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Mass balance of consumption and production of aquatic products in the European Union, and implications for eco-intensification of the aquaculture sector.

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Glossary of Acronyms, country codes and product grouping

Acronym	**Definition**
AC	Apparent Consumption
TSS	Total Seafood Supply
TSR	Trade Supply Ratio (Trade / Supply)
VSD	Verified Seafood Demand
NSB	Net Seafood Balance (Supply minus Demand)
SDR	Supply Demand Ratio (Supply / Demand)
OCL	Optimal Consumption Level
IUU	Illegal, Unreported and Unregulated
EU	European Union
EUMOFA	European Market Observatory for Fisheries and Aquaculture Products
MeHg	Methylmercury
Country codes and names	
BEL	Belgium
FIN	Finland
FRA	France
GER	Germany
IRE	Ireland
ITA	Italy
POL	Poland
POR	Portugal
SPA	Spain
UK	United Kingdom
Products/species grouping	
Cod	All cod species, including haddock and pollock
Tuna	*Katsuwonus pelamis, Thunnus spp, Auxis spp, Sarda sarda*
Seabream	*Sparus aurata, Diplodus spp,* other *Sparidae*
Seabass	All seabass species
Freshwater fish	Tilapia, catfish, pangasius, all other freshwater fish species
Carp	All carp species
Salmon	Atlantic salmon, sockeye salmon, other salmonid species
Shellfish	All mussel and clam species
Trout	*Oncorhynchus mykiss* and other trout species

Notes
Seafood is used in this document to mean all aquatic products, including marine, brackish and freshwater fish and shellfish. Algae for human consumption, which are sometimes included in official production and consumption statistics, are not addressed in this report.
Shellfish include only the bivalve species of mussels and clams. No consumption data were available for oysters[1]—given the relevance of *Crassostrea gigas* and *Ostrea edulis* in the European market, this is identified as an important area for further study.
The results, analysis, tables, and figures in this report are only relevant for the specific products and specific countries analysed as displayed in Table 2 of the Methodology section of this report.

[1] A sectorial analysis for Italy is included in this document as an example, but only for illustrative purposes.

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1. Press release

How much fish do we really eat?

The GAIN project found that some of the most popular seafoods in Europe, such as salmon, tuna, and seabass, appear to have a higher consumption than that reported in official statistics. The report, based on seafood demand data, focused on ten European countries and a large number of seafood products.

In addition to demand data, new supply statistics were considered to include other sources of seafood, including subsistence and illegal fishing. This showed that for cod, salmon, or tuna, consumption may be higher than previously estimated.

We found that salmon, the most consumed farmed aquatic product in the EU, appears to have a consumption of 2.21 kg per capita, significantly higher than the 1.30 kg per capita estimates based on supply data. This means that each European consumer appears to eat almost one extra kilogramme each year of salmon unaccounted for in official statistics. Although an extra 900 g of salmon eaten annually by each person only corresponds to an extra meal every two months, if this gap is scaled up to the European population the numbers are of concern.

Similar numbers were determined for tuna, cod, trout, and other common seafood products. Total consumption of seafood in Europe could be as much as 4.3 kg per capita for farmed products and 8.9 kg per capita for wild-caught products.

Taken on aggregate, the mass balance gap for aquatic products, i.e. from fisheries and aquaculture combined, means that as much as one million metric tons per year of seafood could end up on European plates without being recorded in official statistics.

The most likely reason for this substantial discrepancy between supply and demand data are flaws in the datasets—collectively, this introduces substantial uncertainties for policy outcomes. The GAIN project makes a number of suggestions for improvements in this critical area—without good data, there are no good decisions.

2. Executive summary

GAIN is an EU-funded research project that brings together partners from academia, industry and associations with the primary aim of supporting ecological intensification of aquaculture in the European Union (EU) and the European Economic Area (EEA). The core focus of GAIN is to increase production and competitiveness of the industry, while ensuring sustainability and compliance with EU regulations on food safety and the environment.

In order to inform policy makers on sustainable aquaculture production in the EU, it is necessary to understand which seafood products have the highest demand and external dependence. To assess seafood demand and identify potential discrepancies, different datasets were compared: (i) Supply-side data, i.e. *Total Seafood Supply* (TSS) in the EU; and (ii) Demand-side data, i.e. the *Verified Seafood Demand* (VSD), which reveals the seafood actually eaten by consumers.

The seafood supply and demand profile for each product and country was analysed with the objectives of (i) providing reliable data for setting growth and development targets for the aquaculture sector; and (ii) to support integrated policies for management of fisheries and aquaculture, which are at present often fragmented.

Our analysis determined the external dependence for each aquatic product, as well as the (apparent) unmet demand in the EU, expressed as the relative balance of supply and demand. Products identified with a higher external dependence (expressed as the percentage of supply sourced from trade: Trade Supply Ratio, or TSR) were salmon (74%), seabream (65%), seabass (54%), and carp (26%). In contrast, wild-caught seafood typically has a 36% dependence on exports.

The mass balance of supply and demand allowed the identification of the products with lower Supply Demand Ratio (SDR): trout (42%), seabream (47%) and seabass (48%). Wild-caught seafood products have an estimated SDR of 81%. SDR is an indicator of the mass balance gap (Net Seafood Balance, or NSB): products with lower SDR percentage have a lower demand met by supply (SDR<100% = unmet demand).

High TSR species are obvious choices for aquaculture expansion in Europe—in all cases analysed herein, these species can be fished and/or cultivated in European waters.

The mass balance gap (NSB) determined for the ten countries and the range of species studied is in excess of one million tonnes per year for, for fisheries and aquaculture combined. This is roughly twenty percent of overall Apparent Consumption for those countries and species, and highlights the potential liabilities associated with policy decisions due to poor data quality.

A number of recommendations are made in order to improve public confidence in the verified consumption of the main finfish and shellfish species. These include better approaches to both supply- and demand-based assessment methods, and comparisons with similar studies for agricultural products.

3. Introduction and objectives

Seafood consumption in Europe has been increasing for a number of years, and the decline of wild fish stocks in Europe and elsewhere (Halpern *et al.*, 2012) has caused a considerable increase in EU dependence on external seafood supply. Although farmed seafood production has grown worldwide since the 1970s (Lopes *et al.*, 2017), the supply of internal EU aquaculture products has declined in recent years. An increase in internal production is a policy objective of the European Union, but competition for space, licensing, and regulatory constraints, and the lower price point of imported aquatic products have held back growth of the aquaculture sector in Europe.

Although the farmed seafood sector in the EU does not produce a volume capable of fully supplying all of the apparent consumption, European consumer demand for farmed products has increased—despite a persistent preference for wild products, consumers are eating larger volumes of farmed seafood, as well as demanding more sustainability of their farmed fish. Alongside these demands for more sustainable seafood, consumers want more information on what they eat, and they want to eat local food (Feucht and Zander, 2017; European Commission, 2018). This increases the demand for sustainably farmed EU seafood.

EU policy makers should enable appropriate conditions for the growth of the farmed seafood sector, as well as setting realistic growth targets. In order to achieve this, reliable and detailed seafood consumption statistics are required. Currently, the most commonly used approach to estimate seafood consumption in a country, or of a particular product, is based on the apparent consumption method (AC), (Eq. 1):

$$AC = P + I - E \qquad \text{(Eq. 1)}$$

Where:

AC: Apparent consumption;

P: Production;

I: Imports;

E: Exports.

Although the AC methodology has clear advantages when dealing with large datasets for many regions over large time periods, it does not estimate the seafood actually eaten by consumers—rather, it represents an official estimate of the available seafood of a particular species or product in a country or group of countries (Failler, 2007; Lopes *et al.*, 2017). In addition to this, it ignores aspects like as illegal and unregulated fishing that can lead to actual consumption but do not appear in official consumption statistics.

There are additional issues related to currently used methodologies, such as the grouping of several species, or groups of species, as commodities. This is needed when dealing with large datasets that require harmonization, although it results in a loss of accuracy in product identification across the seafood supply chain due to the clustering of finfish and/or shellfish species into groups. These are grouped into commodities with similar characteristics or processing methods, both in retail statistics and in official inquiries to consumers (Lopes *et al.*, 2017).

The commoditization of seafood species into clusters of groups can also lead to difficulties in dealing with the mislabelling of products and create challenges in establishing growth targets for particular farmed species based on actual consumer demand.

In this work we applied a mass balance approach to estimate seafood consumption of specific seafood products in Europe (Lopes *et al.*, 2017). The objectives of the research were to:

1. Compare data for supply and demand of seafood for Europe as a whole;
2. Analyse data by segment, for individual products and countries;
3. Identify trends with respect to discrepancies between wild and farmed seafood;
4. Highlight exceptions in the data for particular products and countries;
5. Support policy makers in setting development targets for aquaculture industry growth, based on internal production and trade;
6. Inform policy makers about the variability in consumption estimated using supply- and demand-side approaches and propose actions to improve data reliability;
7. Contribute to the harmonisation of fisheries and aquaculture policies, which have not traditionally been considered as a unified management challenge.

4. Methodology

Seafood consumption estimates in official data, such as those from FAO, are determined by the AC method (Eq. 1). The method considers that all seafood made available in a country is eaten by consumers—it disregards IUU inputs and assumes zero wastage. The omission of IUU may act to underestimate seafood supply, due e.g. to unreported catch or imports, but may have the opposite effect e.g. if exports are underdeclared. Since there is no verification of the actual consumption of seafood, the calculation of per capita consumption may be further flawed. These issues highlight the need for a double-entry accounting system to perform a mass balance of supply and demand, analyse the results, and use this analysis to support policy definition.

While AC data are readily available from sources such as FAO, Eurostat, or FEAP, the same cannot be said of demand data. Nevertheless, data from both ends of the supply chain are critical in order to analyse the consistency of consumption estimates that should be an integral part of policy definition. Demand-side data are based either on supermarket sales, or on surveys and questionnaires to consumers, if sourced at the very end of the supply-chain. In the latter case, overall consumption estimates for each country and product can represent the specific preferences of the groups of consumers, rather than the overall consumption of the country.

The supply-side analysis, henceforth termed *Total Seafood Supply (TSS)*, considers all seafood available in a country (Eq. 2):

$$TSS = F + A + I + IUU - E \qquad \text{(Eq. 2)}$$

Where:

TSS: Total Seafood Supply;

F: Wild catch;

A: Aquaculture;

I: Imports;

IUU: Illegal, Unreported and Unregulated fishing;

E: Exports.

The demand-side analysis is termed *Verified Seafood Demand (VSD)*, and the mass balance outcome, i.e. the *Net Seafood Balance (NSB)*, is given by Eq. 3:

$$NSB = TSS - VSD \qquad \text{(Eq. 3)}$$

Where:

NSB: Net Seafood Balance (kg per capita);

TSS: Total Seafood Supply (kg per capita);

VSD: Verified Seafood Demand (kg per capita).

In order to estimate the difference between supply and demand, the approach developed in GAIN (see also Lopes et al. 2017) consists of three steps:

1. Estimate the **Total Seafood Supply** of seafood products;
2. Calculate the **Verified Seafood Demand** for each product;
3. Compare both estimates to obtain a **Net Seafood Balance**.

The mass balance of supply and demand can be estimated for any country or economic area. In this work, NSB was calculated for 10 European countries (Table 1), representing over 75% of the population of the European Union. Data with detailed product resolution were available only for these 10 countries.

Table 1. Population data in 2016 for the 10 countries (Eurostat, 2019).

Country	**Population (2016)**	**Percentage of total (%)**
Belgium (BEL)	11,311,117	2.9
Finland (FIN)	5,487,308	1.4
France (FRA)	66,638,391	17.0
Germany (GER)	82,175,684	21.0
Ireland (IRE)	4,726,286	1.2
Italy (ITA)	60,665,551	15.5
Poland (POL)	37,967,209	9.7
Portugal (POR)	10,341,330	2.6
Spain (SPA)	46,440,099	11.9
United Kingdom (UK)	65,379,044	16.7
Total	**391,132,019**	**100.0**

The seafood products included in the report and the estimates of TSS and VSD in each country were based on the demand data available for each product (Table 2).

Table 2. Seafood products and corresponding countries. The classification of products as (i) mostly farmed; (ii) mixed origin; and (iii) mostly wild is also shown. This separation was used to analyse results.

Seafood products and corresponding data for countries		
Mostly (>80%) from wild catch products (also referred to herein as wild fish)	Cod	All
	Mackerel	BEL, IRE, UK
	Sole	BEL, IRE, ITA
	Lobster	BEL, IRE
	Herring	All except POR
	Sardine	BEL, IRE, POR, SPA
	Squid and/or cuttlefish	BEL, ITA, POR, SPA

	Tuna	All
	Hake	IRE, ITA, POR, SPA
	Plaice	All except BEL, POR
	Octopus	ITA, POR, SPA
Mixed origin	Shrimp and prawn	BEL, IRE, ITA, SPA, POR, UK
	Salmon	All
	Mussel	BEL, IRE, ITA, SPA, UK
	Other freshwater fish	All except POR
Mostly farmed products	Seabream	All except BEL
	Seabass	All except BEL
	Trout	All except BEL, POR
	Carp	All except BEL, POR
	Clam	ITA, POR

Although some studies focus on demand for groups of products (e.g. fresh or chilled and frozen seafood), statistics of demand data for detailed products (e.g. cod, tuna and salmon) are few. Therefore, this analysis of European seafood supply and demand was based on products with available demand data, including some of the most important farmed products in Europe, which are the focus of the GAIN project. Data sources for each country and product are shown in Table 31 in annex.

4.1 Total Seafood Supply

Total Seafood Supply includes all seafood supply from official statistics plus IUU estimates for each product. TSS was calculated using Eq. 2. Several potential sources were considered for these data, including Eurostat, FEAP, and FAO.

Production estimates from all three sources are very similar: for instance, Eurostat reports a European salmon production of 1 456 887 tonnes for 2016 (sourced through META, Longline Environment, 2019); FEAP reports 1 488 434 tonnes (FEAP, 2017); and FAO reports 1 421 474 tonnes (FAO, 2019). For carp those numbers are 52 972 t, 54 874 t, and 58 995 t respectively[2]. Most official datasets lack IUU estimates, which can affect estimates of total supply of seafood, and both Eurostat and FEAP do not provide trade data. The FAO dataset was therefore selected to estimate supply values, since it contains the required taxonomic resolution, including all the farmed production, trade, and wild catch data for the countries and products analysed[3].

TSS for each seafood product was estimated by country for the period between 2000 and 2016. Official data from FAO (FAO, 2019) were used to calculate production (fisheries and aquaculture) and trade (import and export) volumes[4,5].

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[2] Salmon production volumes correspond to 6 countries (Norway, UK, Faroe Islands, Ireland, Iceland and France) and carp production volumes to 7 countries (Poland, Czech Republic, Hungary, Germany, France, Croatia and Italy) in the datasets. The Eurostat carp dataset additionally includes Austria, Bulgaria, Estonia, Greece, Lithuania, Latvia, Romania, Serbia, Slovenia, Slovakia, Turkey, and the UK, which means that the total 2016 production of carp in Europe is actually 71 145 t.

[3] In addition, the 2017 FEAP European aquaculture production report states that 'FAO provides further statistical information on aquaculture production and values' (FEAP, 2017).

[4] Data were obtained using the FAO FishStatJ tool for aquaculture and fishery statistics

[5] The seafood supply data shown is only for products with available consumption data, as given in Table 2 of the methodology section. Products for which seafood consumption data are unavailable in any given country are not considered.

In order to estimate subsistence and illegal seafood contributions to total supply, IUU was assessed based on Agnew *et al.* (2009). IUU tonnage was estimated based on the percentage of the total catch for separate groups of species and the average percentage was applied to wild catch data for each product (Table 32). No data for illegal or subsistence fishing were found for carp and other freshwater species.

The final TSS per capita values (Table 3) were used, both to support the assessment of demand and to estimate final NSB results.

Table 3. per capita supply (TSS, kg) for each country and product. These were used to determine final TSS volumes (tonnes) and to help estimate VSD.

Seafood products	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK	EU
Cod	1.46	1.03	1.88	1.87	1.73	0.54	1.02	9.13	2.02	3.90	**2.11**
Mackerel	0.34				5.18					0.21	**0.11**
Sole	0.34				0.11	0.16					**0.04**
Lobster	0.19				0.20						**0.01**
Herring	0.43	18.99	0.63	1.46	3.85	0.03	1.86		0.06	0.38	**1.00**
Sardine	0.19				2.94			5.31	0.90		**0.29**
Squid and cuttlefish	0.07					2.21		1.92	2.55		**0.70**
Tuna	1.03	1.54	1.93	0.76	0.09	2.17	0.23	5.27	5.69	1.82	**2.02**
Hake					0.36	0.84		3.50	3.85		**0.68**
Octopus						1.01		1.52	0.70		**0.28**
Plaice		0.00	0.05	0.05	0.15	0.16	0.05		0.03	0.14	**0.08**
Shrimp and prawn	1.38				0.25	1.46		1.59	2.92	2.29	**1.04**
Salmon	1.73	4.15	1.72	1.00	2.40	0.65	0.78	0.80	0.93	2.07	**1.30**
Mussel	2.36				2.66	1.08			3.92	0.36	**0.79**
Other freshwater fish	0.21	0.03	0.14	0.26	-0.06	0.12	0.25		0.35	0.09	**0.18**
Seabream		0.00	0.21	0.03	-0.06	0.47	0.00	1.13	0.55	0.00	**0.21**
Seabass		0.00	0.16	0.01	0.07	0.44	0.00	0.43	0.33	0.00	**0.15**
Carp		0.00	0.07	0.15	0.00	0.02	0.55		0.00	0.00	**0.10**
Clam						1.07		1.08			**0.20**
Trout		3.81	0.49	0.46	-0.14	0.51	0.43		0.45	0.24	**0.45**

4.2 Verified Seafood Demand

To estimate VSD, data from three different sources were used; details are provided in Annex 1, Table 31. Each study focused on specific seafood products, countries, and had different aims. Seafood consumption data that is not based on the apparent consumption method (Eq. 1) and on supply side estimates are not available in most official EU seafood data sources. Most of the studies and literature that contain such data have a different scope to the one in this report, therefore adaptations were needed to estimate and harmonize seafood demand data (see also Table 2).

