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ESTABLISHMENT OF A LOCAL AND CROSS-BORDER NETWORK FOR TRAINING AND EDUCATION OF ALL STAKEHOLDERS OF THE FISHERIES SECTOR FOR THE PURPOSE OF ENVIRONMENTAL PROTECTION AND SUSTAINABILITY

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1. INTRODUCTION

FAO, the Food and Agriculture Organization of the United Nations, in its last year's report, "The State of World Fisheries and Aquaculture", notes already in the preamble that despite significant progress, the world is not on the way to ending hunger and malnutrition by 2030, as was optimistically predicted in 2016. Degraded ecosystems, an intensifying climate crisis and increased biodiversity loss threaten economies, jobs, the environment, and food security around the world, all exacerbated by the effects of the COVID-19 pandemic. Today, 811 million people suffer from hunger, and 3 billion cannot afford a healthy diet. These facts have become calls for the urgent transformation of our agricultural and food systems in order to ensure a sufficient amount of quality food for the growing world population and at the same time preserve natural resources (FAO, 2022).

In these circumstances, the key role in ensuring a sufficient amount of food is attributed to food from water, that is, aquatic organisms, plant and animal. Consequently, expectations from the fisheries and aquaculture sector are high because it is believed that this sector will not only provide the necessary quantity, but also the quality of food. Aquatic organisms, in addition to being a source of high-value proteins, are a unique and extremely diverse source of essential omega-3 fatty acids and bioavailable micronutrients. Determining real priorities and better integration of fishery and aquaculture products in the world, regional and national food system strategies, and policies, should be a vital part of the necessary transformation of our agri-food systems (FAO, 2022).

Considering that the catch from natural populations has reached its maximum and has been maintained at a constant level for years, the aquaculture sector has developed rapidly in the last decade. Fishing includes a number of different activities, means and techniques that are used in catching fish, mollusks, crabs, and in the collection of sea plants, as well as numerous ways of exploiting the catch and its processing for food and industrial purposes. Until a stronger focus on breeding (aquaculture), fishery was mainly improved by new methods of discovering the natural habitats of marine organisms and by perfecting tools and techniques for fishing.

The total amount of aquatic resources cultivated or harvested for human consumption (excluding algae) was 157 million tons in 2022 – a new record. Overall, the growth rate has been doubling the rate of population growth since 1961, and consumption has now reached 20.2 kg per capita, more than double the consumption in the 1960s. The global seafood

market, estimated at US$116.8 billion in 2022, is projected to reach US$134 billion by 2026, growing at a rate of 2.9% per year (Research and Markets, 2022).

Croatia has a long tradition of fishing, which is a source of income for coastal and island communities throughout the year. Although the fisheries sector in Croatia accounts for less than 1% of the gross domestic product (GDP), its actual contribution and importance in the national economy far exceeds its share in GDP. Coastal communities and island populations are highly dependent on this sector, which is closely related to the development of tourism as the most important branch of the coastal industry. In 2020, Croatia ranked 14th in the EU-27 in the area of production in fisheries and 11th in the area of production in aquaculture. In 2018, the number of employees in this sector, including processing, reached 36,363 jobs.

Recently, fishing and aquaculture, like other sectors of food production, have been faced with the challenge of ecologically, socially, financially, and energetically sustainable development (Gavrilović and Jug-Dujaković, 2019). The most frequently cited definition of sustainability comes from the UN World Commission on Environment and Development: "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." The following should be taken into account:

• Environmental sustainability —fisheries and aquaculture should not create significant ecosystem disturbances or cause loss of biodiversity or significant pollution.

• Economic viability — fisheries and aquaculture must be sustainable businesses with good long-term prospects.

• Social and community sustainability — fisheries and aquaculture must be socially responsible and contribute to community well-being.

The ARGOS project (Joint management of sustainable fisheries and aquaculture activities as financial support for the protection of marine resources in the Adriatic Sea) is financed by the Interreg program within the cross-border cooperation program between Italy and Croatia for the period 2014 - 2020. The main goal of the project is to achieve sustainable joint management of fisheries resources. ARGOS establishes a common management framework within which all institutions related to fisheries and aquaculture from the Program area act as a single entity for the purposes of managing and protecting common biological resources of the Adriatic, under the leadership of the scientific community.

The aim of this study is to collect data on the main topics and identify problems in fisheries and aquaculture on both sides of the Adriatic, Croatian and Italian, which should be the basis for the establishment of a local and cross-border network for training and education of all stakeholders in the fisheries sector for the purpose of environmental protection and sustainability. In addition to the detailed analysis of existing databases, data were collected at all levels of the fishing and aquaculture industry and research and scientific institutions. The opinions, suggestions and wishes of representatives of fishermen and producers from the Italian and Croatian sides of the Adriatic, as well as representatives of scientific, educational and research institutions, were considered.

2. THE IMPORTANCE OF THE FISHERIES AND AQUACULTURE SECTOR IN THE NATIONAL ECONOMY

The fisheries sector in Croatia, sea catch, fresh water catch and aquaculture, accounts for less than 1% of the gross domestic product (GDP), but its real contribution and importance in the national economy far exceeds the share in GDP. Coastal communities and island populations are highly dependent on this sector, which is closely related to the development of coastal tourism as the most important branch of the coastal industry.
The situation is similar with Italy, where the contribution of the fishing sector to the national GDP is still limited to just over 0.5%, and is more significant in certain regions, especially in the south (EUROFISH, 2021).

There is a narrow and wrong focus on the contribution of fisheries to GDP at the first level of sales. Its contribution to the national economy must be considered taking into account the contribution to GDP of all activities related to the sector, directly and indirectly. In addition to the direct production value of the fish catch, fish farming and processing sector, this contribution should also include the construction and servicing of vessels, the production of fishing tools and equipment, transport, storage, marketing and related logistics, port activities related to fisheries and to some extent for some forms tourism.

Furthermore, an accurate assessment of the value of the sector should also include the supply of fresh, high-quality food, a positive contribution to the foreign trade balance, and the special importance of employment on the coast and islands, where fishing is one of the few activities that provides a source of income throughout the year.

Accordingly, despite a series of systemic obstacles, the "fish potential" in Croatia is good, and it could be significantly improved. Concrete measures can be considered to increase the economic value of the sector, with the repeated remark that the importance of fisheries for the country cannot be reduced to the mere monetary value of its production. This is especially true considering the role that tourism has and will increasingly play in the development of the country, especially for the coastal and island population. In addition, the demand for fish is high and constantly increasing, and it cannot be satisfied with the current domestic production either in Croatia or in Italy.
In 2018, employment in the fisheries sector, including processing, accounted for 36,363 jobs. This represented 8% fewer jobs than in 2008. In the same period, the average value of

production per employee decreased by 7% in marine fisheries and by 9% in aquaculture (EUROFISH, 2021).

2.1. Financing of services to the fisheries sector

Governments support their fisheries sectors through a wide range of policies. The objectives vary but tend to focus on factors such as maintaining employment, improving the welfare of fishermen or ensuring the sustainability of the sector and the resources it relies on. Usually, the government finances services to the fisheries sector, which benefits the sector as a whole or certain segment of it, and also provides direct support to individuals and companies.

In 2018, Italy spent EUR 41.8 million (USD 49.4 million) on financing services to the fisheries sector. Net cost recovery fees amounted to 4.4% of production value, while the OECD average was 8.5% in 2018. The financing intensity of fishing services relative to fleet size was USD 337.4 per gross tonne (GT) of total fleet capacity in 2018. This amount is not high compared to the OECD average of USD 601.8 per GT in 2018.

Some services to the sector aim to ensure its sustainability or improve the well-being of fishing communities, while only indirectly supporting the intensity of fishing activities. In the OECD, such services, including management, control, and supervision, accounted for an average of 59.2% of spending on services.

Other services focus on the ability of fishermen to run their business more efficiently or sustainably, such as investments in education and training, marketing and promotion, or research and development. These services accounted for an average of 16% of spending on services in the OECD sector in 2018. Finally, some forms of support may have a more direct relationship with productive capacity, such as investment in or subsidized access to infrastructure such as fishing ports. In the OECD, these services accounted for an average of 24.5% of financing services to the sector in 2018.

In 2018, Italy provided support totaling EUR 64.7 million through incentives that directly benefited individuals and companies in the fisheries sector, an increase of a total of 1713% since 2008. This amounted to 6.8% of production value.

3. ANALYSIS OF THE FISHERIES SECTOR IN THE REPUBLIC OF CROATIA AND ITALY

3.1. Catch analysis

3.1.1. Republic of Croatia

With a sea area of 31,067 km², 1,242 islands, islets and rocks, a total of 6,278 km of coastline, Croatia has a long tradition in fishing, which is a year-round source of income for coastal and island communities. In addition to being a source of healthy food supply, fishing adds value to tourism as the most profitable sector of the coastal area (EUROFISH, 2021a). According to EUMOFA (2023a), in 2020, Croatia ranked 14th in the EU-27 in the area of production in fisheries and 11th in the area of production in aquaculture.

There are two basic categories of fishing at sea in the Republic of Croatia - economic and non-economic (MPS, https://ribarstvo.mps.hr/default.aspx?id=13). Within commercial fishing, there is a distinction between commercial fishing in the narrower sense and the category of small coastal commercial fishing, which is limited by tools and conditions of performance. In addition, according to the Law on Sea Fisheries (Official Gazette 62/2017, 14/2019, 30/2023), fishing tourism is also included in the economic category.

In the Republic of Croatia, according to the latest data from the State Statistical Office (DZS, 2022), there are, including small-scale coastal fishing, 6,563 holders of the license, of which 3,548 fishermen have the license for small-scale coastal fishing.

Non-commercial fishing is sport and recreational, and there are management mechanisms for both. Sports or recreational fishing in the sea of the Republic of Croatia is permitted based on a valid license for sport fishing at sea, or license for recreational fishing at sea (Official Gazette 62/2017, 14/2019, 30/2023).

Landings include the initial unloading of all fishery products from a fishing vessel in a specific EU member state, including aquatic plants that are not intended for human consumption. Landings are recorded in net weight and value (EUMOFA, 2023a).

According to the latest data of the State Statistical Office (DZS, 2022), the total catch in 2021 was 61,574 tons, of which 55,945 tons or 91% were small pelagic fish, 3,741 tons were white fish or 6%, 656 tons or 1% cephalopods and 1021 tons or 1.7% crustaceans (Table 1).

In 2020 (DZS, 2021), the total landing was 14% higher than in 2021 and amounted to 70,973 tons, of which 65,057 tons or 91.66% were small pelagic fish, 3,883 tons white fish, 932 tons

or 1.33% cephalopods and 925 tons or 1.3% crustaceans. The estimated value of landings was also dominated by small blue fish with 53.76% of the total value of sales of fishery products (EUR 32.82 million), while the sale of white fish amounted to EUR 14.4 million or 23.58% of the total value of sales.

Table 1. Capture and aquaculture production of marine fish, shellfish, and cephalopods in 2020 and 2021 (DZS, 2022). The data refer to the edible and inedible weight of the catch.

	Capture and aquaculture (tons)			
	2020.	2021.		
	total	total	capture	aquaculture
Total	89.965	85.341	61.574	23.767
Fish	87.415	82.543	59.686	22.857
Small pelagic fish	68.380	61.046	55.945	5.101
European pilchard(=Sardine)	50.134	40.485	40.485	-
European anchovy	9.781	11.621	11.621	-
Tuna	4.223	6.002	901	5.101
Chub mackerel	1.966	1.144	1.144	-
Atlantic horse mackerel	1.755	1.212	1.212	-
Other species	521	582	582	-
Other fish species	19.035	21.497	3.741	17.756
European hake	1.202	1.062	1.062	-
Red mullet	788	793	793	-
Mullet	91	99	99	-
European conger	35	36	36	-
European seabass	6.769	9.094	11	9.083
Giltheaed seabream	7.911	7.783	184	7.599
Picarel	93	102	102	-
Bogue	82	81	81	-
Common sole	214	159	159	-
Other species	1.850	2.288	1.214	1.074
Crustaceans [1)]	925	1.021	1.021	-
Common spiny lobster	6	9	9	-
Norway lobster	238	251	251	-

Prawns and other crustaceans	681	761	761	-
Shellfish[1)]	693	1.121	211	910
Oysters	29	74	18	56
Great Mediterranean scallop	40	52	52	-
Warty venus	58	67	67	-
Mediterranean mussel	529	886	32	854
Other shellfish	37	42	42	-
Cephalopods	932	656	656	-
European squid and other squid species	331	228	228	-
Common octopus	168	130	130	-
Common cuttlefish	103	91	91	-
Musky octopus and other cephalopods	330	207	207	-

If the above data are compared with the year 2018 (DZS, 2019), the value of sales of crabs in that year amounted to EUR 5.09 million or 8.34% of the total realized value of sales of fishery products. In the total landing of small blue fish, sardines accounted for 50,133 tons or 78.3% of the quantity, anchovies for 9,781 tons or 15.28%, sardines and mackerel accounted for 3,720 tons (5.81%). Sardine accounted for 67.03% of the value of small bluefish sales, or 22.17 million euros, while the value of anchovy sales was 9.22 million euros, or 27.87% of the total value of small bluefish sales. Of the other types of small blue fish, 311 tons of giant sardine, 46 tons of mackerel, 33 tons of sprat and about 2 tons of sprat with a total value of 164 thousand euros were recorded.

The available data show that after a period of continuous decline in the amount of small blue fish landed during the years 2014-2019. landing increased to 65 thousand tons in 2020, which also increased its value to 28.6 million. A smaller amount was recorded in 2019 (63 thousand tons), and the largest landing was recorded in 2014, when it exceeded 70 thousand tons. The total amount of landings in 2020 exceeded that of 2019 by 11%, which reversed the downward trend that had lasted since 2014. However, the data for 2021 again show a significant decline (Table 1).

According to the quantity landed in 2020 (DZS, 2021), the most important species of white fish were European hake (1202 t, 33.15%) and red mullet (762 t, 21.03%), followed by a much smaller share of common sole (214 t, 5.9%), gilthead seabream (131 t, 3.63%), gurnards (114 t, 3.215%) and angler (110 t, 3.04%). Between 50 and 100 tons of catches were recorded individually for the species: mullets, picarel, bogue, common pandora, flounders and John dory. Between 10 and 50 tons individually for the species: red scorpionfish, salema, weeverfish, black scorpionfish, conger eel, saddled seabream, surmullet, poor cod, common dentex, forkbeard, common two-banded seabream, European seabass, white seabream and turbot. For the remaining species, less than 10 tons of catches were recorded individually (red porgy, black seabream, sharpsnout seabream, flounders, stargazer, Mediterranean sand smelt, big-scale sand smelt, European barracuda, axilarry seabream, meagre, blotched picarel, Mediterranean moray, annular seabream, picarel, sand steenbras, bluefish, blackspot seabream, common dentex, comber, east Atlantic peacock wrasse, common doplhinfish, brown meagre, shi drum, European eel, groupers, brown wrasse, painted comber, rainbow trout)(https://podaci.ribarstvo.hr/novosti/iskrcaj-po-grupama-i-vrstama-morskih-organizama-u-2020-godini/).

The highest value in the first sale was achieved by the first sale of European hake (EUR 3.88 million, 34.12%), common sole (EUR 1.48 million, 13.12%) and red mullet (EUR 1.11 million, 9 .81%). The sale of gurnards and John dory generated 763.20 (6.71%), or 731 thousand EUR (6.43%), the sale of angler 606.35 thousand EUR or 5.33%, and the sale of gilthead seabream 534.67 thousand EUR or 4.7%. From 100 to 500 thousand EUR sales were achieved for the following species: red scorpionfish, spotted flounder, common dentex, whiting, common pandora, turbot i picarel.

Between EUR 50,000 and EUR 100,000 worth of sales were realized for the following species: mullets, red porgy, salema, surmullet, bogue, common two-banded seabream, weeverfish, black scorpionfish, saddled seabream and European seabass. Between EUR 10,000 and EUR 50,000 for the following species: sharpsnout seabream, flounders, conger eel, forkbeard, poor cod, white seabream, big-scale sand smelt, black seabream, common dentex i stargazer. For the remaining species, less than 10,000 EUR of first sales were achieved in 2020 (European barracuda, meagre, sand steenbras, axillary seabream, shi drum, brown meagre, Mediterranean sand smelt, blotched picarel, picarel, bluefish, groupers, European eel, blackspot seabream, annular seabream, common dolphinfish, Mediterranean moray, comber, brown wrasse, East Atlantic peacock wrasse, rainbow trout, painted comber)

(https://podaci.ribarstvo.hr/novosti/iskrcaj-po-grupama-i-vrstama-morskih-organizama-u-2020-godini/).

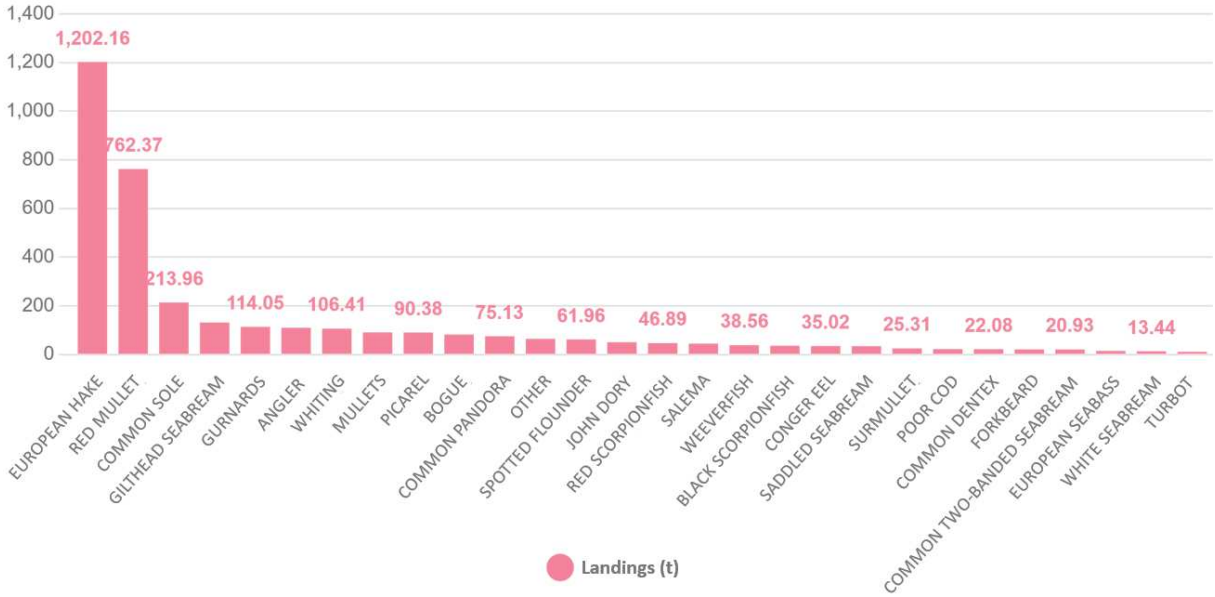

Figure 1. Share of white fish in the landed quantity in 2020 (https://podaci.ribarstvo.hr/novosti/iskrcaj-po-grupama-i-vrstama-morskih-organizama-u-2020-godini/)

Table 2 shows the main landed commercial species and their mass and value share in the total catch in 2020 according to EUMOFA (2023a).

Table. 2. Main commercial species landed and % of the total in 2020 in millions of euros (nominal value) and thousands of tons (EUMOFA, 2023a)

Species	Value (millions of euros)	Percentage of the total value of the catch (%)	Quantity (thousands of tons)	Percentage of total catch (%)
European Pilchard (=Sardine)	22	36	50	44
European anchovy	9	14	10	26

European hake	5	7	2	7
Norway lobster	3	5	2	7
Common octopus	2	4	1	5
Other	21	34	5	11

In Croatia, 264 fishing ports and landing places are planned, and due to geographical restrictions and conditions (numerous islands), the catch is landed at numerous small landing places along the coast. Most of these places do not have the necessary infrastructure. In accordance with the Decision of the Government of the Republic of Croatia on the list of landing places for vessels engaged in commercial fishing at sea (NN 10/20, 145/20, 112/21 and 135/22) and in accordance with it, the Order and amendments to the Order on the list of landing places there are currently 121 landing places for landing catches from fishing vessels engaged in commercial fishing at sea (NN 53/22, 112/22, 39/23) (Table 3). The distribution of landings depends on the size of the vessel, the fishing area, and the target species. In the Istrian region, the landing includes mostly demersal and pelagic species. In the areas of the northern Adriatic channel, landings include small pelagic blue fish, hake, and shrimp. In Zadar County, landings mainly consist of pelagic species. In the Šibenik area, most of the landings are demersal catches. In central Dalmatia, the landing of small pelagic fish, hake and mullet was recorded. In the southern part of the Croatian coast, landings are dominated by small pelagic fish.

