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WP 3 – Policy and Markets

Task 3.5 Report on standards for competitiveness and employment, with risk profiles for eco-intensification

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GLOSSARY OF ACRONYMS

Acronym	Definition
AIPCE	EU Fish Processors and Traders Association
ASFIS	Aquatic Sciences and Fisheries Information System
BCG	Boston Consulting Group
CAGR	Compound annual growth rate
CEP	European Federation of National Organizations of Importers and Exporters of Fish
CN	(European Union) Combined Nomenclature
CPC	Central Product Classification
CR_4	Concentration ratio (of the four largest companies)
EEA	European Economic Area
ERS	Economic Research Service
EU	European Union
EUCU	European Union Customs Union
EUMOFA	European Union Market Observatory for Fisheries and Aquaculture products
FAO	Food and Agriculture Organisation (of the United Nations)
FTE	Full time employee
GVA	Gross value added
HS	(United Nations) Harmonised System
ISSCAAP	International Standard Statistical Classification of Aquatic Animals and Plants
JRC	Joint Research Centre (of the European Union)
LWE	Live weight equivalent
MCS	Main Commercial Species
nei	Not elsewhere included
RCA	Revealed comparative advantage
RDMS	Relational database management system
RMA	Revealed seafood import
RXA	Revealed seafood export
STECF	Scientific, Technical and Economic Committee for Fisheries
ULC	Unit labour cost

Executive summary

A variety of publicly accessible sources of data on aspects related to competitiveness and strategy exist and this study aims to help make better use of them by creating an integrated and market-oriented interactive toolbox of quantitative measures. Quantitative data from a range of sources was integrated into a relational database to allow the calculation of quantitative aggregate indicator-based indices of economic performance and competitiveness with strategic relevance. The selection of indicators, analysis and interpretation of the results was guided by strategic management concepts focusing on identifying potential strategies for the development of the sector. The analysis covers eleven farmed aquatic species, which account for 97% of the output of aquaculture in the EU. Particular attention was paid to salmonids, one of the most valuable category of products on the EU seafood market. The results indicate that a large proportion (62%) of the EU seafood market, whether imported or domestically produced, consisted of species that could not be produced in aquaculture, which carries implications for policies promoting aquaculture growth as means to food security. Further, the results reveal the heterogeneity in performance between sectors and countries along various dimensions and maintains that a nuanced and targeted approach needs to be taken to the development of aquaculture policy.

The final section on aquaculture insurance highlights the risk associated with aquaculture operations which have implications for the competitiveness of the sector. Aquaculture is regarded as an inherently risky industry with high volatility in annual loss ratios. High losses are still experienced due to unpredictable disease and extreme weather events, some of which could perhaps be mitigated by the innovations within the GAIN project.

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1. Introduction

The development of an effective growth strategy for the aquaculture sector requires consideration of a large number of inter-connected issues and the reconciliation of often conflicting objectives (Nash, 1995). There is a need for the application of systems thinking in addressing the complex challenges of sustainable aquaculture development and a greater availability and use of evidence for policy making (Stead, 2019), as well as new analytical approaches to guide management decisions (Gomes Ferreir*a et al.*, 2020). Indicator-based approaches have been used in a variety of economic sectors and contexts (Rose *et al.*, 2016) but remain an under-explored area in aquaculture, especially with respect to issues other than environmental impacts of aquaculture (Volpe *et al.*, 2013; Gomes Ferreira *et al.*, 2020).

Economic performance and competitiveness-related indicators in the context of aquaculture have been identified by Hofherr, Natale and Fiore (2012), Bostock *et al.* (2009) and Cai, Leung and Hishamunda (2009), while a more systematic application of indicators to EU aquaculture can be found in the biennial edition of the EU Joint Research Centre's (JRC) economic report (Nielsen, Carvalho and Guillen, 2018). Open source analytical tools relevant to markets and competitiveness of the EU seafood industry are offered by EUMOFA (2020), albeit mostly in the form of raw data collations and dissemination and the periodic release of focused reports, such as the annual "EU Fish Market" report (EUMOFA, 2019c). Gomes Ferreira et al. (2020) integrated multiple data sources to develop an overall investor index for the EU aquaculture and operationalised it in the form of a software tool. The tool covers five broad categories of indicators (market, production, regulatory, environmental, and social). It carries the advantages of combining multiple competing factors into an aggregate index rating of the attractiveness of aquaculture for investors. However, the results do not indicate particular strategic actions for investment. Moreover, while the tool provides European country level advice, it treats aquaculture as a homogenous industry and does uncover the broad species-system diversity that exists within the sector and across Member States (Bostock *et al.*, 2016)..

A variety of publicly accessible sources of data on topics related to competitiveness and strategy such as patterns of production, trade, economic performance, consumption and prices, are also regularly collected by governmental and intergovernmental agencies. However, the data remains scattered across multiple locations and reaches the user in different formats, which limits its applicability in strategy and policy making. Thus, there appear to be unexploited opportunities for combining and harmonising these data sources (Janger *et al.*, 2018)..

1.1 Aims and objectives

The objectives of this study phase were two-fold. First, to establish the context for the set of studies that form the rest this report by examining the EU seafood market and aquaculture production patterns, contributing to iteration of the research questions in following study phases. Secondly, to examine the performance of selected aquaculture industries in the EU against third country competitors and to evaluate the contribution of these industries to national economies.

More specifically, the study aimed to extend the scope of tools available to decision makers in aquaculture by (i) developing relevant sector-level indicators of competitiveness for evaluation and continuous monitoring of EU aquaculture performance; (ii) operationalising the indicators into strategy support tools and (iii) applying them to the main EU aquaculture commodities to uncover policy implications with particular focus on opportunities and threats for different growth strategies.

The underlying assumption of this study was that sufficient heterogeneity exists both across products on the seafood market and across member states (in their capacities as producers and consumers) to render a “one-size fits-all” policy or investment strategy approach to be ineffective. The target audience of this study is policy makers and export-orientated businesses/business consultants for whom sector-level considerations play an important part in decision-making.

1.2 Theoretical framework

To address the objectives outlined above, a survey of the literature on competitiveness indicators was conducted, which revealed the availability of a wide variety of indicators accompanying various strategic framework approaches underpinning their classification. Detailed reviews on the topic can be found in Buckley, Pass and Prescott (1988); Latruffe (2010b); Peneder *et al.* (2018) among others.

The selection of indicators for this study, which can be found in Table 4, and their organisation into tools relevant to sectoral strategy, in line with the objectives, was guided by common strategic management tools, namely the BCG (Boston Consulting Group) matrix (Henderson, 1973) and the McKinsey matrix (Dyson, 1990). While complex methods of data modelling and simulation exist, the use of simple tools such as the two-dimensional (2D) matrix remain common in strategic management. The concept of the 2D framework is that the two dimensions (typically plotted as X-axis and Y-axis), on which the units of analysis are plotted, do not correlate with each other, but rather represent two important aspects that the analyst needs to consider. The value of this approach lies in the ability to reduce complexity to the essence of an issue and frame it in terms of priorities and choices that can be made. An important feature of the 2D matrix is that it is typically divided into quadrants, each carrying different strategic implications. As such, it is particularly useful for distributing the units of analysis into categories and thus for developing typologies that allow more precise yet standardised and coordinated strategic action. Hence, an important feature is that the quadrants of the 2D matrix do not necessarily represent right or wrong positions. Rather, they represent options that decision-makers need to consider in line with the objectives of the analysis.

While indicating investment priorities, neither the BCG nor the McKinsey matrix provides specific options on how growth should be achieved i.e. consistent with EU aquaculture policy objectives. To address this deficiency, we make reference to a third framework, Ansoff's product-market matrix (Ansoff, 1957), which is one of the most widely adopted frameworks in marketing strategy (Johnson *et al.*, 2014). It defines four options for growth based on choices about products and markets, which can be represented as a two-dimensional matrix, Figure 1. Typically, the analysis starts by considering the existing products and markets served, from which point it proceeds to consider possibilities for increasing diversity by increasing the novelty along both axes, which results in four broad strategies to growth: 'market penetration', 'market expansion', 'product development' and 'diversification'.

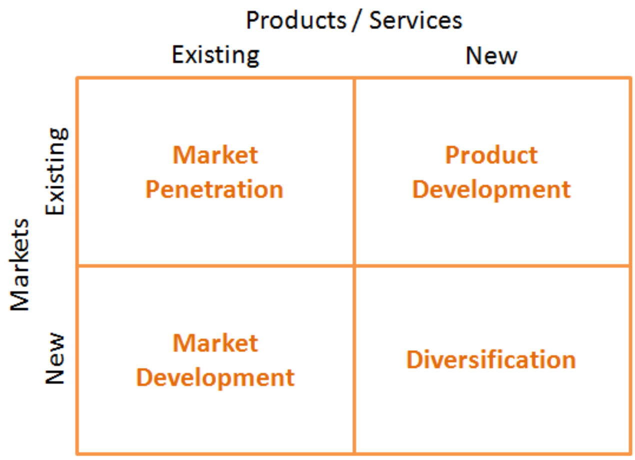


Figure 1. Strategies for growth. Source: Ansoff, (1957)

(A) Market penetration targets growth by increasing the share of the currently existing product range on the currently served markets. This is the least risky strategy as it relies on established strategic capabilities and existing business scope. This strategy can be pursued through marketing mechanisms such promotion and advertising to entice existing customers to consume more of the same product. The benefits of high market share include increased power against buyers and suppliers, greater economies of scale and experience curve benefits.

(B) Product development refers to considerably increasing the novelty of existing products ('product upgrading') or developing altogether new products, while targeting the currently served markets. Product development strategy can be risky and expensive because it requires new strategic capabilities and experience, which typically need to be acquired for the success of the new project. In the context of seafood production, new products would refer to the development of technologies e.g. for culturing new species (which is costly and time-consuming) or varying degrees of innovation in processing and presentation of products based on existing species and products (which carries relatively lower risks as it is more related to current activities).

(C) Market development implies offering existing products to new markets by varying degrees of innovation along the vertical axis of the matrix. Some level of products development is typical when targeting new markets (e.g. packaging or presentation), but the end product is still highly related to the original product. New market can be considered both new users and new geographies. New users (e.g. higher purchasing-power segment) can be targeted for example by increasing the value of the offering, using new channels e.g. high-end restaurants etc). The essence of this strategy is in meeting the critical success factors of the new market. In this respect this strategy carries higher risks than Market penetration as it requires additional strategic capabilities and experience with unfamiliar customers which are likely to have different needs.

(D) Diversification refers to targeting new markets with new products i.e. combining A & B strategies. The level of relatedness to existing products can vary from products which are new but related to completely unrelated products, but it entails expanding both the range of products and geographical coverage in pursuit of growth. However, it also carries the highest costs and risks of all growth strategies. The value-creating drivers for diversification include economies of scope (efficiency gains from applying existing capabilities to new contexts), increasing market power against competitors by increasing mutual forbearance and ability to cross-subsidise (discouraging aggressive moves from competitors by having similar ranges and thus the ability to retaliate on a wide range of the portfolio), responding to market decline by moving into new growth markets and spreading risk across a wide range of markets.

The analysis in this study is guided primarily by the three theoretical models described above. In order to avoid the limitation of the BCG matrix in its narrow definition of industry attractiveness and competitive position, the multi-variate approach of the McKinsey model is adopted, while retaining the BCG structure of plotting only two variables as at a time i.e. in essence dis-aggregating the composite and complex concepts of industry attractiveness and market position into multiple BCG plots. The Ansoff's model was in turn used to build on this analysis by evaluating potential growth strategies.

1.3 Methods

1.3.1 Scope

The selection of species for analysis started with a survey of all aquatic products from fisheries and aquaculture in the EU, in the process of which eleven aquaculture species were selected for in-depth analysis, which covered >90% of the aquaculture quantity output in 2017. The aim was to provide an EU-wide aquaculture analysis covering both freshwater and coastal/marine environments and a range of strategically important commercial species for the sector in line with the GAIN project. Species were selected according to two key criteria: (i) they are representative of regional distributions (e.g. European geography, cold/warm water, marine/fresh water), and (ii) have socio-economic relevance, including production. The final list of EU aquaculture species

selected for analysis was: Atlantic salmon (*Salmo salar*), rainbow trout (*Oncorhynchus mykiss*), European sea bass (*Dicentrarchus labrax*), gilthead bream (*Sparus aurata*), common carp (*Cyprinus carpio*), mussels (*Mytilus spp*), Pacific oyster (*Crassostrea gigas*), turbot (*Psetta maxima*), and good clam (*Ruditapes decussatus*). In addition, Nile tilapia (*Oreochromis niloticus*) and pangasius catfish (*Pangasius hypophthalmus*) were added to the analysis because of their strategic importance as competitors to white fish species produced in the EU and as raw materials for further processing (A.I.P.C.E.-C.E.P, 2019).
While production statistics are reported down to the species level, this is not always so in the case of trade statistics. Since the starting point of the analysis was apparent consumption, which involves for its calculation, data combining data on production and trade, species level data on production needed to be aggregated with other similar species into categories that include the primary species but are not limited to it. The aggregation was necessary in order to match the minimum level of aggregation according to which trade statistics are reported[1]. The final categories of commercial species are presented in Table 1. However, where possible and necessary for the analysis, the categories were disaggregated further with focus on the primary species listed above[2].

Table 1. Composition of EU (28) production for aggregate commodities used in the analysis. Source: EUMOFA (2020b)

Commodity	Species	Scientific name
Carp		
Crucian carp		*Carassius spp*
Bighead carp		*Hypophthalmichthys nobilis*
Common carp		*Cyprinus carpio*
Grass carp (=White amur)		*Ctenopharyngodon idellus*
Silver carp		*Hypophthalmichthys molitrix*
Catfish		
Pangasius		*Pangasius spp*
Channel catfish		*Ictalurus punctatus*
North African catfish		*Clarias gariepinus*
Wels (=Som) catfish		*Silurus glanis*
Clam		
Clams, etc. nei		*Bivalvia*
Common edible cockle		*Cerastoderma edule*

[1] For example, the CN trade statistics code (03027200) under which fresh pangasius is reported covers species other than pangaius: “Fresh or chilled catfish "Pangasius spp., Silurus spp., Clarias spp., Ictalurus spp.”. This necessitated the addition of the other together with pangasius into a broader category “Catfish” which became the minimum level of aggregation in most of the analysis

[2] For example, frozen filets of pangasius (CN code 03046200) covers only a single species “Frozen fillets of pangasius (Pangasius spp.)”, which makes it possible to a species-level analysis

Grooved carpet shell	*Ruditapes decussatus*
Japanese carpet shell	*Ruditapes philippinarum*
Pullet carpet shell	*Venerupis pullastra*
Mussel	
Blue mussel	*Mytilus edulis*
Mediterranean mussel	*Mytilus galloprovincialis*
Sea mussels nei	*Mytilidae*
Oyster	
Cupped oysters nei	*Crassostrea spp*
European flat oyster	*Ostrea edulis*
Flat and cupped oysters nei	*Ostreidae*
Pacific cupped oyster	*Crassostrea gigas*
Salmon	
Atlantic salmon	*Salmo salar*
Coho(=Silver) salmon	*Oncorhynchus kisutch*
Huchen	*Hucho hucho*
Seabass	
European seabass	*Dicentrarchus labrax*
Seabream	
Gilthead seabream	*Sparus aurata*
Tilapia	
Nile tilapia	*Oreochromis niloticus*
Tilapias nei	*Oreochromis (=Tilapia) spp*
Trout	
Brook trout	*Salvelinus fontinalis*
Rainbow trout	*Oncorhynchus mykiss*
Sea trout	*Salmo trutta*
Trouts nei	*Salmo spp*
Turbot	
Turbot	*Psetta maxima*

1.3.2 Data

The data in this study cover three broad domains: domestic production, international trade and economic performance, collected from several public sources. Data were harmonised and integrated with a relational database management system (RDMS) using Microsoft Access 2016 and Microsoft Power BI 2019. The use of RDMS and Power BI add value to publicly available data, by integrating various sources and formats into a single database, which allowed the flexibility of aggregating and visualising data in a wide range of ways so that new insight on the issues of competitiveness could be derived. A significant amount of effort was dedicated to this stage of the research.

Production, trade, input-cost and other economic data were derived from seven principle data sources (Table 2) covering all or most of EU member states. Seafood trade statistics came from two primary sources: EUROSTAT (2019) and UN Comtrade (2019), while production statistics were collected from FAO (2019).

All production and trade statistics were reclassified according to the Main Commercial Species (MCS) classification developed by EUMOFA (2020) for the purposes of analysis of the EU seafood market, in order to harmonise the different levels of aggregation between sources, as described in the preceding section. The conversion of European Union Combined Nomenclature (CN) and United Nations Harmonised System (HS) data into MSC was achieved using the correspondence tables published by EUMOFA, (2020a) and EUMOFA, (2020c), respectively. Similarly, the capture fisheries and aquaculture production data obtained from FAO (2019) has been harmonised into the MCS classification system using the correspondence tables between ASFIS (ERS) and MSC codes (EUMOFA, 2020b).

A variety of standard product classifications exist (e.g. CPC, ISCAAP, etc), however MCS has been selected as the basis for analysis here because it allows maximum possible level of disaggregation of combined production and trade data. Another advantage is its species-centric nature, which is particularly useful to aquaculture where species-system combinations is a central aspect for development policy. Additional reason for the use of this classification system was the potential for integration with data and analysis that EUMOFA publishes regularly and which are based on this classification, which would make comparisons possible.

Since trade data are reported in net product weight, their conversion to live weight equivalent (LWE) was necessary in order to harmonise them with production data (reported in LWE) and to be able to make a meaningful estimation of supply balance. CN net weight trade data were converted to LWE using the conversion factors published by EUMOFA (2019a). Since no published conversion factors exist between HS product codes and MCS, EUMOFA's CN conversion factors (EUMOFA, 2019a) were also used for this classification system. This was possible because the CN classification is an extension of the HS system (HS is the root 6-digit code to which 2 more digits are added in the CN system in order to provide a greater level of detail needed for the EU trade description purposes). For the products that do not correspond exactly (i.e. more than one CN code exists for a single HS code), an average of the relevant published CFs was calculated. Due to its large size (covering more than 700 entries), the resulting list of conversion factors is not included in this report.

In order to establish the extent to which aquaculture expansion can serve as a means to increasing food security in seafood, the commercial species categories were classified on the basis of whether they could be produced in aquaculture i.e. whether technologies existed for aquaculture globally. The classification was done based on whether production was reported in aquaculture production statistics in FAO (2019) and on whether farming technologies for the species were available[3].

[3] E.g. while there was no reported production of Atlantic cod (*Gadus morhua*) in aquaculture, the technologies for its production are available (Lambert and Dutil, 2001)

Table 2. Raw data variables and sources

Variable	Source	Unit
Aquaculture output volume and value	FAOSTAT	Tonnes (LWE), USD
Imports (M) / Exports (X) Volume and value	EUROSTAT Easy Comext UN Comtrade	Net weight (100 kg); EUR Net weight (kg); USD
Fisheries output volume	FAOSTAT	Tonnes (LWE)
Conversion factors (CF)	EUMOFA	Ratio
Revenue and cost variables, FTE	STECF	EUR, No
GDP	World Bank	USD
Exchange rates	European Central Bank	Ratio; Annual average

The calculation of a measure of market structure (here CR_4, which represents the extent to which the market is controlled by the four largest firms in the industry), required detailed company-level data, which was not possible to obtain for all species and countries. Such data are usually not publicly accessible (with the exception of Turkey), which necessitated the compilation of data from a variety of sources and formats (Table 3).

Table 3. Raw data variables and sources for the calculation of concentration ratio

Species	Country	Variable	Source	Unit	Coverage
Salmon	Norway, UK, Chile, Faroe Islands, Canada, World	Output volume	Kontali Analyse (2018)	Tonnes (LWE)	2000-2015
Sea bass & bream	Spain	Turnover	Orbis (2017)	EUR	2005-2015
	Turkey	Production capacity	Republic of Turkey Ministry of Agriculture and Forestry, (2017)	Tonnes (MAB)	2010,2015, 2017
Rainbow trout	Scotland	Output volume	The Scottish Government (2018)	Tonnes (LWE)	2000-2015
	Turkey	Production capacity	Republic of Turkey Ministry of Agriculture and Forestry (2017)	Tonnes (MAB)	2010, 2013, 2015, 2017
Pangasius	Viet Nam	Export	VASEP (2018)	USD	2010-2016

	value

1.3.3 Indicators and performance metrics

The list of indicators and economic performance metrics applied and/or further developed in this study is presented in Table 4.

Table 4. Rationale and calculation of economic performance indicators and metrics

Indicator	*Rationale\explanation*	*Calculation*
Total supply	A measure of the quantity of input of a particular category into a country or region from all sources	Total supply (T, lwe) = capture fisheries production + aquaculture production + imports
Apparent consumption	A measure of market size and proxy for demand.	Apparent consumption (T, lwe) = (aquaculture production + capture fisheries production) + Imports – Exports
Share of trade flow (imports or exports) in total supply	A measure of the extent of trade in a commodity normalised by the total input into a country	Share of trade flow in total supply (%, lwe) = Trade flow / total supply * 100
Share of regional trade flow (intra-EU or extra-EU) in total trade	A measure of the geographic scope of trade normalised by total trade	Share of regional trade flow in total trade (%, lwe) = Regional trade flow / total supply * 100
Mean price	A measure of unit value	Price (EUR/kg) = Value (EUR) / Net volume (kg)
Self-sufficiency	A measure of the extent to which the quantity of home production meets home demand	Self-sufficiency (%, lwe) = Production / Apparent consumption
Concentration ratio (CR_4)	A measure of market structure and in particular, the control of the four largest firms in the industry	The total market share of the four largest firms in an industry *CR_4 = (S_1+S_2+S_3+S_4) / Total industry sales*
Gross value added (GVA)	An economic productivity metric that measures the contribution of a sector to national economy. It provides a monetary value for the amount of goods and services that have been produced in a country, minus the cost of all inputs and raw materials that	GVA = Turnover + Other income – Energy costs – Livestock costs – Feed costs – Repair and maintenance costs – Other operational costs The calculation is based on methodology by Nielsen, Carvalho and Guillen (2018)

	are directly attributable to that production.	
Unit labour cost (ULC)	A proxy for cost-competitiveness. Higher ULC for the same unit of output is a sign of lower competitive potential.	ULC = Wages and salaries / FTE
Labour productivity	Productivity is the key source of economic growth and competitiveness. It is defined as the ratio between output and input	Labour productivity (EUR /FTE/ Year) = GVA at factor costs / FTE
System productivity	The efficiency with which a production system to create economic value per unit of output	System productivity = GVA per year / Total volume output (T, lwe) per year
Net profit margin (%)	A measure of the economic performance of a sector or enterprise expressed in relative terms. It is a difference between total income and all incurred costs (operating, capital and financial)	Net profit margin (%) = (Turnover + Other Income + Subsidies – Energy costs – Wages and salaries - Imputed value of unpaid labour - Livestock costs – Feed costs – Repair and maintenance – Other Operational costs – Depreciation of capital – Financial costs, net) / (Turnover + Other Income + Subsidies) *100
Revealed comparative advantage (RCA aka Balassa Index)	A measure of specialisation in the export of a commodity and a proxy for comparative advantage A value of >1 indicates the existence of comparative advantage in the production of a commodity as inferred by export specialisation patterns, (Cai, Leung and Hishamunda, 2009)	$RCA_{ip} = \frac{\sum ip}{\sum is} \Big/ \frac{\sum mp}{\sum ms}$ Where i = Country (MS) p = Commodity (particular seafood product) s = Seafood (all seafood commodities traded) m = EU28 (all MS)
Compound annual growth rate, % (applied to any of the above indicators)	Compound annual growth rate (CAGR) was chosen as a measure of change because of its ability to dampen the effects of fluctuations within the examined period and thus	$CARG\ (t_0, t_n) = \left(\frac{V\ (t_n)}{V\ (t_0)}\right)^{\left(\frac{1}{t_n - t_0}\right)} - 1$ where t_0 is the initial of the year, t_n is the end year, $t_n - t_0$

	to isolate the trend in the data (Chan, 2012)	is the number of years in the specified period (3 in this case). Three years rolling intervals was used here because of the limited time period 2012-2017

2. Results

2.1 Revealed Comparative Advantage (RCA)

The results of the analysis of revealed comparative advantage (RCA) show that in 2017 the EU28 scored < 1.0 on seafood (as an aggregate commodity) in terms of exports but >1.0 on imports (Figure 2). In all other reference nations, apart from Turkey, the patterns of trade reveal specialisation on seafood through export, as signified by values > 1.0. The rate of change in RCA (exports) for the EU28, has remained stable, near 0%, for the period 2012-2017, as seen in Figure 3.

When decomposed to member state level, the results show a high level of diversity within the EU28 in terms of revealed comparative advantage, Figure 4. Ten MS (Sweden, Denmark, Portugal, Greece, Lithuania, Spain, Cyprus, Estonia, Poland and Croatia) score above 1.0 on Revealed seafood export (RXA), of which all except Croatia score above 1.0 also on RMA indicator. These results indicate relatively high level of specialisation on seafood and thus the important role the industry plays in the overall economies of these states. In the case of Sweden, however, which has the highest scores of all MS, the result can be interpreted as a consequence of the proximity of the country to Norway, from where large quantities of seafood imports enter the EU and are consequently re-exported to other member states (as seen in later sections).

