

## Aquaculture in Çanakkale: Current Status and Future Perspectives

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**Abstract:** This study was conducted to examine the current status of aquaculture in Çanakkale province and to offer solutions that will contribute to the aquaculture sector's development. The study involved a detailed analysis of the aquaculture facilities in Çanakkale and the data related to these facilities. The province's current aquaculture structure and potential were highlighted, drawing attention to the diversity in aquaculture production and the opportunities available in the region. The study revealed that there are a total of 18 aquaculture facilities in Çanakkale. Of these, 38.9% are involved in mussel farming, 27.8% in trout farming, 22.2% in carp farming, 5.6% in lugworm farming, and 5.6% in the cultivation of seabass, gilthead seabream, turbot, and grouper. The highest production by species occurs in mussel farming, while lugworm and marine fish farming remain at the lowest levels. A total of 581.92 tons of aquatic products were produced in Çanakkale in 2023, 292.76 tons of which were from inland waters and 289.16 tons from sea waters. However, it was determined that the share allocated to the sector in the support payments made in the same year was 5.61%. It has been determined that global climate change and the accompanying drought threaten the freshwater resources in Çanakkale province, and the marine ecosystem is also affected by the mucilage phenomenon due to the increase in water temperature and organic pollution load. These problems experienced in water resources cause production losses in the aquaculture sector. The sustainable development of the aquaculture sector in Çanakkale, which also has a wide range in terms of cultivated species, requires a multidisciplinary approach and planning using advanced technology tools. It is anticipated that such an approach will provide significant increases in aquaculture production.

**Keywords:** Çanakkale, aquatic products, aquaculture, production

## Çanakkale'de Su Ürünleri Yetiştiriciliği: Mevcut Durum ve Gelecek Perspektifleri

**Özet:** Bu çalışma, Çanakkale ilinde su ürünleri yetiştiriciliğinin mevcut durumunu incelemek ve sektörün gelişimine ışık tutacak çözüm önerileri sunmak amacıyla gerçekleştirilmiştir. Araştırma kapsamında, Çanakkale'deki su ürünleri yetiştiriciliği işletmeleri ve bu işletmelere ait veriler detaylı bir şekilde analiz edilmiştir. İlin mevcut yetiştiricilik yapısı ve potansiyeli ön plana çıkarılarak, su ürünleri üretimindeki çeşitliliğe ve bölgenin sahip olduğu fırsatlara dikkat çekilmiştir. Çalışmada, Çanakkale genelinde toplam 18 su ürünleri yetiştiricilik tesisi bulunduğu tespit edilmiştir. Bu tesislerden %41,2'sinin midye, %23,5'inin alabalık, %23,5'inin sazan, %5,9'unun kum kurdu ve %5,9'unun da levrek, çipura, kalkan ve granyöz yetiştiriciliği yaptığı belirlenmiştir. Tür bazında en yüksek üretim midye yetiştiriciliğinde gerçekleşirken, kum kurdu ve deniz balıkları yetiştiriciliği en düşük seviyede kalmıştır. 2023 yılında, Çanakkale'de toplam 581,92 ton su ürünleri üretimi gerçekleşmiş, bunun 292,76 tonu içsularda, 289,16 tonu ise denizlerde üretilmiştir. Ancak, aynı yıl yapılan destekleme ödemelerinde, sektöre ayrılan payın %5,61 olduğu tespit edilmiştir. Küresel iklim değişikliği ve beraberinde gelen kuraklığın Çanakkale ilindeki tatlısu kaynaklarını tehdit ettiği, denizel ekosistemin de su sıcaklığındaki yükseliş ve organik kirlilik yükündeki artış nedeniyle yaşanan müsilaj olayından etkilendiği tespit edilmiştir. Su kaynaklarında yaşanan bu sıkıntılar yetiştiricilik sektöründe üretim kayıplarının yaşanmasına neden olmaktadır. Kültüre alınan türler bakımından da geniş bir yelpazeye sahip olan Çanakkale'de yetiştiricilik sektörünün sürdürülebilir gelişimi multidisipliner bir yaklaşım ve ileri teknoloji araçları kullanılarak yapılacak planlamaya ihtiyaç duymaktadır. Bu tür bir yaklaşımın, su ürünleri üretiminde kayda değer artışlar sağlayacağı öngörülmektedir.

**Anahtar kelimeler:** Çanakkale, su ürünleri, yetiştiricilik, üretim

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**Citation:** Yılmaz, E., Harmantepe, F. B., (2025), Aquaculture in Çanakkale: Current Status and Future Perspectives, Memba Water Sciences Journal, 11, (1) 116–129.

<https://doi.org/10.58626/memba.1649378>

**Submission Date:** 2 March 2025

**Acceptance Date:** 24 March 2025

**Publishing Date:** 28 March 2025

## 1. Introduction

Aquaculture is one of the important sectors that provide continuous input to the economy of all countries today (Çöteli, 2023). The aquaculture sector has come a long way in the last 50 years with the spread of training and the increase in technology. In the 1950s, 4 per cent of total aquaculture production, 5 per cent in the 1970s, 19 per cent in the 1990s and 44 per cent in the 2010s were obtained from aquaculture. In 2021, 50% (91.2 million tonnes) of the 182 million tonnes produced was obtained from fishing and 50% (approximately 90.9 million tonnes) was obtained from aquaculture (FAO, 2024). Looking at the world aquaculture production data for 2022; it is seen that a total of 185,452,672 tons of products were obtained, with 91,037,271 tons from hunting and 94,415,401 tons from aquaculture (DGFA, 2024). In its published report, FAO announced that it expects total fisheries and aquaculture production, excluding algae, to increase gradually and reach 202 million tons in 2030, and that most of this increase will come from aquaculture (FAO, 2022).

According to the data of the Federation of European Aquaculture Producers (FEAP), Turkey is one of the leading countries in aquaculture in Europe. Turkey, which has a very high position especially in sea bream and sea bass production, competes with major producers such as Norway and Greece. Norway is the European leader in cold water fishing and salmon production and has the largest production volume thanks to its developed infrastructure. Turkey, on the other hand, has come to the fore in Europe with its specialization in species specific to the Mediterranean climate (especially sea bream and sea bass) and its farming methods suitable for warm climates. Turkey's focused production strategy in these species makes the country a strong player in the Mediterranean region (FEAP, 2023).