The three sources used are described in detail below.

Data source 1: EU Horizon 2020 SUCCESS project data

The EU Horizon 2020 SUCCESS project, on consumer preferences for seafood products (Feucht *et al.*, 2017), was used to estimate demand for 13 fish products in 8 countries (Table 33 in annex). The questionnaires in SUCCESS addressed 4103 consumers in 2014 and 2015.

Those data were combined with the TSS for the (13) products and (8) countries to estimate per capita consumption of each product. This was done by first determining TSS of all products in Table 33 for each country, and then the demand volume for each of these products. The demand volume was estimated based on the consumption of the chosen fish species (D2.2 of SUCCESS, Table 3 - Most bought/consumed fish species per country and over all countries; Feucht *et al.*, 2017)(Table 3. . The raw data was processed to express consumption as part of the total seafood consumption (Table 33).

In the second stage, a range of consumption volumes was estimated for each product. The data in SUCCESS (Feucht *et al.*, 2017) were obtained using questionnaires submitted only to fish consumers, therefore the initial per capita consumption estimates were not representative of the entire population of each country. To estimate per capita consumption levels, the proportion of fish consumers in each of the 8 countries (see Table 37) was calculated, based on data from SUCCESS and a Eurobarometer study on seafood consumer habits (European Commission, 2018).

The different numbers of fish consumers in each country were used to estimate per capita consumption values for each product (Table 38). These values were compared to the TSS per capita consumption volume of each product (Table 3). The final per capita volumes were determined using the smallest difference between per capita consumption volumes (for each number of consumers) and TSS per capita for each product. The final per capita consumption values are given in Table 38 (in annex 1).

Data source 2: methyl mercury accumulation in EU fish consumers

The second approach used to estimate demand (Jacobs *et al.*, 2017) focused on risk assessment of methylmercury intake. The authors used seafood consumption patterns for 5 countries to estimate total intake of MeHg ($HgCH_3^+$). The questionnaire was executed in 2013 (sample size n=2824) and contained data for a total of 24 products (Table 40 in annex). Per capita consumption volumes of each product were estimated using: (i) mean and median body weight; (ii) exposure to the contaminant (Table 41 in annex); and (iii) population of each country (see Table 1).

First, we converted the exposure to contaminant data for each of the products (in µg kg^{-1} of body weight d^{-1} in Table 41) into consumption per capita volumes for each product in Table 40 by means of Eq. 4:

$$Cc = \frac{ExC * ExD}{ConcC} * bw \qquad \text{(Eq. 4)}$$

Where:
Cc: consumption per capita;
ExC: exposure to contaminant in each country;
ExD: contribution to exposure from each product based on diet patterns;
ConcC: concentration of MeHg in each product;
bw = body weight in each country.

Appropriate conversions were applied to estimate yearly consumption volumes from daily data and to tonnes for total volume. This process was repeated for each of the countries for mean and median body weights and for mean, P_{50} and P_{75} estimates of exposure in each country (Table 41 in annex). Per capita consumption volumes (Table 42 in annex) were used in the final VSD estimates. In order to verify the demand volume, the OCL method (Lopes *et al.*, 2017) was used: per capita volumes were determined using the smallest difference between per capita consumption volumes and TSS per capita for each product.

Data source 3: Seafish UK

The final dataset was obtained from the Seafish website (Seafish, 2018), and consisted in retail and out-of-home purchases of seafood products, expressed as total yearly sales (tonnes). These were used to estimate demand for 8 products in the UK (Table 39 in annex), by combining with population data (Table 1).

The calculations described above allowed us to estimate several per capita values for seafood products in the countries considered herein (Table 2). In order to select the most appropriate per capita value for each product, per capita demand values were determined using the smallest difference between demand (VSD) and supply (TSS) for each product.

The final per capita values for each product (Table 4) represent the **Verified Seafood Demand** used to determine **NSB**, and to analyse seafood demand of farmed products in GAIN.

Table 4. per capita demand (VSD, kg) for each country and product. Percentage totals of each product for the EU are also shown.

VSD (kg per capita)	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK	EU	EU (%)
Cod	1.44	8.65	5.44	1.53	2.27	1.28	1.97	6.16	4.98	4.91	**3.40**	22.7
Mackerel	0.30				0.68					0.93	**0.17**	1.2
Sole	0.40				0.29	0.61					**0.11**	0.7
Lobster	0.15				0.20						**0.01**	0.0
Herring	0.37	3.99	0.42	0.80	0.37	0.19	3.29		0.22	0.22	**0.72**	4.8
Sardine	0.61				1.36			3.63	1.74		**0.34**	2.2
Squid and cuttlefish	0.21					1.96		1.82	1.60		**0.55**	3.7
Tuna	1.10	10.86	2.47	0.85	1.80	2.46	0.92	2.55	5.70	1.97	**2.35**	15.7
Hake					0.36	0.77		3.81	2.53		**0.52**	3.5
Octopus						1.09		1.68	0.79		**0.31**	2.1
Plaice		0.57	0.13	0.37	0.92	1.08	0.30		0.06	0.37	**0.38**	2.6
Shrimp and prawns	0.85				0.64	1.23		1.51	1.55	2.35	**0.84**	5.6
Salmon	1.10	17.14	4.07	1.51	2.18	0.87	1.86	1.56	1.08	2.47	**2.21**	14.7
Mussel	0.49				0.37	1.08			1.50	0.26	**0.41**	2.7
Other freshwater fish	0.47	0.04	0.43	0.40	0.10	0.26	1.08		0.47	0.13	**0.40**	2.6
Seabream		0.04	0.87	0.21	0.07	0.95	0.20	1.38	0.92	0.09	**0.52**	3.5
Seabass		0.00	0.67	0.06	0.30	0.65	0.20	0.90	0.70	0.62	**0.46**	3.1
Carp		0.00	0.12	0.11	0.00	0.06	0.75		0.02	0.03	**0.13**	0.9
Clam						1.00		0.88			**0.18**	1.2
Trout		1.88	1.26	1.09	0.60	0.63	1.75		1.44	0.25	**0.96**	6.4

4.3 Net Seafood Balance

In order to identify trends in NSB for both specific seafood products and countries, two final sets of NSB data were generated: (i) the first estimated demand for each product and country based on demand data (Table 31); (ii) the second calculated trends for specific seafood products, considering population changes and the estimated per capita demand.

The supply and demand ratio of seafood products (SDR), was determined using TSS and VSD (Eq. 5).

$$SDR\ (\%) = \frac{TSS}{VSD} \quad \text{(Eq. 5)}$$

The interpretation of NSB and SDR is shown in Table 5, and the final NSB and SDR values are given in Table 6.

Table 5. Final concept for NSB interpretation.

Short description	NSB (kg per capita)	SDR (% of TSS and VSD)
Supply is higher than demand	NSB > 0	SDR > 100
Demand equals supply	NSB = 0	SDR = 100
Demand is higher than supply	NSB < 0	SDR < 100

Seafood products with NSB lower than zero and SDR less than 100% are in theory the ones which represent the best prospects for production increases. Despite this, a more detailed analysis is required to assess which products represent the best opportunities in each of the analysed regions.

Table 6. Supply (TSS), demand (VSD), and NSB for each product (kg per capita), representing the total of the European countries in the study. Estimates account for each country population size. Negative values represent products in which demand exceeds supply (i.e. a negative balance of supply and demand).

Seafood product	TSS	VSD	NSB	SDR
Cod	2.11	3.46	-1.30	61.9
Mackerel	0.11	0.17	-0.06	62.4
Sole	0.04	0.11	-0.07	32.9
Lobster	0.01	0.01	0.00	115.9
Herring	1.00	0.63	0.27	137.5
Sardine	0.29	0.34	-0.05	85.7
Squid and cuttlefish	0.70	0.54	0.15	127.2
Tuna	2.02	2.35	-0.33	86.0
Hake	0.68	0.52	0.16	130.4
Octopus	0.28	0.31	-0.03	91.4
Plaice	0.08	0.38	-0.31	20.2
Shrimp and prawn	1.04	0.84	0.20	124.0
Salmon	1.30	2.21	**-0.91**	**58.7**
Mussel	0.79	0.41	**0.39**	**194.8**
Other freshwater fish	0.18	0.36	-0.21	46.0
Seabream	0.21	0.52	**-0.31**	**40.1**
Seabass	0.15	0.46	**-0.31**	**32.9**
Carp	0.10	0.13	**-0.03**	**74.3**
Clam	0.20	0.18	**0.02**	**109.6**
Trout	0.45	0.76	**-0.51**	**46.5**

4.4 Product classification: supply and Net Seafood Balance

Supply (TSS) and demand (VSD) estimates for each seafood product were analysed considering origin and NSB of each product.

The NSB analysis was carried out for each country and focused on typically farmed products (Table 2). The system developed by Lopes *et al.* (2017) was adapted and updated to classify each product according to TSS.() This system is described below (Table 7) and was developed to identify seafood products according to external dependence based on TSS percentage from external sources (i.e. Trade Supply Ratio, or TSR). It attributes a class from ***A*** (no external dependence) to ***E*** (total external dependence).

Table 7. Seafood products classified by their most important source, TSS from imports or internal production.

Classification	Description	TSS from trade
A	Exclusively internal	≤ 0%
B	Mainly internal	≤ 25%
C	Mixed origin	25% > 75%
D	Mainly imported	≥ 75%
E	Exclusively imported	= 100%

To categorize each product, country, or the overall EU seafood demand and supply profile, the SDR was used (Table 8), allowing the classification of each product based on discrepancies between supply and demand. This index is used herein to identify seafood products with different SDR values (see Table 5).

Products with an SDR above 100% have a supply higher than demand (type ***V***). In theory, and considering only the classification system, these are not the best candidates for production increases, since demand is already fully met by supply. Nonetheless other opportunities can exist for these products, such as niche markets. Considering only the classification system developed in Table 8, products with a demand higher than supply (types ***I*** to ***IV***) are the best prospects for production increases.

Table 8. Product classification by SDR, adapted from Lopes *et al.*, 2017.

Type	Conditions/description
V	≥ 100%
IV	75% < 100%
III	50 ≤ 75%
II	25% < 50%
I	≤ 25%

5. Results and discussion

5.1 Total Seafood Supply

Seafood supply in the EU[6] (Table 3 and Table 6) has increased since 2000, from 4.2M to 4.8M tonnes. Despite the increase in TSS, production volumes have decreased in both the farmed and wild fish sectors. Fisheries have felt this more, with a decrease of approximately 100 000 tonnes since 2000, representing a drop from 41% to 34% in the proportion of total supply (Figure 14 in annex). In 2014, the slight increase in catches (Figure 1) was mainly due to higher volumes of mackerel caught in the UK and Ireland.

The IUU volume also declined from 8% (2000) to 6% (2016) of TSS, which may be due to the discard ban (Veiga *et al.*, 2016).

In 2016, EU Aquaculture production represented 16% of TSS, compared to 20% in 2000. Although TSS has increased, aquaculture production declined by more than 80 000 tonnes since 2000. Despite that decrease, demand for these products still represents 29% of VSD (Table 6).

[6] All figures, estimates and analysis in this report are only relevant for the products and countries analysed, as explained in the glossary and in Table 2.

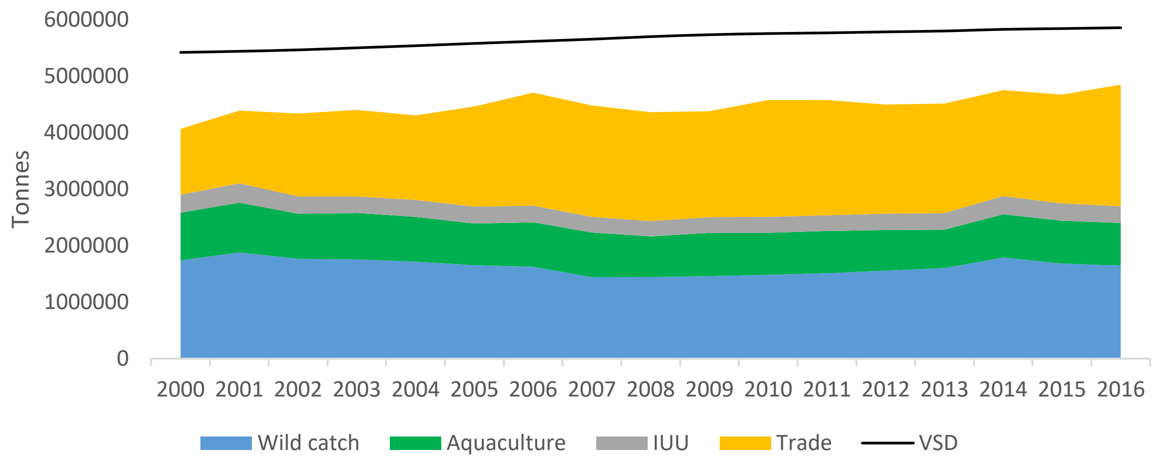

Figure 1. Total Seafood Supply in Europe (countries and products list in Table 2) and VSD. Trade statistics include intra-EU trade[7].

The decrease in farmed seafood production was concentrated in three products (carp, trout, and bivalve shellfish) representing a total decrease in production of 123 155 tonnes. In contrast, output for the other three farmed products (salmon, seabream, and seabass) increased by 58 378 tonnes. If we consider consumer preference for marine over freshwater fish (European Commission, 2018) in the 10 countries studied, the production decreases could be interpreted as lower demand for freshwater fish and the increases in the other farmed products as higher demand for marine and brackish water fish (Table 34 in annex).

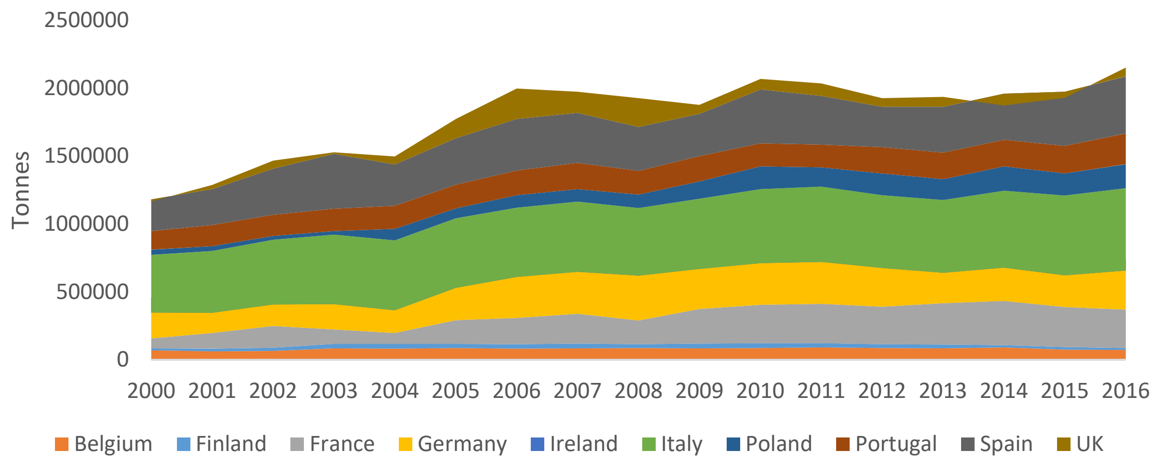

Figure 2. Trade volumes in the EU for the products and countries analysed in this report, based on official estimates from FAO (FAO, 2019) [7].

Imports are the most important source of seafood in the EU. In 2016, trade represented 45% of TSS, an increase from 28% in 2000. Total trade volume has almost doubled from 1.2M to 2.1M tonnes for the period between 2000 and 2016 (Figure 2). Italy is the largest contributor to this high volume, accounting for 28% of all trade in 2016. When we rate the seafood supply in Europe by origin (Table 7), the sector has a C rating, with an import dependence between 25% and 75%, a tendency that has been increasing since 2000 (Table 43 in annex).

Despite the high overall volume of imports, the UK has registered some years of trade surplus (2000, 2013, and 2014). These periods were driven by high production and export volumes of

[7] This figure only applies to the countries and products covered (Table 2).

salmon, herring, and mackerel. Ireland differs from the remaining countries and presents a trade surplus for the products considered herein, with exports driven by mackerel and herring. The lower seafood demand can also be a factor in Irish trade.

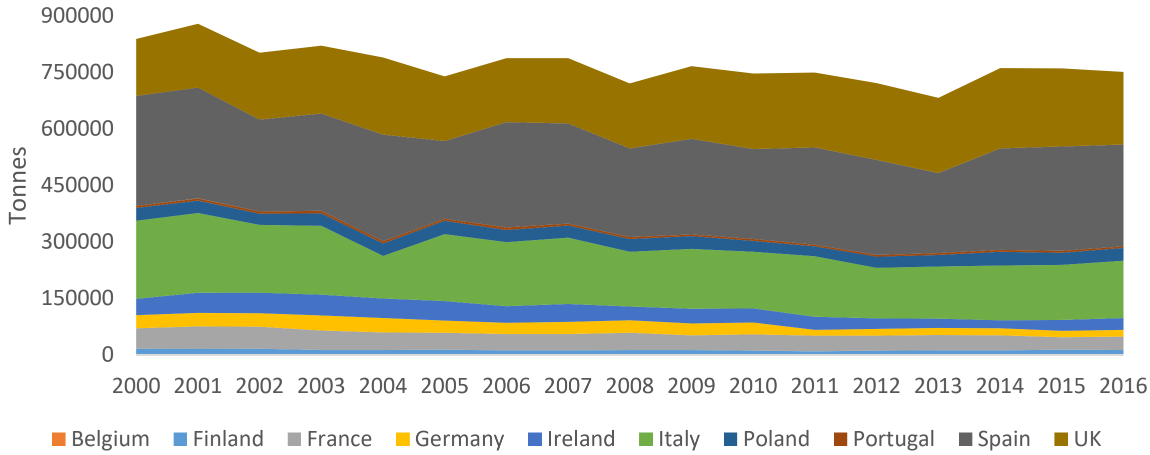

Figure 3. Aquaculture production of selected products and countries in the EU (Table 2) estimated based on FAO data (FAO, 2019).

