Black Sea National Aquaculture Briefs

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Aquaculture in Türkiye (Republic of Turkey)

The Republic of Türkiye bridges Asia and Europe. The total area of the country is 783,562 km^2 and the coastline is 8,333 km. It borders the Aegean Sea to the west, the Mediterranean to the south, and the Black Sea to the north. The Sea of Marmara runs through the western part of the country and links the Black Sea with the Mediterranean Sea. The total population of the country was 85.7 million in 2024, and the annual population growth rate was 3.4‰ (TURKSTAT, 2025).

Türkiye is a major aquaculture producer, the second largest in Europe. In 2023, the total aquaculture production was 556 000 MT (Table 1) and has grown by about 700% over the last two decades (FishBase, 2025). Presently, more than half of the fish supply in Türkiye comes from aquaculture (TURKSTAT, 2025), and aquaculture exports amount annually to € 1.7 billion (Eurofish, 2024) while capture fisheries are declining. There are 2352 operating fish farms in Türkiye, including 1829 in inland waters and 533 in the open sea (Aydin et al. 2025). Most of the aquaculture is marine (80%) in cages and during recent years, aquaculture in Türkiye has developed more towards marine production. Around 56% of the aquaculture is in the Aegean Sea, while about 14% is in the Black Sea.

Three species account for 96% of the production in terms of volume: Seabass, Seabream and, rainbow trout (Table 1). Türkiye is a large producer of seabass and seabream, and the second largest producer of rainbow trout in Europe (Eurofish, 2024). Rainbow trout is produced in land-based facilities, mainly raceways (Aydin et al. 2025). Some are marketed at portion size (300-500 g), while others may be grown to a larger size (5 kg) in cages in the Black Sea and marketed as Turkish salmon or trout. The production of this Turkish or Black Sea salmon has reached 66,055 MT (in 2023) (Aydin et al. 2025). The aquaculture sector is developing rapidly with several emerging interesting species such as meagre, bluefin tuna, whiteleg shrimp, the algae spirulina, and frogs (Table 1). There is also a production of Black Sea trout/salmon (*Salmo labrax*), some of which is

produced in the Black Sea. However, the distinction between *Salmo labrax* and large rainbow trout in terms of brand names appears to be somewhat fuzzy.

Table 1. Aquaculture production in Türkiye in 2023. Data from (FishStatj, 2025)

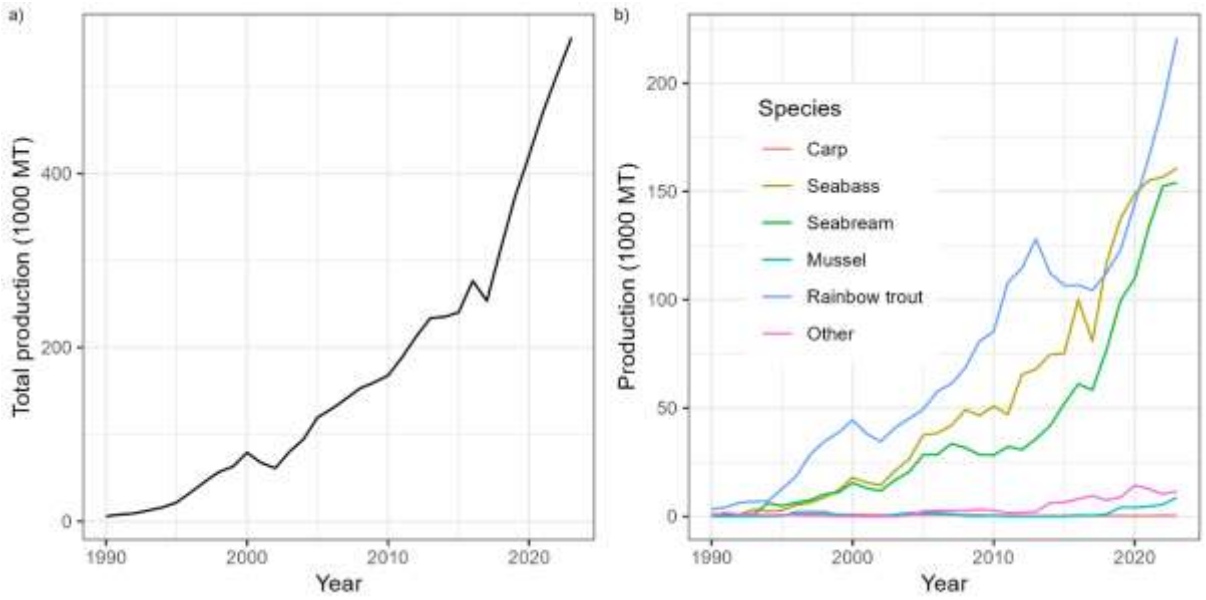
Species	Production (MT)	
Atlantic bluefin tuna	3 674	1 %
Blue crab	1	0 %
Common carp	216	0 %
European seabass	160 802	29 %
Frogs	31	0 %
Gilthead seabream	154 011	28 %
Meagre	6 149	1 %
Mediterranean mussel	8 738	2 %
Rainbow trout	221 046	40 %
Red porgy	59	0 %
Spirulina NEI	10	0 %
Sturgeons NEI	1	0 %
Trouts NEI	1 440	0 %
Truncate donax	21	0 %
Wels(=Som) catfish	79	0 %
Whiteleg shrimp	18	0 %
	556 296	100 %