In recent years, there have been significant developments in aquaculture systems in our country, the transfer of fish farms in the seas to open and deep waters has necessitated the use of new techniques suitable for these conditions, and improvements have been made by applying advanced technology in the size and structure of net cages, net and feeding systems (Bilgüven and Can, 2018). Aquaculture production in Turkey increased by 8% in 2023 compared to the previous year and reached 1,010,346 tons. Total production by hunting reached 454,059 tons in 2023, and total production by aquaculture reached 556,287 tons. In Turkey, 55% of aquaculture production originates from aquaculture, 72% of this production is provided from the seas and 28% from inland waters. Looking at the data for 2023, the amount of aquaculture production in our seas is 399,529 tons, and in our inland waters it is 156,758 tons, and the production in our seas is higher than the amount of production in our inland waters for the last 10 years. The most important fish species cultivated in Turkey are trout with 152,566 tonnes in inland waters, sea bass with 160,802 tonnes and sea bream with 154,011 tonnes (DGFA, 2024). According to 2023 data, the most produced species are mussels with 8,738 tonnes, meagre with 6,149 tonnes and tuna with 3,674 tonnes (TURKSTAT, 2023). In recent years, mussel farming has gained importance in our country in terms of healthy, reliable and sustainable product supply. Apart from the production by hunting, aquaculture production has also started in our seas (Serdar and Yıldırım, 2018). Rainbow trout, which was started to be cultivated in concrete ponds in fresh waters, has become possible to be cultivated in seawater thanks to the accumulation of knowledge and technological developments in production techniques. Today, it is offered to the global market with the Turkish Salmon brand (FCRI, 2012; Yıldırım and Çantaş, 2022). Turkish salmon is the leading species cultivated in the sea in the Black Sea Region, and according to the data of the Eastern Black Sea Exporters' Association (DKİB), it is exported to 48 countries (Erol and Eruz, 2024).

Çanakkale has an important aquaculture potential as a land and sea area due to being the second largest fishing center in the Marmara Region after Istanbul and having the longest coastline after Muğla. The Çanakkale Strait, which connects the Marmara Sea to the Aegean Sea, allows a wide variety of aquaculture species to live with its relatively less salty surface waters coming from the Black Sea and more salty bottom waters coming from the Mediterranean and its different hydrographic structure, and in this respect, it also forms the migration route of many species. The fish species provided in the province are trout, anchovy, mullet, sea bass, bluefish, swordfish, chub mackerel, bonito, sardine. Depending on its aquaculture potential, Çanakkale province has aquaculture processing and evaluation facilities that have received EU approval numbers. There are 105 facilities in Turkey that export to EU member countries, 9 of which are in Çanakkale province (Anonymous, 1998; Kelkit, 2011; Anonymous, 2023a). Çanakkale, which has Mediterranean mussel beds along its entire coast, has a great potential in terms of mussel farming. This feature of Çanakkale province, together with the Balıkesir coast, made it the region where the first Mediterranean mussel culture was carried out in Turkey (Yıldız et al., 2023).

It is important to know the species and production amounts of aquaculture products obtained through aquaculture in Çanakkale region, which covers a large area, in terms of planning to be made to obtain high efficiency in the aquaculture sector in the region, which has a rich potential. In this context, the current status of the aquaculture sector, its place and development in the aquaculture sector of our country, and

recommendations for the sustainable growth of the aquaculture sector in the province were analysed by using data on water resources in the province, number of aquaculture facilities, settlements, fry and actual capacities, species grown, total production amounts and values of aquaculture products, and support payments made to aquaculture products.

## 2. Materials and Methods

### 2.1 Working area

The working area consists of aquaculture facilities established in natural and artificial water resources in the centre and districts of Çanakkale province. Çanakkale is a province with lands on the Gallipoli Peninsula, which is connected to the Eastern Thracian lands of the Balkan Peninsula by an isthmus, and the Biga Peninsula, which is the western extension of Anatolia. The province covers 993,318 hectares on either side of the Çanakkale Strait, the waterway linking the Aegean Sea and the Sea of Marmara, spanning both Europe and Asia (Anonymous, 2023a). The total coastal length of the province, which has both Marmara and Aegean Sea coasts, is 671 km (Figure 1) (Anonymous, 2024a; Anonymous, 2024b).



Figure 1. Map of Çanakkale province and districts (Anonymous, 2024c)

Within the provincial borders, Kocabaş Stream, Bayramdere, Umurbey Stream and Sarıçay are located in the Northern Marmara Basin in the Biga Peninsula, and Kara Menderes Stream, Tuzla Stream and Mıhlı Stream are located in the Southern Marmara Basin. The river resources in the province and districts are given in Table 1.

Table 1. Rivers of Çanakkale Province (Anonymous, 2023b)

River Name	Total length (km)	Length within the province borders (km)	Max. flow (m <sup>3</sup> /s)	Place of origin	Place of discharge
Kara Menderes Stream	109	109	1530	Kazdağı	Çanakkale Strait
Tuzla Stream	80	80	1400	Kırburun	Aegean Sea
Sarıçay	40	40	1300	Küçükburun	Çanakkale Strait
Kocabaş Stream	84	84	1345	Kaynarca	Marmara Sea
Mıhlı Stream	28	12	75	Kazdağı	Edremit Gulf
Kavak Stream	50	18	1100	Ballı	Saros Gulf
Bayramdere	11	11	1.123	Taşlıburun	Marmara Sea
Büyükdere	10	10	1.048	Genişdağ	Kaleköy
Çınardere	28	28	0.791	Sisalandağı	Marmara Sea
Tayfurdere	19	19	0.642	Ağılyeri	Çanakkale Strait
Umurbey Stream	22	22	16.677	Avcı Tepesi	Çanakkale Strait
Kocaçay	62	62	4.584	Bardakçı	Kocabaş Stream

Agonya Stream	148	70	2.304	Katrandağı	Ortaca
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Although there is no significant lake in the province, there are salt lakes that dry up in the summer in the Gelibolu Peninsula and Gökçeada (Anonymous, 2023b). There are a total of 30 ponds built by the Provincial Directorate of Village Services and the DSI 252nd Branch Directorate within the provincial borders. 22 of these ponds were built by the Village Services and 8 by the DSI (Akbulut et al., 2006; DSI, 2024). There are 5 underground water resources and they are shown in Table 2.

