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Economia agro-alimentare / Food Economy

An International Journal on Agricultural and Food Systems

Vol. 24, Iss. 3, Art. 2, pp. 1-24 - ISSN 1126-1668 - ISSNe 1972-4802

DOI: 10.3280/ecag2022oa14835



Commentary on Italy's international seafood trade and its impacts

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Abstract

Being within a geographical area, EU-27, which imports a large proportion of the fish products consumed annually from abroad, Italy finds itself in a particularly critical situation; domestic production from fishing and aquaculture on the whole accounts for only 20% of consumption and even less in the case of crustaceans and cephalopods.

Despite its strong dependence on foreign countries, per capita consumption is quite high, at 31 kg/y in recent times; furthermore, among the imports from abroad there is a large number of species (or their families) mostly obtained through fishing. A wiser exploitation of national fishing resources, a greater development of domestic aquaculture and consumption patterns relying less on wild fish and shellfish are desirable.

Article info

Type:

Note

Submitted:

28/10/2022

Accepted:

14/11/2022

Available online:

16/01/2023

JEL codes:

Q22, F14, D12

Keywords:

Fish per capita
consumption

Diet

Wild fish stocks

Sustainability

Managing Editor:

Maurizio Canavari

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Introduction

Aquatic animals derived from fisheries and aquaculture and the products derived from them are widely traded, generating an international flow of exports worth, on a global scale, approximately USD 164 billion in 2018, in terms of custom value (FAO, 2020).

Worldwide, a large amount of fish products tend to converge towards areas with a high standard of living, such as the EU-27 (as well as the former EU-28, including Great Britain), the USA and Japan, while the countries of origin are mainly China, Norway, Vietnam, India, Ecuador and other minor areas (EUMOFA, 2017a, 2018 and 2019).

The volume of flows, the large number of involved aquatic species, the great distances travelled and the various processes to which the meat of many species is subjected lead to questions about the “sustainability” of the international fish product trade today. In fact, the carrying out of every human activity in terms of “sustainable development” (which was shortly defined as “development that meets the needs of the present without compromising the ability of future generations to meet their needs” in a seminal report by the UN Burtland’s committee, 1987) implies a short and long-term vision of it from the point of view of environmental, social and economic impacts (Barclays, 2012; Stanton, 2012).

Consequently, in this note, the net flows of fish arriving to Italy from abroad have been examined (considering both the consignments coming from and going to the other EU-27 states, which, according to current legislation, are to be considered exchanges within the European Union, as well as imports and exports with third states) from the perspective of the statistics on Italian foreign trade published on a specific website of the national statistical body (part of the EUROSTAT network), focusing on products deriving from fishing activities for which Italian imports are particularly large (in terms of biomass or fraction of world catches or those in the European seas) and attributable to one or few populations of marine animals. The identification of these fish products whose consumption is particularly high in Italy can be useful to induce greater awareness in citizens of the unsustainability of this pattern, as national fish consumption may contribute to excessive withdrawals from wild stocks that could eventually jeopardize the state of the same populations. This applies in particular to those not subject to regular scientific assessments on their abundance and productivity, and/or induce an increase in fishing effort on these populations or those of related species to meet the growing worldwide demand for fish products (Harding, 1968; FAO, 2018 and 2020).

A greater awareness of the multiple impacts of their fish consumption can, in turn, lead many Italians to selectively reduce it, to further favour

purchasing products derived from aquaculture, and to have a more positive attitude towards the installation of more fish and shellfish farms in national freshwaters, lagoons and coastal marine waters.

1. Methodology

For the purposes of this note, the trend of net trade flows to Italy and EU-27 of fresh or frozen “fish” (mostly teleosts) or fillets, crustaceans and marine molluscs was examined for the period 2012-2019 and then focused on 2016-2019.

Since the Italian and EU trade statistics provide data on the quantities of fish products as “commodity weight” (CWE, the weight of each product, excluding the preserving liquid of many canned preparations), they have been transformed into “equivalent live weight” (LWE) based on the conversion factor tabulated for each fish or shellfish product listed in the EU Common Nomenclature of goods (EUMOFA, 2020a) to reconstruct the original biomasses and compare them with the estimates of fishing and aquaculture production, which have been presented in live weight for years (EUMOFA, 2018 and 2019; FAO, 2018 and 2020). Data on the exchanges of fish products with foreign countries have been traced at the maximum available detail on the websites of ISTAT Coeweb or EUROSTAT; the codes relating to the various items of the EU Common Nomenclature are based on the worldwide Harmonised System of commercial goods (WCO, 2018), where the codes can be two, four or six digits, and the number of items and the detailed descriptions of goods increase with the number of digits.

In particular, the EU Common Nomenclature (previously in force in the EEC) can further subdivide the most detailed six-digit (HS6) commodity codes of the Harmonized System by adding two terminal digits to them to describe the various product in more detail; these CN codes are 8 digits (with the last two being 00 if a certain HS code remains undivided). The Common Nomenclature 8-digit codes (hereafter referred to as CNCs) are used to describe goods in trade among member states and their exports to non-EU states. However, products from non-EU states (constituting imports in the strict sense, under EU legislation) can be described in greater detail through the TARIC system (in which the codes assigned to the various goods are derived from those of the Common Nomenclature by adding two further terminal digits and are 00 in each unseparated category) with 10-digit codes that characterize the goods in greater detail so duties can be imposed depending on the nature of the products and the country of origin (EEC, 1987; EU, 2021; footnote 1).

