



PROTOCOL FOR INCREASING THE COMPETITIVENESS OF SMALL AND MEDIUM ENTERPRISES IN MONICULTURE OF MONTENEGRO



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Analysis of the current situation in the mariculture sector of Montenegro

Mariculture means the production of high quality food in the sea, in natural conditions and in an artificial way. The development of marine fisheries, to which mariculture essentially belongs, is a strategically important issue in food production programs for the domestic market. The program includes the production and breeding of several species of shellfish and fish. Rational exploitation of edible marine organisms implies strict restrictions in space, time, quality and quantity. This form of sea use can be permanent, only if it is rational and protected.

For the Bay of Kotor, the most important is the cultivation of mussels (*Mytilus galloprovincialis*) with an annual production of 229 tons, while the production of oysters (*Ostrea edulis*) is still at a very low level (17 tons, MONSTAT, 2020), but with exceptional breeding potential. This production is realized by about twenty shellfish farms in the Bay of Kotor, which occupy an area between 0.5 and 1 ha per farm. When comparing the total length of the coast of the Bay of Kotor (105 km) with the length of the sea area occupied by farms (about 100 meters per farm), it was obtained that in spatial terms shellfish farming in Montenegro occupies less than 2% of the bay coastline. Since this is the production of healthy food in a clean environment, which is extensive in type and does not involve the intake of food, antibiotics, anti-predatory or fouling agents, this type of production needs to be preserved, branded and improved.

The analysis of the suitability and attractiveness of the Bay of Kotor for the development of shellfish farming was done on the basis of preconditions for defining mariculture sites, which are harmonized with the needs and specifics of the Montenegrin coast and are accepted as a recommendation of the General Fisheries Commission of the Mediterranean (GFCM) of which Montenegro is a member. The analysis was performed using data on pressures on mariculture (fishing posts, eutrophication, contamination, important marine habitats, coastal type, urbanization) and based on environmental data (climatology, exposure to the open sea, seabed characteristics, water quality, trophic status, organographic conditions, type of coast).

The results of the analysis of the suitability of the bay for mariculture confirmed that all existing shellfish farms are located in areas suitable for mariculture development, but also

that a significant part of the Bay of Kotor is very suitable but not used for the mariculture program. Potentially suitable locations obtained by the analysis should be part of the new spatial plans for the purpose of the Bay of Kotor (Figure 1). The analysis was done only for shellfish farming, since fish farming can have a significant negative impact on the environment, and thus represents an additional type of pressure, especially in semi-enclosed systems such as the Bay of Kotor where water exchange is very low, especially during summer period.