Total production of fish and seafood from aquaculture and fisheries in Turkey in 2022 was 834 660 MT. In addition, 115 189 MT were imported (in 2022), while export was about 331 920 MT. The fish imported for local consumption are generally of lower value (mackerel, sardines) than the fish that is exported. The local consumption of fish (Eurofish, 2024; FishStatJ, 2025) was 5-7 kg capita^{-1} year^{-1} which is well under the world average of 20 kg capita^{-1} year^{-1}. However, the consumption of fish varies greatly among regions. Most of the fish in the local market is sold by fishmongers in markets or bazars although sales through supermarkets are increasing.

The aquaculture industry in Türkiye is well developed. Most of the marine aquaculture production (66%) comes from larger companies with a production capacity over 1000 MT (FAO, 2022). These companies are vertically integrated with seed production, fish production, slaughtering, marketing, and even feed production (FAO, 2022). There are also smaller (1-50 MT) family run seawater fish farms, mainly in ponds which are concentrated near the coastline (FAO, 2022). The companies in freshwater aquaculture are smaller than in marine aquaculture and few have production licences over 1000 MT. The estimated production capacity of fish farms is more than the current production. There are at least 20 marine finfish hatcheries, and two employ selective breeding, while most of the rainbow trout eggs are imported (Aydin et al. 2025). There are 29 fish feed factories in Türkiye with a production capacity surpassing 875 000 MT (Aydin et al. 2025) and imported feed is also available from global producers. However, much of the raw materials for the fish feed, especially fishmeal and fish oil, is imported.

The rapid growth of aquaculture in Türkiye during the last two decades is a result of favourable government policies that have supported the growth of the sector. The development of aquaculture in Türkiye also hinges on the vibrant research community in universities and research institutions that actively involved in diverse aquaculture research (Aydin et al. 2025). The universities and other teaching institutions also educate people with a strong and diverse technical background that can provide the staff required for modern aquaculture.

Figure 1. Total aquaculture production in Türkiye (a) and, production of different species (b) from 1990 to 2023. Data from FishBase, 2025.



The main challenges to the growth of aquaculture in Türkiye are similar to those of other countries with a large aquaculture sector. One of the challenges is sourcing raw materials for feed production which are presently imported. Disease outbreaks and containment are also a significant challenge. Seed production remains a challenge and especially establishing local breeding programs for fish. Finally, there are challenges associated with climate change and the resulting deterioration of water quality. Limited freshwater resources are also a challenge for the growth of freshwater aquaculture.

There has been a legislation in place in Türkiye since the 1970's addressing aquaculture (FAO, 2022). These laws have later been amended and changed, in part to align with EU directives. Environmental regulations have been in place since 2007 to protect water quality and fish welfare (Since 2009). Aquaculture is primarily regulated by the Ministry of Agriculture and Forestry. Estimates of carrying capacity and regulations for site selection and marine spatial planning are still lacking. This deficiency has likely caused environmental degradation and social conflicts (FAO, 2022).

