids	2.78	89.5
Sea bass, bream & similar	4.65	20
Halibut, turbot, sole etc	6.26	40
Cod, haddock, hake etc	4.82	50
Carp, tilapia, catfish	1.92	12
Eels, sturgeon, perch, zander etc.	4.44	40
Tuna	11.94	120
Mussels	0.83	15
Oysters & scallops	2.29	11
Clams, cockles etc.	3.34	5
New non-fish aquaculture sp.	11.68	10
Aquatic plants	0.29	3

Source: Unit values calculated from FAO Fishstat data, 2007. Labour per tonne is Stirling Aquaculture Estimates using various literature sources for guidance

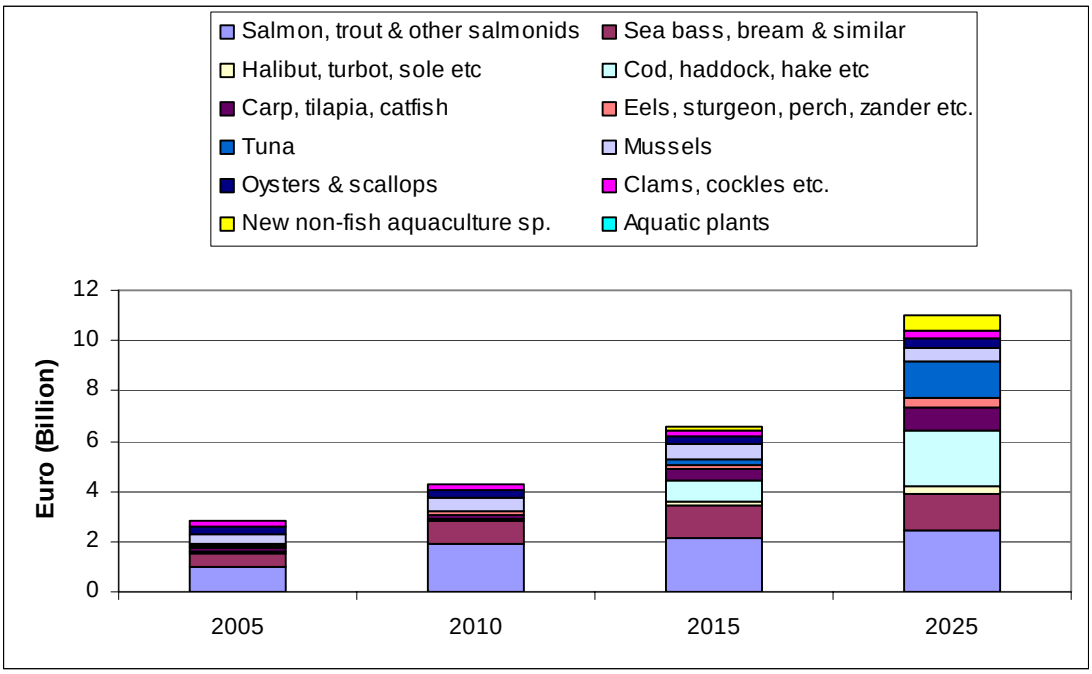
[Figure 73]: Comparative economic impact – EU-25 all scenarios



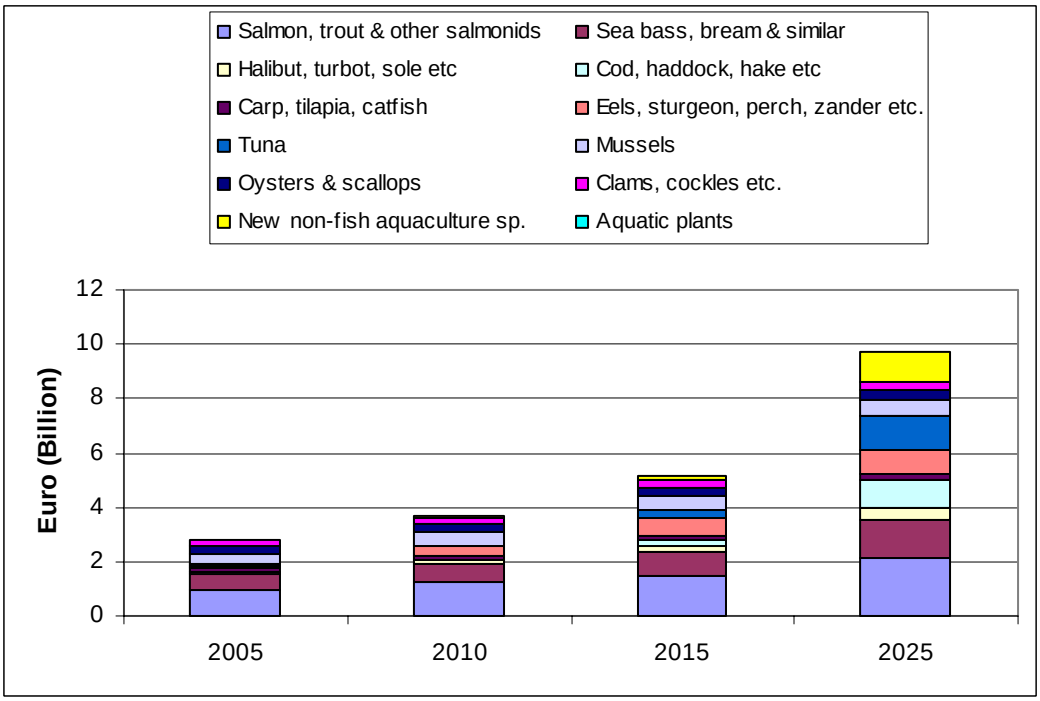
[Figure 74]: Scenario 1 - Baseline – Minimal aquaculture development - Projected value of aquaculture production



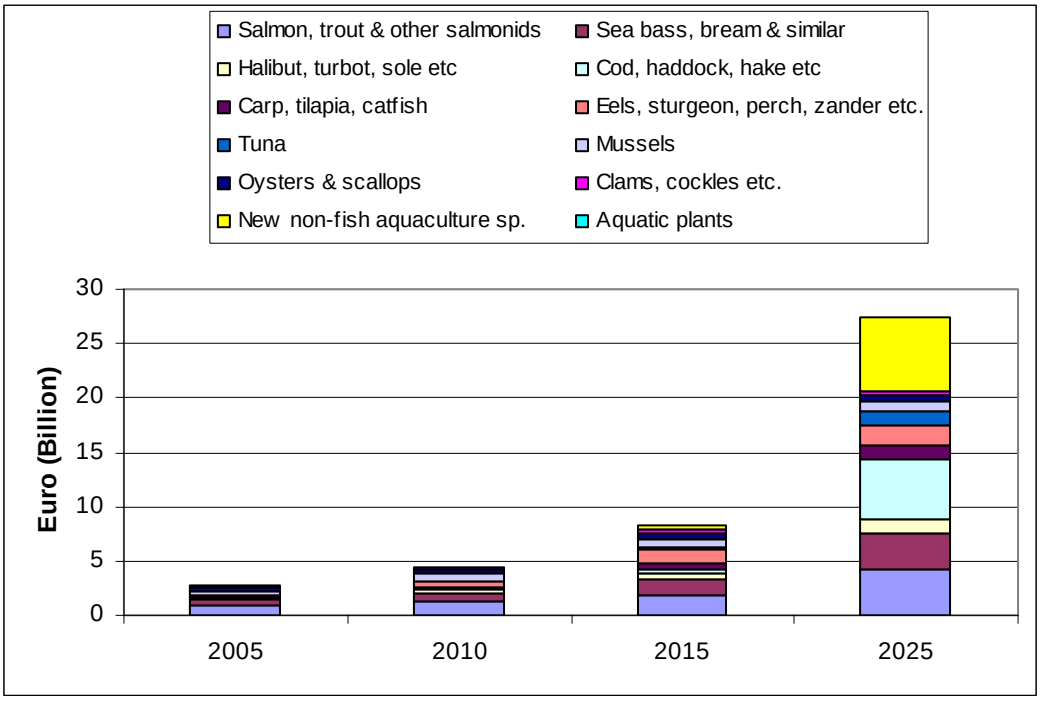
[Figure 75]: Scenario 2 - Projected value of aquaculture production to meet output derived from EU target of 4% per annum growth to 2025



[Figure 76]: Scenario 3: Aquaculture fills capture fisheries gap - Projected value of aquaculture production



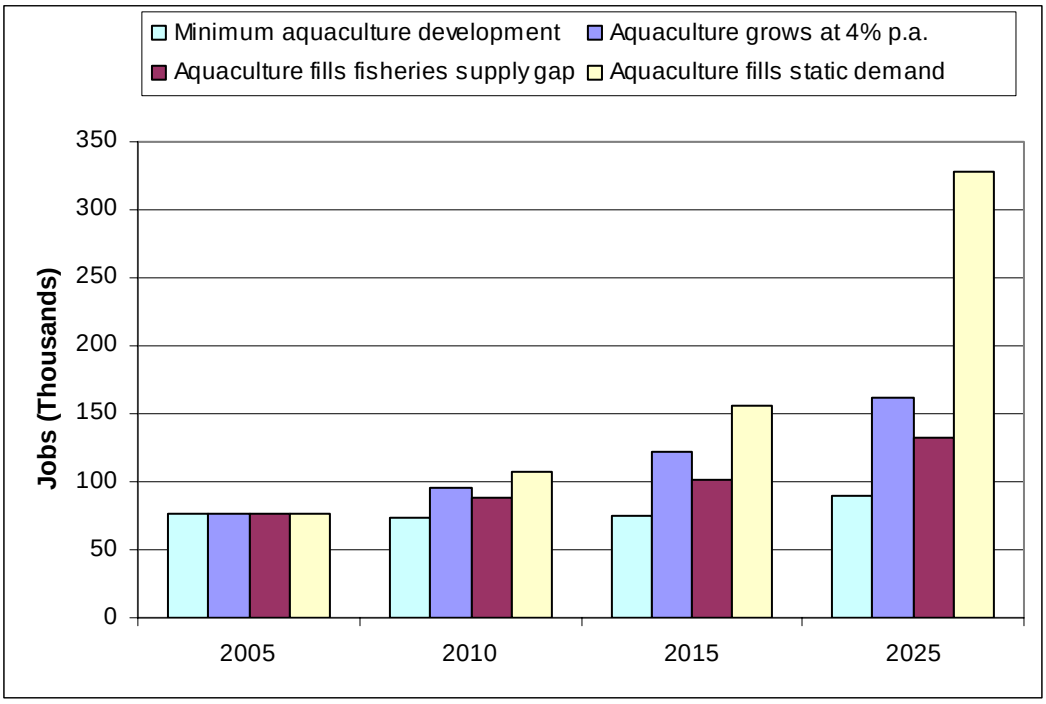
[Figure 77]: Scenario 4: Aquaculture fills static demand gap - Projected value of aquaculture production



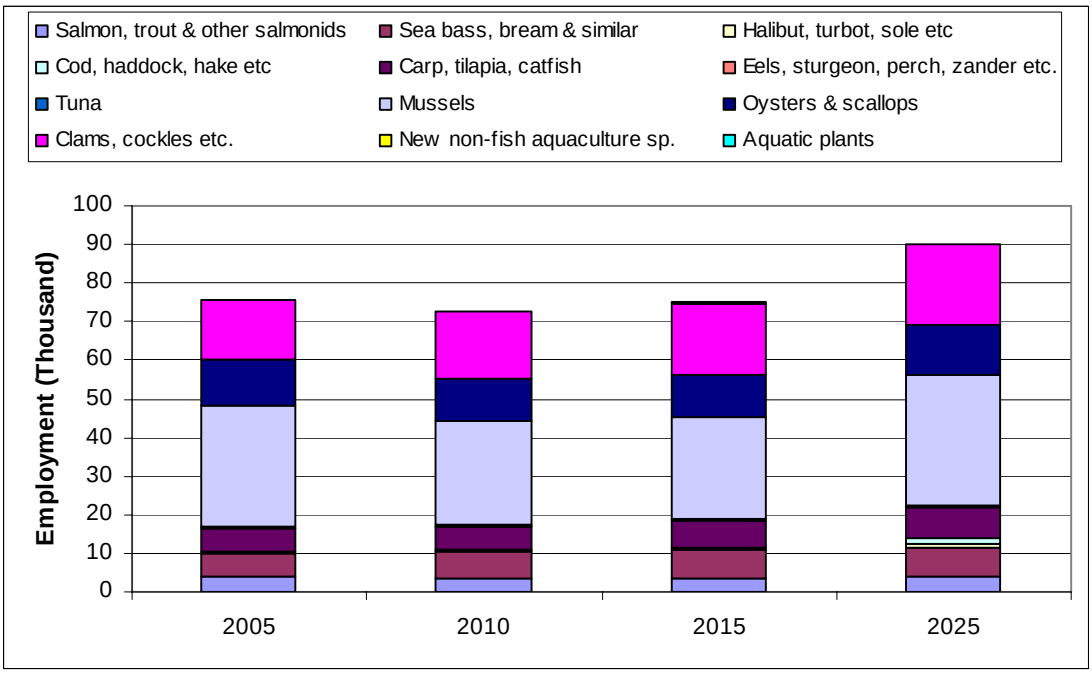
The baseline scenario sees the value of EU-25 aquaculture (at farm gate) rising relatively little, from €2.73b in 2005 to €3.43b in 2025, with both 2010 and 2015 slightly lower than the 2005 value. In the second scenario (EU target growth) farm gate value rises from 2.73b in 2005 to €4.1b in 2010, €5.89b in 2015 and to €9.17b in 2025.

