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AQUACULTURE AND ITS DISTRIBUTION IN TURKEY

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Abstract:

This study discusses aquacultural practices in the world, the driving forces behind its development, its significance and present condition, aquafarming and its spatial distribution in Turkey.

Keywords: Aquaculture, Aquaculture in Turkey, Spatial Distribution of Aquaculture

Introduction

From the very old times fishing has been an important source of income for humans. It was a primitive practice once, but today it has become ramified and a more intensive undertaking.

Countries aware of the importance of balanced nutrition have focused on optimal exploitation of water resources so as to improve their animal protein sources, and to this end have developed projects. Fish are harvested in two ways: fishing and farming (aquaculture). Majority of the production is wild caught. However, the share of aquaculture in fisheries is gradually increasing. This global change has affected Turkey too, as one can understand from the data the sector has grown substantially.

Materials and Methods

Related bibliography, field studies and statistical data set the groundwork for this study. The researcher made observations on the Aegean and Mediterranean coastline and substantiate the field studies with statistical data. The study draws on the statistical data on fishing of FAO (Food and Agricultural Organization) and of Turkish Statistical Institute, of the General Directorate of Fisheries and Aquaculture (of Ministry of Food, Agriculture and Livestock), and Central Union of Fisheries Producers. ArcGIS 10.1 was used to produce the maps.

Results and Discussion

Fishing in the World

136.2 of 158 million tons of global fisheries product was consumed as food (2012). Despite national and regional variations, 16.7% of animal protein is satisfied by fishery products. 20% and 15% of the need of 2.9 billion and 4.3 billion people for animal protein respectively are met by fisheries. This share (2012) accounts for 7.1% in Germany, 3% in Austria, while 59% in Taiwan and 55% in Japan. 50% of the population in developing countries satisfy 40% of their animal protein need from fish. Across the world, people used to consume 9.9 kg per capita on average in 1960s, while it rose to 18.4 kg in 2009 and 19.2 kg in 2012. Average fish consumption amounts to 9.1 kg, 20.7 kg, 24.6 kg, 24.1 kg, and 22 kg per capita in Africa, Asia, Oceania, North America and Europe, respectively, while it is 9.9 kg in Latin America and the Caribbean. Fishing provides a great number of people not only with essential dietary needs but also with employment. Fishing is still an important source of income.

Whereas the amount of fish harvest was 28 million tons in 1955, it escalated to 89, 131 and 158 million tons in 1987, 2000, and 2012, respectively.

Table 1. Global Fish Production and Utilization in 1990-2012 (in million tons)

Production		**1990**	**1995**	**2000**	**2005**	**2012**
Inland	Aquaculture	8.17	13.86	21.3	26.8	41.9
	Capture	6.59	7.38	8.7	9.4	11.6
	Total Inland	**14.76**	**21.24**	**30.0**	**36.2**	**53.5**
Marine	Aquaculture	4.96	10.42	14.2	17.5	24.7
	Capture	79.29	85.62	86.8	82.7	79.7
	Total Marine	**84.25**	**96.04**	**101.0**	**100.2**	**104.4**
Total Aquaculture		13.13	24.28	35.5	44.3	66.6
Total Capture		85.88	93.00	95.5	92.1	91.3
Total World Fisheries		**99.01**	**117.28**	**131.0**	**136.4**	**158.0**
Utilization		70.82	86.49			
Human Consumption		-	-	96.8	107.3	136.2
Non-Food Uses		-	-	34.2	29.1	21.7
Population (billions)		-	-	6.1	6.5	7.1
Per capite food fish supply (kg)		-	-	15.9	16.5	19.2

Notes: Exluding aquatic plants.
http://www.fao.org./ Statistics for different years.

In 2012, total fish production amounts to 158.0 million tons all over the world, 66.6 million tons of which is yielded by fish farms. The figure concerning global wild catch is 91.3 million tons and the annual increase is insignificant.

Aquaculture in the World

Efforts to cultivate fisheries have increased over the last years. Fish farming in channels, creeks, pools and rice fields in Far East dates back to very old times.

Marine species farming is actually a very ancient practice. Some sources date mariculture back to 2000 BC. It is also suggested that the Japanese farmed oysters on the tidal coasts in the 4th century BC.

Fishery products are depleting due to the rapid increase in the global population, growing threat to fish reserves, various adverse environmental factors despite numerous innovations and the use of advance technology in fishing. Increasing threat to fish reserves and proportionate decrease in the catch over the past years is among the most important dynamics. Population on the Earth is over 7 billion. Aquacultural practices make considerable contributions to the satisfaction of nutrition needs of this increasing global population, healthy nourishment of people, provision of raw material for the industry and creation of employment. Its support to rural development by preserving rural population, increase in export and protection of biodiversity are its other contributions. It is clear from the statistics that Aquaculture has remarkably improved within the last years. Carp and trout were the first fish to farm. Although fresh and salt water farming has substantially developed, the substantial growth in marine aquaculture occurred in the 19th century.

Globally Aquaculture harvest increased to 90.4 million tons by 2012. The income produced amounts to 144.4 billion US dollars. 66.6 million tons of this yield is obtained from fish and 23.8 million tons from aquatic algae. These figures are 70.5 million tons of fish and 26.1 million tons of aquatic algae in 2013, respectively. China alone produces 43.5 million tons of fish and 13.5 million tons of aquatic algae. The increase in aquacultural fish harvest accounts for 6.2% from 2000 through 2012. During the same period, the increase in Africa is much higher (11.7%). It is 10% in Latin America and the Caribbean Islands and 8.2% in Asia excluding China. The growth rate accounts for 5.5% (12.7% in 1990 to 2000) in China as the biggest aquafarmer. As a matter of fact, 92.7% of aquacultural (food) products is harvested by 15 producer countries. Employment in this sector is considerably increasing. Across the world, 4.4% of economically active 1.3 billion people were employed in agriculture in 2012.

Generally speaking, the fishery harvest increased from 13.13 million tones in 1990 to 66.6 million tons in 2012. Aquaculture covers around 42.2% of global fish production and is annually growing more than 10%. Aquacultural production has turned out to be the most rapidly growing sector. Moreover, the most rapid employment increase was recorded in this sector. It employs about 55 million people, half of whom are female. 10-12% of the global population deals with fishing. The share of developing countries in global fish export is 50%, China being the forerunner. 600 aquatic species are farmed in about 190 countries.

Marine fish farming is particularly important for the developing countries. To better illustrate, 52.6% of animal meat (produced on land) is consumed by developed countries, whereas 86.4% of fishery products is consumed by developing countries.

Farmed species are fish, crustaceans, molluscs, amphibians (frogs), aquatic reptiles (excluding crocodiles) and other aquatic creatures (e.g. sea cucumbers, sea urchins and jelly fish) Aquaculture is very important for humankind. Besides its many significant features, it is a major employing sector. Lately, the number of fish farmers have substantially increased. In consideration of continents, Asia has the highest number of fish farmers and is where the highest increase has been observed. While the number of fish farmers was 3.772.000 in 1990, it was recorded to be 15.115.000 and 18.860.000 in 2005 and 2012, respectively. Remarkable increases have been reported in the number of fish farmers in all the continents.

Table 2. Distribution of Fish Farmers by Continents (in Thousand)

Fish Farmers	1995	2000	2005	2010	2012
Africa	65	91	140	231	298
Asia	7 762	12 211	14 630	17 915	18 175
Europe	56	103	91	102	103
South America and Caribbean	155	214	239	248	269
North America	6	6	10	9	9
Oceania	4	5	5	5	6
World	**8049**	**12632**	**15115**	**18512**	**18860**

(Fao, Statistics for different years.)

Aquaculture in Turkey

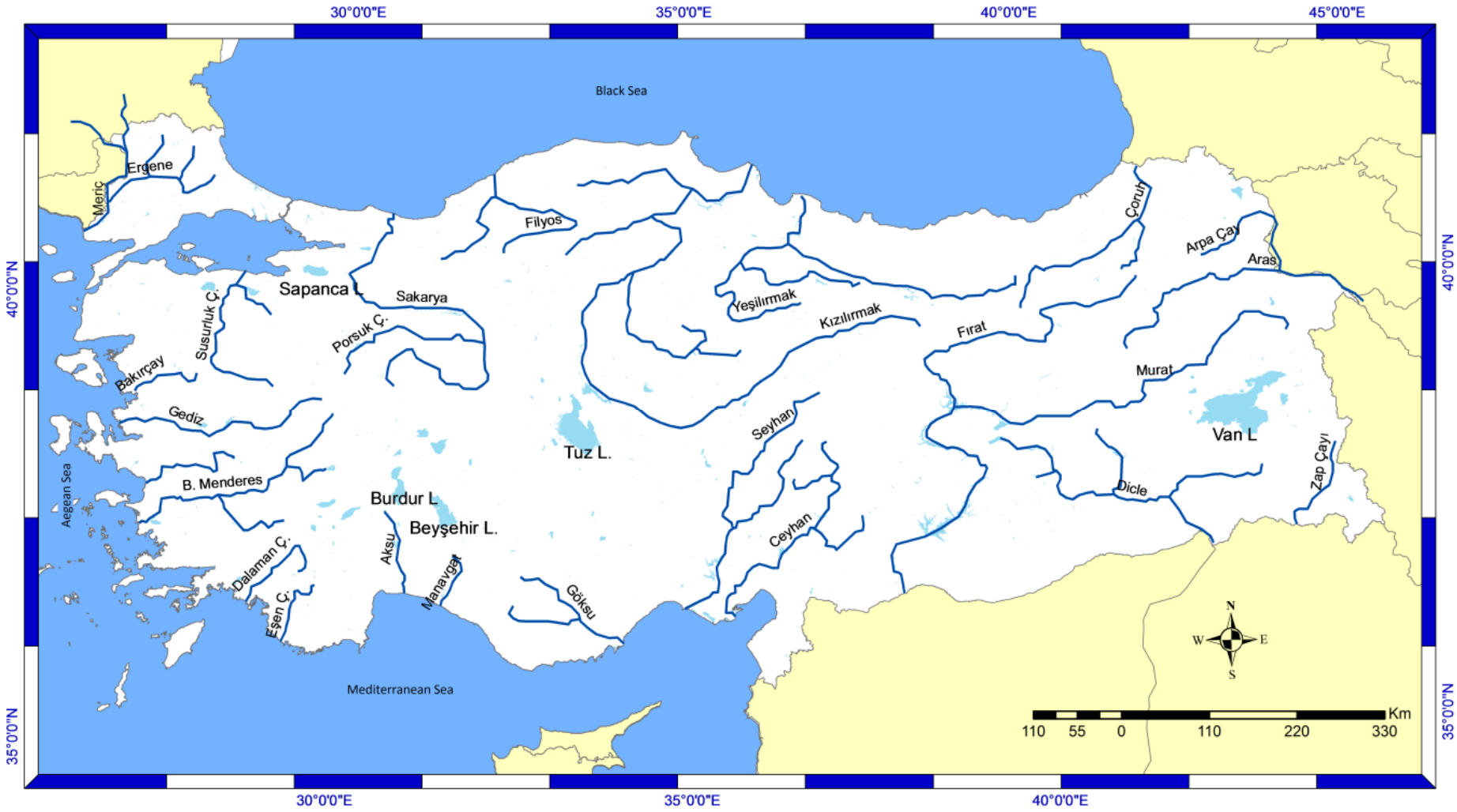
As in the entire world, technological advances in fishing have given way to increase in fishery products. However, in spite of the rapidly developing technology, production increase has come to a halt and been reversed at times due to overexploitation of fish stocks.

Fishing, underdeveloped until 1970s, has significantly developed thanks to incentives since then. The state offered low interest credit loans and customs exemptions, which in return increased the number of fishing boats, boosted fishing capabilities and supported a rapid development. However, fish flour and oil factories were founded, which were more than fish production could satisfy. Thus, fish has come to be used for the production of fish flour and oil, less economic products rather than as a primary human food. This has brought about some problems. Later (after 1988) this practice was given up and fish primarily became a human food again. Fishing in consideration of legal sizes imposed by protective and conservative efforts has contributed to fishermen, tradesmen and national economy. 1970 production of 150 thousand tons increased to 600 thousand tons by 2013. However, the amount of fish consumption is still much lower in Turkey than international figures and global average. It is clear from the statistics that the amount of consumed fish fell to 6.3 kg on average (2013). Fishery product consumption per capita in Turkey is behind the global and European average. It also varies across regions in Turkey: while it is 25 kg per capita on the coastline, it is as low as 1 kg in Central, Eastern and Southeastern regions.