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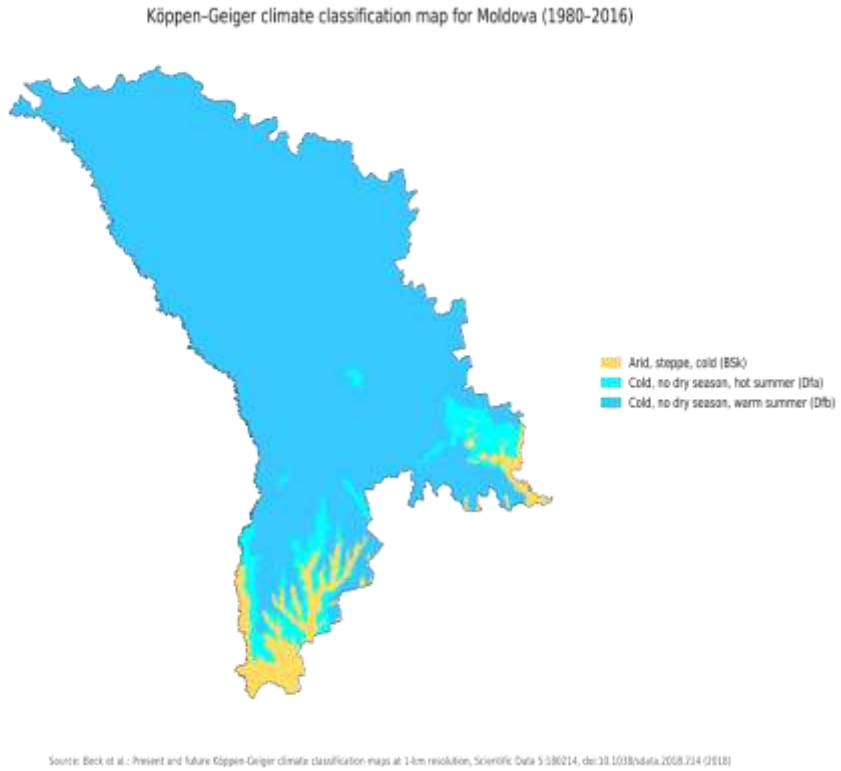
Aquaculture in the Republic of Moldova

Moldova in Eastern Europe is a land-locked country that occupies an area of ~33,800 km^2 (with Transnistria; without ~29,700 km^2). Moldova's population in 2024 is ~2,424,033 with a density of ~83 persons/km^2. The per capita GDP in 2024 was ~$8,260. The national language is Romanian (Moldovan). The topography is hilly and relatively rugged; however, elevations are not >430 m, which is the country's highest point, Balanesti Hill. The hills are the Moldavian Plateau, a part of the Carpathian Mountains which are steep forested slopes of valleys and ravines. In the north is the Bălți steppe region, a plain with an average elevation of 150-200 m). The Dniester River is the main waterway; it is navigable in almost all of country, and it has several tributaries (Răut, Turunchuk, Ichel). The western border of Moldova is the Prut River, a tributary of the Danube, is the western border of Moldova. It passes through Ukraine, Romania and Moldova. The Bîc, Cogalnic, Ciugur, Cainari, Reut, Alcalia, and Hajider are smaller rivers that flow into the Dniester or the Prut. The Nistru River, with an annual flow of ~10 km^3, is a ~630 km border between the Republic of Moldavia and Ukraine. The Köppen–Geiger climate classification system, which identifies climate groups by vegetation type, classifies most of Moldova as "cold, no dry season,

warm summer" with smaller areas in the south and near the river plains and deltas as "cold, no dry season, hot summer" or "arid, steppe, cold".