The other scenarios fall either side of the EU target projections. The highest scenario reaches €21b by 2025. These totals are influenced by the ratio of aquaculture products. The greater value in 2005 is contributed by salmon and sea bass/sea bream, whilst the greater volume is in mussels. The baseline projections indicate the average value of aquaculture produce in 2005 was €2.16/kg, rising to a projected €2.32/kg in 2025. If growth in fish production were dominated with higher value fish, then the average value would rise to around €3.06/kg in 2025, which would increase total value to €4.54b (baseline scenario), an increase of 24.5%. Conversely if the growth in lower value species is stronger at the expense of higher value species and average price remained at €2.16/kg, the total value in 2025 (baseline scenario) would be €3.2b, a 7.15% difference. Variations in species mix will therefore change the value of the aquaculture sector by perhaps up to ± 25%.

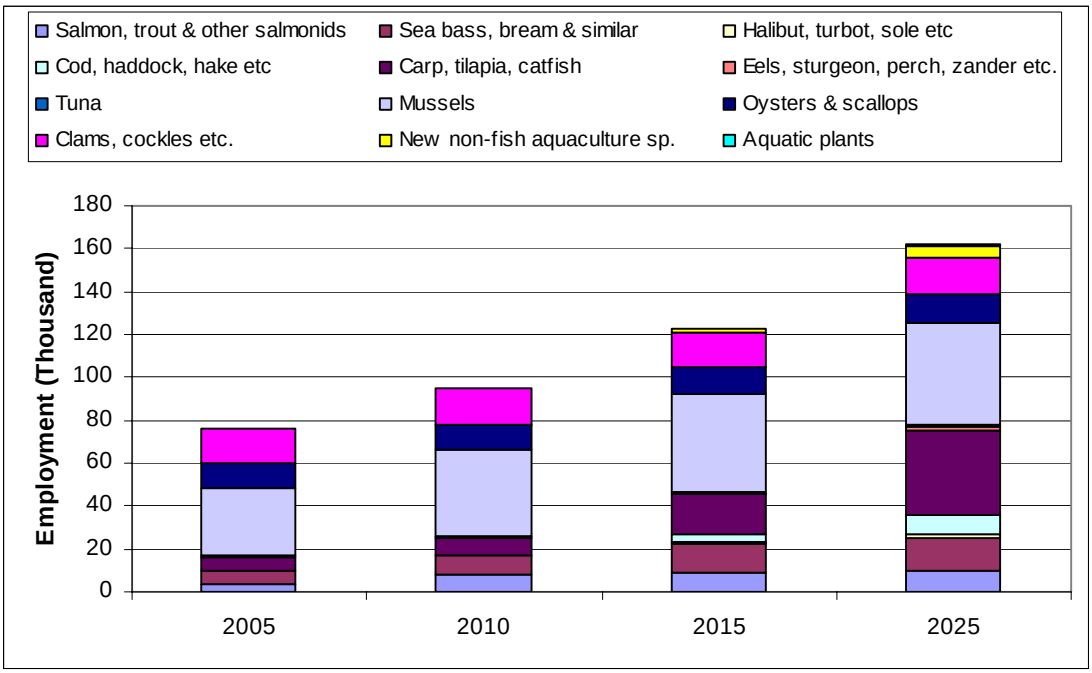
[Figure 78]: Comparative social impact – all scenarios



[Figure 79]: Baseline scenario – Estimated number of jobs with minimal aquaculture development



[Figure 80]: Scenario 2 – Estimated number of jobs if aquaculture expands to meet output derived from EU target of 4% per annum growth to 2025



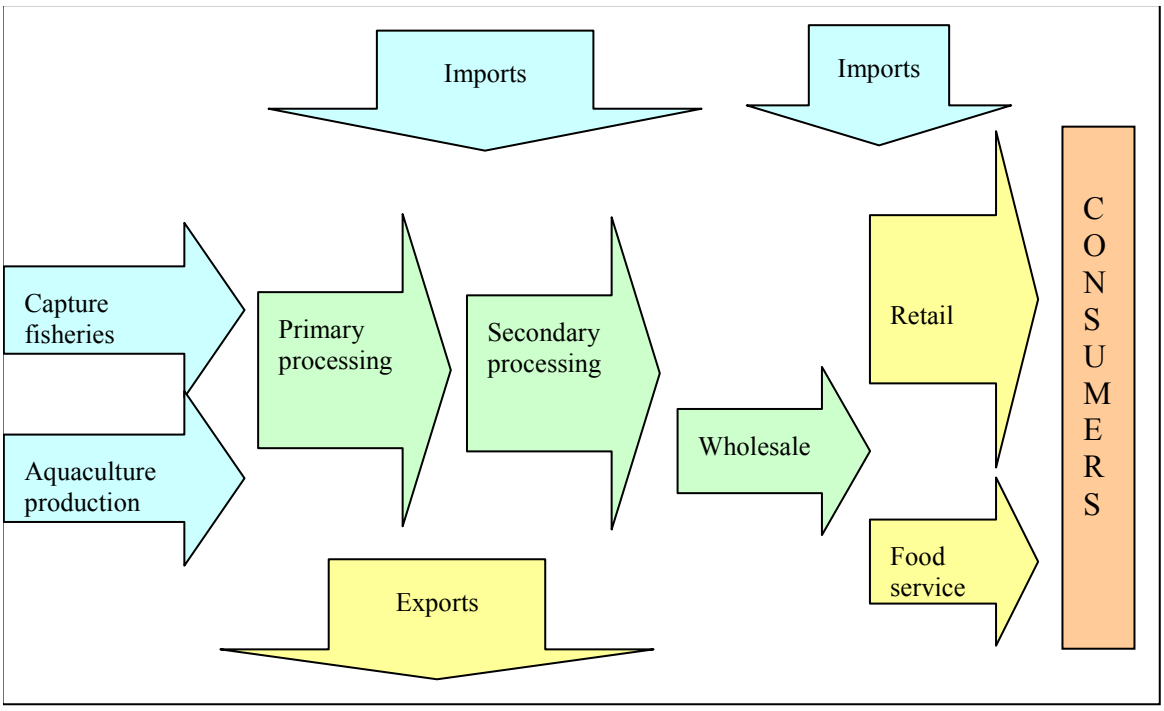
The baseline assumptions calculate the number of EU-25 aquaculture jobs in 2005 to be 75,840. This increases to 89,891 in 2025. The second scenario based on the target of 4% growth rate leads to 162,032 jobs by 2025, whereas the highest scenario leads to 327,831. As with value, the total number of jobs is affected by the mix of species and systems for any given volume. As can be seen from [Table 23], it would only take 5 tonnes of cockle or clam production to keep one person employed compared with up to 120 tonnes of tuna. It would therefore appear that a policy of promoting employment opportunities should encourage the development of less efficient and more labour-intensive aquaculture systems. However, these simple figures do not take into account the jobs generated upstream – in the manufacture and servicing of equipment for more capital intensive production systems, or the employment effects attributable to higher disposable incomes for staff of capital intensive farms (assuming they are paid more). Consideration should also be given to the quality of the jobs, and to wider social benefits e.g. to community health from improving availability of cheaper seafood. Nevertheless, whilst increased employment would appear to be best served by promoting a larger number of smaller enterprises that use more labour intensive production methods, this would not be an option in practice unless market protection measures were in place. European producers would be unable to compete with more efficient production systems elsewhere, making enterprises unsustainable.

The total number of jobs in the aquaculture production sector is therefore highly dependent on the species and productivity of the systems employed. If all the fish production systems were to operate at the higher average of 120 tonnes per person, the number of jobs in 2025 for Scenario 2 would fall from 162,032 to around 113,000, a reduction of 30%

[6.5.2] Value chain effects

The analysis so far has concentrated on the value created by the farming activities. Processing, distribution, retail and food service can easily triple the value of the primary product with consequent benefits for the European economy. The value chain for individual products can be short and simple or long and complex, but in broad terms, it consists of materials inputs (capture, farming imports), transformational stages (processing, packaging and distribution) and final sales to consumers via shops (retail) or restaurants and catering (food service). The value of the EU seafood processing industry alone was estimated to be approximately Euro 15 billion by Glitnir (2007), with Spain as the leading producer. Exports from the EU are also considered as final sales for the purpose of this analysis as no additional value is generated within the EU [(Figure 81)].

[Figure 81]: Seafood value chain



The block arrows in the above diagram are shown unconnected as there are many routes that can be taken to connect the different elements within the system. Some fish farms for instance sell directly to the public (retail) from the pond-side, with no intermediate value addition. Other products will pass through the entire chain, which can also include exporting and then re-importing after overseas processing. Large multiple retailers normally bypass the wholesale stage and buy directly from secondary processors. Products may be exported after primary or secondary processing.

It is beyond the scope of this report to examine all the linkages and product flows in detail, not least because much of this detail is not readily available through official sources at apposite levels of disaggregation. We therefore concentrate on the key input and output values to determine total added value. For the purposes of scenario modelling, mean value addition factors are determined and then multiplied by production from the earlier models. The processing and marketing chain usually results in a reduction in total volume (by weight) of a

product (e.g. processing waste etc.). This is taken into account by using a single utilization factor for each product group and is essentially the difference between original live weight of the product, and the final weight sold or served to consumers or exported. . In practice there may be a number of variants on these crude indices for reasons such as the type of fillet cut from the same species. For example a block or butterfly whitefish fillet might yield around 35% whereas single fillets would generate around 50%. Other preparations will have their own peculiarities which can only be averaged in this exercise so that: Total market chain value is taken as:

(Retail vol. x avg. price) + (food service vol. x avg. price) + (export vol. x avg. price)

The contribution of the production sector is included in these figures. The value added to the raw product can therefore be calculated as total market chain value minus primary production value. The value of waste generated during processing is not included in the present models. The value added to imports is not included in this initial analysis, but is discussed later.