Foods derived from aquatic animals used for direct human nutrition are part of sections HS03 and HS16 of the Harmonized System, which refer, respectively, to “Fish and crustaceans, molluscs and other aquatic invertebrates” (with 392-409 and 419-455 derived CNCs, respectively, in 2012-2015 and 2016-2019) and “Preparations of meat, fish and crustaceans or molluscs or other aquatic invertebrates” (55-61 and 61-62 CNCs during the same periods). For the products of these two HS sections, we searched for all derivative 8- digit CNCs listed in EUMOFA (2020a) for each of the years between 2012-2019, with a description of the nature of the product identified with each EU Common Nomenclature code and the corresponding factor of conversion of the commodity weight into the live weight of the aquatic animals of origin. It is important to note that since the work of EUMOFA (2020a) is based on the subdivision of fish products in the EU Common Nomenclature, the conversion factors defined to estimate the LWEs from CWEs are valid only for those categories.

Using the 8-digit CNCs, data on the commercial flows of fish and shellfish commodities to and from Italy were obtained on the ISTAT Coeweb website (URL: www.coeweb.istat.it) (considering both non-EU countries and the other state members of the European Union), which were then turned into LWE using the conversion factors in EUMOFA (2020a). As ISTAT is part of EUROSTAT, the identical data could have been obtained on the latter body's website (URL: <https://ec.europa.eu/eurostat/data/database>), but the ISTAT Coeweb site was preferred because it is focused on the trade of Italy with foreign countries; therefore, the search of the relative data is done simply by entering the year and the CN code, with the website presenting both the trade flows in and out of Italy for the three-year period ending in the required year and showing some of the main countries (or customs areas) of origin or destination. On the EUROSTAT website, the search methods for these data are more complex, and responses take much more time because every member state and the whole EU are considered.

For the data relating to the quantities of the various marine species landed yearly by the fleets of the EU states (as well as for the quantities of the species raised in aquaculture), it is necessary to use the EUROSTAT website (which uses the data obtained for both activities, for over 20 years, from specific surveys partially financed with EU funds; EU, 2017), as they are not available on the aforementioned ISTAT website. These data are then communicated by EUROSTAT to FAO (entering the FISHSTATJ database) and to other international organizations.

Despite being the most detailed classification available in the EU Common Nomenclature, most of the 8-digit CNCs it contains only allow for the identification of products obtained by several related species; for example, those of the same genus or the same family, but also groups of species

“assembled” for commercial or practical reasons would be grouped under the same 8-digit CNC. This is the case of category CN03038910 concerning “unidentified and frozen fish” in the current version of the Common Nomenclature (EUMOFA, 2020a). Only some CNCs pick out single fish or shellfish species (or a cluster of few species) and, therefore, the commercial data relating to the corresponding net flows to Italy in 2012-2015 and 2016-2019.

The net commercial flows of species or groups of species for which intense breeding activities are known are attributed to aquaculture (salmon, trout and other salmonids, seabasses and seabreams, mussels, oysters) as are the set of fish products attributed to freshwater teleosts, regardless of the systematic level in which they are classified (or grouped) in the statistics of ISTAT Coeweb. However, the teleosts described as “marine” or “unidentified” were all considered to be derived only from fishing. Moreover, the EU Common Nomenclature codes labelling crustacean products of the items CN03061792 (frozen Peneid shrimps other than *Penaeus longirostris*), CN16052110, CN16052190, and CN16052900 (prepared or preserved shrimps and prawns in various packages) were entirely attributed to reared species on the basis of several bibliographic sources (Ngamprsertkit, 2018; World Bank, 2018; Cai *et al.*, 2019; DIT, 2019).

For the commercial categories of the EU common nomenclature concerning single (or few) fish species mainly obtained through fishing activities, the Italian yearly *per capita* consumption was compared with that of the remaining population of the world or of the EU-27 for species mainly caught outside or within European seas, respectively. The comparisons between *per capita* consumption in Italy and all the other countries examined were made using the Mann-Whitney nonparametric test (which has the great advantage of not implying that data are distributed according to a Gaussian curve) relating only to the years 2014-2018 or 2014-2019 because the frequent updates to both the Harmonised System and the EU common nomenclature do not allow long time series (EUMOFA, 2020a). In some cases, missing or even presumably spurious data (because they are strongly incoherent within a time series) on the annual landings of some species (or their groups) have been estimated by averaging data from contiguous years; nevertheless, the data were all considered independent because the few adjustments affected modest portions of the biomass consumed in the geographical areas being compared.

Per capita consumption was estimated by dividing the annual quantities of one or more fish species by the total population attributable to a given area, rounding the figures to the nearest 0.01 kg and giving them distinct ranks in the statistical test if they differed by at least 0.03 kg; additionally, to avoid misclassification and/or misreporting of products invalidating the

comparisons, the values relating to the area with the higher *per capita* consumption were deliberately reduced by 20% in the Mann-Whitney tests (Table 1).