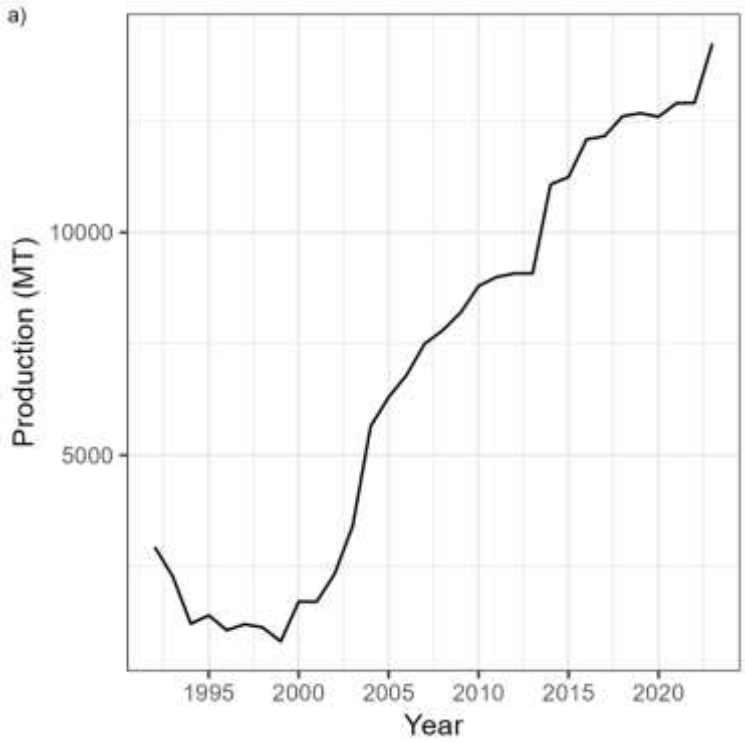


Aquaculture History

Pila and Stanciu (2019) detail the history of aquaculture in Moldova. By 1975 fish farming in ponds in the Republic of Moldova was well established with ~4,570 MT produced in aquaculture. Aquaculture enhanced fisheries in reservoirs managed by the State Fisheries Directorate developed, with an impressive fish productivity of 603 kg/ha reported. Cage fish farming in the Kuchurgan reservoir was reported to occur as far back as the 1980's. FAO data also indicated that major growth of aquaculture occurred between 1968 and 1987 to 7,141 MT (Pila and Stanciu 2019).

In 1961, Chinese carps (silver, *Hypophthalmichthys molitrix*; bighead, *Aristichthys nobilis*; grass, *Ctenopharyngodon idellus*) were introduced to Moldova (FAO, 2018). In the Soviet era (<1990), only state-owned aquaculture farms were present. After independence a transition pond ownership passed to local municipal authority administration, which slowly were privatized as farmers lease ponds for fish farming. The main species produced in aquaculture were grass, silver, bighead and Crucian carps (~55% of total harvests). In 2002 aquaculture production was ~2,258 MT. The association "Piscicola" of former state farms occupied ~9,748 ha and produced about half of the country's total.

Current Status of Aquaculture



Total fish production in Moldova 1992-2923. Source: FishStatJ, 2025.

Aquaculture production in the country is dominated by carps (common, silver, bighead, and grass) which comprise 97% of the ~14,245 MT/year.

The average consumption of fish and fishery products in Moldova is 16.2 kg·capita^{-1}·year^{-1} and slightly higher than in most of the neighbouring countries. Most of the fish and fish products (76%) are imported, while exports of fish are very small (10 MT).

Fish production in Moldova in 2023. FAO FishStat (2024)

Species	Production (MT)	%
Bighead carp	1200	8 %
Common carp	5280	37 %
Crucian carp	2200	15 %
Grass carp(=White amur)	180	1 %
Silver carp	5190	36 %
Carps total	14050	99 %
		0 %
Danube crayfish	5	0 %
Freshwater fishes NEI	50	0 %
Pike-perch	70	0 %
Sturgeons NEI	60	0 %
Wels(=Som) catfish	10	0 %
Total	14245	

There are active programs in aquaculture enhanced fisheries in reservoirs and lakes (Dubosari reservoir on the Dniester River (~6,500 ha), Lower Dniester (from Dubosari town to Palanca village, ~3,000 ha), Costesti-Stynca reservoir on the Prut River (~3000 ha in Moldova), and Lower Prut including Manta lake (2,200 ha). Catches are mostly bream, crucian carp, roach and common carp, together with herbivorous fishes (*Aristhichthys nobilis, Hypophthalmichthys molitrix*and C*tenopharingodon idella*); these are also in the rivers (Dniester, Prut rivers). Aquaculture hatchery supplementation of the Dubasari and the Stânca Costesti is estimated at ~39.4 MT/year of juveniles from the national funds.

Smaller carps (<5 kg) are of lower value and sold mostly in local markets, while higher value fish (catfish, pikeperch, large carps) go to the Chisinau market.

