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## Strategy for the sustainable development of aquaculture in the European Union

This article aims to evaluate the state of aquaculture in the European Union and its contribution to the development and life of the local community. It identifies EU standards and policy measures promoting aquaculture and suggests how to increase its production. Descriptive statistics are used to analyze the development of fish and shellfish farming in EU countries and reports describing fish and other marine organisms in farming are referenced. Over the past 20 years, the EU has been making attempts to unlock production potential by issuing strategy papers and establishing the Aquaculture Advisory Council in 2016. It trusts that environmentally sustainable aquaculture has excellent potential for development. It can create new products of high value for a growing world population and reduce the problem of fisheries collapse and overfishing, becoming an alternative source of raw material for the fish industry. Increasing fish production would create new jobs and secure the economic development of local communities.

Keywords: aquaculture, sustainable development

JEL classification: Q22, Q01

### Introduction

Nowadays, fish and seafood as natural resources are common goods. The main objective of the European Union's Common Fisheries Policy (CFP) is to ensure that, in the long term, aquaculture, sea fishing, and fish market organisation balance the environment, at the same time leading to economic success, creating jobs, providing high-quality food, and keeping fishing traditions alive. Aquaculture, unlike fisheries, is not an exclusive EU competence, but due to its importance for the food security, sustainable economic growth, and employment, it was considered that to coordinate the policies of the member states, a system of EU guidelines was needed. It is up to individual countries to adapt them to local circumstances and implement them, but they have an incentive to do that – resources from the future European Maritime, Fisheries and Aquaculture Fund and other EU aquaculture development funds.

## 1. Determinants of aquaculture development

### 1.1. Overfishing of natural resources

Using data provided by the Food and Agriculture Organization of the United Nations (FAO), we can see that the last 50 years of more intense fishing brought a shortage of fish in the sea. According to a FAO report, 33% of fish stocks are overfished, three times more than in the mid-1970s. Over 50% could be fully fished. According to scientists, a catastrophic situation is taking place in the Mediterranean and Black seas, where this problem affects over 62% of fish stocks; the same goes for south-east Pacific Ocean (61%) and south-west Atlantic Ocean (58.8%) [FAO, 2020]. There is still a threat to the cod population in the Baltic Sea. Growing fishing pressure is observed in oceans and seas. Most European fish resources are managed in an incorrect way. There is fishing on a massive scale to produce fish-meal, which is food for farmed fish [Draganik, 2017, p. 4]. This interferes with the food system in the food chains of Baltic fish, including cod. As a result of overfishing, certain species of fish have suffered more than others, causing biodiversity to decline, which creates further challenges to the ecosystem. All these developments can lead to loss of employment for people who work in the fishing industry [Hojrup, Schriewer, 2012, p. 70].

### 1.2. Consumption of fresh fishery and aquaculture products and consumer preference

Fish are a source of valuable nutrients for the human body, including omega acids. Consumption of fish around the world has grown exponentially. In the 1960s, an average person ate 9 kg of fish per year, in the 1990s – above 14 kg, and nowadays up to 20 kg. The Chinese eat the most fish and seafood in the world – 40 kg per year. In 2016, global fish consumption amounted to 171 million tonnes, with aquaculture accounting for 47% [FAO, 2018].

The EU is one of the biggest players in the global fish market, but the per capita level of fish consumption in its member states varies, from nearly 86 kg in Malta to just 5.6 kg in the Czech Republic. Total per capita consumption of seafood in the EU averages just below 24 kg per year. On the continent, the record holders are undoubtedly the Portuguese, who eat 57 kg of fish per year. Fish are also an essential part of Lithuanian, Spanish, Finnish, French, and Swedish diets. Polish consumers, although aware of their health benefits, do not reach for them very often – they eat on average 13 kg of fish per year, perhaps discouraged by their high prices compared to other food products [Szlinder-Richert, 2019, pp. 11–25]. This is

still twice as much as in Hungary, Romania, and Bulgaria, where the per capita fish consumption is 6 kg per year.