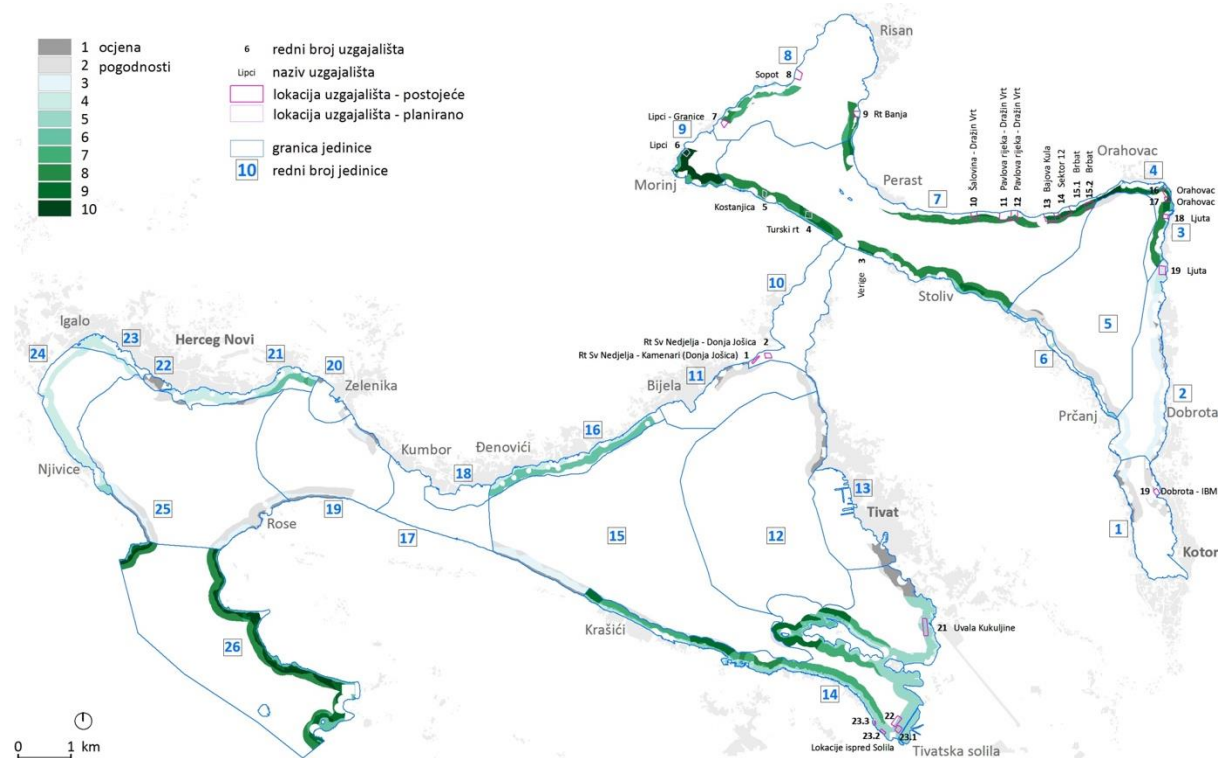


Figure 1. Analysis of the benefits for the development of mariculture in the Bay of Kotor - shellfish farms (PAP / RAC, MORT, 2017)

Among the pressures that have the greatest impact on mariculture are: tourism, due to the growing development of this sector and the impact of pollution caused by waste disposal at sea; then shipbuilding, construction or increasing the capacity of existing ports and marinas - due to turbidity of water, scattering of sand and dust particles, pouring concrete, etc. The impact of the exploitation of mineral raw materials, oil and gas was assessed as highly negative due to the large radius of impact on marine living communities, and thus on the shellfish farming process. Filling of the sea, discharges of municipal and industrial waters have shown very high vulnerability, primarily due to the quality of cultivated organisms, health and safety of consumers, as well as possible "suffocation" of cultivated organisms by filling with inadequate building materials, turbidity of water that can lead to gills, and in the worst case to shellfish mortality.

Special attention should certainly be paid to the preservation and protection of underwater springs - springs and all natural inflows of fresh water in the bay.

Therefore, by defining new zones for mariculture in the Bay of Kotor, it is possible to increase the production of shellfish, with the introduction of new, indigenous species and innovative technologies in the breeding process.

Fish farming in Montenegro still takes place in only two farms (in the localities Brbat - Orahovac and Stoliv). The annual production of sea bream (*Sparus aurata*) is 64 tons, while the production of sea bass (*Dicentrarchus labrax*) is significantly lower and amounts to 38 tons per year (MONSTAT, 2020). Data on the amount of marine fish farming production indicate that the total amount of fish produced has a declining trend. Both farms use the principle of integrated multi-trophic aquaculture (IMTA), which is extremely important to reduce the negative impact of farming on the marine ecosystem. The essence of this practice is the cultivation of species belonging to different trophic levels in a system that allows the assimilation of particles that represent waste from fish farming, thus reducing the impact on the environment and expanding the economic basis of mariculture. The species used in the IMTA system on existing fish farms are mussels and oysters, while in 2020 the cultivation of sea cucumbers (*Holothuria sp.*) under the cage for fish farming began experimentally.

Complete fish production is placed on the domestic market due to the very high demand for farmed products, especially during the tourist season.

In accordance with the recommendations for the development of new zones for open sea mariculture (defined in the PPOPCG until 2020), from January 2019 the Institute of Marine Biology began a detailed study of these zones in accordance with the FAO concept "AZA" (Allocated Zones for Aquaculture)". The AZA concept implies very detailed research of various parameters and criteria that are indicators for defining new locations for mariculture (especially for fish farming). The study resulting from these studies is conducted in accordance with the Environmental Quality Standards for the aquaculture sector, the principles of defining zones for aquaculture (Allocated Zones for Aquaculture), the principles of defining zones of impact (Allowable Zone of Effect) and Indicators of sustainable development aquaculture in the GFCM region (InDam). This program is funded by the Ministry of Agriculture, Forestry and Water Management, as the head of the marine fisheries and mariculture sector.

Deficiencies in shellfish production

Shellfish farming in Montenegro can be said to be a traditional activity, as the first commercial farms began operating in the 1980s. In that decades-long period, despite exceptional development potentials, there was no improvement in the sector, but production was characterized by long-term stagnation with extremely low production.

This situation is due to several causes, the most important of which are:

Complete lack of basic infrastructure on farms

Lack of basic conditions for work and food production, namely: lack of electricity, water and sewage in most locations where farms are located causes hard physical work, especially during the colder period of the year, as well as in different weather conditions and disasters. Due to inadequate infrastructure, even today most farms are not able to provide the basic hygienic conditions necessary for food production (shipping centers, purification centers).

