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An Approach Towards European Aquaculture Performance Indicators

Indicators for Sustainable Aquaculture in the European Union

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Table of content

Executive summary

This report presents the outcome of the JRC research on the development of quantitative indicators to measure the performance of the EU aquaculture (European Aquaculture Performance Indicators - EAPI). The report describes the situation on the basis of the most recent data available at EU level and proposes a set of indicators to assist national authorities in the preparation of the aquaculture strategic plans foreseen under the new Common Fishery Policy.

1. Methodology

Following a commonly accepted definition of sustainability, indicators have been identified along the three dimensions of social, economic and environmental performance. In addition, indicators for governance were defined. 15 indicators have been considered to picture the performance of aquaculture in the four dimensions:

Indicator	Description	Dimension
Production growth (GR)	Variation in production quantity over recent years	Economic
Gross Value Added (GVA)	Ratio between GVA from aquaculture and Gross Value Added from the primary sector	Economic
Profitability (PR)	Ratio between earnings before interest and taxes (EBIT) and turnover	Economic
Self-sufficiency (SU)	Ratio between domestic aquaculture production and total available supply in the freshwater, marine and shellfish segment for main commercial species	Economic
Diversification (DIV)	Extent to which different species contribute to the main production	Economic
Labour productivity (LP)	Ratio between GVA from aquaculture and number of persons employed in aquaculture	Social
Employment (EMP)	Ratio between number of persons employed in aquaculture and total employment	Social
Apparent consumption (AC)	Per capita apparent consumption of fisheries products	Social
Fishmeal (FM)	Ratio between total quantity of fishmeal used and total aquaculture production	Environmental
Fish oil (FO)	Ratio between total quantity fish oil used and total aquaculture production	Environmental
Nitrogen (N)	Ratio between total effluents of nitrogen and total aquaculture production	Environmental
Phosphorus (P)	Ratio between total effluents of phosphorus and total aquaculture production	Environmental
Licenses (LIC)	Number of new licenses and authorized production volume	Governance
Allocated Zones (AZ)	Size of allocated zones for aquaculture	Governance
Subsidies (SUB)	Subsidies allocated/paid for the sector in relation to the value of the national aquaculture production	Governance

The selection of indicators was carried out on the basis of measurability, country coverage and relevance to the EU aquaculture developments goals set in the new Common Fishery Policy.

Since aquaculture is a small and relatively young sector there is very few data available in official statistics to asses its performance at EU level. The EU Data Collection Framework (DCF) is providing data on the performance of marine aquaculture but is still too recent and incomplete to provide a full coverage for all the segments and countries and is not including environmental aspects. While using as much as possible DFC data, the report relies heavily on official statistics on production to calculate missing values and establishing longer time series for most of the indicators.

Environmental indicators are based on parameters specific to production systems which are considered similar across Member States. Where Member State specific data have been made available, these data have been used. With more specific national data in respect to the parameters (e.g. mix of species, production systems, feed conversion rates and further substitution of fishmeal / fish oil) becoming available, Member States will be able to reflect more precisely the national situation compared to this first assessment and to monitor progress over time. Especially for the environmental dimension, if additional data become available, also possible additional indicators could be considered, such as land and water use.

A profitability indicator should be included to measure the economic performance of the sector as more data become available through the DCF. In the present study the analysis of profitability is based on a panel of a limited number of companies which represent around 70% of the EU aquaculture production by value. While this panel may not be fully representative, it gives a useful reference to assess national figures based on statistical sampling.

The 3 proposed governance indicators may be used in the future as a measure of output; at the moment, data on these indicators is not yet available. When the number of authorisations increases more refined governance indicators could be included:

- average time from application to conclusion of the authorisation/license procedure;
- average cost of the authorisation/license procedure for the applicant;
- number of applications and percentage of success of authorisation/license applications;
- number of different public bodies directly involved in the authorisation procedure.

Findings of a qualitative analysis of governance systems in five Member States are included in the reports to cover also this dimension.

The supporting data for each indicator were transformed into normalised scores to allow a comparison across countries and segments. These scores do not indicate strictly good or bad performance along a specific dimension, but rather provide a comparable baseline.

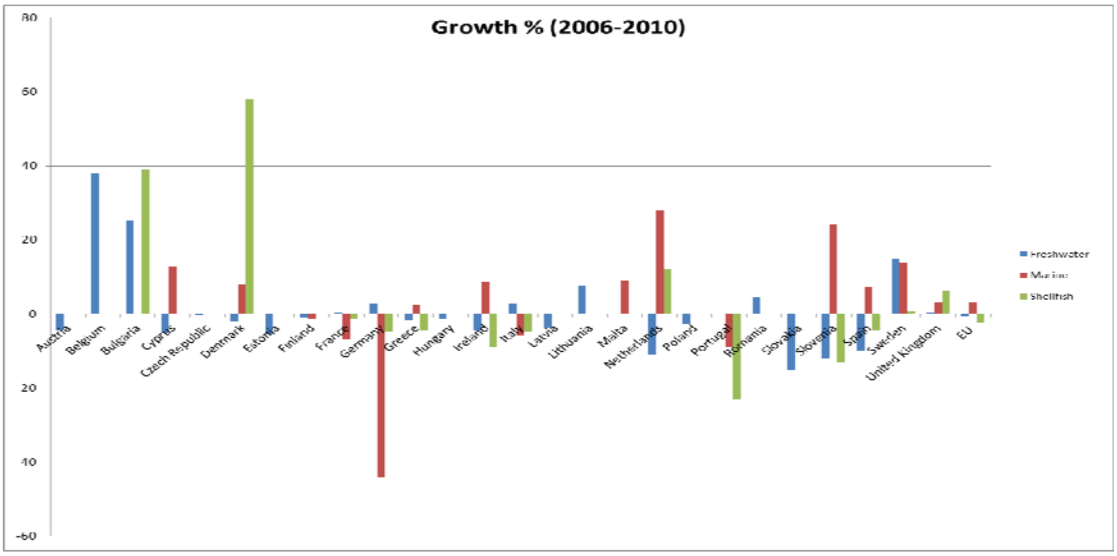
The choice of indicators along sometimes diverging sustainability objectives is a highly subjective exercise which involves the setting of policy priorities varying from country to country and for the different segment of the aquaculture sector. The list of indicators proposed in this study is not intended to represent an optimal selection to reflect all possible policy priorities but is rather resulting from the compromise to represent the main issues surrounding EU aquaculture development and the very limited availability of data. Ideally as new and more data from the DCF will become available this should be used to set a baseline to measure progress in performance and new indicators could be added to better reflect specific policy targets.

2. EU Performance

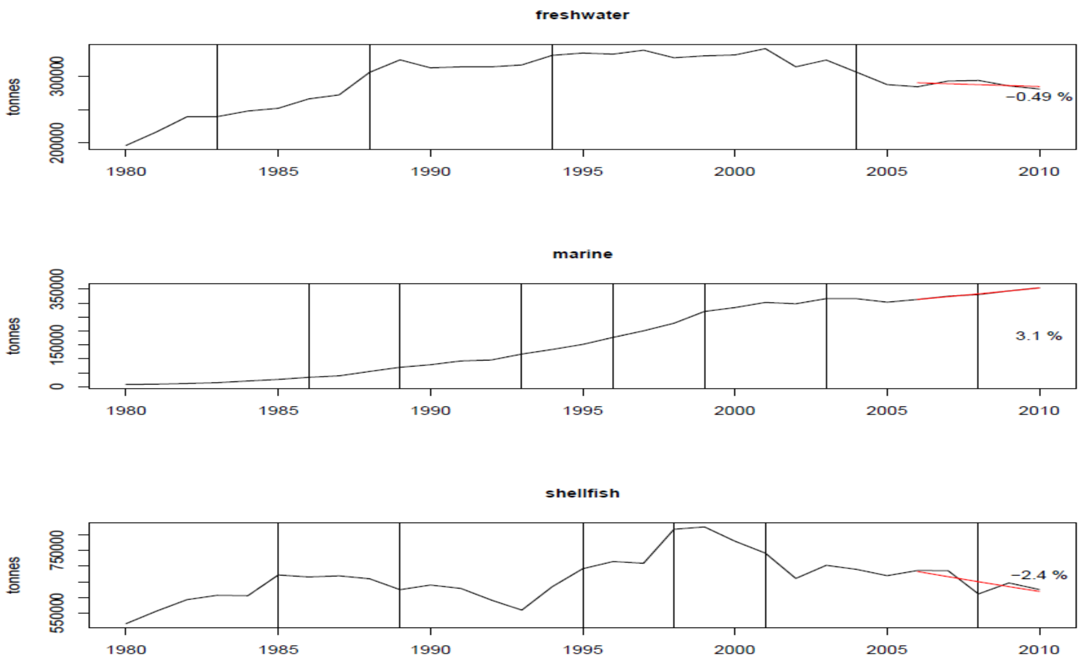
2.1 Growth in production

In 2010, the value of EU aquaculture production was of 3.1 billion Euros and the volume of production was of 1.26 million tonnes. The EU share of world aquaculture production was 2.1% in 2010, down from 2.3% in 2009.

In contrast with the strong growth of production in some regions of the world, mainly in Asia, the overall EU aquaculture production in recent years is stagnating. Between 2009 and 2010 there was a further decline of EU aquaculture production both in volume (-1.14%) and value (-5.3%).



Growth trends of aquaculture production in the Member States between 2006 and 2010 by segments in percentage of volume.



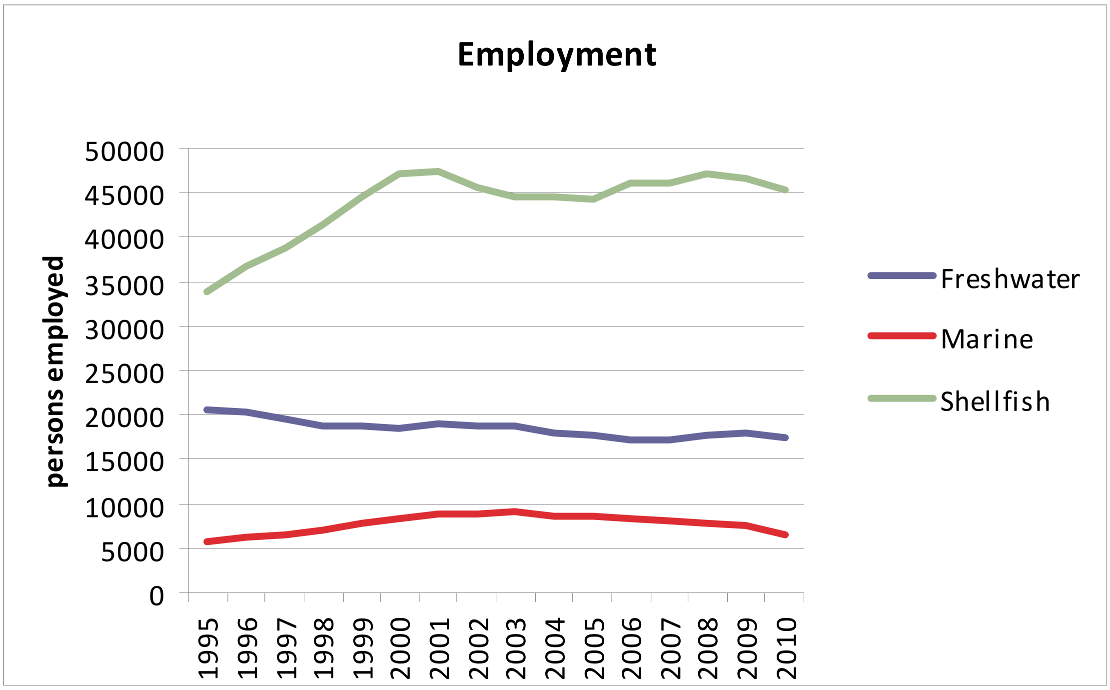
Production volume in EU aquaculture over time by segments and the growth trend over the last five years.

Overall, in the last 15 years the EU aquaculture production grew by around 8% from 1.178 million tonnes in 1995 to 1.276 million tonnes in 2010 with a pike in 1999 of around 1.425 million tonnes. The general growth pattern by volume is strongly influenced by the shellfish segment which expanded until 1999 and then experienced a continuous decline to 625,000 tonnes in 2010. The strongest and most continuous growth can be seen in the marine finfish aquaculture which more than doubled the production volume since 1995 from some 152,000 tonnes to 355,000 tonnes in 2010. In the same period the output from freshwater aquaculture fell from 335,000 tonnes to 280,000 tonnes.

2.2 Socio-economic aspects

The EU aquaculture sector is represented by around 14,000 to 15,000 mostly small enterprises, and it accounts for estimated 70,000 jobs. The highest contribution to employment in absolute terms comes from the shellfish segment. The analysis of trends in employment indicates that the marine segment is going through a process of intensification which is eroding its job creation potential. The shellfish and freshwater segments, which represent most of the employment in absolute terms, are suffering a loss in labour productivity.

Overall, the contribution of aquaculture to general employment is low given the limited size of the sector; however, the analysis of aquaculture sites and their contribution to employment confirms that aquaculture activities offer important contribution to some coastal and rural economies in terms of employment opportunities.

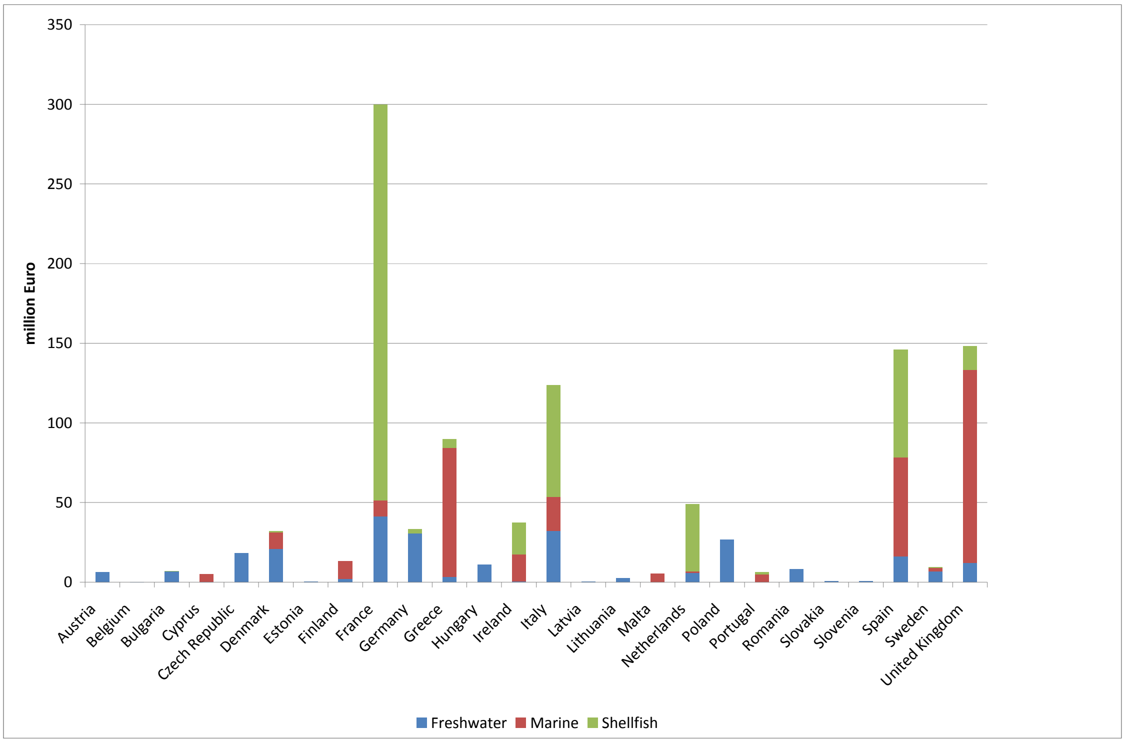


Estimated employment in EU aquaculture over time by segment.

The performance in terms labour productivity is highest in the marine segment, followed by the freshwater and shellfish segment. Over time there has been an increase of labour productivity for the whole aquaculture sector which can be mostly attributed to an increase in the value of production and in the intensification process in the marine segment. While extensive freshwater and shellfish aquaculture offer more jobs to costal

or rural communities per unit of production, the labour-productivity in these traditionally low-input production systems is considerably lower than in more intensive marine farming systems.
The Gross Value Added (GVA) per employed person in the EU shellfish segment in 2010 was around 5,000 Euro while it reached around 52,000 Euro in the marine segment.

The total GVA of EU aquaculture was of 1,084 million Euro in 2010 which represents 0.6% of the GVA in the primary sector. The EU freshwater and shellfish segments are experiencing a reduction in GVA which is well exceeding the slight contraction in the volume of production. The loss in GVA for these two segments can be attributed to the strong decrease in turnover and is indicating problem of lack of profitability and competitiveness of the industry which is confirmed by the analysis of profitability in financial accounting data.



Gross Added Value of aquaculture in million Euro by Member State and segment for 2010

In 2010, the EU freshwater aquaculture contributed with around 75% to the total available supply in this segment, the marine finfish aquaculture with some 29% and the shellfish production with around 68%. The self-sufficiency for the 11 main commercial species with relevance in EU aquaculture decreased from 2004 to 2010 as regards the finfish production and remained relatively stable for shellfish.

2.3 Environmental aspects
From an environmental perspective, large differences in feed demands and effluents can be observed between different species groups and production systems (e.g. extensive carp or shellfish production compared to intensive salmon or trout production). Further improvements in technologies and management may reduce the environmental impacts in order to allow a sustainable growth in production.

The demand of fishmeal and fish oil per tonne of fish produces in marine finfish aquaculture is more than double that for freshwater production. This reflects the strong role of carnivore species in the marine environment, requiring higher levels of fishmeal and fish oil in the diet.
Our estimates suggest that in 2010 the total amount of fishmeal used in the marine finfish segment was more than two times the amount used for freshwater aquaculture, while the amount of fish oil used in marine finfish was three times the amount used in freshwater aquaculture.

The effluents per tonne of finfish produced are also higher in the marine than in the freshwater segment. The nitrogen effluents in marine finfish production are around 1.5 times higher in marine than in freshwater production and the phosphorous effluents around 1.7 times higher than in the freshwater segment.
In 2010, the total estimated effluents of the marine finfish segment were around 1.9 times the amount of freshwater aquaculture for N (around 24,700 compared to 12,700 tonnes) and more than two times the amount for P (around 4,000 compared to 1,800 tonnes).

2.4 Governance

The fact that in past years very few authorisations/licenses have been issued in the main producing Member States is indicative of problems of governance of the sector in addressing some common constrains. These constrains are related to: the competition for space in coastal areas, lack of clear priorities for the development of the sector, fragmentation of competences for the authorization of aquaculture sites, and the way environmental legislation is implemented. In many cases diverging interpretations and applications of legislation increase are perceived as increasing uncertainty for potential investors.

The issue of space is often perceived as a hindering factor for the expansion of EU marine aquaculture; however, a specific study showed that in fact the surface and coastline occupation by aquaculture sites is extremely limited and the availability of space along the coastline in absolute terms seems to be more than adequate to accommodate also a relevant expansion of the sector. The findings from the spatial analysis of existing sites show that the problem should be rather reformulated in terms of the need for identifying the most suitable sites through integrated marine spatial planning. This is particularly important for a relatively small and relatively new sector like aquaculture which struggles in competing with larger and more established economic activities in the coastal areas.

Conclusions

EU aquaculture production is stagnating; problems of governance have been identified, resulting in very few authorisations/licenses being issued in the main producing Member States in past years. Factors contributing to this situation include: the competition for space in coastal areas, lack of clear priorities for the development of the sector, fragmentation of competences for the authorization of aquaculture sites, and the way environmental legislation is implemented. In relation to access to space, our study suggests that this problem should be formulated in terms of the need for identifying the most suitable sites through integrated marine spatial planning, rather than in terms of lack of space.

At a more detailed level, the EU aquaculture sector could be divided in the following four main categories of production. These categories are characterised by different opportunities and constraints and would therefore deserve to be treated according to distinct policy targets.

- Capital intensive marine and freshwater fish production with high input and output, increasing labour productivity and profitability.
  This segment has potential to compete on the increasingly globalised market but it faces constrains which hinder further expansion. Its environmental impacts are also generally higher than those of other aquaculture segments.
- Low input freshwater production, often with low labour productivity and high species diversification, serving mainly local markets (e.g. carp).
  In this category limited demand and strong international competition is limiting the profitability and growth of production, however the extensive and artisanal production may play a role in environmental and recreational aspects (e.g. regarding biodiversity and preserving cultural landscapes).
- Labour intensive shellfish production.
  This segment faces limited environmental concerns. Although affected by loss in competitiveness, this sector has a very important social dimension given the high number of employed persons.
- High input and technology driven production in recirculation systems (RAS).
  This segment despite the high energy demand is not posing environmental concerns and is not competing for space. It requires however higher investments and has at the moment profitability prospect only for niche and targeted markets.

1. Introduction

One of the aims of the reform of the EU Common Fisheries Policy (CFP) is to promote aquaculture through a coordinated approach based on non-binding strategic guidelines, common priorities and exchange of best practices. JRC supports DG MARE with research to identify the relative starting positions and different circumstances in the Member States and to identify possible common priorities and targets for the development of sustainable aquaculture activities.

This document presents the outcome of a research on the development of quantitative indicators to measure the performance of the EU aquaculture (European Aquaculture Performance Indicators - EAPI). Besides describing the current situation on the basis of the most recent data, the chosen performance indicators could assist national authorities in the preparation of the strategic plans.

Following a commonly accepted definition of sustainability the indicators are organised along the three dimensions of social, economic and environmental performance. Since the indicators are developed in support of EU and national policies an additional dimension of governance was included and three indicators were proposed also for this dimension.

2. Methodology

The following table lists the 15 indicators considered to represent the performance of the aquaculture sector in the Member States and for the entire EU along these four dimensions.

Table 1 List indicators in the four dimensions with short descriptions

Indicator	Description	Dimension
Production growth (GR)	Variation in production quantity over recent years	Economic
Gross Value Added (GVA)	Ratio between GVA from aquaculture and Gross Value Added from the primary sector	Economic
Profitability (PR)	Ratio between earnings before interest and taxes (EBIT) and turnover	Economic
Self-sufficiency (SU)	Ratio between domestic aquaculture production and total available supply in the freshwater, marine and shellfish segment for the relevant main commercial species	Economic
Diversification (DIV)	Extent to which different species contribute to the main production	Economic
Labour productivity (LP)	Ratio between GVA from aquaculture and number of persons employed in aquaculture	Social
Employment (EMP)	Ratio between number of persons employed in aquaculture and total employment	Social
Apparent consumption (AC)	Per capita apparent consumption of fisheries products	Social
Fishmeal (FM)	Ratio between total quantity of fishmeal used and total aquaculture production	Environmental
Fish oil (FO)	Ratio between total quantity fish oil used and total aquaculture production	Environmental
Nitrogen (N)	Ratio between total effluents of nitrogen and total aquaculture production	Environmental
Phosphorus (P)	Ratio between total effluents of phosphorus and total aquaculture production	Environmental
Licenses (LIC)	Number of new licenses and authorized production volume	Governance
Allocated Zones (AZ)	Size of allocated zones for aquaculture	Governance
Subsidies (SUB)	Subsidies allocated/paid for the sector in relation to the value of the national aquaculture production	Governance

The selection of indicators was carried out on the basis of measurability, country coverage and relevance to the EU aquaculture developments goals set in the new Common Fishery Policy. Since aquaculture is a small and relatively young sector there is very few data available in official statistics to asses its performance at EU level.

The choice of indicators along sometimes diverging sustainability objectives is a highly subjective exercise which involves the setting of policy priorities varying from country to country and for the different segment of the aquaculture sector. The list of indicators proposed in this study is not intended to represent an optimal selection to reflect all possible policy priorities but is rather resulting from the compromise to represent the main issues surrounding EU aquaculture development and the very limited availability of data.

The proposed governance indicators were: a) the number and maximum production volume of new sites for which authorisation / license was granted, b) the size of allocated zones for new / additional aquaculture activities and c) the amount of subsidies assigned / paid in support of the sector. Despite several attempts if was difficult to obtain data for these basic indicators for all the Member States and segments as they are not systematically collected. In the case of subsidies given the current structure of the European Fishery Fund (EFF) the amount paid is recorded in a form which merges data for aquaculture, inland fisheries, processing and marketing. While data is not yet available, these indicators may be used in the future as measure of output to assess the performance of governance of the sector. When the number of authorisations increases, additional and more refined governance indicators may be also considered, such are:

- average time from application to conclusion of the authorisation/license procedure;
- average cost of the authorisation/license procedure for the applicant;
- number of applications and percentage of success of authorisation/license applications;
- number of different public bodies directly involved in the authorisation procedure.

In relation to profitability the most recent data from the last DCF data call in 2012 has limited coverage in terms of countries and segments and shows still strong variations and anomalous values. An alternative source is represented by financial data for individual companies from the database AMADEUS. This data gives in most cases a more positive picture regarding profitability than DCF data. The data despite covering 70% of total turnover of the sector cannot be considered statistically representative since it is not including small enterprises especially in the shellfish segment. While both sources are used in this study as reference information, the available data was not considered complete and robust enough to calculate a profitability indicator for all Member States.

The 11 remaining indicators were calculated from disaggregated data, which depending on the indicator refer to a specific economic sub-sector, a production typology or the species produced. In order to get a synthetic measure, the data was then aggregated for each country at the level of the three main segments of freshwater finfish, marine finfish and shellfish aquaculture (hereafter: marine, freshwater, shellfish).

In addition to the performance indicators, contextual data on production was included in the national chapters to give an overview of the structure of the sector in each country and to get an understanding of the main sub-segments which contribute to the country performance.

The supporting data for calculating the indicators was obtained mostly from official statistics from FAO, EUROSTAT, COMEXT, EUMOFA, and from two reports of the Scientific, Technical and Economic Committee for Fisheries on EU aquaculture economic performance (STECF, 2012 and STECF, 2013).
Despite providing the most relevant and updated overview of EU aquaculture, the STECF reports do not cover freshwater aquaculture for all Member States and do not yet provide long time series to identify trends. To address this issue and to give a complete picture for all segments and countries, some indicators were estimated through the support of statistical modelling, mostly linking the indicators to production statistics. This gave the possibility not only to fill gaps in existing data sources but also to identify possible trends on the basis of the longer time series of production data.

To allow comparison across countries and segments the figures from the official statistics and from the models were transformed into normalised scores. These scores do not indicate strictly good or bad performance along a specific dimension but provide a a comparable baseline across segments and countries. Good or bad performance should be assessed in reference to targets established according to political priorities and only at this stage these metrics could be properly defined as indicators.
Despite extensive literature supporting the idea of aggregation (see OECD and JRC, 2008 for a review of methodology), in this study no attempt was done to calculate a single composite indicator across the dimensions to avoid subjectivity in the weighting of interactions between sometimes conflicting objectives. Policy targets may for example be established to give higher priority to the reduction of effluents, which may pose a limit to the growth by volume of the sector, or priority to extensive forms of aquaculture, which may have an important role in terms of general employment but be characterised by low labour productivity. The aggregation of the different indicators into a single performance score would need to balance the tradeoffs among potentially divergent dimensions and policy objectives which was not the aim of the present study.
The present exercise should be considered only as a first step towards establishing proper indicators of performance. The process to transform metrics into proper indicators should be completed by incorporating into the presented framework specific policy priorities and targets.

With the exception of the growth indicator, which is measuring the increase or decrease of production by volume between 2006 and 2010, the other indicators were based on the last year for which statistical figures were available, i.e. 2009 in the case of apparent consumption, and 2010 for all the other indicators.

The following summarises the main methodological aspects for the indicators. A more detailed description of the data sources, the methodology and the assumptions as well detailed figures of the supporting data are given in Annex I.

Production growth

In macro-economics, economic growth is typically measured as GDP. A related measure for a given sector of the economy is GVA. Since aquaculture is not specifically represented in national accounting, the GVA for aquaculture was calculated in this study assuming average operational cost from recent data for main aquaculture segments. However this estimate cannot be extended too far in the past due to changes in the cost structure. On the contrary official statistics on production volume provide longer time series for the analysis of trends therefore growth indicator was derived from production data and in particular considering the compound growth rate in the period between 2006 and 2010.

Self-sufficiency

In order to allow an estimation of how much aquaculture contributes to the total available supply in the three segments (freshwater finfish, marine finfish and shellfish), a self-sufficiency indicator was calculated by combining production and trade figures.

The main methodological challenges in building a self-sufficiency indicator are that fish trade statistics don't distinguish trade flows on the basis of the origin of the products (farmed vs. captured); they use different coding and classifications in respect of production and they are not expressed in live weight equivalents. For this reason the following approach was taken:

- The link between aquaculture production, fisheries production and trade was established using the Main Commercial Species groups and the correspondence tables defined in EUMOFA (2012). Being limited to the aquaculture sector the indicator includes only production and trade data relating to Main Commercial Species with a prevalence of total production from aquaculture (i.e. Clam, Turbot, Eel, Sea bass, Carp, Mussel, Oyster, Trout, Gilthead sea bream, Salmon and Tilapia). These 11 Main Commercial Species where further aggregated at the level of the three main segments of marine, freshwater and shellfish aquaculture;
- In the case of trout and eel the entire production was attributed to the freshwater segment. For Member States which have a strong trout and eel production also in the marine environment, this has to be taken into account when interpreting the self-sufficiency indicator;
- In the case of Member States, the import and export included intra and extra community trade, whereas in the case of the EU as a whole, only extra community trade was included.

Values of the indicator of more than 100% arise when the domestic aquaculture production exceeds the total available supply in the country. This suggests the availability of domestic production for exports and a lower dependency from the imports for the segment.

To give further evidence of the export orientation of some Member States, the self-sufficiency indicator was complemented by the calculation of normalised trade balance in monetary terms for the same groups of Main Commercial Species in the three segments. A positive trade balance could arise either from domestic production or re-processing and trading activities..

GVA

The GVA (Gross Value Added) was measures by adopting a standard cost structure for main production segments. Once data from the DCF will become more stable specific cost structures should be derived directly from this data.

Diversification

The methodology uses a well established index on market concentration which was applied to the production statistics by species. Diversification is not necessarily to be seen as indicator of economic performance and there are several cases of successful economic performance like the salmon industry in Norway based on the intensive farming of a single species. On the other hand the introduction of new species may be considered particularly important especially in a young industry like aquaculture which has still to exploit its full potential in the domestication of new species. In addition, the inclusion of this indicator is considered particularly useful considering the specific target, included in the proposal for the new EMFF (European Maritime and Fisheries Fund), of supporting investment for diversification of the income of aquaculture enterprises through the development of new aquaculture species.

Employment

To provide complete coverage and longer time series the indicators was estimated in relation to production volume using data from DCF and from previous studies. In the relevant graphs beside the modelled employment also the available data are shown to see the degree of convergence. The few cases where the model and the provided employment data do not match well would merit further analysis of the data collection and specificities of production.

Ideally as more robust data will be available from DCF this should be used in the future.

Labour productivity

It is a derived indicator (GVA/employment) using the standard definition economics.

Apparent consumption

Apparent consumption data steam from data published by FAO in the food supply balance sheet.

Environmental indicators

Environmental indicators are based on parameters specific to production systems which are considered similar across most Member States. Only for some Member States specific data have been made available. This means that for most Member States the baseline relates mainly to the situation of production systems and therefore, variations between Member States result from the composition of species groups in the national production. With more specific national data in respect to the parameters (e.g. mix of species, production systems, feed conversion rates and further substitution of fishmeal / fish oil) becoming available, Member States will be able to reflect more precisely the national situation compared to this first assessment and to monitor progress over time. If additional data become available over time, also possible additional indicators could be considered, such as land and water use.

The approach used for calculating environmental indicators is similar to the approach in a study on global impacts of aquaculture produced by the World Fish Center ("Blue Frontiers"). Technical parameters from literature and Life Cycle Assessment studies were applied to production data to derive the indicators.

The methodology for deriving the indicators was reviewed by the expert of the STECF working group on aquaculture in their meeting from 24-28 September 2012. The experts were also asked to provide key highlights on the national aquaculture performance emerging from the interpretation of the indicators. The results of this review process are included in Annex II.

The construction of indicators was accompanied by specific studies addressing some key aspects affecting the aquaculture development in the EU which could not be sufficiently evaluated from the analysis of statistical data.
These studies are related to:

- a survey of governance systems in several Member States;

- the spatial properties of marine aquaculture sites and their contributions to employment for specific coastal communities;
- the interactions between aquaculture and fisheries and key issues affecting aquaculture development from an environmental perspective;
- the analysis of profitability of the aquaculture sector on the basis of financial accounting data extracted from the AMADEUS database.

More detailed information on the results of these specific ad hoc studies can be found in the respective reports and publications.

The following chapters present the main results emerging from the analysis of indicators for the entire EU and for each Member State with the exception of Luxembourg for which the aquaculture sector appeared to be too small to create a country profile.

3. Ad hoc studies

3.1. Governance

The causes often claimed for the stagnating EU aquaculture production are “red tape” and lack of clear policy priorities towards the development of the sector which ultimately results in the limited number of new licenses issued.

The governance and regulatory systems for the EU aquaculture sector were lastly analysed in a study for the European Parliament (2009) and in a survey by OECD (2010).

In the context of the present study, interviews with the relevant authorities and/or producer’s organizations in five Member States (Denmark, France, Poland, Spain and Italy) were carried out to verify the feasibility of establishing quantitative indicators for the governance dimension. These interviews confirmed the main conclusions reached in previous reports on governance problems for the EU aquaculture.

Overall, aquaculture faces common constrains across most Member States regarding:

- competition for space in coastal areas;
- lack of clear priorities for the development of the sector;
- fragmentation of competences for the authorization of new sites;
- environmental concerns.

In many cases diverging interpretations and applications of the EU Water Framework Directive and Marine Strategy Framework Directive by national, regional and local authorities make authorisations of new sites impossible or unpredictable.

More detailed information on the main findings of the survey in five Member States is given in Annex III.

3.2. Spatial properties of marine aquaculture

Although European aquaculture represents a small share of total GVA in the primary sector, it is often claimed to offer a contribution to coastal and rural economies and to give the opportunity to diversify activities from fisheries. To assess the relevance of aquaculture at a more refined geographical scale, a specific study was conducted looking at the spatial properties of existing marine aquaculture sites in UK, Ireland, Greece and Spain, using high resolution imagery from Google Earth Pro. The surface of the sites computed from the satellite images was used as proxy for estimating the employment generated by aquaculture activities and this figure was put in context with general employment conditions in the surrounding areas. The analysis showed that the ratio between aquaculture and general employment in the surrounding coastal areas reaches in some cases values of 0.5-4.7% against an average ratio of 0.016% for national figures. Although limited only to some countries and to marine aquaculture, the study was a first attempt to assess at local level the economic relevance of aquaculture and to define coastal communities which may benefit from the development of this sector. The results are confirming the idea that in some areas characterised by higher concentration of sites and limited alternative employment opportunities, aquaculture may offer important contribution to local economies in terms of employment opportunities.

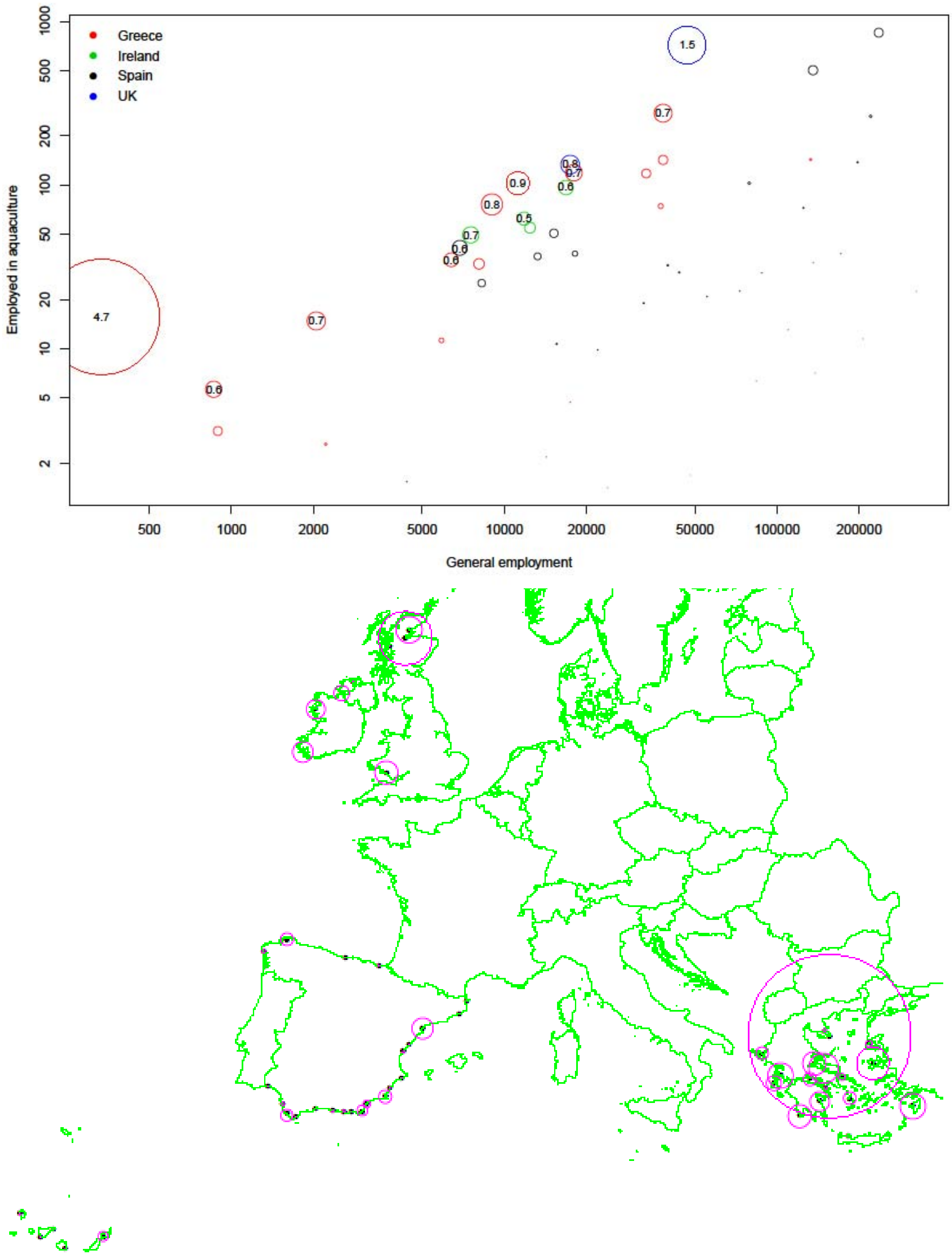


Figure 1 Relevance of marine aquaculture in terms of employment in respect of general employment in the surrounding areas. Each circle is showing a cluster of aquaculture sites. The size of the circle are proportional to the ratio between estimated aquaculture employment and general employment (as larger the circle as more aquaculture contributes to employment opportunities in the surrounding area). Values on employment in the chart above are in logarithmic scale. The numbers in the circles show the ratio between values on the y axis and x axis in percentage.

Another aspect considered in the study is the lack of space often cited as hindering factor for the expansion of EU marine aquaculture. The computation of the spatial properties of existing aquaculture sites showed that the surface and coastline occupation by aquaculture is extremely limited. For example, in the case of Greece, marine aquaculture is occupying a surface of around 240 hectares (equivalent of 1/4 of the surface of the Athens airport), while the portion of coastline affected is 4.3% of the total Greek coastline.

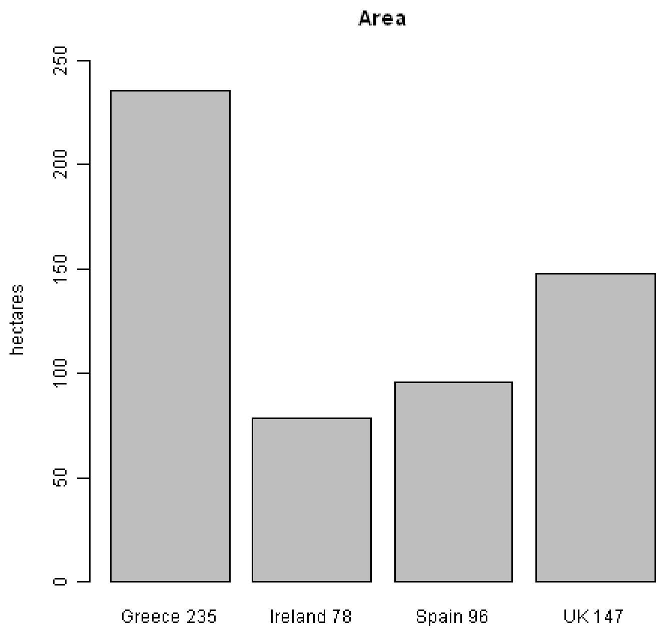


Figure 2 Area occupied by marine cage aquaculture in four Member States

Looking at the position of the sites in respect of other geographical features (i.e. beaches) it emerged that the main criteria for their positioning are, on one side, the tendency to stay as close as possible to facilities on land and in low depth waters to reduce the cost of operations and equipment and, on the other side, the need to avoid interference with the tourist use of the coast line (out of visibility range from beaches).
Based on this consideration, a buffer of 1.5 km from beaches was used to compute the potentially available space for aquaculture in each Member State. This is a very rough estimate of availability since it is not considering many other criteria which normally are taken into account in local or regional site suitability studies; however when considered in combination with the limited amount of space required for existing aquaculture production it indicates that the available coastline would be more than adequate to accommodate also a relevant expansion of the sector.

The findings from the spatial analysis of existing sites show that the problem of lack of space, often indicated as hindering factor for aquaculture development, seems to be overrated and should be rather reformulated in the need for identifying through integrated marine spatial planning the most suitable sites. This is particularly important for a relatively small and new sector like aquaculture which struggles in competing with larger and more established economic activities in the coastal areas.

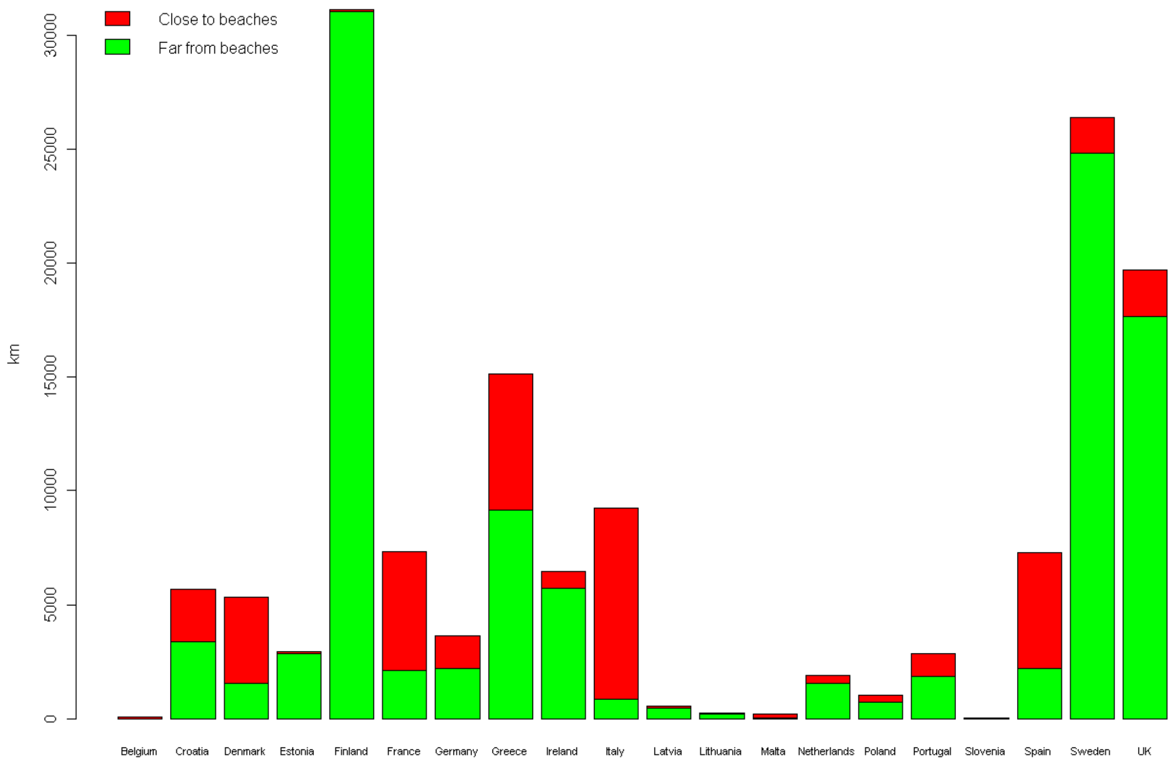


Figure 3 Potentially available spacey for marine aquaculture along the Member States coastlines (red = stretches of coastline with a distance within 1.5 km to beaches, green = stretches of coastline with a distance > 1.5 km to beaches)

3.3. Environmental aspects

The expansion of aquaculture worldwide is generally seen positively for its role and potential in contributing to food security and complementing the stagnating landings from fisheries. On the other hand, aquaculture is accompanied by concerns on the use of resources and the impacts on the environment. Environmental concerns on aquaculture activities focus in particular on the use of fishmeal and fish oil, effluents and changes in biotic communities (alien species and escapees).

It is undisputable that aquaculture as any other form of farming activity poses a series of environmental impacts. However, a more in depth analysis is required to compare these impacts in respect of alternative food producing activities and in particular of fisheries.

The interactions between aquaculture and fisheries have been examined in a review of the most recent literature considering both the environmental perspective and interactions at the level of the sea food and fishmeal/fish oil market. (Natale et al. 2012)

This review showed that research in breeding, genetics and nutrition brought down the inclusion rates of fishmeal and fish oil in the aqua feeds over the last decades for many species. At the same time, feed is being composed, applied and utilised more efficiently, lowering the feed conversion ratios (kg feed needed per kg fish produced). In 2009, around 63% of fishmeal and 81% of fish oil went into aqua feed. Fishmeal is almost equally split between feeds for salmonids, marine fish, crustacean and other species, whereas more than 2/3 of fish oil went into salmonids feeds and around 20% into marine fish. By-products from marine fish processing are increasingly transformed into fishmeal, having reached in 2009 a share of 25% of the global fishmeal production of around 4.8 million tonnes. By-products from fish processing and by-catch still face a number of limitations for feed processing, regarding the availability of the by-products, composition of the resulting meals and reverse effects of some ingredients, which may hinder a higher share in feeds. The recently introduced discard ban for European fisheries may increase the availability of by-catch also for reduction.

Different nutritional and hydrodynamic models have been developed to measure the effluents of aquaculture activities; most of them are quite complex having to take into account parameters, such as water depths, current and temperatures at local levels, e.g. at single farm site or stretch of coastline. Another way of measuring environmental impacts is to use Life Cycle Assessment (LCA). Several studies have analysed at farm level the impacts from aquaculture activities using this standard methodology which allows comparison with other sectors such as livestock production and capture fisheries. The levels of effluents estimated in LCA analyses for specific aquaculture production systems and species have been applied in the current study for groups of species under common production systems to get an estimate of the magnitude of effluents at national and EU level. Also with very sophisticated production systems commercial aquaculture will not achieve a zero-emission status. Large differences in feed demands and effluents can be observed between different species groups and production systems, e.g. extensive carp or shellfish production compared to intensive salmon or trout production. Aquaculture has overall higher demands in terms of input in respect of fisheries however most of existing LCA studies are not fully considering the lower appropriation of biotic resources which can be achieved by transferring an increasing share of sea food supply from capture to farming systems.

3.4. Profitability

The profitability of the aquaculture sector at EU level has been examined in a study by ERNST & YOUNG (2008) with reference to 2006 using data from the financial database AMADEUS, in a report by FRAMIAN (2009) also with reference to 2006, and by STECF (2012) with reference to 2008 and 2009. The analysis from ERNST & YOUNG concluded that the economic performance of aquaculture companies was globally in line with the performance in agriculture but that the structure of the sector was still too fragmented and the size of companies too small to allow economies of scale.

An analysis of profitability was conducted more recently extracting financial information from the same AMADEUS database for the years 2009 and 2010 (Guillen and Natale, 2012). This latest analysis covers companies in 15 Member States (514 in the freshwater segment, 417 in the marine finfish segment and 72 in the shellfish segment), with a turnover representing around 70% of the EU aquaculture value of production estimated from FAO statistics.

While this data is not statistically representative, it gave the possibility to examine economic performance over time looking at the evolution of profitability for individual companies in 2010 in respect of the 2006 analysis of ERNST & YOUNG (2008).

The results shows that in 2009 the overall profitability of the EU aquaculture was of +4.3%. The highest profitability was recorded by companies in the marine segment in respect of freshwater and shellfish. The comparison between 2006, 2009 and 2010 indicated that after the economic downturn in 2009 aquaculture companies started to recover profits in 2010 in almost all segments and countries.

4. Performance of aquaculture at EU level

4.1. Highlights and trends

- Moderate growth of production in the marine segment and stagnation for freshwater and shellfish
- Most employment in shellfish but with lower labour productivity
- Intensification in the marine segments eroding the potential for job generation from increasing production
- GVA and turnover in freshwater and shellfish segment decreasing faster than production volume (i.e. loss in competitiveness)
- The degree of self-sufficiency of production low, especially in the marine finfish segment
- Apparent consumption mostly of marine fish
- Higher effluents and dependency from fishmeal and fish oil for the marine segment

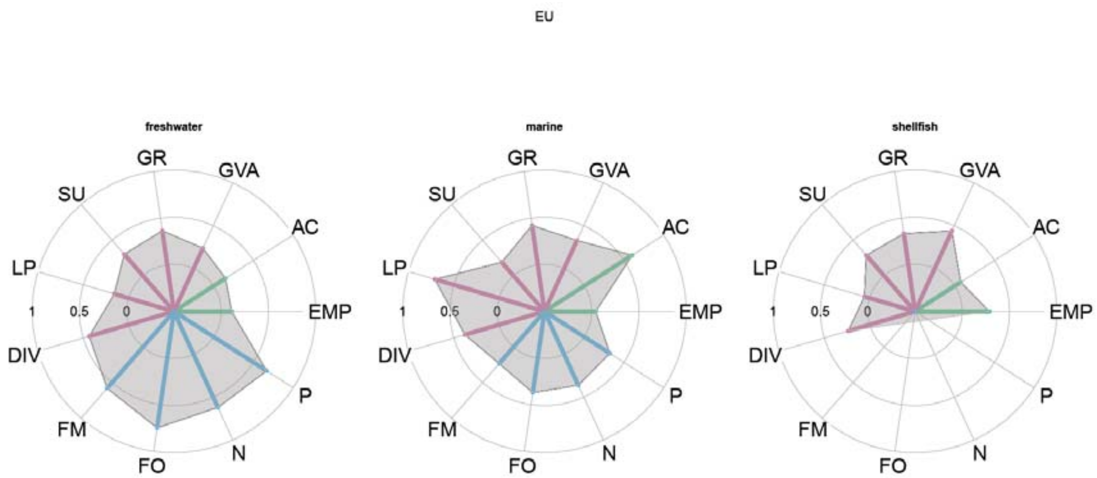


Figure 4 Performance indicators for the EU by segment (GR=Production growth, GVA=Gross Value Added, AC=Apparent Consumption, EMP=employment, P=Phosphorus effluents, N=Nitrogen effluents, FO=Fish Oil, FM=Fishmeal, DIV=Diversification, LP=Labour Productivity, SU= self-sufficiency ratio). In order to give the values of the environmental indicators (fishmeal, fish oil, N and P effluents) the same direction as indicators in the socio-economic dimension, the environmental indicators are presented as conjugated values (1 = lowest dependence on fishmeal/fish oil or lowest effluents, 0 = highest dependence on fishmeal/fish oil or highest effluents).

4.2. General overview, main species and production systems

In 2010, the value of EU aquaculture production was of 3.1 billion Euro and the volume of production was of 1.26 million tonnes. The EU share of world aquaculture production was 2.1% in 2010, down from 2.3% in 2009.

The EU aquaculture sector is represented by around 14,000 to 15,000 mostly small enterprises. The largest producing countries in the EU are Spain, France, United Kingdom, Italy and Greece. These five countries represent more than three quarters of the total EU aquaculture production by value and volume.

Although production covers around 100 different finfish and shellfish species, great part is concentrated on few species. In 2010 the major farmed species in the EU in terms of volume of production were: Mussels spp. (37.4%), Rainbow trout - *Oncorhynchus mykiss* (15.2%), Atlantic salmon – *Salmo salar* (13.5%), Pacific cupped oyster - *Crassostrea gigas* (8.2%), Gilthead sea bream - *Sparus aurata* (6.9%), Common carp - *Cyprinus carpio* (5.2%), European sea bass - *Dicentrarchus labrax* (4.2%), Japanese

carpet shell - *Ruditapes philippinarum* (2.9%), Turbot - *Psetta maxima* (0.6%) and European eel - *Anguilla anguilla* (0.5%). Together these species represented 94.5% of the total volume of EU aquaculture production.
From the total EU aquaculture production around 75% in value takes place in the marine environment. The largest part in terms of production quantity is shellfish culture in Spain (30.8%), France (28.3%), Italy (16.1%) and Netherlands (9.6%) (Figure 5), mainly run in extensive systems by small or family-run companies. Most of the marine finfish is produced in floating sea-cages, characterised by supply of reproductive materials from hatcheries, use of compound feeds and run by few specialised companies. The production is concentrated in United Kingdom (44.1%), Greece (24.7%) and Spain (11.7%). For the production of flatfish, like turbot, halibut or sole, intensive on-land farming in tanks or in recirculation systems is applied. Sea bream and Sea bass marine cage culture accounts for 44.4% of the value of the EU marine segment followed by Salmon marine cage culture with 41.3%.
The freshwater production is represented on one side by semi-intensive or extensive carp production in ponds, often associated to other agricultural and recreational activities and on the other side by a more intensive freshwater production for trout in raceways and tanks. While farming of carp and other cyprinids is very common in most central and eastern Member States, trout production is present in almost all Member States, with Denmark, France and Italy having the highest output in volume.

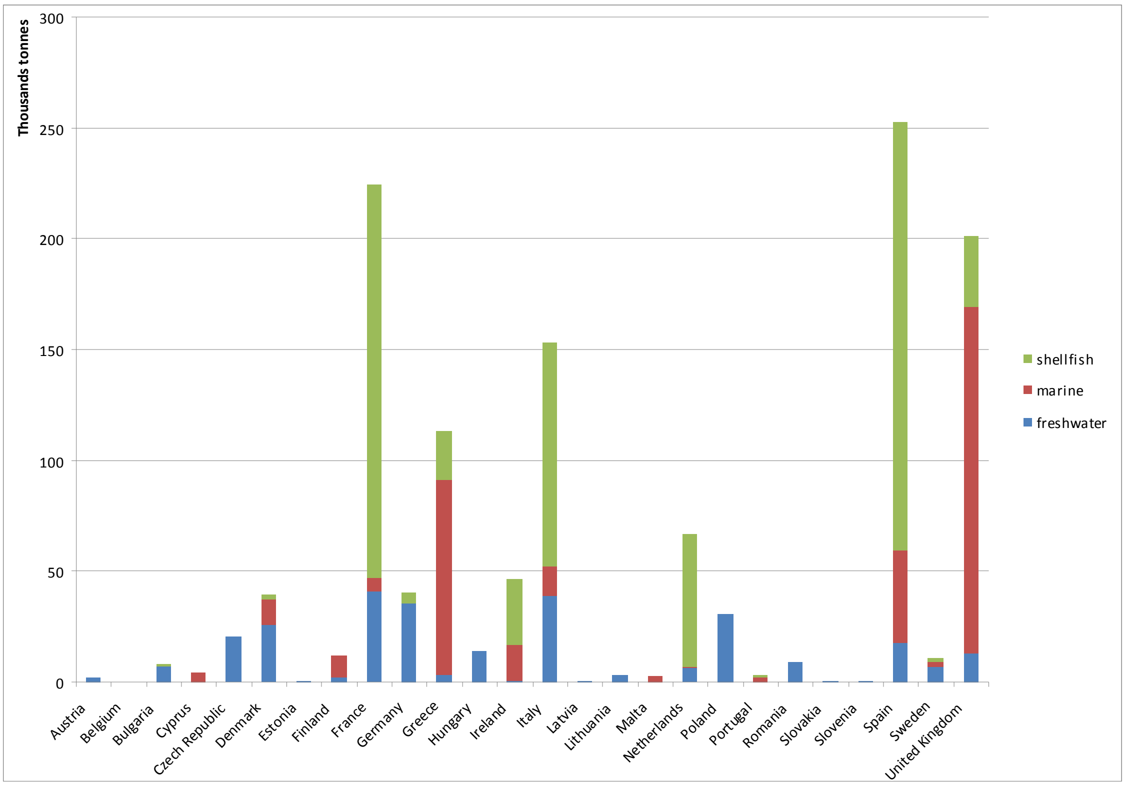


Figure 5 Aquaculture production by Member State and segment for 2010 (Source: FAO data 2010)

4.3. Production growth

In contrast with the strong growth of production in some regions of the world, mainly in Asia, the overall EU aquaculture production in recent years is stagnating. Between 2009 and 2010 there was a further decline of EU aquaculture production both in volume (-1.14%) and value (-5.3%). Overall, the aquaculture sector in the Union expanded in

the last 15 years its production by around 8% from 1.178 million tonnes in 1995 to 1.276 million tonnes in 2010 with a pike in 1999 of around 1.425 million tonnes. The general growth pattern by volume is strongly influenced by the shellfish segment which grew until 1999 from 692,000 tonnes to 825,000 tonnes. With some fluctuation, from 1999 it experienced a continuous decline to 625,000 tonnes in 2010. The strongest and most continuous growth can be seen in the marine finfish aquaculture which more than doubled the production volume since 1995 from some 152,000 tonnes to 355,000 tonnes in 2010. In the same period the output from freshwater aquaculture fell from 335,000 tonnes to 280,000 tonnes. The indicator for marine finfish aquaculture shows the highest value, corresponding to a positive trend of +3.1% from 2006-2010, while the trend in the freshwater and shellfish segment is slightly negative (-0.49% and -2.4%, respectively) (Figure 6).
The highest growth rates in volume in the shellfish segment are in Denmark (+58%), Bulgaria (+39%), Netherlands (+12%); in the marine segment in Netherlands (+28%), Slovenia (+24%) and Sweden (+14%); in the freshwater segment in Belgium (+38%), Bulgaria (+25%) and Sweden (+15%) (Figure 7).

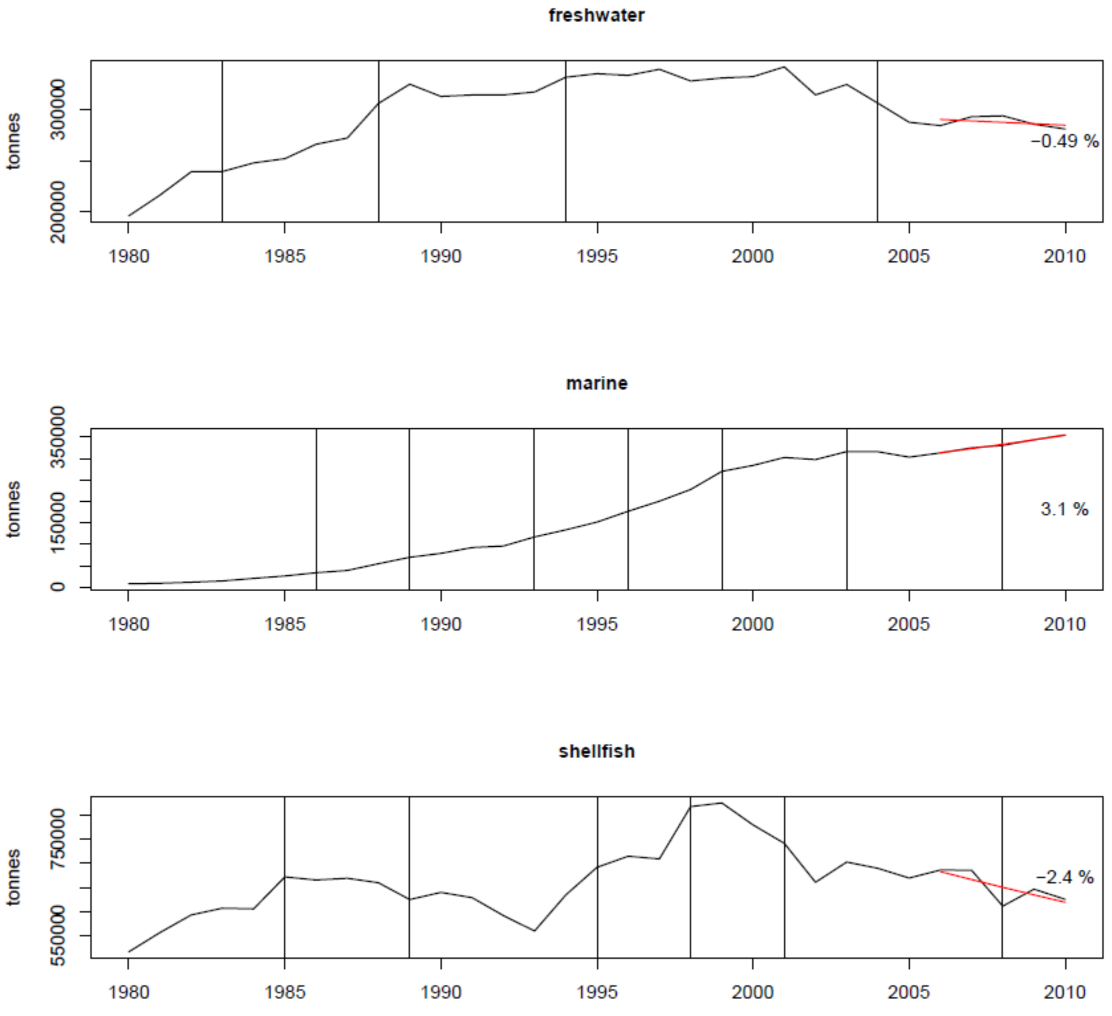


Figure 6 Production growth: production pattern of EU aquaculture by volume over time until 2010 with the trend of the last five years (2006-2010)

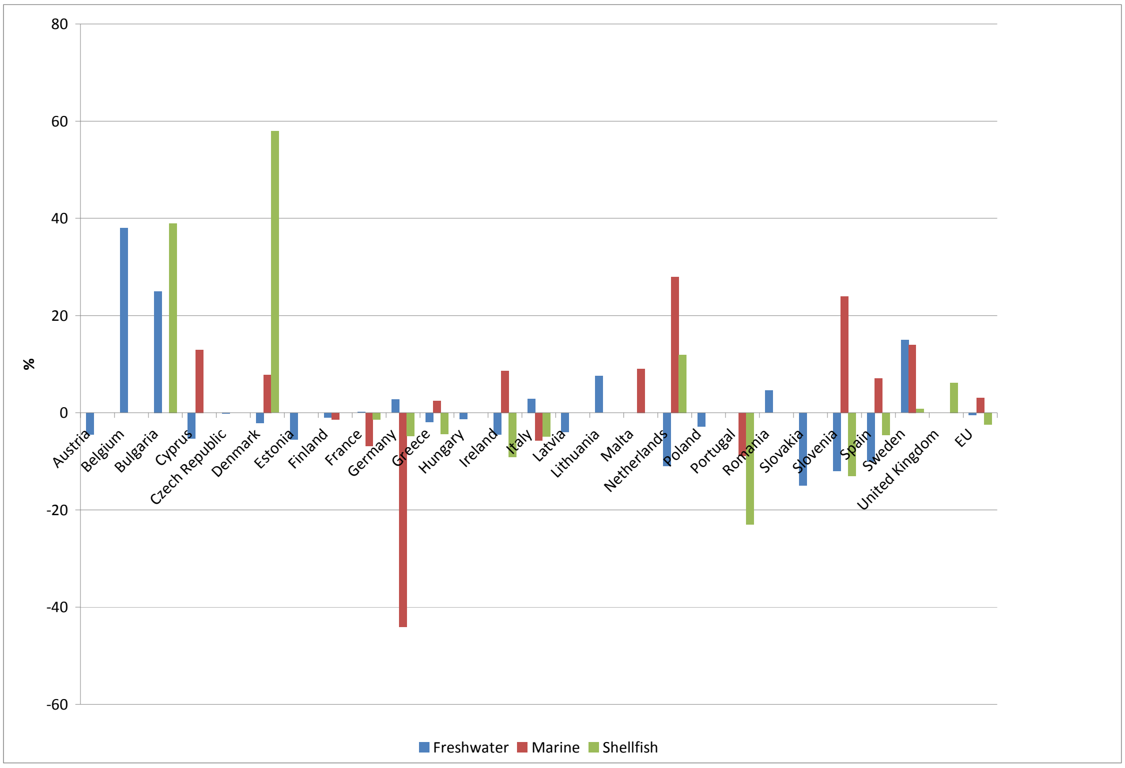


Figure 7 Production growth trends of aquaculture in the Member States between 2006 and 2010 by segments in percentage of volume (Source: own modelling of FAO production data)

4.4. Employment

In 2010, from modelling the employment, EU aquaculture accounted for estimated 69,368 jobs. The highest contribution to employment in absolute terms is coming from the shellfish segment in Spain (29% of total employment) and France (21% of total employment). The freshwater segment showed over the last 15 years little variation. From around 20,000 persons in 1995 the number decreased to around 17,500 in 2010. In the marine finfish segment the employment increased from around 5,000 persons in 1995 to around 9,000 in 2003, and decreased afterwards to around 6,500 in 2010. The shellfish segment showed a steady increase from 33,700 in 1995 to a maximum of around 47,400 in 2001 and accounting in 2010 for estimated 45,000 persons.

The models used to estimate employment are based on data collected in several reports on the employment in the EU aquaculture sector since 1996. The models establish for each segment and country a relation between employment and production volume or productivity over time. The results indicate in many cases a decrease over time in the number of jobs for the same amount of production. This is an effect of increasing production efficiency and intensification which is particularly evident in the case of the marine and in some freshwater segments while almost absent in the more extensive shellfish production.

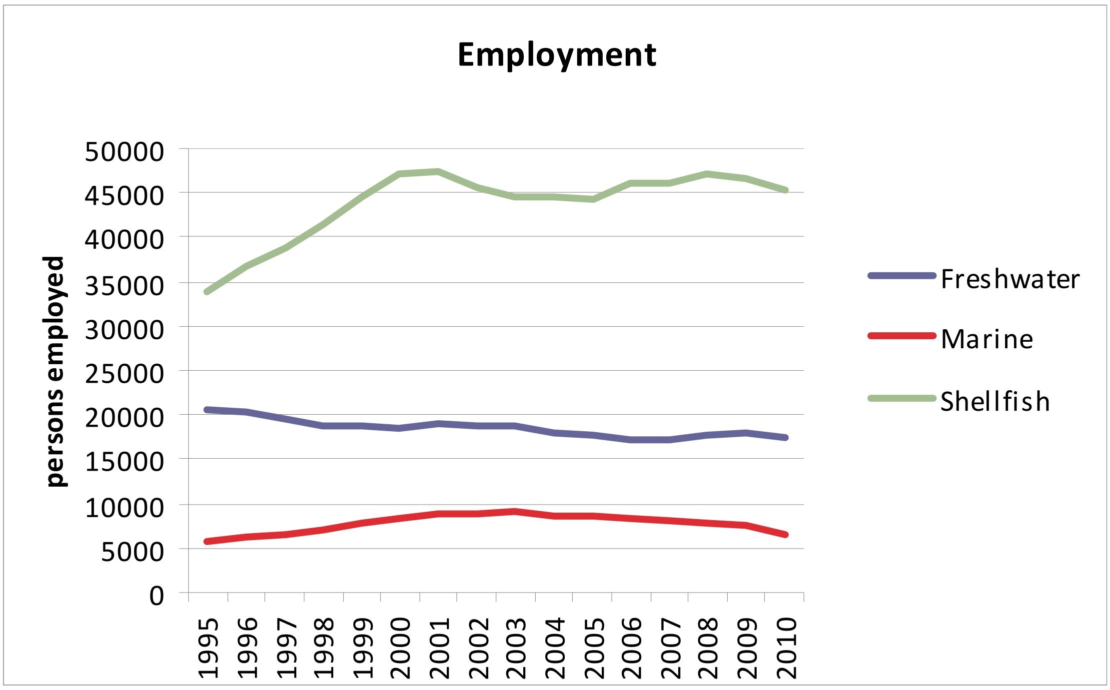


Figure 8 Estimated employment for EU aquaculture by segment

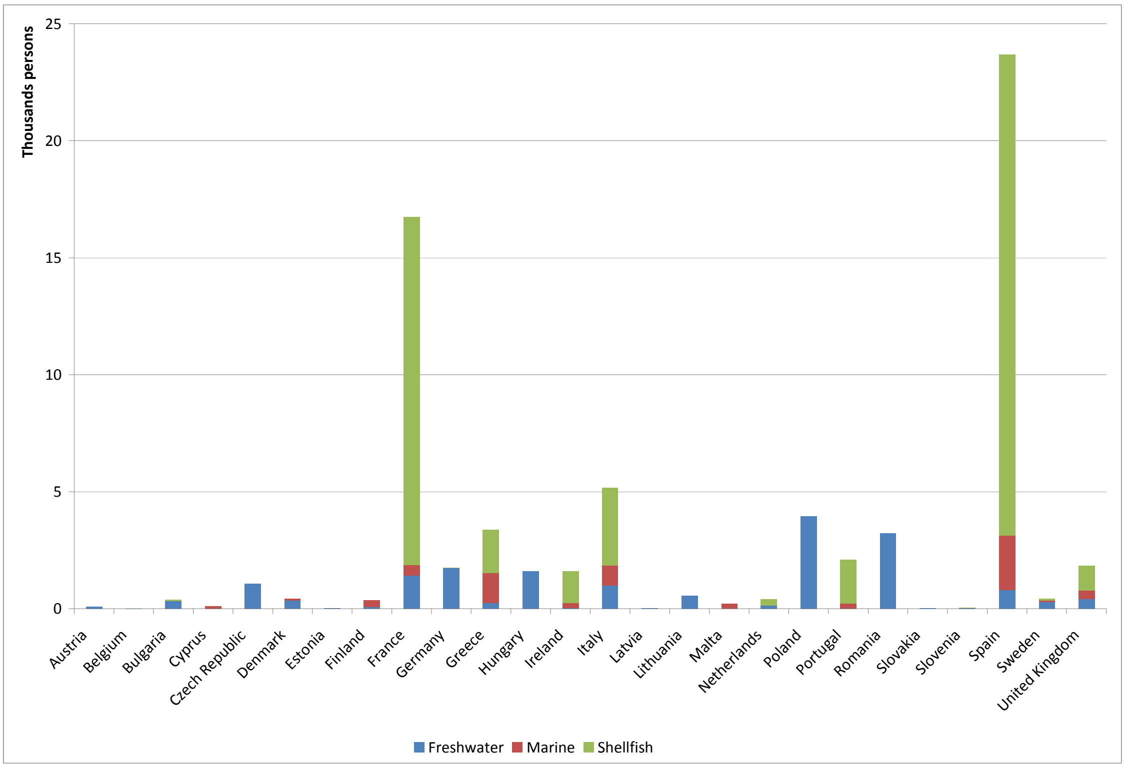


Figure 9 Employed persons in aquaculture by Member State and segment for 2010 (Source: own estimates based on data from FAO; STECF, 2012; STECF, 2013; FRAMIAN, 2009)

4.5. GVA

The total GVA of EU aquaculture was of 1,084 million Euro in 2010 which represents 0.6% of the GVA in the primary sector. The GVA for the marine segment was representing 32% of total aquaculture GVA while the value of production was 46% of the total turnover. The situation is opposite in the case of shellfish culture which thanks

to the lower operational costs is contributing for 44% to total GVA and for 30% to the total value of production. Despite the stagnation of freshwater aquaculture in terms of quantity produced, its ratio to the agriculture GVA was increasing from 2005 to 2009 thanks to an increase of the value of production.
From 2009 to 2010 the freshwater and shellfish segments were characterised by a reduction in GVA respectively of -17% and -13% which is well exceeding the slight contraction in the volume of production (-0.49% and – 2.4% respectively between 2006 and 2010). The loss in GVA for these two segments can be attributed to the strong decrease in turnover and indicating a problem of lack of profitability and competitiveness of the industry.

Table 2 Gross Value Added, employment and labour productivity in EU aquaculture by segment

	2005	2006	2007	2008	2009	2010
Turnover (mln Euro)						
Freshwater	663	689	784	905	910	773
Marine	1,132	1,313	1,567	1,517	1,391	1,446
Shellfish	894	902	1,040	1,034	1,005	917
Total	**2,690**	**2,904**	**3,391**	**3,455**	**3,305**	**3,135**
Gross Value Added (mln Euro)						
Freshwater	221	229	262	300	303	256
Marine	275	318	378	374	341	353
Shellfish	461	468	539	535	518	474
Total	**957**	**1,015**	**1,179**	**1,210**	**1,162**	**1,084**
Employment (persons)						
Freshwater	17,605	17,066	17,132	17,625	18,082	17,565
Marine	8,639	8,298	8,181	7,912	7,502	6,520
Shellfish	44,340	46,063	46,198	47,084	46,620	45,283
Total	**70,584**	**71,426**	**71,510**	**72,622**	**72,204**	**69,368**
Labour productivity (Euro/person)						
Freshwater	10,947	11,850	13,177	14,276	14,329	12,240
Marine	30,298	36,743	44,485	45,315	44,088	52,563
Shellfish	6,184	6,198	7,203	5,381	5,193	4,992

Source: own estimates

Most of the GVA is generated by shellfish production in France (248 million Euro), marine production in Greece (81 million Euro), shellfish production in Italy (70 million Euro) and shellfish and marine production in Spain (respectively 67 and 62 million Euro).

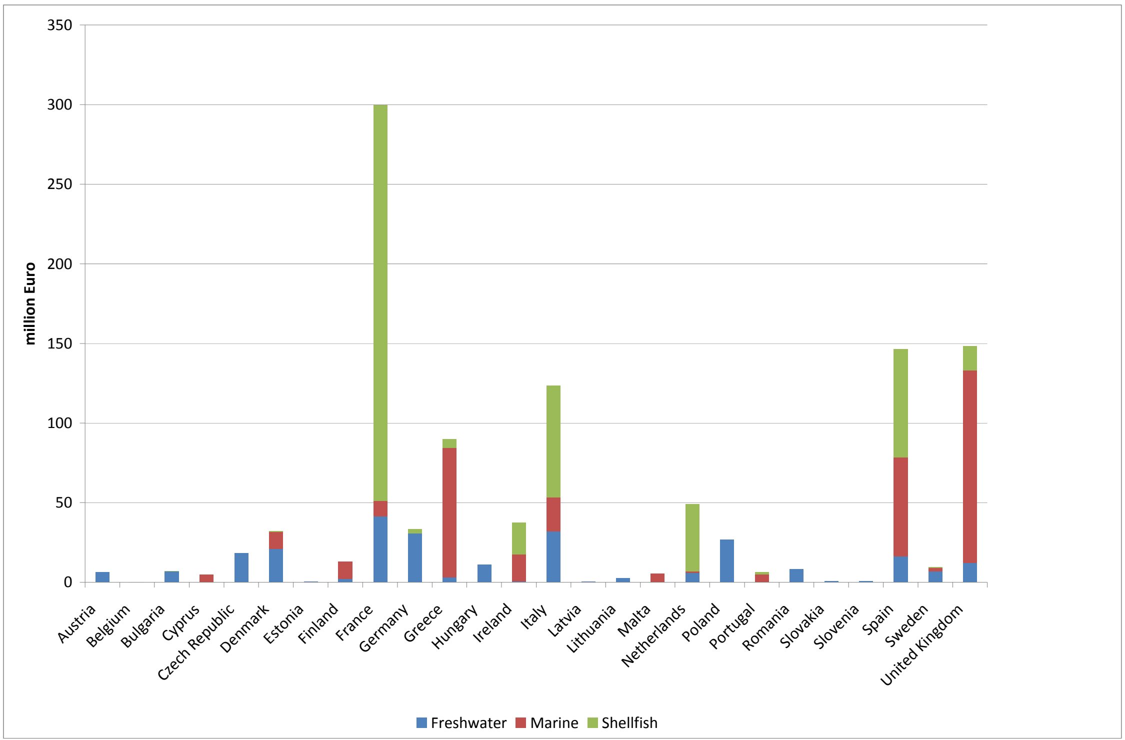


Figure 10 Gross Added Value of aquaculture in million Euro by Member State and segment for 2010 (Source: own calculations based on data from FAO, EUROSTAT, STECF 2012, STECF 2013, FRAMIAN 2009)

4.6. Labour productivity

The inclusion of two separate indicators for employment, based on total number of employed person in the social dimension and labour productivity in the economic dimensions, was dictated by the need of measuring the performance in respect of different and not necessarily homogenous sets of priorities. The performance in terms labour productivity is highest in the marine segment, followed by the freshwater and shellfish segment.

Over time there has been an increase of labour productivity for the whole aquaculture which can be mostly attributed to an increase in the value of production and in the GVA value of freshwater aquaculture and to the intensification process in the marine segment. While extensive freshwater and shellfish aquaculture offer more jobs to costal or rural communities per unit of production, the labour-productivity in these traditionally low-input production systems is considerably lower than in more intensive marine farming systems.

The GVA per employed person in the EU shellfish segment in 2010 was around 5,000 Euro while it reached around 52,000 Euro in the marine segment. In the marine segment between 2008 and 2010 there was a decrease in GVA of -6% while the decrease in employment was of -21%. There is a tendency in the marine sector towards intensification which is absorbing the job creation potential from the increase production volume (+3.1% between 2006 and 2010).

4.7. Profitability

The analysis of profitability is based on a panel of limited number of companies which represent around 70% of the EU aquaculture by value. While this panel may not be statistically representative especially for small companies in the shellfish segment it gave the possibility to analyse the evolution of profitability over multiple years. The profitability measured with the EBIT margin was of 4.26% in 2009, 10.91% in 2006, 7.42% in 2010 and 8.13% in 2011. The comparison of data for the same companies between 2006, 2009 and 2010 indicates that after the economic downturn in 2009 aquaculture companies started to recover profits in 2010 in almost all segments and countries. The highest profitability was recorded by companies in the marine segment in respect of freshwater and shellfish.

Table 3 Profitability (EBIT ratio) of the EU aquaculture sector based on a panel of companies from the AMADEUS database

Years	N. companies	Turnover (‘000 €)	EBIT (‘000 €)	EBIT ratio (%)
2006	510	1,738,826	189,675	10.91
2009	1,024	2,495,624	106,318	4.26
2010	996	2,513,175	186,485	7.42

4.8. Self-sufficiency

Taking into consideration the main commercial species groups with a prevalence in aquaculture (i.e. carp, trout, salmon, sea bass, sea bream, eel, turbot, tilapia, clams, mussel, oyster), the period from 2004 to 2010 is characterised by a decreasing degree of self-sufficiency for the Union’s supply. In the finfish aquaculture, the share fall in the freshwater segment from some 92% in 2004 to almost 75% in 2010, and in the marine segment from some 40% to around 29% while the shellfish segment remained relatively stable at around 68%. For Member States a share on supply of more than 100% indicates that their aquaculture is export oriented, as e.g. for Cyprus, Greece, Ireland, Malta and the United Kingdom in the marine finfish segment, for the Czech Republic, Denmark and Sweden in the freshwater segment ,and for Ireland and the Netherlands in the shellfish segment.
Considering the 11 main commercial species with prevalence in aquaculture, the degree of self-sufficiency of aquaculture for the Member States and the EU as a whole is shown in Figure 11.

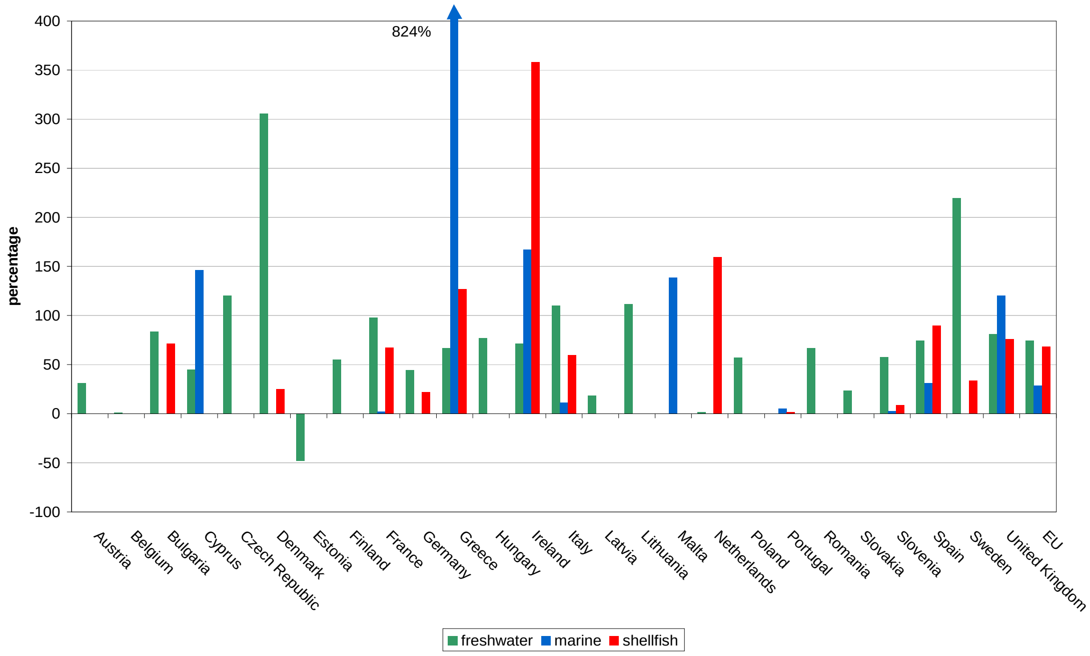


Figure 11 Self-sufficiency ratio of aquaculture for the main commercial species with prevalence in aquaculture by Member State and segment for 2010 (Source: own estimates based on production and COMEXT data)

4.9. Diversification

Diversification expresses a measure on the number of farmed species and how evenly the quantity produced is distributed among these species. In the EU, diversification in production is highest in the freshwater segment where more species contribute strongly to the production and lowest in the shellfish segment.

An indicator for diversification is considered useful in particular in respect of the specific target included in the proposal for the new EMFF to support investment for diversification of the income of aquaculture enterprises through the development of new aquaculture species. It has not necessarily to be seen as indicator of economic performance and there are several cases of successful economic performance based on the intensive farming of a single species. On the other hand the introduction of new species may be considered important especially in a young industry like aquaculture which has still to exploit its full potential in the domestication of new species.

For the EU as a whole, the indicator is calculated as the average of the Member State values as otherwise, due to the diverse national production systems the indicator would shows greater values compared to the national values. It should be seen as a reference point for the values for individual Member States.

4.10. Apparent Consumption

The apparent consumption of fisheries products in the Union (from aquaculture, capture fisheries and imports) is dominated by marine finfish products with estimated 13.9 kg per capita in 2009. Freshwater and shellfish products contributed with around 3.4 kg and 1.7 kg, respectively. While marine finfish and shellfish show little variation, the apparent annual consumption of freshwater products increased steadily from around 1.6 kg in 1990.

4.11. Fishmeal, fish oil

Due to the dominance of carnivorous species in the EU marine finfish aquaculture, the demand of fishmeal and fish oil per tonne of fish produced is around double than for freshwater production (280 kg/t fish fishmeal and 100 kg/t fish oil in freshwater finfish, 490 kg/t fishmeal and 240 kg/t fish oil in marine finfish). The large amount of fish oil per tonne for marine finfish reflects the strong salmon production in the marine environment which requires higher levels of fish oil in the diet. In total, the estimated use in the marine finfish segment was in 2010 more than two times the amount of freshwater aquaculture for fishmeal (177,064 compared to 80,936 tonnes) and three times the amount for fish oil (87,555 compared to 28,178 tonnes).

4.12. Effluents

Nitrogen and phosphorus effluents per tonne of finfish produced are higher in the marine than in the freshwater segment. The nitrogen effluents with some 69 kg/t of marine finfish production are around 1.5 times the nitrogen in the freshwater production with 45 kg/t. With around 11 kg/t fish produced, the phosphorous effluents in the marine finfish segment are around 1.7 times higher than in the freshwater segment (6.6 kg/t). In total, the estimated effluents of the marine finfish segment were in 2010 around 1.9 times the amount of freshwater aquaculture for N (around 24,700 compared to 12,700 tonnes) and more than two times the amount for P (~ 4,000 tonnes compared to 1,800 tonnes).

5. Performance of aquaculture in the Member States

In this chapter for each Member State with the exception of Luxembourg the most important finding are summarised, followed by the overview diagrams for the 11 indicators and charts. For Luxembourg the aquaculture sector appeared to be too small to create a country profile.

The diagrams picture the national situation for the selected indicators in each segment (freshwater, marine and shellfish). Each indicator in the radial graph is presented by a vector. The length of the vector stays for a value between 0 and 1, with 1 at the outer radius of the graph. The normalization of the indicators allows a direct comparison of values between the three segments and between Member States. The shaded area in the background of each radial graph displays the corresponding indicator values for the EU as a total in the segment. The values are shown for the last available year, which is for most indicators 2010, for the apparent consumption the year 2009 and for production growth the last 5-years period (2006-2010). In the case of Member States the import and export included intra and extra community trade, while in the case of the EU as a whole, only extra community trade was included. In order to give the values of the environmental indicators (fishmeal, fish oil, N and P effluents) the same direction as the socio-economic indicators, the environmental indicators are presented as conjugate values (1 = lowest dependence on fishmeal/fish oil or lowest effluents, 0 = highest dependence on fishmeal/fish oil or highest effluents).

Beside the graphic display, the sector, its segments, performance and trends are briefly described.

5.1. Austria

<u>Highlights and trends</u>

- National production in a declining trend (2006-2010 -4.5%)
- Small entities, often in part-time or combined with non-production oriented activities, serving mainly the local market
- High diversification of farmed species contributing to the production
- High labour productivity with limited employment
- GVA is slightly above the EU as a total
- Relative small total amounts of effluent from aquaculture

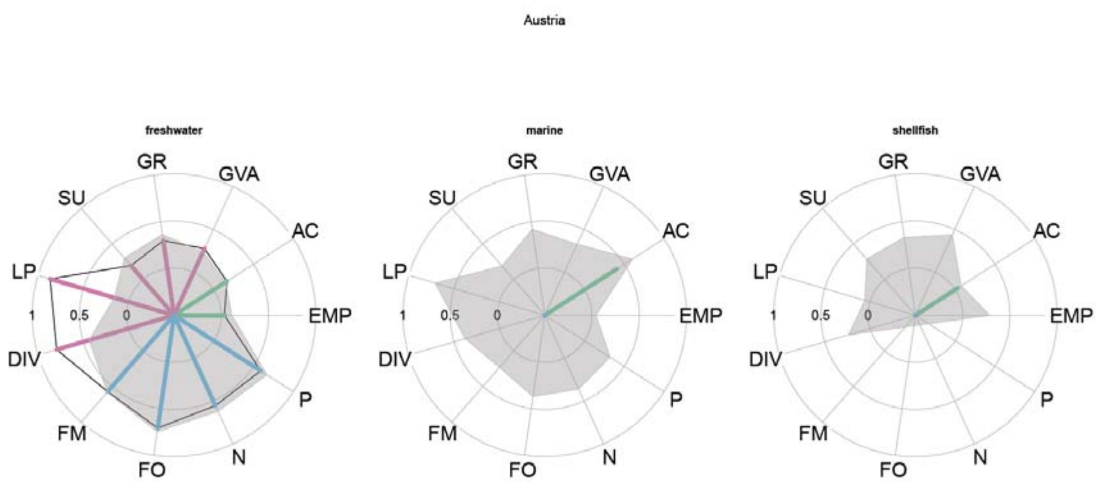


Figure 12 Performance indicators for Austria by segment

Overview of the sector

As a landlocked country, Austria has only freshwater aquaculture and contributes with 2.7% of production value or 0.8% of production volume to the EU freshwater aquaculture. Aquaculture is mostly performed in ponds, lakes and raceways by small enterprises or as part-time activity and fulfils also non-production oriented functions, e.g. for recreation, tourism, sport fishing.

The predominant aquaculture fish species are rainbow trout, brook trout and common carp with together almost 85% of the total annual production of 2,167 tonnes in 2010.

Following a steady decline in production over the last decades, the decreasing trend continued the last five years with -4.5%.

Aquaculture contributes with a low GVA very little to the overall agriculture production but reached in 2010 a level above the freshwater segment of the EU in total.

The contribution of the freshwater aquaculture to the available supply of freshwater fisheries products remained over the last years low (in 2010 with some 31%).

The sector offers very little employment, with a maximum of round 140 persons in 1999; since then a clear downward trend has been observed (in 2010, <100 persons estimated). Labour productivity increased steadily and is well above the EU ratio of the segment.

Apparent consumption of fishery products from freshwater production is slightly above the EU average. Apparent consumption of marine fishery products presents about double the value of freshwater products. Shellfish seems to play a minor role in the Austrian consumption pattern.

The total amounts of fishmeal and fish oil used in aquaculture in 2010 were relatively small (634 and 250 tonnes, respectively). The input per tonne fish produced lies with 293 kg of fishmeal and 115 kg of fish oil close to the Union level of the segment.

The N and P effluents per tonne finfish produced are with 52 kg N and 8 kg P slightly higher than the Union levels. In absolute terms, they were estimated for 2010 to have reached some 112 tonnes of N and 17 tonnes of P.

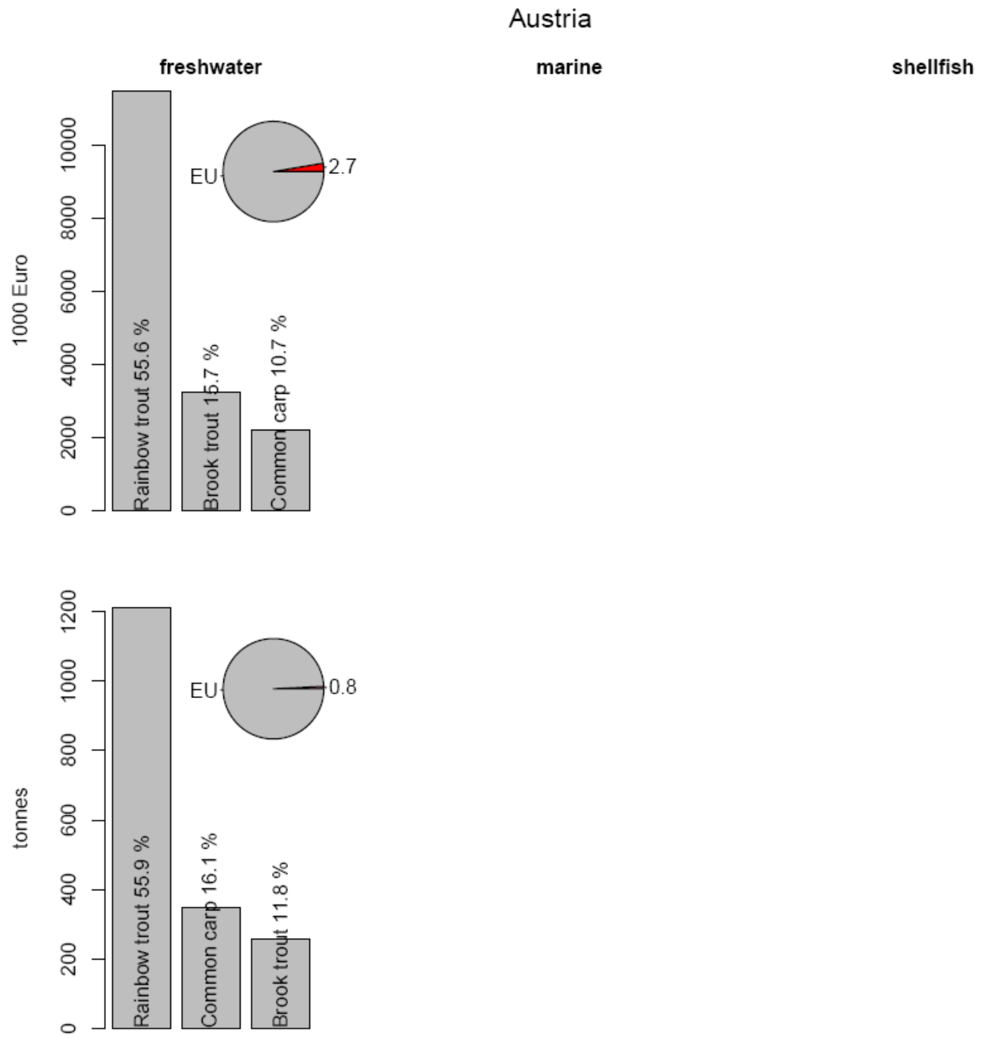


Figure 13 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment

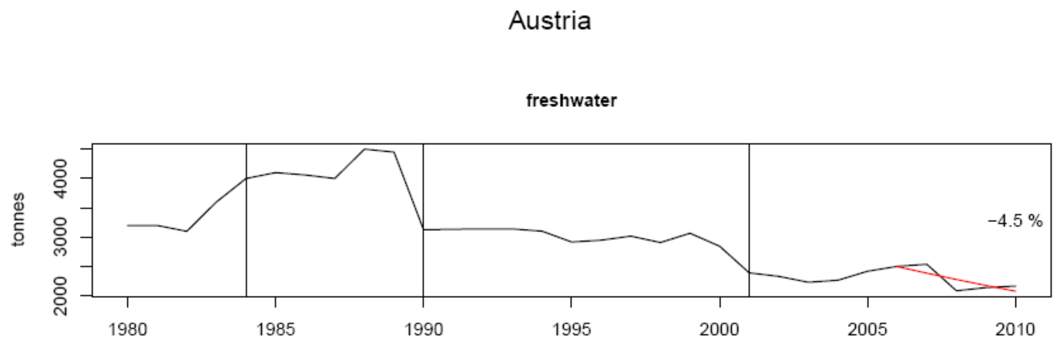


Figure 14 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010)

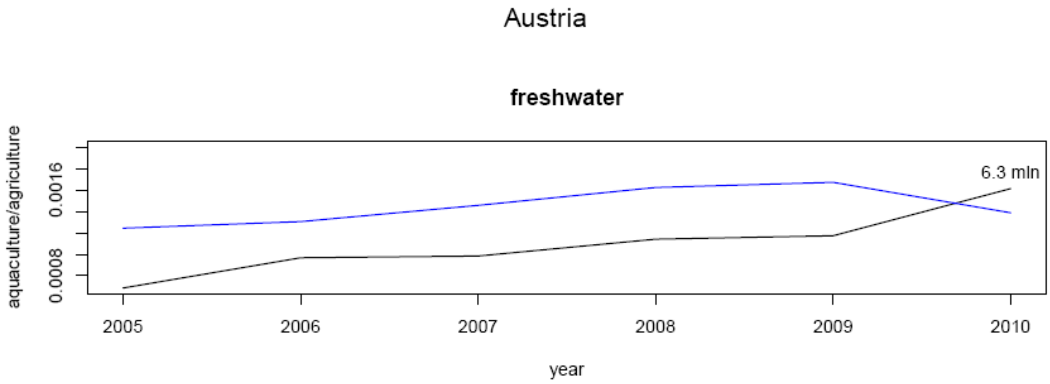


Figure 15 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in million Euro, blue line = GVA ratio for the EU as a whole).

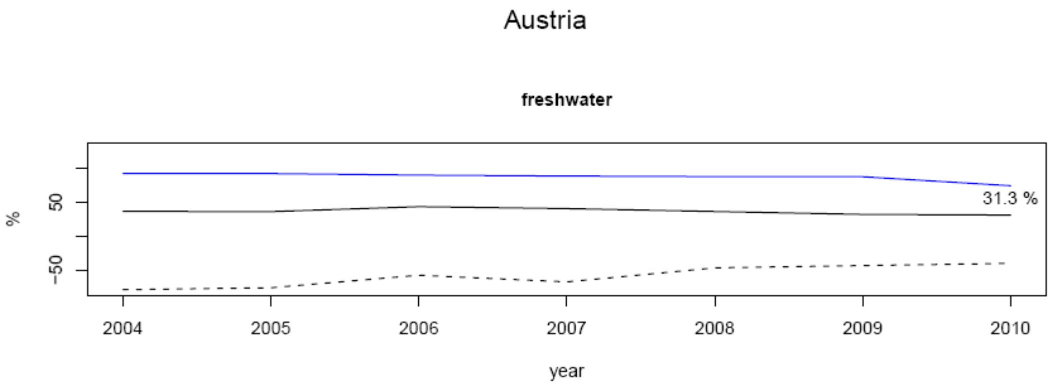


Figure 16 Self-sufficiency and trade: Share of the freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Austria, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segment.

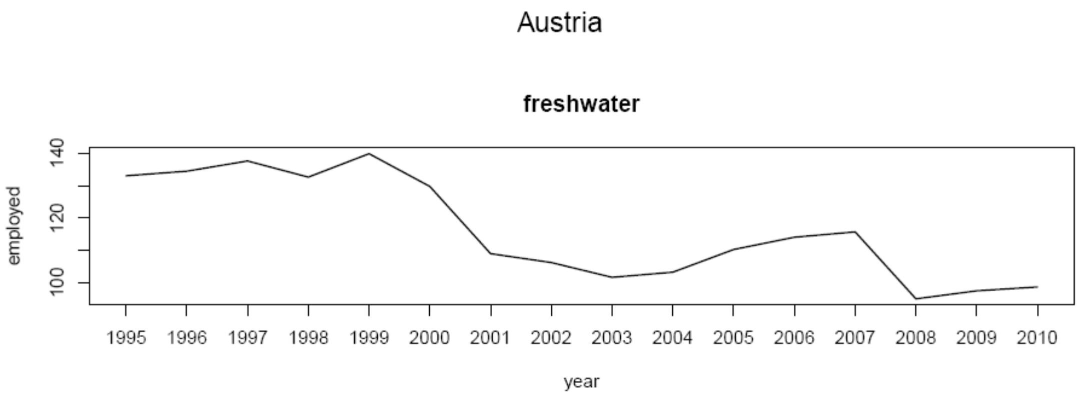


Figure 17 Number of employed persons in the freshwater finfish segment in Austria over time. Since no data was available from DCF or previous reports the employment is estimated from production statistics using a generic EU model.

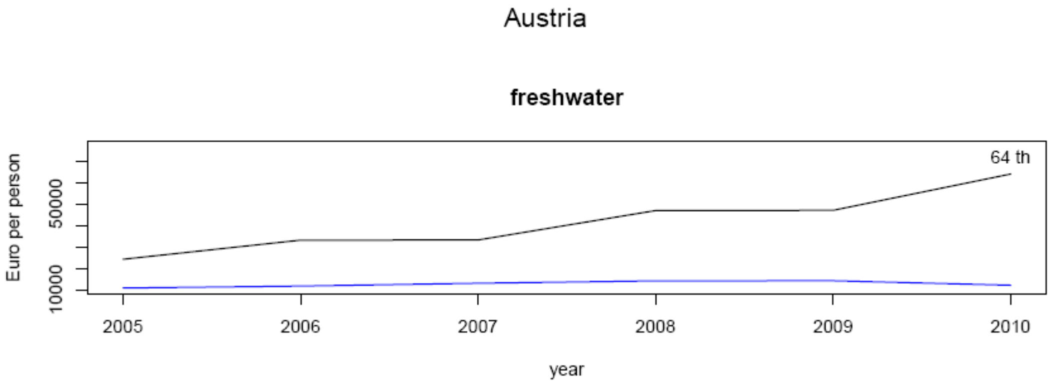


Figure 18 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

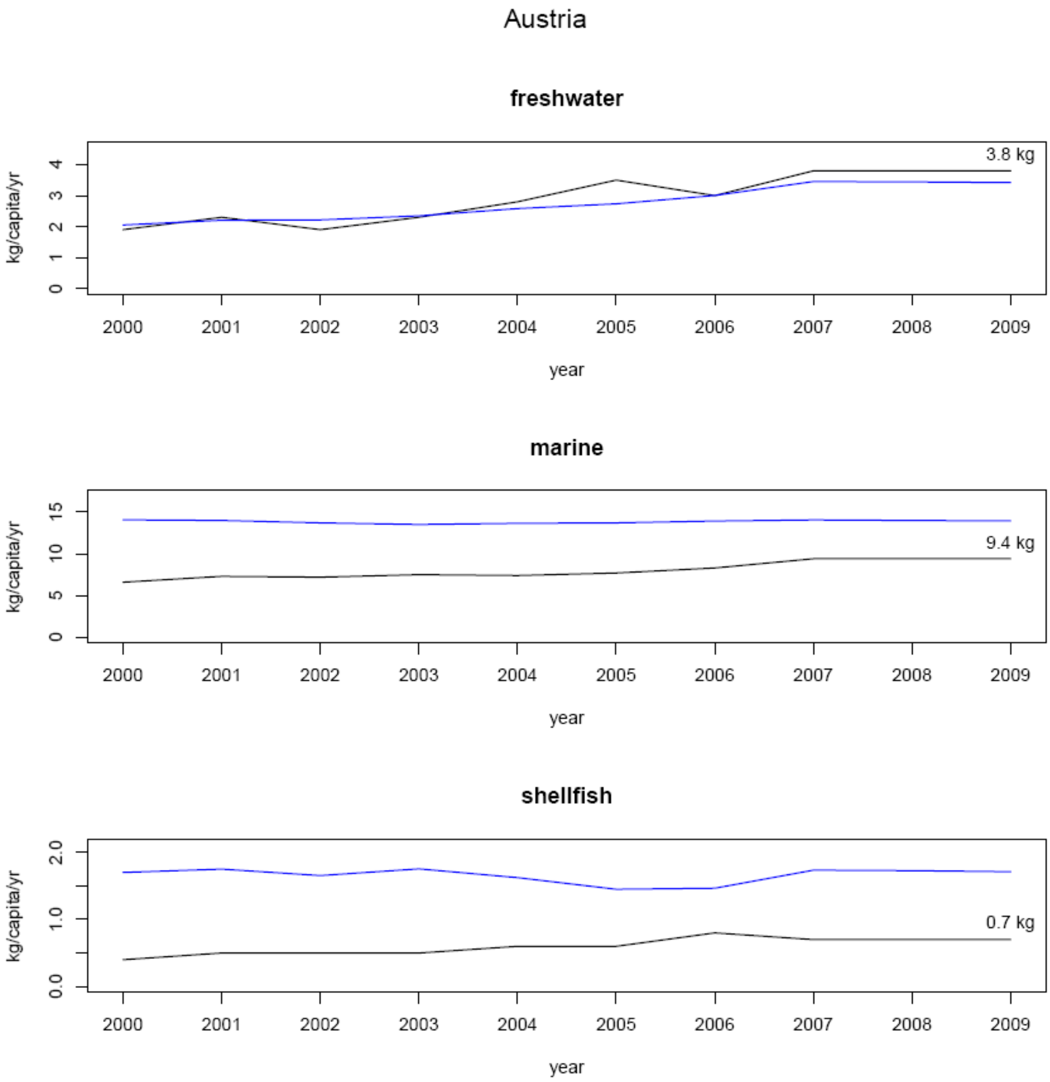


Figure 19 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

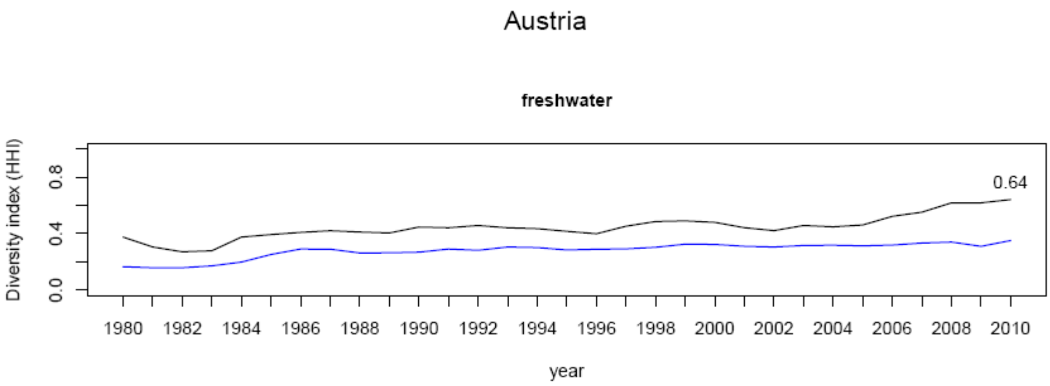


Figure 20 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.2. Belgium

Highlights and trends

- Small national production with a positive growth trend in the period 2006-2010 (+38%) after a fall of production between 2000 and 2006
- View small entities, serving mainly the local market
- High labour productivity with very limited employment
- GVA very low
- High apparent consumption of freshwater finfish and shellfish
- Relative small amounts of effluent from aquaculture in absolute terms
- Fishmeal / fish oil demand and amounts of effluents based on data of high aggregation ("freshwater fishes nei" in the statistics)

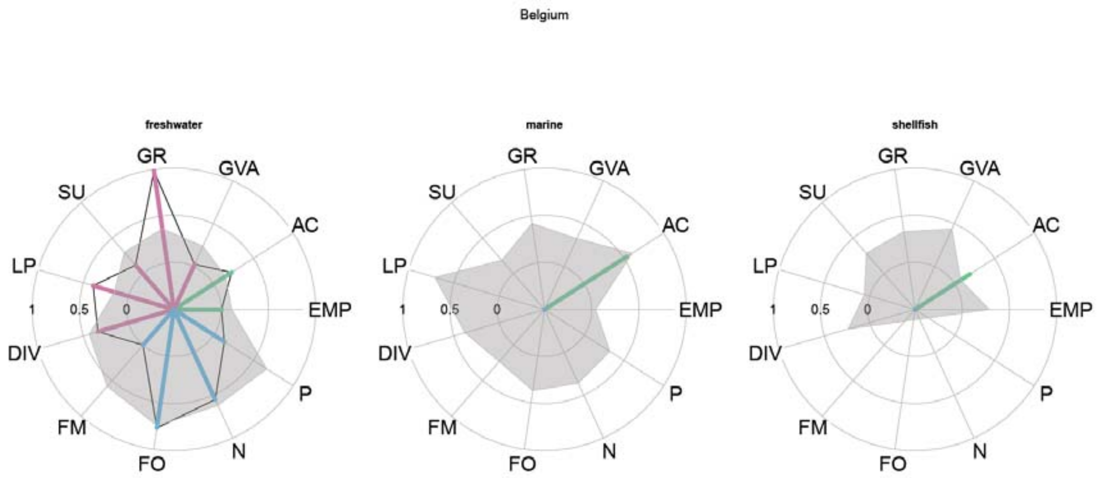


Figure 21 Performance indicators for Belgium

Overview of the sector

Belgium has a small freshwater aquaculture sector with a production of some 476 tonnes in 2009 and 239 tonnes in 2010, mainly trout, carp, tilapia and catfish. There is practically no marine finfish and shellfish aquaculture industry.