EU households spend yearly on fish and seafood somewhat more than EUR 100 per capita – one-fourth of what they spend on meat. The EU is the 6th largest producer of fish products and aquaculture globally, accounting for 3% of global production in 2018 (1.2% of aquaculture and 5.5% of catches). Food production is an essential element of the Polish economy. Poland is the 6th largest food producer in the EU. Over the last 40 years, the value of trade in fish and fish products increased 18 times, reaching USD 143 billion in 2016. Catches provide almost 80%, and aquaculture below 20% of fish supply in the EU [EUMOFA, 2020].

Fish consumers are interested in a balanced sector of fishing, its impact on the environment and well-being of fish, and the quality of farms. According to the Eurogroup for Animals [2018], purchase decisions are influenced by factors such as freshness, quality, overfishing, and aquaculture's environmental impact. The well-being of fish is categorised in: clear water (95%), the health of the fish (94%), the environment (93%), minimal pain (89%). 40% of consumers in Europe declare that they are ready to pay up to 10% more for balanced seafood. The aspects related to ethical, balanced growth can be found in the records of the EU Parliament Resolution [OJEU, 2020].

## 2. Concept of aquaculture in the theory of sustainable development

According to EU laws, aquaculture is part of the fishing economy, and it is defined as a means to produce aquatic organisms through developed techniques to increase the production of the natural environmental performance, in a situation when these organisms stay as property of a physical or legal person throughout the entire period of farming and breeding to catching [EP, 2013]. Aquaculture covers the breeding and farming of fish, shellfish, mollusks, and seaweed. The production occurs in ponds, pools, fairways, baffles and seats, cages, and recirculation systems [EP, 2008].

European aquaculture, which uses diverse technological production techniques, is one of the most innovative in the world. According to EU standards, it is divided as follows: 1) raising and breeding of aquatic organisms (e.g. carp, whitefish, pike-perch), fed naturally at low densities, in earthen ponds which play an important and beneficial role in landscape and water management, and are biodiversity-friendly [Gil, 2009]; 2) growing and breeding aquatic organisms (e.g. rainbow trout, European eel, sturgeon, tilapia) in flow systems, which, although

expensive due to energy costs, allow for better control of water quality (temperature, oxygenation) and combining aquaculture with hydroponic plant production [Czarkowski, 2010, p. 6]; 3) extensive aquaculture in brackish waters (e.g. sole, sea bream, shrimp, clams are often carried by sea currents and are kept in lagoons prepared for this purpose, *vide* Spanish esteros, Italian vallicultura, which play a vital role in preserving the natural coastal heritage); 4) mariculture, most developed in island or seaside states, is a method of breeding marine animals and plants (e.g. Atlantic salmon, sea bass, sea bream, algae; oyster and mussel farming account for 90% of European production) in sea water in tanks on land or in cages on the seabed; 5) lastly, hatchery and larval culture [Czarkowski, 2010, p. 8], where fry or caviar are produced, are also classified as aquaculture.

Sustainable development has long been a priority within the European integration process, including the CFP. The EU is committed to a development that meets the needs of today without reducing the ability to meet the needs of the future. The essence of sustainable development is a dignified life for everyone on our planet, consisting of prosperity, efficient economy, and environmental responsibility. Since 2010, sustainable development has been included in the Europe 2020 strategy [EC, 2010]. The new global framework for sustainable development has been set out by the UN 2030 Agenda for Sustainable Development, signed by world leaders on 25 September 2015. It established 17 sustainable development goals to achieve sustainable development worldwide by 2030, including life under water.

The sources of the concept of sustainable development are often found in the criticism of traditional theories of growth and prosperity. Current production and consumption patterns, as well as technological progress, resulted in increased anthropopression due to the demand for natural resources. The global interest in the effects of human economic activity on the environment dates back to the 1960s and 1970s [Meadows et al., 1972]. Sustainability means combining material development with the long-term existence of the human population, efficient use of natural resources, environmental responsibility and equal opportunities for present and future generations [Roosa, 2009, p. 44]. It is essential to balance environmental protection with the need for development [Tladi, 2007, p. 74]. A report by the World Commission on Environment and Development [1987] defines the following policy objectives: restoring economic growth and changing its quality, meeting human needs in the areas of food, hygiene, work, and energy, stabilizing the population, preserving natural resources and innovation.