Table 3. Number of landing places by county for landing catches from fishing vessels engaged in commercial fishing (NN 53/22, 112/22, 39/23).

County	Number of landing places
Istria	21
Primorje-Gorski Kotar	17
Lika-Senj	3
Zadar	19
Šibenik-Knin	14
Split-Dalmatia	28
Dubrovnik-Neretva	19
TOTAL:	**121**

3.1.2. Italy

The coast of Italy stretches for 9,136 km, which is 8.75% of the total coast of the EU. According to Eurostat, the area of coastal regions is 181,289 km², which is approximately 10% of the total EU territory and 60% of the national territory. Fishing in Italy takes place along the entire coast. The contribution of the fisheries sector to national GDP is still limited to just over 0.5% of Italian GDP, and is more significant in certain regions, especially in the south (EUROFISH, 2021b).

In 2020, according to FAO data, Italy was the 4th largest EU-27 country in terms of aquaculture production, while it was in 11th place in terms of fisheries production (Table 4) (EUMOFA, 2023b).

Table 4. Italian capture and aquaculture production in 2020 on a global scale

(1.000 tons)	Globaly	EU-27	Italy	% globaly	% EU-27
Fisheries	91.260	3.869	141	0,2%	4 %
Aquaculture	122.573	1.088	123	0,1%	11%
Total	213.833	4.957	263	0,1%	5%

In 2018, Italy produced 0.3 million tonnes of fish (including molluscs and crustaceans), valued at USD 1,658.4 million. 32% of this value comes from aquaculture, and 68% from fishing. If these values are compared with the data for 2008, in 2018 the produced quantity decreased by 10%, while its value decreased by 15% (OECD, 2021).

In the last decade, the national Italian fishery production showed a negative trend that continued in recent years. In 2004, the total sea catch was 288,284 tons, while in 2012 it fell to 195,000 tons, in 2017 it reached only 192,202 tons, and in 2020 it fell to 141,771 tons (World Bank, 2023) (Figure 2). The production value in 2012 was 1.2 billion USD, while in 2004 it was 1.8 billion USD (EUROFISH, 2021b).

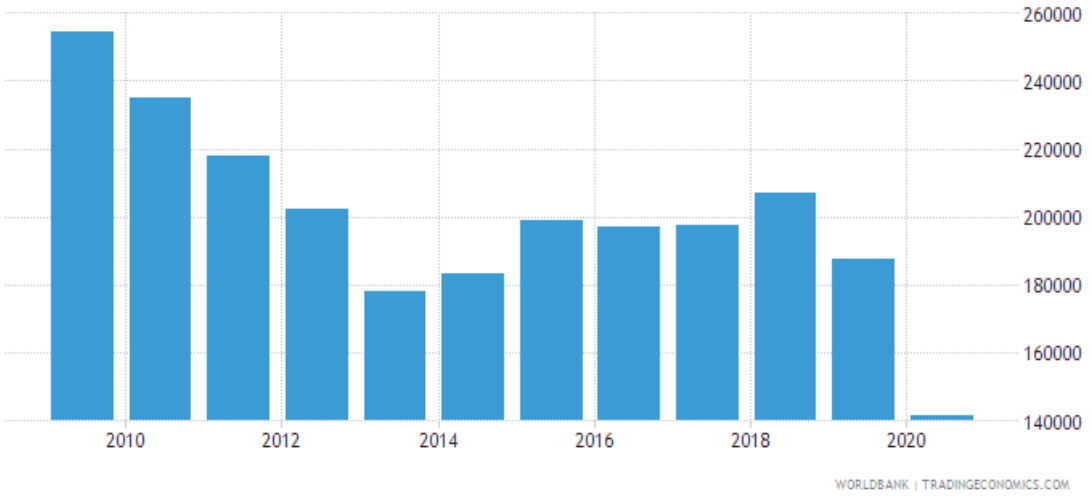

Figure 2. Landing quantity of catches in Italy for commercial, industrial, recreational and private needs (World Bank, 2023)

The main group are representatives of small blue pelagic fish species - anchovy (*Engraulis encrasicolus*) and sardine (*Sardina pilchardus*). Among bottom-dwelling, white fish, the most frequently landed species are hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*). An important part of the total Italian landings are cephalopods, including cuttlefish (*Sepia officinalis*), octopus (*Octopus vulgaris*) and muskrat (*Eledone cirrhosa*).

Deepwater prawn (*Parapenaeus longirostris*) and mantis shrimp (*Squilla mantis*) are the most important crustaceans landed. Among large pelagic fish, the main species landed are bluefin tuna (*Thunnus thynnus*), albacore tuna (*Thunnus alalunga*) and swordfish (*Xiphias gladius*). The catch of hydraulic dredges, which mainly refers to shellfish (mainly *Chamelea gallina*), comes mainly from the northern Adriatic.

The composition of catches in Italian marine fisheries is extremely heterogeneous, reflecting the different tools used in different fishing areas and the high biological diversity of aquatic resources. The first five species (Table 5) make up 51% of the total number of species caught, while the value of the remaining 130 species that are usually landed is rather marginal. Anchovies, sardines, and bivalves are the three main species landed by the Italian fleet. In 2012, the production of anchovies amounted to a total of 42,800 tons (22% of domestic landings), the production of bivalves and sardines resulted in a stable production of about 20,000 tons, or 10% of the total landings. Hake and shrimp were the next most landed species, with 9,393 and 10,600 tons respectively (4.7% and 5.4% of the total landings, respectively). While the catch of anchovy and sardine is fairly stable over time and follows natural fluctuations, the catch of hake is slowly but steadily decreasing. Despite the decline, hake is

still the most valuable species, which with EUR 86.1 million makes up 7.9% of the total value of domestic landings (table 5). Shellfish fishing follows a fairly regular cycle, but production in this case largely depends on market demand.

Table. 5. Main commercial species landed and % of the total in 2020 in millions of euros (nominal value) and thousands of tons (EUMOFA, 2023b)

species	Value (millions of euros)	Percentage of the total value of the catch (%)	Quantity (thousands of tons)	Percentage of total catch (%)
prawns	141	21%	24	17
clams	51	8	21	15
hake	42	6	14	11
anchovy	39	6	11	8
octopus	38	6	8	6
Other	345	53	59	43

A third of the landed volume in 2017 was small blue fish, mainly anchovies and sardines. Other important commercial species included crustaceans, such as deep-water prawns (Parapenaeus longirostris) and mantis (Squilus mantis), as well as cephalopods, mainly cuttlefish, squid and octopus. In addition, tuna also plays an important role in catching.

According to FAO data (2023), Table 6 shows the total amount of landed catch by administrative region in order to get a picture of the amount and trend of catch in the Adriatic regions (partner regions of the ARGOS project) in relation to the rest of Italy.

Table 6. Total quantity of landings by administrative regions (thousands of tons)

YEAR	2004	2005	2006	2007	2008	2009	2010	2011	2012
Liguria	5.7	5.4	4.9	5.0	3.8	4.2	3.7	4.4	3.4
Toscana	9.5	8.5	11.1	10.2	6.2	10.7	10.6	9.0	8.1
Lazio	6.8	7.5	6.9	5.8	4.9	5.7	5.4	5.7	5.0
Campania	18.2	14.9	17.3	14.4	11.3	14.1	14.1	14.1	12.2

Calabria	11.2	11.0	12.2	10.5	8.8	11.7	9.2	10.0	8.8
Puglia	50.4	42.4	47.8	39.1	35.5	37.9	34.8	32.3	25.2
Molise	-	1.5	1.2	1.7	2.1	1.8	2.1	2.2	1.7
Abruzzo	19.6	15.6	22.41	14.6	12.06	12.9	10.94	11.4	12.2
Marche	28.7	25.2	27.7	34.3	30.8	4.9	29.6	25.3	24.9
Emilia Romagna	31.1	29.8	27.5	29.9	23.7	22.2	22.1	17.6	23.1
Veneto	30.3	31.1	27.1	32.3	21.6	25.0	23.4	19.6	22.2
Friuli V. G.	7.5	6.8	6.2	6.4	5.0	4.7	3.7	3.6	4.0
Sardegna	8.4	12.2	11.1	10.9	7.5	8.2	8.0	9.6	7.8
Sicilia	60.2	56.2	62.0	52.1	43.3	49.7	45.0	45.1	36.8
Total	288.3	268.3	285.8	267.4	216.5	234.1	223.0	210.3	195.8

The first sale refers to fish that have been sold or registered at an auction center or sold to registered buyers or producer organizations (POs). First sales may differ from landings as they do not include fish landed by vessels owned by processing companies or sold directly to processors.

In 2021, the total first sale at Italian outlets amounted to 87,023 tons, or 365 million euros (EUMOFA, 2023b). The first three outlets covered 19% and 27% of the total first sale, in terms of quantity and value (table 7).

Table 7. The three most important places of first sale in Italy in 2021

Top-3 places of sale	Volume (tons)	Value (mil. EUR)	Three most important species
Mazara del Vallo	2.048	36,6	Miscellaneus shrimps, deep-water rose shrimps, Norway lobster

Porto Tolle	5.647	34,4	Anchovy, sardine, squillid
Ancona	8.461	25,8	Clam, common sole, warmawater fish

3.2. Analysis of the fishing fleet

The segmentation of the fishing fleet in the Republic of Croatia is carried out on an annual basis, i.e. in the current year for the previous year, according to data on fishing activity from catch documentation (catch reports) in commercial fishing at sea. The preliminary segmentation of the fleet is made after the first processing of data on fishing activity in the previous year entered into the Geoinformation System of Fisheries - GISR (during April of the current year for the previous year), and the final after the entry and validation of the remaining data for the previous year into the Geoinformation Constitution of Fisheries.

The affiliation of the vessel to the original segment of the fleet is determined according to the dominant fishing technique and the length category of the vessel. The dominant fishing technique is determined by the number of fishing days in which a certain type of fishing gear was used. If there are less than ten vessels in the original fleet segment, segment grouping is carried out, that is, that segment is joined to the segment most similar to the original one, and thus the final fleet segment is obtained. The fleet segment is a combination of a certain fishing technique and the length category of the vessel.

3.2.1. Republic of Croatia

In 2021, the fishing fleet of the Republic of Croatia consisted of 7,757 vessels, of which 6,235 vessels were active. Fleet capacity (tonnage - GT and engine thrust - kW) remained stable compared to 2020 (Table 8). The majority of the fleet (56.5%) consisted of vessels smaller than 6 meters and vessels between 6 and 12 meters in length (36.5%). Only 549 vessels (or 7.1%) are longer than 12 meters, including 337 vessels between 12 and 18 meters in length, 103 vessels between 18 and 24 meters in length and 109 vessels between 24 and 40 meters in length (MPS, 2022).

Table 8. Croatian commercial fishing fleet in the period 2012-2021 (MPS, 2022)

Year	GT	kW	No of vessels
2012	45.203,82	329.693,77	4.211
2013	46.034,24	346.247,22	4.358
2014	46.104,38	347.927,35	4.385
2015	53.811,85	429.745,89	7.849
2016	49.157,90	387.601,65	7.746
2017	48.840,26	386.830,98	8.349
2018	46.048,94	360.883,33	7.731
2019	45.208,68	355.579,40	7.829
2020	45.251,54	355.871,16	7.808
2021	44.621,47	354.226,43	7.757
Δ 2021 - 2020	*-1,4%*	*-0,5%*	*-0,7%*
Δ 2021 - average 15-20	*-7,1%*	*-6,6%*	*-1,6%*

The Small-scale Coastal Fleet (SSCF) covered 86% (5,366) of active vessels and 2.7% of landed weight in 2021 (Table 9) (MPS, 2022). The Large Fleet (LSF), with a total of 869 vessels in 2021, represented 14% of the active fleet and landed nearly 98% by weight and 83% by value. The majority of LSF in Croatia consists of highly active commercial seine vessels and bottom trawlers that are under a strict management regime. The number of LSF vessels decreased by 13 vessels (-1.5% between 2021 and 2020, and by 0.1% in the SSCF (corresponding to 3 vessels). In 2021, the inactive fleet (1,522 vessels) further decreased by 2 , 2% compared to 2020.

Table 9. Basic characteristics of the fleet of active vessels based on fishing activity in 2021 (MPS, 2022).

Fleet	No of vessels	Total GT	Total kW	Share in fleet	Share of time in fishing	Share in landing weight	Share of landing value
LSF	869	23.214,26	125.505,57	*13,9%*	*32,4%*	*97,3%*	*82,9%*
SSCF	5.366	8.933,77	128.014,51	*86,1%*	*67,6%*	*2,7%*	*17,1%*

Although the structure of the fishing fleet has changed somewhat with the inclusion of 3,500 small coastal fishing vessels in 2015, the fleet operates largely the same. A significant factor in the large reduction of the fleet since 2013 is the scrapping of ships.

3.2.2. Italy

Italian sea fishing involves numerous types of gear with a very heterogeneous fleet widely dispersed along the coast. A diverse fleet with a wide range of vessel types is intended for different types of fishing mainly in the Mediterranean Sea. Seventy percent of the fleet consists of small fishing vessels, smaller than 12 meters (EUROFISH, 2021; Carvalho et al., 2020). The size of the Italian fleet has been steadily decreasing over the decades, in correlation with the decline in catches, however, the numbers have recently stabilized. In 2018, the fleet consisted of 12,059 motor vessels, a decrease of 11% compared to 2008. Small vessels, those under 12 meters in length, accounted for 71.7% of the total number of vessels. The total gross tonnage of the Italian fleet in 2018 was 146,260 tons, a decrease of 26% since 2008. Small ships accounted for 12.2% of the total gross tonnage. In 2017, 12,250 vessels were registered, and in 2016, 12,310.

As far as fishing tools are concerned, the most significant decline is recorded in the most important segments. In the period 2004/2012. production of bottom trawlers decreased by 36%, seiners and small fisheries by 35%. Landings of floating trawlers (volanti) of medium size and dredge landings varied around 40,000 and 23,000 tons, respectively. In both cases, the demand in the market at that time greatly influenced the level of production.

In 2012, the fleet consisted of 12,814 vessels divided by fishing system, and 69% of the fleet consisted of small fishing boats shorter than 12 m. Longlines and similar tools of this group made up 37% of the fleet, followed by trawlers (23%). , seines and hydraulic dredges. In 2012, 27,800 people were directly employed in fisheries and aquaculture (FAO, 2023).

Table 10 shows the basic parameters of the Italian fishing fleet and employment in the fishing sector by administrative region in order to get a general picture of the situation in the partner regions of the ARGOS project.

Italian small-scale fishing is the most important segment of fishing from a social aspect and in terms of employment, and mostly uses passive tools and includes one-day trips carried out by a small crew of one or two fishermen. The tools that are most often used are: surrounding nets, bottom trawls of various dimensions, floating trawls (volanti), dredges (turbosoffiante) and three-layer nets. The small-scale fishing fleet also uses seines and longlines, including floating longlines, which are now widely used to catch large pelagic fish (EUROFISH, 2021).

Table 10. Technical parameters of the national fleet and employment by administrative regions in 2012 (FAO, 2023).

Region	No of vessels	GT	Engine power (kW)	Crew
Liguria	525	3 503	33 114	849
Tuscana	600	5 531	42 706	1 053
Lazio	582	7 293	53 725	982
Campania	1124	9 482	65 575	2 387
Calabria	854	5 478	44 196	2 474
Apulia	1572	19 286	131 639	3 653
Molise	91	2 570	10 667	283
Abruzzo	547	9 850	46 881	1 184
Marche	855	17 564	91 547	1 827
Emilia Romagna	714	8 951	72 541	1 501
Veneto	712	11 771	80 866	1 644
Friuli V G	400	1 949	26 889	733
Sardegna	1292	9 718	78 037	2 354

Sicilia	2946	49 277	241 529	7 357
Total	12 814	158 630	1 008 682	28 217

Reduction of fleet capacity is only one of many factors that influence the decline of total catch and productivity: the state of stocks, changes in fishing zones due to increased production costs, different composition of catches. All of them contributed to such a result. Moreover, the new restrictions imposed by the Mediterranean Regulation (Regulation (CE) 1967/2006, Sustainability Regulation 2023) also had a direct effect on production: larger mesh size, distance from the coast, prescribed minimum catch size for certain species, de facto closure of a considerable number of traditional crafts and other changes in fishing activities contributed to the reduction of production. Finally, new controls and sanctions approved by the Council of Europe (Reg (CE) 1224/2009 Sustainability Regulation 2023), which cover all operations from catch to sale, have led to changes in fishing operations, including traditional ones.

3.3. Fishing gears and fishing practices

3.3.1. Selectivity of fishing gear and other measures for sustainable management of marine resources

The selectivity of fishing tools means their adaptation to catch a certain category of fish. In addition to the design, it includes the minimum mesh size of the net, the dimensions of the opening of the trawl net or nets in order to monitor the fishing mortality of the intended species (target species), i.e. the reduction of unwanted bycatch. Experience has shown that fishing restrictions by prescribing fishing gear are not sufficient to establish long-term sustainable fishing. Persisting on frequent improvements in the selectivity of fishing gear in application requires large financial expenditures, and the consequence may be an effort to catch as much as possible in order to recover the investment. Regulation of fishing by prescribing the characteristics of fishing gear is aimed at a specific target species in the adult phase, but immature individuals of larger species are still caught. The use of additional devices, which will increase the selectivity and focus of the tools on the target species, is desirable in order to reduce the share of non-target and often endangered species in the catch. The seasonal suspension of fishing (ban) is a mild and often used technical measure to enable the restoration and protection of endangered live stocks. It is ineffective in itself if the total reduction of hunting in the remaining part of the year is not regulated and monitored. The permanent suspension of fishing (moratorium) is used only in exceptional cases, when the

disappearance of live stocks of certain populations is imminent. It would be difficult to implement in demersal fishing due to different fishing interest groups and a large number of demersal species. Spatial ban on fishing can be occasional or seasonal, most often to protect natural spawning grounds and breeding grounds of economically important species of fish and other organisms. This measure can also be applied in the protection of special habitats, and it certainly has a positive effect on the restoration of overfished populations in the neighboring environment. Marine protected areas (MPAs) contribute significantly to the restoration and protection of stationary species, as well as to the protection of critical stages of migrating species.

Spatial and time limitations, in the protection of living resources, can significantly reduce or eliminate the contradictions between different forms of fishing or between users of different fishing tools. By placing individual fishermen and/or their interest groups in the appropriate space and time, contradictions can increase even more, especially if individual users feel deprived of their rights in relation to others.

Technical measures for the management of the biological resources of the sea are the basis of the sustainability of fishing itself. As such, they were introduced into the legal regulations, and include:

1. spatial and temporal limitation of fishing
2. constructional and technical characteristics, marking, method of use and purpose of certain types of fishing tools and fishing equipment (including lighting devices in fishing with seine nets) and conditions and methods of fishing
3. the minimum reference size for the conservation of certain types of fish and other marine organisms
4. ban for certain types of fish and other marine organisms
5. prohibition of all or certain types or methods of fishing
6. ban on issuing or limiting the number of privileges for commercial fishing at sea, privileges for small coastal fishing and authorizations for fishing tourism
7. the permitted amount of catch in the fishing sea of the Republic of Croatia in a specific fishing zone, fishing subzone or area, by individual fishing gear, by individual privilege, by individual approval or by group of vessels participating in fishing together
8. permitted fishing effort in the fishing sea of the Republic of Croatia in a specific fishing zone, fishing subzone or area and permitted fishing effort per individual privilege
9. method of distribution and management of allowed catch quantities
10. recovery plans for shellfish stocks and habitats
11. special measures necessary to reduce the impact of fishing activities on the marine ecosystem

12. protected areas and methods of fishing in them for the protection of habitats, fish and other marine organisms
13. areas with a special management regime (NN 62/2017, 14/2019, 30/2023).