Moreover, the net LWE flows of products originating from elasmobranchs as well as from “forage fish” (i.e., schooling fish species located at low or middle levels of the trophic chains in marine or fresh waters, with populations that are usually abundant, allowing large quantities to be easily caught while maintaining mortality at levels acceptable for the stocks; Alder *et al.*, 2008; Mkunda *et al.*, 2018) have been noted, as their consumption should be avoided or, conversely, increased (at least to some extent; Kim *et al.*, 2020).

For the purposes of these comparisons, the world population was estimated at 7.21 and 7.55 billion people for the periods 2012-2015 and 2016-2019, respectively, while for the EU-27 and Italy, it was accepted that the respective populations remained at approximately 380 and 60 million individuals, respectively.

2. Results

In 2016-2019, under item HS0302 (fresh or chilled fish; see footnote 2), there was an overall net flow towards Italy corresponding to a biomass of 134,000-162,500 t/y, with parallel customs cash flows between € -850 and € -960 million per year, for 89-97% towards the other states of the current EU-27; 60-65% of the biomass came from abroad (considering jointly trade with other EU states and import proper, i.e. from non-EU areas) derived from fish farming (the main species being Atlantic salmon, seabream and European seabass). In 2012-2015, the net inflow from abroad under the same HS0302 item ranged from 103,500-123,000 t/y in LWE, mainly deriving from pisciculture (only 30,000-35,500 t/y from foreign fisheries).

For frozen fish, whole or headless or eviscerated (HS0303), in 2016-2019, the net flow from abroad was -89,000/-96,000 t/y LWE (corresponding to financial liabilities between € 285 and € 305 million per year), with products from fish farming accounting for a modest amount, which contributed approximately 9-13%. In the previous four years, the net flows to Italy of HS0303 goods were rather stable, between -86,700 and -88,800 t/y in live weight (ISTAT Coeweb).

The net flow of fish fillets (HS0304) to Italy was between -296,500 and -311,500 t/y in estimated live weight and between -658 and -777 € million in 2016-2019; farmed species accounted for 20% LWE, although there is some uncertainty in the products attributed to aquaculture. In the previous four

years, analogous flows had been -262,000/-292,000 t/y, with an incidence of reared fish of 63,000-74,000 t/y.

Taking into consideration the smoked, dried, salted or marinated fish (HS0305) in 2016-2019, Italy recorded a deficit of -115,000/-120,000 t/y LWE (in financial terms, between -440 and -475 € million per year), and the fraction attributable to farmed species was 33-36%. In 2012-2015, the analogous flows were between -102,000 and -122,000 t/y, with 27-34% of that due to farmed species (ISTAT Coeweb).

The net flows of crustaceans (HS0306) to Italy were -122,000/-130,000 t/y LWE 2016-2019 (ISTAT Coeweb), to which similar flows between -9,800 and -11,800 t/y were added due to the preserves of animals from this phylum (7 CNCs within the chapter HS1605, concerning prepared or preserved aquatic invertebrates), so that the national production of crustaceans, on average approximately 22,000 t/y (EUROSTAT), covered only 15% of consumption. In 2012-2015, the net flows of chapter HS0306 were -109,500/-118,000 t/y as estimated biomass, with further analogous flows between -8,000 and -9,000 t/y in the form of prepared or preserved crustaceans. Yearly liabilities due to foreign trade of crustaceans and derived products fluctuated between 694-753 € million in 2016-2020.

Crustaceans from aquaculture (CN03061792, CN16052110, CN16052190 and CN16052900, entirely originating from outside of European areas) consisted of net flows between -43,600 and -46,700 t/y LWE in 2016-2019, approximately one-third of the net inflows from abroad of these invertebrates when considering fresh and chilled or frozen crustaceans together with those of chapter HS1605. In 2012-2015, the contribution of the mentioned CNCs was higher, i.e., 37-42% of the crustacean biomass estimated in the various years (ISTAT Coeweb; EUMOFA, 2020a).

The net flow of molluscs from abroad was -304,000/-361,000 t/y in LWE in 2016-2019 when considering jointly the product classified under chapter HS0307 and that of chapter HS1605 used for preserves of the animals of that zoological *taxon* living in the sea and between -301,500 and -378,000 t/y in the previous four years, with liabilities between € 1,075 and 1,162 million/y during the first period (ISTAT Coeweb).

Considering the cephalopods alone (EU Common Nomenclature codes from CN03074110 to CN03075990 in 2016 and from CN03074210 to CN03075900 in 2017-2019, with 19 and 24 CNCs, respectively, plus CN16055400 and CN16055500 for the preserved individuals; EUMOFA, 2020a), the net flow fluctuated between -234,000 and -251,000 t/y in LWE during 2016-2019 (with liabilities between € 808 and 1,055 million per year), while in 2012-2015, the analogous flows were -218,000/-232,000 t/y including the small share of preserved cephalopods. Consequently, the national catch,

approximately 16,000-21,000 t/y in 2012-2019 (EUROSTAT), covered only 7-8% of domestic consumption.

Examining canned fish (HS1604), net flows from abroad fluctuated (after conversion of the CWEs reported in the ISTAT Coeweb statistics into LWEs) between -368,000 and -386,000 t/y in biomass (€ -765/-890 million per year) during 2016-2019. The share of farmed species (or their groups) is not easily estimated but seems not to exceed 8,500 t/y in live weight, i.e., not more than 3.5% of the equivalent live product of section HS1604. In the previous four-year period, the net liabilities in section HS1604 were 334,500-375,500 t/y, and the role of fish farming was small in supplying products for canneries (undetailed data).