### 3. Evolution of the EU strategy for the sustainable development of aquaculture

The first EU document supporting aquaculture was the Strategy for the sustainable development of European aquaculture [EC, 2002]. Its objectives included employment growth in the aquaculture sector of between 8,000 and 10,000 new jobs in the period 2003–2008, environmentally friendly aquaculture and farming, healthy high-quality aquaculture products, and high welfare standards for farmed fish and seafood. The specified targets have not been achieved, although environmental sustainability and quality have been ensured. In addition, EU aquaculture faced the difficulties related to increased competitiveness of goods from developing countries and the economic crisis of 2007. By contrast, aquaculture worldwide was booming.

Next came the communication “Building a sustainable future for aquaculture: A new impetus for the strategy for the sustainable development of European aquaculture” [EC, 2009]. A number of steps were taken to maintain the EU as an essential partner in global aquaculture. The priority was to support the competitiveness of EU aquaculture production by technical means and the promotion of development and high performance. Over the next four years, it became clear that past efforts had failed to produce the desired results. The Advisory Committee for Aquaculture concluded that the main reasons were insufficient implementation and that critical issues were not resolved.

In 2013, the EC issued Strategic guidelines for the sustainable development of aquaculture, which were intended to help meet aquaculture targets. The EU member states submitted national strategic plans to develop aquaculture in their territories for 2014–2020, which mostly envisaged increasing the production of fish and other aquatic organisms, increasing their value, expanding the number of farmed species, and introducing innovative breeding technologies. Carp producers who have a significant surface potential of fish ponds (incl. in Poland) do not expect a significant increase in carp production but diversify revenues from pond farms e.g. by enhancing the environmental role of ponds and developing agritourism. National aquaculture strategies of Italy, Germany, and Poland introduce innovative, intensive technologies for the farming of salmonids (incl. trout), European eel, and sturgeon. The essential elements for the competitiveness of European freshwater aquaculture are the expansion of the range of new fish species and the development of fish processing. The Advisory Committee for Aquaculture proposed focusing on three priority areas: ensuring the sustainable growth of aquaculture by optimizing licensing procedures, increasing the competitiveness of EU aquaculture, and promoting a level playing field. It was accepted that EU

aquaculture must be innovative and environmentally sustainable, and products must be competitive compared to imports from third countries. Significant levels of seafood imported into the EU come from aquaculture in third countries. Countries that produce food imported to EU markets should meet EU production and environmental standards. Expanding an existing farm or setting up a new fishing farm requires access to the so-called environmental space that must align with the objectives set out in the WFD, the Marine Strategy Framework Directive, the Nature 2000 directives, and the Blue Growth Guidelines. The ability of aquaculture to meet future food needs depends on the availability of space.

The Strategic guidelines for a more sustainable and competitive aquaculture in the EU for 2021-2030 [EC, 2021] present new trends in the development of aquaculture. The EU fisheries sector must be competitive. Access to space and water and a transparent and effective regulatory and administrative framework is designed to assist planning. Coordinated spatial planning should cover marine, freshwater, and terrestrial aquaculture (recirculating aquaculture systems). Lower environmental impact (e.g. combining certain types of farming to reduce nutrient and organic matter emissions) and ecosystem services to protected areas should be a priority. The sustainable growth of EU aquaculture is more critical today than ever. It is also vital to rebuild it in the aftermath of the pandemic and ensure its long-term resilience.

Aquaculture production is expected to increase by 37% compared to 2016 and reach 109 million tonnes in 2030. Per capita global fish consumption is expected to reach 21.5 kg in 2030, compared to 20.3 kg in 2016. "Increasing global aquaculture production is predicted to fill the supply and demand gap. Aquaculture has great potential to create value and short supply chains locally, contributing to the environmentally, economically, and socially sustainable food production process. It will continue to be one of the fastest-growing sectors of livestock production" [FAO, 2018].