From some 103 companies 100 engage in freshwater and 3 in marine aquaculture.

Since 2004 a strong decrease in production occurred. For the period from 2006-2010 a positive growth trend (+38%) can be observed due to a higher production in 2009.

Aquaculture has a very low GVA.

The contribution of the freshwater production to the self-sufficiency of fisheries products is marginal.

Very little employment emerges from the model, with a maximum of around 80 persons in 2002, followed by a strong decrease since then. The decrease in employment is resulting in an increase of labour productivity.

Apparent consumption of freshwater and shellfish products is well above and of marine finfish products close to EU average.

Most of the production is subsumed in the annual statistics under "freshwater fishes nei". As a consequence, the calculations for the environmental indicators are based on parameters for "other finfish" with a high FCR value (2.0) and high content of fishmeal in the diet (35%). For this reason Belgium shows a high dependence of its production on fishmeal (around 640kg/tonne fish produced). The demand of fish oil is with 91 kg/tonne fish produced close to the Union level in freshwater production. In total, for 2010 some 153 tonnes of fishmeal and 22 tonnes of fish oil have been calculated.

The high P effluents (14 kg/tonne finfish) relate to the fact that most of the national production falls under the category “other finfish” with a relatively high P effluent value. N effluents are with 52kg/ton finfish produced close to EU level. The estimated total load can be considered as rather minor (some 12 tonnes of N and 3 tonnes of P in 2009).

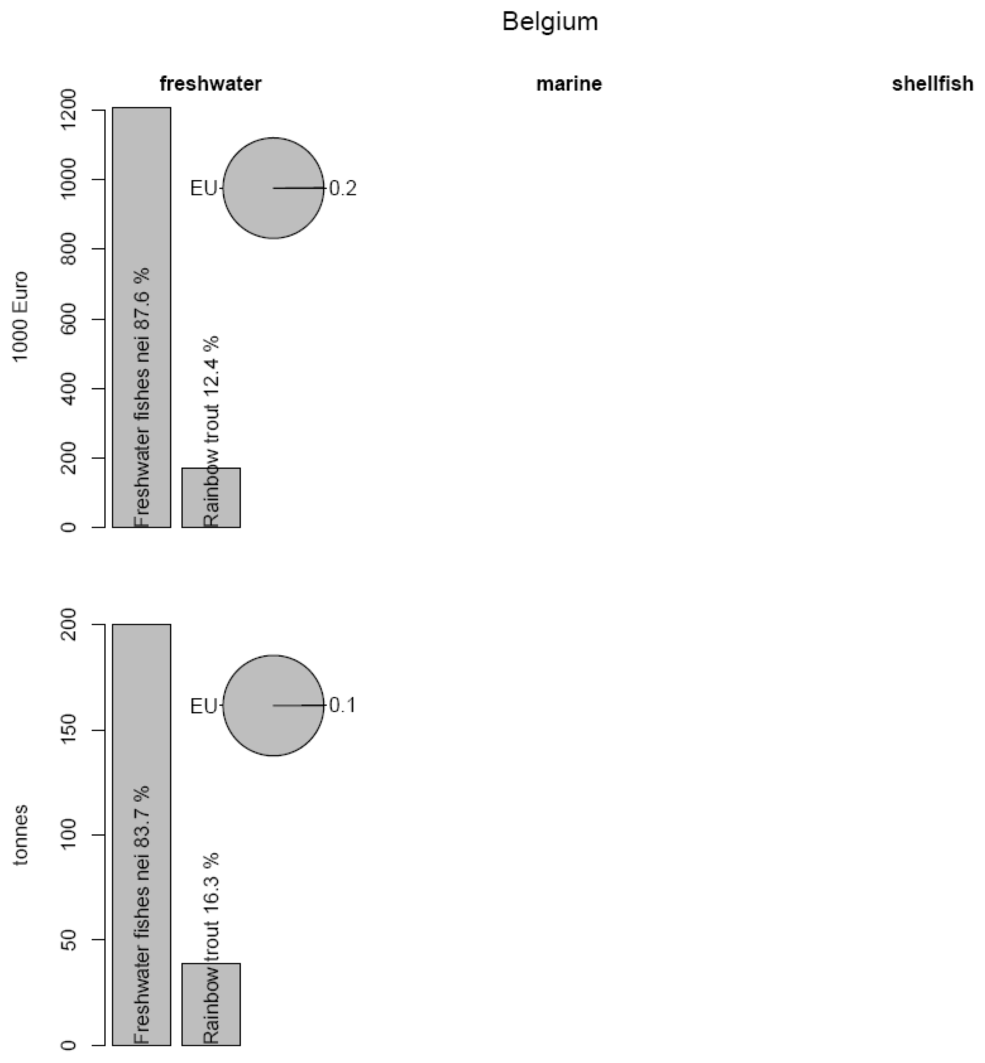


Figure 22 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

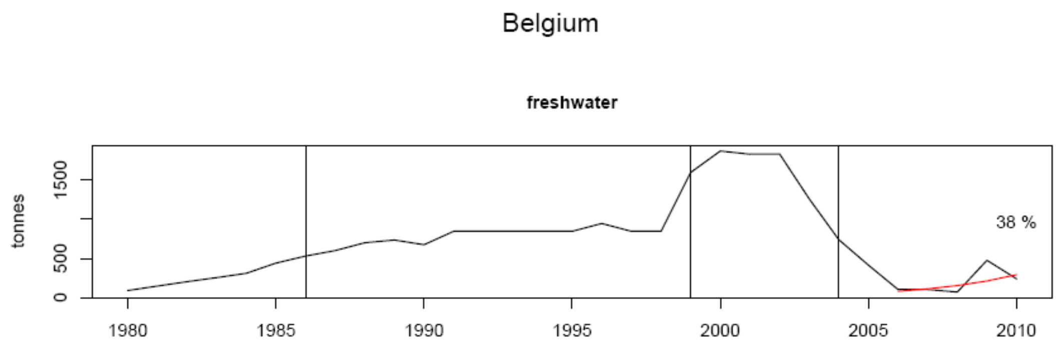


Figure 23 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

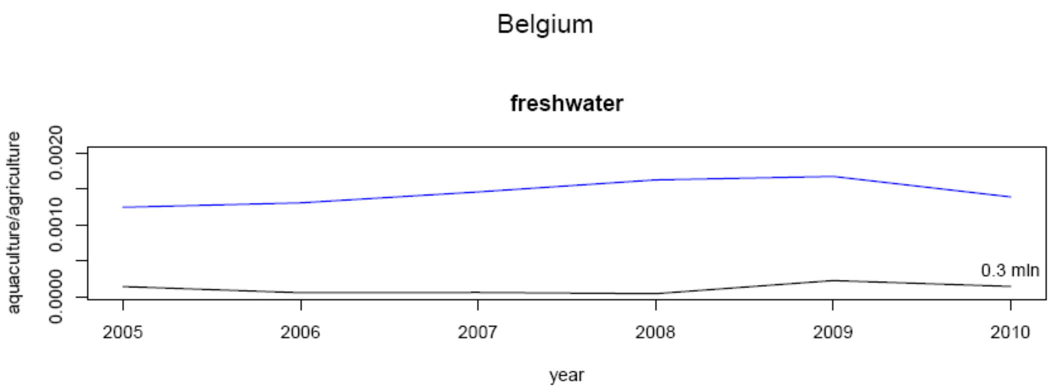


Figure 24 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in million Euro, blue line = GVA ratio for the EU as a whole).

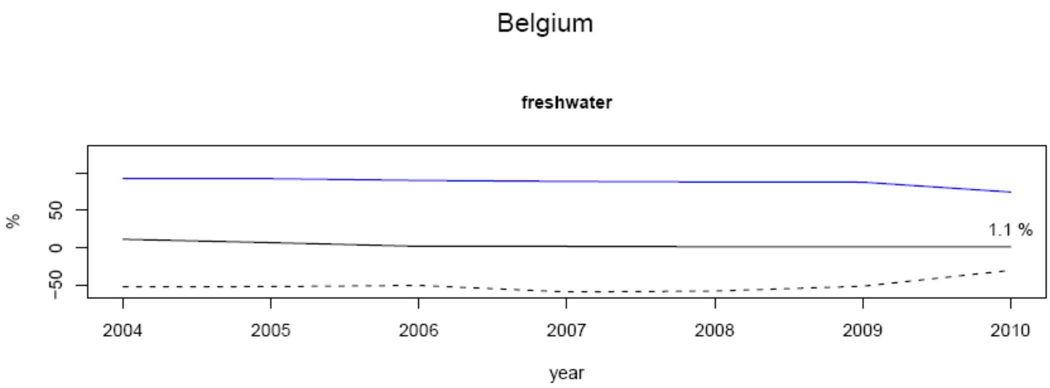


Figure 25 Self-sufficiency and trade: Share of the freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Belgium, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segment.

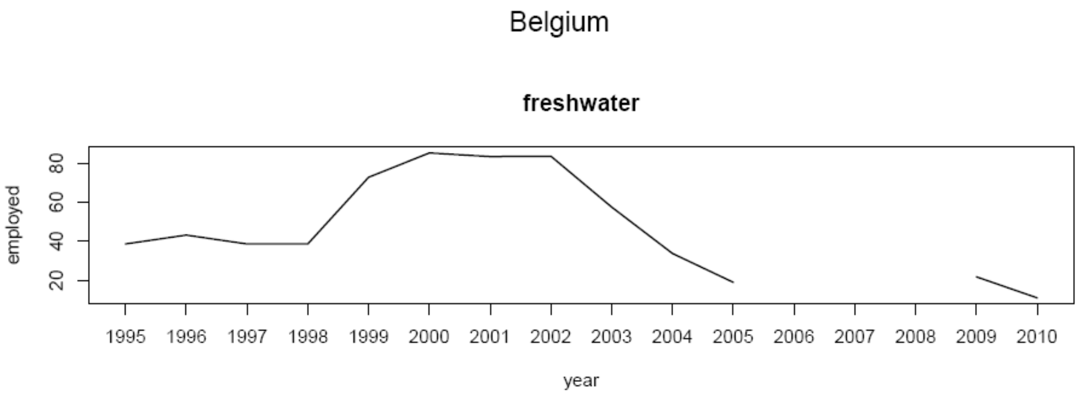


Figure 26 Number of employed persons in the freshwater finfish segment in Belgium over time. Since no data was available from STECF (2012 and 2013) the employment is estimated from FAO production statistics using a generic EU model (calculated values below 10 persons employed are not pictured).

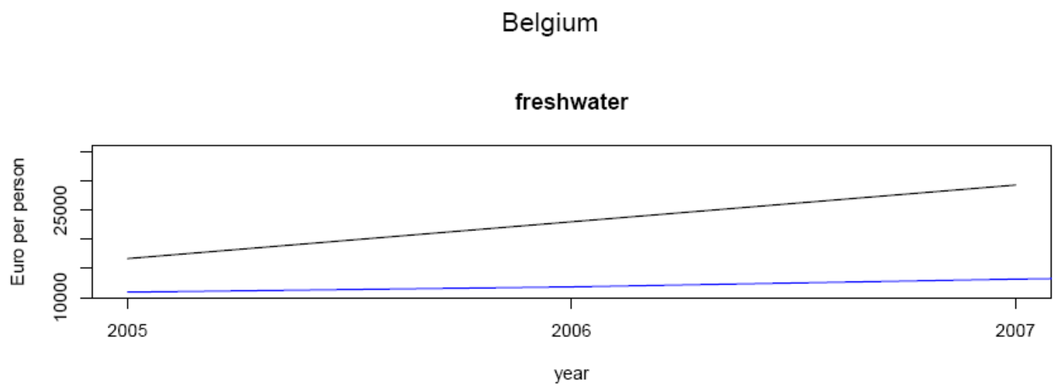


Figure 27 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

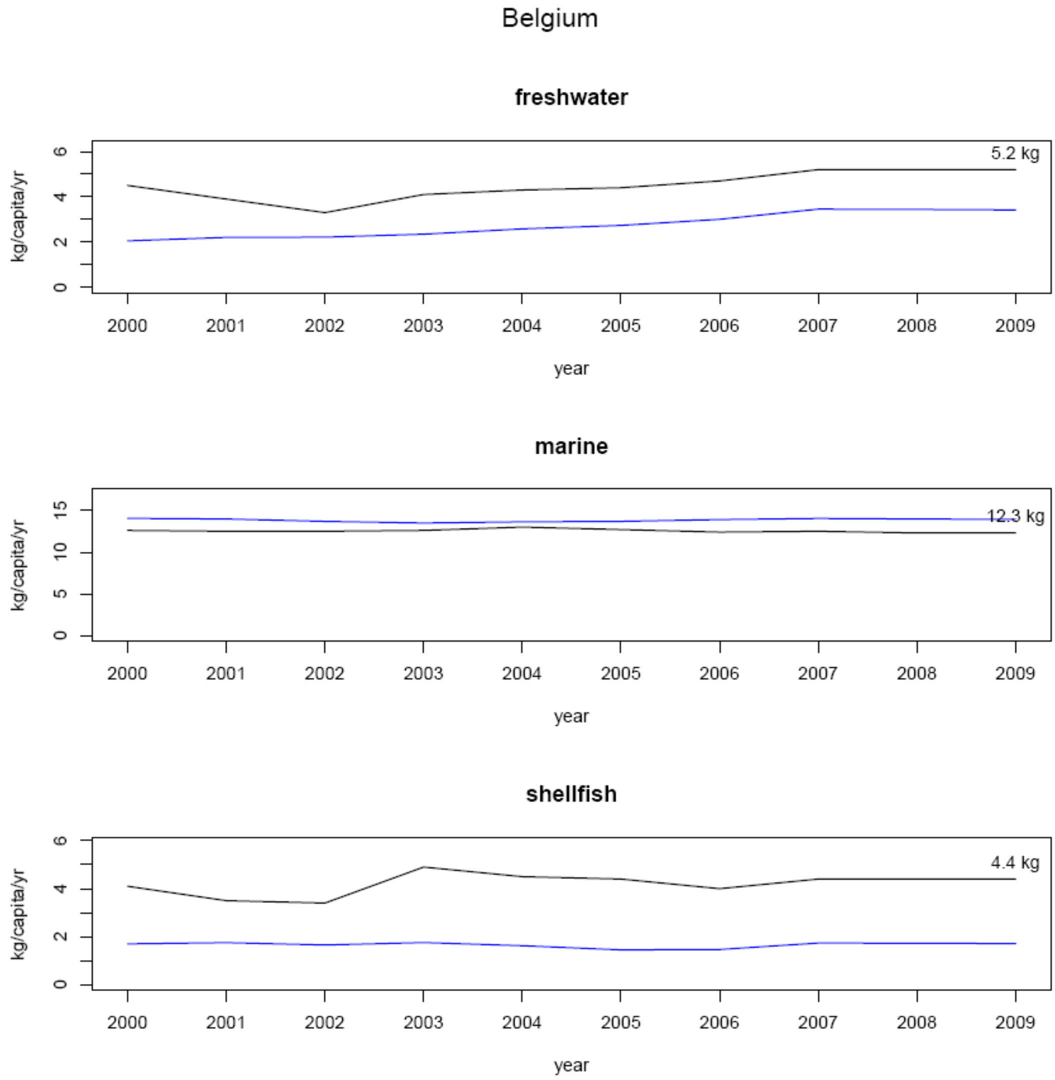


Figure 28 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

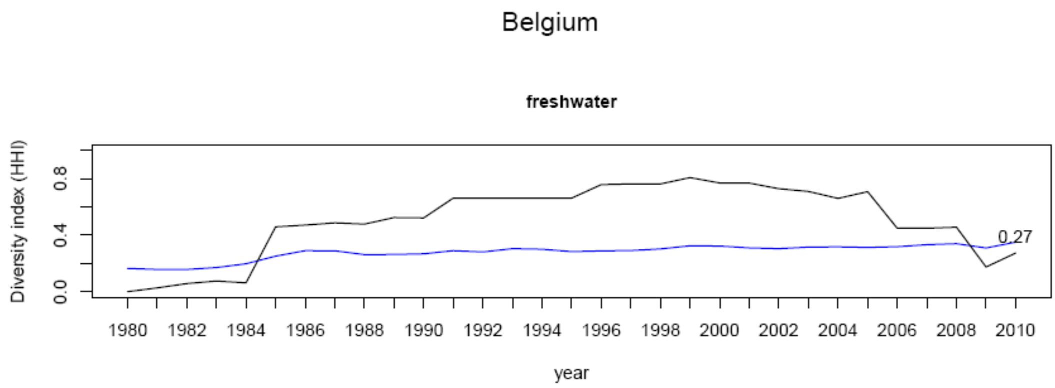


Figure 29 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.3. Bulgaria

Highlights and trends

- Small national production with a strong growth in freshwater and shellfish aquaculture (2006-2010 +25% and 39%, respectively)
- High diversification of farmed species contributing to the production
- Limited employment
- In freshwater production GVA is high while is extremely low in the shellfish segment
- Low apparent consumption of fisheries products

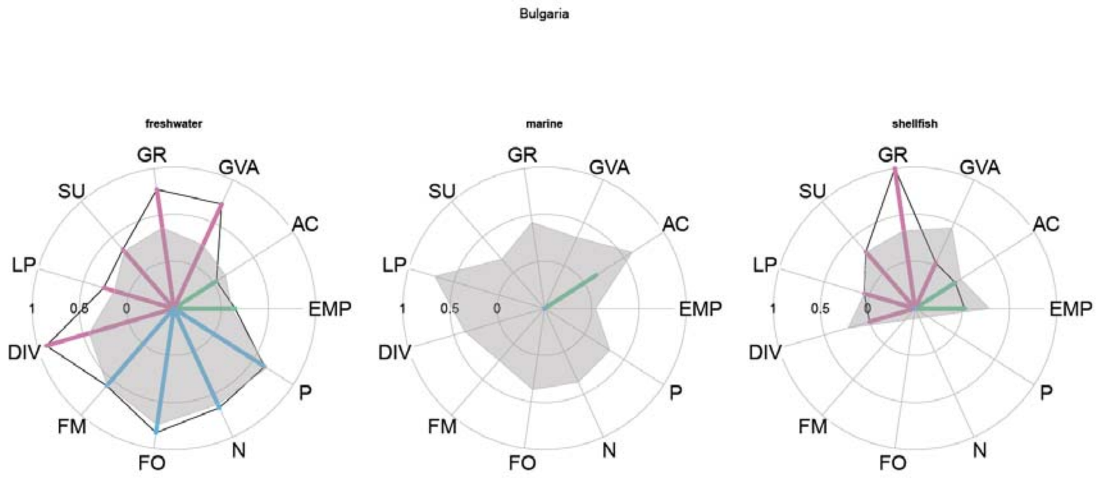


Figure 30 Performance indicators for Bulgaria

Overview of the sector

Aquaculture is a relatively small sector in Bulgaria with some 7910 tonnes in 2010 and 336 entities. It presents a share of 2.6% in production volume or 2.5% in production value to the EU freshwater finfish segment.

In terms of volume, rainbow trout presents 40% of the production, another 45% are made up by common carp and other carp spp. Sturgeon as a high value species presents with some 4% in volume nearly 10% of production value. The shellfish production of some 700 tonnes in 2010 is based on Mediterranean mussels. Marine finfish aquaculture is practically not present.

Since 2006, freshwater and shellfish aquaculture experienced a strong upward trend (+25% and +39%, respectively).

Freshwater aquaculture reached in 2010 a GVA above EU level.

The freshwater aquaculture contributed in 2010 with some 84% to the supply for fisheries products in that segment, shellfish production with some 71%.

Employment showed in 2010 an increase to around 330 persons in freshwater and 60 in shellfish aquaculture, but remaining in the latter very much below the ratio of the EU in total. Labour productivity stays in the freshwater aquaculture well above the segments as a total.

Apparent consumption of fish products is very low with the highest value in marine finfish products (3.5kg/capita in 2009).

The use of fishmeal was for 2010 with 284kg/tonne finfish produced very similar to the overall use in the Union, while for fish oil it is with 67kg/tonne fish below EU level. In total, for the segment the use of some 2,050 tonnes of fishmeal and almost 500 tonnes of fish oil have been estimated.

N and P effluents per tonne fish produced are with around 42kg and around 7 kg, respectively close to the emission in the EU freshwater production in total.

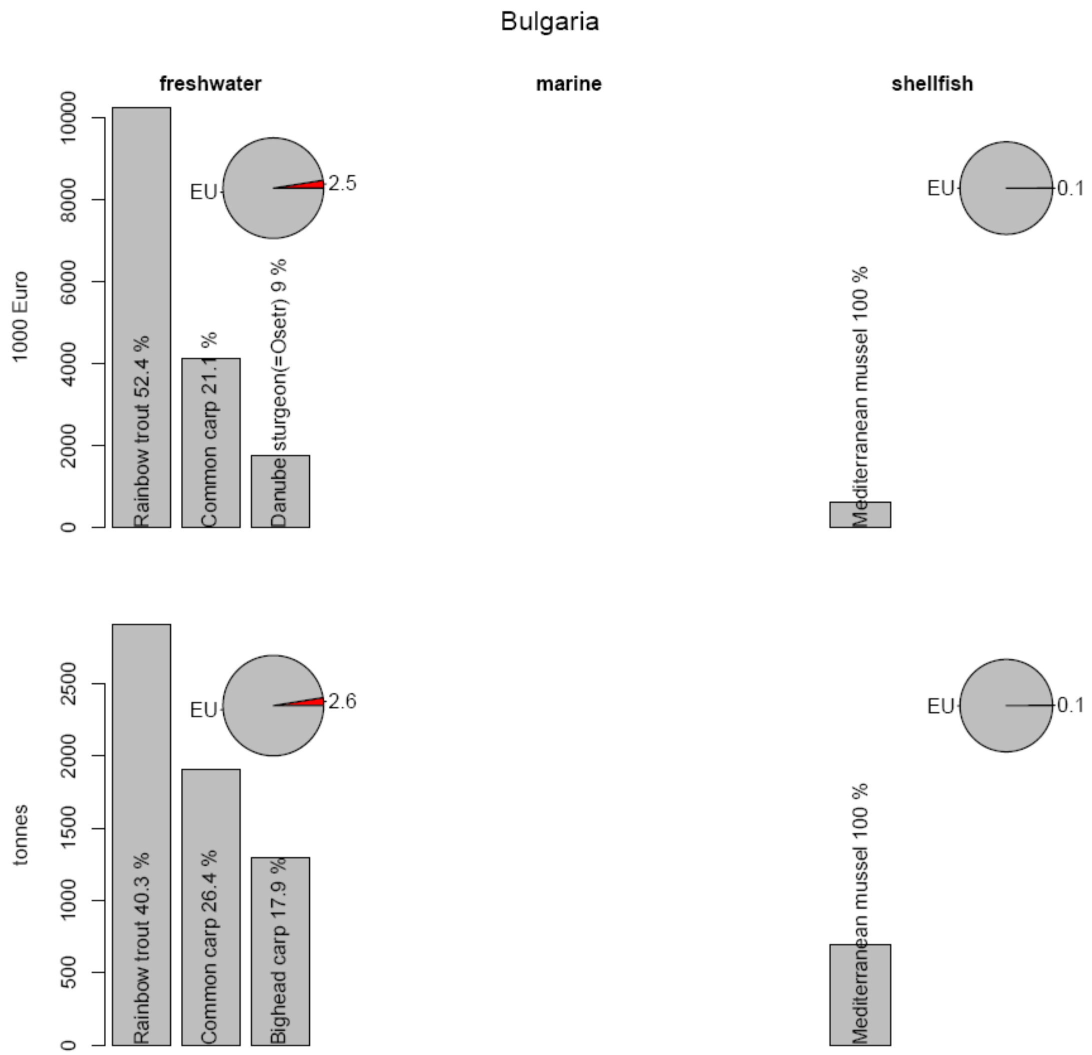


Figure 31 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish and shellfish segment.

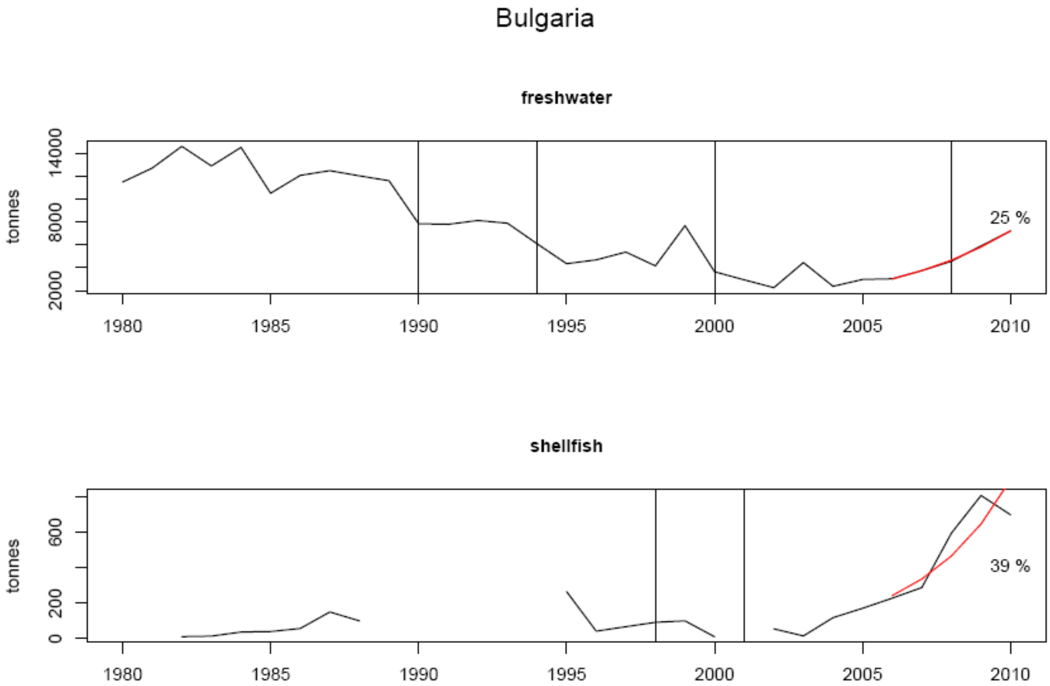


Figure 32 Production growth: Production patterns of the freshwater finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

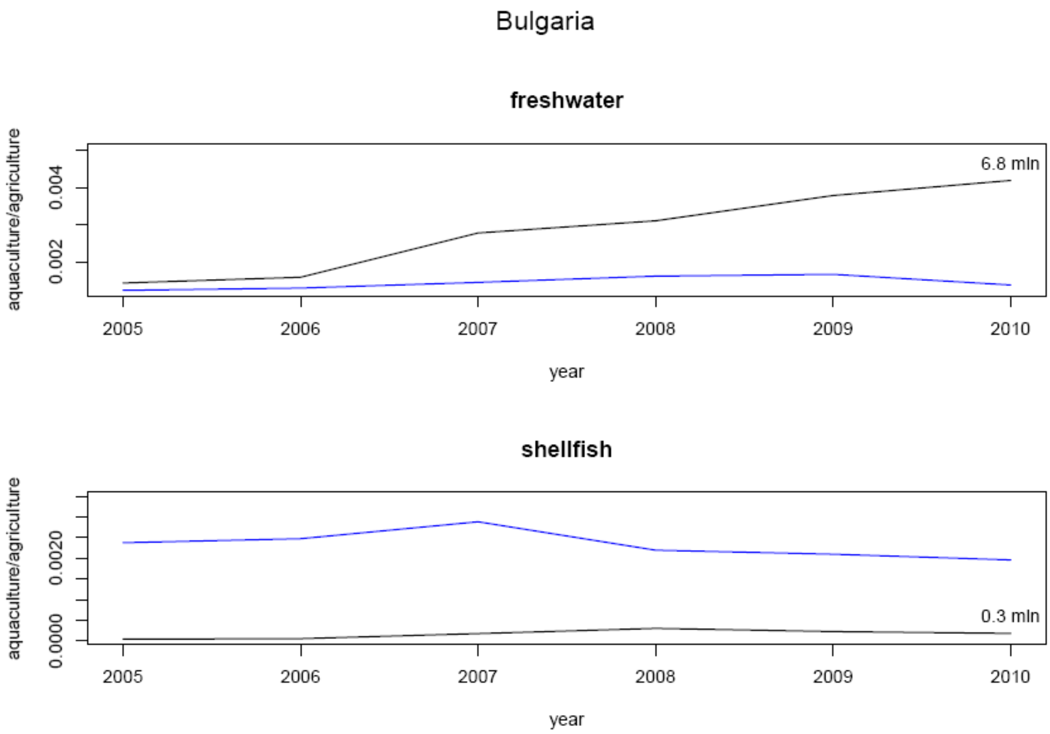


Figure 33 GVA: Economic importance of the output by the freshwater finfish and shellfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

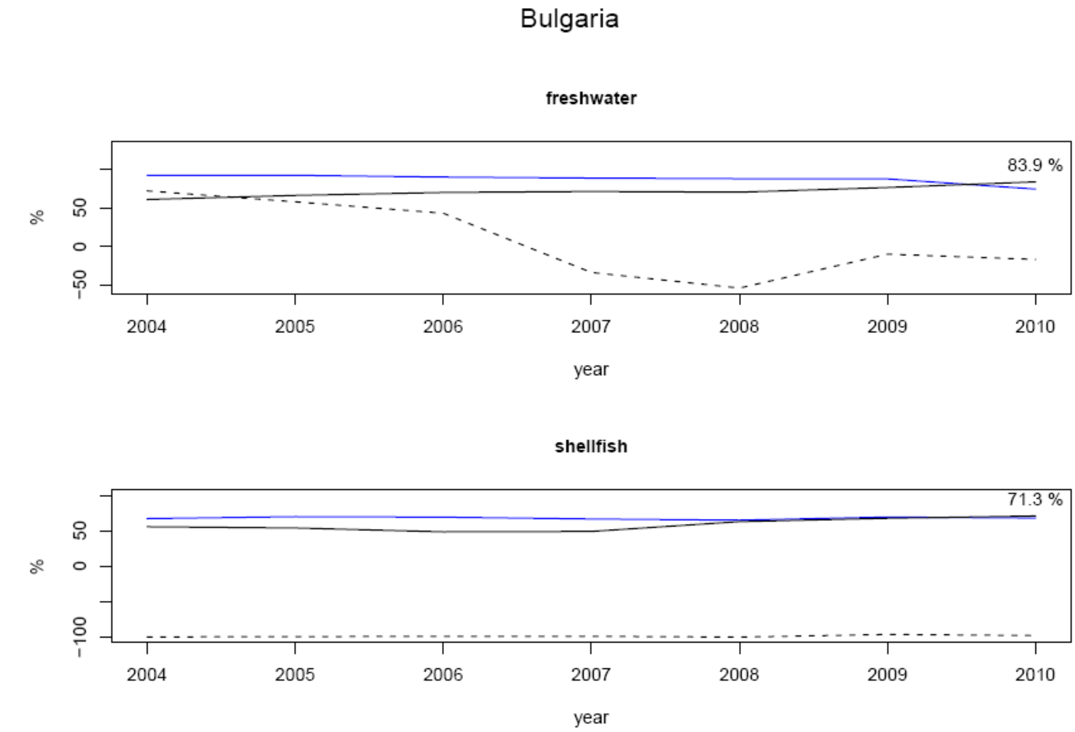


Figure 34 Self-sufficiency and trade: Share of the freshwater and shellfish aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Bulgaria, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments.

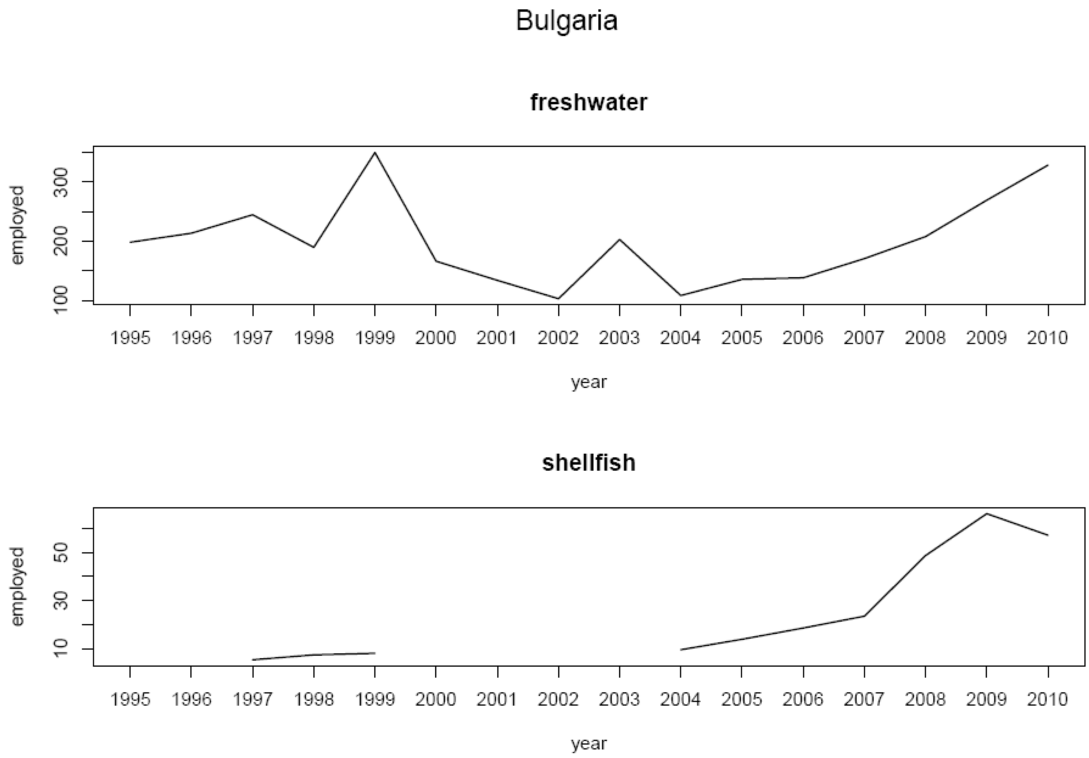


Figure 35 Number of employed persons in the freshwater and shellfish segment in Bulgaria over time. Since the only few figures are available from STECF (2012, and 2013) the employment was estimated from FAO production statistics using a generic EU model (calculated values below 10 persons employed are not pictured).

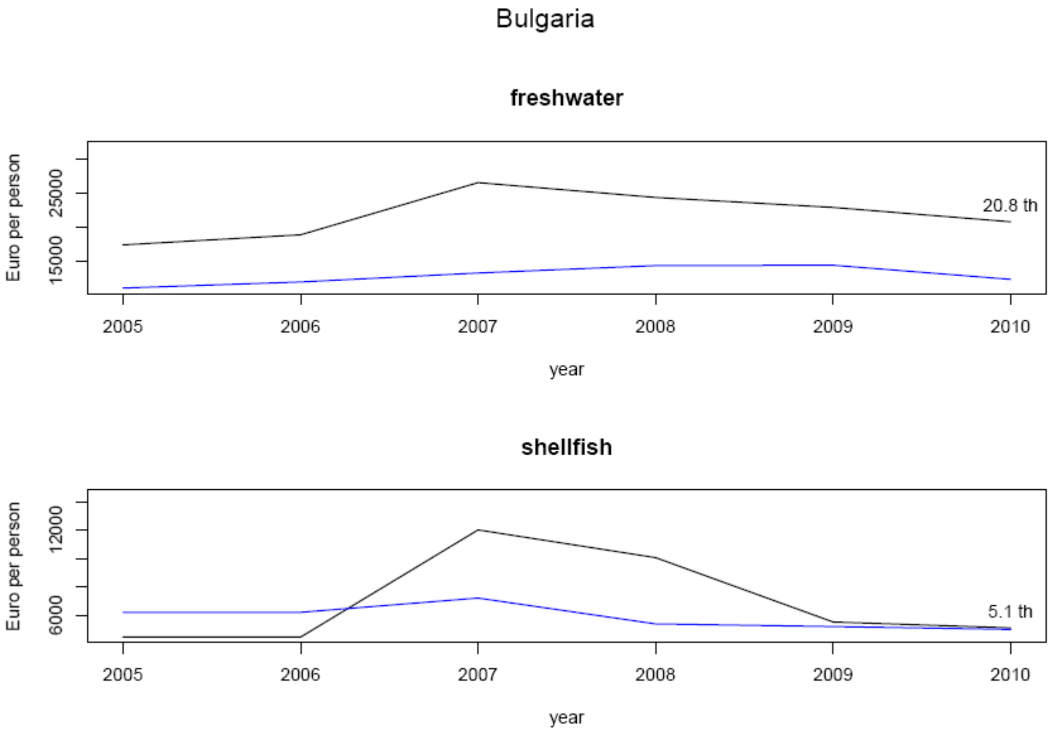


Figure 36 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

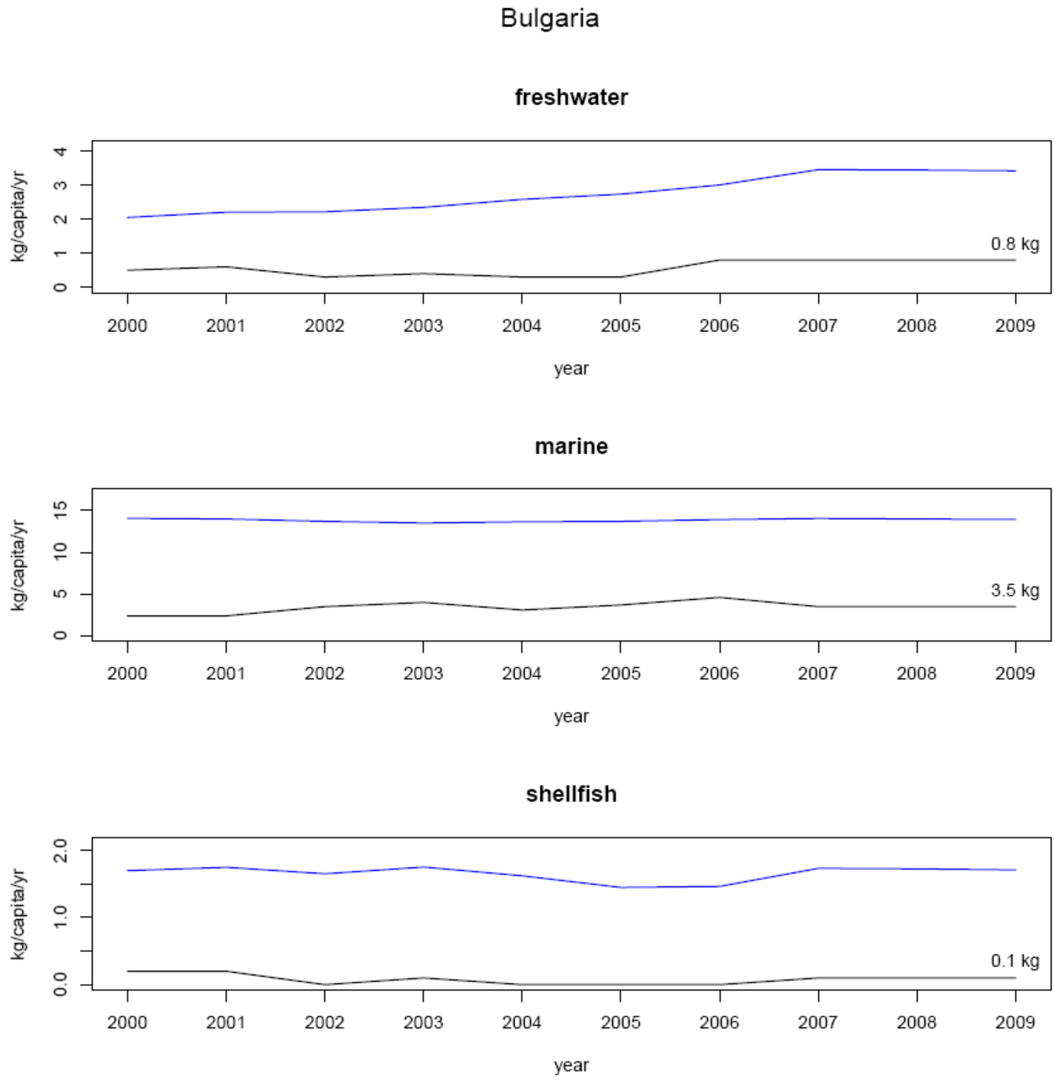


Figure 37 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

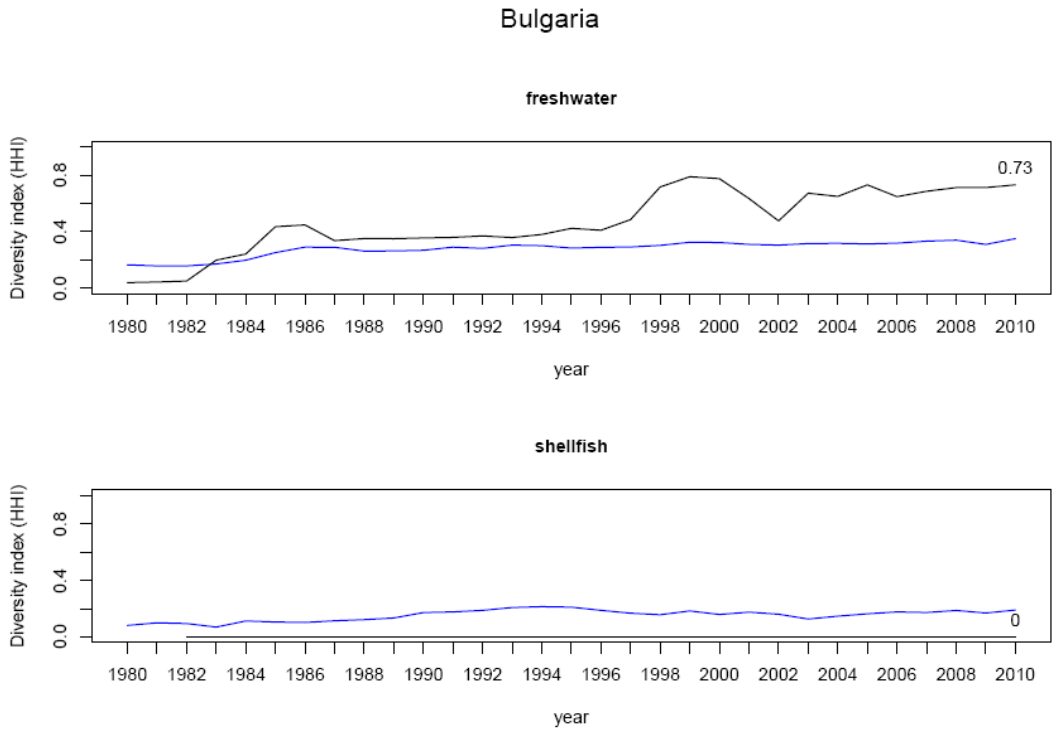


Figure 38 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.4. Cyprus

<u>Highlights and trends</u>

- Small, but important national production of marine finfish, with a strong growth (2006-2010 +13%). Freshwater aquaculture is marginal
- Marine finfish production contributes strongly to outgoing trade
- High diversification of farmed species contributing to the production in the marine segment
- In absolute terms, limited employment with a declining trend as labour productivity increases
- GVA is high in the marine segment
- High demand for fishmeal and fish oil in the production
- Effluents load smaller than at EU average

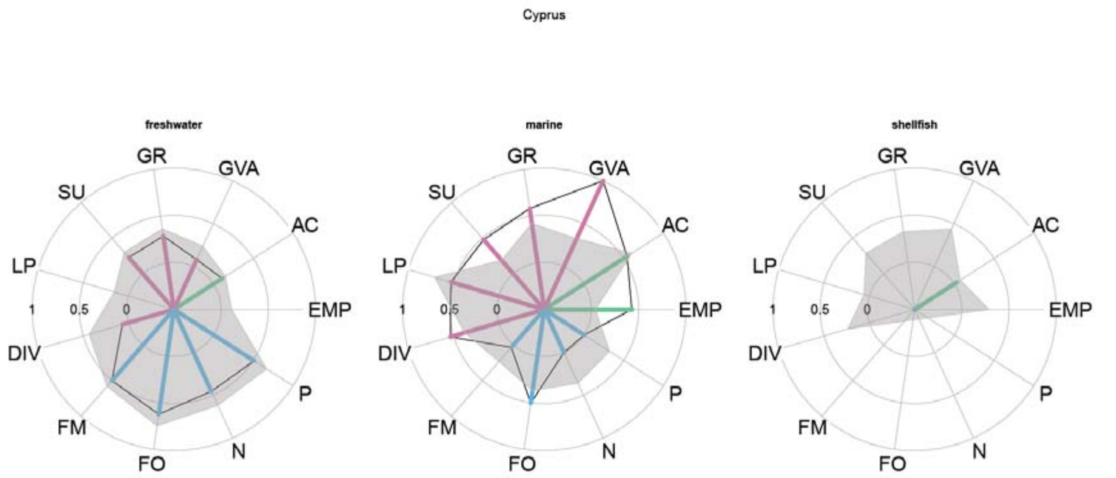


Figure 39 Performance indicators for Cyprus

<u>Overview of the sector</u>

Gilthead sea bream and European sea bass contribute with almost 70% and 30% respectively to Cyprus' marine finfish aquaculture production of almost 4,050 tonnes in 2010 which presents some 1.4% of the EU marine finfish aquaculture in value. Fresh water aquaculture is in volume and value extremely small (around 70 tonnes in 2010).

Over the last decade, the aquaculture sector has been one of the fastest growing food production sectors in Cyprus. It accounts with some 12 companies for around 70% of the national fisheries production. Beside the full cycle aquaculture there are also some off-shore farms for capture-based bluefin tuna fattening with substantial variations in the annual production figures.

Marine finfish aquaculture shows strong growth with a clear upward trend (since 2006 +13%), while the freshwater segment is tending downwards (-5.3%) but remaining close to EU level.

From all Member States, Cyprus has the highest GVA of marine finfish production, indicating its importance compared to the agriculture sector. Producing some 146% of the domestic supply of marine finfish underlines the importance of the segment to the outgoing trade. The positive values in the trade balance for fisheries products support this finding.

Overall, freshwater and marine finfish aquaculture offer very little employment. In the marine segment, the employment ratio is above the EU ratio but with a decline, most probably due to increases gained in the labour productivity.

Marine finfish fisheries products contribute strongly to the apparent consumption (around 12.5kg/capita in 2010).

Being small in absolute terms (24 tonnes fishmeal, 11 tonnes fish oil in 2010) the freshwater production has a higher demand on fishmeal (around 325 kg) and fish oil (around 150 kg) per tonne fish produced than the Union level in the segment. The marine finfish segment was calculated to use in 2010 around 2,500 tonnes of fishmeal and 788 tonnes of fish oil. The dominant sea bass and sea bream production resulted in a higher demand of fishmeal (around 619 kg/tonne fish) but a lower demand for fish oil (195 kg/tonne fish) than for the EU in total in the marine finfish segment.

The effluents of N and P per tonne of fish produced are higher than the EU level in the freshwater environment (around 61 kg N, around 9 kg P) and much higher in marine finfish produced (around 103 kg N, around 16 kg P). In total, the estimated effluents summed up to some 420 tonnes of N and 65 tonnes of P in 2010.

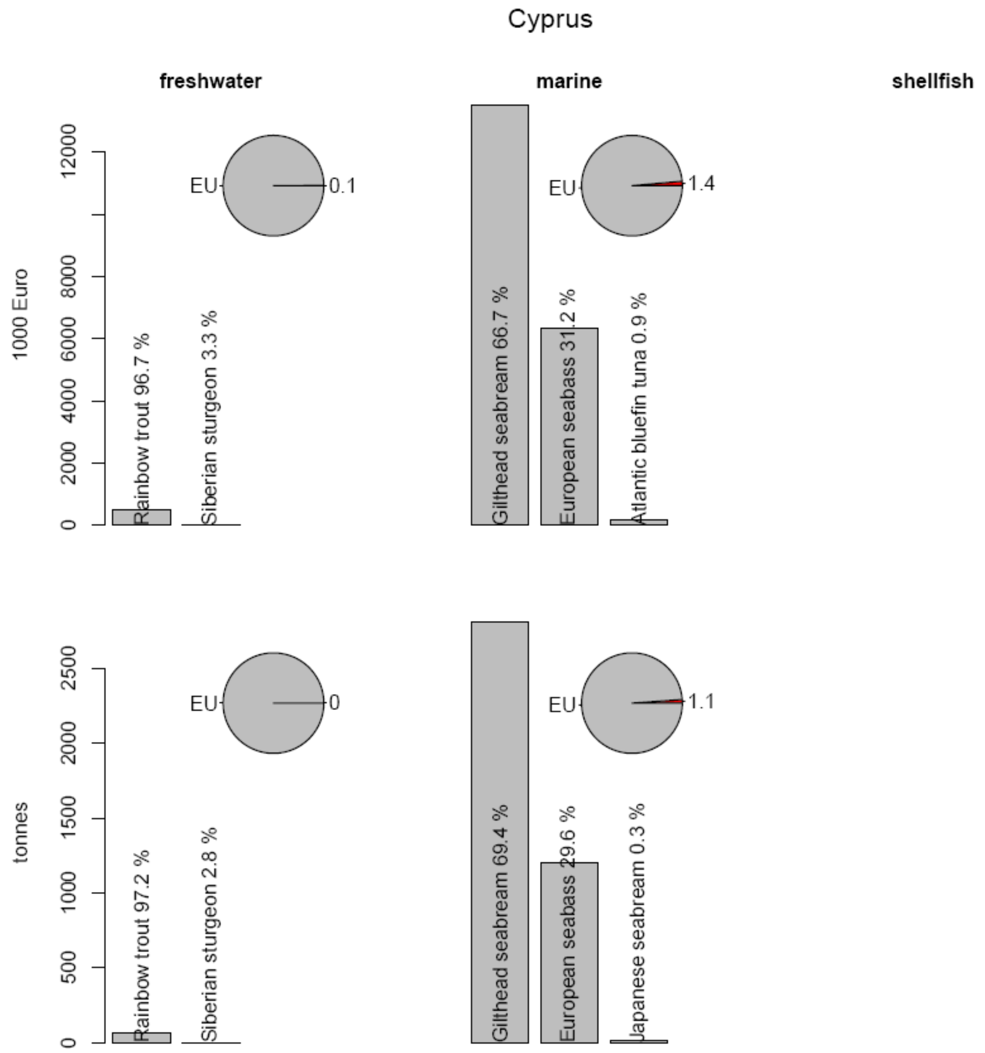


Figure 40 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish and marine finfish segment.

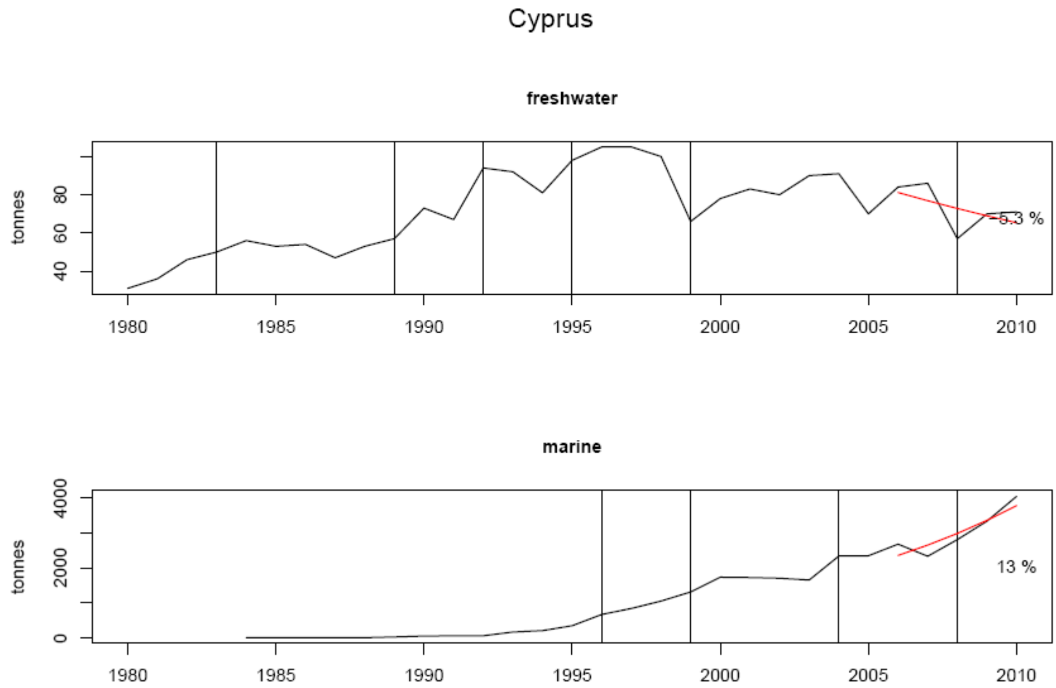


Figure 41 Production growth: Production patterns of the freshwater and marine finfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

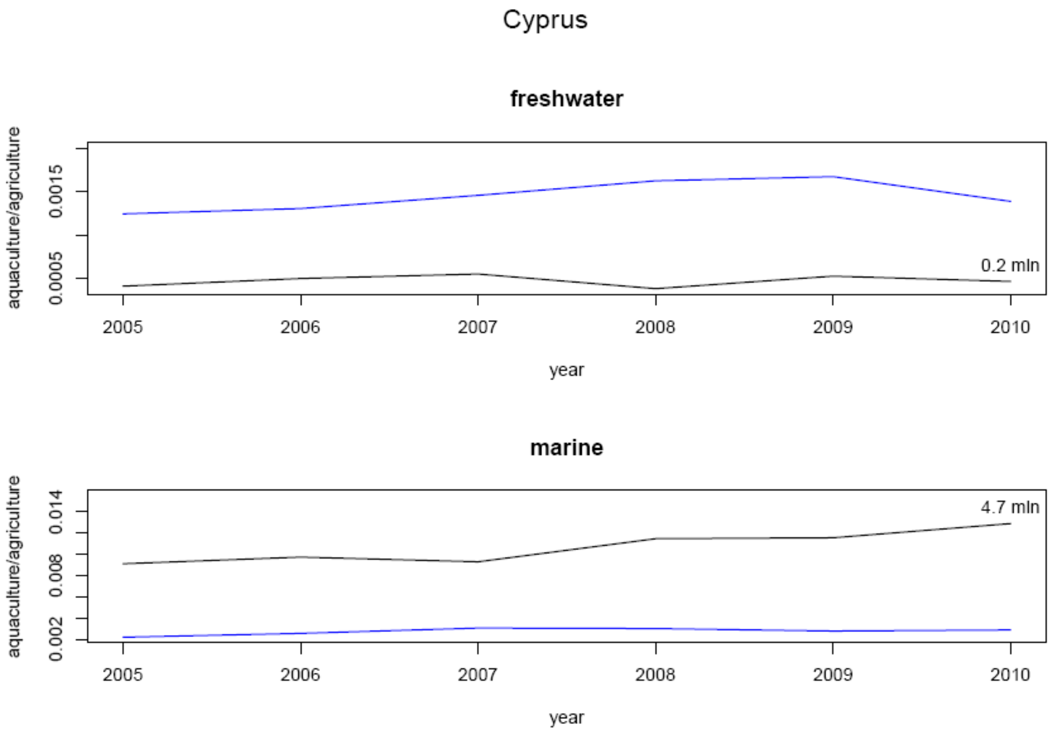


Figure 42 GVA: Economic importance of the output by the freshwater and marine finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

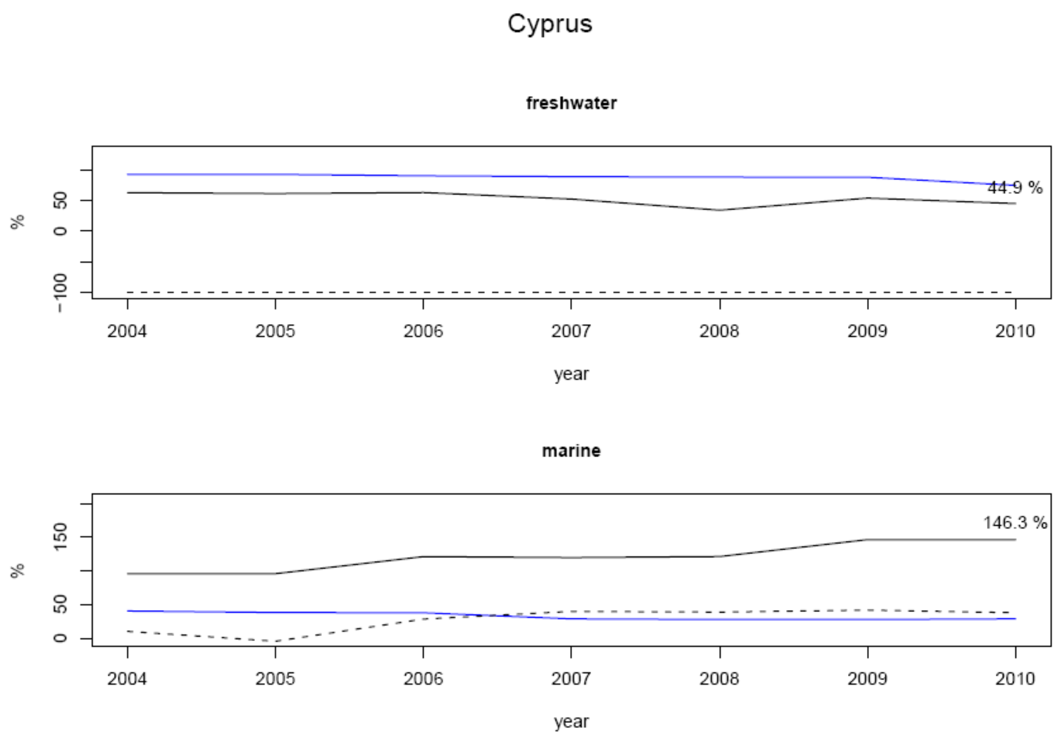


Figure 43 Self-sufficiency and trade: Share of the freshwater and marine aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Cyprus, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments.

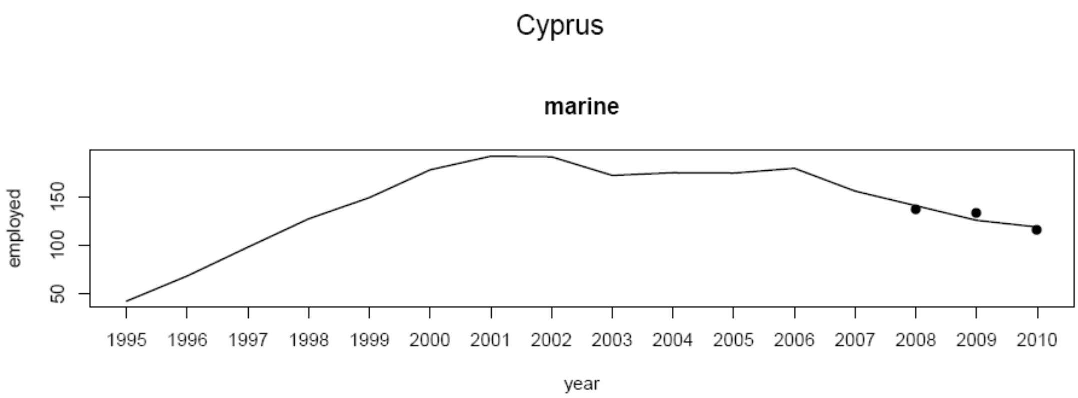


Figure 44 Number of employed persons in the marine segment in Cyprus over time. The trend line is derived from a country specific model based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

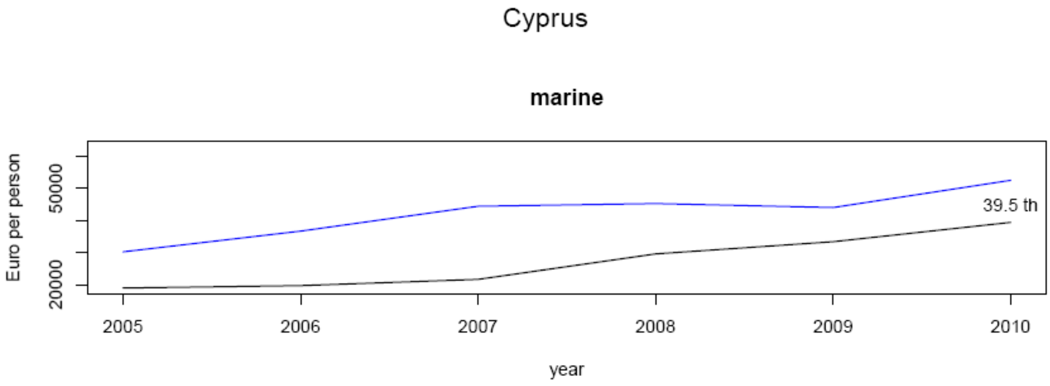


Figure 45 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

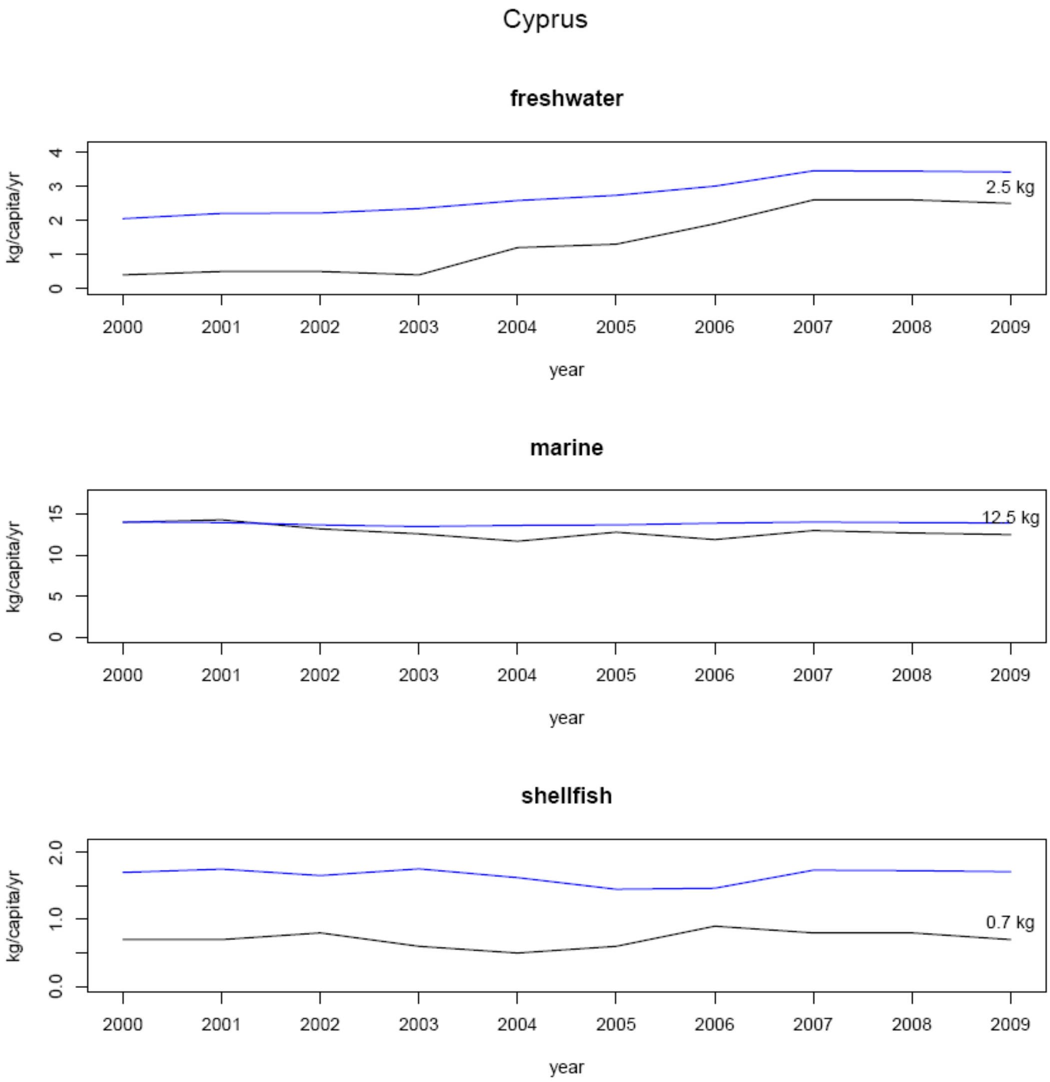


Figure 46 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

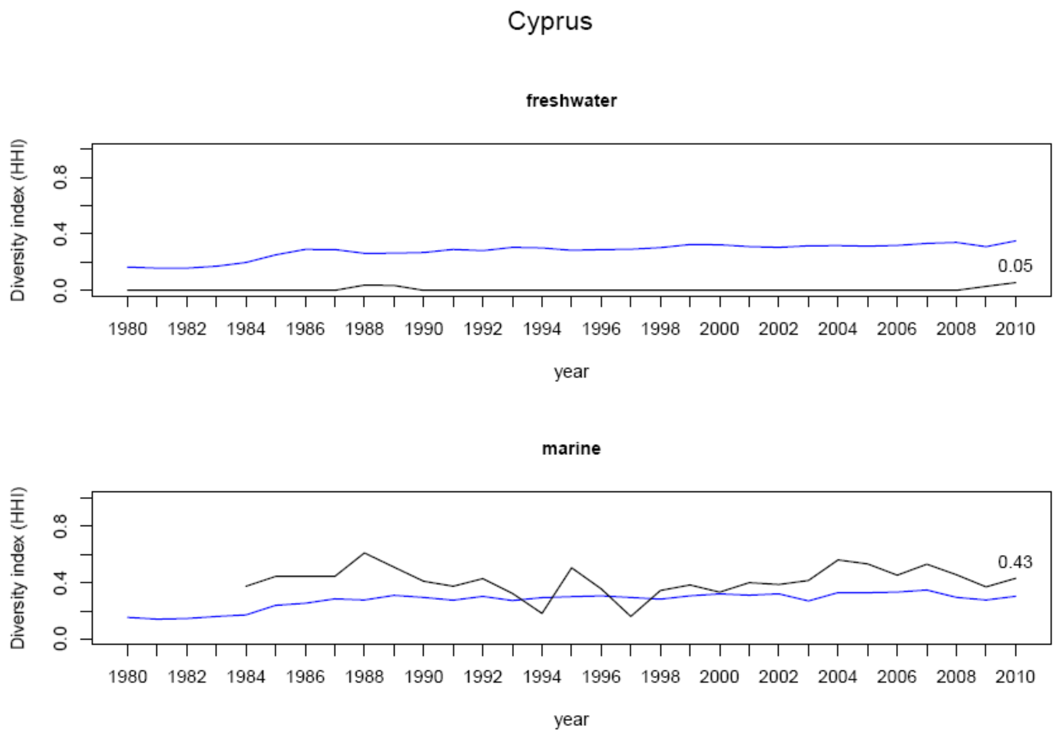


Figure 47 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.5. Czech Republic

Highlights and trends

- Important national production, mainly carp, with almost stable production in the last five years (2006-2010 -0.2%)
- Production contributes strongly to country's outgoing trade
- GVA is high
- Employment in the sector is above EU average
- Low consumption of fisheries products
- Relative small amounts of fishmeal / fish oil used
- Effluent load from aquaculture is below EU average

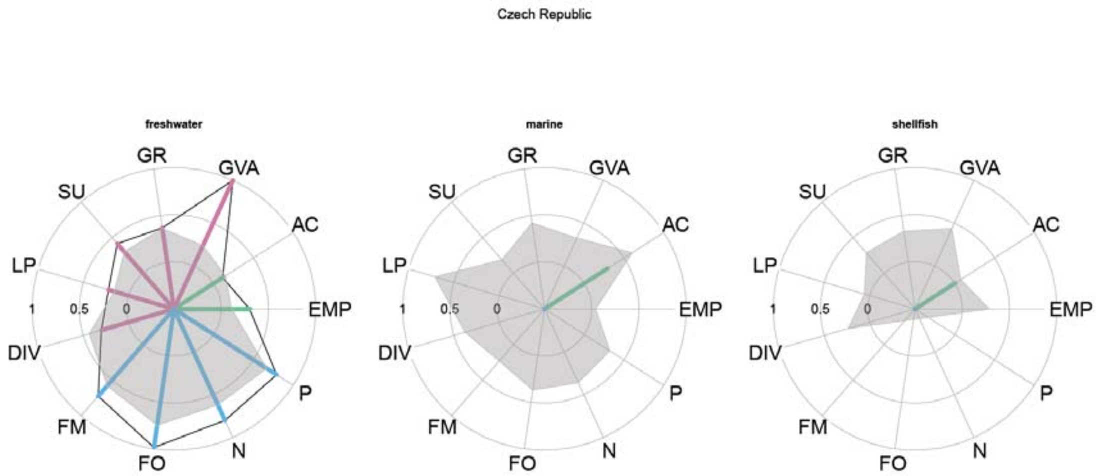


Figure 48 Performance indicators for the Czech Republic

Overview of the sector

The Czech Republic contributes with 5.4% of production value or 7.3% of production volume to the EU fresh water aquaculture. In the landlocked country, aquaculture is performed traditionally in ponds and lakes, occasionally in tanks or raceways. More than 86% of the annual production (>20,400 tonnes in 2010) relates to common carp, followed by rainbow trout with 2.4%. The few large producers are organized in the Czech Fish Farmers Organisation with a share of >80% of the production, but there are also many small entities or part-time enterprises. In the Czech Republic aquaculture fulfils also non-production oriented functions, e.g. for sport fishing or tourism.

While the production increased between 1999 and 2005, during the last years, food fish production has not changed much. Since 2006 there is a slight decreasing trend in the production (-0.2%) which is laying close to the growth trend of the segment at EU level.

Freshwater aquaculture GVA is high underlining the importance of the sector.

With a self-sufficiency of more than 120%, freshwater aquaculture is likely to contribute strongly to outgoing trade of fisheries products which is also underlined by the positive values for trade balance of fisheries products.

The sector has experienced a strong downward trend over the last 15 years from over 2,500 persons to an estimated 1,080 persons in 2010. But compared to the EU ratio, employment ratio in the sector is high. Labour productivity has been increased steadily and stays well above the EU level of the segment.

Apparent consumption of fisheries products from freshwater was increasing over the years with around 2 kg/head in 2007, but in volume much lower than consumption of around 8.2 kg from marine finfish sources which remained relatively constant over the years.

With the dominance of carp production the use of fishmeal (around 200kg/t) is below the EU as a whole per tonne fish produced and for fish oil very low (8kg/t). In absolute terms, around 4,010 tonnes of fishmeal and 162 tonnes of fish oil have been estimated for 2010.

Effluents of N (around 29 kg/t) and P (around 5 kg/t) per tonne fish produced are clearly lower than in the overall EU freshwater production. In total, the estimated emissions summed up to some 585 tonnes of N and 100 tonnes of P in 2010.

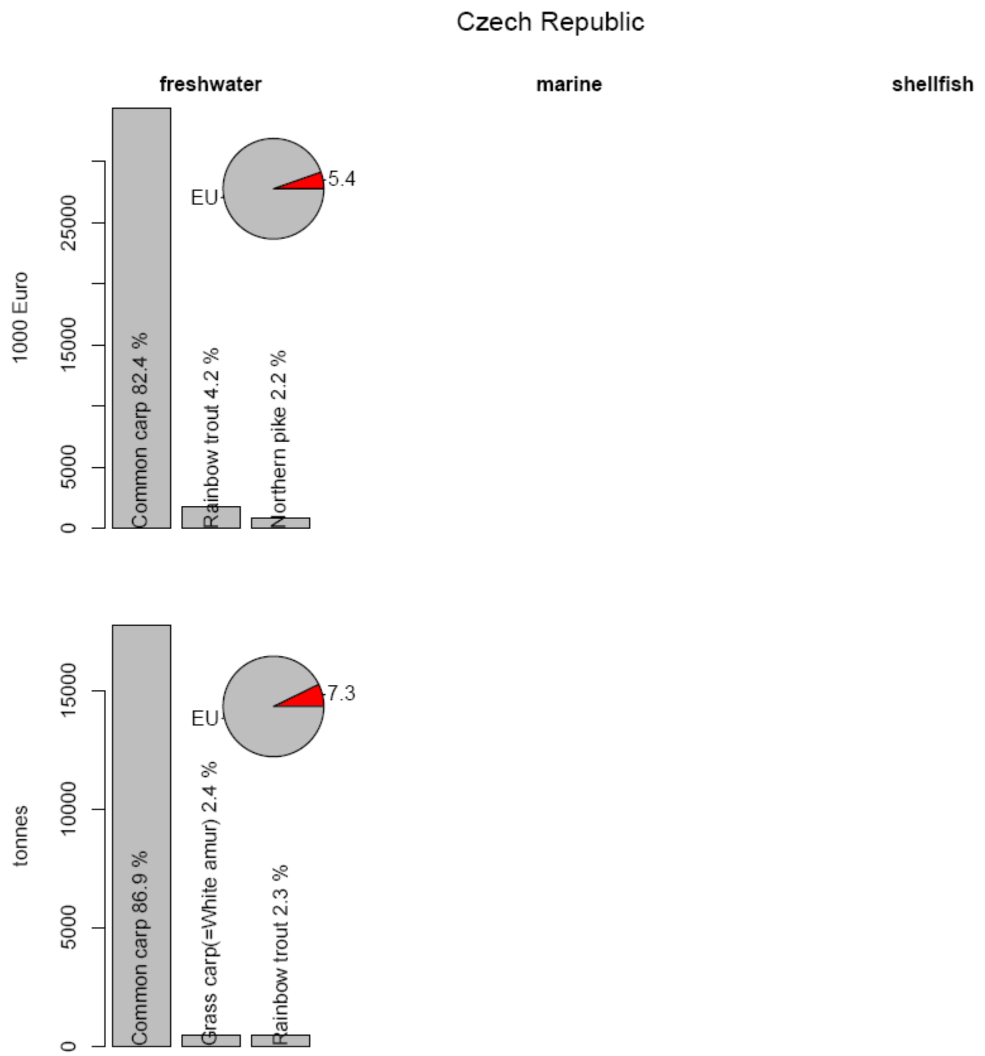


Figure 49 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

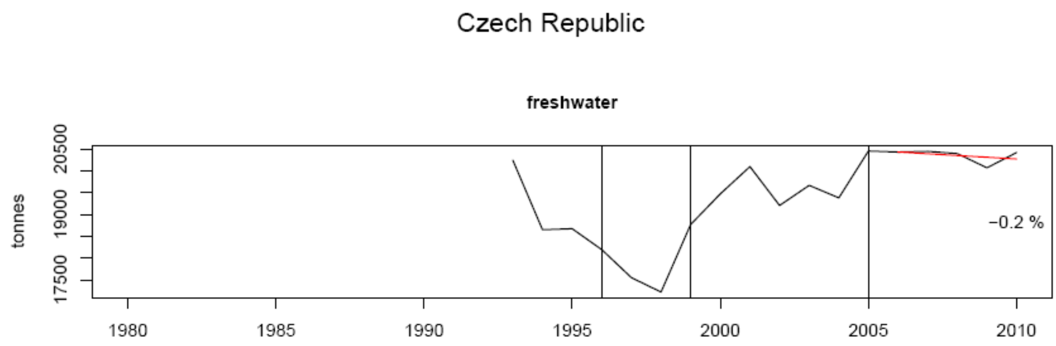


Figure 50 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

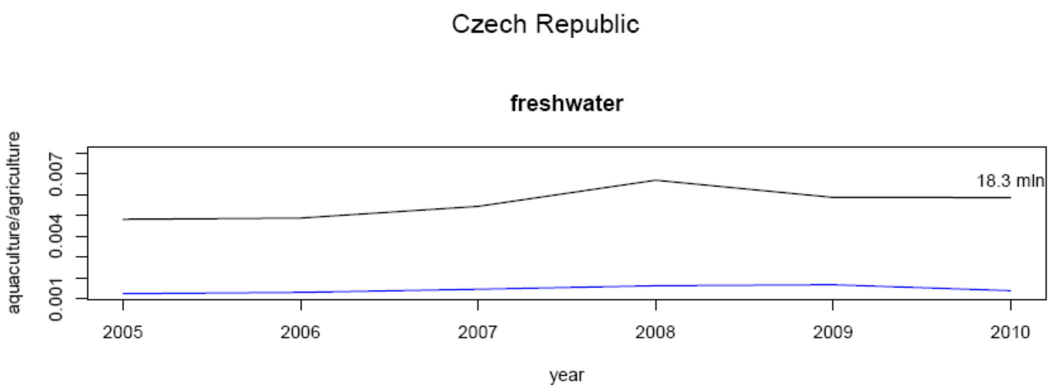


Figure 51 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

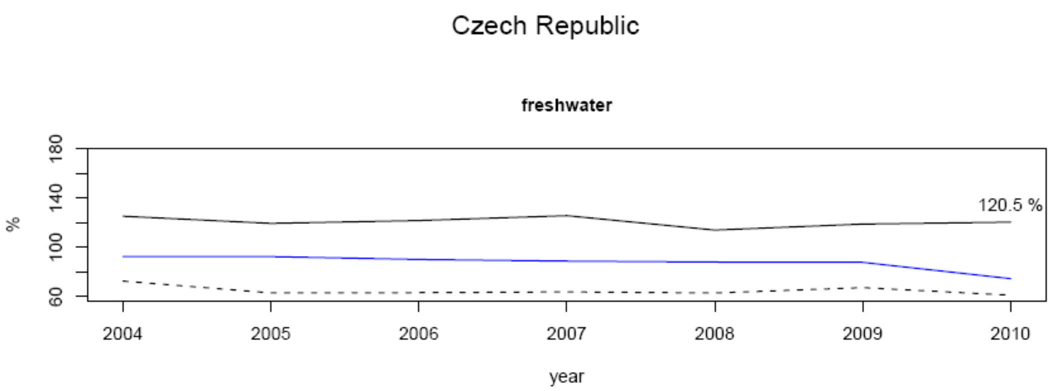


Figure 52 Self-sufficiency and trade: Share of the freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Czech Republic, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments.

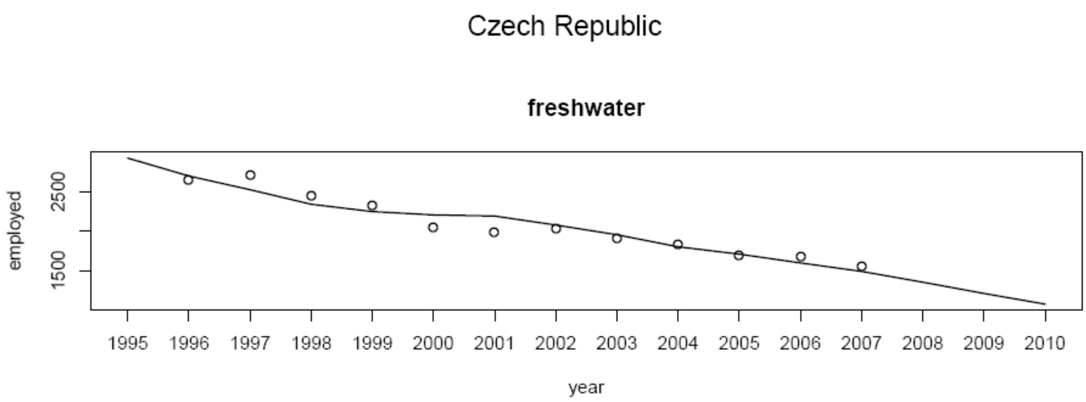


Figure 53 Number of employed persons in the freshwater segment in Czech Republic over time. The trend line is derived from a country specific model based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

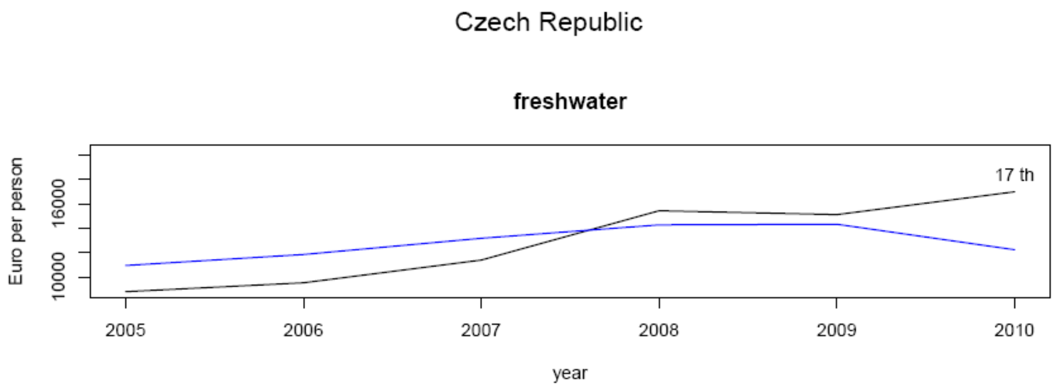


Figure 54 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

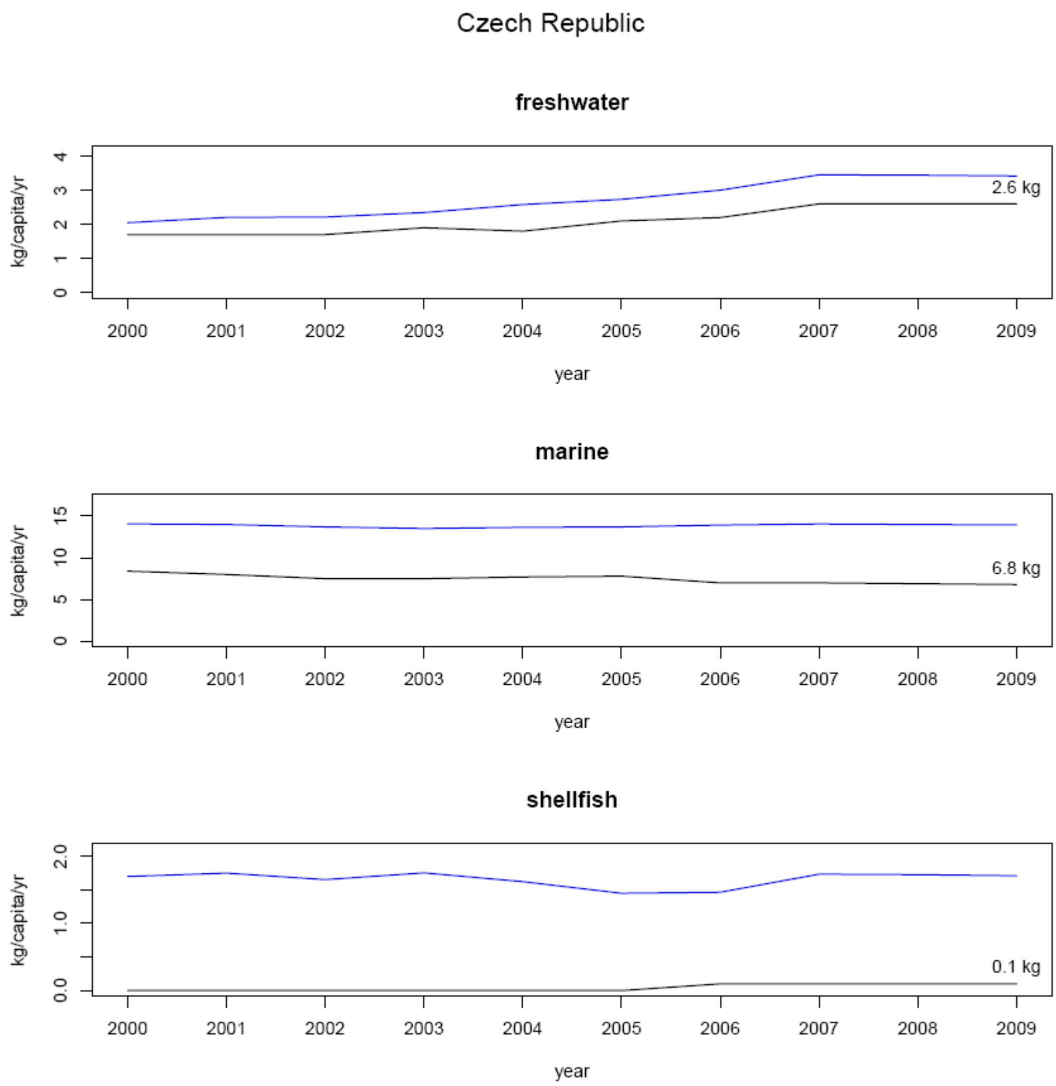


Figure 55 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

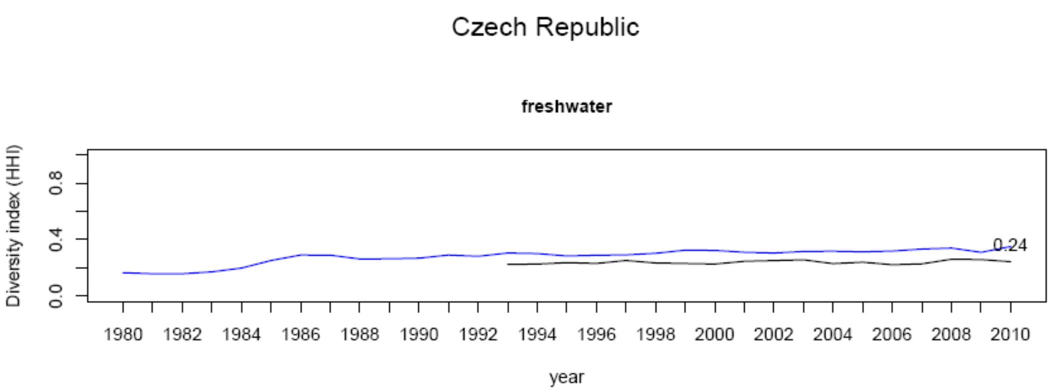


Figure 56 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.6. Denmark

Highlights and trends

- Strong trout producing industry which sees market opportunities for growth, showing positive growth trends in the marine finfish and shellfish production for 2006-2010.
- Trout production contributes strongly to the country's outgoing trade
- High GVA in the finfish aquaculture
- In absolute terms, reduced employment in the finfish segments due to high labour productivity
- Relative high demand of fishmeal / fish oil in the freshwater segment
- Effluent load from aquaculture is below EU average

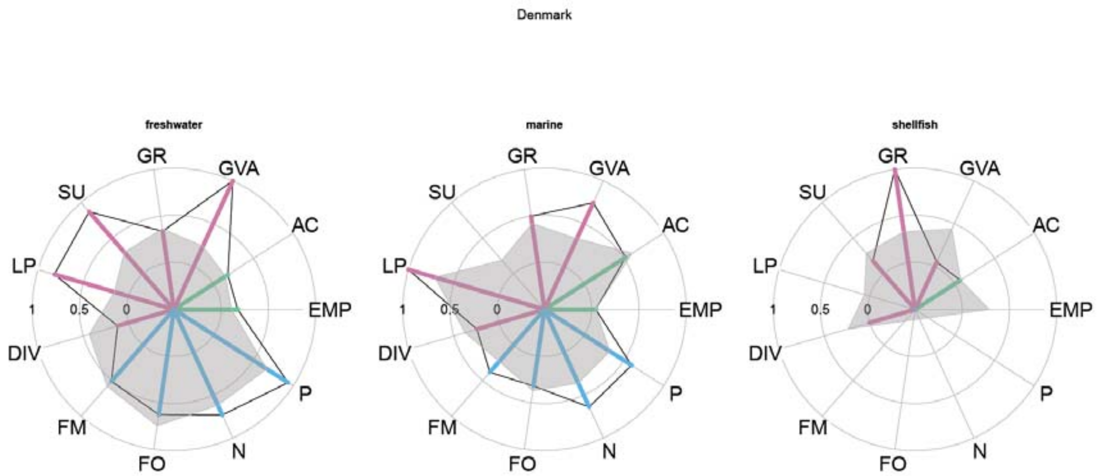


Figure 57 Performance indicators for Denmark

Overview of the sector

In Denmark, freshwater finfish aquaculture is the main aquaculture segment, producing around double the volume and value of the marine finfish aquaculture and participating with around 9.2% to the EU freshwater segment by volume. Marine finfish aquaculture has a share of around 3.2% in volume to the EU marine finfish aquaculture segment. The annual production of the industry with some 160 companies and 272 farms accounted for almost 40,000 tonnes in 2010. In freshwater as well as in the marine environment, the most farmed species is rainbow trout with 95% or 90% of freshwater and 89% or 74% of marine finfish aquaculture by volume or value, respectively. Portion size trout is mainly produced in ponds, tanks, raceways or recirculation systems, large size trout typically in sea cages.

Other species, such as European eel, pike-perch and Atlantic salmon are mainly cultured in recirculation systems. The eel production is expected to decrease due to restrictions in harvesting glass eels. Shellfish production is relatively new and small, consisting of almost 100% of blue mussel culture.

Both, the freshwater and the marine finfish production contribute to GVA very much above the Union as a whole. With a self sufficiency of finfish production of more than 300% the Danish finfish aquaculture seems strongly export oriented.

The employment ratio for finfish aquaculture is declining, but still above the EU ratio for the freshwater segment. While in the freshwater segment a strong decrease has been calculated over the last 15 years from around 800 to below 400 persons, the marine finfish segment fell in the model to some 80 persons. In the shellfish segment very few persons are employed.

In absolute terms, freshwater production consumes almost double the amount of fishmeal than the marine finfish production (around 8,500 versus around 4,600 in marine environment). Per tonne fish produced marine finfish account for 407 kg fishmeal and 266 kg fish oil, while the freshwater finfish production accounts 330 kg fishmeal and 147 kg fish oil. Per tonne fish produced the freshwater segment is below Union levels for the use of fishmeal and fish oil.

N and P effluents per tonne finfish produced are less than the level for the Union in total (around 35 kg N and around 3 kg P in freshwater, around 44kg N and 8 kg P in the marine environment). For 2010, in total some 900 and 490 tonnes of N effluents and 74 and 85 tonnes of P effluents were calculates for the freshwater and marine finfish environment, respectively. With new maximum N and P emission levels driven by better filtering technologies (imposed by legislation of 2012), a substantial reduction of effluents per tonne fish produced can be expected in the coming years in the freshwater segment.

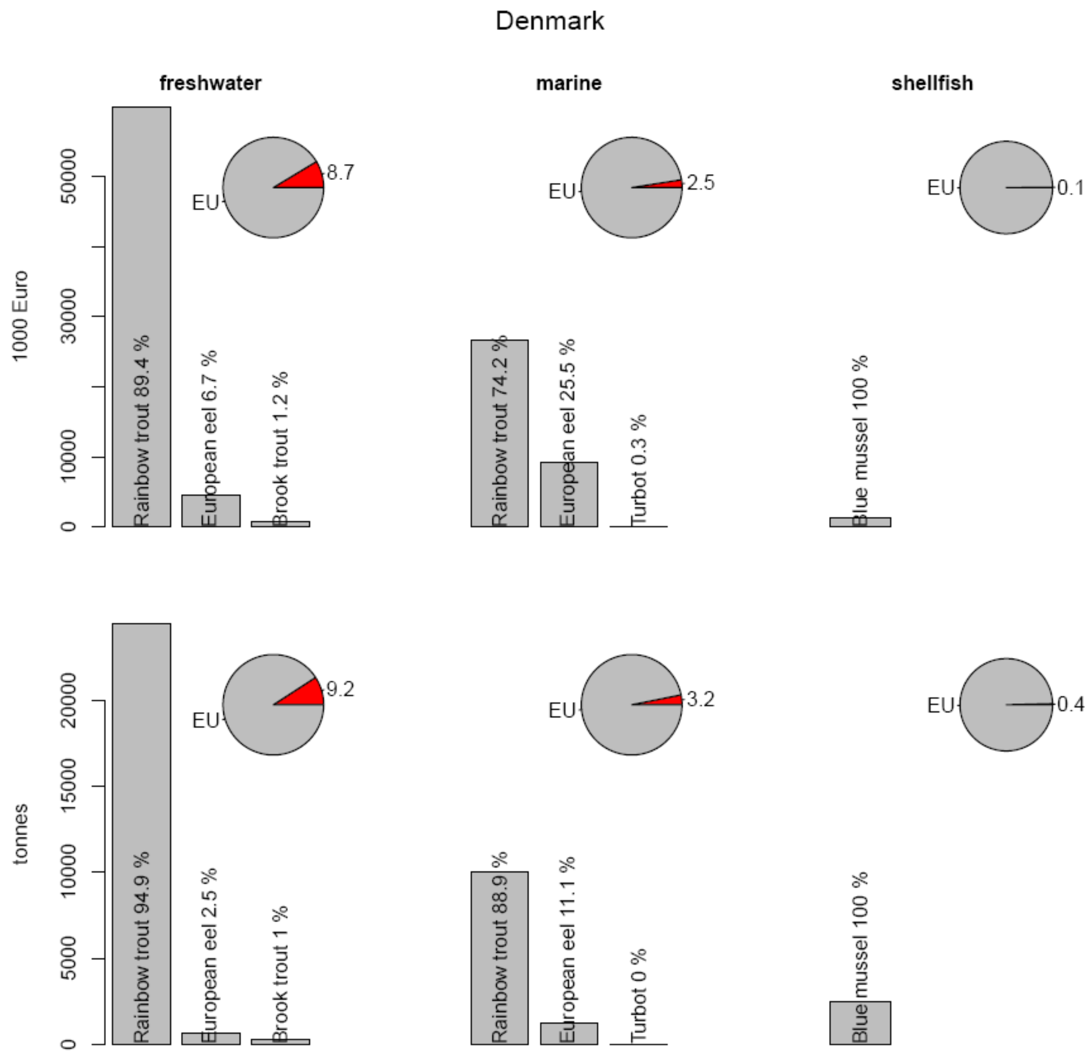


Figure 58 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

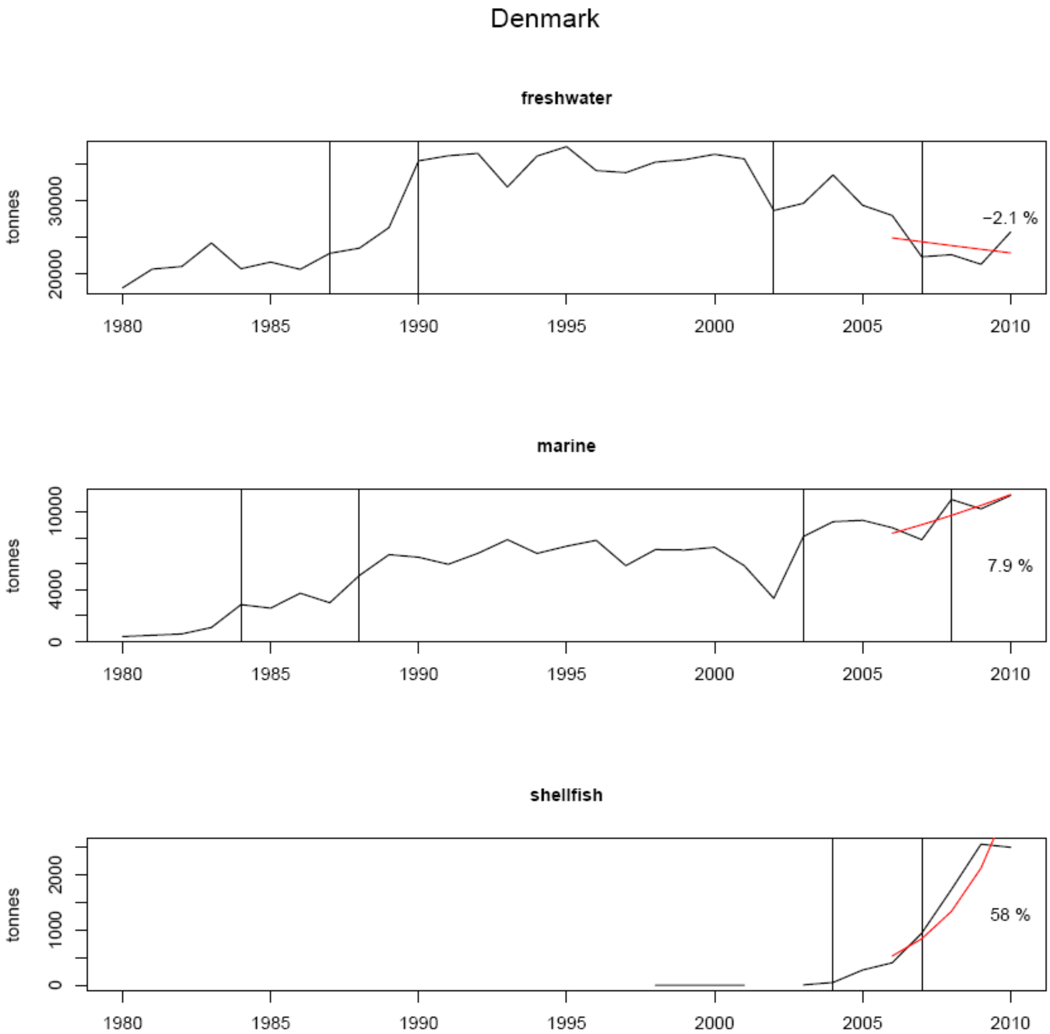


Figure 59 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

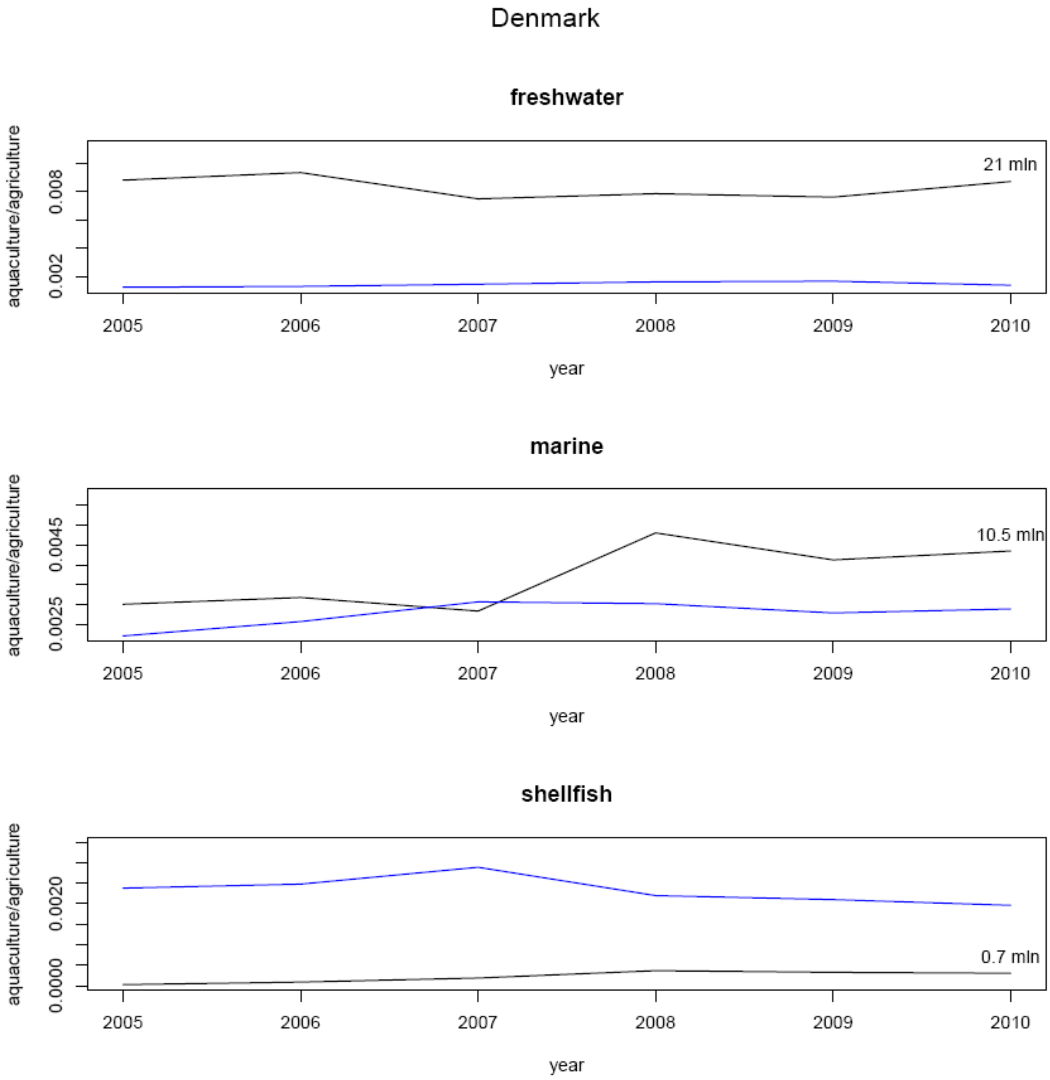


Figure 60 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

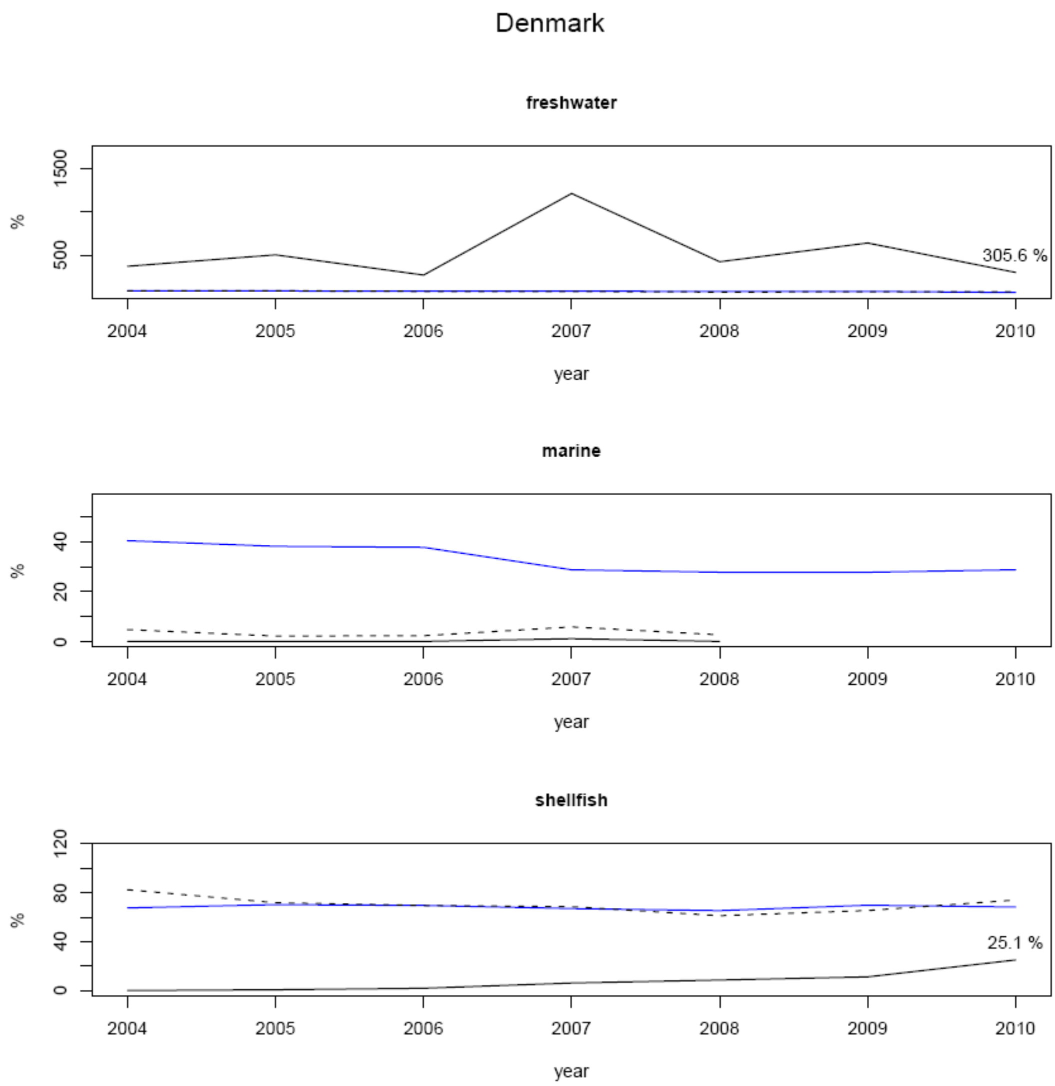


Figure 61 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Denmark, blue line: overall self-sufficiency of the EU production in the segments (for simplification, freshwater and marine trout and eel production were merged for calculating self-sufficiency), dotted line: normalised trade balance on fishery products in the relevant segments.