Challenges & Opportunities

FAO (2004) stated “Aquaculture is the most promising sector for supply of freshwater fish. The main problem of this subsector is the inefficient use of natural resources.

Aquaculture ponds in Moldova grow fish in polyculture, an efficient and resource conserving use of the entire volume of water. Species grown are common Asian carps. FAO (2004) estimated that considering the climate and soil and water quality, polyculture aquaculture could provide at least 500 kg fish/ha without supplementary feeding, but with fertilization and feedin the yield can ~1 MT/ha/year or further by intensification of polyculture. The zander, or pikeperch (*Sander lucioperca*), was introduced as a predator to remove unwanted juvenile fish in aquaculture ponds and is reported to increase productivity by 100 kg/ha. (FAO 2018; Pila and Stanciu 2025). Large scale hatcheries for pikeperch in Victori, Edinets are reported operating.

Taraclia, the largest fish farm, produced 50 MT in 2024. The company was established 8 years ago and grows species in polyculture, with good profitability. The biggest problem facing farms in the region is the growth of valuable fish (carp, silver carp, grass carp) up to >5 kg. Most farms produce fish weighing 1.5 to 2 kg. Only Taraclia managed to grow carp weighing >5 kg in large quantities (Pila and Stanciu 2018).

Considering that the main watercourses are also border areas with the neighboring countries, regional, cross-border projects would further support the growth of aquaculture and conservation objectives to restore natural habitats and the fish population in the Nistru and Prut rivers (Pila et al. 2018).

Governance

Pila, M.M. *et al*. (2019) reviewed the governance structure for aquaculture and fisheries in Moldova. They state “The State Fisheries Department, Ministry of the Environment, according to the Law no.149 of 08.06.2006 on fish fund, fisheries and fish farming, exercises the state supervision on the observance of the mentioned law…it ensures the protection of the fishery resources, it carries out measures of fish improvement and fish reproduction and it combats poaching…authorization for the fishing of reproductive fish, the certificate of commercial fishing quota, the commercial fishing permits, the sport fishing permits, and amateur and recreational fishing permits issued by the Environment Agency.”

However, they point out “The lack of a national strategy for the development of fish farming and insufficient investment projects shall slow the development of this sector.”

Aquaculture R&D Capacity Building

Aquaculture research is conducted by the Moldovan Scientific Research Fish Farming Station (selection, reproduction, growing technologies, hydrochemistry, ichthyopathology). Training of experts in aquaculture in Moldova is conducted by the State University and the Institute of Applied Science. Other institutions are: The Institute of Zoology of the Academy of Science (two laboratories); Zoology Department of Chisinau University; Zoology Department of the Tiraspol Pedagogical Institute. Along with these are non-governmental and nonprofit organizations: Ecological society “Biotica”; Moldova-Ukraine organization “Akvair”; Research and Production Alliance “Ecotoks”. However, funding for scientific research has significantly decreased, and scientific staff has been reduced to one-third in recent years. Furthermore, Pila and Stanciu (2019) claim that “One of the most acute problems is the lack of qualified personnel who can quickly and efficiently implement activities specific to technological innovation”

Conservation and Nature-based Solutions

According to the Law of the Republic of Moldavia no. 149 of June 8, 2006, priority aquatic conservation objectives are the Nistru with its tributaries, the Dubăsari reservoir, the Cuciurgan reservoir, the Turunciuc arm, the Prut River with its tributaries, the Costeşti-Stânca reservoir, and the Manta, the Beleu and Cahul lakes.

Fish of the Nistru River is represented by ~130 species. The fish fauna of the Prut River has native fish species predominate (European catfish, common barbel or Romanian barbel, European carp, common nase, burbot) as it has “deep pits in the riverbed, and meanders”. However, major floods occurred in 2008 and 2010, significant amounts of Asian cyprinids (bighead, silver, grass carps) escaped into the ecosystem of the Prut River. Plans for intensive fishing removals of the exotic species and conservation aquaculture are not well known.

it is worth noting that there has been some dispute between the aquaculture and tourism industries. The establishment of the General Directorate for Fisheries and Aquaculture has improved governance and coordination of the aquaculture sector, simplifying project approval and licensing procedures.