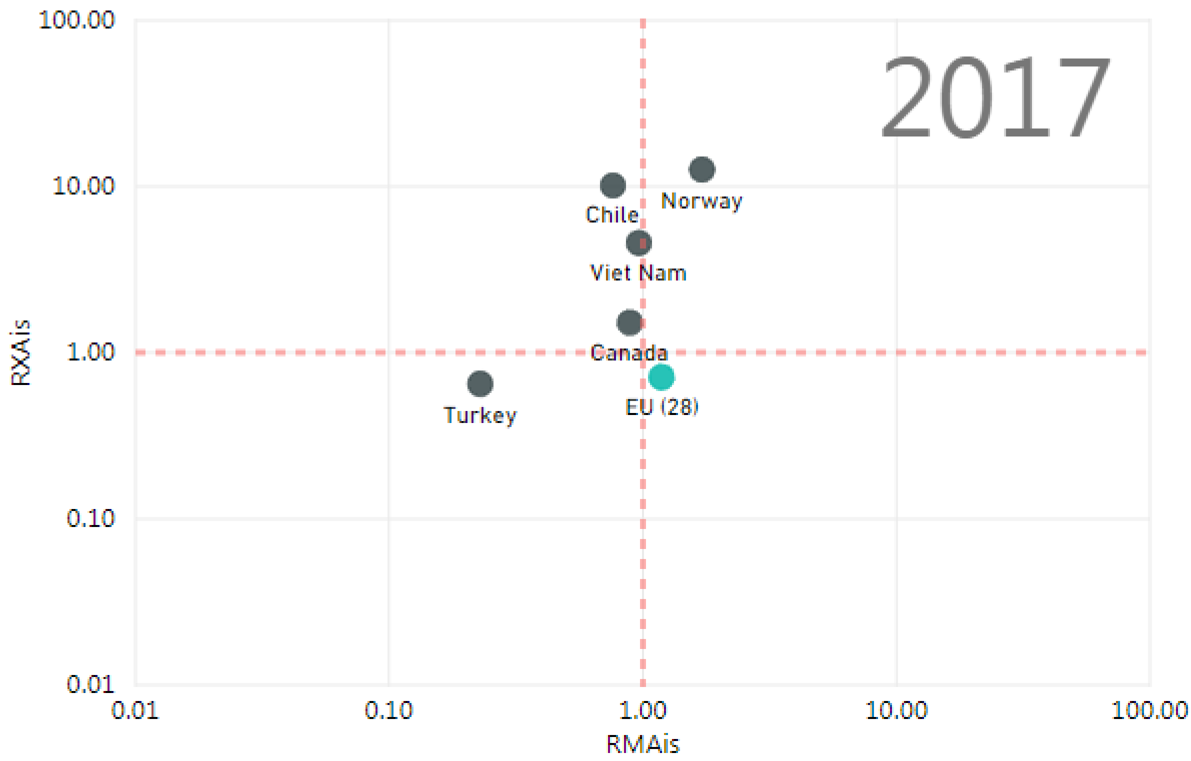


Figure 2. Revealed seafood export (RXA) and import (RMA) advantage for EU28 and selected competitors. In the case of EU28 trade refers to third countries only. Source: Eurostat (2019), UN Comrade (2019)

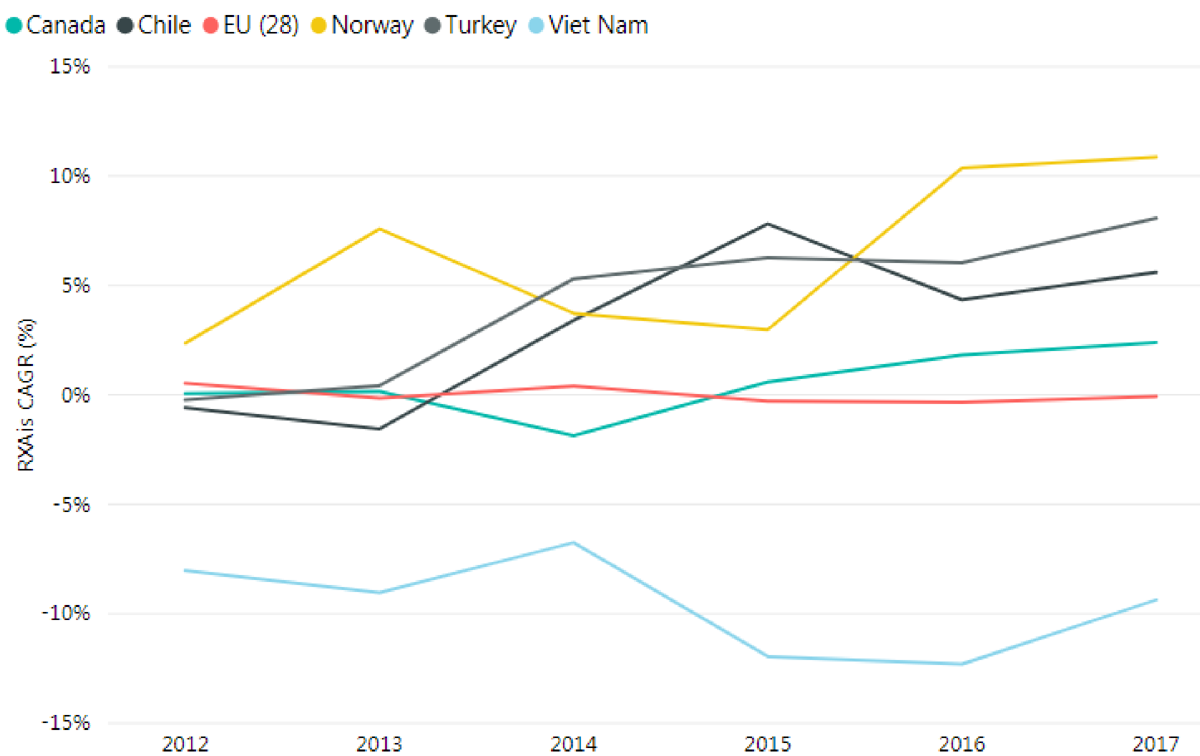


Figure 3. Compound annual growth rate (CAGR) in the revealed comparative advantage for seafood (RXA) for the EU28 and reference countries. Source: Eurostat (2019), UN Comrade (2019)

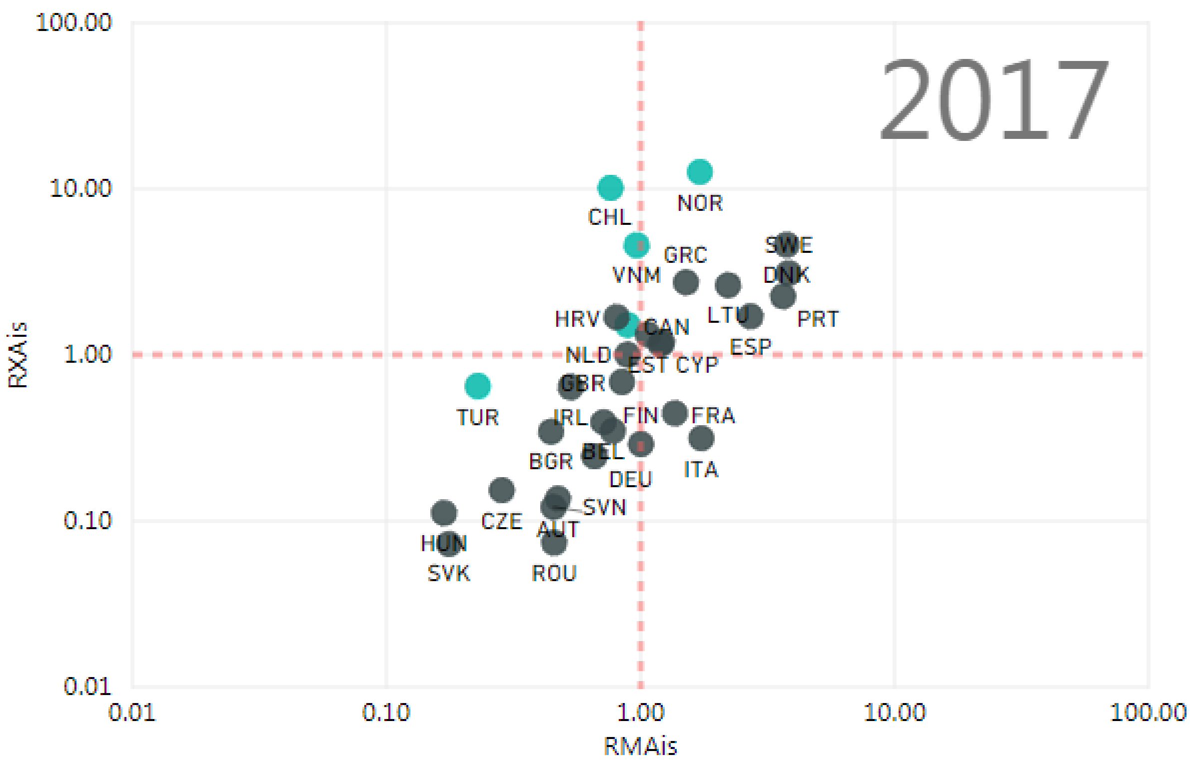


Figure 4. Revealed seafood export (RXA) and import (RMA) advantage for EU28 by member state and selected competitors. Source: Eurostat (2019), UN Comrade (2019)

2.2 Sector composition

The total size of the EU seafood market in 2017 was 13.6 million tonnes, lwe. Of which some 5.3 million tonnes, or 38%, consisted of products that could be produced by aquaculture. Within this category ('aquaculturable'), the EU28 reported a total production for 2017 of 2.1 million tonnes, of which some 1.35 million tonnes (or 10% of the total seafood market) actually originated from EU aquaculture, Figure 5.

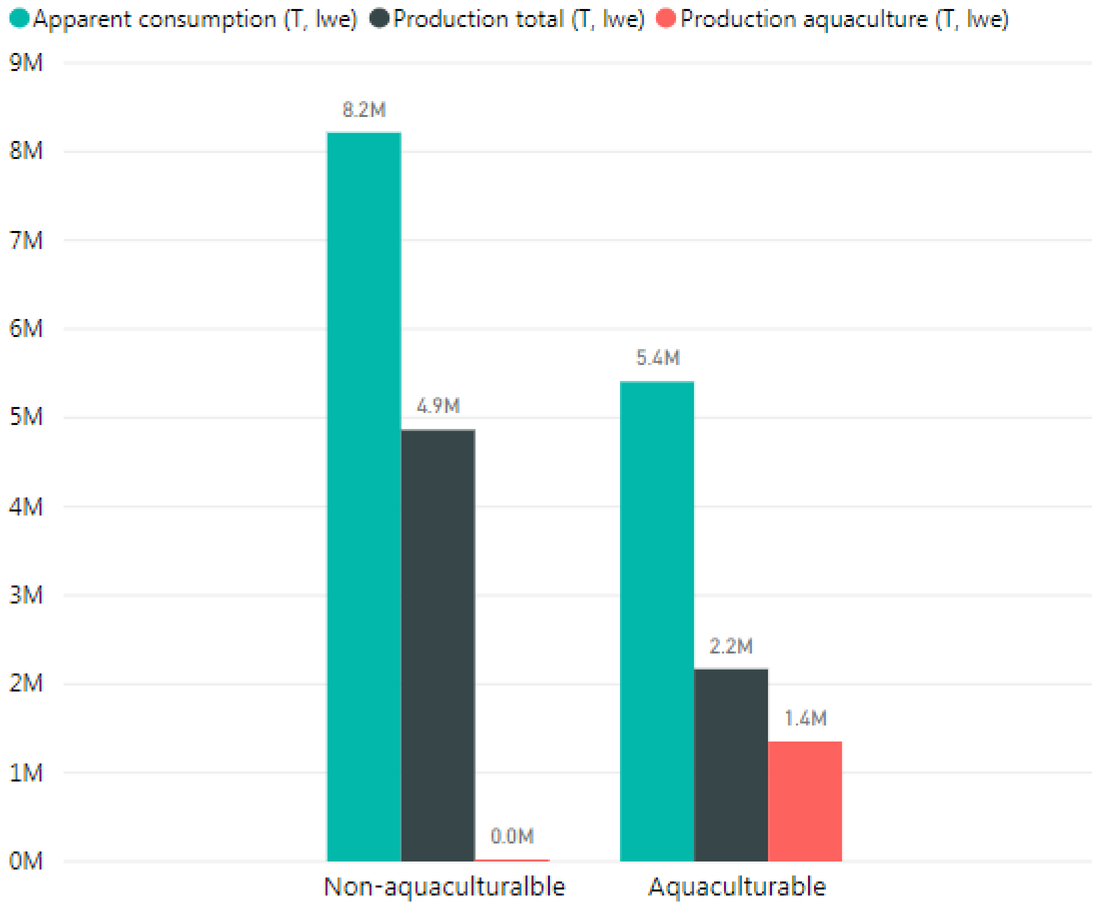


Figure 5. Split of apparent consumption, total seafood production (capture fisheries and aquaculture) and aquaculture production in the EU28 in 2017, according to the possibility to be produced in aquaculture. Source: EUROSTAT (2019), FAO (2019)

A breakdown of the 'aquaculturable' category into species (Table 5), revealed that the total EU28 aquaculture production volume in 2017 accounted for 24% of the total consumption volume (lwe) of the same species. Important commercial species which can be produced in aquaculture but for which there was no or negligible EU production, include cod and shrimp. The commodities highlighted in red were selected for the analysis that follows; they represented 97% of the total aquaculture production in the EU.

Table 5. Apparent consumption, imports and EU28 aquaculture production of 'aquaculturable' species in 2017. Species selected for further analysis highlighted in red. Source: EUROSTAT (2019), FAO (2019)

Species	Apparent consumption (T, lwe)	Imports volume (T, lwe)	Share of total EU28 import volume (%)	Imports value (EUR'000)	Share of total EU28 import value (%)	EU28 aquaculture production volume (T, lwe)	Share in total EU28 aquaculture production volume (%)	EU28 aquaculture production value (EUR'000)	Share in total EU28 aquaculture production value (%)
Cod	1,178,429	1,158,874	28.38%	2,463,276	16.1%				
Salmon	1,145,977	1,097,878	26.9%	6,100,271	39.7%	209,230	15.5%	1,336,324	29.1%
Mussel	666,688	137,165	3.4%	145,897	1.0%	493,844	36.5%	431,555	9.4%
Shrimp, miscellaneous	364,818	367,021	9.0%	1,814,787	11.8%	204	0.0%	938	0.0%
Shrimp, warmwater	346,558	346,584	8.5%	2,289,854	14.9%	103	0.0%	1,854	0.0%
Other marine fish	317,748	339,351	8.3%	873,294	5.7%	8,030	0.6%	45,005	1.0%
Trout	214,680	38,094	0.9%	148,864	1.0%	190,812	14.1%	667,412	14.6%
Catfish	186,307	179,736	4.4%	175,461	1.1%	10,200	0.8%	23,362	0.5%
Clam	170,755	67,527	1.7%	79,978	0.5%	43,071	3.2%	155,126	3.4%
Other freshwater fish	145,698	62,953	1.5%	209,354	1.4%	16,782	1.2%	68,168	1.5%
Scallop	141,625	91,298	2.2%	241,514	1.6%	19	0.0%	152	0.0%
Seabream	125,702	31,111	0.8%	132,770	0.9%	95,390	7.1%	481,452	10.5%
Carp	102,054	7,035	0.2%	16,115	0.1%	87,484	6.5%	185,555	4.0%
Seabass	100,730	20,640	0.5%	101,491	0.7%	79,350	5.9%	489,128	10.7%
Oyster	79,036	239	0.0%	2,101	0.0%	83,971	6.2%	399,413	8.7%
Crab	78,387	30,716	0.8%	126,095	0.8%	11	0.0%	8	0.0%
Seaweed and other algae	76,326	-	0.0%	23,286	0.2%	246	0.0%	3,297	0.1%
Molluscs and aquatic invertebrates, other	61,664	23,870	0.6%	76,254	0.5%	95	0.0%	392	0.0%
Tilapia	59,027	59,844	1.5%	62,907	0.4%	215	0.0%	669	0.0%

Seabream, other	43,707	6,916	0.2%	37,774	0.3%	1,612	0.1%	11,066	0.2%
Sole, common	24,279					6	0.0%	52	0.0%
Turbot	17,410	253	0.0%	2,277	0.0%	11,571	0.9%	80,989	1.8%
Other salmonids	15,564	2,351	0.1%	7,795	0.1%	5,844	0.4%	35,688	0.8%
Sole, other	12,890	4,188	0.1%	19,902	0.1%	1,438	0.1%	15,635	0.3%
Tuna, bluefin	11,309	4,167	0.1%	44,973	0.3%	6,616	0.5%	87,969	1.9%
Pike	10,938					428	0.0%	1,970	0.0%
Eel	10,022	1,932	0.1%	18,518	0.1%	5,938	0.4%	60,688	1.3%
Pike-perch	8,342					645	0.1%	4,146	0.1%
Halibut, Atlantic	2,458	2,448	0.1%	19,498	0.1%				
Abalone	126	86	0.0%	796	0.0%	8	0.0%	157	0.0%
Cobia	7	108	0.0%	960	0.0%				
Caviar, livers and roes		-	0.0%	109,649	0.7%				
Freshwater crayfish		296	0.0%	1,746	0.0%	33	0.0%	346	0.0%
Seabass, other		142	0.0%	691	0.0%	-	0.0%	1	0.0%
Sea cucumber		51	0.0%	815	0.0%				
Totals	**5,719,261**	**4,082,874**	**100%**	**15,348,963**	**100%**	**1,353,196**	**100%**	**4,588,517**	**100%**

As seen in Table 5, considerable amount of the market is met through imports. A large proportion of the imports of the selected aquaculture species by volume consisted of Norwegian salmon (Figure 6), which also had by far the largest share in terms of value (Figure 7). Other main sources of salmon imports were China, Chile, United States and the Faroe Islands. Viet Nam was the main source of pangasid catfish imports and Chile of mussels. Turkey was the main exporter of seabass, seabream and trout to the EU market.

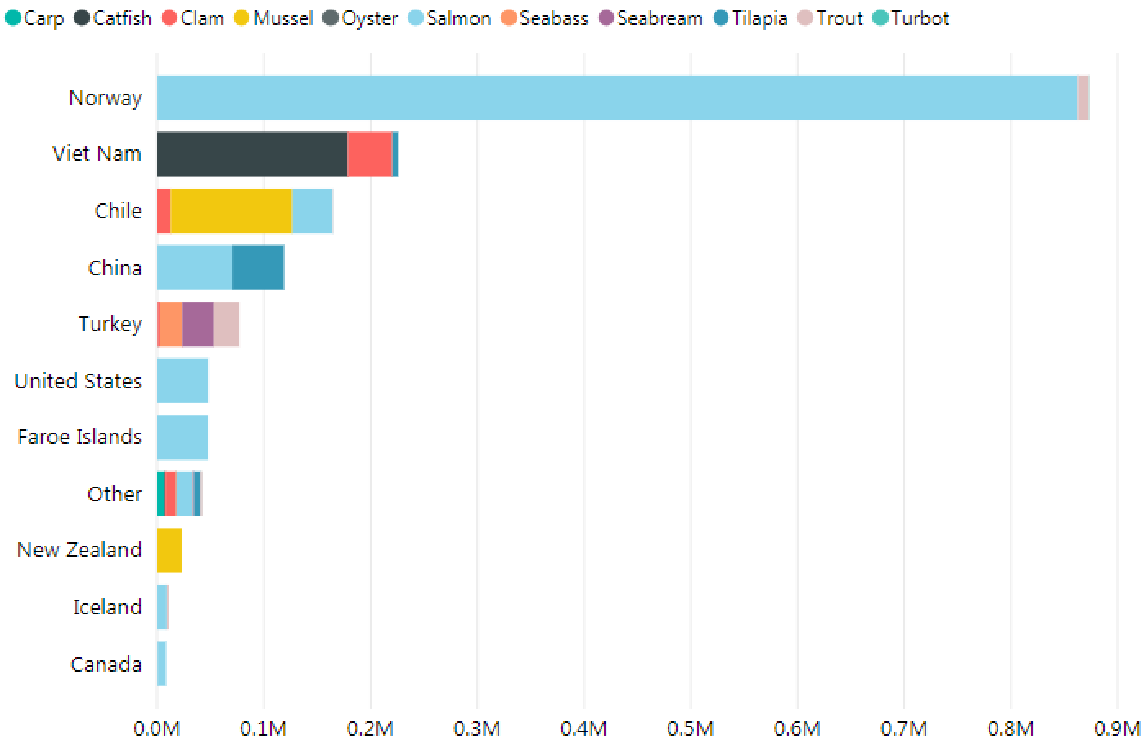


Figure 6. EU28 import volume (T, lwe) of selected main commercial species by third country source (top 10) in 2017. Data source: EUROSTAT (2019)

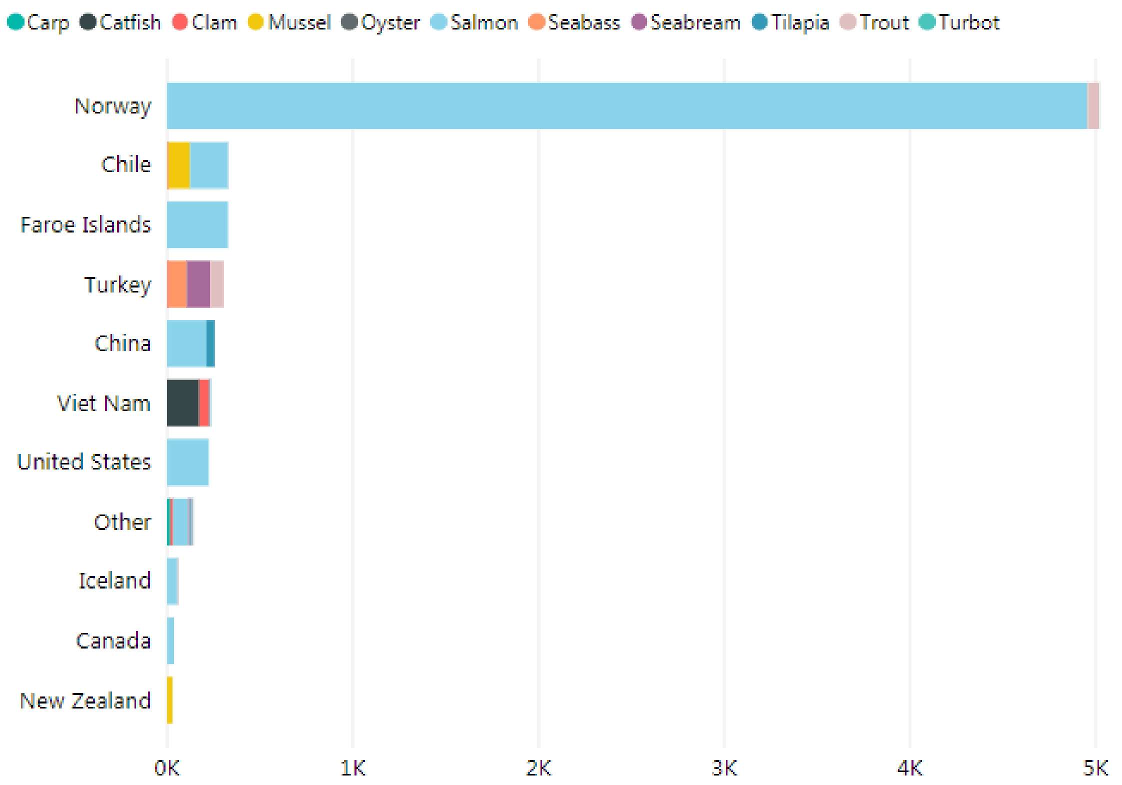


Figure 7. EU28 import value (EUR Million) of selected main commercial species by third country source (top 10) in 2017. Data source: EUROSTAT (2019)

2.3 Market opportunities and threats

2.3.1 Market size

The apparent consumption of selected commodities in the EU28 in 2017 is shown in Figure 8 None of the commodities examined had a CAGR higher than 5%, whereas Clam, Tilapia, Oyster and Catfish showed a negative growth rate for the period 2015-2017. Salmon had the largest market of nearly 1 million tonnes (lwe). However, it exhibited a static consumption rate of 0% (down from 4% CAGR in 2015). Mussels was the second largest market by live weight with 600,000 t, showing a positive trend in consumption in the period 2015-2017. Seabass, Seabream and Carp had similar market sizes of around 100,000 tonnes lwe. Turbot and Tilapia had the smallest apparent consumption of 17,000 t and 49,000 t lwe, respectively. A decline in consumption of Catfish, Tilapia and Oysters can be observed relative to 2015, while the opposite trends was found seen in the case of Mussels, Carp and Turbot (Figure 9). Generally this shows positive trends for EU species which are almost all growing in popularity albeit at modest rates.

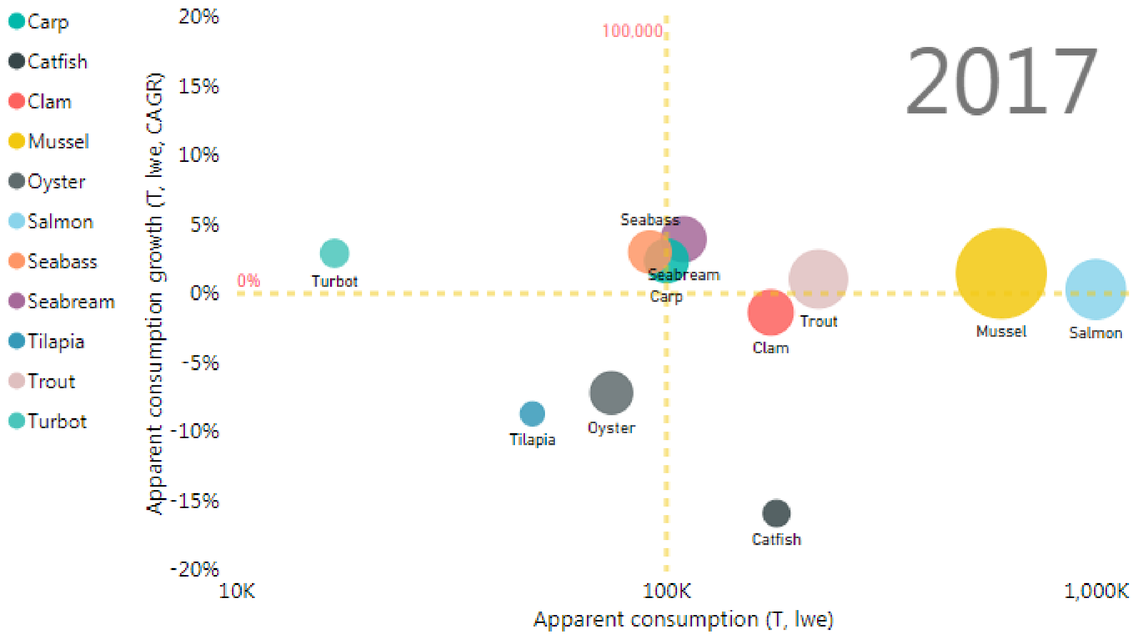


Figure 8. Apparent consumption (T, lwe) of selected commodities on the EU market, 2017. Bubble size indicates EU28 production by volume. Horizontal axis is on a log-scale. Data source: EUROSTAT (2019), FAOSTAT (2019), EUMOFA (2019)

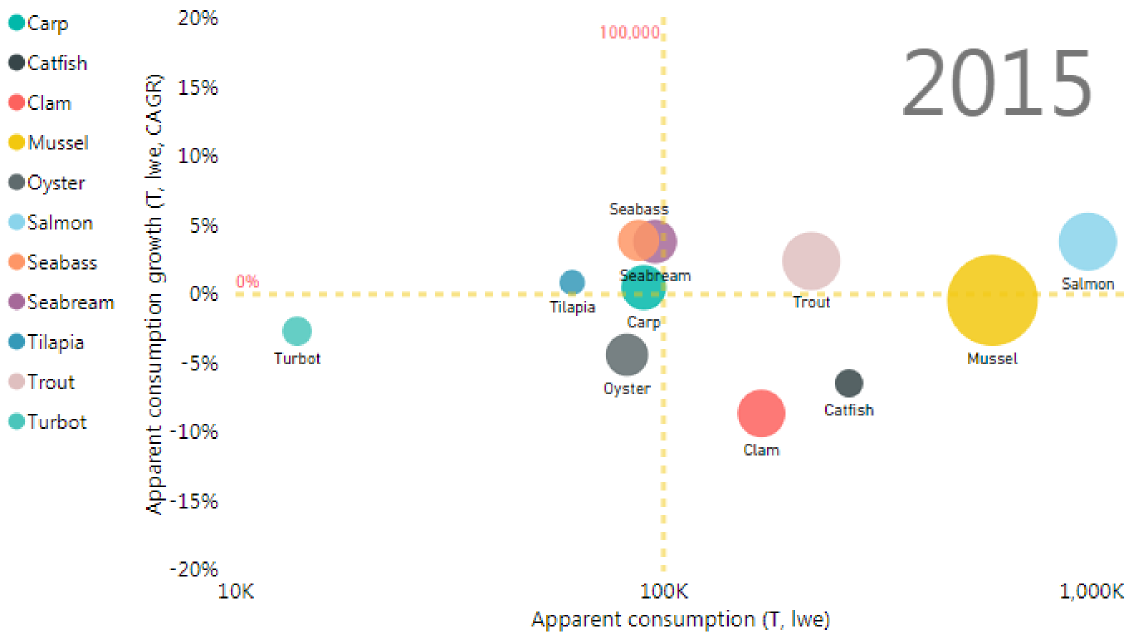


Figure 9. Apparent consumption (T, lwe) of selected commodities on the EU market, 2015. Bubble size indicates EU28 production by volume. Horizontal axis is on a log-scale. Data source: EUROSTAT (2019), FAOSTAT (2019), EUMOFA (2019)

2.3.2 *Market globalisation*

The extent and geographic scope of trade with the selected commercial species on the EU market is shown in Figure 10 and Figure 11. Salmon showed high trade level on both dimensions, reflecting the global market for this commodity. Catfish and Tilapia were supplied almost exclusively from third countries, while very low levels of trade in Carp, both external and internal, were found. However, most commodities were characterised by low levels of third-country imports and exports but significant intra-EU trade indicating regional (within EU) consumption and competition. No major differences in the trends of import and export sourcing were found between 2015 and 2017.