[Table 25]: Multipliers used for calculation of value addition

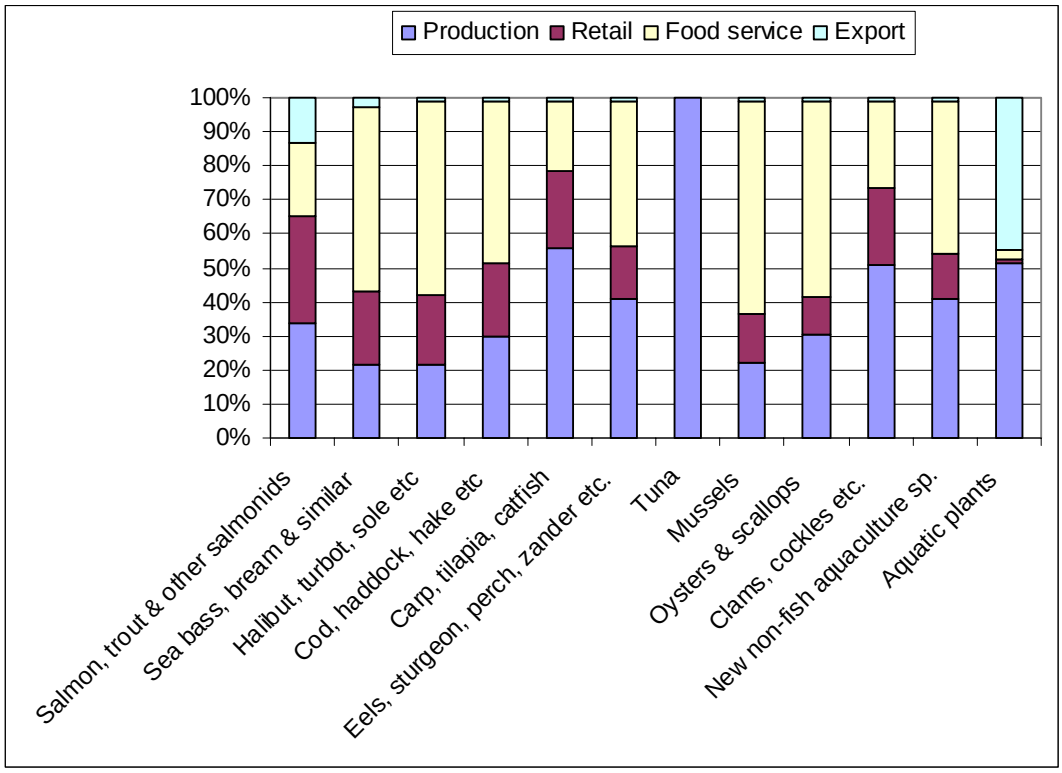
	Breakdown of route to market				**Value multiplier**		
	Utilized	EU Retail	EU Food service	Exported	Retail	Food service	Export
Salmon, trout & other salmonids	60%	55%	20%	25%	4.3	8	4
Sea bass, bream & similar	80%	40%	50%	10%	4	8	2
Halibut, turbot, sole etc	77%	40%	55%	5%	4	8	2
Cod, haddock, hake etc	44%	53%	38%	9%	4.4	13.6	1.6
Carp, tilapia, catfish	35%	65%	30%	5%	4	8	2
Eels, sturgeon, perch, zander etc.	40%	40%	55%	5%	4	8	2
Tuna	100%	0%	0%	100%	4	8	1
Mussels	70%	30%	65%	5%	4	8	2
Oysters & scallops	50%	30%	65%	5%	3.5	8.4	2.2
Clams, cockles etc.	40%	65%	30%	5%	3.5	8.4	2.2
New non-fish aquaculture sp.	40%	40%	55%	5%	3.5	8.4	2.2
Aquatic plants	20%	5%	5%	90%	5	10	10

Source: STAQ estimates based on Gudmundsson et al (2006),

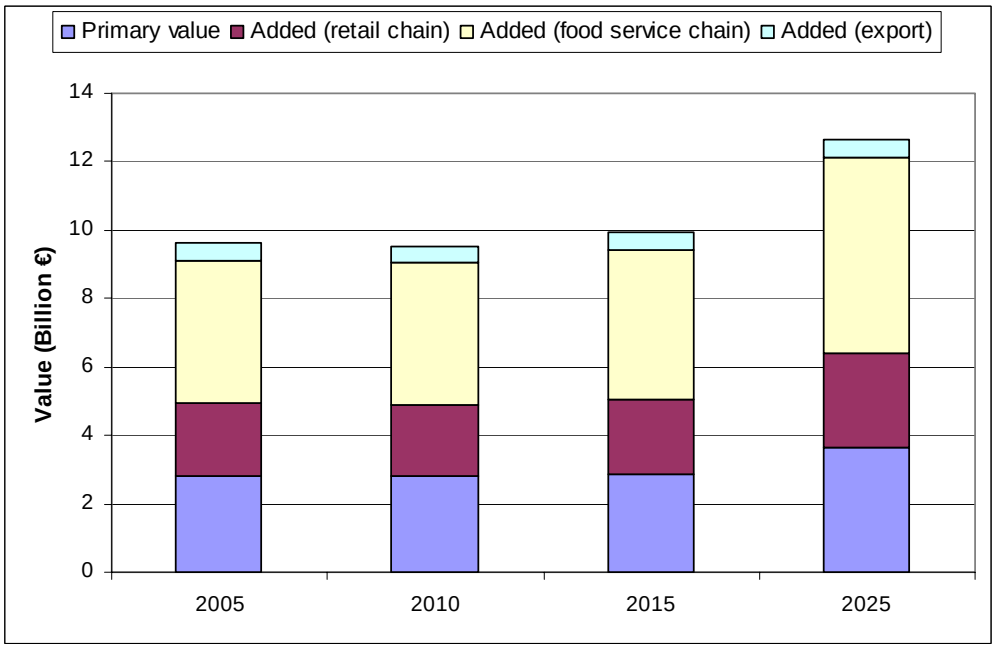
Based on the multipliers presented in [Table 25], it can be seen that the value chain varies significantly between species groups. This is illustrated graphically in [Figure 80] which illustrates those species that have a high proportion of sales through food service (e.g. sea bass, sea bream, halibut and sole etc.), have the highest proportion of value addition overall

The impact of considering the downstream value chain is to take the baseline scenario aquaculture production value for 2025 from €3.64 billion to €12.65 billion [(Figure 82)].

[Figure 82]: Contribution of production, retail, food service and export within different product groups – baseline scenario 2005

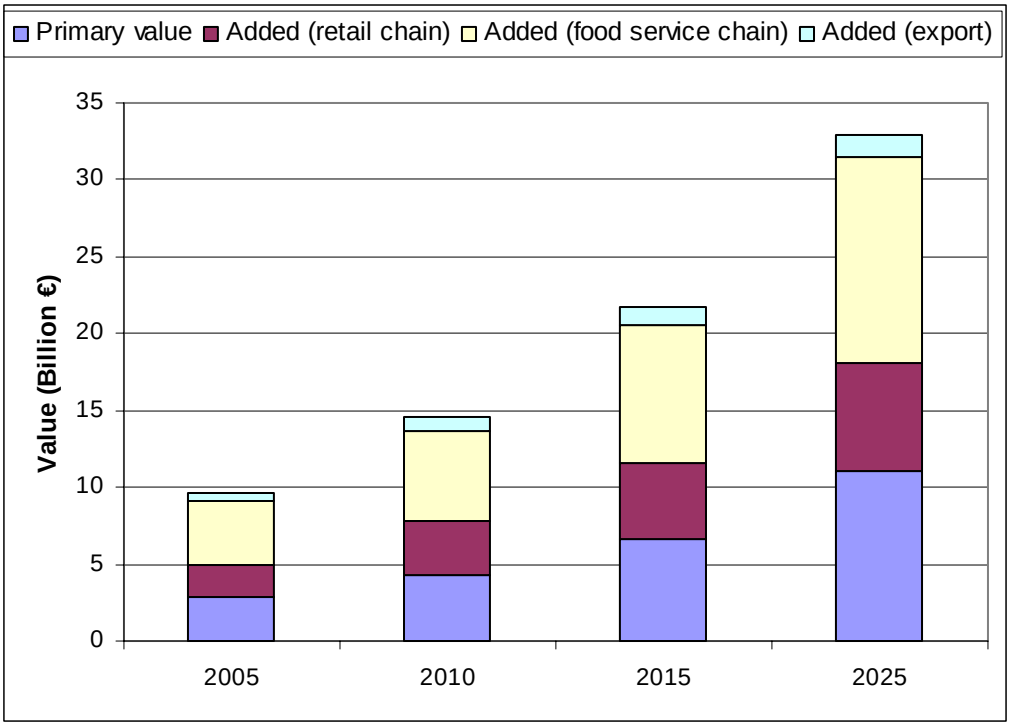


[Figure 83]: Total value addition – baseline scenario - minimal aquaculture development

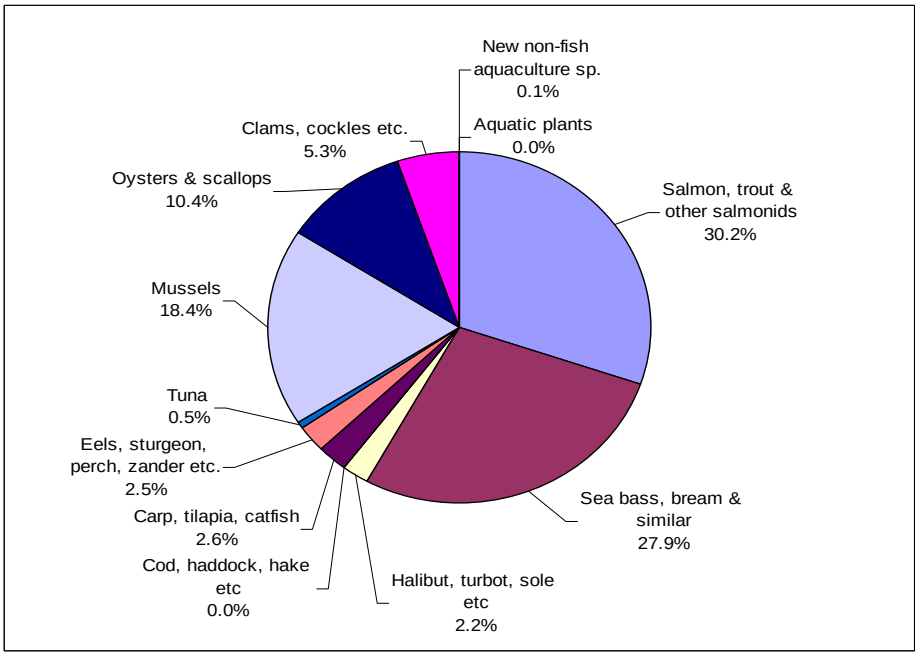


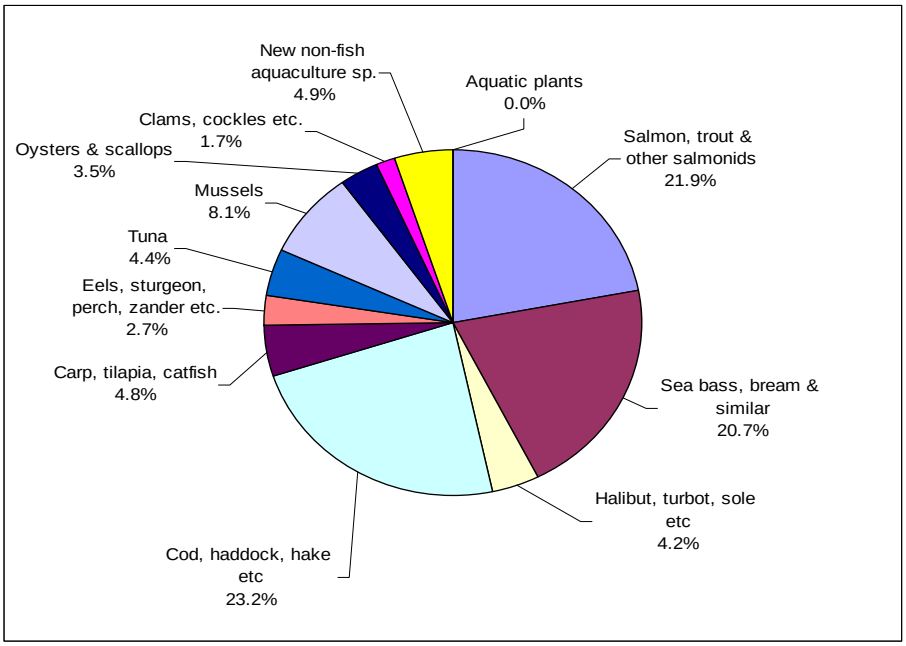
The second scenario (aquaculture increases to meet EU 4% per annum target), shows a similar pattern, with an additional €21.9 billion added to the projected €11.0 billion value at first sale [(Figure 84)].