In Turkey, Aquaculture is conducted with the permission of the Ministry of Food, Agriculture and Livestock. The ministry implemented new regulations so as to regulate fish farming, minimize its environmental effects, ensure a healthy and high-quality production, and published "Regulations of Fisheries (29 June 20014, No. 25507)" in the Official Gazette and put it into effect in line with the acquis on fisheries of Common Fishing Policy of the European Union.

Since 1923, Aquaculture was incentivized for the first time in 2003. In 2005 as well so as to promote the farming of new species. Incentives having been given since 2003 have made remarkable contributions to the rapid development and improvement of aquaculture sector.

A protocol was signed between General Directorate of State Hydraulic Works (DSI) and General Directorate for Agricultural Production and Development in 1994 to start fishery farming in cages in reservoirs, which are officially owned by General Directorate of State Hydraulic Works. The protocol was revised in 2004 to allow semi-intensive and extensive production. In 1995, the Ministry of Agriculture and Rural Affairs and the General Directorate of State Hydraulic Works promoted and started in natural lakes and reservoirs, respectively, which is among the causes of production increase.



Map 1. Water Potencial in Turkey

For the purpose of meeting the project needs of producers and entrepreneurs, Turkish Ministry of Agriculture and Rural Affairs and the General Directorate of Ziraat Bankası (Agricultural Bank) collaborated to create typical projects of Aquaculture in cages.

Whereas there was only one fishery facility in 1971, today there are 2912 authorized projects (Facility, Project, Prior Authorization), of which 2392 are inland and 520 are marine facilities (Suymerbir, 2014).

According to 2013 data of the Turkish Statistical Institution (TUIK, 2014), 607515 tons of fishery products were harvested in Turkey, of which 101062.8 tons were exported and 67538.21 tons were imported. Domestic consumption amounts to 479708.3 tons, processed products (fish flour and oil) 87896.2 tons and 6378.1 tons wasted. In consideration of these data, it is obvious that geographical capacities of Turkey should be realized and aquacultural practices should be promoted. Thanks to its inland and marine resources, Turkey is a suitable place for aquaculture. The surface area of Turkey's water resources for aquaculture is much larger than forests and almost equal to arable areas. Turkey is surrounded by water on three sides and its numerous streams, natural and manmade reservoirs, ponds are potential locations for aquaculture. Moreover, many dams are under way. Dams being constructed in Eastern and Southeastern Anatolia Regions to satisfy the need for energy and irrigation water would be suitable water resources for aquacultural practices. To clarify, a coastline of 8333 km, natural lakes of 178000 km^2 and reservoirs of 3442 km^2 with different ecological properties are suitable for fish farming. Realization of this potential is crucial to the development of national fishery in Turkey (Map 1).

Upon the completion of the Southeastern Anatolia Project, 201697 hectares of water area will be gained. This will create an important potential to do aquafarming in the inland waters of Southeastern Anatolia. The current production of 900 tons is expected to rise to 10000 tons thanks to efforts in the region (DPT [State Planning Organization], 2001).

Marine fish farms were removed to open and deep waters pursuant to the regulations passed by the Ministry of Environment and Urban Planning in 2009. According to these regulations, fish farms are not allow within 0.6 marine miles off the shore and in waters less than 30 meters in depth. Moreover, technological advances like the introduction of automated feeding systems, scheduled feeding and digital monitoring have substantially prevented feed-induced pollution (DPT, 2014).

Aquaculture

Aquaculture production was 3075 tons in 1986, and escalated to 167141 tons in 2010 and to 233393 tons in 2013. Fishery harvest was 607515 tons in 2013, 38.4% of which was produced by aquaculture. It can be seen that aquafarming harvest increased by 9.9% in comparison to the previous year. Aquacultural production used to account for 0.53% of total fishery harvest, whereas it increased to cover 10.42% in 1998 and 35.4% in 2013. Post-2000 increase is very eminent. Incentivization of fishery production in 2003 for the first time, increasing incentives to farm new species and incentivized juvenile fish raising are the primary drives for this development.

Fishery production decreased in 2013 in comparison with the previous year by 607515 tons (5.8%). Wild catch and farming account for 61.6% and 38.4% of the production, respectively. While production by catching amounts to 374121 tons, farms' production is 233393 tons. Fish farming in Turkey has taken a huge leap over the last years thanks to scientific, technological and economic developments. While 52.7% of the fishery products in Turkey is harvested from the inland waters, 47.3% is produced from the sea. The species widely farmed are european sea basses (*Dicentrarchus labrax*), gilt-head sea breams (*Sparus aurata*) and Rainbow trouts (*Oncorhynchus mykiss*). Rainbow Trout is the most commonly farmed species, which accounts for 56% of the entire production. The shares of bass and gilt-head sea bream farming are 29% and 15%, respectively. Rainbow trout is primarily raised in inland waters, while gilt-head sea bream and European sea bass are farmed in salt waters. Farmed species vary according to market conditions. Accordingly as a fresh water fish trout production has increased, and gilt-head sea bream and bass production went up as salt-water species. Trout farming increased three folds over 9 years (from 2004 to 2013). Further, saltwater fish production tripled over the same period. For example, bass production went up by three folds.

Juvenile Fish Farming and Their Respective Distribution Areas

The juvenile fish needed for fish farming are obtained from hatcheries or in very small amounrs abroad.

In the private hatcheries, gilt-head sea bream and sea bass fries can be successfully produced in the desired amount. Because fish population is dramatically diminishing in seas, the production of new species is of utmost importance. With new species successfully raised, the variety of species increases based on export, which facilitates the access to new markets.

Table 3. Amount of Fishery Products by Capture and Aquafarming (Selected Years between 1985 and 2013)

Years	Capture (Ton)			Aquaculture (Ton)			TOTAL	Aquaculture Percentage (%)
	Inland	Marine	Total	Inland	Marine	Total		
1985	45471	532602	**578073**	0	0	**0**	**578073**	0.0
1990	37315	342017	**379332**	4237	1545	**5782**	**385114**	1.5
1995	44983	582610	**627593**	13113	8494	**21607**	**649200**	3.3
1996	42202	474243	**516445**	17960	15241	**33201**	**549646**	6.04
1997	50460	404350	**454810**	27300	18150	**45450**	**500260**	9.09
2000	42824	460521	**503345**	43385	35646	**79031**	**582376**	13.6
2011	37097	477658	**514755**	100446	88344	**188790**	**703545**	26.8
2012	36120	396322	**432442**	111557	100 853	**212410**	**644852**	32.9
2013	**35074**	**339047**	**374121**	**123019**	**110374**	**233393**	**607515**	38.4

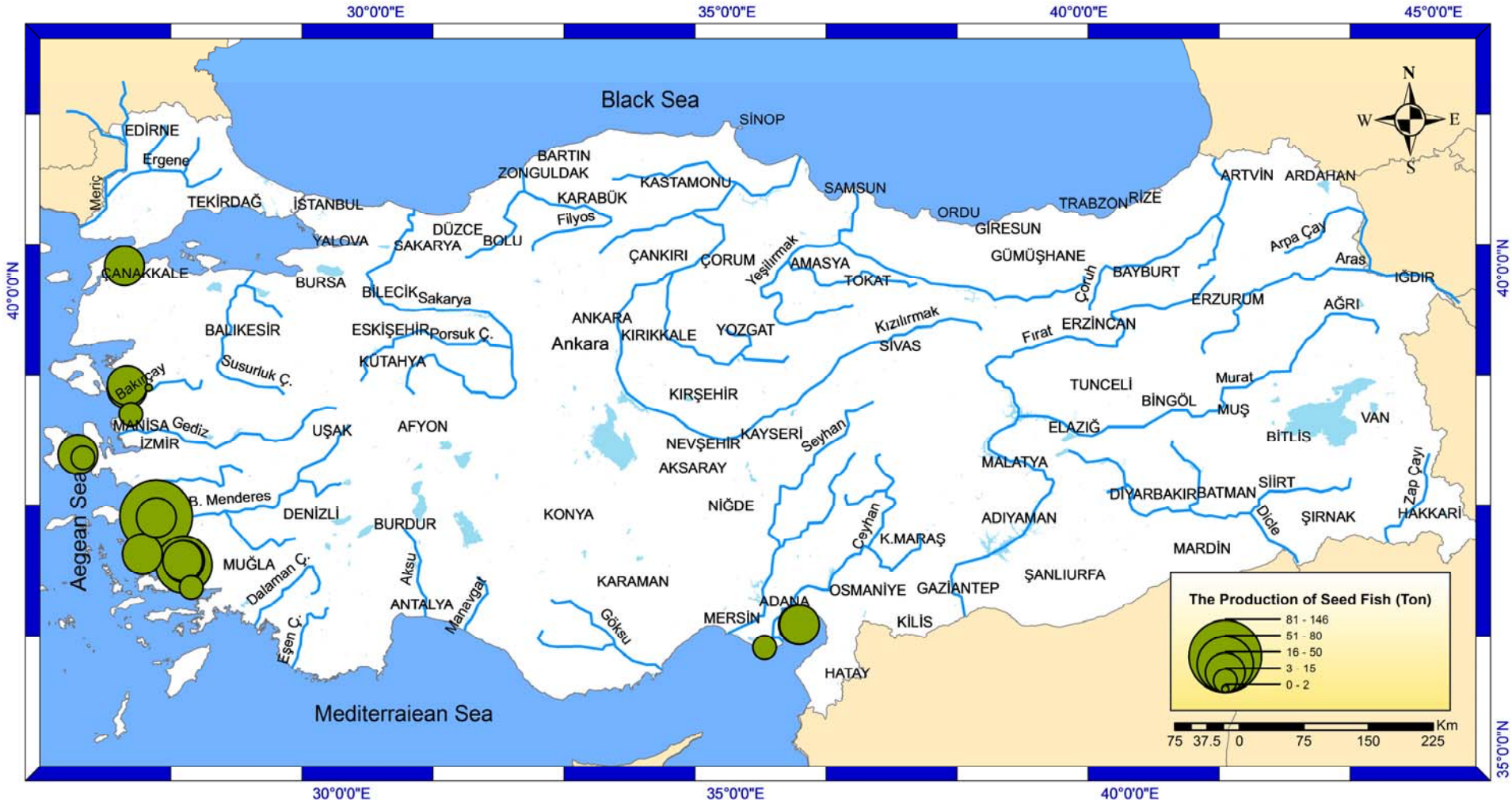
Table 4. Inland and Marine Fish Species Farmed and Their Respective Production Amounts (in Ton)

Fish Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total	**94010**	**118 77**	**128943**	**139873**	**152186**	**158729**	**167141**	**188790**	**212410**	**233393.9**
Inland										
Trout	43432	48033	56026	58433	65928	75657	78165	100239	111335	122873.3
Mirror Carp	683	571	668	600	629	591	403	207	222	145.5
Marine										
Trout	1650	1249	1633	2740	2721	5229	7079	7697	3234	5186
Gilt-head sea bream	20435	27634	28463	33500	31670	28362	28157	32187	30743	35701.1
Sea Bass	26297	37290	38408	41900	49270	46554	50796	47013	65512	67912.5
Other	1513	3500	3745	2700	1968	2336	2541	1447	1364	1575.3

From the Records of the Ministry of Food, Agriculture and Livestock

Table 5. Saltwater Fish Hatcheries in Turkey - February 2013 (BSGM, 2013)