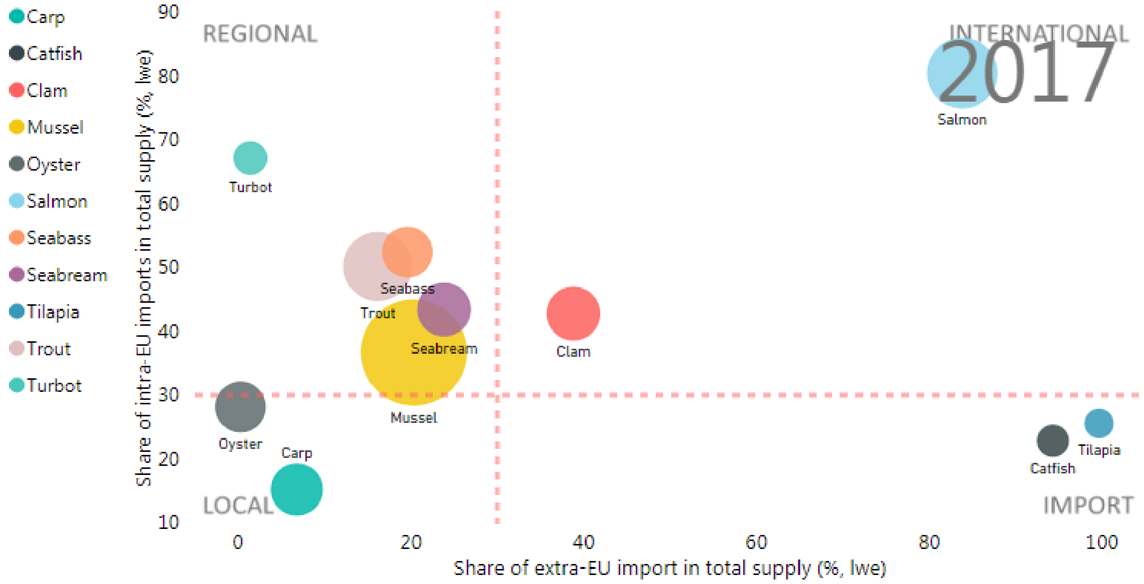


Figure 10. Geographic extent of import sourcing of selected commercial species on the EU28 market, 2017. Bubble size indicates EU28 production by volume. Data source: FAO (2019), EUROSTAT (2019)

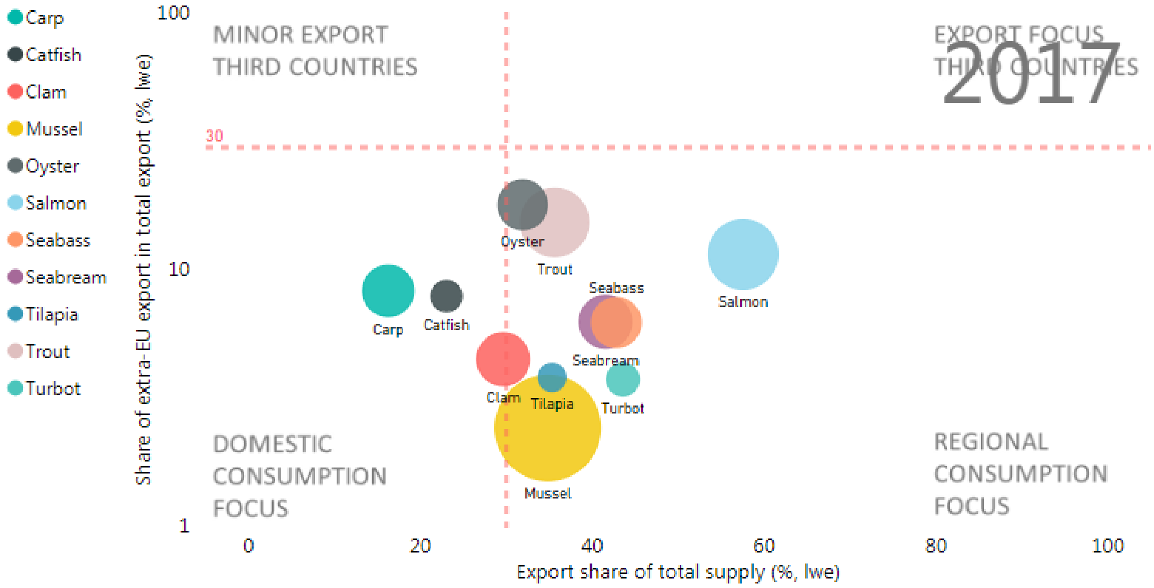


Figure 11. Export orientation of major EU seafood commodities, 2017. Bubble size indicates EU28 production by volume. Source: EUROSTAT (2019), FAO, (2019).

2.3.3 Market share

Positive growth in market share is a sign of competitiveness of an industry. Share is gained and competitive position is strengthened when the industry growth rate is higher than the world average.

In 2017 EU produced Mussels, Trout and Turbot each represent (>20%) of the global production of these species, whereas Seabass and Seabream had a share of 35% and 45%, respectively (Figure 12). However, despite the production growth in EU Seabass and Seabream, their share of the global growth was negative, indicating faster growth in third countries. This trend has been sustained over preceding years as indicated in Figure 13, where it can be seen that in 2015, their share was higher by around 10%.

The production of Salmon, Carp and Mussels in the EU was growing at approximately the same rate as the global production for these commodities, while Clam and Catfish at a higher rate, gaining share, however from a low base. However, the aggregation of commodity data presents a distorted picture as the growth in EU catfish production is of Wels catfish that is not comparable to Vietnamese pangasius imports. Wels catfish has a limited market in Eastern Europe, whereas pangasius is a universal white fish replacement. While EU production shows some growth, it is from a low base with low market share. Overall, EU catfish consumption appears to be in decline, according to data in Figures 12 and 13. Turbot, despite a slight decline in EU production, improved its position due to faster decline in the rest of the world. Oysters and Tilapia production showed a worsening trend.

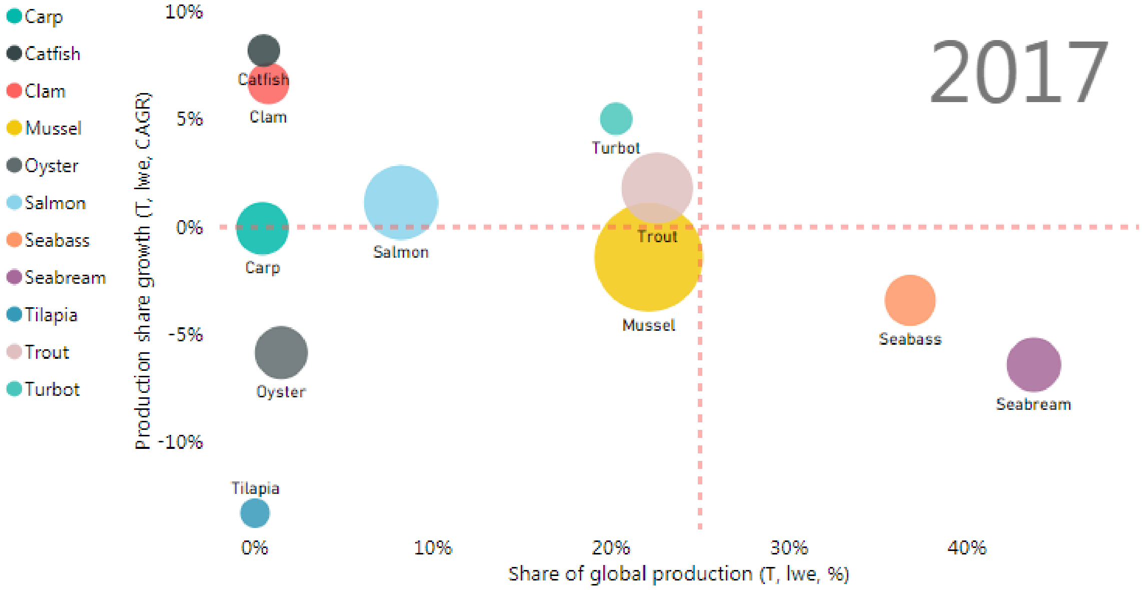


Figure 12. Share of EU28 production in global production, 2017. Bubble size indicates EU28 production by volume. Data source: FAO (2019)

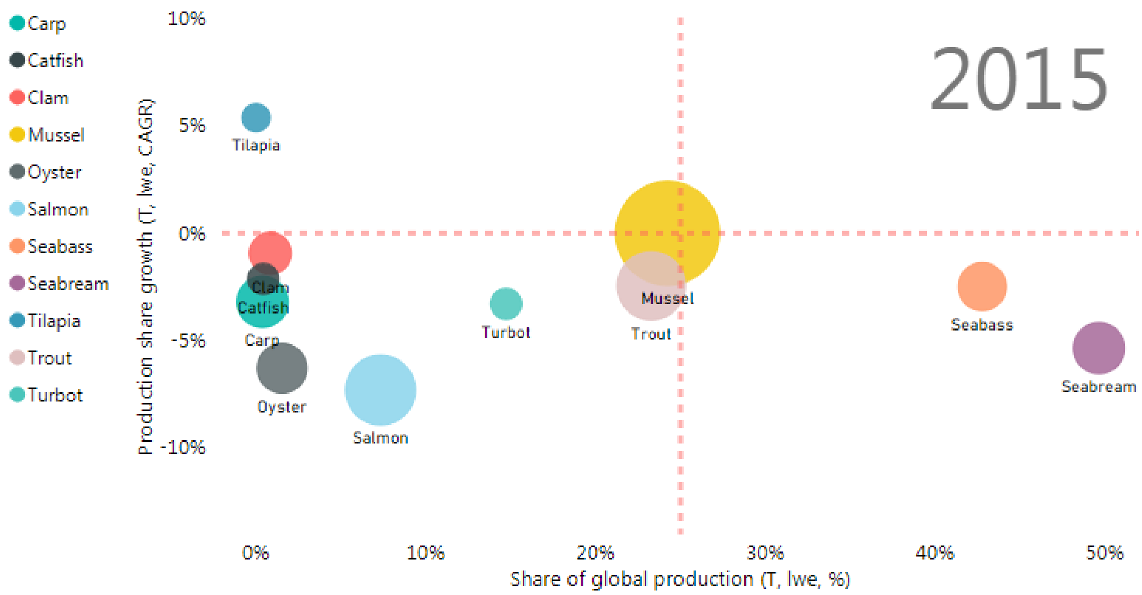


Figure 13. Share of EU28 production in global production, 2015. Bubble size indicates EU28 production by volume. Data source: FAO (2019)

2.4 Production strengths and weaknesses

2.4.1 Industry concentration

An examination of the level of concentration in four of the selected industries in 2015 (Figure 14) reveals that, within the salmon aquaculture industry, Faroe Islands, Canada and the UK, while each having a small share in the global industry output, were the most highly concentrated with CR_4 ranging between 75% and 100%. On the other hand, Norway and Chile, accounting for most farmed salmon output globally, had lower CR_4 of 52% and 42% respectively. Since salmon farming is an international business, with the same firms having operations in the different countries, the four largest salmon firms in the world controlled 40% of the global output.

A high level of concentration was found also in the Spanish sea bass and bream industry. The concentration in this industry had increased in both Spain and Turkey over the period 2010-2015, where in the case of Turkey it had almost doubled from 29% to 56% while in Spain it had risen by 10 percent points (Figure 15). An increase in the concentration of rainbow trout aquaculture in Turkey was also seen, although not to the same extent as for sea bass and bream. Rainbow trout production in Scotland (not including the rest of the UK) was highly concentrated too, with CR_4 close to 90%.

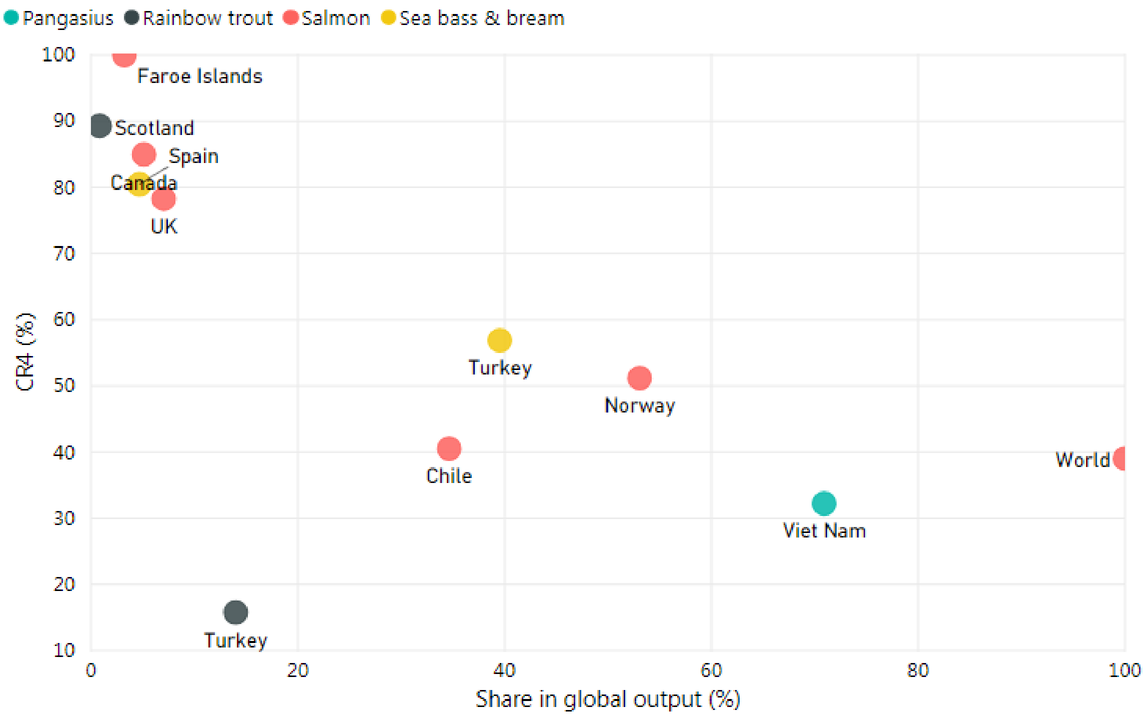


Figure 14. Extent of concentration (share of four largest firms in total industry sales, CR_4) in selected national aquaculture industries, 2015. Data source: Orbis (2017), Republic of Turkey Ministry of Agriculture and Forestry (2017), Kontali Analyse (2018), The Scottish Government, (2018), VASEP (2018)

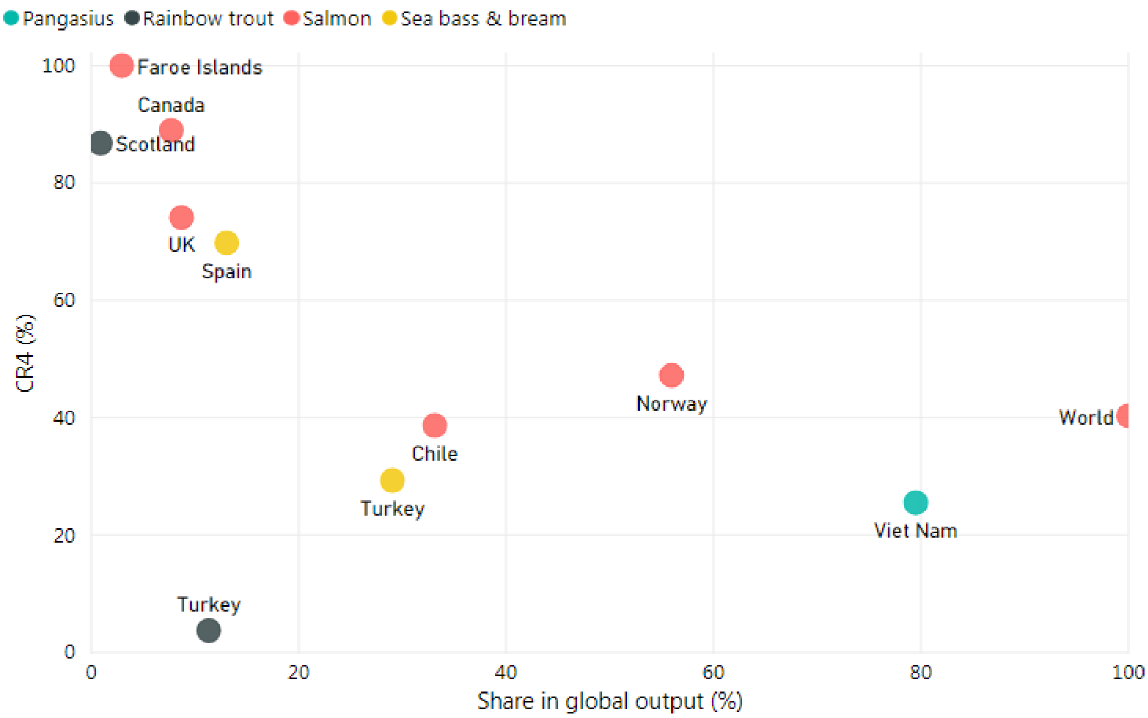


Figure 15. Extent of concentration (share of four largest firms in total industry sales, CR_4) in selected national aquaculture industries, 2010. Data source: Orbis (2017), Republic of Turkey Ministry of Agriculture and Forestry (2017), Kontali Analyse (2018), The Scottish Government, (2018), VASEP (2018)

2.4.2 Self-sufficiency

High self-sufficiency rates of more than 80% were found for many of the commercial species examined including Mussels, Trout, Clam, Seabream, Seabass and Carp, while Oysters and Turbot, showed even higher values of more than 100% indicating a positive trade balance for these commodities, Figure 16. Salmon and Catfish, on the other hand, for which there was high demand, had a low self-sufficiency rate of below 20%.

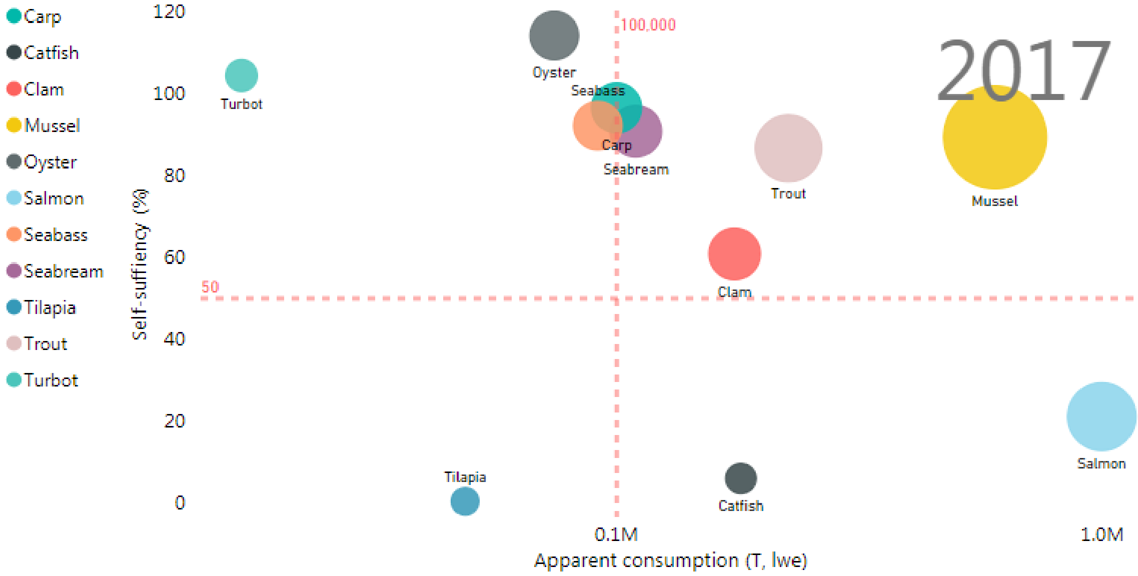


Figure 16. Self-sufficiency for selected EU seafood market commodities, 2017. Bubble size indicates EU28 production by volume. Horizontal axis is on a log-scale. Source: FAO (2019), EUROSTAT (2019)

2.4.3 Productivity

Figure 17 shows the GVA and productivity of the main EU aquaculture production systems. According to the figures provided by Member States, Oyster had the largest share in the total GVA for aquaculture, while Clam was the most productive category, followed by Oysters. However, data is only shown at production stage, whereas value is often added at the processing stage. Significant value is added through filleting, smoking, and further processing into value added products, including utilisation of by-product commodities (Stevens *et al.* 2018). The difference in level of processing and value-add opportunity is evident between species and regions, where carp and shellfish are commonly sold live, seabass and seabream may be sold whole-gutted in Southern Europe or more processed in Northern Europe, trout may be sold as small plate-size whole fish or more processed larger fish, and salmon is almost all sold as large processed fish products. How these products are marketed and the level of separation of different fractions has a large bearing on value addition. These differences are explored more in Value Chain Analyses as part of deliverable 4.2.

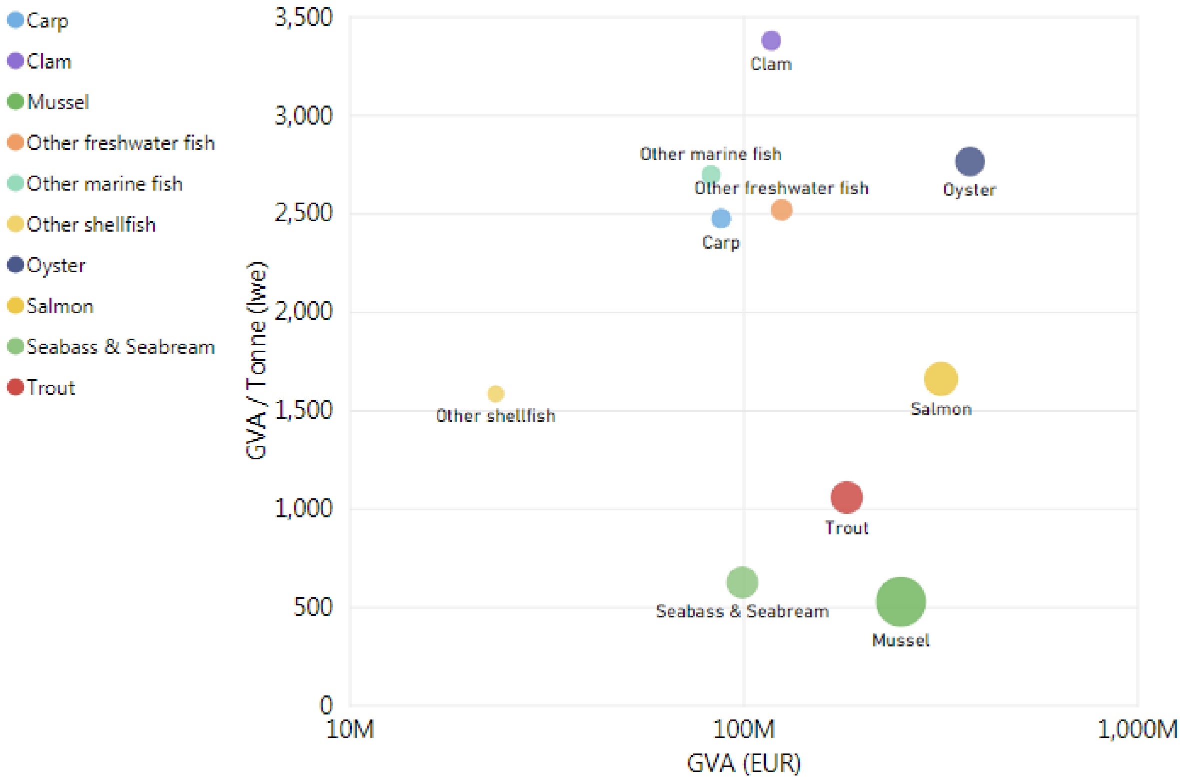


Figure 17. Gross value added (GVA) and productivity of EU aquaculture by commodity, 2014. Bubble size represents total volume sales (T, lwe). Horizontal axis is on a log-scale. Source: Nielsen, Carvalho and Guillen (2018)

Figure 18 shows the 2014 figures reported by member states on employment by industry and the calculated labour productivity expressed as Quantity output per FTE. The largest employer according to these data was the Oyster industry with 7,600 FTEs. Highest labour productivity was revealed for Salmon of less than 1 FTE per 100 tonnes produced, while the Carp industry had the lowest productivity of nearly 10 FTEs. However, these figures do not take into account FTEs in the processing sector. It is difficult to disaggregate processing data because processors commonly process multiple species on the same premises. However, the Seafish Industry Authority produces figures for Scottish salmon, which in 2016 reported 4400 FTEs, giving a productivity of 37 tonnes per FTE. However, the processing sector has been going through rapid consolidation in recent years with FTEs reducing year on year while production increases (Seafish 2016).

Similar observations were made for labour productivity in terms of GVA generated per FTE, Figure 19. The total reported number of employees for all species selected in 2014 was 27,688 FTE with an average productivity of 2.1 FTEs per 100 kg.

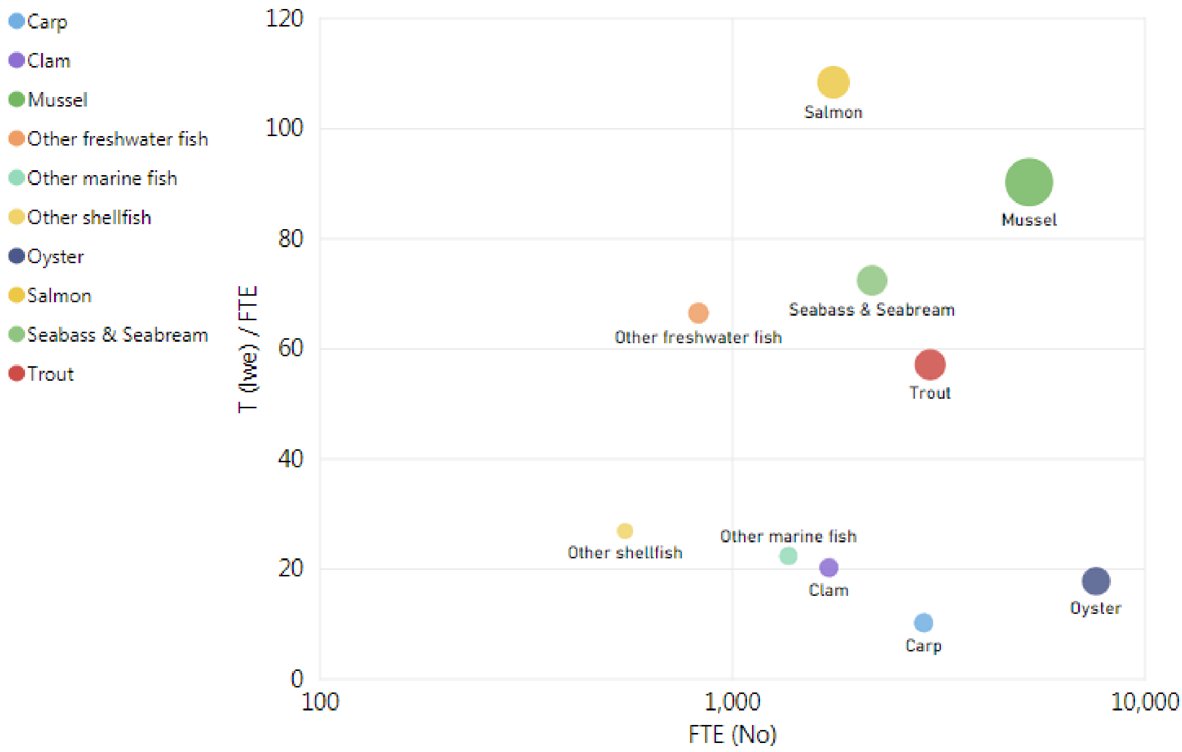


Figure 18. Employment (FTE) and labour productivity per unit volume of output by industry for 2014. Bubble size represents total volume sales (T, lwe). Horizontal axis is on a log-scale. Source Nielsen, Carvalho and Guillen (2018)

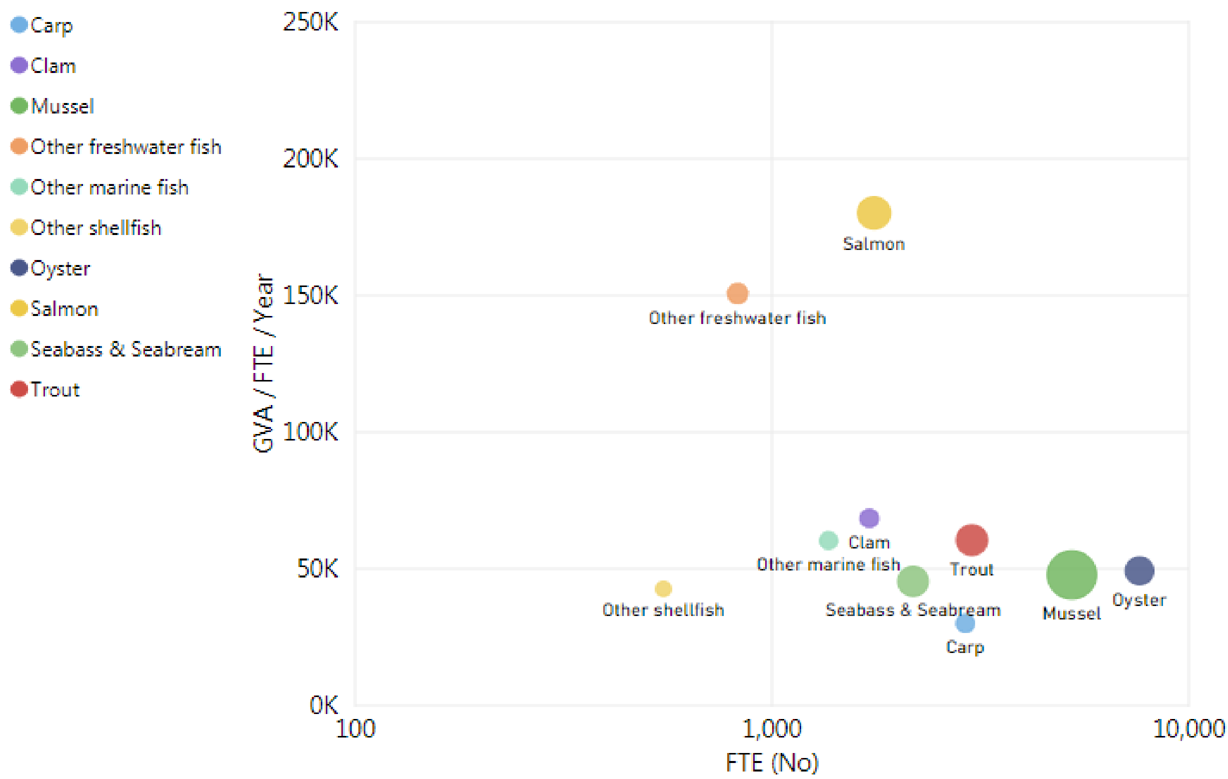


Figure 19. Labour productivity (GVA/FTE) and Employment (FTE) by industry for 2014. Bubble size represents total volume sales (T, lwe). Horizontal axis is on a log-scale. Source: Nielsen, Carvalho and Guillen (2018)

2.5 Inter-species competition

2.5.1 The salmonid sector

The following section presents a more detailed analysis of the salmonid sector in the EU covering the commercial species Salmon and Trout, disaggregated by member state and main competitors. The analysis also provides contextual background to the following chapters in this report. Additional results for other species can be found in the Appendices.