3.3.2. Fishing gears in Croatia

The types of fishing gears and equipment that can be entered in the privilege for commercial fishing and with which commercial fishing is allowed in the fishing sea of the Republic of Croatia are prescribed in the "Regulations on fishing tools and equipment for commercial fishing at sea". The most commonly used gears/tools are:

- bottom trawls: bottom otter trawl, sardine trawl, girder trawl, minnow trawl
- set/standing nets: gillnets, trammel nets, combined gillnets-trammel nets
- dredges: dredge "*kunjkara*", dredge "*rampon*", hydraulic dredge "*vongolara*"
- pots and traps: fish traps, large crab traps, shrimp traps
- hand lines and longlines: hand operated hand lines and pole lines (line with a single hook, line with two or three hooks, fishing line "*samica*", lines for catching cephalopods), set longlines, drifting longlines, troll lines
- other active tools (mobile tools): harpoons, "f*ružata*" and "*ludar*" (directing fish into set gillnets by using ropes), crab grabbers, hand tools for collecting other marine organisms other passive tools: standing fyke net "*kogol*" – "*trata*" i.e. eel traps, bobbit worm traps
- polyvalent passive tools: vessels that only use passive tools, but no single tool is used more than 50% of the time. All vessels in small coastal fishing also belong to this segment.
- polyvalent active and passive tools: Vessels that use both active and passive tools, but neither tool is used more than 50% of the time.
- Seines: seine for large bluefin tuna "*tunolovka*", seine for small bluefish – sardines "*srdelara*", mullet seine "*ciplarica*", needlefish seine "i*gličara*", sable seine "*oližnic*a", bonito seine "p*alamidara*", macrkerel seine "*lokardara*".

3.3.3. Fishing gears in Italy

According to Italian regulations, the fishing fleet is divided into coastal, Mediterranean and overseas vessels (fishing outside the Mediterranean straits). In general, however, small-scale

or artisanal fishing refers to fishing vessels less than 12 meters in length, using passive gear. The most commonly used tools are:

- surrounding nets: purse seine nets are the best known and most commonly used, even for large vessels. Depending on the dimensions, these nets are used both for small bluefish, almost always by attracting fish with a light source (hence the name lampare), as well as for hunting big blue fish especially tuna, in which case they are known as tuna pullers
- bottom trawls of different dimensions are widely used on the entire Italian coast;
- - floating trawls (volanti), which are used to catch small pelagics, are mainly used along Adriatic fishing areas
- drier, the most famous and most used dredging machine is the hydraulic dredging machine, it is called in Italy turbosoffiante and is used exclusively for shellfish hunting;
- three-layer nets, nets and longlines used by the small fishing fleet segment. They allowlimited catch, but mostly commercially valuable fish.
- floating longlines are also widely used today to catch large pelagic fish,especially bluefin tuna, swordfish and albacore (FAO, 2023).

Technical limitations apply to each gear in terms of mesh size, length of net and line, number of hooks or traps.

3.4. Recreational and sport fishing and fishing tourism

This type of fishing is carried out exclusively for recreational or sporting purposes and uses living water resources, and is carried out along the shores of the sea, either on the surface or under water, and thus encourages the development of tourism. It differs from commercial fishing in that the sale of caught products is strictly prohibited in any form, and the catch is limited. Namely, both the Croatian and Italian markets are now subject to regulations that strongly limit the development of recreational fishing due to the impact on water resources. In addition to permits and the obligation to mark catches, there are also a number of restrictions that include lovostaj for certain species, minimum hunting sizes and limiting the amount of catch.

In Croatia, it is allowed to catch and collect up to five kilograms of fish and other marine organisms per day per angler, and the permitted daily amount of catch may be greater for the weight of one fish or other marine organism that exceeds the permitted five kilograms (NN

62/2017, 14/2019 , 30/2023). In the permitted daily catch, the share of live bivalves and snails may be up to 2 kilograms, except for mussels (*Mytilus galloprovincialis*), which may be up to 5 kilograms (NN 122/2017, 12/2018, 54/2018, 69/2020, 125/2020, 87 /2021). In Italy, there is also a daily catch limit of 5 kg, with recreational mussel catches limited to 3 kg per day (FAO, 2023).

Considering the great indentation of the coast, both countries have ideal conditions for the development of fishing tourism, in addition to recreational and sport fishing. This natural predisposition of the territory, together with the high rating of catering services, represents an important opportunity for them to become even more significant tourist destinations.

The development of fishing tourism can be linked to the development of recreational fishing, but also to the development of tourism in general. Considering the growing restrictions on commercial fishing, sustainable fishing tourism is an opportunity to help small fishermen, and this concept is based on the fact that fishing remains intended exclusively for professional fishermen, but they are allowed to expand their activities through diversification of activities. The significance of fishing tourism in the domestic tourist offer and economy is still not great, but it has potential, especially due to the stimulation of the development of the so-called blue economy.

4. ANALYSIS OF THE AQUACULTURE SECTOR IN THE REPUBLIC OF CROATIA AND ITALY

4.1. Production in Croatian aquaculture

In the Republic of Croatia, mariculture includes the cultivation of white fish, bluefin tuna (EBFT) and shellfish. The most important species of fish in farming are sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*) and Atlantic bluefin tuna (*Tunnus thynnus*), and mussel (*Mytilus galoprovincialis*) and oyster (*Ostrea edulis*) (EUMOFA, 2023a).

In 2020, more than 87% of Croatian production in aquaculture was recorded in seawater, while the rest was recorded in fresh water. In terms of value, mariculture accounts for 95% of total aquaculture production (MPS, 2022).

The following main production methods were applied:

- 85% of production: in cages in the sea and brackish waters
- 11% of production: in freshwater basins
- 2% of production: above the bottom (in the sea and brackish waters)
- 2% of production: round tanks and cultivation flow tanks (fresh water)

The total production in mariculture in 2021 was 23,777 tons (Table 11).

Table 11. Production in mariculture in the Republic of Croatia (in tons) for the period 2017-2021. (https://ribarstvo.mps.hr/default.aspx?id=14)

Species	2017	2018	2019	2020	2021
Mediterranean mussel	920	882	947	502.8	854
European flat oyster	62	54	61	14.4	56
Atlantic Bluefin Tuna	2162	3227	2747	3323	5104
European seabass	5616	6220	6089	6754	9083
Gilthhead seabream	4830	5591	6774	7780	7599

Meagre	**	**	**	**	999
Other	253	808	725	618	81
Total	**13843**	**16782**	**17343**	**18992**	**23777**

* meagre, common dentex, greater amberjack, rainbow trout, scallop
**the amount of production until 2020 is included under Other

It is important to note that all the breeding grounds for marine organisms in the Republic of Croatia are located in the area in compliance with all environmental and nature conservation standards, and that all coastal counties have included areas for aquaculture in their spatial plans. Cultivation takes place in all 7 coastal counties (Table 12), in approximately 400 locations (MPS, 2022). Most are small shellfish farms, while fish farming takes place in over 60 locations. It should be noted that part of the cold-water species presented in the table for Lika-Senj county represents trout farming in the sea, while the rest of the cold-water species in the other seven counties belong to freshwater aquaculture.

"Klaster Marikultura" unites Croatian producers in mariculture. It includes more than 90% of producers in Croatian mariculture and has been operating successfully for almost 20 years. The association operates through 3 working groups:

- group of tuna farmers
- group of white fish breeders
- group of shellfish growers,

without organizational structures within them.

Table 12. Overview of cultivation areas for each cultivation segment by county in 2020

COUNTY	WHITE FISH (m2)	TUNA (m2)	SHELLFISH (m2)	COLDWATER SPECIES (m2)
TOTAL	**3.345.241,39**	**1.118.800,00**	**2.963.763,36**	**147.873,79**
Dubrovnik-Neretva	224.890,57		1.520.581,95	
Istria	124.560,00		850.841,00	
Primorje-Gorski kotar	265.412,00		42.158,00	2.492,60
Split-Dalmatia	116.977,41	119.600,00	45.440,41	21.046,00
Šibenik-Knin	47.137,75	179.200,00	272.950,00	7.512,00
Zadar	2.566.263,66	820.000,00	231.792,00	7.322,00

Lika-Senj				102.115,00

4.1.1. Fish production

The production of sea bass, sea bream, meagre and dentex involves a closed breeding cycle, where the first stages take place in the hatchery and then in floating cages at sea. EBFT fry are caught from natural populations and then reared (fattened) for 18 to 30 months in semi offshore cages (FAO, 2023).

Diversification attempts by introducing new species (Table 11), such as turbot (Psetta maxima), dentex (Dentex dentex), red porgy (Pagrus pagrus), sheephead bream (Diplodus puntazzo) and sea trout (Salmo trutta), have not, except for partially dentex, proved successful. In 2014, turbot, dentex, red porgy and sea trout together contributed less than 2% to the total production. In 2015 and 2016, meagre , rhombus and dentex participated with less than 1%, but in 2017 their production, except for meagre, which was returned to commercial frameworks in 2021, and dentex in small quantities, was almost completely abandoned.

The diversification of species was not accompanied by the diversification of production systems and technologies. The same cage culture technology used to breed sea bass and sea bream, with minor modifications, has been used to introduce and experimentally breed new high-quality marine fish species. Croatian producers, researchers and technologists have not developed any type of commercial land-based or ecologically controlled recirculation systems for marine fish farming. Land-based tank systems are more suitable for flatfish, such as turbot or sole, and are widely used in Europe and Asia. Closed recirculating systems can be used for growth from larva to market size fish, but also as hatcheries where juvenile fish are produced and then moved to semi offshore cages where they are grown to market size. Whitefish farming is widespread in semi-enclosed sea locations in almost all coastal counties.

Until the last decade, there were four whitefish hatcheries in Croatia, of which only one is in operation today. This hatchery belongs to the company Cromaris d.d., and produces sea bass and sea bream fingerlings, as well as small quantities of meagre and dentex. Annually, it produces approximately 20,000,000 fry in facilities on land (MPS, 2015). Until 2020, Croatian fry production covered less than 50% of the needs of installed breeding capacities, and today it covers about 75%, so part of the necessary fry is still imported from Italy, France, and Greece (personal communication).

Fish farming in floating cages uses modern technology and involves a completely closed production cycle, from controlled spawning to market-sized products. Most farmed fish, especially those produced by large companies in Croatia, such as “Cromaris”, “Kornati ittica” and “Orada Adriatica”, are sold on the domestic market and the EU market (mainly Italy). Smaller farms, with an annual production of less than 200 tons, place their products on the domestic market, find their market niche and achieve better and more satisfactory prices.

Floating cage technology is used in almost 100% of marine fish production plants. Most of the farms are located in protected areas (except EBFT), so there was no need to use more sophisticated and durable equipment. A wide variety of materials were used for the construction of platforms and runways: wood, metal and polyethylene. Rectangular and round cages of different dimensions are used. The construction is typical of coastal cages and does not include heavy equipment. Most cages, platforms and systems for anchoring and mooring would meet the basic technical and technological requirements. Two major national equipment manufacturers offer satisfactory cage design and equipment, one using polyethylene and the other metal as the main construction material. From an environmental point of view, despite growing concerns, the aforementioned cage farms are still not considered major polluters, mainly because the production sites were identified years ago or are not in an area of high competition with other potential users.

Tuna farming (EBFT) is based on catching small juvenile tuna (8-10 kg) which are then grown until they reach marketable size (30 or more kg). The fish feeds on small bluefish or herring. The amount of production is completely linked to the catch quota regulated by the International Commission for the Conservation of Atlantic Tuna (ICCAT). As for bluefin tuna farming, Croatia is among the leading producers in the EU (Katavić and Gavrilović, 2017).

The cultivation of EBFT in Croatia began in the nineties of the last century. It takes place in floating cages at sea, in Split-Dalmatia County and predominantly in Zadar County. There are four companies registered for tuna farming in a total of 10 locations (FAO, 2023b). The annual production of Atlantic bluefin tuna has stagnated in the last decade due to the restrictive measures in tuna fishing prescribed by ICCAT. Thus, production oscillates, and for example in 2017 it was reduced to 2,162 tons from 4,200 tons in 2009, only to jump again to 5104 tons in 2021 (table 11). As mentioned, EBFT farming volume is fully linked to the ICCAT catch quota which in 2006 adopted a 15-year recovery plan for overfished BFT stocks in the Eastern Atlantic, including the Mediterranean. Thanks to good management and cooperation in the fishery itself, the recovery of stocks was recorded. Consequently, an increase in the catch quota of around 20% has been recommended since 2013, resulting in 13,500 tonnes of total

allowable catch for the EU in 2017, with the results seen in the latest increase in production in 2021.

4.1.2. Shellfish production

Croatian shellfish production includes the traditional production of the European flat oyster (*Ostrea edulis*) and the Mediterranean mussel (*Mytilus galloprovincialis*). In addition to these two species, since 2015, a small amount of sea scallop, Pecten jacobeus (less than 1%) has been produced occasionally.

The total data on production in the last ten years are not consolidated and show significant deviations with respect to the sources. In 2017, the total production of shellfish was 982 tons, of which 920 tons (93.6%) belonged to mussels, and 62 tons (6.3%) to oysters. Since then, according to available data, production has stagnated or fallen, reaching 910 tons in 2021 (Table 11). Compared to the production from 2008 to 2013, a significant decrease was noticed from 2014, mainly due to a decrease in mussel production. In the period from 2008 to 2013, mussel production ranged between 2000 and 3000 tons, and after that period it was always below 1000 tons (MPS, 2015). The production of oysters in the last fifteen years ranged between 32 and 64 tons, except in 2011 and 2012 when, according to the HGK data, it amounted to 150 tons per year. The presented production is an example of inconsistent collection and recording of statistical data. Unreported production is one of the main reasons for the lack of realistic recording of production data. Another reason is the lack of cooperation between several agricultural cooperatives and organizations and related governmental organizations (Jug-Dujaković and Gavrilović, 2014).

If we go back to the last century, according to the data of the Croatian Institute of Statistics, the production of shellfish in 1978 was 444.9 tons, of which 98.7 tons were oysters, 206.8 tons farmed mussels, 47.4 tons of wild mussels were collected, and 92 tons of other shellfish. In 1990, the total production of shellfish in Croatia was 1,807 tons, and in 1999, production increased to 2,227 tons (66 tons of oysters and 2,161 tons of other shellfish) (Gavrilović, 2002). Expected increase in production up to 5,000 tons by 2020, according to the National Strategic Aquaculture Development Plan for the period 2014-2020. (MPS, 2015) was limited by the low production efficiency of small, mostly family operators with low capacity for investment and modernization of production, and the damage caused by predation of sea bream (Katavić and Gavrilović, 2017).

Shellfish farming in Croatia is still small and very traditional. Cultivation takes place in production areas under constant state supervision (MPS, 2023). Oysters are mostly grown in the area of the Maloston Bay and the Little Sea (Dubrovka-Neretva County), while mussels are mostly grown in the area of the west coast of Istria, the area of the mouth of the Krka River and in the Novigrad Sea. About 120 shellfish farms are active (the exact number is variable), of which the largest number (more than 60 farms) is located in Dubrovnik-Neretva County.

The overall production relies on an extensive production model that uses hanging structures (pergolas) suspended from floating parks, the so-called. long-line. The young are also collected from wild populations for the production of mussels and oysters, given that there are no shellfish hatcheries. It is necessary to build facilities and adopt the necessary technologies for the production of oyster fry and other commercially interesting species. A shortage of Mediterranean mussel larvae has never been recorded, and the number of available seed stock collected from nature is considered more than sufficient. For oysters, the situation changes every year, and the first serious lack of naturally collected seed stock was recorded in 2001 and 2002. In order to ensure the existing commercial production and enable its expansion, it is necessary to establish a commercial production of oyster fry.

Several projects have been funded to develop artificial oyster spawning technology, but no commercial-scale hatchery has yet been established. The situation is the same with the application of the results of several projects and experiments that were carried out to upgrade and modernize traditional cultivation technology (Gavrilović et al., 2021; Gavrilović and Jug-Dujaković, 2014; Jug-Dujaković and Gavrilović, 2014). Most mussel farmers in the Maloston Bay and part of the Istrian coast suffer damage from predatory fish, mainly sea bream. Mussels are grown in shallow coastal waters, so sometimes more than 90% of annual breeding populations are eaten by bream. Their relocation to semi-offshore locations and the implementation of new technologies was one of the unachieved goals of the NSPA 2014-2020. communication with producers from neighboring countries, especially Italy, with which we share the same sea (Jug-Dujaković and Gavrilović, 2014).

Furthermore, there is a high demand for oysters in the domestic coastal area, and the wider Croatian market is not sufficiently explored. The total production is placed exclusively on the domestic market, mainly restaurants, due to insufficient and inconsistent production. With the existing situation (insufficient annual production, and a small number or rather the absence and insufficient capacity of distribution and purification centers), shellfish production is not able to meet the basic conditions for export. This problem has been present since the beginning of this century (Jug-Dujaković, 2008), and recently it has become more pronounced.

A marketing strategy and appropriate distribution channels have not been established. The main reasons are insufficient production, underutilization of cultivation areas, lack of development strategies and ineffective association of producers (Jug-Dujaković et al., 2011).

Preservation of the traditional way of growing oysters in the Maloston Bay, also recognized in the NSPA 2014-2020. and NSPA 2021-2027. and represents a challenge to increase the value of the final product with regard to the protection of origin and the development of a specific marketing strategy, while mussel farming requires the implementation of new technology. Considering the intensity of production and the natural characteristics of most shellfish farming areas, there is additional potential in engaging in organic farming. One strategic goal of NSPA 2014-2020. it was achieved in May 2018, when the oyster of the Maloston Bay received the certification of the protected designation of origin (PDO) at the national level and then at the EU level. At the same time, mussel growers from the Novigrad Sea initiated the same procedure for mussels from the Novigrad Sea and already in 2019 received a mark of authenticity from the Croatian Ministry of Agriculture.

4.2. Production in Italian aquaculture

Aquaculture in Italy is based on a long tradition and history. It is developed along the entire Italian coast, with higher density along the Adriatic coast (EUROFISH, 2021b). It is characterized by high specialization and significant production. Out of 30 species, the production is dominated by the Mediterranean mussel (Mytilus galloprovincialis), the cockle (Venerupis philippinarum) and the rainbow trout (Oncorhynchus mykiss). Italy is the main producer of Japanese scallops in Europe. Sea bass (Dicentrarchus labrax) and sea bream (Sparus aurata) are the main types of fish farmed in the sea (EUROFISH, 2021b).

In 2020, 70% of Italian production took place in seawater and brackish water, and 30% in fresh water (EUMOFA, 2023b).

The following production methods are used:

- 41% of production: above the bottom (lagoons and earthen pools) in sea and brackish water
- 28% of production: in tanks and canals, almost entirely in fresh water (a small part in the sea and brackish water)
- 20% of production: on the bottom (lagoons and earthen pools) in sea and brackish water

- 6% of production: in cages, almost entirely in sea and brackish water
- 3% of production: in freshwater ponds
- the rest, 2%, is grown in enclosures in the sea and brackish water.

Traditional extensive aquaculture is still carried out in "valli", brackish lagoons - especially in the northeastern regions. More modern aquaculture techniques for marine species include intensive farms on land, cage systems in the sea and, in the case of shellfish, farming on long-lines and stationary parks (mussels) or directly on intertidal substrate (oysters and cockles). Freshwater aquaculture mainly consists of trout grown in classic race-way systems.

In 2018, the total Italian fishery production was 0.3 million tons, worth 1,658 million USD. The share of aquaculture production was 32%, while 68% of this value was the share of commercial fishing (OECD, 2021).

In 2013, the total national aquaculture production was estimated at 162,600 tons, of which 38,800 tons (24%) were produced in fresh water and 123,800 tons (76%) in marine. The share of fish in mariculture was 11%, while the rest was molluscs (89 %) (FAO, 2023b). In 2016, the total production of the Italian aquaculture sector was 157,109 tons, and in 2020 it fell to 122,778 tons (https://data.worldbank.org/). In the shellfish sector, mussels (63,700 tons) and cockles (36,500 tons) are the main species.