Project Title	Location	Capacity (In Ton)	Produced Species
AKUVATUR-Karataş	ADANA-Karataş	39	Gilt-head sea bream, Sea bass, Dentex, Red Seabream, Bluespotted Seabream, Meager, Red Mullet, Red Striped Seabream, Common Seabream, Axillary Seabream, Sharp Snout Seabream Sargo, Sole, Amberjack
YUNUSLAR	ADANA-Yumurtalık	15	Gilt-head sea bream, Sea bass, Shrimp
EGEMAR	AYDIN-Didim	39	Gilt-head sea bream, Sea bass, Meager, Corb, White Grouper, Dentex, Red Seabream, Common Seabream, Sharp Snout Seabream Sargo, Amberjack
KILIÇ-Bafa	AYDIN-Söke	146	Gilt-head sea bream, Sea bass, Striped Seabream, Sharp Snout Seabream Sargo, Corb, Common Seabream, White Grouper, Dentex, Red Seabream, Meager
SERÇİN	AYDIN-Söke	30	Gilt-head sea bream, Sea bass
İDA GIDA	ÇANAKKALE-Lapseki	40	Gilt-head sea bream, Sea bass
AKUA-TEK	İZMİR-Dikili	38	Gilt-head sea bream, Sea bass, Dentex, Red Seabream, Meager, Common Seabream, Corb, Clown
ÇAMLI-Alaçatı	İZMİR-Çeşme	50	Gilt-head sea bream, Sea bass
ÇAMLI-Ildırı	İZMİR-Çeşme	10	Gilt-head sea bream, Sea bass, Sharp Snout Seabream Sargo, Dentex, Axillary Seabream, Striped Seabream, Brown Meager, Oyster, Scallop, Cockle
İLKNAK	İZMİR-Dikili	20	Gilt-head sea bream, Sea bass, Sharp Snout Seabream Sargo, Dentex, Saddled Seabream, Meager
AKUVATUR -Yeni Şakran	İZMİR-Aliağa	7.5	Gilt-head sea bream, Sea bass, Dentex, Sharp Snout Seabream Sargo, Brown Meager, White Seabream, Corb, Common Seabream, Red Seabream, Meager, Red Striped Seabream, Axillary Seabream
AKUA-TEK -TURKUAZ MARİN	İZMİR-Bergama	2	Gilt-head sea bream, Sea bass
AKUVATUR-Avşar	MUĞLA-Milas	38	Gilt-head sea bream, Sea bass, Sharp Snout White Grouper, Meager, Dentex, Corb, Barbun, Red Striped Seabream, Common Seabream, Axillary Seabream, Sole, Amberjack
HATKO	MUĞLA-Ören	15	Gilt-head sea bream, Sea bass
KILIÇ-Güvercinlik	MUĞLA-Milas	39.5	Gilt-head sea bream, Sea bass, Dentex, Corb, Amberjack
KILIÇ- Akarca	MUĞLA-Milas	39	Gilt-head sea bream, Sea bass, Turbot, Sole
KILIÇ-Ören	MUĞLA-Milas	80	Gilt-head sea bream, Sea bass, Sole, Amberjack, Dentex, Corb, Sharp Snout Seabream Sargo, Red Seabream, White Grouper



Map 2. Distribution of Fish Hatcheries in Turkey

Most valued species are Red Seabream, White Grouper, Dentex and Shrimp whose population is critically low in the wild and economic value is very high. The tuna market which has rapidly grown in the world and in Turkey over the last years provides a considerable amount of foreign currency income. In Turkey, the first tuna farms were opened in 2002. Tuna farms are gradually becoming widespread, leading to economic competitions between countries. Because these farms quickly yield profit although their establishment is costly, many exporters and fishermen are attracted to this undertaking. In summer when prices are relatively lower, tunas are wild caught and fed for 3-6 months and introduced in the market when prices are higher.

As understood from the table, hatchings for aquaculture are performed along the coastline in Turkey. In consideration of total production by provinces, it is seen that 36.2% is performed in Aydın, 35.6% in Muğla, 21.5% in İzmir, 9% in Adana and 6.7% in Çanakkale. 90% of juvenile fish farming is done on the western coastline, i.e. Muğla, Aydın, İzmir and Çanakkale. Hatched fries are also released into the wild. The number of provinces where fish are released in the wild was 28 in 2002 and escalated to 39 in 2012, and the number of sources increased from 200 to 498. The area where fries are introduced covers 152 thousand hectares while the number of released fish is 3.5 million (BSGM, 2013) (Map 2).

Table 6, 7 and 8 include data on the export of farmed species. Trout is mostly exported to Romania, Russia, Germany and Poland, bass to the Netherlands, Libya, the UK, Italy, Germany and gilt-head sea bream to Lebanon, the Netherlands, Libya, Italia, Germany, the UK. Along with fish species, such species as shrimp, oyster and the like are raised in Turkey.

Locations, Characteristics and Distribution of Aquaculture

Turkey has rich water resources thanks to its location, and its climatic conditions and water resources are potentially suitable for aquaculture. These are important factor for the development of fishery sector.

Table 6. Trout Export (Patrona, 2013)

Product Type	Countries	Percentage (%)
Fresh, Cooled	Romania Russia Poland Holland	25 22 12 8
Frozen*	Germany Poland Czech Republic	48 19 7
Smoked	Germany Holland	83 11

*Inc. Fleet

Tablo 7. Bass Export (Patrona, 2013)

Product Type	Countries	Percentage (%)
Fresh, Cooled	Holland Italy Spain Russia	24 16 12 15
Fleet (Fresh, Cooled)	Holland Italy	94 3
Frozen bass	Libya Germany Russia	43 19 8
Filet (Frozen)	United Kingdom Italy France	32 27 13

Turkey has a coastline of 8333 km: Anatolian coastline covers 6480 km, while Thracian and island coastlines cover 786 km and 1067 km, respectively. The Aegean coastline is the longest in Turkey, which extends over 2805 km.dir. It is followed by the Black Sea coastline of 1695 km, the Mediterranean coastline of 1577, the Marmara coastline of 927, the Dardanelles coastline of 172 km and the Bosporus coastline of 90 km (Map 1).

As seen in the Tables, 21 natural lakes alone cover a surface area of more than 8000 km^2, and 18 researvoirs over 3000 km^2 and only 9 rivers over 4000 km.

Table 8. Gilt-head sea bream Export (Patrona, 2013)

Product Type	Countries	Percentage (%)
Fresh, Cooled	Russia Lebanon Holland Italy	14 19 16 14
Filet (Fresh, Cooled)	Holland İtaly	92 7
Frozen	Lebanon Germany Holland, Russia	67 19 4
Fillet (Frozen)	Italy Holland United Kingdom	50 21 17

Table 9. Surface Area of Major Lakes in Turkey (35 km^2 and over) (TUIK, 2014)

Lake	Km^2	Lake	Km^2
Van	3713	Bafa	60
Tuz	1500	Erçek	98
Beyşehir	656	Hazar	86
Eğirdir	468	Köyceğiz	52
Akşehir	353	Işıklı	49
İznik	298	Nazik	48
Burdur	200	Sapanca	47
Kuş (Manyas)	166	Salda	45
Ulubat	134	Yay	37
Eber	126	Akyatan	35
Çıldır	115		

Table 10. Major Rivers and Their Lengths (500 km and over) (TUIK, 2014)

Rivers	Length (km)
Kızılırmak	1355
Fırat (in Turkey)	1263
Sakarya	824
Murat	562
Seyhan	560
Aras (in Turkey)	548
Dicle (in Turkey)	523
Yeşilırmak	519
Ceyhan	509

Table 11. Major Reservoir and Their Surface Areas (TUIK, 2014)

Reservoir	Surface Areas (km^2)
Atatürk	817.0
Keban	675.0
Karakaya	268.0
Hirfanlı	263.0
Manyas	167.4
Altınkaya	118.3
Alparslan-1	114.8
Yamula	88.6
Çatalan	81.9
Sarıyar	78.2
Boyabat	65.5
Kılıçkaya	64.4
Seyhan	63.0
Ermenek	58.7
Kralkızı	57.5
Birecik	56.3
Obruk	50.2
Aslantaş	49.9

Table 12. Turkey's Fishery Product Resources (State palaning Agency, 2001)

Production Area	Amount	Size (Ha)	Length (Km)
Natural Lakes	200	906118	-
Reservoirs	193	342377	-
Ponds	Over 750	15500	-
Rivers	33	-	177714
Seas	-	24607.200	8333
TOTAL		**25871.195**	

To mention the seas surrounding Turkey on three sides: the surface water temperature of the Mediterranean is higher than the annual average temperature. Because of light precipitation and high evaporation, salinity of the Mediterranean is very high, which is around 38-39‰. Salinity decreases towards north and become much lower where rivers discharge.

The current from the Black Sea to the Marmara via the Bosphorus forms a thin surface layer with low salinity (21-25‰). Research on the salinity of the Aegean Sea has revealed the vestiges of a current with low salinity from Marmara through the Dardanelles. For instance, the salinity of the Western Thracian Sea is 30‰ due to the salinity reducing effect of this current. However, it is 38-38.5‰ in the central and southern part of the Aegean Sea. While the salinity is 33‰ around the Biga Peninsula, it is 38.5‰ in the Edremit Gulf (Ardel, 1975). The surface water of the Marmara Sea is typically less saline, which is 22‰. Salinity increases along with the depth. There is a surface current which flows from the Black Sea to Marmara and then to the Aegean Sea and a deeper current running beneath in the opposite direction. These currents affect both salinity and temperature.

The Black Sea is under the influence of the Mediterranean climatic conditions in summer and of terrestrial climate in winter. The temperature of the surface water remains between 20°C and 26°C in summer and 7°C in the southern Black Sea in winter. Because large rivers discharge great amount of fresh water in the Black Sea and due to heavy precipitation and less evaporation, the salinity of the Black Sea is very low (18‰). Towards west and north, the salinity gets lower.

Wide sea surface is always in contact with the atmosphere and contains dissolved gases. In the Black Sea, oxygen amount rapidly decreases below 70-120 meters underwater (Ardel, 1975). Oxygen is only available in the surface water.

The Black Sea has a medium salinity and it get richer in nutrients, which creates a fertile setting. This boosts the population of the migrating pelagic fish such as sprats and anchovies. Because the northern parts of the Marmara Sea and the Aegean Sea are mixed with the warm water of the Mediterranean and the nutritious water of the Black Sea, they are also fertile areas. Besides, these are locations home to such species as mussel, sand mussel and oyster, which are economically important for exportation, be they live or processed.

Distribution of Aquaculture in Turkey

Research has revealed many locations in Turkey suitable for fish farming. For example, salmon, sea trout, turbot have been found to be the right species for the Black Sea; salmon, sea trout, turbot, sea bass, mullet, mussel and oyster for the Marmara; eel, mullet, mussel and sargo for the Aegean Sea and fish and shrimp farming for the Mediterranean Sea.

Table 13. Aquaculture by Region (2013)

REGION	AMOUNTS (TON)
Aegean Region	128006.7
Eastern Anatolia Region	28790.8
Mediterranean Region	22200.4
Black Sea Region	21383.8
Central Anatolia Region	19015
South Eastern Anatolia Region	10331.8
Marmara Region	3665.4
Total	**233393.9**

Aquaculture is widely performed in the Aegean Region (55%), which is followed by Eastern Anatolia Region (12%), the Mediterranean Region (10%), the Black Sea Region (9%), the Central Anatolia (8%), Southeastern Anatolia

(4%), and the Marmara Region (2%). Production in the Aegean Region is more than the total production of the remaining regions. (Map 3)

The Aegean Sea has a coastline of 2805 km and numerous bays and gulfs. Its narrow continental shelf and strategic location have increased the importance of coastal fishery.

Ecological differences are observed in the Aegean Sea. Flows from north and south intermingle here. Therefore, it is home to psychrophilic and thermophilic creatures. For aforementioned reasons, different species live in the south and north of the Aegean Sea. Thus, biodiversity is very rich: Some 400 algae, 5000 invertebrates and 300 fish species were identified. In the region fish farming makes contributions to production and market development and creates employment for many. This activity gradually increases and obtained values become indispensable for the economy.