Extremely high fees for annual permits for cultivation and lease of land

Breeding permits are usually issued annually (or for a maximum period of 5 years) with the provision of documentation prescribed by the Law on Marine Fisheries and Mariculture. The price per m² of sea area for shellfish farming in the Bay of Kotor is EUR 0.50, ie for an average farm size of 1 ha the annual permit for shellfish farming is EUR 1,000.00. This fee is the revenue of the Budget of Montenegro.

In addition to the payment of the breeding permit, the fee for the lease of land for the needs of the breeding farm, which is under the jurisdiction of the Public Company for the Management of Marine Assets of Montenegro, is also paid annually. In accordance with the Plan of temporary facilities in the zone of marine property, the largest number of shellfish farms have the possibility of renting about 20 m² of land for the purpose of setting up a fishing house. The annual fee is from 600 to 1800 EUR (excluding VAT), depending on the location, or an average of about 1000 EUR per year. Although the annual production of shellfish does not depend on the location, the locations for mariculture are categorized in the Plan of temporary facilities according to their attractiveness for tourism, which is absolutely inadmissible for the food production program.

On the other hand, the license for large commercial fishing (attached nets of trawlers and swimmers) annually amounts to EUR 300.00 with an additional payment of EUR 3 for each kilowatt of engine power. Additionally, before the issuance of the permit, a fee is paid to the

Institute of Marine Biology for the issuance of Consent to the technical and technological characteristics of fishing tools and equipment (from 50-100 EUR).

Thus, the price of a license for the production of food in the sea is up to 5 times higher than the license for large-scale commercial fishing.

In order to compare the annual fees for shellfish farmers in Montenegro and neighboring Croatia, below are comparative data for the concession per 10,000 m².

Table 1. Comparative data on the amount of annual fees for shellfish farming in Montenegro and Croatia

Contry	Montenegro	Croatia
Permission for cultivation per m ² of sea use	0,50 EUR	0,03 EUR (0,20 HRK)
Maritime good fee (land)	1000,00 EUR	0,2% annual income
Duration of the Agreement (concessions for maritime property)	1 godina	20 godina
FARM OF 10,000 m2 - total for fees	2.000,00 EUR	250,00 EUR

So, comparative data show that growers in Montenegro pay an annual fee for the permit and use of land, which is almost ten times higher than the same lease in Croatia (European Union)!

Investment uncertainty

The lease of land for the needs of shellfish farms is carried out by the method of public auction in accordance with the Plan of temporary facilities, which is adopted for a period of 5 years. Although one of the basic conditions for the auction is the possession of a valid mariculture license at the location for which it is auctioned, the maximum lease period (ie signing the contract) is only 1 year, ie from the date of signing the contract until 31.12. current year!

This way of planning prevents the security of investments, while each contract states that at any time during the contract (if the space is used for another purpose - especially high tourism facilities) it may be terminated by the Public Company for Marine Management, whereby growers have absolutely no right to reimbursement of funds invested so far.

This type of lease is a precedent in the Mediterranean, and probably in the world. Namely, a well-known practice in the rest of the Adriatic and Mediterranean seas is to lease land and locations in the sea for a period of at least 10 years for the needs of mariculture. This is especially important due to the fact that a minimum of 2 years is required for one production process in shellfish farming (for mussels), or up to 3 years (for oysters).

In addition, due to the extremely short lease period (1 year), breeders do not have the opportunity to regularly apply for the IPARD program, although they are recognized as beneficiaries. Namely, one of the basic conditions of the IPARD call is the Land Lease Agreement for a period of at least 10 years, so no mariculture grower initially has the opportunity to use the mentioned funds.

The biggest shortcoming in the realization of the planned development of the mariculture sector is the lack of connection with the tourism sector, the priority development sector of Montenegro. In this sense, the lack or very low level of inter-institutional cooperation is a significant problem in the development of the mariculture sector. The fact is that the production of food, especially food from the sea, is extremely important for tourism development, preservation and promotion of traditional technologies and tools in breeding in the Bay of Kotor, and the connection of these two sectors should be more intensively planned and acted upon developing opportunities.

Opportunities and development potentials

Connecting with the tourism sector - reducing conflicts in the use of space

Improvement and technological development of the mariculture sector based on safety standards and preservation, improvement and promotion of quality seafood, in accordance with modern production and market trends while preserving the natural values of the area.