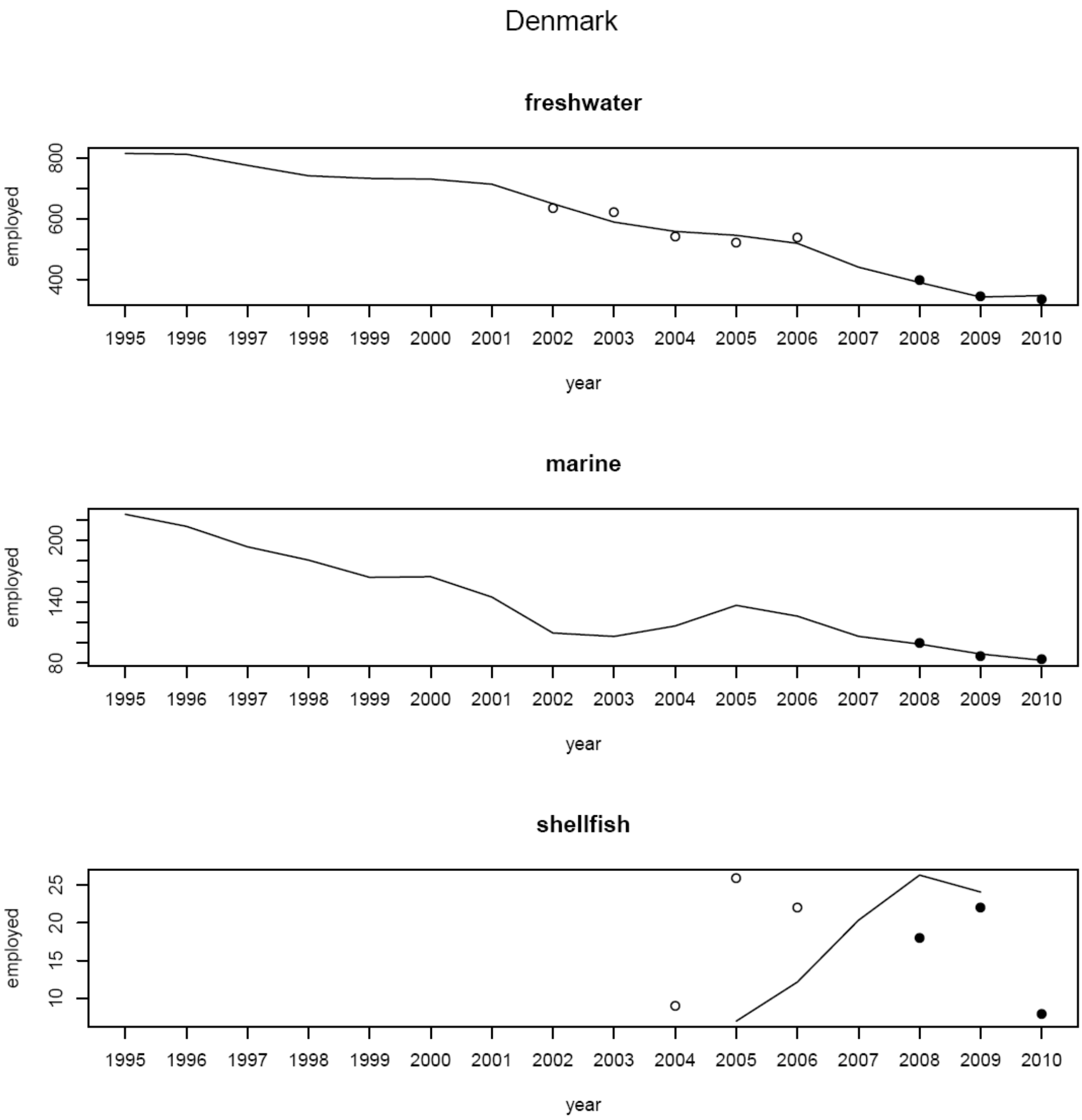


Figure 62 Number of employed persons in aquaculture in Denmark over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

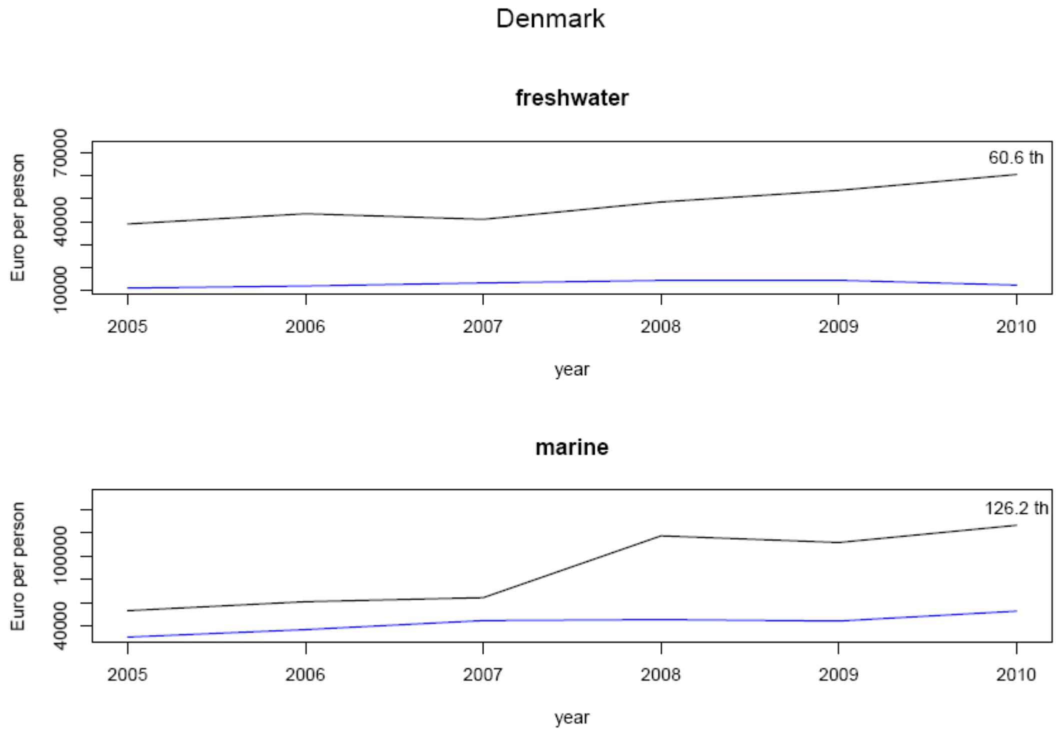


Figure 63 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

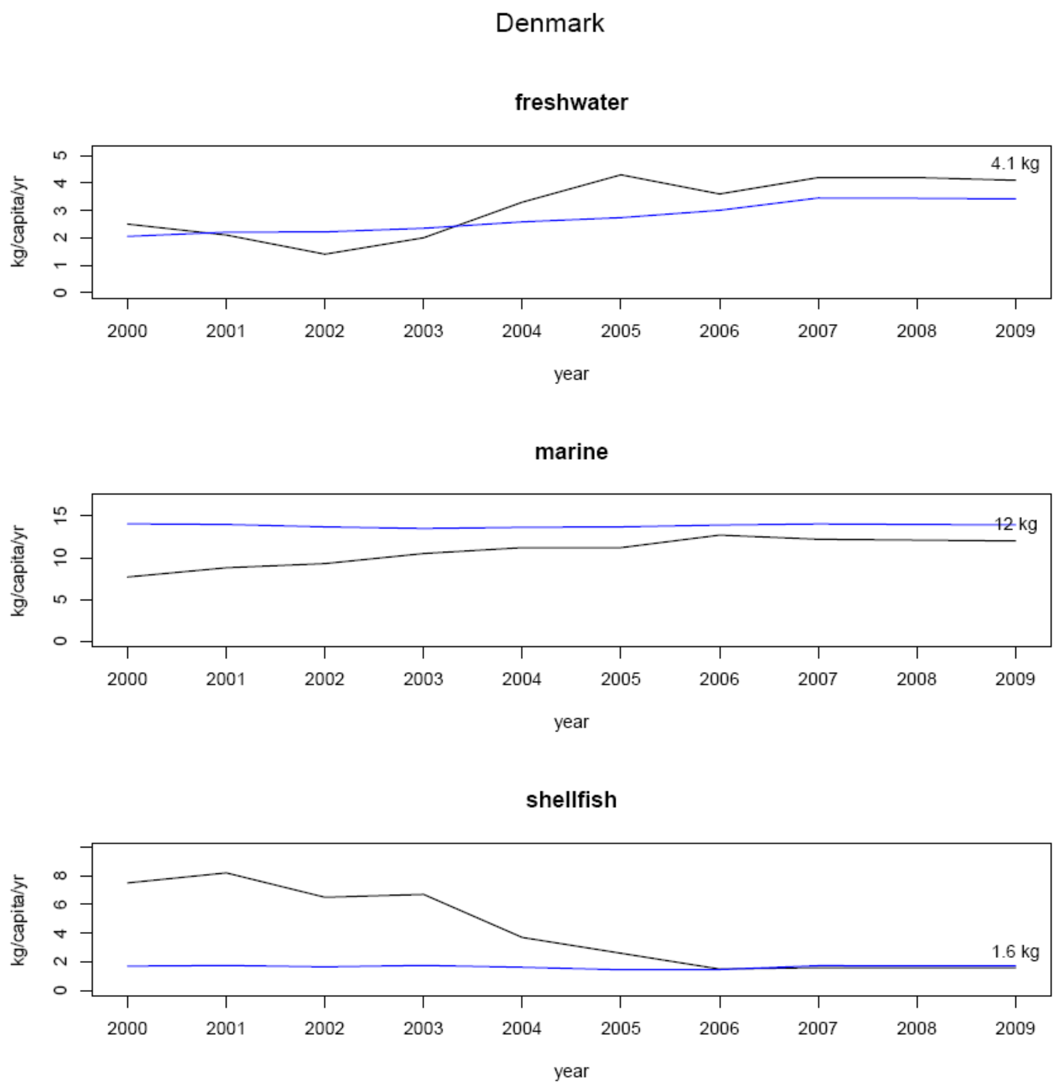


Figure 64 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

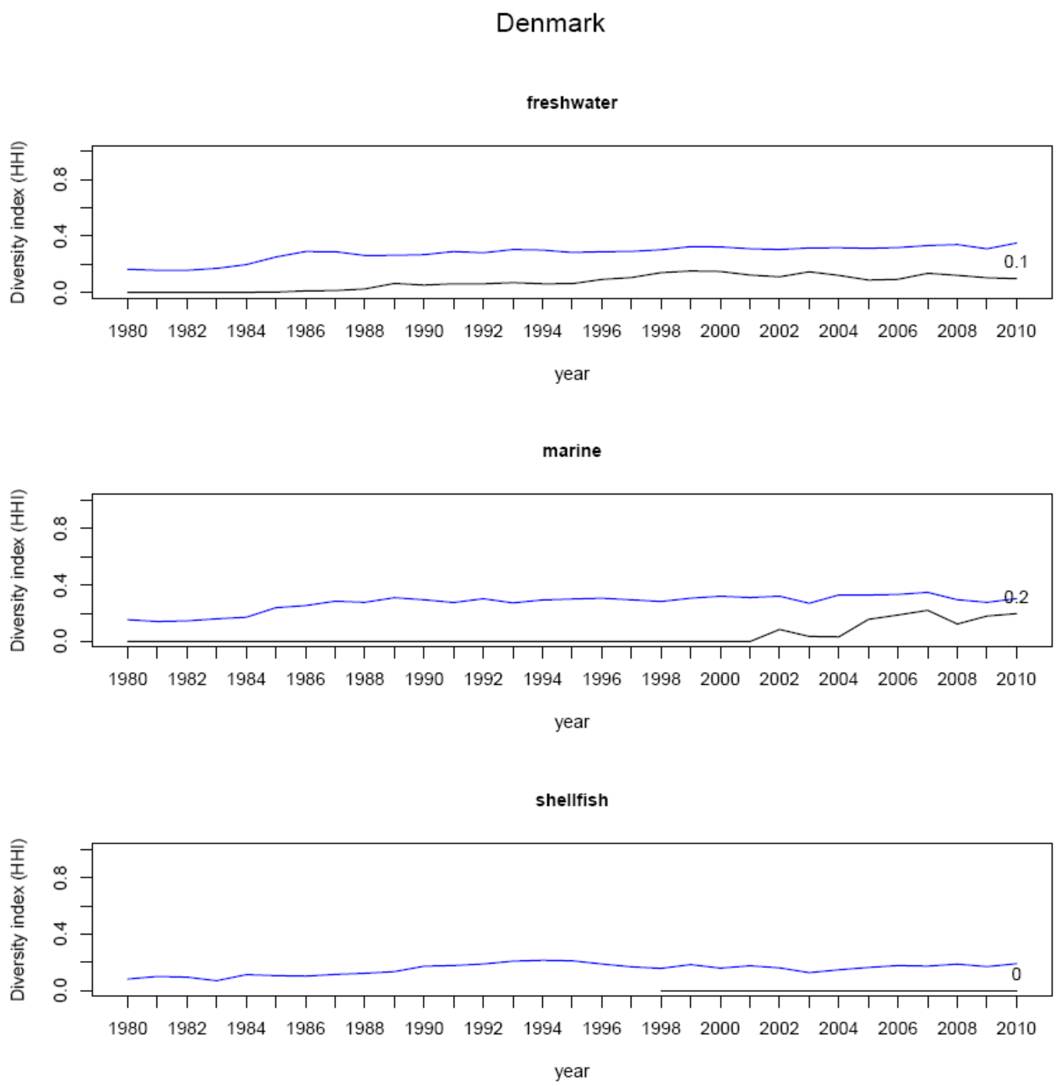


Figure 65 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.7. Estonia

Highlights and trends

- Small freshwater segment with a decreasing trend (2006-2010 -5.5%)
- Decreasing GVA
- In absolute terms, very few persons are employed in the sector

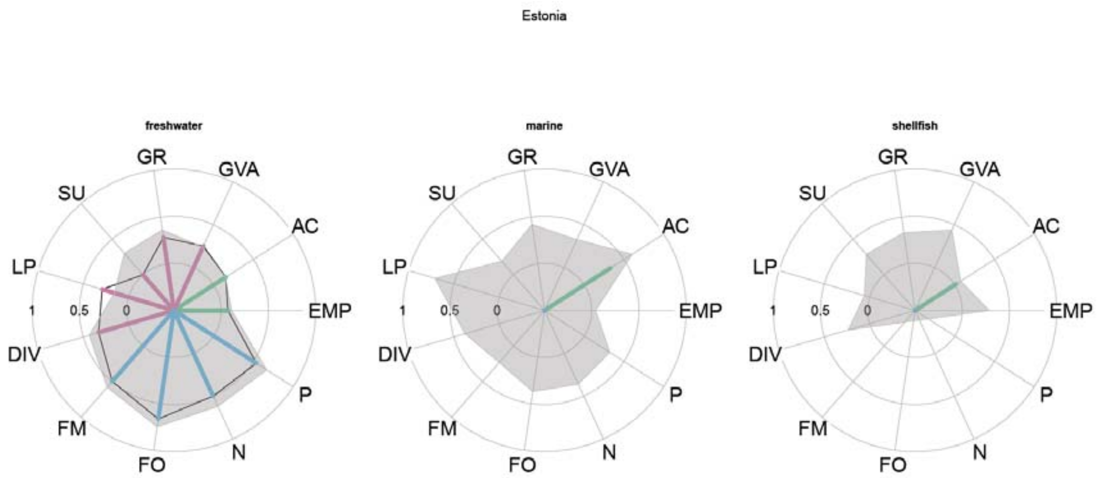


Figure 66 Performance indicators for Estonia

Overview of the sector

The aquaculture sector in Estonia is small. Some 20 commercial companies produced in 2010 around 570 tonnes, mostly in ponds, lakes and raceways. There is no marine finfish or shellfish aquaculture reported.

The three most frequently cultured freshwater species by volume are rainbow trout (85%), common carp (around 7%) and European eel (around 4%). By turnover, trout counts for 78%, sturgeon spp. for 9% and eel for 8%.

After a period of growth there is since 2006 a downward trend in the freshwater aquaculture production of around -5.5%.

GVA of the freshwater aquaculture was slightly above EU ratio for a number of years. The ratio of 2009 and 2010 indicate a decreasing economic importance of the aquaculture production.

In consequence of higher exports than imports of fisheries products, available supply from the freshwater aquaculture in 2010 turned into negative values.

Although the sector has very few persons employed, from 2004 to 2008 a strong increase has been estimated in the employment ratio, followed by a slight decrease.

Being small in absolute terms (194 tonnes fishmeal, 76 tonnes fish oil in 2010), due to the dominant share of trout production the freshwater segment has a demand on fishmeal (around 338 kg) and fish oil (around 133kg) per tonne fish produced above the Union level.

Amounting in 2010 in total to 32 and 5 tonnes, respectively, the effluents of N (around 57kg) and P (around 8 kg) per tonne of fish produced are slightly higher than the EU level.

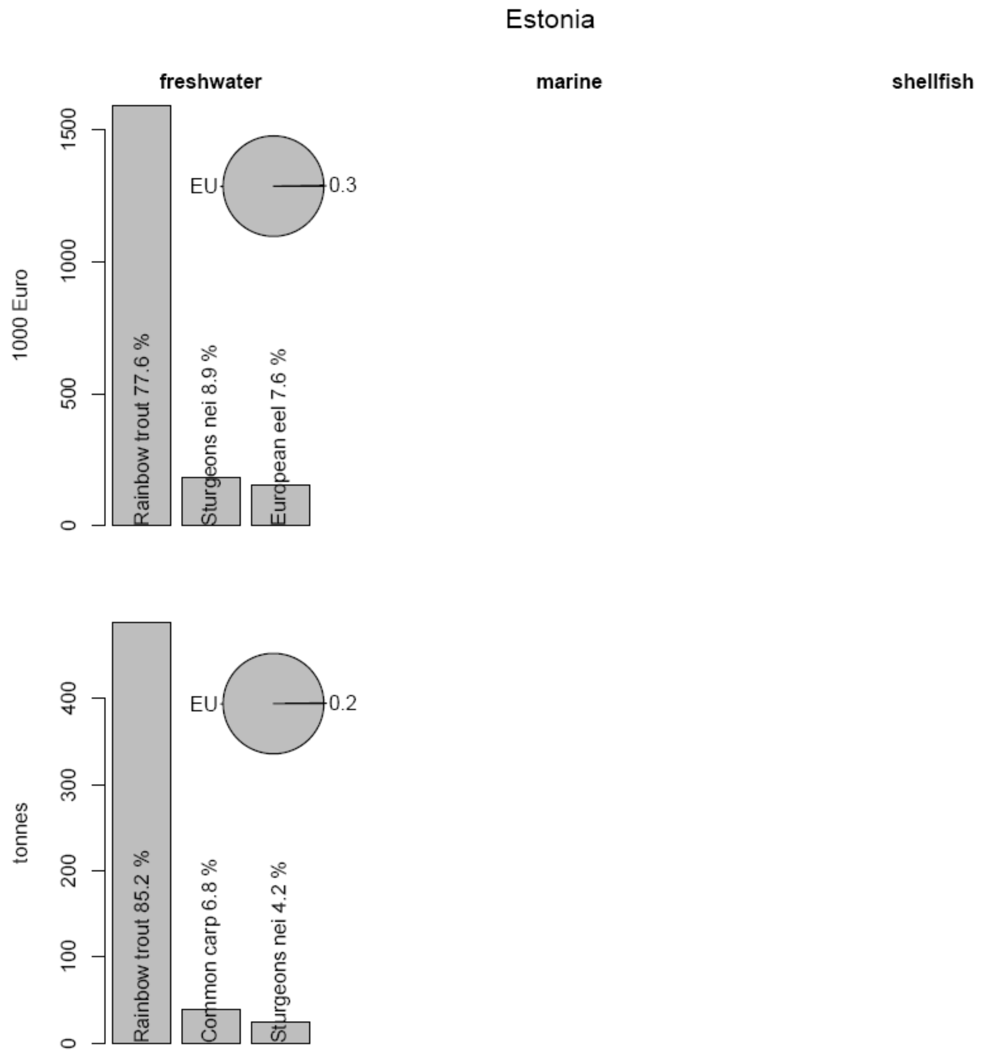


Figure 67 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

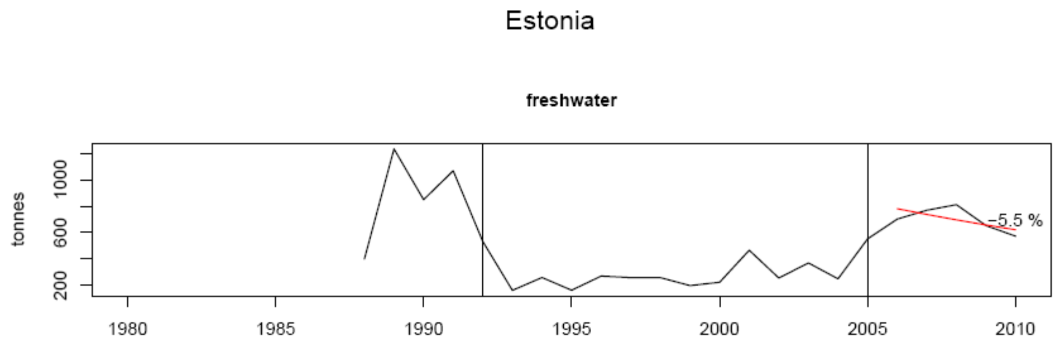


Figure 68 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

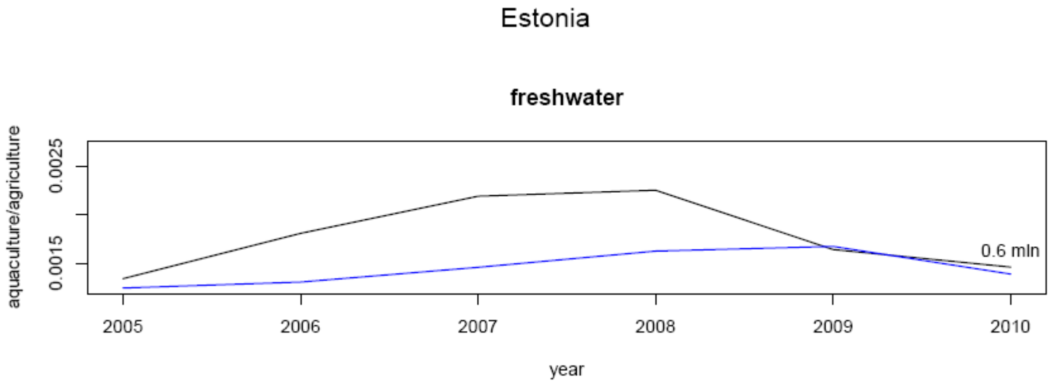


Figure 69 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

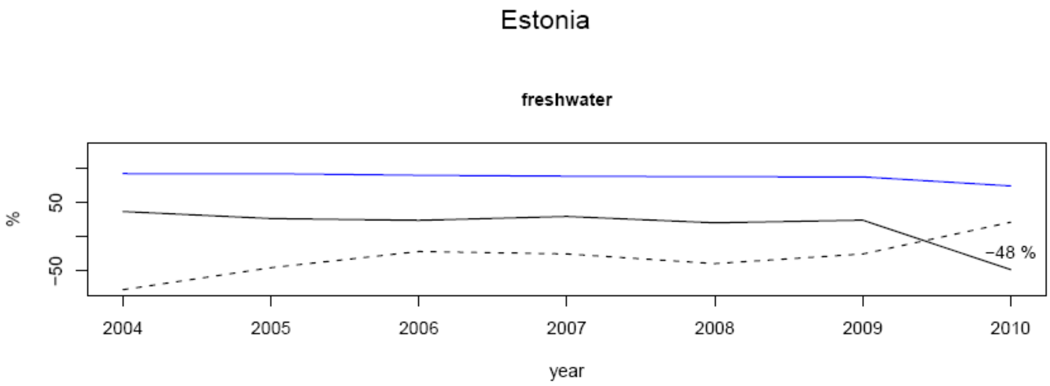


Figure 70 Self-sufficiency and trade: Share of the freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Estonia, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments. Due to the fact that in 2010 more fisheries products were exported than imported, the available supply became negative.

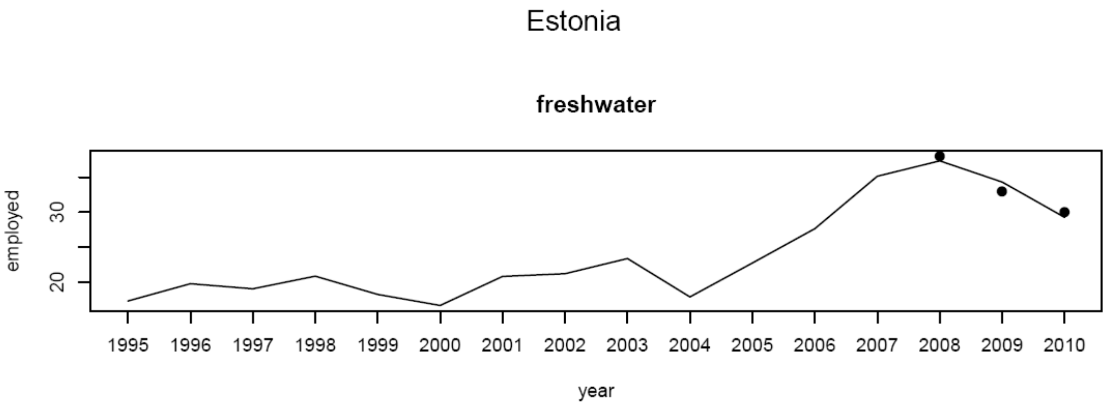


Figure 71 Number of employed persons in the freshwater segment in Estonia over time. The trend line is derived from a country specific model using FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

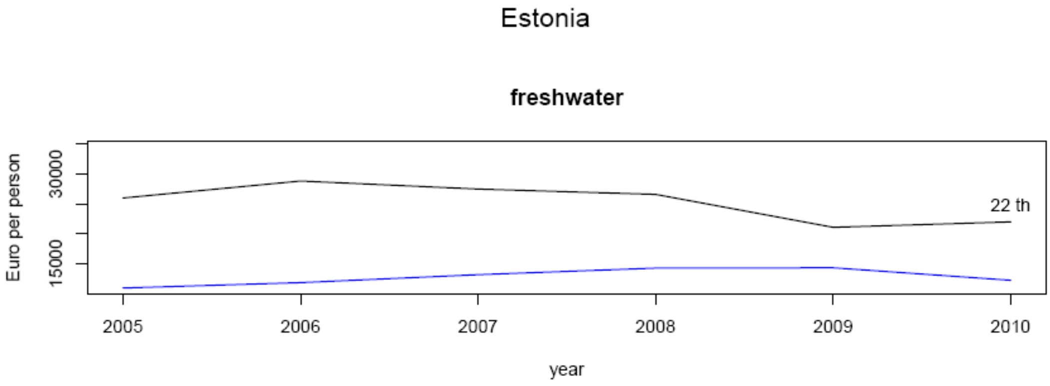


Figure 72 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

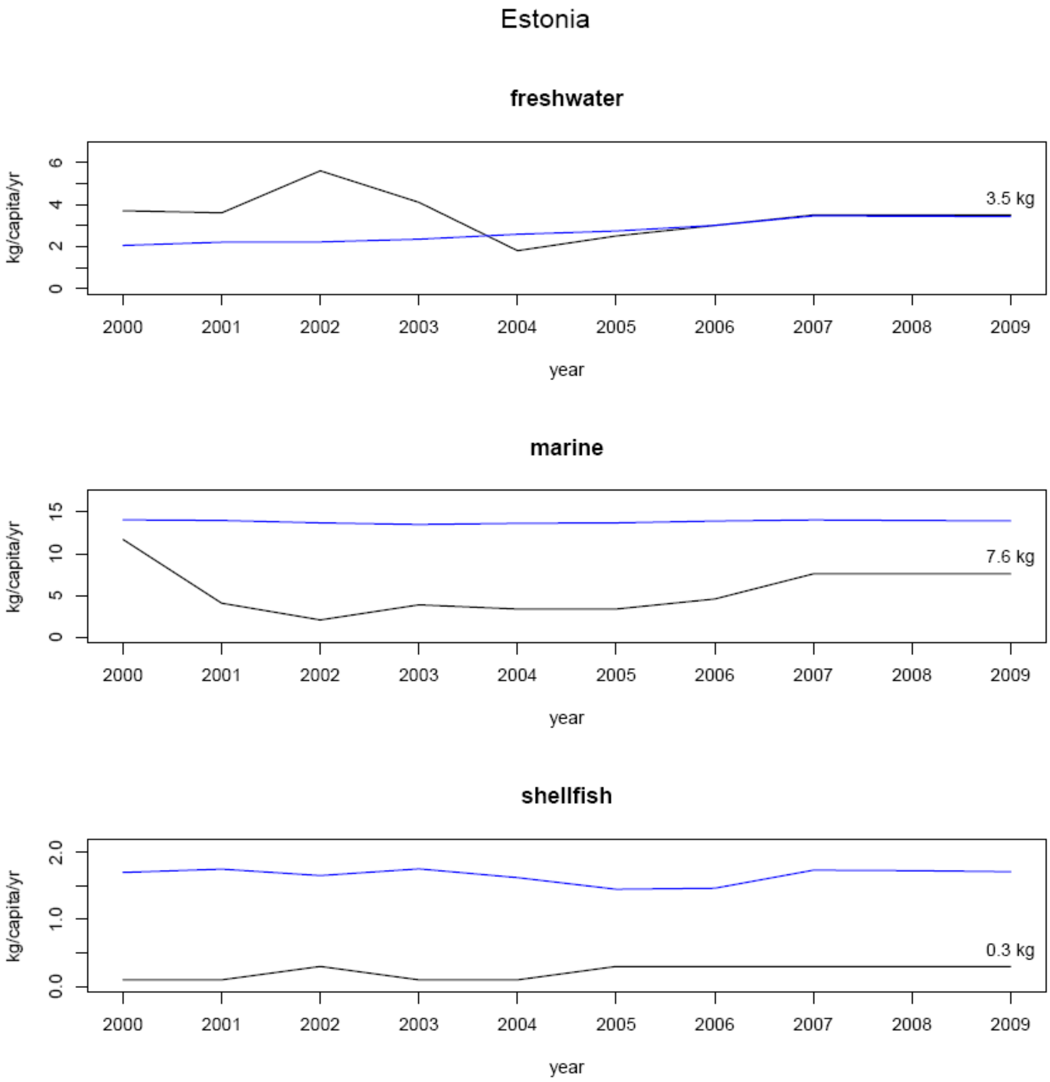


Figure 73 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

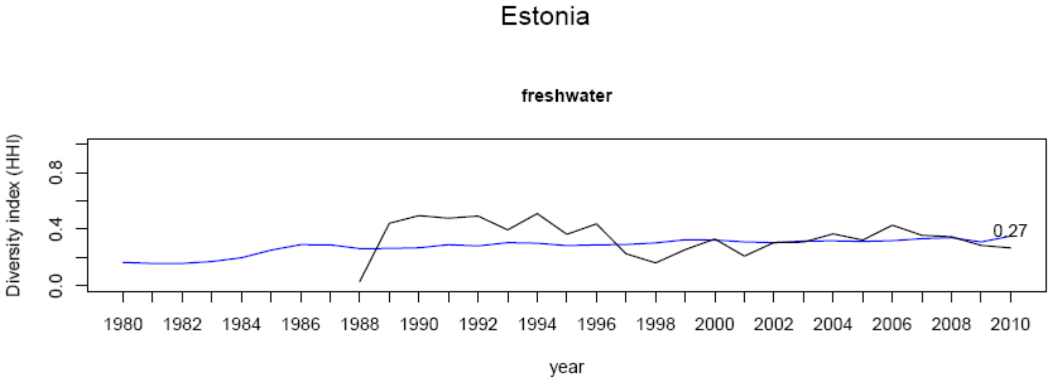


Figure 74 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment).

5.8. Finland

Highlights and trends

- Small national production of freshwater and marine finfish with a slight decrease in growth
- In absolute terms, limited employment as labour productivity increases
- Effluents load is lower than average in the marine finfish segment
- High apparent consumption of fishmeal and fish oil in the freshwater segment.

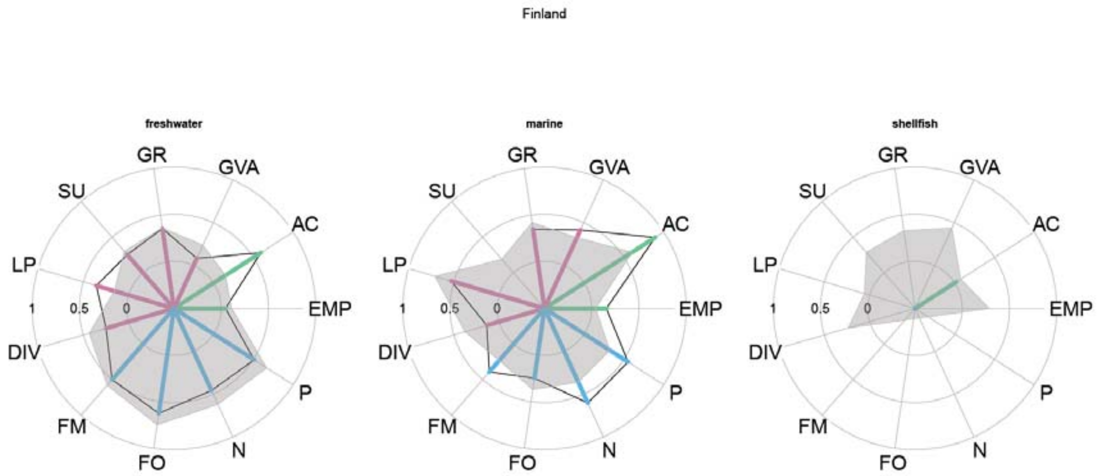


Figure 75 Performance indicators for Finland

Overview of the sector

Marine finfish aquaculture predominates in Finland with a share of some 2.4% of the EU marine finfish aquaculture by value and 2.8% by volume. Freshwater aquaculture reaches around 1/5 of the production in marine finfish environment. The annual production of the 259 entities accounted in 2010 for almost 11,800 tonnes. The most farmed species is rainbow trout with a portion of 89 % or 76% in freshwater and of 94% or 86% in marine finfish environment by volume or value, respectively. European whitefish production is also common and cultured in sea cages, freshwater lakes or raceways. In the freshwater segment the production in natural ponds is very heterogeneous with mainly small scale subsidiary business e.g. of agricultural farms. There is practically no shellfish aquaculture industry.

The situation in Finland is exceptional in the sense that a big part of the aquaculture production value consists of fry. Considerable part of the fry production is used by the owners of private waters and recreational fishing site owners for restocking in natural waters. In addition, power companies and other entities that have legal obligations by courts decisions for restocking are buying fry to compensate lasting harm caused for the fisheries economy. Furthermore fry exports to Russia have increased. According to experts estimates fry production value in 2011 was EUR 24.3 million, out of which perhaps maximal 10 million would account for fry sold to aquaculture farms. Approximately EUR 15 million of this fry production value does therefore not appear in official production statistics and is not represented by the indicators.

An additional development which is not yet captured by the statistics and by the indicators is the construction of 9 modern closed circulation aquaculture production sites with a combined production capacity of about 2 million kg. This production consists exclusively of new high-value species (sturgeon, pikeperch, and whitefish). These units are not all yet in full production volumes.

Since more than a decade the finfish production as a whole shows a downward trend, in the last five years in the freshwater segment of -0.96% and in the marine finfish segment of –1.4%.

The GVA of freshwater and marine finfish aquaculture is relatively constant. The ratio is around the EU ratio for marine but well below for freshwater aquaculture.

The contribution of finfish production to self-sufficiency lays at some 55% with little changes from previous years. In the graph shown below for the self-sufficiency the trout production in freshwater and marine environment have been merged for simplification.

Although the employment ratio for marine finfish aquaculture is above EU average, over the last 15 years in both, in the freshwater and marine segment a clear downward trend is apparent.

In absolute terms, marine finfish aquaculture consumes some 6 to 10 times the amount of freshwater aquaculture in fishmeal and fish oil (around 4,960 tonnes meal and around 2,900 tonnes oil in marine versus 650 tonnes and 285 tonnes in freshwater environment). Also per tonne fish produced, the use of fishmeal and in particular of fish oil is higher in the marine finfish than in the freshwater environment (~ 402 kg fishmeal, 294 kg fish oil in marine versus 336 kg fishmeal and 148 kg fish oil in freshwater environment). The marine finfish segment demands less fishmeal but more fish oil than the level of the Union in total.

N and P effluents per tonne finfish produced are above the Union level in the freshwater segment (around 60 kg/t N, 9 kg/t P) but well below the Union level in the marine finfish environment (around 47kg/t N, around 8 kg/t P).

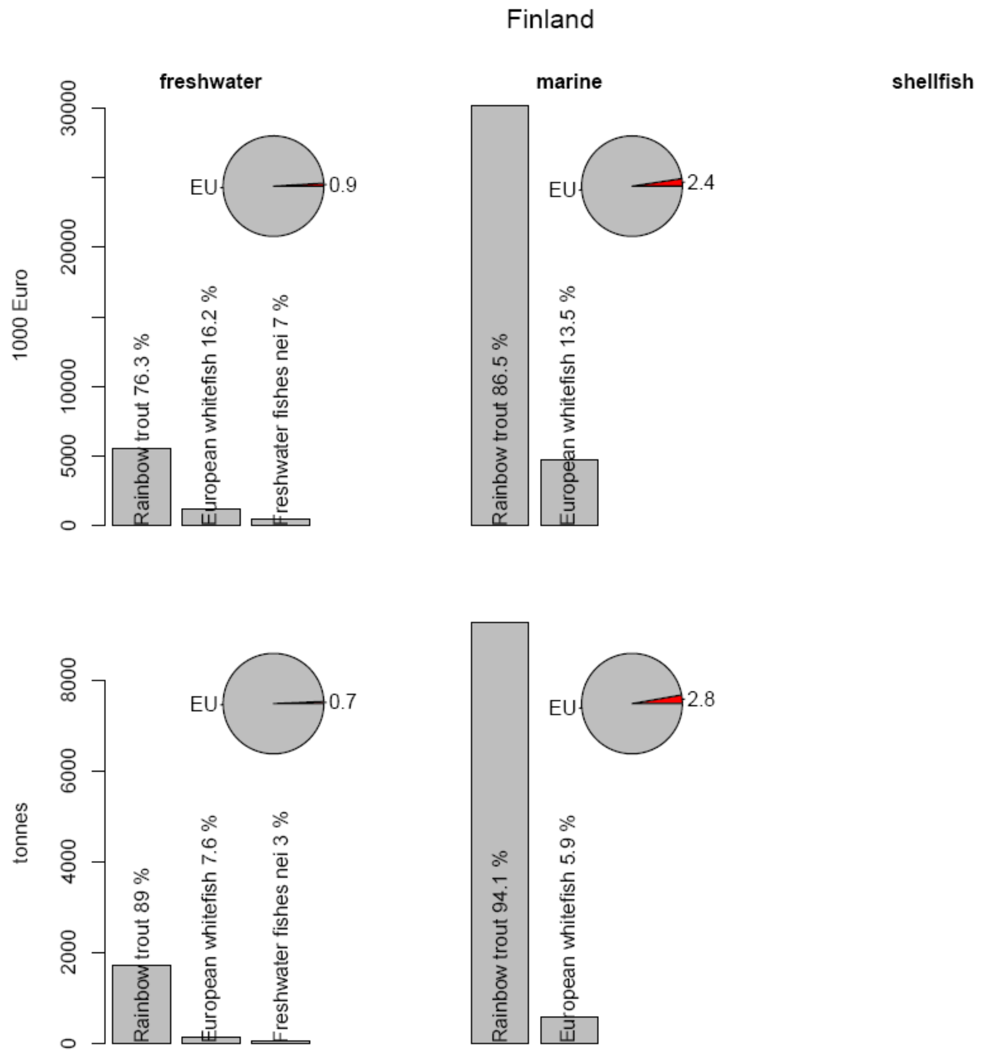


Figure 76 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish and marine finfish segment.

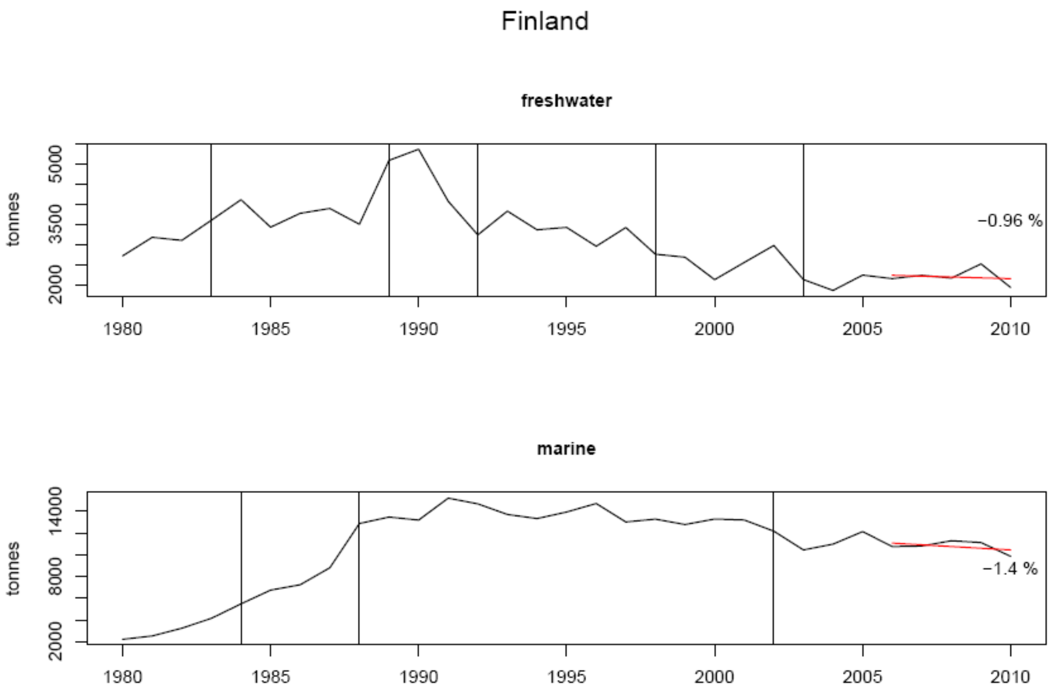


Figure 77 Production growth: Production patterns of the freshwater and marine finfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

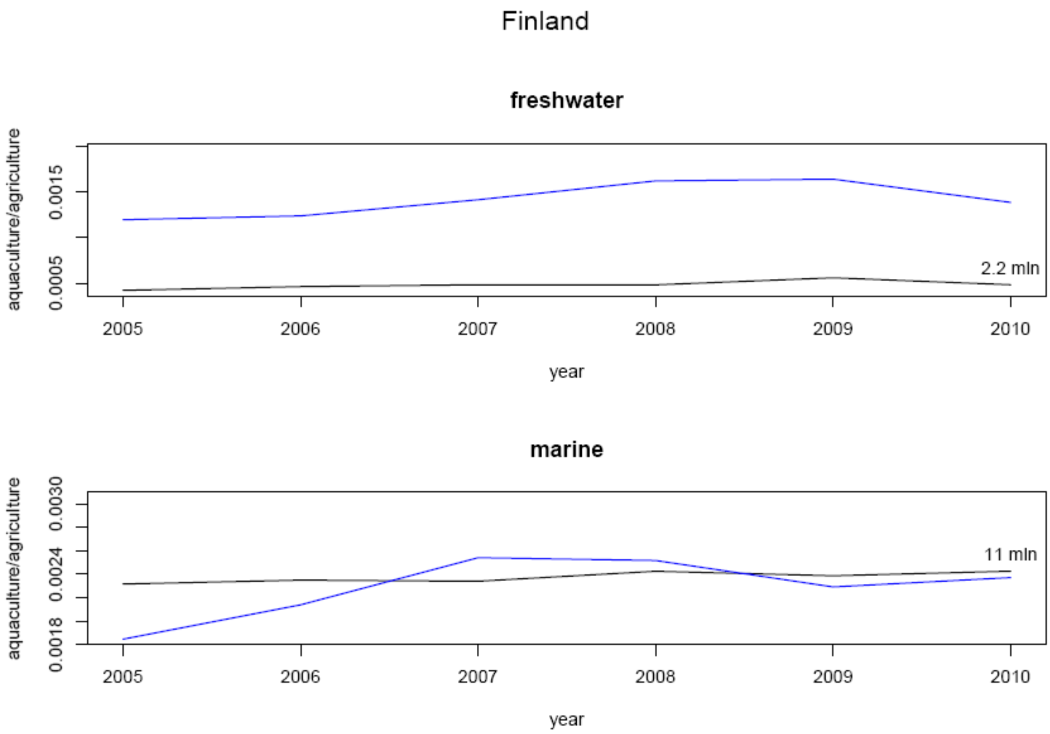


Figure 78 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

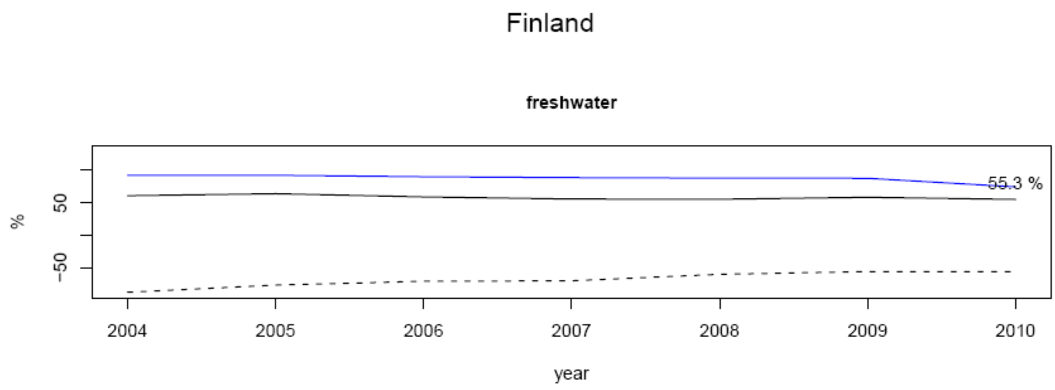


Figure 79 Self-sufficiency and trade: Share of the freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Finland, blue line: overall self-sufficiency of the EU production in the segments (for simplification, freshwater and marine trout production were merged for calculating self-sufficiency), dotted line: normalised trade balance on fishery products in the relevant segments.

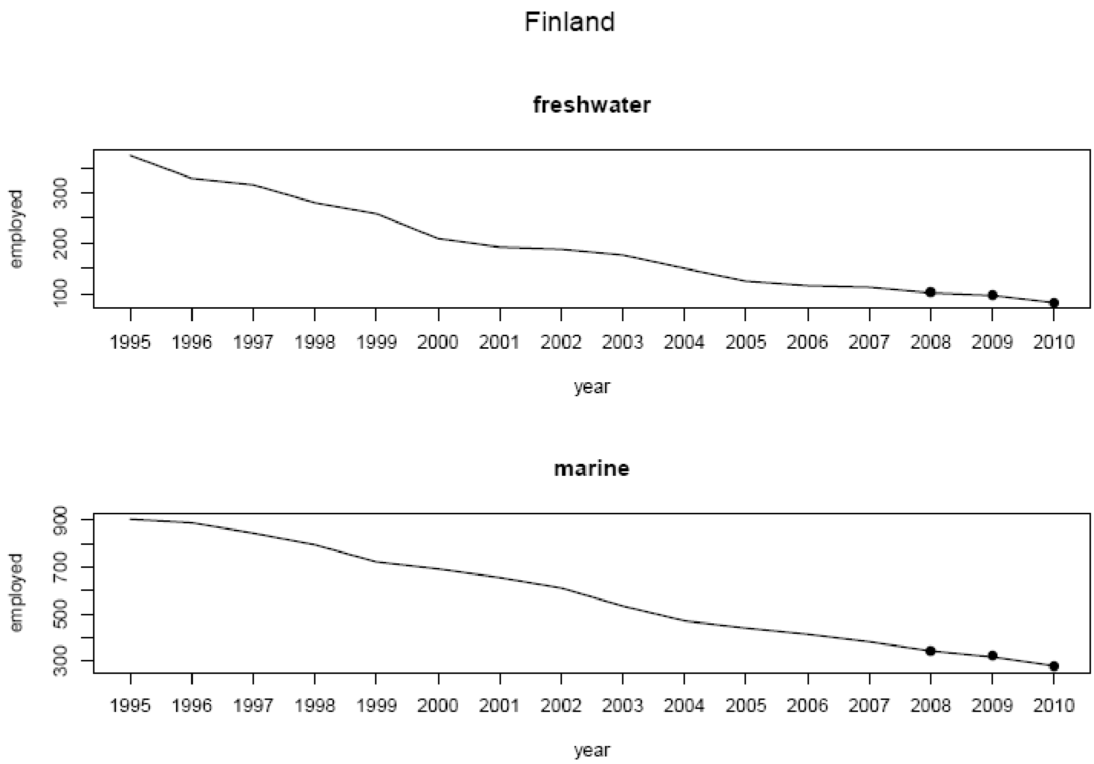


Figure 80 Number of employed persons in the freshwater and marine segment in Finland over time. The trend line is derived from a country specific model using FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

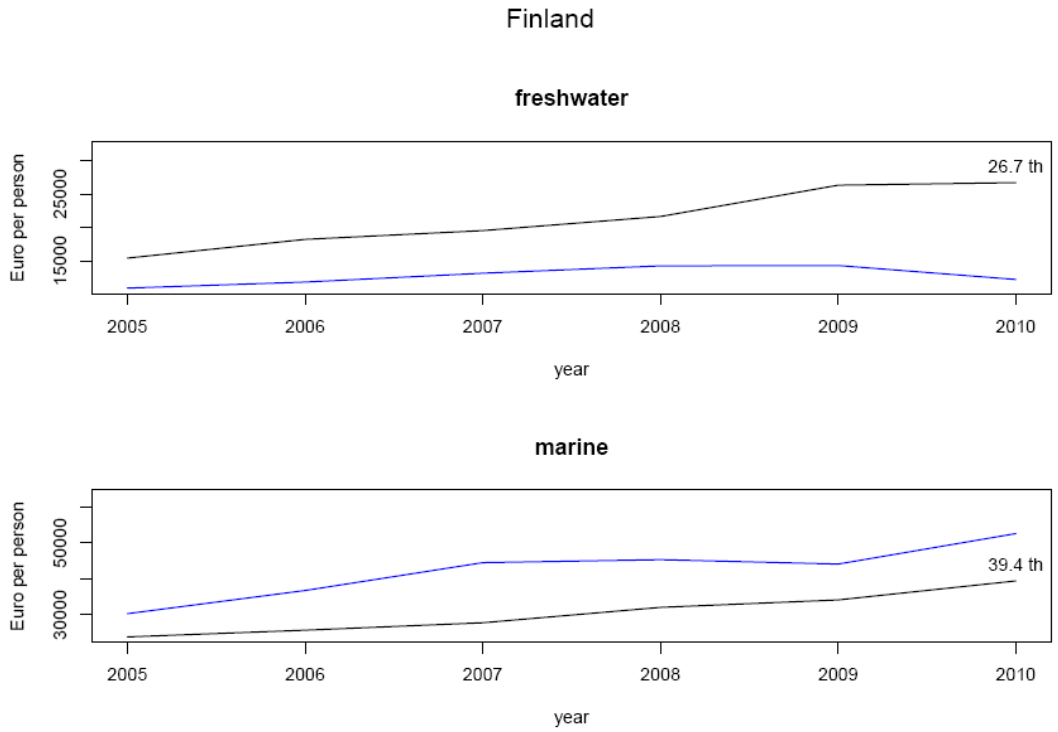


Figure 81 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

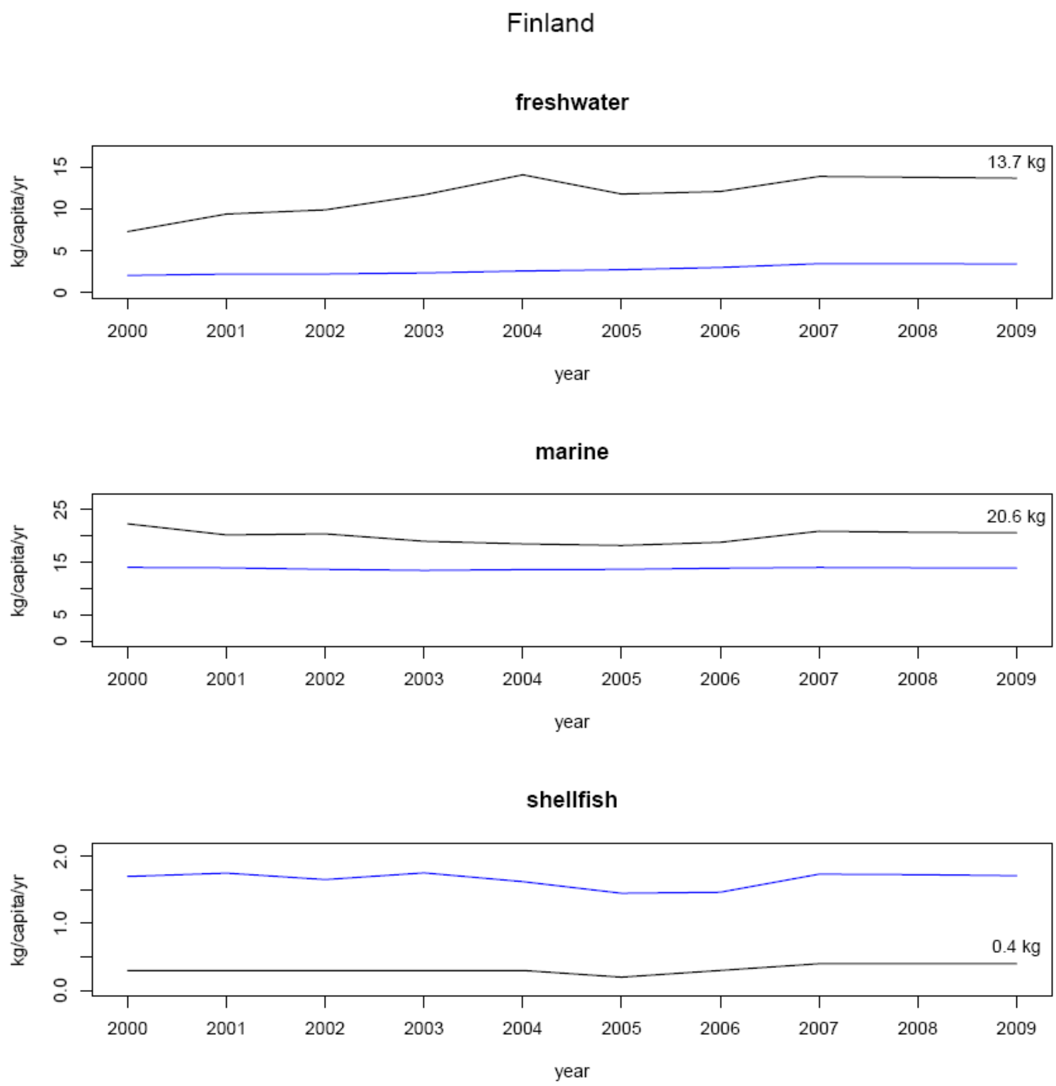


Figure 82 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

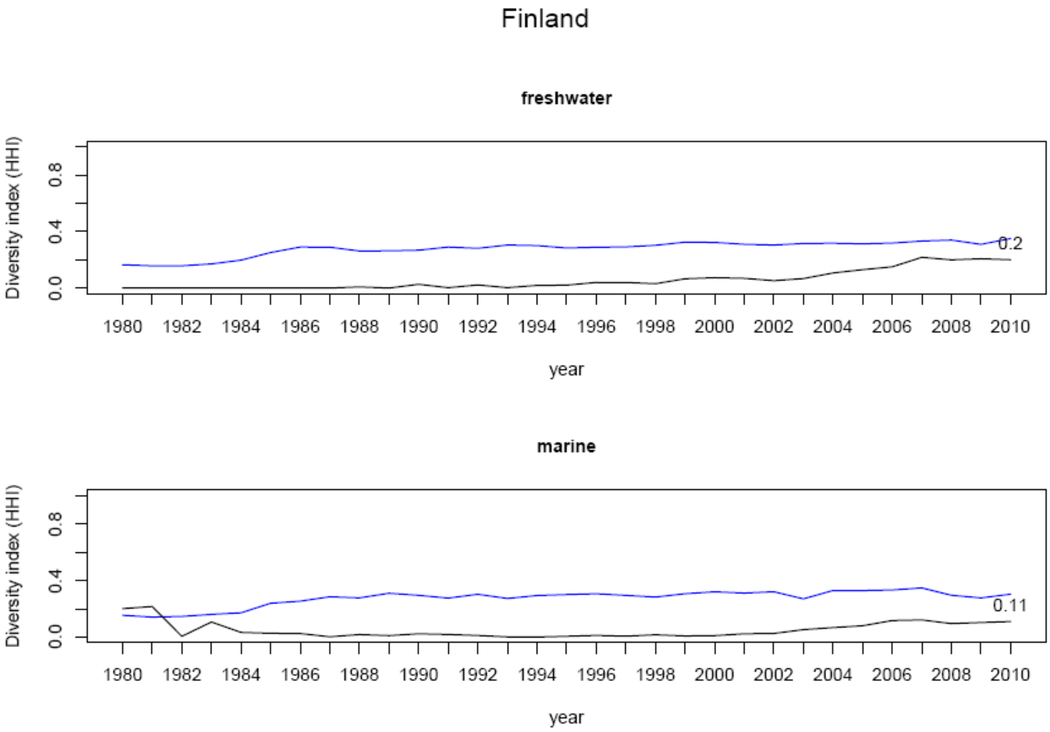


Figure 83 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.9. France

Highlights and trends

- Strong shellfish segment with a downward trend of -1.4% in the last five years..
- The shellfish production contributes with high GVA and productivity.
- High diversification of farmed species contributing to the production, especially in the marine finfish and shellfish segments.
- In absolute terms, employment is high in the shellfish segment but many jobs are part time or seasonal.
- Labour productivity is high in the freshwater and shellfish segment.
- Apparent consumption of fisheries products is high.
- Effluent load from aquaculture is above EU average.

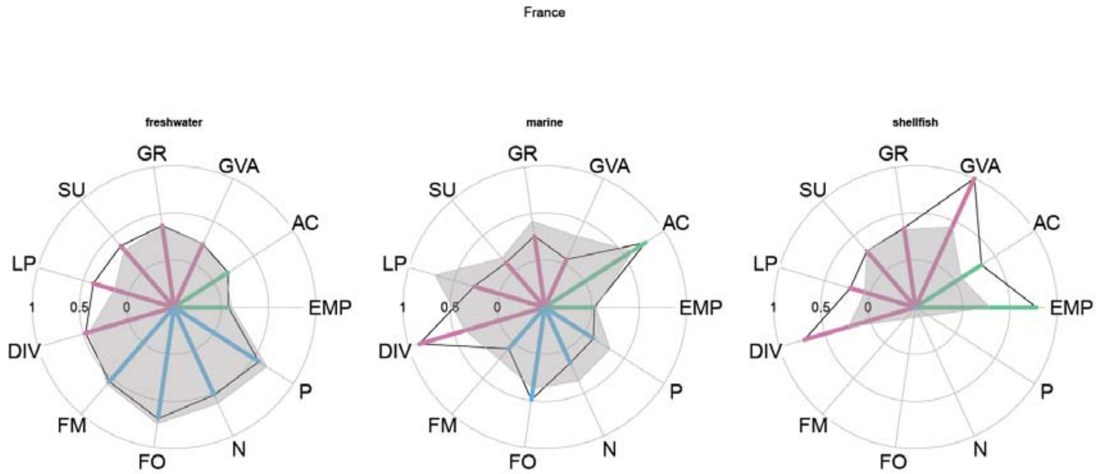


Figure 84 Performance indicators for France

Overview of the sector

With a volume of more than 224,000 tonnes in 2010, France is the second largest aquaculture producer in the Union. The sector is dominated by shellfish production which presents almost 29% of the Unions shellfish production by volume and 54% by value. From some 177,000 tonnes in 2010, 54% accounted for Pacific cupped oyster, 35% for blue mussel and 8.5%for Mediterranean mussel by volume. The freshwater culture of rainbow trout (78%), common carp (10%) and other species contributed with almost 41,200 tonnes to 15% of the EU freshwater finfish aquaculture segment by volume. The marine finfish aquaculture presents with 5,800 tonnes in 2010 a small segment, counting for 1.6% by volume and 2.7% by value of the EU marine finfish aquaculture output. The main marine species are European sea bass, Gilthead sea bream, along the Mediterranean cost and Atlantic salmon and turbot along the Atlantic coast.

Most of the entities are small (some 500 freshwater farms, around 40 marine finfish farming companies and about 3,250 mainly small scale and family based shellfish entities). According to some sources, no new production licenses have been issued in the last 15 years for finfish production and there is fierce competition for space with other users. France has an important production of juveniles and eggs for commercial aquaculture.

Shellfish and marine finfish aquaculture showed over the last five years a slight decreasing trend (-1.4% and -6.8%, respectively), while the freshwater aquaculture remained relatively stabile (0.16%).

Mainly the oyster production has an important share to the GVA in the shellfish segment. The GVA ratio stays close to EU ratio for the freshwater segment and is well below the EU ratio for the marine finfish production.

While freshwater aquaculture achieves a degree of self-sufficiency of 98%, it is with 2.3% very low for marine finfish aquaculture. For shellfish it is very similar to the EU level with some 67%.

Employment is highest in the shellfish segment, remaining since 2003 relatively stable (~14,800 persons). The employment rate for freshwater and marine finfish aquaculture is below the EU ratio. In freshwater production the persons employed fluctuated over the last 15 years between some 1,200 and 1,600, actually around 1,400. For marine finfish aquaculture a downward trend can be observed since 2006 from around 600 to recently some 470 persons.

Apparent consumption is clearly above EU average, strongest in the marine finfish and shellfish segment with some 17.7 and 7.6 kg in 2009, respectively.

In absolute terms, freshwater aquaculture uses around four times the amount of fishmeal and fish oil (in 2010 around 12,740 tonnes fishmeal and 5,000 tonnes fish oil in freshwater versus 3,420 tonnes and 1,164 tonnes in marine environment). Per tonne fish produced, the use of fishmeal and fish oil is higher in the marine segment (around 590 kg fishmeal, around 201 kg fish oil) than in the freshwater environment (around 309 kg fishmeal, around 121 kg fish oil) and in all cases higher than for the EU in total, with the exception of fish oil in marine environment. With a dominant share of sea bass and sea bream in marine production, the use of fish oil per tonne finfish is below the Union level.

N and P effluents per tonne finfish produced are above Union level in both segments, with much higher values in the marine (around 90 kg N, around 14 kg P) than in the freshwater segment (around 55 kg N, around 8 kg P). In absolute terms, in 2010 the effluents were 2,245 tonnes N and 329 tonnes P in the freshwater segment and 519 tonnes N and 83 tonnes P in marine environment. On the other side, the large shellfish production in France would have a mitigating effect when balancing effluent effects.

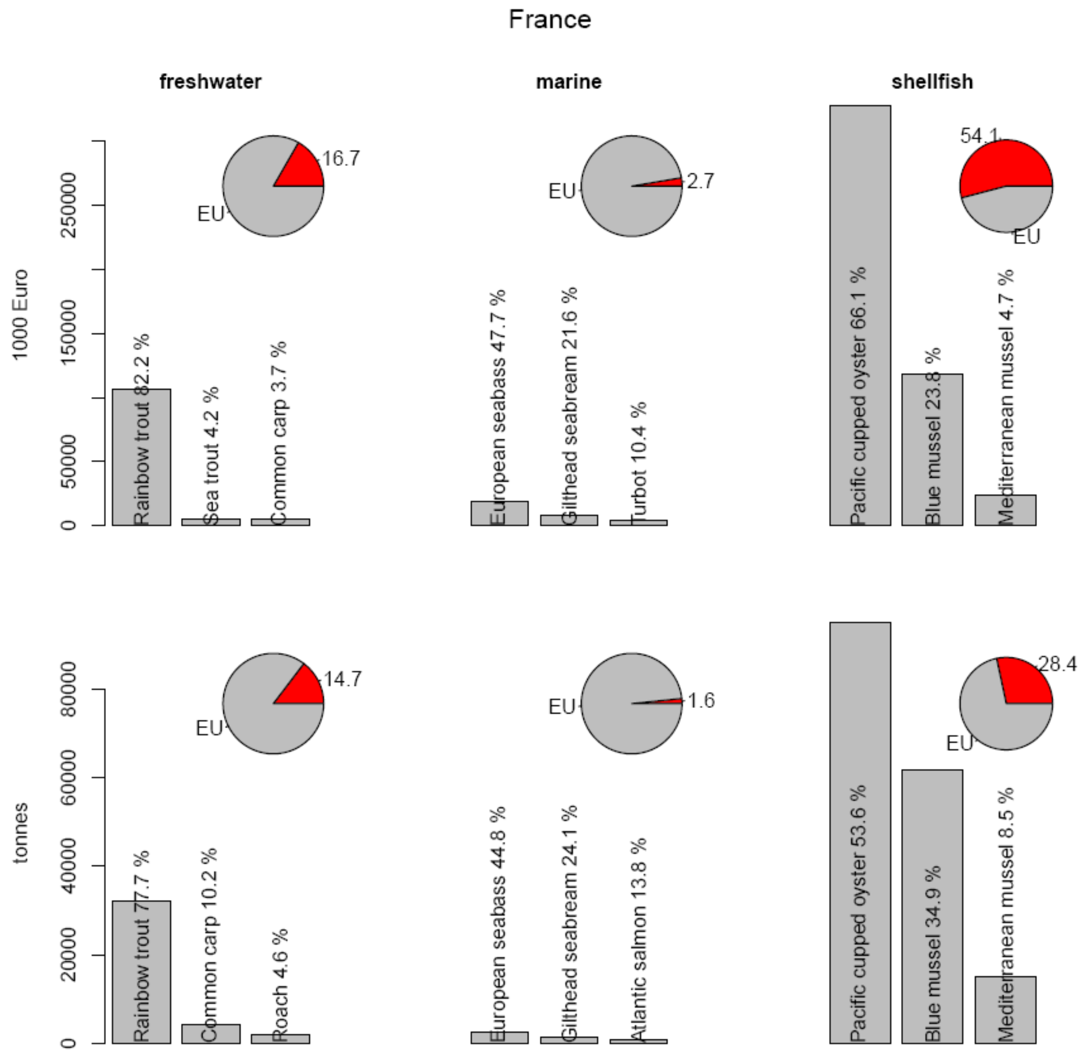


Figure 85 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

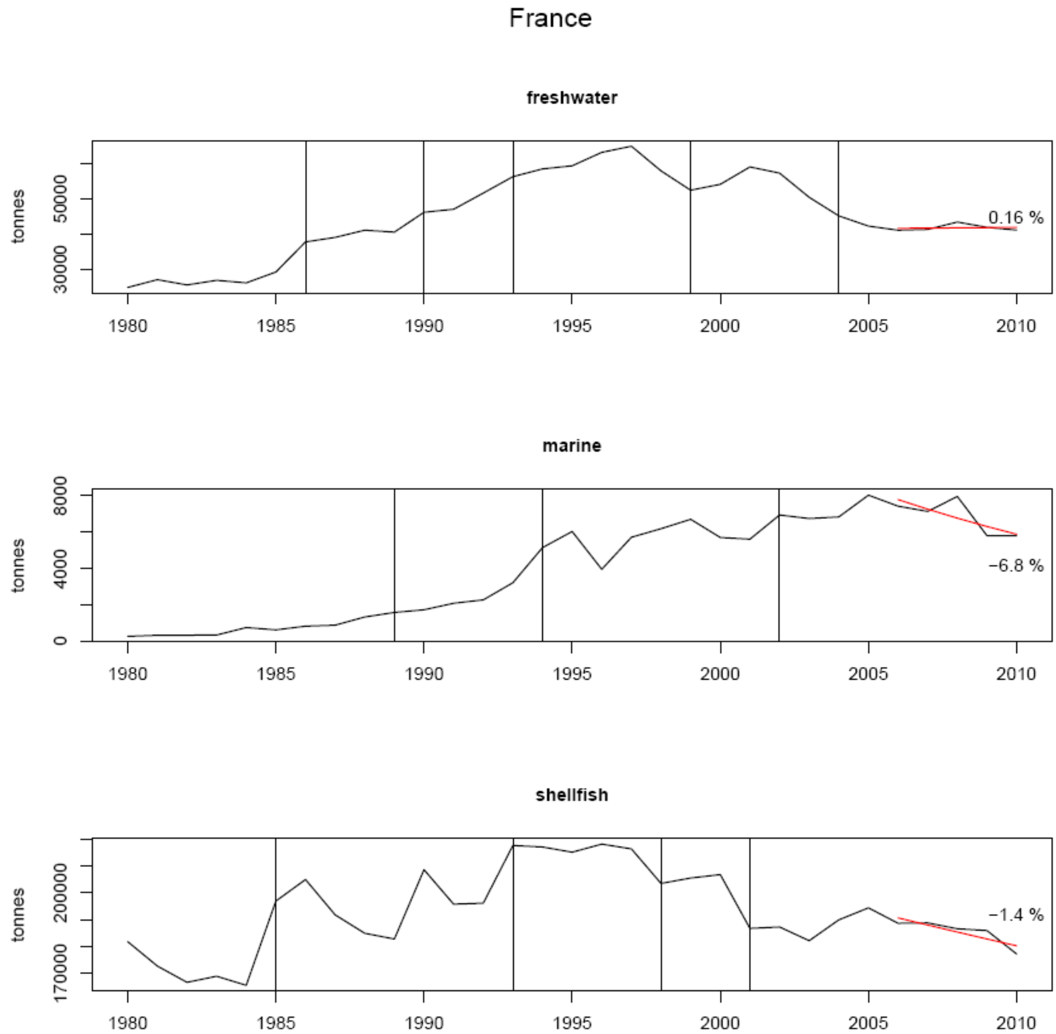


Figure 86 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last three five years (2006-2010).

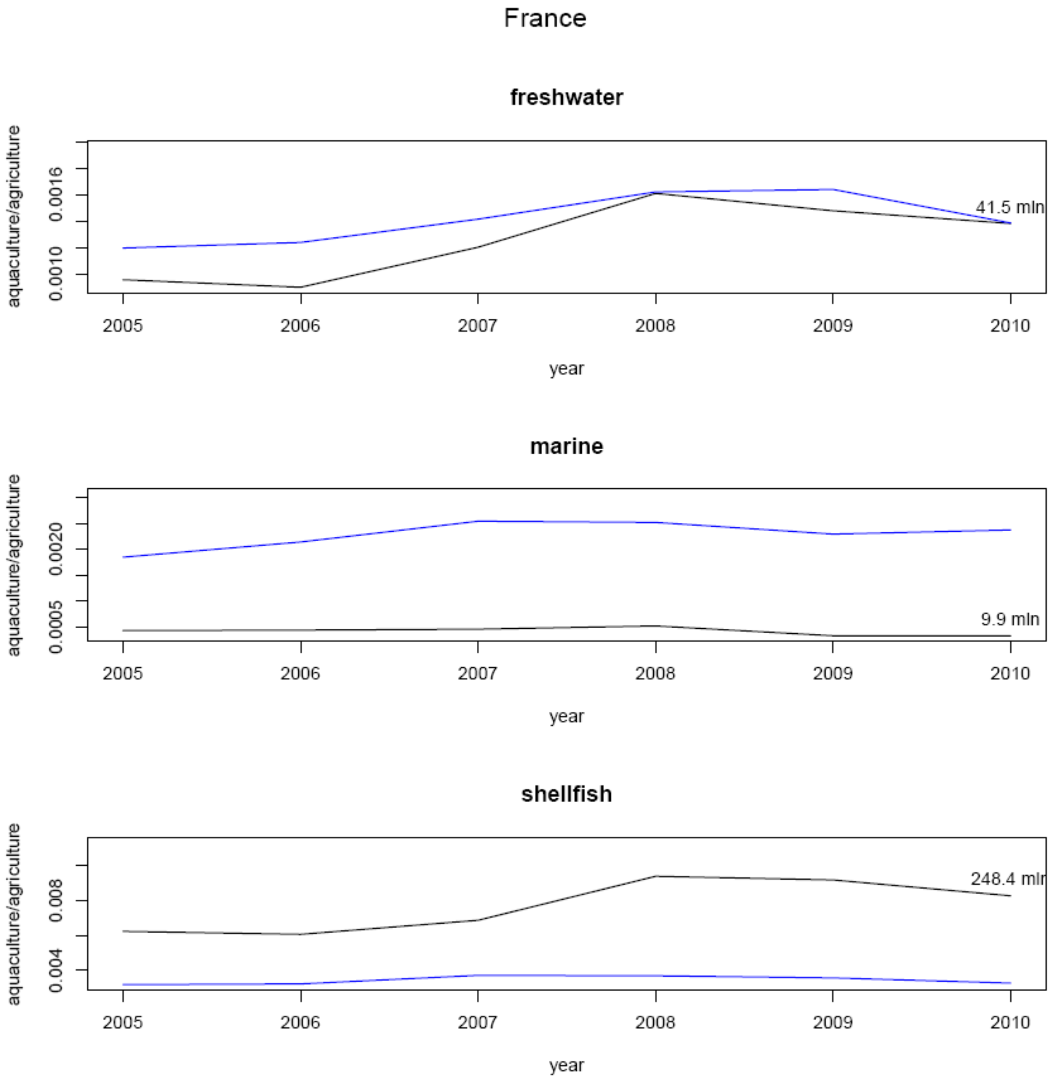


Figure 87 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2009, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole). The ratio for 2010 is based on the agriculture GVA of 2009since GVA data for agriculture for 2010 were not available.

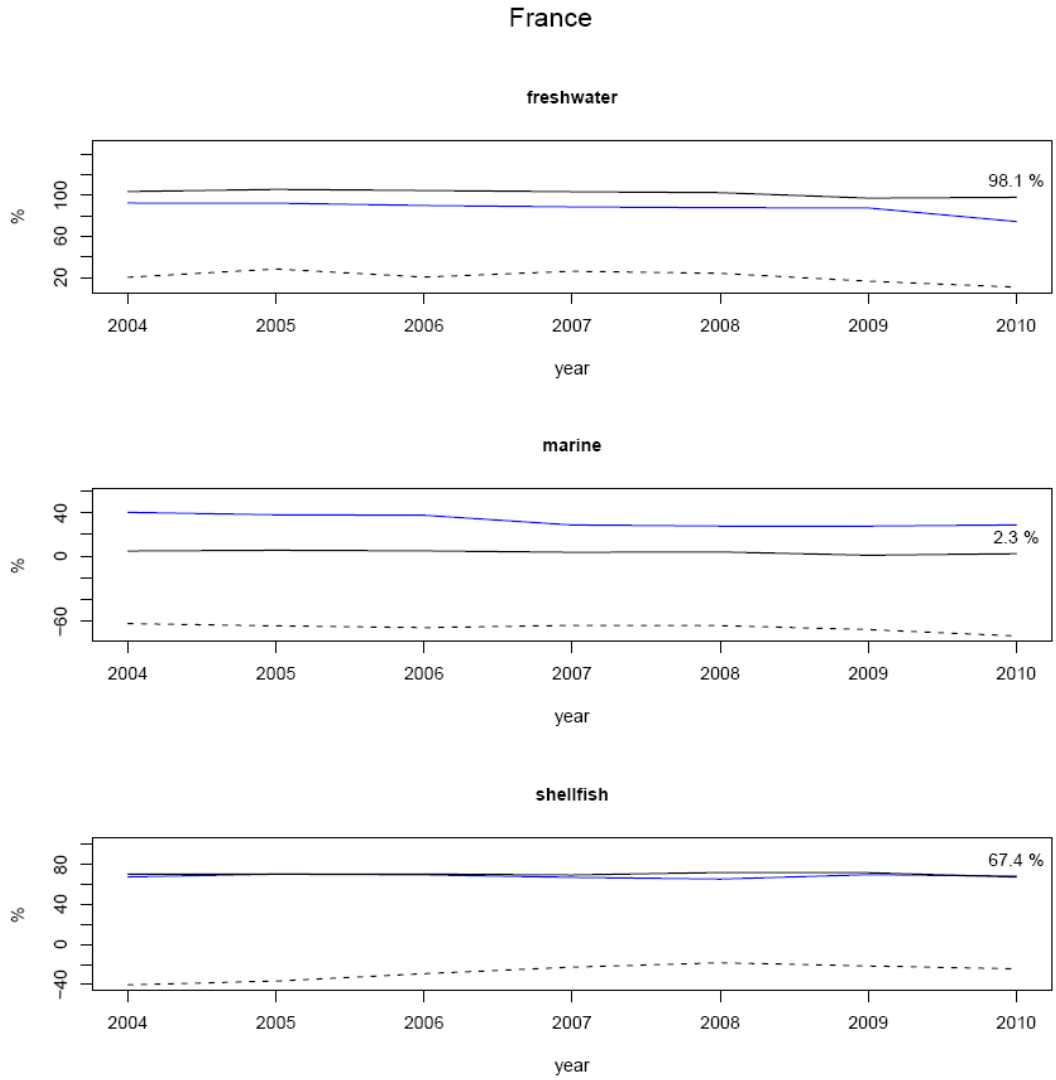


Figure 88 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of France, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

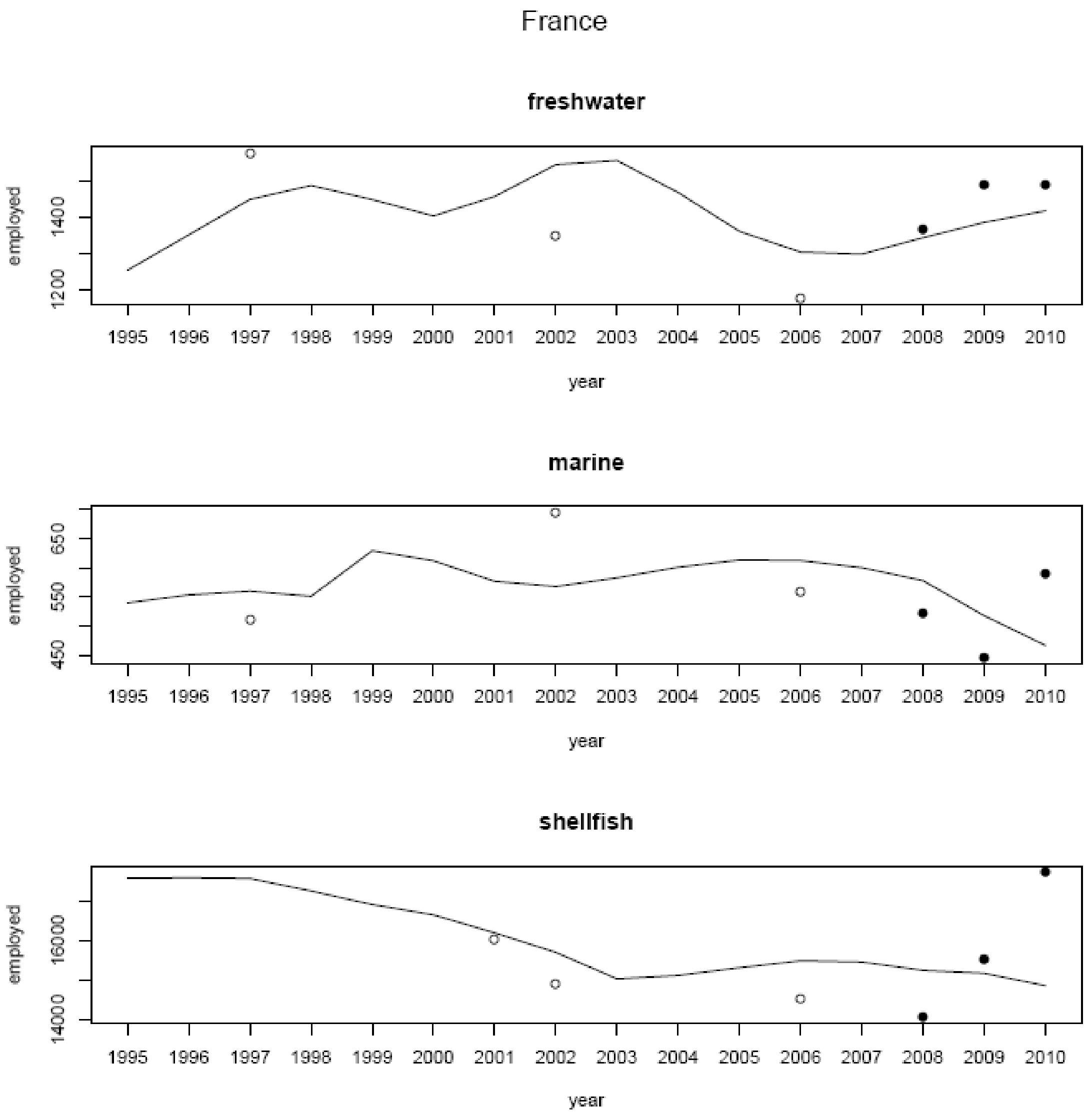


Figure 89 Number of employed persons in aquaculture in France over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

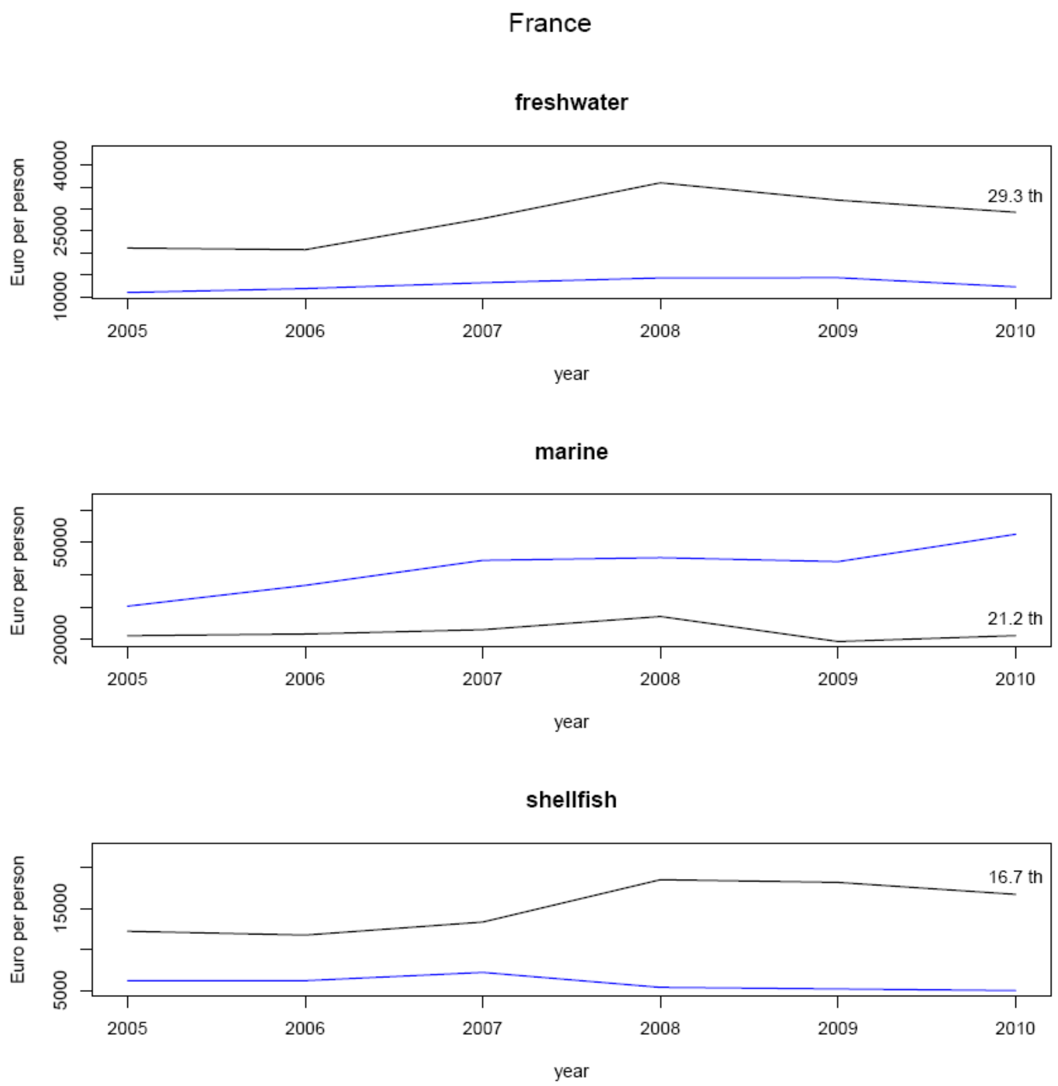


Figure 90 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

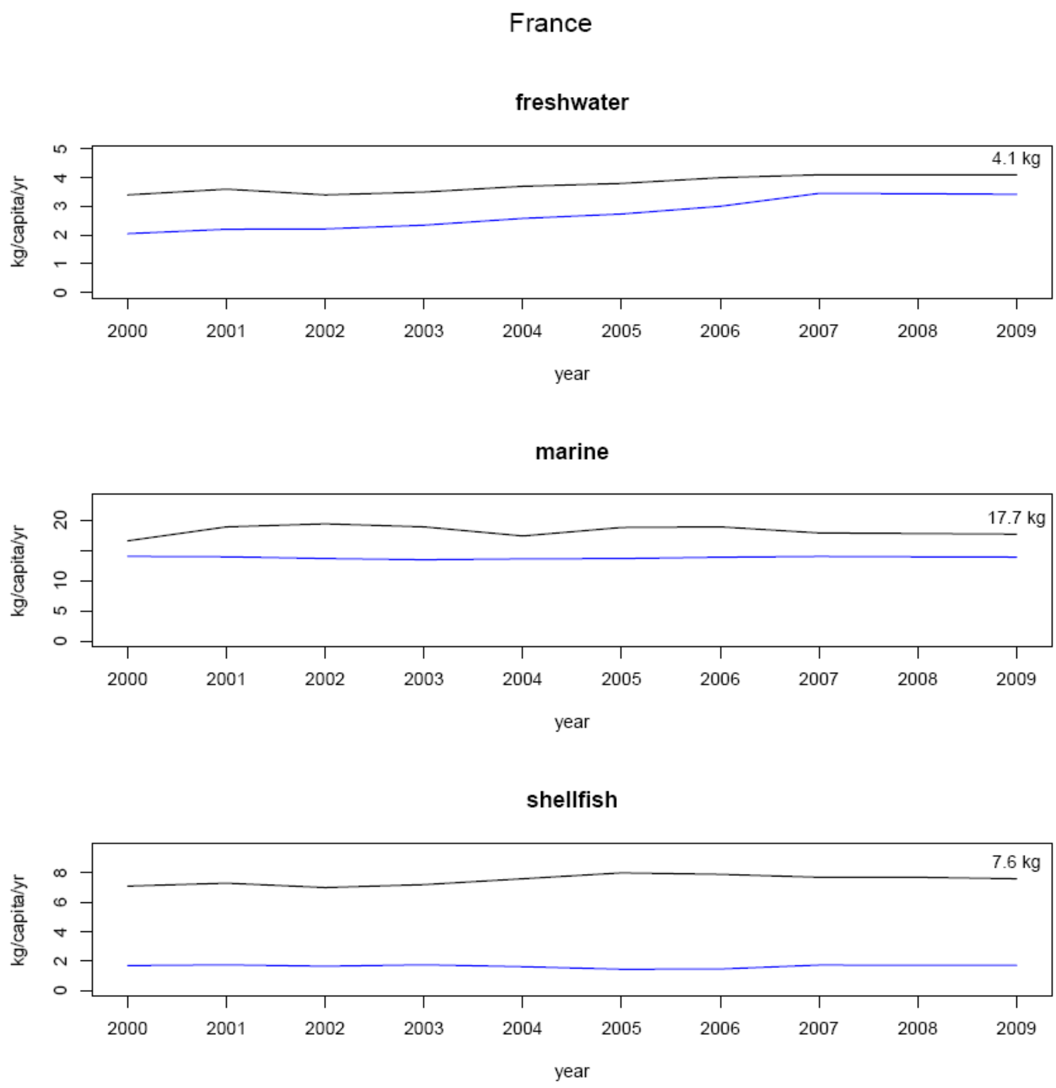


Figure 91 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

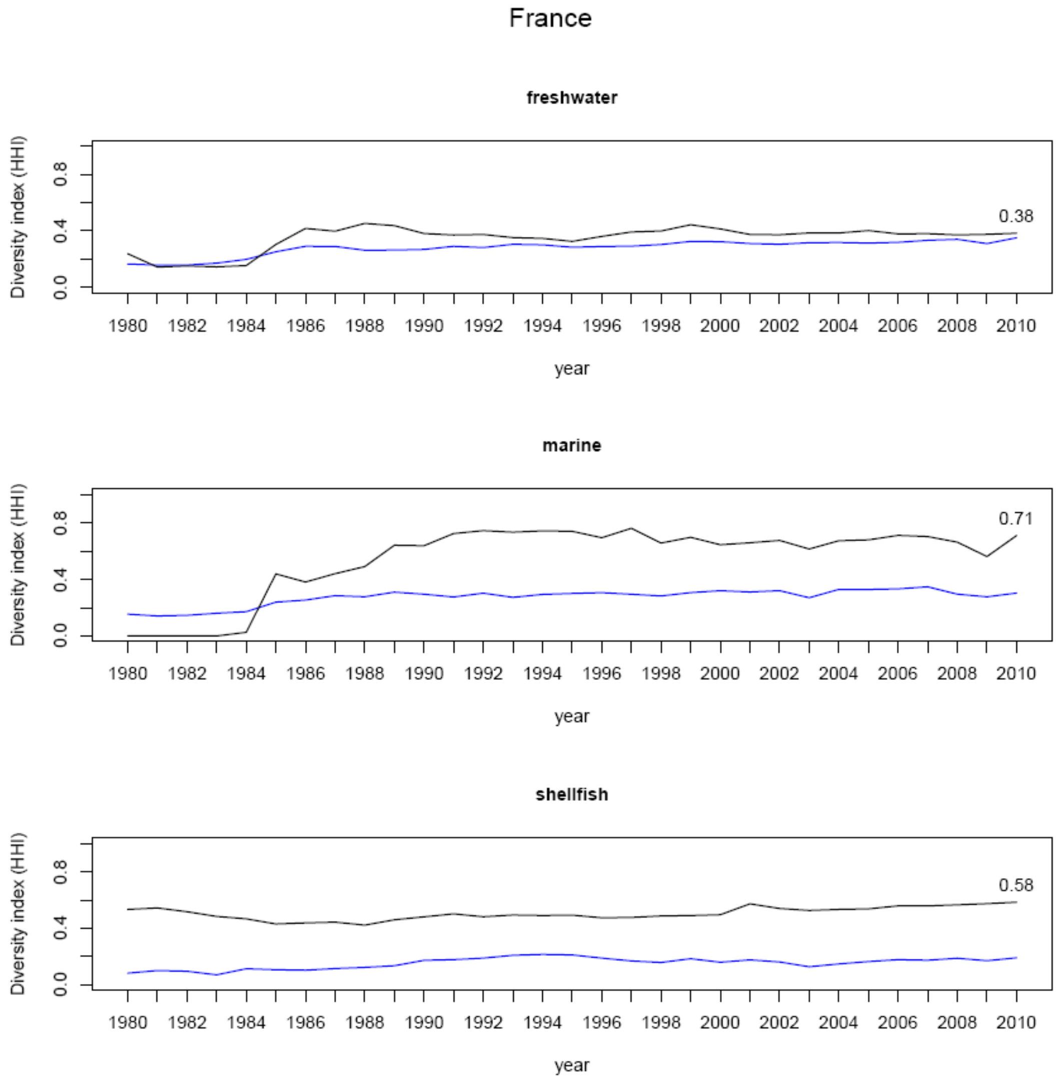


Figure 92 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.10. Germany

Highlights and trends

- Dominated by freshwater finfish aquaculture and shellfish aquaculture with fluctuating production. Freshwater aquaculture shows a positive trend (2006-2010 +2.8%).
- High number of small entities, often in part-time or combined with non-production oriented activities, serving mainly the local market.
- High diversification of farmed freshwater species contributing to the production.
- In general, limited employment, high labour productivity in the shellfish segment.

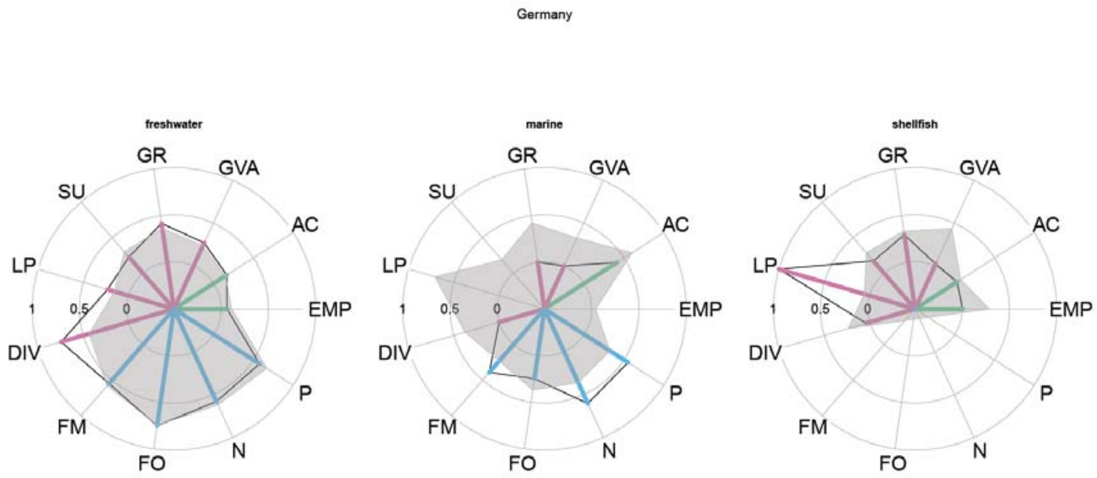


Figure 93 Performance indicators for Germany

Overview of the sector

Freshwater culture presents the strongest aquaculture segment in Germany with a share of some 11.8% of the EU freshwater finfish aquaculture by value and around 13% by volume. Freshwater aquaculture produced some 36,000 tonnes in 2010, mainly rainbow trout (61% by value, 52% by volume), followed by common carp (22% by value, 27% by volume).

Production of fish for stocking intended for recreational fishing and environmental restocking purpose is an important segment in the German aquaculture production.

The shellfish aquaculture industry is relatively small (around 5,000 tonnes in 2010), culturing mainly blue mussels, and to a small extent Pacific cupped oysters. Due to fluctuation of seed material the mussel production shows over the years strong fluctuations. Marine finfish aquaculture is hardly practiced.

The German aquaculture sector with some officially estimated 22,500 mostly small non-commercial entities is very fragmented. Almost 54% of the entities produce carp in ponds, some 46% of fish farmers produce trout, mainly in ponds, tanks or raceways. Environmental concerns make it virtually impossible to obtain water use rights and construction permits for new sites.

Freshwater production shows since 2006 a slight positive trend (+2.8%). From a low production volume, shellfish production decreased since 2006 by 4.8%. Marine finfish production became almost absent.

The GVA of freshwater aquaculture shows over the last years a decreasing tendency, with a ration close to the EU as a whole. Marine finfish and shellfish are very well below the EU ratio.

Aquaculture contributes little to the available supply in fisheries products (freshwater aquaculture ~44%, shellfish aquaculture ~22%).

The employment ratio for freshwater aquaculture is well below the EU ratio. Having in 2010 an estimate of around 1,740 persons employed on the basis of production volume and on the other hand some 22,500 entities estimated by the national authorities, is can be concluded that most of the aquaculture activities are small and non-commercial entities. The marine finfish and the shellfish segments offer extremely little employment opportunities.

Apparent consumption is well below EU average for the marine finfish and shellfish products and slightly above average for freshwater fisheries products.

The freshwater segment had a calculated demand of some 11,000 tonnes of fishmeal and 3,500 tonnes of fish oil. Per tonne freshwater finfish produced, the use of fishmeal and fish oil stays with some 307 kg fishmeal and 100 kg fish oil very close to the EU level.

N and P effluents per tonne freshwater finfish produced are with around 50 kg N and 8 kg P slightly lower than the Union level. In 2010, freshwater aquaculture effluents accounted for some 1,753 N and 280 tonnes P. The N and P effluents from the marine finfish segment were negligible, while the shellfish segment would rather contribute to a mitigating effect in the N and P balance.