Table 2. Groundwater potential of Çanakkale province (Anonymous, 2023b)

Source Name	Water Potential (hm <sup>3</sup> /year)
Bayramiç – Evciler – Ayazma Spring	50.08
Yenice Çınar Spring	0.41
Yenice – Ilıca Spring	1.04
Geyikli – Pınarbaşı – Kırkgözler Spring	0.63
Karadag Village Water Resource Areas	4.20

Information on the current water resources and their status in Çanakkale province was obtained from the Çanakkale 25th Regional Directorate of State Hydraulic Works (DSI), data on aquaculture facilities and production quantities of aquaculture products (2013-2023) were obtained from the General Directorate of Fisheries and Aquaculture (DGFA), the Çanakkale Provincial Directorate of Agriculture and Forestry, and also the Fisheries and Aquaculture Statistics of Turkey and the Çanakkale Turkish Statistical Institute (TURKSTAT) data portal and relevant institutions. Data were analyzed using Microsoft Excel software, percentages were calculated and interpreted in tables and graphs.

### 3. Results and Discussion

According to 2024 data, there are a total of 18 aquaculture facilities in Çanakkale, including 7 mussels, 5 rainbow trout, 4 carp, 1 lugworm and 1 sea bass, sea bream, turbot and meagre. The locations of the active aquaculture facilities in the province on the map are given in Figure 2.



Figure 2. Location of Çanakkale province aquaculture facilities on the map

When the distribution of the facilities according to the province is evaluated, it is seen that the highest number of facilities are in Gelibolu and Lapseki districts with 22.22% and the lowest number of facilities are in Ezine, Çan and Ayvacık districts with 5.56% (Figure 3).

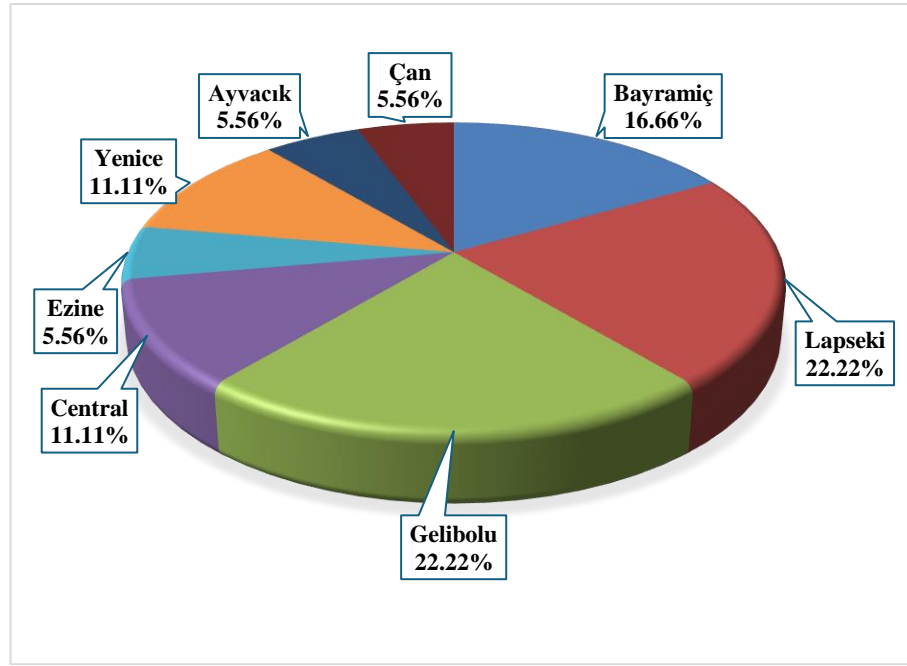


Figure 3. Distribution of aquaculture facilities by districts (%)

The locations, capacities and cultivated species of the facilities in the province are given in Table 3.

Table 3. Aquaculture facilities in Çanakkale

Facilities Number	Dist-ri-cts	Facilities Type	Offspring Ca-pacity (pcs)	Actual Capacity (kg/year)	Species
1	Bayra-miç	Concrete pool	800.000	64.000	Rainbow trout
2	Bayra-miç	Concrete pool	500.000	7.000	Rainbow trout
3	Bayra-miç	Concrete pool	320.000	20.000	Rainbow trout
4	Lapseki	Net cage	-	670.000	Rainbow trout
5	Çan	Concrete pool	300 000	30 000	Rainbow trout
6	Lapseki	Tank-Earth pool	39.000.000	15.000.000	Sea Bass
				21.000.000	Sea Bream
				1.000.000	Turbot
				1.500.000	Meagre
7	Yenice	Net cage	-	20.000	Mirror carp- Com-mon carp
8	Yenice	Net cage	-	15.000	Mirror carp- Com-mon carp
9	Lapseki	Net cage	-	25.000	Mirror carp- Com-mon carp
10	Ezine	Net cage	-	15.000	Mirror carp- Com-mon carp
11	Geli-bolu	Raft/Rope	-	1.400.000	Mediterranean Mussel
12	Geli-bolu	Raft/Rope	-	1.400.000	Mediterranean Mussel
13	Geli-bolu	Raft/Rope	-	1.500.000	Mediterranean Mussel
14	Geli-bolu	Raft/Rope	-	1.000.000	Mediterranean Mussel
15	Lapseki	Raft/Rope	-	990.000	Mediterranean Mussel
16	Central	Raft/Rope	-	1.000.000	Mediterranean Mussel
17	Central	Raft/Rope	-	1.000.000	Mediterranean Mussel
18	Ayvacak	Earth pool	-	35.000	Lugworm



It is seen that mussel farming is the most common and sandworm and sea fish farming are the least common in the province. The percentage distribution of these facilities is as follows; 38.9% mussels, 27.8% rainbow trout, 22.2% carp, 5.6% sea bass, sea bream, turbot and garnet and 5.6% sandworm (Figure 4) (Anonymous, 2024d; Yıldız et al., 2023).