#### 4. Structural aid to EU aquaculture

The main objective of the structural policy in the fisheries sector is to provide financial resources to implement the CFP and ensure the sustainable development of fisheries and aquaculture areas. Structural assistance covered sustainable aquaculture activities intended to preserve species biodiversity, satisfy food needs, and develop local communities connected with fish farming in lakes, ponds, or in special fish farming facilities. The EU fisheries policy, initially financed in 2002–2006 by the Financial Instrument for Fisheries Guidance, was financed by the European Fisheries Fund in 2007–2013 (EUR 3.8 billion for all EU countries,

incl. EUR 600 million for Poland), and is now financed by the new European Maritime and Fisheries Fund. The European Court of Auditors concluded in 2014 that the European Fisheries Fund did not effectively support aquaculture and, despite subsidies, it did not bring the expected growth. At the European level, the support measures were not well designed and insufficiently supervised, and they did not provide a clear framework for aquaculture development. At the level of the member states, they were not properly applied, and national strategic plans and operational programs did not provide a basis for promoting aquaculture. In Poland, PLN 979 million was allocated to the Operational Program "Sustainable Development of the Fisheries Sector and Coastal Fishing Areas 2007–2013" for priorities 1 and 3 concerning aquaculture and sustainable development of areas dependent on fisheries [Obwieszczenie..., 2016]. The value of support for EU countries in 2014–2020 is EUR 6.4 billion, including EUR 4.3 billion for implementing planned investments in sustainable aquaculture and rural development [EP, 2014]. Poland was granted EUR 531 million, which together with the contribution from the national budget (ca. EUR 179 million) amounted to over PLN 2.8 billion. PLN 1.8 billion was allocated to priorities 1 and 2, promoting environmentally sustainable, resource-efficient, innovative, competitive, and knowledge-based fisheries [NIK, 2020].

## 5. Development prospects for aquaculture

Aquaculture, especially in freshwater bodies, has been present in Europe for a very long time. The farming of pond fish and oysters in the Mediterranean was well developed as far back as in Roman times, when "native breeding" systems were very popular among the wealthier families. After the "green revolution" of the 1960s, when agricultural production grew enormously through the use of improved seeds, fertilizers, and pesticides, aquaculture also received a powerful stimulus. Scientists fully domesticated and improved fish species such as salmon, sea bass, and sea bream, increasing their production to an industrial level. However, EU aquaculture has stagnated in recent years compared to world production, increasing by mere 6% since 2007. Negative experiences resulting from past mistakes made by the global agriculture and fisheries sectors necessitate changes in ecosystems.

In 2018, world aquaculture production was almost 82.1 million tonnes – 45% of total fish production. The largest fish and aquatic organisms producer is Asia. The overall trend shows that EU aquaculture production decreased by 2.2% between 2000 and 2019, compared to a 20% decrease in marine catches. EU aquaculture has stagnated over the years [FAO, 2020].

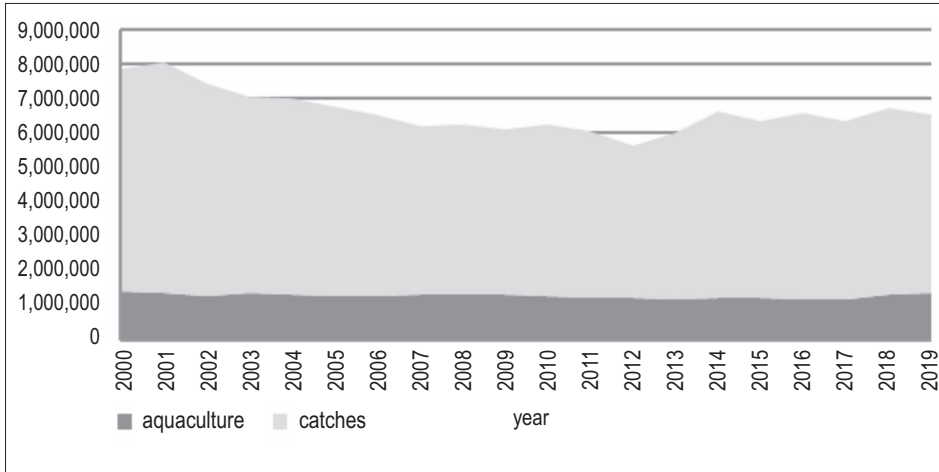


Figure 1. EU total fish production in 2000-2019 (million tonnes of live weight)

Source: Own elaboration based on: [Eurostat, 2011; STECF, 2018].