Among the selected commercial species, Salmon was the one with largest market size by volume and value with France, Germany and the UK being the member states with largest consumption by volume (Figure 20). EU production, however, was limited to only the UK and Ireland (Figure 21) both of which were net exporters while the vast majority of the market was supplied by imports from Norway, but with a large share of processing and value addition occurring within the EU. Overall self-sufficiency of the region for this species remained low at around 20%. On the other hand, as one of the most important commecial species in EU aquaculture, trout production was spread more evenly across member states compared to salmon. Germany was the largest market for trout, however with very low self-sufficiecy level (Figure 22). Italy, Denmark and France were the largest producer states, all being net exporters of Trout (self-sufficiency rate > 100%). Consumption in the region was largely met by local production, as evidenced by low extra-EU trade in this species. Exports to third countries were less than 20% of the total volume traded in 2017. Specialisation in the export of trout (among other commercial seafood species) was observed for Finland, Austria, Turkey, Estonia, Bulgaria, Norway, Italy, Poland and Denmark, however with negative growth rate (i.e. losing specialisation), while in the case of the UK and Sweden there was positive development in the RCA growth rate (Figure 23). Norway, Sweden, Finland, Lithuania, Poland, Denmark, Czech Republic and the UK all showed specialisation in the export of salmon.

Salmon, as indicated previously (Figure 5 and Figure 6), was by far the most significant import commodity among the selected commercial species on the EU28 market. The vast majority of imports in 2017 came from Norway (Figure 24) in the form of fresh whole/gutted salmon (Figure 24 and Figure 25).

According to EUROSTAT (2019), the main importer member states in 2017 were Sweden, Denmark and Poland (Figure 26). However, Sweden (and to some extent Denmark) appears to be only entry points for Norwegian salmon, from which the imports are further distributed within the EU, as the figure indicates, whereas Poland and Denmark are main processing centres.

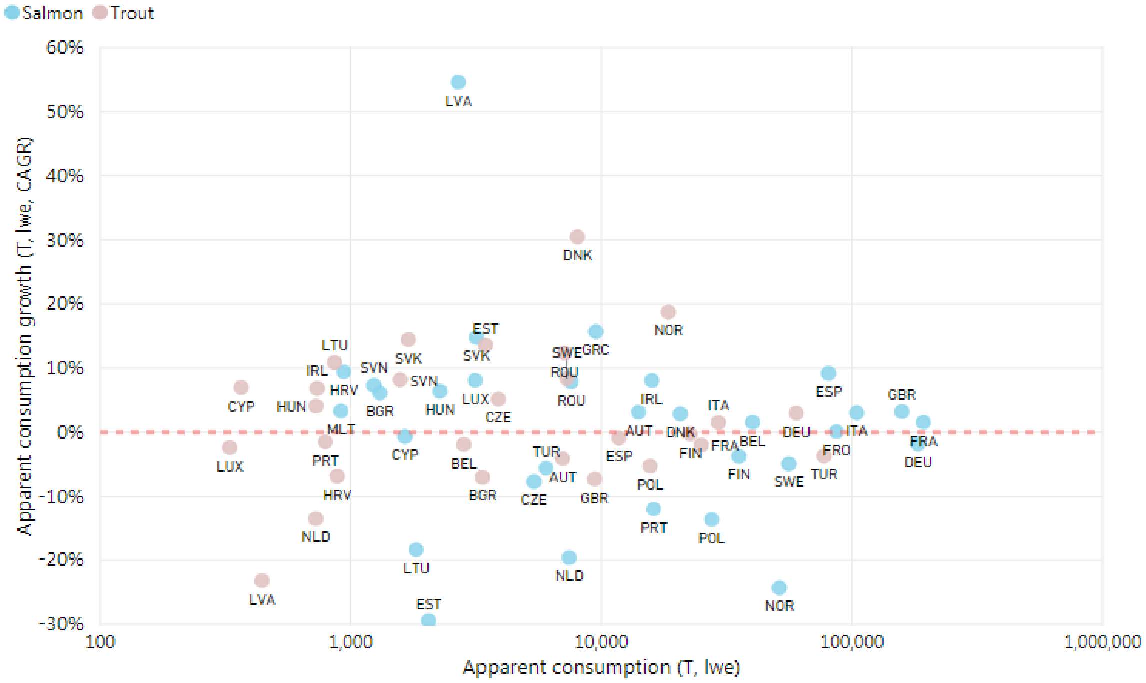


Figure 20. Market size (volume) of Salmon and Trout by member state and main competitors. Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

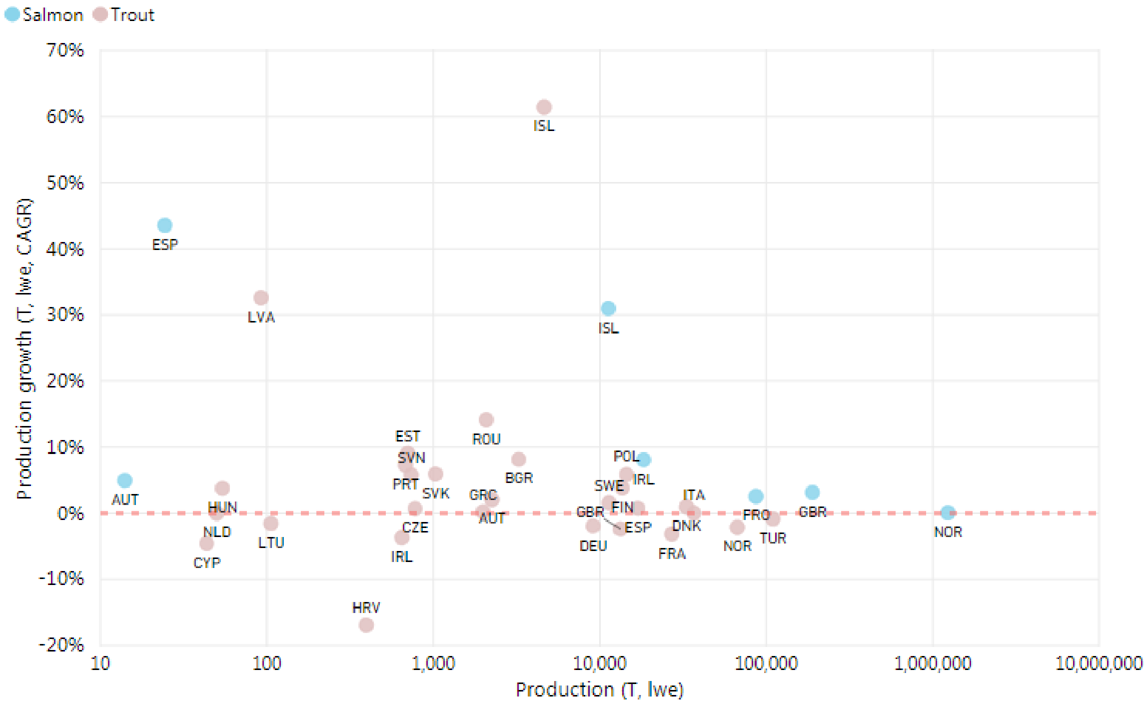


Figure 21. Production of Salmon and Trout by EU28 member state and main competitors, 2017. Horizontal axis is on a log-scale. Data source: FAO (2019)

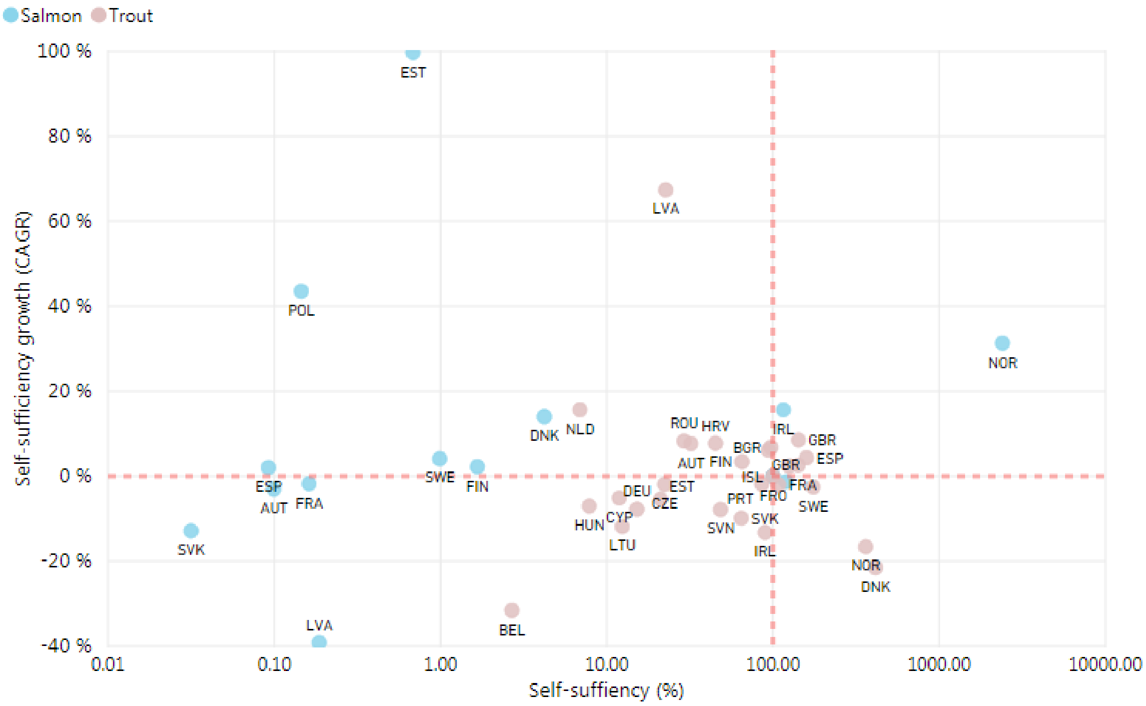


Figure 22. Self-sufficiency of Salmon and Trout by member state and main competitors, 2017 (only for countries where domestic production was reported). Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

Figure 23. Revealed comparative advantage (RCA) for Salmon and Trout by EU28 member state and main competitors, 2017. Horizontal axis is on a log-scale. Data source: EUROSTAT (2019), UN Comtrade (2019)

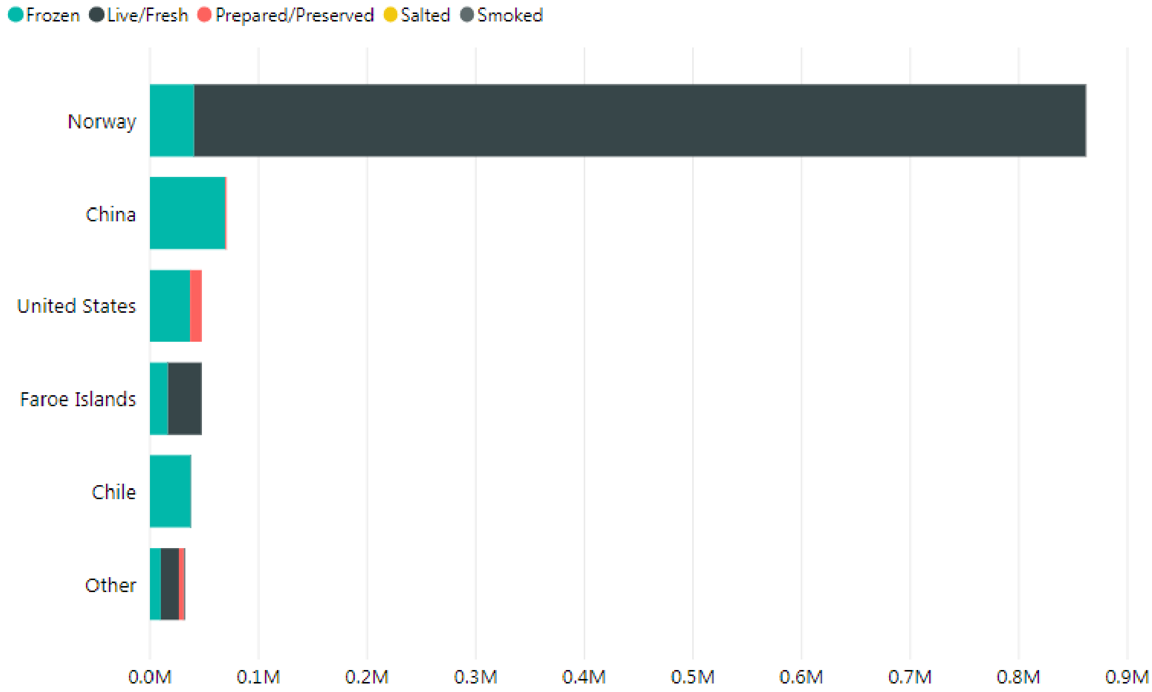


Figure 24. Imports of salmon from third countries into the EU28 by type of preservation in 2017, volume (T, lwe) Data source: EUROSTAT (2019)

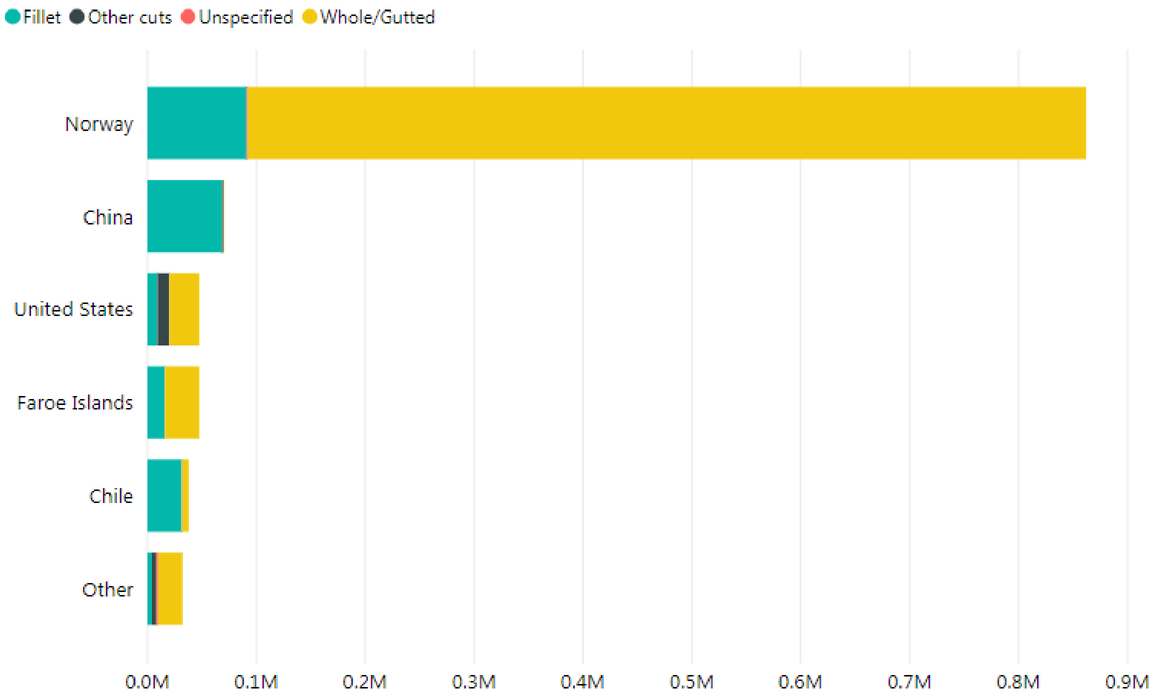


Figure 25. Imports of salmon from third countries into the EU28 by type of presentation in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

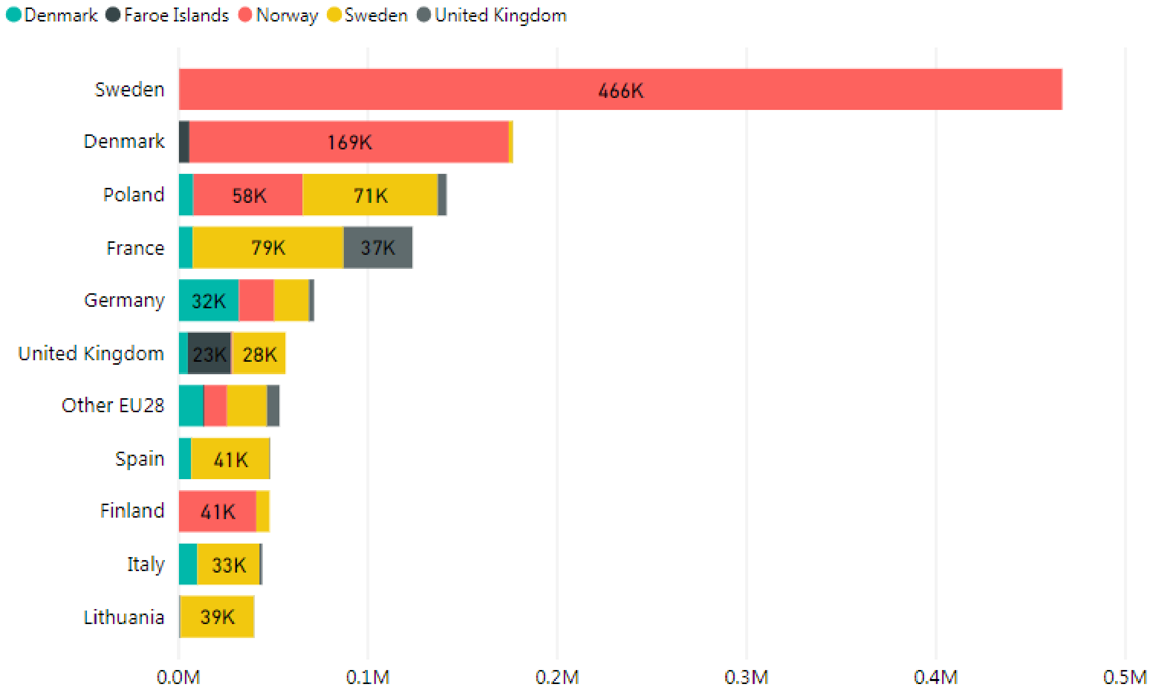


Figure 26. Imports of whole/gutted fresh salmon by MS (top 10 importers) and by country of origin in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

A comparison of the prices of imported fresh whole gutted salmon on the French market from main sources indicates that the United Kingdom had consistently higher price of around 15-20%, relative to imports from Norway/Sweden (Figure 27).

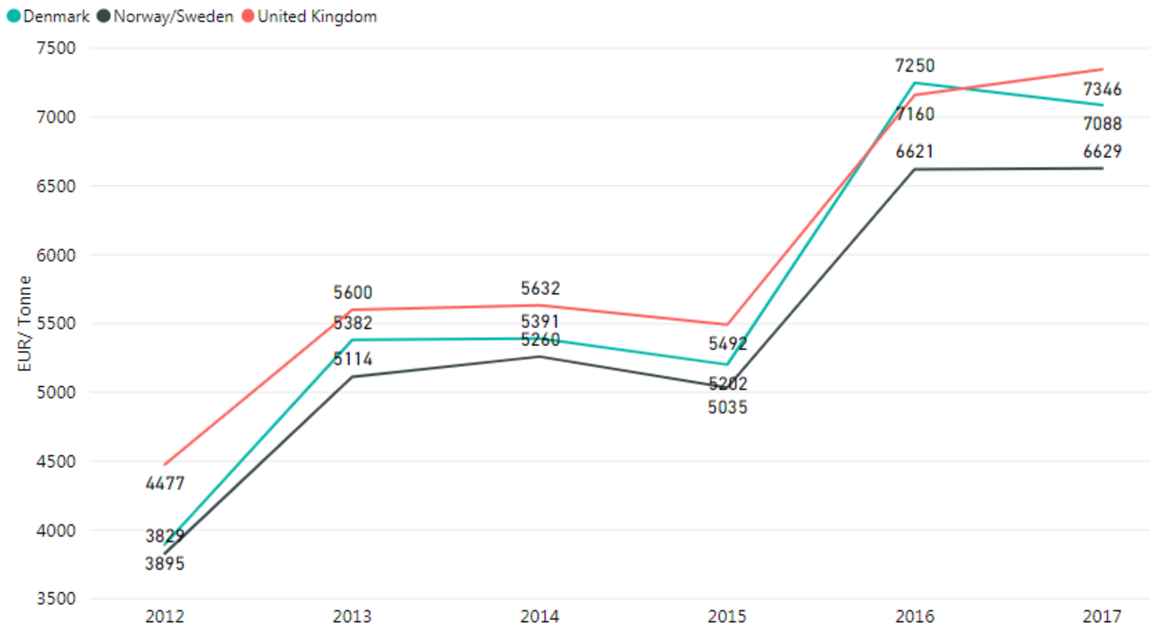


Figure 27 Price of imported fresh whole/gutted salmon into France from main sources, 2012-2017. EUROSTAT (2019)

Unlike salmon, trout can be produced in aquatic environments with different levels of salinity (from freshwater to full-strength seawater), Figure 28. Because of the different farming technologies used in those environments, fish reared in marine water are typically grown to a larger size (harvest size 4-5 kg, similar to salmon), whereas in freshwater – usually of size <0.5 kg (plate-size fish). The size difference determines the attributes of the final products.

Around half of the 37,000 tonnes (lwe) of trout imported from third countries into the EU in 2017 consisted of small (plate-size) trout, dominated by whole/gutted frozen products (Figure 29). On the other hand, in the case of large rainbow trout, imports were composed of whole fresh products. The remaining volume of unspecified size class consisted of smoked trout.

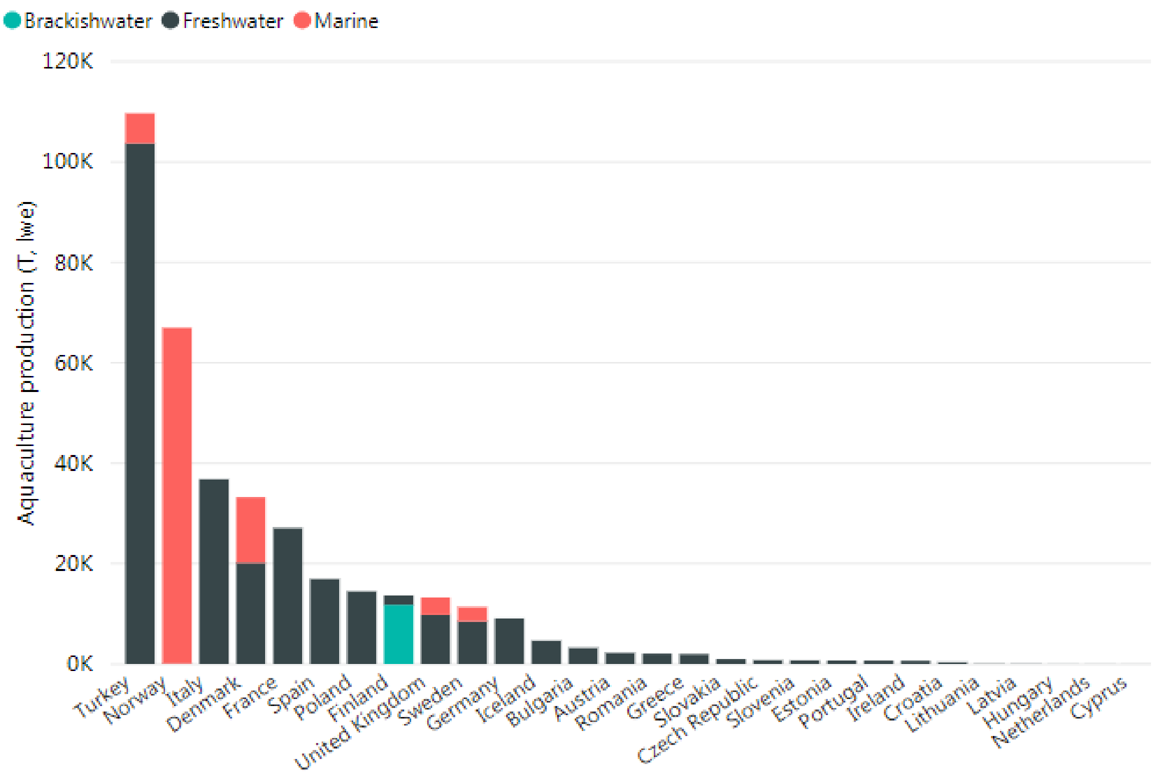


Figure 28. Rainbow trout production by environment, 2017. Data source: FAO (2019)

The main third countries exporting large trout to the EU were Norway, Iceland and Turkey, with Norway by far dominating exports in this category (Figure 30). The main importing member states of were Finland, Sweden and Poland, Estonia and Denmark with considerable trade between these states (Figure 31), particularly from Norway to Sweden and from Sweden to other MS.