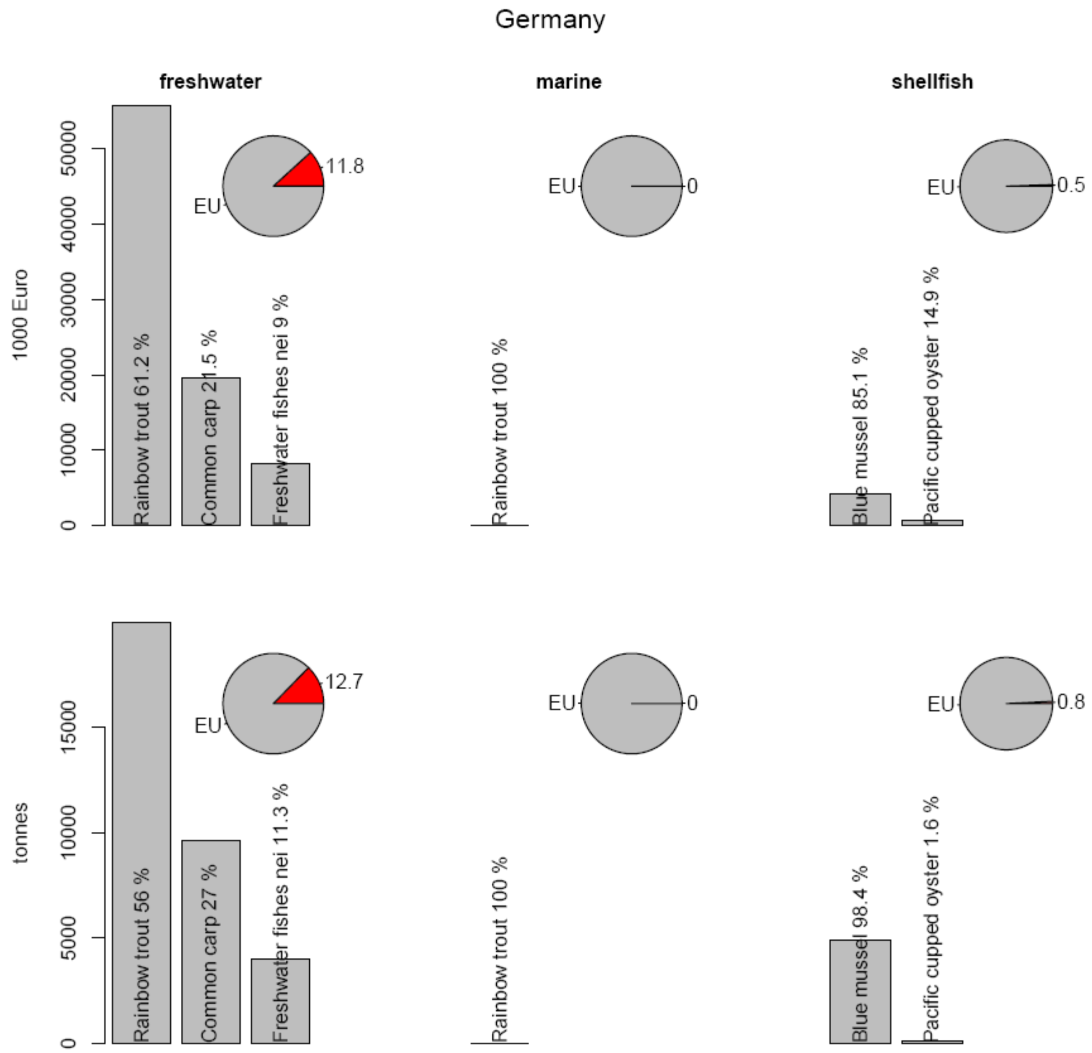


Figure 94 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

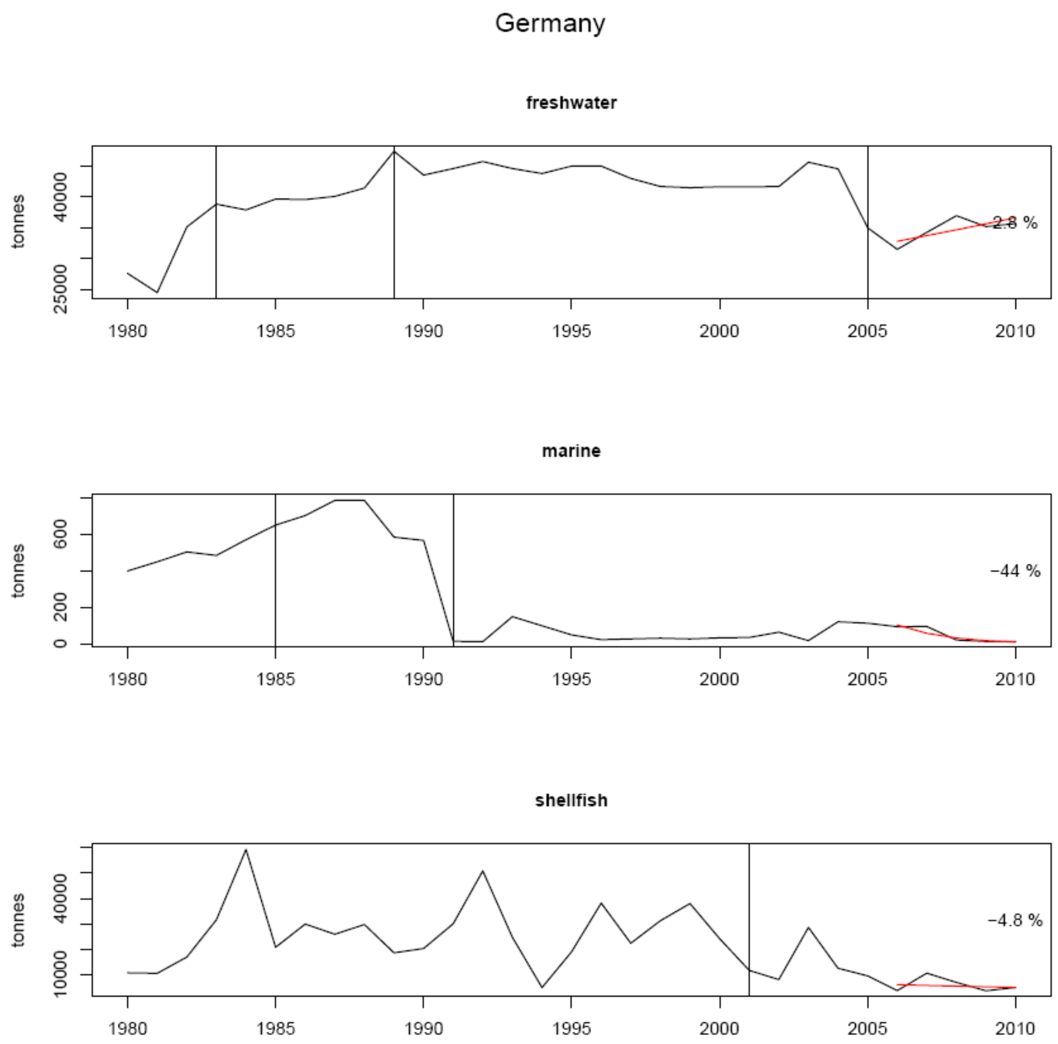


Figure 95 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

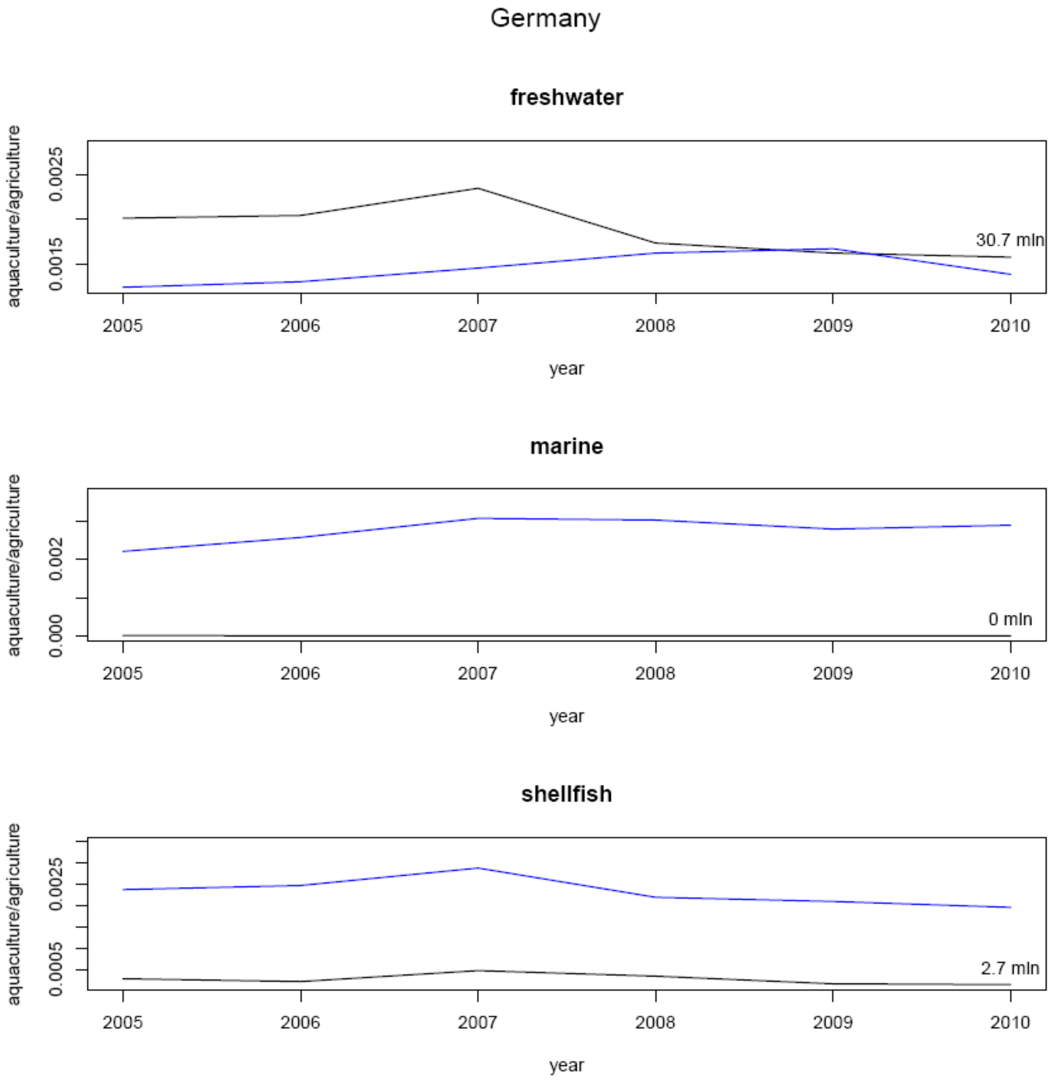


Figure 96 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

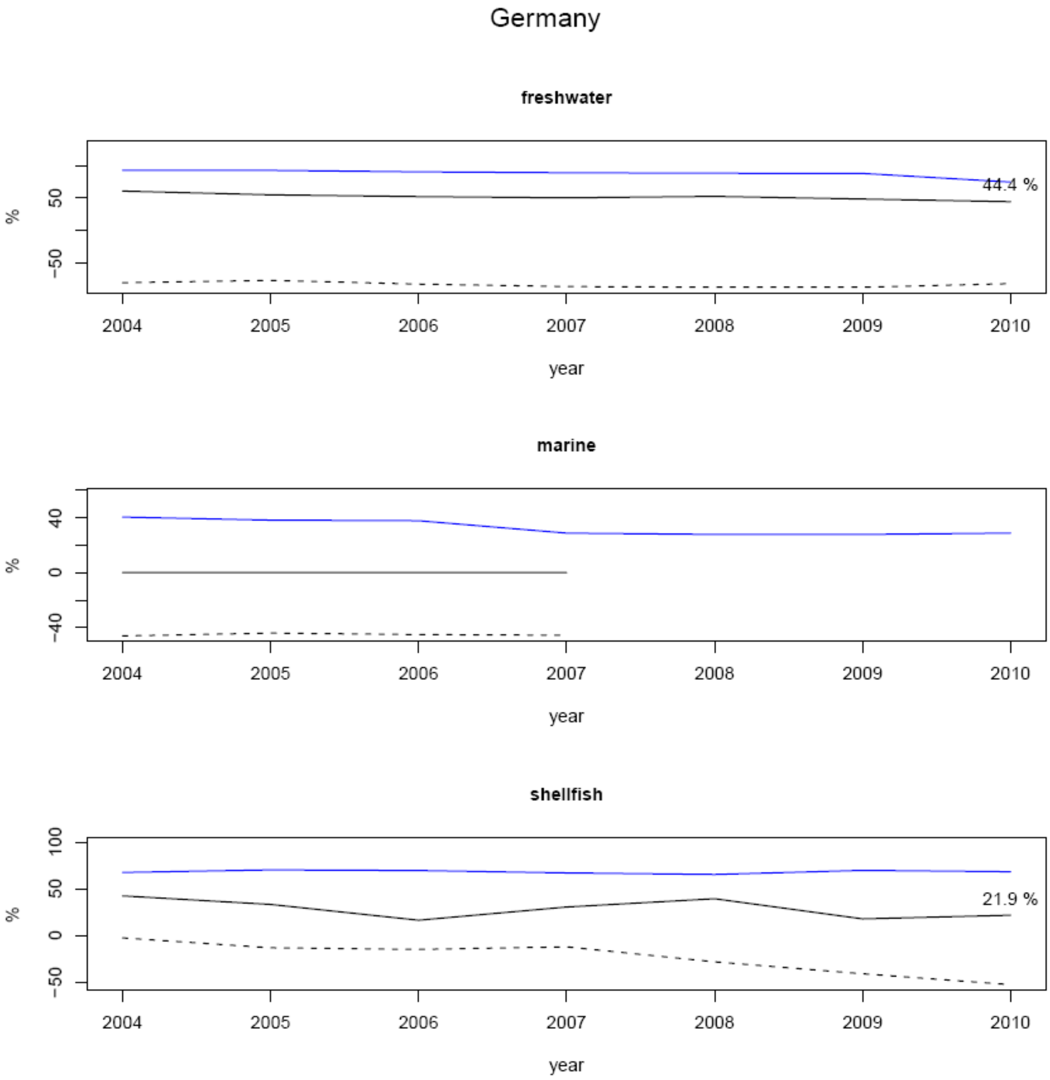


Figure 97 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Germany, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

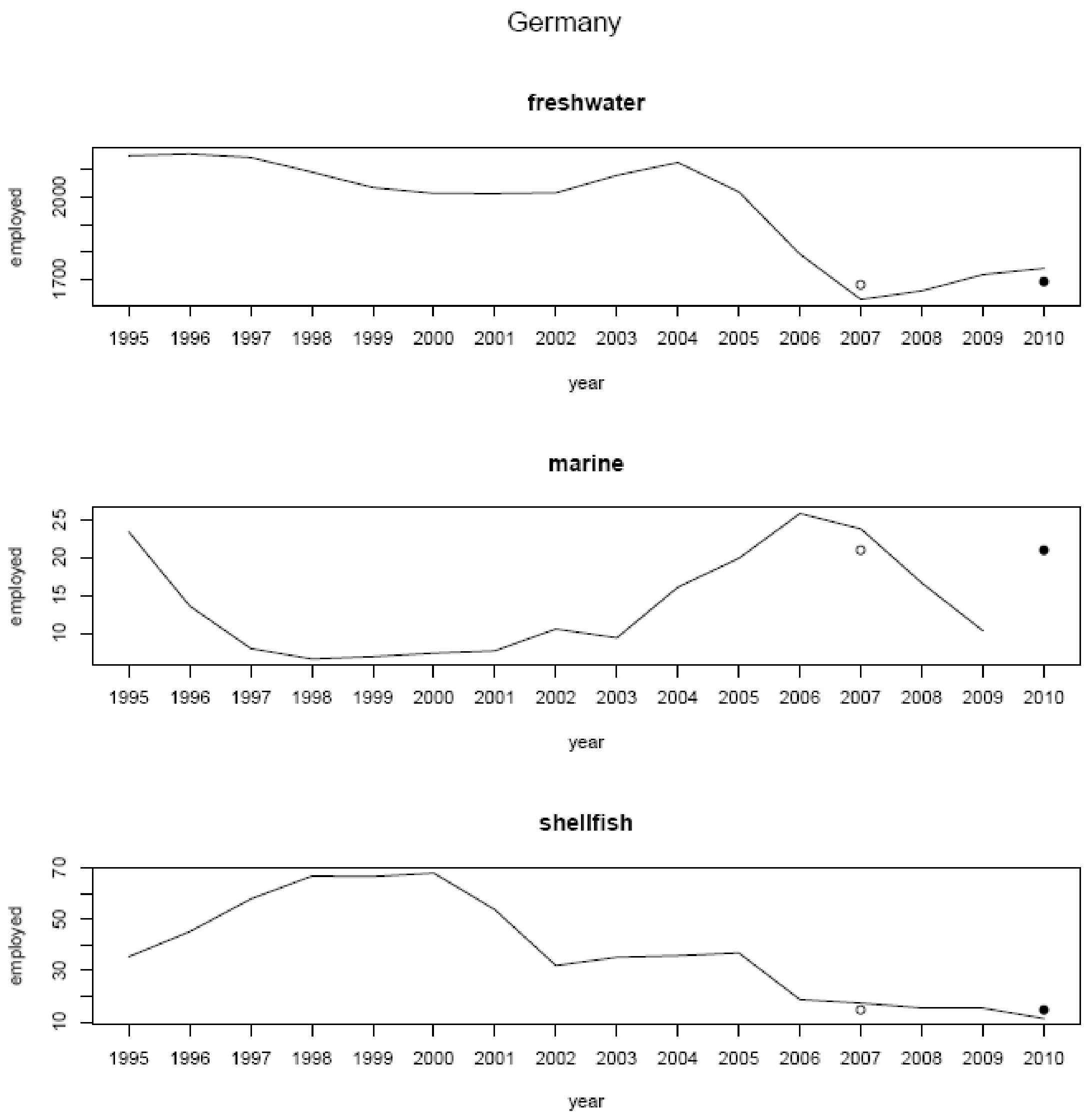


Figure 98 Number of employed persons in aquaculture in Germany over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

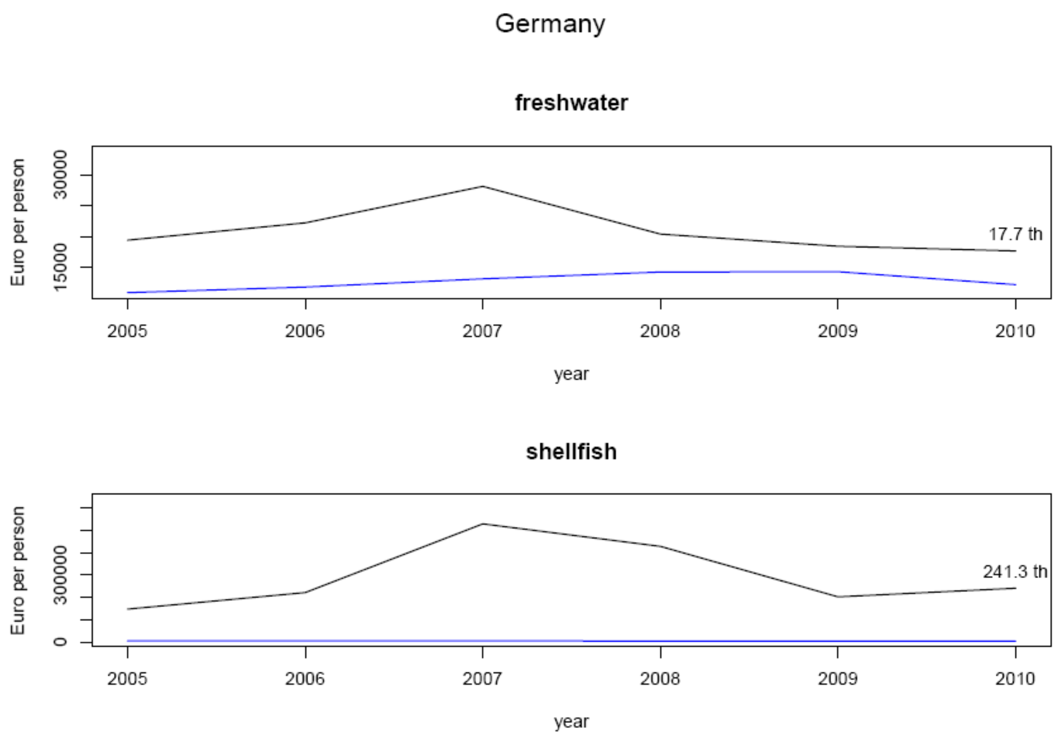


Figure 99 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

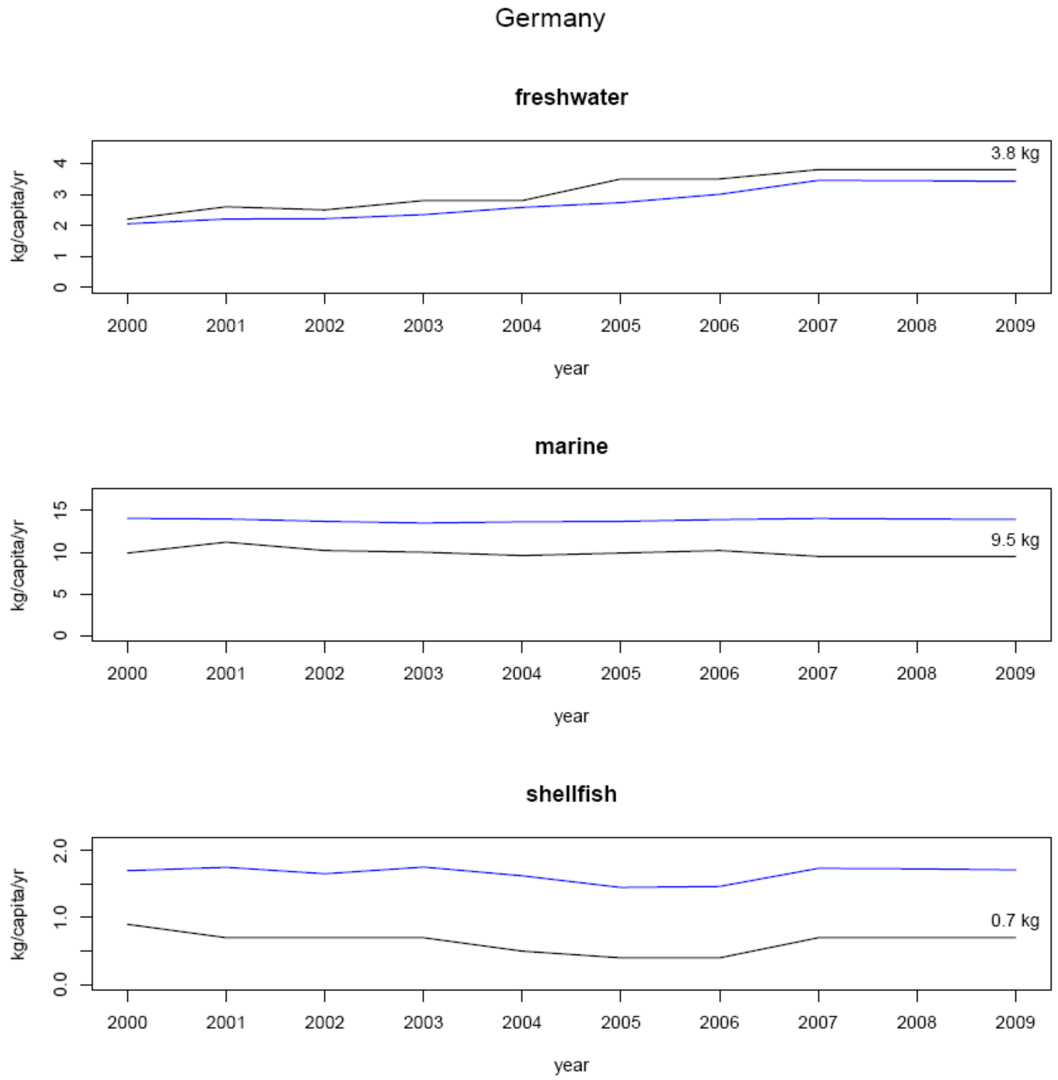


Figure 100 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

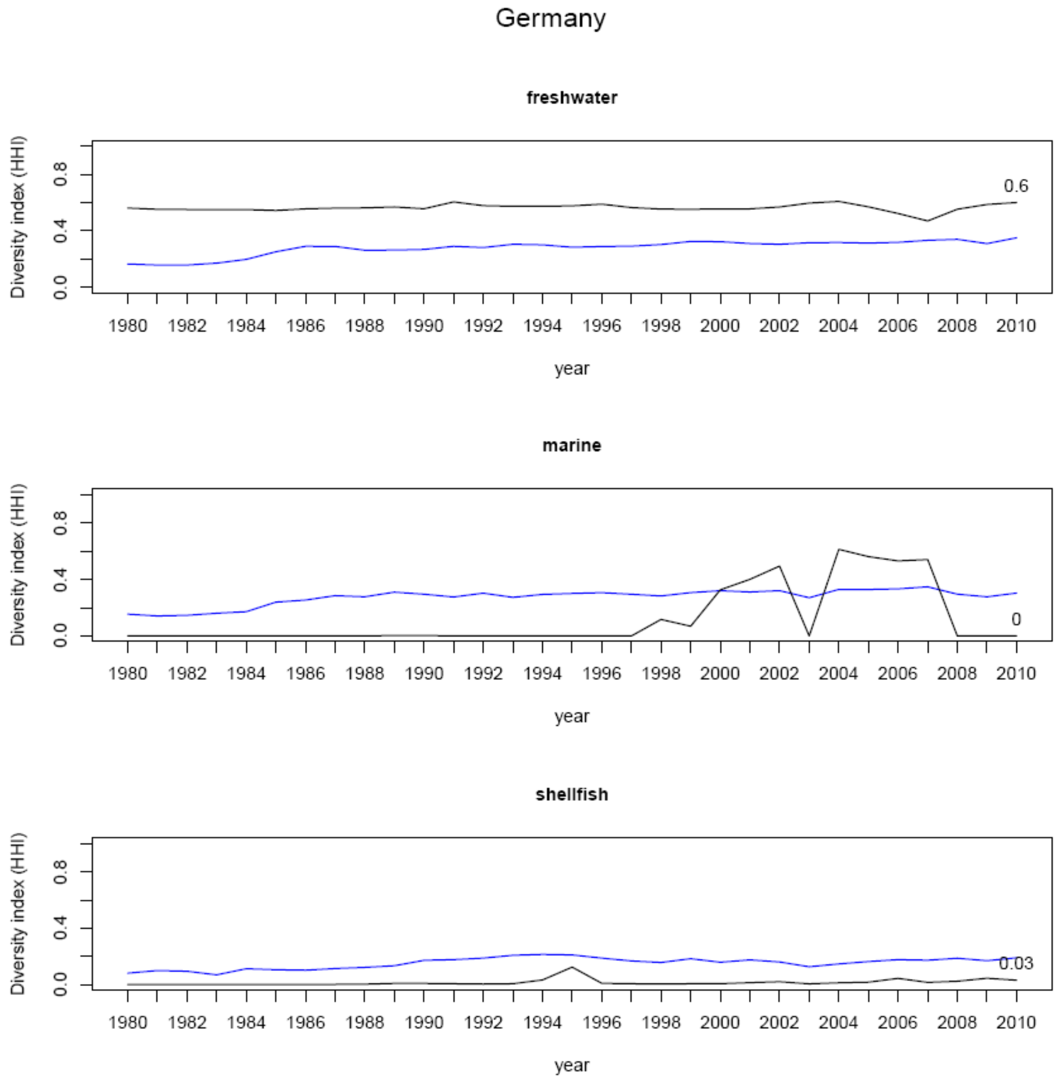


Figure 101 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.11. Greece

Highlights and trends

- Strong marine finfish producing industry with a slightly positive growth trend (2006-2010 +2.5%).
- The marine finfish production contributes strongly to the outgoing trade.
- Marine finfish aquaculture shows a high GVA.
- Employment is above EU average in the marine finfish and shellfish segment.
- The marine finfish segment reached a high labour productivity.
- Relative high demand of fishmeal, lower demand for fish oil in the marine finfish segment.
- Effluent load from aquaculture is well above EU average.

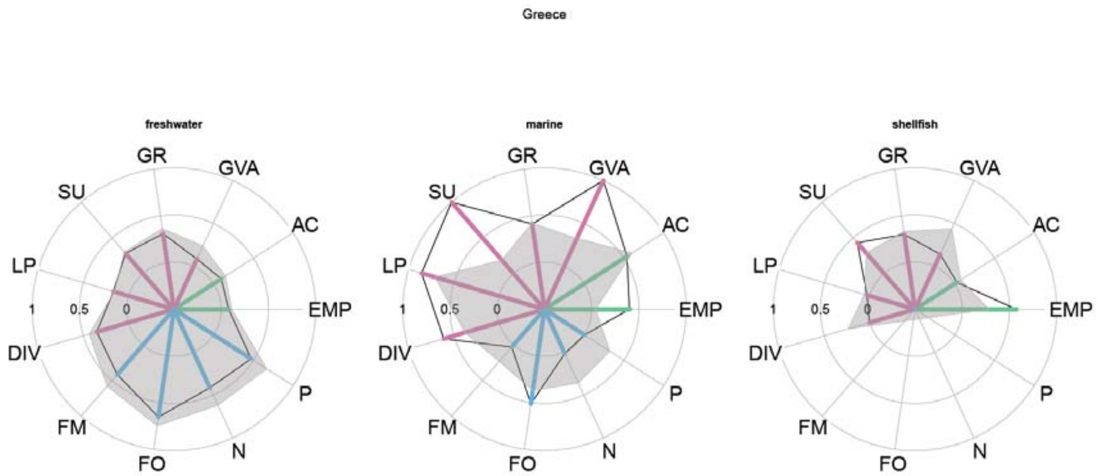


Figure 102 Performance indicators for Greece

Overview of the sector

The Greek aquaculture production is dominated by marine finfish production which presents almost 25% of the Unions marine finfish segment by value and volume. From the almost 88,000 tonnes produced in 2010, 62% account for Gilthead sea bream, 35% for European sea bass, grown out in sea cages. In terms of production value the two species count for 57% and 39%, respectively. Recently, marine finfish aquaculture expanded also into bluefin tuna farming.

Shellfish aquaculture (almost 100% Mediterranean mussel) contributed with around 22,500 tonnes to 3.6% in volume and 1.3% in value to the EU shellfish production in 2009. The freshwater culture presents a small segment (slightly above 1% of the EU total freshwater production), mainly producing rainbow trout, European eel and common carp.

In total there are around 1,000 farming sites, 604 of them for mussel and 83 for trout. Shellfish and freshwater aquaculture consists mainly of small family enterprises. In the last decade the marine finfish aquaculture experienced a concentration towards bigger entities expanding production into Turkey, Albania and Spain. Due to the suspension of new farming site licenses for marine finfish, companies may enter or expand in Greece only by acquisition of existing sites. Greece has an important production of juveniles and eggs for commercial aquaculture.

The marine finfish aquaculture experienced since the 1990ies a steady growth which continued from 2006-2010 with +2.5%. The freshwater finfish and the shellfish production show in the last five years a decreasing trend (-3.9% and -4.4%, respectively).

The high GVA and the ratio above the EU as a whole of marine finfish production indicate the importance of the segment to the national production.

Marine finfish aquaculture shows a self-sufficiency of more than 800% in 2010 which is the highest value in the EU and which underlines its importance to the country outgoing trade of marine fisheries products. Also the shellfish production with a self-sufficiency ratio of 127% may well contribute to outgoing trade. While the contribution of aquaculture to the available supply in marine finfish steadily increased since 2004, it decreased the last years in the shellfish segment.

The employment ratio for marine finfish and shellfish aquaculture is well above the EU ratio and with a general upward trend. The model would estimate almost 1,300 and 1,840 persons employed, respectively. The model sees the freshwater finfish segment below the EU ratio with an decreasing trend and some 250 persons employed in 2010.

Apparent consumption of freshwater and shellfish products are below EU average and fell in recent years also for marine finfish products below.

Being small in absolute terms (1,200 tonnes fishmeal, 423 tonnes fish oil in 2010) the freshwater production has a higher demand per tonne fish produced than the Union in total of the segment (around 387 kg fishmeal, around 136 kg fish oil), but much lower than the demand per tonne marine finfish with some 621 kg fishmeal and 192 kg fish oil. The absolute demand in the marine segment was in 2010 calculated 54,600 tonnes of fishmeal and 18,900 tonnes of fish oil. With a strong sea bass and sea bream production, the marine finfish segment has a higher demand of fishmeal but a lower demand for fish oil/tonne fish than the level for the EU in total in the segment.

The effluents of N and P per tonne of fish produced are above then EU level in the freshwater production (around 65 kg N and 9 kg P) and much above in the marine finfish segment (around 102 kg N and 16 kg P). In absolute figures, marine finfish aquaculture accounted in 2010 for some 9,000 tonnes N and 1,400 tonnes P, freshwater production for some 200 tonnes of N and 29 tonnes of P.

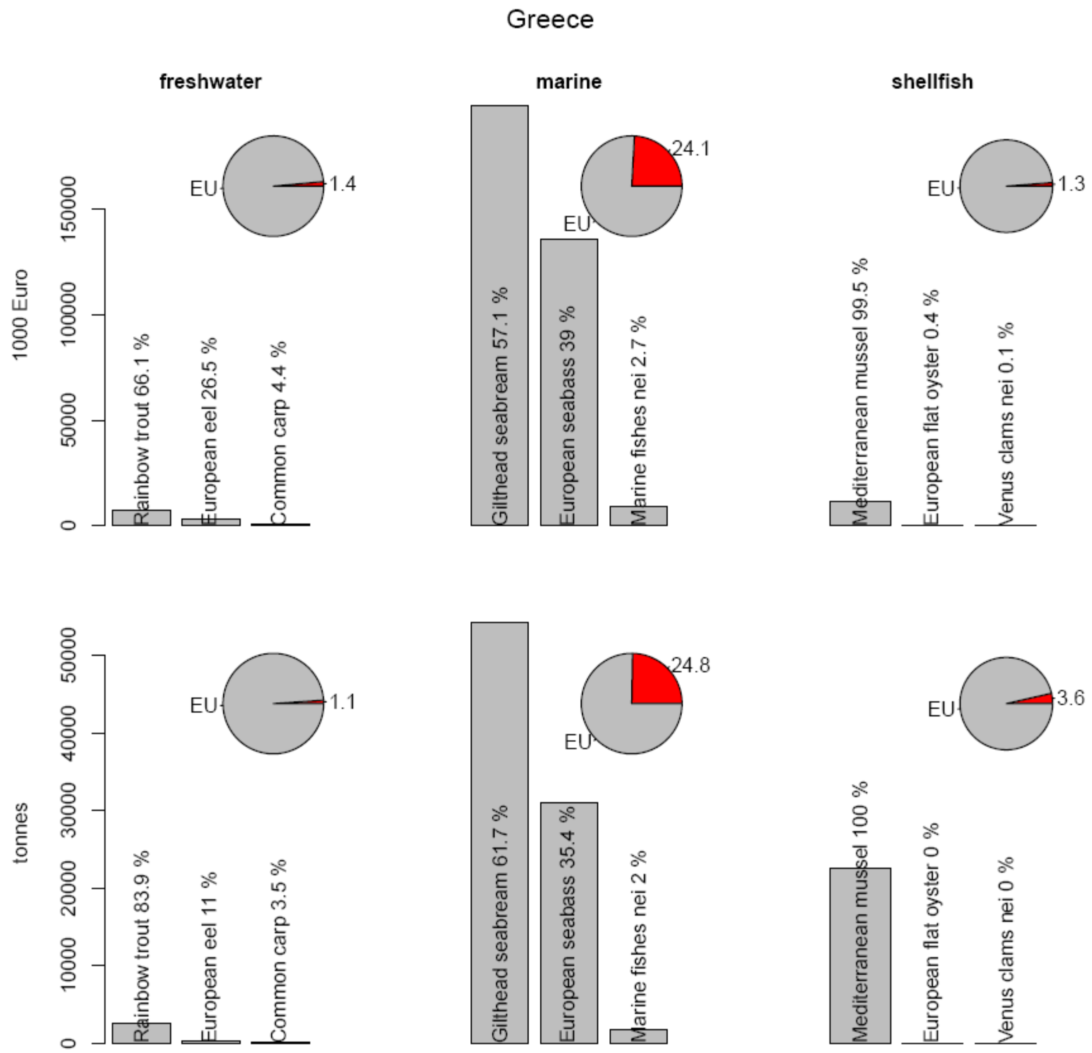


Figure 103 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

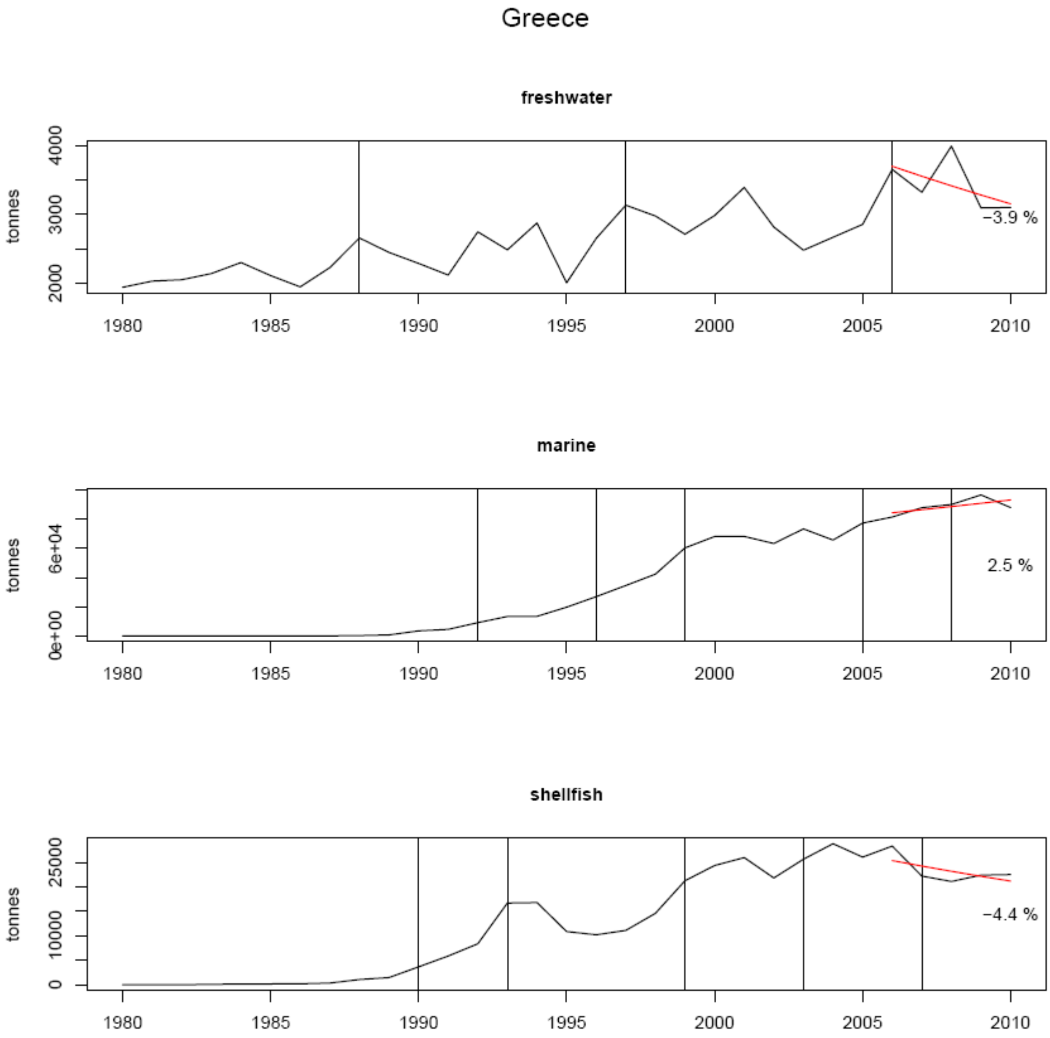


Figure 104 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

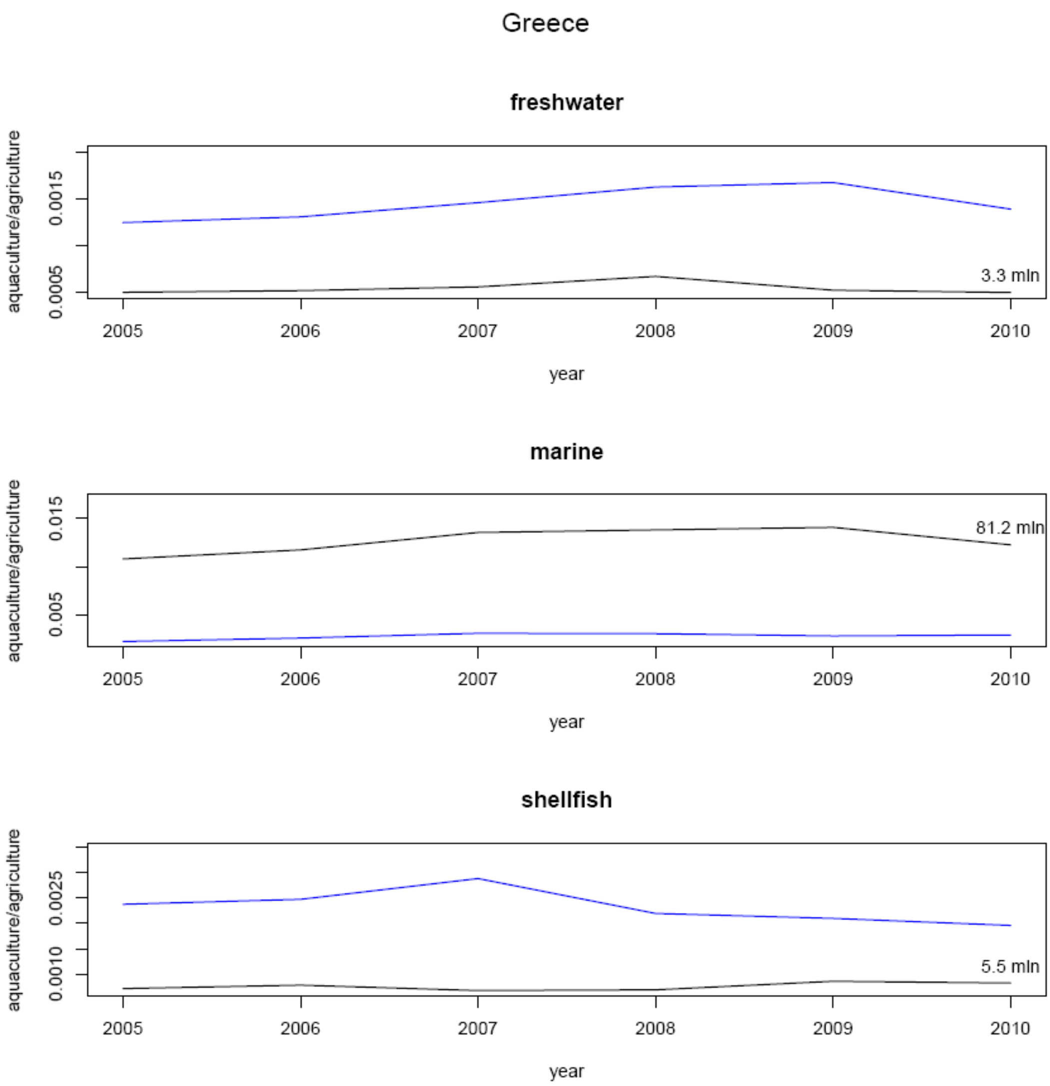


Figure 105 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

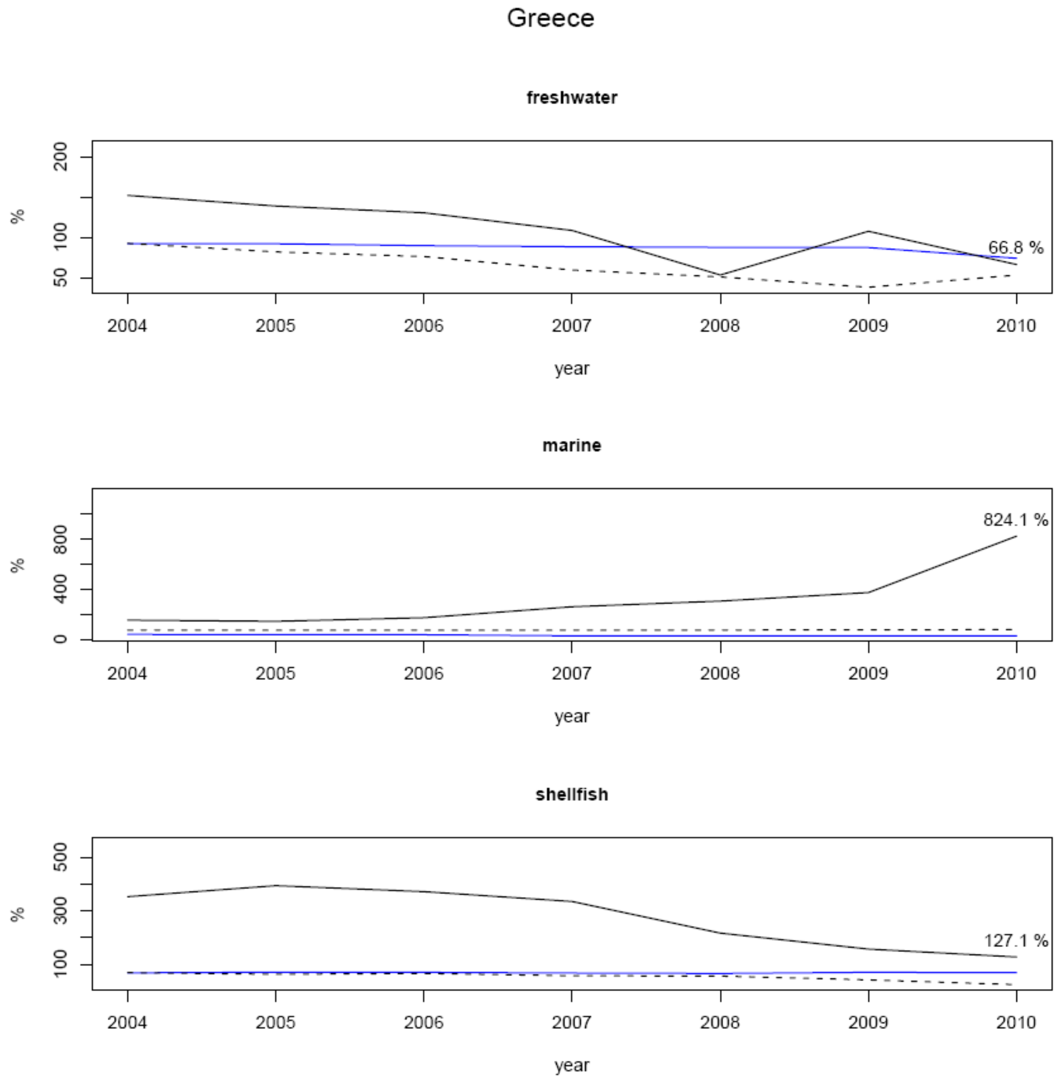


Figure 106 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Greece, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

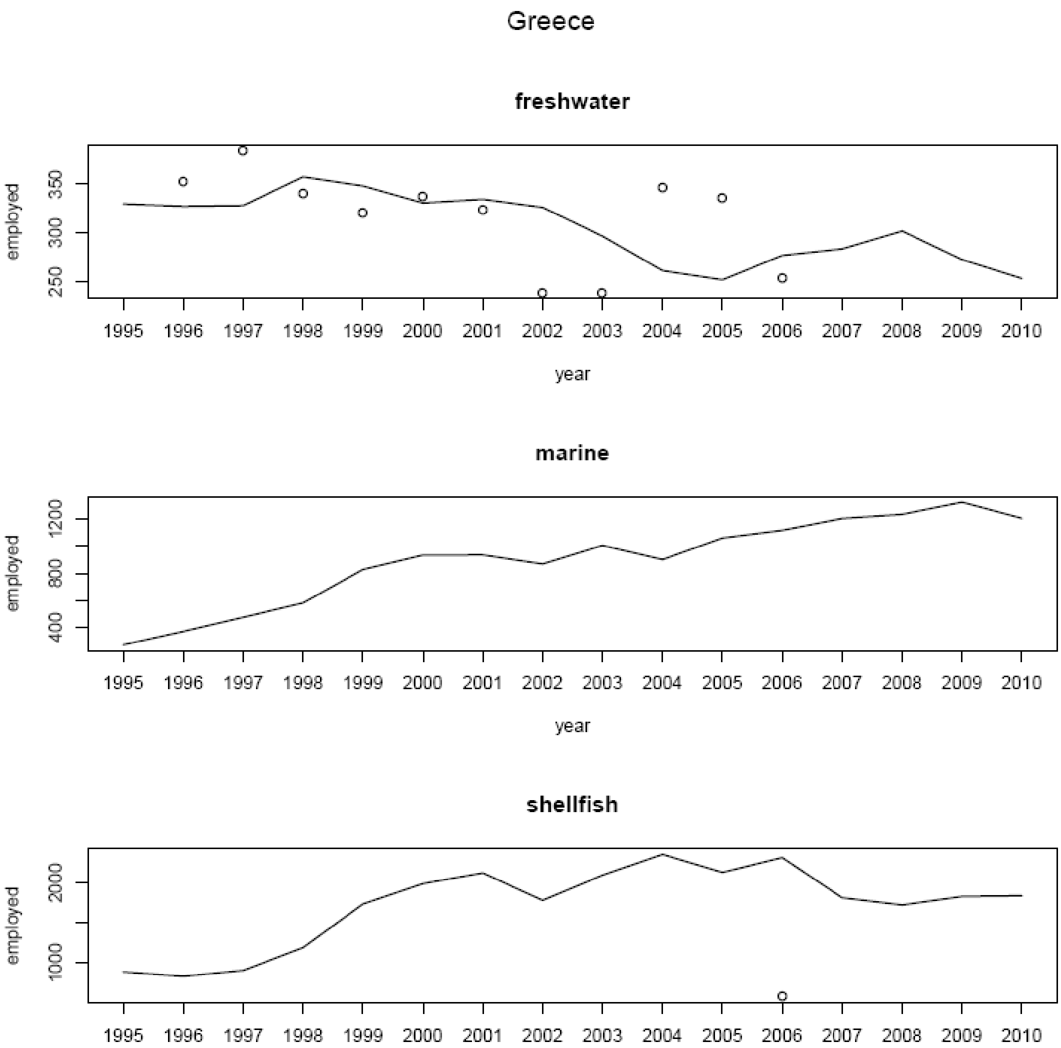


Figure 107 Number of employed persons in aquaculture in Greece over time. The trend lines in the freshwater and shellfish segment are derived from country specific models based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots). Since for the marine finfish segment no data was available from DCF or previous reports the employment is estimated from production statistics using a generic EU model.

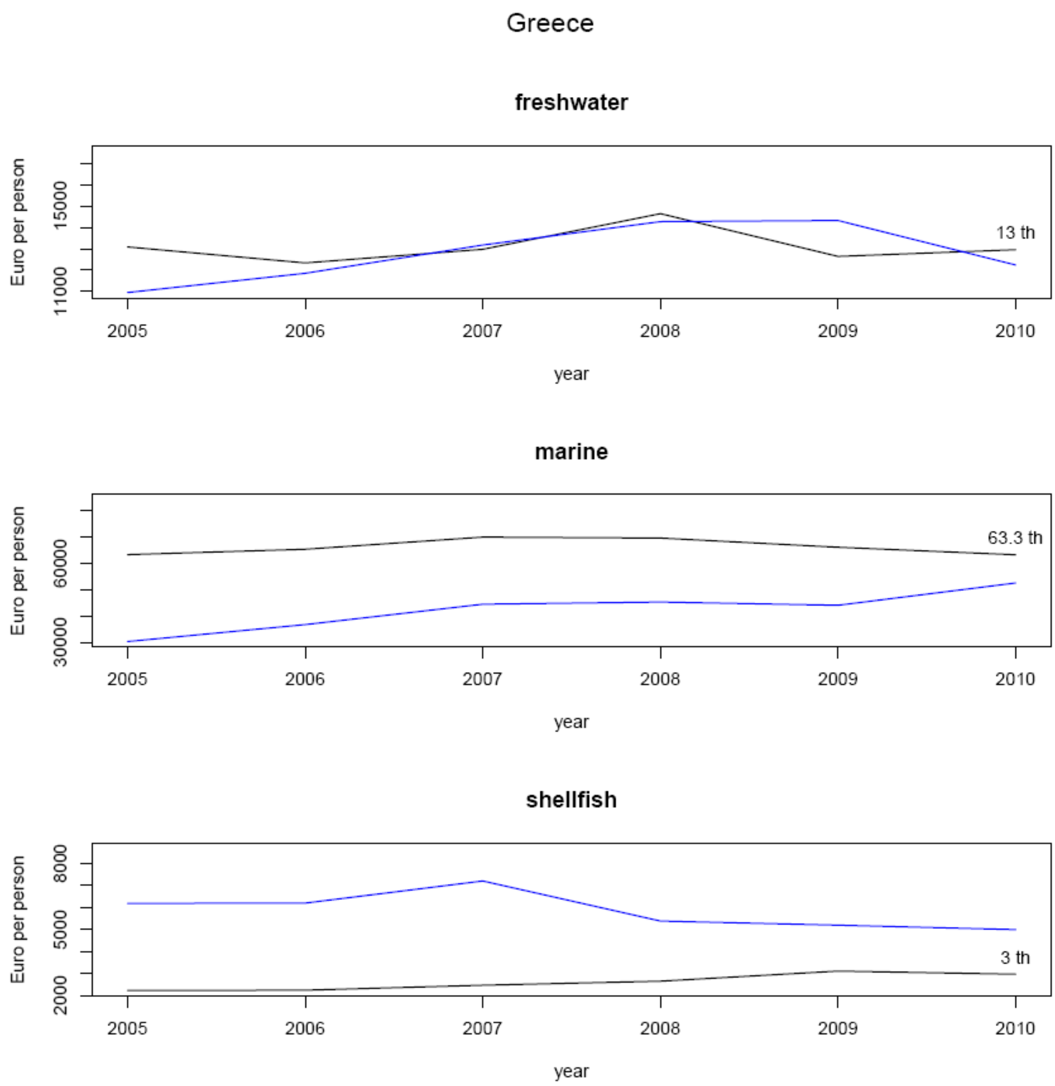


Figure 108 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

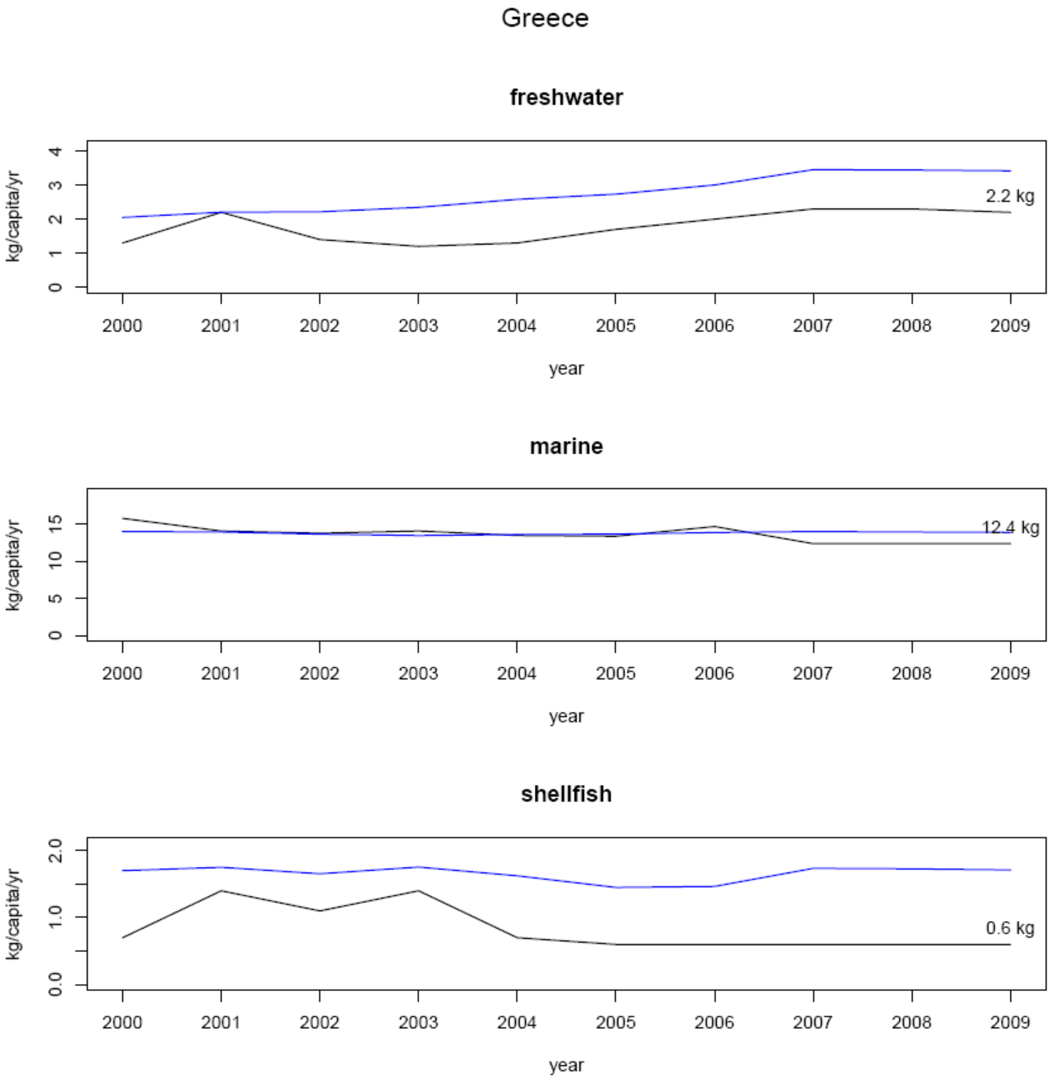


Figure 109 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

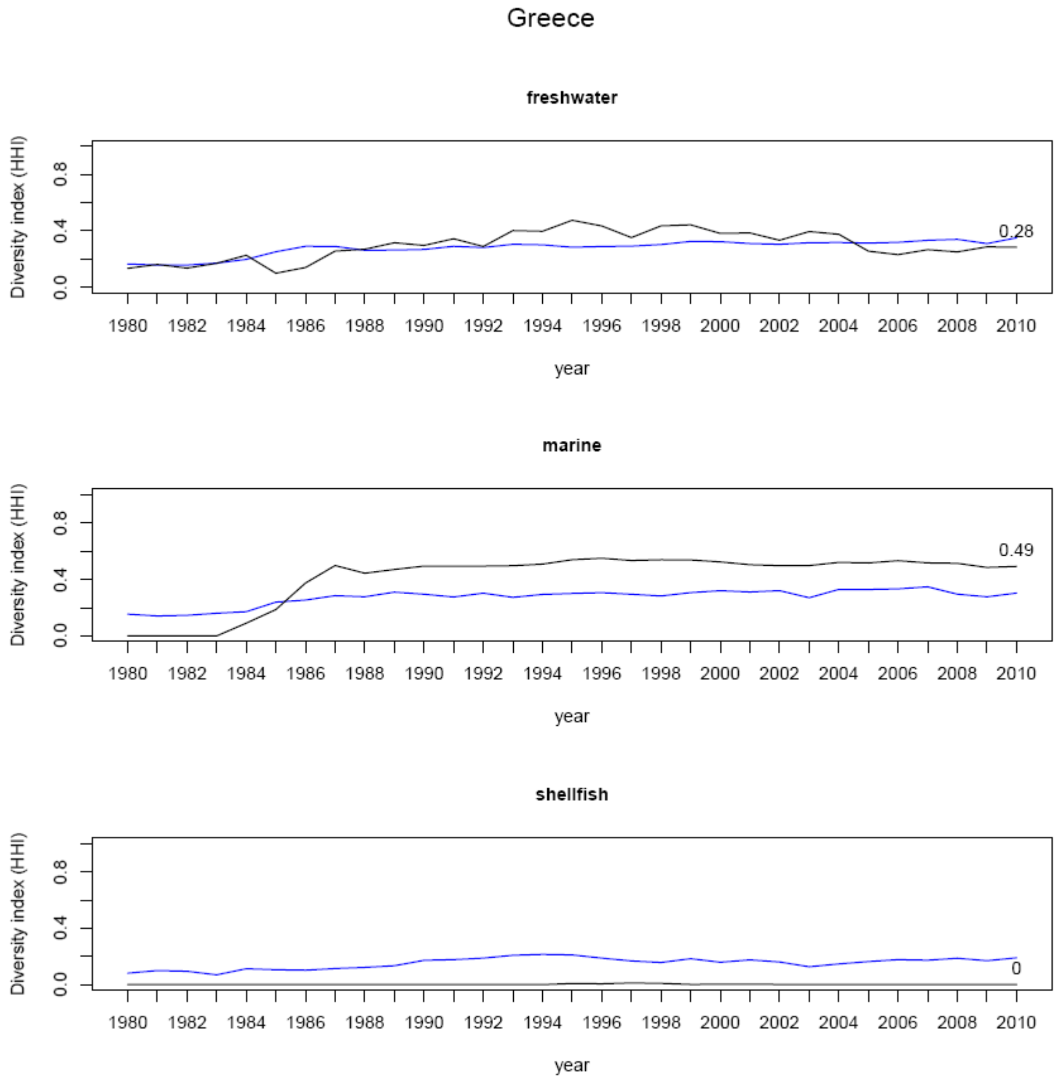


Figure 110 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.12. Hungary

Highlights and trends

- Relatively small freshwater production with a slightly negative trend (2006-2010 -1.3%).
- The freshwater aquaculture shows a high GVA.
- Employment in the segment is above EU average with a lower than average labour productivity.
- Apparent consumption of fisheries products is low.
- Due to the strong carp production a very low demand of fishmeal / fish oil.
- Effluent load from aquaculture is well below EU average.

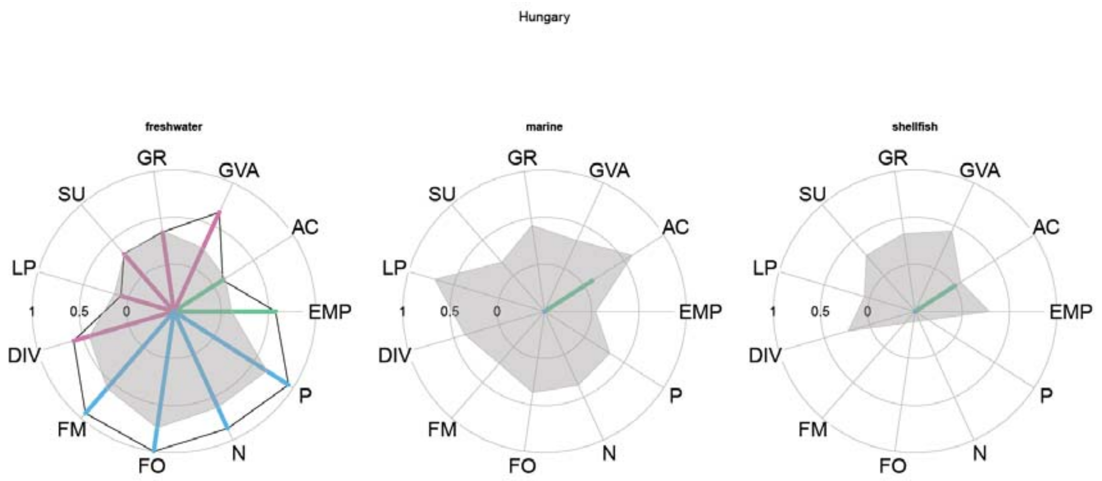


Figure 111 Performance indicators for Hungary

Overview of the sector

As a landlocked country, Hungary has only freshwater aquaculture which contributes with 3.7% by value or 5.1% by volume to the EU fresh water segment. From the more than 14,200 tonnes in 2010 produced, the predominant species are common carp (representing almost 70% in value and volume), North African catfish (16% in value, 13% in volume) and silver carp (3% in value, 8% in volume). Carps are mainly produced in ponds, catfish mainly in recirculation systems.

There are some 320 aquaculture entities recorded, mainly involved in extensive pond farming. Some 10 companies conduct an intensive fish production.

The GVA ratio of freshwater aquaculture is relatively high, showing the importance of the segment in the primary sector.

The freshwater aquaculture contributed in 2010 with some 77% to the available supply in the segment and showing little variation since 2004.
From the model the ratio of employment in the aquaculture is higher than for the EU as a whole and shows an increasing trend in employment ratio over the last 15 years with around 1,600 persons employed in 2010.
In all segments, apparent consumption of fisheries products is low.
With the dominance of carp production the use of fishmeal is well below the EU level per tonne fish produced and almost zero for the use of fish oil (in absolute terms less than 1,100 tonnes fishmeal and 28 tonnes of fish oil in 2010).

Due to the dominance of carp farming, effluents of N and P per tonne fish produced are lower than in the overall EU freshwater production, in 2010 accounting for some 320 tonnes of N and 40 tonnes of P.

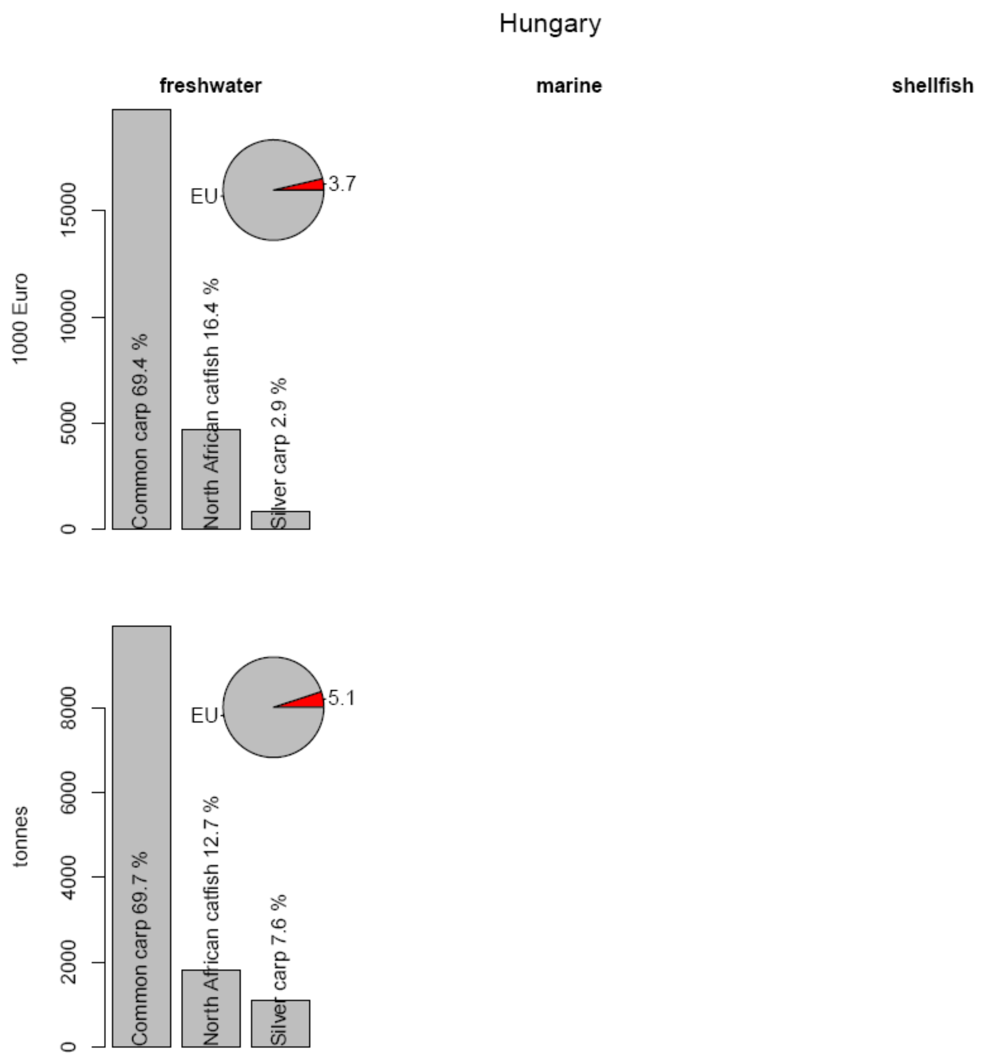


Figure 112 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

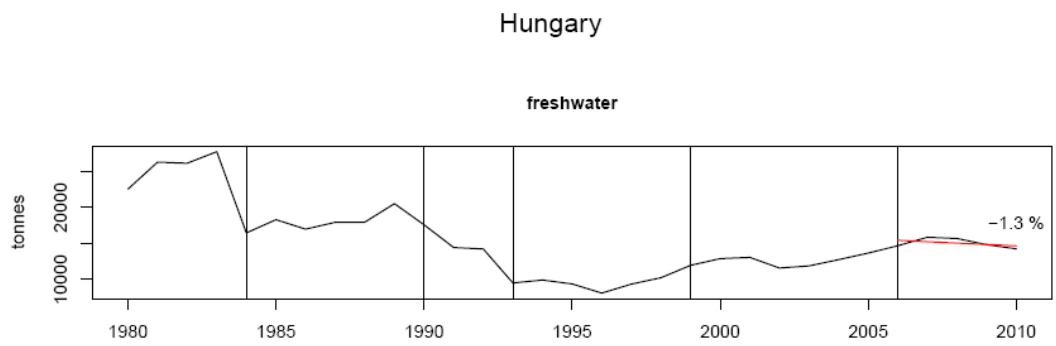


Figure 113 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

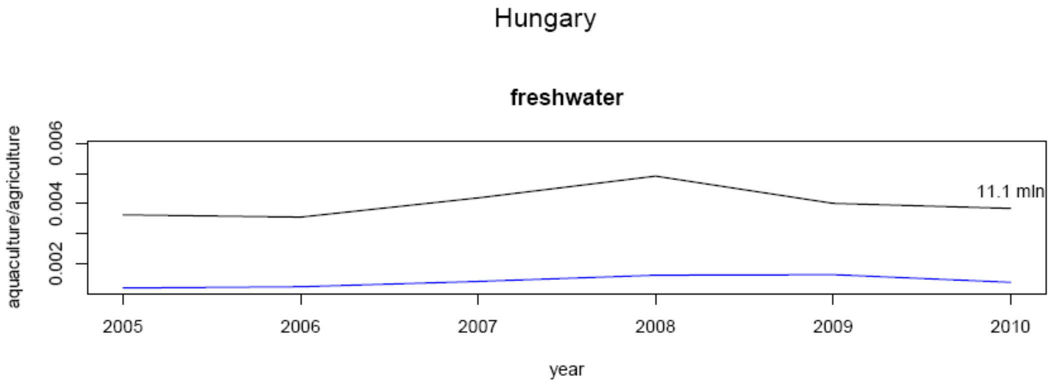


Figure 114 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

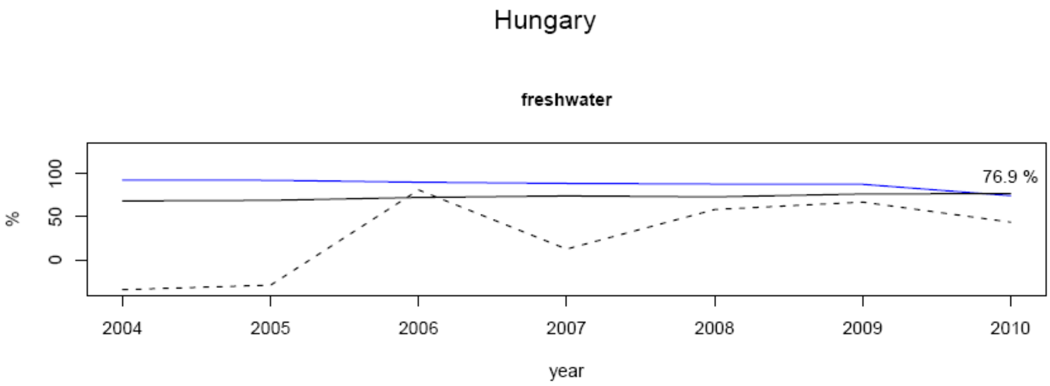


Figure 115 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Hungary, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

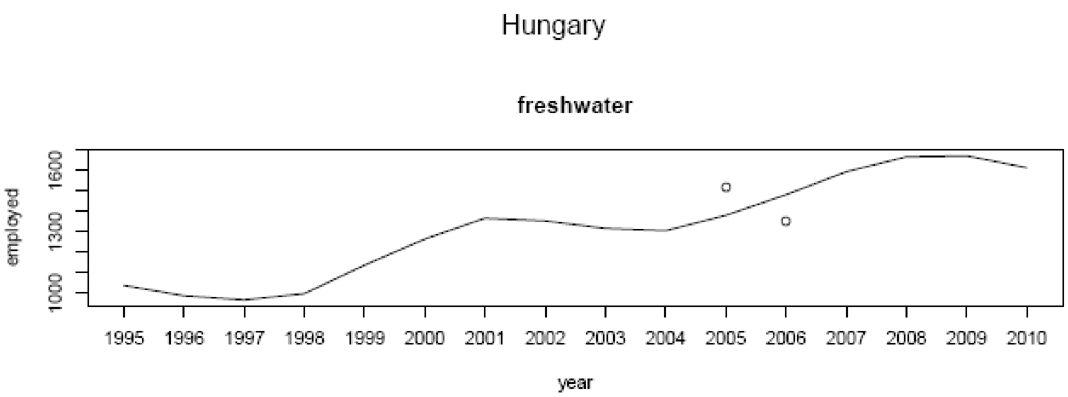


Figure 116 Number of employed persons in the freshwater segment in Hungary over time. The trend line is derived from a country specific model based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

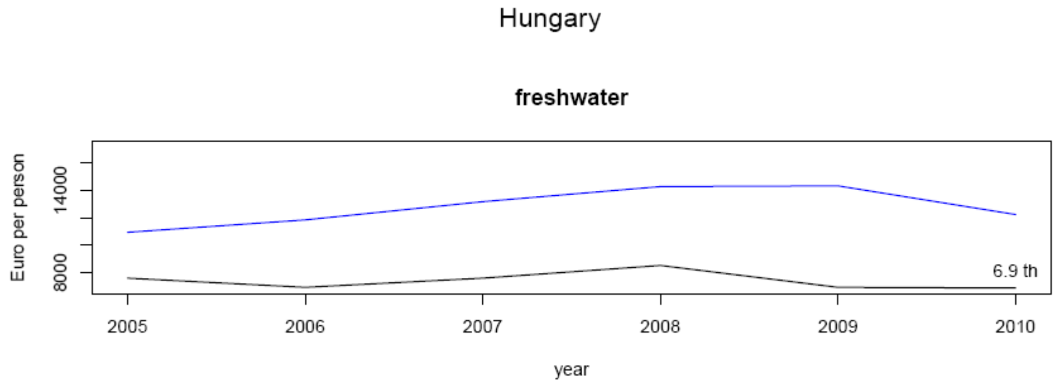


Figure 117 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

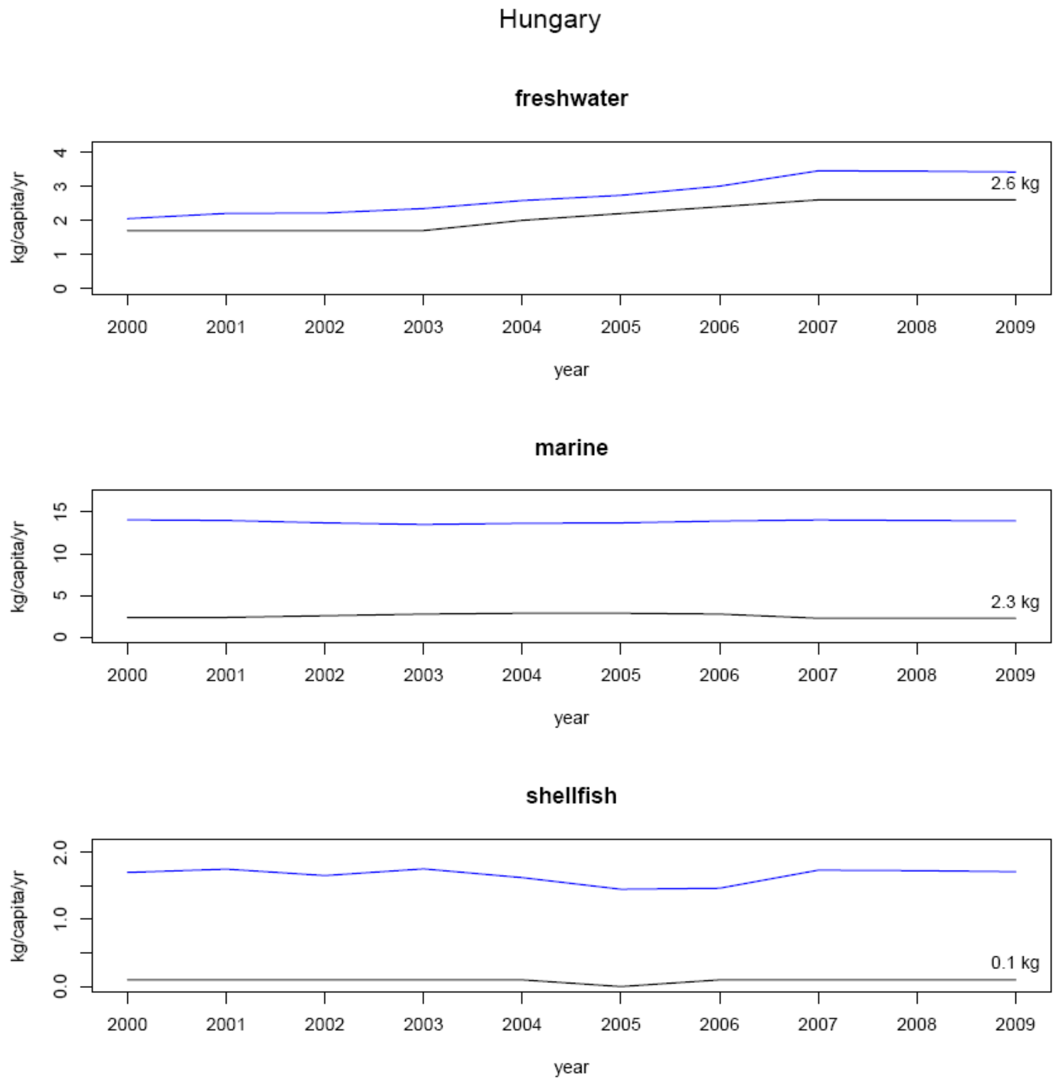


Figure 118 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

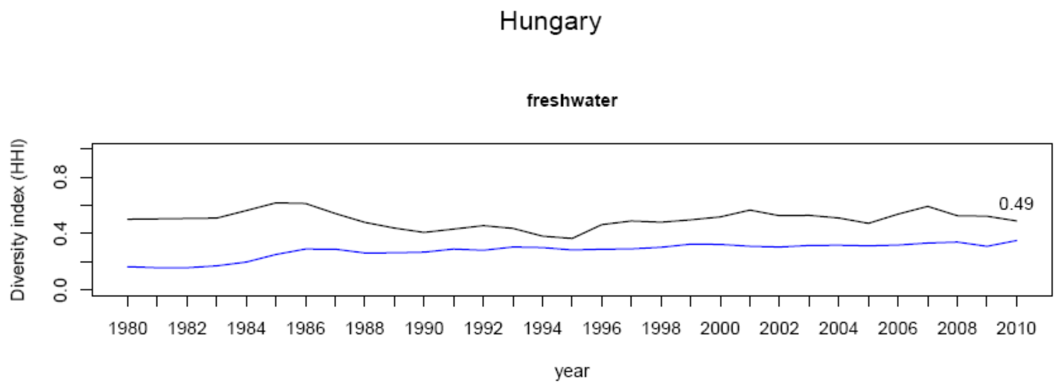


Figure 119 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.13. Ireland

Highlights and trends

- Strong salmon and shellfish industry with a positive growth trend in the salmon production. Freshwater aquaculture plays a minor role.
- The salmon and shellfish production contributes with high GVA and productivity.
- The salmon and shellfish production contribute strongly to the country's outgoing trade.
- High diversification of farmed species contributing to the production in the shellfish production.
- In absolute terms, employment is high in the shellfish segment but many jobs are part time or seasonal.
- Labour productivity is above average in all segments, highest in the salmon production.
- Relative high demand of fishmeal / fish oil in the finfish segments.
- Effluent load from aquaculture is below EU average in the marine finfish segment.

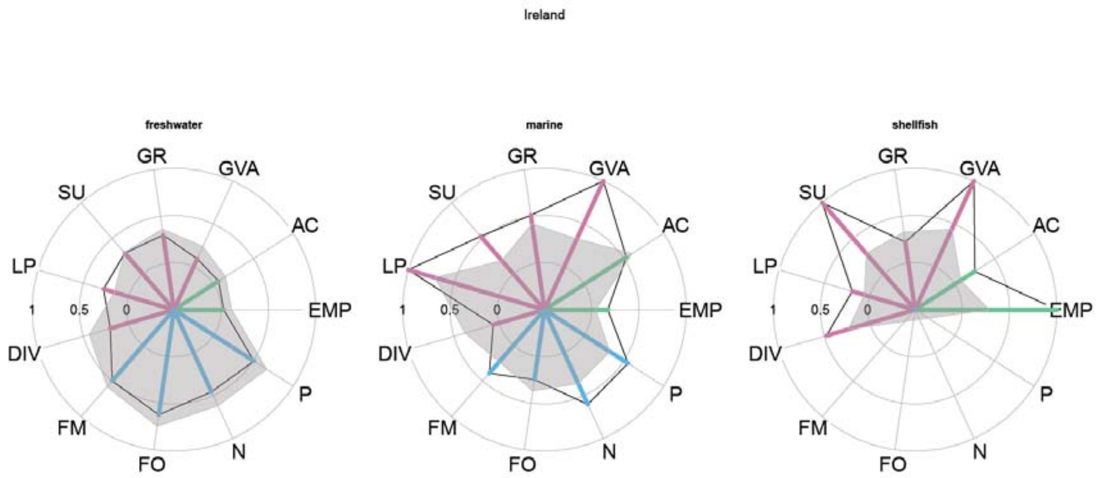


Figure 120 Performance indicators for Ireland

Overview of the sector

In terms of value the marine finfish aquaculture dominants in Ireland, contributing 5.1% to the EU marine finfish aquaculture by value and 4.5% by volume. From some 16,100 tonnes produced in 2010, 97% was Atlantic salmon, the rest rainbow trout. The Irish shellfish culture has with around 29,300 tonnes in 2010 a 4.7% share of the EU shellfish aquaculture by volume and 4.2% by value. While blue mussel contributes with 75% to the national annual production, it presents some 41% by value. For Pacific cupped oyster and European flat oyster the share in value is 53% and 3% compared to 24% and around 1% in volume, respectively. Freshwater aquaculture presents a relatively small segment (around 730 tonnes in 2010), dominated by rainbow trout production (>90%). For environmental concerns, there are no new inland installations expected to be authorised.

The sector comprises 303 enterprises, only few of them in the marine finfish and freshwater finfish segments, 236 in mussel and oyster production. The marine finfish is produced in sea cages and the shellfish segment is dominated by bottom mussel production. Most of the oyster entities run a part-time or artisanal production. The few full-time growers account for the bulk of the output.

Marine finfish sees an upward trend over the last five years of + 8.7%, mainly due to increased Atlantic salmon production. Freshwater finfish and shellfish production experienced since 2006 a clear decline of -4.5% and -9.1%, respectively.

Marine finfish and shellfish production play an important role in the GVA with increasing tendency in the marine finfish segment.

The salmon and shellfish production contributed in 2010 with some 167% and 358%, respectively to the available supply in the relevant segments which shows their importance to the outgoing trade. This is underlined by the positive values in the trade balances for fisheries products.

The employment ratio for marine finfish and shellfish aquaculture is well above the EU ratio, but with some downward trend in the last years. The marine finfish aquaculture increased employment until 2002/2003; since then there is a clear downward trend from some 350 to 230 persons which could be explained by reduced production and increased productivity. For the freshwater segment the model shows a relative stable situation with very little employment (< 40 persons).

Apparent consumption in marine finfish products is close to the EU average. In the last years, as apparent consumption in freshwater finfish products was falling, consumption of shellfish increased strongly.

In absolute terms, marine finfish production demands the largest amount of fishmeal and fish oil (around 6,500 tonnes of fishmeal and 4,740 tonnes oil in marine versus 247 and 108 tonnes in freshwater environment). Also per tonne fish produced, the demand is higher in the marine environment (around 402 kg fishmeal, around 294 kg fish oil). Per tonne fish produced the marine segment's demand for the use of fishmeal is below the Union level but above for fish oil, while for the freshwater segment, the use of fishmeal (around 327 kg/t) and fish oil (around 150 kg/t) is higher than the Union as a whole of the segment. The higher demand is mainly due to the strong salmon and trout production.

N and P effluents per tonne finfish produced are above the Union level in the freshwater segment but well below the level in the marine environment. For 2010, in total around 60 and 760 tonnes of N and 6 and 132 tonnes of P effluents were calculates for the freshwater and marine environment, respectively.

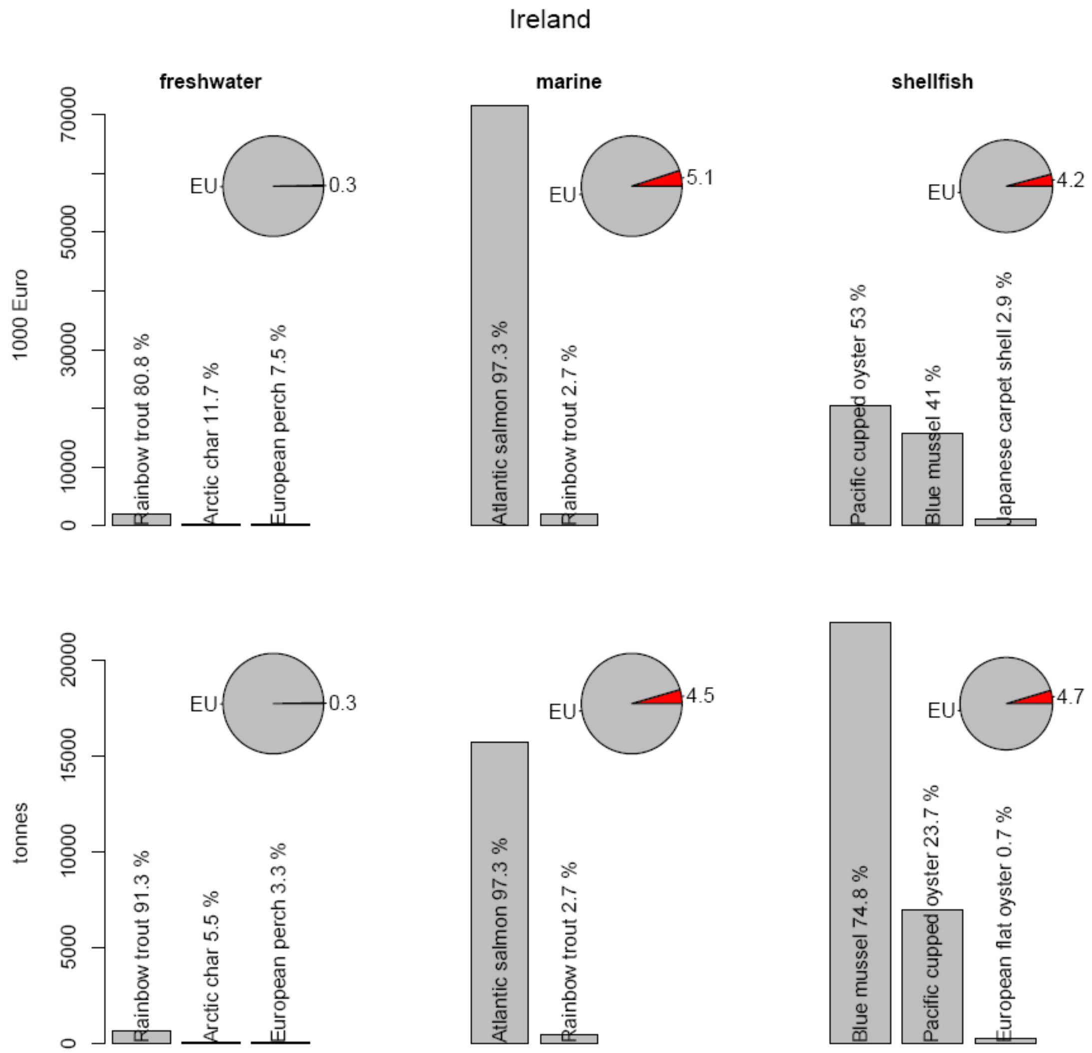


Figure 121 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

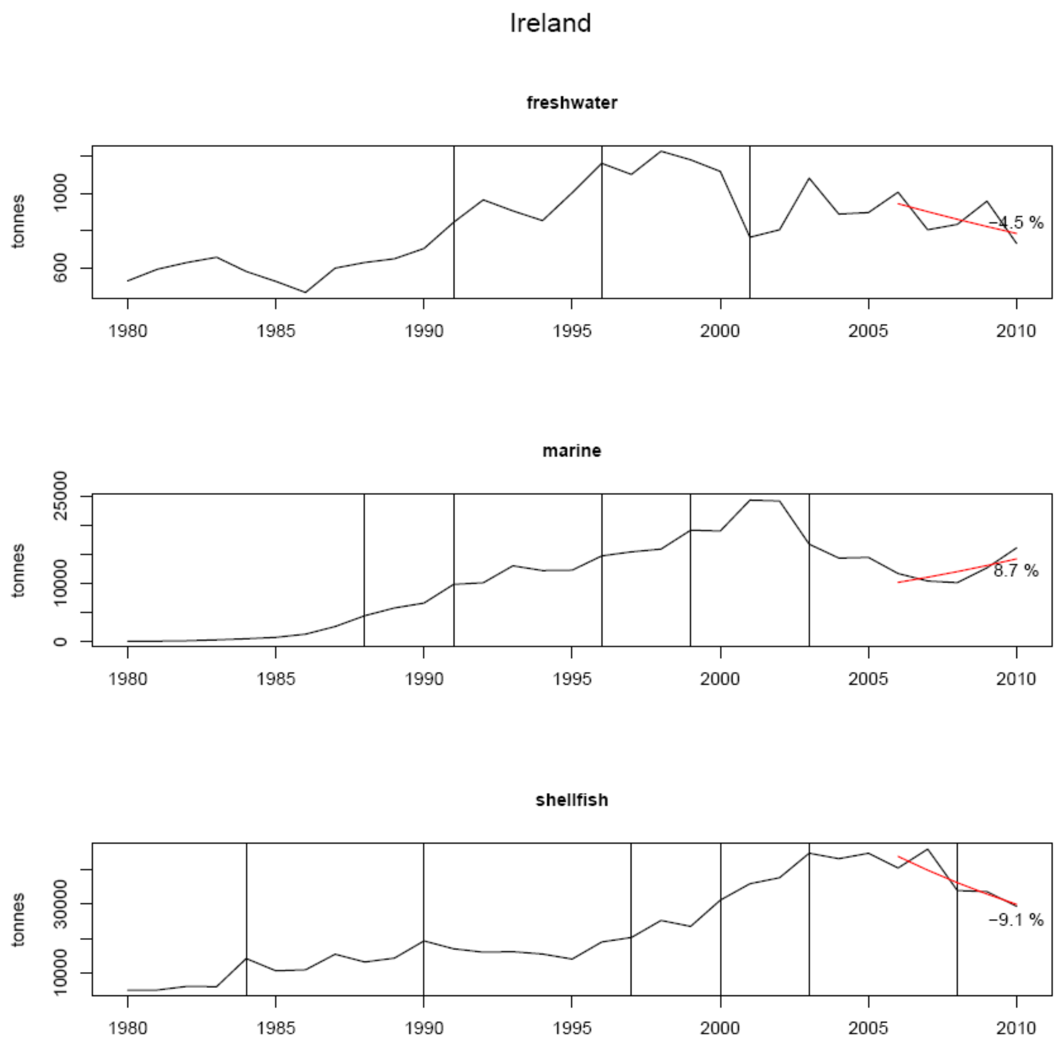


Figure 122 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

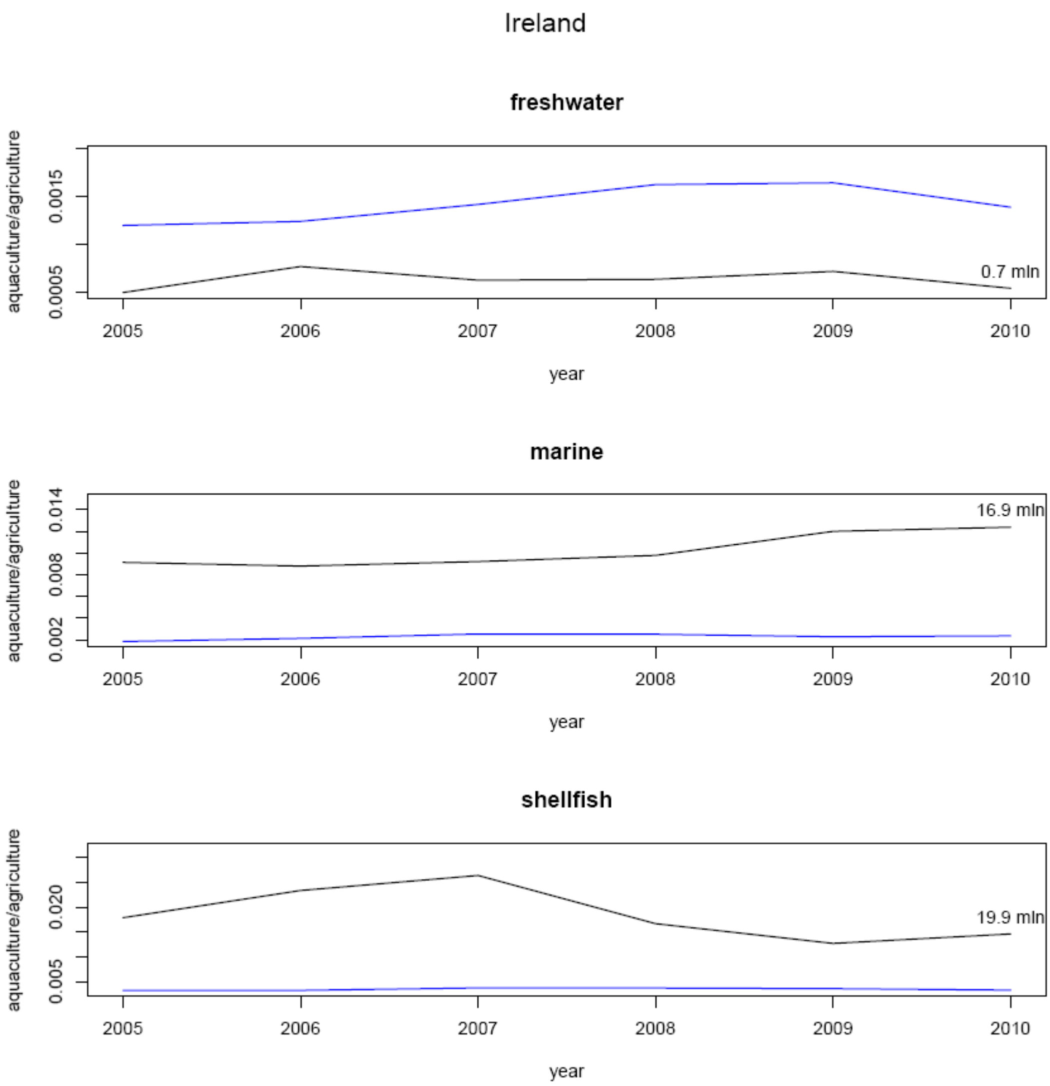


Figure 123 GVA: Economic importance of the output by different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

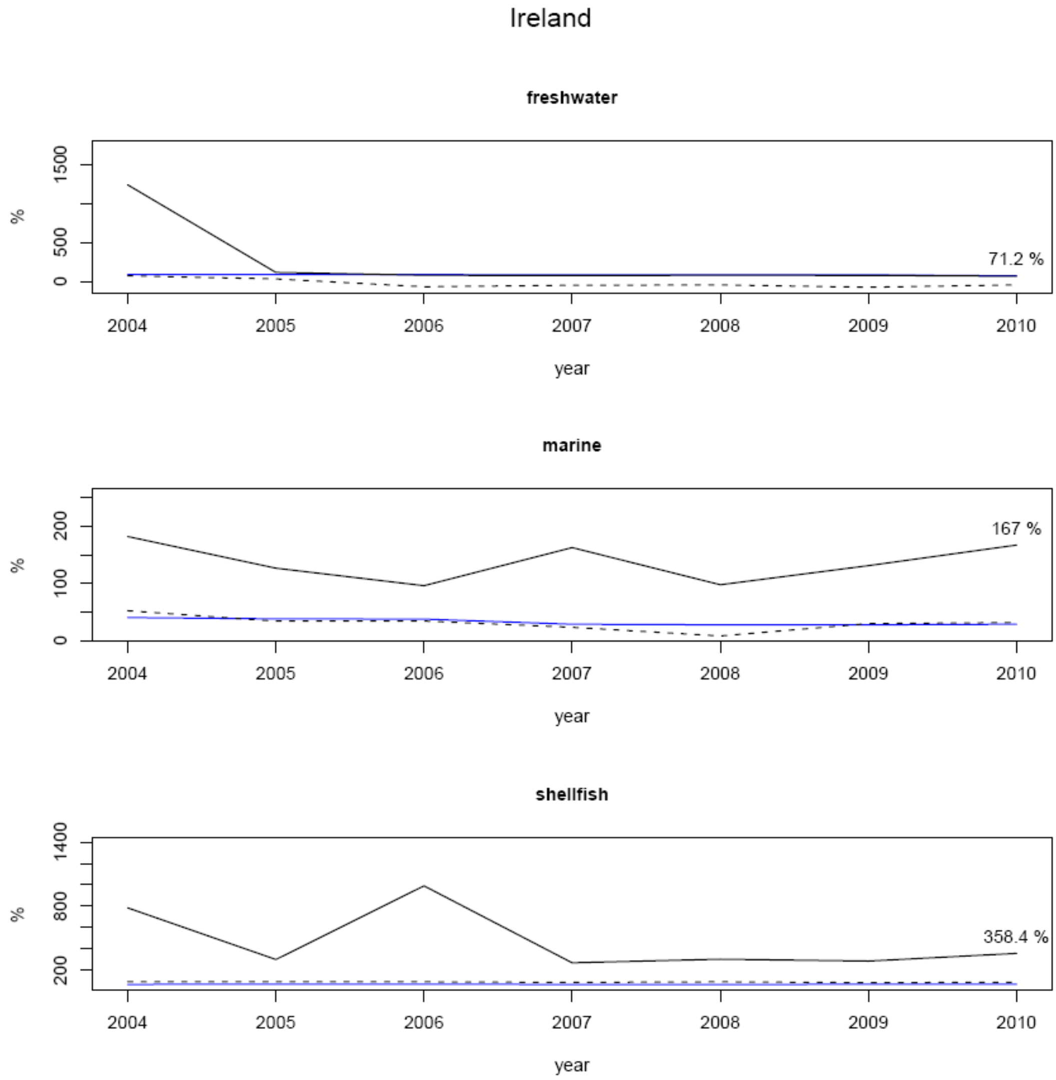


Figure 124 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Ireland, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

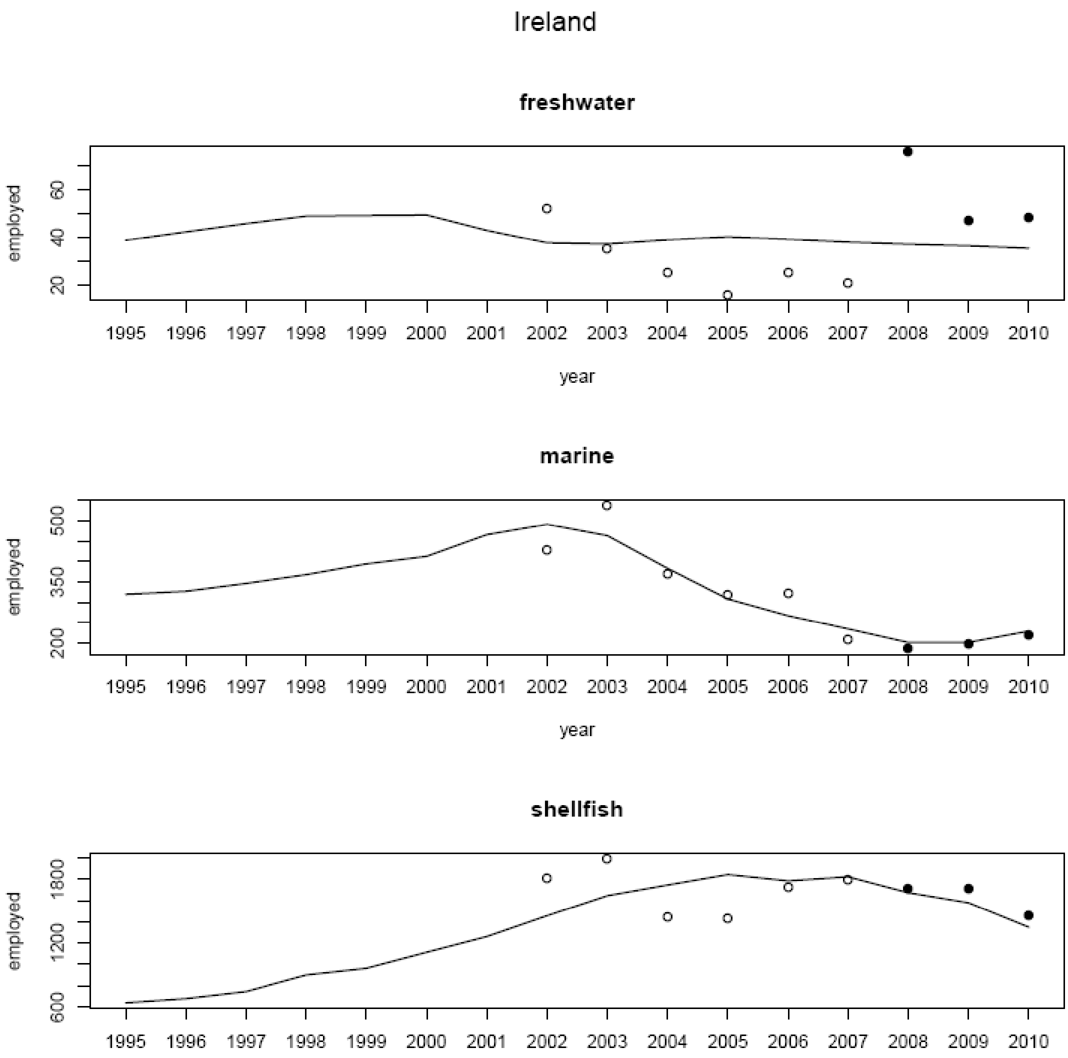


Figure 125 Number of employed persons in aquaculture in Ireland over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

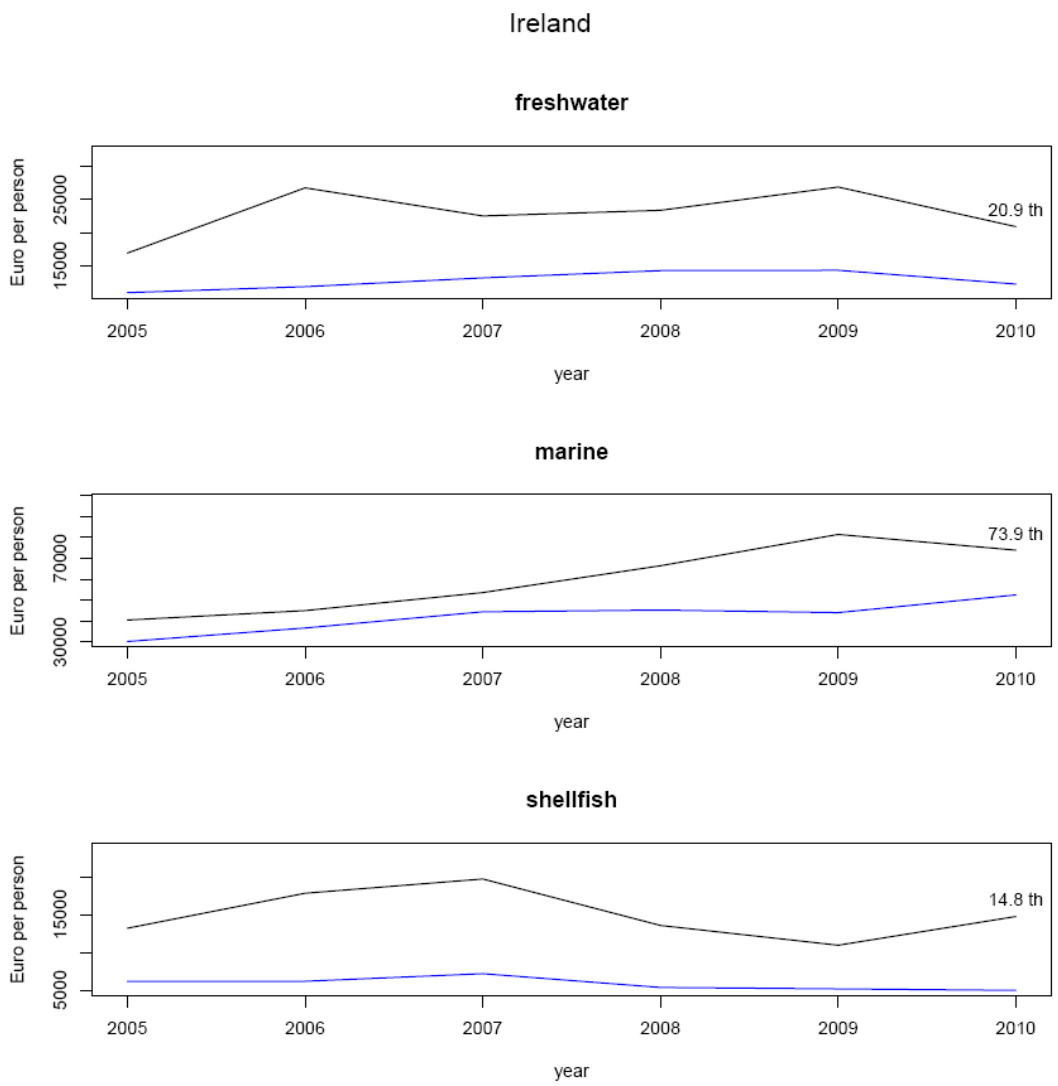


Figure 126 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

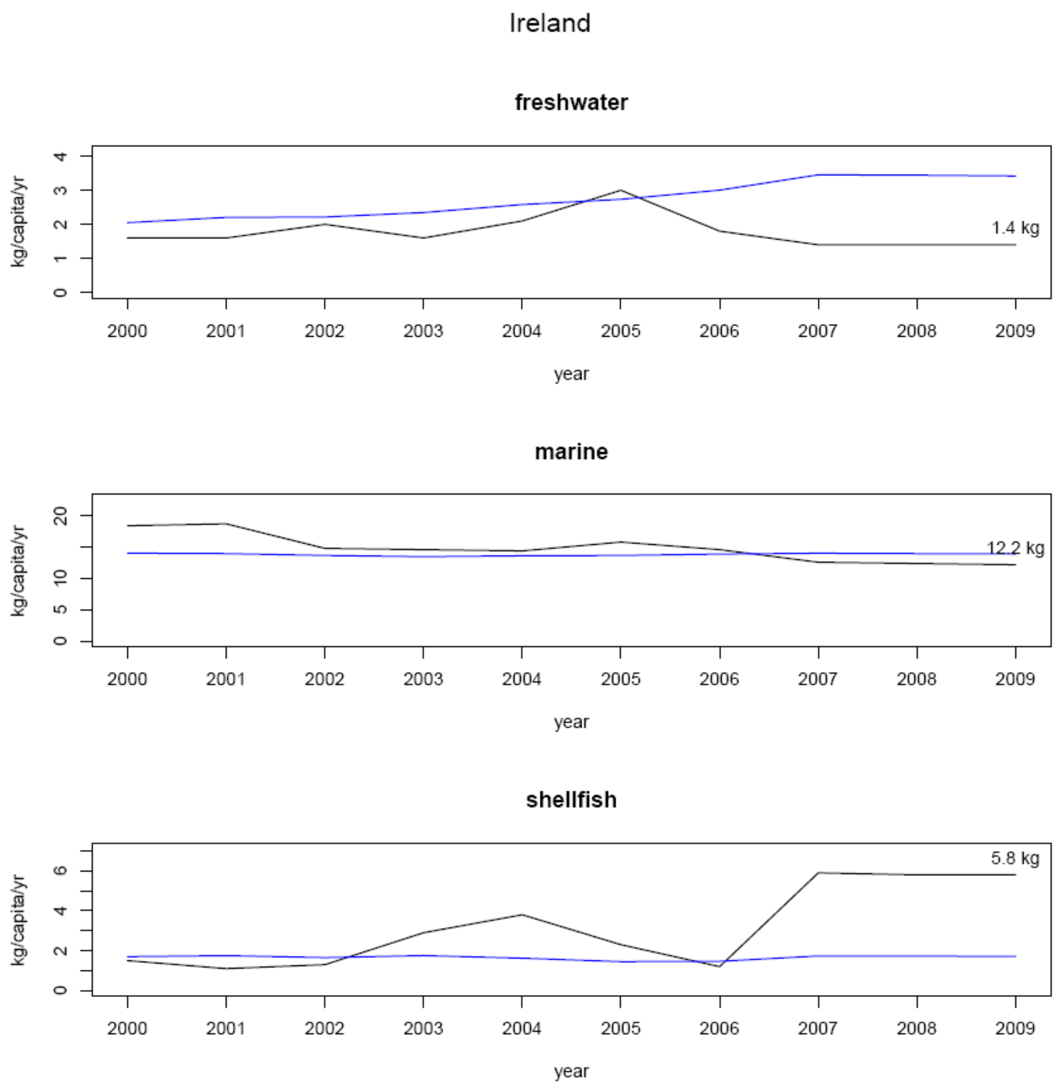


Figure 127 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

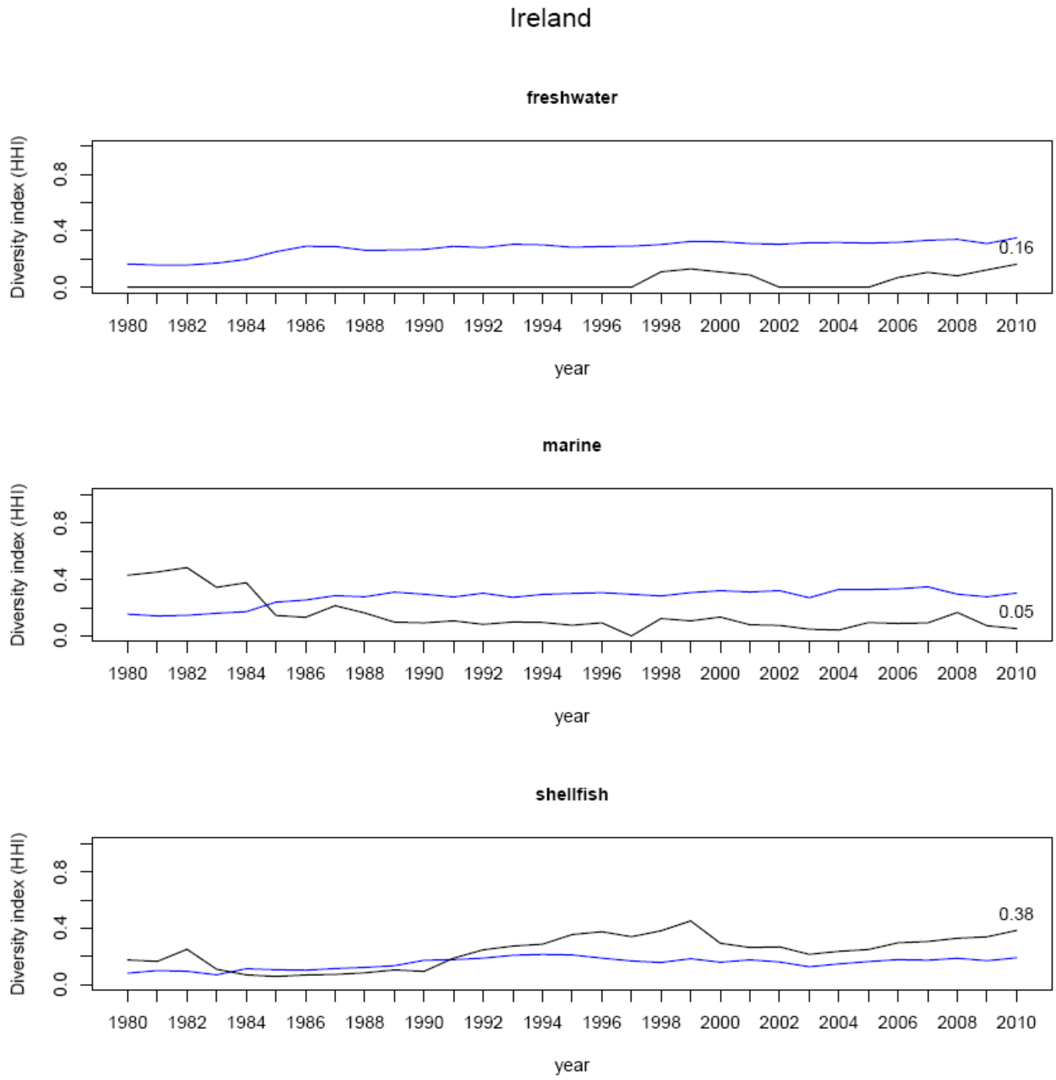


Figure 128 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.14. *Italy*

Highlights and trends

- Strong aquaculture industry, seeing some positive growth trend in the freshwater segment (2006-2010 +2.9%).
- Freshwater aquaculture contributes to the country's outgoing trade.
- High diversification of farmed species contributing to the production in the marine and shellfish production.
- In absolute terms, employment is high in the shellfish segment but many jobs are part time or seasonal.
- Labour productivity is above average in the freshwater and shellfish segment.
- Relative high demand of fishmeal / fish oil in the finfish segments.
- Effluent load from aquaculture is higher than EU average.