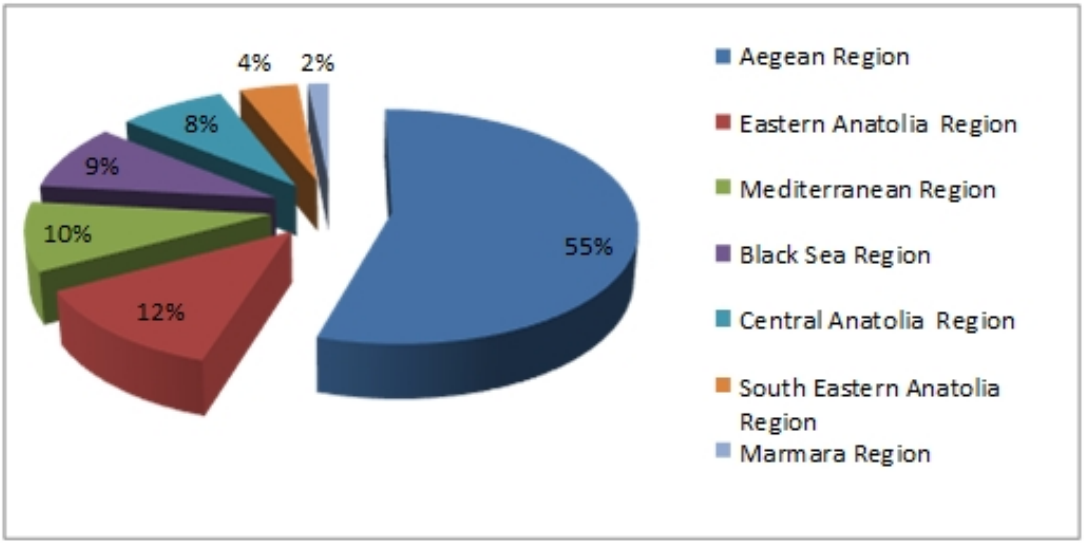
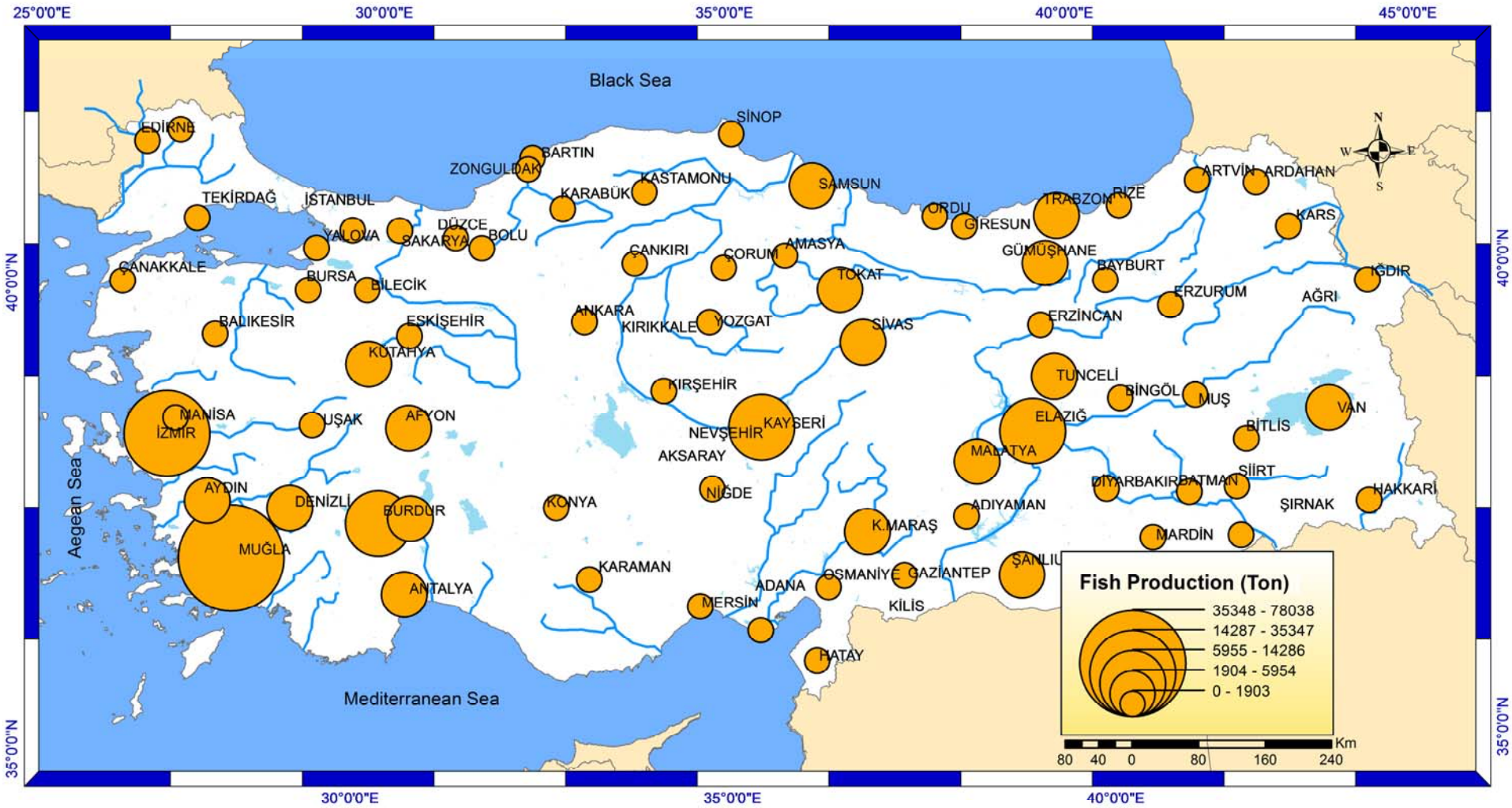


Figure 1. Distribution of Aquaculture in Turkey by Region (2013)

Table 14. Aquaculture in the Aegean Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (TON)
Afyonkarahisar	Trout (Inland)	2808.5
Aydın	Trout (Inland)	2895.3
	Gilt-head sea bream (Marine)	223.4
	Bass (Marine)	1265.1
Denizli	Trout (Inland)	3720.0
İzmir	Trout (Inland)	391.7
	Gilt-head sea bream (Marine)	14702.2
	Bass (Marine)	19344.7
	Other(Marine)	907.5
Kütahya	Trout (Inland)	2120.8
Manisa	Trout (Inland)	1133.3
	Mirror Carp (Inland)	44
Muğla	Trout (Inland)	13900.0
	Gilt-head sea bream (Marine)	20000.0
	Bass (Marine)	43500.0
	Other(Marine)	637.8
Uşak	Trout (Inland)	399.9
	Mirror Carp (Inland)	12.5
TOTAL		**128006.7**



Map 3. Distribution of Total Fish Production in Turkey by Provinces

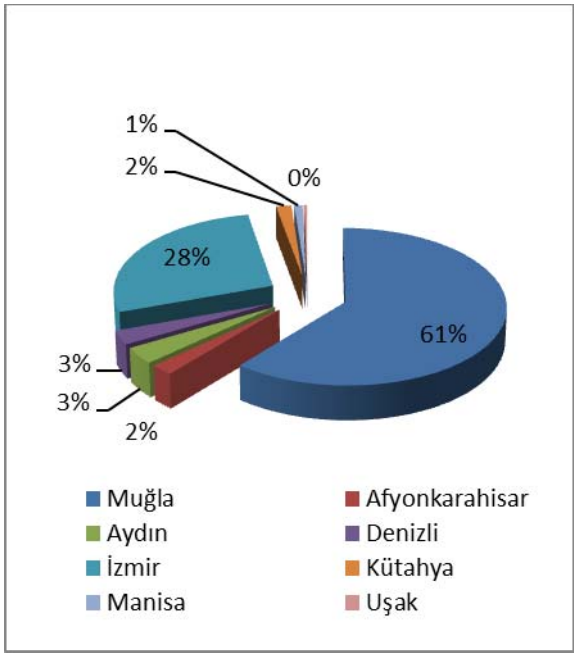


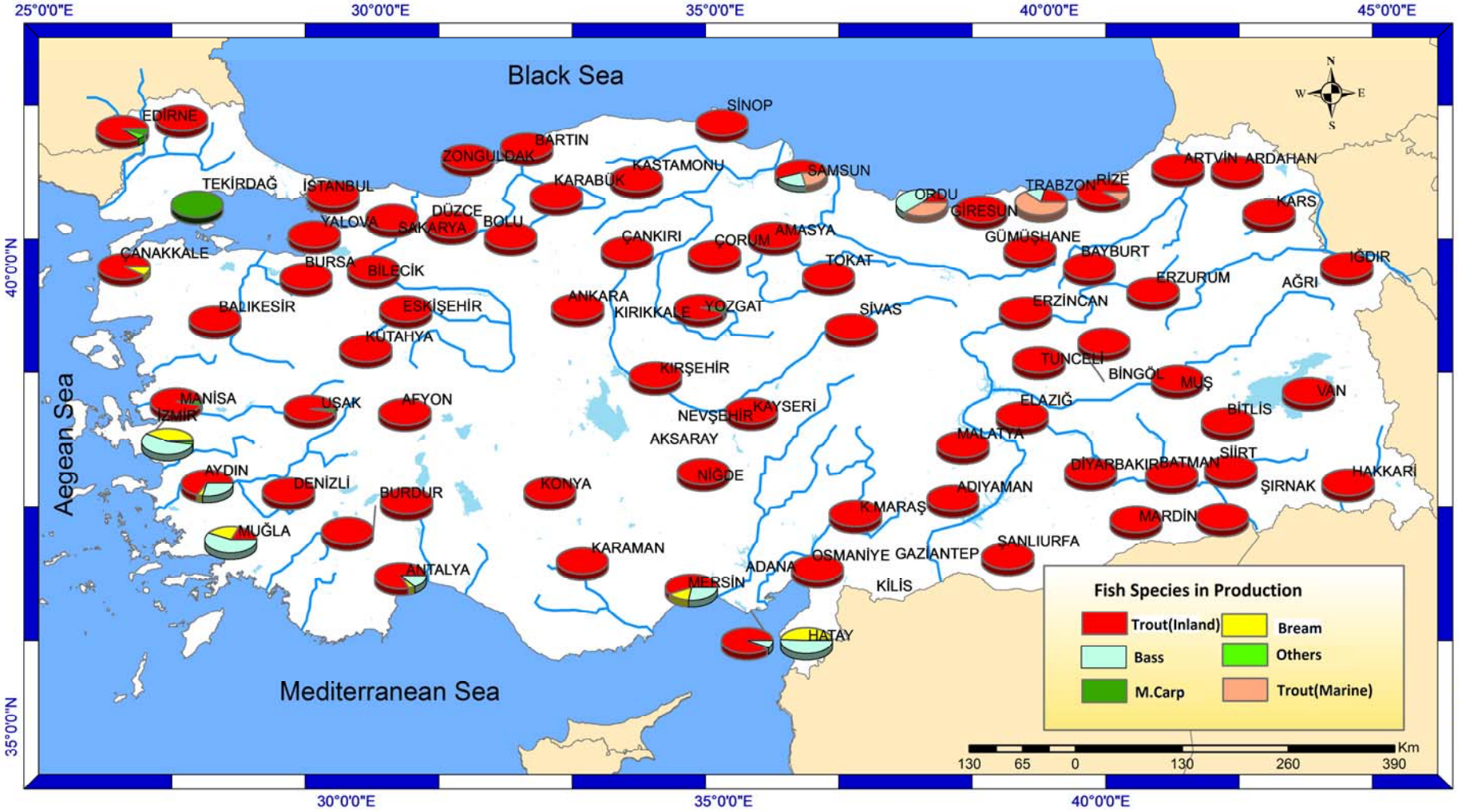
Figure 2. Distribution of Aquaculture in the Aegean Region (2013)

In consideration of regions in terms of farmed species and harvested amounts, production in the Aegean Region amounts to 128006.70 tons. Raised species are sea bass, gilt-head sea bream, trout, mirror carp and other aquatic species. (Map 4, 5, 6, 7, 9, 10)