For the analysis considered in this report, aquaculture production is concentrated in Spain, the UK (Scotland) and Italy. In 2016, these three countries accounted for more than 80% of the total (Table 35 in annex; Figure 3). Between 2000 and 2016, farmed seafood production decreased in all countries except Poland and the UK, the countries showing greatest reductions being Italy and Spain. Although Germany, Ireland, and France do not have large farmed production values when compared to the three leading countries, they have also registered considerable decreases in production. Together, these three nations account for a loss of nearly 50 000 tonnes.

5.1.1 Total Seafood Supply of farmed products

Our analysis of TSS of farmed seafood is divided in two sections. The first section addresses products with a supply from trade in excess of 50% in 2016, and includes products with a classification of C, D, and E according to the origin index (see Table 7).

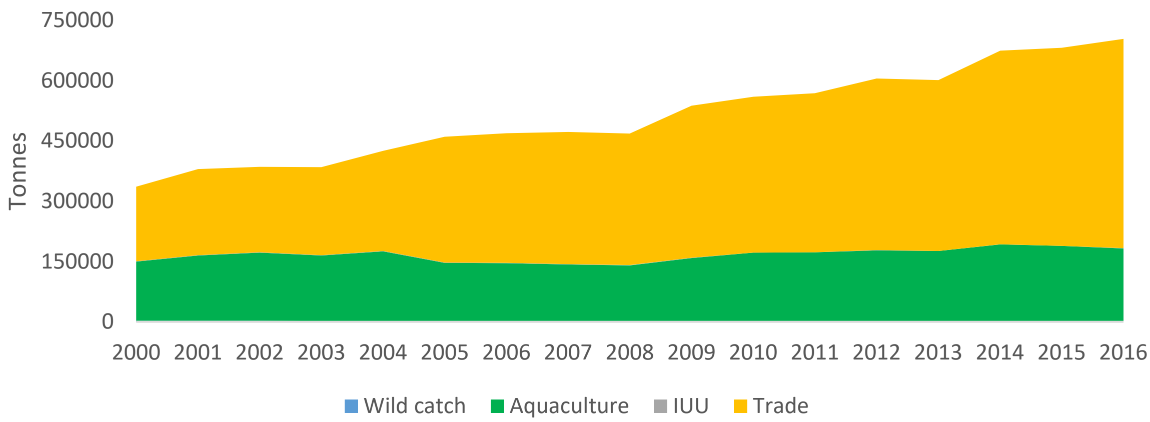

Figure 4. Total supply of salmon represented by source in the EU countries covered (Table 2).

The second section deals with products with a supply from trade equal to or below 50% in 2016. This includes products with a classification of A and B in the origin index (Table 7).

Total **salmon** supply has increased since 2000, from 336 118 tonnes to 704 235 tonnes (2016). Although farmed production has grown by 34 716 tonnes, imports have grown almost ten times more in the 16-year period (335 471 tonnes).

This highlights the EU's increasing dependence on seafood imports (Figure 4).

The most important EU trade partner for salmon is Norway (EUMOFA, 2019a), and for the 10 countries analysed, 90% of salmon production is from the UK (Scotland). If we consider the consequences of Brexit (Garrett, 2017) and the already high dependence on imports of salmon to the EU, this product reliance on external sources could increase in the future.

In order to avoid a scenario of higher external dependence, countries with an existing salmon industry might increase production levels. These countries could include Ireland, France and Germany—Ireland's salmon industry has grown since 2013, and in 2016, production volumes reached 16 300 tonnes. The other two countries have very low annual production volumes (under 2000 tonnes each) and these production volumes could be scaled up to increase supply and reduce imports.

Table 9. Classification of salmon TSR according to origin.

%		2000	2010	2016	Average
TSS	Wild catch	0.7	0.1	**0.1**	0.3
	Aquaculture	43.8	30.6	**25.8**	32.1
	IUU	0.3	0.1	**0.1**	0.1
	Trade	55.2	69.2	**74.0**	67.5
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		C	C	**C**	C

The TSR rating attributed to the salmon supply, considering trade, is C (Table 9). This has remained stable since 2000 despite the higher proportion of imports in the total supply.

Seabass supply is mostly via trade and internal farmed production. Imports have grown since 2000 (13 974 tonnes) and in 2016 they represented 54% (47 056 tonnes) of total supply (Figure 5). EU imports originate mainly from Turkey and the most important producers inside the EU are Greece and Spain (EUMOFA, 2019b).

Table 10. Seabass classification on supply according to origin.

%		2000	2010	2016	Average
TSS	Wild catch	21.0	11.5	**6.0**	11.9
	Aquaculture	35.0	28.9	**37.3**	32.5
	IUU	8.2	4.8	**2.6**	4.9
	Trade	35.9	54.8	**54.2**	50.7
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		C	C	**C**	C

Aquaculture production increased since 2000 from 13 617 tonnes to 32 363 tonnes in 2016. Production from Spain represents 71% of all farmed production. Italy is the second highest producer with 21%. As for salmon, farmed seabass production is concentrated in a small group of countries. Other countries with small productions of farmed seabass include France (4%) and Portugal (1%). Countries with an already installed farmed seabass industry could increase production in order to reduce EU imports.

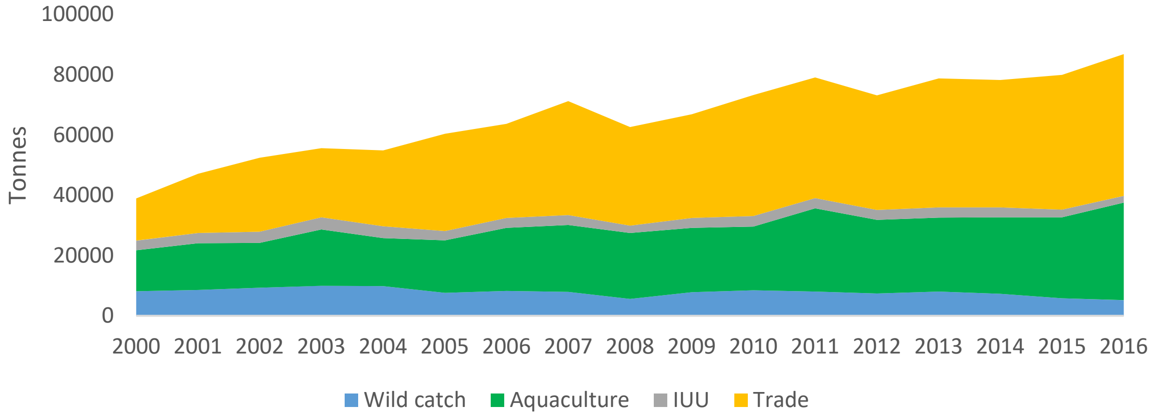

Figure 5. Supply of seabass discriminated by source in the EU countries covered in the report (see Table 2).

The TSR classification attributed to seabass supply, considering trade, is C (Table 10). As for salmon, this is stable since 2000 despite the higher proportion of imports in total supply.

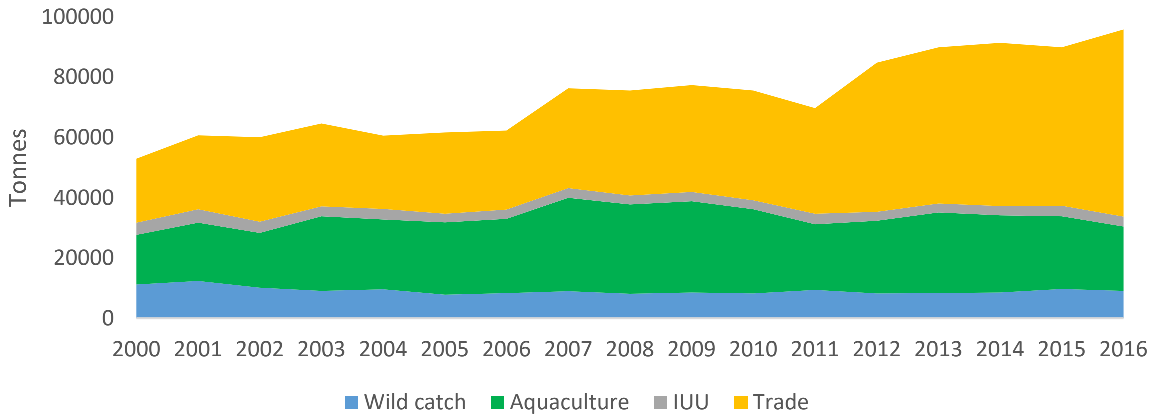

Figure 6. TSS of seabream in the EU countries covered in the report (see Table 2). Supply is discriminated by source.

The supply profile of **seabream** is similar to that of seabass: an increasing dependence from imports (21 270 tonnes in 2000 to 62 137 tonnes in 2016) which account for 40% of supply in 2000 and 65% in 2016. As for seabass, the majority of non-EU imports originate in Turkey. Greece is the main EU producer (EUMOFA, 2019c).

Farmed seabream production has increased from 16 457 tonnes in 2000 to 21 374 tonnes in 2016, with the highest contributions coming from Spain (60%) and Italy (36%). Portugal and France are the other two countries with a contribution of more than 1 000 tonnes. Increases in farmed seabream production could be focused on countries with an already existing industry – Spain, Italy, Portugal and France.

Table 11. Seabream classification on supply according to origin.

%		2000	2010	2016	Average
TSS	**Wild catch**	21.2	11.0	**9.5**	12.5
	Aquaculture	31.1	37.0	**22.3**	33.0
	IUU	7.6	3.9	**3.4**	4.5
	Trade	40.1	48.1	**64.8**	49.9
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		C	C	**C**	C

The TSR score to seabream supply, considering trade, is C (Table 11). Although similar to seabass in score and trend (increased proportion of trade since 2000) the percentage of supply from trade is higher for seabream.

The trade profiles of salmon, seabass, and seabream indicate that EU imports of these products are focused on two countries: Norway for salmon, and Turkey for bass and bream.

The second group of products (trout, carp and shellfish) have a trade dependence (TSR) below 50%, lower than the first group.

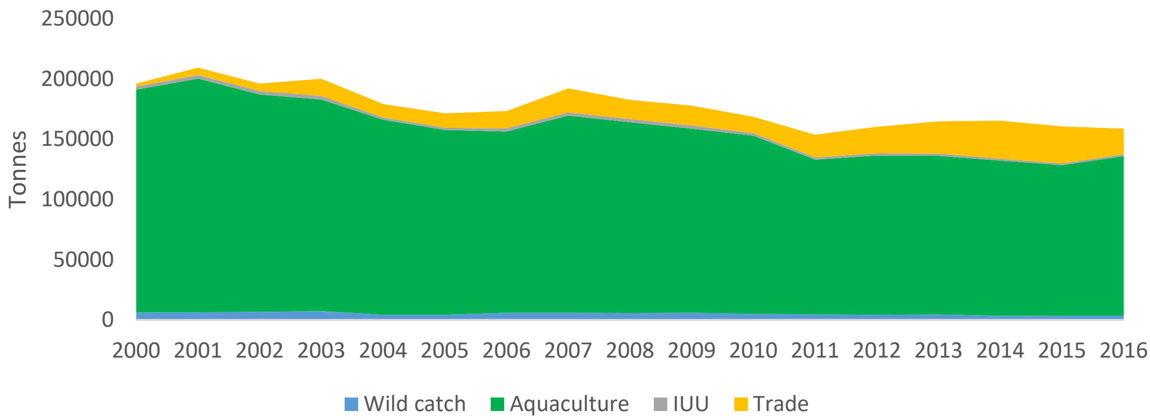

Figure 7. Trout supply and demand in EU countries (Table 2). TSS is discriminated by source: fisheries, aquaculture, trade and IUU.

In 2016, 84% of **trout** supply was supported through farmed production (Table 12). This ratio has decreased since 2000, when aquaculture production provided 94% of supply (184 922 tonnes). Despite the importance of internal supply, farmed trout production has decreased since 2000 to 132 579 tonnes in 2016.

Table 12. Classification of trout supply by source.

%		2000	2010	2016	Average
TSS	Wild catch	3.1	3.0	**2.2**	2.8
	Aquaculture	94.4	87.7	**83.5**	86.5
	IUU	1.4	1.3	**0.9**	1.3
	Trade	1.1	8.0	**13.4**	9.4
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		B	B	**B**	B

TSS has decreased from 195 995 tonnes in2000 to 158 628 tonnes in 2016. This decreasing trend in supply and internal farmed production has not been accompanied by a reduction of imports: since 2000 imports have grown from 2 285 tonnes up to 21 223 tonnes, and in 2016 they represented 13.4% of supply (Figure 7).

Trout farming takes place in many EU countries. In 2016, Italy (28%) was the most important producer, followed by France (20%) and Spain (13%). Despite the impact of these countries in trout farming, between 2000 and 2016 all three decreased production, with two other countries registering increases: the UK (from 11 024 to 14 150 tonnes) and Poland (from 11 445 to 14 481 tonnes). With trade accounting for less than 25% of TSS, trout was classified as a type B product in 2016. This is indicative of a low dependence from external sources for supply (Table 12).

Supply of trout in Europe is for the most part from internal production; expansion could be concentrated in those countries which have reduced their production volumes: Italy, Spain, France, Finland, and Germany.

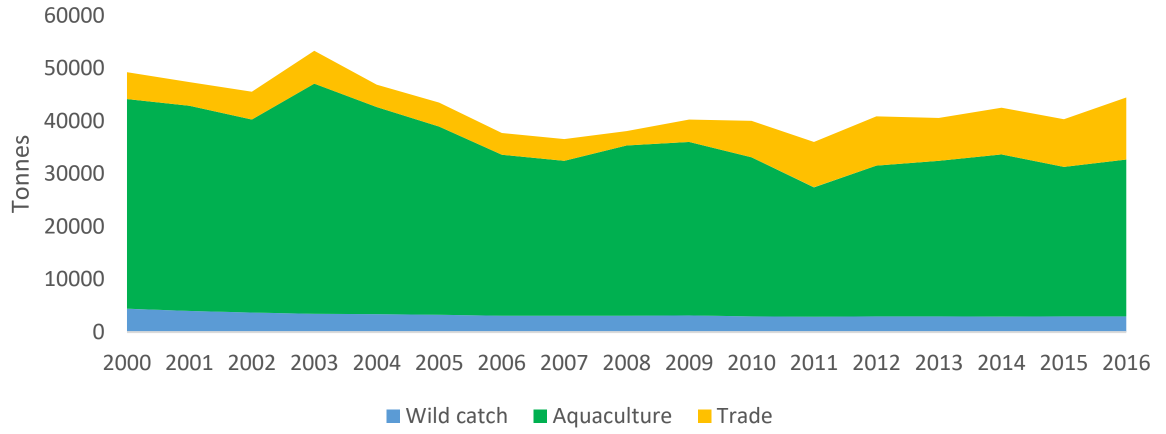

Figure 8. Carp supply in selected EU countries (as displayed in Table 2) and estimated demand. Supply is discriminated by source.

Carp supply is for the most part from EU farmed production (Figure 8). The proportion of farmed production has decreased since 2000 from 81% to 67% in 2016 (39 739 to 29 754 tonnes). Despite the decrease in total supply since 2000 (49 279 to 44 500 tonnes in 2016) imports have more than doubled, from 5 115 tonnes to 11 796 tonnes. According to 2016 data (Table 13) imports account for 26% of supply and farmed production is the largest contributor. This product is classified as C in 2016, a score that improved from B in 2010, when dependence on imports was larger (Table 13).

Table 13. Classification of carp supply according to source.

%		2000	2010	2016	Average
TSS	**Wild catch**	9.0	7.5	**6.6**	7.7
	Aquaculture	80.6	75.3	**66.9**	77.4
	IUU	0.0	0.0	**0.0**	0.0
	Trade	10.4	17.3	**26.5**	14.9
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		B	B	**C**	B

Carp production is concentrated in a small number of countries: Poland, Germany, and France. The largest producer in 2016 was Poland with 66%, followed by Germany with 18%. France tails this group with 13%. All three countries have decreased production since 2000, which accompanied the increase of imports. Given this scenario, production should be focused on these countries, especially in Poland where demand (Table 46 in annex) and production are higher.

In 2016, 87% of the total **shellfish**[8] (mussel and clam) supply came from aquaculture. TSS has decreased due to a reduction in farmed production from 434 045 tonnes in 2000 to 348 314 tonnes in 2016. Imports increased between 2000 (18 122 tonnes) and 2016 (24 972 tonnes), although they still represent less than 10% of supply (Table 14).

[8] Shellfish estimates are only for mussel in BEL, IRE, ITA, SPA, POR and the UK, and for clam in ITA and POR (Table 2).

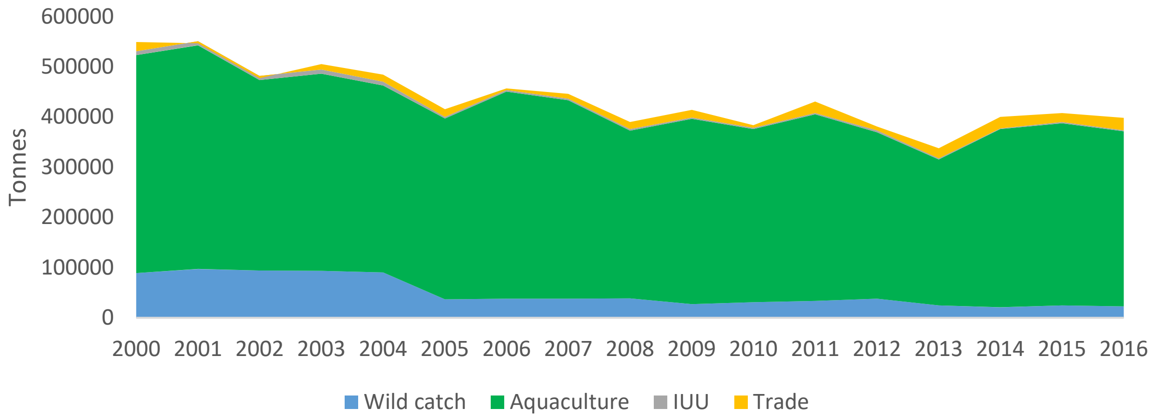

Figure 9. Supply of shellfish products (mussels and clams) in EU countries (as displayed in Table 2). Supply is discriminated by source. Estimated VSD is also shown.