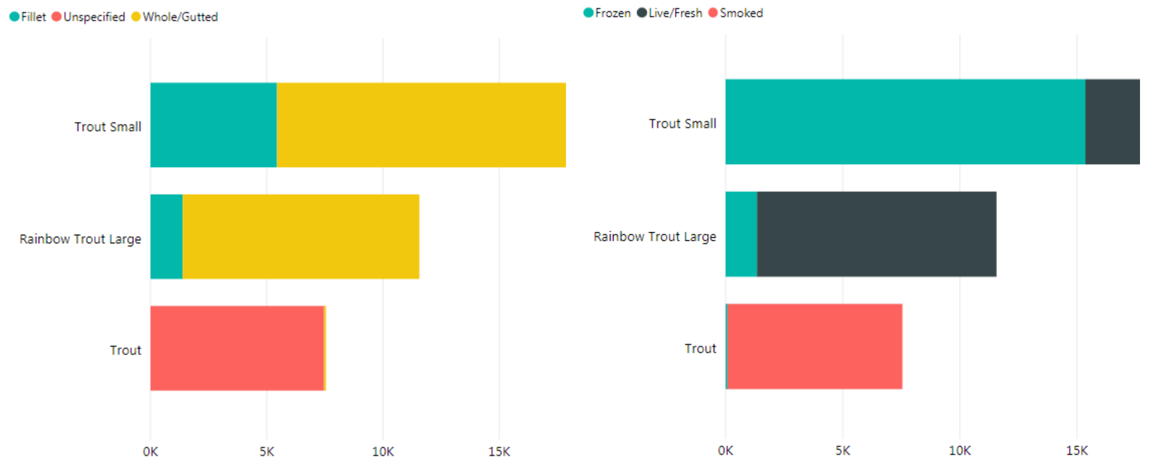


Figure 29 Imports of trout from third countries into the EU28 by size and type of presentation and preservation in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

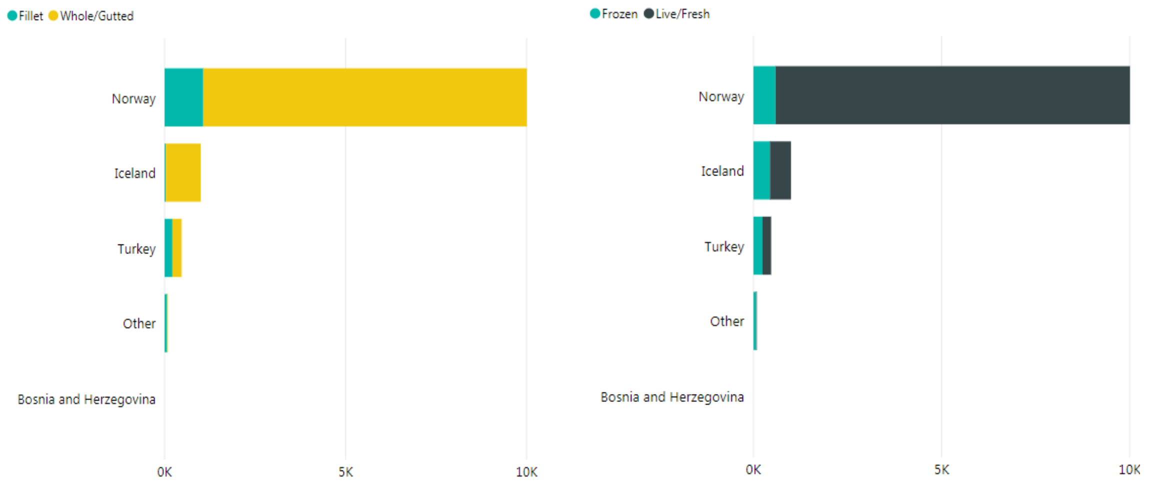


Figure 30. Imports of large rainbow trout from third countries into the EU28 by type of presentation and preservation in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

A price comparison of large rainbow trout imports into Poland (Figure 32), which had the most diverse range of import sources, revealed that Danish trout had a consistently lower price than imports from Norway, Sweden, Finland (grouped together because of the likely single origin Norway). Import from Turkey were recorded in only one year in the period examined and were comparable to the price of imports from Denmark.

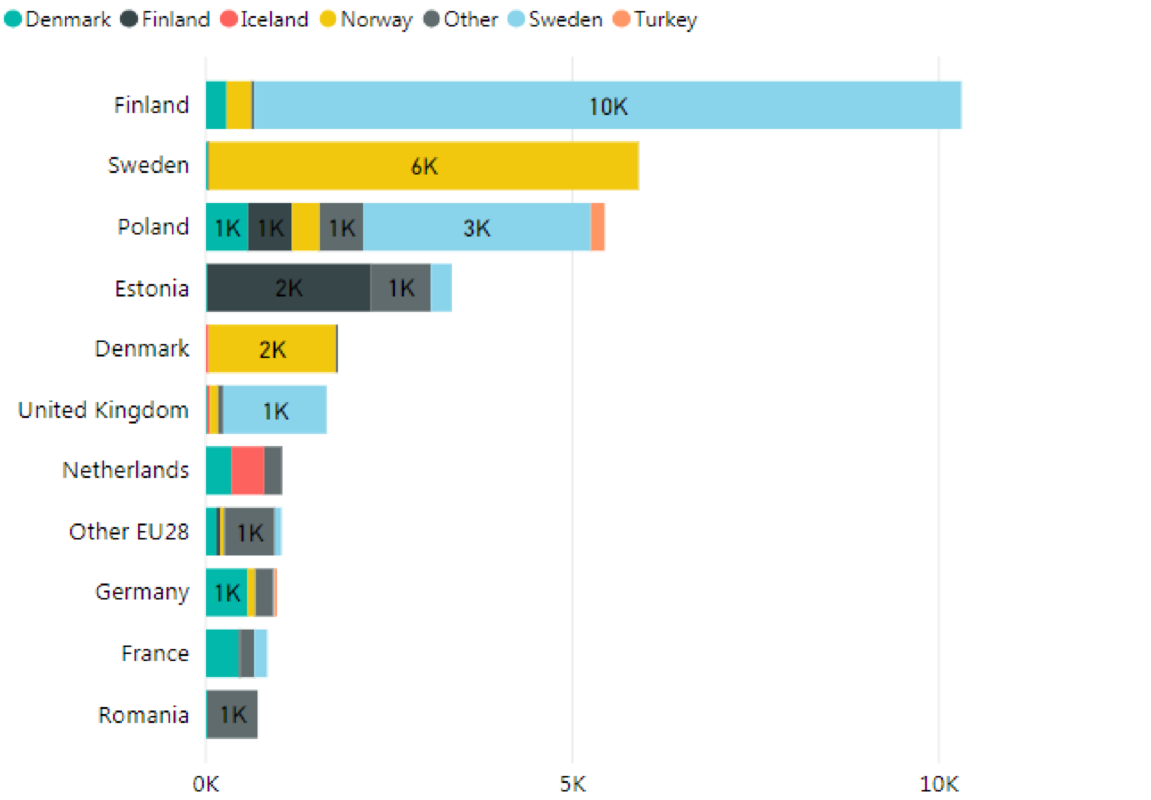


Figure 31. Imports of whole/gutted fresh large rainbow trout by top 10 member states and country of origin in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

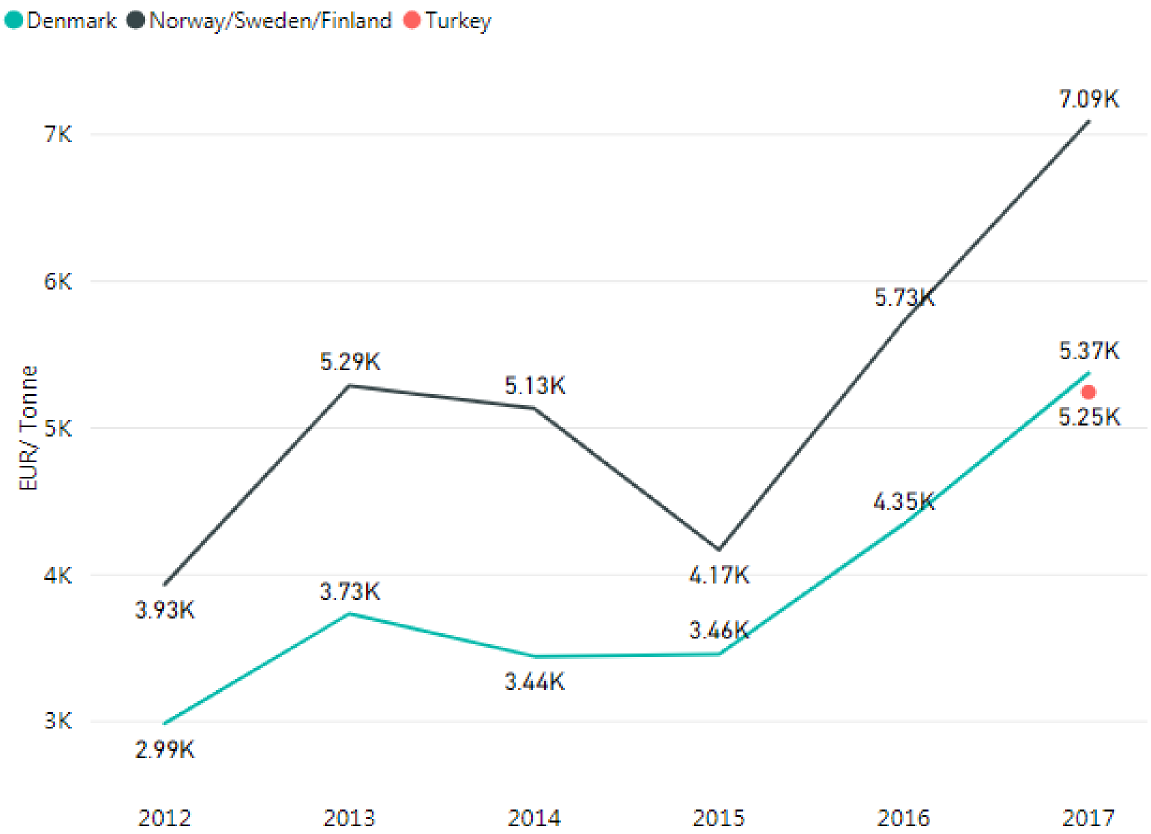


Figure 32. Price of imported fresh whole/gutted large rainbow trout into Poland from main sources, 2012-2017. EUROSTAT (2019)

In the case of small (plate-size) trout, Turkey by far dominated the third country imports into the EU (Figure 33). Germany was the main importer of Turkish trout and the main EU market on which plate-size trout from other EU producer countries was consumed, particularly from Denmark, France and Italy (Figure 34). A price comparison reveals that on the German market, Turkish trout had considerably lower and more consistent price than other main exporter states (Figure 35). Price of Turkish trout was even lower on the Polish market, but still higher than Italian imports in the period 2013-2017 (Figure 36).

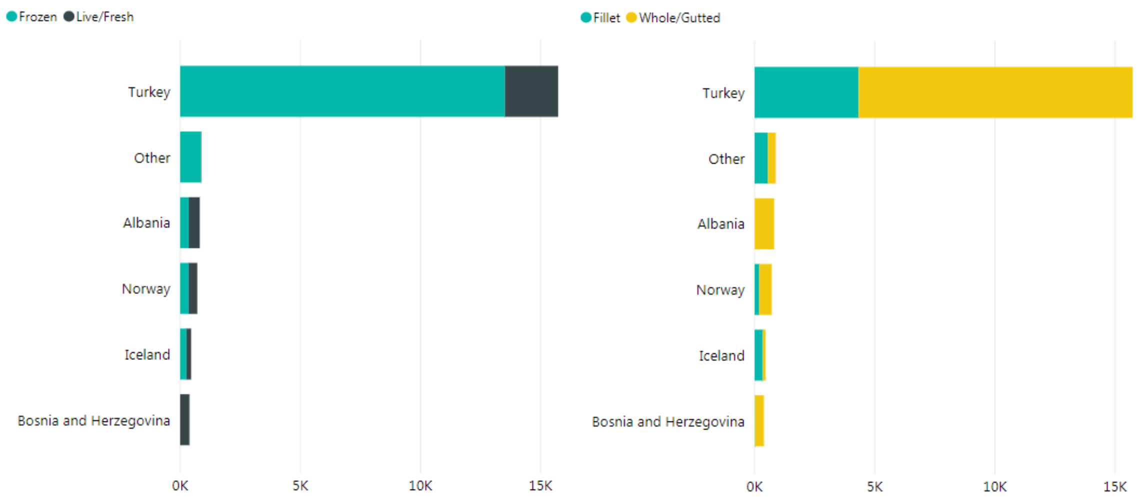


Figure 33. Imports of small rainbow trout from third countries into the EU28 by type of presentation and preservation in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

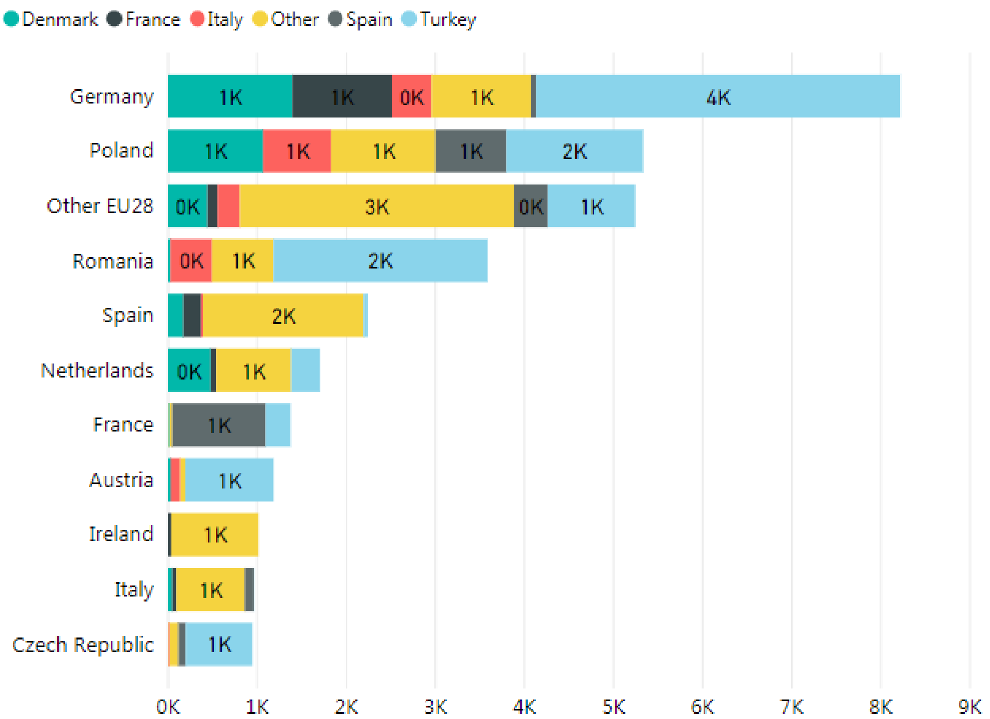


Figure 34. Imports of whole/gutted fresh or frozen small rainbow trout by MS (top 10) and by country of origin in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

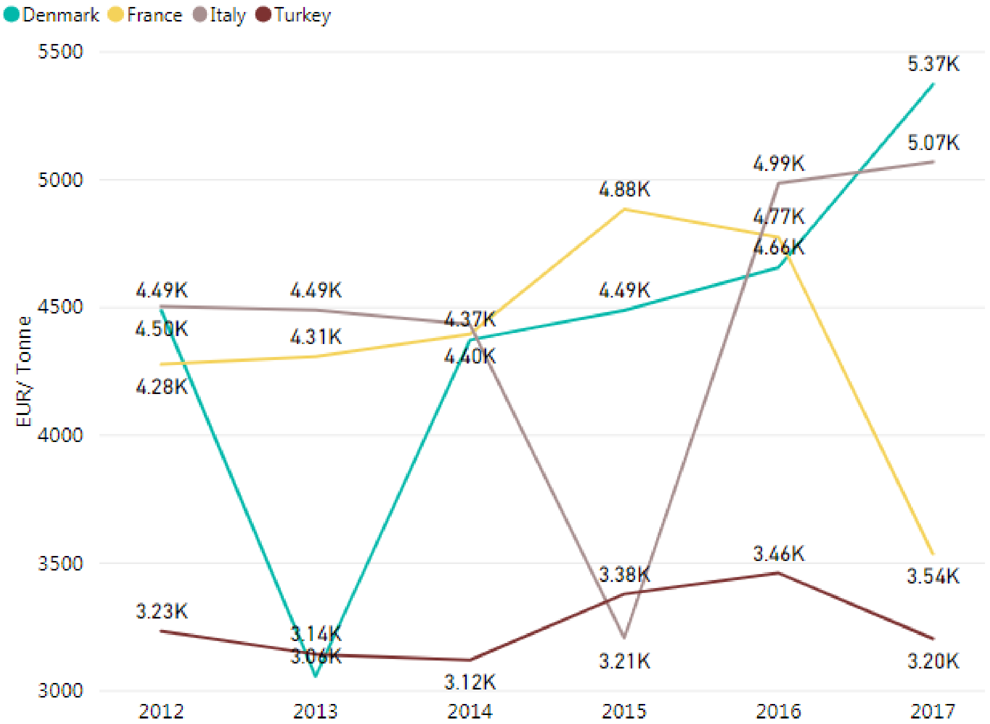


Figure 35. Price of imported fresh or frozen whole/gutted small rainbow trout into Germany from main sources, 2012-2017. EUROSTAT (2019)

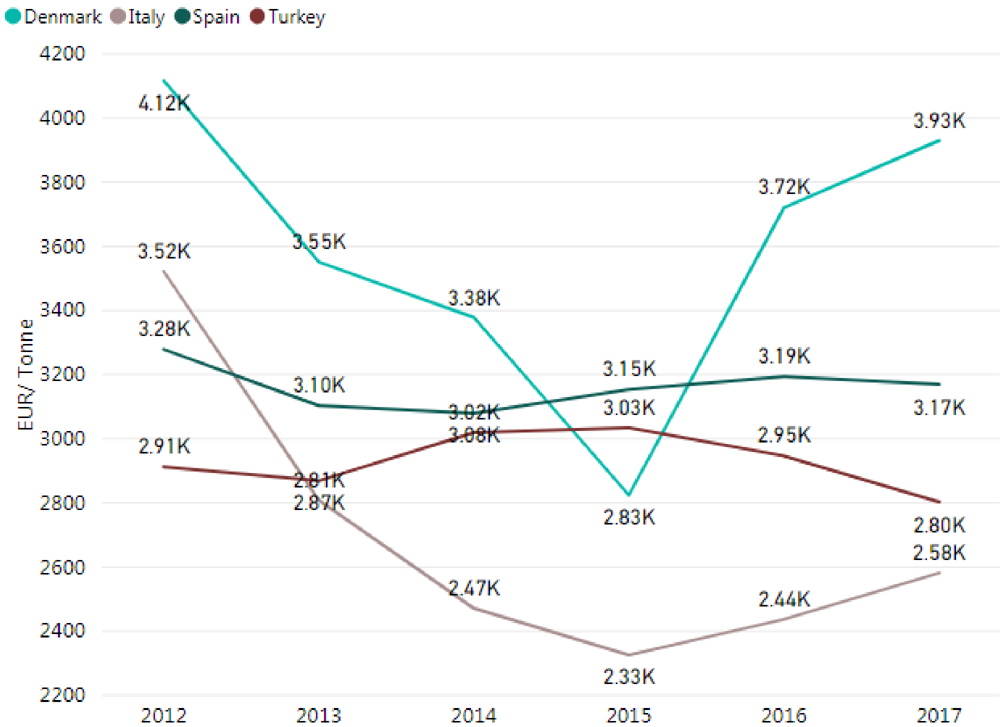


Figure 36. Price of imported fresh or frozen whole/gutted small rainbow trout into Poland from main sources, 2012-2017. EUROSTAT (2019)

More than 7,000 tonnes (lwe) of smoked trout from Turkey were imported into the EU in 2017 (Figure 37), mainly on the German and Austrian markets (Figure 38). On the German market, smoked Turkish trout had a lower price than imports from Poland and Denmark, but higher price than Netherlands (Figure 39).

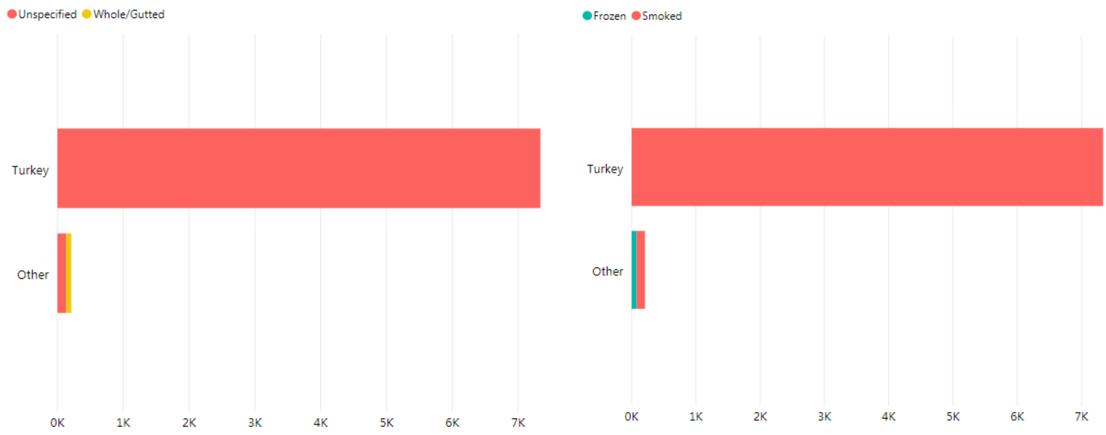


Figure 37 Imports of trout from third countries into the EU28 by type of presentation and preservation in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

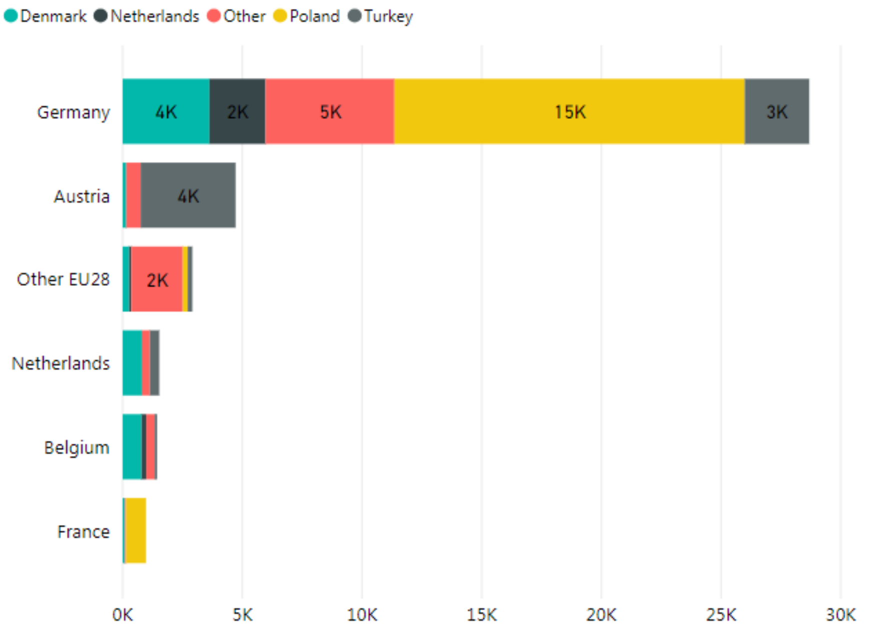


Figure 38. Imports of whole/gutted fresh or frozen small rainbow trout by MS (top 10) and by country of origin in 2017, volume (T, lwe). Data source: EUROSTAT (2019)

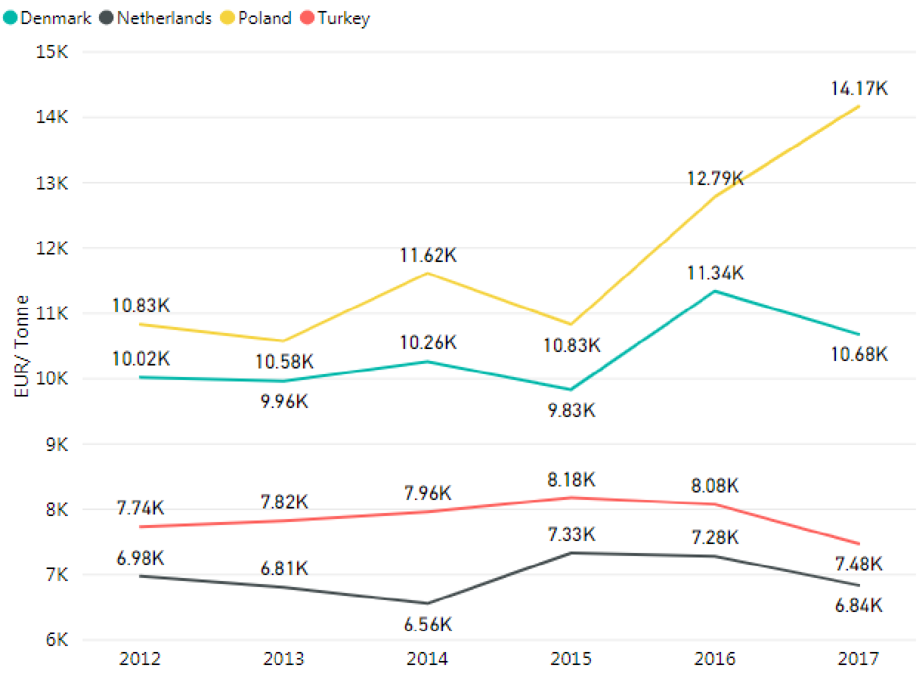


Figure 39. Price of imported smoked rainbow trout into Germany from main sources, 2012-2017. EUROSTAT (2019)

One of the main arguments for promoting aquaculture growth in the EU relates to the region's low self-sufficiency in seafood (European Commission, 2009b). Policies targeting an increase in seafood self-sufficiency emphasize expanding domestic aquaculture production since significant further growth is not anticipated from fisheries (Lopes et al., 2017). However, the results presented above indicated that a large proportion (62% by volume, lwe) of the seafood consumed in the EU, whether imported or domestically produced, consisted of species that could not be produced in aquaculture but could only be supplied from capture fisheries. The implication of this finding is that if all 'aquaculturable' species consumed in the EU were produced in the EU (i.e. imports were substituted by domestic production), while maintaining the same market structure, seafood self-sufficiency would increase by an additional maximum of 28% (on the 10% that are already produced, to reach the maximum of 38%). However, this is unrealistic since the largest share is for cod, which although can be produced in aquaculture, is in direct competition with capture fisheries. Consequently there is unlikely to be a major increase in aquaculture output if no sufficient level of differentiation from fisheries is reached and cost of production remains high (Frampton, 2007). Similarly, shrimp and catfish production is largely confined to tropical and sub-tropical countries, with pangasius being a cheap substitute for white fish and not comparable to European *silurid* catfish. Therefore, from a food security perspective, the seafood market cannot be seen as a single food category, which aquaculture can address uniformly, but a more nuanced and targeted approach needs to be taken to the development of aquaculture in the EU. The analysis suggests that significant growth in EU aquaculture output could improve the balance of trade but is unlikely to provide a major solution to the food security problem unless seafood demand is significantly restructured. Thus, some of increase in aquaculture output can match with local demand, however, global value chains will still be needed to ensure adequate and stable food supply (Kinnunen et al., 2020). This is compounded by aquaculture's reliance on global supply chains to supply feed ingredients (Newton and Little 2018).

Salmon is the main commercial species imported into the EU market worth EUR 4.8 billion in 2018 (EUMOFA, 2019c). With high global demand and low self-sufficiency rate, it presents an attractive market segment. However, major expansion in the salmon industry in the EU is highly unlikely in the short-term because of lack of suitable marine farming sites (Hofherr, Natale and Trujillo, 2015; Lopes *et al.*, 2017). However, the large market for Salmon created by imports presents opportunities for the development of limited amount of local production close to end consumers. However, with the UK having officially left the EU, the capacity for growth of coastal salmon production is limited. The use of land-based systems could provide means for servicing the high-end niche markets in urban areas, provided premium price is achieved to justify the high capital and operational costs of this type of system. Nevertheless, significant growth in production and closing the self-sufficiency gap cannot be expected to come from such development while the highly efficient net pen systems dominate production in third countries and global trade continues. Potential for expansion in EU output in the long term exists in the use of novel technology for off-shore farming (Bostock *et al.*, 2016). On the other hand, economic benefits to the EU can also come from increasing the extent of value addition to imported raw material. While Salmon has a relatively high range of value-added products compared to other seafood commodities, there is still unutilised potential, especially compared to other animal protein sources such as chicken (Asche, Cojocaru and Roth, 2018, Stevens *et al.* 2018).

Since Norway, the primary source of salmon to the EU market, is part of the European Economic Area (EEA), it trades freely with the Union and usually no tariff measures apply for imports from Norway. Also, common rules and equal conditions of competition exist between the two parties. In the cases of mergers of companies in the two jurisdictions, the Commission has exclusive right to deal with anti-competitive behaviour affecting the Community (European Commission, 2014a). An illustration of this was the acquisition of Morpol (EU based company) by Marine Harvest (Norwegian) and the associated requirement by the EC for divestment of production facilities because of concentration concerns (European Commission, 2013a). While the growth of the salmon industry has been accompanied by global consolidation (Asche *et al.*, 2013), the extreme level of consolidation reached the Faroe Islands cannot be reached in the UK due to competition law because of which concentration appears to have stabilised.