[Figure 84]: Total value addition – Scenario 2 - Aquaculture expands to meet output derived from EU target of 4% per annum growth to 2025



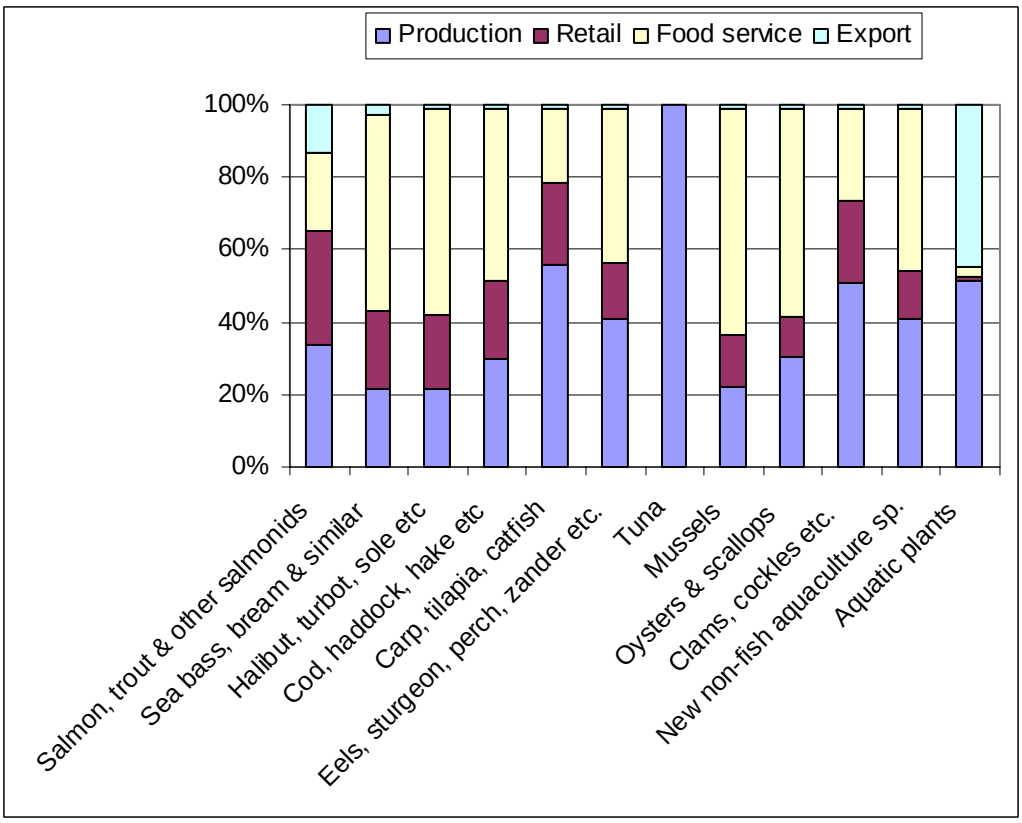
[Figure 85]: Change in value contribution – Scenario 2 - Aquaculture expands at EU target of 4% per annum, 2005 (top) and 2025 (below)





The overall contribution of different species groups and value segments for Scenario 2 in 2025 is shown in [Figure 86].

[Figure 86]: Value contribution by species group – Scenario 2 - Aquaculture expands to meet output derived from EU target of 4% per annum growth to 2025

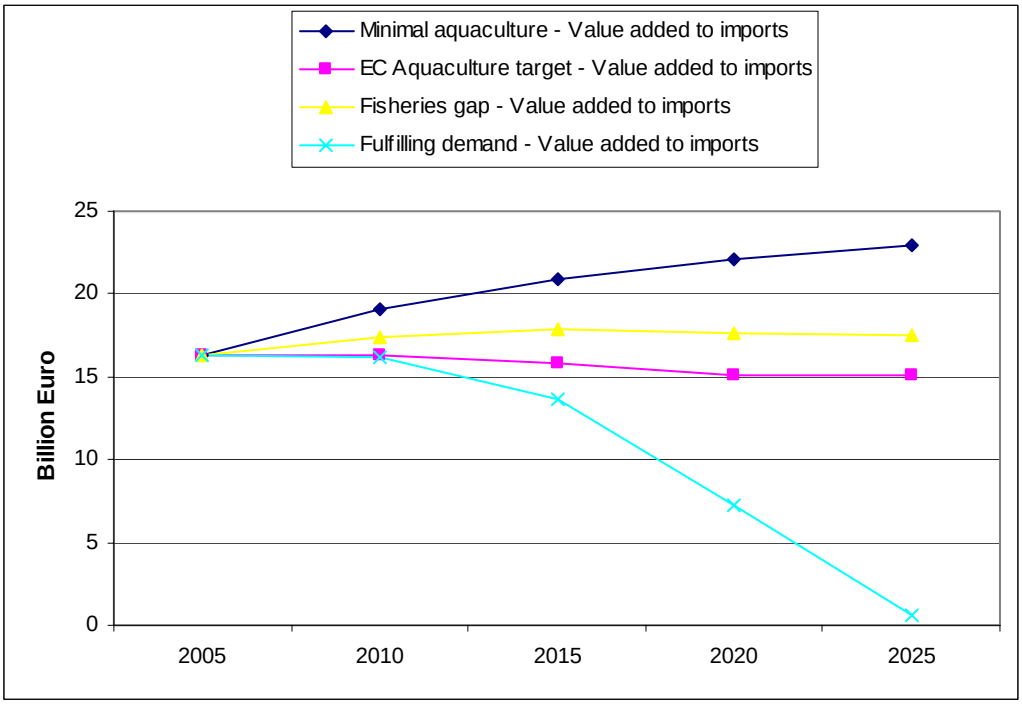


Most imported fish and seafood products have already undergone primary and often secondary processing. However, there may well be further processing and then distribution

through retail, food service and exports as for product produced in the EU. This added value is important, as it will often be greater than the cost of the primary imported material. Gudmundsson *et. al.* (2006), studying four different fisheries products and countries found between 54% and 75% of value addition to be in secondary processing, wholesale and retail. KPMG (2004) studied cod, haddock and nephrops, finding value additions in processing and distribution to be respectively, 69%, 75% and 74%. Removing the primary processing stage reduces these values slightly to 66%, 71% and 74% respectively. These figures compare to an overall average of 58.5% for value addition post first sale calculated for aquaculture products in our model. For the purpose of estimation therefore, [Figure 87] shows the additional value that might be generated from imported fish and seafood products under the 4 scenarios and assuming constant consumption, if the imported raw material constitutes on average, 40% of the final price. This reaches €23 billion by 2025 for the minimal aquaculture development scenario.

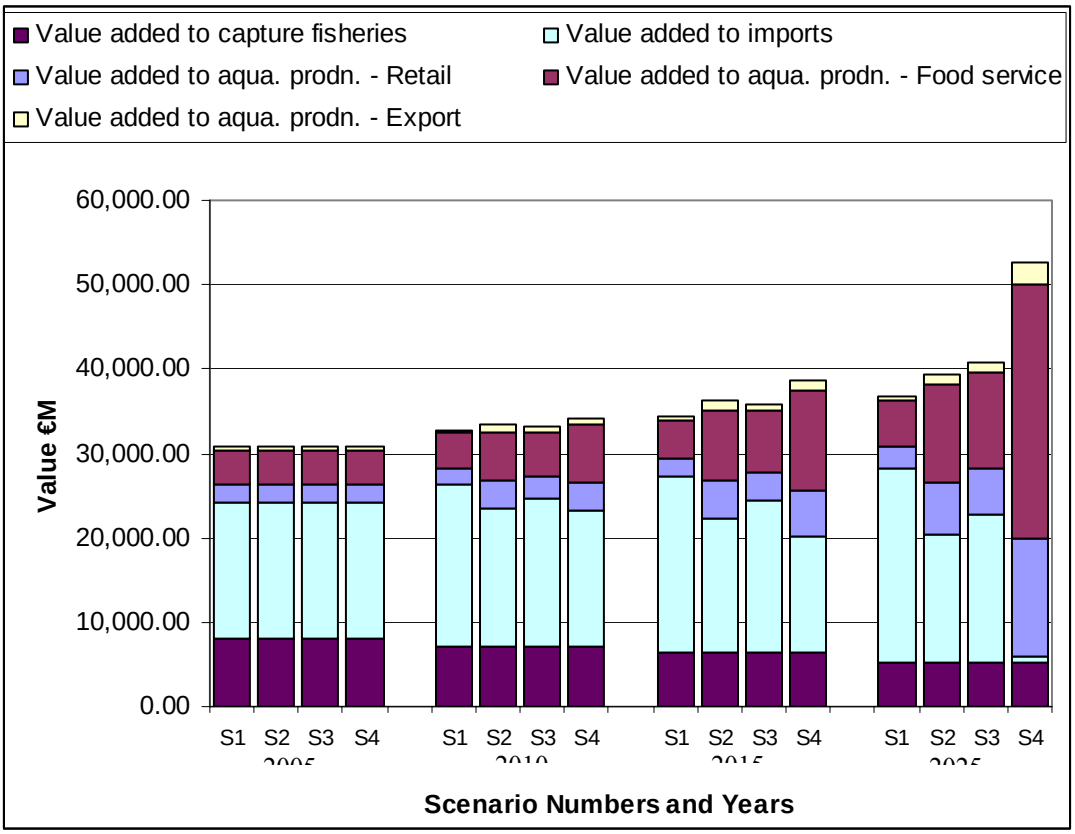
[Figure 88] shows the value addition of imports in relation to those contributed by capture fisheries and projected aquaculture production for each of the 4 scenarios to 2025. Overall value addition ranges from €30.9 billion (all scenarios, 2005) to €52.6 billion (scenario 4 in 2025). The contribution of EU aquaculture production to seafood value addition is around 20% in 2005, potentially rising to around 35% in 2025 if the EU growth objectives were met. The value addition of aquaculture products for export contributes less than 2% to total value addition in 2005, rising only slightly to a maximum of 4.8% by 2025 (highest production scenario).

[Figure 87]: Approximate value added to imported fish and seafood within the EU – all 4 scenarios using static consumption projections



Note: These projections assume an average value addition of 60% within the EU.

[Figure 88]: Approximate value added to all fish and seafood within the EU – all 4 scenarios using static consumption projections



Note: The estimated value addition to capture fisheries assumes an average post-harvest value of €2.48 and value addition of 70%. The average value addition to imports is assumed to be 60%, whilst value addition to aquaculture varies by product group as set out in [Table 25]

[6.5.3] Resource use impacts

A wider range of indicators have been developed to help inform assessments of environmental sustainability. These can be grouped into indicators of resource use and indicators of waste output impact (only the primary production phase is discussed here). On the input side, we examine land or water area utilised, water throughput, and industrial energy consumed. The area used is an indicator of the intensity of the farming operations. Extensive farming will require higher areas per tonne of output. Water throughput is more complex. Intensive farming operations, including cage farming but excluding recirculating systems, will have a high water throughput per tonne of production. The main significance is that the quality of the water will be changed during its passage through the aquaculture system, although in pond systems, there will also be significant water consumption (or more accurately loss) due to evaporation and soil permeability. Where the same species may be cultured in a variety of system types (e.g. carp), we have assumed that future growth in production will be through the identified emerging systems (particularly offshore cages and recirculated aquaculture systems). Industrial energy input (oil, gas, electricity) per tonne of production is calculated through reference to available data on industrial energy input per unit of protein energy output.