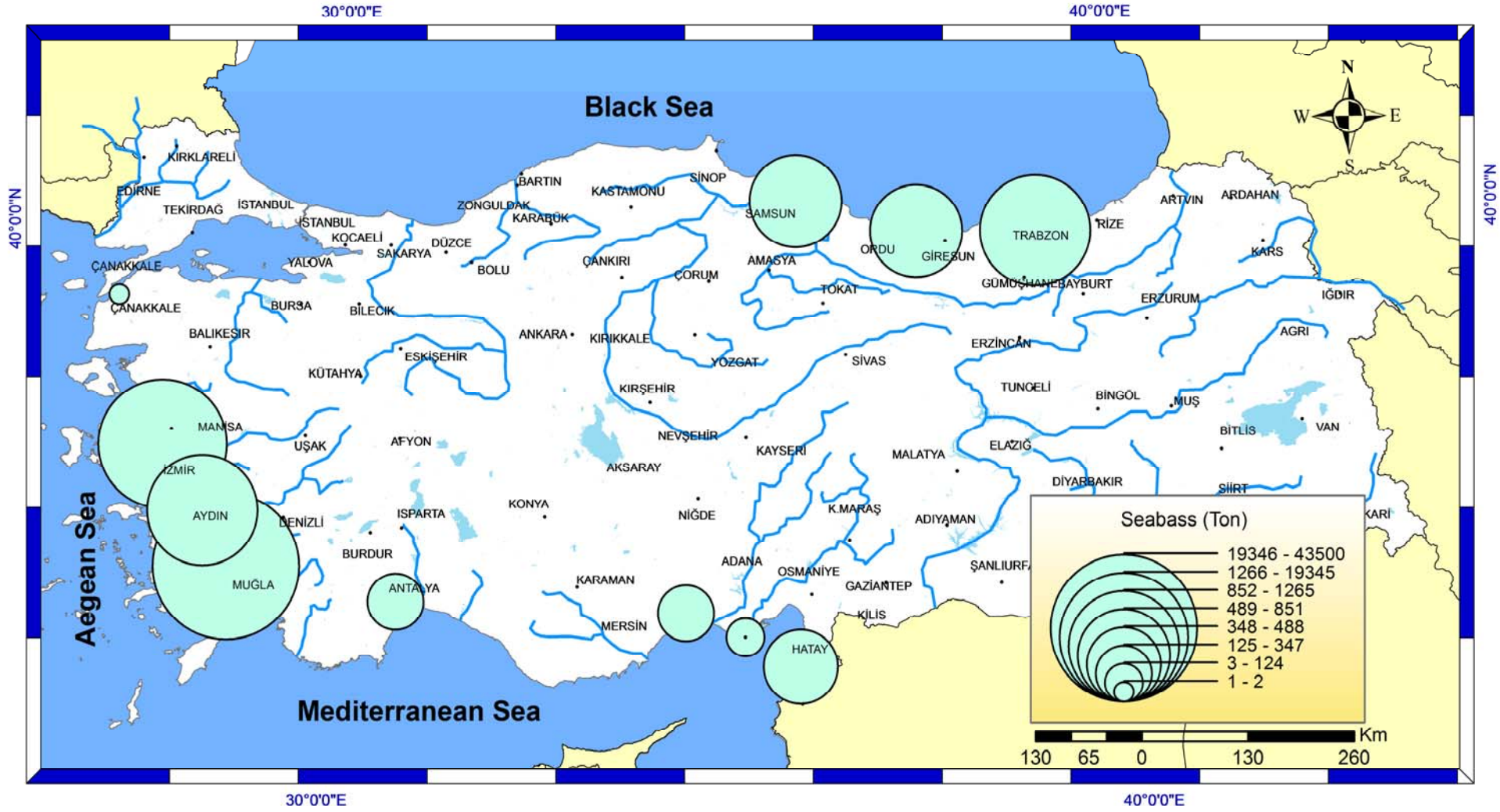
The most farmed species are sea bass and gilt-head sea bream. In addition, Muğla and İzmir stand out as top raisers. In the Aegean Region, generally trout is farmed in the inland waters and sea bass and gilt-head sea bream in the sea. Muğla produces by far the highest amount of fish (be it trout or bream and sea bass). Its production accounts for 61% of the total harvest in the Aegean Region. In consideration of other regions, Muğla's production is much higher than the total amount produced by each region. In terms of trout farming, Muğla is followed by Denizli, Aydın, Afyonkarahisar, Kütahya, Manisa, Uşak, İzmir. As for gilt-head sea bream and sea bass raising, it is followed by İzmir and Aydın. In the Aegean Region, 100580.7 tons of fish are produced, which accounts for 78.6% of the total yield of the region.

Table 15. Aquaculture in the Mediterranean Region (Species and Amounts) (2013)

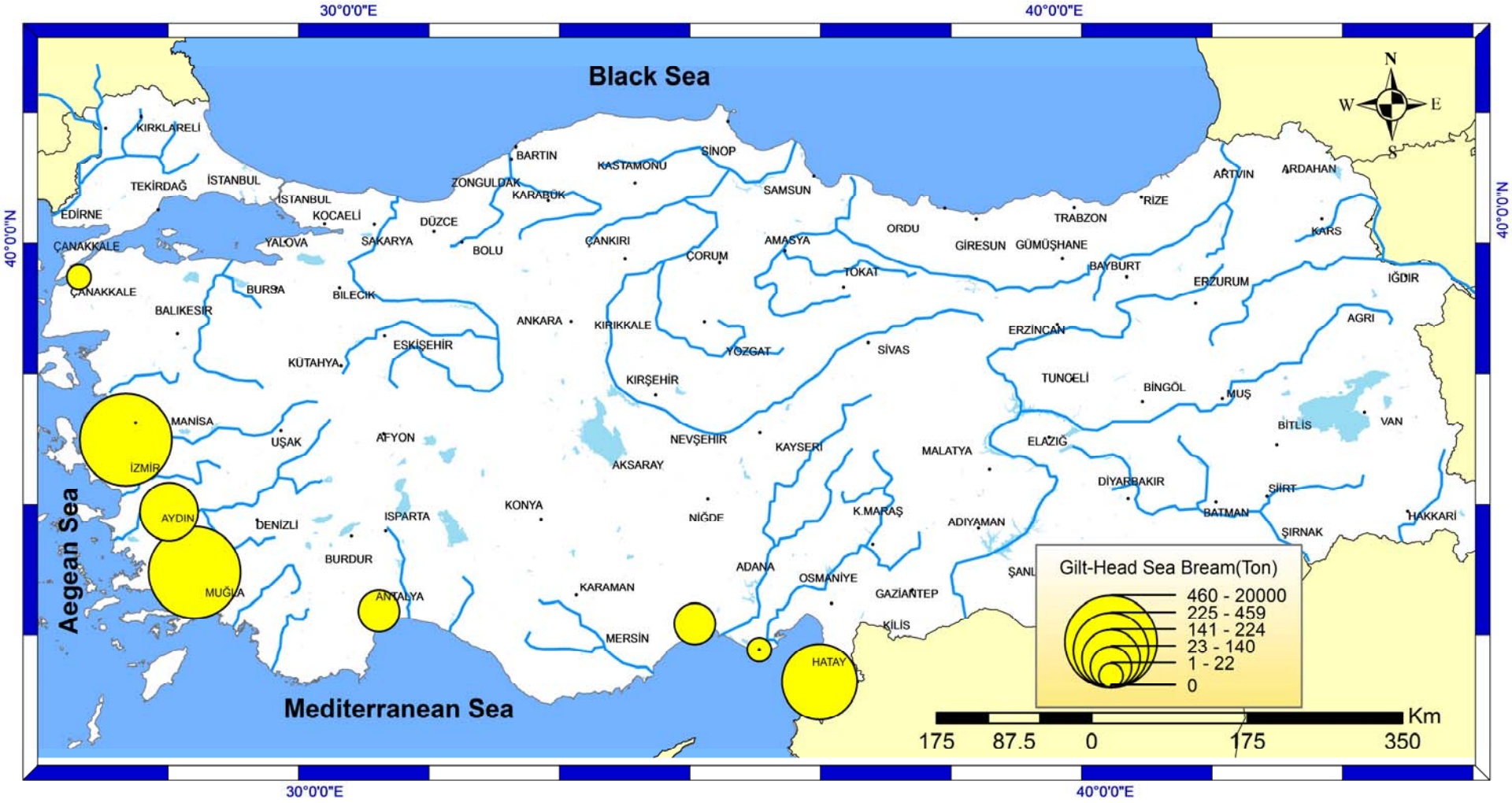
PROVINCES	SPECIES	AMOUNTS (Ton)
Adana	Trout (Inland)	1600.0
	Gilt-head sea bream (Marine)	22.1
	Bass (Marine)	123.7
	Other(Marine)	2
Antalya	Trout (Inland)	2184.1
	Gilt-head sea bream (Marine)	132.6
	Bass (Marine)	346.9
Burdur	Trout (Inland)	9724.0
Hatay	Trout (Inland)	12.9
	Mirror Carp (Inland)	9.3
	Gilt-head sea bream (Marine)	459
	Bass (Marine)	488
Isparta	Trout (Inland)	3605.0
Mersin	Trout (Inland)	499.7
	Gilt-head sea bream (Marine)	140
	Bass (Marine)	241.6
Kahramanmaraş	Trout (Inland)	2493.00
Osmaniye	Trout (Inland)	116.5
TOPLAM		**22200.4**



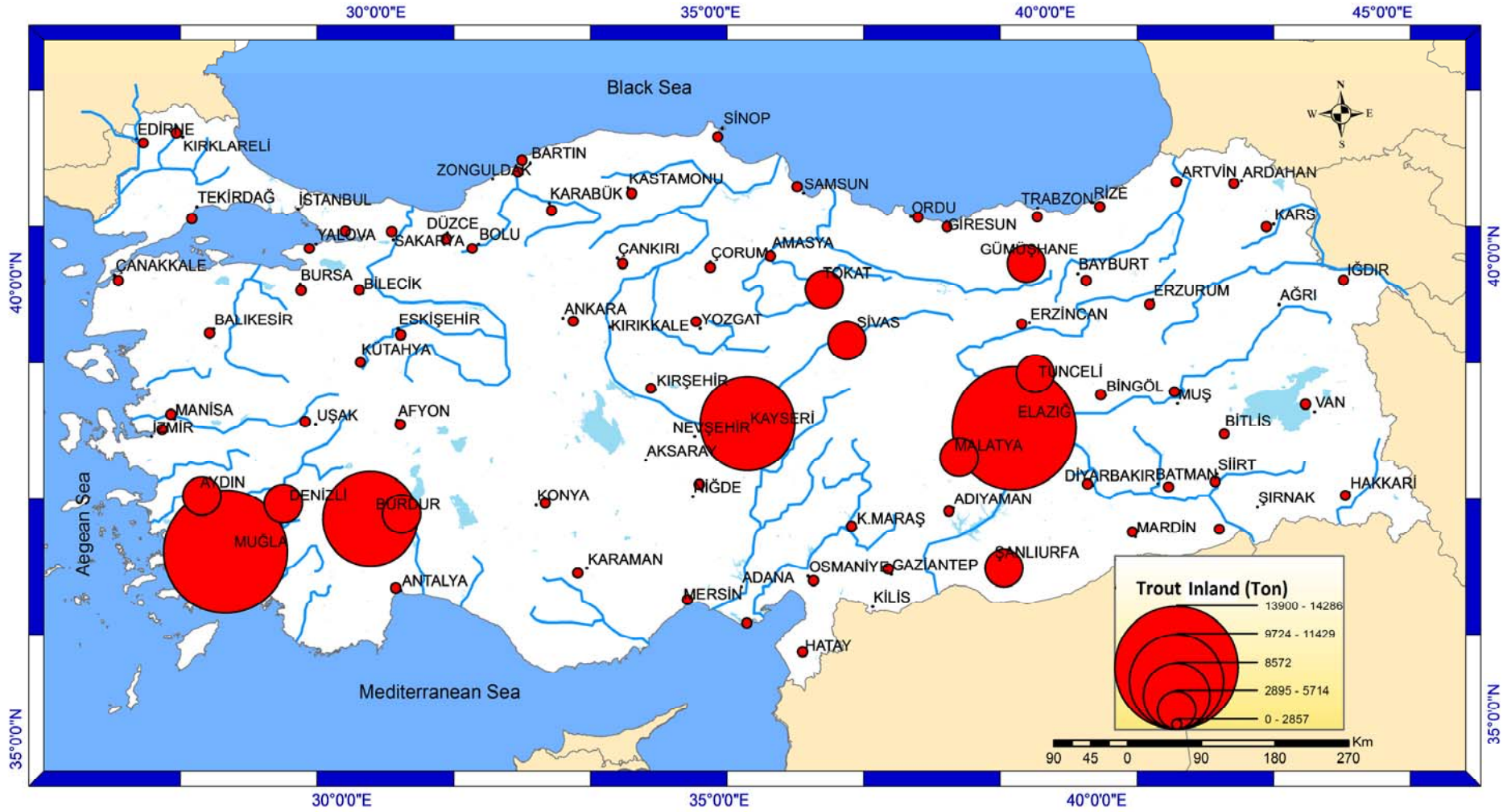
Map 4. Distribution of Fish Species in Turkey by Provinces