Trade with Turkey, on the other hand, which is also a main EU trading partner in seafood, particularly in the import of trout, sea bass and sea bream, while part of the European

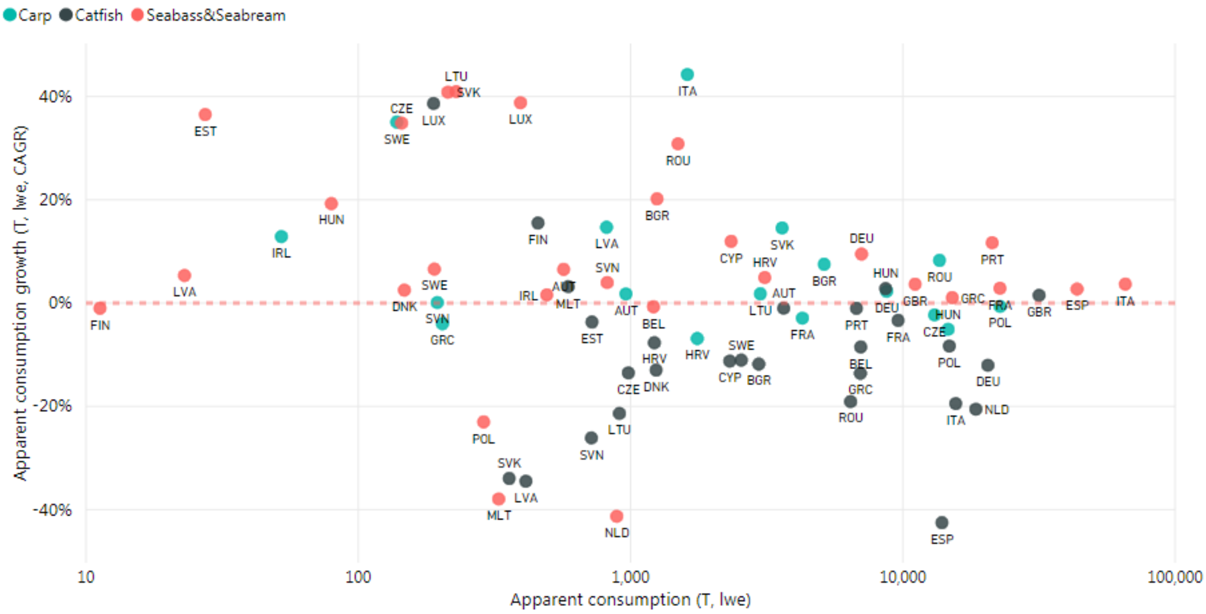
Union Customs Union (EUCU), can be regulated by the application of tariff duties. Such measures have been used in the case of rainbow trout imports, where countervailing duties as high as 9.5% have been applied to trout products in response to EU producers' complaints of unfair competition due to trade-distorting state subsidies (European Commission, 2020). Thus, the analysis indicates that a more useful boundary for further competitive analysis of the seafood sector in the EU is not the EU itself but the EEA, since EEA members are part of the Single market, whereas protection measures can be more easily applied to countries outside.

The results have shown that for many of the main aquaculture species produced in the EU, especially shellfish, sea bass, sea bass, sea bream, carp and trout, self-sufficiency rates were already high or exceeding 100%. Increasing the production of commodities with high self-sufficiency rates, while targeting the same markets and not differentiating from imports, carries the risk of overproduction and price crashes. Although the causes of boom-and-bust cycles that are observed in aquaculture are many and complex, including economic, social and biological, overproduction is one of the main factors (You and Hedgecock, 2019). Therefore, growth in the production of these species needs to be accompanied by the development of export markets and domestic demand e.g. through market penetration and new product development strategies. Thus, strategy development needs to take into account not only which aquaculture sub-sectors to prioritise and their and locations but also at which stage of the value chain interventions are most necessary, in an overall market-orientation approach (Grunert, Trondsen and Young, 2010).

For example, most member states have the factors necessary for trout production, and thus, growth policies targeting the trout industry can benefit a larger number of member states compared to other forms of aquaculture. However, a threat to the growth of the industry is the static demand for trout, partucularly plate-size fish. Moreover, the demand for predominantly portion-size trout is more fragmented than larger salmonids and formed by a number of smaller size markets, corresponding to the main attributes imparted on the product by the different methods of farming and preservation – e.g. large vs. plate size; pink flesh vs. white flesh, fresh vs frozen – each of which is exposed to own demand structure. Nielsen (2011) finds that when portion size trout with white meat was sold fresh on the German market, it had a price elasticity of -1.0, i.e. a 1% increase in imports would lead to a 1% price reduction, although the option of selling frozen instead of fresh provides an option of price stability for producers (Nielsen *et al.*, 2011). Strategies of productivity growth and associated cost reduction have been exemplified by larger farms in Denmark which maintain competitive advantage due to economies of scale and closeness to high value markets (Lasner *et al.*, 2017). On the other hand, Turkish farms benefit from competitive advantages due to low labour cost and favourable climate conditions (Lasner *et al.*, 2017), as well as governmental subsidies (European Commission, 2020) and not necessarily high productivity (Cinemre *et al.*, 2006). However, as the results on industry concentration have indicated, some productivity gains may have been achieved with increasing consolidation in the Turkish trout industry in the past decade. While high concentration was also observed in Scotland, the industry in other EU states is composed predominantly of small-scale traditional farms, which, in the context of Turkey's advantage as a low-cost producer (Lasner *et al.*, 2017), are unlikely to compete successfully on price, which suggests the need for a differentiation strategy and targeted stimulation of demand for the attributes along which products are differentiated.

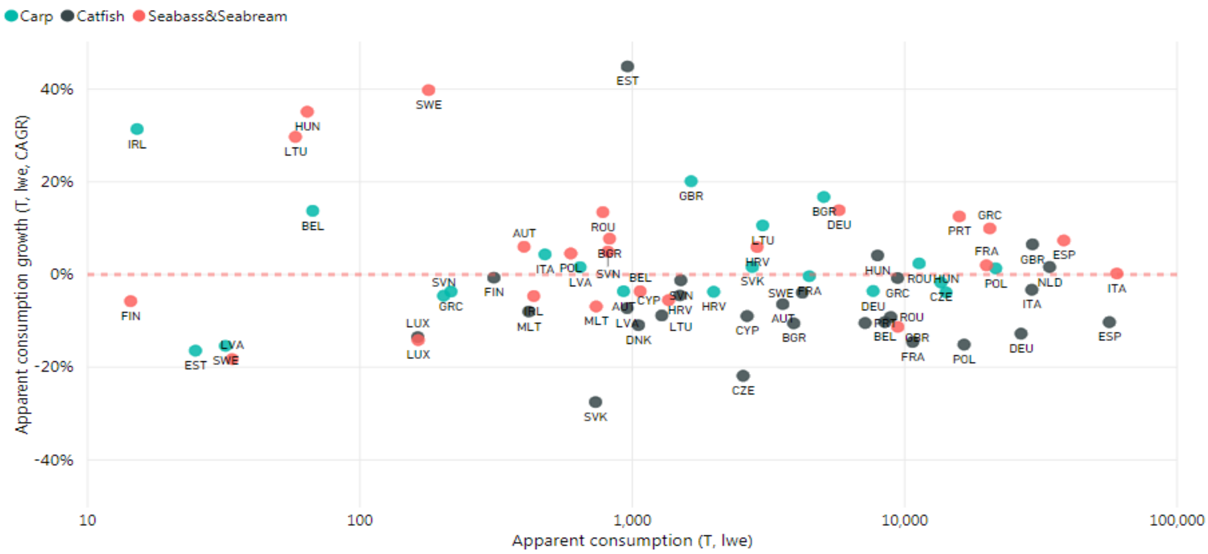
2.5.2 The white fish market

White fish species are potential substitutes on the EU market. Included in the following analysis are Seabass/Seabream and Carp, as well as Pangasius which likely acts as an import substitute for the domestically produced or regionally imported whitefish.
The EU countries with largest market for Seabass and Seabream in 2017 were Italy, Spain, Portugal, France, and Greece all of which showed a positive growth rate in the apparent consumption (Figure 40). On the other hand, most of the largest markets for Pangasius – the UK, Germany, Netherlands, Italy, Poland, experienced a fall in consumption. Particularly striking is Spain, which in 2015 was the MS with largest Pangasius market (Figure 41), while in 2017 consumption had shrunk considerably. With regards to Carp, consumption was concentrated in Eastern Europe with Poland, Hungary, Czech Republic, Romania and Germany being the largest consumers. It had remained relatively stable between 2015 and 2017 with a slight decline in several of these markets.



Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

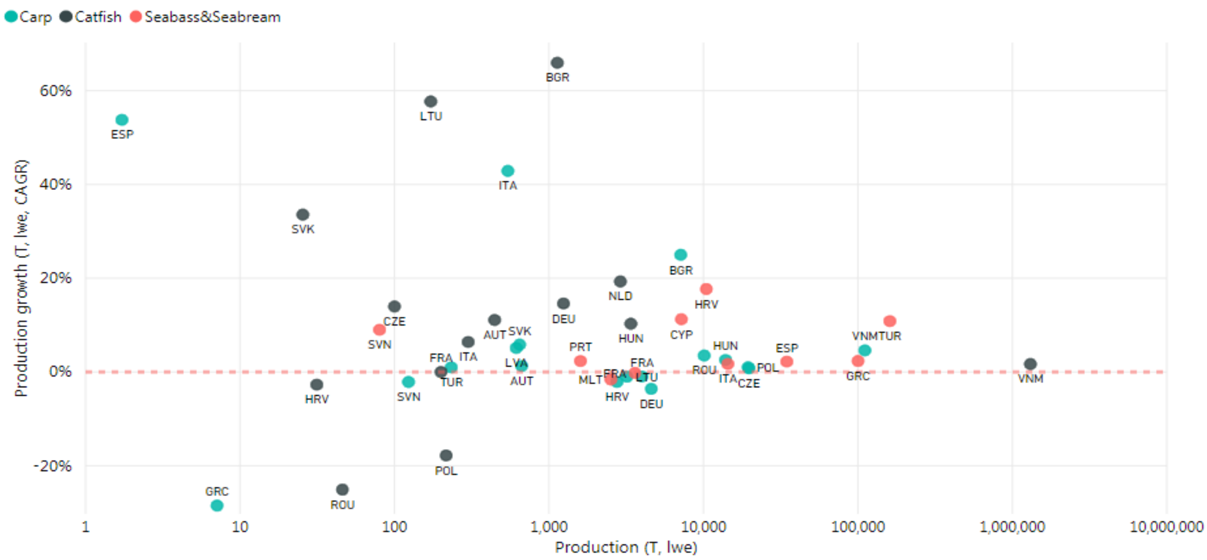
Figure 40. Market size (volume) of Carp, Catfish and Seabass/Seabream by member state, 2017



Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

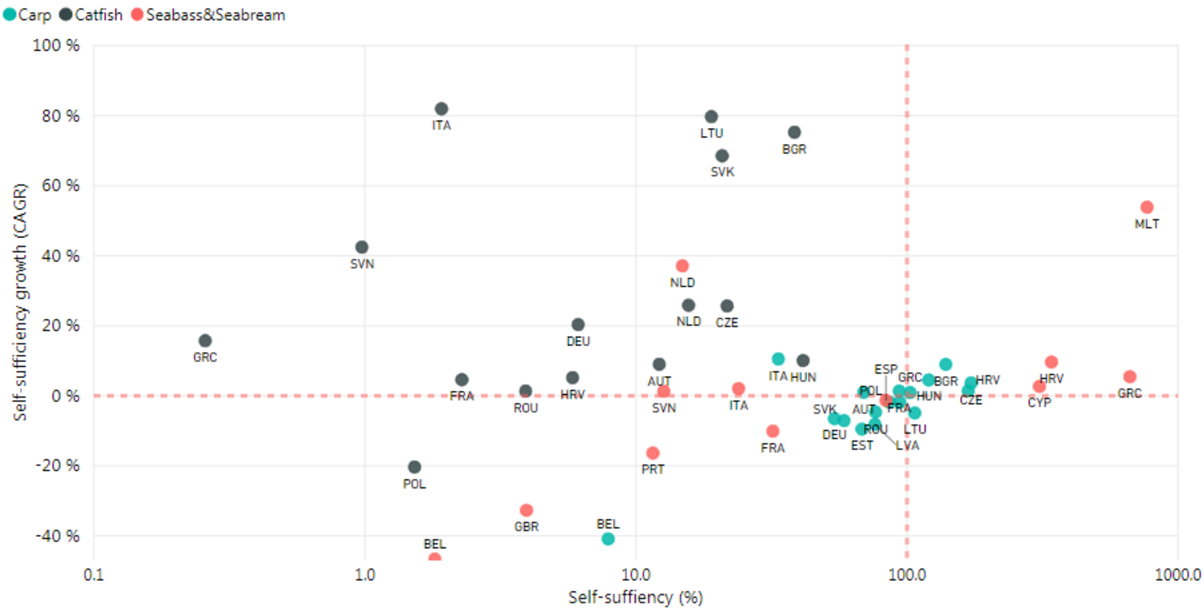
Figure 41. Market size (volume) of Carp, Catfish and Seabass/Seabream by member state, 2015

Turkey and Greece were the leaders in production of Seabass and Seabream, followed by Spain and Italy, with Turkey showing a highest growth rate in 2017 (Figure 42). No substantial production of Catfish was recorded in the EU and whatever production existed in 2017, it was comprised of species other than Pangasius. The largest MS producers of Carp corresponded to the largest markets, in line with the local nature of production and consumption for the species, as discussed previously. No substantial growth in production of Carp was observed. The self sufficiency for Carp was correspondingly close to 100% for most member states, while the opposite was found for Catfish and Seabass/Seabream, with the excetion of Greece, Croatia, Cyprus and Malta in the case of Seabass/Seabream, where self-sufficiency exceeded 100% (Figure 43). As main producers and exporters of Seabass/Seabream, these were the countries with revealed comparative advantage (Figure 44).



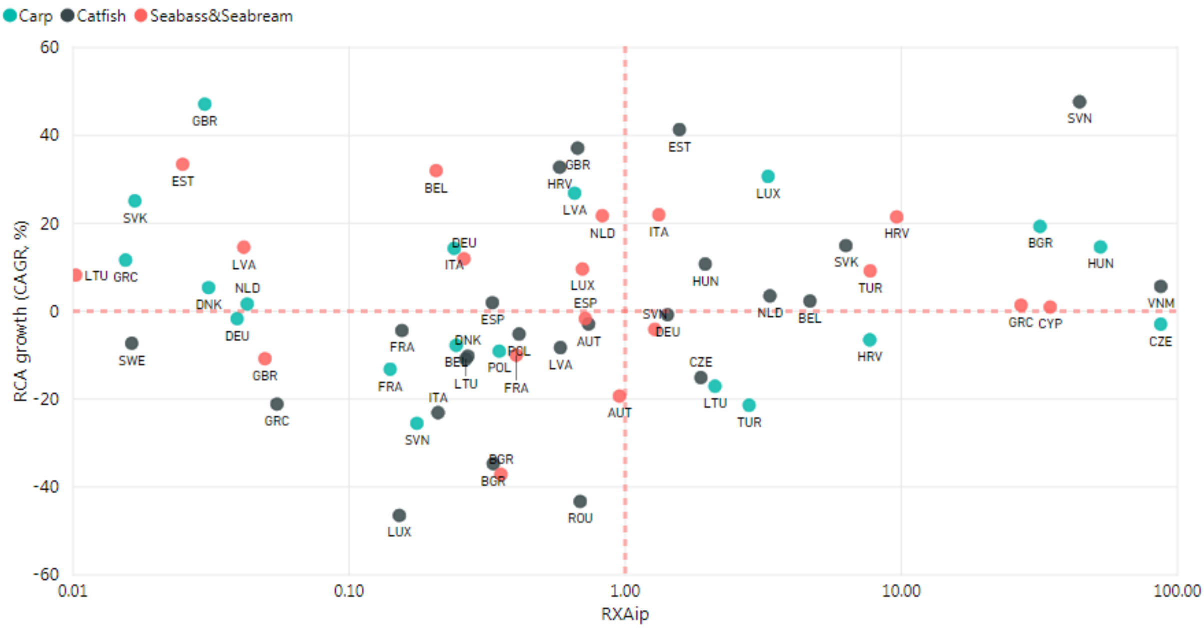
Horizontal axis is on a log-scale. Data source: FAO (2019)

Figure 42. Production of Carp, Catfish and Seabass/Seabream by EU28 member state and main competitors, 2017



Only for countries where domestic production was reported. Horizontal axis is on a log-scale. Data source: FAO (2019), EUROSTAT (2019), UN Comtrade (2019)

Figure 43. Self-sufficiency of Carp, Catfish and Seabass/Seabream by member state, 2017



Horizontal axis is on a log-scale. Data source: EUROSTAT (2019), UN Comtrade (2019)

Figure 44. Revealed export advantage (RXA) for Carp, Catfish and Seabass/Seabream by EU28 member state and main competitors, 2017

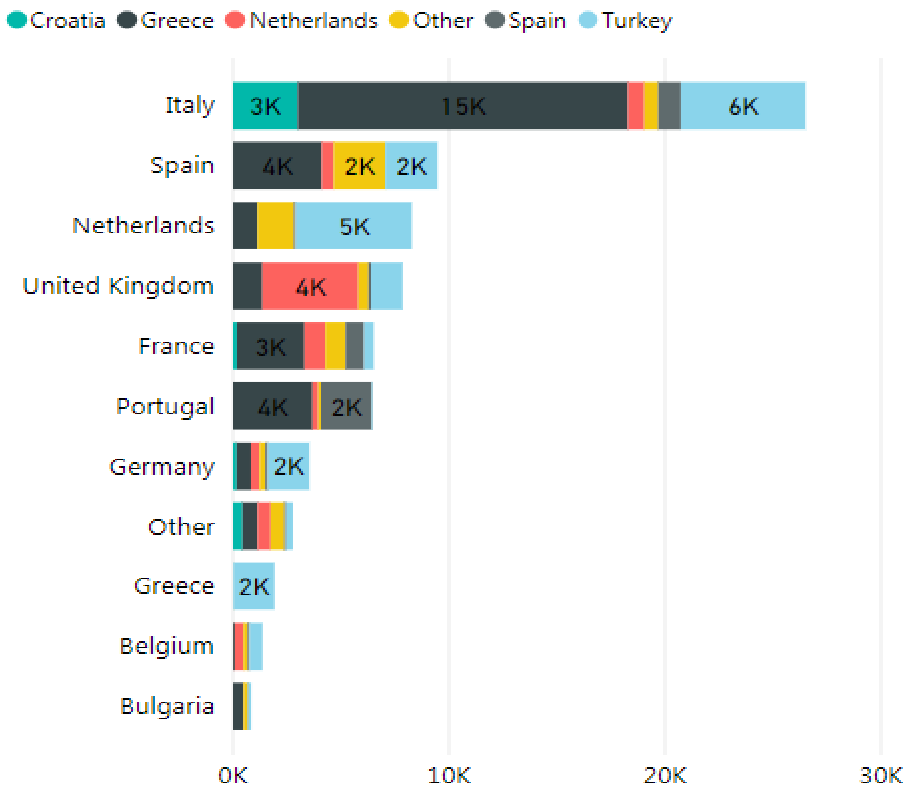
The low self-sufficiency for Seabass and Seabram at the largest markets in the EU is due to substantial imports from third countries, particularly Turkey (Figure 45). Trade statistics only allow the identification of Seabass/Seabream when entering the EU in the form of whole fish. As can be seen on Figure 46, some 20,000 tonnes of Seabass and 30,000 tonnes of Seabream entered the EU market in 2017, mainly as a fresh/chiled product. Additional amount in the form of fillets is likely to have also been imported, but is impossible to discern in trade statistics as it is likely grouped with other species.

Data source: EUROSTAT (2019)

Figure 45. Imports of Seabass (L) and Seabream (R) from third countries into the EU28 by type of presentation (up) and preservation (down) in 2017, volume (T, lwe)

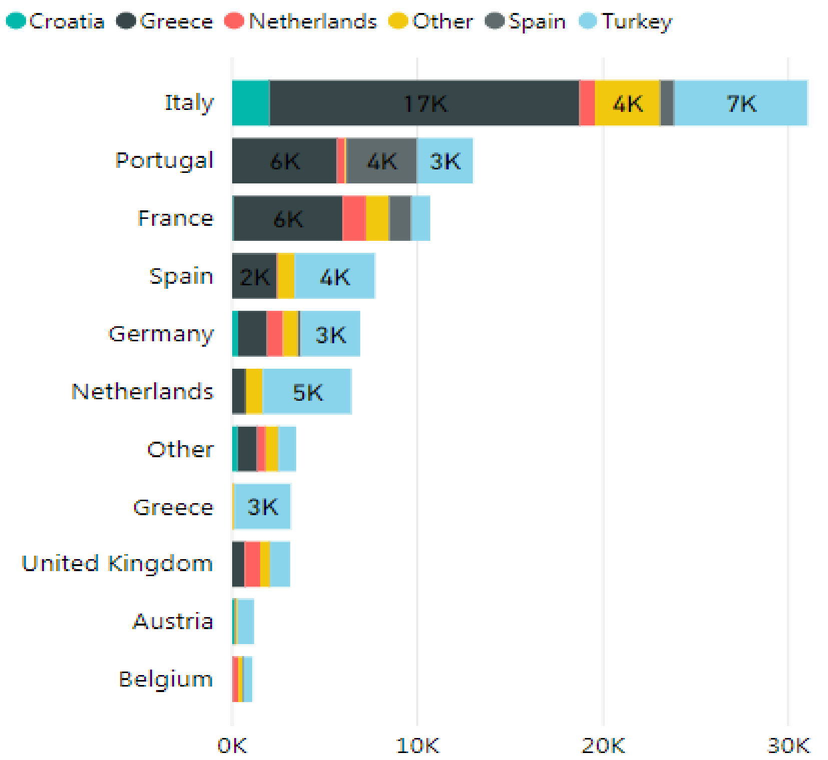
The main importing EU countries were Italy, Spain and Netherlands, and the UK where Turkish Seabass and Seabream were competing with domestic production and imports from other EU countries (Figure 46 and Figure 47). The Netherlands appear to be a distribution hub for Seabass, from which it is re-exported to other member states. Import price comparisons for both species on the Italian market revealed that Turkey was the lowest-cost supplier, with prices 50% lower than Spanish imports (highest price) and around 10% lower than Greece, the main EU producer (Figure 48 and Figure 49).

Viet Nam was almost exclusively the source of pangasius imports in the EU with some 170,000 tonnes (lwe) entering the Union predominantly in the form of frozen fillets in 2017 (Figure 50). The main importers were the Netherlands, UK, Germany, Poland and Spain (Figure 51). In Poland, where Pangasius imports compete with domestic carp production, prices of pangasius fillets were substantially lower than Common carp farm gate prices throughout the period 2012-2017 (Figure 52). The same observation could be made for the UK market, where Pangasius would be integrated into the large whitefish market. Price comparison between imported frozen Pangasius and Norwegian cod fillets, show that pangasius was around 50% cheaper thoughout the period examined (Figure 53).



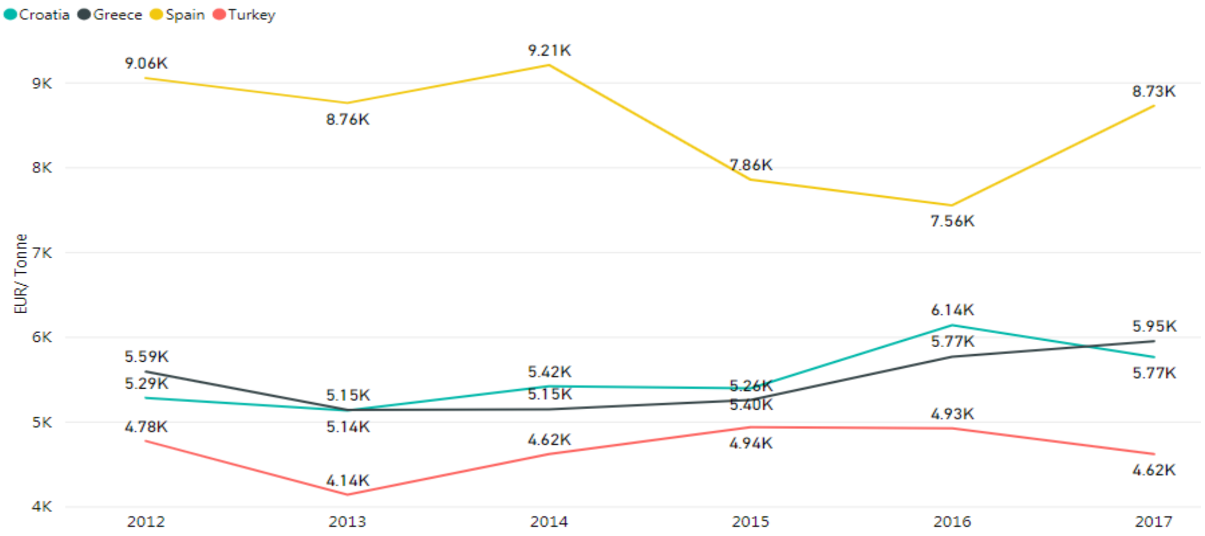
Data source: EUROSTAT (2019)

Figure 46. Imports of whole/gutted fresh Seabream by MS (top 10 importers) and by country of origin in 2017, volume (T, lwe)



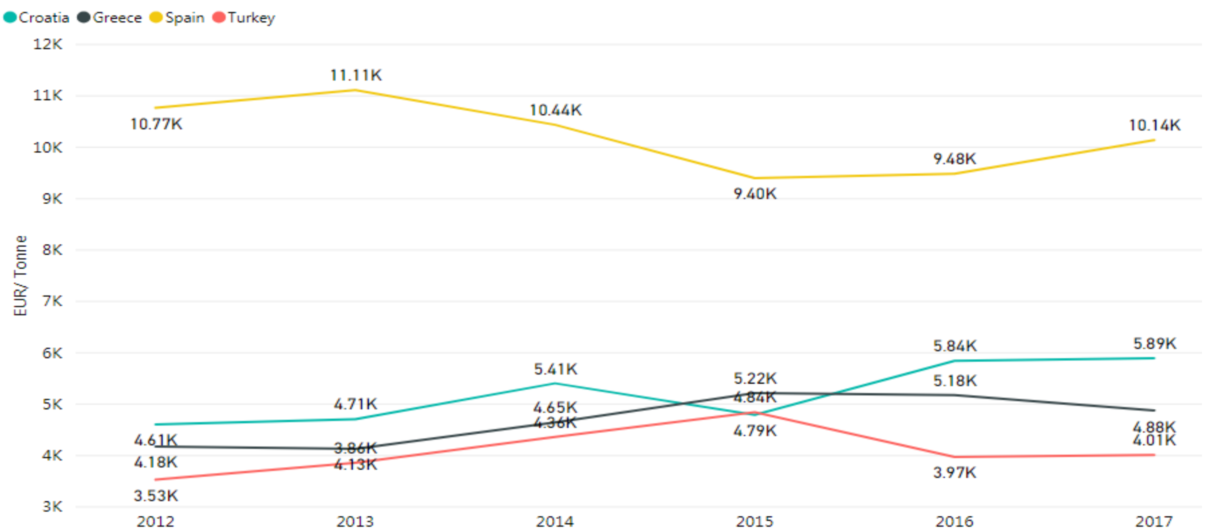
Data source: EUROSTAT (2019)

Figure 47. Imports of whole/gutted fresh Seabass by MS (top 10 importers) and by country of origin in 2017, volume (T, lwe)