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Aquaculture in The Republic of Georgia

Georgia with its abundant water resources, estimated at 5,000 km of rivers, 17,000 ha of lakes, 23,000 ha of reservoirs, 1,300 km of irrigation canals and a Black Sea coast >300 km (but with significant political/security problems). The most significant rivers are the Kura and Rioni.

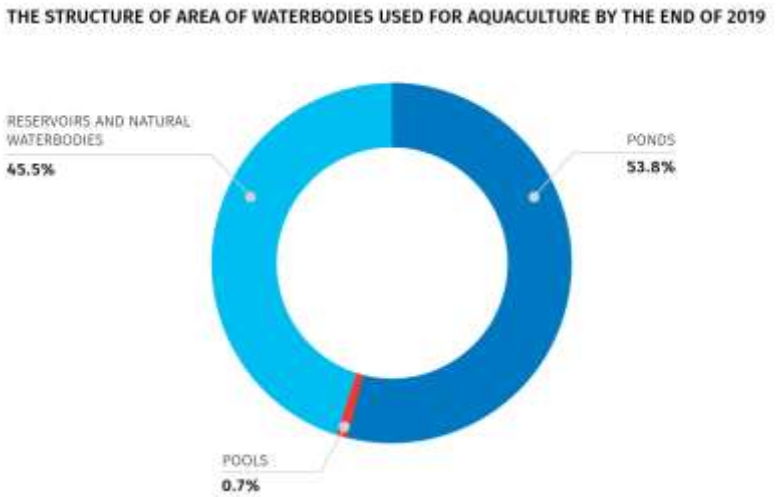
Georgia has been politically unstable for some time, with recent wars and conflicts. Georgia remains in crisis (2024–2025 Georgian political crisis). There are two politically volatile areas of the nation that have partial international, diplomatic recognition, Abkhazia and South Ossetia (Republic of South Ossetia; State of Alania), where aquaculture development is near impossible for international organizations. Inland South Ossetia has an area of ~3,900 km^2 and ~56,500 people (2022). Internally there is the Adjaran Autonomous Republic having an important Black Sea coastline.

The Adjaran Autonomous Republic is defined in Georgian law in its new constitution. Adjara became a full member of the Assembly of European Regions. Adjara has a southeastern Black Sea coast mostly of wooded foothills and mountains of the Lesser Caucasus. The highest mountains are >3,000 m. Adjara receives the highest amounts of precipitation in Georgia and the Caucasus region and is said to be one of the wettest temperate areas of the northern hemisphere, as no area receives less than 2,200 mm/year. Coastal areas are humid as the windward Meskheti Range slopes receive precipitation of ~4,500 mm/year and are covered by temperate and subtropical rain forests.

Abkhazia (Republic of Abkhazia) is a partially recognized state on the eastern coast of the Black Sea, ~8,665 km2 with a population of ~245,000. Abkhazia covers an area of ~8,665 km^2. It is diverse geographically with coastal lowlands stretching to the extremely high mountains (>4,000 m) in the North with many deep river valleys. Abkhazia's landscape ranges from coastal forests

and citrus plantations to permanent snow and glaciers in the north. Abkhazia's ~210 km of Black Sea coast has a wet, subtropical climate, with an average annual temperature ~15°C. Annual precipitation ~1,200–1,400 mm along the coast. The Russian Federation is establishing a naval base in Ochamchire. There has been a Georgian sea blockade of Abkhazia. Russian guard boats provide security for ships bound for Abkhazia. Because of the political/territorial uncertainties, many governments advise against travelling to Abkhazia.

There are three climate zones in Georgia: (1) Kolkhida Lowlands on the Black Sea in the west, with numerous small rivers drain the area; (2) Interior, separated from the western plains by mountain ranges such as the Likhi Mountains, with valleys and plateaus 400-1,000 m; (3) Western plains of Georgia, east of the coast, the climate is more continental, colder in the winter and hotter in the summer (temperature ~38-40 °C). Precipitation is ~1,350 mm/year.