Companies engaged in the production of shellfish make up over 50% of the total number of farms and contribute with 64% of the total aquaculture production. The aquaculture sector is dominated by small enterprises with fewer than five employees. Total employment in the sector comprises 4,920 people, with 3,000 full-time equivalents, which highlights the importance of seasonal work (FAO, 2023a).

Fish farming is divided into freshwater fish species and marine species. Production of fish from marine farming is 15,744 tons, and the main farmed species are sea bream (7,600 tons) and sea bass (6,800 tons). Freshwater fish farming takes place in the northern and central regions of Italy. The production of freshwater farmed fish is 41,243 tons, of which the most is rainbow trout (36,800 tons), followed by eels (1,250 tons). The cultivation of rainbow trout is of interest to producers and scientists in the partner regions of the ARGOS project.

Table 13. Main cultivated commercial species and % of the total number in 2020 in millions of euros (nominal value) and thousands of tons (EUMOFA, 2023b).

species	Value (millions of euros)	Percentage of total production value (%)	Quantity (thousands of tons)	Percentage of total production (%)
clams	141	36	50	41
trout	105	27	35	28
seabream	46	12	24	20
mussels	44	11	6	5
seabass	38	10	5	4
others	16	4	3	2

The Italian aquaculture sector consists of three important clusters:

1. Freshwater fish species
2. Marine fish species
3. Shellfish

Of the three mentioned clusters, the shellfish segment is the most significant in terms of total volume and value. In terms of volume, the freshwater fish segment is second, and marine fish species are third. In terms of value, the cluster of marine species is ahead of freshwater species. The majority of Italian fish production consists of freshwater species, especially trout, catfish and sturgeon. In particular, trout is the most popular farmed species and makes Italy one of the main producers in the EU, and a significant amount is exported to Croatia.

In sea and brackish waters, the most important cultivated species are sea bass and sea bream. Salt and brackish aquaculture also enables the cultivation of other smaller species such as sargo (*Diplodus sargus*), meagre (*Argyrosomus regius*) and mullet (Mugilidae). Of relevant importance is the Italian production of molluscs, which are usually grown in offshore farms, lagoons and in a few cases in earthen basins bordering fish farms (FAO, 2023a).

Currently, the aquaculture sector, after a phase of rapid production increase between the mid-1980s and late 1990s, is stabilizing. Competition has increased, and prices and margins have been significantly reduced, which requires additional efficiency in the productivity system and the introduction of new technologies. Moreover, the sector suffers additional costs associated with the implementation of environmental laws that oblige fish farms to reduce their environmental impact. In this sense, the absence of a special law on aquaculture that regulates this sector proved to be an obstacle to its development. Unlike Italy and numerous EU countries, aquaculture in Croatia has been regulated since 2017 by the Aquaculture Law (NN

130/17, 111/18, 144/20, 30/23). Such a law would also have the potential in Italy to improve the efficiency of the sector and reduce the current fragmentation of competences among different public entities. Passing such a law could contribute to the renewal of interest in the sector and anticipate new investments. Namely, in the period 2001-2011. Italian aquaculture fell by 37.2% in volume and 19.3% in terms of value. Due to the unfavorable environmental conditions of water and temperature and the increasingly pronounced consequences of climate change, the sector of shellfish production shows the largest decrease, -41% in volume and -18% in value. Market competition is responsible for a similar trend in the case of freshwater species, where the value has decreased by 36% and 37% in quantity (FAO, 2023a).

5. ANALYSIS OF THE FISH PROCESSING SECTOR

The tradition of the fish processing industry in Croatia lasts more than 150 years and is one of the first industries on the Croatian coast and islands. It was traditionally located along the coast and on islands near important fishing grounds in order to ensure a stable source of fresh raw materials and speed up production.

During 2020, data was collected on the fish processing industry of the Republic of Croatia for 2018 and 2019. In 2019, there were 34 companies operating in Croatia with fish processing as their main activity. Companies are divided into three segments according to the number of employees (1-10 employees, 11-49 employees, 50-249 employees), and the largest number of companies (17) and the largest number of employees is in the 50-249 employees segment. There were 7 companies in the segment with 11-49 employees, and 10 companies in the segment with less than 10 employees (Fisheries Data Collection Program HR, 2022).

In recent years, there has been a positive process of moving fish processing facilities to the hinterland of large fishing ports (especially Zadar and Split). At the same time, access to pre-accession instruments, and the opening of the EU market after 2013, and later EU funds (EMFF) provided an opportunity for the revival and further growth of the fish processing industry.

Fisheries management measures in terms of limited effort are already affecting the fish processing industry. Therefore, processing plants are forced to import raw materials to maintain their daily operations. The annual import quantity in the last five years is about 25,000 tons.

Canned fish is still the quantitatively predominant form of industrial fish processing. However, due to changes in eating habits and the demands of the domestic and foreign markets, there has been a significant increase in the production of fish products such as salted anchovies, frozen fish, smoked fish, fish marinades, etc. For many years, Croatia has been preparing salted anchovies for Italian and Spanish market. The production of salted marine fish should be highlighted, as it has increased significantly in the past decade.

The value of fish imports to Croatia has increased significantly in recent years, almost 50 million euros in just five years. The main imported products, in terms of value, are frozen squid, and the canned tuna and fresh salmon also make a significant contribution (Fisheries Data

Collection Program HR, 2022). Spain and Italy are the main suppliers of fish products for the Croatian market. Spain accounts for almost one third of the total Croatian fish import, while Italy accounts for 18% of that import.

Croatia reports an export value of EUR 190 million in 2017. Exports have grown by almost EUR 85 million over the past five years. By far the main trade partner is Italy, with more than 30% of the value of Croatian exports. Japan is the second largest destination country for Croatian fishery products, mainly taking fresh bluefin tuna for the sashimi market. Slovenia and Spain are also important importers of Croatian fishery products.

Croatia traditionally exports salted anchovies, and in recent years, increasing quantities of fresh sea bass and sea bream have been produced for export, mainly to Italy. Japanese imports of bluefin tuna from Croatia reached 2,800 tons in 2017, at a unit value of EUR 10.00 per kg. The total foreign exchange income from the trade of bluefin tuna with Japan is worth 26 million euros and thus plays a very important role in the Croatian economy (Jug-Dujakovic et al., 2020).

In Italy, the processing industry plays an important role. It is valued at 1.5 billion euros, and approximately 215,000 tons were produced in 2016. The fish processing industry relies heavily on imports. Prepared or canned tuna is the main product produced with a volume of 82,414 tonnes, followed by frozen whole marine fish products with 39,500 tonnes (EUROFISH, 2021b).

Considerable quantities of frozen products (mainly tuna) are imported into Italy as raw material for the processing industry. Considerable quantities of fishmeal are imported for animal feed. The processing industry has increased production since 2000, producing 100,000 tonnes in 2011, with a corresponding market value of EUR 600 million (ANCIT). The main processed products are tuna canned in oil (68,000 tons, which represents 70% of the total production); anchovies, salted and as fillets in oil (20,500 tons); and shellfish (2,400 tons). Most of the raw materials are imported, while little is available locally. Imports of manufactured goods are increasing, while exports are decreasing. Aquaculture products are mostly sold fresh and whole, but some products are processed, such as trout that are also sold filleted or smoked, and other smaller products are processed by fish farmers to add value to the product. According to Eurostat-SBS data, 5,936 people were employed in the Italian fish processing industry in 2020. The sector recorded an added value of 492.9 million euros, covering 2.1% of the added value of the total production of food products (European Commission, 2022a).

In 2021, the main products sold were "Prepared or canned tuna, mackerel and bonito, whole or in pieces (except minced products and ready meals)" and "Smoked fish (except herring, trout, Pacific, Atlantic and Danube salmon)" (European Commission, 2022b).

U 2021. glavni prodani proizvodi bili su „Pripremljena ili konzervirana tuna, skuša i palamida, cijela ili u komadima (osim mljevenih proizvoda i gotovih jela)" i "Dimljena riba (osim haringi, pastrve, pacifičke, atlantske I dunavski losos)" (Europaean Commission, 2022b).

6. ANALYSIS OF CONSUMPTION OF FISHERIES AND AQUACULTURE PRODUCTS

Global seafood production reached 179 million metric tons (MT) in 2018, with all but 23 million MT going for human consumption. As a result, average consumption rose to 20.5 kilograms per capita, the Food and Agriculture Organization of the United Nations (FAO) estimated in the 2020 edition of its biennial publication "The State of World Fisheries and Aquaculture." Global average consumption reached a record 20, 5 kilograms in 2019. Countries with the highest consumption include coastal countries such as Iceland or the Maldives, averaging more than 80 kilograms per person per year.

The fish diet shows significant differences between continents, regions and nations, and it also depends on the degree of economic development. Annual consumption per inhabitant in the world ranges from 1 kg to 100 kg. Consumption in coastal areas is higher than in continental areas. Fish consumption is influenced by: availability, price, population income, tradition, demographic and life trends. European and North American consumers eat more pelagic fish, while marine cephalopods are favored in Mediterranean and Asian countries. Out of a total of 100 million tons available for consumption in the world, only 6.3 million tons are consumed in Africa (7.8 kg per capita), while two thirds are consumed in Asia (14.1 kg per capita), and China with a consumption of 32.3 million tons (25.6 kg per capita) consumes as much fish as all other Asian countries combined. Per capita consumption in North America is 21.6 kg, in Oceania 2 kg, and in Europe 19.8 kg. Fish consumption is significantly lower in Central America and the Caribbean (9.3 kg) and South America (8.7 kg), (World Economic Forum, 2022).

It is estimated that in developed countries fish provides up to approximately 754 kJ (180 kcal) per inhabitant per day, and in underdeveloped and developing countries from 84 kJ to 126 kJ (20 to 30 kcal) per day. The share of fish proteins in the total protein consumption in the world is 14.9%. They provide more than 50% of the food needs in developing island states and in Bangladesh, Cambodia, Congo, Ghana, Equatorial Guinea, Indonesia, Japan, Sierra Leone and Sri Lanka. The average consumption of fish and fish-like products in underdeveloped countries (8.5 kg per inhabitant) is only a third of that in developed countries (28.6 kg per capita).

6.1. Consumption in Croatia

In 2020, the net supply of fishery and aquaculture products in Croatia amounted to 79,916 tons, of which tourists consumed 1,804 tons, and a total of 78,112 tons were available to residents of the Republic of Croatia. The product groups that are consumed in the largest quantities in the Republic of Croatia are fresh or chilled fish (23%), followed by fish fillets (17%), frozen fish (16%), prepared or canned (16%) and cephalopods (12%). Consumption of commodity groups with a lower percentage share include dried, salted or smoked fish (9%), crustaceans (3%) and molluscs (3%) (Ministry of Agriculture and Fisheries Administration, 2023).

In 2021, the net supply amounted to 92,391 tons, of which consumption by tourists amounted to 3,580 tons, which means that a total of 88,810 tons were available to the residents of the Republic of Croatia. In 2021, the distribution according to product groups is similar to that in 2020, the year we mostly consumed fresh fish (25%), followed by fish fillets (19%), cephalopods (17%) and frozen fish (13%) and canned (9%). These small changes are the result of consumption by tourists in 2021 who prefer fillets and cephalopods (Ministry of Agriculture and Fisheries Administration, 2023).

When the available net supply is divided by the number of inhabitants of the Republic of Croatia, which in 2021 was 3.879 million, the average consumption of fishery and aquaculture products per capita in 2021 was 22.90 kg, which represents an increase of 13.7% in compared to 2020 and 20% compared to 2019, when the average consumption was 20.02 kg/per capita. Improvements in the country's economic performance have resulted in greater demand for fishery products, partially satisfied by the growing aquaculture industry. Like neighboring countries, the Croatian consumer prefers fresh fish, in its whole form. Croatian consumers enjoy fresh sea bass and sea bream from its aquaculture industry. However, according to certain research, the consumption of farmed marine fish in the Republic of Croatia does not exceed 0.5 kg per capita. Based on the results of such research, it is clear that the national market requires targeted information and marketing activities in order to increase the consumption of cultivated products. In this sense, and in order to improve consumer perception of cultivated products, it is necessary to inform consumers about the advantages and characteristics of cultivation, create a national system for collecting data on consumer attitudes, consumption and market trends, and develop a system for performing economic analyzes inside and outside the sector (Jug-Dujaković et al., 2020).

For the tourism sector, several frozen products are on offer, especially frozen squid rings and frozen prawn products.

6.2. Consumption in Italy

The unfavorable decline of the Italian domestic economy caused a general reduction in food consumption, which also affected fish products. The current high fishing effort, together with increased production costs, due to increasing fuel prices and strong regulatory pressure from the EU, have brought the fisheries sector into a period of stagnation (FAO, 2023a).

The consumption of fish and marine products in Italy in 1998 was 28.4 kg per inhabitant. Fresh fish is the most frequently consumed product (84%). This share is significantly higher than the EU average (68%). Mollusks, cephalopods and crustaceans are also commonly consumed. In 2020, the consumption of fishery products was estimated at 29.99 kg per inhabitant (EUMOFA, 2023b). Regular consumers, that is, those who eat fishery and aquaculture products at least once a week, mostly belong to the age groups of 25-39 and 40-54 years. Young people (15-24 years old) are less inclined to frequent fish consumption in Italy, as well as in the EU-28. Italians mostly consume fresh fish, but processed fish (fillets) are consumed much more often (84%) than at the EU level (68 %, including the United Kingdom) (EUMOFA, 2023b).

7. FISH MARKET ANALYSIS

Global seafood demand has rebounded strongly post-Covid-19, adding USD 13 billion in trade in 2021, driven by growing demand for high-value seafood in the EU, the US, and China. This increasing demand for fishery and aquaculture products has positioned seafood as the most traded animal protein, with an estimated trade value of USD 164 billion in 2021. In 2021, seafood trade was approximately 3.6 times larger than beef trade (the second largest trade in animal protein), five times larger than global pork trade and eight times larger than poultry trade, indicating the importance of trade for the seafood sector (RaboResearch, 2022).

China is the world's largest exporter of fish and fish products, and their export value is 4.5 billion USD. The increase in Chinese exports since 1990 with an annual rate of 11% is a consequence of the development of the Chinese processing industry as well as the competitiveness of labor costs and production costs on the world market. At the same time, China is the eighth largest importer of fish and fish products with a value of 2.3 billion USD. In second place is Thailand with exports worth 3.7 billion USD, and in third place is Norway with 3.6 billion USD. It is followed by the USA with 3.3, Canada with 3.0 and Denmark with 2.9 billion USD. Industrially developed countries import 82% of total fish and fish products. The world's largest importer is Japan, which imports USD 13.6 billion worth of fishery products, thus participating with 22% in the total value of world imports. The USA follows with 10 billion, and of the EU countries, the largest importers are Spain (3.9 billion), France (3.2 billion), Italy (2.9 billion), Germany (2.4 billion) and Great Britain (2. 3 billion USD). Developing countries export a quarter of their production. Although the emphasized exchange of fish and fish products among developed countries, traffic is mostly directed from less developed to more developed countries. About 74% of imports are concentrated in three areas: the EU, Japan and the USA (Globefish, 2022).

Given that fish is perishable, more than 90% of international trade in fisheries is in fish products. However, thanks to technological progress (specially adapted tanks and containers, aeration and oxygenation), the turnover of fresh and live fish on the world market is increasing. For many developing countries, trade in fish and fish products is a significant source of foreign exchange earnings, and in addition, it enables employment and solving a number of social and economic issues. Many developed countries invest in processing plants in underdeveloped and developing countries, where production costs are lower. Without such investments, underdeveloped countries would have a hard time achieving hygienic, sanitary and other

market standards, such as consumer health protection measures, and guaranteed monitoring of fish products, from the catch of fish to the end consumer, etc.

Italy is one of the largest markets for fishery and aquaculture products in Europe, and most of the demand is covered by imports. It is the seventh largest market for imported fish and seafood in the world, and the third largest among European Union (EU) countries, behind Spain and France. The total import of fisheries and aquaculture products reached 1.37 million tons with a value of 6 billion euros in 2017. The trade balance is severely deficient at 5 billion euros, as exports reached only 270,000 tons with a value of 0.8 billion euros (EUROFISH, 2021a).

Wholesale is an intermediary stage in the distribution channel that buys in bulk and sells to resellers (eg retailers) rather than to consumers. In Italy, there are two main wholesale markets dealing with the sale of fish and fish aquaculture products, Rome and Milan.

Imports of fish and seafood into Italy have been approximately 7 times higher than exports in recent years. Spain is the main supplier of fishery and aquaculture products to the Italian market with a 20% share of total imports in 2017. Denmark and the Netherlands are also important suppliers to the EU, covering 12% of Italian imports. Cephalopods are the main import product with 18% of value, followed by canned tuna (10%), fresh salmon (5%).

Spain (17%), Germany (13%) and France (10%) received the vast majority of Italian exports of fishery and aquaculture products in 2017. Austria (6%) and the UK (5%) are other important EU markets. The main exports from Italy are live/fresh fish and prepared/canned fish products. Salmonids and shellfish are the most exported live/fresh fish products (EUROFISH, 2021b).

Croatia is one of the member countries of the European Union that exports more fish and fish products than imports, which is most expressed in value. According to data from the National Bureau of Statistics, the export of fish and fish products has been growing steadily since 2013, both in quantity and value, and in 2019 it reached 54 thousand tons and a value of 209 million euros. The import of fish and fish products increased especially in the period 2018-2019. and the quantity almost exceeded the export. However, the value of imported products is lower than the value of exports, mostly due to the large share of herring and frozen sardines imported for the needs of tuna farming. Almost 75% of fish and fish products were imported in 2018 and 2019 from five countries - Spain, Sweden, the Netherlands, Italy and Portugal, and over 82% of total exports refer to Italy, Spain, Slovenia, Albania and Japan. Other important

trade partners are France, Serbia, Argentina, Chile and Germany (Fisheries Data Collection Program HR, 2022).

7.1. Sale value of fisheries products

The size of the global seafood market was estimated at USD 160.2 billion in 2021 and is projected to reach USD 207.2 billion by 2030 (Straits Research, 2022).

The highest value of sales in the last decade was achieved in 2020 and amounted to 54.85 million euros, and the lowest in 2017, 50.17 million (Straits Research, 2022). The value of sales, in relation to the quantity, despite the variability, shows an overall upward trend since 2016. White fish recorded a total decrease in the amount of landings in the observed period, as well as bivalves and cephalopods. Cartilaginous fish and big blue fish recorded a stable amount of landings, while crabs and other organisms recorded an increase with greater importance in the increase of crabs due to the total quantity and value of sales. White fish, cephalopods and other organisms show a trend of increasing sales value, while crustaceans and shellfish show a significant decrease in sales value. Cartilaginous fish and big blue fish maintain stable sales values in the observed period. The EU's Common Fisheries Policy (CFP) sets rules for managing fisheries, protects living marine resources and limits the impact of fisheries on the environment. These include the setting of catch quotas, fleet capacity management, market and aquaculture rules as well as support for fisheries and coastal communities.

By 2010, the share of aquaculture in the total fishery production exceeded 21%, which is higher than the EU average of 20.4%. In the last two years, the share has decreased to 19%, mostly due to the decline in tuna and trout production, but also the increase in catches. In the past ten-year period, there has been an evident increase in the volume of exports of aquaculture products.

Considering that Italy represents almost one third of the world's consumption of sea bass and sea bream, Croatia has an exceptional competitive advantage in this respect due to its proximity. With a focus on the shelf life of fresh fish of ten days, it is extremely important that the time from catch to delivery to the end customer is as short as possible. The result of the above is precisely the advantage of Croatian breeders over those from Greece, Cyprus and Turkey. The same principle applies to the Central European market. A major additional option in Croatia is a stable and predictable growth in tourist consumption and the use of EMFF opportunities, as well as further work on marketing and branding. The quality of farming in

the Adriatic Sea compared to the main competitors is reflected in the stronger structure of fish meat with less fat due to the colder Adriatic Sea. Therefore, in addition to the mentioned freshness of the delivered goods, and with the marketing approach of Croatian producers, the image of better quality goods from Croatian farms was recognized, and thus the demand for the export of Croatian goods to Italy was increased. From the presented trends and analysis, it is clear that, in addition to the general analysis of trends, the categories of mariculture products should also be analyzed separately, so that in marine aquaculture, the figures for the cultivation and trade of "white" fish, tuna and shellfish should be viewed individually, since the cultivation of tuna with its quantity and value significantly changes the general picture of production in marine aquaculture (Jug-Dujaković et al., 2020).