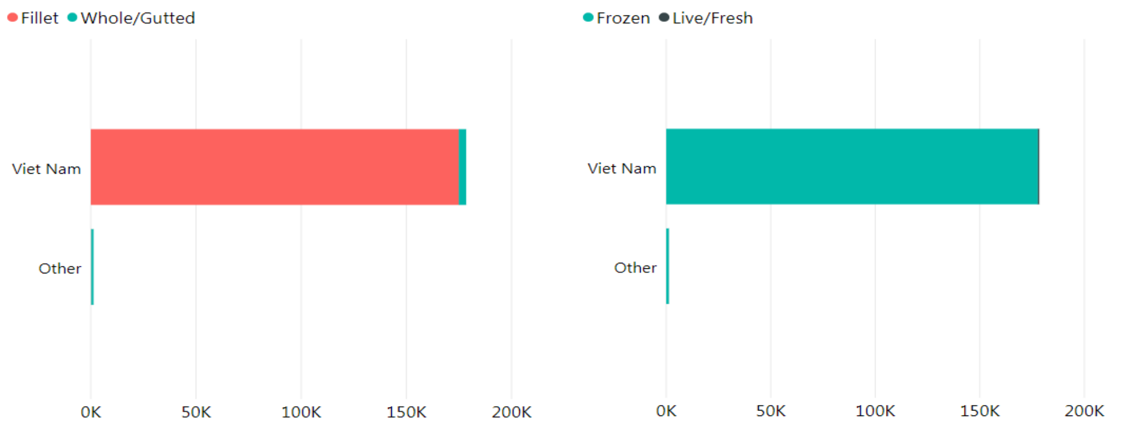
Data source: EUROSTAT (2019)

Figure 48. Price of imported fresh whole/gutted Seabass into Italy from main sources, 2012-2017



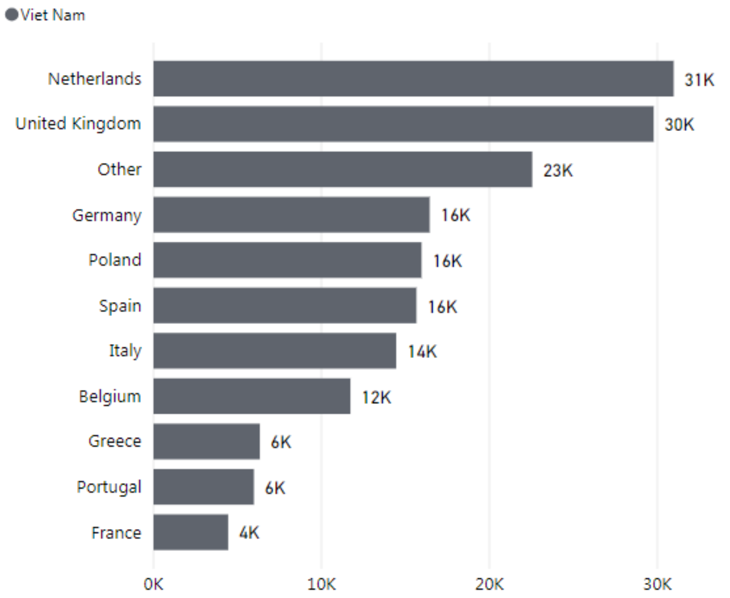
Data source: EUROSTAT (2019)

Figure 49. Price of imported fresh whole/gutted Seabream into Italy from main sources, 2012-2017



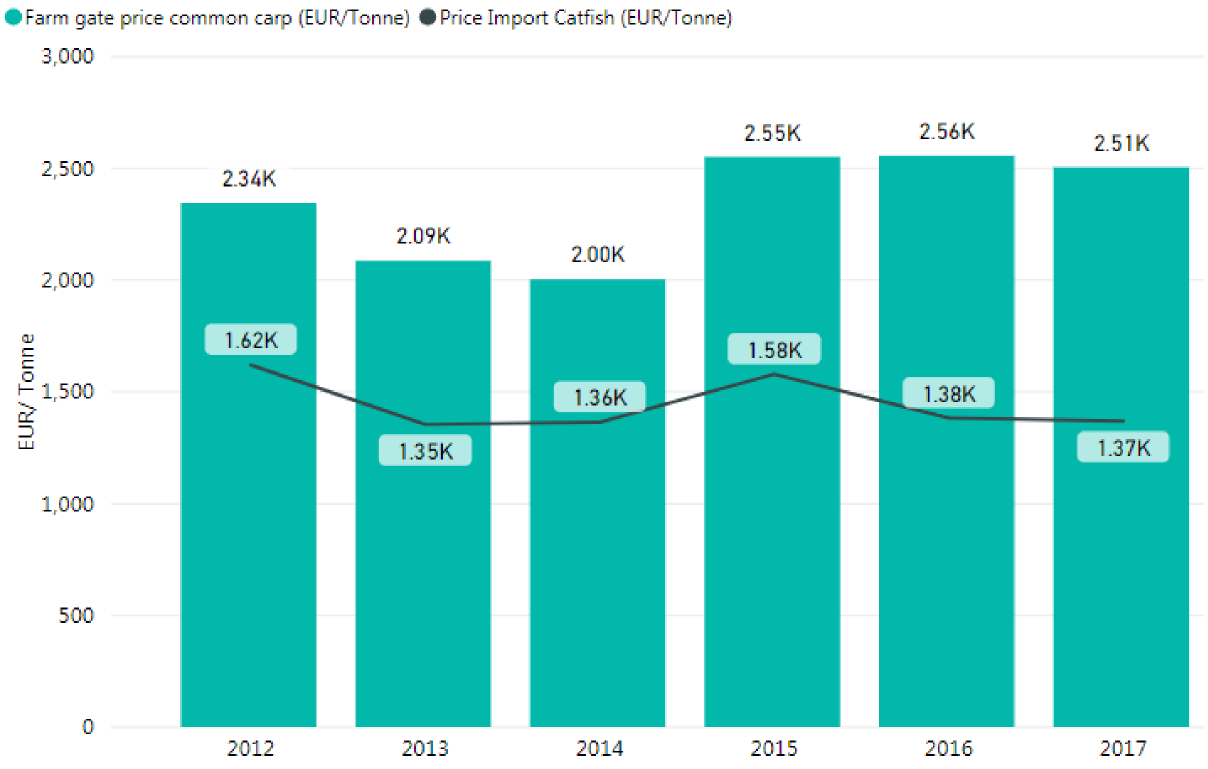
Data source: EUROSTAT (2019)

Figure 50 Imports of Pangasius from third countries into the EU28 by type of presentation (L) and preservation (R) in 2017, volume (T, lwe)



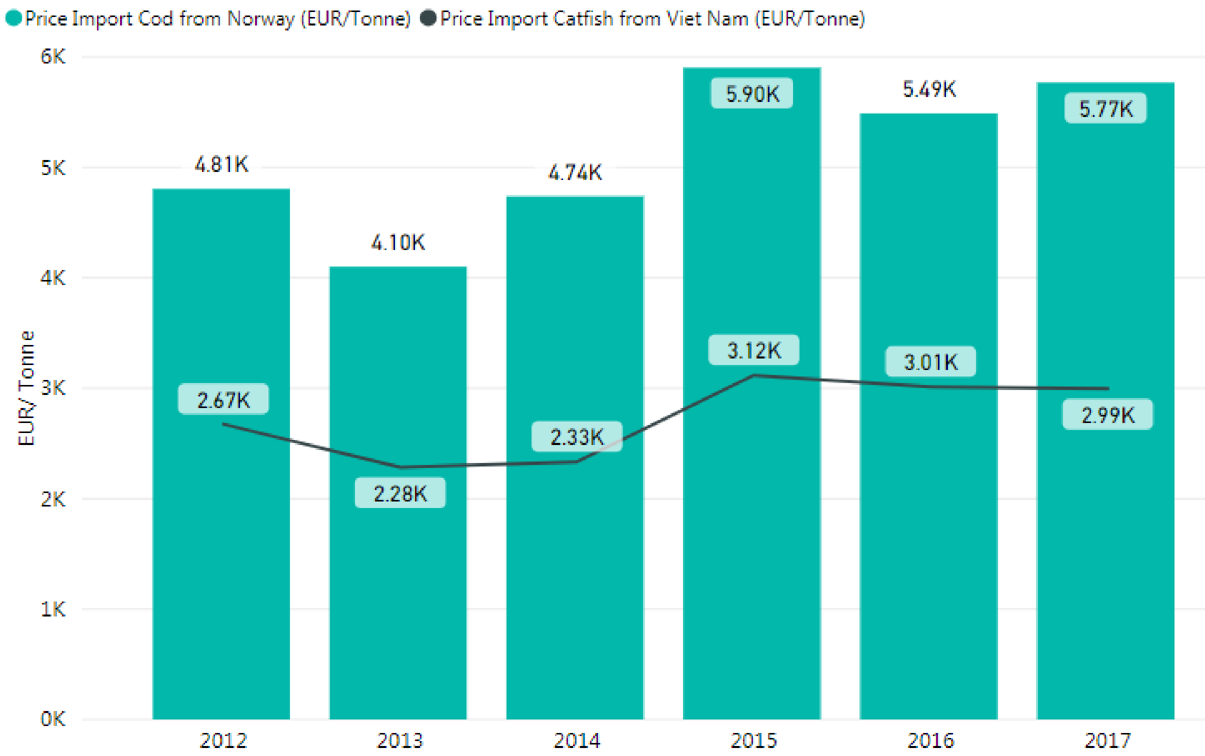
Data source: EUROSTAT (2019)

Figure 51. Imports of frozen fillets of Pangasius by MS (top 10 importers) from Viet Nam in 2017, volume (T, lwe)



Data source: EUROSTAT (2019)

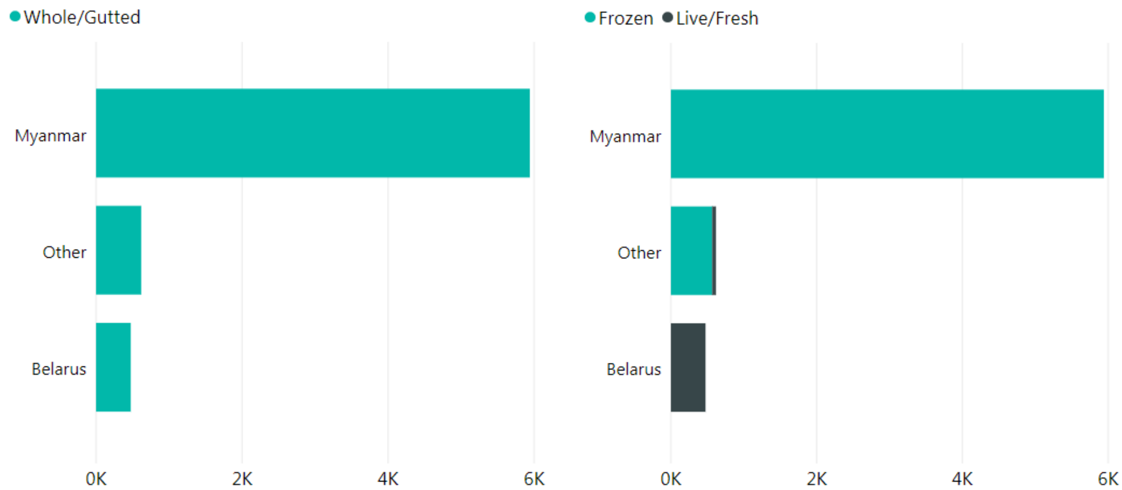
Figure 52. Price of imported frozen Pangasius fillets from Viet Nam and domestically produced Common carp in Poland, 2012-2017



Data source: EUROSTAT (2019)

Figure 53. Price of imported frozen Pangasius fillets from Viet Nam and imported frozen Atlantic cod fillets from Norway in the UK, 2012-2017

As regards Carp, no subtantial imports of this species were observed to enter the EU from third countries. In 2017 the main exporter to the EU was Myanmar with only around 6,000 tonnes (Figure 54).



Data source: EUROSTAT (2019)

Figure 54. Imports of Carp from third countries into the EU28 by type of presentation (L) and preservation (R) in 2017, volume (T, lwe)

The EU holds a major share in the global production of Seabass and Seabream and the sector is one of the main strengths of the aquaculture industry in the region. Production is concentrated in Mediterranean states, dominated by Greece who is a main EU supplier for the region (Wagner and Young, 2009). High share in global production is an indication that factors exist which give comparative advantage for the production of the commodity in the EU. However, faster growth in Turkey, which benefits from lower production costs, and rapid concentration, and increasing imports into the EU challenge the competitive position the industry. To maintain competitiveness in the large but undifferentiated fresh products market, the EU seabass and seabream aquaculture needs to improve productivity. Productivity improvements can be expected since the industry is in a phase of consolidation, in Spain as the results have indicated, but also in Greece (FAO, 2020b). However, segmenting the market developing new products needs to be pursued in parallel to create additional demand through which to reduce the risk of overproduction and bust cycles (FAO, 2019a) and accommodate production increases. Such development can come from the farming of larger size fish which provide greater opportunities for value addition than the dominant size of < 500 g (Asche and Bjørndal, 2011). Since trade remains regional, the development of third country export markets is a further opportunity for growth.

In the case of Carps (mainly Common carp), there is little international demand for this species outside of Eastern EU states as the other notable producers such as China are self-sufficient and prices are low. EU production growth will need to be accompanied with strategies for expanding demand on the domestic markets. Investment decisions need to focus on expanding existing markets, where there is tradition in the consumption of carp. The creation of additional demand locally and within the region can be pursued using penetration and new product development strategies for example through value addition aimed at overcoming fundamental product attribute issues (e.g. intra-muscular bones, off-flavour) and more processed products. The development of boneless convenience products for enhancing the consumer acceptability of the carps has been proposed as a promising route to increasing consumption (Sehgal and Sehgal, 2002; Bochi *et al.*, 2008) which may also improve consumer perception of welfare issues attached to live sale of the species. The opportunity needs to be explored further, particularly in combination with differentiation strategies exploiting current market trends such as environmental sustainability, local origin etc., in order to differentiate the offerings from imports of generic white fish flesh such as pangasius, while limiting price competition between rival domestic producers. Development of value-added products may increase access to modern retail channels and increase regional trade. The development of effective producer organisations can play a vital role in this process. The results have indicated that there is scope for cost reduction, such as improving labour productivity through mechanisation (labour productivity for Carp was the lowest amongst the species groups examined). The risks to growth without demand stimulation and market expansion include intensified competition between domestic producers and profitability erosion. A review of communication campaigns on aquaculture in the EU by European Commission

(2014) concluded that at the background of a lack of general awareness of aquaculture, the promotional campaigns consider aquaculture as a unified sector and not exploring the opportunities that its diversified products and methods of production provide. In order to promote concrete products against the competition, there is a need for a movement from generic messages to clearly segmented commercial and promotional strategies , similar to more established farming sectors such as the poultry industry (Asche, Cojocaru and Roth, 2018).

The production and consumption of oysters in the EU in 2017 was dominated by France, a gloabal leader in this industry and a net exporter to other member states. However, Oyster consumption in the EU showed an overall negative trend in the period 2015-2017, primarily due to a viral disease outbreak in France (EUMOFA, 2019b). While official statistics by FAO (2019) showed an annual production of 65,000 tonnes in 2017, output has likely increased in the past two years as industry sources claim production of over 100,000 for France alone in 2019 (personal communication). Further production expansion needs to be associated with demand stimulation, which may come from market penetration of regional market for example through marketing efforts targeting an increase in the occasions on which oysters are consumed (consumption tends to be seasonal); exploiting new non-traditional but fast-growing markets in the EU such as Germany, Bulgaria, Sweden, Austria. Stimulation of demand and stabilisation of sales throughout the year can also come from increasing the share of value added and long-shelf life products such as canned and smoked oysters. While trade with Mussels was mostly limited to within the EU, expansion of demand could be achieved through increasing differentiation from imports e.g. by the development and promotion of value-added products bases on mussels (Scott *et al.*, 2010).

In the case of Turbot, production growth needs to focus on penetrating the markets of other EU states, as well as seek opportunities for increasing and consolidating exports to third countries. The production increase has to be accompanied with innovation to reduce costs of production to make the species more affordable for consumers and increase market demand. Since production systems are land based, the scope for reducing cost through economies of scale is not as high as for marine net pens, however, limiting the extent to which Turbot can become a widespread commodity (Bjørndal and Øiestad, 2011).

3. Insurance

Aquaculture is an inherently difficult industry to insure due to the unpredictable environments in which it takes place and the large number of risk factors involved. In addition, aquaculture is also one of the fastest growth industries, making it dynamic and innovative. Marine/ coastal aquaculture may be especially prone to risk which could affect multiple sites, potentially owned by the same business. The most extreme examples of losses include the Asian Tsunami in 2004, for example, which devastated thousands of miles of coastline across several countries. However, events such as severe storms, elevated temperature, algal blooms, jelly fish etc. cause substantial losses in European aquaculture. Policies may include the cover of buildings, equipment, stock (including livestock), other capital and operational assets, the safety of full-time and contract employees. Figure 55 shows historical loss by peril data for worldwide aquaculture. Despite the age of this data, disease is still often cited as the major cause of loss in many aquaculture systems.

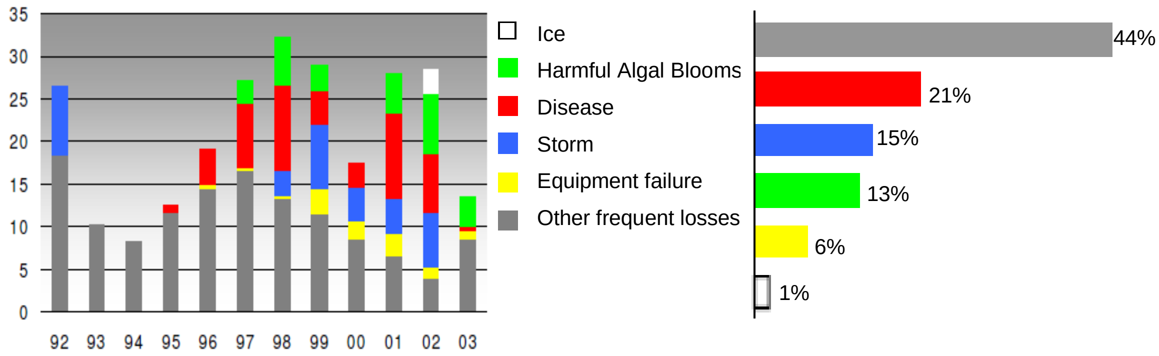


Figure 55 Worldwide loss by peril (%) 1992-2003. Data supplied by Aquarisk (https://www.longline.co.uk/flow/products/aquarisk/).

Differentiation needs to be made between types of aquaculture system and their location. Marine facilities can be difficult to monitor stock and require divers to make repairs and sometimes clean (defoul) cages and collect mortalities. Marine/coastal facilities also include much higher levels of infrastructure than most land-based facilities (i.e. not including Recirculating Aquaculture Facilities or land-based marine facilities), including barges, moorings, cage equipment and various high-tech monitoring infrastructure. Most land-based aquaculture (except Recirculating Aquaculture Systems and hatcheries) consists of ponds with little infrastructure and less exposed to extreme weather and is therefore inherently less risky than marine/ coastal and easier to get insured. However, systems do have some aspects in common. Aquaculture enterprises may be linked through sourcing the same seed/ fingerlings or the same feed, which may make them prone to the same diseases or contamination respectively. Full insurance is likely to only be available to the most well managed operations, after high levels of risk assessment, supported by external service providers with competency in diagnostics and other specialisms. However, the benefits of being insured are significant, not only in financial support in terms of losses, but also legal support in pursuing claims which are due to 3rd party liability, from pollution, for example.

Despite continual improvements in aquaculture technology and management, losses remain high and insurance has been difficult to cost. Loss ratios (the ratio between claims payments and premiums received) between 1992 to 2010 were 72% on average but since then have sometimes been in excess of 100%, meaning that insurance is mispriced and lacking in appropriate diversification, leading to excess exposure of insurance companies. Volatility in loss ratio demonstrates an inability of companies to represent the diversification of aquaculture operations and their consequent exposure to risk (Figure 56).

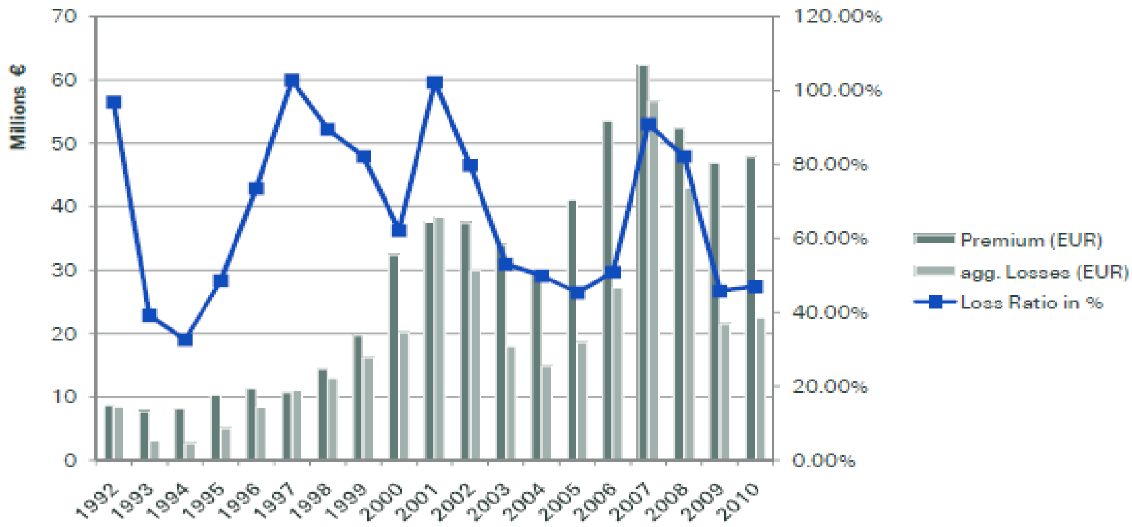


Figure 56. Worldwide aquaculture insurance premiums, losses and loss ratios 1992-2010 (Data from Aquarisk)

Insurance is also a dynamic industry, but the underlying factor as with all industries is shareholder profit and as such it is risk averse and conservative, therefore unlikely to underwrite high-risk enterprises. Underwriting aquaculture industries, therefore, requires a fairly in-depth expert knowledge of the industry to be able to assess the risk and provide acceptable policies to all parties concerned. Despite the risk, there are mitigation measures which insurance underwriters may take such as cover of specific risk factors, and omission of others, sometimes called “named perils”. Another method of mitigation is by spreading the risk by proportional underwriting, where several insurance companies cover a proportion of the policy. This may be advantageous to insurance companies that may not otherwise get involved in aquaculture due to lack of knowledge, whereas knowledgeable companies can reduce their risk by spreading the load. Another mitigation method is reinsurance, where an insurance company themselves, take out insurance against their risk, which may enable them to make payments which they would otherwise be unable to meet.

European aquaculture is less diverse than other regions and has advantages over some other locations due to its high level of regulation, meaning that facilities tend to be well located and follow high standards, making them less susceptible to losses and able to respond to challenges. Many EU species are characterised by large vertically integrated operations (particularly salmon, seabass and seabream) which make them able to absorb a lot of risk themselves and lend themselves to insurance better than small scale enterprises can. Similarly, the level of expertise in husbandry and health management is more advanced than in some other regions, especially in the larger vertically integrated companies, which also makes them more attractive to insure. Table 6 shows the risk perils associated with some of the main European aquaculture species, which agree broadly with perceptions from EU aquaculture stakeholders (Table 7). Mussels and oysters show the lowest risk profiles with little to no risk from disease. The finfish species all suffer from risk from disease, pollution and extreme weather events.

Table 6. Risk Peril ratings across European aquaculture (Data from Aquarisk)

Risk peril	**Salmon**	**Bream**	**Tuna**	**Mussels**	**Oysters**
Average premium	**3.54%**	**4.04%**	**5.50%**	**2.91%**	**2.91%**
Storm, lightning, tsunami, collision, structural failure of equipment	0.77	0.91	1.04	0.70	0.70
Theft and malicious acts including animal rights groups	0.27	0.28	0.63	0.14	0.14
Predation/physical damage predators	0.42	0.56	0.32	0.40	0.40
Freezing, supercooling, ice damage, including collision from ice	0.32	0.14	0.14	0.14	0.14
Pollution, deoxygenation, plankton bloom or competing biological activity	0.76	0.70	2.09	0.91	0.91
Change in concentration of normal chemical constituents of the water	0.25	0.63	0.79	0.63	0.63
Disease	0.76	0.84	0.49	0.00	0.00
Excess/deductible	**20% value**	**10% value**	**20% value**	20% value	**20% value**

Table 7. Stakeholder perceptions of major risks associated with EU aquaculture production in Northern and southern regions (Data from Aquarisk)

Risks	Northern Europe				Southern Europe		
Production risks (catastrophes, disease epidemics)	5	5	5	5	3	5	5
Price risks (input or output price contracts, etc)?	1	3	3	2	1	3-4	5
Marketing risk (business interruption, consequential loss, etc)?	2	3	4	4	3	1	3
Environmental risk (damages to environment)?	2	4	3	3	5	4	1
Consumer risk (product liability, product recall, etc)?	5	5	5	3	2	1	3
Storm, lightning, tsunami, collision (ex. Ice), structural failure of equipment	5	5	4	5	5	5	5
Theft and malicious acts including animal rights groups	3	3	2	3	2	5	4
Predation or physical damage cause by predators	3	3	2	1	1	1	2
Freezing, supercooling, ice damage, including collision from ice	2	2	2	1	1	1	1
Pollution, deoxygenation due to plankton bloom or competing biological activity	4	3	4	3	1	4	4
Any other change in concentration of the normal chemical constituents of the water	2	3	2	2	1	4	2
Disease	5	4	5	5	3	1	4

Innovations within the aquaculture industry, are case specific in terms of the risk that they pose. With regards to GAIN innovations, many of them relate to areas outwith production itself and therefore insurance does not factor highly. However, aspects of precision aquaculture do relate directly to production, welfare and stock losses and could be linked to the main risk factors associated with European aquaculture outlined in Table 6. Real time water quality measurements linked to fish behaviour could provide early warning mechanisms for fish health and other environmental risks. In salmon aquaculture, the majority of losses are routine, i.e. they occur in small numbers frequently due to unspecified reasons, which may be that the fish are comparatively weak within the population hierarchy. Predation, especially due to seals, is another frequent and regular cause of mortality and losses (due to damage and escapees). Insurance companies tend not to be concerned with routine mortality but the occasional spikes in mortality due to environmental or disease reasons which form the majority of insurable losses. High pay outs have been made in the salmon industry due to notable disease outbreaks (e.g. ISA and IPN) algal blooms and escapes from storm damage. The expense of installing precision aquaculture equipment is relatively low compared to the potential losses of stock and therefore the introduction of precision aquaculture technology that improves monitoring, management decisions and welfare can only make it more attractive for insurers to underwrite aquaculture facilities. This is especially the case if the technology can provide early warning of possible health management issues. Other GAIN innovations such as novel feed ingredients or those which mitigate waste production may have benefits, but these are likely to be less marked than adoption of precision aquaculture measures.

4. Conclusions

A central aim of this analysis was to provide a more nuanced understanding of seafood and aquaculture in order to assist with the development of tailored aquaculture policies to growth. First, the analysis here has shown that while the EU did not exhibit revealed comparative advantage for seafood as a whole, performance varies between industries and countries in the pattern of specialisation, which point to the industries with comparative advantages for particular species and locations.

Where RCA is below 0 this does not mean that comparative advantage does not exist in the production of seafood in the EU or there is no potential for it to be developed, but rather, that it cannot be ‘revealed’ through the current patterns of specialisation in exports. Thus, the result should not be interpreted as evidence for diversion of resources away from the seafood industry, but serve as an indication to the industries that are already exploiting comparative advantages. Moreover, further investigation is required to estimate the actual comparative advantage, by using measures such as Domestic

Resource Cost (DRC), provided more data is available (Cai, Leung and Hishamunda, 2009). The RCA index remains useful in monitoring the year-on-year change in the patterns of specialisation, as a proxy measure of the competitiveness of the region.

A targeted approach to the development of aquaculture can also lead to marked differences in economic impact. As the analysis of GVA indicates, there is variability in economic contribution between aquaculture sectors. *Inter-alia*, an increase of aquaculture production by 25% (which was the projected figure according to national level strategies) over the total production for 2014 (1,250,000 tonnes) could be expected to directly create a further 6562 jobs (assuming proportional growth across species), while adding EUR 382 million of GVA to the economy (assuming average productivity of 61,000 EUR/FTE). However, an increase in the economic contribution of aquaculture can be achieved more easily if expansion policies target the more productive species and systems. An increase by one tonne in the production of mussels will lead to GVA growth of EUR 530 while the same increase in the production of Oysters would add EUR 2,700 to the economy.