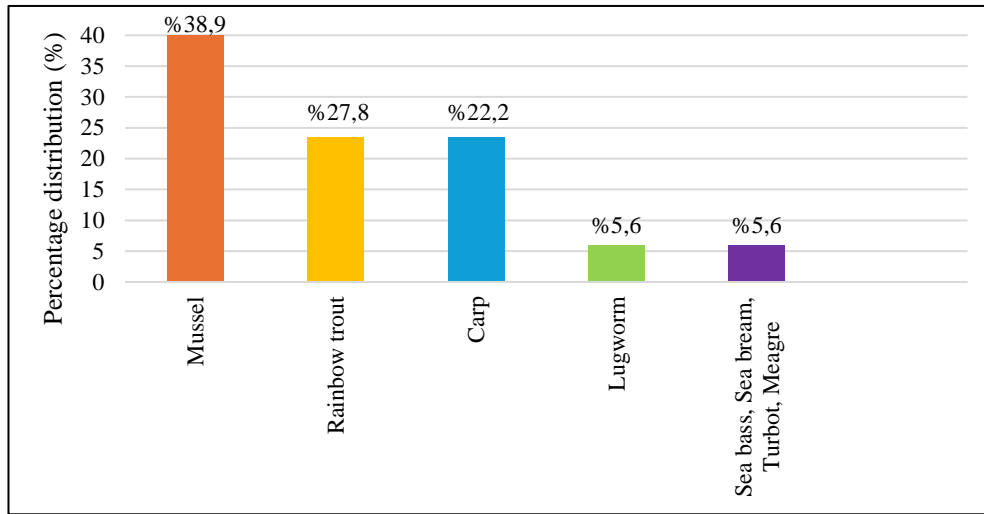


Figure 4. Distribution rates of aquaculture facilities in Çanakkale province (%)

The number of mussel (*Mytilus galloprovincialis*) farming facilities in the sea using raft/rope system is 7 in the province. The distribution of mussel farming facilities by districts is as follows; 4 in Gelibolu (57.1%), 2 in the centre (28.6%) and 1 in Lapseki (14.3%). It is seen that mussel farming is more widespread in Gelibolu district. In addition, there are 6 mussel farming facilities in the province with preliminary permits and rented premises that are in the installation phase. 3 of them are in Çanakkale Central (below Karacaören), 2 in Lapseki (below Güreçe, Güreci village - Tırıpça) and 1 in Gelibolu (Çamlık 2) (Anonymous, 2024d). Çanakkale is the region where the first Mediterranean mussel culture was carried out in our country (Yıldız et al., 2023). Yıldız et al. (2023) and Yıldız and Lök (2005) reported that Çanakkale, which has Mediterranean mussel beds all along its coast, is a region with ideal conditions for mussel farming. In addition, the increase in the domestic demand for mussels leads to an increase in the economic value of mussels (Yıldız and Lök, 2005).

According to TURKSTAT 2023 aquaculture production data, mussel farming in our country was 8,738 tonnes (TURKSTAT, 2023). According to the 'Aquaculture Facilities' table for December 2024, which is regularly updated by the Ministry of Agriculture and Forestry, the number of facilities engaged in mussel farming in the seas in our country is 53 (Anonymous, 2024e). Of these facilities, 30 (60%) are located in the Marmara Region, 18 (36%) in the Aegean Region and 5 (10%) in the Black Sea Region. In the Marmara Region, mussel farming is carried out in 4 provinces and these provinces and the number of facilities are as follows; Balıkesir 12, Çanakkale 7, Yalova 7 and Bursa 4. In the Aegean Region; It is carried out in 2 provinces, 13 in İzmir and 5 in Muğla. In the Black Sea Region, there are 5 production facilities, 4 facilities and 1 university facility in Sinop alone. It is seen that the most intensive mussel farming in Turkey is carried out in the Marmara Region. Çanakkale province stands out as the second most intensive farming province in this region and constitutes 23.3% of the mussel farming carried out in the Marmara Region. The mussel farming production amounts (tons) in the province between 2017-2023 are shown in Figure 5. The highest production was achieved in 2020 with 1371 tons.

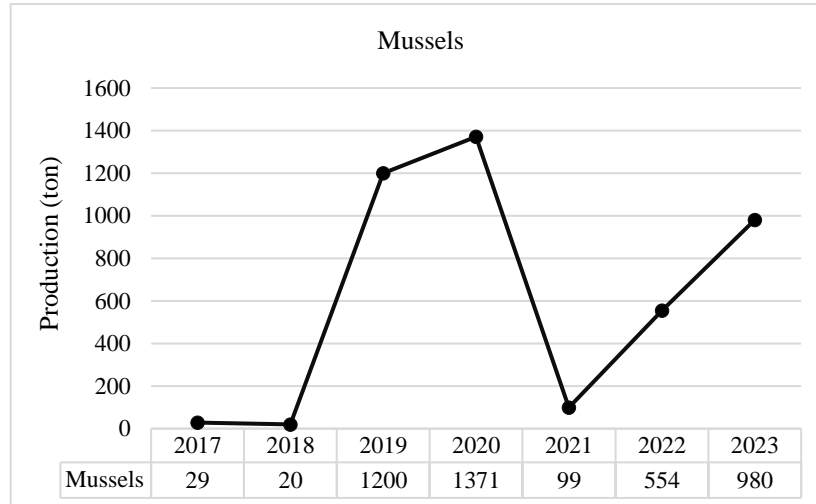


Figure 5. Mussel farming production in Çanakkale province between 2017-2023 (tons)