Analyzing the trends for each type, the following can be concluded:

European sea bass: In the last 5 years, an average of 50% of the total sea bass production was placed on the domestic market, while the rest was placed on the EU market and exported, with a slightly higher price on the domestic market. The average price of exported seabass is 5.26 euros (the most exported to the ITA was fresh), while the average price of sea bass on the domestic market is slightly higher and amounts to 5.35 euros.

Sea bream: According to data, in the last 5 years there has been an increase in the export of sea bream, with a higher price on the domestic market compared to the EU market. In 2022, the average price of exported sea bream was 4.89 euros (the largest export was to the ITA in a freshly chilled state), while the average price of sea bream on the domestic market was 5.15 euros.

Tuna: tuna farming is a very important part of Croatian fisheries and is one of the drivers of the growth of Croatian mariculture. Tuna farming is based on the principle of using caught animals, so that almost the entire tuna catch of the Croatian purse seine fleet is placed in breeding cages. At the same time, most of the small bluefish caught are used as feed for farmed tuna. The annual value of farmed tuna is between 60 and 80 million dollars, and tuna is exported exclusively to the Japanese market. Thanks to tuna farming, Croatia has a positive export balance of fishery products. Production reached its maximum in 2006 when 7,669 tons were placed on the market, followed by a continuous decrease to 1,907 tons in 2012, due to increasing restrictions on tuna catches, only to improve the situation again in the last ten years. The total production of shellfish is placed almost exclusively on the domestic market due to low and inconsistent production. The opening of the European Union market is an opportunity for Croatian producers to further develop this farming segment, especially with regard to

mussel farming, which will require a significant expansion of production and the application of modern farming technologies.

Freshwater aquaculture: Most of the produced freshwater fish is intended for the domestic market (about 85%), although in recent years a large part of the product has also been placed on the EU market (Italy, Germany, Hungary, etc.). Based on the existing breeding capacities, with the current breeding technology in Croatia, it is possible to produce salmonid fish up to a maximum of 1000 tons per year. While the export of rainbow trout is negligible, there is an increase in the export of carp. Traditionally important markets for Croatian freshwater fish producers were the countries of the region, such as Bosnia and Herzegovina, Macedonia, Serbia and Montenegro; however, the entry of the Republic of Croatia into the European Union and the simultaneous exit from CEFTA resulted in unfavorable tariff conditions on the markets of those countries (Jug-Dujaković et al., 2020).

According to the data, and due to the way of breeding, and especially the way of feeding fish during the breeding cycle, the nutritional value of farmed fish is partly different from that of fish in nature, with negative connotations towards farmed fish, mainly considering the higher proportion of total fat in farmed fish and possible traces of antibiotics in meat. On the other hand, with regard to the consumption of wild fish, consumer skepticism is growing due to the deteriorating state of the wild stock, the occasional presence of heavy metals and other harmful substances in the waters due to pollution, and inconsistencies in nutritional value due to seasonal differences in diet, changes in locality, and differences in gender and age of wild fish. Consumers also doubt the freshness of wild fish, due to seasonal catches and storage methods. However, although a small difference in nutritional value between farmed and wild fish does exist, it can be considered negligible, especially if all the comparative advantages of farmed products are taken into account, such as the guaranteed consistent nutritional value of the product, strict control of the production process, stable and lower the price of the final product, guaranteed product freshness and the possibility of traceability. It is important to emphasize that in the Republic of Croatia, aquaculture products are tested for compliance with health safety in terms of bacteriological tests, and are also tested for the presence of residues of harmful substances (Jug-Dujaković et al., 2020).

In addition, ecological parameters are strictly monitored in fish farms, which guarantees a stable environment in which contamination is not tolerated, and at the same time the prevention of fish diseases has a positive effect on their well-being. So far, several studies have been conducted in the Republic of Croatia in order to gain insight into consumer attitudes about farmed versus wild fish. Among other things, the goal of these studies was to determine

the level of public awareness about fish farming, the most important reasons for existing dietary habits regarding fish consumption, as well as the basic reasons for preferring different types of fish. The results of the conducted research showed that as many as 8 out of 10 Croats choose wild rather than farmed fish, and only one in five Croats does not take as a fact prejudices about the quality of farmed fish compared to wild. As for the reasons for choosing wild fish compared to farmed fish, consumers often stated that they think that farmed fish is fattier, softer and has a weaker taste, while, according to them, the prerequisite for introducing farmed fish into the diet is lower price, lower fat %, increased variety, labelling, degree of processing and improved availability (Jug-Dujaković et al., 2020).

Italy is the seventh largest market for imported fish and seafood in the world, and the third largest among European Union (EU) countries, behind Spain and France. The total import of fisheries and aquaculture products reached 1.37 million tons with a value of 6 billion euros in 2017. The trade balance is severely deficient at 5 billion euros, as exports reached only 270,000 tons with a value of 0.8 billion euros (EUROFISH, 2021).

8. ANALYSIS OF GLOBAL TRENDS IN FISHERIES

According to FAO data, 15% of the live stocks of all types of fish in the world's seas have already been overfished, and further reductions in their catches can be expected in the future. A significant increase in catches can only be expected for 25% of economically important species, mainly pelagic bluefish. It is significant that 25% of the fish catch is processed into fish meal. Due to the decrease in catches and the growing demand for fish and fish products, an increasing share of farmed marine products is expected in direct consumption. In marine catch, there are considerable differences between regions. While the catch is increasing in the tropical areas of the Indian and part of the Pacific Ocean, it is noticeably decreasing in the northern and southern parts of the Pacific Ocean and the Atlantic. Global consumption of fish for food is projected to increase by 1.3% per year, a significant decline from 2.3% per year. growth rate recorded in the previous decade. This decline reflects a slowdown in demand caused by lower incomes at the start of the decade, reduced population growth and lower world prices for meat, particularly poultry. Global apparent fish consumption is projected to reach 21.2 kg per capita in 2030, up from 20.5 kg per capita in the base period. Fish consumption per capita will increase in Asia, Europe and the Americas, while it will remain stable in Oceania and decrease in Africa, the continent with the fastest growing population, which will outpace the growth in the supply of fish for food. This increase is associated with a growing human population and economic growth accompanied by an improvement in living standards and an increasing demand for healthy food (OECD-FAO, 2023). Food with highly unsaturated fatty acids (→ fatty acids) such as fish, especially blue fish, can significantly reduce the risk of heart and blood vessel diseases, so an increase in the consumption of fish, with a desirable composition of fatty acids, is expected on a global scale. Fish and fish-like products are above all healthy and high-quality food, and are a source of livelihood for a part of the population employed in fishing, processing, transport, services, etc. Living resources can increase in biomass and abundance up to a level determined by biological and environmental constraints. Reproductive growth of fish communities requires an adequate number of sexually mature individuals and favorable ecological conditions for the development of early developmental stages, and therefore oscillations in biological resources are largely caused by variable ecological factors relevant to recovery. In conditions without exploitation, fish biomass will increase to an average maximum level, limited by the capacity of the given ecosystem, which is subject to changes due to changing environmental conditions, but also due to human activities such as pollution, changes in river flows, destructive fishing tools, etc. The improvement of the quality of the water area, the control of predators and the construction of artificial underwater cliffs certainly have a positive impact on the habitat

capacity. Reasonable and responsible fishing implies a balanced relationship between the maximum allowable catch and the natural increase of living stocks. This does not mean that, for example, the annual catch must never exceed the annual increase. However, the catch must not exceed the maximum allowable level because the costs of hunting would exceed the benefit achieved by fishing. Reckless state interventions (various subsidies) that encourage unreasonable fishing lead to overfishing of commercially important species, and can cause biological and economic collapse. In order to avoid overfishing of fish communities as a whole, it is especially important to pay attention to preserving the composition of communities so that the predator-prey relationship is not severely disturbed. Equally, multi-year fishing of certain parts of populations (eg continuous fishing of larger individuals) can cause a decrease in the frequency of certain genetic traits. In this particular case, a joint approach (of Italy and Croatia) to the regulation of fishing activities and the management of marine resources is necessary, given that we share the same sea, that is, the same marine ecosystem (https://www.enciklopedija.hr).

A special problem is the strategy of the so-called sustainable fishing in the Adriatic, which is abundant in many economically significant species. It is almost certain that the fishing of one species will affect others, either by accidental catch of non-target species (by-catch), or by disturbed prey-predator relationships in a complex food chain. Changing the representation of either predator or prey populations will change the relationships of non-target species, but also disrupt biodiversity as a whole. That is why when managing fishing in which a large number of species are represented (multi-species fishing) it is not possible, nor should it be counted on catching the maximum allowable yield of each species, because this surely leads to overexploitation of certain species and a reduction of biodiversity as a whole. Regulation of fishing activities is the most common measure to preserve fish stocks. By gradually reducing fishing, by reducing the allowable total catch, we try to achieve a biological effect, without significantly harming the social and economic conditions of fishermen.

In March 2023, the European Commission published an Action Plan: Protecting and restoring marine ecosystems for sustainable and resilient fisheries as part of a set of measures aimed at improving the sustainability and resilience of the EU fisheries and aquaculture sector. This action plan is designed to strengthen the support provided by the Common Fisheries Policy to ensure that healthy fish stocks and rich levels of biodiversity are sustainable in time in our oceans. The main actions presented are aimed at reducing the negative impacts of fishing activities on marine ecosystems, especially those related to bycatch of sensitive species and its consequent effects on marine food webs, and to increase the selectivity of fishing gear.

On the other hand, the action plan aims to reduce seabed disturbances caused by fishing gear in protected areas, and the Commission calls on member states to gradually reduce mobile demersal fishing in all protected areas by 2030, as well as to ban it in newly established protected areas. areas. It is important to note that seabed habitats located within protected areas play a key role in the protection of marine biodiversity, as they often represent hotspots of biodiversity and act as reservoirs of blue carbon that are very necessary in the fight against the effects of climate change (EC, 2023).

The program of scientific monitoring of commercial fishing at sea in 2022 was carried out by the Institute of Oceanography and Fisheries in Split, within the framework of the National Plan for collecting data in fisheries of the Republic of Croatia. The program included the collection of biological data at landing sites and fish markets, and sampling at sea by scientific observers on fishing vessels. In addition to fisheries-dependent data collection, the Institute of Oceanography and Fisheries has conducted a comprehensive program of independent scientific research on demersal (MEDITS, SoleMon) and pelagic (MEDIAS) marine resources. The scientific data collected and analyzed in this way are used to evaluate the state of exploited marine resources and the marine ecosystem, to evaluate the balance of different segments of the fishing fleet with available natural resources, and to evaluate the effects of fishing on the ecosystem. In addition to this basic monitoring program, the following scientific studies were conducted in 2022:

- Scientific monitoring of the recreational catch of bluefin tuna at fishing competitions and catching trophy specimens
- Scientific monitoring of eel in commercial fishing at sea
- A study of the influence of coastal trawl nets on the habitats of Posidonia seagrass meadows
- Monitoring the impact of fishing on the protected fishing area in the Jabuka basin
- Study of the assessment of the impact of fisheries on the accidental catch of sensitive species in the economic and recreational fishing

9. ASSOCIATION OF FISHERMEN AND FARMERS IN ASSOCIATIONS, COOPERATIVES AND PRODUCTION ORGANIZATIONS

9.1. Fishing cooperatives

In the Republic of Croatia, in Official Gazette (NN) No. 115/2022, a new Ordinance on recognition of fishing cooperatives was published. Thus, the old Rulebook from 2010 ceases to be valid.

The news are mostly simplifications regarding recognition, but what is particularly important is that all Fishing Cooperatives recognized in accordance with the Ordinance on Fishing Cooperatives (NN 48/2010) will have to apply for Recognition of a Fishing Cooperative in accordance with this Ordinance within from 6 months from the date of entry into force of this Ordinance, i.e. until April 12, 2023. If an already recognized fishing cooperative does not apply for recognition or it is determined that it does not meet the conditions for recognition in accordance with this Ordinance, the Ministry will revoke the existing decision on recognition.

News in the rulebook:

- Previously, it was a requirement that the cooperative must have at least seven members, namely holders of a fishing privilege or holder of an aquaculture permit, and for the activity of fishing there is an additional requirement of at least 60 fishing days per year for each holder

- In the new rulebook, a cooperative can be a fishing cooperative if it has seven members authorized for commercial fishing privileges or only three members who hold an aquaculture permit, although according to the Cooperatives Act it must still have at least seven founders.

- A cooperative that has fishermen as members must be registered as the first buyer.

- Cooperative members may be members of ONLY one fishing cooperative

- According to the new rulebook, the cooperative is allowed to sell more than 80% of the total financial value of the fish sold to the same customer on an annual basis (under the old one, it was not allowed)

- According to the old rulebook, fishing cooperative members had to sell at least 20% of their total sales through the fishing cooperative in the first year after recognition and 80% in the second year after recognition and every subsequent year. With the new rulebook, this is no longer a requirement.

- According to the old rulebook, the members of the fishing cooperative were not allowed to carry out the activity of wholesale fish trade, unless they sold fish from their own catch. With the new rulebook, this is no longer a requirement.

- According to the new rulebook, it is no longer necessary to submit the business and economic plan of the fishing cooperative to the Ministry.

- Pursuant to the Law on Cooperatives, the founding assembly of the cooperative nonetheless adopts rules that are the founding and basic general act of the cooperative. They contain provisions on the method of acquiring membership, stakes, responsibilities of members, use of profits and other issues related to the operation and work of the cooperative.

The first cooperatives in Italy were created in the 19th century, as in most other European countries, and their goal was to supply producers with affordable raw materials and introduce them to new technologies. The central role in the development of cooperatives was played by the National Federation of Agricultural Unions, founded in 1892, as a cooperative and supplier of goods and services to the entire agricultural sector. Also, various political parties were involved in the development, and encouraged cooperatives. In their beginnings, Italian agricultural cooperatives were focused only on the domestic market. With the entry into the European Union, this changes and Italy becomes a food exporter, and cooperatives significantly participate in international trade with other member states of the European Union.

9.2. Producers' organizations

There are four registered Producer Organizations (PO) among fishermen in Croatia. One of them, PO "R.Z. Omega 3", brings together 16 individual fishermen and several companies from Kali, which together have 21 fishing boats. Fourteen of them hunt exclusively for the needs of the cooperative. This PO is the leader in the production of frozen bluefish in Croatia, with an annual turnover of around EUR 10 million. It capitalized on its association by building a production plant in the Šopot business zone near Benkovac, using more than HRK 25 million from EU funds.

In Italy, 49 producer organizations (PO) and 2 producer associations are officially recognized. Their role is to contribute to the achievement of the objectives of the Common Fisheries Policy (CFP) and the Common Market Organization (CMO) through the collective management of the activities of their members. Out of 49 POs, 35 operate in the fisheries sector, and 14 in aquaculture. Two associations of producer organizations operate in the fisheries sector (DG MARE, 2022).

9.3. Analysis of the possibility of establishing Producer Organizations in Croatia

Despite these few examples of successful association and business in fisheries, there are no POs among aquaculture producers in Croatia. In the last 20 years, financial incentives for organizing producers in aquaculture have led to the formation of numerous cooperatives (eg cooperatives "Malostonska kamenica" and "Mirna luka" from Dubrovnik-Neretva County). Although these are voluntary, open, independent and independent organizations managed by their members, financial incentives for association without considering common interests and without business planning and a realistic management framework were not sufficient to maintain this form of organization.

Associations, as a form of free and voluntary association of members without the intention of making a profit, are more widespread among producers in Croatian aquaculture. The largest of them, "Klaster Marikultura", is an association of marine organisms breeders that includes more than 90% of producers in Croatian mariculture and has been operating successfully for almost 20 years. The association operates through 3 working groups:

- group of tuna farmers,

- group of white fish breeders,
- group of shellfish growers,

without organizational structures within them. In freshwater aquaculture, producers of warm-water fish and producers of cold-water fish are organized only through the Chamber of Commerce, and there is only one cooperative of trout producers in the country.

Although most producers are aware of the existence of the Ordinance on Producer Organizations, this form of organization is still not used among aquaculture producers. The limited experience with cooperatives and the "loose" organizations that currently exist support traditional approaches to industry in which small producers compete with each other in local markets and rely on existing market niches. In addition, among manufacturers there is a general aversion to change, such as innovations in business or transformation of distribution channels. However, everyone is interested in growing their own production, expanding the domestic market and exploring export markets, aware that they cannot do this individually.

Despite everything, we can state that there is interest in the formation of PO among producers in Croatian aquaculture. This interest includes a diverse group of producers: i) existing well-organized small cooperatives and associations (eg shellfish producers and collectors in Istria) who want to improve their competitive position and sell directly on the domestic market and not through distributors; ii) large aquaculture companies that gather their current business partners (eg producers of carp, grass carp, catfish, pike, perch) and ; iii) groups of producers within a certain geographical area (e.g. shellfish producers in the Malston Bay in the Dubrovnik-Neretva County) who are currently competing with each other on the local market and are seriously considering exporting, iv) organizations with a wider range of products that combine commercial fishing and aquaculture.

Different situations, problems, business history and challenges require different approaches to the formation of producer organizations. Each producer group includes different technical and technological features of the aquaculture sector, socio-economic characteristics of the region, target market, competition, technological and business education and vision of future business development. Analysis of the characteristics of different groups, a clear understanding of the business development vision (formulation of a business development plan) and guidelines on regulatory requirements for producer organizations are key steps in the producer organization process in PO.

Acquaintance with the experiences of Italian colleagues in founding and managing cooperatives and producer organizations, or in general the association of fishermen and growers, which has many years of positive experience in Italy, could be achieved through visits, education and familiarization with the advantages of various forms of association.

9.4. Encouraging the establishment of production partnerships between producers and buyers

It is necessary to encourage the connection between producers and customers, as well as other interested partners, with the aim of improving existing and developing new distribution chains for fishery products, in order to improve their market placement. It is necessary to encourage investments in the improvement and expansion of production capacities for fisheries and aquaculture products, along with the improvement of processing and the strengthening of marketing activities, in order to encourage the development of new value-added products with a focus on different consumer groups. Accelerate the introduction of recognized commercial certification programs in order to facilitate the placing of products on the market, as well as business models and forms of cooperation that will increase the consumption of fishery and aquaculture products on the domestic market. In this regard, it is necessary to support the organization of partnerships between producers and institutional buyers, such as schools and kindergartens, which will encourage the creation of healthy eating habits among the youngest ages and familiarization with fishing activities. It is also necessary to establish an internet platform that will enable communication and the exchange of information between all relevant stakeholders, with the aim of encouraging joint initiatives between producers, processors and buyers.

10. EDUCATION, RESEARCH, AND INNOVATION IN FISHERIES

10.1. Education and research

According to the Croatian scientific categorization, fisheries (aquaculture and fisheries) belong to the biotechnical group of sciences, the field of agriculture, the branch of fisheries. In a broader sense, research and education in fisheries also includes areas related to veterinary medicine, life sciences, food and water technology, environmental protection, etc.

Scientific research in fisheries is carried out by institutions registered to perform scientific activities. Education is provided at universities, while some study programs include employees from research institutes. In general, six universities, located in all parts of Croatia, provide education related to undergraduate, graduate and doctoral programs at their 10 faculties or departments. Many of these courses, modules or studies include only basic knowledge and skills.

According to the National Standard Classification of Education (NSCE), the fishing activity in the narrow sense belongs to the sixth educational group which includes agriculture, forestry and fisheries. According to the scientific categorization, aquaculture belongs to the biotechnical group of sciences, the field of agriculture, the branch of fisheries. In a more general sense, education includes groups related to veterinary medicine and natural sciences, and according to the categorization of science, aquaculture is also included in the field of food technology, and the field of natural sciences, the field of biology. Aquaculture education in the Republic of Croatia is carried out by academic institutions, and the information and educational system carried out by the Directorate of Fisheries and the Advisory Service of the Ministry of Agriculture.

