

## 2. AQUACULTURE PRODUCTION BY COUNTRIES

The aquaculture sector in Europe is diverse, encompassing artisanal and family shellfish and pond culture operations through medium scale trout and brackishwater fish farm businesses to the modern multinational marine farming companies. Most sectors have increased production in recent years, with marine fish farming showing the greatest increase. In 1997 European aquaculture produced<sup>1</sup> 1 655.3 thousands tonnes with value of 3 800.3 million US\$. The European aquaculture provides full-time employment for around 45 000 people and part-time work for further 60 000, frequently in economically fragile rural and coastal regions.

The European aquaculture industry is made up of the widely differing industries of its nations, all of which have their own unique features. These are a result of the widely differing geographical, climatic, social and cultural conditions in different parts of Europe. Environmental conditions range from the brackish water of the Baltic sea, which freezes in winter shared by Norway, Sweden, Denmark and Finland, to the warm Mediterranean sea shared by the southern European nations. Geographical conditions range from the indented western coastline of Scotland, ideal for cage farming, to the lagoons of southern Europe ideal for shellfish and extensive fish culture.

### 2.1. Northern Europe<sup>2</sup>



**Map 14** Northern Europe

<sup>1</sup> Excluding former USSR countries.

<sup>2</sup> **Northern Europe:** Norway, Finland, Sweden, Denmark, Faeroe Islands and Iceland.

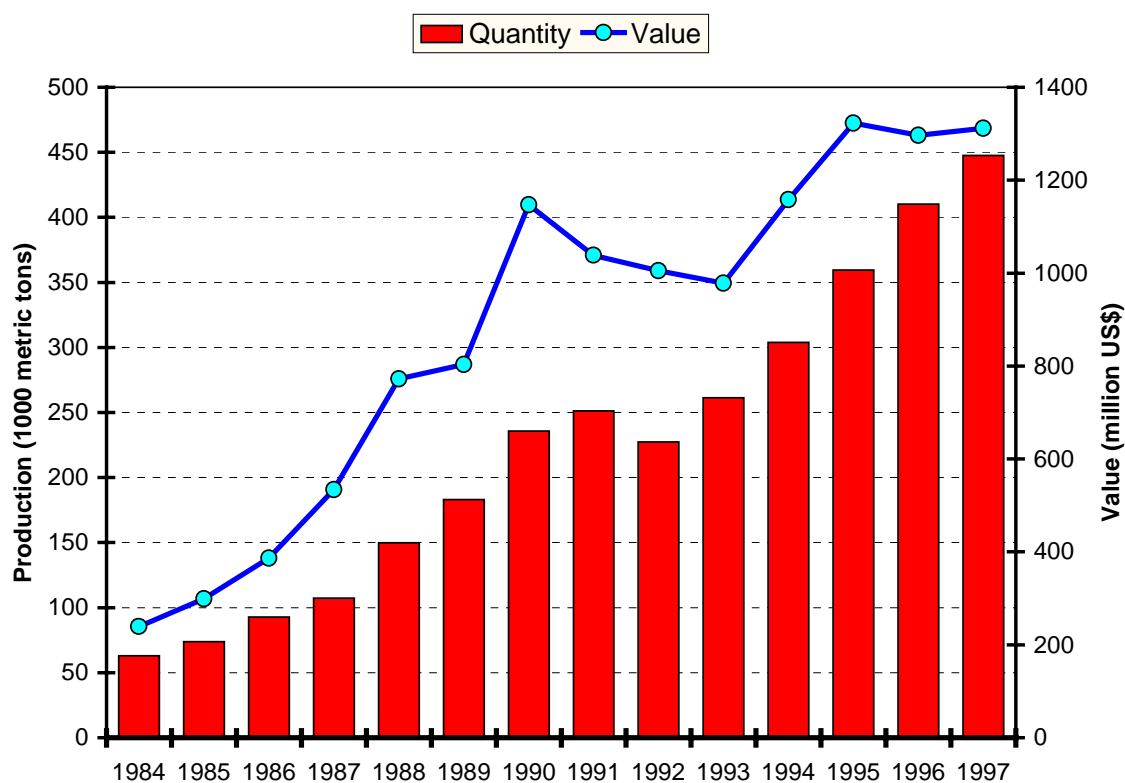
The aquaculture production in Northern Europe is increasing from 1984 up to now with the only exception of the year 1992 (*Table 20, Figures 50, 51*). The most important finfish species are the Atlantic salmon and the rainbow trout in the commercial production and also in the recreational fishery sector.