This general lack of growth in the aquaculture sector is explained, at least partially, by strict environmental regulations and a heavy bureaucratic burden that does not facilitate economic development [Guillen et al., 2019]. The EU imports over 70% of the seafood it consumes. Total aquaculture products (incl. imports) account for 25% of EU seafood consumption, while EU aquaculture products only account for 10%. Considering its exports (which in the case of aquaculture account for less than 2% of world production), the 2018 self-sufficiency rate<sup>1</sup> for EU fishery and aquaculture sector was ca. 42%.

Table 1. Characteristics of the EU aquaculture sector

Country	2011	2019	Share in 2019 total, %	Employment in 2018	
	Production (tonnes live weight)			Total employees	Number of enterprises
total	1,228,773	1,366,682	100.0	74,634	12,389
Spain	274,223	306,507	22.4	17,794	2,990
France	193,672	194,328	14.2	16,265	2,700
Italy	164,127	125,777	9.2	5,456	711
Poland	34,246	39,731	2.9	8,731	1,242

Source: Own elaboration based on: [Eurostat, 2019; STECF, 2019].

<sup>1</sup> Self-sufficiency is defined as the ability of EU member states to meet demand from their own production and can be calculated as the ratio of domestic production to domestic consumption.



In 2019, EU aquaculture production amounted to 1.36 million tonnes and increased by 11% in 2019 compared to 2011, with a total value of EUR 4.9 billion compared to EUR 3.6 billion in 2011. It was mainly concentrated in three countries: Spain (22.4%), France (14.2%), and Italy (9.2%). In 2018, 74,600 people were employed in the aquaculture sector by 2,400 companies, mostly in Spain and France. Freshwater production on land, where trout and carp dominate, increased by 12% in 2019 compared to 2000. In the same period, there was an increase of almost 12% in salmonids and of 27% in other sea fish, i.a. seabass and seabream. The most valuable fish was the bluefin tuna. EU aquaculture production stagnates mainly when it comes to mussel production in Spain and oysters in France, which increased by mere 3.5% in 9 years, as well as cephalopod breeding, which decreased the most in the analysed period.

Table 2. Main species in EU aquaculture

Commodity group	Volume (t)	Value (EUR million)	Volume (t)	Value (EUR million)
	2011		2019	
flatfish	11,338	76.838	12,994	105.124
cephalopods	3	0.100	1	0.007
other marine fish	153,622	817.077	195,677	1,076.394
bivalves and other molluscs and aquatic invertebrates	600,908	1,031.923	622,190	1,105.709
freshwater fish	97,243	262.340	109,404	316.891
miscellaneous aquatic products	86	1.002	569	11.994
crustaceans	242	5.902	414	4.915
tuna and tuna-like species	5,155	93.302	22,434	308.195
salmonids	360,176	1,320.387	403,000	2,056.321
total	1,228,773	3,608.870	1,366,682	4,985.551

Source: Own elaboration based on: [EUMOFA, 2020].

EU aquaculture is very diverse and highly specialized. The variety of activities makes it difficult to link environmental policy with the economics of production, which is a reason of the growing concern about the environmental impact of this sector. On the other hand, it is subsidized precisely to increase the level of environmental protection. The EU guidelines present a vision of the development of this sector consistent with the concept of the European Green Deal. They are also expected to help implement the farm-to-fork strategy, which is the transition of EU countries to a sustainable food system, healthy for people and less harmful to

the environment than land-based farming. Major aquaculture producers, especially China and other Asian countries, need to bring food safety legislation into line with EU legislation. Still, less restrictive environmental protection regulations, therapeutic treatments, and labor laws mean that production costs in Asian aquaculture are much lower. Pursuing profitable aquaculture production must not lead to the renunciation of product quality improvement, production optimization, or environmental achievements. Undoubtedly, these are the reasons for EU's lower competitiveness. We could intensify production and increase the economies of scale, but the environmental protection regulations in the EU are very restrictive. Too often, the EU regulations interfere with the sector, creating obstacles to its development. Another limitation may be finding new places for farming and breeding fish and aquatic organisms. Therefore, it is essential that the science and aquaculture sectors cooperate in the implementation of new production technologies in order to combine three aspects of production: economic profitability, environmental impact, and production acceptable to the consumer.