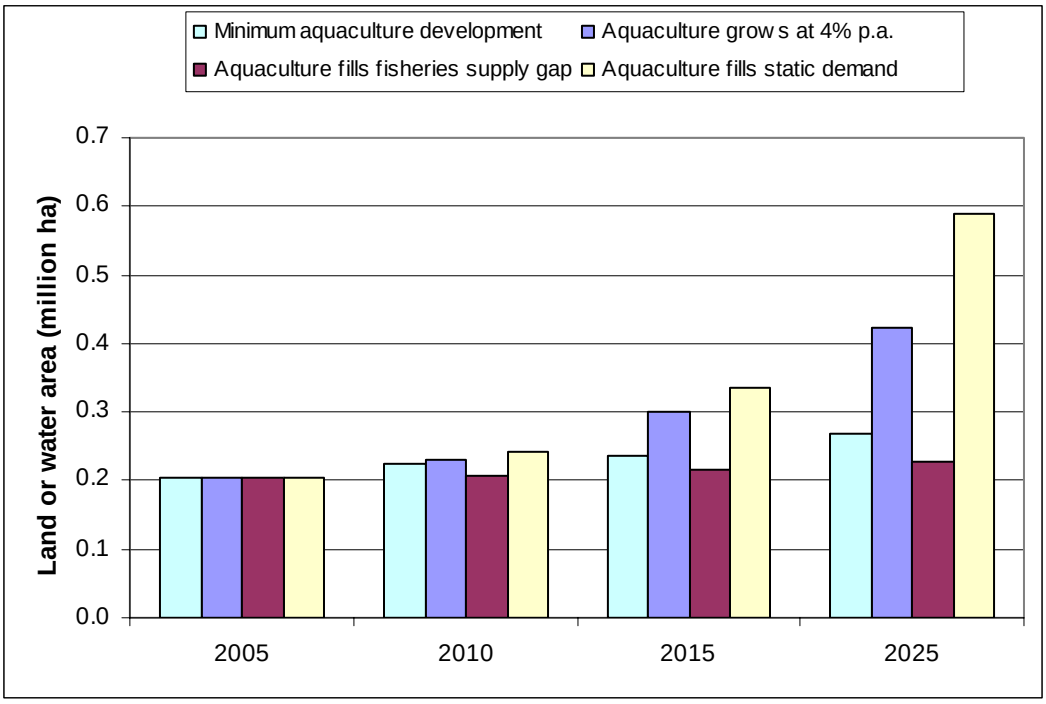
[Table 26]: Multipliers used for calculation of input environmental sustainability indicators

	Land or water t/ha	Water m^3/t	Industrial energy input to protein energy output (J/J)	Protein energy per tonne (J)
Salmon, trout & other salmonids	1,750	2,260,000	50	4,727,920
Sea bass, bream & similar	1,125	2,500,000	40	4,727,920
Halibut, turbot, sole etc	2,676	2,000,000	45	4,727,920
Cod, haddock, hake etc	1200	2,500,000	45	4,727,920
Carp, tilapia, catfish	2	5,000	30	4,727,920
Eels, sturgeon, perch, zander etc.	190	100	35	4,727,920
Tuna	300	3,000,000	50	4,727,920
Mussels	76	3,000,000	10	4,727,920
Oysters & scallops	25	2,000,000	5	4,727920
Clams, cockles etc.	0.5	2,000,000	5	4,727,920
New non-fish aquaculture sp.	150	200	20	4,727,920
Aquatic plants	1	2,000,000	1	3,545,940

Sources: Muir & Beveridge (1987), FAO Fish Stat, Phillips *et al* (1991), O'Hagan (1999), EIFAC (2000), FishStat (2000), Green & Eagle (2000).

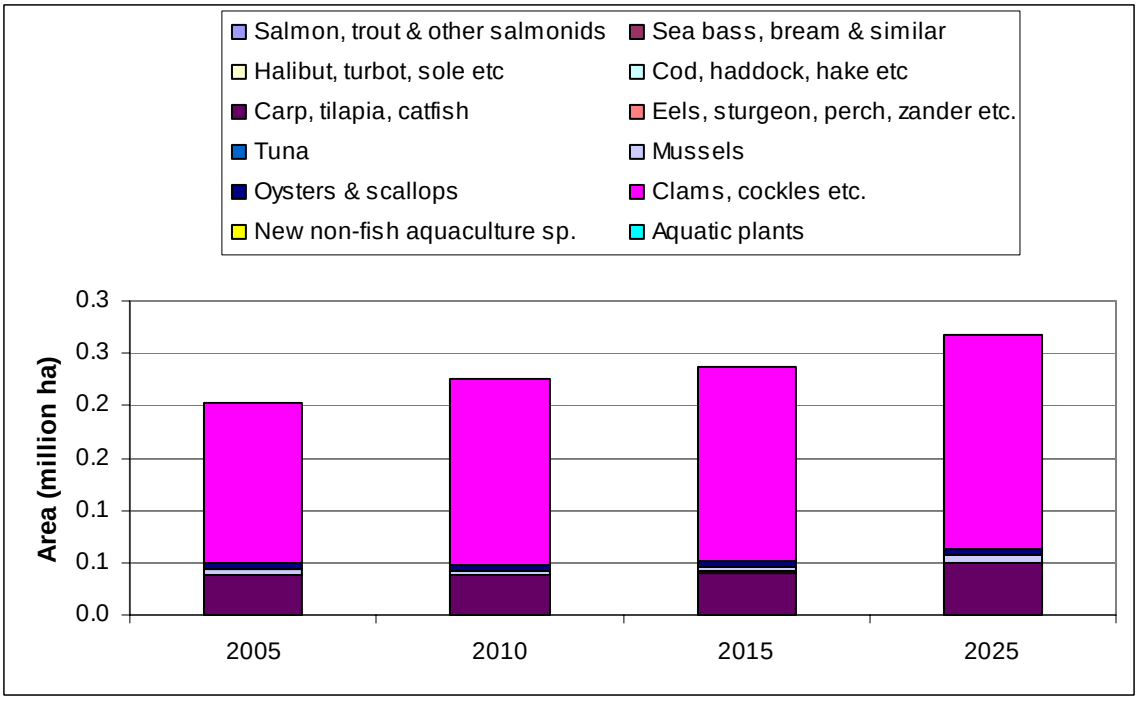
In terms of physical land or water area required for production, shellfish cultivation on beds or trays tends to be least efficient, and therefore dominates the space requirement calculations.

[Figure 89]: All scenarios – Land/water area requirements



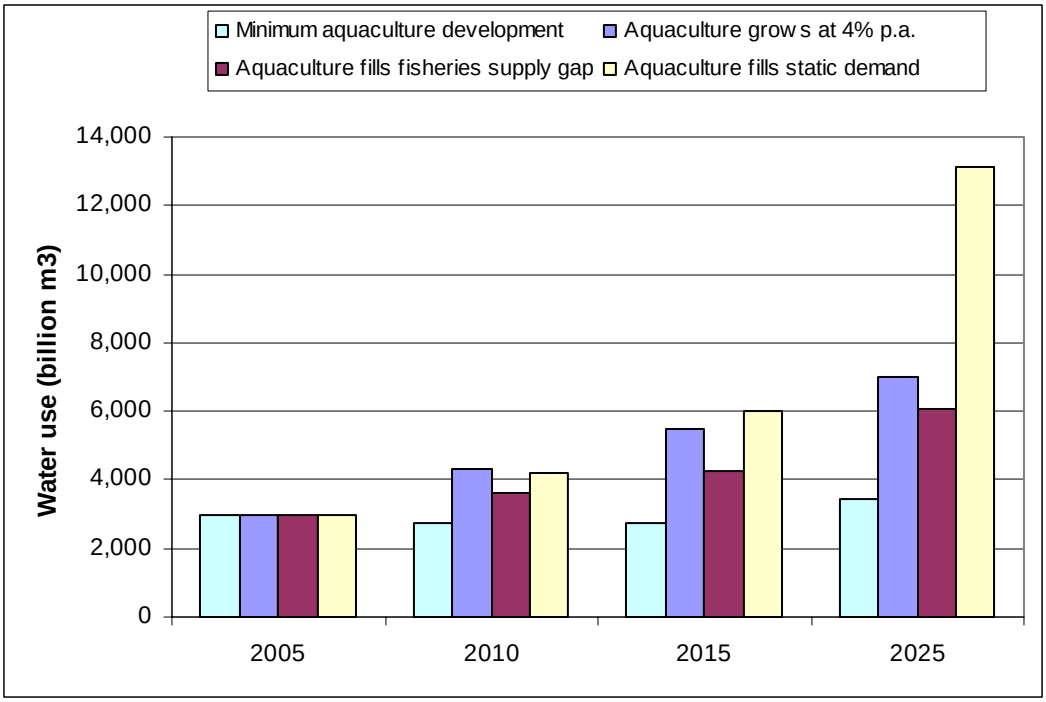
The water area required for marine salmonids, bass and bream in cages is as little as 310 ha, compared with an estimated 165,500 ha for shellfish cultivation. Land areas required for freshwater aquaculture are substantially more than is required for marine cages, but with lower production adds up to around 40,000 ha.

[Figure 90]: Baseline scenario – Land/water area requirements

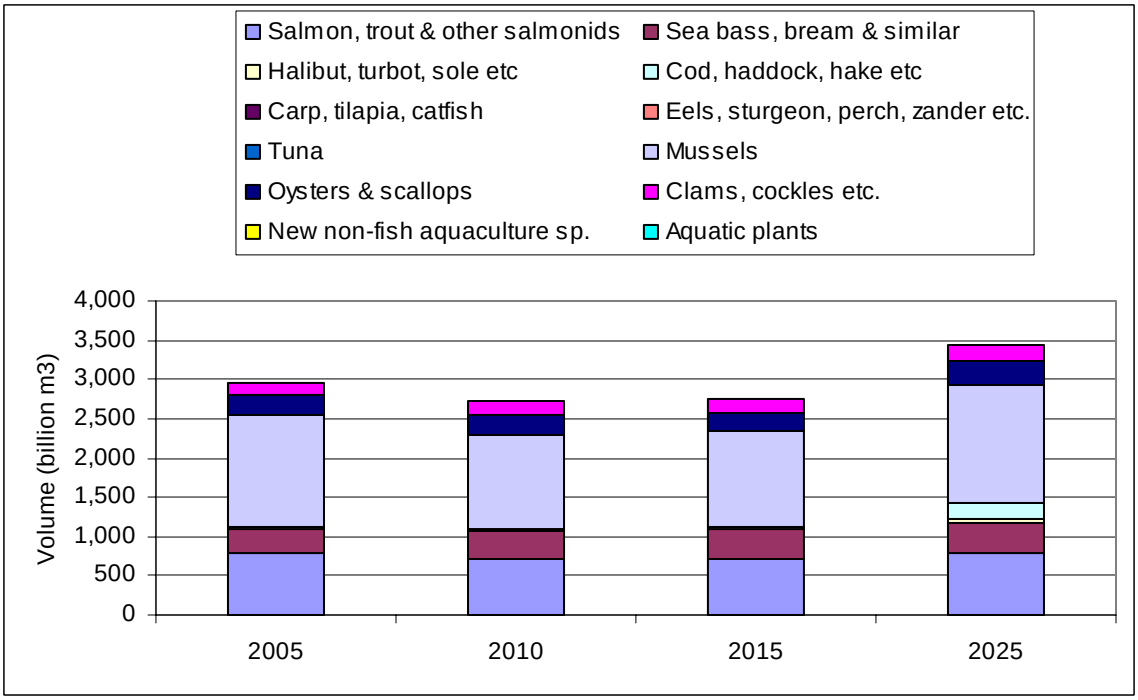


Mussels have the highest water requirement due to the extent to which they are cultured, and their need for constant water exchange. However, as this is provided naturally by currents in the sea, the water requirements of salmonid culture, especially in freshwater, may be considered more significant.

[Figure 91]: All scenarios – Water usage



[Figure 92]: Baseline scenario – Water usage

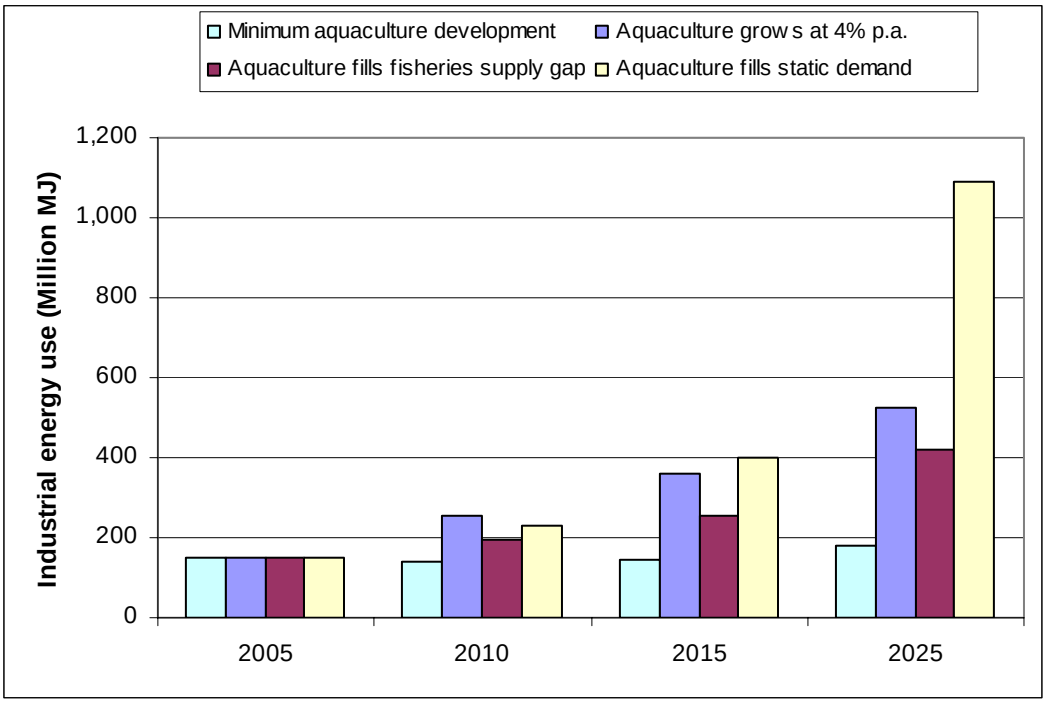


The expansion of aquaculture would most likely require increased use of coastal resources. Currently 8 t of fish from aquaculture are produced per km of coastline in the EFTA countries (which include Norway) (European Environment Agency, 2005a).