The largest producers of farmed mussels and clams in 2016 were Spain (62%) and Italy (30%), considering *only* the 10 countries in this report. Although imports have increased between 2000 and 2016, this product is still internally supplied by more than 75%. Shellfish supply is not dependent on imports, and therefore is classified as type B (Table 14).

Table 14. Classification of shellfish (mussel and clams) supply, according to source.

%		2000	2010	2016	Average
TSS	**Wild catch**	16.3	8.1	**5.8**	11.3
	Aquaculture	79.1	90.0	**87.5**	84.9
	IUU	1.4	0.7	**0.5**	1.0
	Trade	3.3	1.3	**6.3**	2.9
	Total supply	100.0	100.0	**100.0**	100.0
TSR classification		B	B	**B**	B

5.2 Verified Seafood Demand

Demand was estimated based on the data sources for each country and product (Table 31 in annex).

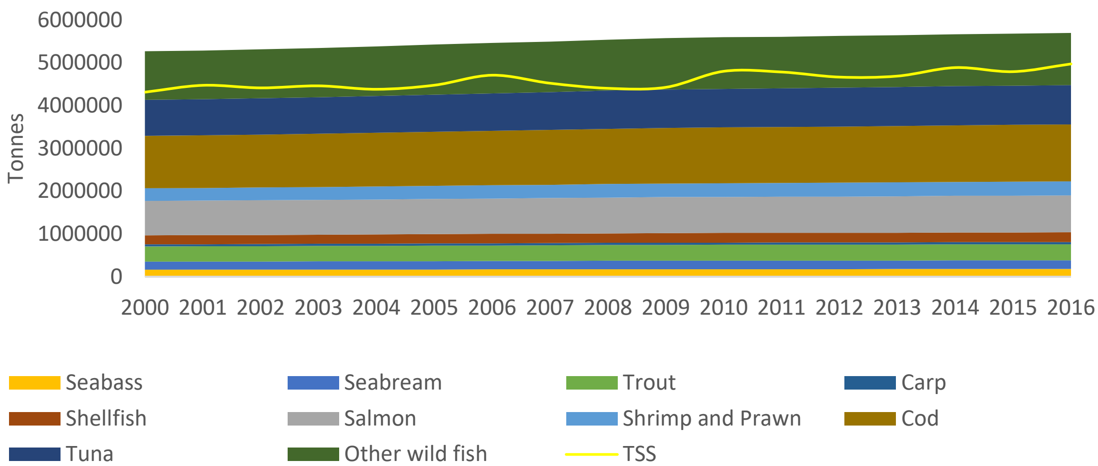

Figure 10. Verified Seafood Demand for all products, by major products (see Table 2). TSS is also shown as a yellow line, which illustrates that overall demand exceeds supply, i.e. people state they eat more than what is calculated from supply-side data.

Seafood demand in the 10 European countries analysed is higher for wild than for farmed fish. This is in agreement with EU reports that have found a higher consumer preference for wild over farmed seafood (Table 34 in annex) (European Commission, 2018). Demand is dominated by three products, which collectively account for more than 50% of all seafood demand in Europe: cod (23%), tuna (16%) and salmon (15%). Combined, they account for 46% of supply (TSS), which contrasts with the higher percentage of demand (54%). The demand for the remaining farmed products is smaller than for salmon. Trout (6%), shellfish (4%), seabass (3%), seabream (3%) and carp (1%) account for less than 20% (Table 15).

Total demand has increased since 2000, but no trends of higher demand for farmed over wild seafood products were identified. Nevertheless, farmed seafood demand accounts for 32% of total VSD. This suggests widespread acceptance of farmed seafood products, despite reports that place higher consumer preference of wild over farmed seafood (European Commission, 2018). The price-point of aquaculture production undoubtedly plays a role in this duality; an analogy could be made for a number of other consumer goods and services, such as holiday destinations or motor cars.

Table 15. VSD of farmed products in Europe expressed as percentage of total demand.

VSD (%)	2000	2010	2016	Average
Salmon	14.84	14.66	**14.74**	14.74
Seabass	3.05	3.06	**3.08**	3.06
Seabream	3.47	3.48	**3.47**	3.48
Trout	6.53	6.43	**6.40**	6.46
Carp	0.95	0.90	**0.89**	0.92
Shellfish	3.86	3.91	**3.91**	3.89
Total (tonnes)	5 417 810	5 751 346	**5 854 847**	5 660 795

5.3 Net Seafood Balance

Two sets of NSB values (volume in tonnes) are included in this report (Table 29) and differ in total volumes of the estimated seafood mass balance. This is due to the method used to estimate trends, which generated two sets of data: the first accounts only for 2016 population data, and was used to define the first set of per capita VSD (Table 4); the second accounts for population changes from 2000 to 2016 and was used to determine trends. In the following analysis, the second dataset was used to generate NSB volumes (Table 28 – upper set of data points, rows 1 to 11).

5.3.1 Mass balance of supply and demand in Europe

NSB, based on the difference between supply and demand (Eq. 3), was estimated to be **-3.25** kg per capita, considering all countries and products examined (Table 2), and the classification for NSB attributed to the European seafood sector was **IV**. This means that demand exceeds supply, and the overall discrepancy is approximately one million tonnes (Table 16), including both aquaculture and fisheries.

Table 16. Classification of the mass balance between supply and demand at European level (see Table 8). NSB values were estimated based on Eq. 3. Values are for 2016.

Product	NSB (kg per capita)	Population	NSB (tonnes)	SDR (%)	Δ between TSS and NSB	Classification
Total	-3.25	391 132 019	-1 055 285	82.0%	22.2%	IV

This is a huge difference (about 22% of AC for the ten countries considered), and clearly shows the need for a reassessment of the accuracy of estimation methods in order to have a reasonable basis on which to set policy for aquaculture expansion and for co-management of fisheries and aquaculture.

It is likely that the real number for consumption of aquatic products lies somewhere in the middle of this range, but even then the estimation error has clear repercussions for policy makers.

The TSS analysis shows that with the decrease of wild catch and farmed production of seafood and an increase of imports, European seafood consumers are increasingly dependent on external sources. This dependence is concentrated in a small number of countries for some of the farmed products analysed: salmon is mainly imported from Norway; seabream and seabass most important origin is Turkey (both are non-EU nations). Even within the EU, the production of farmed seafood is concentrated in a few countries: Greece is the leading producer of seabream and seabass (EUMOFA, 2019b, 2019c); Italy, Spain, and France are the main producers of mussels out of the countries analysed herein (EUMOFA, 2019d); Salmon is mainly farmed in the UK (Scotland) (EUMOFA, 2019a).

In order to understand the overall mass balance gap of 18% of demand compared to supply, a fuller analysis of the datasets, their limitations and choice of variables, must be carried out. In the farmed sector alone, the total discrepancy is 393 659 tonnes, i.e. consumers say they eat almost 400 kt more than the supply-side calculation indicates.

5.3.2 Supply Demand Ratio (SDR) for farmed products

The SDR analysis of farmed products has been split into two sections: finfish products (salmon, seabass, seabream, trout and carp) and bivalve shellfish (mussels and clams). Although we recognise the relevance of oysters in the European seafood diet, consumption data were only available for a specific Italian dataset. We have used it as an example case study, shown at the end of this section.

Finfish products

Salmon SDR was estimated at 82% of demand being met by supply, which rates this product at IV (Table 17). The increases in supply have upgraded the SDR of this product since 2000, although this increase relied for the most part on imports (Table 9). Despite this, there are still 158 833 tonnes of salmon that are not supplied according to the demand-side consumption estimates for 2016.

Table 17. Net Seafood Balance for salmon in European countries.

%	2000	2010	2016	Average	Classification (2016)
SDR (TSS/VSD)	41.8%	66.4%	**81.6%**	61.5%	**IV**

Salmon production could be promoted in countries where there is already an existing industry, such as the UK and Ireland. France and Germany, which have small production volumes, should also aim an increasing production.

The SDR of **seabass** rates this product at II (Table 18), with 48% of demand being met by supply in 2016. As for salmon, supply has increased since 2000 due to higher imports, despite the increases in farmed seafood production (Table 10).

Aquaculture production of seabass in Europe could be increased in countries which already possess an industry: Spain, Portugal, Italy and France (also in Greece to avoid higher imports to the EU).

Table 18. Seabass SDR classification.

%	2000	2010	2016	Average	Classification (2016)
SDR	23.6%	41.6%	**48.2%**	38.1%	**II**

These are also the leading consumers of seabass (Table 46). The composite VSD in Europe for seabass is -93 275 tonnes.

Seabream NSB was estimated at 37% of demand being met by supply, which rates this product at II (Table 19). As for seabass, supply has increased since 2000 due to higher imports, despite increases in farmed seafood production (Table 11). Despite this, there are still 107 359 tonnes of seabream that are not supplied, according to demand data for 2016.

Table 19. Supply Demand Ratio for seabream in European countries.

%	2000	2010	2016	Average	Classification (2016)
SDR	28.2%	37.8%	**47.2%**	37.4%	**II**

The strategy for increased aquaculture production of seabream would be similar to seabass: production could be increased in countries which already possess an industry, such as Spain, Italy, Portugal, and France. Greece, despite already leading the farmed production volume for this product, and not being addressed in this report, should also aim at increasing production to reduce further imports to the EU. The four countries above represent the leading consumers of seabream (Table 46) and collectively have an NSB of 107 359 tonnes.

The farmed products (salmon, seabass, seabream) analysed above have both a high dependence on external sources and large NSB gaps. In order to avoid an even higher dependence on external sources, farmed production should be increased. In the second group of farmed products (below) supply is met by internal production by over 70%, therefore production increases—where necessary—should be more focused on avoiding external dependence.

The SDR of **trout** rates this product at II (Table 20), with 42% of demand being met by supply in 2016. Contrary to the products above, *total* trout supply has decreased since 2000, and shows the clearest reductions in farmed production volume. Despite the lower supply, imports have increased since 2000 (Table 12).

Table 20. Classification of trout SDR for the analysed European countries.

%	2000	2010	2016	Average	Classification (2016)
SDR	55.4%	45.5%	**42.3%**	48.5%	II

Although total supply has decreased, there is a mass balance gap (NSB) of -216 059 tonnes. Farmed production is spread across a number of countries (Italy, France, Spain, Poland, UK, and Finland) and most of those have reduced production since 2000.

The mass balance gap between supply and demand for **carp** is -7 844 tonnes, based on 2016 data (Table 21), which compared to other products analysed, is a small gap. The SDR classifies this product as IV.

Table 21. SDR classification for carp.

%	2000	2010	2016	Average	Classification (2016)
SDR	96.0%	77.2%	**85.0%**	82.2%	IV

This low NSB value is linked to the majority of carp production originating in Poland: two-thirds of farmed production, however France and Germany also present an NSB gap for carp. If Poland is able to increase farmed production, the mass balance gap between supply and demand would be closed and the imports of carp to the EU (11 794 tonnes in 2016) would not be required to meet demand. Since carp production in Poland is still in many respects artisanal, there is scope for eco-intensification of the industry, potentially increasing production without large demands on space.

Bivalve shellfish

The SDR for **shellfish** (only mussels and clams, Table 2, but see case study for Italian oysters below) was 174% in 2016, which classifies the mass balance gap for these products as V, meaning there is more shellfish supply than that required according to the VSD estimates.

Table 22. Classification of shellfish (mussel and clam) SDR in the EU.

%	2000	2010	2016	Average	Classification (2016)
SDR	262.2%	170.5%	**174.1%**	198.1%	V

According to SDR results (Table 22) no increases in farmed shellfish production are required: there is an excess of 169 468 tonnes in the 10 EU countries analysed in this study. Nonetheless, the analysis for these products did not account for all countries (Table 31), so demand for the entire EU may be higher than estimated in this report

Oyster case study – Italy

Methodology

Consumption patterns in oyster markets were analysed by Santeramo *et al.* (2017), allowing for the calculation of different consumption levels for this product and the application of the methodology described earlier, including TSS, VSD, and NSB estimates for oysters in Italy.

Table 23. Information required to estimate oyster consumption in Italy, including serving sizes and details from the questionnaires (adapted from Santeramo *et al.*, 2017).

Sample size	800			
Oyster species	Flat oysters	(*Ostrea edulis*)		
	Cupped oysters	(*Crassostrea gigas*)		
Dimensions (number of oysters per kg)		Minimum	Average	Maximum
	Small	16	23	30
	Medium	10	13	15
	Large	4	7	9
Price (per 6 oysters)	4.00€	6.00€	8.00€	10.00€
Portion sizes in kg (assuming a portion contains 6 oysters, and considering the dimensions above)		Minimum	Average	Maximum
	Small	0.38	0.26	0.20
	Medium	0.60	0.48	0.40
	Large	1.50	0.92	0.67

Questionnaires were distributed in 2015 to 800 people who had eaten oysters at home at least once during the previous year (Table 23)[9], and the oyster consumption frequency was provided (Table 24). The assumption of a 6-oyster portion size was based on the price data (Table 23) in Santeramo *et al.* (2017). Based on this assumption, the portion size was estimated according to the different oyster sizes (small to large) and number of oysters in each portion,

[9]Although the results from this study only include oyster consumers, data are acceptable for estimating the mass balance between oyster supply and demand in Italy.

ranging from minimum to maximum (Table 23).

Table 24. Oyster consumption frequency in Italy (adapted from Santeramo *et al.*, 2017).

Consumption frequency (meals per year)			
	low	**med**	**high**
Minimum	1	5	12
Maximum	4	11	365
Respondents (%)	30.8	39.4	29.8

The TSS estimates for oysters in Italy were obtained using the methodology already applied above (see section 4.1) using supply data from the FAO database (FAO, 2019). In order to estimate VSD, the different consumption frequencies were converted into kg per capita assuming the portion sizes from Table 23 and the consumption frequency from Table 24, using Eq. 6. This process was repeated for each portion size and each consumption frequency.

$$OC = Cf \times Ss \qquad \text{(Eq. 6)}$$

Where:

OC: Oyster consumption (kg per capita);

Cf: Consumption frequency (meals per year);

Ss: Portion size (kg).

This method allowed the calculation of several volumes of oyster consumed in Italy, according to each consumption frequency and serving size. In order to reach absolute consumption volumes (in tonnes) these were calculated for the Italian population using data from Eurostat (Eurostat, 2019). The final selected volumes (closest volumes to TSS) are displayed below. The values used to estimate NSB correspond to the lowest level in Table 25.

Table 25. Estimated values of TSS, VSD (three closest volumes to TSS) and NSB (also included is the SDR) in tonnes and in kg per capita for 2000, 2010 and 2016. The average estimates between 2000 and 2016 are also included (all estimates are only applicable to Italy).

Tonnes		**2000**	**2010**	**2016**	**Average**
TSS		5039	5850.7	5164	5442
VSD	**Low**	11385	11838	12133	11732
	Medium	14850	15441	15826	15302
	High	21346	22196	22750	21997
NSB (TSS-VSD)		-6346	-5987	**-6969**	-6289
kg per capita		**2000**	**2010**	**2016**	**Average**
TSS		0.09	0.10	0.09	0.09
VSD	**Low**	0.20	0.20	0.20	0.20
	Medium	0.26	0.26	0.26	0.26
	High	0.38	0.38	0.38	0.38
NSB		-0.11	-0.10	**-0.11**	-0.11
SDR		44.3%	49.4%	**42.6%**	46.5%

Results and analysis

Oyster supply in Italy is almost entirely from external sources (Table 26 and Figure 11), although there is a growth in farmed production since 2010. Oyster supply from trade in 2016 was 5 019 tonnes, which made up 97.2% of TSS. The remaining 145 tonnes were sourced from internal aquaculture production. TSS estimates register the supply as 0.09 kg per capita, which contrasts with the VSD estimates that place demand (VSD) at 0.20 kg per capita. This identifies a mass balance gap for oysters in the Italian seafood market, estimated to be -6 969 tonnes in 2016 (Table 25).

Table 26. Classification of oyster supply according to source (data only for Italy).

%		2000	2010	2016	Average
TSS	**Wild Catch**	0.0	0.0	**0.0**	0.0
	Aquaculture	0.0	0.6	**2.8**	1.2
	IUU	0.0	0.0	**0.0**	0.0
	Trade	100.0	99.4	**97.2**	98.8
	Total Supply	100.0	100.0	**100.0**	100.0
TSR classification		E	D	**D**	D

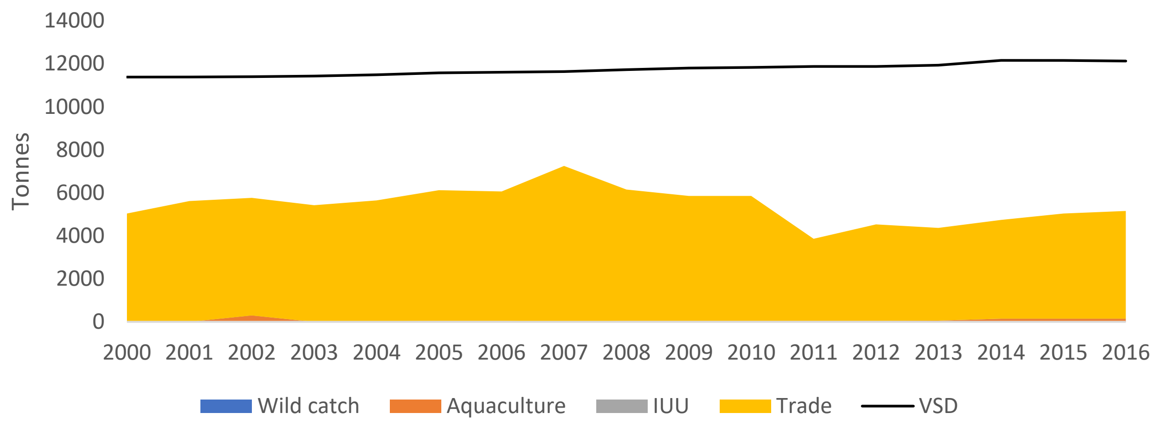

Figure 11. Oyster supply in Italy discriminated by source. The volume of estimated demand (VSD) is also included.