**Table 20 Aquaculture production in Northern Europe**

Quantity (1000 metric tons), Value (million US\$)

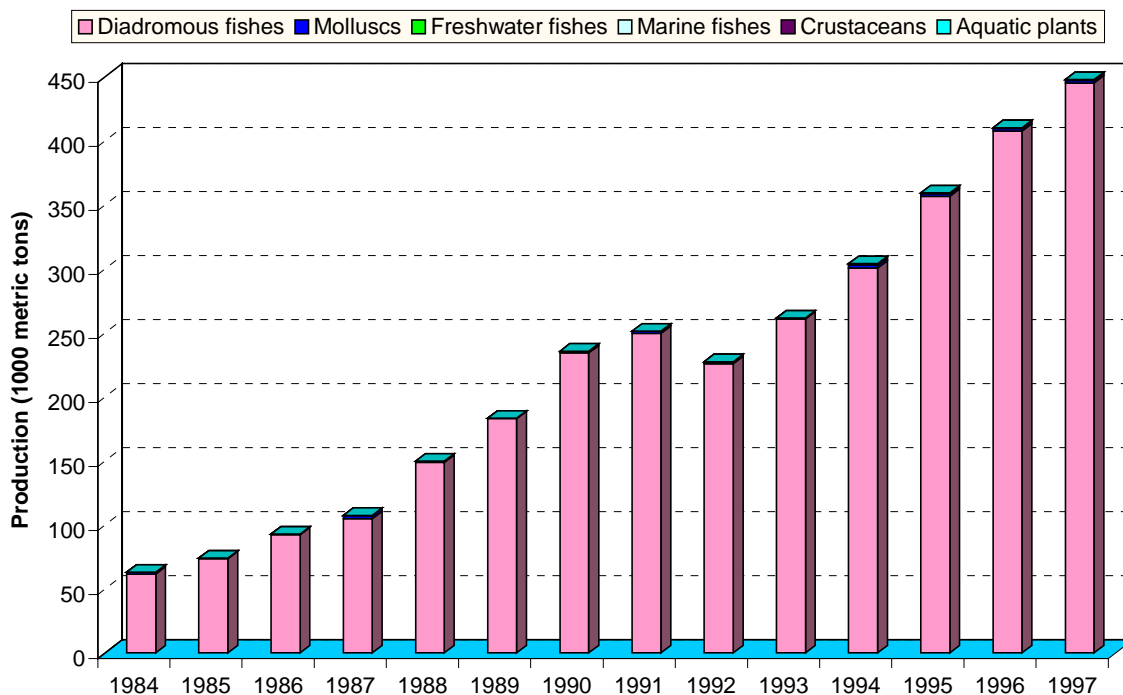
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	149.80	183.12	235.58	251.23	227.33	261.48	304.02	359.38	410.17	447.67
<b>Value</b>	772.00	803.74	1 146.97	1 038.38	1 004.87	978.25	1 158.11	1 322.56	1 296.80	1 311.14

Reference: FAO, FishStat Plus 1999



**Figure 50 Aquaculture production in Northern Europe**

Reference: FAO, FishStat Plus 1999



**Figure 51** Volume of aquaculture production by major species groups in Northern Europe

Reference: FAO, FishStat Plus 1999

### 2.1.1. Norway



Area:	323 877 km <sup>2</sup>
Population:	4 299 000
Active population:	
Employment in aquaculture <sup>1997</sup> :	4 000
Coastline:	21 925 km
Lakes:	16 390 km <sup>2</sup>
Rivers:	2 840 km <sup>2</sup>
GDP/capita <sup>1995</sup> :	26 340 US\$

**Map 15** Norway

#### 2.1.1.1. Hydrography

Norway is well supplied with rivers and lakes, recent estimates of the total area of inland water is composed of about 16 390 km<sup>2</sup> of lakes, 5 000 km<sup>2</sup> of reservoirs and 2 840 km<sup>2</sup> of rivers. Norway has about 1 000 main rivers, 300 000 natural lakes and 11 major reservoirs.

### 2.1.1.2. Land and water use

Norway is about 75% urban and 25% rural. The pattern of land use in 1986 was: arable and permanent crops 2.6%, permanent pasture 0.3%, forest and woodland 25.7%, other land (mostly mountains, snow and ice) 66.4% and inland water 5%.

### 2.1.1.3. Aquaculture

Around 4 000 persons are employed directly in aquaculture production area, but the whole aquaculture business (production, processing and marketing) employs around 20 000 persons in Norway.

The water temperature in Norway limits aquaculture to cold water species such as trout and salmon. On the contrary, the seas around Norway, conditioned by the Gulf Stream, do not have the disadvantage of low water temperature. There are many areas not only ice-free but also sheltered from wind and wave action that provides good sites for salmonid farms. Given such conditions and unable to compete successfully with the foreign market, private trout farms in Norway have shifted emphasis from freshwater to saltwater production. With respect to freshwater fish production in Norway, most of the fish farms are located in the extreme south or east with water derived from springs or lowland rivers. Some farms use electric heating or warm-water from power stations.