Educational institutions that have courses, modules or studies as part of their programs are located in all areas of the Republic of Croatia. This enabled a coordinated approach to creating a strategy for the education system in aquaculture, which today is still fragmented and mostly includes only basic knowledge and skills. In the Republic of Croatia, there are not enough specialized and interactive programs that would integrate basic technological and biological knowledge into business ventures ranging from managing technological processes to designing and creating business plans. Practical application of knowledge and skills is carried out by experts trained in the Republic of Croatia. On the other hand, research and development and scientific institutions in the Republic of Croatia have long-standing

cooperation with institutions in other countries (both in the EU and in countries outside the EU), which in the past guaranteed the successful transfer of knowledge, technology and technological solutions.

Due to many years of experience in production itself, the cooperation of business entities with manufacturers in other countries also helped in the process of transfer of knowledge and technologies. Cooperation with scientific and state institutions and business entities and associations of producers from neighboring Italy should be emphasized here. Specific education and information in aquaculture and fisheries is carried out by competent state institutions. These are primarily the Ministry of Agriculture and its Advisory Service, and occasionally other institutions, such as the Agency for Payments in Agriculture, Fisheries and Rural Development and the Croatian Chamber of Commerce, which has been providing international economic and scientific advice on aquaculture for almost 10 years and financed the publication scientific and professional magazine Croatian Journal of Fisheries. Education and information is provided through lectures, workshops and consultations, as well as through publications, brochures, media and the Internet. But the framework of lifelong learning has not yet been defined. Scientific research in aquaculture is carried out by institutions registered to carry out scientific activities, as well as commercial companies that perform breeding activities.

The main characteristic of these scientific and educational institutions is that many of them carry out mainly fundamental research due to the lack of experimental facilities. Furthermore, the connection with industry is limited, i.e. a limited number of applied, developmental and technological research is carried out directly with the aim of solving the problems of producers or fisheries (NSPA 2014-2020). Although the number of reported projects has increased in the last decade, they are still fragmented and localized, and the flow of information between these institutions and other stakeholders is limited. Many projects and study programs are carried out as part of local strategies, and there seems to be a lack of organized coordination and a strategic approach at the national level.

In order to ensure the connection between scientific/research institutions (universities and research institutes) with the industrial sector, the establishment of strong Production organizations, fishing (fishing and aquaculture) technological and business innovation centers where experimental and demonstration facilities would conduct research and practical training/consulting of workers and students in the fisheries sector. The task of these institutions would be to examine existing technologies, develop innovative technologies, encourage the application of new technologies and their transfer to interested entrepreneurs,

and provide practical training for students and staff who would become the bearers of the development of Croatian fisheries.

Such technological institutions, which are rare in our region, should be professional, educational, and technological support for industry in the development of new technologies and encouragement of entrepreneurship. On the other hand, they provide the possibility of the necessary practical technical and technological education of workers, students, and young scientists. This closes the circle: science - technology - industry.

Technological institutions serve the industry by directing part of the scientific research to the needs of the industry, and educational institutions to the necessary change in the education of students at demonstration, production, and demonstration facilities. This concept would ensure further strengthening of human and technological competences, which will ensure an increase in the competitiveness of national aquaculture and fisheries, and:

1. To improve the connection of small producers and processors with domestic and international markets. The industry is too fragmented, it is difficult to achieve economies of scale in marketing Coordination of activities in the value chain.

2. Strengthen producer organizations, including those lower in the value chain (e.g. primary processing)

3. Facilitate commercial partnerships between producers, processors, wholesalers and retailers, especially in the high-value product segments: fresh, convenient products, products of origin and special products.

In the sphere of marketing, with education, training and cooperation of all stakeholders, it would be possible to solve some clearly identified relevant factors of the success of the fishing industry:

- Support the development of new market opportunities in high-value product segments
- Marketing too focused on lower value products
- Inadequate attention to innovative marketing solutions
- Facilitate access to domestic (tourism) and export (Italy) higher value markets, including "niche" markets, where it is possible to achieve higher prices

- Expand product differentiation, including through additional recognized certifications
- Encourage the development of new marketing methods to increase the consumption of aquaculture products
- Promotion of "food destination" tourism

10.2. Innovations in the fisheries sector

Innovations in the fisheries sector in Croatia defined in the Ordinance on conditions, criteria, and method of awarding support under measure I.1.

"Innovation", according to regulation (NN 83/2018a), means the activities of introducing or developing new or significantly improved products and equipment, processes, techniques and management systems and organizational systems related to commercial marine and freshwater fisheries, including processing and marketing of p fishery products on the market.

"Significant improvement" is defined as an improvement that does not simply mean an improvement of minor importance, made on the basis of existing and already known technologies/methods/techniques/equipment/products.

"Research fishery" is fishing that involves the use of tools, equipment or instruments to identify, locate and increase the catch of target species. The aforementioned Ordinance establishes the conditions, criteria and method of awarding support within the framework of European Union Priorities.

"Promotion of ecologically sustainable, resource-based, innovative, competitive and knowledge-based fisheries".

Acceptable activities are activities that are carried out for the purpose of development and/or introduction:

- New or improved methods and techniques, including methods and techniques to improve the selectivity of fishing gear, reduce unwanted catches and/or discards and reduce negative environmental impact

- New or significantly improved equipment

- New or significantly improved products
- New or improved management and organization systems
- Increase production value while maintaining or reducing production volume

Innovations include technologies that mitigate the occurrence of animal diseases or parasites or that reduce or eliminate the use of antibiotics to treat animals; technologies that improve production efficiency at the hatchery or farm level while mitigating environmental impact; advances in recirculation technology at sea or on land; new feed ingredients; reducing the carbon footprint through improved energy efficiency or regeneration; and social programs designed to improve living and working conditions on the farm or at the processing level (https://www.aquaculturealliance.org).

Aquaculture, like any other food production practice, faces challenges for sustainable development. Recently, traditional aquaculture techniques have been labeled as "polluting" and "unsustainable". Most fish farmers are constantly looking for ways to improve their production processes, make them more sustainable, efficient, and profitable. Sustainable aquaculture is a dynamic concept, and the sustainability of an aquaculture system depends on the species, location, social norms, and the state of awareness, knowledge, and technology. But for a system to be truly sustainable, it must include ecological, economic, social, and community sustainability. Fish farming should not create significant disruptions to the ecosystem, cause loss of biodiversity, or result in significant pollution of the Sea to be socially responsible and contribute to the well-being of the community, but at the same time it must represent a sustainable business with long-term prospects. In traditional aquaculture, fish can be raised in open waters such as lakes, estuaries and coastal bays, where they can be fed naturally available nutrients, or in inland ponds, where they can be fed farm by-products. The main problem with such an approach is that these systems are usually not economically viable. COFI emphasized the need to increase fish production in inland waters through integrated aquaculture and agriculture systems and integrated use of small and medium-sized water bodies. Another sustainability issue is the method by which facilities process and discharge organic waste so that the resulting discharge does not affect the surrounding ecosystem. The solid waste produced by fish grown in net floating cages that falls to the seabed below the fish cages is enriched in carbon, nitrogen and phosphorus compared to natural sediments, therefore fish farming can significantly change the physicochemical composition of natural

sediments in the area below. When waste by-products from any open aquaculture system are discharged directly back into the water column, it cannot be considered a sustainable practice or system.

There are other aquaculture systems that have effective waste management practices, such as integrated multitrophic aquaculture (IMTA), recirculating aquaculture (RAS) or aquaponic systems. Aquaponics refers to any system that combines conventional aquaculture with hydroponics, a method of growing plants in nutrient-rich water instead of fertilized soil. The successful operation of such systems can compensate for the reduced catch of fishing grounds, while also providing a significant level of environmentally friendly agricultural revitalization and employment in urban and rural areas. A comprehensive development program for waste management is needed, which defines the complete processing, processing and recycling of waste generated in their production systems of aquaculture and aquaponics. These technologies reduce water use and remove, process and recycle solid and liquid waste through cogeneration of energy and recycling of organic nutrients. By using these innovative technologies and proper management, by-products of food production and waste reduction can be used for the production of biogas, biodiesel, substances for the pharmaceutical and cosmetic industries, while increasing financial stability and profitability of business (Gavrilović and Jug Dujaković, 2018).

The new European Maritime and Fisheries Fund (EMFF) is part of the Multiannual Financial Framework 2021-2027, the EU's new long-term budget that entered into force on 1 January 2021. The proposed budget combines new instruments with modernized programs to deliver efficiency on priorities of the European Union and responses to new challenges. The new ERDF 2021-2027 continued to support the European fisheries sector towards more sustainable fishing practices, with a particular focus on supporting small-scale fishermen. It will also help unlock the growth potential of a sustainable blue economy towards a more prosperous future for coastal communities. For the first time, it will contribute to strengthening international ocean governance for safer and cleaner, more sustainably managed seas. Finally, the Commission is strengthening the impact of the Fund on the environment with a focus on the protection of marine ecosystems and an expected contribution of 30% of its budget to climate change mitigation and adaptation, in line with the commitments agreed under the Paris Agreement (http:/ /europa.eu/rapid/press -release_IP-18-4104_en.htm).

11. PROBLEMS, NEEDS AND WILLINGNESS FOR COOPERATION

11.1. Fisheries sector

11.1.1. Croatia

After holding four workshops and a series of individual consultations with fishermen whose goal was to determine the real problems and needs of the sector, all participants in the consultation agreed that it is necessary to improve overall sustainability. They emphasize the importance of environmental sustainability, as the first thing that comes to mind when talking about sustainability, i.e. the protection of fish stocks and biodiversity for the sustainability of the entire sector. But in addition, about 20% of them emphasize the issue of improving energy sustainability, while all of them emphasize numerous problems related to socioeconomic sustainability. Namely, fishermen believe that the viability of this sector is questionable from an economic side and the lack of qualified labor that they are currently facing. They also point out that the number of young fishermen who would continue fishing is extremely small, which threatens the sustainability of the entire fishing sector. Therefore, they believe that the basis for preserving and improving the sustainability of fishing is to solve the above-mentioned problems, which are a prerequisite for discussing environmental sustainability.

Fishermen are also aware that the sustainability of the sector is affected by illegal fishing (fishing without privileges) and insufficient control of sport and recreational fishing. Although they emphasize that these controls have been increased in the last two or three years, they believe that this increase is still insufficient. Namely, illegal fishing encourages the reduction of fish prices and reduces their competitiveness on the market, resulting in the non-declaration of part of the catch (which is a much smaller problem from their point of view).

With the emphasized interest of all consulted for cooperation, the general opinion is that study stays should be better organized, taking into account the involvement of as many fishermen as possible from both sides (Croatia and Italy) and the timing of the organization (when fishermen and breeders have less work and can afford going on a study stay or an educational workshop).

Related to inquiries about cooperation with scientific research and educational institutions, all participants of workshops and consultations emphasized the importance of such cooperation, as well as the fact that they would like it to be improved and include more problems they face. They also emphasize that very often it is about their cooperation with individuals from the science sector, and it would be desirable to determine individual, and not just institutional competences, so that they know who to turn to for specific problem they have.

Regarding the cooperation with the Ministry, while emphasizing the importance of the educational workshops organized by this body, the fishermen expressed their desire that, within the framework of bilateral cooperation with Italy, representatives of the competent body also participate in study stays and become better acquainted with the real picture on the ground. In this sense, the majority of fishermen believe that a greater presence of employees of this body in the field would contribute to a more effective and faster joint solution to specific problems of the sector. In addition to joint participation in bilateral study stays, they believe that such workshops with practical examples and joint work in the field would be desirable to organize at the national level as well. Table 14 shows the key problems and needs of the fisheries sector in Croatia.

Table 14. Overview of the key problems and needs of the fisheries sector in Croatia

PROBLEMS	NEEDS
Administration and bureaucracy: - complicated and extensive, takes a lot of time - older fishermen have difficulty coping with the use of IT technologies	Educate, but also simplify the administration without avoiding any legally prescribed measures. To see/learn the experiences of Italy and whether they came up with simpler solutions and procedures. Fishermen believe that this is possible through study stays where they will have the opportunity to see how their Italian colleagues do it. After that, coordinate the problems with the competent authorities and try to find simpler solutions.
Legislation: - a reduction in catches is demanded, which calls into question the survival of the fishery. In this sense,	Through study stays that will represent direct contact with fishermen in Italy (Puglia), see the way of implementing regulations related to fishing tourism, but

fishermen emphasize that they are aware of the need to diversify their activities, especially fishing tourism. However, they point out that the regulation related to fishing tourism is complicated and almost unenforceable. - Complicated conditions for direct sales from the ship, which they do not see the purpose of. They believe that a small catch can be solved without complications through the fiscal cash registers. - Compensation for damage from dolphins for loss of catch, but no compensation for damage to tools. - - The legal position of fishermen, the method of income taxation and the regulation of salary tax	also the way in which the problems that concern them related to conformity in the legislative framework have been solved in Italy. The fishermen suggest that the employees of the legislative institutions take part in the study stays with them, and that they jointly analyze the needs and try to solve the problems. In particular, they highlight the analysis of the position of fishermen and legal regulations related to salaries, taxes and eventual benefits, which could greatly contribute to their economic sustainability.
General lack of skilled labor	Design and organize educations that would be aimed at the initial steps in fishing, that is, find the correct "modus operandi". Education must be simple and practical. In addition to carrying out fishing operations, it is necessary for workers to be trained in boat maintenance and safety at sea. A smaller number of fishermen started to "import workers" from other continents due to the lack of labor in Croatia. They emphasize the complicated legal procedure, for importing labor which requires a lot of time and should be explained to interested fishermen through workshops. They also believe that these procedures could be simpler and proceed faster.
The problem of rejuvenating the sector (not enough young fishermen)	Most of the current fishermen are engaged in fishing by passing on the "craft" from

	older generations, and there is no education for beginners. Organize educations that would be focused on the initial steps in fishing and at the same time find ways to attract new fishermen (increase the attractiveness of the sector). Educate younger fishermen in a simple way about the importance of protecting marine resources so that they can survive from fishing in the future (quotas, minimum catch sizes, rational management of fish stocks). However, it is necessary to create legal conditions so that they could survive economically even with a reduction in fishing effort. Fishermen believe that through competent lecturers, part of the training could be carried out in cooperation with HOK and the Association of Small Coastal Fishermen of the Adriatic.
Merketing	During the study stays, see the experiences of fishermen in Italy. So far, work has been done on promotion and development of brands, however, more practical workshops are needed. A significant part of the fishermen believes that their involvement in marketing activities is necessary and they propose the organization of practical trainings for the establishment of web sales and marketing through social media. Such initiatives have been partially implemented in the Primorje-Gorski Kotar County through LAGUR (Local Action Group in Fisheries), but they need to be continued.

	In addition, a few younger fishermen have established advertising and sales via Facebook, but for the vast majority this is still an unknown and it is necessary, in addition to practical workshops/educations, to conduct preliminary educations where the advantages of using social media will be explained to fishermen. It is also necessary to introduce the mentioned method to the general public, i.e. customers.
Different types of safety and quality improvement: - development of new products - procedure with fish from catch to final consumer - increase in added value - So far, vehicles with cooling devices have been purchased and investments have been made in fish markets, which is necessary, but more can be done.	During study stays, see and discuss the process with fish from catch to final consumer. Fishermen are clear about the legal regulations, however, they would like to see this procedure in practice in other places, as well as learn about the practical solutions of their Italian colleagues.
Market	Compare prices and the way they are regulated
- Innovative projects: - modernization of tools and product development - Improvement of energy efficiency (sustainability) on ships (solar panels, new and efficient engines on ships especially smaller up to 12 m, etc.). Namely, Croatian fishermen especially complain about the impossibility of increasing engine power, which directly affects their economic viability. - Possibilities for solving waste problems	Introducing new and improved tools that improve fishing efficiency and sustainability. Fishermen believe that tools and improvements should be presented and demonstrated in the fishing process, and that only theoretical presentation and lectures are not enough and do not serve the purpose. Regarding engine efficiency, it would be necessary to educate them about engines that can increase efficiency, how to choose, and what to buy.

Projects (guidance and education) While the majority of fishermen believe that in the current situation they do not have time to write project applications and therefore pay that part of the work to consulting companies, there is a significant part of those who would like to learn how to fill out a project application and prepare documentation.	Part of the fishermen (about 30%) wants education about EU projects and continuous establishment of ways of informing about possible financing programs. They also want to hear/see the experiences of Italian fishermen and how they deal with it. Also, part of the fishermen believe that it is necessary to activate the LAGURs, which were established to support fishery, for this work.
The entry into the EU and the globalization of the market intensified the reduction of the competitiveness of local products. Although certification of local products has been initiated at the national and international level, they believe that this is still insufficient. They believe that economic measures should protect the national market. Više o ovom izvornom tekstuZa dodatne podatke o prijevodu potreban je izvorni tekst Pošaljite povratne informacije Bočne ploče	Find out how they solve this problem on the Italian side.
There is no solution for plastic waste, which is mostly collected by trawlers. Fishermen have nowhere to put it.	A rare positive example is Lošinj, as a small part of the Primorje-Gorski Kotar County, where the problem is solved in such a way that the local administration, which installs containers, pays for the removal of waste from the sea, and part of the waste is collected and disposed of with the help of the "Plavi svijet" association.
Illegal fishing (without privileges) – solve, because otherwise the fisherman who tries to comply with the regulations will suffer	We should hear experiences from the Italian side

Bookkeeping and procurement of raw materials	These are topics that around 30% of fishermen believe would be effective for increasing economic sustainability.
Association: Croatian fishermen are aware that the method of association is scarce and that it is difficult to implement it on the territory of Croatia, but they are also aware that it is necessary to design and start this process. It is clear to them that cooperatives in Italy have a 100-year tradition, but also that they need to get to know it in detail in order to strengthen the awareness of its importance here as well and to create a critical mass that would one day be the initiator of such an association.	Familiarizing in detail with the forms of association in Italy and their benefits (how to solve administrative problems, how to jointly apply for EU funds with the help of cooperative employees who are competent for these tasks, joint appearances on the market, procurement of raw materials).

When asked about the method of organizing education, all fishermen prefer "live" education, with as much direct contact as possible with other fishermen, and education that is simple and with the application of practical examples. They consider the following types of education to be the most important:

- Fishermen's meetings, where they exchange experiences with each other, but at the same time have direct contact with representatives of the ministry and scientific-educational and advisory institutions
- Study visits in which they will be in direct contact with fishermen and fishing activities
- Educational workshops when dealing with new regulations and proposing technological solutions. - Fishermen's meetings, where they exchange experiences with each other, but at the same time have direct contact with representatives of the ministry and scientific-educational and advisory institutions
- Study stays in which they will be in direct contact with fishermen and fishing activities
- Educational workshops when dealing with new regulations and proposing technological solutions.

However, at the educational workshops, they want as many concrete examples as possible, stating that very often a theoretical approach to solving a certain problem is not enough to be able to adopt it and improve their work.

11.1.2. Italy

Although it seems from Table 15 that Italian fishermen have fewer problems and fewer needs, Italian fishermen unanimously expressed the need for cooperation with Croatian fishermen. They are particularly interested in study stays and exchange of experiences.

Table 15. Overview of the key problems and needs of the fisheries sector in Italy

PROBLEMS	NEEDS
Lack of skilled labor. They would like to bring fishermen from Croatia or to introduce education that will enable the training of italian personnel for fishing.	Design an education that, in addition to carrying out fishing operations and fishing tools, will enable the creation of personnel capable of maintaining vessels and, safety at sea
Aging of the fishing population, young people are not taking over the job	Find an optimal way of education, but also a way to attract young people.
Young people interested in fishing do not have the basic knowledge that is the starting point for engaging in this business.	Design and introduce education for novice fishermen.
Improve marketing	Design education in which fishermen will be directly involved
The problem of waste disposal, especially plastic	Find solutions and educate fishermen. They want to see how Croatian fishermen deal with that.
Innovative technological solutions	Practically familiarize yourself with all the new possibilities: the use of sustainable tools, the way to deal with plastic waste.