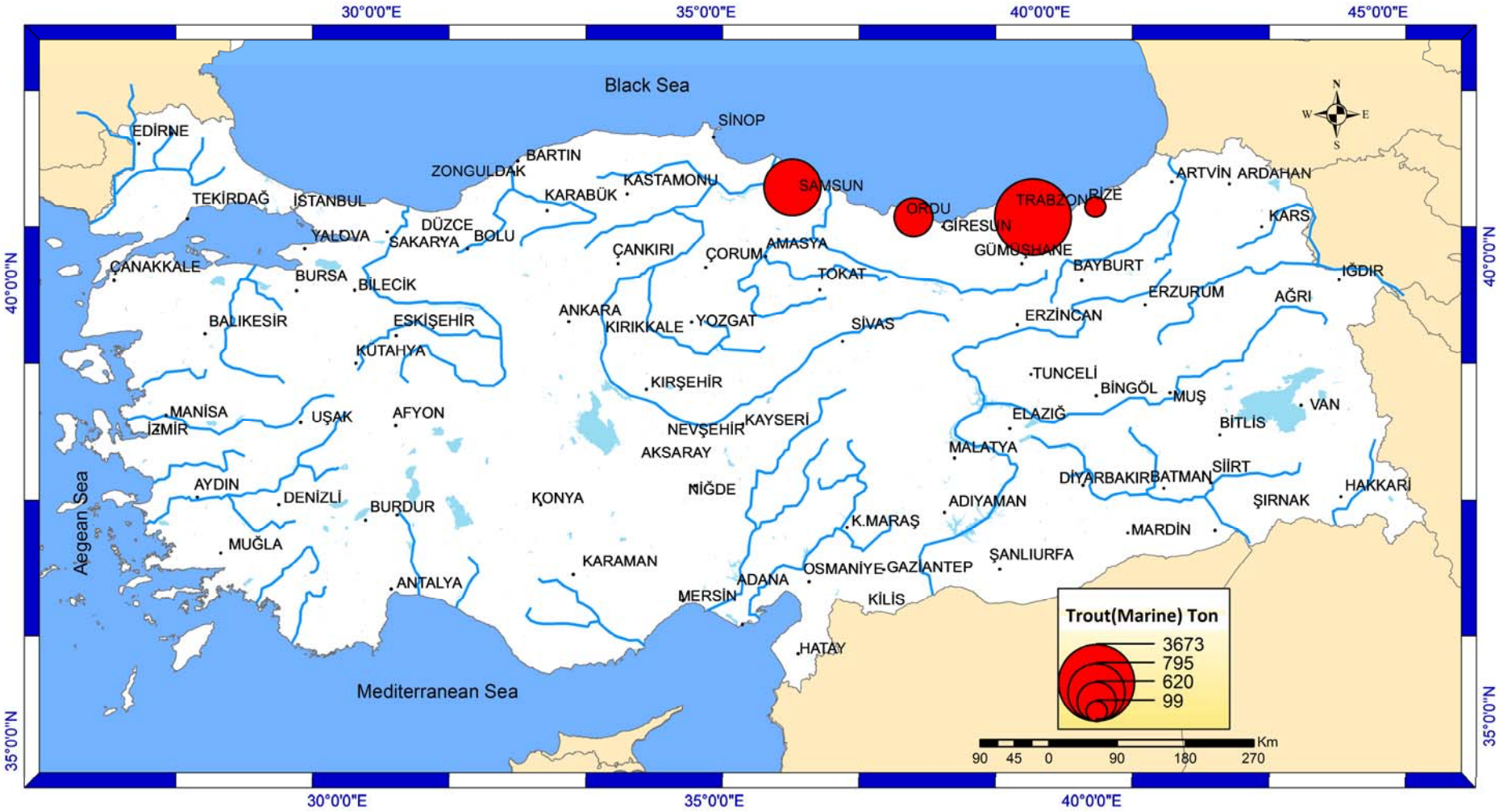
Map 5. Distribıution of Seabass Farming in Turkey by Provinces



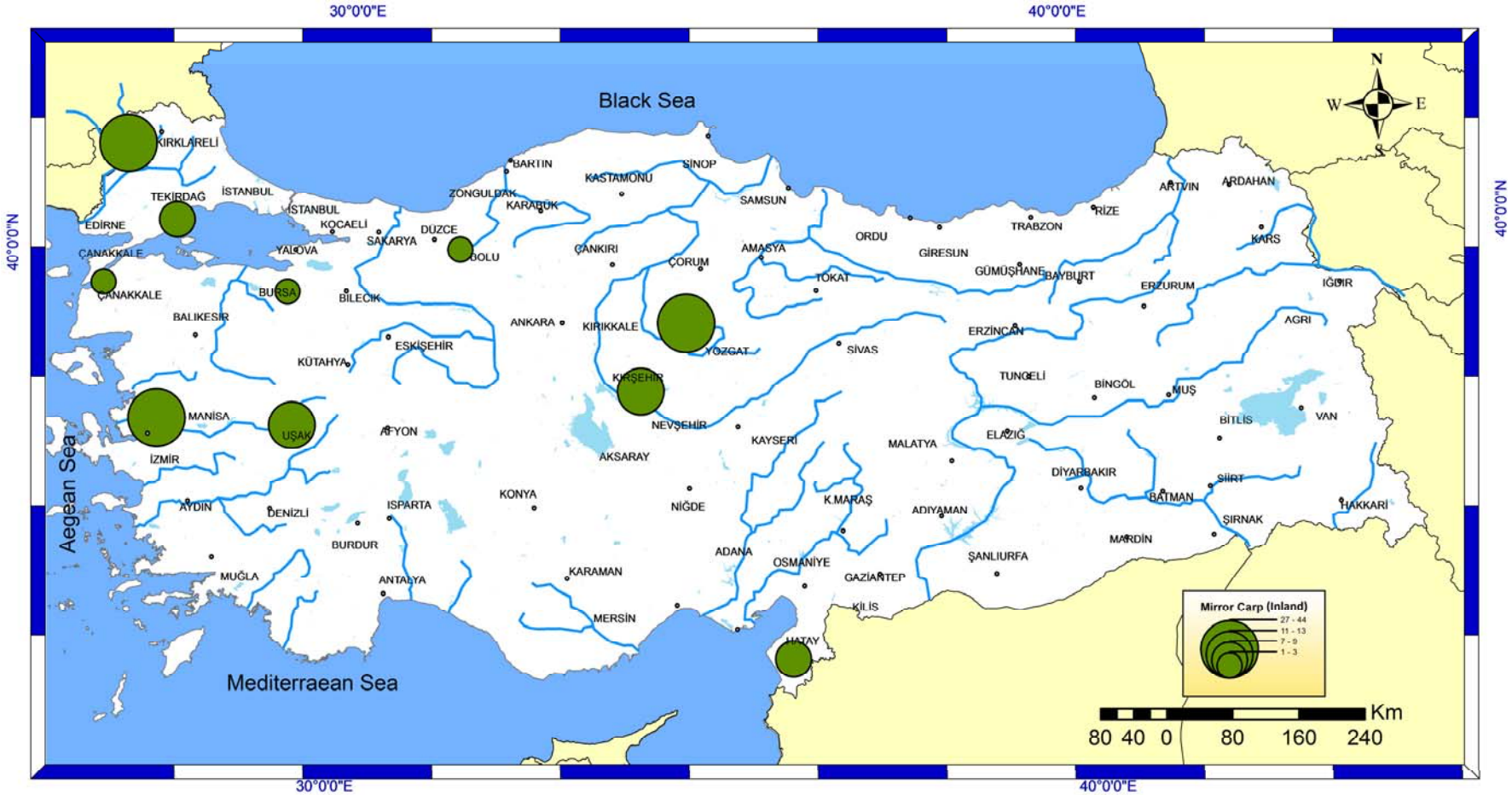
Map 6. Distribution of Gilt-head sea bream Farming in Turkey by Provinces



Map 7. Distribution of Trout Farming (Inland) in Turkey by Provinces



Map 8. Distribution of Trout Farming (Marine) in Turkey by Provinces



Map 9. Distribution of Mirror Carp (Inland Water) Farming in Turkey by Provinces

Map 10. Distribıution of Other Sea Products Farming in Turkey by Provinces

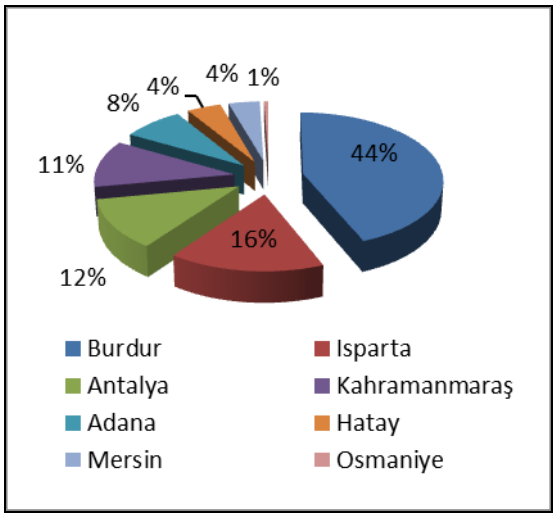


Figure 3. Distribution of Aquaculture in the Mediterranean Region (2013)

Aquaculture production amounts to 22200.40 tons in the Mediterranean Region. Raised species are predominantly trout, gilt-head sea bream, sea bass, mirror carp and other marine species. (Map 4, 5, 6, 7, 9, 10) Trout is most commonly farmed in Burdur (48%), followed by Isparta (18%), Kahramanmaraş (12%), Antalya (11%), Adana (8%), Mersin (2%), Osmaniye and Hatay (1%) and Burdur (a very small share). In terms of gilt-head sea bream production, Hatay is at the top (61%), followed by Mersin and Antalya (18%) and Adana (3%). As for sea bass production, Hatay harvests the highest amount of sea bass, followed by Antalya (29%), Mersin (20%) and Adana (10%). Mirror carp is farmed in Hatay (9.3%) and other species are raised in Adana (2 tons). In the Mediterranean Region, 1955.9 tons of fishery products are harvested in the sea, accounting for 8.8% of the total production.

Total production from aquaculture in the Black Sea Region is 21383.8 tons. As seen in the Figure, Trabzon has the biggest share in production. It is followed by Tokat, Samsun and Gümüşhane with similar shares, after which Ordu, Artvin and the others come.

The predominantly raised species in the Black Sea Region is trout along with sea bass. Moreover, mirror carp is farmed in Bolu. In the Black Sea Region, trout is farmed in both sea and inland waters. (Map 4, 5, 7, 8, 9)

Tokat has the highest amount of trout (3714 tons) raised in the inland waters. It is followed by Gümüşhane, Samsun, Trabzon, Rize, Artvin, Bolu, Bayburt, Giresun, and Ordu. Düzce, Karabük, Bartın, Zonguldak, Sinop, Kastamonu, Çorum, and Amasya are the cities where over 200 tons of trout is farmed. Trabzon is in the first place to farm trout in sea, and followed by Samsun, Ordu and Rize. In the Black Sea Region, generally trout is raised. Sea bass is farmed in Trabzon (994.3 tons), Samsun (851.2 tons) and Ordu (755.5 tons). In the region, 7787.2 tons of products have been harvested from the sea, which account for 36.4% of the total production.

The lowest amount of aquaculture products is harvested in the Marmara Region. Total amount is 3665.4 tons. Sakarya is where the most intensive aquafarming is performed. Bilecik (17%), which is followed by Balıkesir, Edirne and Bursa (13-14%), comes after Sakarya. The Figure reveals that Kocaeli, Çanakkale and Kırklareli have smaller shares. It is even smaller in Yalova and Tekirdağ.