There are 5 farms in the province that farm rainbow trout (*Oncorhynchus mykiss*). The distribution of rainbow trout farming facilities by districts is as follows; 3 in Bayramiç, 1 in the Lapseki and 1 in Çan. The water source of the 3 farms located in Bayramiç is the Ayazma stream, which is a branch of the Kara Menderes stream, Ayazma Küçükçay water and Bıkdidere. The facility in Çan is located in Şeftali Creek, a branch of the Kocabaş Stream, and the facility in Lapseki is located in the Umurbey Dam Lake. The facilities in Bayramiç and Çan cultivate trout in concrete ponds on land, while the company in Lapseki cultivates trout in net cages in the pond. All of the rainbow trout farming in the region is carried out in inland waters. The two facilities in Bayramiç and the facilities in Çan are small-scale facilities. The facilities in Lapseki, which carries out aquaculture in net cages in the lake, is a large-scale facilities with a capacity of 670 tonnes/year. In his study, Yüksel (2022) stated that approximately 13% of the world's trout production is carried out in our country and that our country has an important place in the world trout farming sector. The European Aquaculture Federation (FEAP) December 2023 report states that Turkey was the country with the highest trout, sea bass and sea bream farming in 2022 and that trout production was 127,000 tons (FEAP, 2023). According to TURKSTAT's 2023 aquaculture output statistics, rainbow trout farming in inland waters amounted to 152,566 tons (TURKSTAT, 2023). Demir (2023) and Yıldırım and Çantaş (2022) reported that 471,686 tons of aquaculture was carried out in our country in 2021 and that 35% of this production was trout farming, that trout farming was carried out in a total of 68 provinces, and that Elazığ (26,500 tons; 16%) ranked first in rainbow trout farming. Furthermore, an analysis of DGFA (2024) aquaculture statistics reveals that there are 2,385 operational aquaculture facilities, comprising 1,831 in inland waters and 554 in the seas. According to the Ministry's 2023 data in the Marmara Region; There are 61 rainbow trout facilities. Çanakkale province constitutes 8.2% of the trout farming in the Marmara Region. The rainbow trout farming quantities (tons) in the province between 2013-2023 are shown in Figure 6. The highest production was 700 tons in 2016.

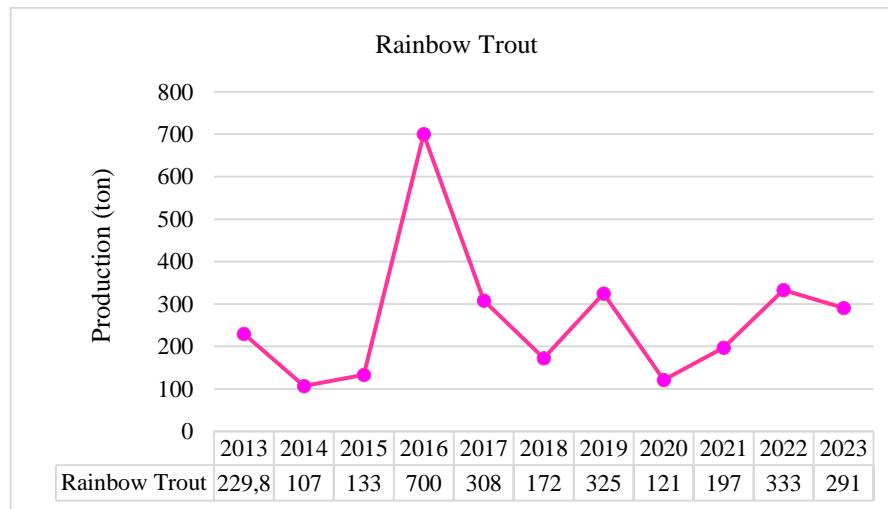


Figure 6. Rainbow trout aquaculture production in Çanakkale province between 2013-2023 (tons)

The number of facilities breeding carp fish (*Cyprinus carpio*) in the province is 4. The facilities are located in Yeniceköy pond and Çınarcık pond in Yenice, Nusratiye Dişbudak pond in Lapseki and Kemallı pond in Ezine. It has been determined that these ponds built for irrigation purposes are rented by carp farming facilities for 5-15 years, the minimum water amounts vary between 2-5.60 hectares, and the facilities in Yeniceköy pond is semi-intensive and the others are extensive (Anonymous, 2023a). According to TURKSTAT 2023 aquaculture production data, carp farming in inland waters was 216 tons (TURKSTAT, 2023). In the whole country, the number of carp farming facilities is 57 (Anonymous, 2024e). Of these facilities, 19 (33%) are located in Marmara, 15 (26%) in Aegean, 9 (16%) in Central Anatolia, 8 (14%) in Mediterranean, 4 (7%) in Southeastern Anatolia and 5 (10%) in Eastern Anatolia. According to the data of the Ministry 2023, it was reported that 19 carp fish facilities in the Marmara Region were distributed in 6 provinces. These provinces and the number of facilities are Edirne 9, Çanakkale 4, Tekirdağ 2, Sakarya 2, Kocaeli 1 and Bursa 1. Çanakkale province accounts for 21% of the carp farming in the Marmara Region. The amount of carp fish farmed in the province between 2013 and 2023 (tonnes) is shown in Figure 7. The highest production was 9 tonnes in 2020.

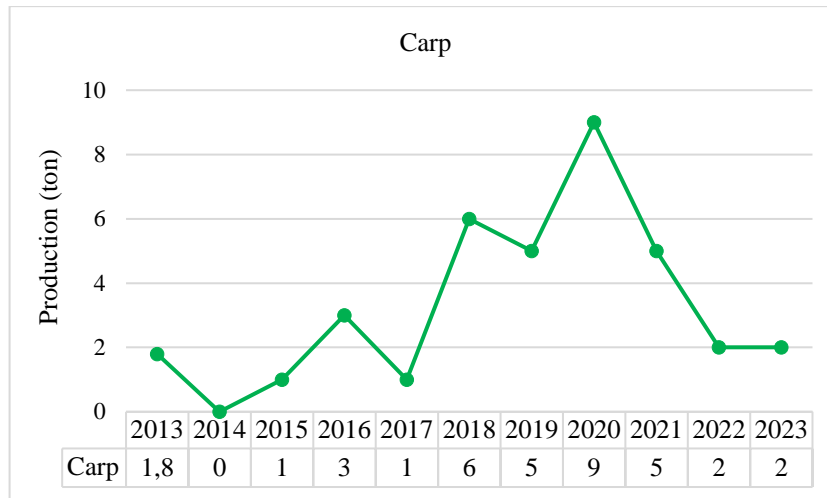


Figure 7. Carp farming production in Çanakkale province between 2013-2023 (tons)