The long-term goal is for Montenegro to be recognizable for growing quality food from the sea, which is provided by very favorable conditions provided primarily by the Bay of Kotor, where shellfish farming has become a tradition, as well as the open sea which is completely unused for mariculture programs. The development of this sector could provide a multifunctional connection with tourism and open the possibility of organizing a tourist offer

that is closely related to fisheries and mariculture. Mariculture and tourism are actually compatible activities and cooperation of these two sectors there are significant development opportunities (gastronomic contribution to the tourist offer, increasing national consumption of healthy food from the sea, reducing fishing pressure on existing resources and job creation). Bearing in mind the growing need in the world for healthy organic food, and at the same time facing the increasing overfishing of fish, the need for farmed fish is growing on the market.

The development of the mariculture sector must be carried out in compliance with the ICZM Protocol, the Ecosystem Approach to Aquaculture Development, Blue Growth, with mandatory compliance with 3 basic principles, which are:

1. The development and management of aquaculture should take into account the full range of ecosystem services, without compromising their sustainability,
2. The development of aquaculture improves human well-being and the principle of equality for all relevant users
3. The development of aquaculture must be developed in line with the development of other sectors, policies and objectives.

Therefore, all of the above is in accordance with EU Directive 2014/89 / EU.

[Subsidies from the Ministry of Agriculture, Forestry and Water Management of Montenegro](#)

The Ministry of Agriculture, Forestry and Water Management has been providing support for years to finance the improvement of infrastructure on farms, as well as the improvement of supporting facilities and equipment to improve the process of growing and placing mariculture products on the market. Public calls for support to the mariculture sector include grants of up to 50% of the approved investment, while in 2021 for the first time through the Public Call for support for investment in processing on farms it was possible to receive support for equipment for processing up to 80% of approved investments (including VAT).

Through the mentioned calls, breeders had the opportunity to provide over the years significant equipment necessary for the operational work of the farm, but also the formation of certain hygienic and sanitary conditions necessary for food production.

For the first time in 2021, the Ministry of Agriculture, Forestry and Water Management of Montenegro introduced a measure for direct payments in mariculture. The measure implies the payment of subsidies in order to stimulate the utilization of the maximum use of available production capacities.

The amount of support is realized on the basis of the area of the farm specified in the marijuana license and on the basis of the achieved average production for the last two years as follows:

- 0.3 € / m² of reported usable area of the farm, if the average of produced shellfish was over 2 kg / m²;
- 0.2 € / m² of reported usable area of the farm, if the average of produced shellfish was between 1-2 kg / m²;
- 0.1 € / m² of reported usable area of the farm, if the average of produced shellfish was below 1 kg / m².

If we compare subsidies for shellfish farming in Montenegro and neighboring Croatia, we come to the data that on the basis of the Croatian "Ordinance on the implementation of the model to encourage production in fisheries (Official Gazette, No. 39/2016), for mussel farming (mussels) breeders receive annual subsidies in the amount of 0.80 HRK (0.11 EUR) per kilogram produced, while for oyster farming the subsidy is 0.50 HRK / piece (0.06 EUR).

On the example of a farm of 1 ha (10,000 m²) in Montenegro, it is possible to apply for subsidies that depend on the total annual turnover of mussels, as follows:

- Turnover up to 10 tons of mussels per year - subsidy of 1000.00 EUR / year
- Turnover between 10 and 20 mussels per year - subsidy of 2000.00 EUR / year
- Turnover over 20 tons of mussels per year - subsidy of 3000.00 EUR / year

In Croatia, however, there are no restrictions on trade, but unique amounts have been defined for different types of shellfish, but in order to compare data for the same turnover, it is possible to obtain the following subsidies:

- Turnover up to 10 tons of mussels per year - subsidy of 1100.00 EUR / year
- Turnover between 10 and 20 mussels per year - subsidy of 2200.00 EUR / year
- Turnover over 20 tons of mussels per year - kg x 0.11 EUR

Thus, it can be concluded that through public calls that the Ministry regularly publishes on an annual basis, significant assistance can be provided in the breeding process, which most breeders benefit from.

Branding of mariculture products and protection of geographical origin

The cultivation of mussels (*Mytilus galloprovincialis*) and oysters (*Ostrea edulis*) in the Bay of Kotor has a decades-long tradition. In the 1960s, the Institute of Marine Biology began experimental research into the possibilities of commercial breeding of these shellfish species, as well as the quality of the marine environment in which they are bred. From that period until today, research has continued with greater or lesser intensity. As a result, for more than 30 years, high quality mussels have been grown in the Bay of Kotor, and most importantly in areas where water quality is high, ie meets all the criteria for cultivation prescribed by the Decree on Classification and Categorization of Surface and Groundwater (Official Gazette of the Republic of Montenegro, No. 2/07). Since 2009, commercial oyster farming has started on only one farm, while today there are a total of 20 shellfish farms, almost half of which are engaged in the cultivation of both species.