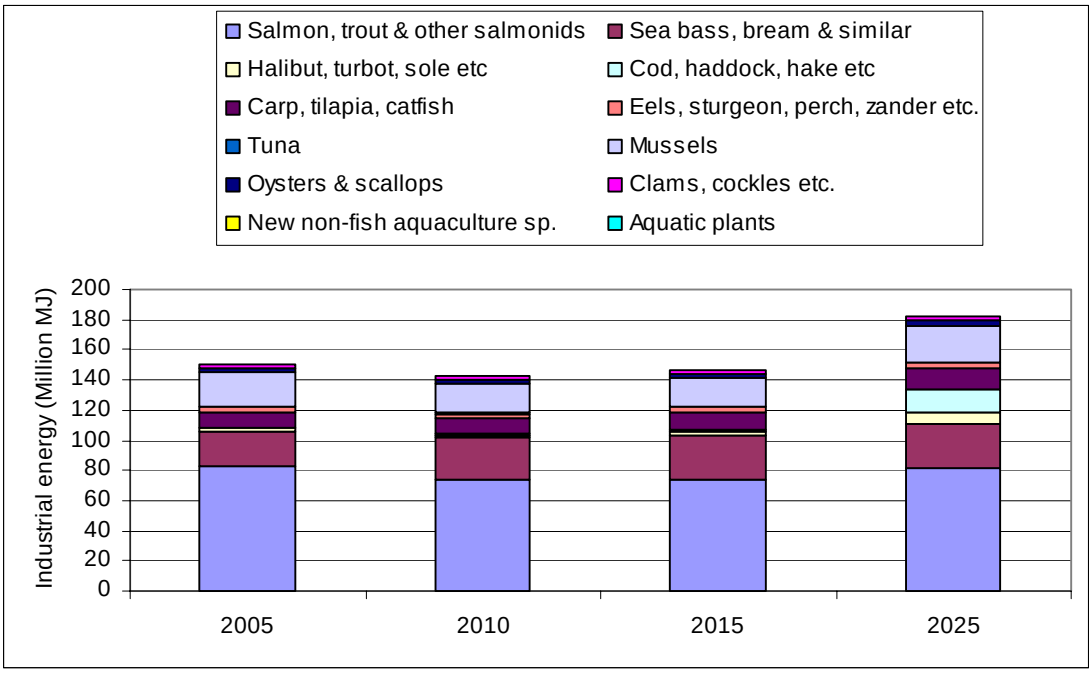
The use of recirculated aquaculture systems can substantially reduce the actual water requirements, but often at the cost of additional energy requirements. The greatest pressure for this is likely to be on intensive freshwater fish farms.

Much of the total use of energy in aquaculture is in the capture of industrial fish and the production of compounded fish diets. Downstream processing and distribution also add substantially but is not included herein. Otherwise, aquaculture systems vary considerably in their use of energy, even between units of broadly similar type due to efficiency factors and degree of mechanisation.

[Figure 93]: All scenarios – Industrial energy use



[Figure 94]: Baseline scenario – Industrial energy use



[6.5.4] Environmental pressures

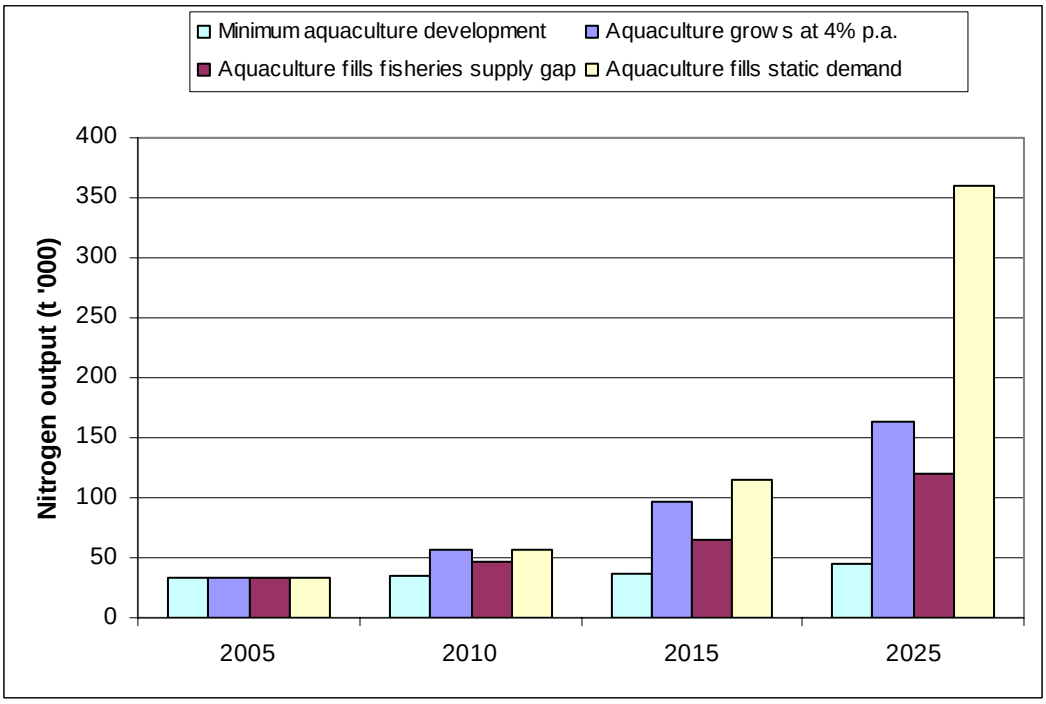
On the output side, the emissions considered are nitrogen, phosphorus, and organic carbon (excluding carbon dioxide from respiration or fuel combustion, or carbon monoxide from fuel etc). These were selected as being the most relevant in a broad scale and most amenable to this analysis, although other environmental issues related to aquaculture exist. These elements are released in both solid and dissolved compounds with the prime concern being those that are discharged directly to the aquatic environment. For fish and crustaceans, these figures will be influenced by a range of factors, including nutritional content of the diet, digestibility and efficiency of feeding systems, and any waste removal mechanisms that are in place before discharge to the environment. For shellfish it is assumed these will be net consumers of nitrogen and phosphorus, but will have a net carbon output due to the discharge of pseudofaeces. Aquatic plants, once harvested, remove nitrogen and phosphorus, but also organic carbon, albeit sourced from the fixation of carbon dioxide. The figures used in the model are shown below. Values presented in the literature can vary widely even for similar species/system combinations. For fish, the output will be dependent on feed conversion ratios achieved, the composition of the diets, and any treatment processes conducted within the system.

[Table 27]: Multipliers used for calculation of output environmental sustainability indicators

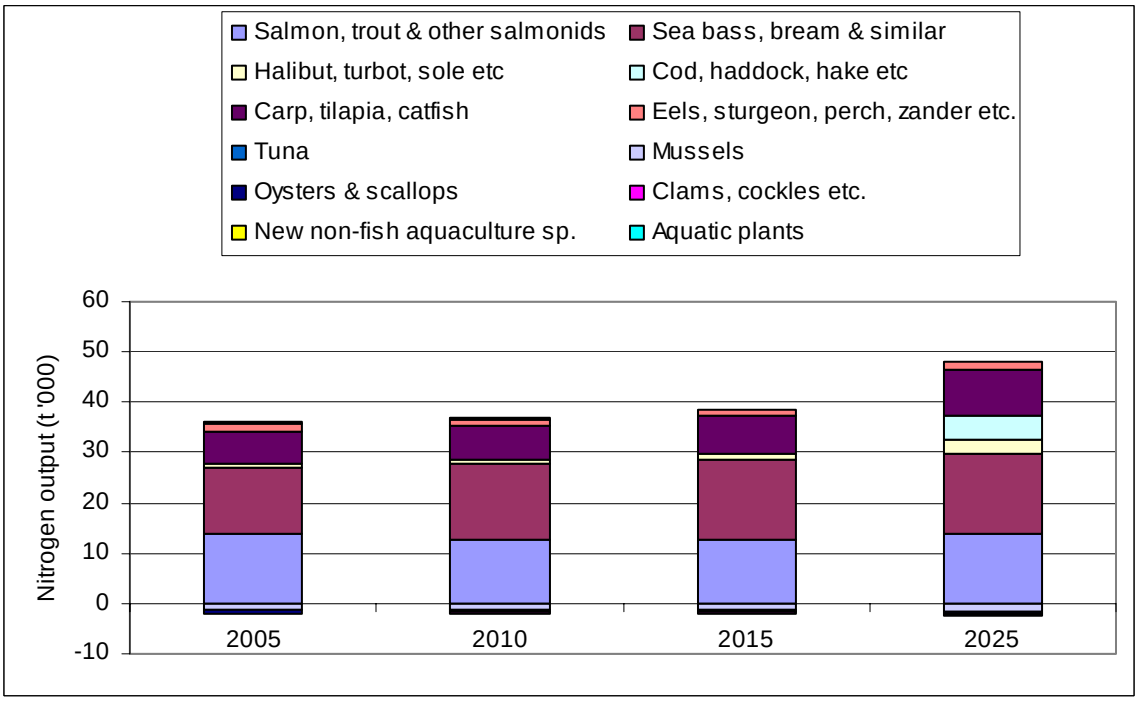
	Nitrogen output kg/t	Phosphorus output kg/t	Carbon output kg/t
Salmon, trout & other salmonids	40	6.7	200
Sea bass, bream & similar	105.4	13	170
Halibut, turbot, sole etc	75	55	200
Cod, haddock, hake etc	67	15.6	200
Carp, tilapia, catfish	90	13	200
Eels, sturgeon, perch, zander etc.	67	15.6	200
Tuna	101	32	200
Mussels	-3	-1	100
Oysters & scallops	-3.33	-1	100
Clams, cockles etc.	-3	-1	100
New non-fish aquaculture sp.	67	15.6	200
Aquatic plants	-47	-6.67	-300

Note – No adjustment is made for recirculated systems as most of these still produce discharges, although they may not be discharged immediately back into the environment. Sources: Musango et. al. (2007), Papatryphon et. al. (2004), Aubin et. al. 2006. Aquatic Sciences Inc (1999), Johnsen et. al. (1993), Alvarado (1997), Islam (2005), Davies & Slaski (2003), Bergheim & Brinker (2003), Wu (1995), Siddiqui & Al-Harbi (1999) and Stirling Aquaculture estimates.