Another aquaculture facilities in the province is located in Lapseki district. In this facilities, sea bass (*Dicentrarchus labrax*), sea bream (*Sparus aurata*), turbot (*Psetta maxima*) and meagre (*Argyrosomus regius*) are farmed in tanks and earthen ponds. There are 104 hatcheries (marine and freshwater) across the country. Of these hatcheries, 27 are marine fish hatcheries and have a capacity of 1.028.250.000 fry/year and 140.402.000 eggs/year (Yüksel, 2022). In 2022, Turkey produced 156,000 tonnes of portion sea bass, 230,000 tonnes of juvenile sea bass, 134,000 tonnes of portion sea bream and 240,000 tonnes of juvenile sea bream (FEAP, 2023). According to the 2023 aquaculture production data for our country, sea bass ranked first with a production of 160,802 tonnes, while sea bream ranked third with 154,011 tonnes (DGFA, 2024). According to TURKSTAT, 2024a data, the amount of sea bass and sea bream farming (tonnes) in Çanakkale province between 2013-2022 are given in Figures 8 and 9. An analysis of the figures reveals that production has fluctuated over the years, with sea bass production reaching its highest level in 2021 (19 tonnes) and sea bream production peaking in 2020 (33 tonnes). Çanakkale province contributes to the production potential of our country, which is the leader in Europe in terms of sea bream and sea bass farming, albeit at a low level.



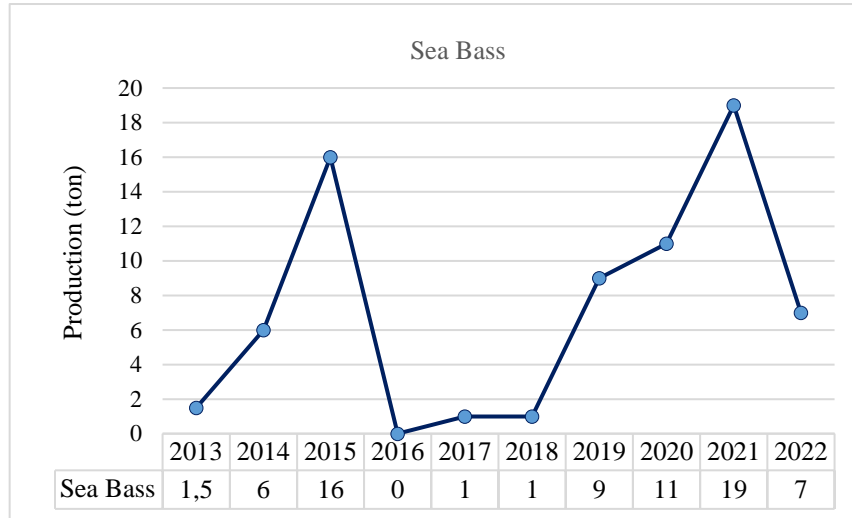


Figure 8. Sea bass aquaculture production in Çanakkale province between 2013-2022 (tons)

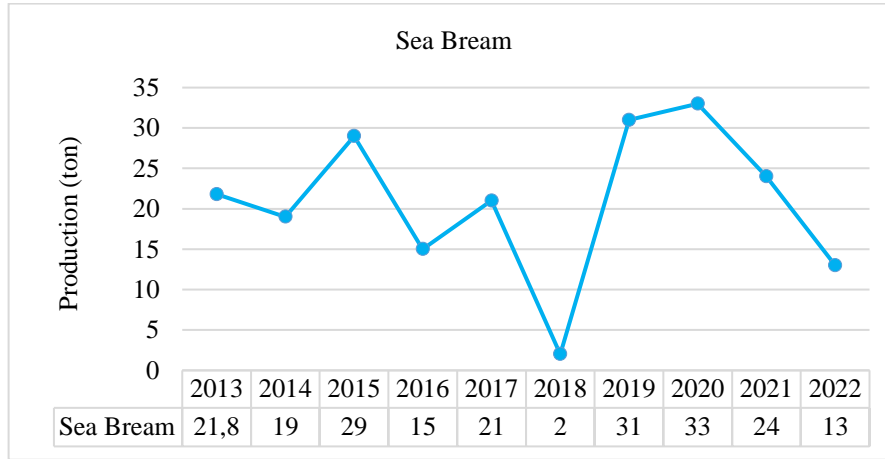


Figure 9. Sea bream aquaculture production in Çanakkale province between 2013-2022 (tons)

According to TURKSTAT's aquaculture production data for the year 2024, meagre aquaculture in Turkey was 6,149 tonnes (TURKSTAT, 2024a). According to the FEAP December 2023 report; Turkey ranks second after Spain in meagre (*Argyrosomus regius*) fish farming (FEAP, 2023). When the aquaculture facilities report for 2024 published by the Ministry of Agriculture and Forestry is examined; it is seen that there are 102 meagre facilities in our country, 97 of these facilities are in the Aegean Region, 4 in the Mediterranean Region and 1 in the Marmara Region. Meagre cultivation is mostly done in the provinces of Muğla, İzmir and Aydın in the Aegean Region, and the number of facilities is 72, 18 and 7, respectively. While Muğla province ranks first in terms of facilities, Çanakkale province ranks last. There is no data on the production amount of meagre fish in Çanakkale province, including previous years.

Turbot, one of the most valuable commercial flatfish species of our country, is attracting attention as a potential species for stock increase and aquaculture (Aydın et al., 2019). Turbot farming is carried out in 2 facilities in our country, one in earthen ponds in Muğla in the Aegean Region and the other in earthen ponds and tanks in Çanakkale in the Marmara Region. In addition, turbot is raised for research and fish breeding purposes at the Trabzon Fisheries Research Institute within the Ministry. No data was found on the amount of turbot production in Türkiye and Çanakkale province.

Lugworm (*Arenicola marina*) cultivation is also carried out in earthen ponds in the Ayvacık district of Çanakkale province. This facilities is the only facilities in our country that breeds lugworm.