It is very important to note that in the process of breeding there is no addition of food or any chemicals and / or means to prevent the growth of fouling organisms on breeding facilities, no environmental pollution, on the contrary - the life cycle of shellfish is such that they feed by filtering water, biological filters, and increase water quality. The breeding process in the Bay of Kotor is such that there are no imports of young individuals that would be further bred (as is the case with fish farming), but the whole process is based on collecting young individuals from natural populations in a very specific area such as the Bay of Kotor.

Due to the high quality of water, and then shellfish meat, branding and protection of the geographical origin of these products would significantly contribute to the development and

promotion of the mariculture sector, increase the production of healthy and organic food from the sea, improve Montenegro's gastronomic offer and tourism. The results of the analysis of shellfish meat can be the starting point for the development of a specification for the Protection of Geographical Origin.

Registration of designation of origin

Registration of designations of origin, geographical indications and names of guaranteed traditional specialties of agricultural and food products is an instrument that enables food producers to increase the market value of their products.

The promotion of such products contributes to the recognizability of the regions from which they originate, has a positive effect on the income of agricultural farms and encourages agricultural producers to unite and appear more organized on the market.

The process of registration of marks / names enables the improvement and achievement of constant product quality.

Registered marks / names are protected from use for marking products that are not covered by the registration, from misuse and imitation, or any action that may mislead the consumer as to the actual origin / properties of the product.

Designation of origin and geographical indication

A **designation of origin** is the name of a region, a specific place or, in exceptional cases, a country, used to designate an agricultural or food product:

- who originates from that region, ie from that place or that state;
- whose quality or characteristics are exclusively or essentially conditioned by natural and human factors of a certain geographical environment;
- whose production, processing and preparation take place in a certain geographical area.

A **geographical indication** is the name of a region, a specific place or, in exceptional cases, a country used to designate an agricultural or food product:

- who originates from that region, ie from that place or that state;
- which has a specific quality, reputation or other characteristics attributable to its geographical origin;
- whose production and / or processing and / or preparation takes place in a certain geographical area.

The designation of origin and the geographical indication identify the product by origin and testify to the connection between the proven quality, reputation and specific characteristics of a particular product and its geographical origin. The condition of connection with the geographical area must always be met. What that connection is and to what extent depends on the label itself.

Conditions that must be met for:

Designation of origin (DO):

- the quality or characteristics of the product are **mainly** or **exclusively influenced by natural and human factors** (climate, soil quality and local skills) of a particular geographical area, and
- production, processing and preparation take place in that geographical area (ALL PHASES).

Geographical Indication (GI):

- the quality, reputation or any other characteristic of the product is attributed to its geographical origin and
- at least one phase of production (production or processing or preparation) takes place in a defined geographical area.

Unlike a designation of origin, where there is an objective and close link between the characteristics of a product and where all stages of production of that product must take place in a particular geographical area, a geographical indication is of a different nature. Namely, in the case of a geographical indication, it is sufficient that one production phase takes place in a defined geographical area and that the reputation or some characteristic of the product is attributed to its geographical origin.

Who can use the registered mark / name?

Registration of a mark gives manufacturers the exclusive right to use it for their products. It is an intellectual property right.

A registered designation of origin or geographical indication may be used by the producer or processor of an agricultural or food product if the product meets the requirements of the relevant specification.

It is important to point out that the right to use a registered mark belongs to all producers in the defined geographical area who meet the requirements of the specification, and not only to the producers of the association that originally applied for registration.

Manufacturers in this field (whose products meet the requirements of the specification) may place or advertise their products under a registered name, as a product with the designation "PROTECTED DESIGNATION OF ORIGIN" or "PDO", or "PROTECTED GEOGRAPHICAL INDICATION" or "PGI", with the corresponding sign.

The right of exclusive use allows manufacturers to highlight their products in relation to competing products on the market and at the same time provide consumers with clear information about the origin of products.

All manufacturers in defined geographical areas may prohibit all other persons from using the registered mark.

Starting organic shellfish farming

Starting organic mariculture in Montenegro represents an exceptional potential for increasing the competitiveness of growers, both in the national and regional market.

Although there is a Rulebook on detailed rules and conditions of organic production for aquaculture animals and seaweed (2018), there is still no accepted method of certification at the national level that would enable the initiation of the procedure of organic certification in shellfish farming.

However, it is important to point out that the technology of shellfish farming used in Montenegro is absolutely acceptable for starting the certification of organic production, that the conditions provided by the Bay of Kotor are exceptional for shellfish farming. It is early to expect that shellfish have the potential to be the first organically certified aquaculture product in Montenegro.

A detailed description of organic farming in aquaculture with a protocol on organic shellfish farming has been prepared as a separate document, and will not be discussed in more detail in this section.