By combining the estimates relating to net product flows of sections HS0302-HS0307 and HS1604-HS1605, we arrive at totals of net fluxes ranging, in terms of equivalent live weight, between -1,507,000 and -1,525,500 t/y in 2016-2019. To these quantities is added the fleet catch and national aquaculture production, for a total of approximately 355,000 t/y in fresh weight in 2016-2018 (out of which approximately 90,000 t/y were molluscan bivalves; Anonimo, 2019; EUROSTAT; Tudini, 2020).

The estimate in terms of equivalent live weight of the Italian commercial flows of fish product makes it possible to evaluate the incidence of domestic consumption on the world catches (alternatively, on those from the European seas) of some species (or their groups) that are obtained almost exclusively through fishing. In particular, the commercial statistics in ISTAT Coeweb (therefore also in EUROSTAT) made it possible to detect the following cases (see Table 1):

Monkfish (*Lophius* spp.) (ALPHA3 codes = MON, MVJ, ANG and ANK) (EUROSTAT code: MNZ)

In the EU Common Nomenclature, starting from 2012, there were the following four numerical codes concerning products taken from specimens of *Lophius* spp.: CN03028950, CN03038965, CN03048960 and CN03049965 (EUMOFA, 2020a). Considering these codes together, it was inferred that the net inflows to Italy were, in terms of LWE, 13,000-16,500 t/y in 2014-2019 (ISTAT Coeweb). Unfortunately, estimates are lacking for most of the period on the national catch of monkfish, but the EUROSTAT data on landings of the Italian fishing fleet show a production of approximately 1,400 t/y at the end of the period 2004-2014, and the same can be admitted for the following years (EUROSTAT). Consequently, the Italian *per capita* consumption of monkfish is estimated at 0.24-0.28 kg/y in the period 2014-2019.

In the same period, the EU-27 imports were 47,500-57,500 t/y in terms of LWE, whereas total landings of all national fleets can be roughly estimated at 30,000 t/y by gathering data from various sources (EUROSTAT; ICES, 2019 and 2021). Consequently, the *per capita* consumption rates of the remaining

EU-27 (i.e., the EU- 27 excluding Italy) citizens result in 0.17-0.18 kg/y, which is significantly lower than those of Italians (Table 1). Moreover, in Italy, the level of procurement through the national fleet was 8-10% in 2014-2019 vs. 40- 45% for all the other EU member states.

European plaice (*Pleuronectes platessa*) (ALPHA3 code = PLE)

By combining the items CN03022200, CN03033200 and CN03048310, it was possible to deduce that in terms of estimated live weight, the net flow to Italy was -24,500/-30,400 t/y in 2014-2014, while FAO data show that the fishing carried out in the European seas (species' area) gave annual landings of 80,100-116,700 t in the same period (EUROSTAT; FAO's FISHSTATJ). Since the species is mainly consumed in the EU-27, the *per capita* consumption rates in Italy and all other countries of the current EU were compared (Table 1), and it was found that in the former case, the average annual consumption was 0.41-0.49 kg vs. 0.12-0.21 kg in the rest of the EU-27, with the two clusters of values statistically differing from each other (U=36; p<0.01).

Table 1 – List of some marine animal species (or groups) whose national consumption mainly derives from foreign fisheries and comparison of the per capita consumption rates in Italy and in the rest of the world or the EU-27

Consumption in Italy during the period, in tons and live weight [data source(s)] (range of the annual <i>per capita</i> consumption rates)	Consumption in the rest of the EU-27 in the period, in tons and live weight [data source(s)] (range of the annual <i>per capita</i> consumption rates)	Consumption in the rest of the world in the period, in tons and live weight [data source(s)] (range of the annual <i>per capita</i> consumption rates)
Monkfish (<i>Lophius</i> spp., years 2014-2018) 78,200 t [EUROSTAT; ISTAT Coeweb] (0.24 kg – 0.28 kg)**	338,500 t [EUROSTAT] --	--
European plaice (<i>Pleuronectes platessa</i> , years 2014-2019) 166,300 t [EUROSTAT; ISTAT Coeweb] (0.41 kg – 0.51 kg)**	381,700 t [EUROSTAT; FISTSTATJ] (0.12 kg – 0.18 kg)**	--
Swordfish (<i>Xiphias gladius</i> , years 2014-2019) 187,900 t [EUROSTAT; ISTAT Coeweb] (0.45 kg – 0.56 kg)**	--	534,000 t [FISHSTATJ] (0.01 kg – 0.01 kg)**
Yellowfin tuna (<i>Thunnus albacares</i> , years 2015-2019) 650,800 [EUROSTAT; ISTAT Coeweb] (1.85 kg – 2.39 kg)*	--	6,785,600 [FISTSTATJ] (0.18 kg – 0.19 kg)*