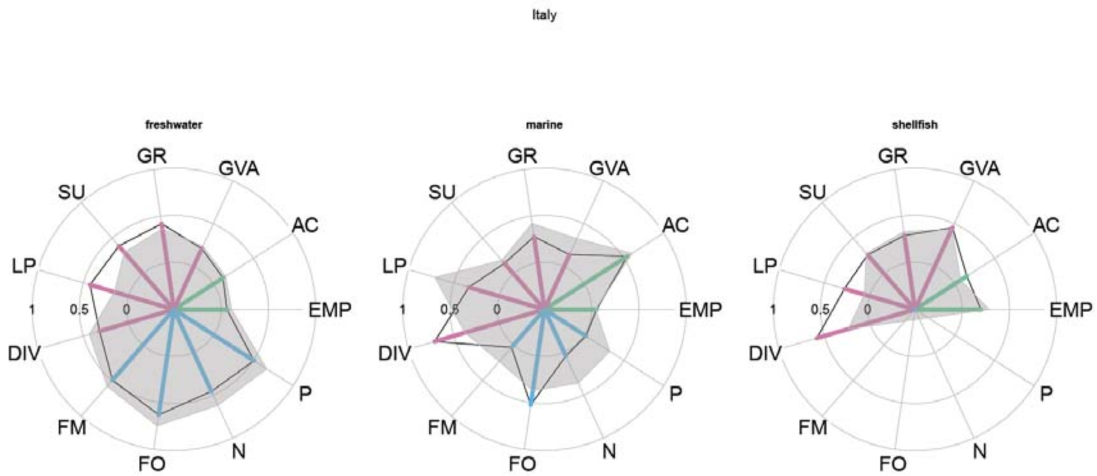


Figure 129 Performance indicators for Italy

Overview of the sector

Being one of the largest producers in the Union with a production volume of around 153,500 tonnes in 2010, Italian aquaculture is dominated by shellfish and freshwater finfish production. The freshwater segment with some 38,600 tonnes presents 13.7% of the Unions freshwater aquaculture by turnover and 13.8% by volume, mainly with rainbow trout (around 86%), sturgeon and sea trout. The freshwater production is characterized by traditional small to medium size companies, farming trout in tanks or raceways and with their own fry production.

The shellfish culture of around 101,000 tonnes contributes to some 15% to the Unions shellfish production by turnover and 16% by volume. Main species are Japanese carpet shell (67% in value, 64% in volume) and Mediterranean mussel (30% in value, 35% in volume). For mussel farming mainly long-line technique and for clam farming bottom technique is used. Shellfish famers are largely organized in cooperatives.

The marine finfish segment with around 13,800 tonnes in 2010 has a share in the EU marine finfish production of 6.5% in value and almost 4% in volume, producing mainly European sea bream and Gilthead sea bass in land-based installations (tanks, raceways), enclosures, pens and sea cages with a high technological standard. Italy is an important producer of juvenile sea bream and sea bass, supplying to a large extent producers outside Italy.

The sector shows a high level of specialization, industrialization and large scale production. As a relatively new field, bluefin tuna farming has been developed, with some nine active installations been reported in 2006.

In 2010, 754 entities were recorded, some 400 in finfish and some 320 in shellfish production.

After a decrease since the mid nineties the freshwater segment show since 2006 a slight increasing trend of +2.9%. The Marine finfish and shellfish production experienced in the last five years a clear negative trend (-5.7% and -4.9%, respectively).

Aquaculture GVA is relatively high, the ratio to agriculture is either close (freshwater finfish and shellfish) or well below (marine finfish) the ratio for the EU as a whole.
The freshwater production contributed in 2010 with some 110% to the available supply in the relevant segment which indicates some importance for the outgoing trade. This is underlined by the positive values in the trade balances for freshwater fisheries products. The marine production has a share of 11% and 60% to the available supply of finfish and of shellfish, respectively.
Freshwater and shellfish aquaculture are in the employment ratio well below the EU ratio, the marine finfish segment above. The model shows for the freshwater environment after a low of <900 persons in 2006 an increase to > 1,000 persons in 2010. For the marine finfish segment the modelled employment is decreasing due to reduced production and increased productivity, while in shellfish the model sees a downward trend from >4,000 in 2007 to some 3,330 in 2010 following the decrease in production.
Apparent consumption is close to the EU average in the freshwater and marine finfish segments, while shellfish consumption remains well above EU average.

In absolute terms, the freshwater segment has a much higher demand of fishmeal and fish oil than the marine finfish segment (in 2010 some 13,100 tonnes fishmeal and 5,600 tonnes fish oil for freshwater compared to 8,500 tonnes fishmeal and 2,600 tonnes fish oil for marine production). Per tonne fish produced the freshwater production has with some 340 kg fishmeal and 146 kg fish oil a higher use than the Union as a whole of the segment, but much lower than for marine finfish (around 619 kg fishmeal and 187 kg fish oil). With a strong sea bass and sea bream production, the marine finfish segment has a higher consumption of fishmeal but a lower demand for fish oil/tonne fish than the EU in total in the segment.

The effluents of N and P per tonne of fish produced are above the EU level in the freshwater production (around 61 kg N and 9 kg P) and much higher per tonne marine finfish (around 99 kg N and 15 kg P). In absolute figures, freshwater finfish aquaculture contributed with around 2,350 tonnes N and 340 tonnes P and marine finfish production with around 1,370 tonnes of N and 214 tonnes of P to the effluents.

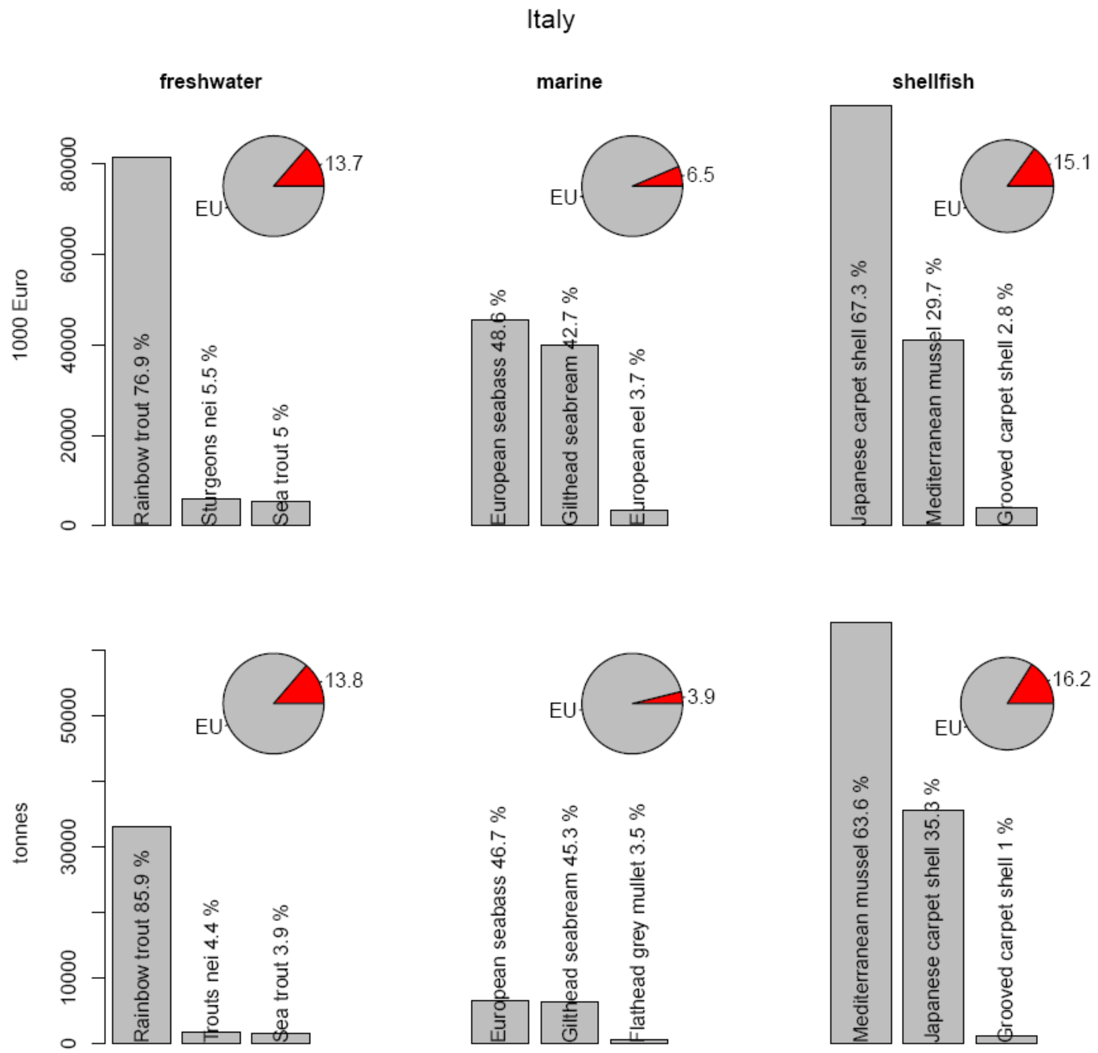


Figure 130 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

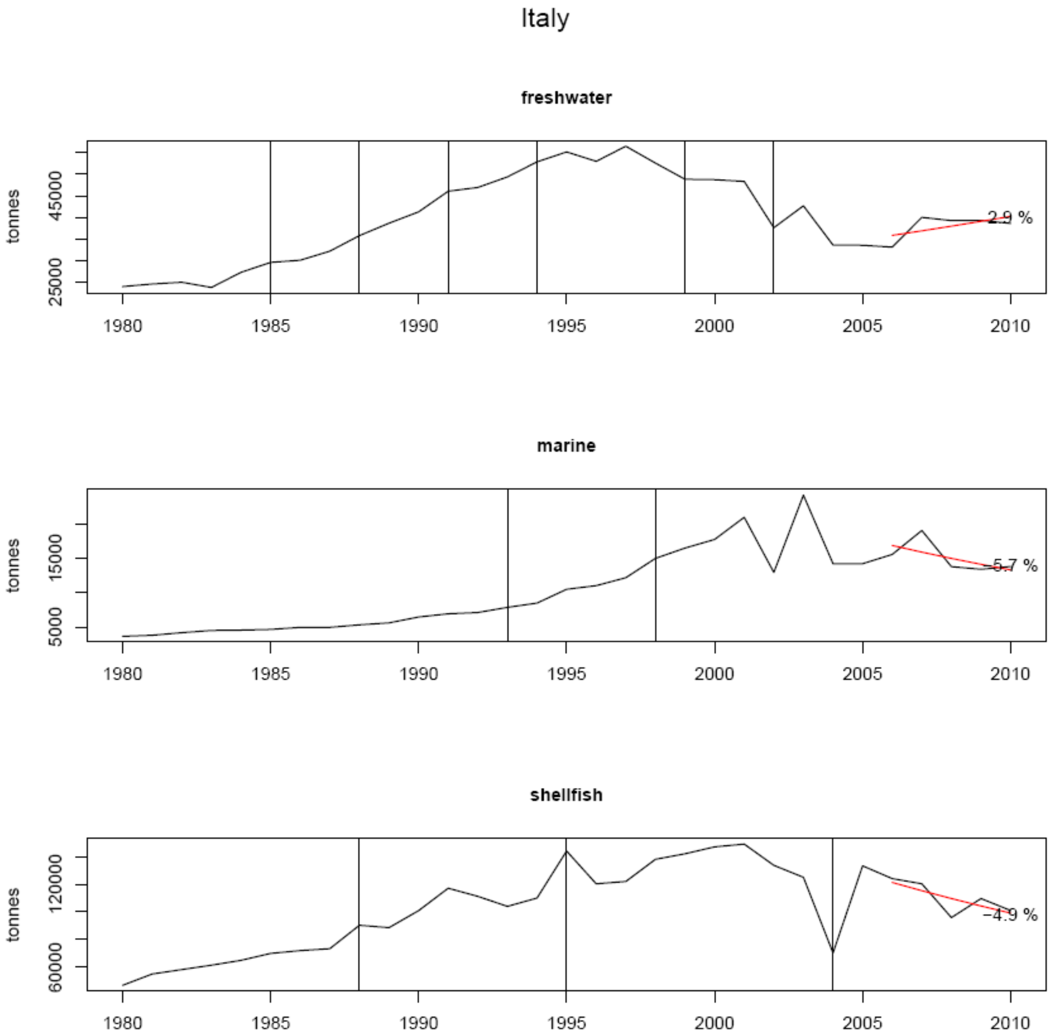


Figure 131 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

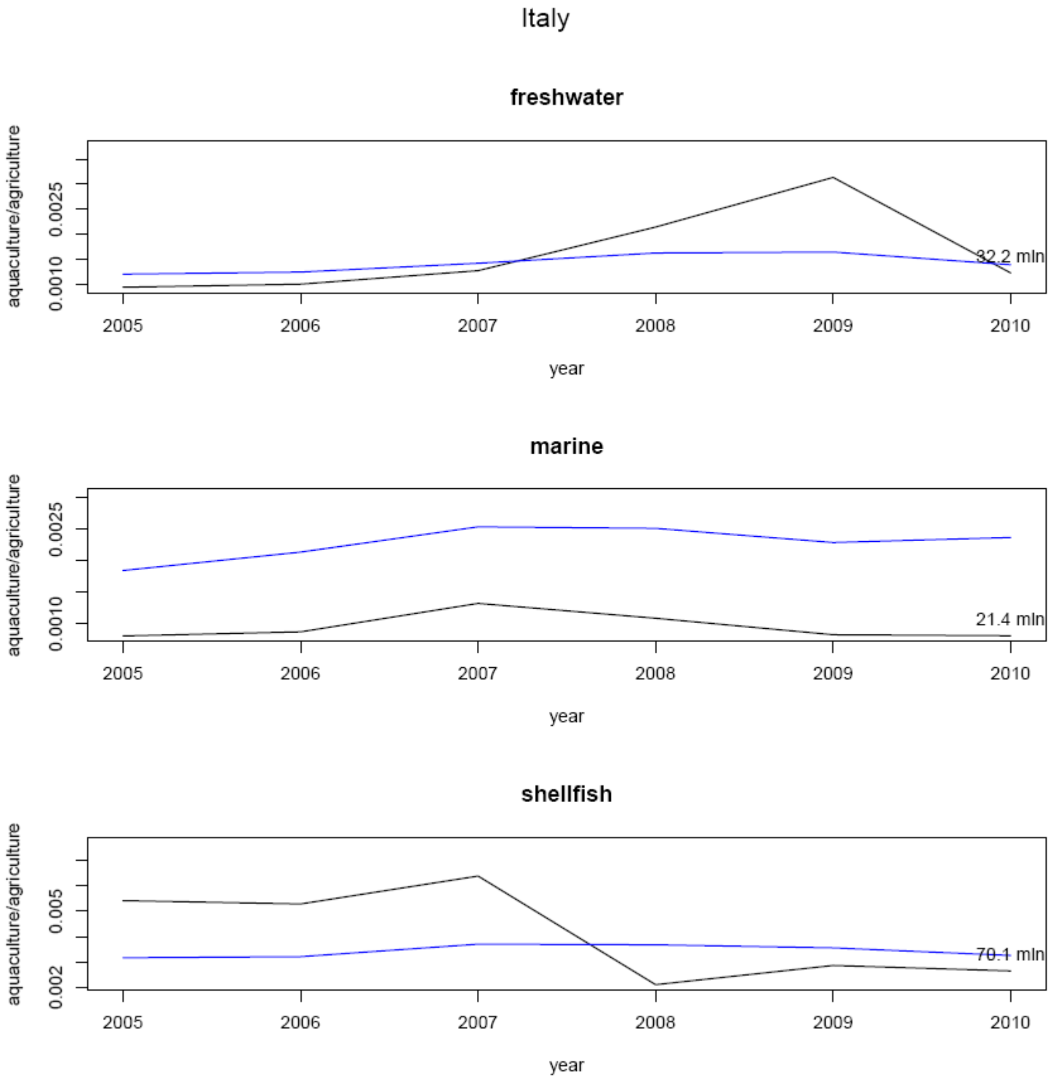


Figure 132 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

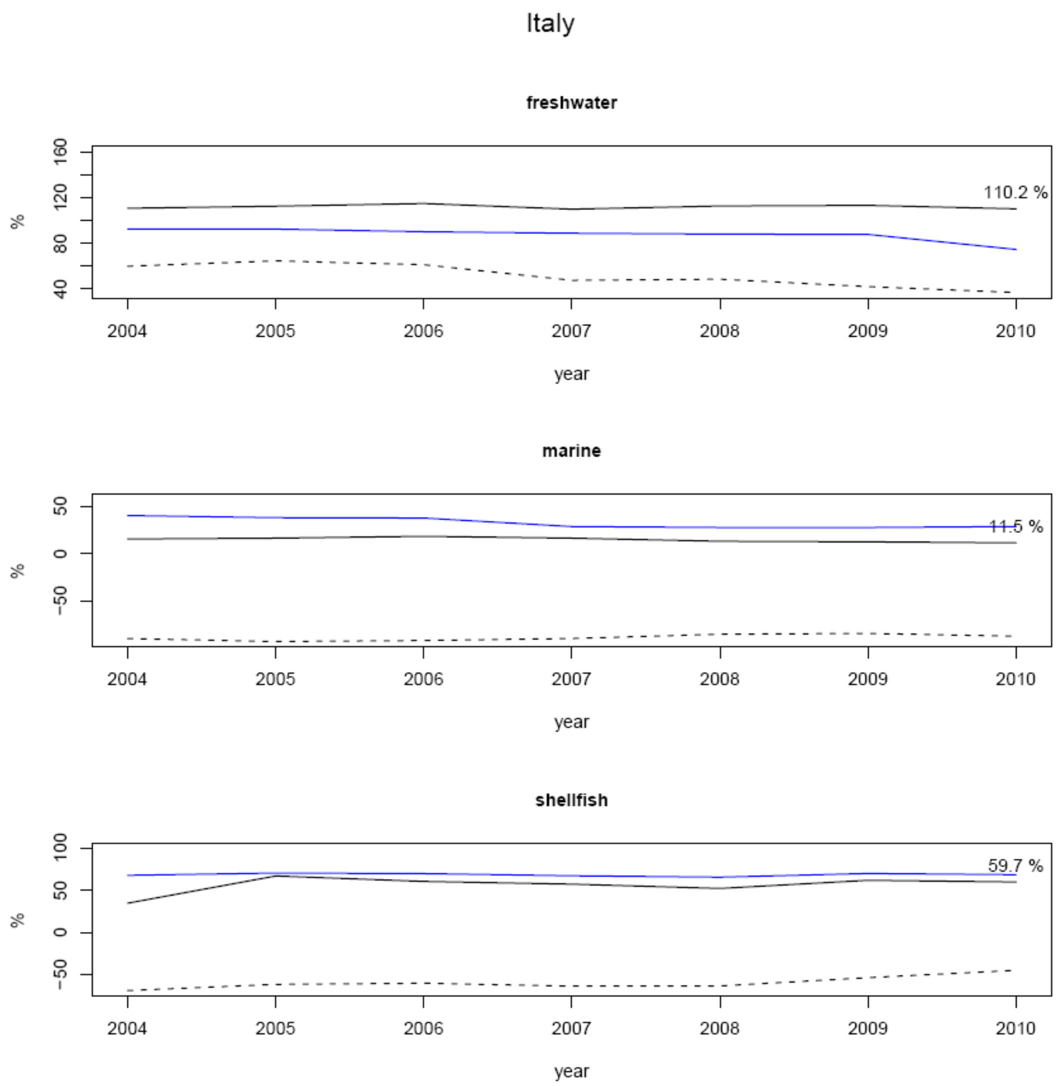


Figure 133 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Italy, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

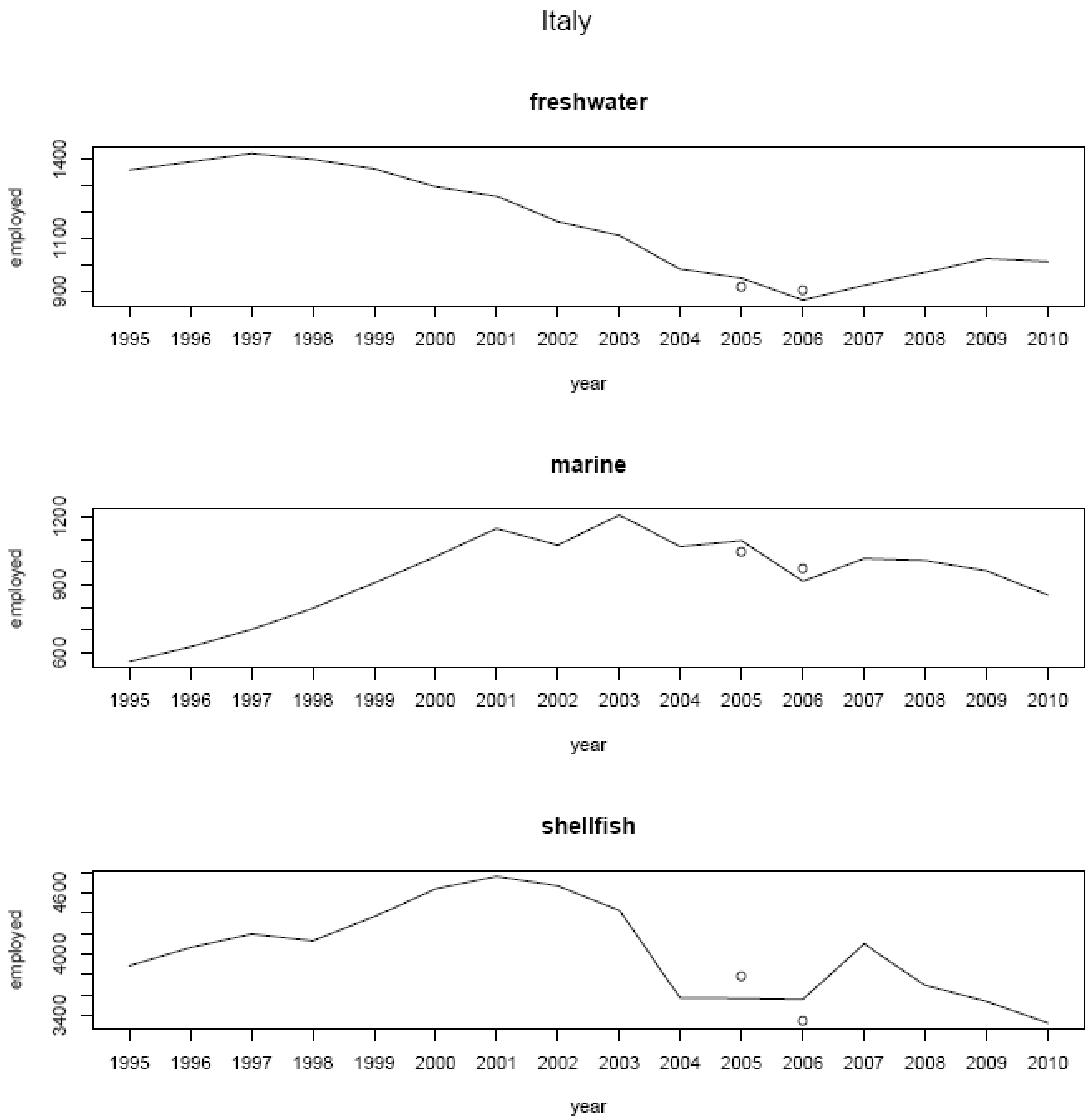


Figure 134 Number of employed persons in aquaculture in Italy over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

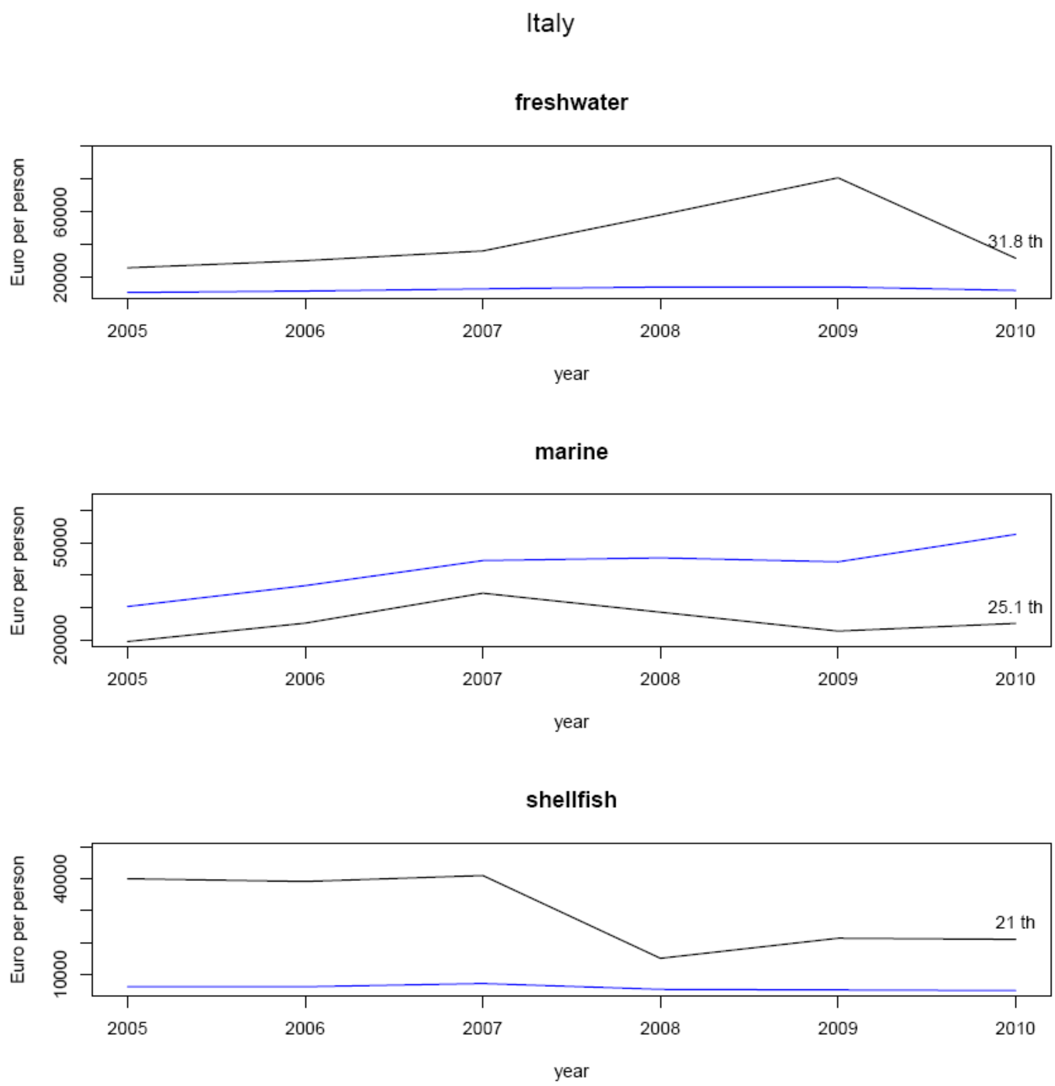


Figure 135 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

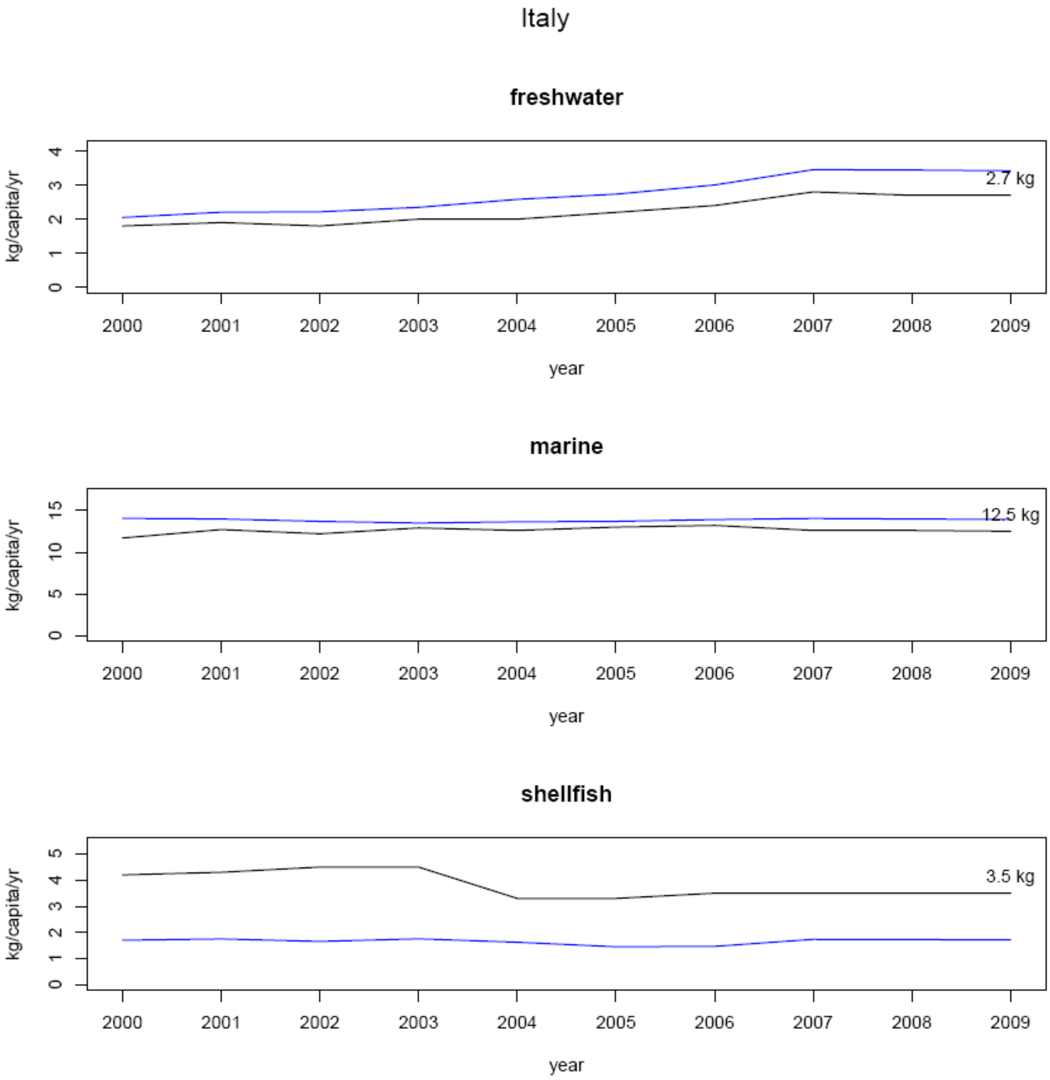


Figure 136 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

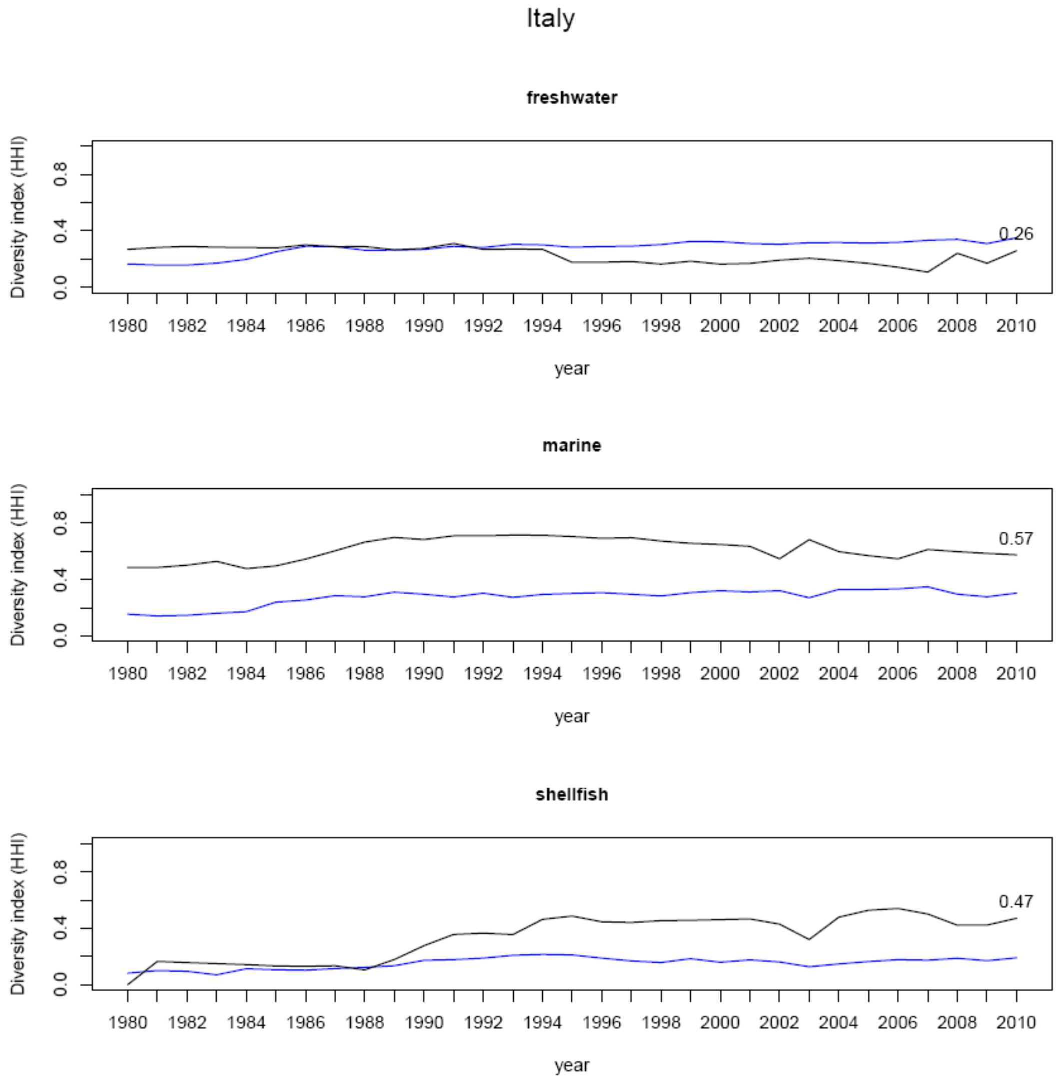


Figure 137 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.15. *Latvia*

Highlights and trends

- Small freshwater aquaculture with slightly negative trend for growth (2006-2010 -3.9%).
- In absolute terms, employment is very limited.
- Labour productivity is above average in the freshwater segment.
- Relative low demand of fishmeal / fish oil.
- Effluent load from aquaculture is lower than EU average.

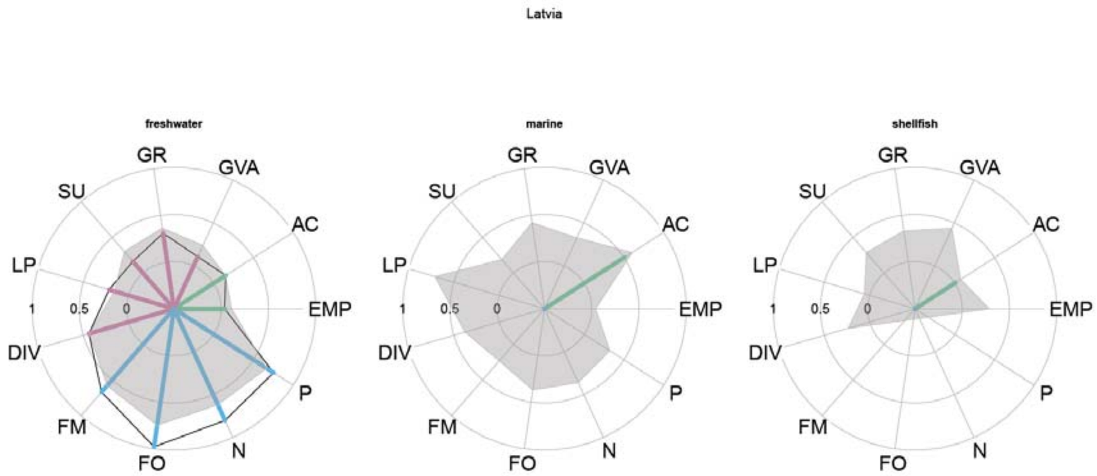


Figure 138 Performance indicators for Latvia

Overview of the sector

The Latvian aquaculture sector is small with a volume of some 550 tonnes in 2010 derived from freshwater production. The main farmed species are common carp (67% by value and 80% by volume), sturgeon, pike and catfish.

The number of entities in the sector is not known. Amongst the entities for which aquaculture is not the primary activity, it seems that many agricultural companies have entered aquaculture as a complement to their core businesses in agriculture. These investments were encouraged by a special EU programme of pre-accession measures, of which diversification of rural economy was a priority measure. Some entities seem to specialize in angling tourism.

The available data show since 1992 a relative low production with a negative trend of -3.9% in the last five years.

The GVA of aquaculture is low.
Aquaculture participates only with some 18% to the available supply.
From the model it can be concluded that the sector has very few person (around 25 in 2010) employed, the ratio is well below the EU ratio of the segment.

Apparent consumption of freshwater products rose from 1992 to 2009 from below 1 kg to around 3.5 kg per capita, while in marine finfish products it fell in the same period from close to 30 kg to some 11.7 kg/head. Shellfish products present a very small amount.

With the dominance of carp production the use of fishmeal is below the EU demand per tonne fish produced and very low for fish oil (in absolute terms around 130 tonnes fishmeal and 6 tonnes of fish oil in 2010).

Effluents of N and P per tonne fish produced are lower than in the overall EU freshwater production and also in absolute terms very low (in 2010, 16 tonnes of N and 3 tonnes of P).

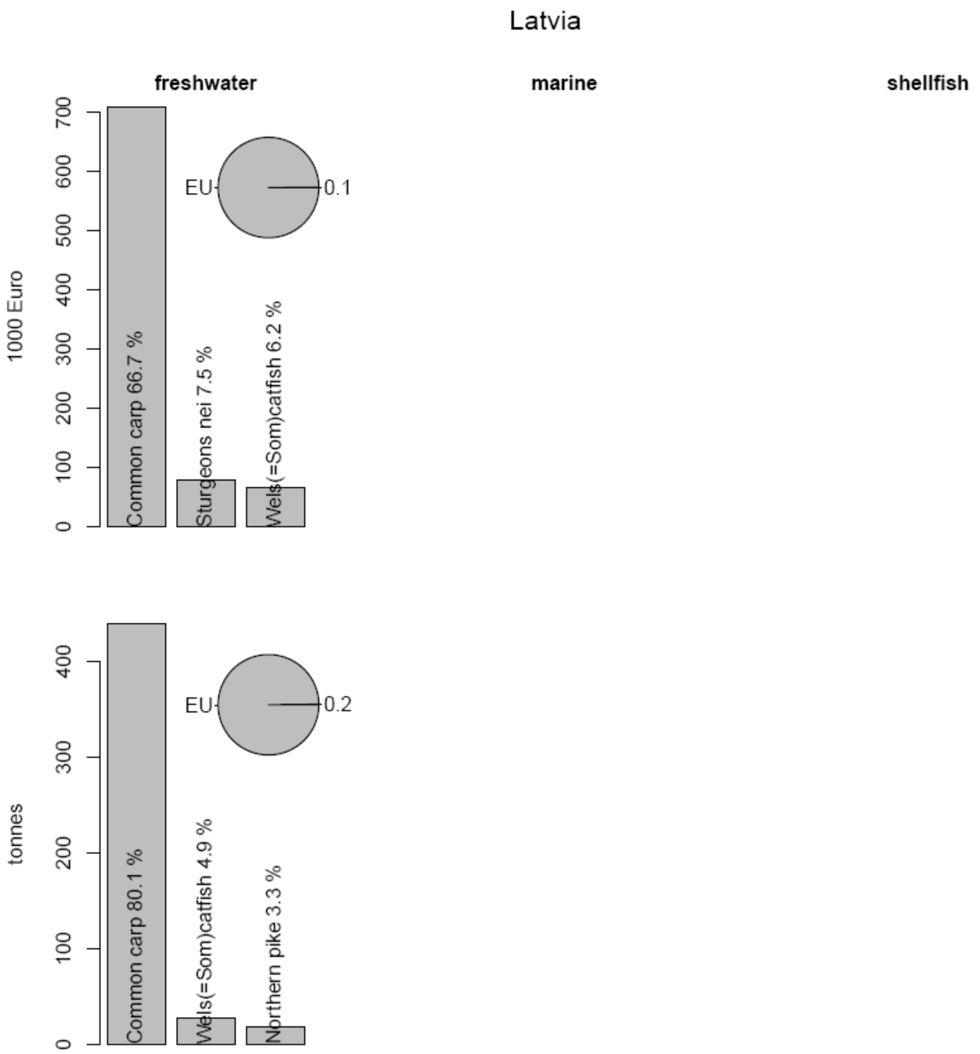


Figure 139 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

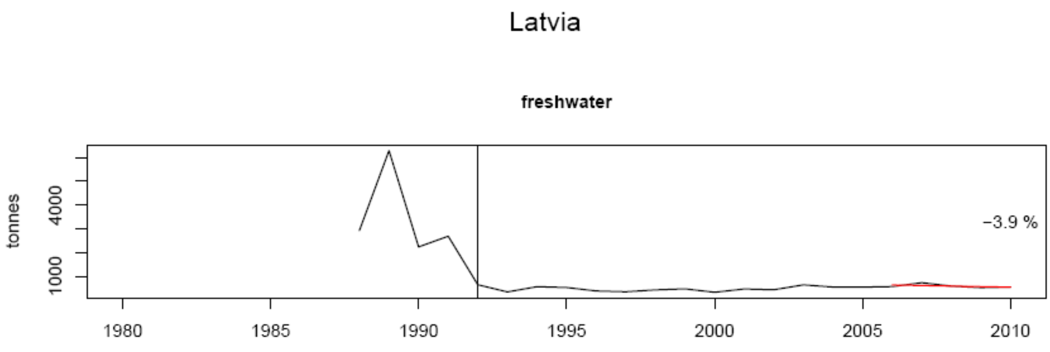


Figure 140 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

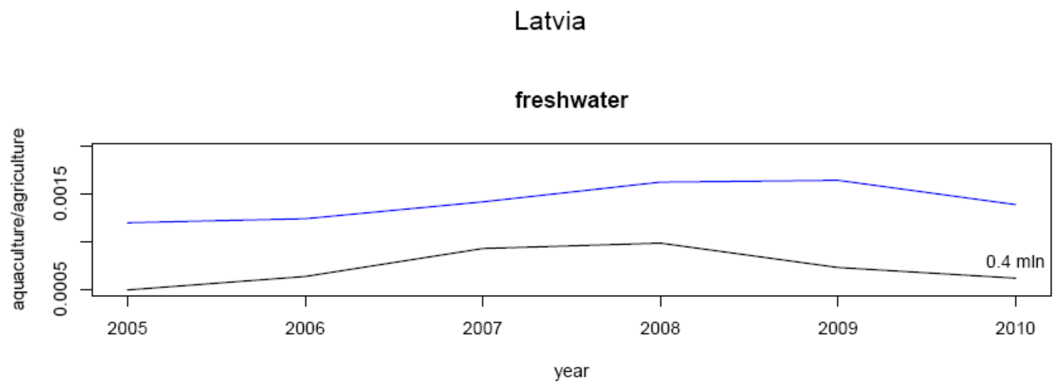


Figure 141 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

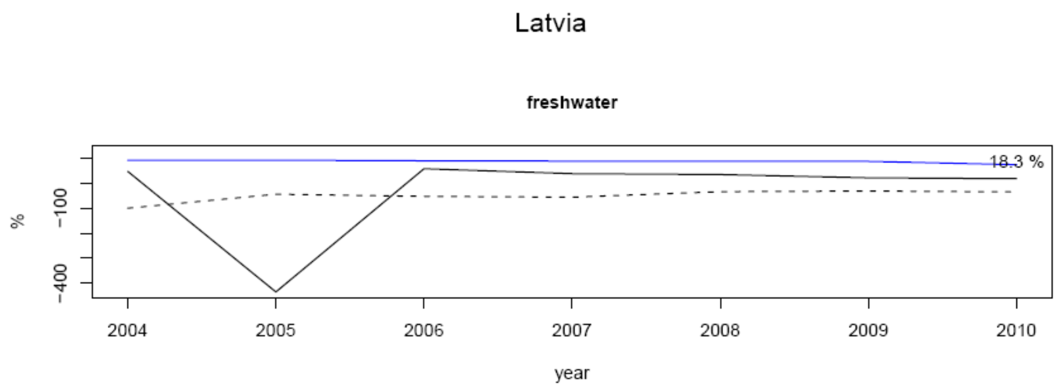


Figure 142 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Latvia, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

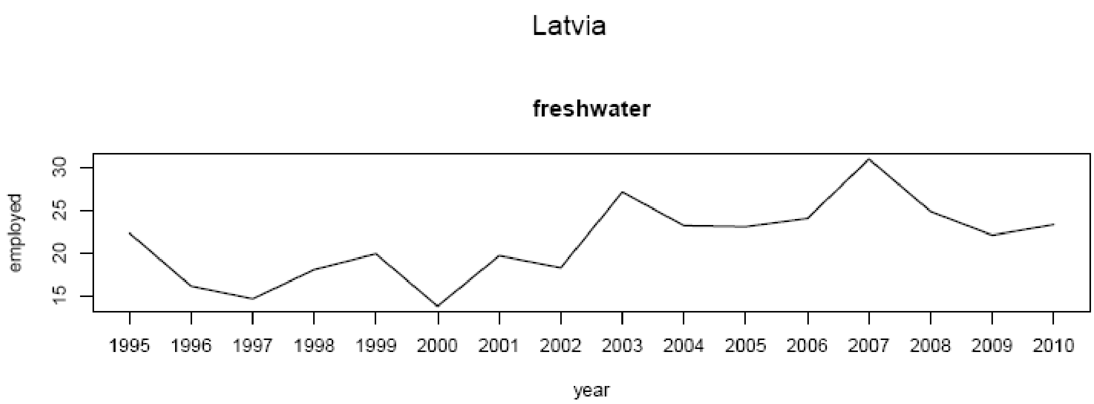


Figure 143 Number of employed persons in the freshwater finfish segment in Latvia over time. Since no data was available from DCF or previous reports the employment is estimated from production statistics using a generic EU model.

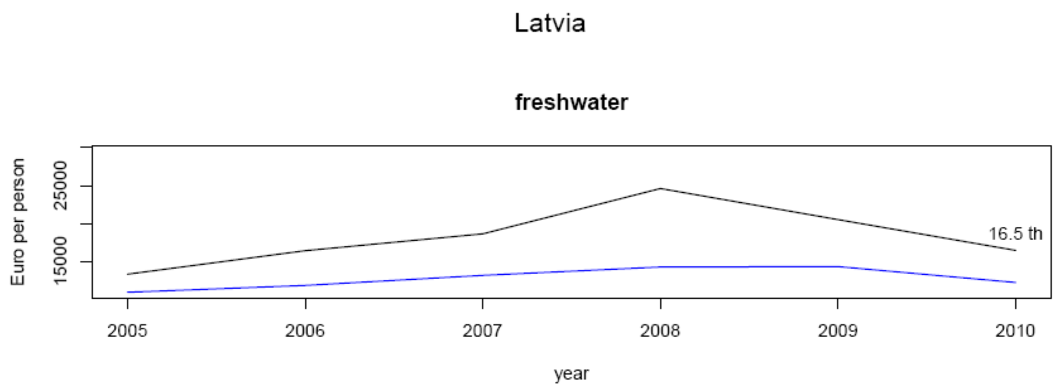


Figure 144 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

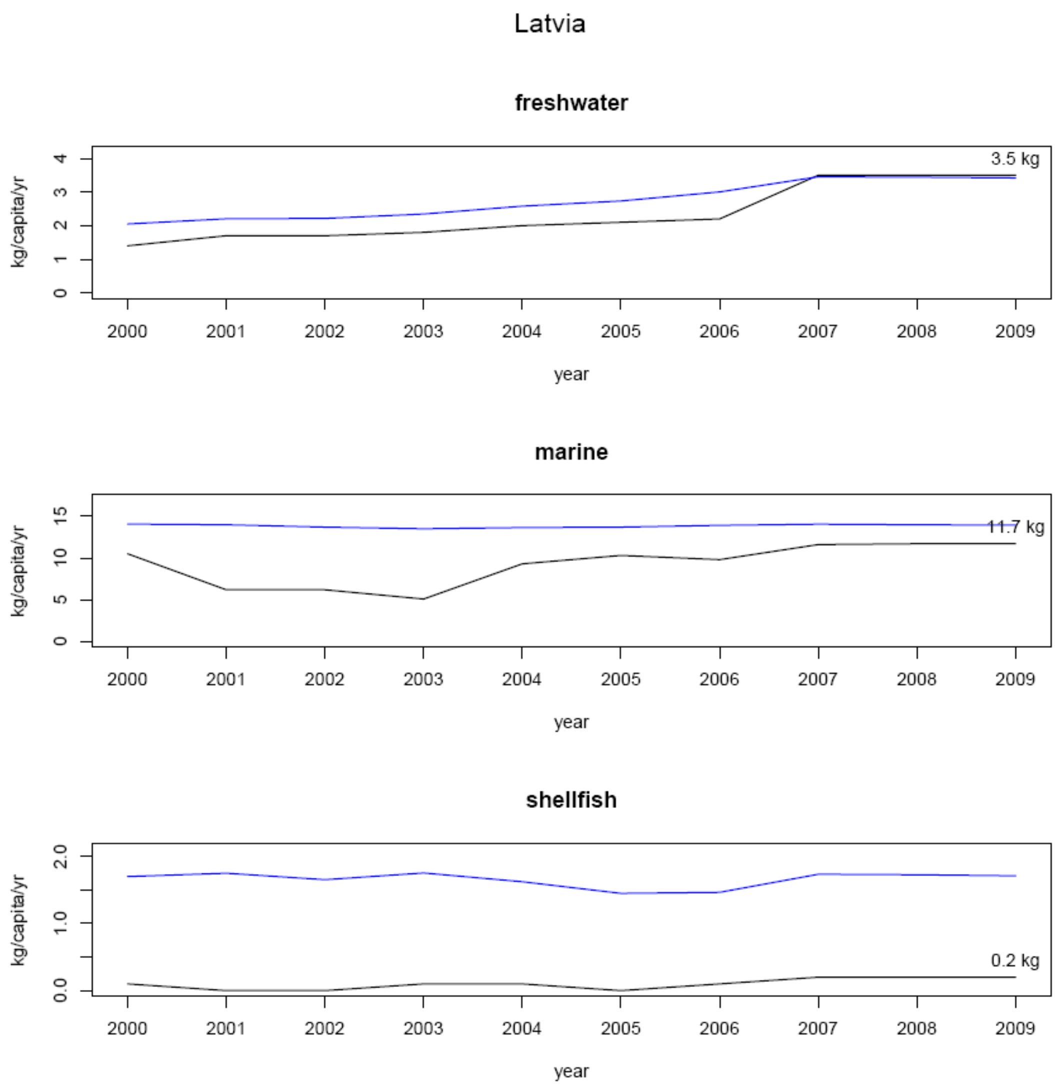


Figure 145 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

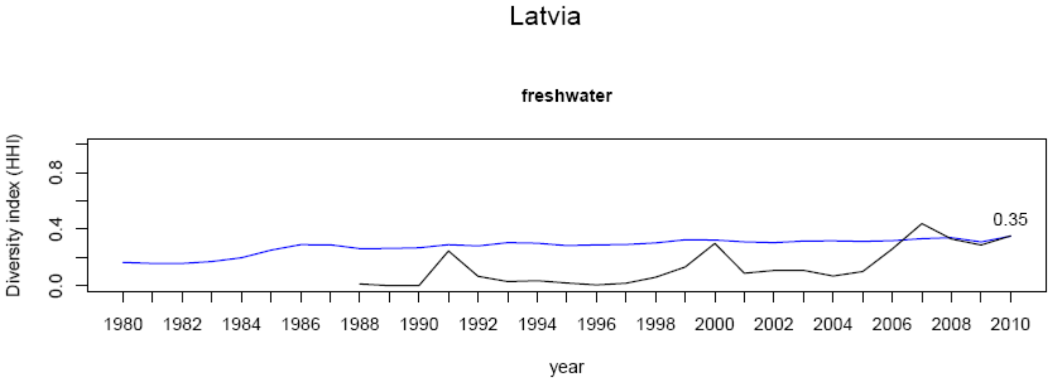


Figure 146 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.16. *Lithuania*

Highlights and trends

- Small freshwater aquaculture with a positive trend for growth (2006-2010 +7.6).
- The freshwater aquaculture shows a high GVA.
- In absolute terms, employment increased over the years and stays above EU average with a low labour productivity.
- Apparent consumption of fisheries products, especially from marine finfish is high
- Relative low demand of fishmeal / fish oil.
- Effluent load from aquaculture is lower than EU average.

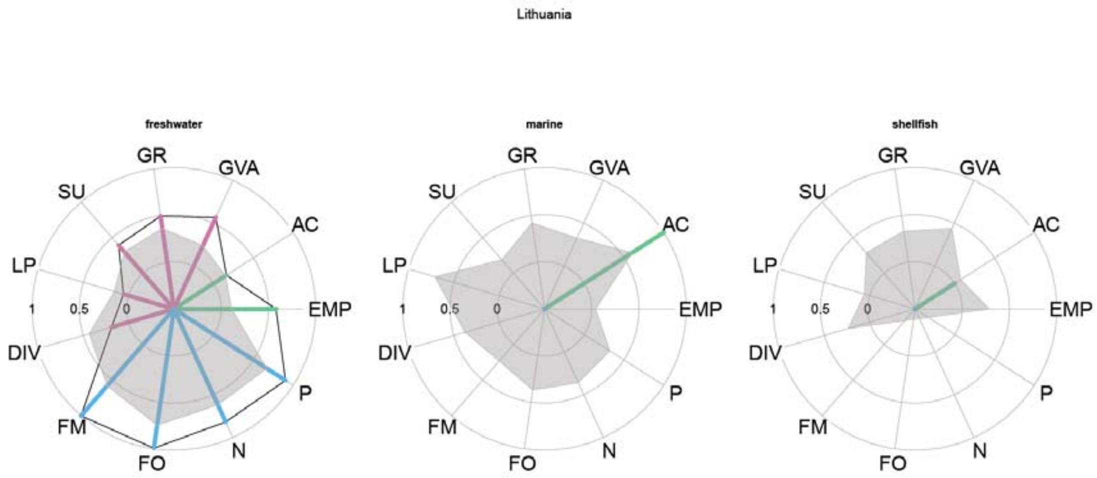


Figure 147 Performance indicators for Lithuania

Overview of the sector

The Lithuanian aquaculture production presents around 1% of the EU freshwater segment with some 3,200 tonnes recorded for 2010. Of the 21 active entities, 19 are involved in pond farming, some providing also services for sport fishing. From the 11 different freshwater species cultured common carp presents 86% by turnover and 92% by volume. Some of the other species are produced in recirculation systems, tanks or raceways. Organic aquaculture presented 2008-2010 between 40-55% of the total aquaculture production, but experienced a strong decrease, partially due to a lack of marketing opportunities. Actually, 10 organic aquaculture producers are certified and five more are in a transitional phase. Beside the commercial production also restocking activities take place.
The available data show since 1999 a continuous upward trend of production, in the last five years of +7.6%.

According to experts opinion the aquaculture sector was profitable in 2010.

The freshwater aquaculture is an important source for GVA in relation to the national agriculture production.
Freshwater aquaculture contributed in 2010 with some 112% to the available supply in that segments which indicates some importance to the outgoing trade. This is underlined by the positive value in the trade balances for freshwater fisheries products.
The available data indicate a continuous upward trend from below 200 in 1996 to > 570 persons employed in 2010. The ratio also shows the relatively high contribution of

freshwater aquaculture to the employment when compared to the EU ratio for the segment.
Apparent consumption increased from 1992 to 2009 from some 1.5 kg to 3.7 kg of freshwater products and from 20 to 35.3 kg of marine finfish products per capita. Shellfish consumption remained during that period very low.
With around 90% of freshwater finfish production related to carp the use of fishmeal and fish oil is very low (in absolute terms around 100 tonnes fishmeal and 16 tonnes of fish oil in 2010).
Effluents of N and P per tonne fish produced are lower than in the overall EU freshwater production and also in absolute terms low (in 2010, 86 tonnes of N and 11 tonnes of P).

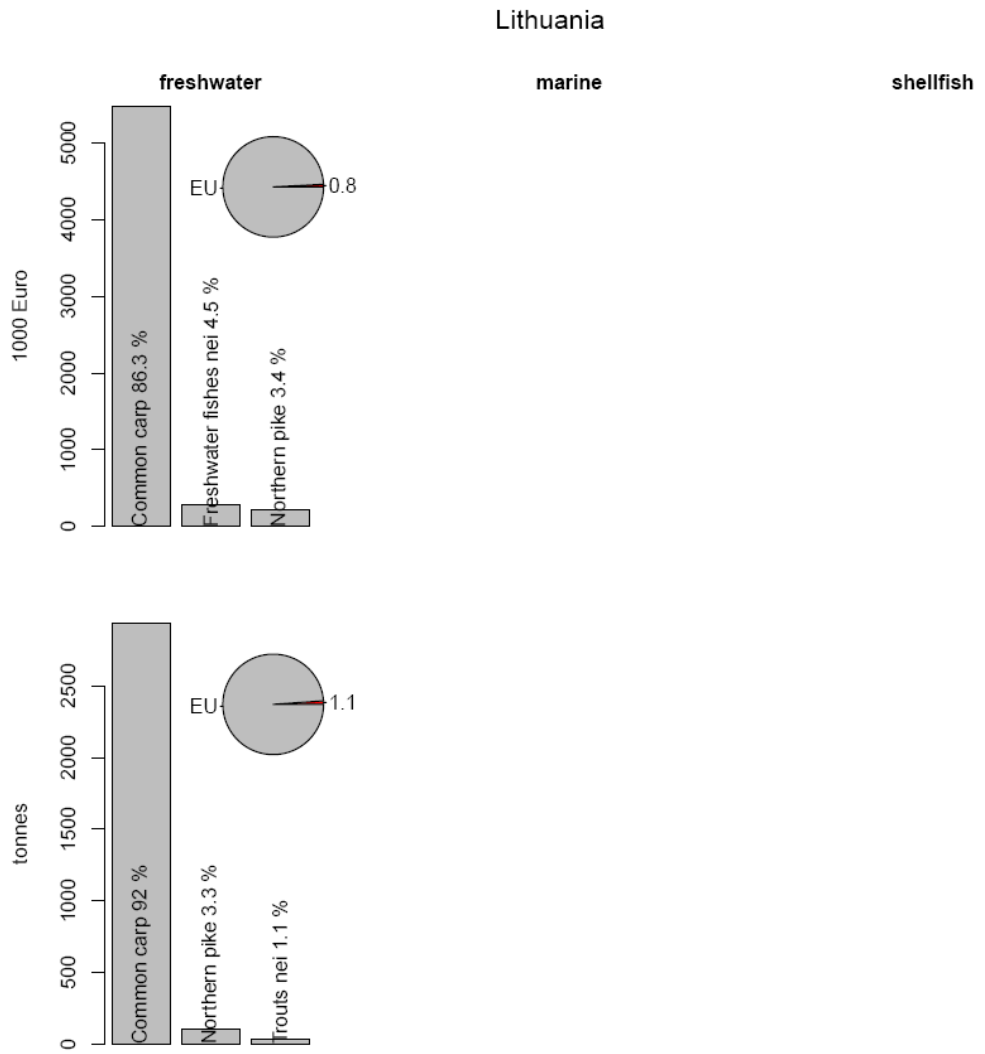


Figure 148 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

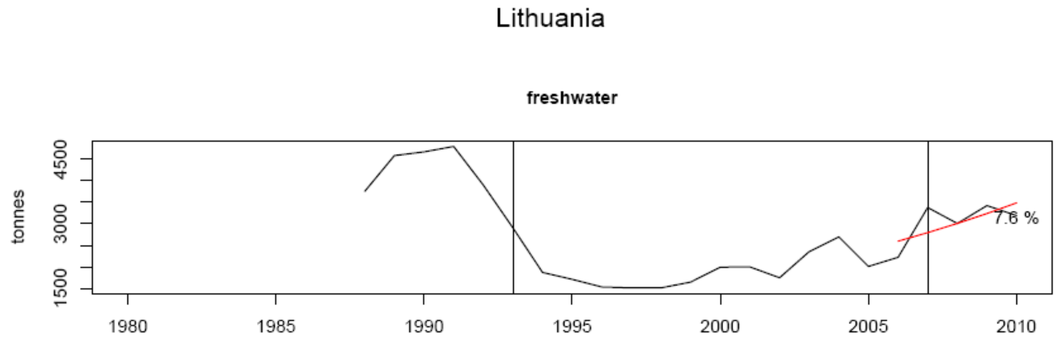


Figure 149 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

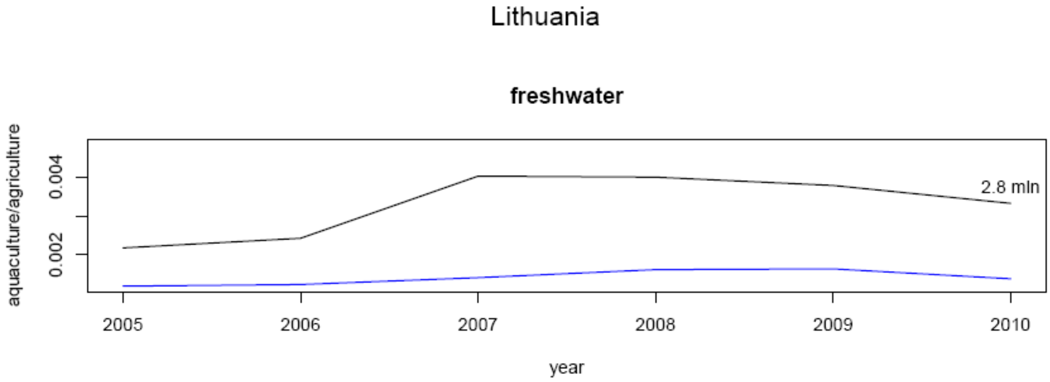


Figure 150 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

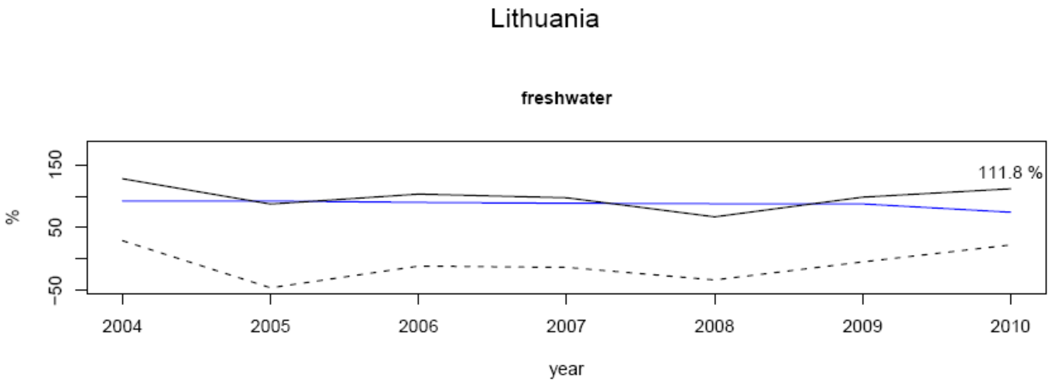


Figure 151 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Lithuania, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

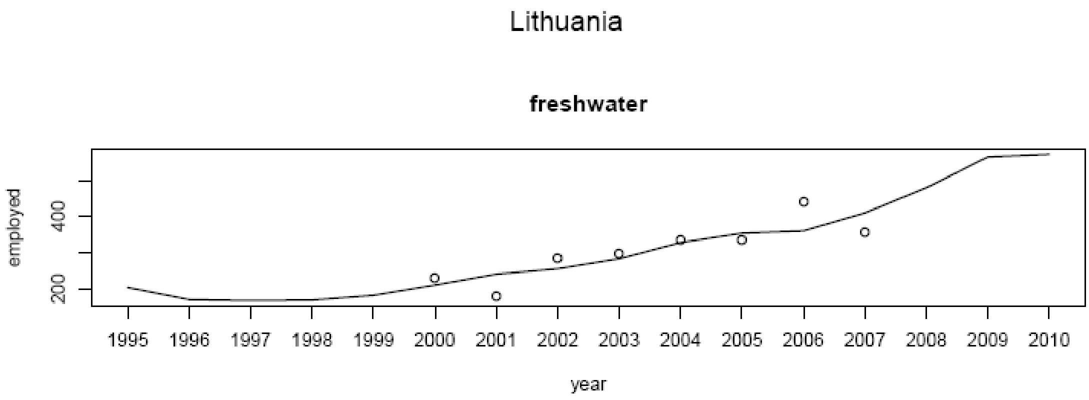


Figure 152 Number of employed persons in the freshwater segment in Lithuania over time. The trend line is derived from a country specific model based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

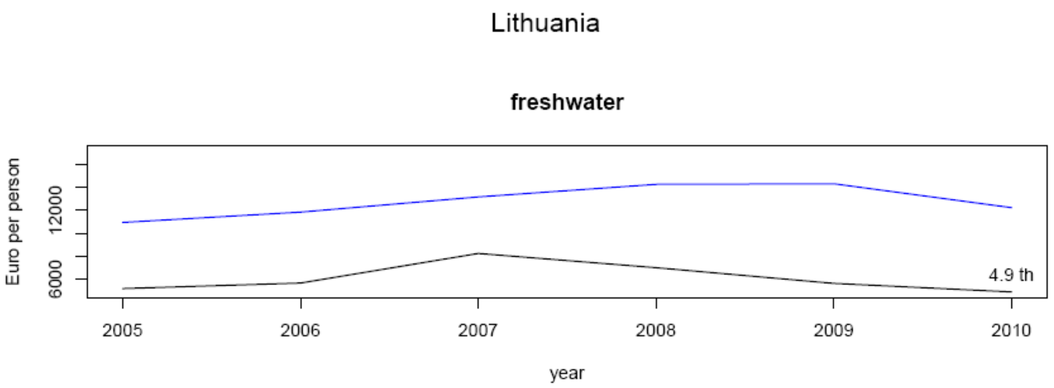


Figure 153 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

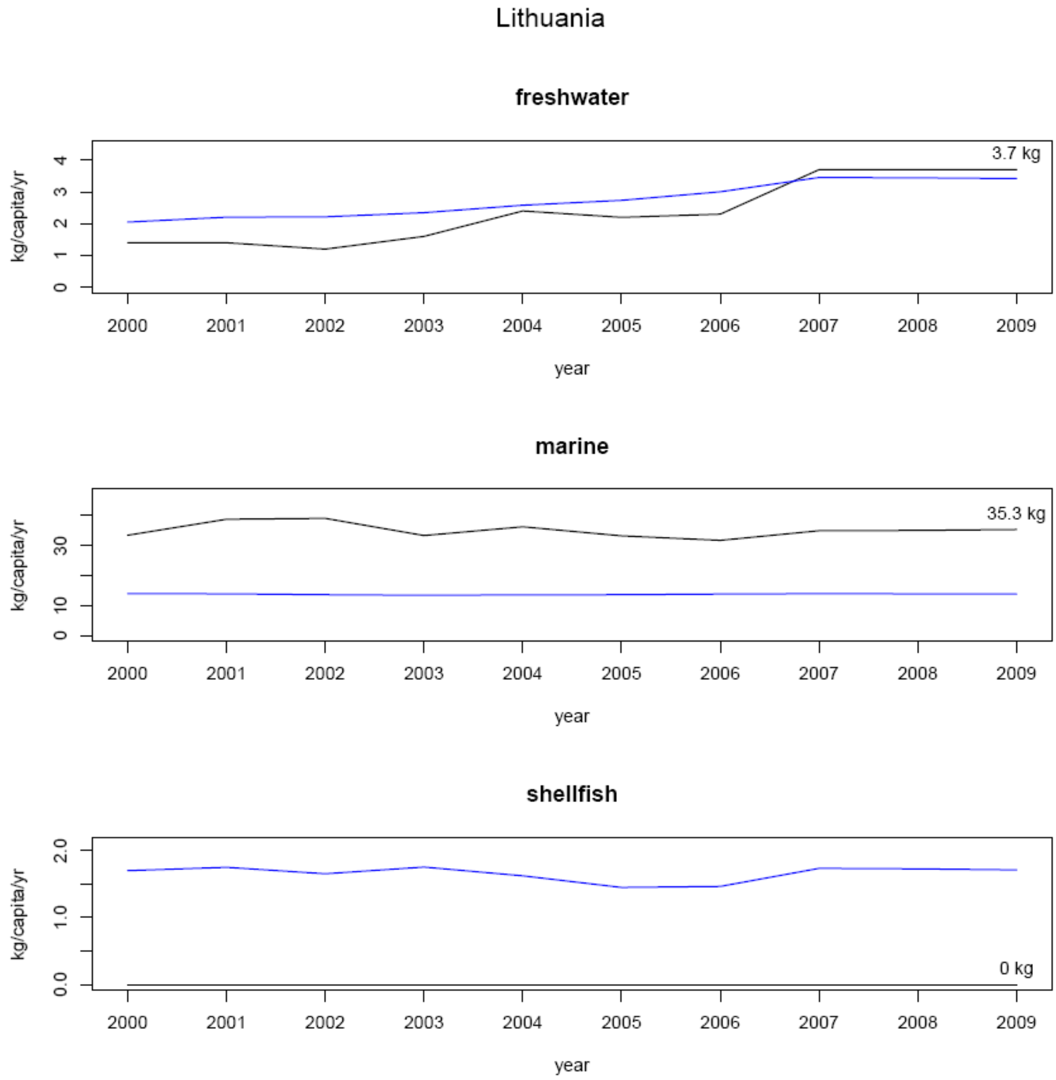


Figure 154 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

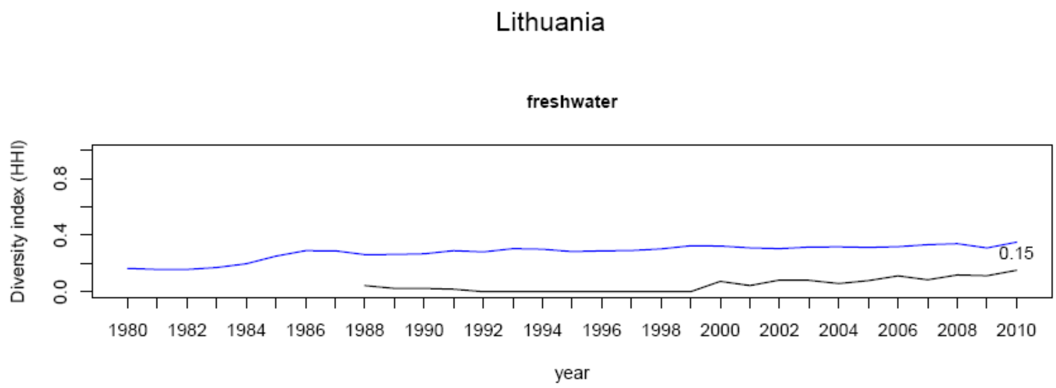


Figure 155 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.17. Malta

Highlights and trends

- Important marine aquaculture with a positive trend for growth (2006-2010 +9.1%).
- The marine finfish production shows a high GVA and contributes strongly to the country's outgoing trade.
- High diversification of farmed species contributing to the production.
- In absolute terms, employment is very limited but above EU average with a low labour productivity.
- Apparent consumption of marine finfish and shellfish is high.
- Relative high demand of fishmeal.
- Effluent load from aquaculture is higher than EU average.

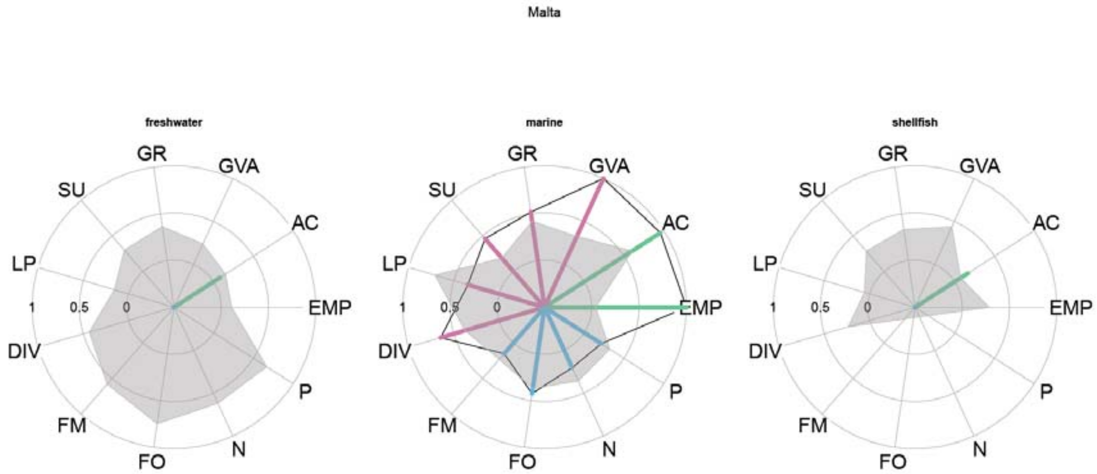


Figure 156 Performance indicators for Malta

Overview of the sector

The aquaculture sector in Malta consists of marine finfish production only. It is characterized by a strong capture-based Atlantic bluefin tuna fattening which presented 63% of the total value and 34% of the total volume of 2,916 tonnes in 2010. Gilthead Sea bream and European sea bass contributed with around 60% and 3.5% to the total production by volume, respectively.

The industry comprises 6 companies. Most juveniles for sea bream and sea bass are imported. Further growth is limited by finding suitable sheltered sites and by strong competition with tourism.

After a decline, marine aquaculture rose strongly since 2005, mainly due to increases in the sea bream production.

The marine finfish production is a very important segment in relation to agriculture.
The marine production contributed in 2010 with almost 140% to the available supply in the marine finfish segments which shows its importance to the outgoing trade. This is underlined by the positive value in the trade balances for marine fisheries products. From 2005 on, the share of the marine aquaculture on the available supply decreased strongly, but seems to stabilise since 2008.
Some 200 persons were employed in 2010 according the modelled employment. The employment ratio shows the relatively high contribution of the marine aquaculture to the employment when compared to the EU ratio for the segment.

Apparent per capita consumption is higher than EU average for marine finfish and shellfish products.
Very much in line with the dominant role of the sea bass and sea bream production, there is a higher demand of fishmeal (around 548 kg/t finfish) but a lower demand for fish oil (around 226 kg/t finfish) than the EU level for the marine segment. The use amounted in 2010 to around 1,600 tonnes of fishmeal and 660 tonnes of fish oil.
In absolute terms, the effluents were in 2010 around 250 tonnes of N and 37 tonnes of P. Per tonne of fish produced the effluents are with around 84 kg N and 13 kg P above the EU level in the segment.

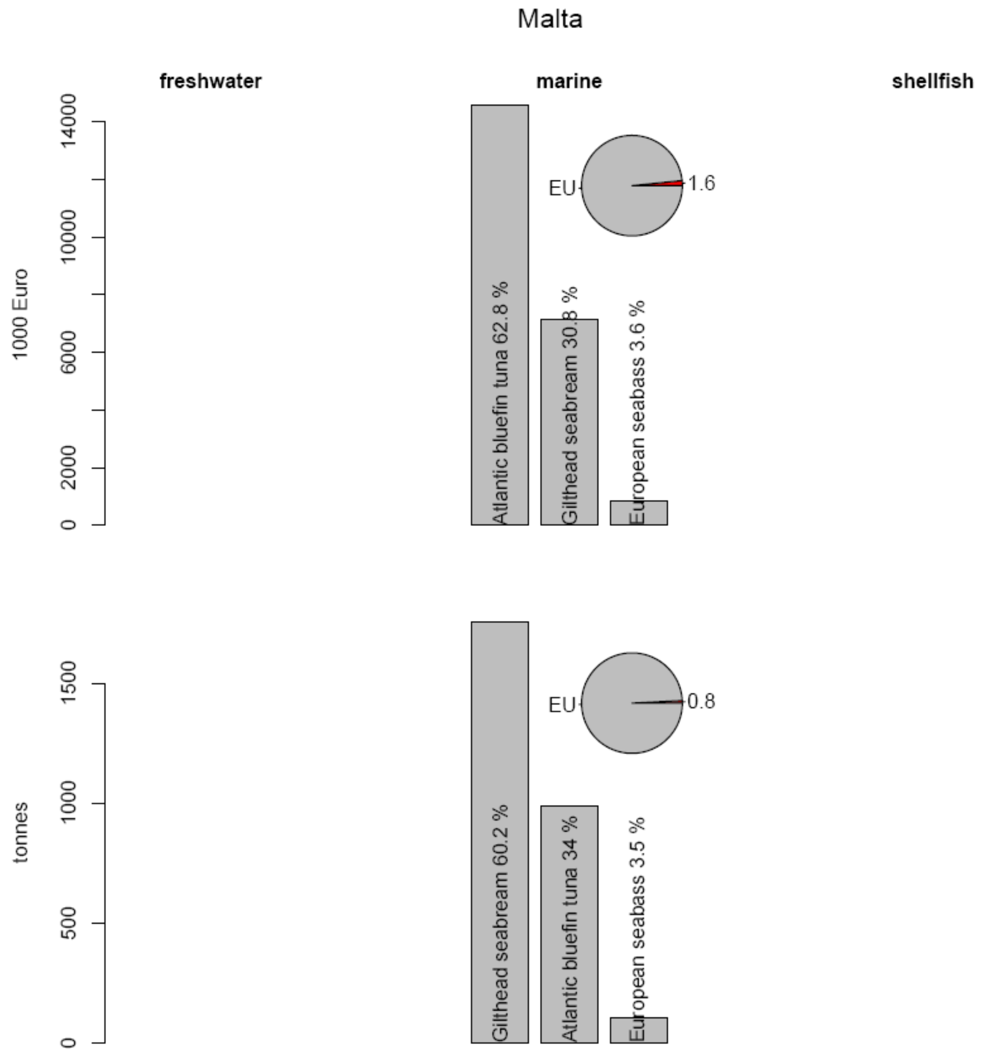


Figure 157 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the marine finfish segment.

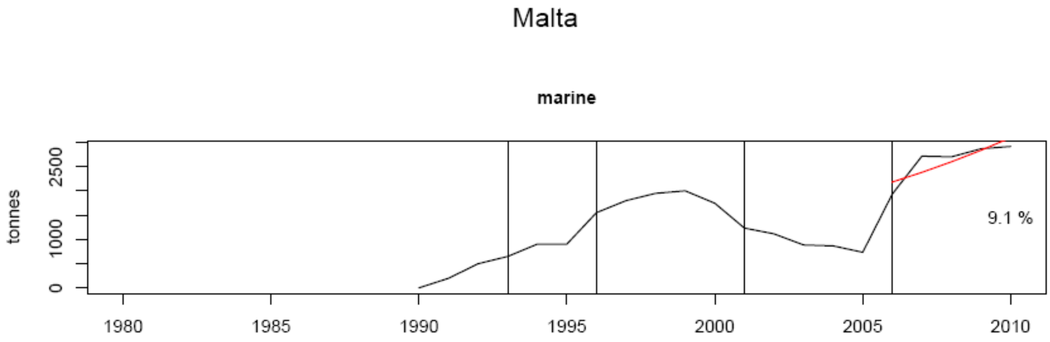


Figure 158 Production growth: Production pattern of the marine finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

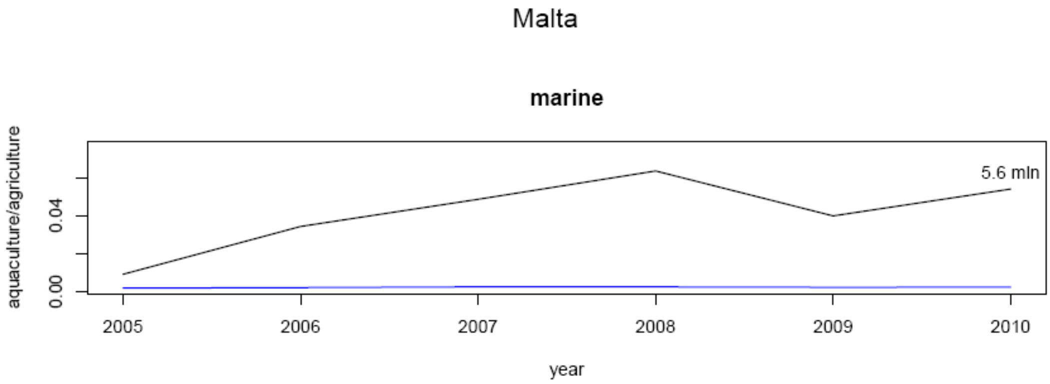


Figure 159 GVA: Economic importance of the output by the marine finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

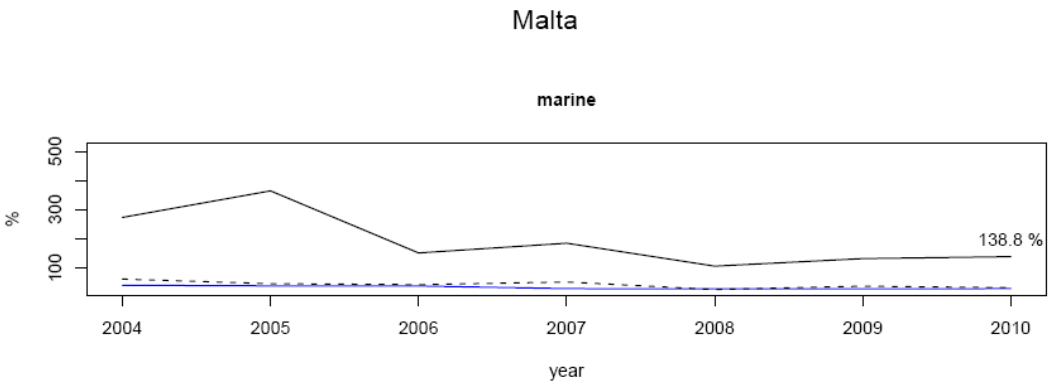


Figure 160 Self-sufficiency and trade: Share of marine finfish aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Malta, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

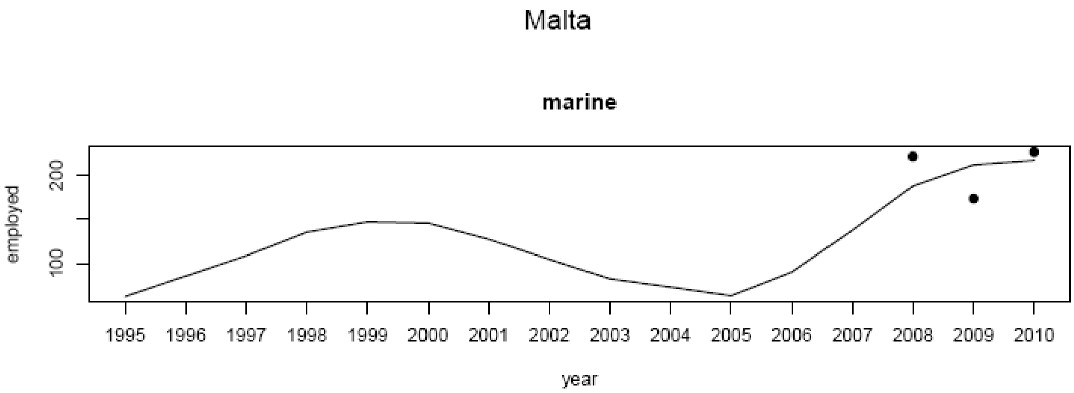


Figure 161 Number of employed persons in the marine segment in Malta over time. The trend line is derived from a country specific model using FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

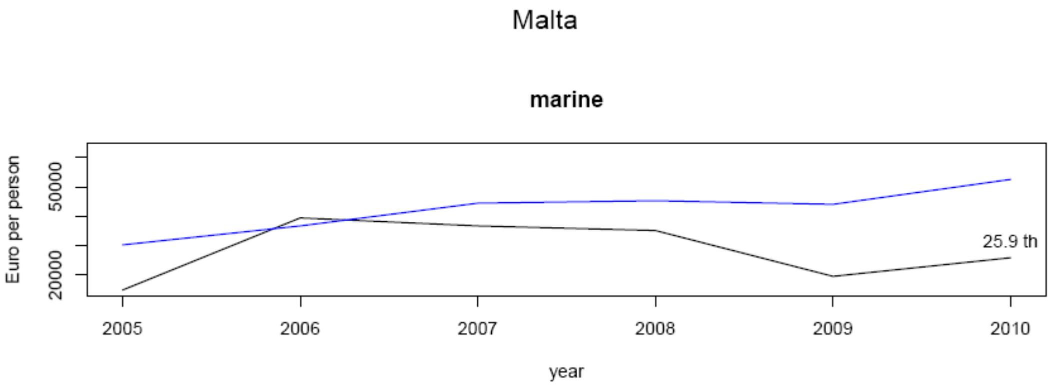


Figure 162 Labour Productivity: Ratio between employment and GVA for the marine segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

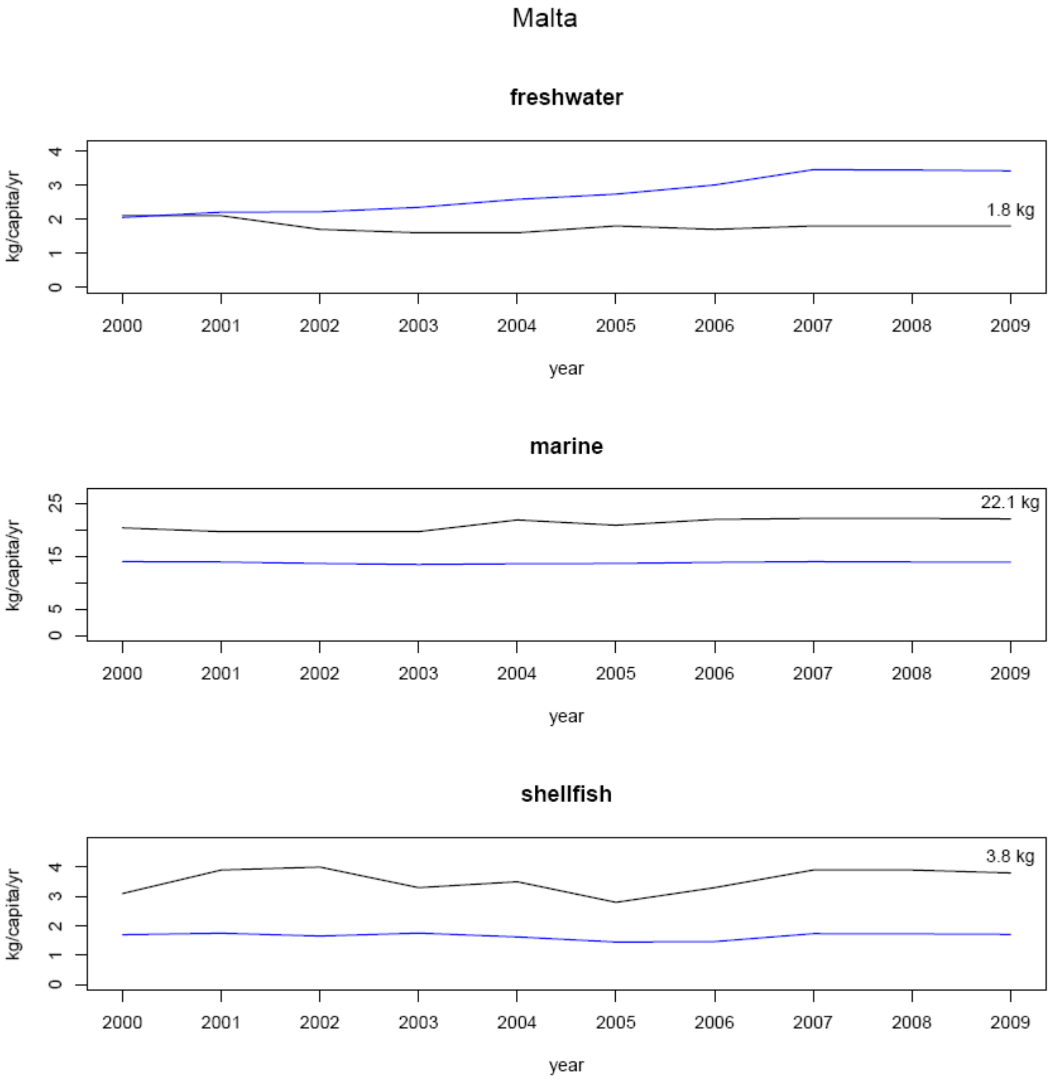


Figure 163 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

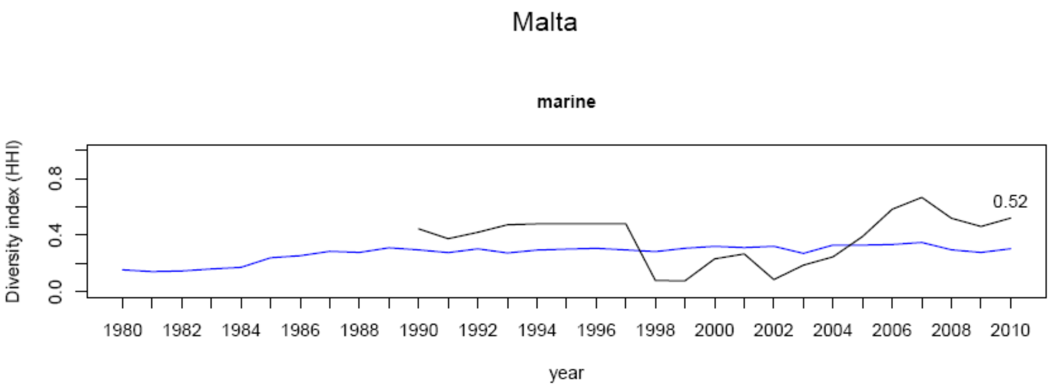


Figure 164 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.18. *Netherlands*

Highlights and trends

- Mainly freshwater and shellfish aquaculture and a small marine finfish production in full recirculation systems. Within the last five years the marine finfish and the shellfish segments experienced a positive trend for growth (2006-2010 +12% and + 38%, respectively)
- GVA is high in the shellfish segment
- High diversification of farmed freshwater species contributing to the production
- In absolute terms, employment is very limited with high labour productivity in the freshwater and shellfish segment
- Relative low demand of fish oil
- Effluent load from aquaculture is lower than EU average

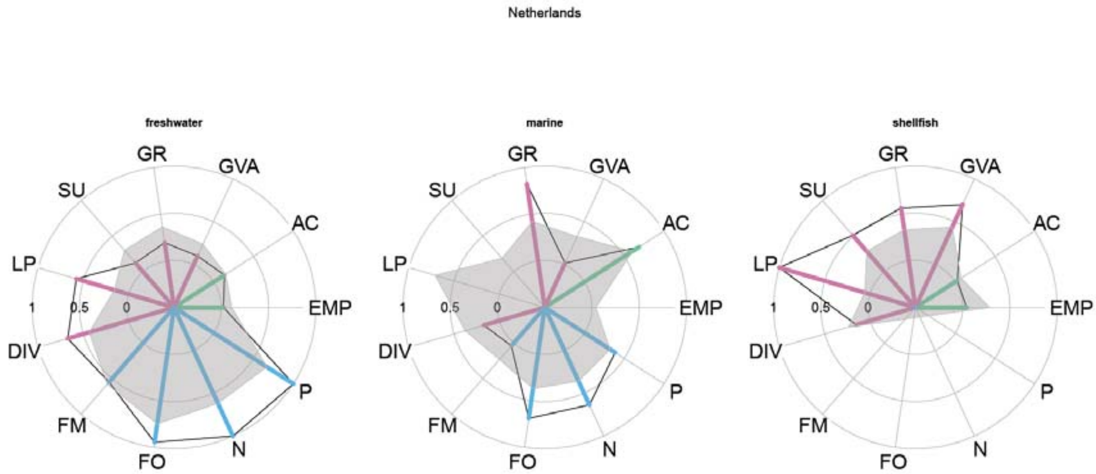


Figure 165 Performance indicators for the Netherlands

Overview of the sector

In the Dutch aquaculture sector shellfish production presents with some 60,000 tonnes in 2010 the strongest segment, contributing 8.1% by turnover and 9.6 % by volume to the EU shellfish output. The main species by volume are blue mussel (93%) and oyster (around 7%), mostly in bottom growing systems. The freshwater production of almost 6,500 tonnes presents a share of 4.1% by value to this segment in the European Union and is mainly carried out in recirculation systems. The most common cultured species are European eel (81% by turnover, 46% by volume), North African catfish (11% by turnover, 50% by volume), tilapia and pike perch. The production of turbot (around 93%) and soles (around 7%) in recirculation systems makes up the small marine finfish aquaculture segment (around 270 tonnes in 2010).

The sector comprises around 100 finfish and 80 shellfish enterprises. 30-50% of the eel and catfish farms produce fish as a side activity. Some farmers have specialized in ornamental fish production and in stocking for sport fisheries.

The freshwater finfish segment shows after a peak in 2007 a clear downward trend in production of -11%. The shellfish production rose in the last five years from a low in 2006 with a trend of +12%. The marine finfish aquaculture had after the start of production in recirculation systems in 1996 a strong upward trend (+28% in the last five years).

Except of the shellfish production, aquaculture has only a small contribution as regards GVA.
The shellfish production contributed in 2010 with almost 160% to the available supply in that segment which shows its importance to the outgoing trade. This is underlined by the positive value in the trade balances for shellfish products. From 2005 on, the share of the shellfish aquaculture on the available supply decreased strongly, but seems to regain grounds since 2008.
The employment ratio in all three segments is well below the EU ratio. According to the model, over the last 15 years the freshwater segments increased the employment continuously to around 140 persons in 2010, while the shellfish segment provided over the time less job opportunities (estimated around 260 persons in 2010). The marine finfish segment seems to provide very little employment.
Apparent per capita consumption rose from 1990 to 2009 in the marine finfish segments from 5 to 15.8 kg, in freshwater products it increased to 3.1 kg, while in shellfish products it fell from 4 to 0.6 kg.
In 2010, more than 90% of the around 2,200 tonnes of fishmeal used in aquaculture went into freshwater production. For producing one tonne of finfish, the freshwater segment is estimated to demand 306 kg fishmeal and 24 kg of fish oil, while the marine segment needs 615 kg of fishmeal and 123 kg of fish oil. The amount of fishmeal needed per tonne finfish produced is at EU level for the freshwater segment but above for the marine segment. The fish oil demand per tonne of fish produced is in both segments very much below Union as a whole.
N and P effluents per tonne finfish produced are in both segments below Union level, with very low effluents in the marine finfish segment (44 kg N/t and 10kgP/t). For 2010, in total effluents of around 76 tonnes of N and 16 tonnes of P were calculates for the freshwater and marine finfish environment together.

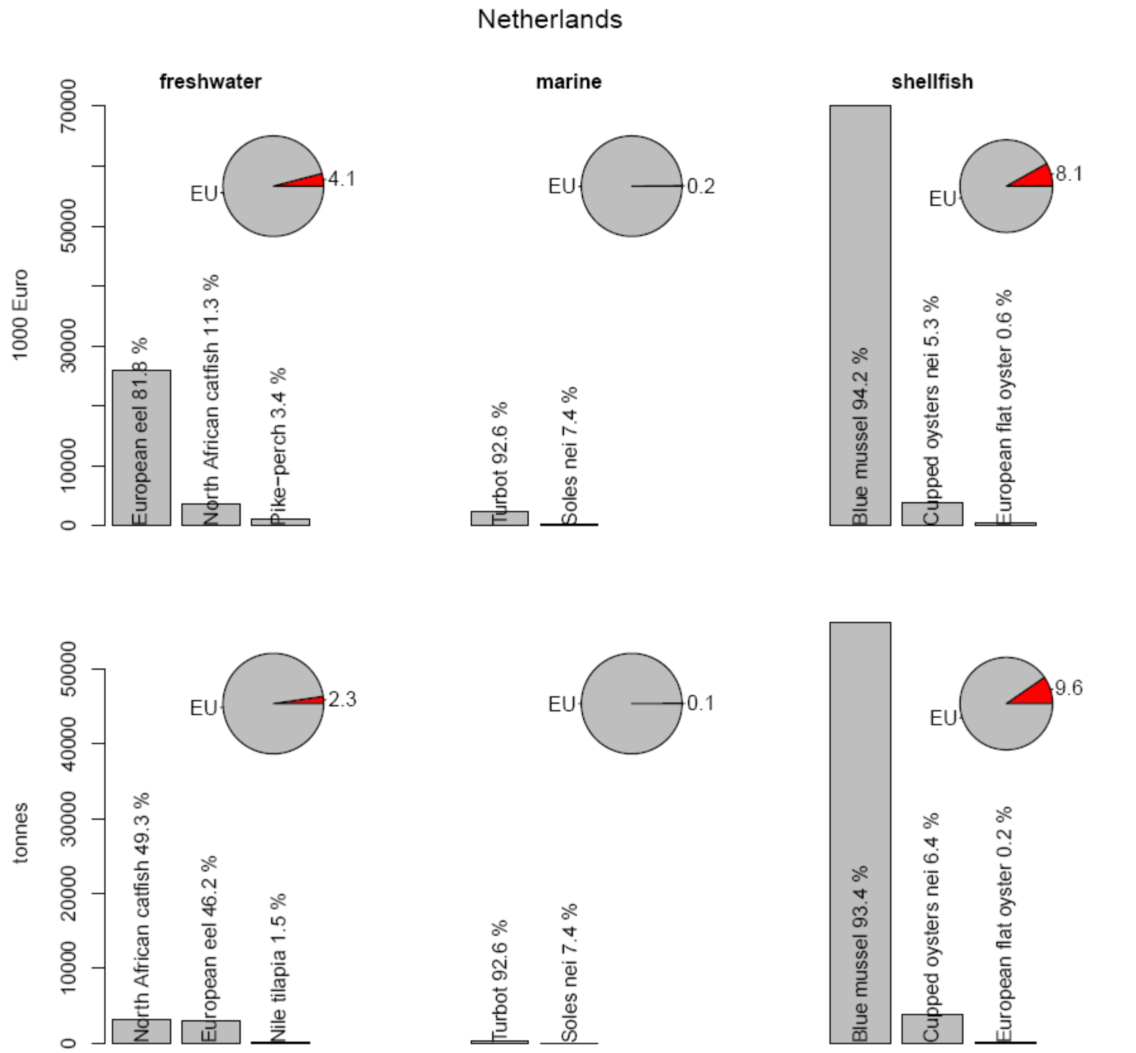


Figure 166 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

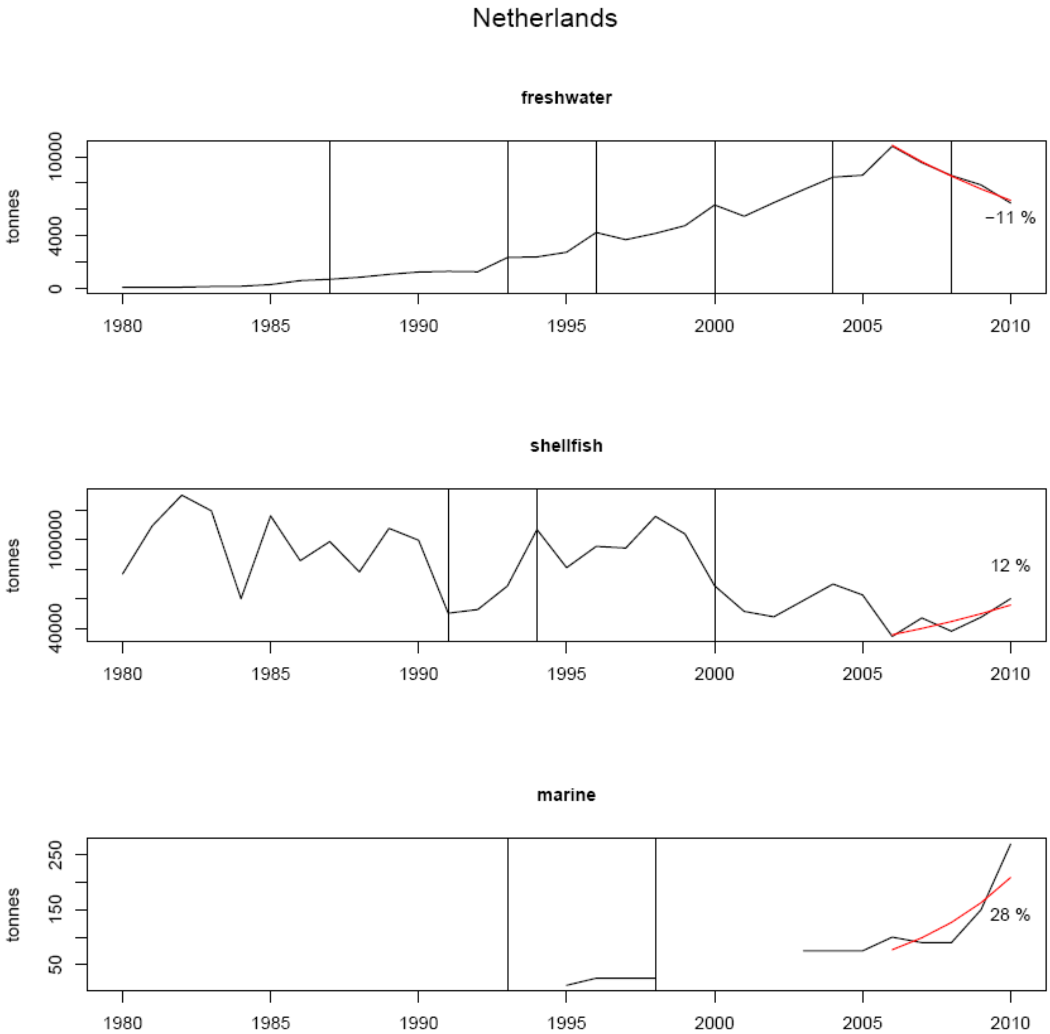


Figure 167 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last three five years (2006-2010).