SWOT analysis for the shellfish farming sector¹

¹ Lamprakis et al., 2021. The decline of mussel aquaculture in the European Union causes, economic impacts and opportunities. Reviews in aquaculture.

Benefits	Weaknesses
<p>The existence of a market</p> <p>Low environmental impact</p> <p>Clean water</p> <p>Inclusion of added value</p>	<p>Access to the breeding area</p> <p>Low prices</p> <p>Availability of new breeding permits</p> <p>Fragmentation of the farm</p>
Opportunities	Threats
<p>Certification</p> <p>Subsidies</p> <p>Increasing per capita consumption</p> <p>Diversification</p> <p>Spatial planning of the purpose of the sea</p> <p>Relocation of the farm to the open sea</p> <p>Multi-trophic aquaculture</p>	<p>Harmful algae blooms</p> <p>Climate change</p> <p>Bad weather</p> <p>Diseases</p> <p>Predators</p> <p>Poor water quality</p> <p>Lack of shellfish spat</p>

Weaknesses

The main weaknesses that hinder the growth of the shellfish farming sector are low shellfish prices, fragmentation (atomization) of farms, lack of adequate space to increase or establish new farms and difficulties in obtaining new breeding permits.

¹ Lamprakis et al., 2021. The decline of mussel aquaculture in the European Union causes, economic impacts and opportunities. Reviews in aquaculture

<https://doi.org/10.1111/raq.12465>

Low prices. Mussel prices in most EU countries are relatively low and have been stagnant for several years. The main reason for this is reflected in the "fragmentation" of producers, insufficient association of growers, which ultimately results in reduced bargaining power to ensure a guaranteed price of the product. Another important reason for low prices may be the import of cheaper products.

This problem can be solved by better organization of breeders or the formation of producer organizations, which as such could be engaged to provide better conditions for breeding (production), especially in the field of product marketing. The association of growers can enable the development of new business strategies and product diversification, e.g. basic product (without certificate), organic product and product with the recognition of a protected designation of origin (PDO).

Access to the breeding area. Difficulties in providing space for expansion or new farms can prevent the growth of mussel production, especially given that mussel production requires more space than other species produced in aquaculture. Careful spatial planning of the purpose of the sea, as well as ongoing research initiatives to find suitable locations can be potential solutions (opportunities) to alleviate the lack of adequate space for aquaculture.

Availability of breeding permits. The administrative burden, the long duration of this process and the uncertainty of the outcome are significant shortcomings in the process of renewal or issuance of new permits, even if there is room for the formation of shellfish farms. Uncertainty and the time required to obtain a permit are two factors that pose a major risk to producers and investors. Uncertainty is often caused by a limited number of permits and strict production requirements, which can be partly attributed to political will and environmental regulations.

The average time to obtain a new permit varies from country to country and can take from 6 to 18 months (in some countries several years). This variability is related to the ability of a country or region to properly deal with bureaucratic, administrative and environmental aspects. Therefore, there is still a need to alleviate and harmonize the administrative burden of obtaining a new permit.

Fragmentation of the farm. The shellfish farming sector in many EU countries is characterized by fragmentation, ie. a large number of small producers. Most shellfish farmers are small or micro enterprises. This issue could be resolved by horizontal integration of these producers into larger producer organizations.

Strength

The main strengths identified that maintain the shellfish farming sector and that could support its growth in the near future are increasing consumption, the growing tendency to introduce added value, low environmental impact of shellfish production and their capacity for water purification (biofilters).

The existence of a market. Traditionally, some countries have high consumption of shellfish. However, in Montenegro, relatively low production and its placement is mainly related to the duration of the tourist season. Also a good side in Montenegro is a fast and efficient logistics network, ie. the relatively short time required to transport live shellfishes from farms to final consumers.

Low impact (environmentally friendly). Shellfish farming is one of the methods for producing food of animal origin that has the least impact on the environment, in a series of global / regional environmental indicators (eutrophication, acidification, climate change, space use, energy consumption, biotic depletion). Moreover, shellfish farming is not as critical as fish farming, because:

- breed indigenous species;
- performs extensive cultivation, ie uses natural food sources in situ. Does not require external feed materials used in fish farming (fishmeal / fish oil)
- does not include the use and release of drugs or treatments against fouling organisms;
- is not associated with the multiplication of pathogens that could then infect wild stocks;

However, like any food production, shellfish farming cannot be considered completely benign to the environment. This includes aspects such as breeding systems that involve placing physical structures in the environment, which can affect currents and light; plankton removal; organic enrichment of the seabed with pseudo-feces reducing biodiversity and abundance; transfer of juveniles from one place to another and thus transfer of autochthonous and foreign pests; collecting juveniles by taking wild individuals from nature which affects habitat and ecology. However, consideration of these impacts must be balanced with the potential benefits, which are still greater in the case of shellfish farming.