International organisations created to coordinate development of aquaculture across countries in Europe include The General Fisheries Commission for the Mediterranean (GFCM) whose mandate is to federate the sustainable development of aquaculture and the conservation and sustainable use of living marine resources at all levels (biological, social, economic and environmental). Similarly, a regional organisation with a mandate to aid in the development of aquaculture is the Network of Aquaculture Centres in Central and Eastern Europe (NACEE). While the GFCM has a strategy for the development of aquaculture, it consists of general guidelines and principles (FAO, 2018a). It could be enhanced by disaggregating aquaculture to systems and species levels and provide a direction to the development of particular sectors, working alongside national governments to ensure coordinated aquaculture development efforts in the region.

The tools developed in this study can help in this regard. They have aimed to provide an initial “big picture” analysis of the issues of strategic importance and establish a basis for coordinated strategy development. It was not the intent of this study to capture the full complexity of the issue of competitiveness but rather to serve as a starting point, to generate ideas that could be explored in more detail with additional sources of data. The functionality can be improved by the addition of further ‘modules’ to expand the scope of analysis. These can include for example diversification, exchange rate and purchasing power parity to account for competitiveness arising from currency valuation fluctuations. The approach taken here was to add value to data by developing multiple indicators but allowing the user access to detailed and disaggregated indicator-level information, having in mind that the interaction between research and policymaking is not linear and straightforward, but rather complex and context specific. The same approach is unlikely to be applicable to all situations and simple tools are unlikely to capture the complexity of multi-faceted problems that are typically the target of policymaking. Therefore, users can decide which tools to work with that are most applicable to their context. Nonetheless, the additional aggregation of indicators into categories (e.g. market attractiveness and producer position) and the provision of a weighting system would allow for a summary presentation of results, which would allow the ranking of commodities and countries and the establishment of priorities for support and investment easier. This is one possible direction that the future development of the tool can take.

This study has identified a set of indicators based on publicly available data to compare across of commodities and member states and has indicated priorities for support for aquaculture development. The results indicate that a large proportion (62%) of the EU seafood market, whether imported or domestically produced, consisted of species that could not be produced in aquaculture, which carries implications for policies promoting aquaculture growth as means to food security. Further, the results reveal the heterogeneity in performance between sectors and countries along various dimensions and maintains that a nuanced and targeted approach needs to be taken to the development of aquaculture policy. In order to ensure economic sustainability of interventions, adopting a market-orientation approach and considering how markets will absorb additional output when targeting sectoral expansion was emphasised.
For the commodities that comprise a relative large market segment, such as Seabass, Seabream, focus needs to be given on strengthening competitive advantage against competitors and pursuing a leadership position through upgrading and development of strong third-country export markets, in addition to developing additional domestic and regional demand through product innovation and market penetration. For the commodities with high self-sufficiency but no global market access, such as Carp and bivalves, regional market development through product line extension and market penetration is more appropriate.

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Appendix 1: Conversion factors for HS codes

HS version	HS code	SH6_CF
H2	030191	1.00
H2	030192	1.00
H2	030193	1.00
H2	030199	1.00
H2	030233	1.00
H2	030240	1.00
H2	030264	1.00
H2	030266	1.00
H3	030721	1.00
H3	030731	1.00
H4	030711	1.00
H2	030624	1.00
H2	030721	1.00
H2	030731	1.00
H2	030791	1.00
H3	030191	1.00
H3	030192	1.00
H3	030193	1.00
H3	030194	1.00
H3	030195	1.00
H3	030199	1.00
H3	030233	1.00
H3	030240	1.00
H3	030264	1.00
H3	030266	1.00
H4	030191	1.00
H4	030192	1.00
H4	030193	1.00
H4	030194	1.00
H4	030195	1.00
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H4	030284	1.09
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H3	030362	1.70
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H3	030372	1.40
H3	030373	1.51
H3	030375	1.33
H3	030377	1.18
H3	030378	1.45
H3	030379	1.33
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H4	030312	1.30
H4	030313	1.16
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H4	030319	1.18
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H4	030324	1.12
H4	030329	1.12
H4	030331	1.30
H4	030332	1.07
H4	030333	1.05
H4	030334	1.10
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H4	030342	1.14
H4	030343	1.13
H4	030344	1.05
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H4	030346	1.15
H4	030349	1.11
H4	030353	1.20
H4	030355	1.11
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H4	030365	1.51
H4	030366	1.45
H4	030367	1.61
H4	030368	1.20
H4	030369	1.36
H4	030381	1.33

H4	030382	1.33
H4	030383	1.70
H4	030384	1.18
H4	030389	1.41
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H5	030314	1.15
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H5	030324	1.12
H5	030329	1.12
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H5	030332	1.07
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H5	030344	1.05
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H2	160419	1.89
H2	160420	1.71
H2	160510	1.80
H2	160520	1.66
H2	160530	1.08
H2	160540	2.40
H2	160590	1.90
H2	190220	1.00
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H3	160413	2.02
H3	160414	2.16
H3	160415	1.79
H3	160419	1.89
H3	160420	1.71
H3	160510	1.80
H3	160520	1.66
H3	160530	1.08
H3	160540	2.40
H3	160590	1.90
H3	190220	1.00
H4	160510	1.80
H4	160521	1.66
H4	160529	1.66
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H5	160563	1.00
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H3	030710	1.00
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H2	030622	1.63
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H2	030759	1.28
H2	030799	2.78
H3	030541	2.10
H3	030542	1.81
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H3	030612	1.85
H3	030613	1.28
H3	030619	1.88
H3	030622	1.63
H3	030623	1.15
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H3	030741	1.47
H3	030749	1.37
H3	030791	1.00
H3	030799	2.78
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H4	030617	1.34
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H4	030621	1.70
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H4	030624	1.27
H4	030625	1.70
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H4	030749	1.37
H4	030759	1.31
H4	030779	3.86
H4	030789	3.18
H4	030799	2.12
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H4	030829	2.33

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H5	030539	3.14
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H5	030544	2.26
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H5	030553	4.30
H5	030611	1.95
H5	030612	1.85
H5	030619	1.99
H5	030632	1.00
H5	030692	1.95
H5	030695	1.15
H5	030699	1.00
H5	030739	4.50
H5	030742	1.35
H5	030743	1.36
H5	030749	1.28
H5	030791	1.00
H5	030792	1.00
H5	030799	5.00
H5	030830	2.50
H5	030890	2.33
H2	030420	2.70
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H3	030419	2.03
H3	030421	1.83
H3	030422	2.20
H3	030429	2.73
H3	030530	3.26
H4	030431	2.48
H4	030432	2.30
H4	030433	2.50
H4	030439	2.48
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H4	030442	2.03
H4	030443	2.77
H4	030444	2.72
H4	030445	2.60
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H4	030449	3.19
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H4	030462	2.30
H4	030463	2.50
H4	030469	2.22
H4	030471	2.85
H4	030472	3.06
H4	030473	2.55
H4	030474	2.37
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H4	030483	2.74
H4	030484	1.83
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H4	030486	2.05
H4	030487	2.50
H4	030489	3.10
H4	030531	3.76
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H5	030443	2.77
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H5	030449	3.19
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H5	030462	2.30
H5	030463	2.50
H5	030469	2.22
H5	030471	2.85
H5	030472	3.06
H5	030473	2.55
H5	030474	2.37
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H5	030481	1.80
H5	030482	1.94
H5	030483	2.74
H5	030484	1.83
H5	030485	2.20
H5	030486	2.05
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H5	030488	2.60
H5	030489	3.29
H5	030531	3.76
H5	030532	3.55
H2	160416	2.00
H3	030411	1.30
H3	030412	1.32
H3	030499	0.70
H3	160411	1.52
H3	160416	2.00
H4	030451	1.00
H4	030459	1.10
H4	030493	3.08
H4	030494	3.09
H4	030495	0.68
H4	030499	1.27
H4	030571	10.00
H4	160411	1.52
H4	160412	1.43
H4	160413	2.02
H4	160414	2.16
H4	160415	1.79
H4	160416	2.00
H4	160417	1.64
H4	160419	1.89
H4	160420	1.71
H5	030292	10.00
H5	030392	10.00
H5	030451	1.00
H5	030457	2.55
H5	030493	3.08
H5	030494	3.09
H5	030495	0.68
H5	030496	1.00
H5	030497	2.55
H5	030499	1.27

H5	030571	10.00
H5	160411	1.52
H5	160412	1.43
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H5	160415	1.79
H5	160416	2.00
H5	160417	1.64
H5	160418	10.00
H2	030270	0.00
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H2	121220	0.00
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H2	150420	0.00
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H3	160430	0.00
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H5	160431	0.00
H5	160432	0.00
H5	210410	0.00
H5	210420	0.00
H5	230120	0.00

Appendix 2: Main commercial species in aquaculture

Main commercial species	*'Aquaculturable'*	*Farmed in the EU*
Abalone	Yes	Yes
Alaska pollock	No	No
Anchovy	No	No
Blue whiting	No	No
Brill	No	No
Carp	Yes	Yes
Caviar, livers and roes	Yes	Yes
Clam	Yes	Yes
Cobia	Yes	No
Cod	Yes	No
Crab	No	No
Cusk-eel	No	No
Cuttlefish	No	No
Dab	No	No
Dogfish	No	No
Eel	Yes	Yes
Fish oil	No	No
Fishmeal	No	No
Flounder, European	No	No
Flounder, other	No	No
Freshwater catfish	Yes	Yes
Freshwater crayfish	Yes	Yes
Grenadier	No	No
Gurnard	No	No
Haddock	No	No
Hake	No	No
Halibut, Atlantic	Yes	Yes
Halibut, Greenland	No	No
Halibut, other	No	No
Herring	No	No
Horse mackerel, Atlantic	No	No
Horse mackerel, other	No	No
Jellyfish	No	No
John dory	No	No
Ling	No	No
Lobster Homarus spp	No	No
Lobster, Norway	No	No
Mackerel	No	No
Megrim	No	No
Miscellaneous fin-fish, n.e.s.	No	No
Miscellaneous small pelagics	No	No

Molluscs and aquatic invertebrates, other	Yes	Yes
Monk	No	No
Mussel Mytilus spp	Yes	Yes
Mussel, other	Yes	Yes
Nile perch	No	No
Octopus	No	No
Other cephalopods	No	No
Other crustaceans	No	No
Other flatfish	No	No
Other freshwater fish	Yes	Yes
Other groundfish	No	No
Other marine fish	Yes	Yes
Other non-food use	No	No
Other products	No	No
Other salmonids	Yes	Yes
Other sharks	No	No
Oyster	Yes	Yes
Pangasius	Yes	No
Picarel	No	No
Pike	Yes	Yes
Pike-perch	Yes	Yes
Plaice, European	No	No
Plaice, other	No	No
Pollack	No	No
Pouting (=Bib)	No	No
Ray	No	No
Ray's bream	No	No
Red mullet	No	No
Redfish	No	No
Rock lobster and sea crawfish	No	No
Saithe (=Coalfish)	No	No
Salmon	Yes	Yes
Salmon Atlantic/Danube	Yes	Yes
Salmon Pacific	Yes	Yes
Salmon Sockeye	Yes	Yes
Sardine	No	No
Scabbardfish	No	No
Scallop	Yes	Yes
Sea cucumber	Yes	Yes
Sea urchin	No	No
Seabass, European	Yes	Yes
Seabass, other	Yes	Yes
Seabream, gilthead	Yes	Yes
Seabream, other	Yes	Yes
Seaweed and other algae	Yes	Yes
Shrimp Crangon spp	No	No

Shrimp, coldwater	No	No
Shrimp, deep-water rose	No	No
Shrimp, miscellaneous	Yes	Yes
Shrimp, warmwater	Yes	No
Smelt	No	No
Sole, common	Yes	Yes
Sole, other	Yes	Yes
Sprat (=Brisling)	No	No
Squid	No	No
Squillid	No	No
Surimi	No	No
Swordfish	No	No
Tilapia	Yes	No
Toothfish	No	No
Trout	Yes	Yes
Tuna, albacore	No	No
Tuna, bigeye	No	No
Tuna, bluefin	Yes	Yes
Tuna, miscellaneous	No	No
Tuna, skipjack	No	No
Tuna, yellowfin	No	No
Turbot	Yes	Yes
Weever	No	No
Whiting	No	No

Appendix 3: Commercial species profiles

Key market and production indicators the EU by country, 2017

Carp

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Poland	22761	-0.7%	19629	1.0%	0.35	-9	86.2	-2%
Hungary	14665	-5.1%	17640	1.2%	52.63	15	120.3	5%
Romania	13634	8.3%	10436	3.5%	0.46	75	76.5	-5%
Czech Republic	13085	-2.3%	22555	0.2%	86.96	-3	172.4	4%
Germany	8727	2.3%	4710	-3.5%	0.04	-2	54.0	-6%
Bulgaria	5143	7.5%	7149	15.7%	31.79	19	139.0	9%
United Kingdom	4745	61.3%			0.03	47		
France	4278	-2.9%	4003	-1.0%	0.14	-13	93.6	1%
Slovakia	3603	14.5%	2109	1.3%	0.02	25	58.5	-7%
Lithuania	2997	1.8%	3200	-1.0%	2.11	-17	106.8	-5%
Croatia	1758	-6.9%	2955	-2.2%	7.69	-7	168.1	1%
Italy	1617	44.3%	542	42.9%	0.24	14	33.5	11%
Austria	962	1.8%	666	1.3%	1.27	56	69.2	1%
Latvia	816	14.7%	622	4.9%	0.66	27	76.2	-8%
Netherlands	461	150.9%			0.04	2		
Greece	204	-4.0%	209	-2.7%	0.02	12	102.7	1%
Slovenia	195	0.1%	183	-2.2%	0.18	-26	94.0	-2%
Belgium	139	69.1%	11	0.0%	0.24	-8	7.9	-41%
Sweden	138	35.0%			0.01	31		
Ireland	52	12.9%				-100		
Luxembourg	22	-339.9%			3.29	31		
Cyprus	10					-100		
Estonia	9	-43.1%	6	-31.7%	0.01	-25	68.2	-10%
Finland	1	71.0%				-100		
Portugal	1					-100		
Spain	0	-68.1%	2	53.8%	0.01	51	537.5	196%

Data source: FAOSTAT 2019, EUROSTAT, 2019

Catfish

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
United Kingdom	31655	1.5%			0.67	37		
Germany	20536	-12.1%	1257	14.3%	1.42	-1	6.1	20%
Netherlands	18551	-20.6%	2900	19.3%	3.34	3	15.6	26%
Italy	15642	-19.5%	300	6.4%	0.21	-23	1.9	82%
Poland	14818	-8.3%	226	-17.4%	0.41	-5	1.5	-20%
Spain	13919	-42.5%			0.33	2		
France	9608	-3.4%	219	-7.4%	0.16	-4	2.3	5%
Hungary	8646	2.8%	3576	9.5%	1.95	11	41.4	10%
Belgium	7005	-8.5%			4.67	2		
Greece	6986	-13.6%	18	0.0%	0.05	-21	0.3	16%
Portugal	6754	-1.0%			0.46	-14		
Romania	6430	-19.1%	252	-6.6%	0.69	-43	3.9	1%
Austria	3651	-1.0%	445	11.1%	0.74	-3	12.2	9%
Bulgaria	2958	-11.8%	1137	55.8%	0.33	-35	38.4	75%
Sweden	2551	-11.0%			0.02	-7		
Cyprus	2315	-11.2%			0.31	-100		
Denmark	1241	-13.0%			0.27	-10		
Croatia	1223	-7.7%	71	-0.7%	0.58	33	5.8	5%
Czech Republic	982	-13.5%	213	6.3%	1.88	-15	21.7	26%
Lithuania	910	-21.4%	173	57.9%	0.26	-11	19.0	80%
Estonia	722	-3.7%			1.57	41		
Slovenia	718	-26.1%	7	-2.6%	44.22	48	1.0	42%
Malta	590	3.2%				-100		
Finland	457	15.5%				-100		
Latvia	413	-34.5%			0.58	-8		
Slovakia	358	-34.0%	75	3.4%	6.30	15	20.8	69%
Ireland	357	-152.3%			0.00	-90		
Luxembourg	189	38.7%			0.15	-46		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Seabass

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	30651	3.7%	7037	-0.1%	1.11	17	23.0	2%
Spain	21446	0.3%	18258	3.8%	0.91	3	85.1	1%
France	10375	2.0%	4913	-7.6%	0.56	-12	47.4	-11%
United Kingdom	8060	4.7%	438	-16.6%	0.08	-9	5.4	-33%
Portugal	7283	12.9%	998	2.1%	0.15	-2	13.7	-15%
Greece	7172	22.9%	44526	4.3%	24.74	0	620.8	-9%
Germany	1827	5.4%	0		0.25	12	0.0	
Croatia	1501	5.0%	5626	18.0%	10.10	20	374.8	15%
Cyprus	825	2.4%	2255	15.4%	23.51	2	273.4	5%
Bulgaria	765	27.1%			0.46	-35		
Belgium	683	-4.1%	22	-32.3%	0.25	21	3.2	-45%
Ireland	492	1.7%			0.00	-60		
Romania	442	23.6%			0.09	70		
Slovenia	440	4.5%	84	8.8%	1.81	11	19.1	2%
Austria	228	1.4%			0.22	-37		
Slovakia	201	56.5%			0.00	-100		
Luxembourg	111	40.9%			0.83	8		
Poland	92	-38.3%			0.00	-100		
Czech Republic	82	51.7%			0.02	111		
Malta	74	-16.1%	59	-14.0%	0.00	-100	80.5	-19%
Sweden	68	0.4%			0.00	8		
Hungary	45	19.6%			0.00	-32		
Lithuania	41	29.7%			0.01	11		
Denmark	29	-22.4%			0.01	-10		
Finland	6	14.5%				-100		
Estonia	4	-14.6%			0.05	32		
Latvia	0	-72.0%			0.04	27		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Seabream

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	34975	3.6%	8656	4.4%	1.55	27	24.8	2%
Spain	22197	5.3%	18232	0.9%	0.51	-8	82.1	-4%
Portugal	14011	11.1%	1461	5.4%	0.23	18	10.4	-18%
France	12363	3.6%	2362	3.3%	0.23	-3	19.1	-6%
Greece	8024	-9.6%	56331	1.0%	29.73	2	702.0	14%
Germany	5228	11.1%			0.28	12		
United Kingdom	3037	1.0%	0		0.02	-17	0.0	
Netherlands	2389	5.4%			0.41	20		
Croatia	1610	4.9%	4992	17.3%	9.10	24	310.0	5%
Cyprus	1516	19.0%	4953	9.3%	46.60	0	326.8	0%
Romania	1052	34.4%			0.21	79		
Belgium	531	4.5%			0.16	120		
Bulgaria	486	11.8%			0.24	-41		
Slovenia	381	3.4%	20	12.7%	0.71	-20	5.3	-3%
Austria	340	10.7%			1.74	-12		
Luxembourg	283	38.0%			0.56	12		
Malta	254	-41.2%	2460	-1.2%	0.00	-100	967.8	65%
Poland	197	-6.6%			0.03	229		
Lithuania	188	44.0%			0.01	4		
Sweden	122	10.8%			0.00	-36		
Denmark	118	16.8%			0.00	-15		
Czech Republic	62	20.8%			0.05	152		
Hungary	35	18.9%			0.00	-43		
Estonia	23	78.8%			0.00	149		
Latvia	23	-476.1%			0.04	8		
Slovakia	12	-20.6%				-100		
Finland	5	-12.1%				-100		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Clam

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Italy	70464	8.0%	50138	3.2%	7.27	-1	71.2	-9%
Spain	68938	-2.6%	11280	-0.6%	0.66	5	16.4	1%
Portugal	20380	-22.7%	11037	10.3%	3.51	7	54.2	45%
Denmark	8129	10.3%	8866	105.8%	0.12	42	109.1	2%
France	4651	-3.4%	8803	3.6%	1.44	12	189.3	6%
United Kingdom	4139	-19.1%	6875	12.7%	1.23	-14	166.1	6%
Germany	1174	35.4%	9		0.04	-8	0.8	
Belgium	1060	-2.7%			0.13	12		
Romania	291	22.4%						
Luxembourg	227	7.8%			0.16	55		
Croatia	201	18.0%	177	29.8%	0.21		88.2	-9%
Poland	197	-159.6%			0.00	7		
Hungary	189	49.5%			0.02	-33		
Czech Republic	185	150.4%			0.03	60		
Austria	175	10.1%			0.04	-2		
Sweden	157	-40.2%	5	10.8%	0.00	-15	3.2	186%
Malta	103	-29.0%						
Slovenia	66	18.3%	5	20.1%	0.44	48	7.6	-29%
Slovakia	29	126.2%						
Cyprus	22	143.6%						
Finland	21	37.0%						
Latvia	2	-19.0%						
Estonia	0	-11.8%						

Data source: FAOSTAT 2019, EUROSTAT, 2019

Oyster

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
France	60567	-6.1%	64959	-4.2%	8.45	2	107.3	1%
Italy	5495	4.8%	145	25.3%	0.27	-16	2.6	-5%
Ireland	3449	-8.2%	10409	6.6%	9.56	4	301.8	11%
Belgium	1895	-6.3%			0.04	-23	0	
Portugal	1457	38.8%	2116	20.9%	0.34	-6	145.2	-11%
Netherlands	1078	-14.8%	3267	5.2%	0.82	-3	303.2	17%
Germany	1047	11.1%	80	0.0%	0.06	5	7.6	-10%
United Kingdom	1039	9.3%	2359	9.1%	0.38	-19	227.1	4%
Bulgaria	816	386.1%						
Sweden	406	35.2%	8	-6.2%	0.00	-24	2.0	-19%
Austria	139	10.2%			0.04	-11		
Luxembourg	114	2.2%			0.96	5		
Cyprus	61	17.3%				-100		
Lithuania	57	58.2%			0.00	-48		
Croatia	52	-25.7%	237	27.7%	0.86	124	456.3	8%
Czech Republic	50	1.5%			0.01	-5		
Latvia	39	8.5%			0.14	6		
Poland	37	-41.0%			0.01	144		
Romania	22	16.6%			0.04	102		
Slovenia	16	7.4%			1.98	120		
Finland	13	37.4%			0.00	-78		
Hungary	9	-11.3%			0.01	6		
Estonia	9	43.8%			0.00	61		
Malta	7	-5.0%				-100		
Slovakia	1	26.0%				-100		
Spain			1300		1.09	74		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Mussels

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	180741	0.7%	241924	3.5%	1.53	4	133.9	2%
France	143665	0.1%	57339	-6.8%	0.52	5	39.9	-3%
Italy	126890	2.8%	63700	0.1%	1.34	7	50.2	-3%
Belgium	39308	8.0%			0.40	3	0	
Netherlands	22571	17.1%	53000	5.8%	3.35	-1	234.8	-15%
United Kingdom	18031	-12.7%	16865	-13.3%	0.19	-23	93.5	7%
Portugal	12160	13.6%	1218	23.6%	0.57	8	10.0	-16%
Greece	11503	16.4%	19240	2.9%	0.88	2	167.3	-10%
Germany	10928	-20.5%	16856	19.4%	1.06	14	154.2	85%
Denmark	9752	12.4%	43058	1.5%	0.85	0	441.5	-11%
Sweden	4920	1.5%	2014	6.1%	0.03	-11	40.9	2%
Ireland	3942	1.3%	17110	-3.7%	2.14	-6	434.1	10%
Bulgaria	3204	3.9%	3303	30.2%	0.60	40	103.1	5%
Croatia	2114	10.8%	949	15.3%	0.09	26	44.9	-4%
Austria	1801	1.1%			0.17	10		
Poland	1411	12.3%			0.00	-22		
Romania	1304	28.3%	142	66.8%	0.04	6	10.9	37%
Slovenia	1250	15.6%	641	15.7%	0.61	10	51.3	-1%
Cyprus	1067	5.0%			0.06	-100		
Luxembourg	725	-0.5%			0.42	8		
Hungary	679	8.0%			0.01	-64		
Malta	606	-11.7%				-100		
Finland	571	4.0%			0.00	-37		
Czech Republic	510	10.9%			0.07	0		
Latvia	412	21.1%			0.14	9		
Estonia	369	22.2%			0.04	-18		
Lithuania	353	-4.2%			0.02	-10		
Slovakia	77	4.1%			0.04	52		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Tilapia

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	13503	-7.5%	1		0.08	-28	0.0	-56%
Poland	11834	5.3%	100	-12.9%	0.65	-14	0.9	-53%
Germany	6646	-1.0%	112	25.5%	0.61	-8	1.7	0%
United Kingdom	5544	-5.0%	1	-60.0%	0.28	-28	0.0	-79%
France	5217	-5.3%			0.13	-10		
Italy	4550	0.2%	1	0.0%	0.04	-33	0.0	-6%
Belgium	1117	-8.5%			2.66	-8		
Czech Republic	955	-14.2%			1.98	19		
Austria	740	-2.9%			0.46	-12		
Denmark	654	-8.7%			0.27	-9		
Hungary	644	32.7%			0.31	-29		
Sweden	584	-12.1%			0.03	-16		
Bulgaria	562	23.0%				-100		
Portugal	470	166.9%			0.25	-8		
Slovakia	429	3.8%			0.22	118		
Lithuania	372	-12.1%			0.43	-4		
Ireland	368	13.9%			0.00	-100		
Estonia	210	13.7%			0.07	-4		
Romania	168	8.0%			0.00	-100		
Finland	164	13.2%			0.00	-45		
Latvia	159	-21.5%			0.73	1		
Greece	93	-20.9%			0.01	-13		
Luxembourg	86	-35.1%			0.08	-42		
Cyprus	65	4.0%				-100		
Slovenia	51	67.3%			7.38	94		

Data source: FAOSTAT 2019, EUROSTAT, 2019

Turbot

Country	Apparent consumption (T, lwe)	Apparent consumption growth (T, lwe, CAGR)	Production (T, lwe)	Production growth (T, lwe, CAGR)	RCA	RCA growth (CAGR, %)	Self-suffiency (%)	Self-sufficiency growth (CAGR)
Spain	7060	11.8%	8830	2.5%	2.93	0	125.1	-7%
Italy	2497	-2.6%	62	-36.5%	0.35	-4	2.5	-55%
France	2075	-0.9%	1031	5.2%	0.93	0	49.7	0%
Portugal	992	-14.7%	2453	-11.2%	4.66	-5	247.3	3%
Netherlands	840	-4.6%	2236	3.1%	1.92	3	266.3	15%
Germany	792	2.9%	312	6.1%	0.34	8	39.4	2%
United Kingdom	750	-1.1%	920	4.0%	0.37	18	122.7	4%
Ireland	722	14.6%	228	2.2%	0.20	3	31.6	-3%
Belgium	446	6.6%	565	6.3%	0.73	25	126.6	2%
Sweden	198	-0.8%	22	-9.4%	0.00	-55	11.1	-17%
Austria	85	3.6%			0.04	0		
Poland	84	12.5%	63	-0.9%	0.00	-54	74.9	14%
Denmark	79	58.1%	742	0.8%	0.51	0	937.6	-34%
Romania	76	-7.5%	43	0.0%	0.03	-36	56.4	-2%
Greece	56	-12.5%	66	1.3%	0.02	-17	117.0	5%
Slovenia	46	14.9%	1	0.0%	0.42	7	2.2	-31%
Croatia	45	-4.6%	25	1.7%	0.71	14	55.4	5%
Luxembourg	43	-2.1%			1.94	440		
Czech Republic	11	26.9%			0.00	-5		
Lithuania	9	-8.0%	7	-11.6%			82.0	9%
Finland	8	-11.2%	0				0.0	
Latvia	6	-33.4%	2	-27.5%	0.01	-23	34.8	-1%
Hungary	2	8.2%			0.03	-14		
Estonia	1		1		0.00		100.0	
Cyprus	1	-16.5%						
Slovakia	1	-235.7%			0.00			

Data source: FAOSTAT 2019, EUROSTAT, 2019