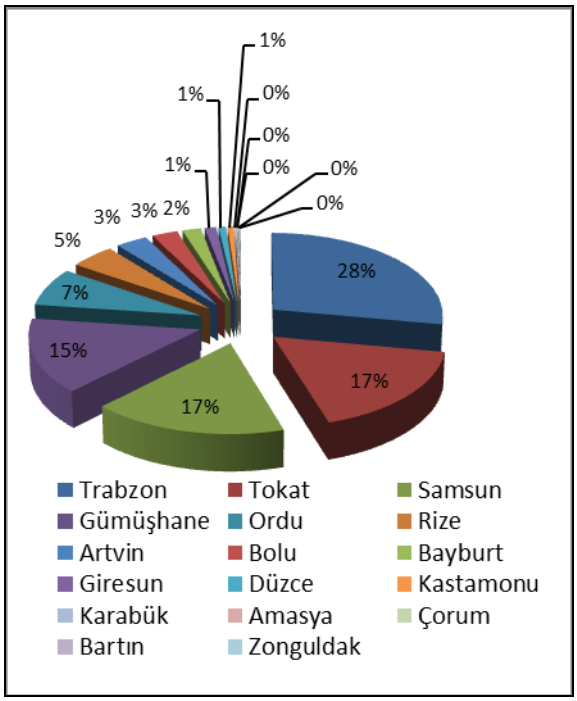


Figure 4. Distribution of Aquaculture in the Black Sea Region (2013)

Table 16. Aquaculture in the Black Sea Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (Ton)
Amasya	Trout (Inland)	24.6
Artvin	Trout (Inland)	697.8
Bolu	Trout (Inland)	558.8
	Mirror Carp (Inland)	0.7
Çorum	Trout (Inland)	14.8
Giresun	Trout (Inland)	250
Gümüşhane	Trout (Inland)	3121.8
Kastamonu	Trout (Inland)	134
Ordu	Trout (Inland)	203
	Trout (Inland))	620
	Bass (Marine)	755.5
Rize	Trout (Inland)	899.6
	Trout (Marine)	98.5
Samsun	Trout (Inland)	2041.0
	Trout (Marine)	795.3
	Bass (Marine)	851.2
Sinop	Trout (Inland)	17.8
Tokat	Trout (Inland)	3714.0
Trabzon	Trout (Inland)	1286.9
	Trout (Marine)	3672.4
	Bass (Marine)	994.3
Zonguldak	Trout (Inland)	11.2
Bayburt	Trout (Inland)	404
Bartın	Trout (Inland)	12.6
Karabük	Trout (Inland)	42
Düzce	Trout (Inland)	162
TOTAL		**21383.8**

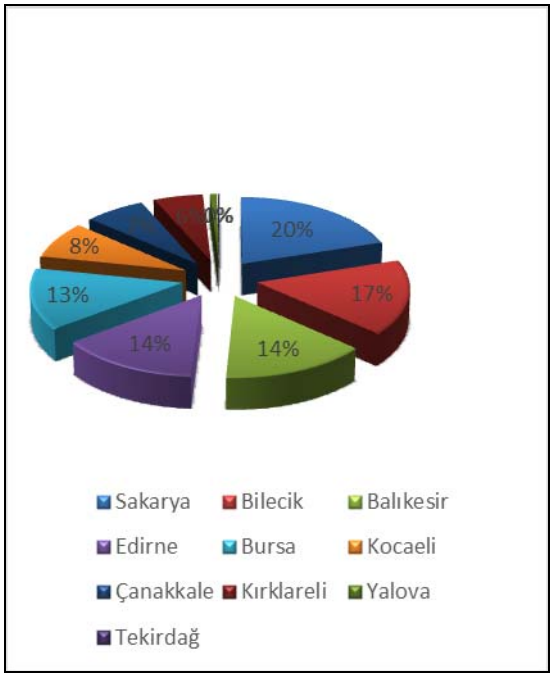


Figure 5. Distribution of Aquaculture in the Marmara Region (2013)

Table 17. Aquaculture in the Marmara Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (Ton)
Balıkesir	Trout (Inland)	527.6
Bilecik	Trout (Inland)	604
Bursa	Trout (Inland)	489.3
	Mirror Carp (Inland)	2.3
Çanakkale	Trout (Inland)	229.8
	Mirror Carp (Inland)	1.8
	Gilt-head sea bream (Marine)	21.8
	Bass (Marine)	1.5
Edirne	Trout (Inland)	450
	Mirror Carp (Inland)	29.5
	Other(Marine)	28
Kırklareli	Trout (Inland)	208
Kocaeli	Trout (Inland)	300.8
Sakarya	Trout (Inland)	735
Tekirdağ	Mirror Carp (Inland)	7
Yalova	Trout (Inland)	29
TOTAL		**3665.4**

The most common aquaculture species in the Marmara Region is trout. Other than trout, mirror carp, gilt-head sea bream, sea bass and other fishery species are raised in very small amounts. (Map 4, 5, 6, 7, 9 and 10)

The highest trout production is harvested in Sakarya, followed by Bilecik, Balıkesir, Bursa, Edirne, Kocaeli, Çanakkale, Kırklareli, and Yalova. Mirror carps are mostly farmed in Edirne, Bursa, Çanakkale and Tekirdağ. But production amount is not high. Total production amounts to around 50 tons, more than half of which is harvested in Edirne. Gilt-head sea bream and sea bass are farmed only in Çanakkale, while other species are raised in Edirne. 51.3 tons of the total production is obtained from the sea. This is equal to 1.4% of the total production in the Marmara Region.

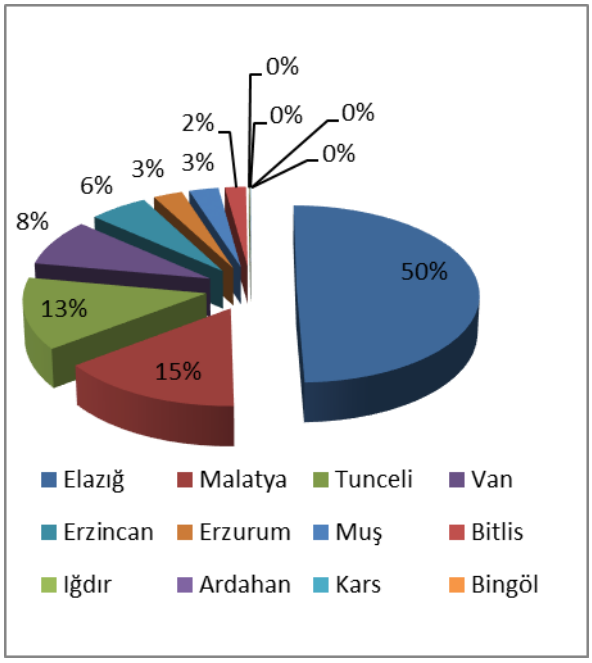


Figure 6. Distribution of Aquaculture in the Eastern Anatolia Region (2013)

Total production in the Eastern Anatolia Region is 28790.8 tons. The only farmed species is trout. (Map 7), The highest production is in Elazığ. It accounts for half of the total production in the East Anatolian Region. Elazığ is followed by Malatya, Tunceli, Van, Erzincan, Erzurum, Muş, and Bitlis, while Iğdır, Ardahan, Kars, and Bingöl have the lowest production rates.

Table 18. Aquaculture in the Eastern Anatolia Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (Ton)
Bingöl	Trout (Inland)	1
Bitlis	Trout (Inland)	583.8
Elazığ	Trout (Inland)	14.286.3
Erzincan	Trout (Inland)	1.643.1
Erzurum	Trout (Inland)	815.6
Kars	Trout (Inland)	10
Malatya	Trout (Inland)	4350.0
Muş	Trout (Inland)	815
Tunceli	Trout (Inland)	3779.0
Van	Trout (Inland)	2469.0
Ardahan	Trout (Inland)	15
Iğdır	Trout (Inland)	23
TOTAL		**28790.8**

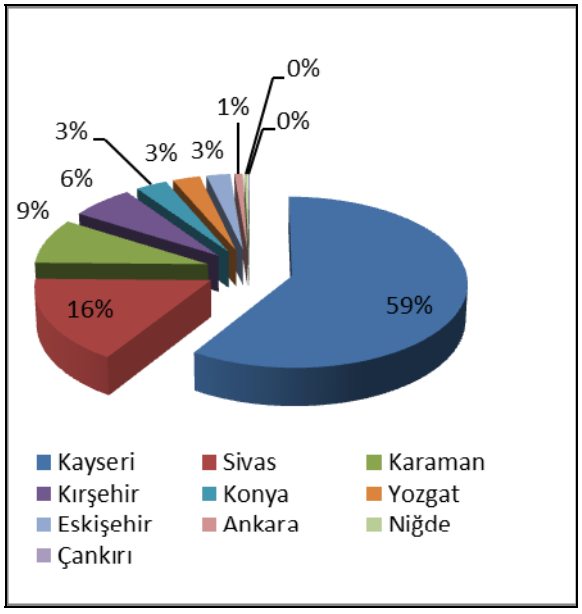


Figure 7. Distribution of Aquaculture in the Central Anatolia Region (2013)

Table 19. Aquaculture in the Central Anatolia Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (Ton)
Ankara	Trout (Inland)	156.4
Çankırı	Trout (Inland)	23.4
Eskişehir	Trout (Inland)	460.7
Kayseri	Trout (Inland)	11227.0
Kırşehir	Trout (Inland)	1206.3
Kırşehir	Mirror Carp (Inland)	11.2
Konya	Trout (Inland)	604.8
Niğde	Trout (Inland)	67.1
Sivas	Trout (Inland)	3084.10
Yozgat	Trout (Inland)	503.8
Yozgat	Mirror Carp (Inland)	27.2
Karaman	Trout (Inland)	1643.0
TOTAL		**19015**

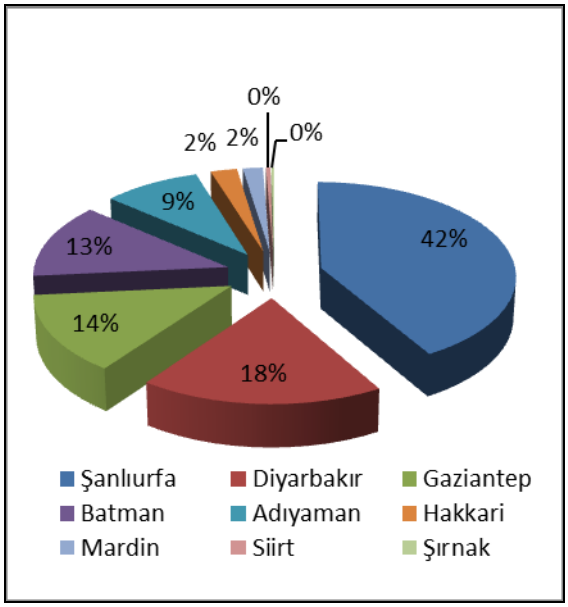


Figure 8. Distribution of Aquaculture in the Southeastern Anatolia Region (2013)

Total production in the Central Anatolia Region is 19015 tons with trout being the dominant species. 27.2 tons and 11.2 tons of mirror carp is farmed only in Yozgat and Kırşehir, respectively. (Map 4, 7 and 9) Production in Kayseri constitute more than half of the total production in the Central Anatolia Region. Kayseri is followed by Sivas, Karaman, Kırşehir, Konya, Yozgat, Eskişehir, Ankara, Niğde, and Çankırı.

Total production in the Southeastern Anatolia Region is 10331.8 tons and the only species farmed is trout. (Map 7) Almost half is produced in Şanlıurfa, followed by Diyarbakır, Gaziantep, Batman, and Adıyaman. Production in Hakkari, Mardin, Siirt and Şırnak is even lower.

As in the Aegean Region, the amount of the production in Muğla is nearly half of the national production. Muğla has a special place in aquaculture. The indented formation of the coastline has created the suitable setting for Muğla to be able to start aquacultural activities in 1982. The number of the successful practices increased from 1986 onwards.