From Geostat, 2020

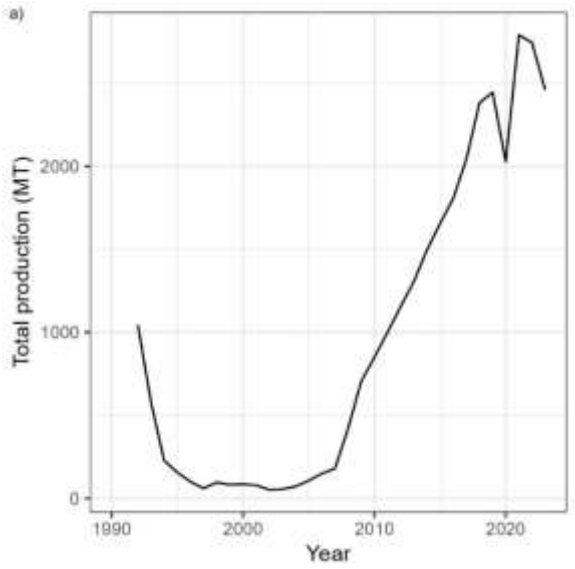
According to the National Statistics Office of Georgia (GEOSTAT 2020), in 2019 the total area of waterbodies used in aquaculture amounted to 4,500 ha, of which ponds represented 50%, followed by reservoirs and natural waterbodies (~46%).

Aquaculture History

Rice (2009) reported that aquaculture began in Georgia during the 1930s Soviet era with hatchery stocking of carps into lakes, reservoirs and collective ponds (aquaculture enhanced fisheries). In the 1950s, there were ~50 farms with a total area of ~2,500 ha. Trout culture developed in inland, upland areas with fish marketed in the capital, Tbilisi (Akhaltsikhe trout farm, Akhalkalaki, Samtskhe-Dzhavakheti region). After independence in 1991 aquaculture production fell to ~50 MT (Van Anrooy *et al*. 2005, 2006) to management failures/skills etc.

Status of Aquaculture in Georgia

Aquaculture production in Georgia is small, estimated at 2,458 MT (FAO FishStat) to 2,792 (Eurofish Magazine 2024). Aquaculture is dominated by trout species (46%) and carps (42%).



Fish production in Georgia in 2023. (FishStatJ, 2025)

Species	Production (MT)	%
Common carp	467	19 %
Grass carp(=White amur)	196	8 %
Silver, bighead carps NEI	370	15 %
Carps total	1033	42 %
Rainbow trout	1132	46 %
Sturgeons NEI	232	9 %
Wels(=Som) catfish	63	3 %
Total	2460	100 %

Registered aquaculture farms totalled 792, of which 425 were active. Most farms were family-run, with 3-4 employees producing small volumes. The Georgian Fish Farmers Union reported 129 small- to medium-sized farms accounted for ~90% of total aquaculture production (FAO 2022).

Status of Marine Aquaculture

An experimental (IPA, Gonio) mussel (*Mytilus galloprovincialis*) farm produced ~20 MT through a business and academic research and outreach partnership (Rice 2009). FAO (2022) reported that "the farm is not running at full capacity".

According to Eurofish Magazine (2024), "Guriafish, a Georgian company on the Black Sea coast, in the village of Tskaltsminda, Guria District is growing "Norwegian salmon" in flow through tanks. The farm received eggs of Norwegian salmon and of three species of trout in 2019. Sea water is said to be pumped 500 m from the coast, from a depth of 40 m. Imported feed from Aller Aqua, Denmark is used. The operation has received a preferential agricultural loan of ~EURO 532,000".

Aquaculture Governance

A "Law on Aquaculture" was enacted in 2020 in cooperation with FAO and international experts from the GFCM (General Fisheries Commission for the Mediterranean). It defines terms used in aquaculture, different technologies and methodologies, including mariculture (Article 11). There are provisions for state management and permitting of aquaculture (Articles 4 & 12), aquaculture allocation zones (Article 13), formation of an "Aquaculture Inter-Agency Council" (Article 5), and transitional provisions (Article 40). The law designates responsibility to coordinate the process of awarding aquaculture permits to the National Environmental Agency (NEA).

Aquaculture/Fisheries Trade

Fish consumption in Georgia is low, with a per capita seafood consumption of 8.2 kg in 2016 compared to the world average of 19.6 kg (FAO 2022). Capture fisheries and aquaculture in Georgia provide ~10-15% of the total seafood, with imports the rest. Imports are mackerel (~40%), hake and herring.