Water purification capacity. Shellfish farming is the only food production system for human use that does not release pollutants from the breeding process, but removes them from the

production environment. Shellfish and other organisms that feed on filtration improve the quality and transparency of water, making the marine ecosystem better.

Inclusion of added value. In the context of reducing natural resources and increasing production costs, adding value to aquaculture products is a great challenge and opportunity for producers. Traditionally, mussels are marketed fresh or fresh mussels are prepared in various sauces, while shellfish processing has not yet been established. Given the national production of shellfish, the chance is to improve the traditional offer of certified and organic products.

Threats

The economic performance of the shellfish sector can be challenged by some threats that mainly take place at the level of primary production: Harmful algae blooms, weather disasters, diseases, predators, poor water quality and pollution.

Harmful algae blooms. Algae blooms, ie the rapid growth of the algae population, mainly occur due to an excessive amount of nutrients and organic matter in the water. Flowering often leads to changes in pH and dissolved oxygen (eutrophication), as well as to changes in water color due to algae pigments. Harmful algae blooms are events that cause a negative impact on other organisms, are associated with cases of high mortality and are associated with various types of shellfish poisoning (biotoxins).

Climate change and sea acidification. Since the Industrial Revolution, human activities emitting greenhouse gases (CO₂ and others) have increasingly affected the climate. Climate change has begun to affect environmental parameters, and much more lies ahead: rising sea and ocean temperatures, rising sea levels, ocean acidification, changes in rainfall, and therefore salinity, and nutrient concentration and quality. the economic damage to shellfish production caused by acidification alone in Europe will reach one billion US dollars a year by 2100.

Shellfish spat mortality is another indirect effect of climate change, more common in the productive areas of southern Europe, but northern Europe has also recently been affected.

Bad weather or adverse weather conditions. Shellfish farming tends to take place in more protected areas (eg in bays) than other species in marine aquaculture, so it is generally less exposed to the weather. However, extreme weather events can cause physical damage to

farmed shellfish and supporting structures used for farming. Structures that hold planted shells can move out of proper alignment and strain or crack and can cause significant production losses. Extreme weather events can also cause changes in the water column, e.g. sudden decrease in salinity due to fresh water intake; re-suspending anoxic sediment deposited beneath shellfish farms that can cause suffocation.

Some production techniques (eg floating parks and raft systems) may be more exposed to the weather if they are not placed in sufficiently protected (sheltered) areas.

Diseases and parasites. Mussels, like other molluscs, can be affected by a wide range of parasites. Studies have mainly focused on the causes that cause mass mortality, but they can also reduce the growth of mussels.

The presence of certain parasites can vary depending on the breeding technique. Some research shows that the number of certain parasites may be higher in breeding technologies that are close to the bottom compared to those that are separated from the bottom, as well as in production at higher densities.

Predators. Shellfish farms are experiencing production losses caused by the predation of wild fish (such as gilthead sea bream), starfish, etc. For example, in the Eastern Adriatic, shellfish farms are an extremely attractive habitat for wild fish. A significant increase in the population of wild gilthead seabream (both wild and farm escapees) documented in some coastal areas of the eastern Mediterranean has had a strong negative impact on shellfish farms. It has been reported that fish predation is the main cause of the loss of juveniles on commercial mussel farms in recent years.

On the other hand, the socio-economic impact of increasing the number of sea bream populations is evident and can cause the closure of many shellfish farms because the loss of production can reach over 90%. Further plans for the development of the shellfish industry should also take into account knowledge of the occurrence, seasonal distribution and behavior of potential predators in shellfish farming areas (their real-time impact) in order to achieve their sustainable management.

Marine pollution. Pollutants and poor water quality can cause significant damage to farmed shellfish. The filtering nature of shellfishes makes them vulnerable mainly to heavy metals and plastics. Mussels accumulate a wide range of heavy metals in their soft tissue (meat) by filtering water. The transfer of heavy metals from mussels through the food chain to other species has been proven, and the consumption of heavy metals has a potentially harmful effect on human health.

There is a growing concern about plastics, especially microplastics in water. It is estimated that 9 million tons of plastic per year end up as waste in the oceans and beaches, out of more than 300 million tons of plastic produced annually (UN Environment 2017). The introduction of microplastics has been reported in mussels and the transfer of microplastics through the food chain from shellfish to other species has been demonstrated. Implications for the health of marine organisms, food chains and human health have yet to be determined.