Table 20. Aquaculture in the Southeastern Anatolia Region (Species and Amounts) (2013)

PROVINCES	SPECIES	AMOUNTS (Ton)
Adıyaman	Trout (Inland)	915.5
Diyarbakır	Trout (Inland)	1902.9
Gaziantep	Trout (Inland)	1393.8
Hakkari	Trout (Inland)	247.8
Mardin	Trout (Inland)	187.7
Siirt	Trout (Inland)	40,9
Şanlıurfa	Trout (Inland)	4297.7
Batman	Trout (Inland)	1321.0
Şırnak	Trout (Inland)	24.5
TOTAL		**10331.8**

Table 21. Top Ten Provinces by Their Production Amounts (2013)

PROVINCES	AMOUNTS (Ton)
Muğla	78037.8
İzmir	35346.1
Elazığ	14286.3
Kayseri	11227.0
Burdur	9724.0
Trabzon	5953.6
Aydın	4383.8
Malatya	4350.0
Şanlıurfa	4297.7
Tunceli	3779.0
Total	**177385.3**
Other	**62008.6**
Grand Total	**233393.9**

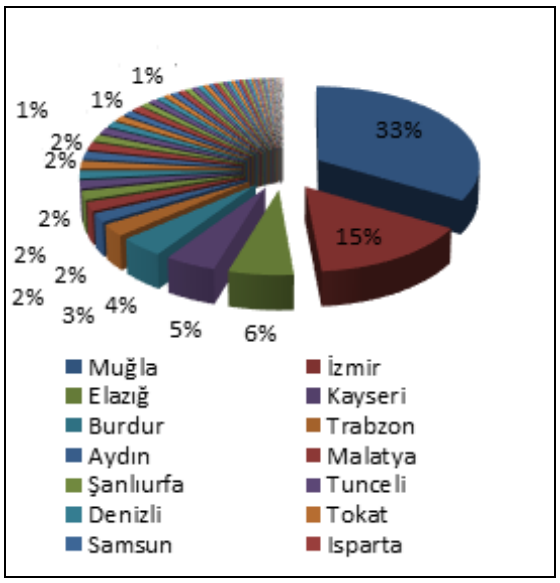


Figure 9. Distribution of Aquacultur in Turkey by Provinces (2013)

Project Capacity and Facilities by Provinces

The total capacity of 2193 aquaculture facilities (Map 11) in Turkey is 449756.5 tons. (Map 12) Turkey's potential for aquaculture is being appreciated better and therefore the number of facilities and the national capacity are increasing. For example, while there was only one aquaculture facility in 1971, the number increased to 1444 in 1999 and 2193 in 2013. In 1970, the first trout farm was established while the first sea bass and gilt-head sea bream facility was opened in 1985.

Table 22. Top Ten Provinces by Total Project Capacity (2013)

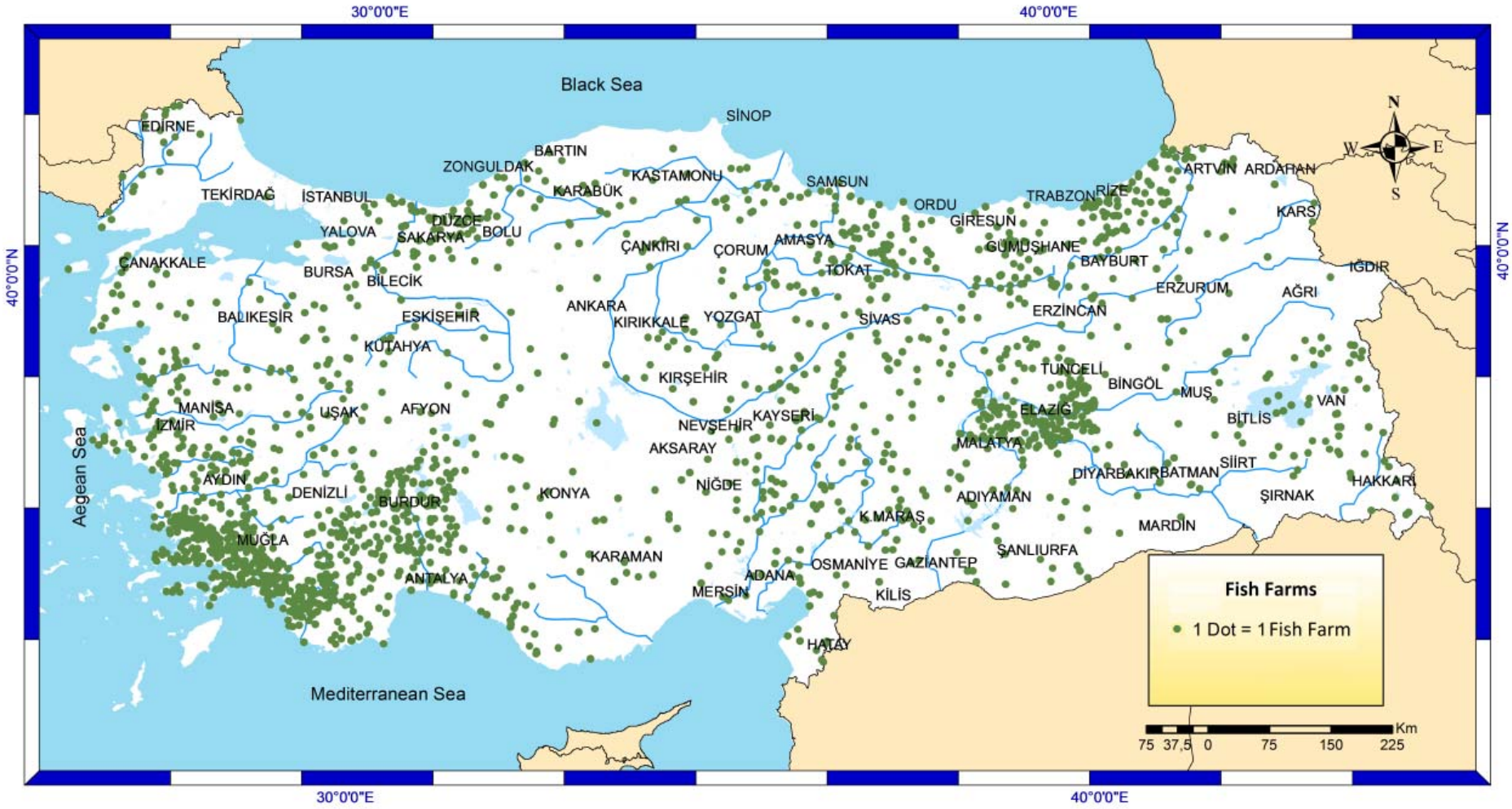
PROVINCES	PROJECT CAPACITY (Ton)
Muğla	111189
Afyonkarahisar	83388
İzmir	70264
Elazığ	31404
Kayseri	29660
Aydın	15929
Trabzon	13729.5
Malatya	10528
Şanlıurfa	10330
Burdur	8639
Total	**385060.5**
Other	**70271**
Grand Total	**455331.5**

Calculated with data from www.tarim.gov.tr

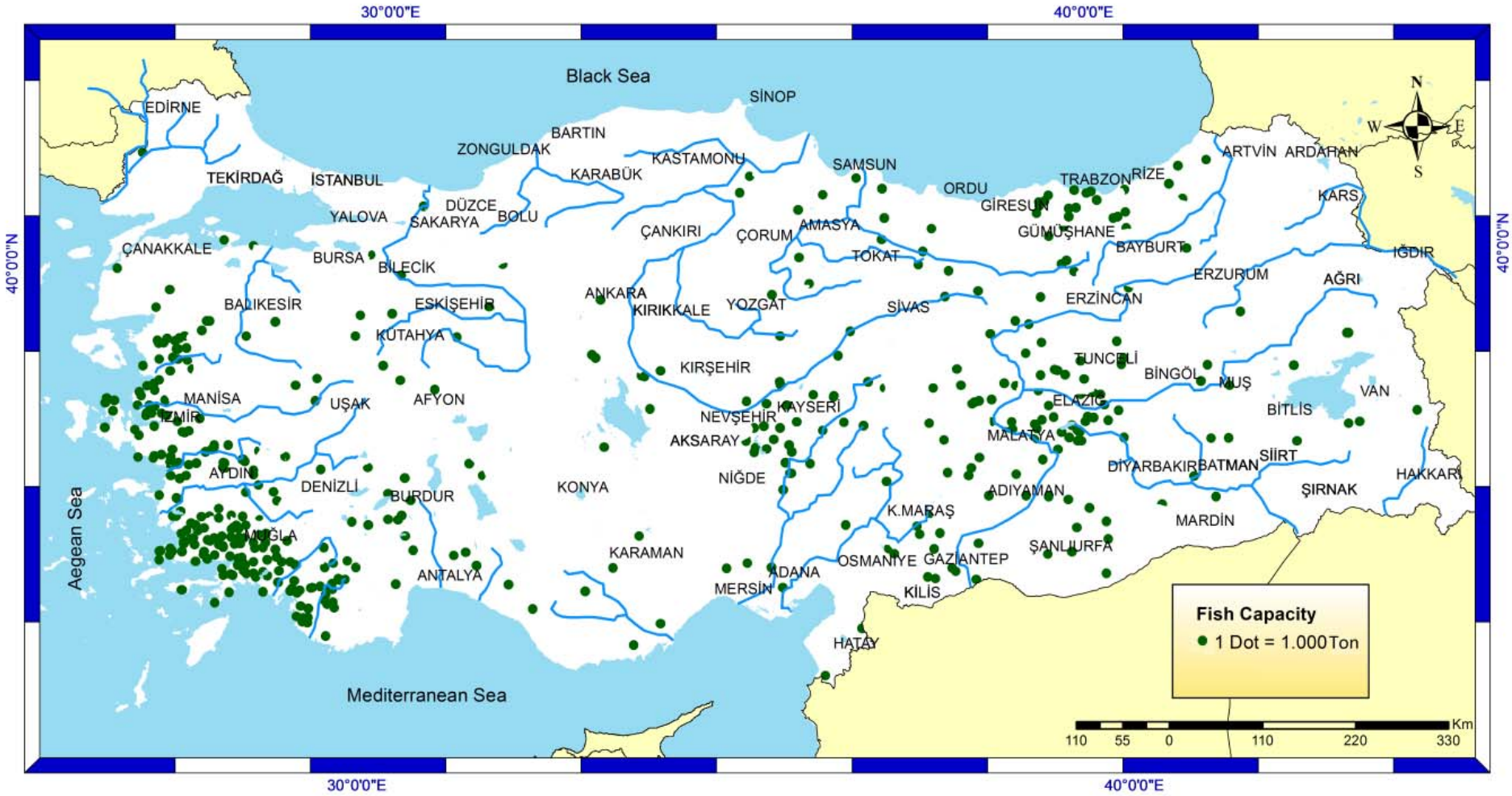
Table 23. Top Ten Provinces by the Number of Facilities (2013)

PROVINCES	NUMBER OF FACILITIES
Muğla	354
Elazığ	158
Antalya	96
İzmir	85
Isparta	82
Trabzon	82
Malatya	78
Burdur	69
Sivas	52
Mersin	51
Total	**1107**
Grand Total	**2193**

Calculated with data from www.tarim.gov.tr



Map 11. Distribution of Fish Farms in Turkey by Provinces



Map 12. Distribution of Fish Capacity in Turkey by Provinces

The capacity of the top ten provinces is 385060.5 tons, which accounts for 84.6% of the total capacity. Moreover, 1107 (50.5%) of the total facilities are owned by ten provinces at the top of the list.

Muğla is placed at the top thanks to the number and capacity of its facilities. Its capacity accounts for 25% of the total. It is followed by Afyonkarahisar with a capacity share of 18% and by İzmir with 16%. The total capacity of the first three provinces is 59%.

Figures on the number of facilities show that Muğla is at the top of the list and followed by Elazığ, Antalya and İzmir. Muğla has 354 facilities, accounting for 16.2% of the total number, while Elazığ, Antalya and İzmir's shares are 7.2%, 4.4% and 3.9%, respectively.

Bingöl has the lowest capacity, which is 25 tons and is followed by Tekirdağ, Şırnak and Iğdır. There are 6 provinces with only one aquacultural facility, which are İstanbul, Siirt, Ardahan, Iğdır, Şırnak and Tekirdağ. Of these, Iğdır, Şırnak and Tekirdağ has a capacity of 25 tons, which is higher than the others. For instance, it is 100 tons for Istanbul.

Conclusion

Rapid growth of the global population, the need for food, the demand for healthy nutrition, employment, growing export and other socio-economical factors are the most important factors for the development of aquaculture. Turkey's physical and human conditions are suitable for aquacultural practices. Preservation of water resources, highly qualified labour force and supporting these two factors by laws will promote the development of aquaculture. Aquaculture which rapidly developed on Turkish coasts in the past has come to contradict other practices and especially has been put forward as a threat to tourism activities. Today, thanks to precautions to prevent such allegations, new practices have cleared the way for aquaculture. Fish farms in the sea were moved to open and deep waters as per regulations introduced by the Ministry of Environment and Urban Planning in 2009. According to these legal regulations fish farms cannot be established within 0.6 nmi off the coast and where depth is less than 30 m. Moreover, technological advances like automated feeding mechanisms, scheduled feeding and digital monitoring have substantially prevented feed-induced pollution (DPT, 2014).

As indicated in the study, the species variety is exiguous. Sustainably farming present species, introduction of new species and diversity in farming would allow people to make better use of water resources, help expand the market and increase its share in national economy.

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