Table 1 – Continued

Consumption in Italy during the period, in tons and live weight [data source(s)] (range of the annual per capita consumption rates)	Consumption in the rest of the EU-27 in the period, in tons and live weight [data source(s)] (range of the annual per capita consumption rates)	Consumption in the rest of the world in the period, in tons and live weight [data source(s)] (range of the annual per capita consumption rates)
Lobsters (<i>Homarus</i> spp., years 2014-2019) 25,550 [EUROSTAT; ISTAT Coeweb] (0.07 kg – 0.08 kg)**	84,700 [EUROSTAT] (0.04 kg – 0.04 kg)**	--
Norway lobster (<i>Nephrops</i> <i>norvegicus</i> , years 2014-2019) 114,300 [EUROSTAT; ISTAT Coeweb] (0.27 kg – 0.36 kg)**	136,300 [EUROSTAT] (0.05 kg – 0.06 kg)**	--
^a Argentine shrimp (<i>Pleoticus</i> <i>muelleri</i> , years 2015-2019) 162,300 [EUROSTAT; ISTAT Coeweb] ^b (0.47 kg – 0.55 kg)	--	--
All other wild crustaceans (many species, years 2014-2019) 319,700 [EUROSTAT] ^c (0.65 kg – 1.05 kg)**	901,500 [EUROSTAT] ^c (0.31 kg – 0.47 kg)**	--
Cephalopoda spp. (years 2014-2018) 1,180,000 [EUROSTAT; ISTAT Coeweb] (3.49 kg – 4.20 kg)*	--	19,280,000 [Arkhipkin, 2020] (0.45 kg – 0.65 kg)*
Atlantic scallop (<i>Pecten</i> <i>maximus</i> , years 2014-2019) 85,000 [EUROSTAT; ISTAT Coeweb] ^c (0.15 kg – 0.55 kg)*	243,500 [FISHSTATJ] (0.07 kg – 0.19 kg)*	--

*: data clusters related to species (or group of species) whose *per capita* consumption rates differed in distinct geographic areas with $p<0.02$;

**: data clusters as above, differing from each other with $p<0.01$;

^a: identified as CN03061799 crustaceans coming from Argentina;

^b: see text on the *per capita* consumption rates in Italy and Spain;

^c: all crustacean products except those listed above or classified CN03061792, CN16052100, CN16052190 and CN16052900 in the EU Common Nomenclature

Swordfish (*Xiphias gladius*) (ALPHA3 code = SWO)

This valuable teleost is present on the market in various preparations – fresh or chilled, frozen, filleted or with minced meat – so by combining the linked items, it is possible deduce that the net flows to Italy were, as

LWE, between 24,600 and 30,000 t/y in 2014-2019, while the national fleet landed approximately 1,800-4,000 t/y (EUROSTAT), reaching a domestic consumption of 28,000-33,400 t/y.

In the same period, the FAO estimated the world catches of the species at 111,200-120,300 t/y (FISHSTATJ); therefore, the great weight of national consumption on the global scale is clear, with an average *per capita* consumption of 0.45-0.56 kg/y in Italy vs. 0.01-0.01 kg/y in the rest of the world (U=36; p< 0.01; Table 1).

Yellowfin tuna (*Thunnus albacares*) (ALPHA3 code = YFT)

Summing up the net flows of the CNCs concerning the various market preparations of this species (eight CNCs in 2015-2016 and seven in 2017-2019), after conversion of the commercial data in the corresponding live weights, total arrivals of 111,300-143,200 t/y were obtained in 2015-2019 (ISTAT Coeweb), which was approximately 8-9% of the annual catches of *T. albacares* during that period (FISHSTATJ).

The strong inflows of this tropical tunnid allowed *per capita* consumption rates in Italy of 1.85-2.39 kg/y in the five-year period compared to 0.18-0.19 kg/y for the rest of the world population, and the difference was statistically relevant (U=25; p<0.02).

Lobsters (*Homarus* spp.) (ALPHA3 codes = LBA and LBE)

FAO data show that the world catches of lobsters, *Homarus* spp., were approximately 163,000-168,000 t/y in 2014-2019, consisting of 96-97% *Homarus americanus* (present in the coastal waters of the NW Atlantic) and the remainder from the European congener *H. gammarus* (FAO; FISHSTATJ).

By summing up the CNCs related to *Homarus* spp., there were 13,000-19,300 t/y imports in live weight to the EU-27, to which are added the modest catches of the Union fleet of *H. gammarus*, equal to 725-1,255 t/y in the period (EUROSTAT). Although the Italian catches of European lobster are nearly zero (EUROSTAT; Pavicic *et al.*, 2020), the domestic *per capita* consumption, 0.07-0.08 kg/y, was significantly higher than in the rest of EU-27 in 2014-2019, although the difference was small (Table 1).

Norway lobster (*Nephrops norvegicus*) (ALPHA3 code = NEP)

Norway lobster is a very popular crustacean in Italy, feeding net inflows from other European or Mediterranean countries (the species is spread in the NE Atlantic and connected seas) of 15,000-20,500 t/y in 2014-2019 in terms of estimated biomass (in 2014-2016 through the codes CN03061510, CN03061590, CN03062510 and CN03062590; in the following three years with the items CN03061500, CN03063400 and CN03069400), while from the national fleet 1,300-1,800 t/y were obtained (EUROSTAT). Italian

consumption was therefore 16,250-21,850 t/y during that period, equal to 31-43% of world catches in the various years (EUROSTAT; FISHSTATJ).