Aquaculture depends on the cleanliness and pristine condition of marine and freshwater areas. EU legislation sets high health, consumer protection, and environmental sustainability standards that must be respected in aquaculture activities. Undoubtedly, they affect the costs incurred by producers, but they may contribute to gaining a competitive advantage as consumer awareness increases. The reform of the CFP is based on these high standards. The new labeling rules proposed in the Single CMO regulation can help distinguish EU aquaculture products. An essential element is the development of short food supply chains that will help people appreciate high-quality fresh local produce. In addition, sustainability certification was introduced in the EU to create market incentives for farmers to use responsible aquaculture to be more competitive. In 2005–2011, the FAO developed guidelines for a certification system to eco-label fish and seafood. The standards are closely related to the Code of Responsible Fisheries [FAO, 1995]. Compared to other countries, EU aquaculture is subject to some of the strictest quality, health, and environmental regulatory requirements. Nevertheless, it can further improve its environmental performance and thus contribute to meeting the objectives of the European Green Deal and related strategies [EC, 2021]. The FAO has developed the climate-friendly agriculture concept, covering aquaculture for food security in a changing climate [FAO, 2018]. Fish farmers are already looking at the concept of climate-friendly agriculture as an alternative and innovative practice. Fish, plants, and animals' aquatic litter are to remove solids and dissolved waste from fish farming and thus provide a self-sufficient source of food.

The EC's Blue Growth Policy for the Baltic Sea Region [Beyer, 2017] identifies aquaculture as one of the most promising sector of the maritime economy in terms of growth and employment potential. However, in the Southern Baltic, including

Poland, marine aquaculture is still underdeveloped, which may indicate its untapped potential. In the development of innovative mariculture in Poland, the increase in knowledge at the local level is of key importance, as there is a great demand for highly qualified personnel<sup>2</sup>.

Local fisheries groups are being created with the support of the EU FLAG, as it is unlikely that aquaculture will meet all the labor and income needs of the local communities [Freeman et al., 2021]. Complementary activities are needed. The groups' strategies envisage a wide range of such complementary activities, ranging from tourism and gastronomy to the processing of by-products. Sometimes fish farms themselves create valuable landscapes and habitats (e.g. carp ponds in Central Europe). The aquaculture sector can increase the region's attractiveness, leading to the development of tourism and strengthening of local social ties.

## Conclusions

There is a growing global demand for fish, not only due to population growth, but also health benefits. Unfortunately, intensive exploitation of natural resources and human activity have disrupted ecosystems' natural balance, which manifests itself in dramatic declines in the population of many fish species. Therefore, it is necessary to develop aquaculture to satisfy local demand for fish and seafood through its production in the EU. Rural fisheries make a significant contribution to preserving the biodiversity of these water resources, and their protection is a condition for sustainable economic and social development. The preservation of natural values undoubtedly shapes tourist attractiveness and improves the quality of life in areas dependent on aquaculture. Aquaculture has great potential. It supplies raw materials to fish processing plants, becoming an alternative to sea fishing. It must bridge the growing gap between aquatic food supply and the demand of a more affluent population. Support from CFP aims to improve food security and economic development in line with the EU Blue Growth strategy and the potential of creating sustainable growth and jobs in marine sectors.

Aquaculture is the fastest-growing global food production sector, the most efficient producer of animal protein with the lowest carbon footprint. Even so, it remains surprisingly little known among those outside the industry. It has been

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<sup>2</sup> From January 2020, the AquaVIP project coordinated by the Science and Technology Park in Klaipeda, with the participation of the University of Rostock, the University of Gdańsk and the University of Klaipeda, has been conducted for 3 years. Virtual platform for career development in aquaculture for the South Baltic region (South Baltic Interreg program), which aims to strengthen the marine aquaculture sector in the region. The AquaVIP project partners have diverse competences in innovative aquaculture, including fish and shellfish farming in recirculating water systems, experience in aquaponics and microalgae cultivation.

perceived as a development industry for many years. However, when analyzing the production results, it can be expected that its success will be determined by the consumer and nutritional trends.

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