The production quantities (tons) of the species cultivated in Çanakkale province between 2013 and 2023 are given in Figure 10. The figure highlights that the production quantities of the species vary significantly over the years. It is observed that the highest production between 2013 and 2023 was in rainbow trout (inland) and mussel species. Mussels reached their highest production amount (1371 tons) in 2020, but production amount (99 tons) decreased suddenly in 2021. The reason for this decline may be due to the mucilage event seen in the Marmara Sea that year, which negatively affected the marine ecosystem. Koncagül et al., (2022) stated in their research on mucilage that mucilage was seen in the Marmara Sea

in 2021, that the mucilage spread over an area of kilometers affected the marine ecosystem, that the mucilage settled on the sea bottom and caused living creatures to be deprived of oxygen, and that creatures such as mussels that clean the seas could not perform their functions as a result of their surfaces being covered with mucilage.

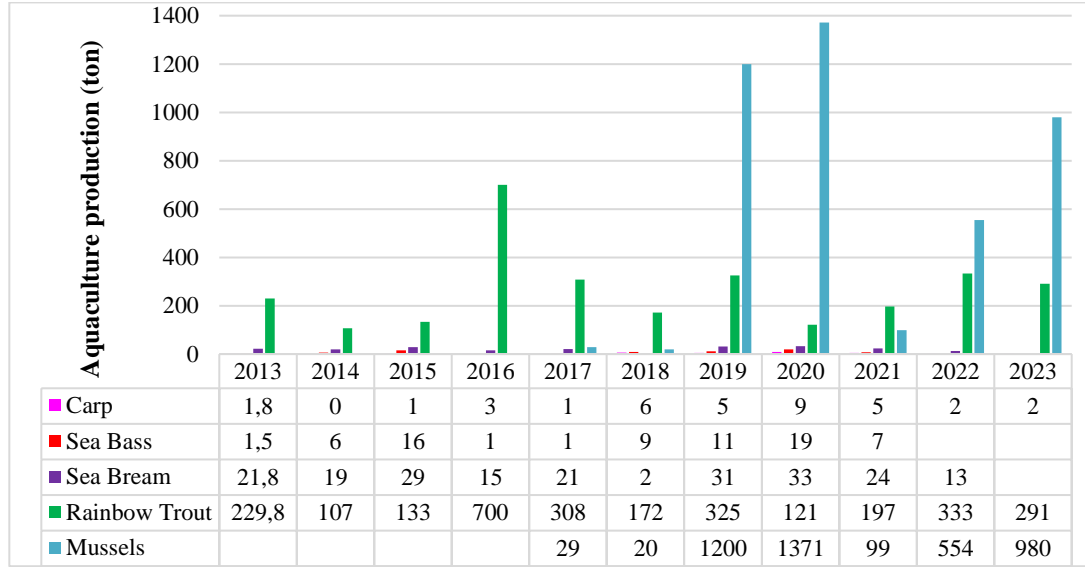


Figure 10. Aquaculture production quantities of Çanakkale province between 2013-2023 (tons)

Total aquaculture production amount and total production value of Çanakkale in 2023 are given in Table 4.

Table 4. Total production amount and total production values of aquaculture in Çanakkale province

Product Name	Total Production Amount (ton)	Total Production Value (TL)
Inland Aquaculture	292,76	18.151.074,00
Mariculture	289,16	11.156.827,63
<b>Total</b>	<b>581,92</b>	<b>29.307.901,63</b>

The total production amount obtained from inland aquaculture in 2023 was 292.76 tonnes and the total production value was 18,151,074.00 TL. The total production amount obtained from mariculture is 289.16 tonnes and the total production value was 11,156,827.63 TL. The total amount of aquaculture production was 581.92 tonnes and the total value of aquaculture production was 29,307,901.63 TL. In 2023, the amount of inland aquaculture production was higher than the amount of marine aquaculture production. The aquaculture sector has been included in the scope of support since 2003 (Çötel, 2023). The fisheries support data within the scope of rural development support provided in Çanakkale between 2016-2023 are shown in Table 5.

Table 5. Fisheries support payments in Çanakkale province by year (TL)

Year	Fisheries Support Payments (TL)
2016	166.573
2017	522.629
2018	464.737
2019	872.130
2020	714.000
2021	1.979.575
2022	925.700

Of the total support amount of 3,788,418 TL for 2023, 212,666 TL was for aquaculture support. The remaining part (3,575,752 TL) belonged to traditional coastal fishery support. In 2023, while the share allocated for coastal fisheries was 94.4 %, the share allocated for aquaculture was as low as 5.61 %, which was quite remarkable. In the Aquaculture Specialization Commission report, it was emphasized that there has been a significant increase in production with the increase in support provided to the aquaculture sector, and that increasing and diversifying production in a way that takes environmental sustainability into account should be among the main priorities (Anonymous, 2014). In addition, Çöteli (2023) stated that the types and amounts of support given to aquaculture in our country are effective in preventing the pressure of the increase in feed costs on prices, and that rearranging the supports given according to the FCR rate and aquaculture costs will contribute greatly to the development of aquaculture. In 2023, our country's aquaculture import amount was 105,252 tons and export amount was 272,192 tons (TURKSTAT, 2024b). According to these economic data, exports were seen to be more than twice the amount of imports. In 2023, the annual import rate in Çanakkale was 92,075 tons and the export rate was 203,785 tons, and in the same year, Çanakkale's marine product farming import rate was 17,290 tons and the export rate was 28,967 tons. It was determined that 19% of the imports and 14% of the exports in the province were provided from mariculture. The graph of import and export data of mariculture in Çanakkale province between 2019-2023 is given in Figure 11.