Oyster products are supplied in Italy mostly by trade (97.2% in 2016, see Table 26), which classifies these products as **D** in terms of external dependency Table 7). The NSB for oysters in Italy has been constant between 40% and 50% since 2000, with no change in NSB classification (see Table 8), and in 2016 the classification was II. This indicates that only 42.6% of the demand for oysters in Italy was met (Table 27).

Table 27. Net Seafood Balance for oysters in Italy.

%	2000	2010	2016	Average	Classification (2016)
NSB	44.3%	49.4%	**42.6%**	46.5%	**II**

According to the TSS and NSB classifications, D and II respectively (see also Table 7 and Table 8 in the main methodology section) oyster products could be a candidate for an increase in farmed production, which could close the mass balance gap of oysters, corresponding to -0.11 kg per capita (Table 25) in the Italian seafood market.

Summary of SDR for finfish and shellfish

According to the TSR and SDR, the products with the largest external dependence and wider mass balance gap between supply and demand are **seabass** and **seabream** (Table 28).

Despite this, the products with wider NSB gap are **salmon** and **trout,** with a total of 374 892 tonnes, which should also be the focus of eco-intensification efforts.

Table 28. Classification of each farmed product in the EU according to TSR (Table 7) and SDR (Table 8). Highlighted products represent the best opportunities for increases in farmed production. Maximum and minimum NSB volumes are included.

			NSB	***(tonnes)***
	TSR	***SDR***	***Minimum***	***Maximum***
Wild-*caught* fish	C (36%)	IV	-605 684	-660 199
Shrimp and Prawns	D (90%)	V	-1 427	15 050
Salmon	C (74%)	IV	**-158 833**	-356 534
Seabass	***C (54%)***	***II***	**-93 275**	-114 508
Seabream	***C (65%)***	***II***	**-107 359**	-118 849
Trout	B (13%)	II	**-200 482**	-216 059
Carp	C (26%)	IV	**-7 844**	-12 634
Shellfish	B (6%)	V	**169 468**	204 949
Total			-1 005 436	-1 258 784

For all finfish, NSB is negative, often strongly so, whereas for bivalve shellfish the opposite is true. The differences provide the upper (if negative) or lower (if positive) confidence limits. On aggregate, the consumption range based on the minimum NSB is between 4.8-5.8 million tonnes, which corresponds to the uncertainty in estimated consumption of aquatic products for the ten countries analysed. The consequences of this and potential mitigation strategies are discussed more fully in the final section of this report.

6. Conclusions and recommendations

Seafood in the EU is for the most part imported from external sources (Table 43 in annex), and internal farmed and wild fish production have both decreased since 2000.

Mass balance discrepancies were identified for all the products examined. Salmon and trout showed a negative NSB, corresponding to a ratio of IV and II respectively (see Table 8), which identifies these as products where **demand (VSD) exceeds supply (TSS)**.

Farmed salmon increases could be directed at countries with an already existing industry: the UK, which is by far the largest producer, but also other countries like Ireland, Germany, and France. Increases in salmon aquaculture would also help reduce external dependence from single markets, in this case from Norway, which is the most important salmon supplier to the EU.

Trout aquaculture in the EU is spread over a large number of countries with considerable production volumes. In order to avoid further increases in imports, Italy, Germany, Spain, Poland, and France are countries that could increase production.

Despite salmon and trout presenting the largest mass balance discrepancies, seabass and seabream are the two products on which eco-intensification efforts could be more focused. This is due to the combination of both the TSR and the SDR. Both products have a high external dependence indicated by the **C** ratio on TSS, and low NSB classification: **II** for both products.

Table 29. Mass balance (NSB) for each country in 2016. Positive values indicate that Apparent Consumption (AC) exceeds apparent consumer demand, whereas negative values mean that consumption estimated through demand-side calculations exceeds AC. Rows 1 to 11 accounts for population changes from 2000 to 2016 and was used to determine products demand trends; Rows 12 to 22: data is only considering 2016 population values, which was used for specific country analysis. The differences in volumes reflect the maximum and minimum VSD range.

Species or Group	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**POL**	**POR**	**SPA**	**UK**	**EU**
Wild fish	-9 874	-25 133	-107 367	-55 559	-7 421	-108 982	-46 774	-38 638	-155 880	-104 572	-660 199
Shrimp and Prawns	-42				-13	-325		-68	-312	-667	-1 427
Salmon	-2 292	-17 310	**-49 891**	**-22 785**	-1 893	-9 757	**-12 966**	-2 963	-9 240	**-29 736**	**-158 833**
Seabass			**-23 059**	-2 693	-739	**-20 302**	-3 849	-4 840	**-16 728**	**-21 064**	**-93 275**
Seabream		-110	**-30 748**	-8 982	-181	**-30 392**	-3 927	-7 531	**-22 504**	-2 985	**-107 359**
Trout		-5 954	**-48 444**	**-51 742**	-1 627	**-22 085**	**-38 293**		**-38 629**	-9 285	**-216 059**
Carp			-1 229	-1 415		-510	-4 286		-149	-254	-7 844
Other freshwater fish	688	27	3 722	4 334	65	2 092	5 337		2 872	1 106	20 242
Shellfish	4 066				1 287	93 291		6 730	51 692	12 402	169 468
Total	-7 455	-48 479	-257 016	-138 842	-10 520	-96 970	-104 759	-47 310	-188 877	-155 055	-1 055 285
	BEL	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**POL**	**POR**	**SPA**	**UK**	**EU**
Wild fish	-6 277	-13 758	-265 117	49 081	36 030	-140 116	-125 971	72 693	-85 045	-127 203	-605 684
Shrimp and Prawns	5 973	0	0	0	-1 822	13 889	0	809	0	-3 800	15 050
Salmon	7 102	-71 263	**-156 412**	**-41 273**	1 044	-13 768	**-40 825**	-7 797	-6 977	**-26 366**	**-356 534**
Seabass	0	5	**-33 547**	-4 175	-1 116	-12 270	-7 336	-4 866	**-16 869**	**-34 335**	**-114 508**
Seabream	0	-203	**-44 516**	-14 604	-634	**-29 312**	-7 322	-2 543	**-17 012**	-2 704	**-118 849**
Trout	0	10 557	**-51 632**	**-51 892**	-3 476	-7 265	**-50 207**		**-45 862**	-706	**-200 482**
Carp	0	8	-3 494	2 707	-21	-2 425	-7 567		-949	-892	-12 634
Other freshwater fish	-2 897	-44	-19 224	-12 218	-796	-8 764	-31 206		-5 774	-2 769	-83 692
Shellfish	21 157	0	0	0	9 107	53 813	0	2 081	112 048	6 743	204 949
Total	25 058	-74 698	-573 942	-72 373	38 318	-146 218	-270 433	60 379	-66 440	-192 033	-1 272 384

Seabass has mass balance gap (TSS<VSD) between 93 275 and 114 508 tonnes. This is more pronounced in some EU countries such as France, Italy, and Spain. The mass balance gap for seabream is between 107 359 and 118 849 tonnes (Table 29) and is more pronounced in southern Europe. Countries in which production increase efforts could be focused include Spain, Italy, Portugal, and France, as well as Greece, which is not included in this analysis but is the most important EU producer. Farmed production increases for seabream and seabass could avoid the current EU dependence on single markets, in this case from Turkey.

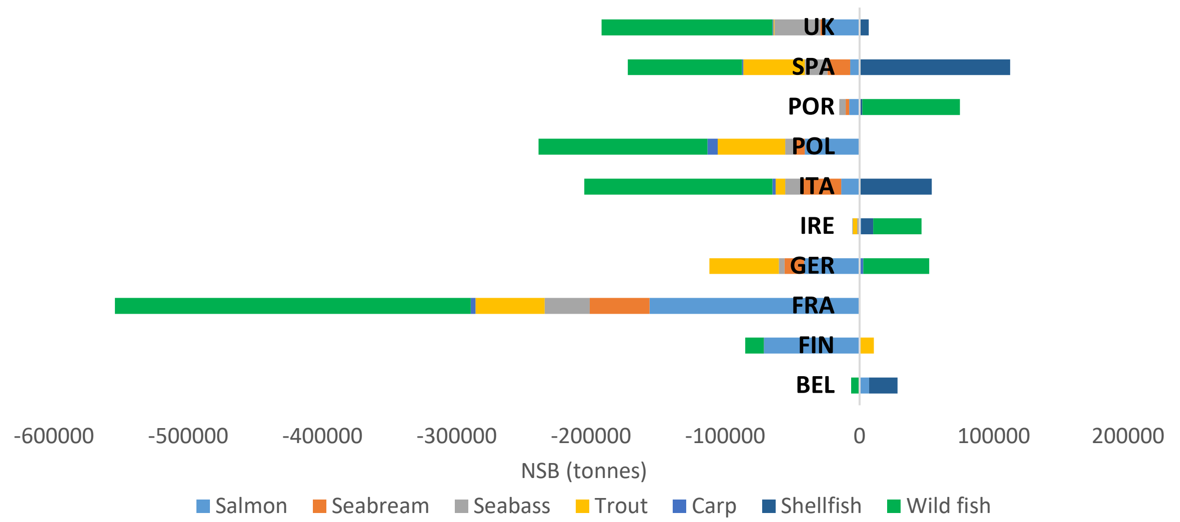

Figure 12. NSB discrepancies for farmed products and wild fish. Volumes are presented in tonnes and correspond to the average NSB volumes in Table 29.

The mass balance discrepancy (NSB<0) is largest in France (Figure 12) and corresponds to 35% of the 10 EU countries analysed. The other countries with a significant negative NSB are Poland (16%), the UK (14%), Spain (11%) and Italy (10%).

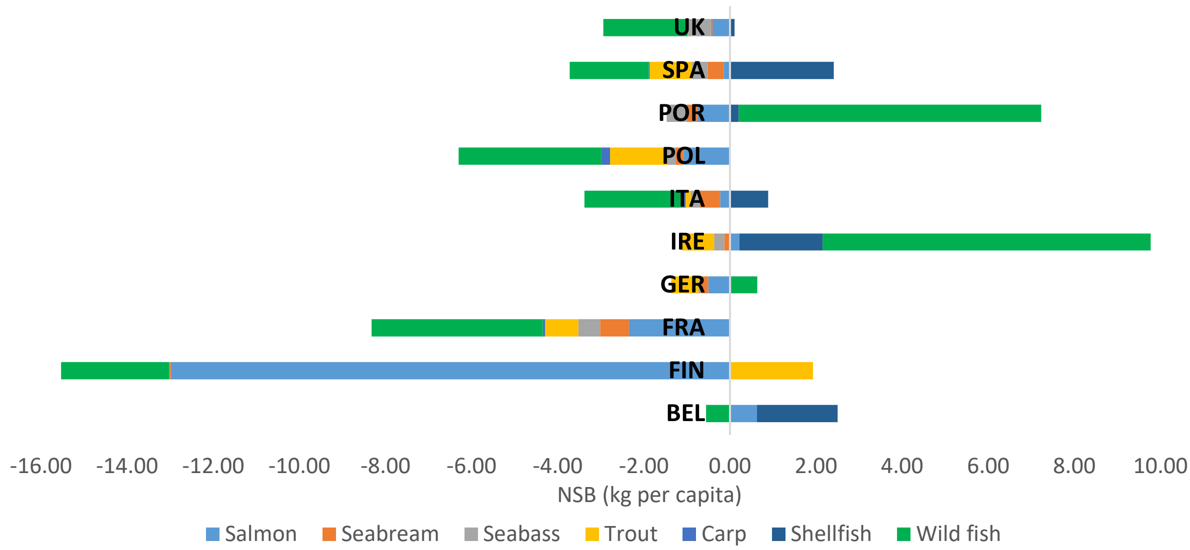

Figure 13. NSB discrepancies for farmed products and wild fish. Values in kg per capita from Table 46.

The discrepancies identified for salmon in France are also present in Finland; this becomes clearer when data are shown as per capita consumption (Figure 13). Another relevant aspect is the excess of wild fish supply in Ireland (herring, sardine and mackerel) and in Portugal (cod and tuna), which contrasts with the unmet demand of certain farmed products – trout in Ireland and salmon in Portugal.

Mussel and clam products present a large mass balance discrepancy, but have a positive NSB, i.e. there appears to be an oversupply. This would suggest no further increases in production are required to satisfy the domestic market, at least for the countries where demand data are available (Table 31 in annex).

Recommendations for eco-intensification

Sound policy decisions towards an eco-intensification of aquaculture rely on good data. This study shows that for ten European countries and a wide variety of aquatic products, both cultivated and wild-caught, data quality is an issue that must be considered.

Table 30. TSS and NSB values (tonnes) for each product analysed. The discrepancy between TSS and NSB (NSB/TSS) is also displayed as percentage of total supply.

Product	***TSS***	***NSB***	***Discrepancy (%)***
Wild fish	2 817 538	-660 199	23.4
Shrimp and Prawn	327 139	-1 427	0.4
Salmon	704 235	-158 833	22.6
Seabass	86 855	-93 275	107.4
Seabream	95 863	-107 359	112.0
Trout	158 628	-216 059	136.2
Carp	44 500	-7 844	17.6
Other freshwater fish	175 321	20 242	11.5
Shellfish	348 314	169 468	48.7
Total	4 758 392	-1 055 285	22.2

The fact that all species and countries considered show discrepancies, which overall correspond to 22% of TSS, i.e. the supply-side estimates (Table 30), highlights the importance of having a double-entry system (similar to that used in accounting) to address the seafood that enters EU markets through production, trade, *and* IUU (supply-side estimate) and the amount of seafood that is actually eaten by the population (demand-side estimate).

The *apparent* demand shortfall is highest for seabass, seabream, and trout, while shellfish show an apparent supply shortfall. This is largely due to mussels, since Eurostat data for clams obtained through META (Longline Environment, 2019) shows a production of 39 183 t y^{-1} for Manila clam (*Venerupis philippinarum*) and 3895 t y^{-1} for Good clam (*Venerupis decussatus*)[10] for 2017, i.e. only about 10% of the overall bivalve production.

Another clear inconsistency is found in FAO-sourced Irish trout data for 2016, where TSS has a negative value of -3230 t y^{-1}, which is obviously impossible. This occurs also for 2002. In addition, all seabream data for Ireland also has a negative TSS, although there is no domestic catch (and therefore no IUU) or aquaculture, and thus no export.

There is an urgent need for better supply-side data, and it is in the interest of any nation that produces and trades aquatic products to understand more fully where and why these gaps exist. In that context, since trade tends to be more regulated, it is worth noting that the shrimp and prawn commodity (Table 30), which Europe does not cultivate (but which some countries'

[10] The FORWARD project (http://www.goodclam.com) analysed production data for good clam is southern Portugal using various metrics, including official statistics, employment estimates, and informal fisheries data, and concluded that production is *at least* 5000 t y^{-1}.

fleets do fish), has a negligible (0.4%) NSB shortfall—to all intents and purposes, that is the most reliable dataset in this study.

Improvement of supply-side data is a challenge; our recommendation is to select appropriate case studies from this dataset and improve the demand-side data quality to understand whether the NSB gaps observed are primarily linked to one methodology or the other.

Questionnaires are one way to approach the issue, but there will often be sub-sampling challenges and other issues—consumers do not always have a precise perception of what they eat and when they eat it. This is more of an issue in northern Europe, where consumer preference is for fish fillets and other forms of presentation that make species difficult to identify.

The vast majority of consumer purchases are made in supermarkets, with some fish also sourced from fish markets—in southern Europe, this is relevant for both individual consumers and the restaurant trade, but in northern Europe this is largely restricted to the catering industry. The best way to improve demand-side data is through a dialog between fisheries agencies and retailers to obtain data on sales for the species selected for analysis, together with consumer numbers. There are challenges to this approach as well, because purchases are usually made for family meals, so one 'consumer' may actually be three or four.

On the supply side, a proportion of wild-caught fish has always been traded informally, and we must therefore assume this may also occur for aquaculture. This largely falls under the umbrella of IUU, although the undocumented component of IUU might be the most relevant for aquaculture. An additional question that must be examined is mislabelling, which can skew estimates of consumption.

In selecting such case studies, the NSB data reported per country and species in Table 29 is helpful. There is a remarkable consistency in NSB trend across countries for any particular species, and *all* marine finfish show a negative mass balance for *all* the countries considered. These results suggest that the same factors may be at play in generating the inconsistencies we have observed.

An additional possibility to help analyse mass balance discrepancies is to review a similar exercise done for a few agricultural commodities, or if such data do not exist, to promote such a study—agriculture is far better studied than aquaculture.

As an overarching conclusion, our analysis has shown that (i) aquaculture expansion is particularly promising in countries and species where trade dominates supply, and identified both components; and (ii) policy decisions on aquatic production in both fisheries and aquaculture are subject to a twenty percent error at present due to the uncertainties in estimating seafood consumption.

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Annex 1 – Data used to support estimates and analysis

Annex 1 shows the detailed data sources for Total Seafood Supply (TSS), Verified Seafood Demand (VSD), and Net Seafood Balance (NSB) for each country and product.

Table 31. Data sources for each country and product.

Demand data source	*Countries*	*Products*
(Feucht *et al.*, 2017)	FIN, FRA, GER, IRE, ITA, SPA, UK	Salmon, cod, tuna, trout, herring, seabream, seabass, plaice, other freshwater fish and carp
(Jacobs *et al.*, 2017)	BEL, IRE, ITA, POR, SPA	Salmon, cod, tuna, herring, seabream, seabass, octopus, hake, lobster, squid and cuttlefish, mackerel, sardine, sole, shrimp and prawn, mussel, clam and other freshwater fish
(Seafish, 2018)	UK	Salmon, cod, tuna, trout, mackerel, shrimp and prawn and mussel

Table 32. Data used to estimate IUU volumes for each product (adapted from Agnew *et al.*, 2009).