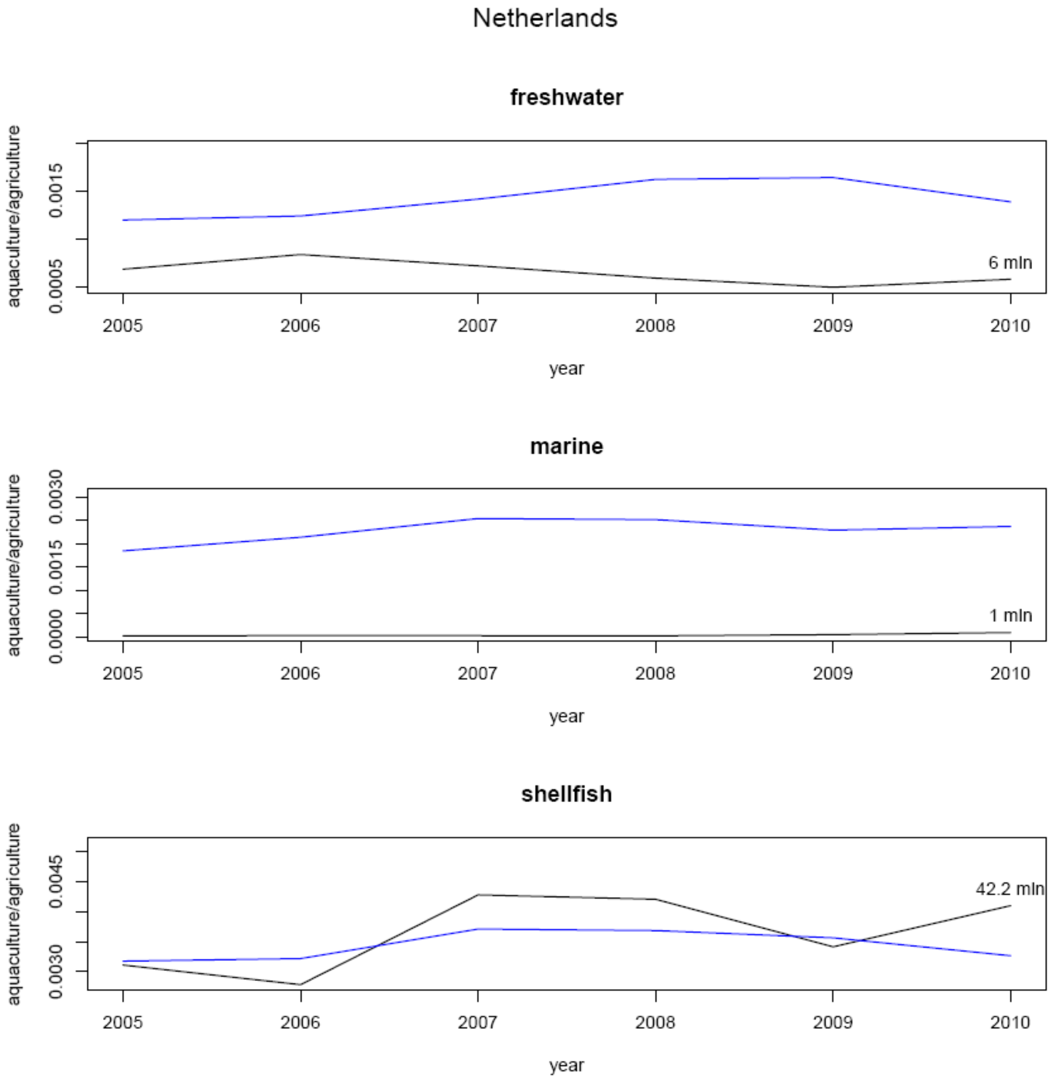


Figure 168 GVA: Economic importance of the output by the three segmentst over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

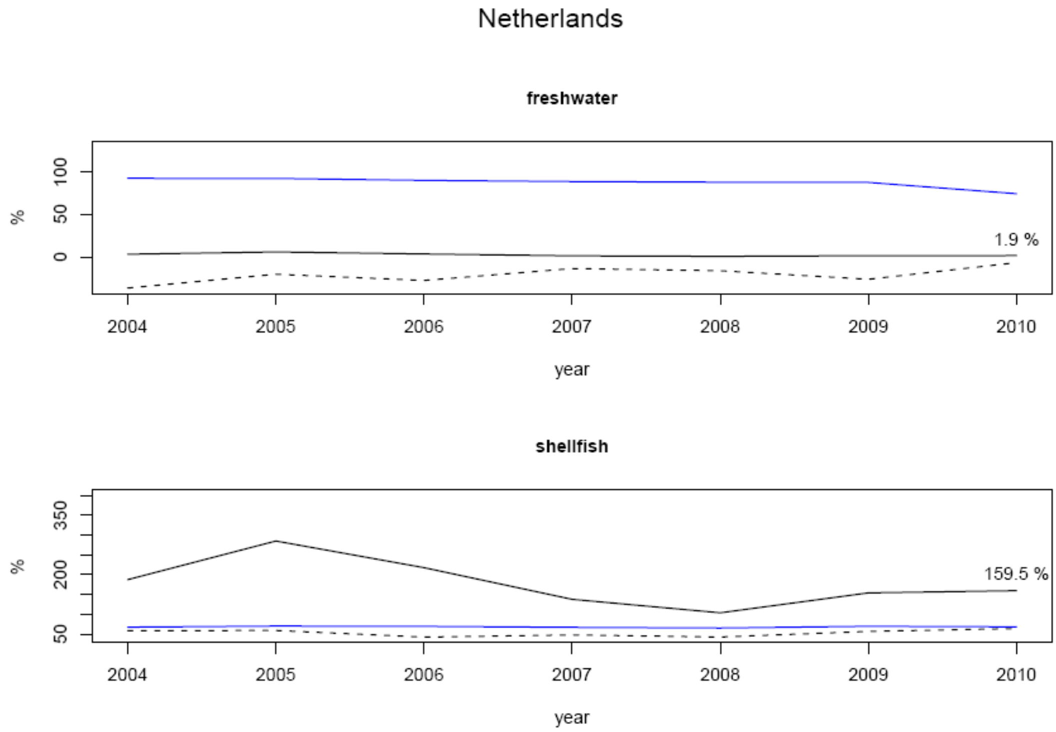


Figure 169 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of the Netherlands, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

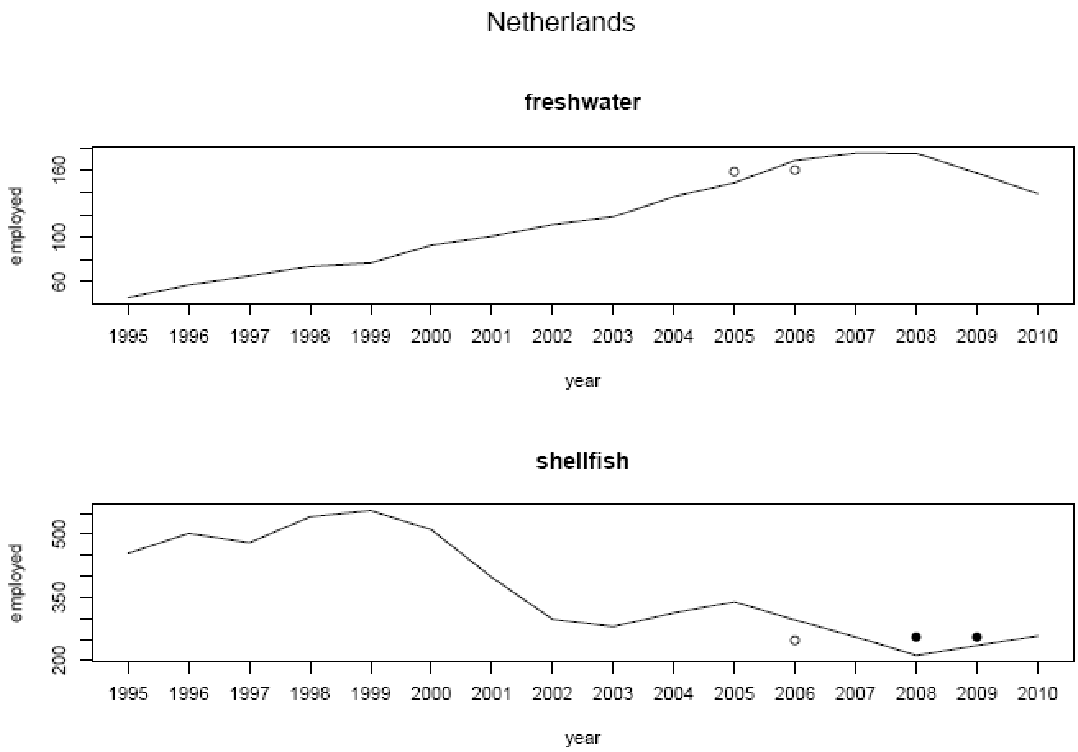


Figure 170 Number of employed persons in the freshwater and shellfish segments in the Netherlands over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

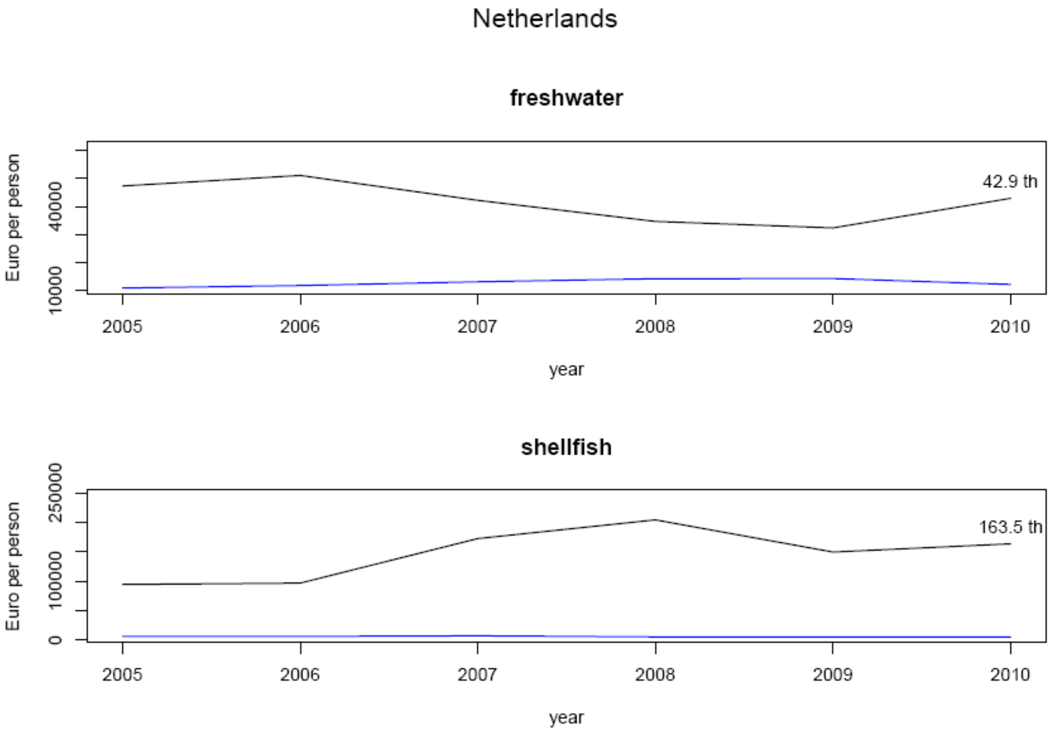


Figure 171 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

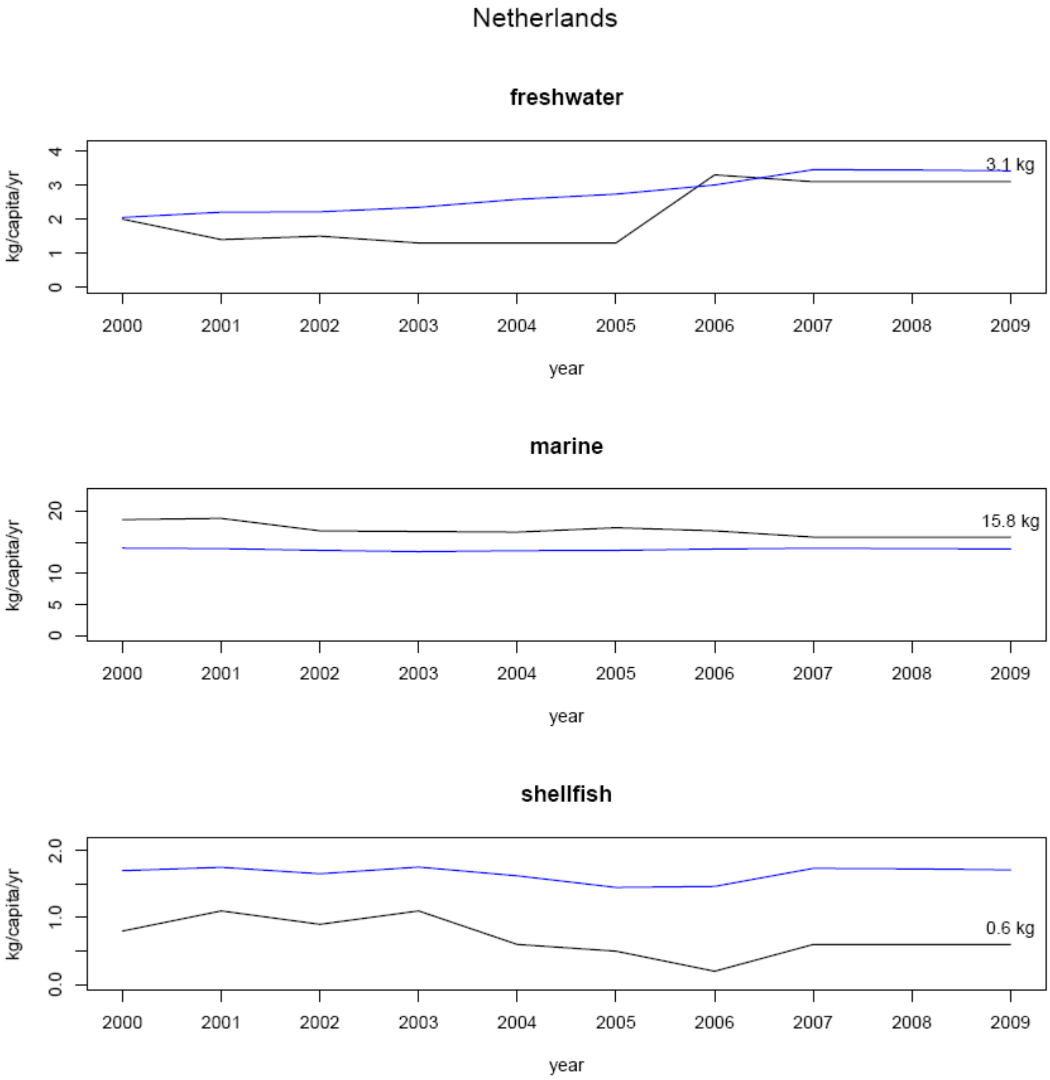


Figure 172 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

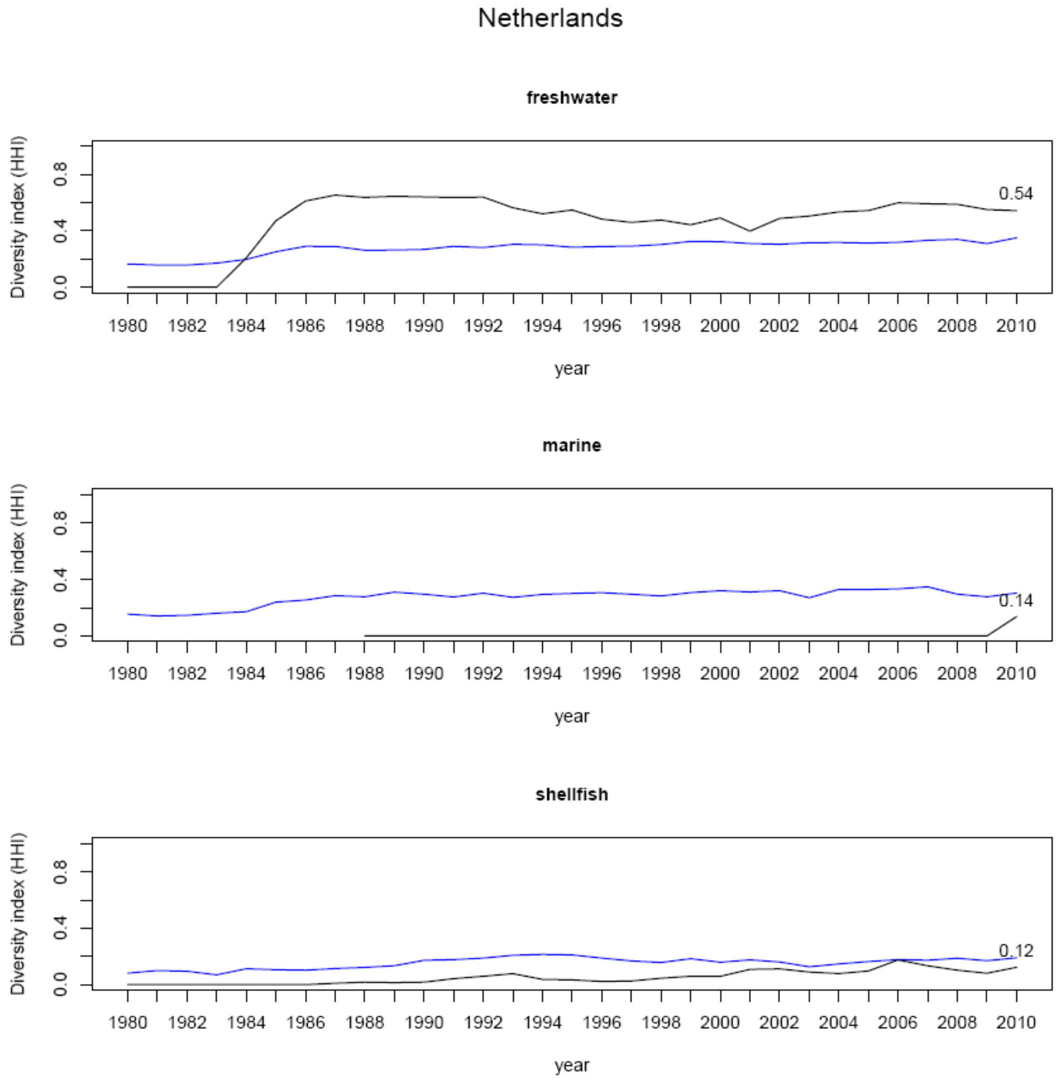


Figure 173 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.19. *Poland*

Highlights and trends

- Traditional freshwater aquaculture with a slightly negative trend for growth within the last five years (2006-2010 -2.8%)
- Small entities, often in part-time or combined with non-production oriented activities, serving mainly the local market
- GVA is high
- High diversification of farmed freshwater species contributing to the production
- Employment is increasing, being clearly above EU average with a low labour productivity
- Apparent consumption of fisheries products is low
- Relative low demand of fishmeal / fish oil
- Effluent load from aquaculture is lower than EU average

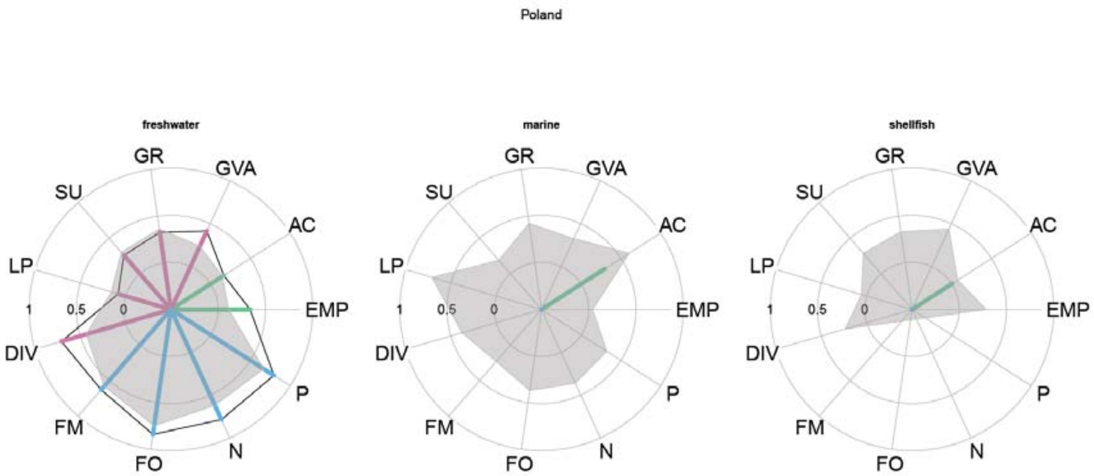


Figure 174 Performance indicators for Poland

Overview of the sector

The Polish aquaculture consists of land-based freshwater farms. Marine finfish and shellfish farming does not take place. The freshwater segment presented in 2010 with almost 31,000 tonnes almost 9% of the EU freshwater aquaculture by turnover and some 11% by volume. Traditional carp farming in ponds account for 50% of the production volume, the intensive trout farming in ponds, raceways and recirculation systems for around 42%. A number of other species form the rest, such as torpedo shaped catfish, other carp species, tench, pike, sturgeon, pikeperch, Atlantic salmon. Most aquaculture farms produce more than one species. The production of the additional fish species is driven by the need to diversify production to reduce the problems with sales, especially of carp. To reassert carp's position in the internal market promotional carp consumption campaigns were conducted in the years 2005-2009.

In addition to the production of fish for the food market, the sector produces juveniles of some 26 species for restocking in open waters. Some of the restocking is driven by the preferences of the Polish Angling Association and other leaseholders.

In 2009, there were 1,077 aquaculture entities in Poland, about half of them small and medium sized companies or family enterprises. Many farms were turned into

multifunctional pond fish farms, which offer also services in recreation, maintaining biodiversity and improving water management.
After a continuous increase of production, the trend of the last five years is slightly negative (-2.8%).

The freshwater aquaculture has some importance in relation to the national agriculture production.
The freshwater aquaculture contributed in 2010 with some 57% to the available supply in that segment. Its share was relatively constant since 2004 before it started to decrease in 2008. In a similar pattern the positive trade balances for fisheries products fell from 2008 to 2010 to a value close to a balanced level.
From the few data available, the modeled employment ratio indicates over the last 15 years an upward trend with a strong increase until 2005 and a moderate increase since then with an estimate of almost 4,000 persons employed in 2010.
Apparent consumption is well below EU average with little variation over the years for marine finfish and shellfish products. For freshwater finfish, consumption rose since 2005 to 3.8kg in 2009.
With the strong carp production the demand for fishmeal and fish oil is below the EU level per tonne fish produced (around 258 kg fishmeal and 64 kg fish oil). In absolute terms, the sector demanded some 8,000 tonnes fishmeal and 2,000 tonnes of fish oil in 2010.
Effluents of N and P per tonne fish produced are lower than in the overall EU freshwater production (around 30 kg N, around 5 kg P). The total effluents for 2010 were estimated to be about 920 tonnes of N and 150 tonnes of P.

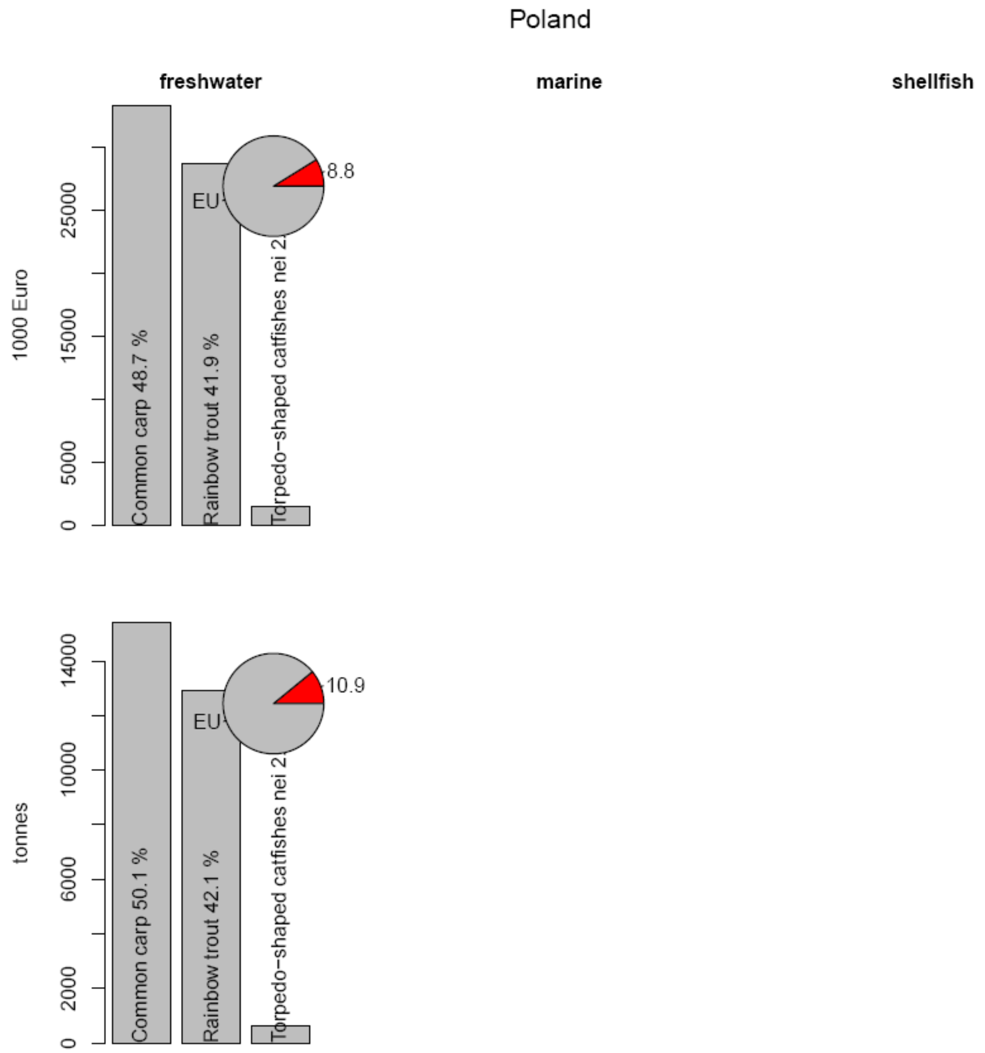


Figure 175 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

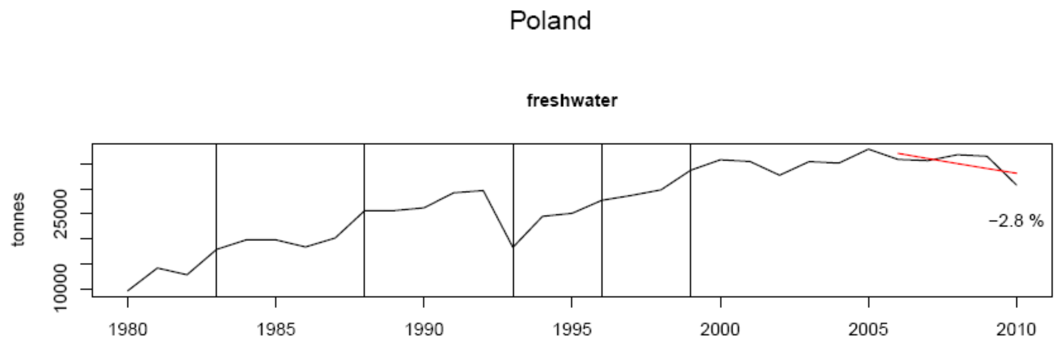


Figure 176 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

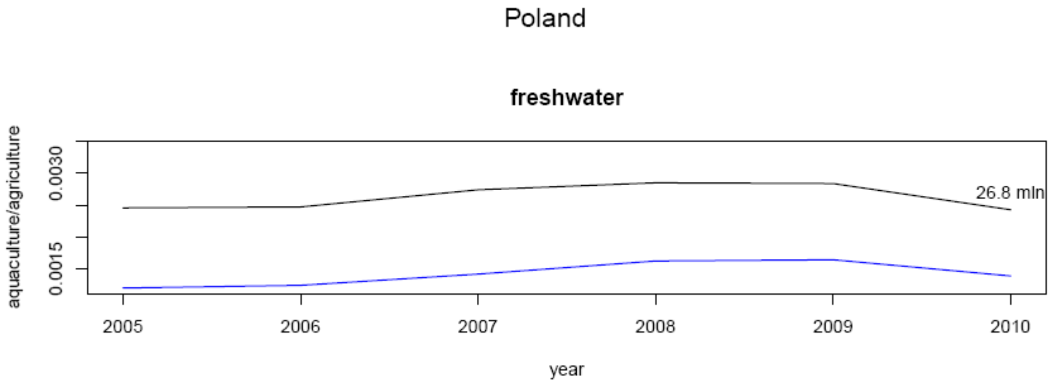


Figure 177 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

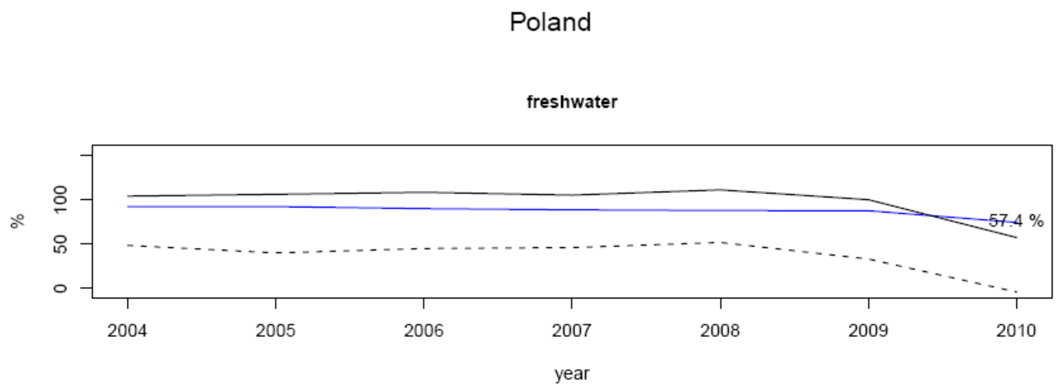


Figure 178 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Poland, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

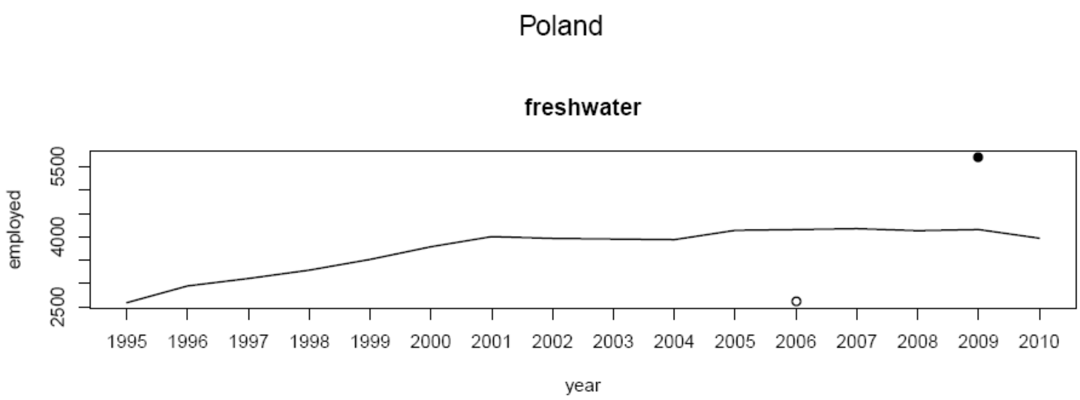


Figure 179 Number of employed persons in the freshwater segment in Poland over time. The trend line is derived from a country specific model based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

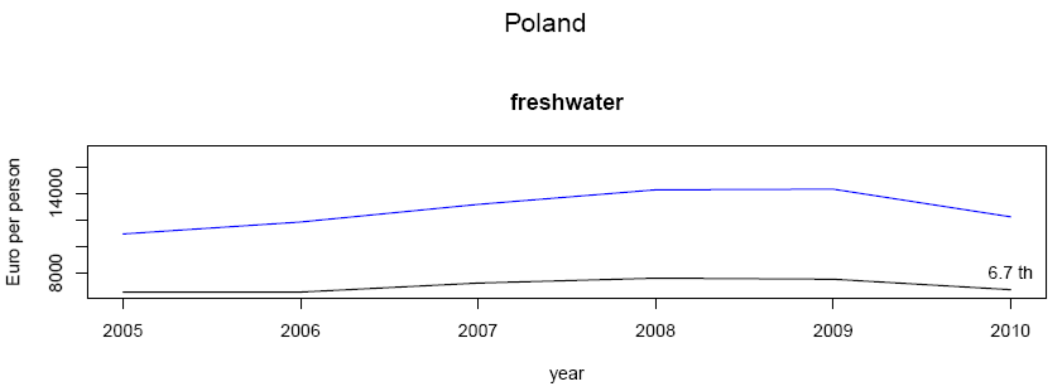


Figure 180 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

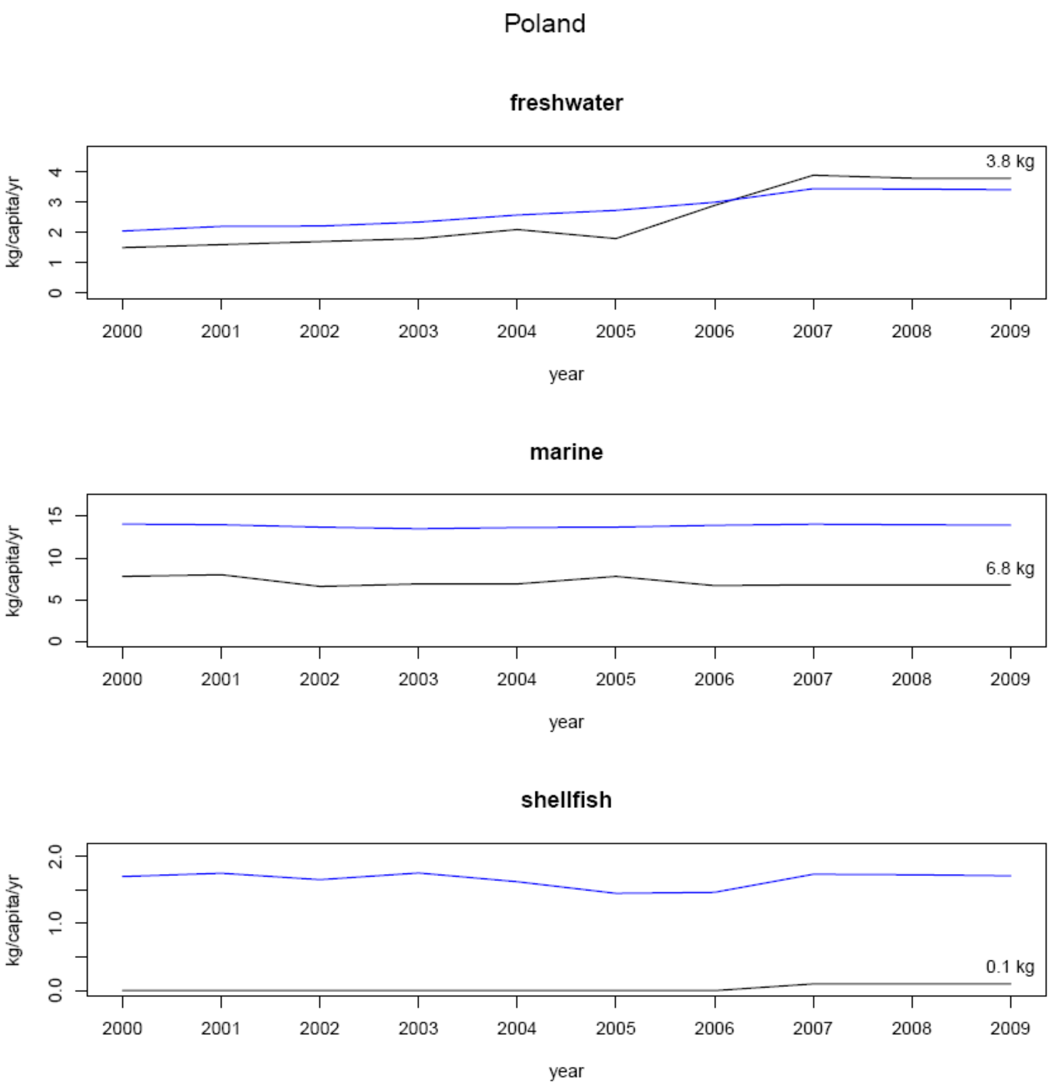


Figure 181 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

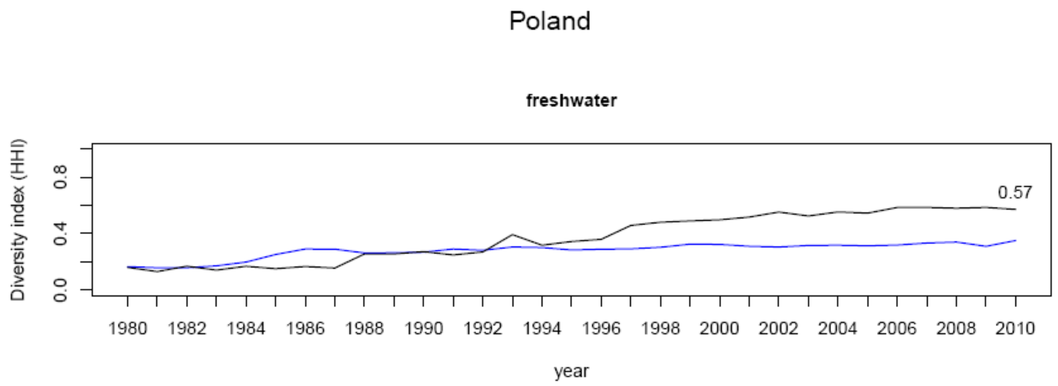


Figure 182 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.20. Portugal

Highlights and trends

- Small marine finfish and shellfish aquaculture. Within the last five years, production in the marine finfish and the shellfish segments experienced a strong negative trend (2006-2010 -8.9% and -23%, respectively). The freshwater aquaculture seems to have disappeared.
- High diversification of farmed species contributing to the production
- Employment in the marine finfish segment follows the decline of production, in the shellfish segment employment was until 2009 increasing
- Highest apparent consumption of fisheries products within the Union
- Relative low demand of fish oil
- Effluent load from aquaculture is lower than EU average

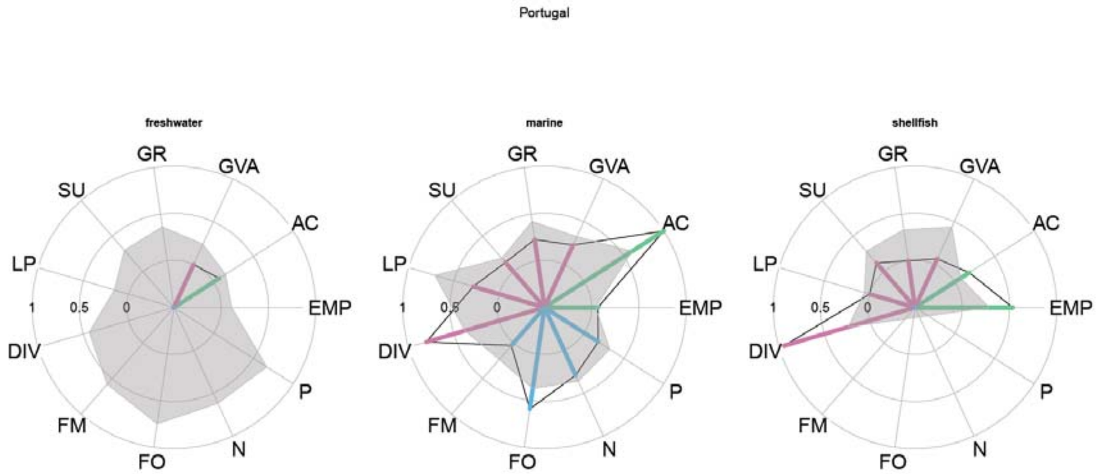


Figure 183 Performance indicators for Portugal

Overview of the sector

The Portuguese shellfish production account for about 30 % and the marine finfish segments for about 70% of the total national aquaculture production with almost 3,200 tonnes in 2010, contributing 1% and 0.3% to the corresponding segment in the Union by turnover. The production in brackish and marine environment consists mainly of grooved carpet shell, oyster subspecies, turbot, Gilthead sea bream and European sea bass. The freshwater segment is very small, mainly producing rainbow trout.

The aquaculture producers are mostly small familiar units. Of the 1,454 entities most (92%) are growing shellfish in extensive bottom culture, 2% culture marine finfish in off-shore sea cages and 6% in ponds, tanks, raceways or recirculation systems.

The freshwater aquaculture experiences since 2007 a strong downward trend with no reported production in 2010. Also the other two segments show a clear decrease, shellfish with a trend since 2006 of -23% and marine finfish of -8.9%.

Aquaculture has only a small and decreasing contribution as regards the GVA.
Aquaculture contributes little to the available supply of fisheries products.
In marine finfish and shellfish aquaculture the actual employment ratios are well above the EU ratio, but following the decline in production. Employment in marine finfish aquaculture peaked a decade ago, showing since 2002 a slight downward trend with

some 225 persons employed in 2010. In shellfish aquaculture, employment rose until 2009, employing actually some estimated 1,860 persons.

Portugal accounts the highest apparent per capita consumption of marine finfish products, although experiencing a decrease from 54 to some 49 kg between 1990 and 2009. In the same period apparent consumption of shellfish products increased from 1 to 4.2 kg and freshwater products from 0.2 to 1.6 kg.

The marine finfish segment is characterised by a high demand of fishmeal per tonne fish produced (around 617 kg). The absolute demand in the marine segment was in 2010 some 1,400 tonnes of fishmeal and 360 tonnes of fish oil.

The effluents of N and P per tonne of finfish produced are slightly above EU level in marine production (76kgN/t and 13kgP/t), mainly due to the dominance of sea bream and sea bass. In absolute figures, the effluents in marine finfish aquaculture accounted for estimated 170 tonnes N and 30 tonnes P.

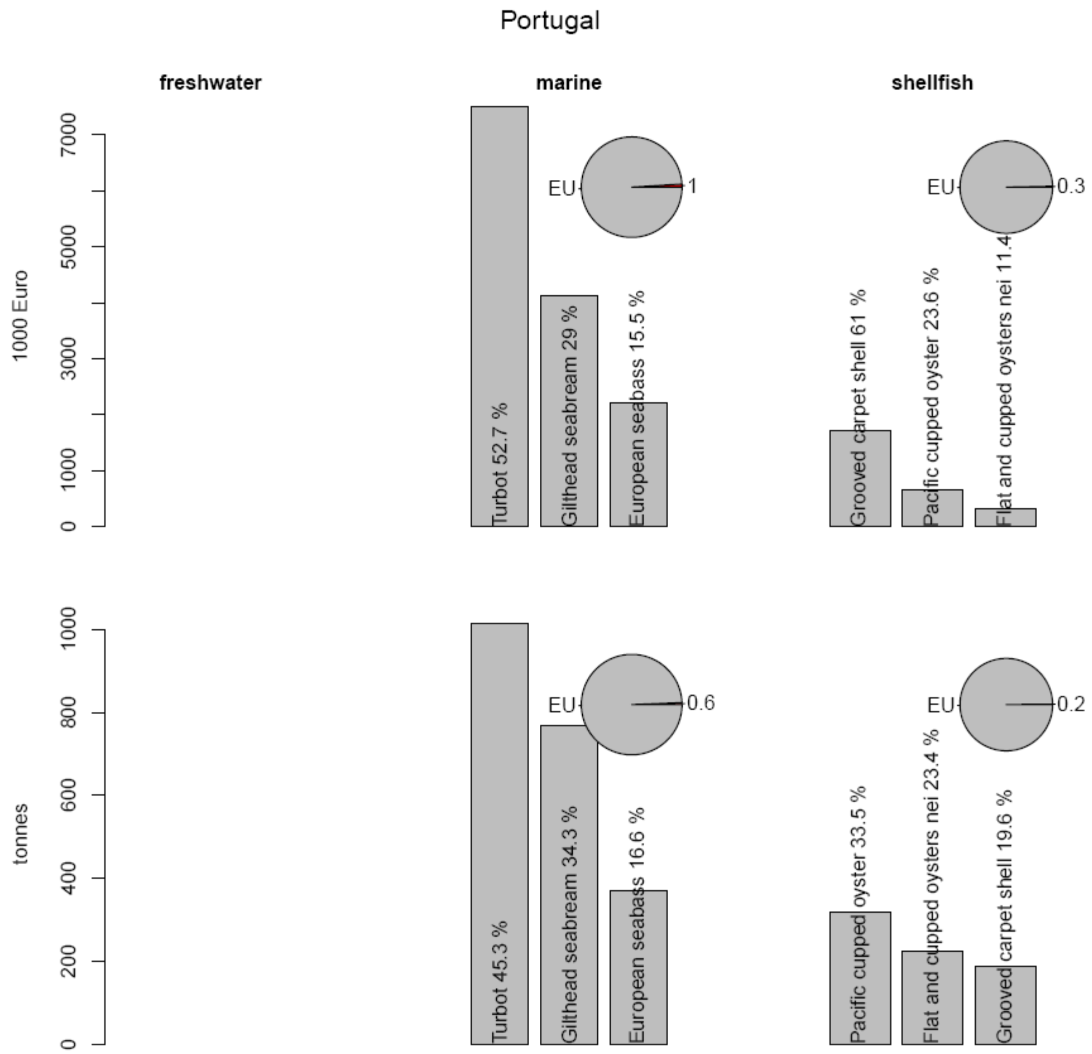


Figure 184 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

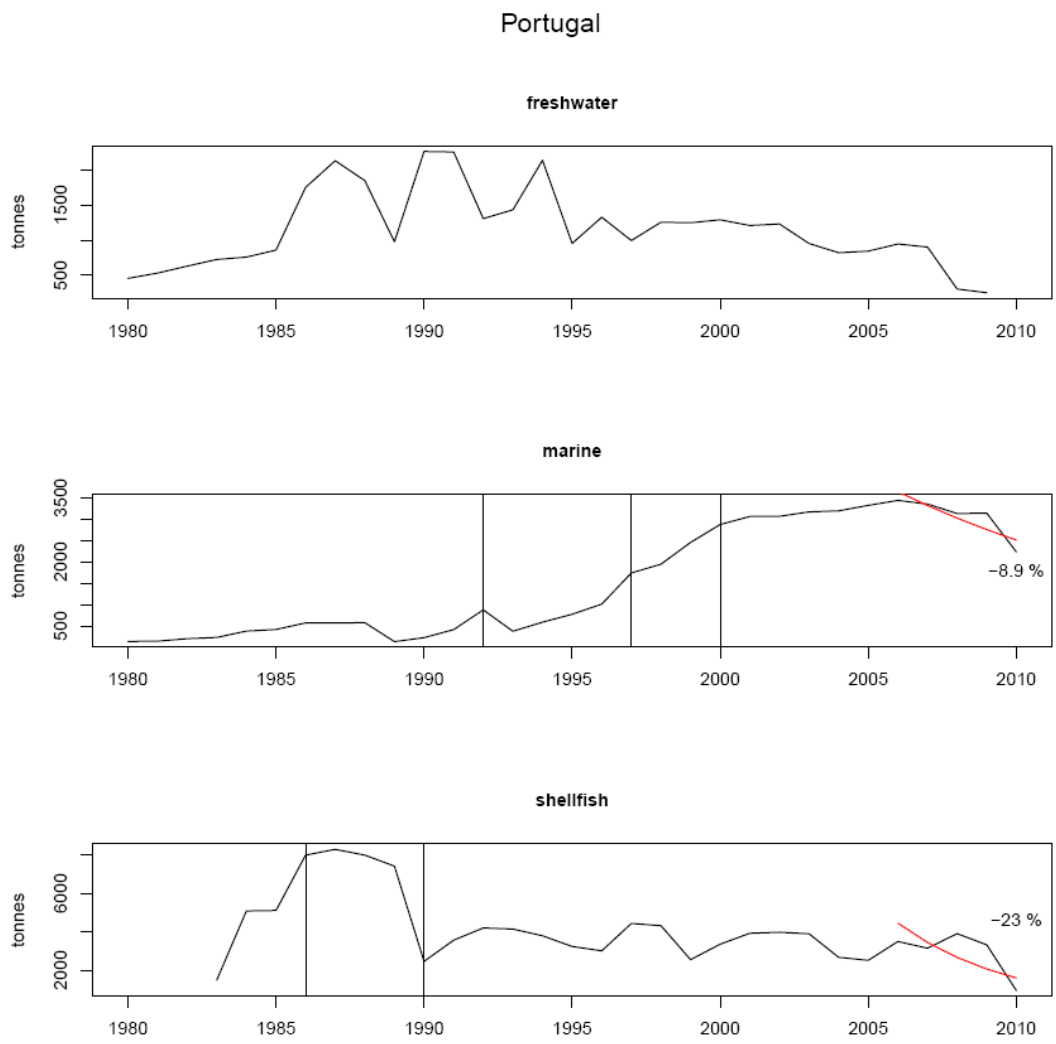


Figure 185 Production growth: Production pattern of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

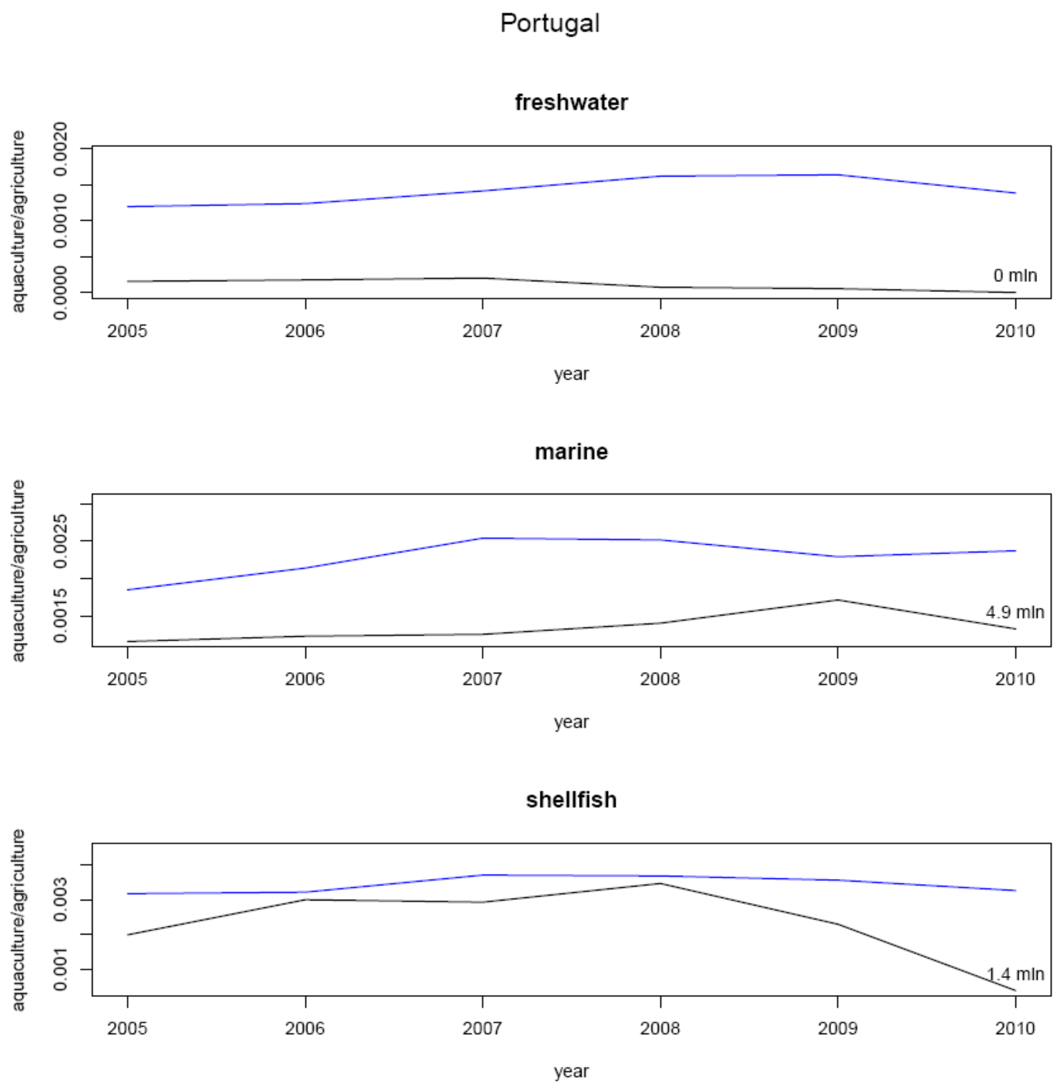


Figure 186 GVA: Economic importance of the output by the three segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

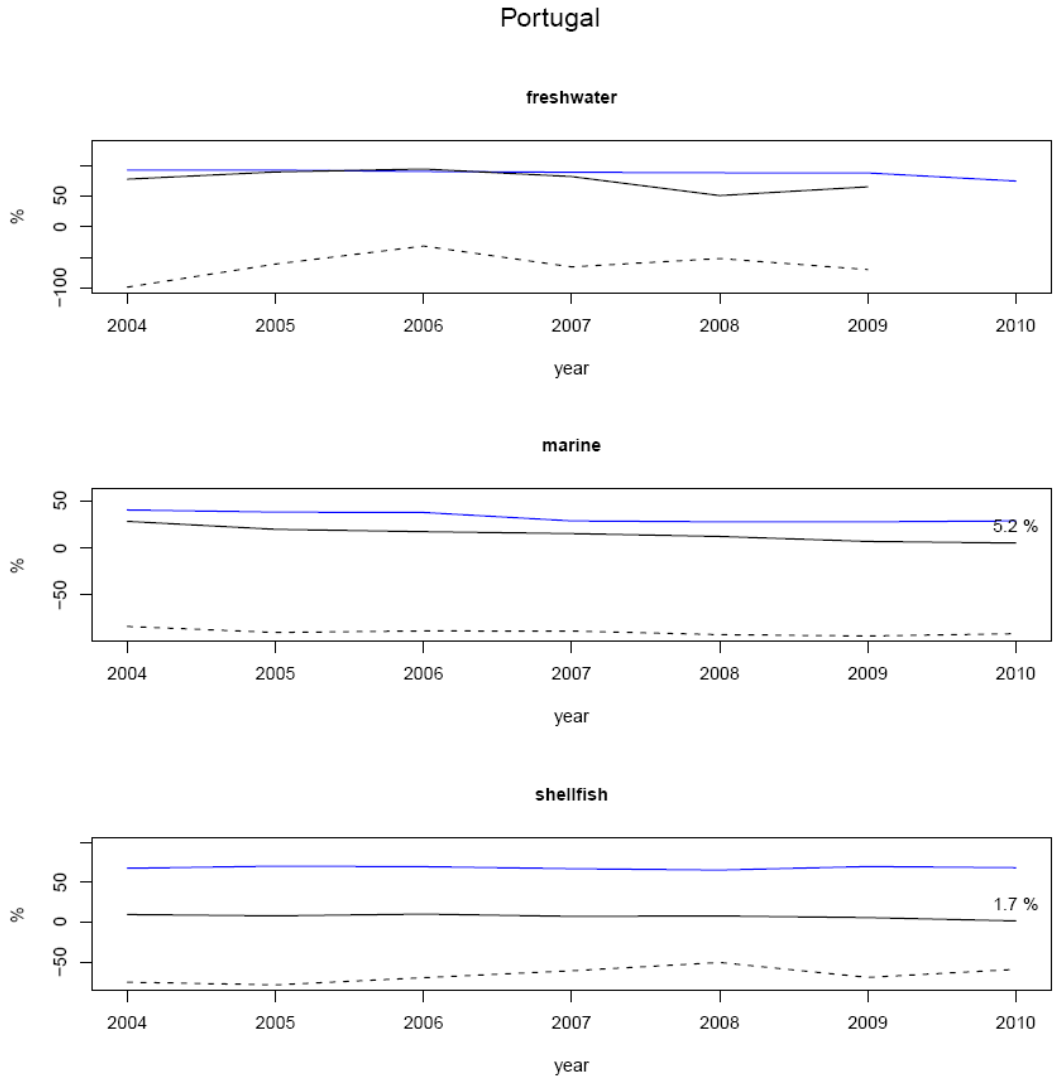


Figure 187 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Portugal, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

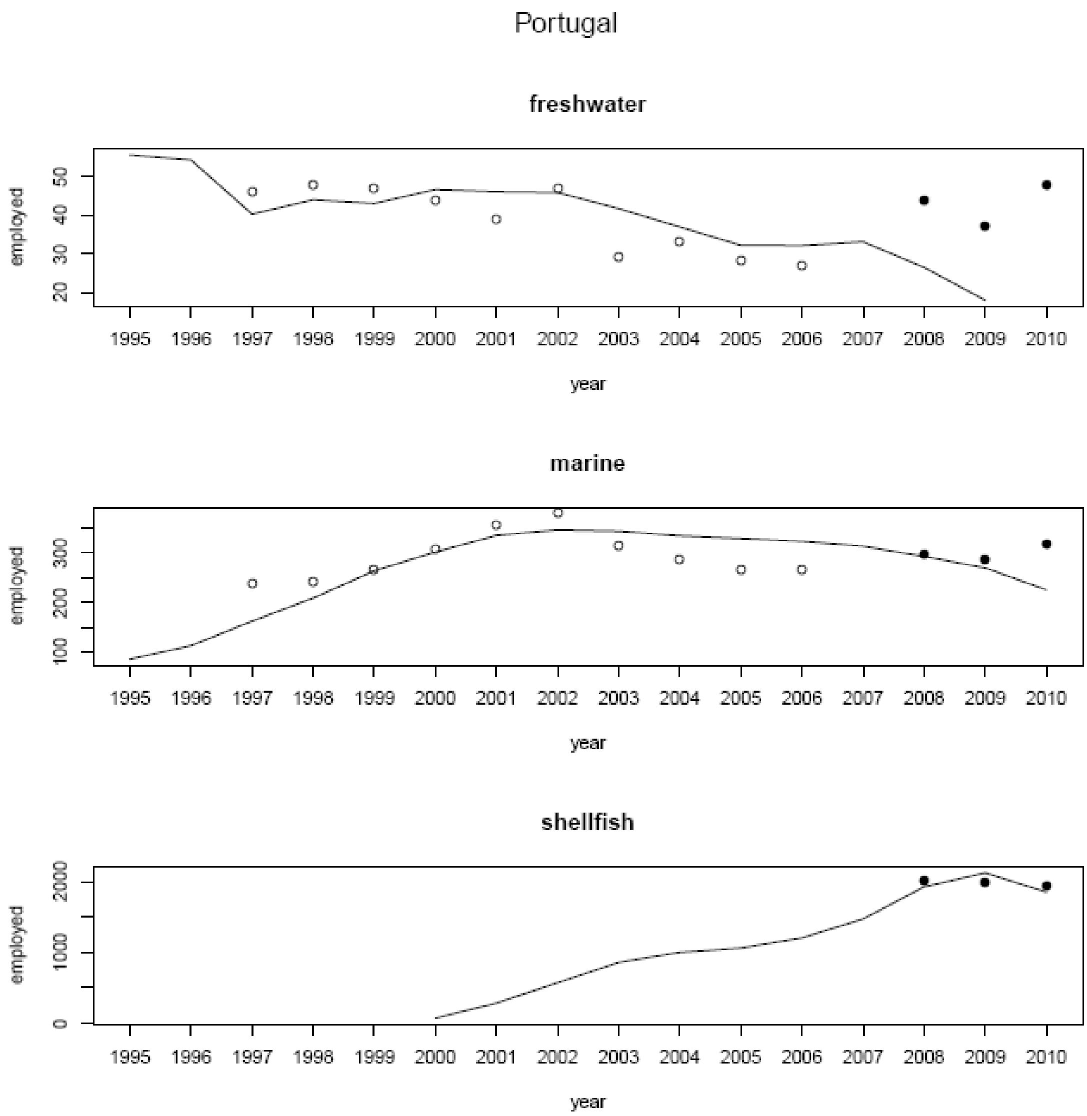


Figure 188 Number of employed persons in aquaculture in Portugal over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

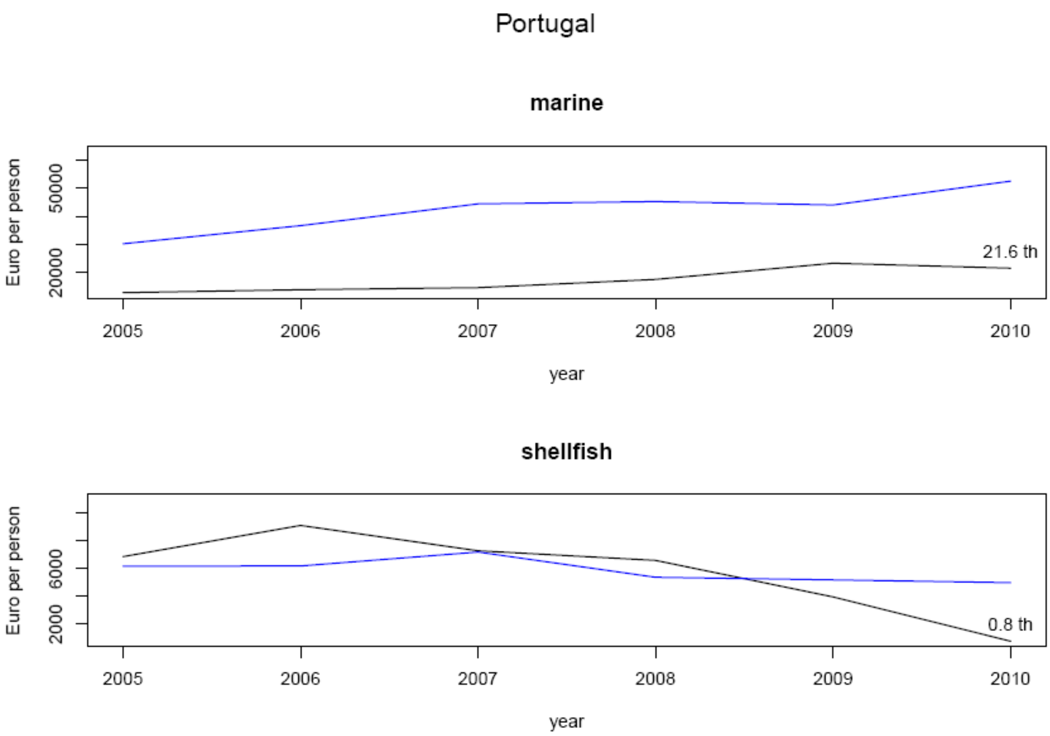


Figure 189 Labour Productivity: Ratio between employment and GVA for the marine and shellfish segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

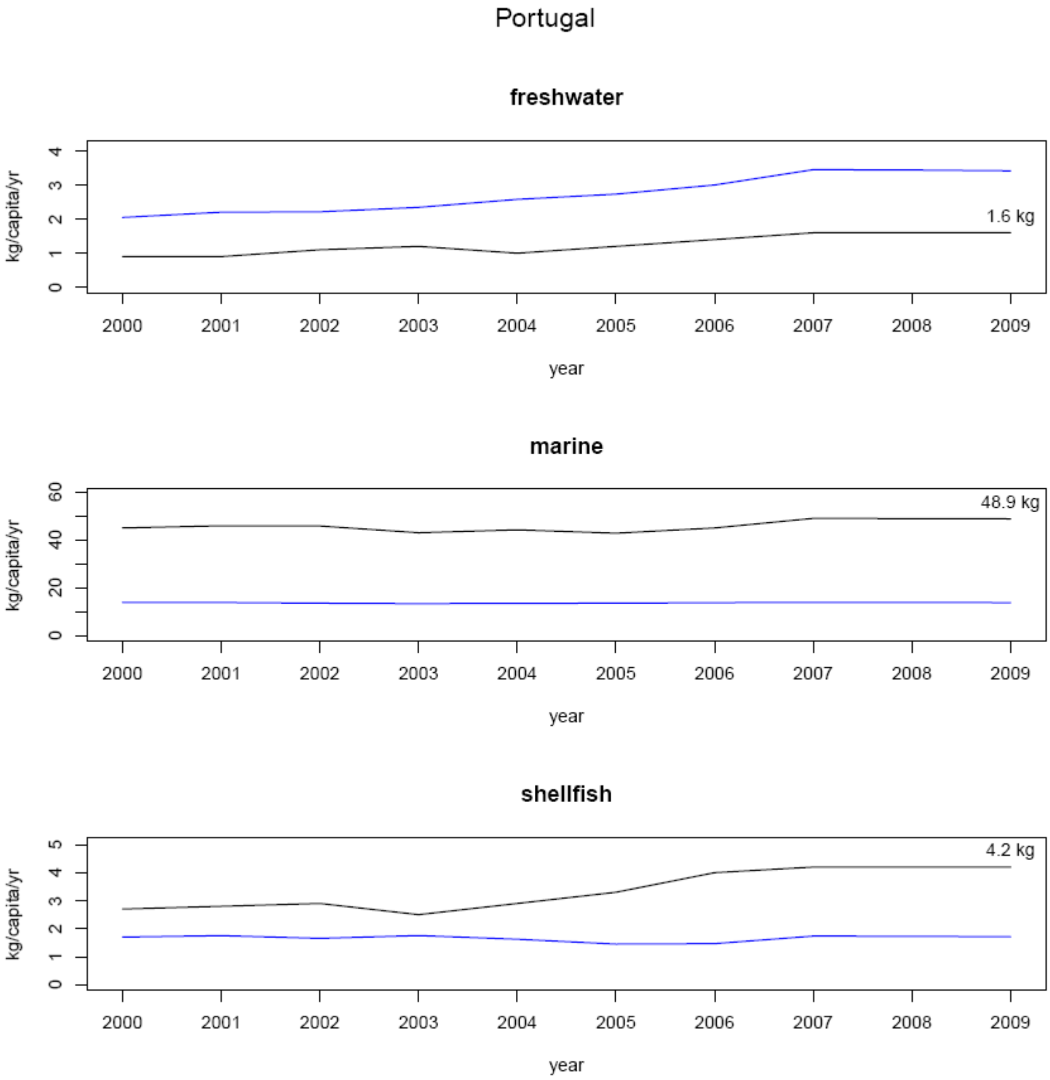


Figure 190 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

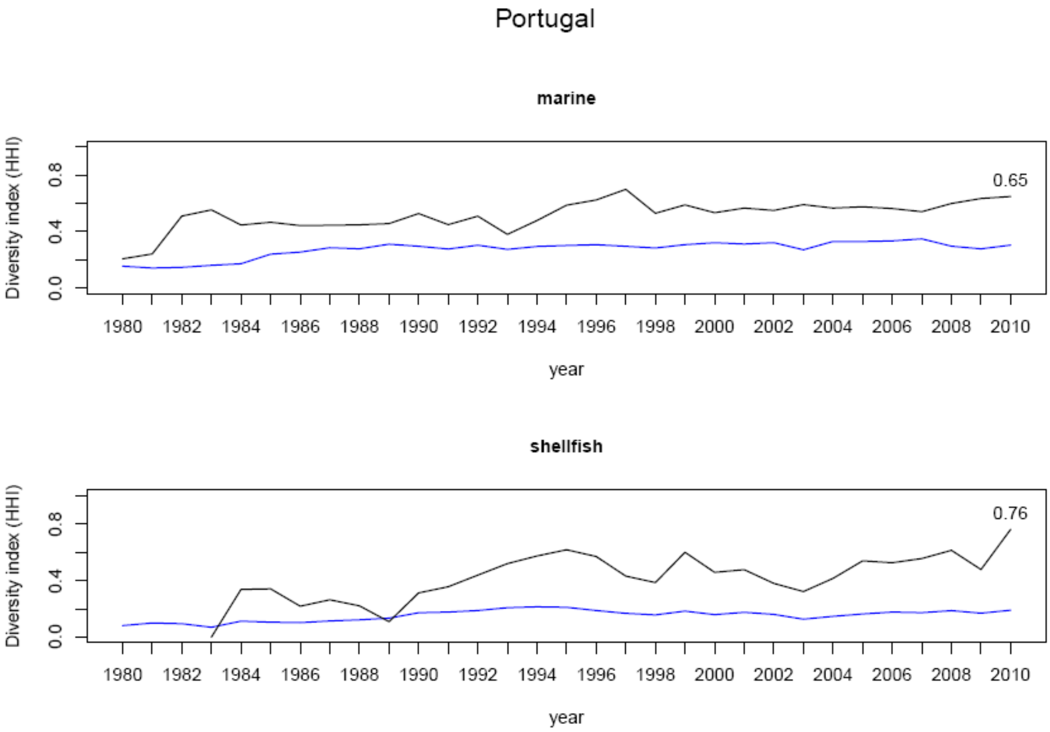


Figure 191 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.21. Romania

<u>Highlights and trends</u>

- Traditional freshwater aquaculture with a positive trend for growth within the last five years (2006-2010 +4.6%)
- Mainly small and medium size entities, often in part-time or combined with non-production oriented activities, serving mainly the local market
- High diversification of farmed freshwater species contributing to the production
- Employment is increasing over the last years, being clearly above EU average with a low labour productivity
- Apparent consumption of fisheries products is low
- Relative low demand of fishmeal / fish oil
- Effluent load from aquaculture is almost at EU average

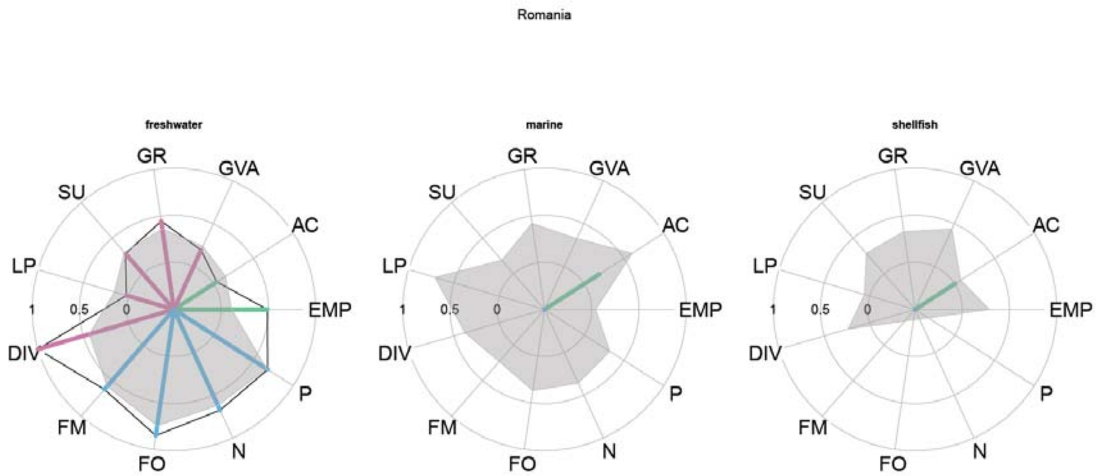


Figure 192 Performance indicators for Romania

<u>Overview of the sector</u>

The aquaculture consists of land-based freshwater farms contributing by nearly 70 % to the total fisheries activities in Romania. The segment presents with some 8,980 tonnes in 2010 around 2.6% by value and 3.2% by volume of the EU freshwater aquaculture. Traditional carp farming in ponds count for almost 2/3 of the production; trout, pike, perch, catfish, other cyprinids and sturgeon make up for the rest. Most of aquaculture farms produce more than one species.

From the 315 aquaculture entities most are small and medium sized companies or family enterprises. Some farms focus on recreational fisheries, while 80% of the 30 trout farms are state owned.
After a long decline, the overall freshwater production shows since 2006 an upward trend (+4.6%).

GVA from aquaculture was over the last years increasing.
Aquaculture production contributed in 2010 with around 67% to the available supply in the freshwater segments.
The modeled employment ratio is well above the EU ratio, estimating after a low in 2006 an increase in employment to around 3,230 persons in 2010.
Apparent per capita consumption of fisheries products is relatively low.

With the strong carp production the demand of fishmeal and fish oil is below to the Union level per tonne fish produced. In absolute terms, for 2010 the estimated demand was around 2,350 tonnes of fishmeal and 540 tonnes of fish oil.
Effluents of N and P per tonne fish produced are lower than in the overall EU freshwater production. The amount of effluents for 2010 was estimated around 360 tonnes of N and 58 tonnes of P.

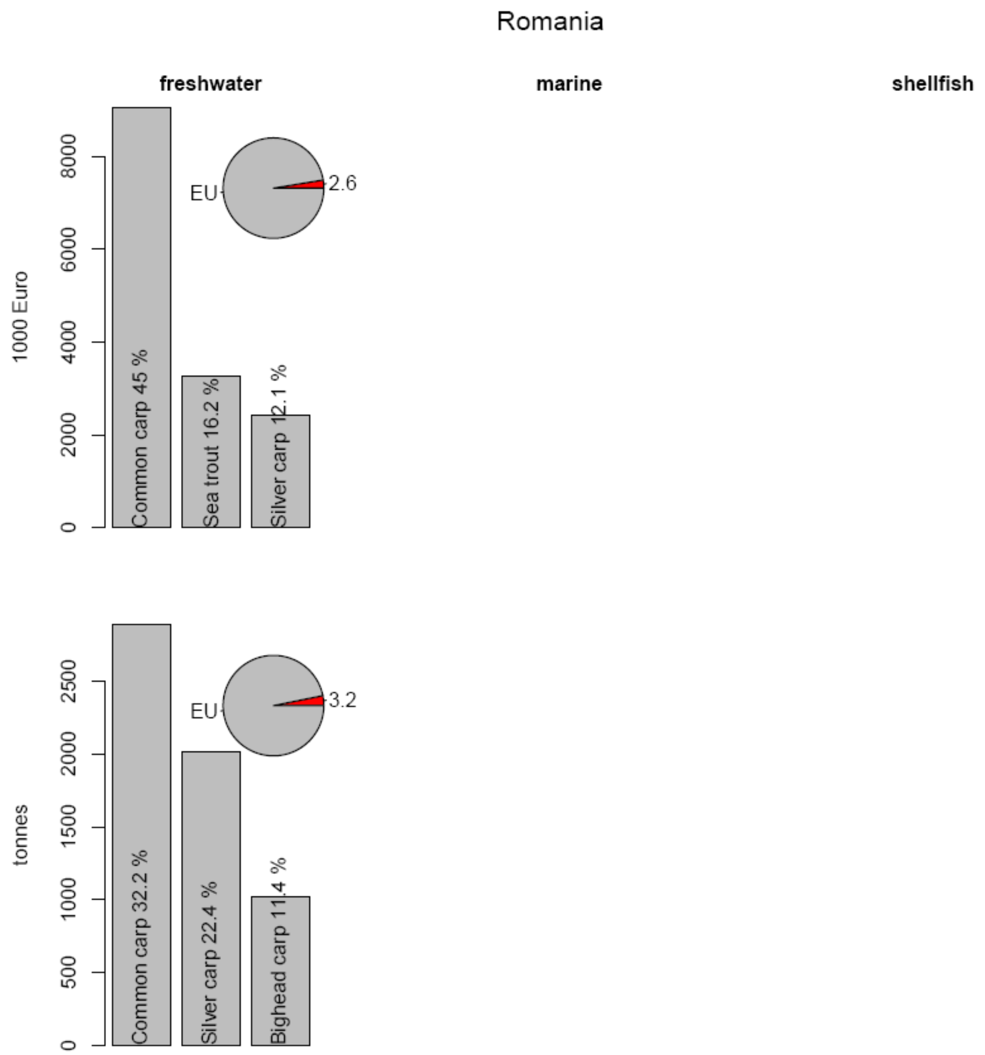


Figure 193 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

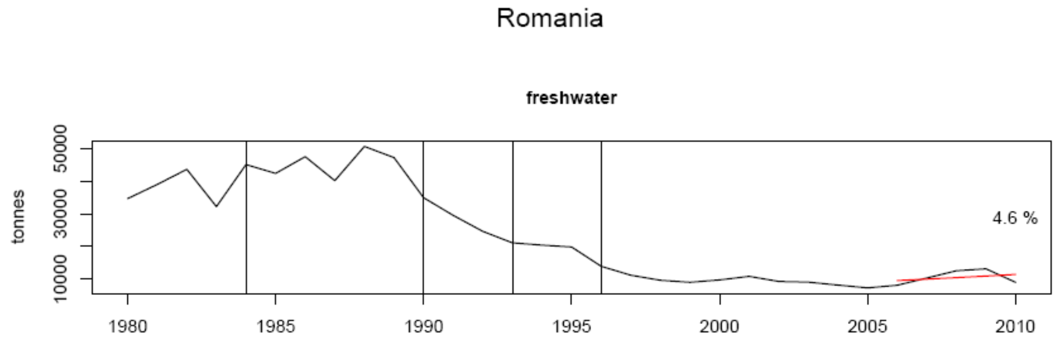


Figure 194 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

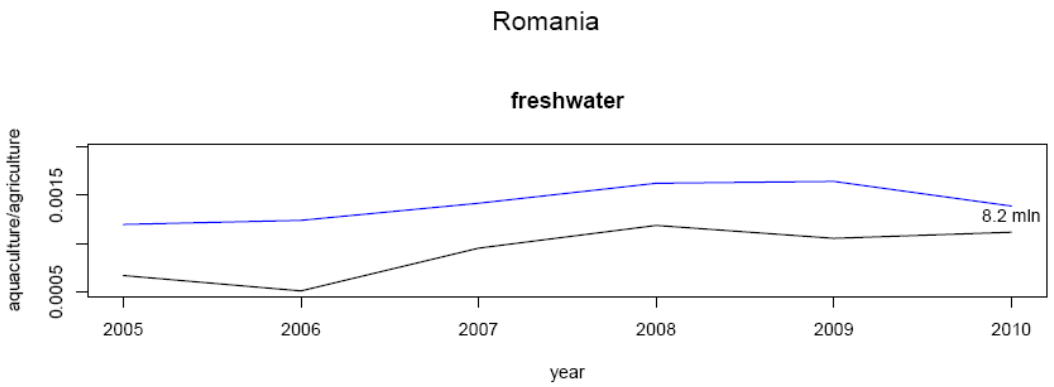


Figure 195 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

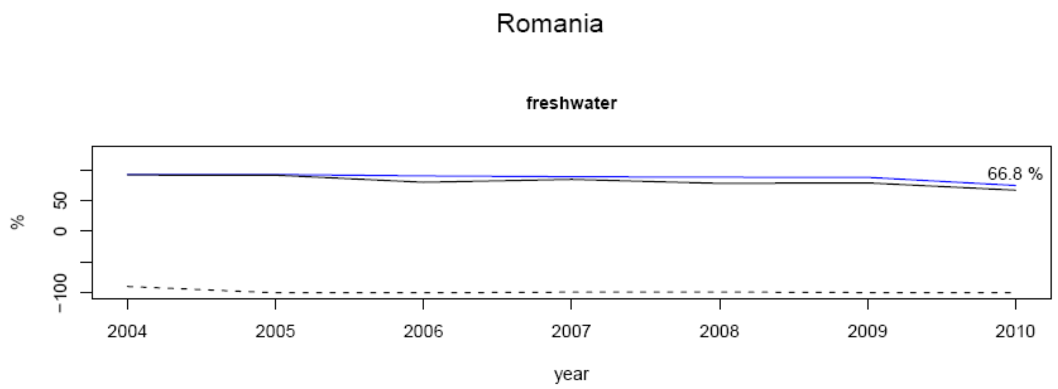


Figure 196 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Romania, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

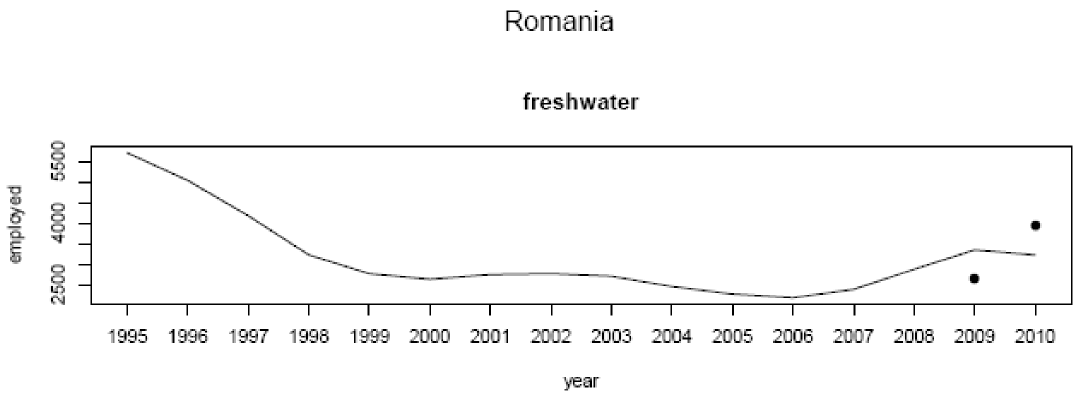


Figure 197 Number of employed persons in the freshwater segment in Romania over time. The trend line is derived from a country specific model using FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

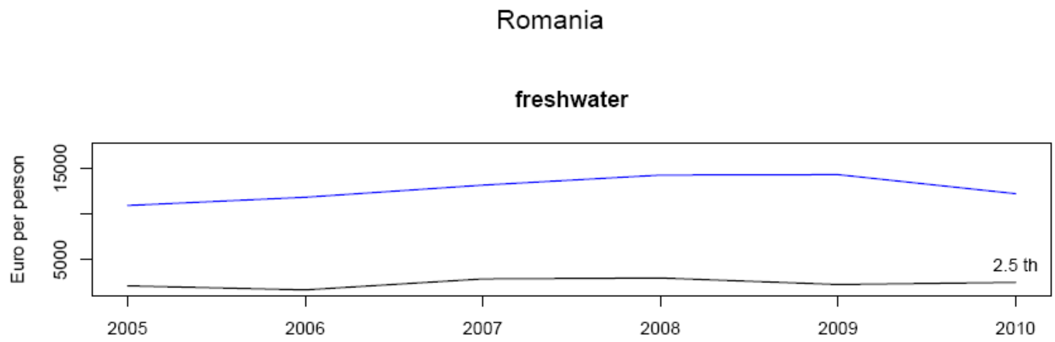


Figure 198 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

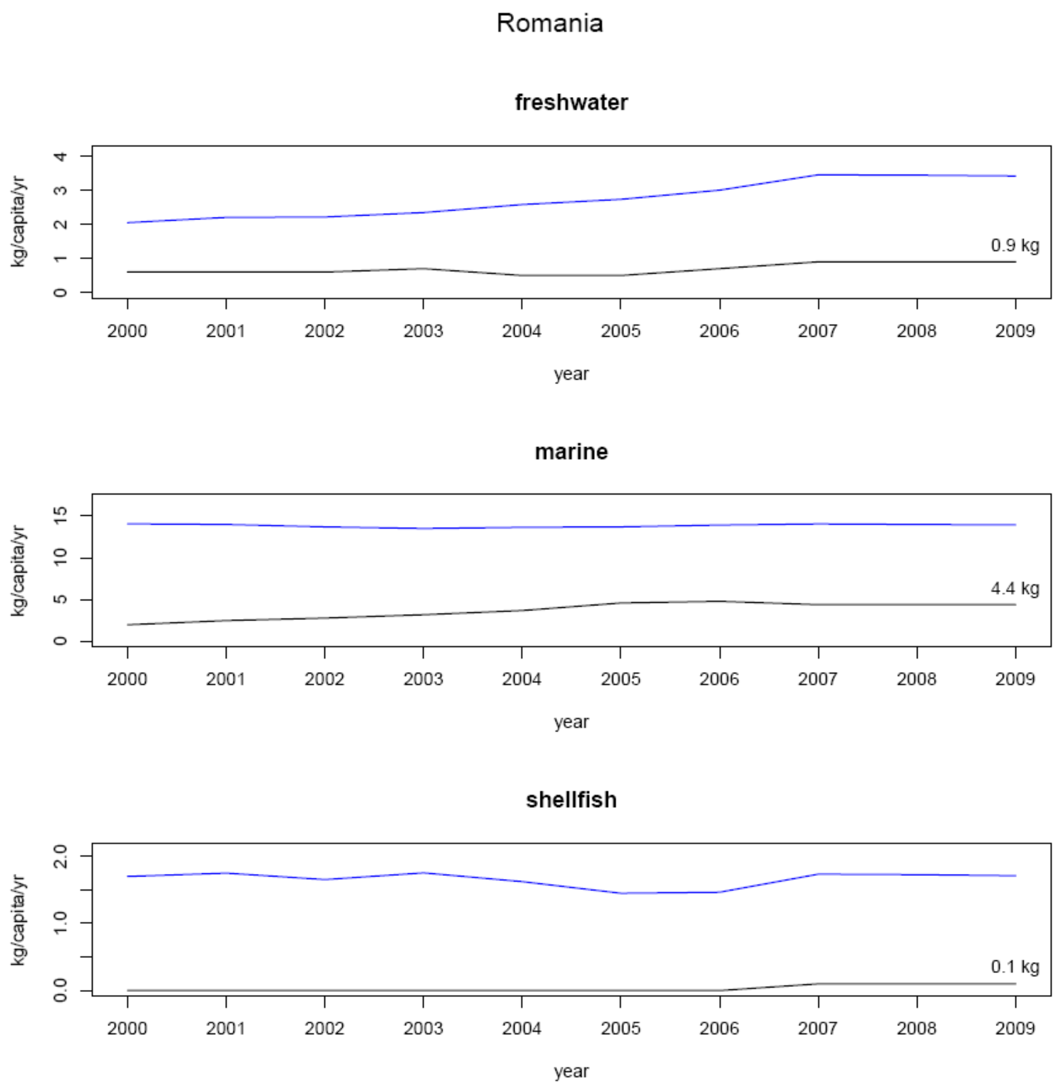


Figure 199 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

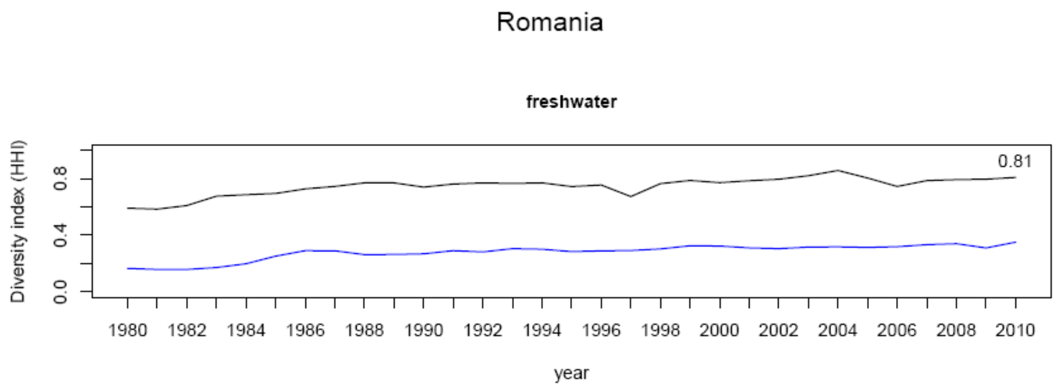


Figure 200 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.22. *Slovakia*

Highlights and trends

- Traditional small freshwater aquaculture with a strong negative trend in production (2006-2010 -15%)
- Mainly small and medium size entities, often in part-time or combined with non-production oriented activities, serving mainly the local market
- Labour productivity higher, but GVA lower than EU average for the segment
- Very limited employment
- Apparent consumption of fisheries products is low
- Fishmeal and fish oil use as well as effluent loads are close to EU average

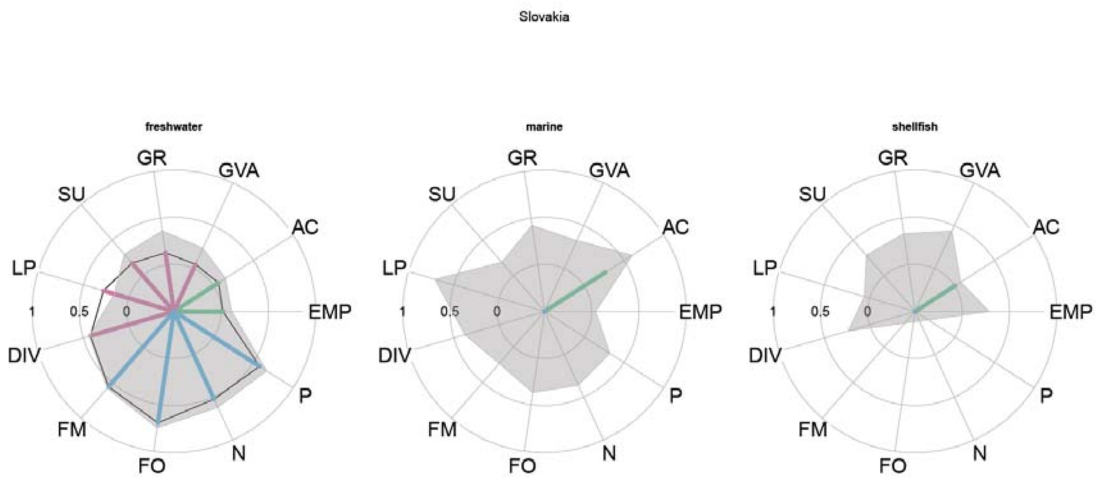


Figure 201 Performance indicators for Slovakia

Overview of the sector

Being a landlocked country, Slovakia has a small freshwater production (some 687 tonnes in 2010). The most predominant aquaculture fish species are rainbow trout and common carp with around 80% and 17% by volume, respectively.

Showing strong fluctuations over time, the trend since 2006 is clearly negative (-15%).

Aquaculture has only very small contribution as regards GVA.
Over the period from 2004 to 2010 the share of freshwater aquaculture to the total available supply of freshwater fishery products fell from over 40% to 23%.
Following the production figures, the modeled employment ratio is well below the EU ratio, estimating an employment of around 30 persons in 2010.
Apparent per capita consumption of fisheries products is relatively low.
The use of fishmeal and fish oil is close to the EU level per tonne fish produced, due to a strong share on trout production (in absolute terms around 210 tonnes fishmeal and 83 tonnes of fish oil in 2010).
Effluents of N and P per tonne fish produced are slightly higher than in the overall EU freshwater production. The effluents for 2010 were estimated to be about 37 tonnes of N and 5 tonnes of P.

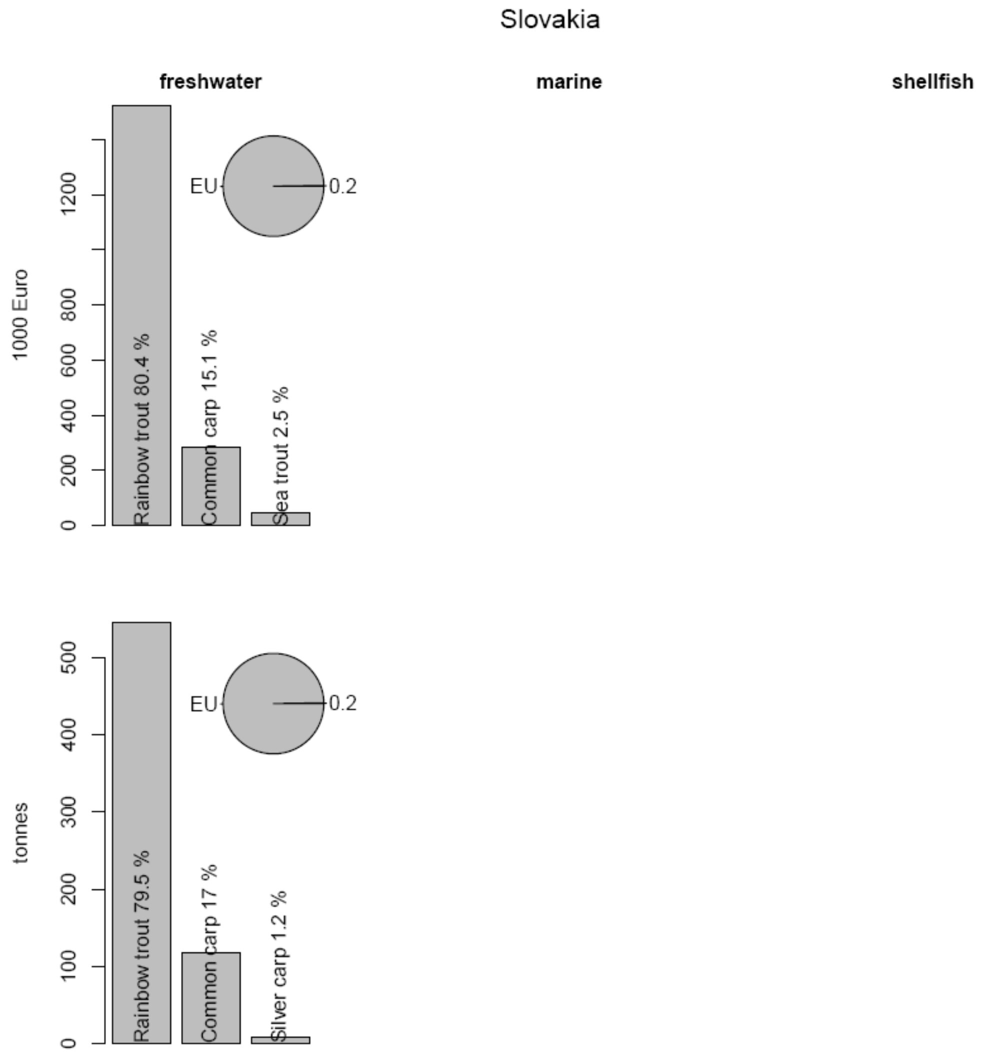


Figure 202 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish segment.

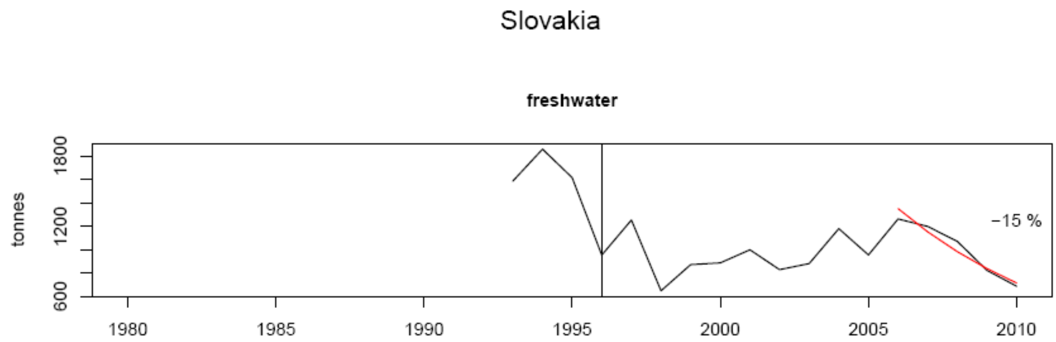


Figure 203 Production growth: Production pattern of the freshwater finfish segment by volume over time until 2010 with the trend of the last five years (2006-2010).

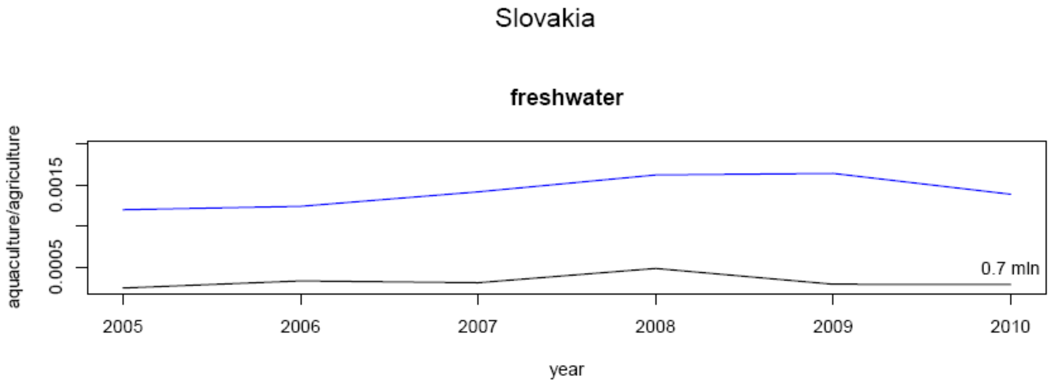


Figure 204 GVA: Economic importance of the output by the freshwater finfish segment over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

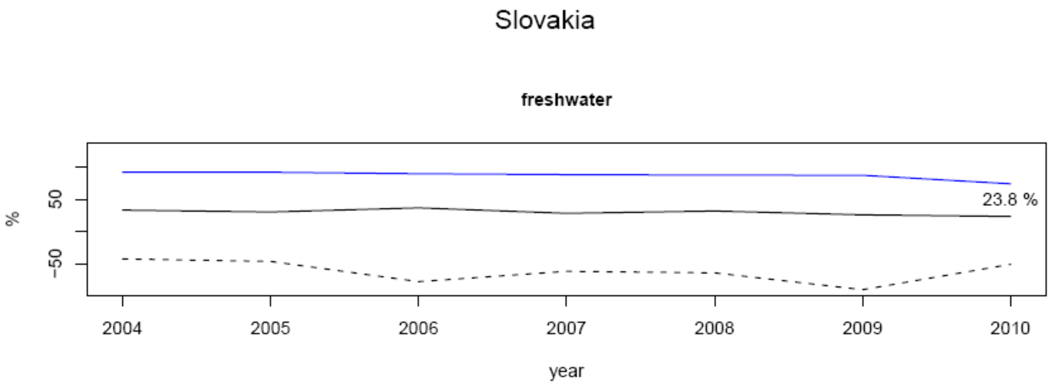


Figure 205 Self-sufficiency and trade: Share of freshwater aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Slovakia, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

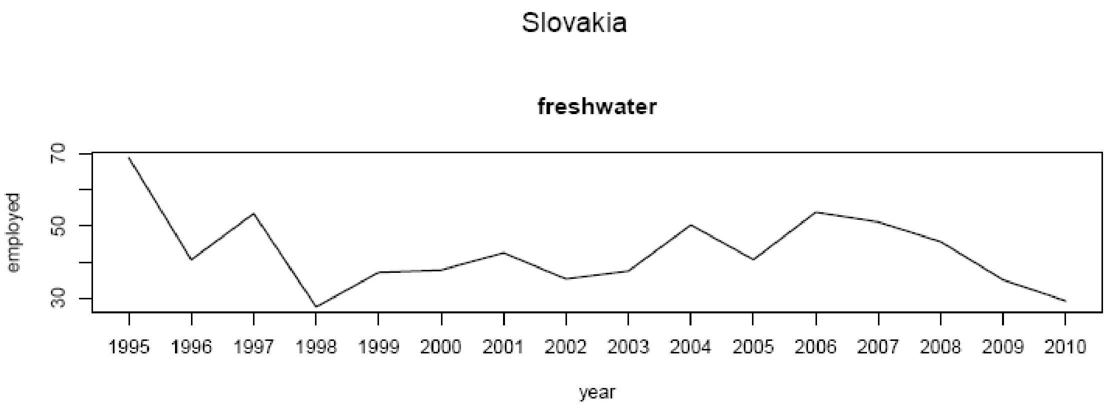


Figure 206 Number of employed persons in the freshwater finfish segment in Slovakia over time. Since no data was available from DCF or previous reports the employment is estimated from production statistics using a generic EU model.

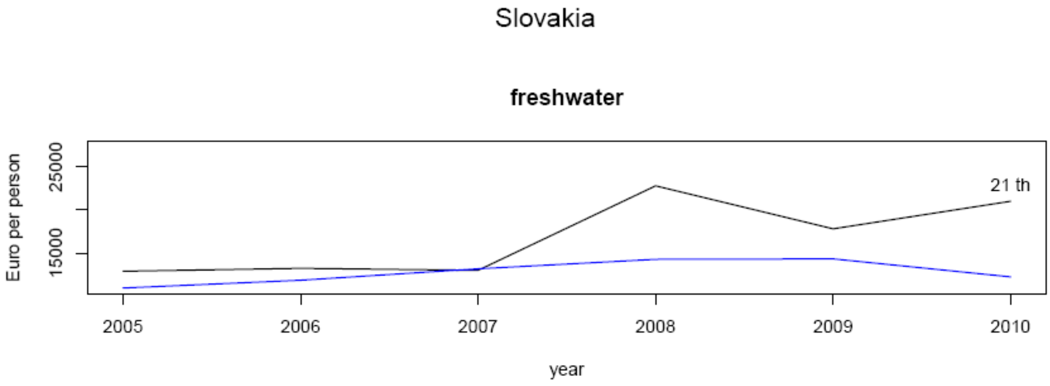


Figure 207 Labour Productivity: Ratio between employment and GVA for the freshwater segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

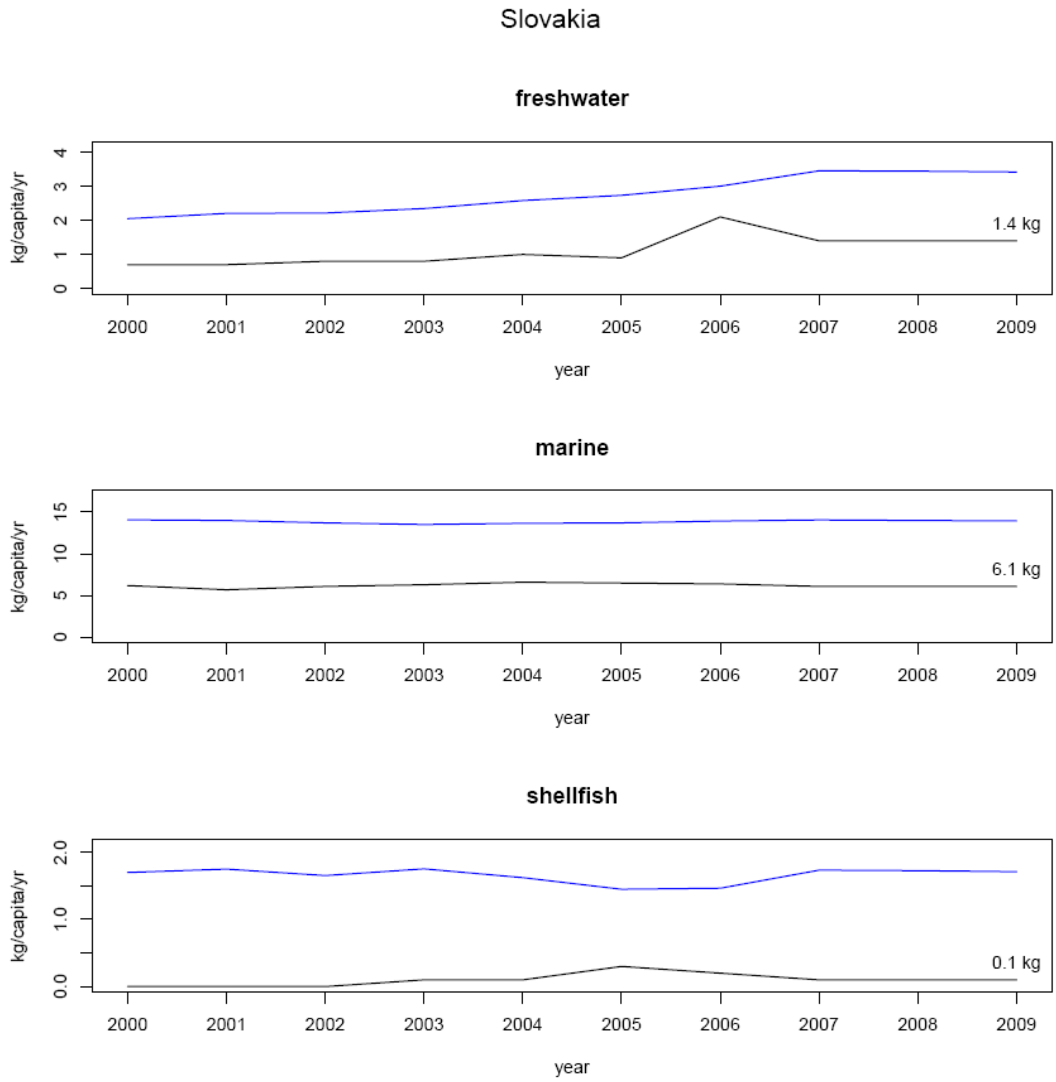


Figure 208 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

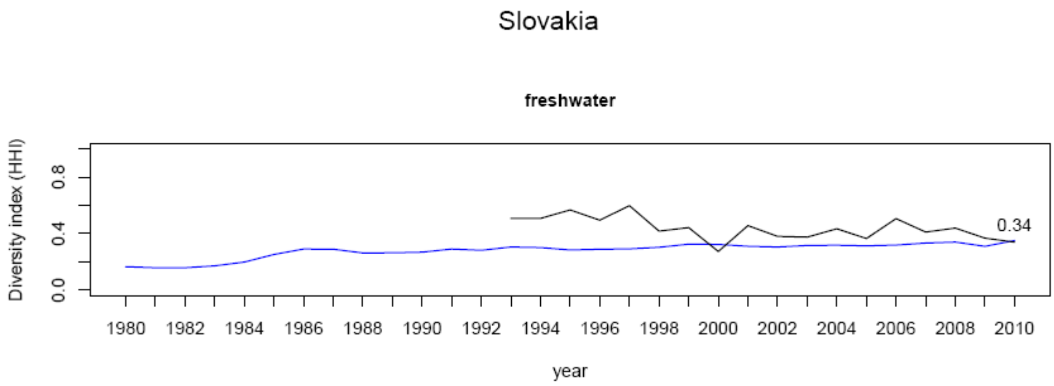


Figure 209 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.23. Slovenia

Highlights and trends

- Small finfish and shellfish aquaculture with a strong trend for growth in the marine finfish production (2006-2010 +24%)
- Production is serving mainly the local market
- High diversification of farmed freshwater species contributing to the production
- Limited employment in all three segments with a high labour productivity in the freshwater aquaculture
- Apparent consumption of fisheries products is low
- Relative low demand of fish oil
- Effluent load from aquaculture is lower than EU average, especially in the marine finfish segment.