Atlantic salmon (*Salmo salar*) is the most important farmed species supplied to Georgia; in 2019, the volume was ~889 MT. Turkey exported ~220 MT of trout into Georgia in 2019, 60% fresh or chilled and ~30% frozen, with the remaining live or cured/smoked trout (FAO 2022).

Capacity Building

The Georgian National Science Foundation (http:// rustaveli.org.ge/) has a limited research budget (~US$ 7 million, 2017). Support for increased involvement of local scientists in international research projects is critical.

The European Union provides support to rural development and agriculture in Georgia through ENPARD, the European Neighbourhood Programme for Agriculture and Rural Development (see the many projects at ENPARD - EU for Georgia). A strategy for the sustainable development of aquaculture in Georgia was released in 2023 prepared by the Georgian Aquaculture Task Force with the Ministry of Environmental Protection and Agriculture, FAO, supported by the European Union and FAO under the EU ENPARD Programme. A roadmap for the development of aquaculture in Georgia (freshwater and marine water) has four strategic objectives: (1) Improve the legal framework, (2) Promote the growth and reinforcement of the aquaculture sector (production), (3) Support development of trade and marketing for aquaculture products, (4) Achieve social acceptability (social aspects).

EU and FAO conducted a comprehensive value-chain analysis of the freshwater aquaculture sector in Georgia in 2022. (https://capacity4dev.europa.eu/projects/value-chain-analysis-for-development-vca4d/info/235-georgia-freshwater-aquaculture). The study consisted of four analyses: 1) functional, 2) economic, 3) social, and 4) environmental. The analysis suggested that there was potential for growth in the aquaculture sector as only ~30-40% of the potential of ponds and basins was being utilized.

Another important effort was "Support to Environmental Protection and Fight against Climate Change in Georgia (ENI/2022/433-066)" where areas in the Black Sea were identified for the development of marine aquaculture. The new zones allocated for marine aquaculture were subsequently approved by ehe Georgian government.

Shota Rustaveli State University (http:// bsu.edu.ge/en/) has a Faculty of Agricultural Sciences that has been involved in mussel farming. Located in the city of Batumi, one of the major capture fishery centers for the southeastern Black Sea Region as well as a center for Georgia's developing mussel culture and trout farming industries. Fisheries experts also exist at Institute of Zoology, Ilia State University, Tbilisi, Georgia

Observations, Recommendations

Fish Feeds

Does Georgia have the resources to start its own high quality fish feed industry? Georgia produces fishmeal and fish oil and exports these mostly to Turkey and much of this is sent back to Georgia as animal feeds. FAO (2022) stated that "According to experts' estimates, the share of the total annual volume of processed seafood represented by fishmeal and fish oil is up to 90%".

NbS/Restorative Aquaculture

Mumladze, L. *et al*. (2019) stated that Georgia is a key Caucasus biodiversity hotspot and that major gaps remain in animal diversity research in Georgia. This lack of research in native species limits aquaculture that must be developed in a sustainable, ecological manner with clear development plans that incorporate ecosystem conservation and rehabilitation. Government and international authorities are recommended to not "recreate the aquaculture wheel" of unsustainable discharges into the Black Sea from land-based aquaculture, and unsustainable accelerated permitting of cage aquaculture in the Black Sea without strong area management and carrying capacity assessment and controls, all in the interest of both sustainable economic development and environmental stewardship.

Varshanidze (2025) reviewed some innovative aquaculture systems possible for Georgia such as integrated multi-trophic aquaculture (IMTA), but did not mention the potentials for restorative and conservation aquaculture and aquaculture tourism. Development of cooperative, applied research and development demonstration sites in restorative and conservations aquaculture are highly recommended, especially in coastal areas of high scenic and tourist values.

Aquaculture Tourism

Aquaculture and culinary/heritage tourism can both be important industries for economic development, particularly in tourism areas of geographies endowed with natural beauty. Tourism can increase demand for a particular product, with higher profit margins. Food for tourists sourced from local fish farms is fresher, has less environmental impacts and can support local

research and educational organizations and livelihoods (Helgadóttir *et al*. 2021; Budhathoki *et al*. 2025).

The Adjara region is Georgia's major coastal tourism hub. Its capital city, Batumi, is the country's primary gateway to the sea and could be an important region for aquaculture tourism development.

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