Seafood products	**IUU as percentage of total catch (%)**		
	Minimum	Average	Maximum
Cod and hake	15	*26.5*	38
Mackerel	10	*17.0*	24
Sole and plaice	0	*2.5*	5
Lobster	16	*28.0*	40
Herring and sardine	14	*21.5*	29
Squid, cuttlefish and octopus	13	*25.0*	37
Tuna	1	*5.5*	10
Shrimps and prawns	15	*26.0*	37
Salmon and trout	30	*45.0*	60
Mussel and clams	5	*8.5*	12
Seabream and seabass	22	*36.0*	50
Carp and other freshwater fish	No data available		

Table 33. Most bought/consumed fish species per country (adapted based on data from Feucht *et al.*, 2017).

Fish products (%)	**Germany**	**Spain**	**Finland**	**France**	**Ireland**	**Italy**	**Poland**	**UK**	**Total**
Salmon	23.7	22.1	40.1	26.4	27.0	19.4	17.6	21.9	24.5
Saithe/Pollock	17.5	0.2	16.8	19.7	3.0	0.2	2.0	1.4	7.5
Cod	5.9	19.1	3.4	13.8	28.8	20.0	16.6	27.0	17.0
Tuna	13.5	25.9	25.4	16.1	14.3	19.2	8.7	17.5	17.4
Trout	12.4	5.6	3.7	6.0	2.5	4.9	10.6	2.2	6.0
Herring	9.1	0.9	7.8	2.0	1.1	1.5	19.9	1.5	5.3
Sea bream	3.3	13.5	0.1	5.7	0.3	14.9	1.9	0.8	5.2
Sea bass	1.0	10.4	0.0	4.3	5.1	8.7	1.9	5.5	4.7
Haddock	0.7	0.0	0.1	1.7	13.7	0.2	0.1	17.4	4.3
Plaice	5.8	0.2	1.3	0.9	3.9	8.4	2.8	3.3	3.4
Pangasius/Catfish	4.7	1.2	0.0	1.7	0.2	1.8	6.5	0.2	2.0
Carp	1.3	0.1	0.0	0.8	0.0	0.4	7.1	0.2	1.2
Tilapia	0.3	0.5	0.1	0.3	0.2	0.2	3.7	0.8	0.7
Total	100	100	100	100	100	100	100	100	100

Table 34. Preferences over wild vs farmed, and sea vs freshwater aquatic products for the 10 countries in the report (European Commission, 2018).

%	Sea	Freshwater	No pref.	Don't know origin	Varies
Total	43	8	33	6	9
%	**Wild**	**Farmed**	**No pref.**	**Don't know origin**	**Varies**
Total	37	9	32	11	11

Table 35. Aquaculture production as a percentage of total production (above) and in tonnes (below). Values for 2000, 2010 and 2016 are displayed.

%	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK
2000	0.16	1.82	6.42	4.24	5.17	24.65	4.06	0.63	34.83	18.02
2010	0.01	1.47	5.84	4.18	5.08	20.14	3.87	0.60	32.03	26.78
2016	0.00	1.80	4.74	2.33	4.19	20.26	4.56	0.58	35.95	25.60
Tonnes	**BEL**	**FIN**	**FRA**	**GER**	**IRE**	**ITA**	**POL**	**POR**	**SPA**	**UK**
2000	1370	15277	53796	35534	43320	206725	34045	5301	292046	151090
2010	39	10991	43594	31184	37925	150336	28919	4471	239096	199878
2016	0	13482	35550	17469	31421	152092	34259	4391	269848	192147

Table 36. Total demand volume, based on TSS of each product for each country and the proportions from Table 33 (volumes in tonnes).

Product (tonnes)	Germany	Spain	Finland	France	Ireland	Italy	Poland	UK	Total
Salmon	123811	263989	94058	271096	30262	151499	70457	161582	1166754
Saithe/Pollock	91008	2977	39295	202346	3334	1702	8080	10170	358912
Cod	30603	227765	7943	142189	32228	155471	66579	199435	862212
Tuna	70206	309641	59570	164845	15986	149229	34744	128814	933035
Trout	64606	66990	8570	61329	2821	38300	42501	16102	301217
Herring	47604	10421	18184	20313	1197	11632	79830	11017	200198
Sea bream	17001	160775	209	58204	342	116036	7434	5650	365650
Sea bass	5200	124551	0	44532	5728	68089	7434	40678	296212
Haddock	3800	0	209	17969	15302	1702	323	128249	167554
Plaice	30203	2977	3135	8984	4360	65252	11312	24011	150235
Pangasius/Catfish	24602	13894	0	17188	171	13902	26018	1695	97469
Carp	6801	992	0	8203	0	3404	28603	1695	49699
Tilapia	1800	5458	209	3125	171	1702	14867	6215	33548

Table 37. Fish consumers for each country (based on data from European Commission, 2018)

Number of fish consumers (%)	GER	SPA	FIN	FRA	IRE	ITA	POL	UK
Average	80	91	89	82	73	83	78	80
Minimum	72	84	83	73	69	80	64	75
Median	81	92	89	83	73	83	81	81
Maximum	86	96	94	90	76	87	89	85

Table 38. Per capita consumption for the products obtained using the Feucht *et al.*, 2017 study and estimated TSS data (values in kg per capita)

Fish products	Germany	Spain	Finland	France	Ireland	Italy	Poland	UK
Salmon	1.51	5.68	17.14	4.07	6.40	2.50	1.86	2.47
Saithe/Pollock	1.11	0.08	7.16	3.04	0.71	0.04	0.24	0.21
Cod	0.37	4.90	1.45	2.13	6.82	2.56	1.75	3.05
Tuna	0.85	6.95	10.86	2.47	3.38	2.46	0.92	1.97
Trout	0.79	1.44	1.88	0.92	0.60	0.63	1.12	0.25
Herring	0.80	0.22	3.99	0.42	0.37	0.19	2.36	0.22
Sea bream	0.21	3.46	0.04	0.87	0.07	1.91	0.20	0.09
Sea bass	0.06	2.68	0.00	0.67	1.21	1.12	0.20	0.62
Haddock	0.05	0.00	0.04	0.27	3.24	0.03	0.01	1.96
Plaice	0.37	0.06	0.57	0.13	0.92	1.08	0.30	0.37
Pangasius/Catfish	0.30	0.36	0.00	0.26	0.05	0.23	0.69	0.03
Carp	0.11	0.02	0.00	0.12	0.00	0.06	0.75	0.03
Tilapia	0.02	0.12	0.04	0.05	0.05	0.04	0.39	0.10

Table 39. Per capita consumption (in kg) of seafood products in the UK, based on data from Seafish, 2018.

	Salmon	Tuna	Cod	Haddock	Mackerel	Mussels	Trout	Shrimps and Prawns
Per capita consumption (kg)	2.81	3.45	3.57	1.31	0.93	0.26	0.14	2.35

Table 40. Contribution to MeHg exposure, considering consumption patterns for each country (adapted from Jacobs *et al.*, 2017)

Contribution to exposure for each seafood product and country, considering consumption patterns (%)									
Portugal		**Belgium**		**Ireland**		**Italy**		**Spain**	
Tuna	26.5	**Tuna**	40.8	**Tuna**	40.0	**Tuna**	32.5	**Tuna**	29.5
Canned tuna	14.8	**Canned tuna**	18.3	**Canned tuna**	16.2	**Canned tuna**	19.6	**Canned tuna**	21.2
Cod	7.4	**Cod**	11.0	**Cod (fresh)**	8.3	**Seabream**	11.8	**Hake**	10.5
Salmon	1.3	**Salmon**	3.0	**Seabass**	6.8	**Seabass**	8.5	**Seabream**	9.3
Seabream	11.5	**Pollock**	5.5	**Hake**	4.4	**Octopus**	5.5	**Seabass**	7.5
Hake	9.7	**Mackerel**	3.1	**Haddock**	4.3	**Hake**	3.7	**Octopus**	4.9
Seabass	7.7	**Sole**	2.6	**Cod (dry/salted)**	3.5	**Cuttlefish**	3.5	**Cuttlefish**	3.6
Octopus	5.8	**Lobster**	2.4	**Shrimp and prawn**	3.5	**Cod (fresh)**	3.4	**Shrimp and prawn**	2.8
Monkfish	4.8	**Herring**	1.4	**Mackerel**	3.2	**Cod (dry/salted)**	2.8	**Sardine**	2.6
Sardine	2.9	**Sardine**	2.2	**Salmon**	2.6	**Shrimp and Prawn**	2.6	**Squid**	2.5
Cuttlefish	2.7	**Mussel**	0.7	**Sardine**	2.5	**Squid**	2.0	**Canned Sardine**	1.9
Squid	1.9	**Squid**	1.3	**Canned sardine**	1.7	**Sole**	1.8	**Sole**	1.8
Shrimp and prawn	1.8	**Shrimp and prawn**	5.9	**Sole**	1.5	**Salmon**	1.1	**Salmon**	1.1
Canned sardine	1.0	**Canned sardine**	1.9	**Lobster**	1.4	**Clams**	0.7	**Mussel**	0.6
Clam	0.3	**Pangasius**	0.1	**Mussel**	0.2	**Mussel**	0.5	**Clam**	0.5

Table 41. Body weight (kg) and exposure to contaminant (µg*kg^{-1} of body weight*day^{-1}) on each country data used in per capita consumption estimates (Jacobs *et al.*, 2017)

	Portugal	**Belgium**	**Ireland**	**Italy**	**Spain**
Mean	71.68	75.99	78.51	71.17	72.22
Median	70.53	74.99	73.39	70.12	70.45
Exposure to contaminant (µg * kg^{-1} of body weight * day^{-1})					
Mean	0.114	0.028	0.051	0.078	0.092
P50	0.101	0.020	0.036	0.066	0.080
P75	0.142	0.033	0.061	0.098	0.113

Table 42. Final per capita (in kg) consumption volumes estimated based on the work from Jacobs *et al.*, 2017.

Belgium	**Cod**	**Salmon**	**Mackerel**	**Sole**	**Lobster**	**Herring**	**Mussel**	**Squid**	**Shrimp and prawn**	**Other freshwater fish**	**Sardine**	**Tuna**
	1.44	1.10	0.30	0.40	0.15	0.37	0.49	0.21	0.85	0.47	0.61	1.10
Ireland	**Seabass**	**Hake**	**Haddock**	**Shrimp and Prawn**	**Mackerel**	**Salmon**	**Sole**	**Lobster**	**Mussel**	**Sardine**	**Tuna**	**Cod**
	0.30	0.36	0.92	0.64	0.68	2.18	0.29	0.20	0.37	1.36	1.80	1.35
Italy	**Seabream**	**Seabass**	**Octopus**	**Hake**	**Shrimp and Prawn**	**Sole**	**Salmon**	**Clam**	**Mussel**	**Cod**	**Tuna**	**Squid and cuttlefish**
	0.95	0.65	1.09	0.77	1.23	0.61	0.87	1.00	1.08	1.22	3.15	1.96
Portugal	**Cod**	**Salmon**	**Seabream**	**Hake**	**Seabass**	**Octopus**	**Squid and cuttlefish**	**Shrimp and Prawn**	**Clam**	**Sardine**	**Tuna**	
	6.16	1.56	1.38	3.81	0.90	1.68	1.82	1.51	0.88	3.63	2.55	
Spain	**Hake**	**Seabream**	**Seabass**	**Octopus**	**Shrimp and prawn**	**Squid**	**Salmon**	**Mussel**	**Sardine**	**Tuna**		
	2.53	0.92	0.70	0.79	1.55	1.60	1.08	1.50	1.74	5.70		

Table 43. Percentage of TSS according to origin for countries and products in the report.

%	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Wild Catch	41	43	41	40	40	37	34	32	33	33	32	33	35	36	38	36	34	36
Aquaculture	20	20	18	19	18	17	17	17	17	18	16	16	16	15	16	16	16	17
IUU	8	8	7	7	7	7	6	6	6	6	6	6	6	6	7	7	6	7
Trade	28	29	34	35	35	40	42	44	44	43	45	45	43	43	40	42	45	40

Table 44. Kg per capita supply for each country in the report and each product. Per capita values in the final column represent the sum for all the EU countries, considering population. Lines 13 and 23 are the sum of all the wild and farmed products respectively (Table 2).

TSS (kg per capita)	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK	EU
Cod	1.46	1.03	1.88	1.87	1.73	0.54	1.02	9.13	2.02	3.90	**2.11**
Mackerel	0.34				5.18					0.21	**0.11**
Sole	0.34				0.11	0.16					**0.04**
Lobster	0.19				0.20						**0.01**
Herring	0.43	18.99	0.63	1.46	3.85	0.03	1.86		0.06	0.38	**1.00**
Sardine	0.19				2.94			5.31	0.90		**0.29**
Squid and cuttlefish	0.07					2.21		1.92	2.55		**0.70**
Tuna	1.03	1.54	1.93	0.76	0.09	2.17	0.23	5.27	5.69	1.82	**2.02**
Hake					0.36	0.84		3.50	3.85		**0.68**
Octopus						1.01		1.52	0.70		**0.28**
Plaice		0.00	0.05	0.05	0.15	0.16	0.05		0.03	0.14	**0.08**
Wild catch	4.03	21.6	4.49	4.15	14.6	7.13	3.16	26.7	15.8	6.46	**7.31**
Shrimp and prawn	1.38				0.25	1.46		1.59	2.92	2.29	**1.04**
Salmon	1.73	4.15	1.72	1.00	2.40	0.65	0.78	0.80	0.93	2.07	**1.30**
Mussel	2.36				2.66	1.08			3.92	0.36	**0.79**
Other freshwater fish	0.21	0.03	0.14	0.26	-0.06	0.12	0.25		0.35	0.09	**0.18**
Seabream		0.00	0.21	0.03	-0.06	0.47	0.00	1.13	0.55	0.00	**0.21**
Seabass		0.00	0.16	0.01	0.07	0.44	0.00	0.43	0.33	0.00	**0.15**
Carp		0.00	0.07	0.15	0.00	0.02	0.55		0.00	0.00	**0.10**
Clam						1.07		1.08			**0.20**
Trout		3.81	0.49	0.46	-0.14	0.51	0.43		0.45	0.24	**0.45**
Farmed	4.29	4.19	2.30	1.45	5.00	3.84	1.59	3.45	6.08	2.51	**2.92**
Total	9.71	29.5	7.27	6.06	19.7	12.9	5.18	31.7	25.3	11.5	**11.7**

Table 45. Kg per capita demand for each country in the report and each product. Per capita values in the final column represent the sum for all the EU countries, considering population. Lines 13 and 23 are the sum of all the wild and farmed products respectively (Table 2).

VSD (kg per capita)	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK	EU
Cod	1.44	8.65	5.44	1.53	2.27	1.28	1.97	6.16	4.98	4.91	**3.40**
Mackerel	0.30				0.68					0.93	**0.17**
Sole	0.40				0.29	0.61					**0.11**
Lobster	0.15				0.20						**0.01**
Herring	0.37	3.99	0.42	0.80	0.37	0.19	3.29		0.22	0.22	**0.72**
Sardine	0.61				1.36			3.63	1.74		**0.34**
Squid and cuttlefish	0.21					1.96		1.82	1.60		**0.55**
Tuna	1.10	10.86	2.47	0.85	1.80	2.46	0.92	2.55	5.70	1.97	**2.35**
Hake					0.36	0.77		3.81	2.53		**0.52**
Octopus						1.09		1.68	0.79		**0.31**
Plaice		0.57	0.13	0.37	0.92	1.08	0.30		0.06	0.37	**0.38**
Wild catch	4.59	24.1	8.47	3.55	8.25	9.44	6.47	19.6	17.6	8.40	**8.87**
Shrimps and prawn	0.85				0.64	1.23		1.51	1.55	2.35	**0.84**
Salmon	1.10	17.14	4.07	1.51	2.18	0.87	1.86	1.56	1.08	2.47	**2.21**
Mussel	0.49				0.37	1.08			1.50	0.26	**0.41**
Other freshwater fish	0.47	0.04	0.43	0.40	0.10	0.26	1.08		0.47	0.13	**0.40**
Seabream		0.04	0.87	0.21	0.07	0.95	0.20	1.38	0.92	0.09	**0.52**
Seabass		0.00	0.67	0.06	0.30	0.65	0.20	0.90	0.70	0.62	**0.46**

Carp		0.00	0.12	0.11	0.00	0.06	0.75		0.02	0.03	**0.13**
Clam						1.00		0.88			**0.18**
Trout		1.88	1.26	1.09	0.60	0.63	1.75		1.44	0.25	**0.96**
Farmed	2.05	17.2	6.16	2.30	3.02	4.86	4.08	4.72	4.69	3.59	**4.30**
Total	7.49	43.2	15.9	6.94	12.5	16.2	12.3	25.9	25.3	14.6	**14.9**

Table 46. NSB (TSS-VSD) in kg per capita for each country and each product. Per capita values in the final column represent the sum for all the EU countries, considering population. Lines 13 and 23 are the sum of all the wild and farmed products respectively (Table 2).