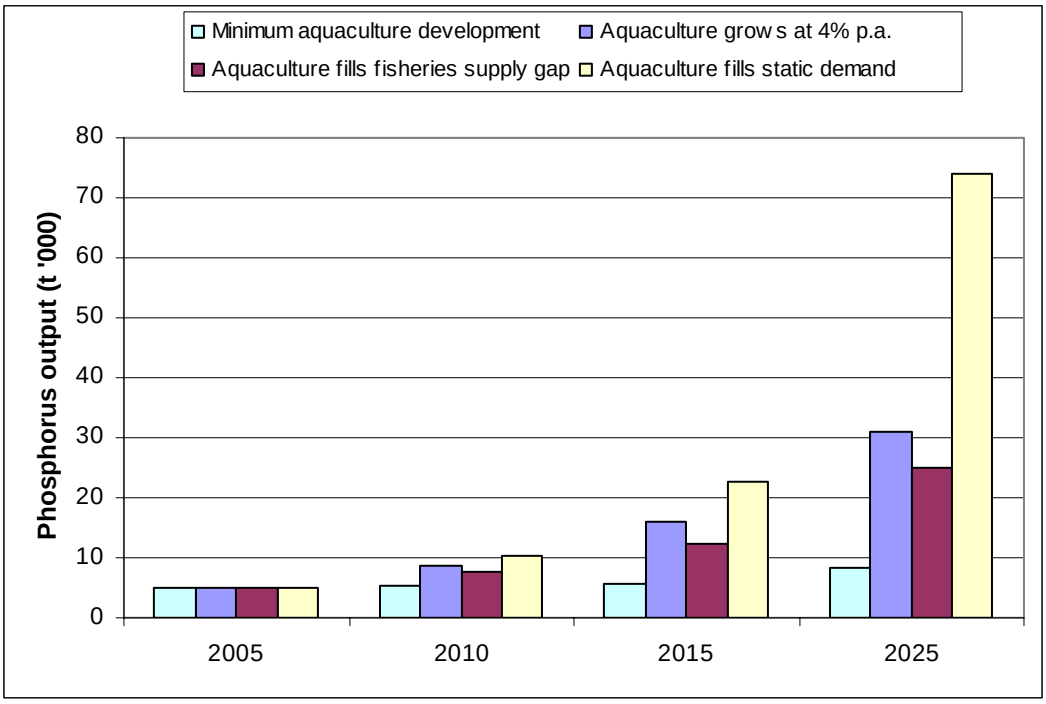
[Figure 95]: All scenarios – Nitrogen output



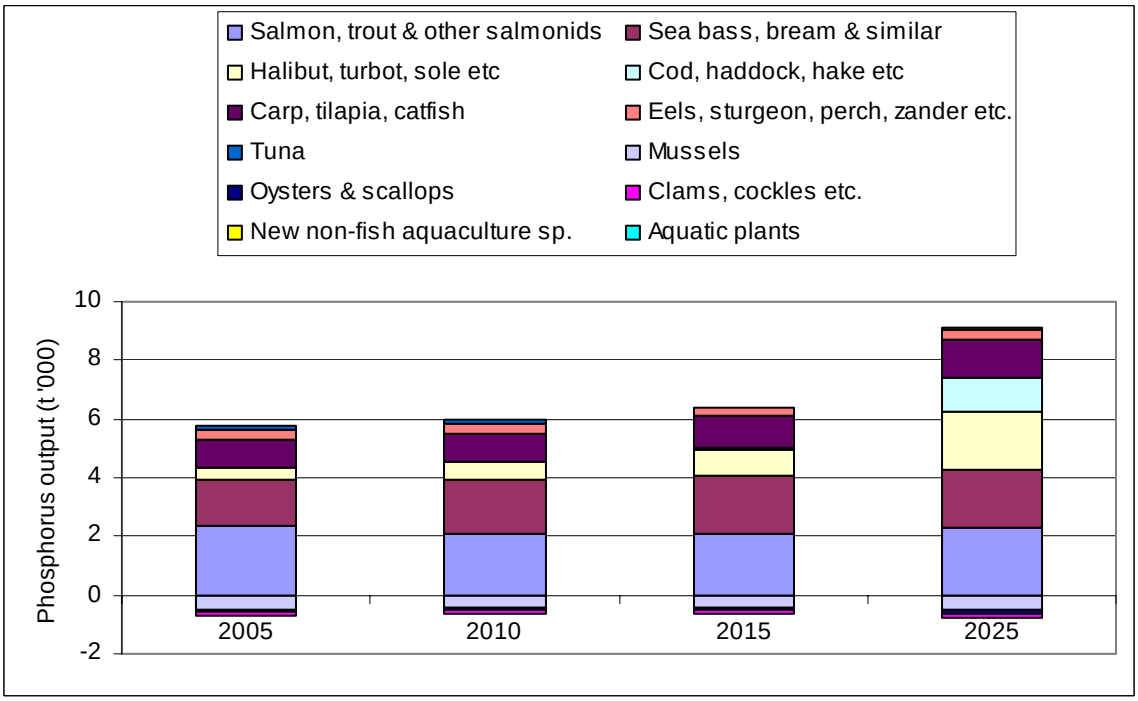
[Figure 96]: Baseline scenario – Nitrogen output



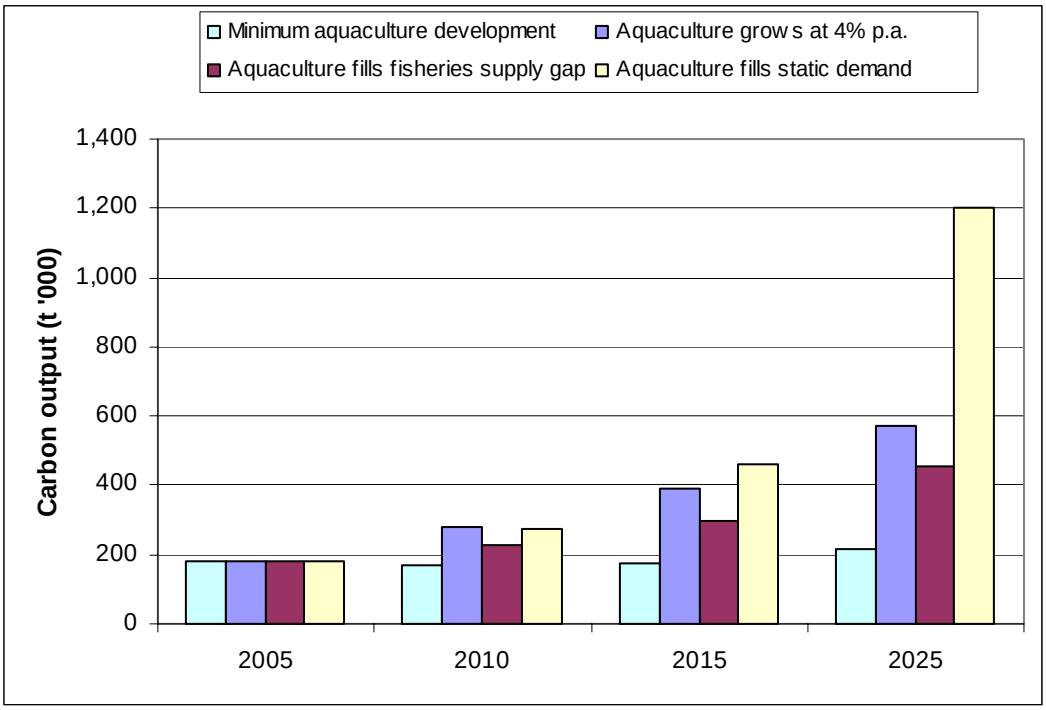
[Figure 97]: All scenarios – Phosphorus output



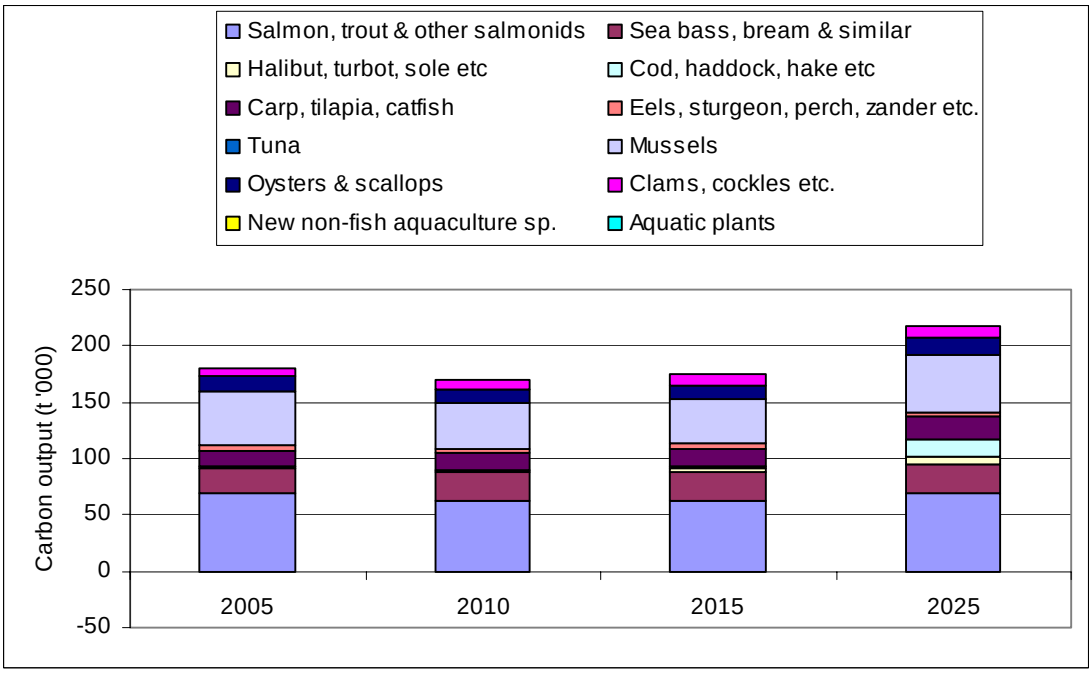
[Figure 98]: Baseline scenario – Phosphorus output



[Figure 99]: All scenarios – Carbon output



[Figure 100]: Baseline scenario – Carbon output.



The baseline scenarios suggest a 2.7 fold increase in production between 2005 and 2025, but a 4.1 fold increase in nitrogen, 6.3 fold increase in phosphorus and 3.2 fold increase in carbon output. This is due to an increased proportion of finfish in the aquaculture mix. Given existing concern over aquaculture waste output, it appears likely that regulators would wish to encourage this additional development to take place offshore, where the wastes are more easily dispersed and have lower impact, or produced in recirculated aquaculture systems

where the waste streams can be captured and treated or utilised in a way that has lower environmental impact. These estimates do not account however for potential reduction in nutrient emissions due to improved diets or efficiency gains through better systems management or genetic improvements. These for instance might be reflected in improved feed conversion efficiencies. Alterations could also occur in waste nutrient profiles if fish meal is replaced to considerable extent with plant ingredients.

[6.6] Summary of scenario model results and implications for emerging systems

[6.6.1] Model development

The models presented above explore the potential for increased aquaculture production in EU Member States. They firstly identify potential market demand for fish and seafood products and compare this with supply from the capture fisheries sector. The shortfall in supply is then expected to be met through aquaculture and net imports from third countries. The implications of only part of the shortfall being met through aquaculture, or virtually all the shortfall being met through aquaculture are explored. The models are not intended to be predictive, but rather to indicate the development needed and associated implications of different options.

[Table 28]: Summary of main assumption scenarios used for modelling

Demand	Calculated as a function of population numbers multiplied by apparent average per capita fish and seafood consumption. Three main scenarios: that per capita consumption does not change that per capita consumption continues to rise based on last 15 year trend that the per capita consumption falls again (inverse of growth rate) Price is not included as a factor at this level, as although clearly important, it is only one of a wide range of factors affecting overall fish consumption. Demand is not broken down by product group for the purpose of the model, but is a factor considered in the analysis. The first scenario is used as the demand baseline.
Capture fisheries supply	The status of different EU fish and shellfish stocks varies widely, and the capture supply scenarios do not attempt to break down supply by individual stocks. Three main capture supply scenarios are considered: supplies are maintained at current levels supplies fall in line with recent trends at 2% per annum supplies fall in line with more catastrophic projections at 4% per annum.

	The second scenario is used for most of the models presented in the main report.
Balance of trade	The models assume that if there is a shortfall in supply from EU production, it will be met through imports. Net import calculations therefore depend only on the assumptions used for demand, EU capture and aquaculture production. They do not consider production trends outside Europe, prices, market preference or any other factors. In practice, the development of aquaculture in Europe will depend very much on its ability to compete effectively in both EU and export markets. For the purpose of policy development however, the potential deficit in production in relation to expected consumption is a useful indicator.
Aquaculture production	Four main aquaculture production scenarios are considered. Except for the first, these are target based: Minimal development – current trend of decline continues for remainder of this decade, before reversing as the gap between production and demand rises To meet output targets derived from the EU 2002 policy objective of 4% annual increase in aquaculture production EU aquaculture develops to fill the gap left by capture fisheries declining at 2% per annum EU aquaculture develops to fill the entire gap between capture fisheries supply and expected demand. Within each scenario, 12 categories of aquaculture product are considered, and how these might develop in order to achieve the target production levels. Particular attention is given to the role of emerging aquaculture systems in achieving these goals.