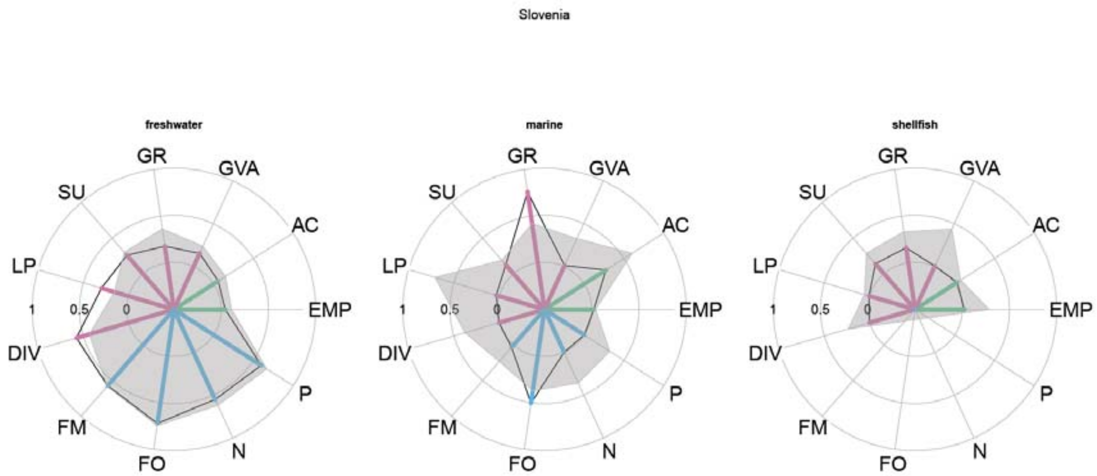


Figure 210 Performance indicators for Slovenia

Overview of the sector

The aquaculture of Slovenia consists of land-based freshwater farms; marine finfish and shellfish farming. The freshwater segment is with around 660 tonnes in 20109 the largest of the three segments, mainly culturing trout spp. (around 70%) and common carp (24%). Most of the mariculture accounts for shellfish with around 78 tonnes of Mediterranean mussel. The marine finfish segment is small with around 42 tonnes of European sea bass produced in 2010.

In 2007, three larger areas were designated for marine finfish aquaculture in Slovenian territorial waters, divided into 22 plots for which farming concessions were granted in 2009 (20 for shellfish and 2 for finfish). Further expansion of the designated zones seems unlikely. Marine farms are reported to operate at about 50% of their maximum capacity.

All segments show strong fluctuation in production volumes over the years. The freshwater finfish and the shellfish aquaculture experience since 2006 a downward trend of -12 to 13%, while the trend in marine finfish aquaculture turned for the same period positive.

Aquaculture has only small contribution as regards GVA, with a steady decrease in the ration over the last years, especially in the freshwater segment.

Aquaculture production contributes in the marine and shellfish segments very little to the available supply in those segments. In the freshwater segment its share in the total available supply fell from almost 90% in 2004 to some 58% in 2010.
From the few data available, the modeled employment rates of all three segments are well below EU rates with most employed persons in the freshwater segment (around 30 persons in 2010).
Apparent per capita consumption of fisheries products remained over the last years low.
In absolute terms the demand of the finfish aquaculture for fishmeal and fish oil is relatively small (220 tonnes fishmeal, 80 tonnes fish oil in 2010). The freshwater production has a higher demand per tonne fish produced than the Union in total of the segment (around 293 kg fishmeal, around 110 kg fish oil), but lower than the around 620 kg fishmeal and 195 kg fish oil used per tonne of marine finfish. Due to sea bass and sea bream production, the marine finfish segment has a higher demand of fishmeal but a lower demand for fish oil/tonne fish the EU as a whole in the segment.
The N and P effluents per tonne of fish produced are higher than EU in total in the freshwater environment (around 52 kg N, around 8 kg P) and in marine finfish production (around 103 kg N, around 16 kg P). However, in absolute figures the amounts in both segments are small with together some 50 tonnes of N and 6 tonnes of P.

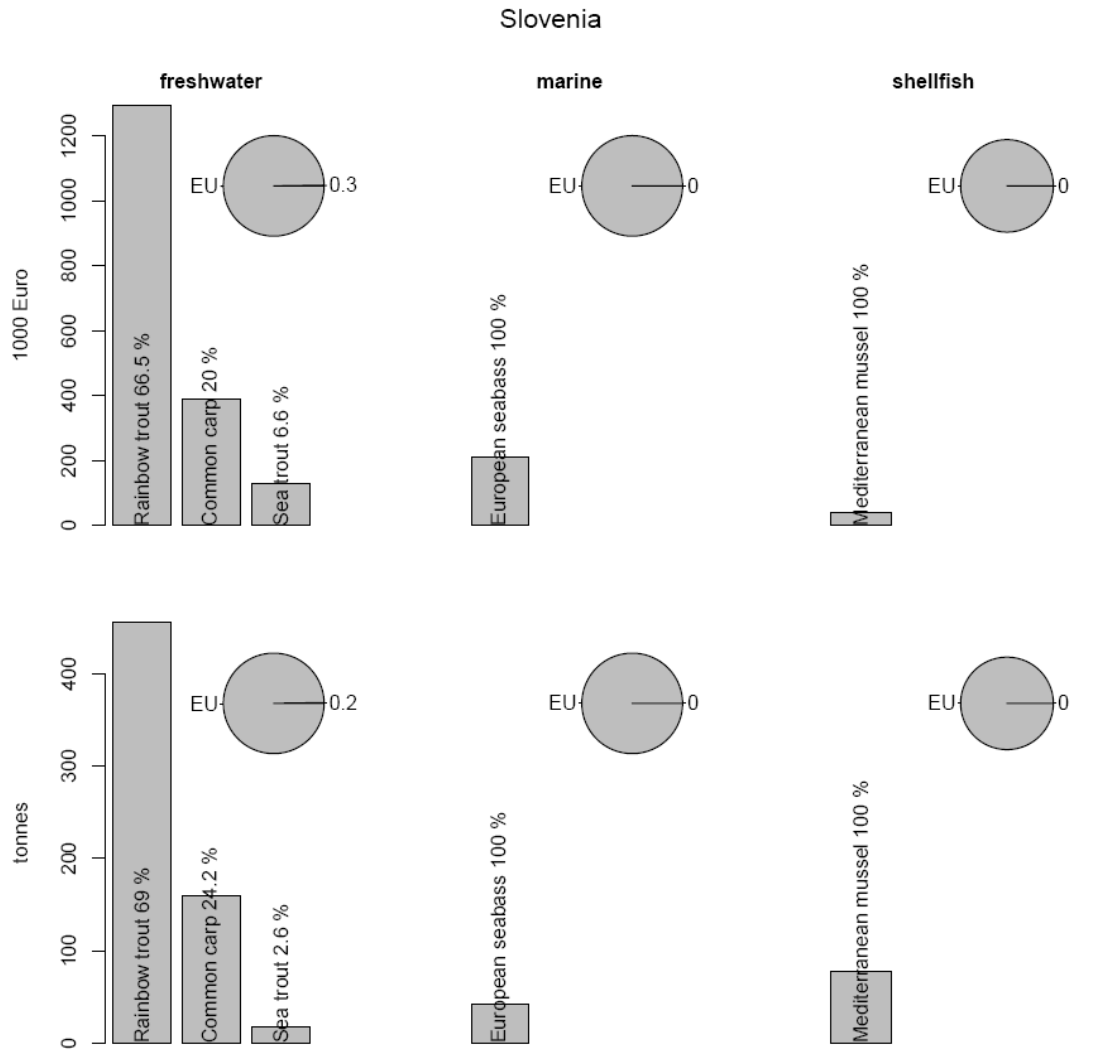


Figure 211 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

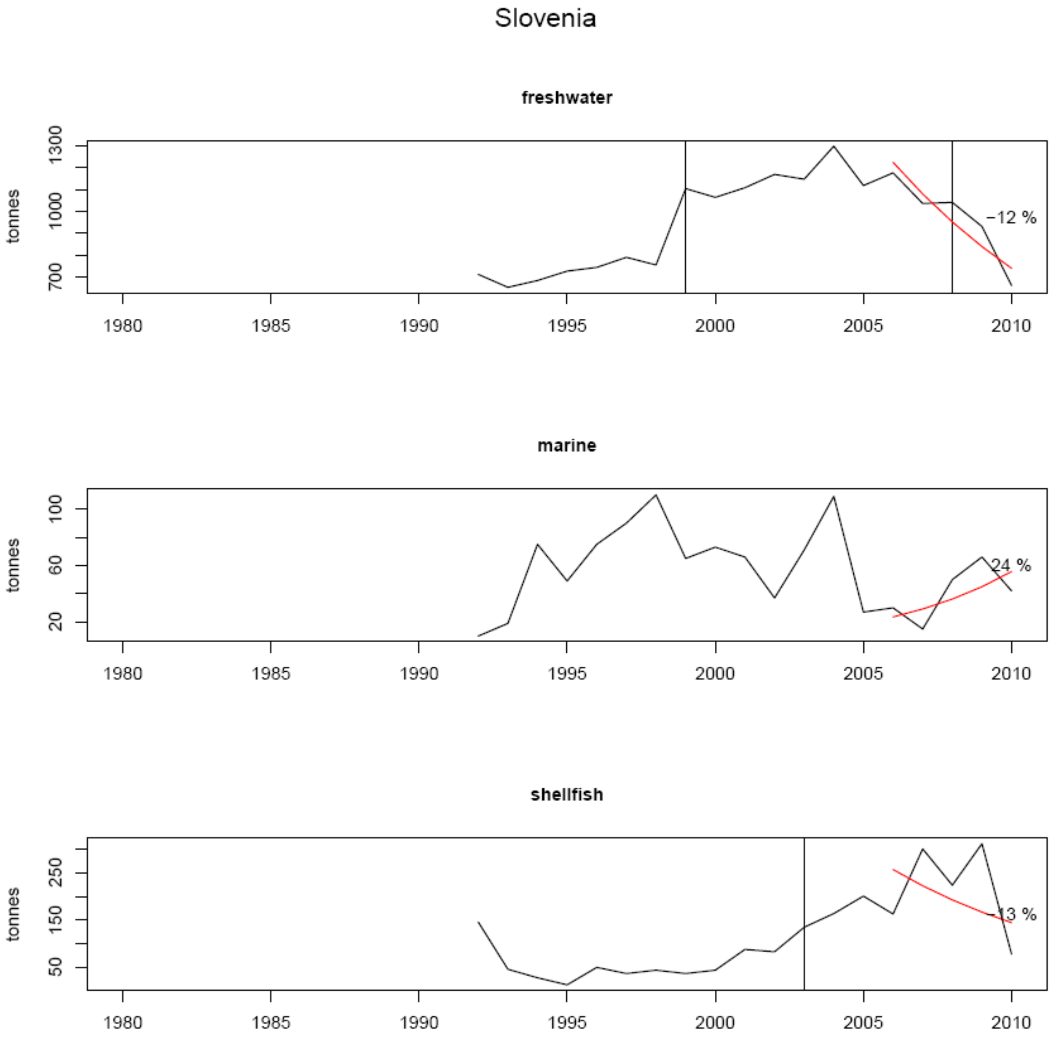


Figure 212 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

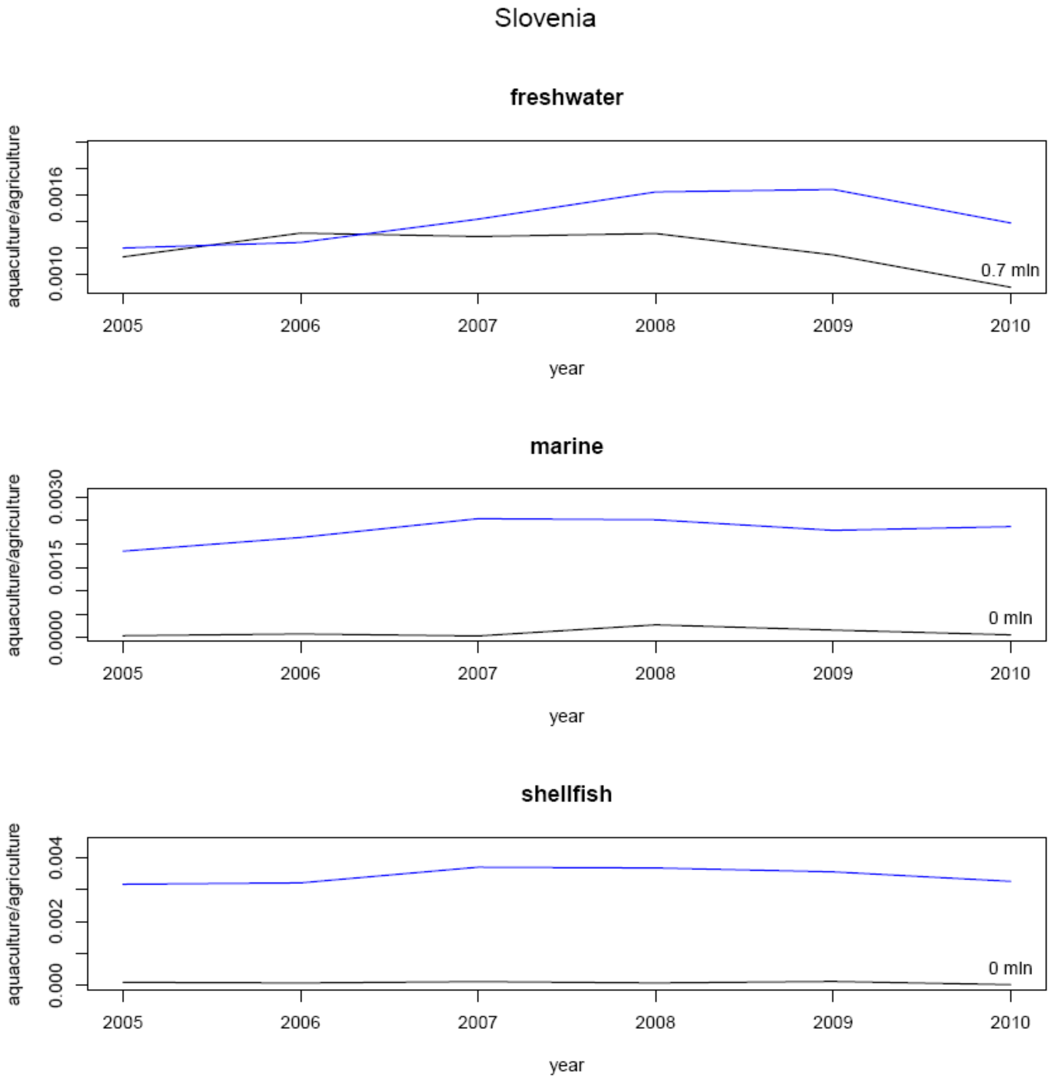


Figure 213 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

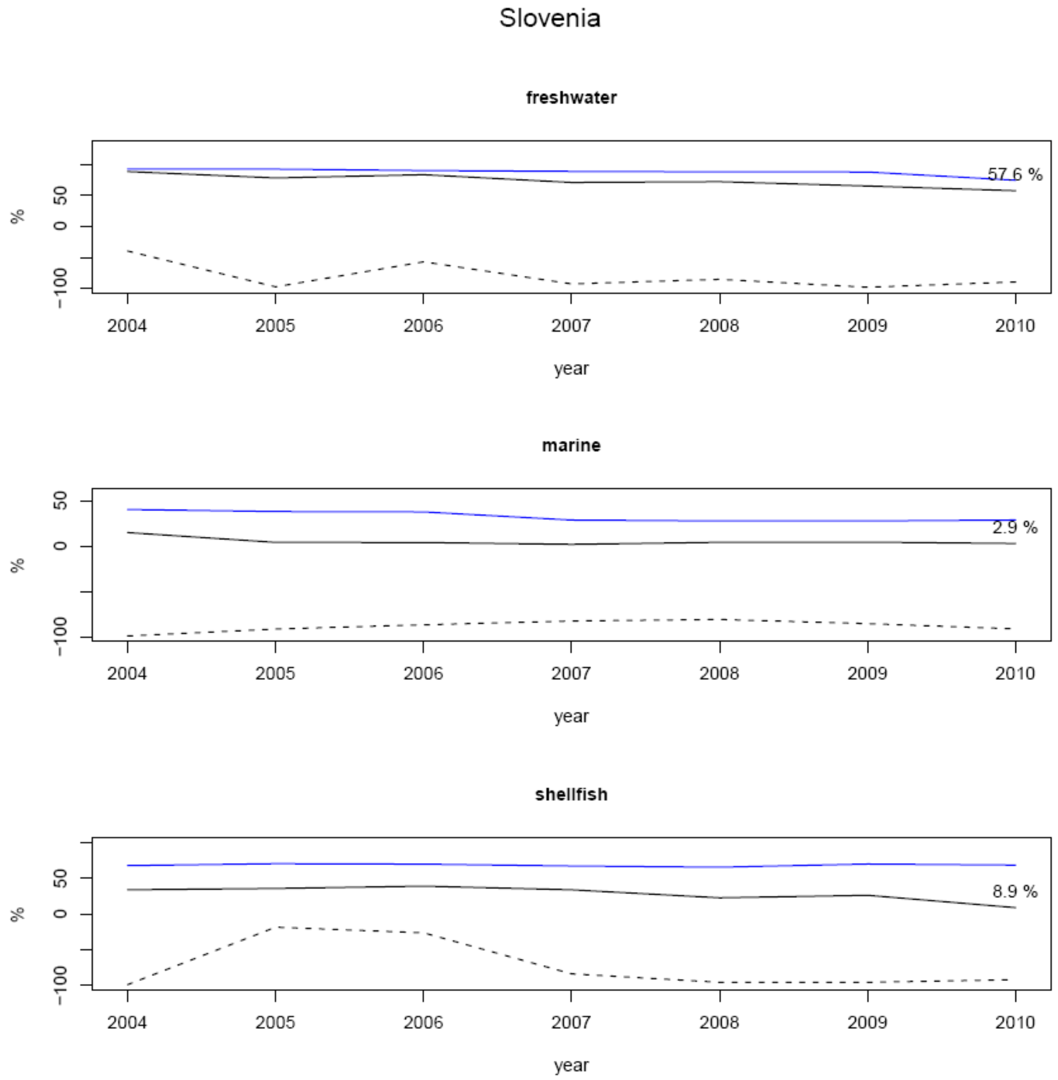


Figure 214 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Slovenia, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

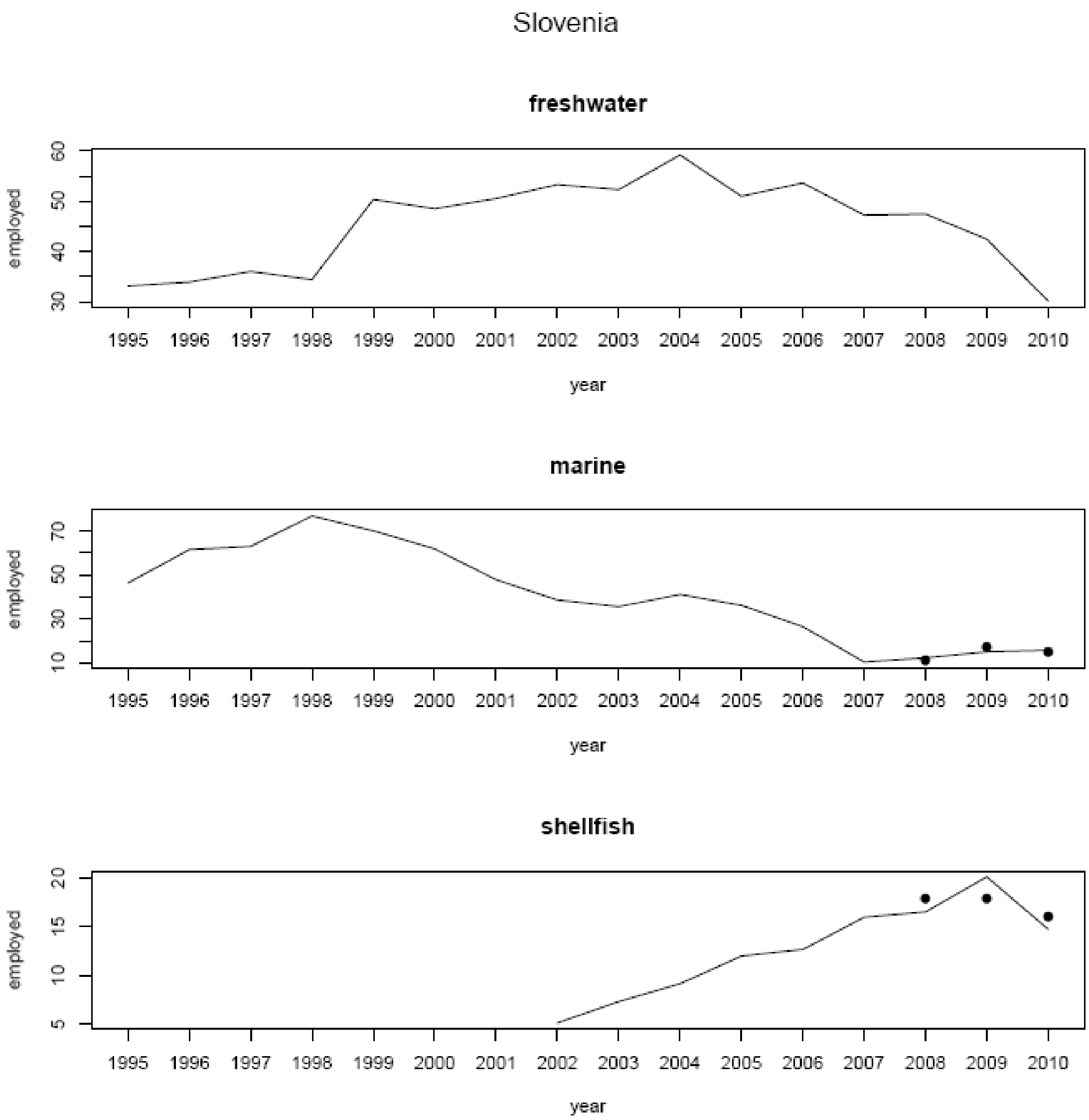


Figure 215 Number of employed persons in aquaculture in Slovenia over time. Since for the freshwater segment no data was available from DCF or previous reports the employment is estimated from production statistics using a generic EU model. The trend lines in the marine finfish and shellfish segments are derived from country specific models using FAO production statistics and employment data from STECF (2012 and 2013) (black dots).

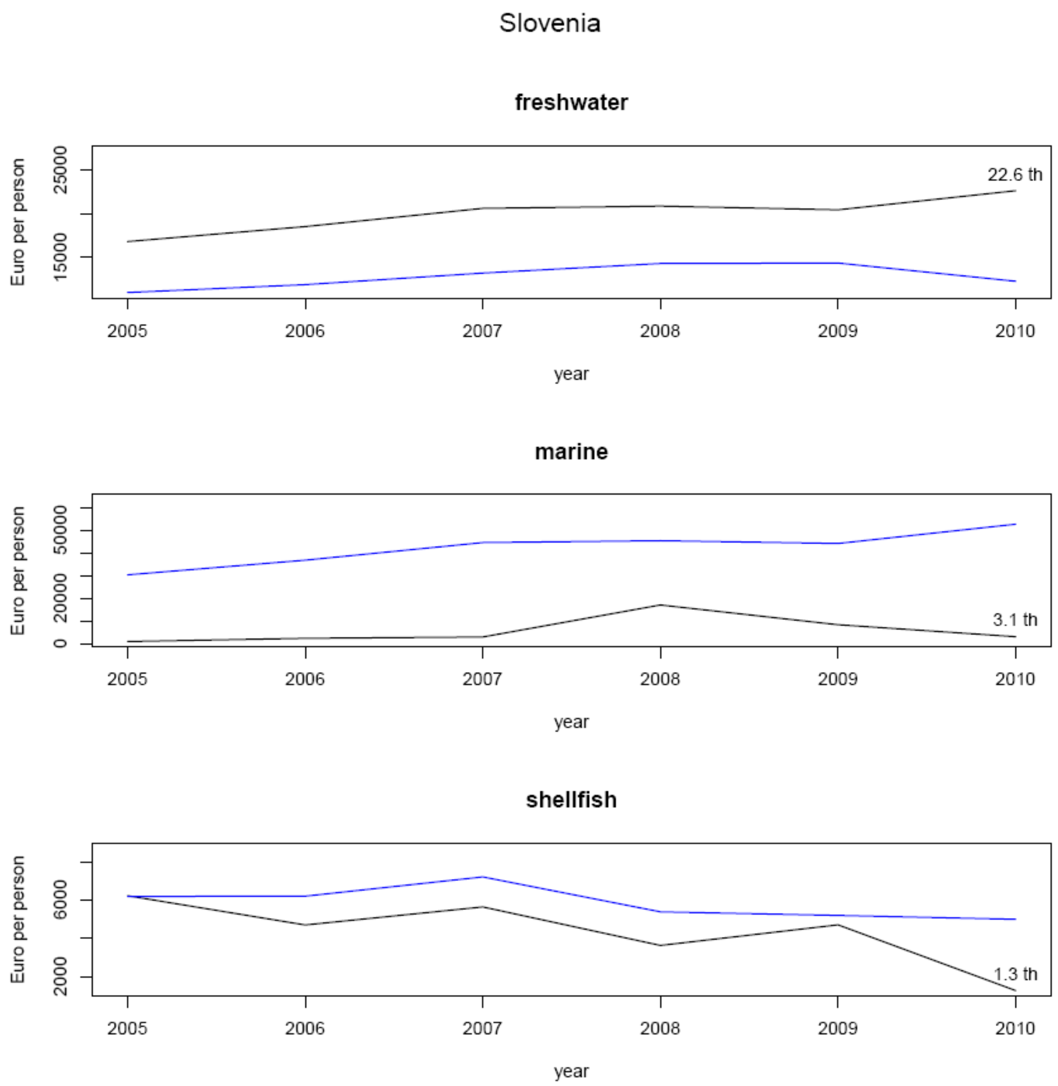


Figure 216 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

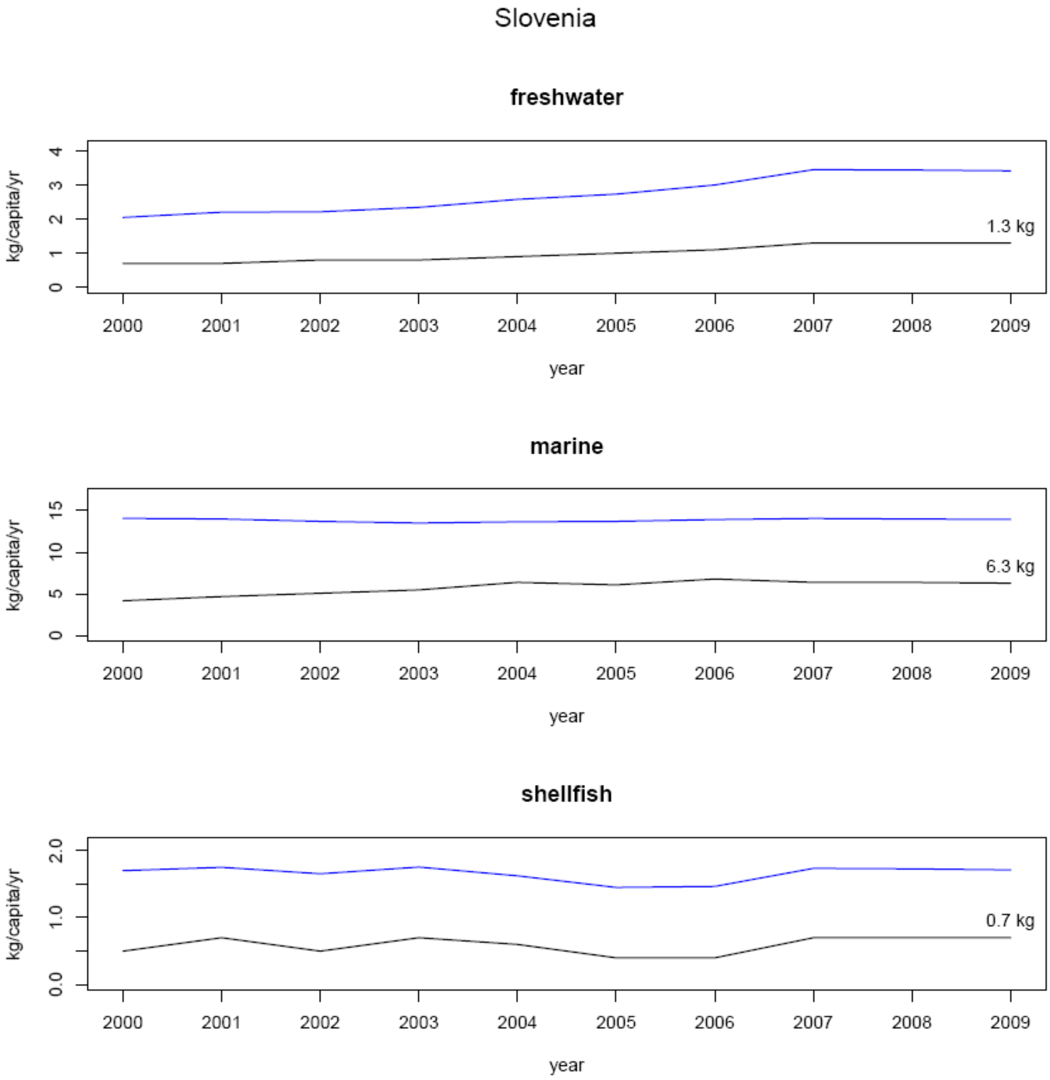


Figure 217 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

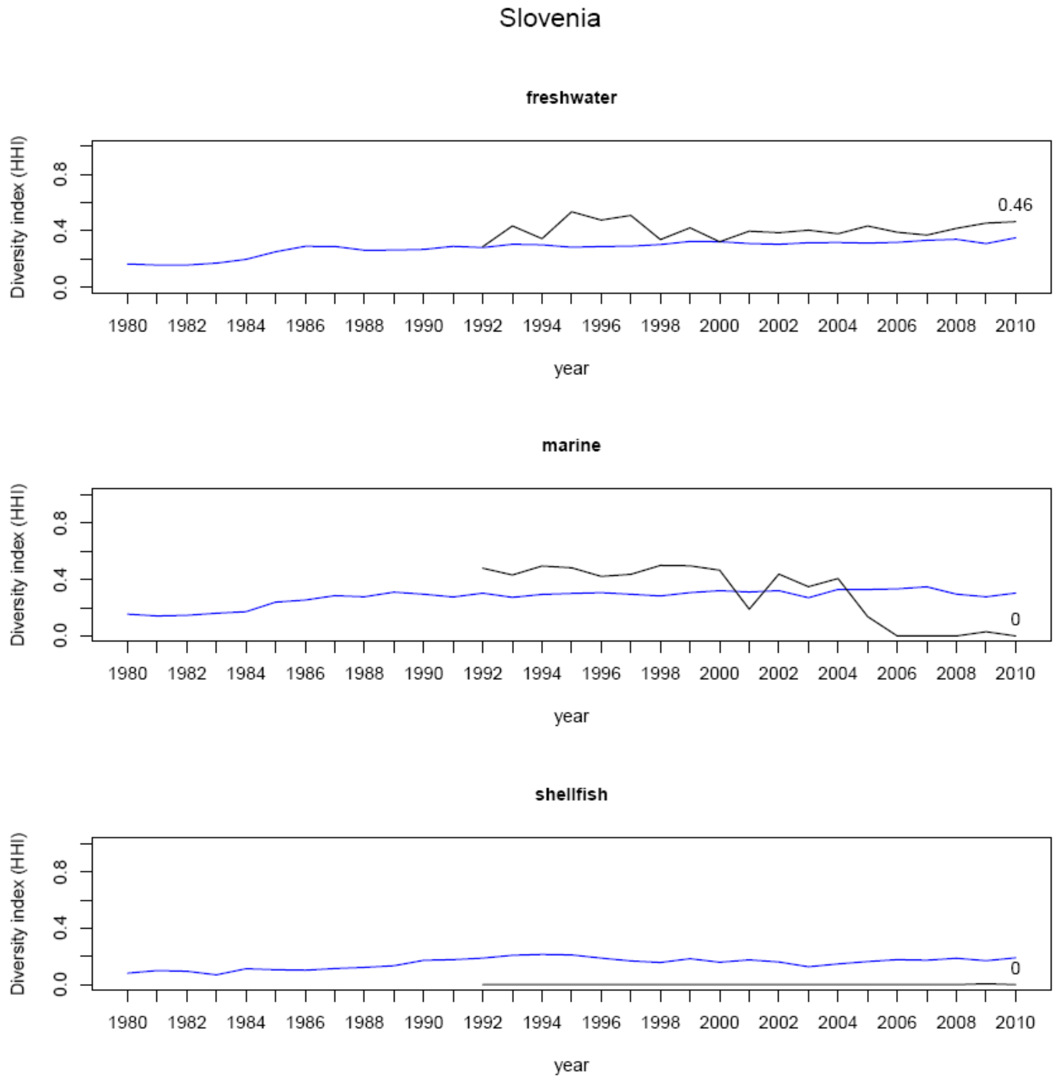


Figure 218 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.24. *Spain*

Highlights and trends

- Largest shellfish aquaculture in the Union with a positive growth trend and strong finfish aquaculture
- GVA is high in the marine finfish segment
- High diversification of farmed species contributing to the production in the marine finfish segment
- Highest employment of the sector in the Union, especially in the shellfish aquaculture, being clearly above EU average, but with a low labour productivity
- Apparent consumption of fisheries products is high
- Relative low demand of fish oil in the marine finfish production
- Effluent load from aquaculture is higher than EU average

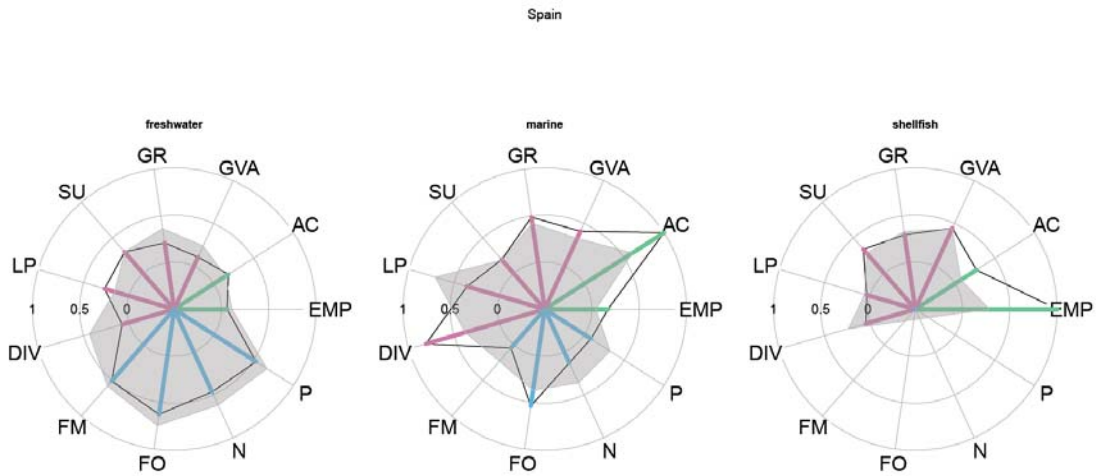


Figure 219 Performance indicators for Spain

Overview of the sector

In the European Union, Spain has with some 252,000 tonnes in 2010 the largest aquaculture sector in terms of volume and a turnover of 440 million Euro. Marine finfish aquaculture has the highest turnover, contributing 15.4% to the EU marine finfish aquaculture by value and 11.7% by volume. From some 41,500 tonnes produced, turbot contributes with 22% by value and 17% by volume. Most cultured are Gilthead sea bream (41% by value, 49% by volume) and European sea bass (30% by value, 28% by volume).
The shellfish culture accounted with almost 193,000 tonnes for almost 31% of the EU shellfish aquaculture by volume and for 13.2% by value. Production is dominated by sea mussel spp. with 98% in volume and 80% in value. Japanese carpet shell, Pacific cupped oyster and European flat oyster stand for the rest.

Freshwater aquaculture produced in 2010 with around 18,000 tonnes 6.7% of the EU output in this segment in value and 6.4% in volume, dominated by rainbow trout (>90%), followed by European eel, sturgeon and tench. There is also some production of prawns, shrimps, caviar from sturgeons and other aquatic species. Spain has an important production of juveniles and eggs for commercial aquaculture but also for restocking rivers and coastal zones.

The sector comprises 5,388 establishments run by 3,105 enterprises, some 320 of them producing in freshwater, the rest in marine or brackish water. The specialization is high, many entities producing only one species. 2,066 enterprises grow mussels in more than 3,500 rafts, mainly concentrated in Galicia.

The freshwater finfish and shellfish aquaculture experiences since 2006 a downward trend of -10% and -4.6%, respectively. Marine finfish aquaculture was growing steadily from 1985 on. This positive trend continued for the last five years (+7.1%).

Aquaculture has only small contribution in relation to the agriculture sector, with the marine finfish and shellfish segments reaching a ratio of the GVA at or close to the EU ratio.

The shellfish production contributed in 2010 with almost 90% to the available supply in that segment. The freshwater production's share on the total available supply in that segment fell from almost 130% in 2004 to some 75% in 2010.. Marine aquaculture had over the last years a relative stable share of around 30% the total available supply in its segment.

Based on the production the model shows for Spain the highest employment in the EU aquaculture. Shellfish and marine finfish aquaculture are estimated to employ in 2010 some 20,500 and 2,230 persons, respectively. The importance of the segments is well above the EU ratio, in particular in shellfish. Employment in the shellfish segment is however also characterised by high number of seasonal and part time employment. For the freshwater segment the model indicates since 2003 a declining employment ratio with a decrease from some 1,400 persons in 2003 to around 800 in 2010. The estimated employment figures show discrepancies with the data collected through DCF. This is resulting from differences between values reported in DCF and in previous studies. Further information would be needed to better understand the specific employment situation in the shellfish segment in Spain as it seems to relate to an extremely low labour productivity (from the modelled employment the labour productivity in the shellfish segment in 2010 results in some 3,300 € per person and year, while from the figures provided by the DCF, labour productivity would fall to around 1,000 € per person and year).

Apparent consumption is high for marine finfish fisheries products with 23.1 kg per capita in 2009, it rose for freshwater products to 4.2 kg per capita in 2009 and for shellfish products it remained over the last years with 6.2 kg per capita relatively stable.

The freshwater segment has a higher demand of fishmeal and fish oil per tonne fish produced than the Union as a whole of the segment (around 329 kg fishmeal, around 147 kg fish oil), but in any case lower than the demand per tonne marine finfish (around 612 kg fishmeal, around 182 kg fish oil). With a strong sea bass and sea bream production, the marine finfish segment has for fishmeal a demand above and for fish oil/tonne fish demand below EU level in the segment. The absolute demand was calculated for 2010 with some 24,500 tonnes of fishmeal and 7,500 tonnes of fish oil in the marine segment and around 5,900 tonnes fishmeal and 2,600 tonnes of fish oil in the freshwater segment.

The effluents of N and P per tonne of fish produced are above EU level (some 60 kg N and 8 kg P in the freshwater and around 92 kg N and 15 kg P in the marine production). Also in absolute figures marine finfish aquaculture had with almost 3,800 tonnes N and 610 tonnes P much higher effluents than freshwater production (around 1,100 tonnes of N and 150 tonnes of P).

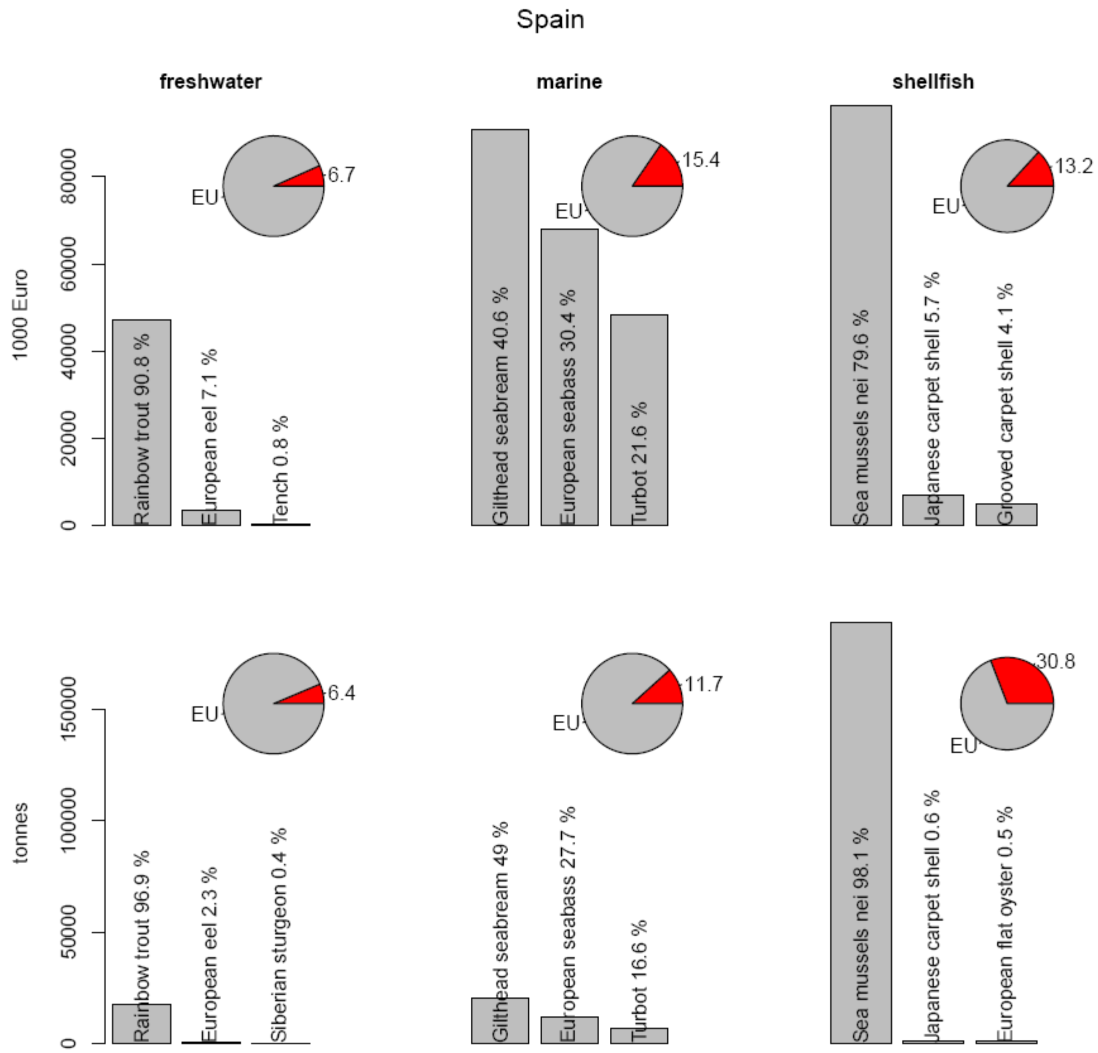


Figure 220 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

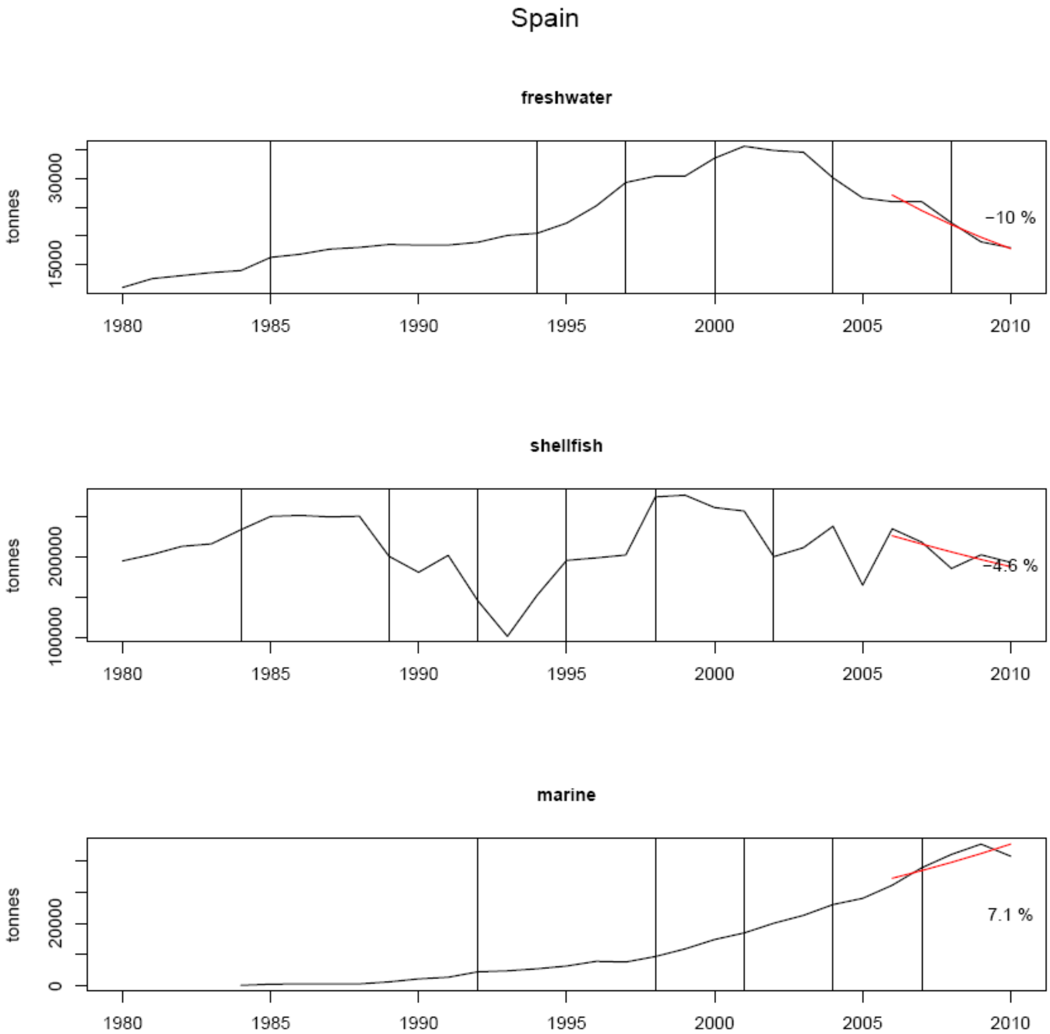


Figure 221 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

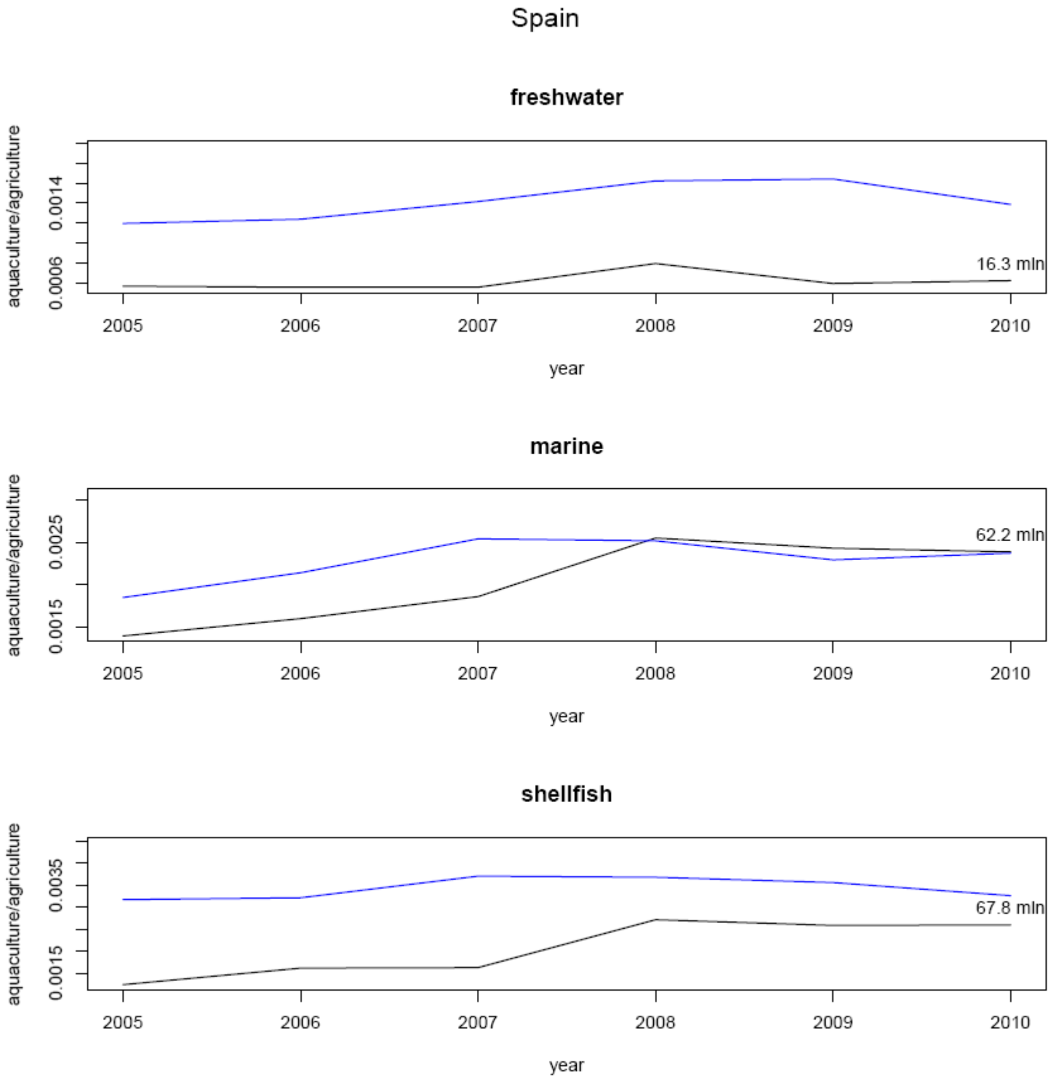


Figure 222 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

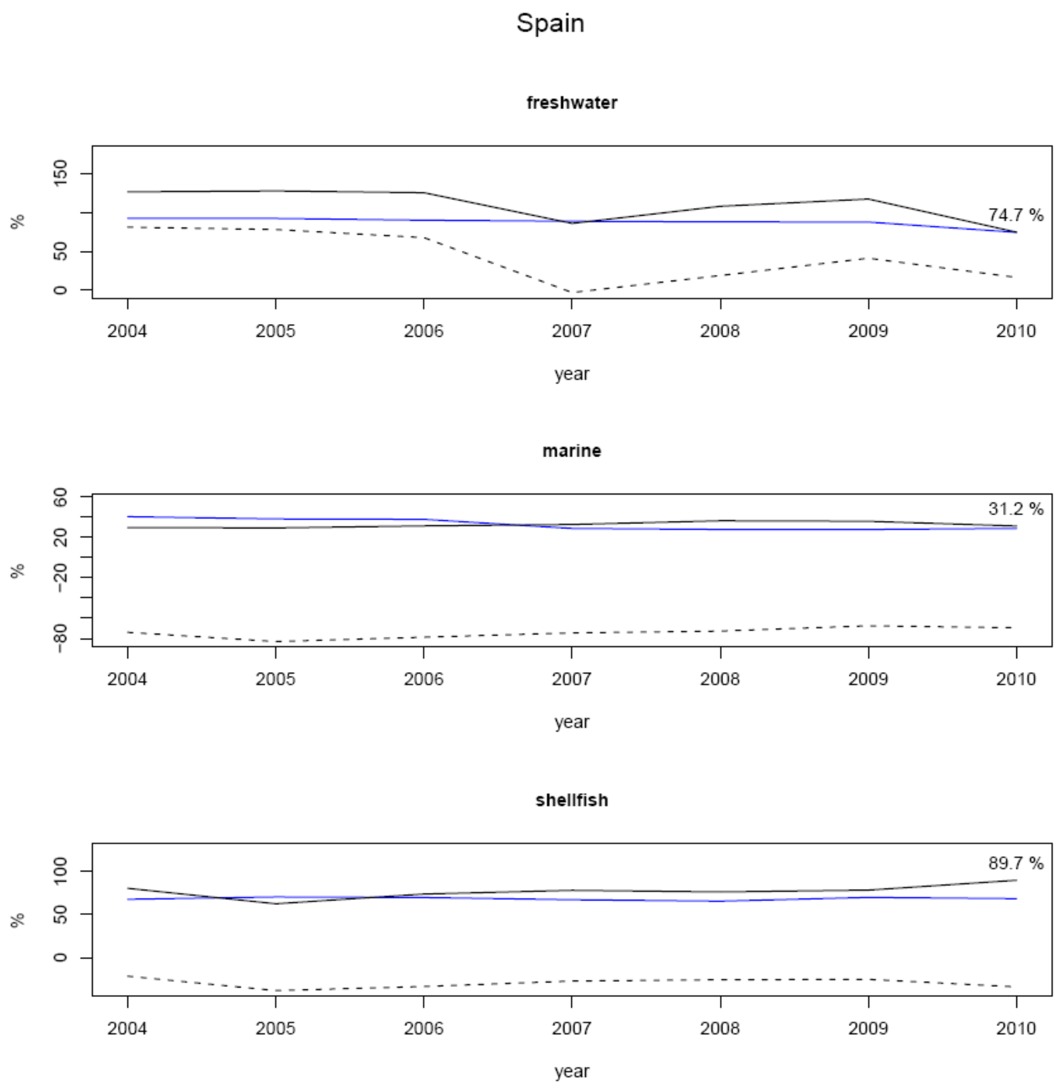


Figure 223 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Spain, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

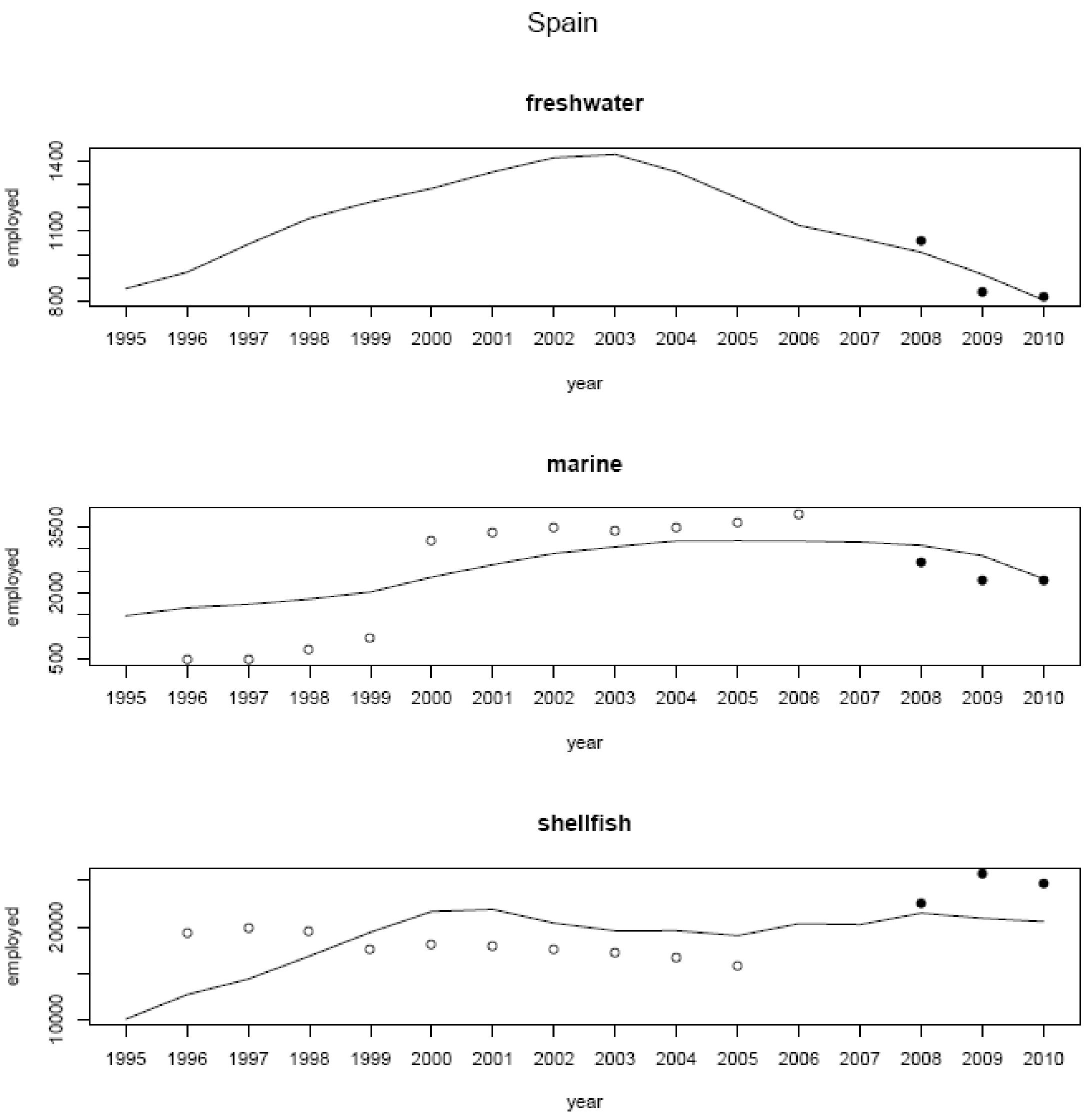


Figure 224 Number of employed persons in aquaculture in Spain over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

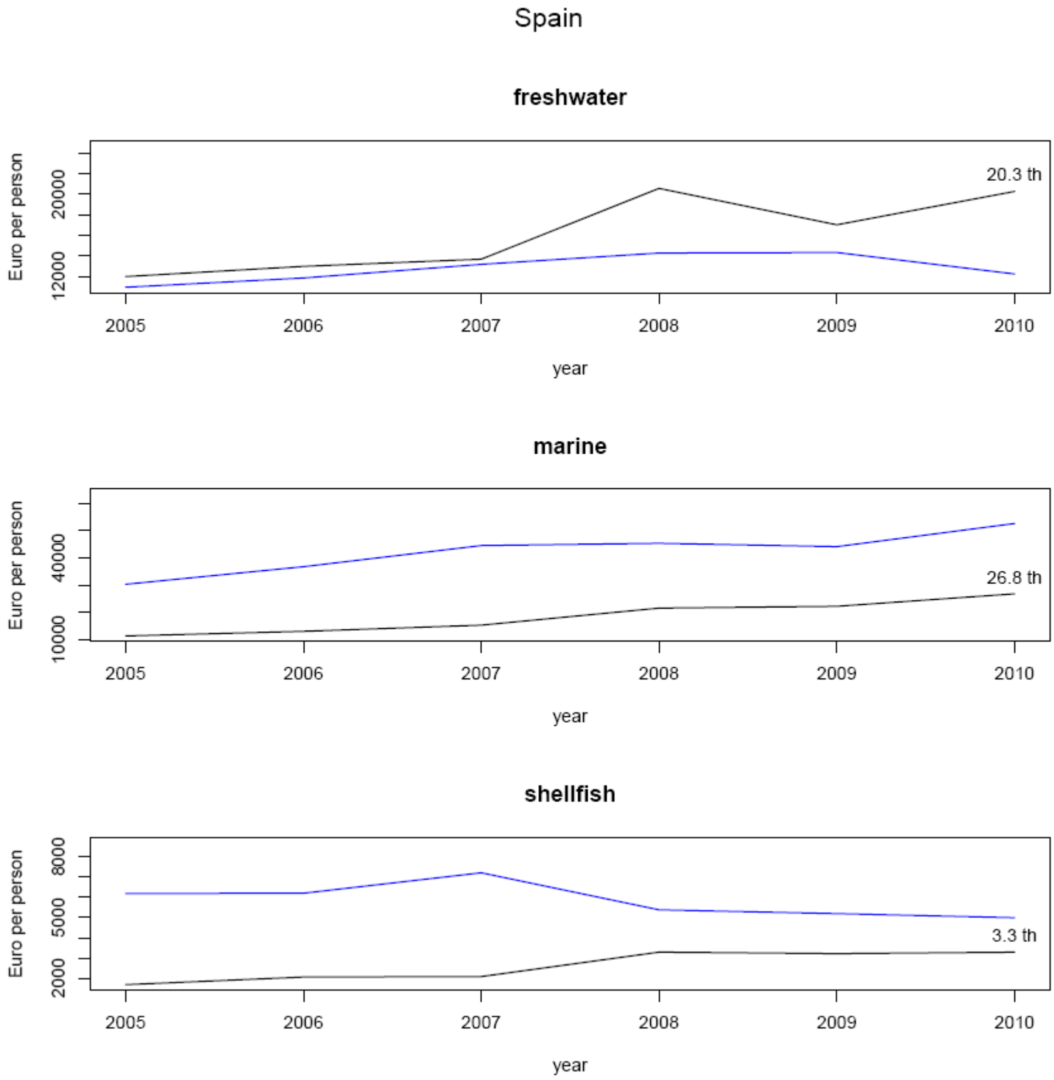


Figure 225 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

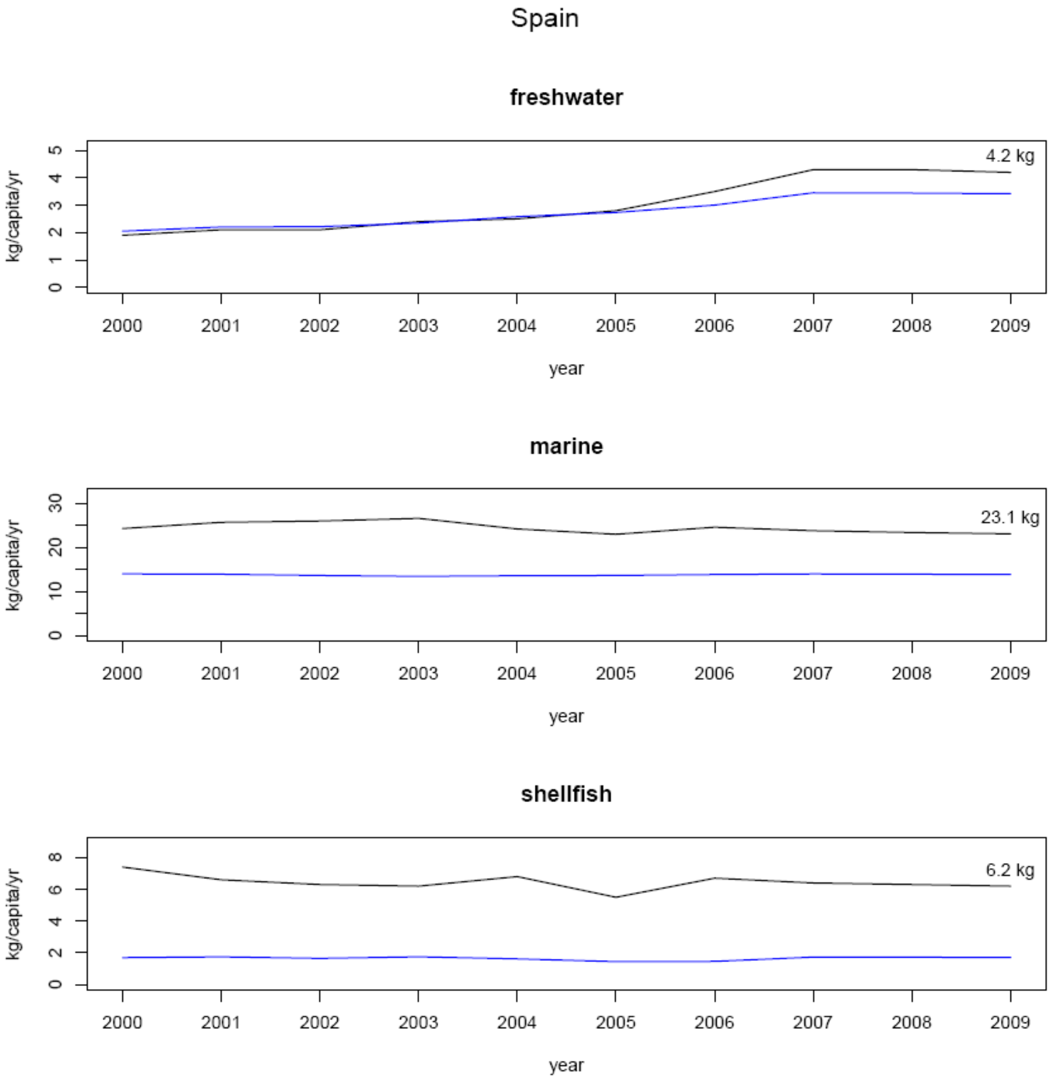


Figure 226 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

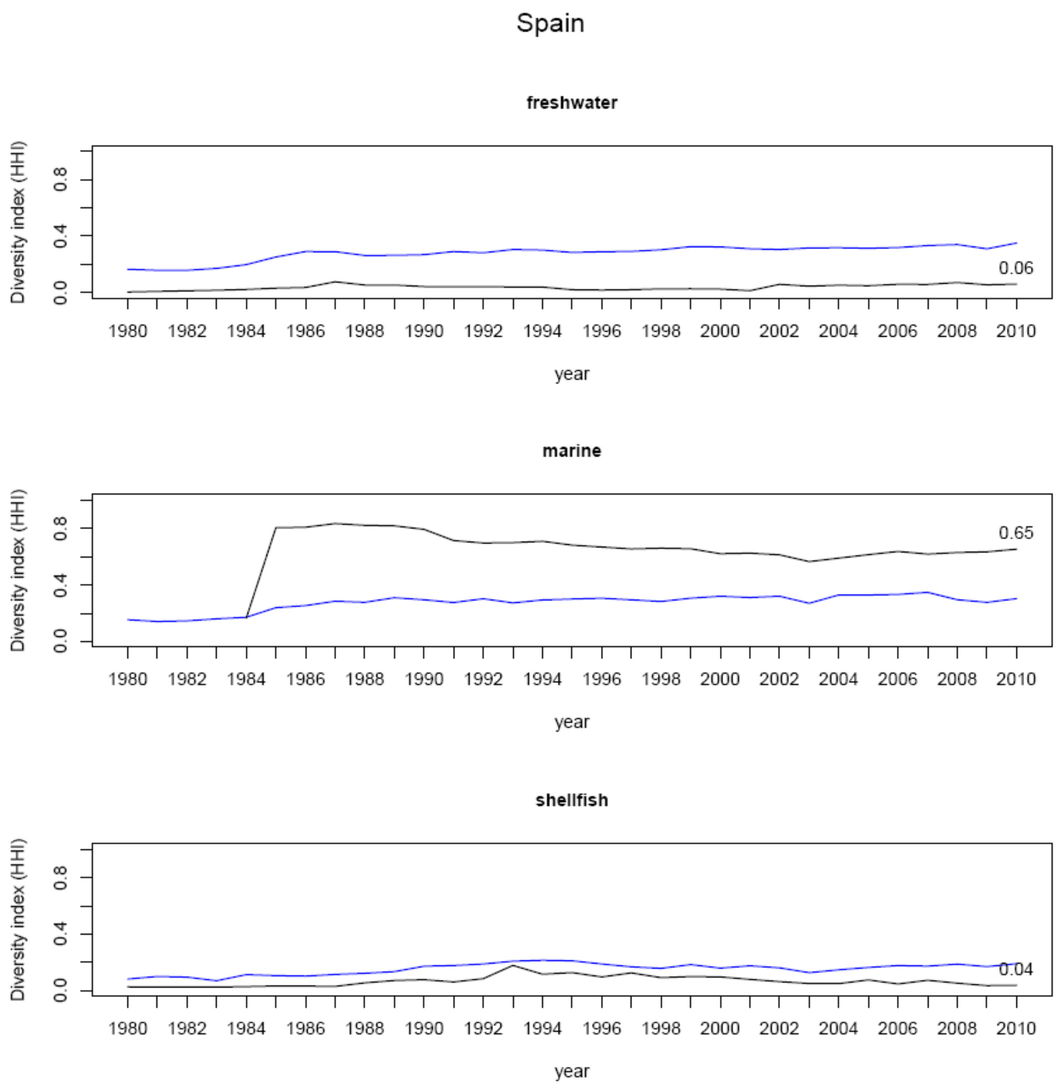


Figure 227 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.25. Sweden

Highlights and trends

- Strong finfish and shellfish aquaculture with a positive trend for growth in all three segments.
- Almost 50% of production by few large entities.
- Freshwater and marine finfish production is export oriented
- Employment is the segment is limited.
- High labour productivity in the freshwater segment.
- Apparent consumption of fisheries products is high.
- Relative high demand of fishmeal / fish oil.
- Effluent load from marine finfish aquaculture is lower than EU average.

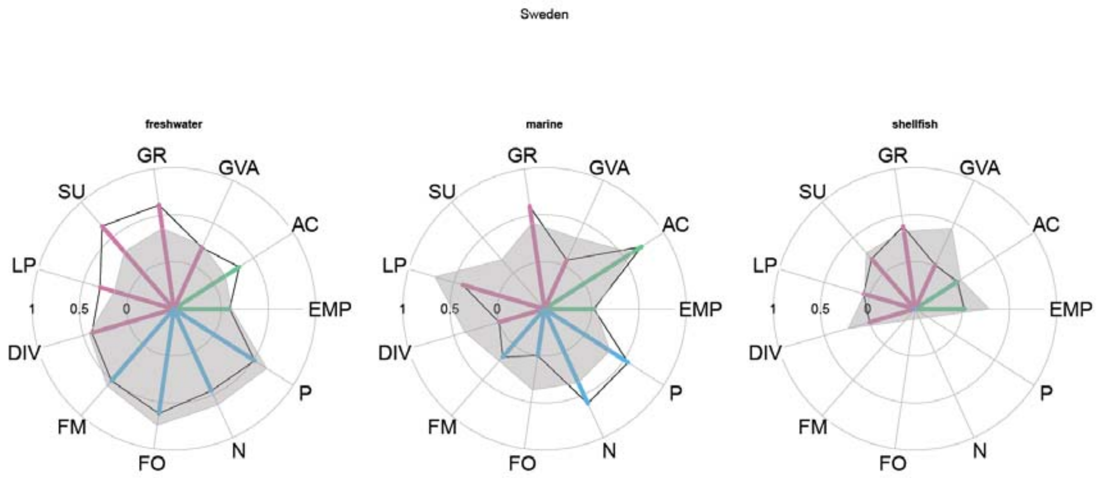


Figure 228 Performance indicators for Sweden

Overview of the sector

The aquaculture sector in Sweden presents a total volume of some 10,600 tonnes in 2010. The two main species are rainbow trout (in freshwater and saltwater) and blue mussel on long lines, presenting almost 100% in the marine environment, followed by arctic char, oyster and crayfish. The finfish segment holds the biggest share with around 87%. A small number of enterprises produce salmon in raceways and ponds for stocking in open waters.

Over the last decade the Swedish aquaculture sector has experienced a structural consolidation with a trend towards clustering to larger units. The 4 largest enterprises now account for almost 50 per cent of the total value of aquaculture production. Most of the 191 entities are located in sparsely populated areas.

Aquaculture in Sweden appears to have a large potential for further development with a clear political goal to expand the sector in line with the increasing demand for locally produced, environmentally sustainable food. Projects and investments are undertaken, particularly to explore the potential of marine finfish aquaculture.

After a long period of relative stable production, the freshwater finfish aquaculture shows a strong increase for 2010 and also the marine finfish production is in a raise. The recent growth of production in both segments influence the five-year trend (+14% and +15%, respectively). The shellfish segment is characterised by strong fluctuations in production output and a slight positive trend since 2006 (+0.8%).

Aquaculture makes only a small contribution to the GVA with an increasing importance of the freshwater finfish segment which is coming close to the EU ratio for 2010.

The freshwater and marine finfish production (mainly trout and char) contributed in 2010 with almost 220% to the available supply in that segment which shows its importance to the outgoing trade. This is underlined by the positive value in the trade balances for finfish products. Similar to the production pattern, the contribution of shellfish aquaculture to the available supply in this segment is characterised by some fluctuation between 33% and 50%.

From the few available data, the modeled employment rate over the last 15 years shows in the freshwater aquaculture a downward trend which obviously changed in 2010. Along the production in 2010 almost 300 persons should be employed in the segment. For the marine finfish aquaculture the model sees since 2002 some upward trend with some 70 persons employed in 2010, while the employment in the shellfish segment fluctuates with the production and a constant low ratio.

While apparent per capita consumption of freshwater products rose until 2009 from 7.4 kg, it fell in marine finfish products to 16.6 kg. In shellfish products consumption remained relatively low over the years.

In absolute terms, freshwater finfish production used estimated 2,300 tonnes of fishmeal and 1,000 tonnes of fish oil, the marine finfish segment around 1,220 tonnes of fishmeal and around 900 tonnes of fish oil. Per tonne fish produced, the demand is higher in the marine than in the freshwater environment, although below Union level for the use of fishmeal but highest for fish oil. The differences to the EU level are mainly due to the strong production of salmonids.

Estimated N and P effluents are with some 61 kg N and 9 kg P per tonne finfish produced above the Union level in the freshwater segment but with around 47 kg N and 8 kg P well below the Union level in the marine environment. For 2010, in total around 530 tonnes of N and 80 tonnes of P effluents were calculates.

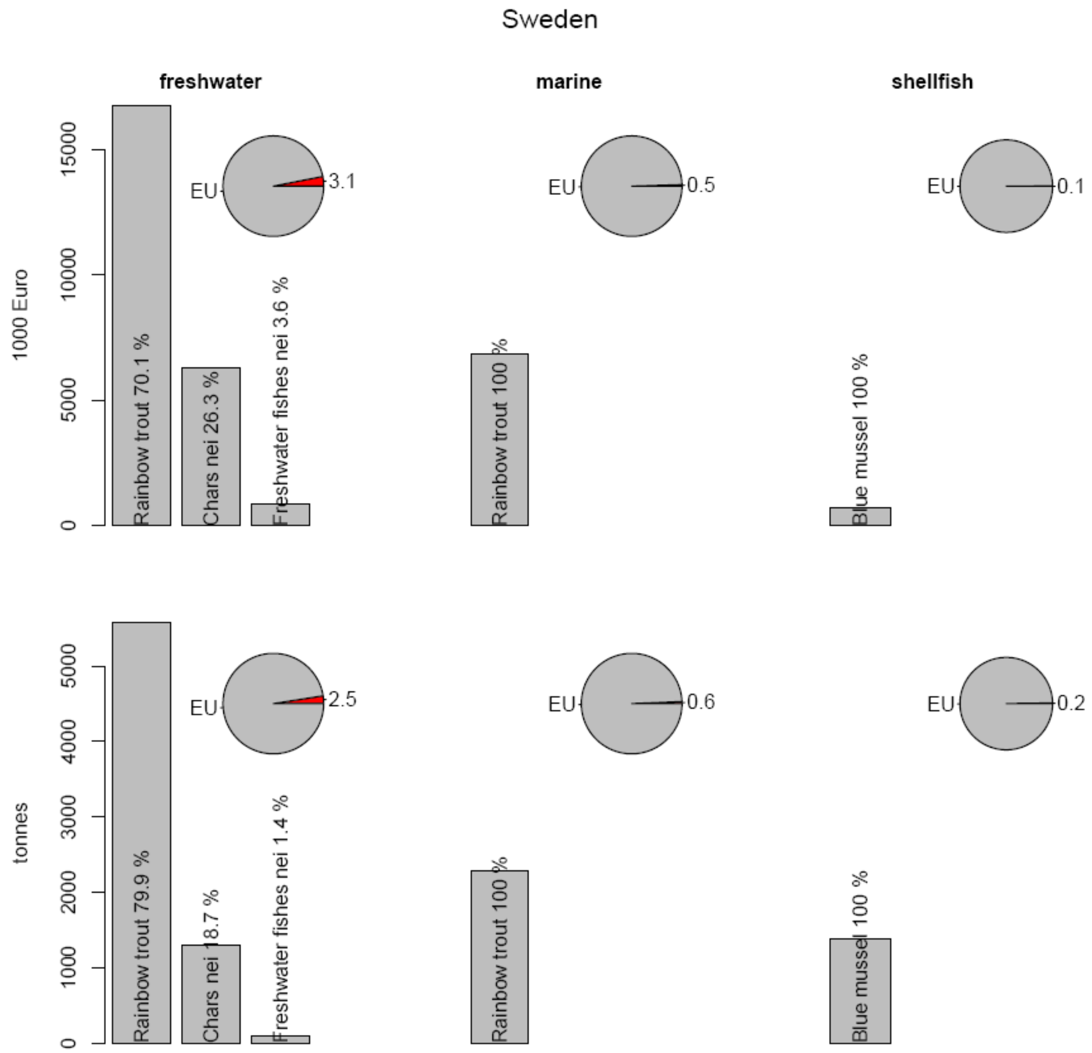


Figure 229 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

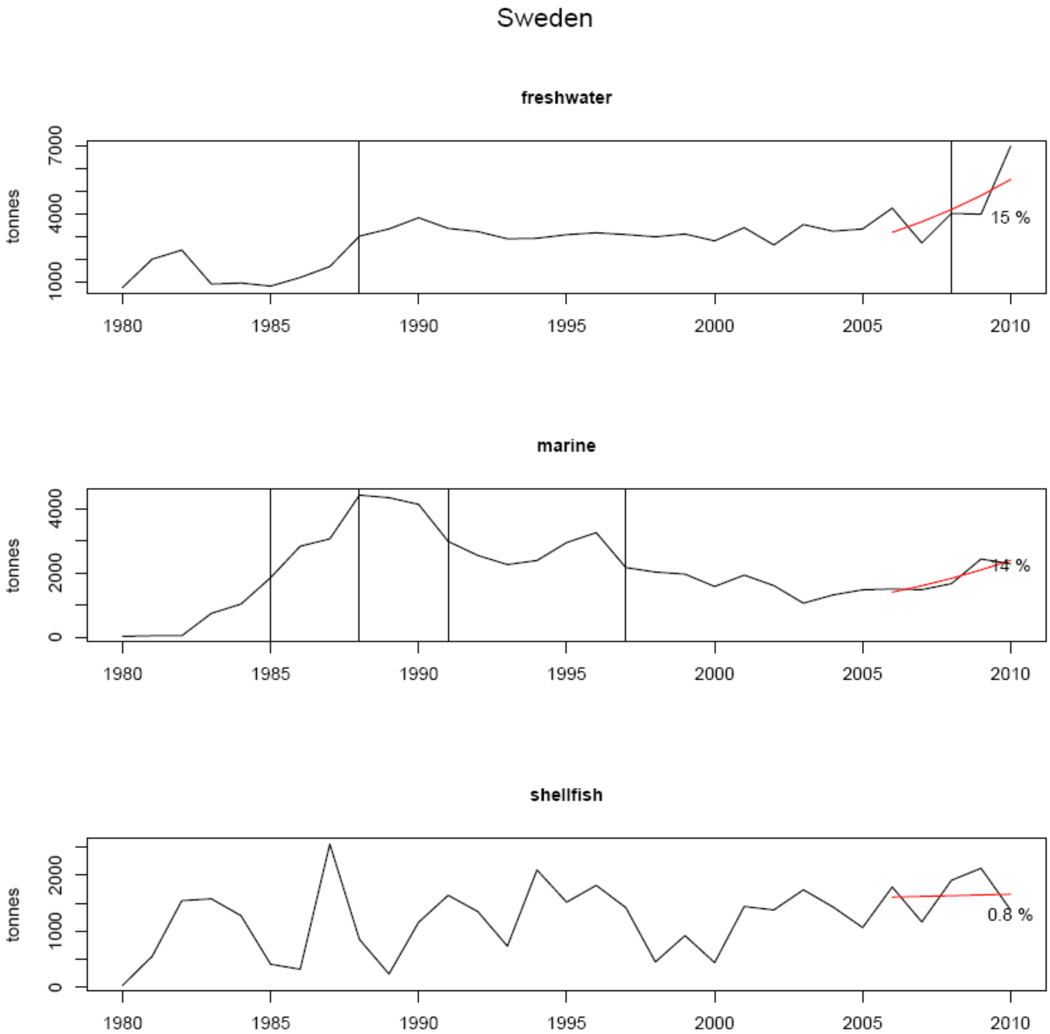


Figure 230 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

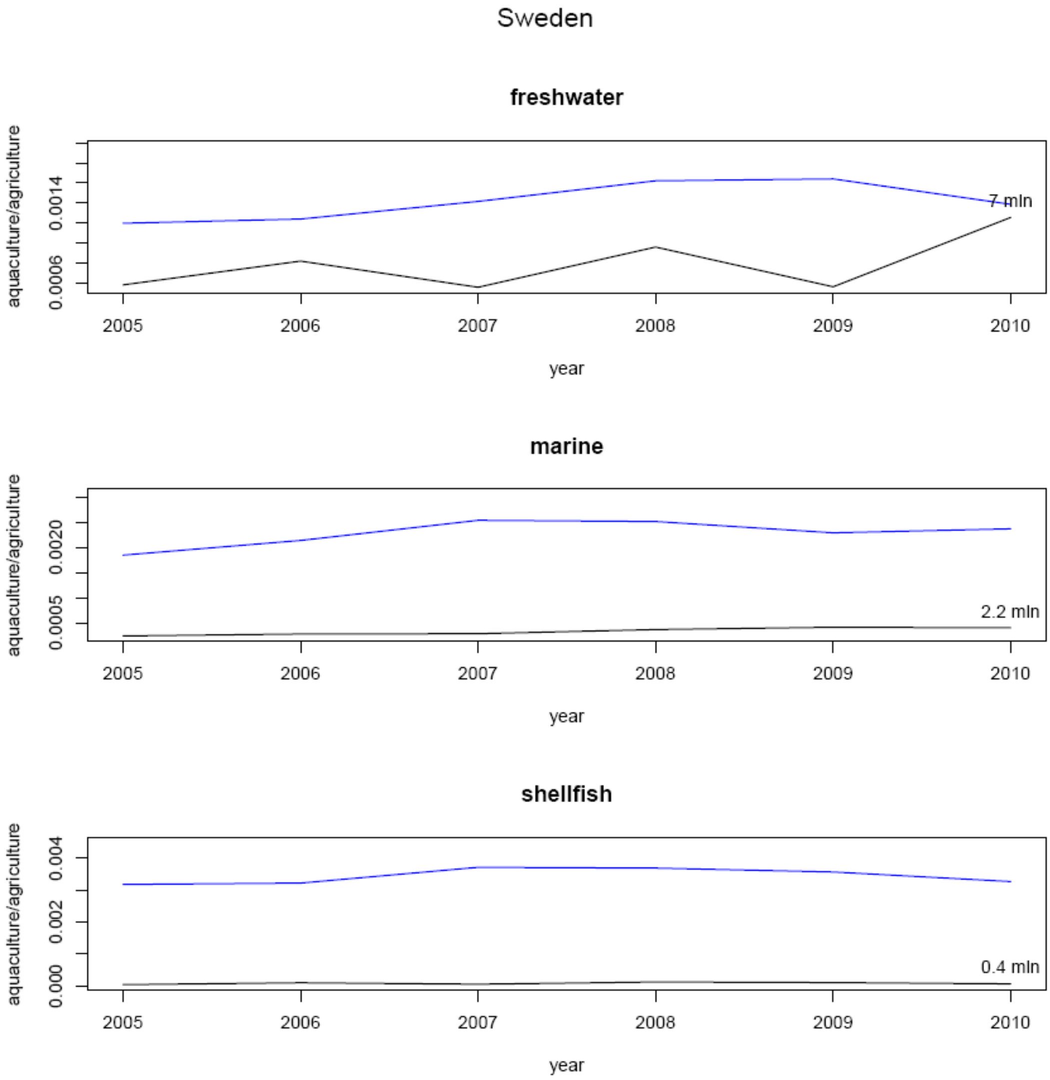


Figure 231 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

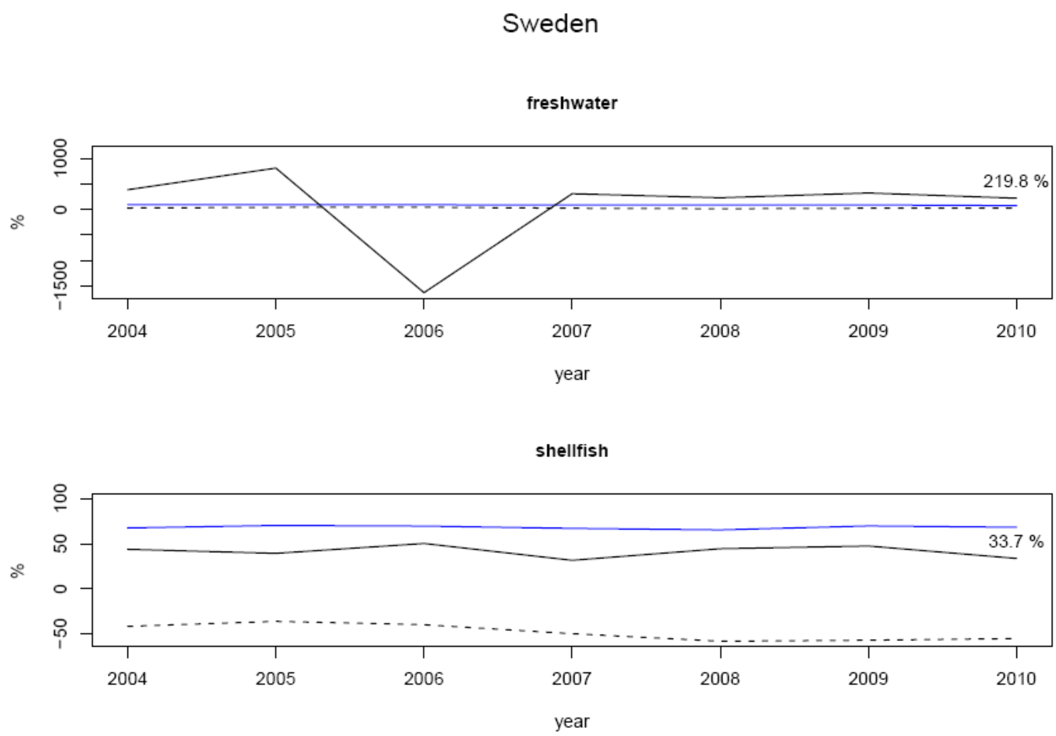


Figure 232 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species (for simplification, freshwater and marine trout production were merged for calculating self-sufficiency); black line: self-sufficiency of Sweden, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments.

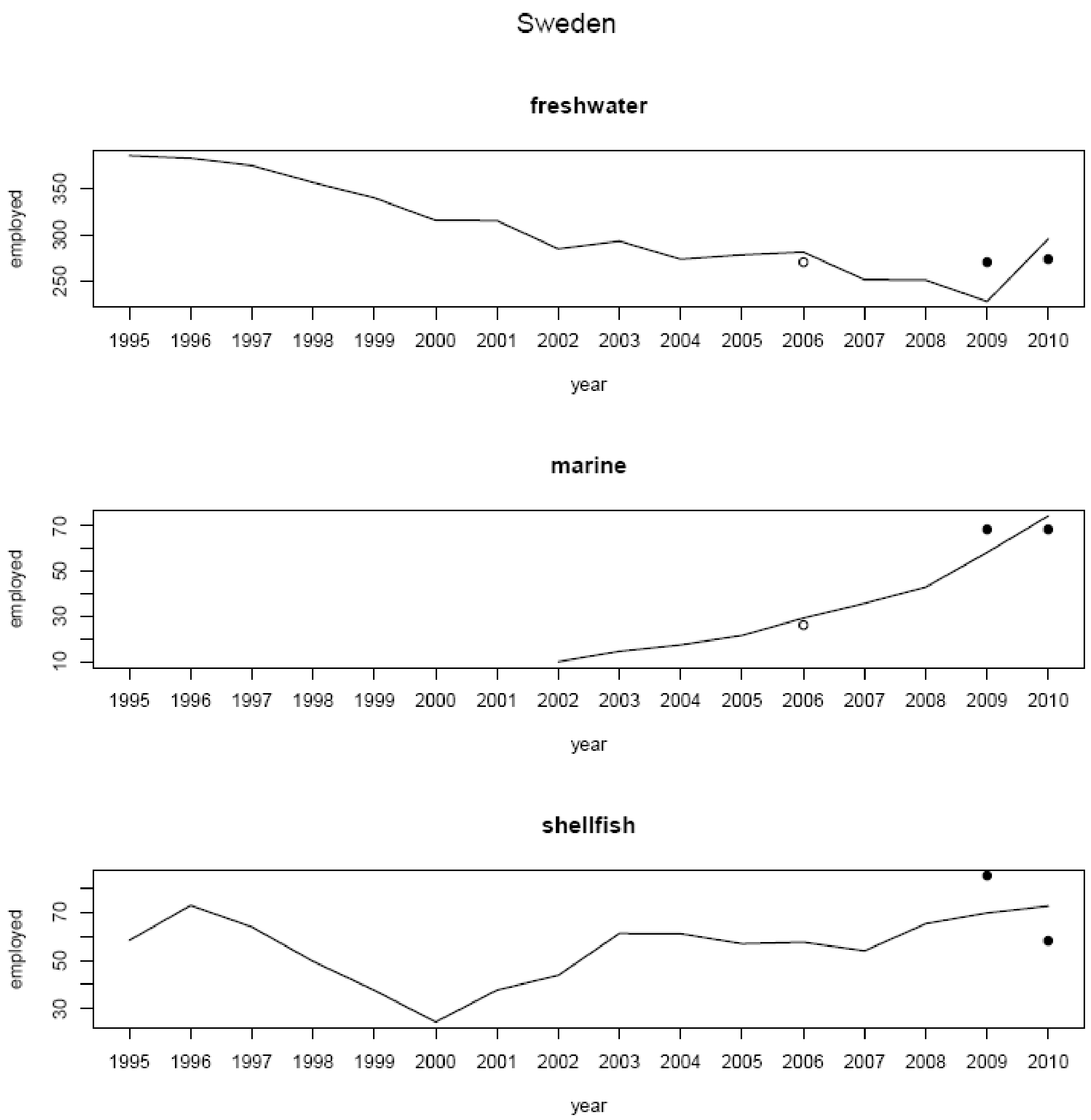


Figure 233 Number of employed persons in aquaculture in Sweden over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from STECF (2012 and 2013) (black dots), FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots) - calculated values below 10 persons employed are not pictured.

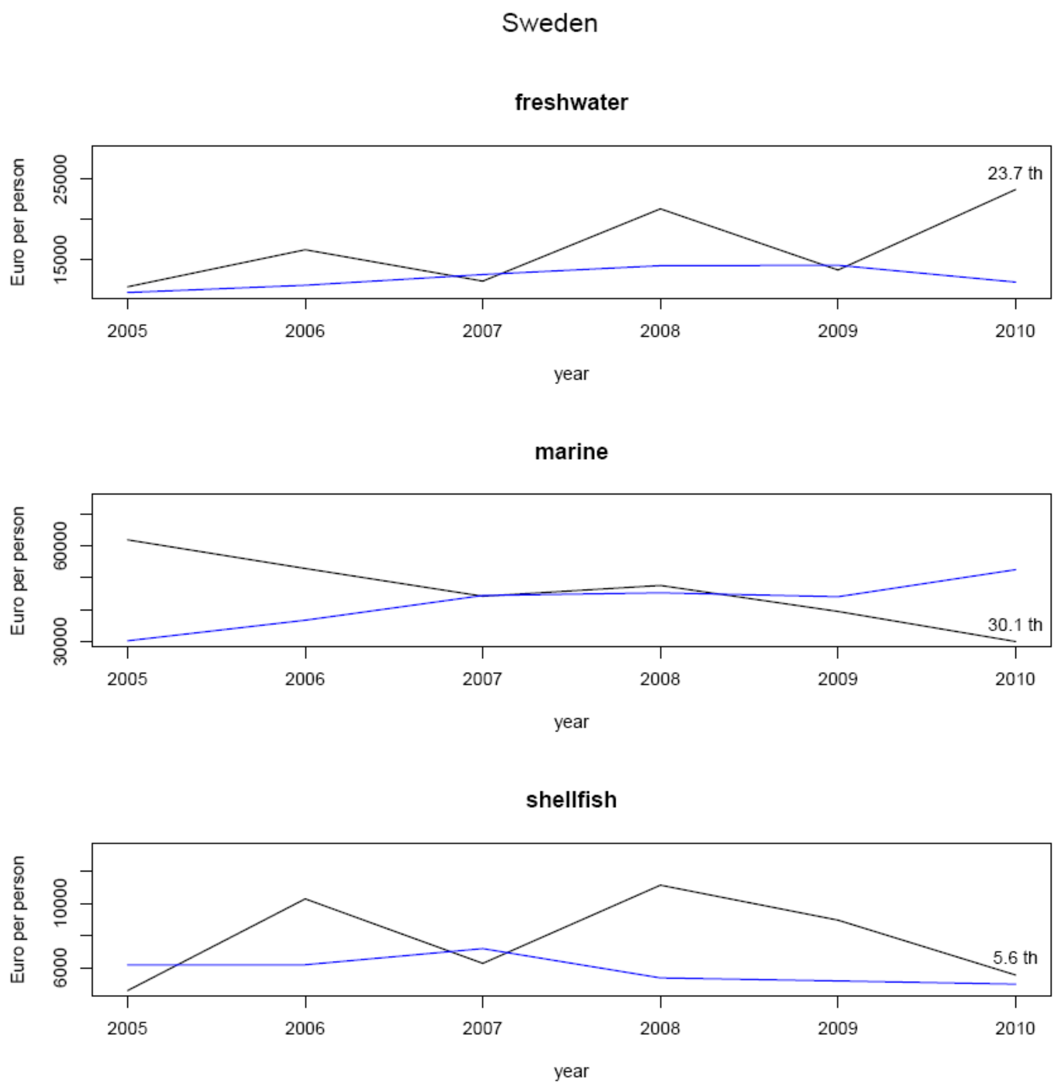


Figure 234 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

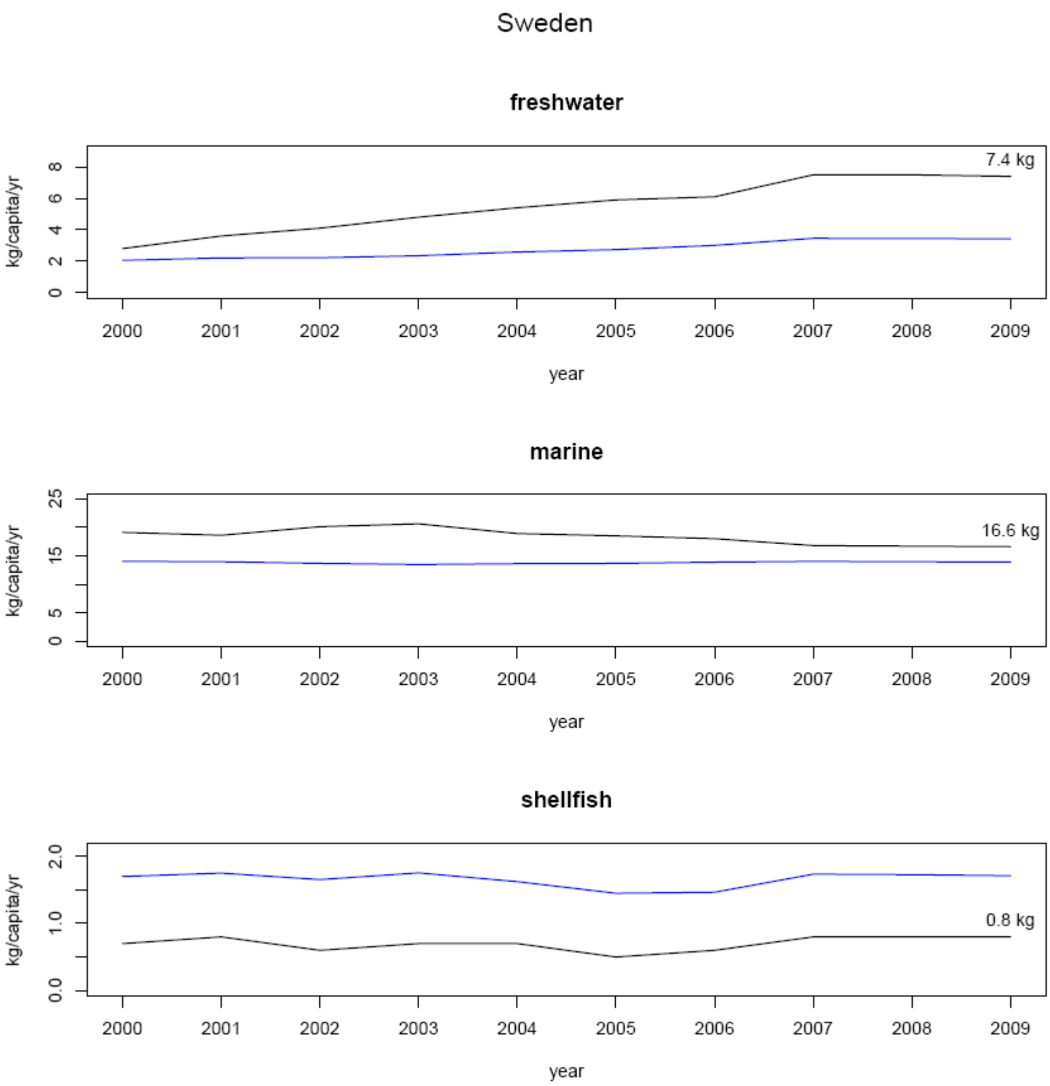


Figure 235 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

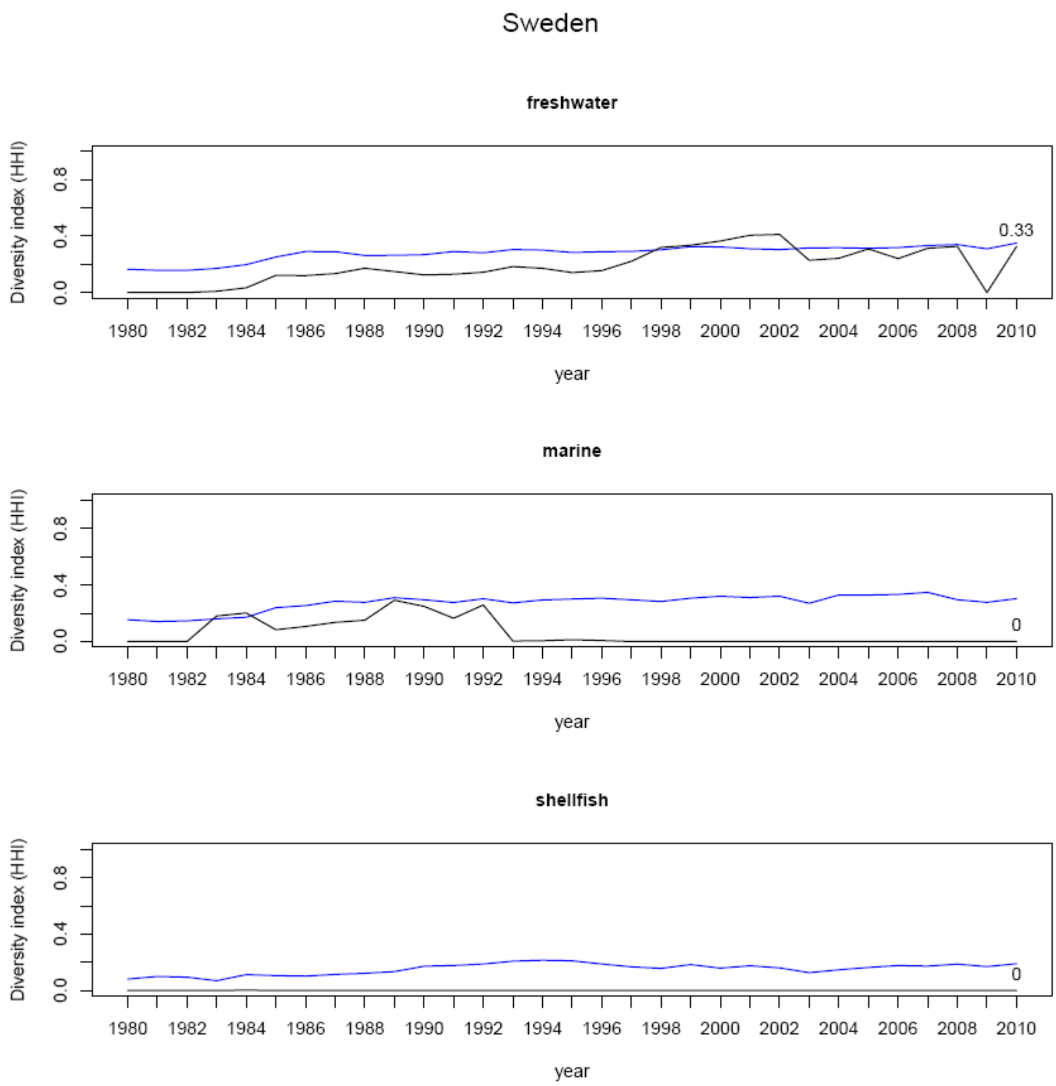


Figure 236 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

5.26. United Kingdom

Highlights and trends

- Largest marine finfish industry in the Union, mainly producing Atlantic salmon and strong freshwater and shellfish production. All three segments show a positive trend in production.
- Highly specialised salmon entities.
- Salmon contributing strongly to the country's outgoing trade.
- Marine finfish production shows a high GVA.
- Employment is in all three segments limited.
- Labour productivity is in all three segments high.
- High demand of fish oil in the marine finfish production.
- Effluent load from marine finfish aquaculture is lower than EU average.

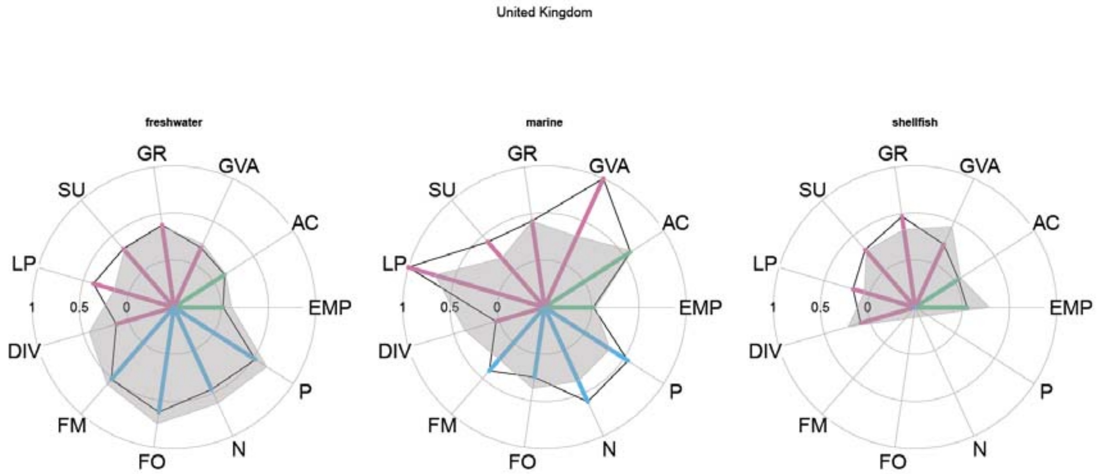


Figure 237 Performance indicators for the United Kingdom

Overview of the sector

Being the third largest aquaculture producer in the Union, the UK has the strongest marine finfish production. The marine finfish segment presents almost 37% of the EU production in this segment by value and 44.2% by volume. Atlantic salmon production has by far the biggest share with 156,850 tonnes in 2010, accounting for a turnover of more than 500 million Euro. Production of rainbow trout adds in the marine finfish environment some 1% to this segment, while it is with 94% the predominant species in the freshwater segment. The most common shellfish species in the UK are blue mussel (92% by value, 96% by volume) and oyster spp. (7% by value, 4% by volume) having a share of 5% in the EU shellfish segment by volume (some 31,500 tonnes in 2010).

There are some 442 entities operating around 800 sites. Atlantic salmon production in sea cages forms a highly commercialized industry, concentrated mainly in Scotland and owned by various large companies. Freshwater production in ponds, tanks or raceways and sea cages and shellfish production on bottom and rafts is more spread over the UK.

The marine finfish aquaculture seems to experience after a steady growth some saturation with a slight upward trend since 2006 (+3.2%). Also the shellfish segment continuous in a long positive trend (+6.2% since 2006). In contrast, the freshwater segment shows a slow decrease of production over the last two decades with a slight positive trend for the last five years of +0.56%.

While for the freshwater and shellfish production the GVA is below the EU ratio, the marine salmon aquaculture presents an important segment in relation to the agriculture production. While the GVA ratio for freshwater finfish re-bounced in 2010 after a low in 2009, the ratio for shellfish is decreasing over the last years.