The Italian consumption was therefore estimated to be 0.29-0.36 kg/y compared to 0.05-0.06 kg/y for the remaining population of the EU-27, and the difference between the two ranges was highly significant ($U=36$; $p<0.01$); furthermore, in Italy, the langoustine catches of the Italian fleet were 7-9% of national consumption, while that of the remaining population of the EU-27 was almost exclusively covered by the pertinent cumulative catches of the other national fishing fleets (EUROSTAT).

Argentine shrimp (*Pleoticus muelleri*) (ALPHA3 code = LAA)

Since 2015, the Argentine shrimp *Pleoticus muelleri* has been part of a heterogeneous group of crustaceans coded CN03061799 in the EU Common Nomenclature (frozen shrimps and shrimps other than Pandalidae spp., *Crangon* spp. and *Peneidae* spp.); however, the species in question accounts for almost all exports from Argentina for this group of crustaceans (CEDEPESCA, 2017), and thus, all Italian imports from that country under item CN03061799 refer to *P. muelleri*. By adopting a conversion factor to live weight of 1.38, we found that the Italian net imports from Argentina for this shrimp were 19,000-28,350 t/y in 2015-2019. Similar imports passing through Spain must be added to these direct imports, accounting for approximately 4,500-6,500 t/y LWE in the same period, meaning that Italian consumption was approximately 14-18% of the annual catches of the species (ISTAT Coeweb; FISHSTATJ).

However, within the EU-27, the largest imports of *P. muelleri* (of which the Argentine's fishing fleet takes almost all the world catches) are by Spain, which, despite sending some to other member states (especially Italy), is the largest European market for this species (EUROSTAT); their consumption levels are equal to or slightly higher than those of Italy in the same years (undetailed data).

Other wild crustaceans

Once all CNCs derived from crustacean aquaculture (CN03021792, CN16052100, CN16052190, CN16052900) have been eliminated along with all CNCs concerning lobsters, Norway lobsters and *P. muelleri* quantities directly reaching Italy from Argentina and indirectly through Spain, the remaining crustacean products come mostly from wild species. Table 1 shows that the *per capita* consumption rates on this heterogeneous cluster of crustaceans ranged from 0.65-1.05 and 0.31-0.47 kg/y in Italy and the rest of EU-27, respectively, during 2014-2019, and the value sets significantly differed from each other ($U=36$; $p<0.01$).

Cephalopoda spp.

As previously stated, almost all cephalopods present on the Italian market are supplied from abroad; however, it is not easy to assess the extent of the national consumption, estimated at approximately 210,000-265,000 t/y in live weight in 2014-2019 (ISTAT Coeweb), compared to the world catches of this class of animals because on a global level, the estimates are quite uncertain and are often the sum of the data relating to the most abundant species (Clark, 2020). However, referring to a graph in Arkhipkin (2020), it appears that in 2014-2018, the world catch of this molluscan subgroup was approximately 3.65-4.85 million t/y, and therefore, the national consumption equalled approximately 4-7% of the annual catches.

In *per capita* terms, Italian consumption was 3.49-4.20 kg/y in the five-year period, while for the remaining world population, it was 0.45-0.65 kg/y, i.e., 6-8 times lower. Despite the few years of comparison, the mentioned differences are highly significant ($U=25$; $p<0.02$).

Furthermore, it should be noted that in 2016-2018, the Italian consumption of cephalopods was about one- third of that of the then EU-28 (EUMOFA, 2017a, 2018, 2019).

Great Atlantic scallop (*Pecten maximus*) (ALPHA3 code = SCE)

The EU Common Nomenclature codes CN03072910 and CN03072210 refer, for the years 2014-2016 and 2017-2019, respectively, to frozen specimens of *P. maximus*, which are the major commercialized form of the species and usually have no valves (or only part of them), for which the LWE/CWE ratio is 6.50:1.00 (EUMOFA, 2020a). Considering only this item, in 2014-2019, the Italian net flow had a peak of -37,000 t live weight in 2016 (mostly coming from the United Kingdom) and between -9,000 and -12,500 t in the other years of the period (EUMOFA, 2020a). In 2016, national consumption corresponded to 56% of the species catch; in the other years, it constituted shares of 14-18% (FISHSTATJ).

In Italy, the *per capita* consumption of Atlantic scallops was 0.15-0.55 kg/y (therefore 0.12-0.44 kg/a taking the precaution of “cutting” these values by 20%) compared to 0.07-0.19 kg/y for the other 380 million citizens of the EU-27; however, the two clusters of values do not differ in statistical terms ($U=31$; $p = 0.05$). This implies that mislabelling/misreporting of products obtained by this molluscan bivalve could hinder an appropriate comparison among the *per capita* consumption rates.

3. Discussion

The EU is the economic area that imports the most fish products from external areas worldwide, with trade liabilities for the EU-28 of 19.7 billion € in 2016, 20.3 billion € in 2017 and 20.8 billion € in 2018 (EUMOFA, 2017a, 2018, 2019).

In the case of Italy, the dependence of the fish market on products of foreign origin is particularly notable because *per capita* consumption is somewhat higher than the average in the former EU-28 states (but not in comparison with consumption in Portugal, Spain, France and Greece as a whole; EUMOFA, 2017b), with 30.9-31.1 kg/y in 2016-2019 (for a total of approximately 1,850,000 t/y in live weight); moreover, fishing is not very productive, aquaculture is mostly stable, and the market demand is concentrated on a few species or groups of species (EUROSTAT).