Within the different production scenarios, growth rates for each product group were considered in 5-year blocks. The overall 20-year growth rates are compared in [Table 29]. The EU 4% growth target would now require an 8.4% per annum average growth rate to reach the same production by 2025 as would have been achieved by a 4% annual increase from 2000 onwards.

[Table 29]: 20 year average annual growth rates for different aquaculture product groups by scenario (2005 to 2025)

	Scenario 1 (minimal)	Scenario 2 (EU output target)	Scenario 3 (Compensate fisheries)	Scenario 4 (Meet all demand)
Salmon, trout & other salmonids	0.0%	7.4%	5.8%	16.9%
Sea bass, bream & similar	1.0%	7.7%	7.2%	23.9%
Halibut, turbot, sole etc	20.3%	27.8%	50.4%	130.0%
Cod, haddock, hake etc	5,462.5%	34,133.1%	14,721.3%	84,527.5%
Carp, tilapia, catfish	1.7%	26.4%	2.3%	39.3%
Eels, sturgeon, perch, zander etc.	0.3%	14.0%	43.1%	87.8%
Tuna	-5.0%	150.9%	132.2%	132.2%
Mussels	0.4%	2.5%	2.6%	7.4%
Oysters & scallops	0.4%	0.7%	0.7%	4.5%
Clams, cockles etc.	1.7%	0.5%	0.0%	2.3%
New non-fish aquaculture sp.	-0.3%	1,018.8%	1,727.5%	10,525.0%
Aquatic plants	-3.8%	231.3%	231.3%	146.9%
TOTAL	**0.9%**	**8.4%**	**6.1%**	**22.3%**

In this table, the product groups “cod, haddock, hake etc.” and “New non-fish aquaculture sp.” show very high percentage increases. This is an artefact of starting from very low production in 2005 (e.g. only 69 tonnes of cod). The resulting projection of 471,100 tonnes of production of these marine species by 2025 is high, but this growth rate was achieved by the salmon industry in Chile, and both the Norwegian and Chile marine cage aquaculture industries exceed 600,000 tonnes.

The scenarios assume that the growth rates in marine whitefish will be highest. This is a reflection that whitefish have historically formed the largest share of the fish market, so demand is high, but capture fisheries supply is declining. This should create opportunities for aquaculture, providing it can supply economically. Offshore aquaculture appears the most likely system to meet the volume demands projected. The technology is developing incrementally within the salmon, tuna and sea bass and sea bream industries with gradually larger cages moored in more exposed locations serviced by larger vessels etc. Newer marine species will borrow heavily from existing growout technology and could therefore be expected to scale-up faster than was the case with the more established species. There also remains the possibility of transformational change. This could come about through the development of a new offshore cage design that swings the production economics in favour of offshore farming. Competitive forces would then ensure rapid adoption, assuming appropriate regulatory measures are in place. The main centres of investment in offshore cage design at

present are Norway and the USA, which suggests transformational development, if it occurs, is more likely to start outside the EU.

Good growth rates for (bluefin) tuna culture are also assumed in most scenarios if the life cycle can be closed and juveniles supplied from hatcheries. The grow-out sector is already in place, but is expected to be increasingly contrained through juvenile supply. A switch to formulated diets would also improve environmental sustainability and should be possible if juveniles are weaned onto dry diets at an early age.

Further development of recirculated systems for higher unit value species (both marine and freshwater) appears likely. This is assumed for species such as turbot, sole, eel, and perhaps perch and zander. Recirculated systems are also used for African catfish culture in Europe, which has low unit value, but can be cultured at very high densities. There is scope for substantial increases in production if the market were better developed. Several companies are also producing tilapia in freshwater recirculated systems, suggesting there is some optimism that economic production can be achieved and markets can be developed.

Except for the baseline model, all assume quite strong growth for salmonids, which are already the largest fin fish group cultured in Europe. Salmon has the best prospects if offshore farming is developed, but potential exists for freshwater trout and in some cases charr. This may be through greater industrialisation and use of recirculated water systems, or may be through functional diversification of fish farms and local product and label development. Elsewhere however, further contraction of traditional trout farms is expected due to increasingly restrictive environmental regulation, uncompetitive cost structures and failure to attract new entrants.

None of the scenarios assumes high growth rates for molluscs, since there is much less scope for substitution than between say whitefish species. Growth will depend on market development. Mussel farming is assumed to have the fastest growth rate since it is a lower unit value product and industrial scale farming operations are developing. More traditional shellfish bed style culture is less likely to expand due to growing pressures on coastal resources.

[6.6.2] Model outputs

The model helps to answer questions such as “if the EU wished to eliminate its trade deficit with respect to seafood (by volume), as well as compensate for declining fisheries, how much extra area would be required and how many jobs would it create?” The key figures generated by the model are shown below.

[Table 30]: Summary of key indicators by 2025 for the four scenarios

	Scenario 1 (minimal)	Scenario 2 (EU target)	Scenario 3 (Compensate fisheries)	Scenario 4 (Meet all demand)
Aquaculture production (million tonnes)	1.48	3.37	2.80	6.88
Aquaculture value (€ billion)	3.64	11.01	9.69	27.40
Direct jobs	89,890	162,030	131,690	327,830
Land or water area required (M ha)	0.270	0.420	0.230	0.590
Water use (billion m^3)	3,429	6,975	6,048	13,108
Industrial energy used (M MJ)	181	527	419	1,091
Nitrogen output (t)	45,590	163,370	119,590	360,400
Phosphorus output (t)	8,330	30,940	25,100	74,060
Carbon output (t)	216,840	569,320	456,450	1,210,890

Note, Figures are rounded as appropriate

The model suggests that raising aquaculture output in line with earlier EU policy objectives would double the land and water area required. However, overall area usage would remain very small compared with agriculture (less than 0.5 million ha estimated, compared with over 6 million ha of terrestrial organic agriculture, which is only 4% of total agriculture)[85]. Of more concern would be increased output of nutrients (a 3.8 fold increase in nitrogen output for instance). However, this should be judged in the wider context. In comparison with the livestock sector for example, the additional nitrogen would be equivalent to increasing the European cattle population by around 0.7%[86]. More important would be how and where the nutrients are released. Offshore aquaculture would have very high waste dispersion characteristics, whilst recirculated systems provide greater means of control and removal for further processing or use.

The estimated direct usage of industrial energy (based on selected mix of systems) would triple if aquaculture develops to meet EU targets over the minimal development scenario. This increase of 346 million MJ is equivalent to the average annual energy usage of 4,600 European homes[87], or 10,500 people, which is around 1% of the annual European population growth. In terms of power generation it equates to a wind farm of about 15 turbines of 2.5

85 Eurostat press release 80/2007 (12 June 2007)

86 An approximation based on a mean nitrogen output of around 100 kg per head per year for cattle (http://www.mfe.govt.nz/publications/climate/projected-balance-emissions-jun06/html/page11.html) and a European cattle population of approximately 130 million (http://cattle-today.com/)

87 Calculations based on energy use per dwelling of 1.75 to 1.8 t oil equivalent per annum (http://themes.eea.europa.eu/Sectors_and_activities/households/indicators/energy/hh06households.pdf) converted to MJ using 1 toe = 42 GJ (42,000 MJ) (http://en.wikipedia.org/wiki/Ton_of_oil_equivalent).

MW capacity each[88]. However, full lifecycle analysis (LCA) is needed to understand total energy consumption, as Grőnroos *et. al.* (2006) found feed production to be the major energy cost in Finnish trout farming.

Using constant multipliers, employment would more than double by 2025 if output matched the EU target growth rate of 4% per annum for aquaculture development. However, it is likely that price competition and market demand will result in the major increases in production volume through new marine fish production, especially in offshore systems that have much higher efficiencies. Employment per tonne of production however is greatest for small-scale artisanal and family-run farms, which might increasingly need to address niche markets to survive.

The scenarios outlined present a range of alternative interpretations and implications with varying degrees of likelihood of emergence. The spread and combination of determining factors is effectively impossible to predict with any certainty. However the impacts of the most likely scenarios have been identified and the wider implications of these for policy are discussed in the following concluding section.

[6.6.3] Non-food aquaculture species

The models presented in this section have focused on fish as food. Aquaculture activities may also be carried out to produce fish for angling, ornamental purposes, or for the production of other biotechnology products including pharmaceuticals, fine chemicals and functional food components. These are not major activities within Europe, but can have considerable local significance.

The global trade in ornamental fish was worth US$ 0.9 billion (€0.68 billion) at wholesale values in 2000. This equates to at least US$3 billion (€2.28 billion) at retail values (FAO, 2007). Europe plays a large part in this trade, with imports of ornamental fish into EU-25 countries valued at around US$110 million (€85 million) in 2005[89]. Ornamental fish are produced to some degree in many European countries, however, by far the largest producer in the Czech Republic, with an export value of US$7.76 million (€6 million) in 2005[90]. Further expansion of this industry is anticipated, but unless there are major changes in the cost of transporting live fish, EU producers will continue to face substantial competition from third countries with lower cost base. Successful ornamental production within the EU has focused on quality, or the production of higher value marine species.

Aquaculture is also providing stock for angling lakes throughout Europe. The European Anglers Alliance estimates the European leisure fishing sector to be worth at least €25 billion, of which €5 billion is in tackle sales[91]. This is almost ten times the value of food fish aquaculture production. An increasing number of aquaculture farms include leisure angling facilities, particularly in East and Central Europe, or the valliculture areas in Italy, where larger water bodies are forming the centre pieces for a variety of nature-based activities,

---

88 Typical turbine output is 2,628 MWhours/year per MW of installed capacity (http://www.westmill.coop/windfarmsites.php). Typical turbines are 2.5 MW capacity and 1 MWhour is equivalent to 3600 MJ.

89 UN Comtrade data for classification HS2002/030110 Live ornamental fish (www.comtrade.un.org).

90 Op cite.

91 http://www.eaa-europe.eu/docs/DEFINITION-EAA_Angling_Def_long_FINAL_EN.pdf

include nature trails, angling and camping. In Scotland, 14.7 % of trout production is for restocking to "put-and-take" angling lakes, of which there were 287 in 2002[92]. Although unlikely to significantly increase total fish production, these initiatives greatly increase the value and employment multipliers for aquaculture, and for that reason should be taken into account in aquaculture policy development.

The potential for obtaining valuable fine chemicals, nutritionals and biologically active therapeutic compounds from marine organisms is continually under investigation. The major products at present are agar and carrageenan from seaweeds, but microalgae are also of interest for pigments, neurotoxins, polysaccharides, lipids, peptides and enzymes etc. Many other marine organisms are potential sources of future anti viral, anti-microbial or anti-cancer drugs. Already commercialised compounds include an antihelmintic insecticide from the red algae *Digenea simplex*; an antiviral (herpes) from the sponge Cryptotethya crypta, an anti tumoural compound from the sponge *Cryptotethya crypta*, and an antibiotic from marine fungi (*Cephalosporium sp.*)[93]. In some cases, once identified, a compound can be synthesized using chemical processes, or produced via bacterial fermentation (e.g. using genetic engineering approaches). In other cases, aquaculture of the species is the most appropriate solution. The high costs of product development, especially for pharmaceutical products, is likely to restrict rapid development in this area. Aquaculture for bioactive compounds will also be subject to the same competitive pressures as aquaculture for food products and would not necessarily develop in Europe even if the core development and primary market is here.

[6.6.4] Export of aquaculture related goods and services

It should be noted that the models presented in this section do not take into account the value of aquaculture goods (e.g. feeds, medicines and equipment) or other services that are exported from Europe. Only goods and services sold within Europe contribute to measured turnover from European aquaculture production. There is little data available on the additional value of exports, but these may include for instance:

- Aquaculture equipment such as cages, nets moorings, tanks and water treatment equipment
- Aquaculture feeds, ingredients, pharmaceuticals, vaccines and diagnostic kits
- Information systems, software, monitoring and control equipment
- Analytical, consultancy, management and advisory services
- Contract research services
- Financial and insurance services
- Education and training

The greater the technological edge that Europe is able to maintain, the greater will be the prospects for, and potential value of these exports.

---

92 Walker, 2002.

93 European Science Foundation Marine Board, 2001.