11.2. Aquaculture

11.2.1. Fish farming

Fish farmers from both sides of the Adriatic expressed the need for and importance of cooperation between the two countries. Most of them (with the exception of one breeder) prefer live meetings, i.e. direct communication and mutual exchange of experiences. This primarily includes study stays and education tailored to growers and their specific problems. They prefer education with more practical examples, presented in a simple way without theorizing in which examples from practice are absent. The minority, which is not in favor of joint meetings due to lack of time, would like to exchange experiences by communicating over the Internet and posting video clips on the web. This type of education, just as one of the possibilities, is also accepted by other breeders so that they can discuss simple problems and see on video clips the possibilities of new practical technological solutions and good practice procedures (examples: how to change the net more easily, clean it, what to do when the anchor breaks , solutions for sorting fish, how to count juveniles). In this way, techniques and technologies could be compared and then tested for their application on their own farms and plants. Breeders definitely want to see examples of practice at other farms, and not just listen to theory without demonstration of how to apply it.

Both Italian and Croatian growers are advocating the organization of meetings and conferences where producers from both countries would participate in order to exchange experiences and where new technological solutions would be presented.

Growers also expressed their desire for cooperation with scientific and educational institutions, but they believe that it should be improved in such a way that research is more applied, and that research and education are carried out by competent scientists.

Croatian breeders have expressed the need for the creation of guides/instructions in which guidelines will be given in a high-quality, simple and comprehensible manner for solving certain technological procedures, following the example of the Italian side. They also think that it is necessary to create more manuals/guides of good practice on legal regulation, as Italy has.

Marketing: simply explain to the population/customers the principles of aquaculture production, the control of the production cycle and the growing environment that ensure the health and quality of the product and popularize aquaculture in a simple way. They emphasize that the current perception of aquaculture, despite campaigns such as the Croatian Chamber of Economy "Fish of Croatia - eat what is worth", and the way in which aquaculture is often

presented from the professional and scientific side in our country is not correct and does not encourage production and consumption. As an example, they cite a TV presentation of a scientific study that simply says that a cage farm pollutes the environment as much as a settlement of 20,000 inhabitants. Without the basic information about the nature of the waste, without information about the location, applied technology and the capacity of the farm. The above example, as well as others like it, arouse mistrust among breeders and cause doubt in the competence of scientific research and educational institutions that present such data.

For breeders, waste from processing and dead fish, as well as old nets, are a problem, and they would like to know and possibly adopt ways to solve this problem. They are aware that economic sustainability by creating added value can increase the incorporation of waste processing into value-added products. According to the above, they believe that the areas of inclusion of aquaculture in the circular economy need to be covered through education in such a way as to show them the possibilities and examples of good practice in dealing with waste and achieving added value for its use.

In addition to the previously mentioned examples that would represent a solution to their waste problems, they also consider it necessary to receive practical and simply presented guidelines on how to act for aquaculture to be in line with environmental protection. During such educations, they believe that it is necessary to cite negative examples as well (for example, that nets should not be thrown into the sea, where breeders mostly mention fishermen and especially those who are illegal without privileges).

Additionally, breeders would also like practical education as well as support from professional institutions related to legal regulations. Here they state the current problem: the obligation to carry out a risk analysis on infectious diseases and the actions they take to prevent their spread. They emphasize that they need help here, especially small farms, because they are not experts in this field.

Like other sectors, this sector also faces a general lack of manpower, and the need for its education, which has not been systematically addressed, is emphasized.

Italian growers listed the lack of manpower and lack of education for workers in this sector as the biggest problem. They stated that they had certain vocational training, but also that such training was only partial (on a specific topic) and they do not consider it sufficient. They are of the opinion that it is necessary to establish systematic educational programs that will include all relevant activities related to fish farming:

- choosing a location
- setting up breeding grounds
- the application of classic technology and the application of new technologies, all with the aim of achieving all aspects of sustainability while increasing production
- ensuring health and product quality
- maintenance of hatcheries
- sustainable waste management (including how to deal with plastic waste and reducing the negative impact of plastic).

The participants of the ARGOS project also stated that in addition to sea fish farming (sea bream, sea bream and meagre) they also farm trout in their region, and are interested in including this sub-sector in future projects and educational activities.

Regarding cooperation with scientific institutions, Italian growers believe that it is important that both parties, scientists and growers, are involved in future projects, in order to properly evaluate new solutions and technologies and jointly improve the quality of environmental monitoring and production.

11.2.2. Shellfish farming

After the held workshops and a series of individual consultations with shellfish growers whose goal was to determine the real problems and needs of the sector in order to increase sustainability, all participants in the consultation confirmed that it is necessary to improve sustainability. At the same time, they point out that they are not only thinking about environmental sustainability, which they are aware is a guarantee of future successful farming, but also socio-economic sustainability, which is a prerequisite for the future of farming.

Shellfish farmers from both countries emphasize their interest in cooperation and mutual exchange of practical experiences. Although apparently Italian growers have fewer problems (Tables 16 and 17), they are extremely interested in bilateral cooperation. The main emphasis is on timely organization and selection of dates that suit them, considering the work at the farm, and a program that includes study stays and mutual exchange of experiences.

Shellfish farmers are also interested in cooperation with scientific and research institutions, but they believe that it is necessary to identify competent individuals from that sector and base future cooperation which would result in applied innovations on that.Školjkari su također zainteresirani i za suradnju sa znanstveno-istražiačkim institucijama, ali smatraju da je potrebno identificirati kompetentne idividualce iz tog sektora i na tome zasnovati buduću suradnju koja će rezultirati aplikativnim inovacijama.

11.2.2.1. Croatia

During the holding of workshops and individual consultations, segmentation at the geographical level was observed. Growers from the southernmost areas of Croatia (Maloston Bay) and partly from the central Adriatic area complain the most about complicated administrative procedures. In general, the percentage of growers who complain about the complicated administration is significant (more than 95%). This problem is also highlighted by growers from the northernmost areas of Croatia (Istria), although they do not consider it essential. In addition to the above, Maloston Bay faces the problem of depuration and the lack of such facilities.

Growers from the area of the northern Adriatic, in addition to the need to improve labor rights and improve their position, the lack of qualified workers, diversification of production, point out numerous other problems that the sector is facing (Table 16).

In addition to the geographical segmentation mentioned above, three types of growers have been identified in this sector, according to which it is necessary to adapt the training:

1. Those who are just starting out and are getting a concession (one starts with choosing a location and setting up a farm, placing goods on the market, organizing distribution center, traceability, running a trade or company, using IT).
2. Those who have been engaged in shellfish farming for about 20 years, got into the business by inheriting a family tradition and want to improve technology (ongoing issues including labor force, development of European flat oyster spawning technology)
3. Older people (mostly 60+) who have been in this business for a long time (almost since birth), and over time have become skeptical, do not believe in the system and do not see the point of education.

When considering the needs of the aforementioned groups, it is necessary to take into account that beginners also need basic education, which includes:

- Location selection
- Knowledge of administrative steps to start production and establish a company.

Regarding predation, which is mainly caused by sea bream in Croatian areas due to farming technology (mainly technology adapted to coastal areas), it is necessary to develop production planning modalities with losses taken into account and assess the business.

Technological education and management of biological production represent an important element for new growers, who have not been involved in this business since they were young or it does not represent a traditional family business for them, but are just entering this sector considering it a favorable investment.

Table 16 shows the key problems and needs of the shellfish sector in Croatia.

Table 16. Overview of key problems and needs of the shellfish sector in Croatia

PROBLEMS	NEEDS
Administration: - complicated and extensive, takes a lot of time - older growers have a hard time coping with the use of IT technologies	Educate growers, but also simplify the administration without avoiding any measures prescribed by law. See/learn the experiences of Italy and whether there are simpler solutions. They believe that this is possible through study stays where they will have the opportunity to see how their Italian colleagues deal with that. After that, coordinate the problems with the competent authorities and try to find the simplest solution.
Labor rights, legal position of breeders, method of tax regulation	Through study stays and exchange of experiences, learn how to solve this segment of the economic sustainability of the sector. In particular, they highlight the analysis of the position of growers and legal regulations related to wages, taxes, and eventual benefits, which could greatly contribute to their economic sustainability.

Lack of labor in general, and skilled labor in particular	Introduce a method of training workers so that they are able to carry out all the necessary operations on farms without help (or constant supervision), including the maintenance of breeding grounds, vessels, equipment, etc.
Unresolved issues regarding the coastal work area; the unresolved issue of concessions with a certain part of breeders (if concessions were granted for a short-term period - investing in the development of breeding grounds is not profitable)	Study stays to see what the working areas look like on the coast in Italy and the way in which this basic infrastructure need is legally solved in Italy.
Diversification of production	The greatest interest of the central and northern Adriatic in this sense is the adoption of the spawning technology of the European flat oyster, *O. edulis*, although breeders are also interested in introducing new species into farming. There are also ideas about the possibility of introducing mobile hatcheries.
Other innovations in production technology, such as: introduction of new mussel farming equipment that will significantly reduce bream predation, machine cementing of oysters or application of other methods that will improve production efficiency.	Study stays to determine the existence of potential solutions, develop manuals of good practice, prepare educations in which possible solutions will be presented simply and clearly
Ways of association and organization of producers in Italy	Familiarize yourself with asiciations and see the benefits of such organization
Market organization	To see how cooperatives in Italy work and to fully understand the distribution chain
Shipping and depuration centers and purchase stations	Get acquainted with:: - by the way the distribution centers function - elements that affect the efficiency of depuration

	- technological solutions with regard to the efficiency and selection of the depuration system - with the way repurchase stations function
Product safety on the market	Although the legal regulations are clear and there are regularly organized educations by the Ministry, it is necessary to see practically how the traceability systems work in Italy
Quality	Familiarizing with the possibilities of improving quality, from the handling of shellfish after harvesting, through the possibility of wet storage, packaging methods, the development of quality control system indicators to the end customer. Consider and educate producers about the possibility of mild preservation of products (pasteurization) and product development for the HoReCa system.
Solving the problem of waste, especially plastic (mostly old mussel socks). Waste disposal is completely unresolved, plastic piles up when shellfish are processed at the farm, and the farmers have no solution.	Exchange experiences with Italian producers during study stays. Develop education or models of good practice for dealing with plastic waste. Eventually, find technological solutions that will reduce the amount of plastic waste or recycle it by processing it into products with added value.
Business education / entrepreneurship / management, to encourage entrepreneurs from other industries to invest in this business.	Develop models of education, but also ways of presenting the sector to make it attractive to investors.
Although most growers entrust the writing of project applications to consultants, some growers are interested in training in this area	To see how this segment works in Italy
Bookkeeping and procurement of raw materials	These are topics that younger breeders (by seniority) state as interesting for education,

	believing that they will help increase the economic viability of the company.

When talking about the education model, study stays of a minimum of three effective days are the first choice of breeders. Then they list breeder meetings and equipment fairs. Classic educations organized online are not preferred by breeders, while they believe that "live" ones organized at the national level should last one day.

11.2.2.2. Italy

Italian breeders, as well as Croatian, are interested in study stays and bilateral exchange of experiences. Growers are interested in improving cultivation technology and diversifying production. Although in the first place they emphasize the development of the spawning technology of the European flat oyster, O. edulis. The introduction of other species into cultivation is also interesting to them, considering that they are faced with the problem of collecting shellfish from the natural environment.

Italian breeders cooperate with scientific and research institutions, but they believe that this cooperation needs to be improved by focusing on applied research.

Table 17 shows the key problems and needs of the shellfish sector in Italy.

Table 17. Overview of key problems and needs of the shellfish sector in Italy

PROBLEMS	NEEDS
Production diversification	Adoption of the spawning technology of the European flat oyster and the introduction into cultivation of species that are currently collected from natural populations and the development of their spawning technology.
Improvement of technology in order to increase production	To consider and together with scientific institutions examine different technological solutions
Lack of labor in general, and skilled labor in particular	Introduce a method of training workers so that they are able to carry out all the necessary operations on farms without help,

	including the maintenance of nursrries, vessels, equipment, etc.
The predation problem caused by the sea turtle, *Carreta carreta*	Finding a technological solution to reduce predation in view of large damages for which there is no compensation
Quality improvement	Familiarize yourself with the possibilities of improving quality, from the handling of shellfish after harvesting, through the possibility of wet storage, packaging methods, the development of quality control system indicators to the end customer.
Solving the problem of waste, especially plastic (mostly old mussel socks). Waste disposal is completely unresolved, plastic piles up when shellfish are processed at the farm, and the farmers have no solution.	Exchange experiences with Croatian producers during study stays. Develop education or models of good practice for dealing with plastic waste. Eventually, find technological solutions that will reduce the amount of plastic waste and its harmful effects on the environment, and find opportunities to recycle this type of waste by processing it into products with added value.

11.3. Assessment of the needs for education of the fisheries and aquaculture sector representatives of professional and scientific research institutions of the partners of the ARGOS project

According to the analyses, the international projects carried out so far in which the partners of the ARGOS project participated (Table 18) were mainly focused on small-scale fishing, i.e. fishermen using vessels smaller than 12 m. However, part of the education was also related to participants in the aquaculture sector.

Table 18 presents an overview of the participants in bilateral INTERREG projects so far, including participants from Italy and Croatia in the multilateral INTERREG ADRION/PLUS project and participants in the ARGOS project.

Table 18. Overview of participants in the bilateral INTERREG Italy - Croatia projects, including participants from Italy and Croatia in the multilateral INTERREG ADRION/PLUS project and participants in the ARGOS project.

Institution/country/web page	PROJECT			
	INTERREG ADRION „ARIEL"/PLUS	Adri.SmArtFish	PRIZEFISH	ARGOS
CNR-IRBIM, Istituto per le Risorse Biologiche e le Biotecnologie Marine (IRBIM), IT https://www.irbim.cnr.it/	+		+	
CNR - National Research Council, IT http://www.ismar.cnr.it/				+
Marche Region, IT https://www.regione.marche.it/	+			+
Marche Region - Fisheries Economy Department, IT https://www.regione.marche.it/Regione-Utile/Agricoltura-Sviluppo-Rurale-e-Pesca/Pesca#15627_Adri.SmArtFish		+		
Assam - Agency for Agrofood Sector Services of Marche, IT http://www.assam.marche.it/en/			+	
Cestha - Experimental Centre for Habitat Conservation, IT http://www.cestha.it/			+	
Region of Sicily, IT	+			
Institute of Oceanography and Fisheries, Split, HR https://galijula.izor.hr/ https://acta.izor.hr/wp/ *	+	+	+	+*
Public Institution RERA SD for Coordination and Development of Split Dalmatia County, HR http://www.rera.hr/	+		+	+
Università degli Studi di Palermo, IT	+			

https://www.unipa.it/				
Veneto Region - Agri-Environment, Fishery and Wildlife Programming and Management Directorate, IT https://www.regione.veneto.it/web/guest/direzione-agroambiente-caccia-e-pesca https://www.regione.veneto.it/		+*1		+*2
Ca'Foscari University of Venice - Department of Environmental Sciences, Informatics and Statistics, IT https://www.unive.it/pag/28183		+		
Autonomous Region of Friuli Venezia Giulia - Hunting and Fish Resources Unit, IT https://www.regione.fvg.it/rafvg/cms/RAFVG/economia-imprese/pesca-acquacoltura/FOGLIA24/ *1 https://www.regione.fvg.it/rafvg/cms/RAFVG/ *2		+*1		+*2
Emilia Romagna Region - General Directorate for Agriculture, Hunting and Fishing, IT http://agricoltura.regione.emilia-romagna.it/pesca*1,2 https://www.regione.emilia-romagna.it/ *3		+*1,2	+*1,2	+*3
Molise Region, IT http://www.regione.molise.it				+
Regione Puglia, Department of Agriculture, Rural and environmental Development of the Apulia Region, IT https://www.regione.puglia.it/				+
Region of Istria - Administrative Department for Agriculture, Forestry, Hunting, Fishery and Water Management, HR https://www.istra-istria.hr/index.php?id=2337 *1 https://www.istra-istria.hr/hr/ *2		+*1		+*2
Primorje-Gorski Kotar County, HR https://www.pgz.hr/		+		+
Zadar County, HR https://www.zadarska-zupanija.hr/		+	+	+

Ministry of Agriculture of the Republic of Croatia https://poljoprivreda.gov.hr/ *1,3 https://www.savjetodavna.hr/2019/10/03/provedba-projekta-prizefish/ *2		+*1,3	+*2	+*1,3
Italian Ministry of Agriculture, Food and Forestry Policies https://www.politicheagricole.it				+
Alma Mater Studiorum – University of Bologna, The Inter-Departmental Centre for Research in Environmental Sciences, IT https://centri.unibo.it/cirsa/en			+	
Secondary High School 'Remo Brindisi' - Pole of Sea Crafts, IT http://www.istitutoremobrindisi.it/			+	
OGS - National Institute of Oceanography and Experimental Geophysics, IT https://www.inogs.it/en			+	
Fisherman's Cooperative Omega3, HR https://www.rz-omega3.hr/en			+	
Fishing Cooperative Istra, HR https://riba-istra.hr/			+	
Organisation Producers of Bivalve Mollusc of the Veneto Sea (Adriatic Sea), IT http://www.ipescaori.it/			+	
Dubrovnik Neretva County, HR http://www.edubrovnik.org/en/				+
Public Institution Development Agency of Šibenik-Knin County, HR http://www.rra-sibenik.hr/				+

During the project **INTERREG ADRION "ARIEL"/PLUS** ("Promoting small scale fisheries and aquaculture transnational networking in Adriatic-Ionian microregion"; https://arielplus.cnr.it/) in which eight partners from Italy, Croatia, Greece and of

Montenegro, during the consultation phase with representatives of the fisheries and aquaculture sector, common and specific needs were detected, on the basis of which trainings were held and educational materials were developed. The goal of the training was to support the implementation of pilot testing of innovative solutions and the creation of new competencies. The following training modules and corresponding educational materials were developed (https://arielplus.cnr.it/training-materials/):

- Marketing and branding of seafood
- ICT tools for marketing support
- New tools and practices for improving the sustainability of fishery products and related valorization on the market
- Innovative techniques of sustainable fishing and aquaculture
- Development of business plans for fishing tourism (pilot/case study for Greece)

During the **INTERREG Italy-Croatia project "Adri.SmArtFish"** ("Valorisation of SMall-scale ARTisanal FISHery of the Adriatic coasts in a context of sustainability"; https://www.italy-croatia.eu/web/adrismartfish/about-the -project), seminars/workshops were organized whose goals were:

- support the further valorization of small-scale fishing, the transition to more selective and improved fishing tools and techniques (fishing, etc.)
- improve the use of a low-cost monitoring system in small-scale fishing
- improve the marketing and branding of seafood products (during the project the Rulebook on the use of the common EU mark "Adriatic Small-scale fisheries" was drawn up according to the EUIPO evaluation).

Within the **INTERREG Italy-Croatia project "PRIZEFISH"** ("Piloting of eco-innovative fishery supply-chains to market added-value Adriatic fish products"; https://www.italy-croatia.eu/web/prizefish/about-the -project) seminars/trainings were organized for the training of fishermen and breeders in order to improve their competences and training for the use of the virtual market application "PRIZEFISH" developed by AMAP (Agency for Innovation of the Agri-Food and Fisheries Sector of the Marche Region).

The topics of the held trainings were:

- Marketing of local seafood
- Improved use of ICT tools (social media, virtual market applications) in daily work
- Access to funding opportunities (e.g. application management)
- Diversification and multifunctionality.

Project partners from Italy organized trainings and pilot activities at the national level, which included:

- A pilot project for the development of the use of ICT tools for marketing, where fishermen were taught the use of Face book in marketing in order to promote direct sales to consumers.
- Pingers - training how to use them
- Improving the competences of fishermen and breeders
- Development of the ability to apply the principles of sustainability and traceability (GPS trackers)

Practical trainings for the use of more sustainable tools (tips) (pilot project, where tools were developed and tested in cooperation with scientific institutions, and then fishermen's meetings (events) were organized where the principles of work were explained and tips were distributed to fishermen.