Therefore, in 2016-2019, Italy recorded a trade deficit (considering jointly the flows with the EU-27 states and those with third countries) of -20.20 billion € in the four-year period, followed by France with a similar deficit of -17.45 billion and Germany with -10.87 billion (EUMOFA, 2017a, 2018, 2019). In 2016-2019, the net inflow of fish was approximately -1,050,000 t/y in terms of estimated biomass (including approximately 10,000 t/y of elasmobranchs and positive or negative net flows of several hundred tons LWE per year of “forage fish”, mainly sardines, anchovies and horse mackerels), out of which 815,000 t/y of teleosts resulted from fishing activities; for comparison, the national production of teleosts was approximately 210,000 t/y (out of which approximately 60,000 t/y were from pisciculture), and therefore, the ratio with teleosts of foreign origin was 4:1 in terms of biomass (Anonimo, 2017; EUROSTAT; Tudini, 2020).

In the case of crustaceans and cephalopods, net flows from abroad were approximately 135,000 and 240,000 t/y, respectively, in live weight over the four-year period, which covered approximately 88% and 94% of national consumption, respectively; for crustaceans, it must also be noted that the contribution of farmed species (CN03061792, CN16052100, CN16052190, CN16052900) amounted to approximately 33% of Italian consumption and 50% of that in the rest of the EU-27.

The strong inflows from abroad imply that supplies to the Italian market can form nonnegligible shares of the catches made on certain fish stocks, so in Table 1, the flows relating to ten fish or shellfish species (or their groups) have been examined as well as their impacts on the corresponding global catches and *per capita* consumption rates in Italy and other broad geographical areas of comparison.

Luckily, for some of the species under examination, fairly frequent scientific monitoring is available to ensure that their populations are not

overexploited (at least this was known or hypothesized at the date of publication of the examined papers), a fact sometimes confirmed by stable or increasing catches in previous years (CEDEPESCA, 2017; ICES, 2019, 2020 and 2021, Myers and Moore, 2020); however, this is not the case for populations of other species or of heterogeneous groups of species.

In this regard, it should be noted that the situation of the *X. gladius* stocks is not well known worldwide, and in the Mediterranean Sea, a multiyear plan has been adopted to ease the reconstitution of the local population, and the global catches of the species have been decreasing in recent years (FISHSTATJ; ICCAT, 2021a, 2021b). For cephalopods, it is known that the world production of this large group of marine animals has greatly increased over the last 50 years and the populations of various species nevertheless appear to have a positive trend (perhaps in relation to the increase in water temperature and the rarefaction of some teleosts which are potential predators; Doubleday *et al.*, 2016); however, the number of stocks being fished has also increased and global catches, after a peak of 4.70 million t/y in 2014-2015, were approximately 3.70 million t/y in 2016-2019 (FAO, 2018; Arkhipkin, 2020; Clark, 2020); thus, the possibility that some stocks are overexploited, especially in recent years, cannot be excluded.

If we consider that there has been a growing demand for fish products from fishing and aquaculture worldwide for years (FAO, 2018 and 2020), the strong Italian consumption of some species mainly obtained through fishing can be an excessive burden on the biological resources and persistently unbalances in the consumption of the resulting foodstuffs, laying the groundwork for an intensification of fishing in some areas (as each subject aims to have a greater share of common catches, even when they are declining; Harding, 1968) or an expansion of fishing towards new areas or new stocks and/or species.

The data reported in Table 1 show that for nine out of the ten fishing resources listed therein, the Italian *per capita* consumption rates were statistically higher than those in the other broad geographic areas taken as a reference for the periods under examination, with ratios in the *per capita* quantities which for *X. gladius* and the cephalopods were almost 40 and 8 times higher, respectively. Moreover, for all listed biological resources, domestic consumption is almost exclusively based on products of foreign origin.

In the case of American lobsters, it should also be noted that the commercialization of live specimens (CN0302210 in 2014-2016 and CN03063210 in 2017-2019, EUMOFA, 2020), which accounted for approximately 80% of the estimated biomass arriving in Italy during 2014-2019, is presumably the main factor in the expansion of this species in the coastal waters of the NE Atlantic and Mediterranean Sea (Pavicic *et al.*, 2020).

Conclusion

This work highlights that within the EU-27, Italy has commercial deficits significantly higher than those of the other member states with similar populations. Inflows from abroad in 2016-2019 were approximately 1.50 million t/y in terms of live weight and were considerably concentrated on some species (or their groups), including those identified in Table 1 based on codes of the EU Common Nomenclature. For some of the listed species, Italian consumption makes up a significant part of their catches worldwide.

With a view to achieving more sustainable fish consumption in the short and long term, both in relation to the level of exploitation of wild stocks in the social equity of said consumption, it appears important that in Italy information campaigns are carried out to make citizens aware of the excessive consumption of some products and the need to further favour those derived from aquaculture and the importance of taking into consideration species little appreciated on the domestic market (e.g., tilapias).