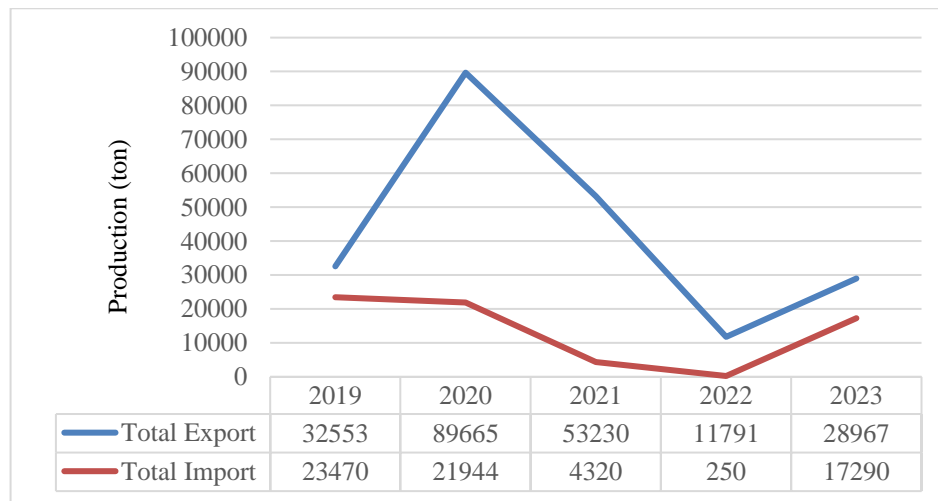


Figure 11. Import and export data of marine products farming in Çanakkale between 2014-2023 (tons)

#### 4. Conclusion

Within the scope of the research, Çanakkale province aquaculture facilities and the data belonging to these facilities were comprehensively discussed. In addition, information was provided on issues such as the province's water resources, aquaculture facilities in districts, support rates, import and export quantities, and evaluations were made. In the research, it was seen that Çanakkale province has a rich perspective in terms of the diversity of aquatic products cultivated. This shows that the region has potential to be evaluated based on alternative species in terms of aquaculture.

Çanakkale has a great potential for the development of the aquaculture sector with its 671 km coastline. Examining the facilities reveals that the majority are mussel production facilities operating with raft/rope systems at sea. In particular, the fact that sea water in the region contains suitable properties for mussel cultivation and that mussel cultivation has the advantages of being more economical and easier than the cultivation of other species has led to the increase of this type of cultivation in the region. It seems that Çanakkale has the potential to come to the forefront with mussel farming in our country's aquaculture sector. The studies to be carried out by the Ministry to identify and open new mussel farming areas in the region will allow the aquaculture sector to develop further in the field of mussel farming and will also contribute to the national economy. In addition to the existing facilities, there are 6 mussel farming facilities that have received project approval, are in the preparation phase, and have not yet started production. After completing the necessary preparations as soon as possible, these facilities will start production and make a significant contribution to both the region and the sector in terms of employment and production. Minimizing the problems encountered in mussel production by establishing bilateral cooperation between

the Ministry and the University and conducting studies on the development of new and alternative production technologies can contribute to the development of mussel farming. In addition, carrying out training activities to train expert and educated personnel in mussel farming within the scope of cooperation between the ministry, university and private sector may enable the closure of the experienced personnel gap. Increasing sea water temperatures due to climate change, stagnation in the sea and the increase in the amount of nutrients in the sea cause mucilage problems in the Marmara Sea. Although dense mucilage may negatively affect mussel farming, it is important to cultivate mussels that filter seawater to reduce mucilage formation in a planned manner to preserve the ecological balance. In Çanakkale, which serves as a gateway from the Black Sea to the Aegean Sea through the Sea of Marmara, it is important to plan facilities to be established in the marine environment in a way that does not affect maritime traffic and tourism.

In the research, it was determined that there is one marine fish production facilities in the province, where sea bass, sea bream, turbot and meagre fish are grown, and that the region's need for juvenile fish is also met to some extent. Considering the advantage of using many different cultivation environments such as earthen pools and closed circuit systems in the cultivation of this species, it is possible to increase production with new cultivation facilities to be opened in Çanakkale, where the climate conditions are also suitable. In addition, the opening of more hatcheries in Çanakkale to raise marine fish species will meet the need for juvenile fish in the sector.

Freshwater trout farming is carried out in the province, and three of the existing facilities use river water sources and one uses a dam lake water source. Additionally, it has been determined that two trout facilities have received project approval and are in the preparation phase. Carp fish are raised in 4 ponds within the provincial borders. These ponds are artificial irrigation ponds built by Village Services and DSI. As a result of the intensive use of ponds by local farmers to irrigate agricultural lands, there is a high probability that carp facilities will face water shortages in the near future. There are carp facilities in the region that have closed due to drought, and the Ministry does not accept applications for breeding in ponds due to the drought.

The aquaculture sector is one of the sectors heavily affected by global climate change. Due to drought caused by climate change, efficient use of water resources is extremely important for the continuation of biodiversity and access to healthy food. At this point, it is important to prepare water resources usage plans by considering the sustainability of both plant agriculture and aquaculture in the province. Water pollution is a major problem affecting the entire world. Both freshwater resources and seas are affected by pollution. The diversity of the elements that cause pollution makes the task even more complicated. Aquatic products grown in polluted waters can accumulate pollutants in their tissues, from heavy metals to pesticides and even microplastics. This will cause aquatic products, which are known as healthy foods, to be considered among risky foods.

For the development of the aquaculture sector in a region, the concept of a sustainable blue economy must first be well understood. This concept includes the correct and careful use of resources, better management and protection of marine and ocean ecosystems. It is a matter of debate whether these concepts are fully understood by anyone other than large companies in the aquaculture sector. It would be beneficial to organize educational seminars that aim to raise awareness among the stakeholders of the aquaculture sector in our country; on the correct use of water resources, good management of ecosystems, environmentally friendly, sustainably planned and protected, and environmentally responsible awareness, aiming to leave protected resources for future generations.

Considering the current situation, it is inevitable to make planning using advanced technology tools with a multidisciplinary perspective for the sustainable development of aquaculture in Çanakkale province.

## **5. Compliance with Ethical Standard**

### **a) Authors' Contributions**

E. Y.: Designing of study, Data collection, Data analysis, writing original draft preparation.

F. B. H.: Data collection, writing original draft preparation.

### **b) Conflict of Interest**

The authors declare that there are no conflicts of interest or competing interests.

### **c) Ethics Committee Approval**

Ethics committee approval is not necessary for this study.

#### d) Declaration of Not Using Artificial Intelligence

The authors declares that they did not use any type of generative artificial intelligence in the writing of this article, including the creation of visuals, graphics, tables, or corresponding titles.

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