The salmon finfish production contributed in 2010 with almost 120% to the available supply in that segment which shows its importance to the outgoing trade. This is underlined by the positive value in the trade balances for marine finfish products. Freshwater and shellfish production present around 80% and 76%, respectively to the available supply in those segments.

The estimated trend in the employment for the marine finfish aquaculture shows a decline from some 1,400 persons in 2001 to around 350 in 2010. Unofficial sources report around 1500 employed persons in 2009 and 2010. This seems to indicate an under-estimation of the employment figures modelled in this study. Further information would be needed to better understand the specific employment situation in the marine finfish segment.

From the available data in the freshwater and shellfish aquaculture, the estimated employment shows over the last 15 years a steady upward trend but remaining well below the EU.

For freshwater and marine finfish products the apparent per capita consumption is very close to the EU average, while for shellfish products it is with around 1 kg well below EU average.

As a consequence of the strong salmon aquaculture, the marine finfish segment dominates the fishmeal and fish oil demand (in 2010, around 63,000 tonnes fishmeal and 46,000 tonnes oil in marine versus 4,200 and 1,900 tonnes in freshwater environment). The demand of fishmeal and fish oil in the freshwater segment is above EU level (around 329 kg and 148 kg, respectively) but below the marine segment with some 403 kg fishmeal and 294 kg fish oil per tonne finfish. Although in the marine production the demand for fishmeal per tonne fish is below the demand at Union level, it is highest for fish oil.

N and P effluents per tonne finfish produced are above the Union levels in the freshwater segment (around 61 kg N, around 9 kg P) but well below that level in the marine environment (around 47 kg N, around 8 kg P). For 2010, a total around of 8,100 tonnes of N and some 1,400 tonnes of P effluents were calculates, with around 90% steaming from the marine finfish production.

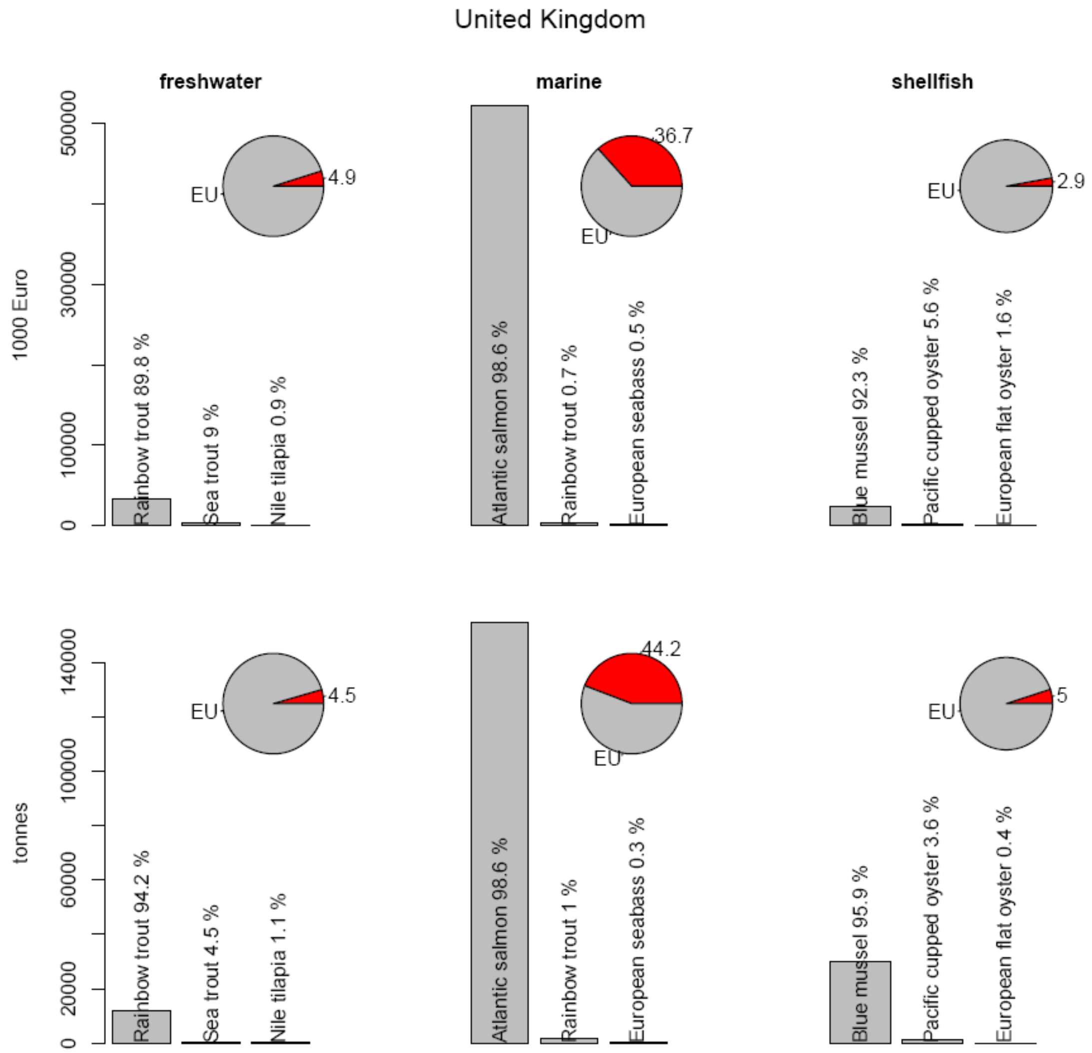


Figure 238 Production in 2010 by value and volume for the predominant species produced as well as the share on the EU production in the freshwater finfish, marine finfish and shellfish segment.

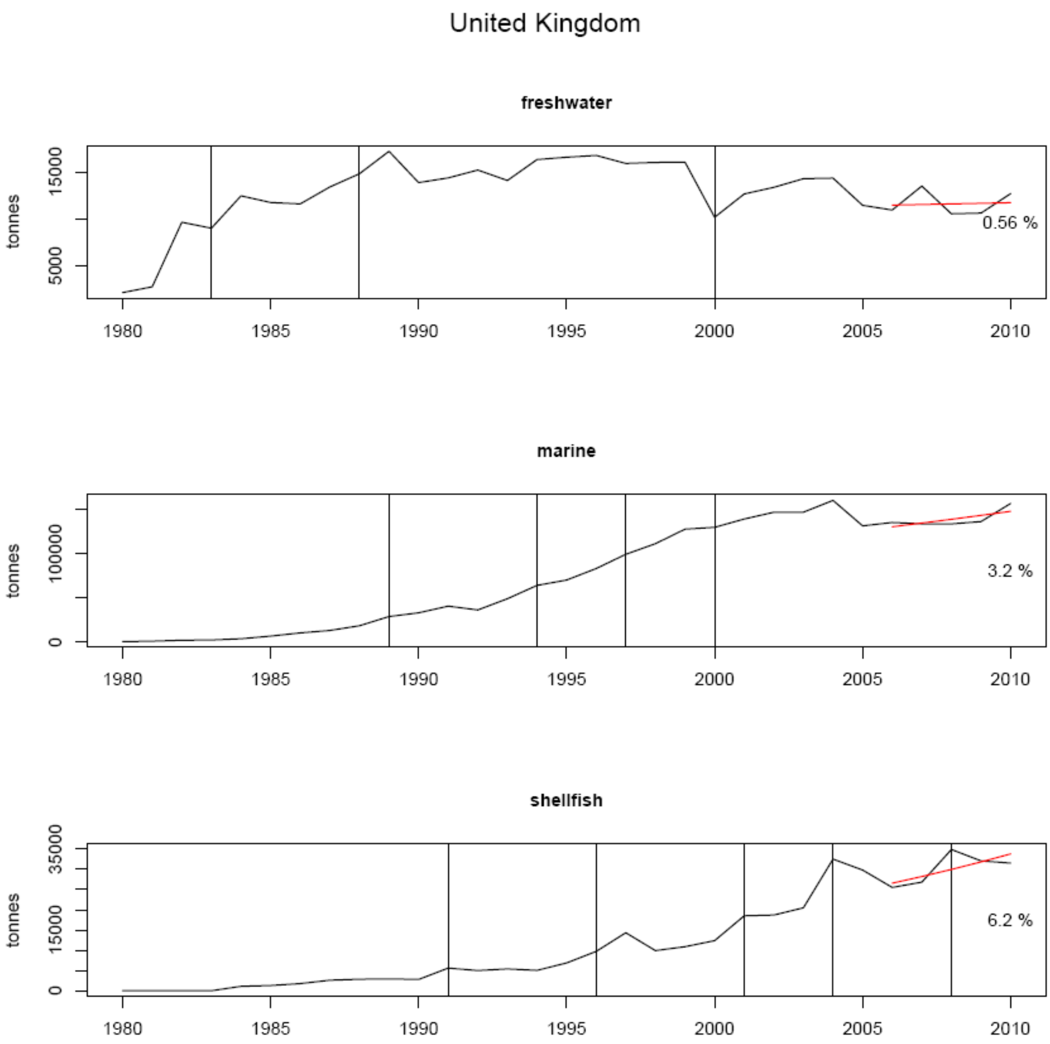


Figure 239 Production growth: Production patterns of the freshwater, marine finfish and shellfish segment by volume over time until 2010 with the trends of the last five years (2006-2010).

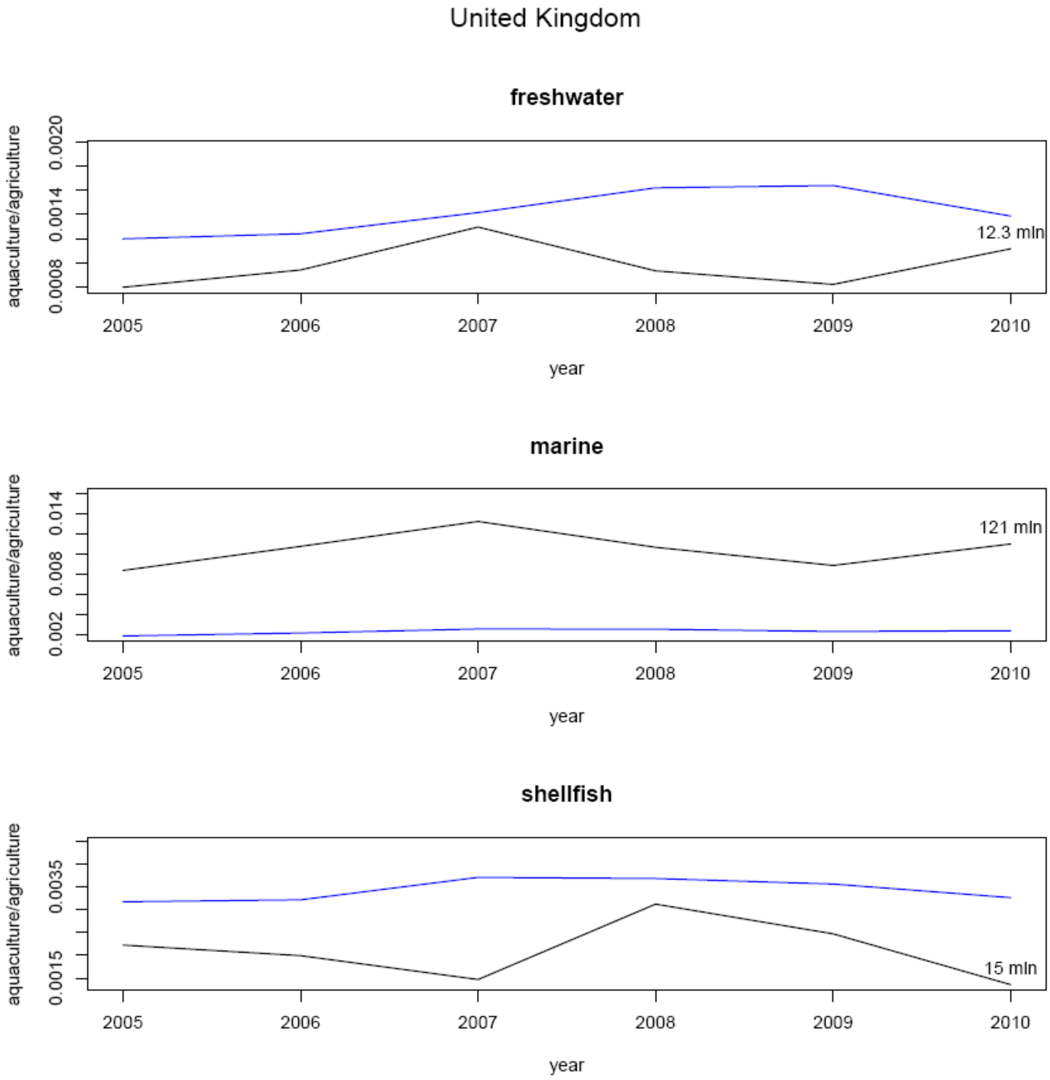


Figure 240 GVA: Economic importance of the output by the different segments over time in relation to the output of agriculture (x-axis years 2005-2010, y-axis ratio of GVA of the segment to GVA of agriculture, value of the aquaculture production reported in official statistics minus estimated operational costs in Million Euro, blue line = GVA ratio for the EU as a whole).

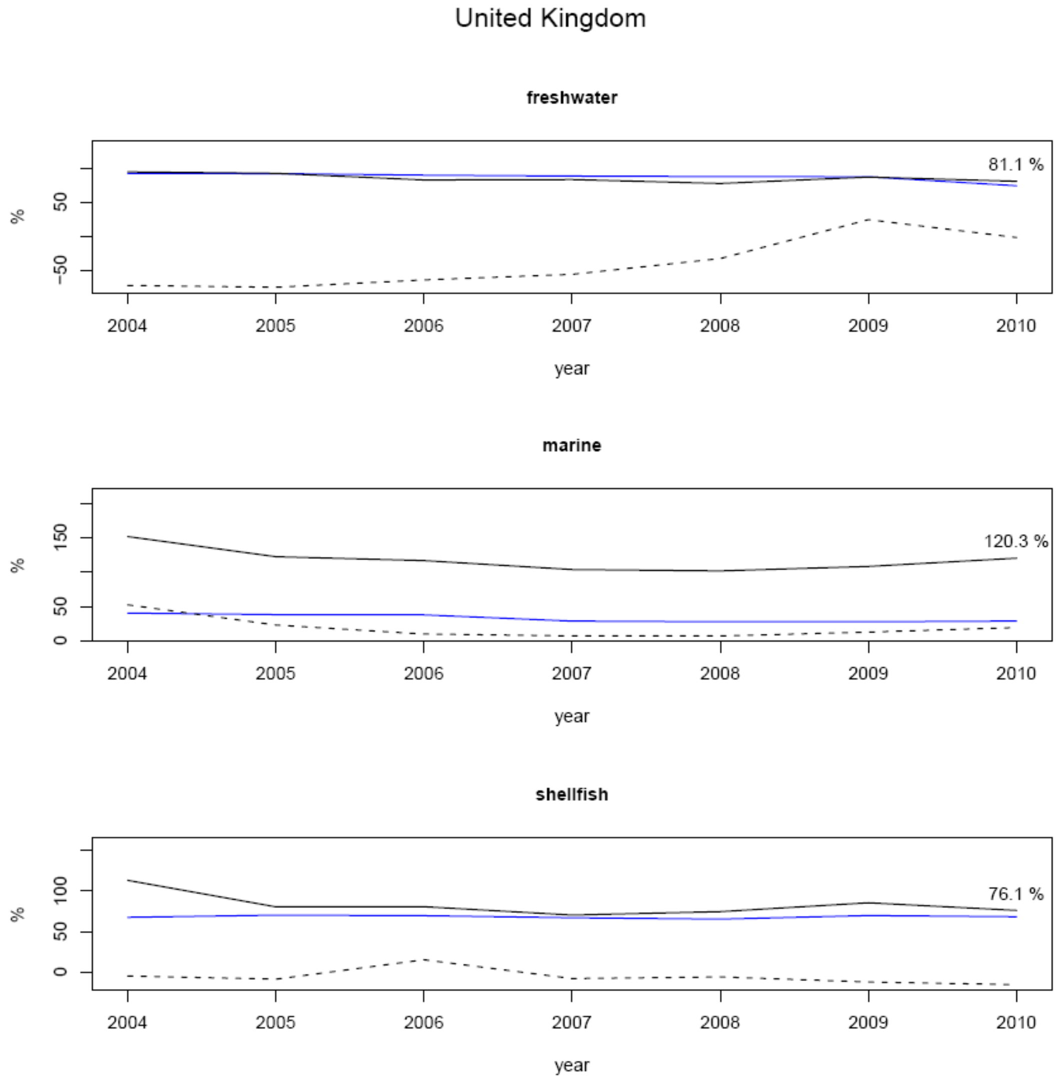


Figure 241 Self-sufficiency and trade: Share of aquaculture to the total available supply of fisheries products of the same segment in percentage for the years 2004,- 2010 taking into account the main commercial species; black line: self-sufficiency of Sweden, blue line: overall self-sufficiency of the EU production in the segments, dotted line: normalised trade balance on fishery products in the relevant segments..

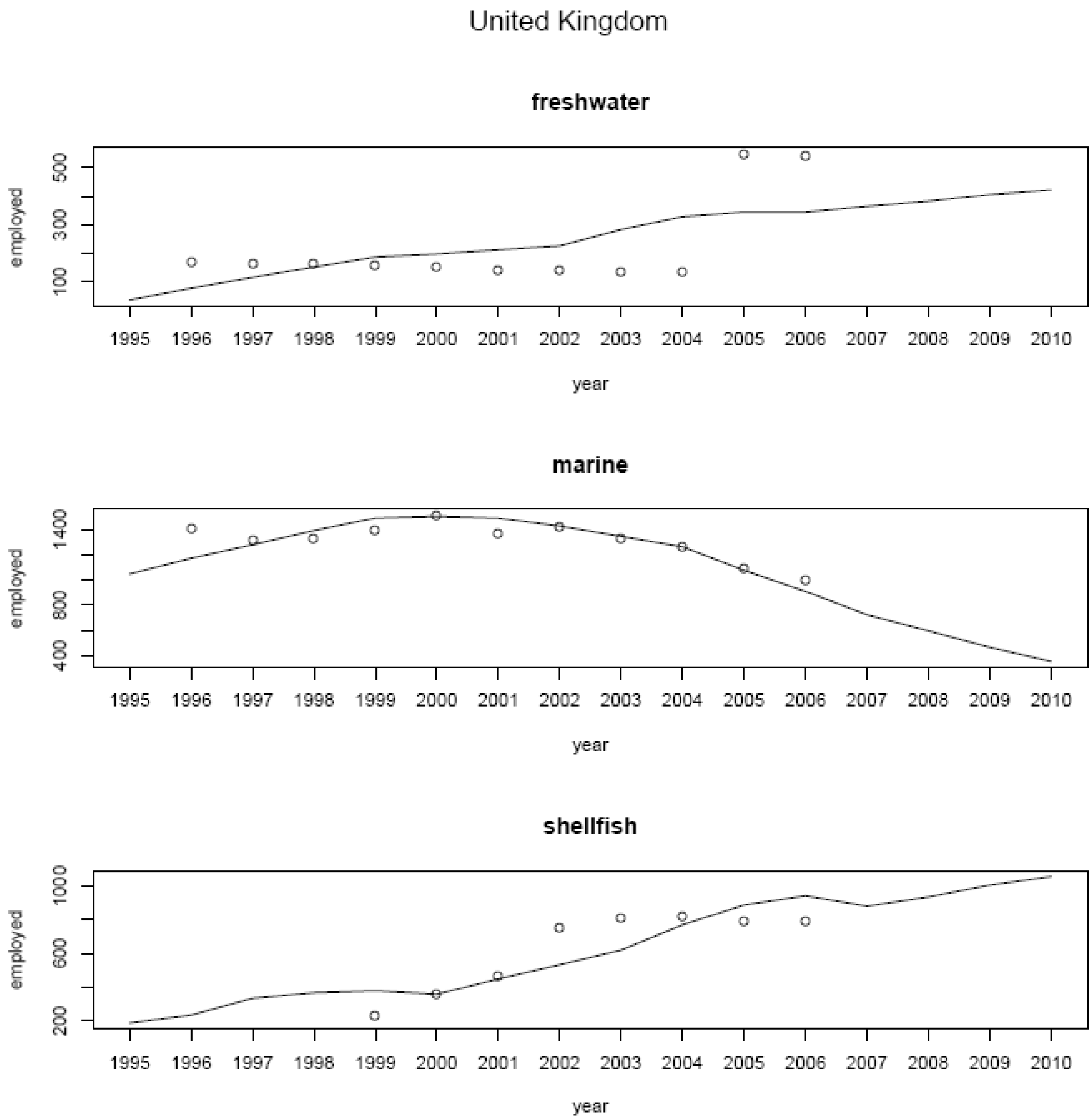


Figure 242 Number of employed persons in aquaculture in the United Kingdom over time. The trend lines are derived from country specific models based on FAO production statistics and employment data from FRAMIAN (2006 and 2009) and Salz and Mac Fayden (2007) (white dots).

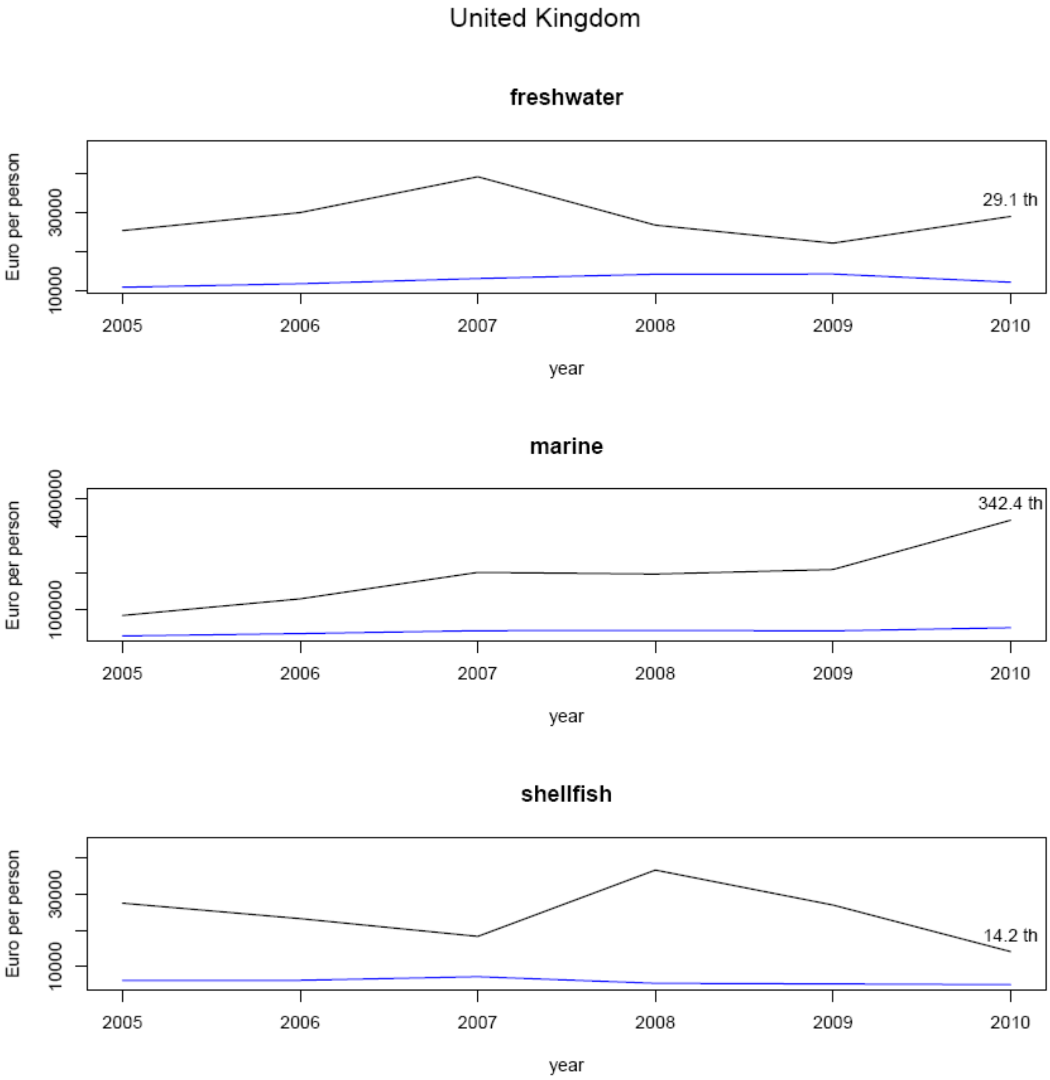


Figure 243 Labour Productivity: Ratio between employment and GVA for each relevant segment over time (y-axis: value produced per employed person per year in Euro; value of labour productivity for 2010 indicated in the graph, blue line: labour productivity of the relevant segment for the EU in total).

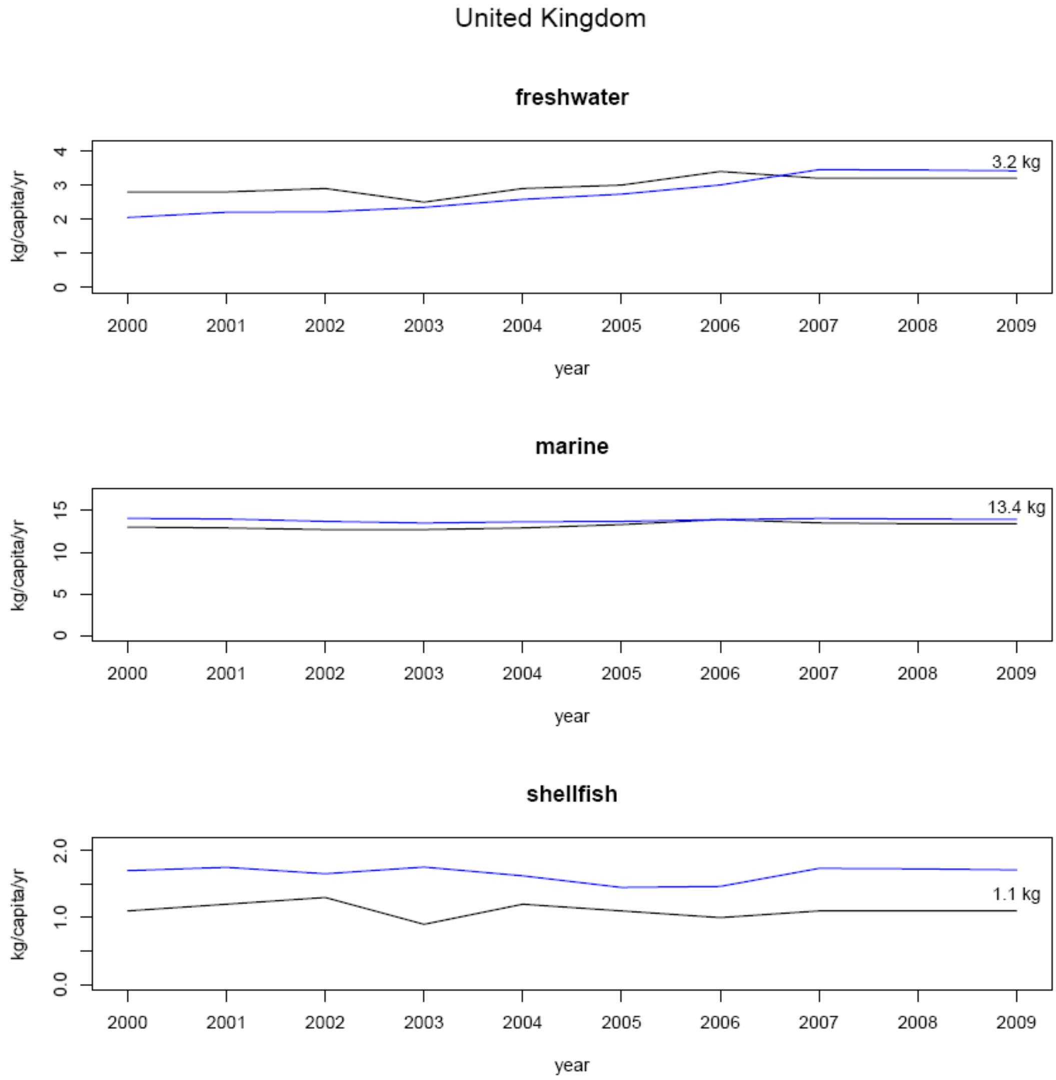


Figure 244 Apparent consumption: apparent per capita consumption by segment over time (y-axis: kg/capita/year; value for 2009 indicated in the graph, blue line: per capita consumption in the relevant segment for the EU in total).

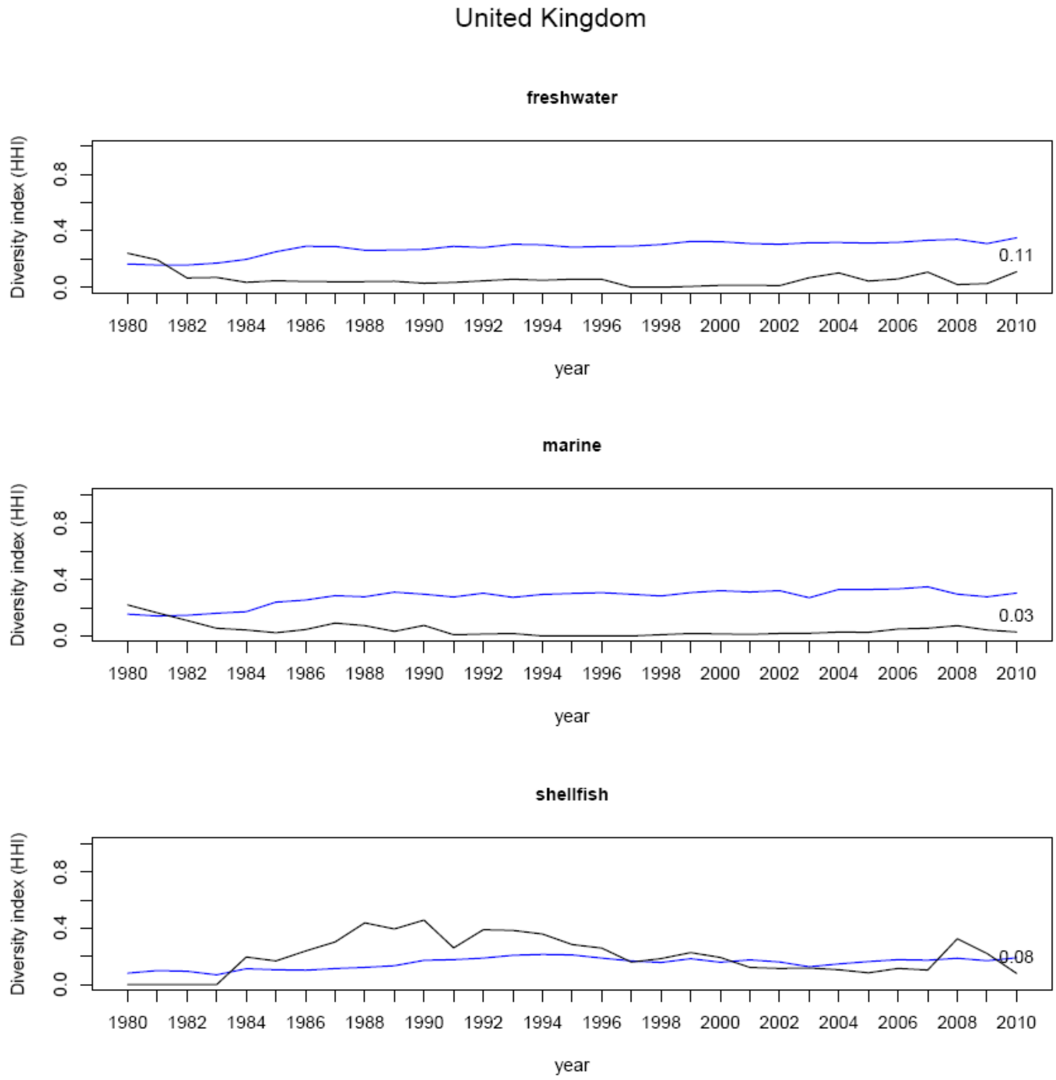


Figure 245 Diversification: Index on number of species and how evenly the production is distributed among the species within the segment over time (blue line – diversification index for the EU in total for the relevant segment)

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Annex I Methods and supplementary data

The selection of indicators was carried out on the basis of measurability, country coverage and relevance to the EU aquaculture developments goals set in the new Common Fishery Policy. Since aquaculture is a small and relatively young sector there is very few data available in official statistics to asses its performance at EU level.
As stated in the chapter on methodology, the EU Data Collection Framework (DCF) is providing data on the performance of marine aquaculture but is still too recent and incomplete to provide a full coverage for all the segments and countries and is not including environmental aspects. While using as much as possible DFC data, the report is based on official statistics on production to calculate missing values and establishing longer time series for most of the indicators.

1. *Contextual data on production*

Contextual data on production quantity and value was included as background information to understand the specific production systems which characterise the three main segments in each country. Production data was extensively used as variable to derive the indicators in case of missing information. The three main segments of marine, freshwater and shellfish aquaculture are made in most countries by few key species/production system therefore it was considered justifiable to present the indicators at this higher level of aggregation while more detailed segmentations by species and species farming systems combinations was used in the calculations of the supporting data for the indicators. The data on production was taken from the FAO (2012) Global Aquaculture Production database. A comparison with EUROSTAT statistics indicated that there are minor differences between the two data sources which can be attributed to the reporting of the production of some species under different environment (i.e. freshwater versus marine in the case of some anadromous species), the reporting under capture versus aquaculture statistics in the case of tuna fattening and the fact that FAO data includes estimates for values of production in the case of missing data.

Recently both FAO and EUROSTAT have started to collect data also about surfaces and breakdown of production by farming typologies however no data has been yet made public. Additional information regarding the share of production among different production systems has been obtained from the STECF aquaculture report of 2012 (STECF, 2012) and from the review of the EU aquaculture sector by FRAMIAN (2009). The breakdown of production by farming typology was in particular used for the calculation of specific cost structures for the GVA indicator and for the calculation of the environmental indicators.

The following table lists for the 3 main species in each segment and country the production volume and its cumulative share of the total production in the segment.

Table 4 Production for main species in 2010

Country	Species	Freshwater Prod (t)	Freshwater Share (%)	Marine Prod (t)	Marine Share (%)	Shellfish Prod (t)	Shellfish Share (%)
Austria	Rainbow trout	1211	55.9				
	Common carp	348	71.9				
	Brook trout	256	83.8				
Belgium	Freshwater fishes nei	200	83.7				
	Rainbow trout	39	100				
Bulgaria	Rainbow trout	2909	40.3				
	Common carp	1906	66.8				
	Bighead carp	1294	84.7				
	Mediterranean mussel					698	100
Cyprus	Gilthead sea bream			2807	69.4		
	European sea bass			1198	99		
	Rainbow trout	69	97.2				
	Japanese sea bream			14	99.3		
	Siberian sturgeon	2	100				
Czech Republic	Common carp	17746	86.9				
	Grass carp(=White amur)	488	89.3				
	Rainbow trout	476	91.6				
Denmark	Rainbow trout	24450	94.9	9900	100		
	Blue mussel					2500	100
	European eel	650	97.5	1250	99.1		
	Brook trout	250	98.4				
Estonia	Rainbow trout	488	85.2				
	Common carp	39	92				
	Sturgeons nei	24	96.2				
Finland	Rainbow trout	1715	89	9269	94.1		
	European whitefish	146	96.6	577	100		
	Freshwater fishes nei	58	99.6				
France	Pacific cupped oyster					90000	50.8
	Blue mussel					61000	85.2
	Rainbow trout	32000	77.7				
	Mediterranean mussel					14000	93.1
	Common carp	4200	87.9				
	Roach	1900	92.5				
	European sea bass			1400	44.8		
	Gilthead sea bream			900	60.3		
Germany	Rainbow trout	19982	56	14	100		
	Common carp	9634	83				
	Blue mussel					4905	98.4
	Freshwater fishes nei	4028	94.3				
	Pacific cupped oyster					80	100
Greece	Gilthead sea bream			54000	61.5		
	European sea bass			31000	96.7		
	Mediterranean mussel					22500	100
	Rainbow trout	2600	83.9				
	Marine fishes nei			1750	98.7		
	European eel	340	94.8				
	Common carp	110	98.4				
	European flat oyster					10	100
	Venus clams nei					1	100

Table 4 Production for main species in 2010 (cont.)

Hungary	Common carp	9927	69.7				
	North African catfish	1810	82.4				
	Silver carp	1081	90				
Ireland	Blue mussel					21934	74.8
	Atlantic salmon			15691	97.3		
	Pacific cupped oyster					6942	98.5
	Rainbow trout	668	91.3	434	100		
	European flat oyster					219	99.2
	Arctic char	40	96.7				
	European perch	24	100				
Italy	Mediterranean mussel					64256	63.6
	Japanese carpet shell					35000	98.3
	Rainbow trout	33172	85.9				
	Gilthead sea bream			4063	29.4		
	European sea bass			3683	76.1		
	Trout nei	1710	90.3				
	Sea trout	1512	94.2				
	Grooved carpet shell					1048	99.3
Latvia	Common carp	439	80.1				
	Wels(=Som)catfish	27	85				
	Northern pike	18	88.3				
Lithuania	Common carp	2936	92				
	Northern pike	106	95.4				
	Trout nei	34	96.4				
Malta	Gilthead sea bream			1755	60.2		
	Atlantic bluefin tuna			990	94.1		
	European sea bass			102	97.6		
Netherlands	Blue mussel					56227	93.4
	Cupped oysters nei					3860	99.8
	North African catfish	3200	49.3				
	European eel	3000	95.5				
	Turbot			250	92.6		
	Nile tilapia	100	97.1				
	European flat oyster					98	100
	Soles nei			20	100		
Poland	Common carp	15400	50.1				
	Rainbow trout	12940	92.2				
	Torpedo-shaped catfishes nei	650	94.3				
Portugal	Turbot			1014	45.3		
	Gilthead sea bream			767	79.7		
	European sea bass			371	96.2		
	Pacific cupped oyster					319	33.5
	Flat and cupped oysters nei					223	56.9
	Grooved carpet shell					187	76.6
Romania	Common carp	2888	32.2				
	Silver carp	2016	54.6				
	Bighead carp	1020	66				
Slovakia	Rainbow trout	546	79.5				
	Common carp	117	96.5				
	Silver carp	8	97.7				

Table 4 Production for main species in 2010 (cont.)

Slovenia	Rainbow trout	456	69				
	Common carp	160	93.2				
	Mediterranean mussel					78	100
	European sea bass			42	100		
	Sea trout	17	95.8				
Spain	Sea mussels nei					184277	98.1
	Rainbow trout	17372	96.9				
	Gilthead sea bream			16261	39.1		
	European sea bass			7040	56.1		
	Turbot			6882	72.6		
	European eel	412	99.2				
	Siberian sturgeon	70	99.6				
Sweden	Rainbow trout	5576	79.9	2283	100		
	Blue mussel					1382	100
	Chars nei	1307	98.6				
	Freshwater fishes nei	95	100				
United Kingdom	Atlantic salmon			154625	98.6		
	Blue mussel					30212	95.9
	Rainbow trout	11988	94.2	1606	99.6		
	Pacific cupped oyster					1150	99.5
	Sea trout	574	98.7				
	European sea bass			473	99.9		
	Nile tilapia	135	99.8				
	European flat oyster					117	99.9

Source: Own elaboration of FAO (2012) data

2. *Normalisation and treatment of outliers*

In order to compare the indicators across countries and segments, the values of the supporting data were normalised into homogenous scores ranging from one (more) to zero (less). The normalised indicators were established on the basis of supporting values for each indicator considering the minimum and maximum across all segments and countries according to the following formula:

$$N_{ics} = \frac{x_{qcs} - \min(x_i)}{\max(x_i) - \min(x_i)}$$

where:
N_{ics} is the normalised value for the indicator *i* for country *c* and segment *s*;
x_{ics} is the value from the official statistics or estimated from the model for the indicator *i* for country *c* and segment *s*;
$\min(x_i)$ and $\max(x_i)$ are the minimum and maximum across all countries *c* (including EU as a whole) and segments *s*.

Where needed the values for the supporting data have been constructed in such a way to neutralise effects of size, by considering for example ratios in respect of the primary sector in the case of GVA or in respect of general employment in the case of the employment indicator.
The normalization offers the possibility of comparing across segment and countries i.e. the score on employment in the marine segment for Denmark can be compared with the score for the freshwater segment for Austria.
In the normalization the EU is treated at the same level of a Member State; the EU value does not therefore represent the average across Member States.
While the normalisation is beneficial for comparison it may bring to a skewing effect. For example the high value of employment ratio for Malta sets the maximum limit for the scale of normalised scores and compresses all the other values in a limited range which makes difficult to appreciate differences.
To contain this effect, prior to the normalisation, extreme high and low values (exceeding three times the inter quartile range) were respectively re-scaled to the values of the upper and lower quartiles.

3. *Production growth*

The growth indicator provides a measurement for the rate of change of production by volume over time.

In a first step, time series over the period from 1979 to 2010 for the volume of production from the FAO statistics have been analysed to identify breakpoints in linear trends. Breakpoints were identified to delimit periods, with a minimum span of 3 years, during which a linear trend in production could be considered stable according to the statistical methodology described in Bai (2003). Graphically breakpoints have been marked with a vertical line in the time series. The growth indicator was estimated through the Ordinary Lease Squares (OLS) method using production volume data from 2006 to 2010. The OLS derives from the logarithmic transformation of the following compound growth formula and represents the common approach used in GDP growth calculations (Kakwani, 1997).

$$Xt = X_1(1+r)^{t-1}$$

where:

X_t is the volume of production for country and segment at time t;

X_1 is the volume of production for country and segment at the beginning of the time window (i.e. 2006);

r is the growth rate with compounding over the time t.

The regression equation takes the form of:

$$\ln Xt = \alpha + \beta t$$

where:

$\alpha = \ln X_1 - \ln(1+r)$ and $\beta = \ln(1+r)$

The calculation of the growth rate can be very sensitive to the endpoints of the temporal windows and consistent trend may be identified starting from different point in time. To address this issue and to allow comparison across all countries and segments the indicator refers to a fixed window of five years from 2006 to 2010 while the breakpoints analysis provides additional information on the consistency and starting point of a trend. Normalisation and treatment of outliers has been performed as described in chapter 2.

Table 5 Production growth rate for the aquaculture production by volume for the period 2006-2010

Country	Freshwater (%)	Marine (%)	Shellfish (%)
Austria	-4.5		
Belgium	38		
Bulgaria	25		39
Cyprus	-5.3	13	
Czech Republic	-0.2		
Denmark	-2.1	7.9	58
Estonia	-5.5		
Finland	-0.96	-1.4	
France	0.16	-6.8	-1.4
Germany	2.8	-44	-4.8
Greece	-3.9	2.5	-4.4
Hungary	-1.3		
Ireland	-4.5	8.7	-9.1
Italy	2.9	-5.7	-4.9
Latvia	-3.9		
Lithuania	7.6		
Malta		9.1	
Netherlands	-11	28	12
Poland	-2.8		
Portugal		-8.9	-23
Romania	4.6		
Slovakia	-15		
Slovenia	-12	24	-13
Spain	-10	7.1	-4.6
Sweden	15	14	0.8
United Kingdom	0.56	3.2	6.2
EU	**-0.49**	**3.1**	**-2.4**

Source: Own elaboration on the basis of FAO (2012)

Table 6 Calculation of the production growth indicator

Country	Freshwater			Marine			Shellfish		
	Value	Rescaled	Normalised	Value	Rescaled	Normalised	Value	Rescaled	Normalised
Austria	-4.50		0.30						
Belgium	38.00		0.98						
Bulgaria	25.00		0.77				39.00		1.00
Cyprus	-5.30		0.29	13.00		0.58			
CzechRepublic	-0.20		0.37						
Denmark	-2.10		0.34	7.90		0.50	58.00	39.00	1.00
Estonia	-5.50		0.28						
Finland	-0.96		0.36	-1.40		0.35			
France	0.16		0.37	-6.80		0.26	-1.40		0.35
Germany	2.80		0.42	-44.00		0.00	-4.80		0.29
Greece	-3.90		0.31	2.50		0.41	-4.40		0.30
Hungary	-1.30		0.35						
Ireland	-4.50		0.30	8.70		0.51	-9.10		0.22
Italy	2.90		0.42	-5.70		0.28	-4.90		0.29
Latvia	-3.90		0.31						
Lithuania	7.60		0.49						
Malta				9.10		0.52			
Netherlands	-11.00		0.19	28.00		0.82	12.00		0.56
Poland	-2.80		0.33						
Portugal				-8.90		0.23	-23.00		0.00
Romania	4.60		0.45						
Slovakia	-15.00		0.13						
Slovenia	-12.00		0.18	24.00		0.76	-13.00		0.16
Spain	-10.00		0.21	7.10		0.49	-4.60		0.30
Sweden	15.00		0.61	14.00		0.60	0.80		0.38
United Kingdom	0.56		0.38	3.20		0.42	6.20		0.47
EU	-0.49	-0.49	0.36	3.10	3.10	0.42	-2.40	-2.40	0.33

Source: Own elaboration on the basis of FAO (2012) statistics

4. *Gross Value Added*

The Gross Value Added (GVA) indicates the economic importance of the output produced by a sector of the economy and links to the GDP (Gross Domestic Product). In national accounts the GVA is calculated as the value of sales minus the monetary value of goods and services consumed or used as inputs in production. In this study the GVA for the aquaculture sector was calculated from the value of the aquaculture production reported in official statistics minus an estimate of operational costs.

The value of production was obtained at single species level from FAO statistics while in an estimate of costs was carried out for main species groups, using from the Report on Economic Performance of the EU Aquaculture Sector in 2009 (STECF, 2012) and in 2010 (STECF, 2013) and from a survey on costs and earnings of the EU aquaculture in 2006 (FRAMIAN, 2009).

Given the lack of detailed and consolidated cost data for all combination of species, farming systems, years and countries, a uniform cost structure was applied across countries, considering 15 main species groups and the following cost categories: feed, energy, livestock (seed, fry, juveniles, breeding stock, etc.), repair and maintenance and other costs (see table 7).

Costs for each group were calculated as percentage of turnover by averaging more detailed values reported in the mentioned data sets for specific country, farming system and year. In the averaging process values were weighted according to the relevance of the associated turnover to reflect a greater influence of the values reported for most representative segments in EU aquaculture.
The assumption of considering an averaged cost structure across years, countries and farming systems was considered acceptable given the main aim of the study which is to establish a macro-economic indicator covering the entire EU aquaculture. Results of the exploratory analysis of cost data supported this approach by showing limited variation in costs ratios by countries, years and farming system and indicating rather a stronger influence of species groups in particular in relation to feed and livestock costs.

A relation between the more detailed FAO statistics and the estimates of cost ratios was established by referring FAO species codes to the closest main species group. On the basis of this relation the estimated cost ratios were applied to the value of production for each aquaculture species reported in FAO statistics for 2010 to calculate the total value of operational costs. The GVA was obtained as the difference between value of production reported in FAO statistics and total operational costs. GVA values for each species have then been aggregated into the three main segments of marine, freshwater and shellfish aquaculture
To have a comparable measure relative to the size of the country the value for the aquaculture GVA was divided by the Member State’s GVA of the primary sector reported by EUROSTAT for the year 2010 (see table 8). The reference to a fixed point in time for the GVA of agriculture was necessary to avoid a masking effect by the larger variations of the agriculture GVA in respect of the much smaller aquaculture GVA. Normalisation and treatment of outliers has been applied to the ratio between the estimated aquaculture GVA in 2010 and the agriculture GVA as described in chapter 2.

Table 7 Cost structure for main species groups

Species group	Ratio between operational costs and turnover (%)					Total
	Feed	Energy	Livestock	Other	Repair	
Carp	16.5	5.3	7.4	15.8	8.0	53.0
Catfish	55.4	7.7	7.7	9.2	7.7	87.7
Clam	0.1	13.6	22.6	8.7	3.1	48.0
Eel	22.6	13.4	26.6	14.4	3.5	80.6
Mussel	0.1	5.6	18.6	13.0	5.3	42.7
Other freshwater fish	39.2	5.5	14.1	15.1	4.3	78.2
Other marine fish	17.5	4.5	24.4	25.2	3.7	75.2
Other shellfish	0.0	2.6	20.8	9.4	4.8	37.5
Oyster	0.2	2.5	33.2	13.4	3.1	52.4
Salmon	46.1	2.5	10.1	16.3	2.3	77.3
Sea bass and Sea bream	34.9	3.1	18.2	18.6	1.9	76.8
Trout	32.2	4.7	14.4	12.0	4.2	67.4
Tuna	0.0	7.2	61.9	7.6	0.0	76.7
Turbot	21.3	8.0	1.4	25.1	0.2	56.0
Carp	16.5	5.3	7.4	15.8	8.0	53.0

Source: Own elaboration on the basis of cost and earnings accounting in STECF (2012); STECF (2013); FRAMIAN (2009); and FAO (2012) production value and volume statistics

Table 8 GVA from aquaculture in 2010

Country	GVA aquaculture (million Euro)			Ratio with agriculture (%)		
	Freshwater	Marine	Shellfish	Freshwater	Marine	Shellfish
Austria	6.3			0.161		
Belgium	0.3			0.014		
Bulgaria	6.8		0.3	0.419		0.018
Cyprus	0.2	4.7		0.047	1.287	
Czech Republic	18.3			0.586		
Denmark	21.0	10.5	0.7	0.872	0.435	0.031
Estonia	0.6			0.146		
Finland	2.2	11.0		0.049	0.243	
France	41.5	9.9	248.4	0.138	0.033	0.828
Germany	30.7	0.0	2.7	0.158	0.000	0.014
Greece	3.3	81.2	5.5	0.050	1.226	0.082
Hungary	11.1			0.384		
Ireland	0.7	16.9	19.9	0.054	1.240	1.460
Italy	32.2	21.4	70.1	0.122	0.081	0.266
Latvia	0.4			0.062		
Lithuania	2.8			0.333		
Malta		5.6			5.408	
Netherlands	6.0	1.0	42.2	0.058	0.010	0.410
Poland	26.8			0.243		
Portugal		4.9	1.4	0.000	0.132	0.039
Romania	8.2			0.112		
Slovakia	0.7			0.028		
Slovenia	0.7	0.0	0.0	0.090	0.006	0.002
Spain	16.3	62.2	67.8	0.063	0.239	0.260
Sweden	7.0	2.2	0.4	0.126	0.040	0.007
United Kingdom	12.3	121.0	15.0	0.111	1.097	0.136
EU	256.5	352.6	474.4	0.139	0.190	0.256

Source: Own elaboration on the basis of cost and earnings accounting in STECF (2012); STECF (2013); FRAMIAN (2009); and FAO (2012) production value and volume statistics

Table 9 Calculation of the GVA indicator

Country	Freshwater			Marine			Shellfish		
	Value	Rescaled	Normalised	Value	Rescaled	Normalised	Value	Rescaled	Normalised
Austria	0.0016		0.2754						
Belgium	0.0001		0.0247						
Bulgaria	0.0042		0.7147				0.0002		0.0305
Cyprus	0.0005		0.0797	0.0129	0.0059	1.0000			
Czech Republic	0.0059	0.0059	1.0000						
Denmark	0.0087	0.0059	1.0000	0.0044		0.7428	0.0003		0.0525
Estonia	0.0015		0.2491						
Finland	0.0005		0.0829	0.0024		0.4141			
France	0.0014		0.2361	0.0003		0.0563	0.0083	0.0059	1.0000
Germany	0.0016		0.2694	0.0000		0.0001	0.0001		0.0240
Greece	0.0005		0.0847	0.0123	0.0059	1.0000	0.0008		0.1405
Hungary	0.0038		0.6554						
Ireland	0.0005		0.0927	0.0124	0.0059	1.0000	0.0146	0.0059	1.0000
Italy	0.0012		0.2086	0.0008		0.1387	0.0027		0.4536
Latvia	0.0006		0.1054						
Lithuania	0.0033		0.5679						
Malta				0.0541	0.0059	1.0000			
Netherlands	0.0006		0.0988	0.0001		0.0166	0.0041		0.6998
Poland	0.0024		0.4142						
Portugal	0.0000		0.0000	0.0013		0.2260	0.0004		0.0657
Romania	0.0011		0.1907						
Slovakia	0.0003		0.0486						
Slovenia	0.0009		0.1536	0.0001		0.0110	0.0000		0.0042
Spain	0.0006		0.1069	0.0024		0.4073	0.0026		0.4438
Sweden	0.0013		0.2143	0.0004		0.0683	0.0001		0.0123
United Kingdom	0.0011		0.1902	0.0110	0.0059	1.0000	0.0014		0.2317
EU	**0.0014**		**0.2365**	**0.0019**		**0.3251**	**0.0026**		**0.4374**

Source: Own elaboration on the basis of cost and earnings accounting in STECF (2012); STECF (2013); FRAMIAN (2009); and FAO (2012) production value and volume statistics

5. *Self-sufficiency*

The self-sufficiency indicator provides a measure of how much the domestic aquaculture production contributes to the total available supply in each aquaculture segment and country, taking into account import and exports and the production from fisheries.
The indicator was calculated by combining production and trade figures according to the following formula.

$$SU = \frac{P_a}{I_{lw} - E_{lw} + P_c + P_a}$$

Where:
I_{lw} are total import and E_{lw} total export expressed in live weight equivalents;
P_a is the production from aquaculture;
P_c is the production from fisheries.

In the case of Member States the import and export included intra and extra community trade, while in the case of the EU as a whole, only extra community trade was included.
In order to allow comparison between trade and production figures the quantities from COMEXT (2012) were converted into live weight by applying the coefficients defined in EUMOFA (2012). The link between aquaculture production, fisheries production and trade was established using the Main Commercial Species groups and the correspondence tables defined in EUMOFA (2012). The Main Commercial Species provide a relation, on one side, with commodities in the trade data, expressed in CN8 codes, and, on the other side, with species in production data, expressed in ISSCAAP codes.
Being limited to the aquaculture sector the indicator includes only production and trade data relating to Main Commercial Species with a prevalence of total production from aquaculture (i.e. Clam, Turbot, Eel, Seabass, Carp, Mussel, Oyster, Trout, Gilthead sea bream, Salmon and Tilapia). These 11 Main Commercial Species where further aggregated at the level of the three main segments of marine, freshwater and shellfish aquaculture. In the case of trout and eel the entire production was attributed to the freshwater segment.

A self-sufficiency ratio > 100% of the indicator arise when the domestic aquaculture production exceeds the total need of supply in the country. This suggests the availability of domestic production for exports and a lower dependency from the imports for the segment. To give further evidence of the export orientation the self-sufficiency indicator is accompanied by the calculation of normalised trade balance according to the following formula:

$$TB = \frac{E - I}{I + E}$$

Where:
I are total import and E total export values for the commodities related to the Main Commercial Species and segments considered.

While self-sufficiency from aquaculture to the total available supply and trade-balance have been plotted for the years 2004-2010, the self-sufficiency indicator was derived from the data related to the year 2010 and normalised as described in chapter 2.

Table 10 Self-sufficiency indicator and normalised trade balance in 2010

Country	Self-sufficiency indicator %			Trade balance %		
	Freshwater	Marine	Shellfish	Freshwater	Marine	Shellfish
Austria	31			-40		
Belgium	1			-30		
Bulgaria	84		71	-17		-98
Cyprus	45	146		-100	38	
Czech Republic	120			61		
Denmark	306		25	83		74
Estonia	-48			21		
Finland	55			-56		
France	98	2	67	11	-74	-24
Germany	44		22	-81		-52
Greece	67	824	127	54	78	24
Hungary	77			44		
Ireland	71	167	358	-41	32	88
Italy	110	11	60	37	-87	-45
Latvia	18			-35		
Lithuania	112			22		
Malta		139			32	
Netherlands	2		160	-6		64
Poland	57			-4		
Portugal		5	2		-92	-59
Romania	67			-100		
Slovakia	24			-50		
Slovenia	58	3	9	-90	-91	-92
Spain	75	31	90	16	-69	-34
Sweden	220		34	26		-55
United Kingdom	81	120	76	-2	19	-15
EU	75	29	68	-46	-81	-67

Source: Own elaboration on the basis of FAO (2012 and COMEXT (2012).

Table 11 Calculation of the self-sufficiency indicator for 2010

Country	Freshwater Value	Freshwater Normalised	Marine Value	Marine Normalised	Shellfish Value	Shellfish Normalised
Austria	31.33	0.20				
Belgium	1.06	0.12				
Bulgaria	83.89	0.32			71.30	0.29
Cyprus	44.93	0.23	146.33	0.48		
Czech Republic	120.46	0.41				
Denmark	305.56	0.87			25.13	0.18
Estonia	-48.03					
Finland	55.28	0.25				
France	98.09	0.36	2.31	0.12	67.43	0.28
Germany	44.42	0.23			21.94	0.17
Greece	66.79	0.28	824.06	1.00	127.12	0.43
Hungary	76.87	0.31				
Ireland	71.15	0.29	167.05	0.53	358.43	1.00
Italy	110.23	0.39	11.47	0.15	59.71	0.27
Latvia	18.34	0.16				
Lithuania	111.80	0.39				
Malta			138.84	0.46		
Netherlands	1.91	0.12			159.55	0.51
Poland	57.36	0.26				
Portugal			5.19	0.13	1.68	0.12
Romania	66.84	0.28				
Slovakia	23.82	0.18				
Slovenia	57.58	0.26	2.94	0.13	8.91	0.14
Spain	74.66	0.30	31.16	0.19	89.65	0.34
Sweden	219.76	0.66			33.70	0.20
United Kingdom	81.08	0.32	120.26	0.41	76.13	0.31
EU	**74.51**	**0.30**	**28.80**	**0.19**	**68.36**	**0.29**

Source: Own elaboration on the basis of FAO (2012) and COMEXT (2012).

6. *Diversification*

The indicator on the diversification measures the number of farmed species and how evenly the quantity produced is distributed among these species. It gives an indication on how much the industry is active in introducing new species and how large is the production basis within each segment. This helps not only to quantify the composition of production as expressed in the contextual charts but also in measuring the progress towards the objective of diversifying the industry. The indicator could be seen as a complementary measure of the production growth indicator and its temporal evolution shows if an expansion of the industry is taking place through species diversification rather than concentration.

The indicator is based on a well known index of diversity used in ecology to measure species diversity (Simpson index) and in economics to measure market competition (Herfindahl-Hirschman index). The indicator is calculated as conjugate of the HHI.
The index was applied to FAO data on production quantity by species to measure diversification within each segment and country combination according to the following formula:

$$H = 1 - \sum_{i=1}^{N} s_i^2$$

where for the given country, segment and year:
s_i is the share of production for species *i* in respect of the total production in the segment and *N* is the number of farmed species in the segment (proportional abundance)
The index ranges from the lowest score of zero in the case of one species covering the entire production to the limit of one with an infinite number of species having equal shares of the total production. Normalisation has been performed as described in chapter 2.

The index for the entire EU has intrinsically greater values in respect of the national values thanks to the contribution of the many and diversified national production systems therefore in the case of the EU the index is calculated as average of the Member State values.

Table 12 Calculation of the diversification indicator

Country	Freshwater			Marine			Shellfish		
	Value	Rescaled	Normalised	Value	Rescaled	Normalised	Value	Rescaled	Normalised
Austria	0.6408		0.7926						
Belgium	0.2731		0.3378						
Bulgaria	0.7314		0.9046				0.0000		0.0000
Cyprus	0.0548		0.0677	0.4310		0.5331			
Czech Republic	0.2425		0.2999						
Denmark	0.0979		0.1212	0.1978		0.2447	0.0000		0.0000
Estonia	0.2671		0.3303						
Finland	0.2004		0.2479	0.1103		0.1365			
France	0.3828		0.4735	0.7115		0.8801	0.5841		0.7225
Germany	0.6004		0.7426	0.0000		0.0000	0.0316		0.0391
Greece	0.2832		0.3503	0.4932		0.6100	0.0010		0.0012
Hungary	0.4895		0.6054						
Ireland	0.1632		0.2018	0.0524		0.0648	0.3846		0.4757
Italy	0.2585		0.3197	0.5749		0.7111	0.4706		0.5820
Latvia	0.3524		0.4359						
Lithuania	0.1514		0.1873						
Malta				0.5207		0.6441			
Netherlands	0.5427		0.6712	0.1372		0.1697	0.1231		0.1522
Poland	0.5709		0.7062						
Portugal				0.6480		0.8015	0.7624		0.9430
Romania	0.8085		1.0000						
Slovakia	0.3391		0.4194						
Slovenia	0.4646		0.5746	0.0000		0.0000	0.0000		0.0000
Spain	0.0596		0.0738	0.6540		0.8089	0.0377		0.0466
Sweden	0.3262		0.4035	0.0000		0.0000	0.0000		0.0000
United Kingdom	0.1099		0.1360	0.0281		0.0347	0.0799		0.0989
EU	**0.3504**		**0.4335**	**0.3039**		**0.3759**	**0.1904**		**0.2355**

Source: Own elaboration on the basis of FAO (2012) statistics

7. *Labour productivity*

The labour productivity indicator is derived from the employment and GVA indicators and calculated as simple ratio between the two. The indicator provides an additional dimension along which to evaluate possible policy targets related to employment.

This additional dimension is needed to appreciate differences on the nature of the employment in the different segments.

Since the collection of employment data for aquaculture in Full Time Equivalents (FTE) according to a standard methodology has only recently started and is not including freshwater aquaculture it is not yet not feasible to compare employment figure on the basis of FTE for all countries and segments. The consideration of labour productivity helps to appreciate the differences in the nature of employment as in the case of shellfish and extensive freshwater aquaculture which are characterized by a high proportion of part time and occasional employment. Normalisation and treatment of outliers has been performed as described in chapter 2.

Table 13 Calculation of the labour productivity indicator

Country	Freshwater			Marine			Shellfish		
	Value	Rescaled	Normalised	Value	Rescaled	Normalised	Value	Rescaled	Normalised
Austria	64,011		0.86						
Belgium	29,291		0.39						
Bulgaria	20,774		0.27				5,101		0.06
Cyprus				39,459		0.53			
Czech Republic	16,988		0.22						
Denmark	60,565		0.82	126,204	73,919	1.00			
Estonia	22,003		0.29						
Finland	26,743		0.36	39,404		0.53			
France	29,256		0.39	21,200		0.28	16,705		0.22
Germany	17,678		0.23				241,255	73,919	1.00
Greece	12,957		0.17	63,276		0.85	2,962		0.03
Hungary	6,889		0.08						
Ireland	20,924		0.28	73,919		1.00	14,784		0.19
Italy	31,824		0.42	25,105		0.33	21,041		0.28
Latvia	16,464		0.21						
Lithuania	4,877		0.06						
Malta				25,919		0.34			
Netherlands	42,907		0.58				163,542	73,919	1.00
Poland	6,746		0.08						
Portugal				21,616		0.29	762		
Romania	2,527		0.02						
Slovakia	21,015		0.28						
Slovenia	22,623		0.30	3,101		0.03	1,271		0.01
Spain	20,275		0.27	26,797		0.36	3,295		0.03
Sweden	23,724		0.31	30,064		0.40	5,560		0.07
United Kingdom	29,083		0.39	342,403	73,919	1.00	14,151		0.18
EU	**12,240**		**0.16**	**52,563**		**0.71**	**4,992**		**0.06**

Source: See GVA and employment tables

8. *Employment*

The employment indicator provides a measurement of how much each aquaculture segment contributes to general employment. It was constructed on the basis of available data reported in several studies on employment in the fisheries and aquaculture sectors in the EU (FRAMIAN, 2006; Salz and Macfayden, 2007; FRAMIAN, 2009; STECF 2012, STECF 2013).

Given the lack of data for some countries, segments and years combinations a modeling approach was used to estimate employment figures in function of production quantity from FAO. Three different models were tested for each country and each of the three segments: a country/segment specific model based on a simple linear relation between employment and production quantity, a model considering also the dependency with time and a generic model based on the linear relation between employment and production quantity for the segment at EU level.

In most cases employment figures showed a strong correlation with production volume ensuring a good significance for the parameters of the first model. Differences in the functional relation between employment and production levels for specific countries and segment can be attributed to the different structure of production and farming systems.

The incorporation of time in the second model allowed considering in addition to the relation with the level of production, a possible increase of production efficiency over time. The negative parameters in the models for the time variable indicate the employment of fewer people for the same amount of production. Differences in this parameter can be attributed to different trends towards an intensification of the production with consequent efficiency gain in the use of labour.

When comparing the results of the two models with the recorded employment data, it became evident that the simple production/employment model fits best for most Member States for the shellfish segment where the simpler production techniques cater for little increase in efficiency.

The model taking into account annual efficiency gains in production fitted best for most Member States in the freshwater and marine environment showing a general tendency in intensification for the aquaculture industry.

For calculating the employment indicators, for each Member State and each segment the best fitting model was applied using the Akaike information criterion. The third general model derived from global EU figures was used for some combinations of countries/segments for which it was not possible to establish a specific country model given the lack of sufficient employment data.

To allow comparison between Members States the values obtained from the employment models were divided by general employment statistics from EUROSTAT.

In analogy to the GVA indicator a fixed value was considered for the general employment using the 2010 data. Normalisation and treatment of outliers was been performed as described in chapter 2.

Table 14 Employment in aquaculture and ratio to general employment in 2010

Country	Employment aquaculture (persons)			Ratio with general employment (%)		
	Freshwater	Marine	Shellfish	Freshwater	Marine	Shellfish
Austria	99			0.002%		
Belgium	11			0.000%		
Bulgaria	329		57	0.011%		0.002%
Cyprus		119			0.032%	
Czech Republic	1,079			0.022%		
Denmark	347	83		0.013%	0.003%	
Estonia	29			0.005%		
Finland	82	279		0.003%	0.012%	
France	1,419	467	14,869	0.006%	0.002%	0.058%
Germany	1,739		11	0.005%		0.000%
Greece	254	1,284	1,841	0.006%	0.030%	0.043%
Hungary	1,614			0.043%		
Ireland	35	229	1,349	0.002%	0.013%	0.075%
Italy	1,012	853	3,330	0.005%	0.004%	0.015%
Latvia	25			0.003%		
Lithuania	573			0.043%		
Malta		217			0.134%	
Netherlands	139		258	0.002%		0.003%
Poland	3,969			0.025%		
Portugal		225	1,860		0.005%	0.040%
Romania	3,225			0.037%		
Slovakia	31			0.001%		
Slovenia	30	16	15	0.003%	0.002%	0.002%
Spain	805	2,320	20,562	0.004%	0.013%	0.112%
Sweden	296	74	73	0.007%	0.002%	0.002%
United Kingdom	423	353	1,058	0.002%	0.001%	0.004%
EU	**17,565**	**6,520**	**45,283**	**0.008%**	**0.003%**	**0.021%**

Source: Own elaboration on the basis of FRAMIAN (2006), Salz and Macfayden (2007), FRAMIAN (2009), STECF (2012), STECF (2013) and FAO (2012)

Table 15 Calculation of the employment indicator

Country	Freshwater			Marine			Shellfish		
	Value	Rescaled	Normalised	Value	Rescaled	Normalised	Value	Rescaled	Normalised
Austria	0.002		0.032						
Belgium	0.000		0.003						
Bulgaria	0.011		0.145				0.002		0.025
Cyprus				0.032		0.426			
Czech Republic	0.022		0.299						
Denmark	0.013		0.174	0.003		0.041			
Estonia	0.005		0.070						
Finland	0.003		0.045	0.012		0.154			
France	0.006		0.074	0.002		0.024	0.058		0.777
Germany	0.005		0.061				0.000		0.000
Greece	0.006		0.078	0.030		0.398	0.043		0.570
Hungary	0.043		0.574						
Ireland	0.002		0.026	0.013		0.169	0.075		1.000
Italy	0.005		0.060	0.004		0.050	0.015		0.197
Latvia	0.003		0.036						
Lithuania	0.043		0.579						
Malta				0.134	0.075	1.000			
Netherlands	0.002		0.022				0.003		0.042
Poland	0.025		0.337						
Portugal				0.005		0.064	0.040		0.532
Romania	0.037		0.488						
Slovakia	0.001		0.018						
Slovenia	0.003		0.042	0.002		0.022	0.002		0.021
Spain	0.004		0.058	0.013		0.169	0.112	0.075	1.000
Sweden	0.007		0.089	0.002		0.022	0.002		0.021
United Kingdom	0.002		0.020	0.001		0.016	0.004		0.050
EU	**0.008**		**0.110**	**0.003**		**0.041**	**0.021**		**0.284**

Source: Own elaboration on the basis of FRAMIAN (2006); Salz and Macfayden (2007); FRAMIAN (2009); STECF (2012), STECF (2013); FAO (2012)

9. *Apparent consumption*

The indicator on apparent consumption measures the per capita consumption of fisheries products on the basis of the available supply.

The indicator was constructed using directly data from the FAO food balance sheets where apparent consumption is calculated in kg per capita from the national annual available supply of fisheries products (national aquaculture production + national capture fisheries production + imports - exports) divided by national population. Normalisation has been performed as described in chapter 2.

An attempt was made to calculate the apparent consumption of aquaculture products separately from captured fish. However analyzing the results it became evident that the distinction would be artificial since in many cases the farmed fish and capture fish are becoming substitutes at the level of the sea food market.

The indicator is included in the social dimension to account for the contribution of aquaculture and more in general of fish to food security. In consideration of the highly nutritional value of fish, policy targets may be established to increase fish consumption. This may benefit the aquaculture sector in so far as the market conditions make domestic production competitive in respect of imports and fisheries.

Table 16 Calculation of the apparent consumption indicator

Country	Freshwater		Marine		Shellfish	
	Value	Normal.	Value	Normal.	Value	Normal.
Austria	3.8	0.1645	9.4	0.4069	0.7	0.0303
Belgium	5.2	0.2251	12.3	0.5325	4.4	0.1905
Bulgaria	0.8	0.0346	3.5	0.1515	0.1	0.0043
Cyprus	2.5	0.1082	12.5	0.5411	0.7	0.0303
Czech Republic	2.6	0.1126	6.8	0.2944	0.1	0.0043
Denmark	4.1	0.1775	12.0	0.5195	1.6	0.0693
Estonia	3.5	0.1515	7.6	0.3290	0.3	0.0130
Finland	13.7	0.5931	20.6	0.8918	0.4	0.0173
France	4.1	0.1775	17.7	0.7662	7.6	0.3290
Germany	3.8	0.1645	9.5	0.4113	0.7	0.0303
Greece	2.2	0.0952	12.4	0.5368	0.6	0.0260
Hungary	2.6	0.1126	2.3	0.0996	0.1	0.0043
Ireland	1.4	0.0606	12.2	0.5281	5.8	0.2511
Italy	2.7	0.1169	12.5	0.5411	3.5	0.1515
Latvia	3.5	0.1515	11.7	0.5065	0.2	0.0087
Lithuania	3.7	0.1602	35.3	1.0000	0.0	0.0000
Malta	1.8	0.0779	22.1	0.9567	3.8	0.1645
Netherlands	3.1	0.1342	15.8	0.6840	0.6	0.0260
Poland	3.8	0.1645	6.8	0.2944	0.1	0.0043
Portugal	1.6	0.0693	48.9	1.0000	4.2	0.1818
Romania	0.9	0.0390	4.4	0.1905	0.1	0.0043
Slovakia	1.4	0.0606	6.1	0.2641	0.1	0.0043
Slovenia	1.3	0.0563	6.3	0.2727	0.7	0.0303
Spain	4.2	0.1818	23.1	1.0000	6.2	0.2684
Sweden	7.4	0.3203	16.6	0.7186	0.8	0.0346
United Kingdom	3.2	0.1385	13.4	0.5801	1.1	0.0476
EU	**3.4**	**0.1480**	**13.9**	**0.6024**	**1.7**	**0.0741**

Source: Own elaboration on the basis of FAO (2012) Food balance sheets

10. *Dependence on fishmeal and fish oil*

The indicator on the amount of fishmeal and fish oil utilised for aquaculture production gives an estimated measure regarding the dependence in the Member States and in the Union on feed produced from pelagic fish, discards and fish processing offal. Comparing the values for the indicator over time allows a view on the development regarding the environmental pressure in relation to the production volume. The indicator is relevant for the freshwater and marine finfish segment only, since in shellfish aquaculture no fishmeal and fish oil is used.

The indicators are based on parameters specific to production systems which are considered similar across most Member States. This means that for most Member States, the baseline relates mainly to the situation of production systems and therefore, variations between Member States result from the composition of species groups in the national production. With more specific data in respect to the national parameters (e.g. regarding the mix of species, production systems, feed conversion rates and further substitution of fishmeal / fish oil) Member States will be able to reflect the national situation compared to this first assessment and to monitor progress over time.

The amount of fishmeal and fish oil is calculated on the basis of the following parameters:

- available scientific publications on the feed conversion ratio (FCR) for species/species groups in specific production systems,
- the common inclusion rates for fishmeal and fish oil in commercial aqua feeds for the different species groups and production systems,
- the annual national production for the given marine and freshwater species groups as derived from the contextual indicator on aquaculture production.

The FCR gives the amount of feed (in kg) necessary for 1 kg of weight gain in the fish produced. For the calculations of the fishmeal and fish oil indicators FCR values were taken from the most recent scientific publications referring to specific species / species groups and production systems. The FCR may well vary for the same species and production systems between different Member States due to a number of factors, such as fish genetics, the production environment, the feed specifications, feeding regimes and technology. Unless more specific data becomes available for individual Member States, across the Union a common FCR value for each species group was used for the indicator calculations. A similar approach was used for the parameter regarding the inclusion of fishmeal and fish oil in commercial aqua feeds (Table 19).

After having calculated for each Member State the amounts of fishmeal and fish oil utilized for each species group on the basis of the annual production, the totals in the relevant segment were divided by the total production in the segment. Table 20 shows the values for the fishmeal and fish oil dependence indicators for the freshwater and marine aquaculture for 2010 (last available data on aquaculture production).

Normalisation has been performed as described in chapter 2. In order to give the values of the fishmeal and fish oil indicators the same direction as indicators in the socio-economic dimension (1 = lowest dependence, 0 = highest dependence), the indicator presents the conjugate value.

Table 17 Parameters for calculating the amount of fishmeal and fish oil utilized

Segment	Species groups	Production system	FCR	Inclusion in aqua feed (in %) fishmeal	fish oil
freshwater	carp and other cyprinidae	ponds	2.00	10	0
		ponds extensive	0.00	0	0
	catfish	tank, raceway	1.50	10	2
		recirculation	***1.50***	***10***	***0***
		other	***1.50***	***10***	***0***
	eel	tank, raceway	2.00	***45***	***4***
		recirculation	1.00	45	4
		other	1.40	45	4
	other finfish	tank, raceway	2.00	35	4
		recirculation	***1.70***	***35***	***4***
		ponds	***2.00***	***35***	***1***
	trout and other salmonidae	tank, raceway	1.00	33	15
		recirculation	***1.00***	***33***	***15***
marine	eel	Recirculation	1.00	45	4
	other finfish	sea cage	2.00	35	4
	salmon and other salmonidae	sea cage	1.20*	34	25
	Sea bass and sea bream	sea cage	1.77	35	11
		ponds	***1.77***	***35***	***11***
	turbot and other flatfish	recirculation	***1.23***	50	10
		ponds/cages	***0.96***	***50***	***10***
	tuna	sea cage	***1.20***	***34***	***25***

Source: unless more specific information was available, the conversion and inclusion rates are based on the survey from Tacon and Metian (2008). Figures in bold and italic are assumed as no specific data for the production system have been found. The FCR for salmonids in marine cages in Sweden (*) was set to 1.592 according to STECF expert opinion

The following tables show the amounts of fishmeal and fish oil used on the basis of the aquaculture production (tonnes/2010) in the Union by freshwater and marine segments and species-groups.
The column “share” indicates how much a certain production type was considered to contribute to the annual production for a species group. The shares of main production types in the Member States are based on data from FRAMIAN (2009) and the economic performance report of the EU aquaculture sector (STECF, 2012).

Table 18 Calculated fishmeal / fish oil use in the EU by segments and species groups on the basis of annual production in 2010

species group	Production (t)	Production type	Share	Fishmeal (t)	Fish oil (t)
carp and other cyprinids	77,302	ponds	0.85	11,448	0
		ponds extensive	0.14	0	0
catfish	7,406	tank, raceway	0.76	197	33
		recirculation	0.22	882	18
		other	0.01	32	0
eel	5,203	tank, raceway	0.23	651	58
		recirculation	0.77	2,016	179
		other			
other finfish	9,823	tank, raceway	0.83	5,849	668
		recirculation	0.05	238	27
		ponds	0.12	746	21
trout and other salmonids	181,158	tank, raceway	0.90	56,584	26,116
		recirculation	0.10	2,292	1,058
Total freshwater	**280,892**			**80,936**	**28,179**
eel	1,616	recirculation	1.00	727	65
other finfish	3,036	sea cage	1.00	2,125	243
salmon + other salmonids	195,386	sea cage	1.00	78,845	57,663
sea bass & sea bream	144,376	sea cage	0.96	82,274	25,857
		ponds	0.04	6,957	2,186
turbot and other flatfish	9,046	recirculation	0.88	5,478	1,096
		ponds/cages	0.12	67	13
tuna	1,472	sea cage	1.00	592	433
Total marine	**354,932**			**177,064**	**87,556**

Table 19 Indicator for dependence on fishmeal

Country	Freshwater		Marine	
	Value (t/t finfish)	Normalised (conjugate)	Value (t/t finfish)	Normalised (conjugate)
Austria	0.293	0.571		
Belgium	0.639	0.000		
Bulgaria	0.284	0.585		
Cyprus	0.336	0.500	0.619	0.033
Czech Republic	0.200	0.724		
Denmark	0.330	0.510	0.407	0.382
Estonia	0.338	0.496		
Finland	0.336	0.499	0.402	0.391
France	0.309	0.543	0.590	0.081
Germany	0.307	0.548	0.402	0.391
Greece	0.387	0.415	0.621	0.029
Hungary	0.076	0.929		
Ireland	0.337	0.497	0.402	0.391
Italy	0.340	0.493	0.619	0.032
Latvia	0.234	0.668		
Lithuania	0.032	1.000		
Malta			0.548	0.150
Netherlands	0.306	0.548	0.615	0.039
Poland	0.258	0.627		
Portugal			0.617	0.035
Romania	0.261	0.623		
Slovakia	0.301	0.556		
Slovenia	0.293	0.570	0.620	0.032
Spain	0.329	0.510	0.612	0.045
Sweden	0.330	0.509	0.533	0.174
United Kingdom	0.329	0.511	0.403	0.389
EU	**0.288**	**0.578**	**0.499**	**0.231**

Table 20 Indicator for dependence on fish oil

Country	Freshwater		Marine	
	Value (t/t finfish)	Normalised (conjugate)	Value (t/t finfish)	Normalised (conjugate)
Austria	0.115	0.708		
Belgium	0.091	0.770		
Bulgaria	0.067	0.832		
Cyprus	0.148	0.624	0.195	0.503
Czech Republic	0.008	0.985		
Denmark	0.147	0.626	0.266	0.320
Estonia	0.133	0.663		
Finland	0.148	0.624	0.294	0.247
France	0.121	0.692	0.201	0.488
Germany	0.098	0.752	0.294	0.247
Greece	0.136	0.654	0.192	0.511
Hungary	0.002	1.000		
Ireland	0.148	0.625	0.294	0.247
Italy	0.146	0.629	0.187	0.523
Latvia	0.011	0.978		
Lithuania	0.005	0.992		
Malta			0.226	0.424
Netherlands	0.024	0.944	0.123	0.688
Poland	0.064	0.839		
Portugal			0.162	0.588
Romania	0.060	0.851		
Slovakia	0.121	0.693		
Slovenia	0.110	0.721	0.195	0.503
Spain	0.147	0.627	0.182	0.537
Sweden	0.149	0.621	0.390	0.000
United Kingdom	0.148	0.622	0.294	0.249
EU	0.100	0.747	0.247	0.369

Source: own elaboration of on the basis of the production figures from the tables above. Values are expressed in tonnes of fishmeal and fish oil needed to produce one tonne of finfish. The calculated absolute values have been normalised in a conjugated form to a scale from 1 to 0 (1 = lowest dependence, 0 = highest dependence)

11. *Nitrogen and phosphorous effluents*

Different parameters are used for estimating the environmental impacts of aquaculture production to the water and to the benthic, in particular in the close vicinity or at the water outlet. Amongst the numerous parameters, nitrogen (N) and phosphorus (P) effluents from the farms have been studied intensively for a range of species and production types. The effluents of N and P to the environment in form of dissolved and insoluble compounds steam mainly from the animals' excretion and unused feed. There are differences in the N and P effluents between species, production types and production intensities, e.g. shellfish aquaculture is considered to produce no or negligible N and P effluents. Advances in animal genetics, breeding, feeding and management can contribute to reduce or mitigate environmentally adverse effects of the production.

The indicators are based on parameters specific to production systems which are considered similar across most Member States. Only for some Member States specific data have been made available. This means that for most Member States, the baseline relates mainly to the situation of production systems and therefore, variations between Member States result from the composition of species groups in the national production. With more specific data in respect to the national parameters (e.g. regarding the mix of species, production systems, feed conversion rates) Member States will be able to reflect the national situation compared to this first assessment and to monitor progress over time. Especially for the environmental dimension, if additional data become available, possible additional indicators could be considered, such as land and water use.

The indicators on the N and P effluents give an estimated measure regarding the relative load of N and P released to the environment per tonne of the national aquaculture production separately for the freshwater and marine finfish segments. As higher the contribution of a less emitting production type is to the national production, as less is the overall national N and P load per tonne of production. Comparing the values for the indicators over time allows a view on the development regarding the environmental pressure in relation to the production volume.
Emissions calculated in absolute terms at a national level cannot by themselves be considered as negative environmental impacts. The evaluation of impacts would need to be carried out at single farm level considering the specific surrounding environment and conditions.

N and P loads are calculated in kg/tonne finfish produced on the basis of N and P effluents data obtained in scientific publications regarding different production types (e.g. salmon in sea-cages, trout in raceways, trout in recirculation, sea bream and sea bass in sea cage, turbot n recirculation, carp in ponds) and the annual national production for the given marine and freshwater species groups as derived from the contextual data on aquaculture production. Emission data for the species groups which present over 90% of the freshwater and marine production where available. For the species group “other finfish” average effluents data were assumed. Average data were also applied in the case when studies provided differing values for the same species. Unless specific values could be found for recirculation systems, values of 1/6 of the effluents of conventional production were assumed as described by D'Orbcastel (2008). N and P emission of shellfish were considered negligible and set to 0 (Iribarren et al., 2010). Table A11.1 shows the parameters of N and P effluents used with reference to the source of the information.

After having calculated the amounts of N and P effluents for each species group on the basis of the annual production (table 23), the amounts in the relevant segment were summarised and divided by the total production in the segment. Table 24 shows the values for the N and P indicators for the freshwater and marine aquaculture for 2010.

Normalisation has been performed as described in chapter 2. In order to give the values of the fishmeal and fish oil indicators the same direction as indicators in the socio-economic dimension (1 = lowest dependence, 0 = highest dependence), the indicator presents the conjugated value.

Table 21 Parameters for calculating the amount of nitrogen and phosphorus effluents

Species group	Production system	Effluents per tonne finfish produced kg N/t	kg P/t	References
carp and other cyprinidae	ponds	26.8	4.6	Olah et al. (1994) Schreckenbach et al. (1999) Gal et al. (2003)
	ponds extensive	26.1	2.9	Knosche et al. (2000)
catfish	tank, raceway	10.7	4.8	Bosma et al. (2011)
	recirculation	1.8	0.8	D'Orbcastel (2008)
	other	10.7	4.8	assumption
eel	tank, raceway	105.6	15.7	Chen, S. et al. (2006)
	recirculation	17.6	2.6	D'Orbcastel (2008)
	other	105.6	15.7	assumption
other finfish	tank, raceway	50.0	15.0	Muir (2004)
	recirculation	8.5	8.5	Martins, C. et al. (2010)
	ponds	20.0	5.0	Muir (2004)
trout and other salmonidae	tank, raceway	61.0*	8.6*	Aubin et al. (2009a) Gronroos (2006)
	recirculation	10.2	1.4	D'Orbcastel (2009)
eel	recirculation	17.6	2.6	D'Orbcastel (2008)
other finfish	sea cage	50.0	15.0	Muir (2004)
salmon and other salmonidae	sea cage	47.0	8.2	Pelletier et al. (2009) Ayer et al. (2009)
Sea bass and sea bream	sea cage	103.3	15.8	Aubin et al. (2009b)
	ponds	103.3	15.8	Lopez-Alvarado et al. (1997) Lupatsch et al. 1998)
turbot and other flatfish	recirculation	43.8	10.5	Aubin et al. (2006) Aubin et al. (2009a)
	ponds/cages	51.0	8.7	Mallekh et al. (1999)
tuna	sea cage	50.8	7.2	Xu (2006)

(*) Average effluents in freshwater trout farming systems in Denmark are set to 36.1 kg N/t and 2.9 kg P/t according to figures provided by the University of Copenhagen

Table 22 Calculated Nitrogen and phosphorous effluents by segments and species groups in the EU on the basis of annual production of 2010

Species group	Production(t)	Production type	Share	N (t)	P ()
carp and other cyprinids	77,302	ponds	0.85	1,534	263
		ponds extensive	0.15	524	57
catfish	7,406	tank, raceway	0.76	14	6
		recirculation	0.22	10	5
		other	0.01	2	1
eel	5,203	tank, raceway	0.23	76	11
		recirculation	0.77	79	12
		other	0.00		
other finfish	9,823	tank, raceway	0.83	418	125
		recirculation	0.05	3	3
		ponds	0.12	21	5
trout and other salmonids	181,158	tank, raceway	0.90	10,016	1,358
		recirculation	0.10	67	9
Total freshwater	**280,892**			**12,765**	**1,857**
eel	1,616	recirculation	1.00	28	4
other finfish	3,036	sea cage	1.00	152	46
salmon + other salmonids	195,386	sea cage	1.00	9,183	1,602
sea bass & sea bream	144,376	sea cage	0.95	13,719	2,098
		ponds	0.05	1,160	177
turbot and other flatfish	9,046	recirculation	0.88	390	93
		ponds/cages	0.13	7	1
tuna	1,472	sea cage	1.00	75	11
Total marine	**354,932**			**24,714**	**4,033**

The column “share” indicates how much a certain production type was considered to contribute to the annual production for a species group. The shares of main production types in the Member States are based on data from FRAMIAN (2009) and the economic performance report of the EU aquaculture sector (STECF, 2012)

Table 23 Nitrogen effluents indicator

Country	Freshwater Value (t/t finfish)	Freshwater Normalised (conjugate)	Marine Value (t/t finfish)	Marine Normalised (conjugate)
Austria	0.052	0.552		
Belgium	0.052	0.551		
Bulgaria	0.042	0.657		
Cyprus	0.061	0.455	0.103	0.002
Czech Republic	0.029	0.799		
Denmark	0.035	0.731	0.044	0.637
Estonia	0.057	0.498		
Finland	0.061	0.456	0.047	0.602
France	0.055	0.522	0.089	0.148
Germany	0.049	0.580	0.047	0.602
Greece	0.065	0.414	0.102	0.016
Hungary	0.022	0.865		
Ireland	0.061	0.456	0.047	0.602
Italy	0.061	0.455	0.099	0.043
Latvia	0.028	0.800		
Lithuania	0.027	0.817		
Malta			0.084	0.204
Netherlands	0.010	1.000	0.044	0.637
Poland	0.030	0.784		
Portugal			0.076	0.291
Romania	0.040	0.675		
Slovakia	0.054	0.523		
Slovenia	0.052	0.549	0.103	0.000
Spain	0.060	0.464	0.092	0.125
Sweden	0.061	0.454	0.047	0.602
United Kingdom	0.061	0.457	0.047	0.600
EU	**0.045**	**0.619**	**0.070**	**0.360**

Table 24 Phosphorous effluents indicator

Country	Freshwater Value (t/t finfish)	Freshwater Normalised (conjugate)	Marine Value (t/t finfish)	Marine Normalised (conjugate)
Austria	0.008	0.588		
Belgium	0.014	0.133		
Bulgaria	0.007	0.640		
Cyprus	0.009	0.508	0.016	0.002
Czech Republic	0.005	0.790		
Denmark	0.003	0.935	0.008	0.595
Estonia	0.008	0.535		
Finland	0.009	0.508	0.008	0.550
France	0.008	0.565	0.014	0.113
Germany	0.008	0.576	0.008	0.550
Greece	0.009	0.471	0.016	0.003
Hungary	0.003	0.940		
Ireland	0.009	0.506	0.008	0.550
Italy	0.009	0.506	0.015	0.022
Latvia	0.005	0.753		
Lithuania	0.003	0.902		
Malta			0.013	0.214
Netherlands	0.002	1.000	0.010	0.384
Poland	0.005	0.794		
Portugal			0.013	0.175
Romania	0.006	0.678		
Slovakia	0.008	0.576		
Slovenia	0.008	0.597	0.016	0.000
Spain	0.008	0.529	0.015	0.082
Sweden	0.009	0.515	0.008	0.550
United Kingdom	0.009	0.524	0.008	0.548
EU	**0.007**	**0.665**	**0.011**	**0.321**

The tables above lists the estimated N and P values for 2010 (dependence across different species groups and production systems on the basis of the production figures from the table above expressed in tonnes of Nitrogen and Phosphorus effluents at the water outlet or to surrounding water and benthic environment for 1 tonne of finfish produced) The calculated absolute values have been normalised in a conjugated form to a scale from 1 to 0 (1 = lowest dependence, 0 = highest dependence). There was no need to apply a correction of out layers.

Annex II Review of the EAPI report by experts of the STECF

1. *Terms of reference for the STECF working group*

In support of DG MARE, JRC developed European Aquaculture Performance Indicators (EAPI), identifying the relative starting positions and different circumstances in the Member States. The EAPI are based on statistical data and data from the aquaculture data call. The chosen performance indicators could also serve as a tool to make the results of the policy cooperation measurable.

The EWG12-13 (24-28 September 2012, Ispra, Italy) is requested to comment on the proposed EAPI. In particular, they are invited to provide for their relevant national chapter of the EAPI documents a reply to the following questions:
Do the data are consistent with the national aquaculture situation?
If not, what data are not consistent and what would be the correct data?
Does the national chapter of the EAPI report give a fairly correct picture of the national aquaculture situation?
If not, what part and why does it not sufficiently reflect the national situation?

2. *Background*

One of the aims of the new Common Fisheries Policy is to ensure the development of aquaculture - taking into consideration the necessary promotion of sustainability as well as the contribution that aquaculture can provide to food security and employment. As foreseen in the Common Fisheries Policy reform, the Commission proposes to promote aquaculture through an open method of coordination. An open method of coordination is a voluntary process for political cooperation based on strategic guidelines, multiannual national plans, agreeing on common priorities and targets.

The EU strategic guidelines will represent the basis for the development of Multiannual Strategic Programs at national level, aimed to improve the industry competitiveness as well as other elements of the sector (employment, economy, quality of local life, access to waters, etc.). The guidelines should take also into account of the relative starting positions and different circumstances in Member States.

On request of DG MARE, The Joint Research Centre (JRC) has developed a set of indicators which are aimed to identify the starting positions and different circumstances in the Member States. The study explores 3 main aquaculture dimensions (economic, social, environmental) for a set of 11 indicator (Growth, Gross value added, Labour productivity, Self-sufficiency, Diversification, Employment, Apparent consumption, Fishmeal/Fish oil use, Nitrogen and Phosphorus Emission). The original intention was also to include governance indicators in the study, but the lack of relevant data as well as the stagnation in the farm licensing system suggests to differently consider the mentioned indicators.

The outcome of the study can have a double benefit: a) to provide the Member States with an instrument to draft the multiannual national strategic program - as established by the new CFP; and b) to help the Member States to progressively monitor the achievement of the goals foreseen in their national strategic program.
As the study will be delivered to DG MARE soon, STECF experts are asked to review the study.

3. *Summary of the review from the expert working group*

The experts from the EWG welcomed the JRC presentation and the EAPI. The EWG considers that it is a good idea to use such indicators to obtain a quick vision of the EU aquaculture sector. These indicators could be complemented with the analysis of this EWG performed in the STECF report.

The EWG has considered the draft report as well as the methodology and the data/graphs which form the basis of the study. Based on this, experts have formulated their opinion in terms of consistency of the pictured scenario in each country, robustness of the methodology, and finally possible suggestions of additional indicators in future.

The EWG made the following points in response to the presentation on Indicators:

Growth ought to include both volume and value because of the importance of changes and the difficulty of comparing volumes alone of different species. The use of money as a common measure is useful in overcoming this problem.

The EWG wonders if the methodology could be improved to allow for small, especially family, production units. The EWG considers that the current methodology leads the results to be biased towards large producers. Data from the present DCF on the production from small enterprises may contribute to improve the quality of the exercise.

The EWG wonders if the uses of fishmeal and fish oil indicators are appropriate indicator. The EWG notes that the use of fishmeal and fish oil does not imply an economic cost. As foreseen in the new Common Fisheries Policy, environmental indicators have to be taken into consideration in the development of the Multiannual Strategic Programs of the Member States. However, the EWG are economic experts, and environmental issues should be analysed in more detail by more appropriate experts.

The diversity index used is the conjugate of the Herfindahl-Hirschman Index (HHI), not directly the HHI, as stated. This raises the implications that may be derived from seemingly bald statistics in that diversity in the industry structure may or may not be economically desirable. Indeed, some of the most successful cases have taken place in aquaculture sector with a very limited or null diversification. Besides, the diversification of the industry is currently a political target in the new CFP. It should be noted that this indicator itself does not give any preference for diversification, but it is just a good measure of the level of diversification based on produced species. Attention should be given in making clear the distinction between the measurement (the indicators are aimed to provide measurement and not assessment) and the evaluation that administrators/politicians could do of it.

On this sense, attention should be exercised when presenting the results. It was implied that the presentation of the results in the report is intended to be neutral. However, sometimes graphics have an implicit message which may (or may not) be misleading, unless each set of indicators is provided with a caveat to ensure that misinterpretations are prevented. The method of normalisation using the quartiles is obscure. There is a general consensus on the responsibility of the policy-makers to decide their national target.

The radar charts (alternative name, spider's web diagrams) are not good for showing growth. In fact, the growth indicator is derived from a growth rate and therefore is the only one built on a temporal time series rather than fixed point in time. It is represented for consistency on the same chart with the other indicators, but time series are provided in the annex. The overall size of a sector is not shown because there is no weighting (this is done to compare across segments and countries, but contextual data is provided in the annexes to give an appreciation of size). Normalisation has potential problems according to the starting date chosen and the absence of weighting. JRC will look at other ways to measure growth trying to incorporate weighting on size and reference to same starting date. Estimates depend in some cases heavily on the reliability of the regressions which appear to depend on very limited time series. This aspect can be addressed with the availability of further data, and current this limitation should be better described.

The report authors emphasized that their analysis did not imply which direction of each indicator was to be viewed as good or bad: that is a policy decision. However, advice on the use of radar charts (http://www.math.yorku.ca/SCS/sugi/sugi16-paper.html#H1_5:Star) is that all scales should run in the same sense, so every plotted variable shows “more” as equivalent (either better or worse). The charts as shown show the eight variables equally spaced by angles, with colour coding to group the economic, social and environmental variables. Use of red/green/blue is not optimal (consider colour-blindness). Such charts do not code information in the directions, so the format could be adapted to have larger angles between groups of variables: if the software has no other method, try inserting dummy variables with zero values. Radar charts are suggested as a visual tool for multivariate comparisons, so are best arranged in arrays of “small multiples” (Tufte's term), which might be in a “trellis display” (Cleveland's term), arranged in pairs with their national “target” patterns (as determined by policy), or overlaid on a country map to aid identification.

Radar plots have some history (i.e. Florence Nightingale's bat-wings http://www.york.ac.uk/depts/maths/histstat/small.htm) and have visual impact, but have the complexity of lines at arbitrary angles. An alternative would be parallel coordinates (profile plot), which also makes it easier to adjust the spacing between axes so that variables are grouped and allows actual and target values to be plotted on one axis. You could even join them and code the sense of the variance in colour.

The normalisation of plotting as described maps the inter-quartile range (over the countries within each year) onto [0,1] as radii. It seems undesirable to show non-zero values as zero and may cause confusion of which variable is which. Each radius should therefore have a small but non zero length to indicate minimum values, the low value to be determined pragmatically. As a further comment on the normalisation, the proposed method is linear (X-min)/max. It would be worth looking at the distributions of values from the countries and considering alternatives such as rank (non-parametric) or z-value (Inverse Normal of CDF).

4. *JRC’s feed-back*

The JRC has welcomed and appreciated the technical contribution and advice of the EWG experts. All comments have been taken into serious consideration and the report was amended accordingly. The JRC exercise was following the basic criteria foreseen in the draft Common Fisheries Policy and was based on the latest available data for aquaculture. However, as soon as new data will be made available this will justify the review of the calculations and a more updated picture.

JRC fully shares the view of the EWG experts to prevent misinterpretation of the results of the study by an accurate explanation of indicators and results to the policy makers. JRC is confident that the open method of coordination in place will ensure that - in collaboration with DG MARE as well as with the responsible authorities of the Member States - the results can be unambiguously communicated.

Annex III Summary of a survey on governance systems in five Member States

1. *Denmark*

- As the aquaculture industry sees sufficient demand for Danish trout in other Member States and third countries, the goal is to double the freshwater production and triple marine production. A governmental aquaculture committee agreed in 2010 on a number of recommendations for a sustainable development of the industry through result based management focused at managing nutrient effluents rather than regulating the use of methods and technology. Although some of the recommendations have been implemented, the main constraints for sustainable growth of production are still seen in environmental constraints. Growth in freshwater aquaculture will only be possible by applying new technologies in existing production sites or in fully recirculated systems. In the marine environment, growth may take place in non-costal areas less sensitive to impacts of nutrients or in productions where the nutrient impact is neutralised through mussel or sea weed culture.
- In the past years and in foreseeable future no authorisations have been or will be issued for new freshwater finfish aquaculture sites as in all Danish waters nitrogen loads have to be reduced to be in line with the Water Framework Directive. Shellfish producers normally do not face authorisation problems.
- In the freshwater segment, since 2001 "model farms" have been tested to get effluents decreased while increasing production. The experience gained lead to a new national environmental legislation on freshwater aquaculture (January 2012) which diverted from the previous system to limit production by the amount of feed to use (input) to a more flexible output system (limiting the amount of nutrients, nitrogen and phosphorous emitted). This change helps existing freshwater farms to increase production by using new technologies (mainly filtering systems). Existing farms should be re-authorised under the new terms.
- For the marine environment, suitable aquaculture zones for growth were identified (blue areas) which would allow for new sites without conflicting with other users. From the environmental requirements however, the potential new sites must not lead to any (further) deterioration of the aquatic environment. This makes it virtually impossible for new farm sites to get authorised under environmental legislation. Existing marine farms may increase production if mitigating measures are applied, such as additional culture of seaweed and mussels to neutralise the additional load. This multi-trophic production will require additional space for existing farms.
- Despite some guidance by the central authorities for the practical application of the environmental requirements at local level for the freshwater farms and costal marine farms differences can be experienced between municipalities. Cooperation with the central authorities to support the responsible administration at municipalities has been established but is not sufficiently used by the responsible local authorities.

2. *France*

- In the freshwater and marine finfish segments, except for sturgeon production facilities (caviar production sector), the last 15 years. The administrative procedure of the authorisation process for sites may be heavy, but it seems not to be the main inhibiting factor. But Union legislation on environmental issues as interpreted and implemented by the environmental authorities makes it nearly impossible for new aquaculture sites to be set up. In this respect, regarding the caviar sector, the new

production facilities are mostly linked to consortiums in luxury goods who can afford firm consultants advices in financial and environmental matters. Differences between regions and districts in the applications occur. In order to harmonise the application, circular notes have been issued or are planed to be issued.
- The freshwater trout producers would see sufficient market opportunities for growth. In contrast, the marine finfish production sees niche market opportunities due to strong competition from other Member States and third countries. The marine finfish production sector is mainly specialised in hatchery activities. Regarding the oyster sector, a market kept rather closed ensures price stability. In mussel farming the demand would allow some growth. As shown by regional planning activities, suitable space for new shellfish and marine aquaculture production sites would be available.
- Since 2 years an initiative for zonal planning in running at regional level (scheme regional) to identify the existing and additional suitable site locations for marine and shellfish production. The planning should be completed by end of 2012 and does not include inland waters.

3. *Poland*

- A wide range of aquaculture activities are carried out mainly in freshwater, such as
  - culture and breeding of carp and the accompanying production of additional species (e.g. other cyprinids – herbivorous or reofils and also predatory fish);
  - the production of salmonids, mainly rainbow trout;
  - hatchery production (producing eggs and larvae of fish) or nursery production, which also leads to further on-growing larvae brood and the older forms of stocking material (e.g. fry);
  - newly developed forms of aquaculture such as sturgeon breeding (also for restocking activities and production of caviar) and production in Recirculating Aquaculture Systems.
- Poland's aquaculture is dominated by two freshwater species, carp and rainbow trout. The conditions for marine and shellfish aquaculture are considered unsuitable (salinity and eutrophication).
- Common to Member States with similar production patterns, governance, environmental and animal health requirements are considered to hinder growth of the sector. Especially in the carp pond farming, predators, limited market opportunities for the existing products and production patterns are also seen as limiting factors. The national production is highly segmented, and producer organisations appear to be weak. Carp farming shows on average a very low profitability and is extremely dependent of seasonal and local markets (sold only for around few days on Christmas, mostly bought alive by consumers).
- In contrast to its economic and commercial limits, carp farming may play an important environmental and cultural role for maintaining biodiversity and the cultured landscape of the pond lands. Potential for added value is seen in combining pond farming with leisure and recreational activities.

4. *Spain*

- In the Strategic Plan for aquaculture 2007/2013 a set of 10 strategic priorities has been indicated, including species diversification, improvement of closed systems (recirculation), transfer of aqua-farms to less environmental impact zones, establishment of environmental friendly farming systems, zone planning for integration of aquaculture.

- In some autonomous regions costal zone planning is already advanced (e.g. Galicia, Andalucía) to identify suitable zones for aquaculture. In some regions (e.g. Andalucía, Galicia, Cantabria, Valencia,) from 2006 to 2011 almost 100 new authorisations have been issued, mainly in coastal zones.
- The licensing system for marine aquaculture and its application varies between the regions, in particular for the environmental impact assessments/monitoring and the procedures are considered time consuming and expensive.
- Freshwater aquaculture suffers from low prices and feels not receiving the support of the competent authorities which was demonstrated by the lack of information on the segment.

5. *Italy*

Figures received from the Italian aquaculture association (Associazione Piscicoltori Italiani) indicated some new authorisations (6 in the freshwater segment during 2008-2010 and two in the marine finfish segment in 2007 and 2010). However, these newly authorized sites had already some kind of license before. In addition, in 2009 for one site an increase in production volume was authorized.

National legislation is perceived by the association as very restrictive towards new authroisations. Especially in marine aquaculture, multiple authorities and often conflicting administration are seen to render an authorization process extremely complicated. Ongoing studies are aimed for identifying and planning of suitable areas.

As regards funding under the EFF, administrative requirements, the complexity of application and the lengthy process for application and allocation of funds at regional and local level together with the economic situation discourage or deter the sector from accessing the EFF.

- as total production for each of the three aquaculture segments (freshwater, marine and shellfish production);
- listing the three most important farmed species in each segment with their production volume and their relative importance to the national production in the relevant segment.

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Abstract

This report presents the outcome of the JRC research on the development of quantitative indicators to measure the performance of the EU aquaculture (European Aquaculture Performance Indicators - EAPI). Besides describing the current situation on the basis of the most recent data, the chosen performance indicators could assist national authorities in the preparation of the aquaculture strategic plans and measuring the progress in their implementation.

The study concludes that the EU aquaculture sector could be divided mainly in following four main categories of production. These categories are characterised by different opportunities and constrains and would therefore deserve to be treated according to distinct policy targets.

- Capital intensive marine fish production with high input and output, increasing labour productivity and profitability. This sector has potential to compete on the increasingly globalised market but is currently facing a series of administrative and environmental constrains which hinder further expansion.
- Low input freshwater production, often with low labour productivity and high species diversification, serving mainly local markets (e.g. carp). In this category, limited demand and strong international competition is limiting the profitability and growth, however the extensive and artisanal production may play a role in environmental and recreational aspects (e.g. regarding biodiversity and preserving cultural landscapes).
- Labour intensive shellfish production. This segment faces limited environmental concerns. Although affected by loss in competitiveness, this sector has a very important social dimension given the high number of employed persons.
- High input and technology driven production in recirculation systems. This segment, despite the high energy demand is not posing environmental concerns and is not competing for space. It requires higher however investments and has at the moment good profitability prospect only for niche and targeted markets.

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