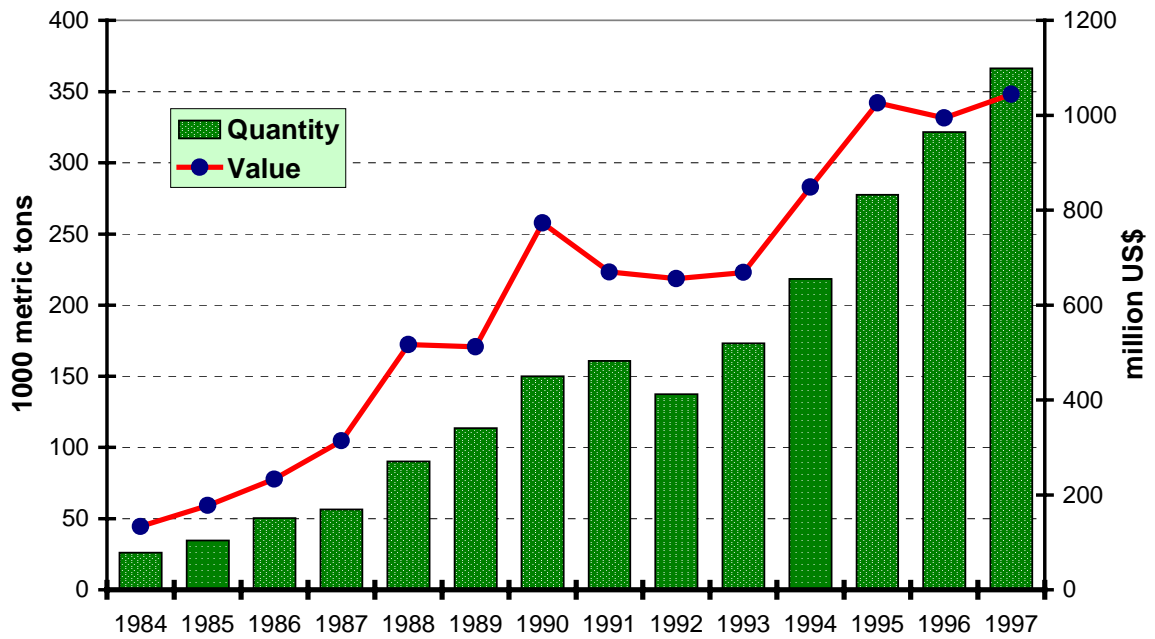
The total aquaculture of Norway increased really significantly, it was 89 987 metric tons in 1988 and 366 281 metric tons in 1997 (*Table 21, Figure 52*). Norway is the major salmon producer country of Europe and obviously the main cultured species is the Atlantic salmon its production was 331 367 metric tons in 1997. The most important freshwater species farming in Norway is the rainbow trout (*Figure 53*). Its aquaculture production expanded rapidly between 1988 and 1997, from 9 351 metric tons to 33 491 metric tons. Other important cultured species are the blue mussel and the Atlantic cod, with about their 300-500 produced metric tons.

**Table 21 Aquaculture production in Norway**

Quantity (metric tons), Value (million US\$)

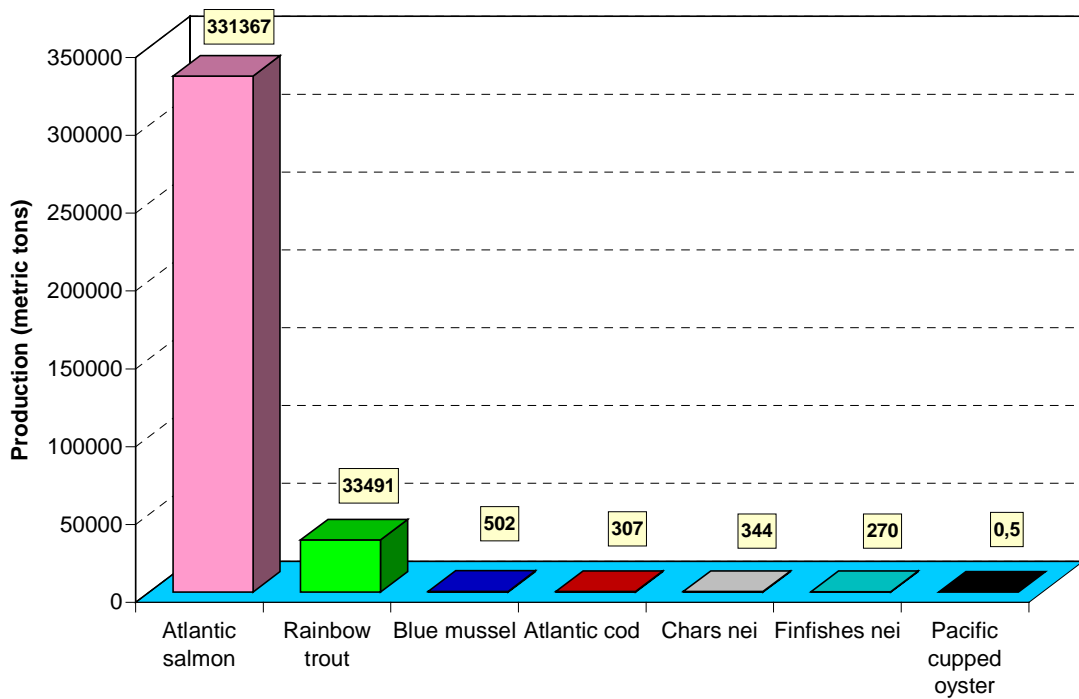
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	89 987	113 768	150 028	160 705	137 387	173 130	218 457	277 636	321 542	366 281
Value	516.87	511.93	773.20	669.84	655.76	668.77	848.91	1026.12	994.63	1043.82