NSB (kg per capita)	BEL	FIN	FRA	GER	IRE	ITA	POL	POR	SPA	UK	EU
Cod	0.01	-7.62	-3.56	0.35	-0.54	-0.74	-0.95	2.97	-2.96	-1.01	**-1.30**
Mackerel	0.04				4.50					-0.72	**-0.06**
Sole	-0.06				-0.18	-0.45					**-0.07**
Lobster	0.04				0.00						**0.00**
Herring	0.07	15.00	0.21	0.66	3.49	-0.16	-1.43		-0.17	0.15	**0.27**
Sardine	-0.43				1.59			1.68	-0.84		**-0.05**
Squid and cuttlefish	-0.15					0.25		0.11	0.95		**0.15**
Tuna	-0.07	-9.32	-0.55	-0.09	-1.71	-0.28	-0.68	2.73	-0.01	-0.15	**-0.33**
Hake					0.00	0.07		-0.31	1.32		**0.16**
Octopus						-0.08		-0.15	-0.09		**-0.03**
Plaice		-0.57	-0.09	-0.32	-0.77	-0.91	-0.25		-0.04	-0.22	**-0.31**
Wild catch	-0.55	-2.51	-3.98	0.60	6.38	-2.31	-3.32	7.03	-1.83	-1.95	**-1.56**
Shrimps and prawn	0.53				-0.39	0.23		0.08	1.37	-0.06	**0.20**
Salmon	0.63	-12.99	-2.35	-0.50	0.22	-0.23	-1.08	-0.75	-0.15	-0.40	**-0.91**
Mussel	1.87				2.29	0.00			2.41	0.10	**0.39**
Other freshwater fish	-0.26	-0.01	-0.29	-0.15	-0.17	-0.14	-0.82		-0.12	-0.04	**-0.21**
Seabream		-0.04	-0.67	-0.18	-0.13	-0.48	-0.19	-0.25	-0.37	-0.09	**-0.31**
Seabass		0.00	-0.50	-0.05	-0.24	-0.20	-0.19	-0.47	-0.36	-0.62	**-0.31**
Carp		0.00	-0.05	0.03	0.00	-0.04	-0.20		-0.02	-0.03	**-0.03**
Clam						0.08		0.20			**0.02**
Trout		1.92	-0.77	-0.63	-0.74	-0.12	-1.32		-0.99	-0.01	**-0.51**
Farmed	2.24	-13.0	-3.86	-0.85	1.97	-1.02	-2.48	-1.27	1.39	-1.08	**-1.38**
Total	2.22	-13.6	-8.61	-0.88	7.23	-3.22	-7.12	5.84	-0.06	-3.09	**-3.25**

Annex 2 – Sectorial analysis by country

Annex 2 shows the detailed graphs and tables used to analyse TSS, VSD, and NSB for the ten European countries considered in this report. Additional calculations of the Supply Demand Ratio (SDR) and the Trade Supply Ratio (TSR) are shown where appropriate.

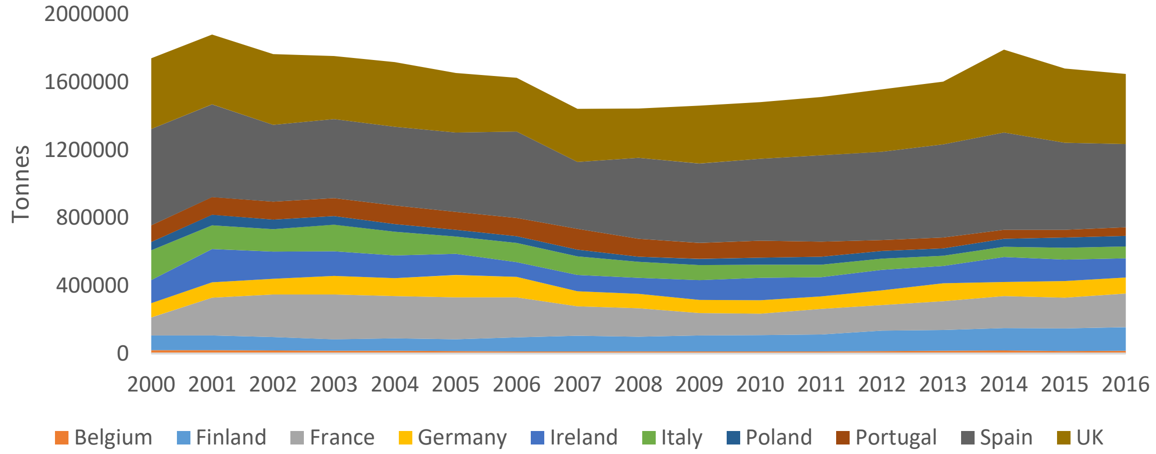

Figure 14. Wild catch production of selected products in the EU.

Annex 2.1 – Belgium

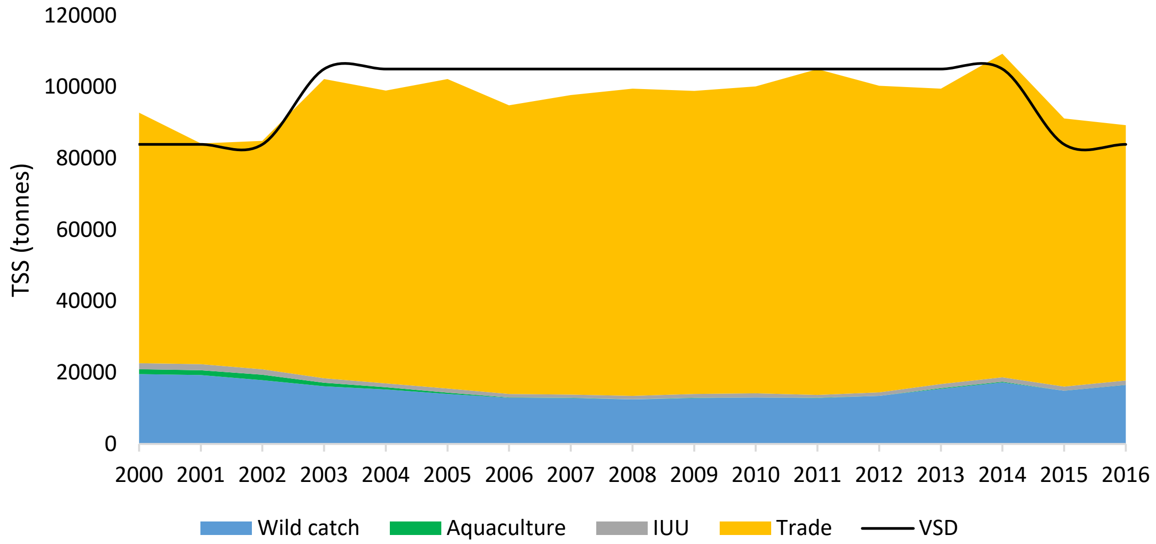

Figure 15. Total supply of selected products in Belgium and estimated demand.

In Belgium, 83% of demand is met by imports. Tuna (19%), cod (18%) and salmon (14%) dominate VSD. The impact of aquaculture production is only 0.4%. Since 2000 aquaculture production has decreased from 1 370 tonnes to zero. In 2016, the SDR for Belgium was 106%.

Table 47. Total supply (TSS), Estimated demand (VSD), and net balance of seafood products in Belgium.

Supply and demand (kg per capita)	Cod	Salmon	Mackerel	Sole	Lobster
VSD	1.44	1.10	0.30	0.40	0.15
TSS	1.46	1.73	0.34	0.34	0.19
NSB	0.01	0.63	0.04	-0.06	0.04

Products with the largest NSB discrepancies in Belgium are sardine and tuna –both originate from wild catch. There is also a discrepancy in freshwater products.

Annex 2.2 – Finland

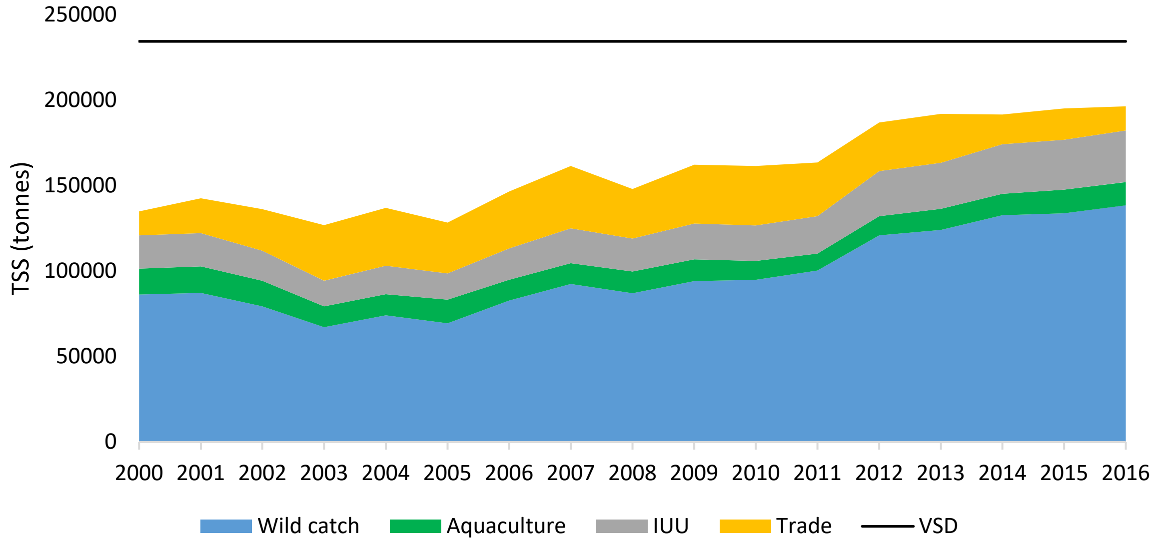

Figure 16. Total supply of selected products in Finland and estimated demand (VSD).

According to VSD estimates, Finland has an SDR of 68%. The NSB between 2000 and 2016 is over 75 000 tonnes. Despite the high volume, this discrepancy has decreased: in 2016, SDR was 84%

Production from fisheries is the most important source of aquatic products (62%) in the country. The impact of IUU is 14%, whereas trade is responsible for 17%. Imports have been decreasing since 2010, accompanied by an increase in wild catch. Herring and farmed trout respectively lead fisheries and aquaculture production.

Salmon (40%), cod (20%) and tuna (25%) have the highest VSD. Despite a high demand these products have an SDR of less than 30% each. For cod and tuna SDR is below 15%. VSD also exceeds TSS for the most produced seafood, trout and herring.

Table 48. Supply (TSS), demand (VSD), and net balance (NSB) in Finland.

Supply and demand (kg per capita)	Cod	Salmon	Tuna	Trout	Herring
VSD	8.65	17.14	10.86	1.88	3.99
TSS	1.03	4.15	1.54	3.81	18.99
NSB	-7.62	-12.99	-9.32	1.92	15.00

These large discrepancies between seafood supply and demand for Finnish consumers suggest that these values may have been overly influenced by specific consumer preferences and may not accurately represent demand, and/or that the apparent consumption data warrants closer analysis.

Annex 2.3 – France

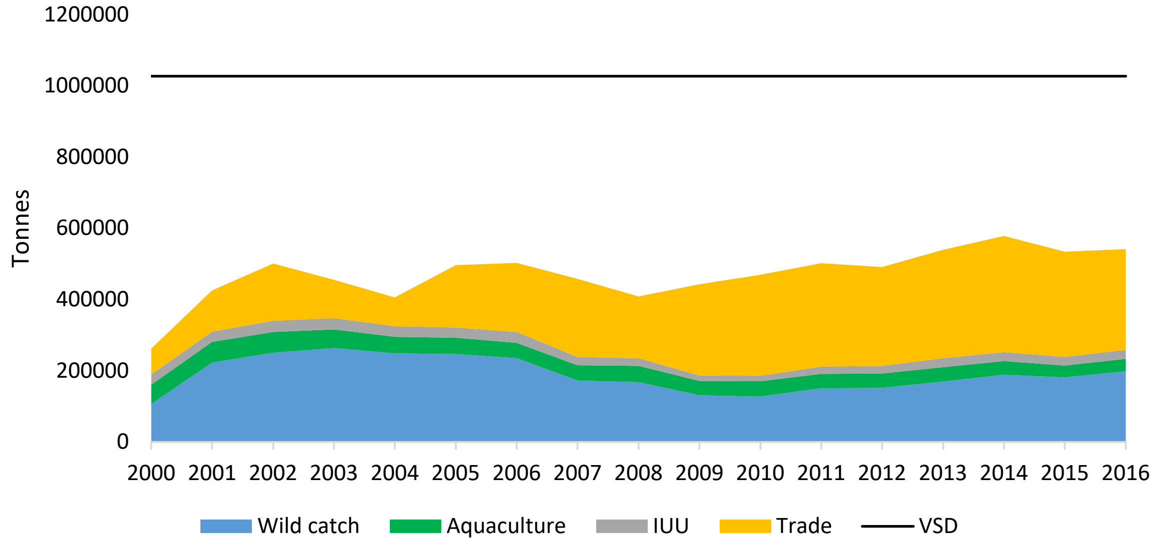

Figure 17. Supply and estimated demand of selected seafood products in France.

Supply in France is met in roughly equal parts by trade (44%) and fisheries (41%). Aquaculture provides 9% of TSS. Trade and wild fish catches in France show opposite trends, with trade increasing from 19% to 49% between 2000 and 2016 and catches decreasing from 60% to 39%. During this period, aquaculture production has also halved, from 14% to 7%. This decrease was mostly due to a reduction in trout farming.

Salmon has an SDR of 42%. Trout, seabream, and seabass all have under 60% of SDR. The volume of trout corresponding to per capita NSB (37 542 tonnes) could be partly filled by the decrease in farmed trout production between 2000 and 2016 (16 464 tonnes) (Table 49).

France is the country with the lowest overall SDR: 46% for average volumes between 2000 and 2016. These large discrepancies between supply and demand suggest that these values may have been overly influenced by consumer preferences and may not accurately represent the per capita demand and/or that the apparent consumption data warrants closer analysis.

Table 49. Supply, demand, and net balance for the most important fish products in France.

Supply and demand (kg per capita)	Cod	Salmon	Trout	Herring	Seabream	Seabass
VSD	5.44	4.07	1.26	0.42	0.87	0.67
TSS	1.88	1.72	0.49	0.63	0.21	0.16
NSB	-3.56	-2.35	-0.77	0.21	-0.67	-0.50

Annex 2.4 – Germany

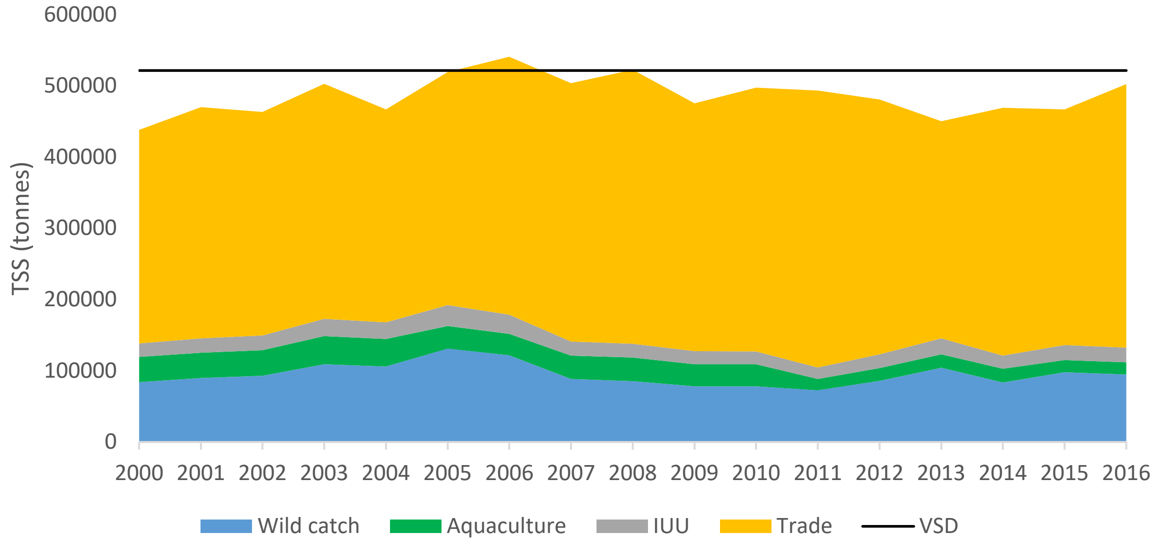

Figure 18. Total supply of selected fish products in Germany and estimated demand.

During the 2000-2016 period, VSD in Germany has been 92% of TSS, although in recent years, TSS has decreased due to a reduction in trade. Despite this, imports are the most important supply source, accounting for 70% of TSS. As for France, aquaculture production since 2000 has decreased by 18 065 tonnes, and the two most affected products were carp (a 50% drop in production) and trout (from 25 027 tonnes to 9 114 tonnes).

Other farmed products with SDR discrepancies are seabream and seabass—both have an SDR below 40%. As in other countries, salmon has an SDR of 67%, i.e. consumers report that they eat more than appears to be available through supply-side calculations.

Table 50. Supply, demand, and net balance for the most important seafood products in Germany.

Supply and demand (kg per capita)	Salmon	Trout	Seabream	Seabass	Freshwater fish
VSD	1.51	1.09	0.21	0.06	0.40
TSS	1.00	0.46	0.03	0.01	0.26
NSB	-0.50	-0.63	-0.18	-0.05	-0.15

Annex 2.5 – Ireland

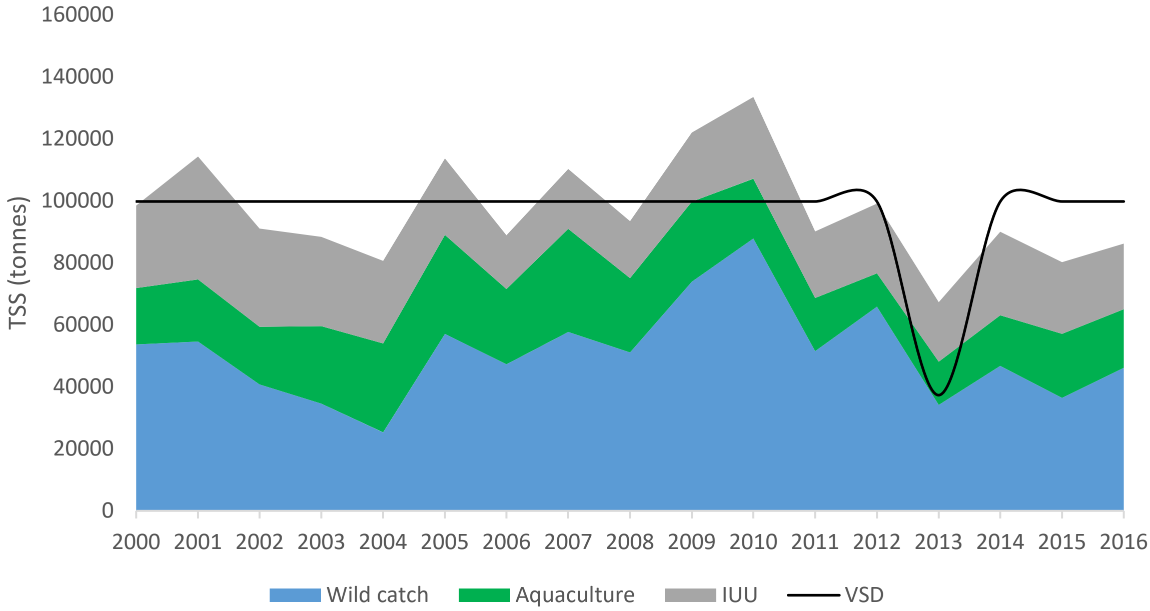

Figure 19. Ireland's total supply of seafood species, and estimated demand.