Although for some species (or their clusters) listed in Table 1, FAO data and those from the examined literature show that there are no signs (or did not exist in the recent past) of their stocks being exploited outside their appropriate BRPs (Biological Reference Points, concerning the spawning biomass, fishery mortality and catches); however, this reassuring picture may not be true for stocks of swordfish and various species of cephalopods. Moreover, scientific assessments mainly concern the most economically relevant stocks, belonging to few target species, while many other fisheries are managed on the basis of historical official (often underestimated) data on fleets and catches and on knowledge of conspecific stocks, those of akin species or with interventions not strictly targeted (Carruthers *et al.*, 2014; STECF, 2021).

Beyond the lack of knowledge on the present and past status of many “minor” commercial stocks, there is the problem that among bony fishes and elasmobranchs, the adults of many species at higher trophic levels reach on average larger sizes (Romanuk *et al.*, 2010), so they often have higher prices for weight units. These species are inherently less abundant per unit area than species at lower trophic levels (in fact, the efficiency of trophic chains is approximately 10%; thus, only this percentage of the biomass ingested by animals of a certain trophic level becomes additional biomass for them; e.g., Libralato *et al.*, 2015), so they provide more modest catches, and their populations can easily be exploited beyond their renewal rates. Similarly, cephalopods are globally not abundant because they are carnivorous, feeding on fishes as well as crustaceans and other cephalopods (Jereb *et al.*, 2005).

Finally, it should be considered that throughout the oceans, conspicuous IUU (illegal, unreported, unregulated) fisheries exist, with catches estimated

20-25 years ago at 11-26 million t LWE per year (mainly coming from marine waters off West Africa, NW Pacific and SW Atlantic), equal to 13-30% of the total catches at that time (FAO, 2002; Soldo, 2014; GFCM, 2022). Consequently, a high demand for products from wild fish stocks can facilitate the persistence, at high levels, of IUU fishing to meet the demands of these products in various parts of the world. Despite the actions taken by the EU to deter and repress IUU fishing (for example, through rules for precise labelling of fish products or to exclude nontraceable products from the market; EU, 2008 and 2013), bibliographic data show that the situation is still serious (Pramod *et al.*, 2014 and 2017), although presumably less than in the recent past.

With regard to aquaculture, it is necessary to keep in mind that within 15-20 years, 70% of fish products will presumably come from this source (Black and Hughes, 2017), and it is considered important to develop mariculture (currently, freshwater aquaculture still prevails in biomass and economic turnover; FAO, 2018 and 2020) to allow marine ecosystems to significantly contribute to human nutrition, partly safeguarding terrestrial ecosystems (SAPEA, 2017).

In Italy, a better exploitation of fishing resources and a greater development of national aquaculture (a sector that in the last 30 years has encountered considerable difficulties in finding new production sites, as has also happened in other EU-27 countries, due to bureaucratic hurdles, competition with other uses of freshwater and coastal marine areas and, implicitly, also due to the large inflow of cheap fish products from abroad; Macias *et al.*, 2019) would allow an increase in domestic production, which would not be very high due to the limited availability of suitable sites and adverse climatic factors (e.g., Rodrigues *et al.*, 2015).

Nonetheless, it is desirable that aquaculture can grow in Italy, with a view of reducing the dependence on foreign fish products and producing local economic development. In this regard, Directive 2014/89/EU provided an important legal tool to identify new areas for aquaculture, i.e., AZA zones in the coastal waters of the various Italian administrative regions (by mid-2020, this process had been completed in two regions; in two other regions, it had not yet started, and in the others, it was in a "state of progress" of 25-75%; MiPAAFT, 2022a). Regardless, in recent years, the average time for authorizing new aquaculture plants has been decreasing (particularly for those of bivalve molluscs), and guidelines have been developed for the identification of AZA areas and for environmental assessments on farm plants (Marino *et al.*, 2020). Moreover, the use of antibiotics in intensive pisciculture has been decreasing; in approximately one-third of freshwater fish farms, interventions have been made to reduce the nutrient loads in effluents and in plants at sea, there is interest in jointly growing fish, filtering

bivalves and/or seaweeds (IMTA aquaculture; Chopin, 2012) to have less phosphate and nitrate in the seawater masses flowing away (MiPAAFT, 2022a and 2022b). Therefore, it is desirable that Italian consumers increase their appreciation of domestic aquaculture products, rewarding their quality and, indirectly, the better environmental sustainability of that activity in comparison with most catches from wild stocks. Consequently, it is advisable for the Italian public to hold a more positive attitude towards this kind of livestock farming.

Moreover, by new institutional public campaigns, it is advisable to reduce, to some extent, the *per capita* consumption rate of certain products, such as those related to clearly (or presumably) overexploited fish or shellfish wild stocks (e.g., North Atlantic swordfish), and to increase the processing and/or consumption of massive species (“forage fish”).

Footnote 1: In this note, the 8-digit codes of the EU Common Nomenclature have been used, instead of the 10-digit TARIC codes, because they are common to all trade flows of fish products.

Footnote 2: Section HS0301 of the Harmonised System has not been considered because it concerns the trade in live fish (for fish farming or aquarophilia), not intended for direct human consumption.

Funding

This study did not receive any specific grant from funding agencies in the public, private or not-for-profit sectors.

Declaration

The authors declare they have no conflicts of interest regarding what is set out and discussed in the note.

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