Lack of natural shellfish spat. There are three systems for obtaining juveniles: collection from the wild, use of collectors on farms and production in hatcheries. The availability of juveniles affects which breeding methods are used. Mussels are characterized by a high rate of fecundity (fertility) and a mobile phase of live larvae, and their breeding has always depended on the use of natural juveniles (collection, collectors). However, obtaining a natural supply of juveniles is often subject to large variations and may not always be able to match the growing demand in the sector.

Production of mussels from hatcheries is possible, but hatcheries are the most expensive method for producing juveniles, with the price of consumption often too low to be economically viable.

Opportunities

The shellfish sector could benefit from various factors that could enhance its development: Product certification, availability of subsidies, increased per capita consumption, product diversification, spatial planning of marine use, relocation of farms to the high seas and application of integrated multi-trophic aquaculture

Certification. EU consumers value product quality and have increasingly stringent standards. Certification can guarantee the quality or origin of the shells. There is a tendency among consumers to value the consumption of local shellfish and recognize their value if there are quality certificates, an organic certificate or a protected designation of origin, which ensure a certain origin and exclusivity of traditional production methods.

However, certification is not always an opportunity to achieve higher prices, but a business requirement. In this case, certification acts as a social licensing. Some retailers insist on certification, such as the Marine Stewardship Council (MSC). As a result, only products with

the appropriate labels can enter the market. In this regard, MSC mussel growers certify their production system and products with the MSC standard in order to confirm their environmental friendliness and improve their position. Fresh mussels can benefit from certification in traditional markets. However, certification may prove even more useful for processed products or in non-traditional markets, where consumers may have more difficulty appreciating quality.

Subsidies to improve environmental sustainability. In the European Maritime and Fisheries Fund (EMFF) from 2014 to 2020, the emphasis is on environmental sustainability in fisheries and aquaculture. Support could be given to investments in aquaculture farms that reduce the negative impacts of aquaculture on the environment (eg recirculation system) or contribute to the positive impact on the environment (eg shellfish production contributes to the reduction of eutrophication).

Increasing consumption through new markets and consumers. Shellfish meat is a low-fat and low-calorie food and animal protein. Moreover, it has highly competitive prices in the food market. In the global context of population growth and increasing demand for food and protein, we can also expect an increase in demand for shellfish. Processing of mussels (eg frozen, canned, finished products, ready meals of fresh mussels in different sauces) allows their commercialization for new consumers and new markets, while extending their limited shelf life.

Diversification and integration. Currently, the degree of diversification in the shellfish sector is very low. This is partly explained by the atomization (fragmentation) of the sector. For the time being, the diversification of production is mainly reflected in the fact that in addition to mussels, oysters are also grown, or rarely fish. Diversification of economic activity is less common though; there are only a few cases related to tourism.

Spatial planning of the purpose of the sea. Maritime spatial planning consists of determining when and where human activities at sea should be carried out to ensure their efficiency, safety and sustainability.

Therefore, spatial planning of the sea can help provide additional marine space for the development of aquaculture, for the expansion of existing or the establishment of new farms.

Relocation of farming to the open sea (away from the coast). Another solution to avoid congestion in coastal areas is to relocate the shellfish production system to the high seas. However, relocating outdoors is expensive and involves greater risks, especially those associated with adverse weather conditions. Current technologies for offshore shellfish production are less cost-effective than traditional farming, and new strategies are being explored, such as reusable platforms, where shellfish farming can be combined with other activities, such as offshore wind energy or even IMTA.

Integrated Multi-Trophic Aquaculture (IMTA). Integral multi-trophic aquaculture (IMTA) describes an arrangement by which species are bred together for mutual benefit. IMTA allows by-products, including waste from the cultivation of one species, to be input (eg fertilizer, food) for another species.

Moreover, mussel production in the context of IMTA contributes to some of the Sustainable Development Goals (SDGs), especially Sustainable Development Goals 2 and 14, and could become a new source of livelihood for communities around the world (United Nations 2015).

Recommended indicators for monitoring the level of progress of the mariculture sector in order to increase the competitiveness of SMEs

- % Reduction of annual fees for the permit for cultivation and use of land
- Increasing investment security (increasing the land lease period to a minimum of 10 years)
- Development of shellfish farming in the Bay of Kotor (supplementing spatial plans, defining new suitable zones for shellfish farming)
- Number of new, active fish farms on the high seas of the Montenegrin coast
- Annual production in mariculture (growth trend)
- Development of land fish farming (recirculation systems) - number and production capacity
- Progress in product branding and number of organic production certificates
- Number of services offered / new tourist offers closely related to mariculture
- Number of new jobs in the mariculture sector
- Progress in the formation of producer clusters

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