Ireland is the only country of the ten analysed with an SDR greater than 100%, i.e. consumer demand is totally met by internal production and IUU. The balance between imports and exports has allowed for an average surplus of 94473 tonnes between 2000 and 2016, which corresponds to 97% of TSS. This is mostly achieved by the high volume of exports of mackerel and herring from wild catch. Fisheries account for 52% of TSS and farmed fish correspond to 22%.

Salmon has a high SDR, due to a high aquaculture production. Despite high export volumes, there is a discrepancy in the estimates for herring in Ireland, equivalent to 3.49 kg/capita (slightly under 16 500 tonnes). As seen in other countries, seabass and seabream also register a discrepancy, with an SDR below 100%. The negative NSB for seabream and trout might be explained by errors in official data due to the use of conversion factors, or potentially through mislabelling. Trout data for 2016 is of greater concern due to the higher volumes involved, with a negative TSS of 3230 tonnes (see Conclusions section for a more detailed analysis).

Table 51. Supply, demand, and net balance for the most relevant seafood products in Ireland.

Supply and demand (kg per capita)	Cod	Salmon	Seabass	Trout	Herring	Seabream
VSD	2.27	2.18	0.30	0.60	0.37	0.07
TSS	1.73	2.40	0.07	0.14	3.86	-0.02
NSB	-0.54	0.22	-0.24	-0.46	3.49	-0.09

Annex 2.6 – Italy

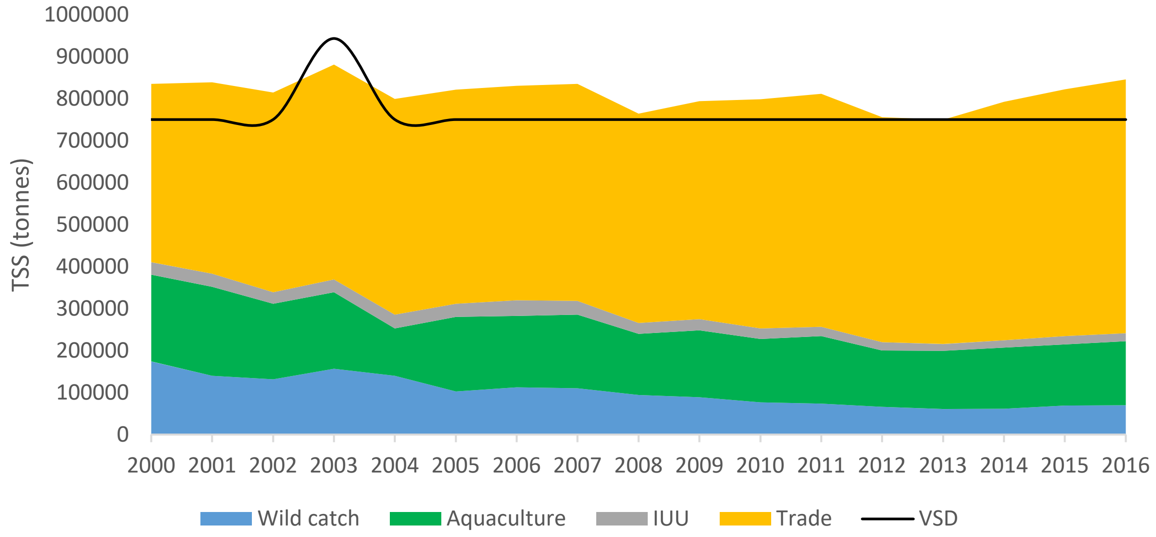

Figure 20. Supply of selected products and estimated demand in Italy.

Overall, Italy has an SDR of 107%. Trade makes up 64% of TSS, and aquaculture and fisheries, which on average supply 20% and 13% of TSS, have declined since 2000. Wild fish catch dropped by more than 100 000 tonnes (21% to 8% of TSS) and aquaculture decreased from 25% to 18% of TSS.

There is a mass balance discrepancy for all farmed fish products in Italy: Seabream has an SDR of less than 50% SDR, and seabass and salmon have SDR values of 69% and 74% respectively.

Trout supply is 7 265 tonnes below the VSD.

Table 52. Supply, demand, and net balance for the most relevant seafood products in Italy.

Supply and demand (kg per capita)	Cod	Seabream	Seabass	Salmon	Clams	Mussels	Trout
VSD	1.28	0.95	0.65	0.87	1.00	1.08	0.63
TSS	0.54	0.47	0.44	0.65	1.07	1.89	0.51
NSB	-0.74	-0.48	-0.20	-0.23	0.08	0.81	-0.12

Annex 2.7 – Poland

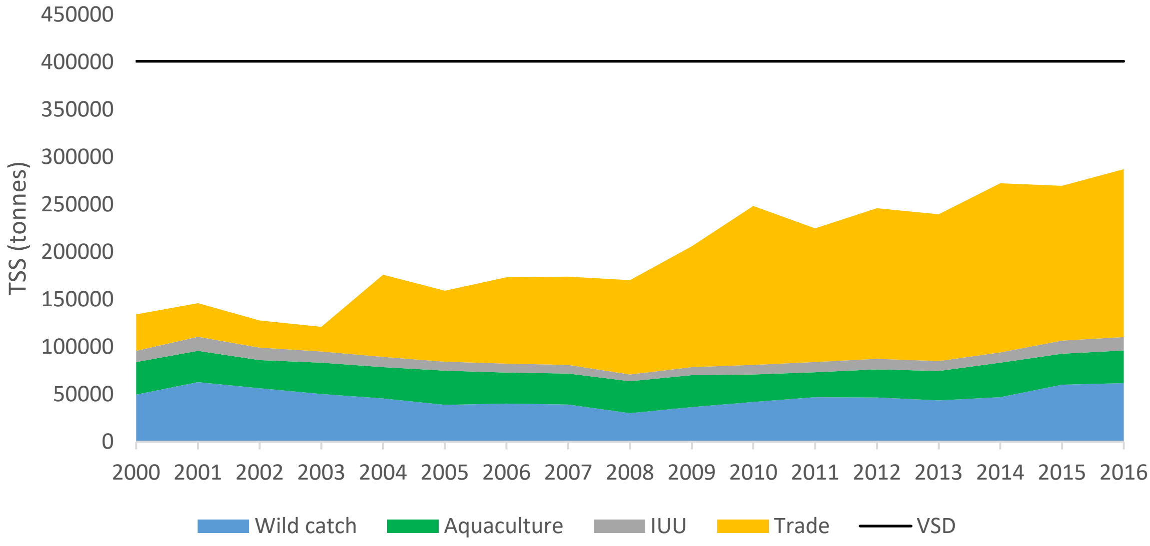

Figure 21. Estimated supply of selected species and seafood demand in Poland.

When analysing average values of VSD and TSS between 2000 and 2016, SDR is 50%. If we consider the increasing TSS trend, the situation has improved (mostly since 2008), and SDR in 2016 was of 74%. This has been achieved due to an increase in imports, which in 2000 made up 29% of TSS, and in 2016 represent 63%. Aquaculture relevance has decreased (25% to 12%), but the production volume remains relatively stable since 2000. Farmed fish production is dominated by carp (average of 18 000 tonnes) and trout farming (13 000 tonnes on average).

Poland is the country with the highest VSD of carp and other freshwater fish. SDR is below 75% for carp, and below 25% for other freshwater fish. All the other products which are typically farmed also have a negative NSB: salmon (40 825 tonnes) and trout (26 300 tonnes) are the ones with the lowest SDR.

Table 53. Supply, demand, and net seafood balance for the more relevant fish products in Poland.

Supply and demand (kg per capita)	Salmon	Trout	Seabream	Seabass	Carp	Other freshwater fish
VSD	1.86	1.75	0.20	0.20	0.75	1.08
TSS	0.78	0.43	0.00	0.00	0.55	0.25
NSB	-1.08	-1.32	-0.19	-0.19	-0.20	-0.82

Annex 2.8 – Portugal

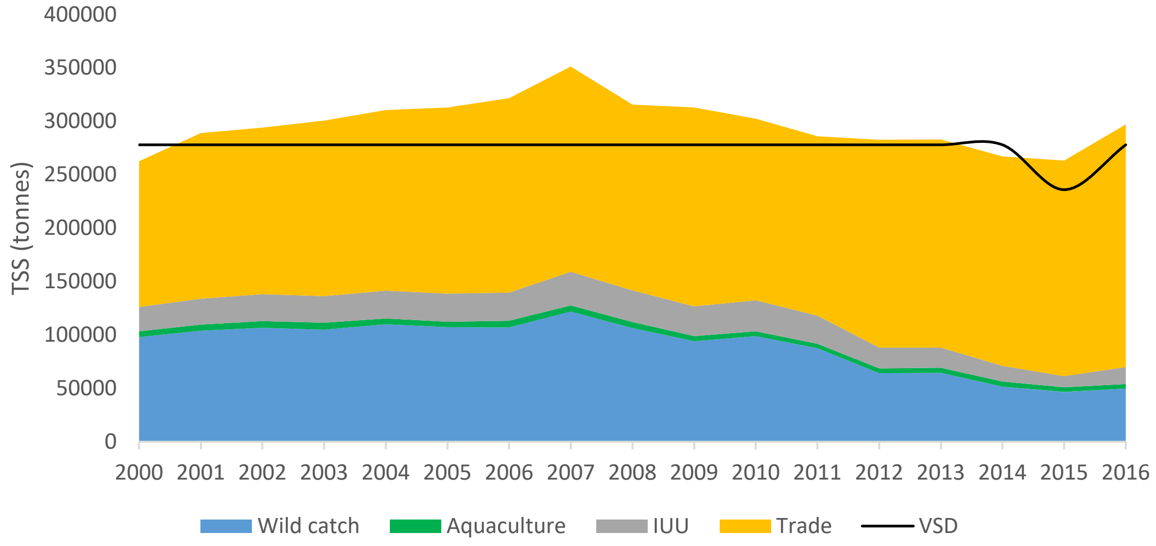

Figure 22. Supply of selected species and estimated VSD for Portugal.

Overall seafood demand in Portugal between 2000 and 2016 has an NSB of 122%. Imports make up the most comprehensive portion of TSS (53% on average), with an increased role in recent years. This is being mostly driven by a reduction in wild fish catch, which has approximately halved from 2000 to 2016. Farmed fish production in Portugal is still quite small (2%).

Despite the reduced role of aquaculture in TSS, farmed fish such as salmon, seabream, and seabass register a discrepancy in NSB due to a high VSD. Salmon SDR is 52%. If this number is accurate, the Portuguese eat double what the official supply-side statistics tell us. If it is not, this may be due to a variety of factors, including overstatement of consumption rates by interviewees and underestimation of supply. Seabass and seabream, both of which are farmed in Portugal in low volumes, have an SDR of 48% and 82% respectively.

Table 54. Supply, demand, and net balance for the most important seafood products in Portugal.

Supply and demand (kg per capita)	Cod	Salmon	Seabream	Seabass
VSD	6.16	1.56	1.38	0.90
TSS	9.13	0.80	1.13	0.43
NSB	2.97	-0.75	-0.25	-0.47

Annex 2.9 – Spain

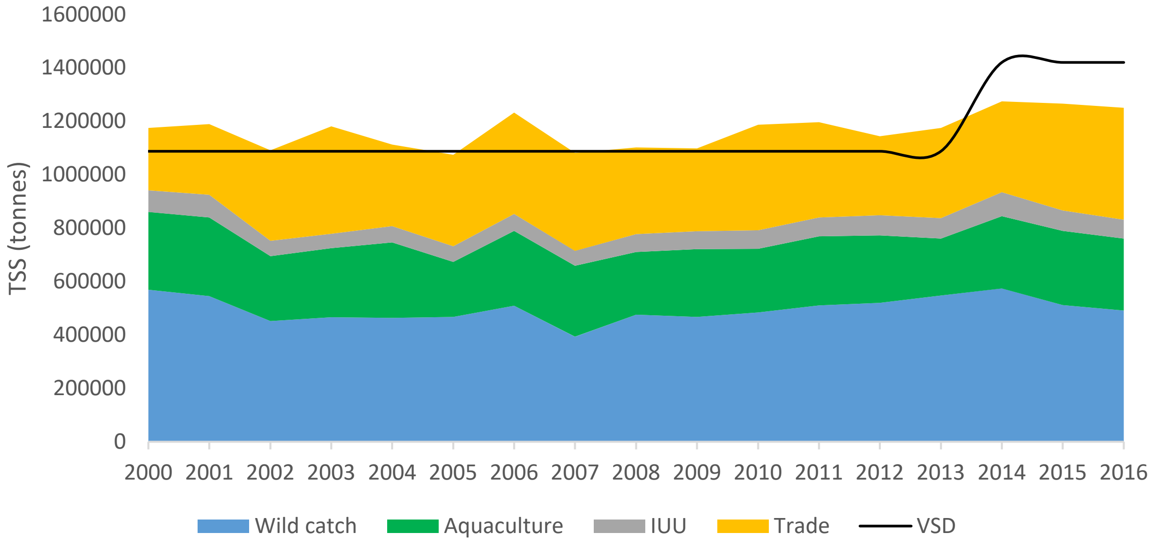

Figure 23. Supply of selected species and estimated demand in Spain.

In Spain, SDR was on average 102% between 2000 and 2016. Despite this, in recent years TSS and VSD have increased, and in 2016 the SDR was 88%. Wild fish catch is the most important source of seafood – on average, wild catch represents 43%, although this has decreased since 2000 from 48% to 39%. Aquaculture production accounts for 22% of TSS and has been relatively stable since 2000. The most important farmed product that drives this growth are mussels, although seabass and seabream production have increased during this period.

Salmon and trout are the other two farmed products with considerable per capita demand and low supply. According to the estimated VSD, trout SDR is 31%, and salmon SDR 86%. Mussel SDR is above 100%.

Table 55. Supply, demand, and net balance for the most important seafood products in Spain.

Supply and demand (kg per capita)	Seabream	Seabass	Salmon	Mussel	Trout
VSD	0.92	0.70	1.08	1.50	1.44
TSS	0.55	0.33	0.93	3.92	0.45
NSB	-0.37	-0.36	-0.15	2.41	-0.99

Annex 2.10 – United Kingdom

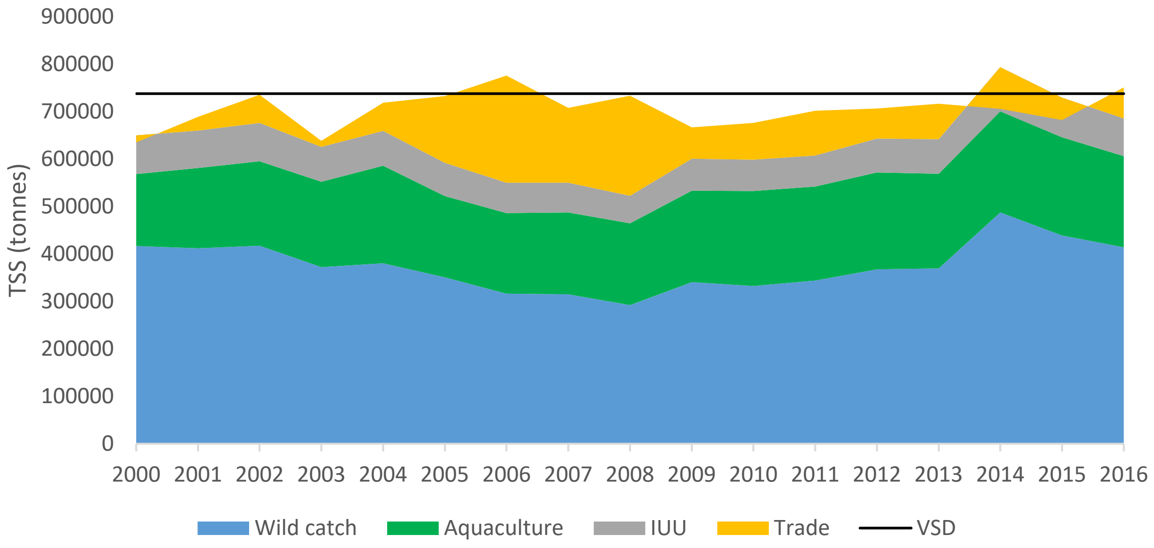

Figure 24. Total supply of selected species and estimated demand in the UK.

Demand in the UK was almost fully met by TSS: on average, between 2000 and 2016, there was only a discrepancy of 5% in SDR, corresponding to 33 489 tonnes. TSS is mostly composed of wild catch (53%), in which mackerel, herring and cod are the most important products. Aquaculture production has seen slight growth since 2000 (151 090 to 192 147 tonnes) and on average is responsible for 26% of TSS. Trade is small (10%) when compared to other large EU countries, and in certain years exports have surpassed imports.

Lower SDR are noticeable in a number of farmed products: salmon SDR is at 84%, seabream and seabass have a lower SDR with 52% and 16% respectively and trout demand is marginally undermet with an SDR of 96%.

Table 56. Supply, demand, and net balance for the most important seafood products in the UK.

Supply and demand (kg per capita)	Salmon	Tuna	Trout	Seabream	Seabass
VSD	2.47	1.97	0.25	0.09	0.62
TSS	2.07	1.82	0.24	0.05	0.10
NSB	-0.40	-0.15	-0.01	-0.04	-0.53