All the mentioned activities were carried out by the supporting institution AMAP (Agency for innovation of agri-food and fisheries sector of Marche Region) in cooperation with scientific - research institutions - project partners (mainly CNR) or experts were paid for education (for example for ICT). These trainings did not take root in a systematic way, and were carried out mainly for fishermen who are members of the Trade Union.

The same organization, Agency for innovation of agri-food and fisheries sector of Marche Region, assessed during the implementation of the ARGOS project the presence of the following problems for which in the future it is necessary to design the education of fishermen and farmers:

- Lack of labor force, especially qualified persons in fisheries (design education programs)
- Solving administrative problems

- Lack of systematic education, and in addition to fishing, fishermen also need education on safety at sea, maintenance of machines and other equipment.
- Diversification of activities: Develop a business plan for fishing tourism - develop guidelines for the implementation of regulations (both in Italy and in Croatia). A positive example, but also the only one, is the region of Puglia, but they believe that it is necessary to cover all areas.

AMAP suggests that all, Croatian and Italian partners, of the ARGOS project form a joint program through the Network of Regional Education Centers, and that the educations cover common topics:

- Marketing (especially education in the use of IT technology, social media)
- Sustainable fishing tools
- Administration (bureaucracy)
- Diversification of fishing activities
- Application of new technologies.

In addition to the proposals of AMAP during the preparation of this study, representatives of scientific research organizations, partners of the ARGOS project, propose the following topics for further education:

- Bycatch of sensitive species (turtles, birds, mammals, crustaceans) - which would include the importance of bycatch of these species, the importance of reporting and mitigation measures
- Marine litter and microplastics - to emphasize the importance of trawling in the elimination of marine litter ("fishing for litter"), in addition to the need to solve the problem that trawlers have with the disposal of microplastics
- The importance of establishing marine protected areas (MPA - Marine protected areas)
- Diversification of fishing activities - diversification within fishing (replacing destructive fishing gears with more selective ones), diversification outside fishing (tourist fishing, tourism)

- Education on fishing skills, considering that today it is almost impossible to find a fisherman who knows how to mend nets, make longlines, drill and other gears
- Education on withdrawing funds from EU fisheries funds
- Education on the legal regulation of fishing in the EU
- The importance of forming fishing associations or other forms of association
- The importance of harmonizing the curriculum for fishing professions in schools
- Diversification of production (introduction of new species into cultivation)
- The need for sustainable fish food (insect meal, microalgae)
- Finding new materials that would reduce the harmful impact of plastic.

In addition, scientists emphasize the importance of strengthening cooperation with the production sector in both countries. Considering the problems mentioned by fishermen, it is necessary to strengthen cooperation and restore trust in the scientific research sector by selecting educators according to individual competencies. Table 18 shows that a small number of scientific and educational institutions are involved in this project. Table 19 shows the scientific research and educational institutions that deal with fisheries and aquaculture issues in Croatia, and a detailed, high-quality list of available staff should definitely be made.

Table 19. Public sector stakeholders involved in education and innovation in the fisheries and aquaculture sector: - scientific research and educational institutions in Croatia

Institution	Faculty/Department
University of Zagreb	Faculty of Agriculture Faculty of Food Technology and Biotechnology Faculty of Science Faculty of Veterinary Medicine Faculty of Mechanical Engineering and Naval Architecture
University Josip Juraj Strossmayer in Osijek	Faculty of Agrobiotechnical Sciences

	Faculty of Food Technology
University of Dubrovnik	Department of Applied Ecology Institute for Marine and Coastal Research
University of Zadar	Department of ecology, agriculture and aquaculture
Sveučilište Jurja Dobrile u Puli	Faculty of Natural Sciences
University of Split	University Department of Marine Studies Faculty of Science
Institute for Oceanography and fisheries Split	
Institute Ruđer Bošković, Zagreb, including ots' Center for Marine Research in Rovinj	
Croatian Veterinary Institute Zagreb	

Bearing in mind all that has been stated so far, there is also a proposal to form an Education Platform instead of the Network of Regional Education Centers, where potential partners for entering the platform will be all stakeholders of the sector in accordance with individual competencies.

On the other hand, it is necessary to design a way that will enable the long-term sustainability of the Platform and the created education programs. It should also be considered in detail whether to make education voluntary or compulsory. For example, an aquaculture farm must have a person who is educated for this activity.

Also, there are ideas to introduce a program related to sustainability and mitigating the consequences of climate change as mandatory, but it should be implemented in a planned manner within the project. When making a decision, it should be taken into account the fishermen, that is, the fact that when fishermen does not work (when they are in education) he loses money. It means that the education should be designed in such a way that the fisherman recognizes it as useful for himself, and not as a waste of time. Only in this way can any organized form of education succeed, be sustainable and make sense.

12. SUMMARY WITH CONCLUSIONS

With a sea area of 31,067 km², 1,242 islands, islets and rocks, Croatia has a total of 6,278 km of coastline, while Italy's coastline stretches for 9,136 km, and constitutes 8.75% of the total EU coastline. The area of the Italian coastal regions is 181,289 km², which is approximately 10% of the total territory of the EU and 60% of the national territory. Both countries have a long tradition in fishing, which is a source of income for coastal and island communities throughout the year.

In 2020, Croatia ranked 14th in the EU-27 in the area of production in fisheries and 11th in the area of production in aquaculture. The total landing of Croatian fisheries in 2021 was 61,574 tons, of which 91% was small pelagic fish, 6% white fish, 1% cephalopods and 1.7% crabs. In the total landing of small blue pelagic fish, 78.3% of the quantity was sardine, and 5.28% was anchovy. In 2020, the most important species of white fish were hake with 33.15% and flounder with 21.03% of the total white fish catch. Last year, Croatia reduced the catch and cultivation of marine fish and other marine organisms compared to the previous year by 6.5 percent. The number of fishermen also decreased by 0.3 percent, but that is why the value of fishing increased by as much as 11.4 percent.

Fishing in Italy takes place along the entire coast. In the last decade, the national Italian fishery production showed a negative trend that continued in recent years. In 2004, the total marine catch was 288,284 tons, while in 2012 it dropped to 195,000 tons, in 2017 it reached only 192,202 tons, and in 2020 it dropped to 141,771 tons. The main group in the total catch are representatives of small blue pelagic fish species - anchovy and sardine. Unlike Croatia, Italy is dominated by the anchovy catch with a total of 42,800 tons (22% of domestic landings), while the production of clams and sardines regularly results in a stable production of around 20,000 tons, or only 10% of the total Italian landings. Among bottom-dwelling white fish, as in Croatian fisheries, the most common species are hake and red mullet. An important part of the total Italian landings are cephalopods, including cuttlefish, octopus, and curled octopus. As in Croatia, deep-water prawn and mantis shrimp are the most important crustaceans landed. Among large pelagic fish, the main fishing species are bluefin tuna, albacore tuna, and swordfish. A significant catch of hydraulic dredges, which mainly refers to shellfish (mainly clams), and is better represented in Italy than in Croatia, comes mainly from the northern Adriatic.

In 2021, the fishing fleet of the Republic of Croatia consisted of 7,757 vessels, of which 6,235 were active. The majority of the fleet (56.5%) consisted of vessels smaller than 6 meters and vessels between 6 and 12 meters in length (36.5%). Only 549 vessels (or 7.1%) are longer than 12 meters, including 337 vessels between 12 and 18 meters in length, 103 vessels between 18

and 24 meters in length and 109 vessels between 24 and 40 meters in length. The size of the Italian fleet has been steadily decreasing over the decades, in correlation with the decline in catches, however, the numbers have recently stabilized. In 2018, the fleet consisted of 12,059 motor vessels, a decrease of 11% compared to 2008. Small vessels, those under 12 meters in length, accounted for 71.7% of the total number of vessels. The total gross tonnage of the Italian fleet in 2018 was 146,260 tons, a decrease of 26% since 2008. Small ships accounted for 12.2% of the total gross tonnage. In 2017, 12,250 vessels were registered, and in 2016, 12,310.

The unfavorable decline of the Italian domestic economy caused a general reduction in food consumption, which also affected fish products. The current high fishing effort, together with increased production costs, due to increasing fuel prices and strong regulatory pressure from the EU have brought the fishing sector into a period of stagnation.

In the Republic of Croatia, mariculture includes the cultivation of white fish, bluefin tuna (EBFT) and shellfish. The most important species of fish in cultivation are sea bass with an annual production of 9,083 tons in 2021, gilthead sea bream with 7,599 tons and Atlantic bluefin tuna with 5,104 tons. Less than 1,000 tons of clams, Mediterranean mussels and European flat oysters were produced. In 2021, more than 87% of Croatian production in aquaculture was recorded in seawater (of which marine fish farming accounts for more than 80%), while the rest was recorded in fresh water. In terms of value, mariculture accounts for 95% of the total value of aquaculture production.

In 2020, the total production of the Italian aquaculture sector was 122,778 tons. The share of fish in mariculture was 11%, while the rest was made up of mollusks. In the shellfish sector, mussels (63,700 tons) and clams (36,500 tons) are the main species. Production of fish from marine farming in Italy is 15,744 tons, and the main farmed species are sea bream (7,600 tons) and sea bass (6,800 tons). Freshwater fish farming takes place in the northern and central regions of Italy. The production of freshwater farmed fish amounts to 41,243 tons, of which the most is rainbow trout (36,800 tons), whose production in Croatia with an annual value of about 600 tons has become only symbolic, followed by eels (1,250 tons). . Companies engaged in the production of shellfish make up over 50% of the total number of farms and contribute with 64% of the total aquaculture production, in contrast to Croatia, where their production is reduced to around 800 tons. That is, the quantity produced in Italy by one major producer.

In Croatia, the average consumption of fishery and aquaculture products per capita in 2021 was 22.90 kg, which represents an increase of 13.7% compared to 2020 and 20% compared to 2019.

In 2020, the consumption of fishery products in Italy was estimated at 29.99 kg per inhabitant. Fresh fish is the most frequently consumed product (84%). This share is significantly higher than the EU average (68%). Mollusks, cephalopods and crustaceans are also commonly consumed in Italy.

Croatia is one of the member states of the European Union that exports more fish and fish products than imports, which is most expressed in trade value. The import of fish and fish products increased especially in the period 2018-2019. mostly due to the large share of herring and frozen sardines imported for the needs of tuna farming, and the quantity almost exceeded exports. Nevertheless, the value of imported products is lower than the value of exports. Almost 75% of fish and fish products were imported in 2018 and 2019 from five countries - Spain, Sweden, the Netherlands, Italy, and Portugal, and over 82% of total exports refer to Italy, Spain, Slovenia, Albania, and Japan. Other important trade partners are France, Serbia, Argentina, Chile, and Germany.

Considering that Italy represents almost one third of the world's consumption of sea bass and sea bream, Croatia has an exceptional competitive advantage in this respect due to its proximity. With a focus on the shelf life of fresh fish of ten days, it is extremely important that the time from catch to delivery to the end customer is as short as possible. The result of the above is precisely the advantage of Croatian breeders over those from Greece, Cyprus and Turkey. The same principle applies to the Central European market. A large additional option in Croatia is a stable and predictable growth in tourist consumption and the use of EFPR opportunities, as well as further work on marketing and branding. The quality of farming in the Adriatic Sea compared to the main competitors is reflected in the stronger structure of fish meat with less fat due to the colder Adriatic Sea. Therefore, in addition to the mentioned freshness of the delivered goods, and with the marketing approach of Croatian producers, the image of better-quality goods from Croatian farms was recognized, and thus the demand for the export of Croatian goods to Italy was increased.

The aquaculture sector in Italy faces several problems, including, among others, the intense competition that Italian producers of sea bass and sea bream face with producers from other countries such as Greece and, to some extent, Turkey, and Croatia. Increasing competition from low-cost products produced in developing countries is another emerging problem.
Italy is one of the largest markets for fishery and aquaculture products in Europe, and most of the demand is covered by imports. It is the seventh largest market for imported fish and seafood in the world, and the third largest among European Union (EU) countries, behind

Spain and France. The total import of fisheries and aquaculture products reached 1.37 million tons with a value of 6 billion euros in 2017. The trade balance is severely deficient at 5 billion euros, as exports reached only 270,000 tons with a value of 0.8 billion euros.

There are four registered Producer Organizations (PO) among fishermen in Croatia, while 49 Producer Organizations (PO) and 2 Producer Associations are officially recognized in Italy. Their role is to contribute to the achievement of the objectives of the Common Fisheries Policy (CFP) and the Common Market Organization (CMO) through the collective management of the activities of their members. Out of 49 POs, 35 operate in the fisheries sector, and 14 in aquaculture.

Despite this difference, we can state that there is interest in the formation of PO among producers in Croatian fishery and aquaculture. This interest includes a diverse group of producers: i) existing well-organized small cooperatives and associations (eg shellfish producers and collectors in Istria) who want to improve their competitive position and sell directly on the domestic market and not through distributors; ii) large aquaculture companies that gather their current business partners (eg producers of carp, grass carp, catfish, pike, perch) and ; iii) groups of producers within a certain geographical area (e.g. shellfish producers in the Malston Bay in the Dubrovnik-Neretva County) who are currently competing with each other on the local market and are seriously considering exporting, iv) organizations with a wider range of products that combine commercial fishing and aquaculture.
Different situations, problems, business history and challenges require different approaches to the formation of producer organizations. Each producer group includes different technical and technological features of the aquaculture sector, socio-economic characteristics of the region, target market, competition, technological and business education, and vision of future business development. Considering the long tradition of the producer organization in Italy, which has resulted in better organization in all segments of fishery, from the procurement of materials, fishing tools, marketing, social benefits and many other proven advantages, one of the basic forms of cross-border cooperation should be familiarizing Croatian fishermen with the way associations and leading and managing cooperatives and production organizations.

With improvements in fishing practices, the fishing industry should aim to certify at least some of its fishery products under several eco-labelling schemes (eg Marine Stewardship Council) and project an image of excellence and sustainability. In both countries, it is necessary to speed up the introduction of recognized commercial certification programs in order to facilitate the placing of products on the market, as well as business models and forms of cooperation that will increase the consumption of fishery and aquaculture products on the domestic market. In this regard, it is necessary to support the organization of partnerships between producers and institutional buyers.

It is also necessary to establish an internet platform that will enable communication and exchange of information between all relevant stakeholders, with the aim of encouraging joint initiatives between producers, processors, and buyers.

Scientific research in aquaculture is carried out by institutions registered to carry out scientific activities, as well as commercial companies that perform breeding activities. On the other hand, the research and development and scientific institutions of Croatia and Italy have long-term cooperation with institutions in other countries (both in the EU and in countries outside the EU). One of the main characteristics of these scientific and educational institutions is that many of them carry out mainly fundamental research due to the lack of experimental facilities. Furthermore, the connection with the industry is limited, i.e. a limited number of applied, developmental and technological researches are carried out directly in order to solve the problems of producers or fisheries.

Cooperation and the establishment of local and cross-border networks should be based on education, training, and information of the stakeholders of the fisheries and aquaculture sector and should be carried out in Italy and Croatia through meetings, lectures, workshops and consultations as well as through publications, brochures, media and the Internet. With the emphasized interest of all consulted for cooperation, the general opinion is that the study stays should be better organized, taking into account the involvement of as many fishermen as possible from both sides and the time of organization (when fishermen and breeders have less work and can afford to go on a study stay or educational workshop). The majority of producers expressed their desire that, within the framework of bilateral cooperation with Italy, representatives of the competent administrative body also participate in study stays and become better acquainted with the real picture on the ground. In this sense, the majority of fishermen believe that a greater presence of employees of administrative body in the field would contribute to a more effective and faster joint solution to specific problems of the sector.

It is proposed to establish a Network of regional centers for education, or a Platform in which individual experts will be involved in education according to their individual competencies in order to establish the most efficient cooperation with fishermen and breeders. Regardless of the way of organization (Network or platform), education should primarily cover the following broader topics of common interest:

- Marketing (especially education in the use of IT technology and social media)
- Sustainable fishing tools
- Administration (bureaucracy)
- Diversification of fishing activities
- Diversification of production in aquaculture
- Application of new technologies.

Through a more detailed analysis, the following problems were identified for which in the future it is necessary to design the education of fishermen and breeders:

- Lack of labor force, especially qualified persons in fisheries (design education programs)
- Solving administrative problems
- Lack of systematic education, and in addition to fishing, fishermen also need education on safety at sea, maintenance of machines and other equipment.
- Develop a business plan for fishing tourism - develop guidelines for the implementation of regulations (both in Italy and in Croatia). A positive example, but also the only one, is the region of Puglia.

Representatives of scientific and research organizations, partners of the ARGOS project, propose the following topics for further education:

- Accidental catch of sensitive species (turtles, birds, mammals, crustaceans) - which would include the importance of bycatch of these species, the importance of reporting and mitigation measures Marine litter and microplastics - emphasize the importance of trawling in the elimination of marine litter ("fishing for litter"), in addition that it is necessary to solve the problem that trawlers have with the disposal of microplastics
- The importance of establishing marine protected areas (MPA - Marine protected areas)
- Diversification of fishing activities - diversification within fishing (replacing destructive gears with more selective ones), diversification outside fishing (tourist fishing, tourism)
- Education on fishing skills, considering that today it is almost impossible to find a fisherman who knows how to mend nets, make longlines, traps and other gears
- Education on withdrawing funds from EU fisheries funds
- Education on the legal regulation of fishing in the EU
- The importance of forming fishing associations or other forms of association
- The importance of harmonizing the curriculum for fishing professions in schools
- Diversification of production (introduction of new species into cultivation)
- The need for sustainable fish food (insect meal, microalgae)
- Finding new materials that would reduce the harmful impact of plastic.

In the sphere of marketing, education, training and cooperation of all stakeholders would make it possible to solve some clearly identified relevant factors of the success of the fishing industry:

- Support the development of new market opportunities in high-value product segments
- Redirect marketing that is overly focused on lower value products
- Pay adequate attention to innovative marketing solutions using own solutions as well as those that have proven to be effective in other countries and environments
- Facilitate access to domestic (especially including tourism as an important branch of coastal industries in both in both countries) and higher value export markets including markets "niche" where higher prices can be achieved
- Expand product differentiation, including additional recognized certificates
- Encourage the development of new promotional methods to increase the consumption of aquaculture products.

Fishermen are also aware that the sustainability of the sector is affected by illegal fishing (fishing without privileges) and insufficient control of sport and recreational fishing. Although they emphasize that these controls have been increased in the last two or three years, they believe that this increase is still insufficient. Namely, illegal fishing encourages the reduction of fish prices and reduces their competitiveness on the market, they emphasize.

Aquaculture, like any other food production practice, faces challenges for sustainable development. Recently, traditional aquaculture techniques have been labeled as "polluting" and "unsustainable". Most fish farmers are constantly looking for ways to improve their production processes, make them more sustainable, efficient and profitable. Sustainable aquaculture is a dynamic concept, and the sustainability of an aquaculture system depends on the species, location, social norms, and the state of awareness, knowledge, and technology. But for a system to be truly sustainable, it must include ecological, economic, social, and community sustainability. Fish farming should not create significant disruptions to the ecosystem, cause loss of biodiversity, or result in significant pollution of the Sea to be socially responsible and contribute to the well-being of the community, but at the same time it must represent a sustainable business with long-term prospects.

Another sustainability issue is the method by which facilities process and discharge organic waste so that the resulting discharge does not affect the surrounding ecosystem. The solid waste produced by fish grown in net floating cages that falls to the seabed below the fish cages is enriched in carbon, nitrogen and phosphorus compared to natural sediments, therefore fish farming can significantly change the physicochemical composition of natural sediments in the area below. When waste by-products from any open aquaculture system are discharged directly back into the water column, it cannot be considered a sustainable practice or system.

A comprehensive development program for waste management, including plastics, is needed, which defines the complete processing and recycling of waste generated in production systems of aquaculture and aquaponics. These technologies reduce water use and remove, process and recycle solid and liquid waste through cogeneration of energy and recycling of organic nutrients. By using these innovative technologies and proper management, by-products of food production and waste reduction can be used to produce biogas, biodiesel, substances for the pharmaceutical and cosmetic industries, while increasing financial stability and profitability of business.

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