Reference: FAO, *FishStat Plus 1999*



**Figure 52** Volume and value of aquaculture production in Norway

Reference: FAO, FishStat Plus 1999



**Figure 53** Aquaculture production by species in Norway (1997)

Reference: FAO, FishStat Plus 1999

#### 2.1.1.4. Administration and management

In Norway, the Ministry of Fisheries is concerned only with marine or sea fisheries. With respect to inland fisheries and those for anadromous Salmonids in both salt and fresh water, it is the Ministry of Environment that is responsible for their administration. Much of the work such as hatching, rearing and stocking of fish is done by local sportsmen's clubs in co-operation with the fishery consultants of the Directorate.

#### 2.1.2. Sweden



<i>Area:</i>	449 964 km <sup>2</sup>
<i>Population:</i>	8 749 000
<i>Active population:</i>	4 498 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	543
<i>Coastline:</i>	3 218 km
<i>Lakes:</i>	40 000 km <sup>2</sup>
<i>Rivers:</i>	60 000 km <sup>2</sup>
<i>GDP/capita<sup>1997</sup>:</i>	28 522 US\$

**Map 16** Sweden

##### 2.1.2.1. Hydrography

The total area of inland water in Sweden as given in or calculated from data in numerous publications throughout the 1957-1988 period, ranges from about 30 017 to 40 477 km<sup>2</sup> or roughly from 6.8 to 8.9% of the country's total area. The total length of Sweden's rivers is about 60 000 km. Sweden has a large number of natural lakes, estimated variously as from 96 000 to 100 000 in number, and from about 38 340 km<sup>2</sup> to 40 000 km<sup>2</sup> in total area. The largest volume of water in Europe is stored in the reservoirs of Sweden and Spain. Since 1976, efforts to improve reservoir fishing have included stocking with fish and food organisms, and improvement of biotopes. There are several major ship canals in Sweden. Sweden has a 7 600 km coastal area.

##### 2.1.2.2. Land and water use

Sweden is considered about 84 % urban and 16 % rural. The pattern of land use in 1987 was: arable and permanent crops 6.6%, permanent pasture 1.3%, forest and woodland

58.7%, other land 24.9% and inland water 8.5%. Sweden has reasonably good groundwater sources, and its surface water supply is excellent. There are around 3 250 professional fishermen of which 250 are fishing in lakes. The number of fishermen has decreased by 15% in the period 1985-90. Half of the salt-water fishing population is living on the west coast. Around 600 persons are employed in aquaculture. The processing industry employs around 3 000 persons of whom 1 500 are working in 42 companies with more than 10 employed. Another 500 persons are connected to fish production, bringing the total employment in the land-based industry up to 3 500 persons.

### *2.1.2.3. Aquaculture*

Intensive aquaculture started in the seventies, developed in the eighties and reached a peaked production in 1990 9 146 metric tons. The total aquaculture production of Sweden was 8 317 metric tons in 1988 and 6 709 metric tons in 1997 (*Table 22, Figure 54*). According to, aquaculture in Sweden has had two different types of development: small-scale production run by a single family and large-scale cultures in industrial plants. Small-scale culture includes production of rainbow trout and salmon in net cages, and European crayfish in ponds.

The aquaculture production of rainbow trout decreased from 6 783 metric tons in 1988 to 4 875 metric tons in 1997. The average production quantity per rainbow trout farm is only 26 metric tons. However 14 farms with a production of more than 100 metric tons per year produced app. 3000 metric tons or almost 60% of Sweden's total production. The reduction in trout production since 1990 has been attributed to the increase in salmon production leading to reduced prices for trout. Most trout is marketed fresh within Sweden. However, seasonal variation in production has made it necessary to freeze a large part of the production. Japan and USA are the main export markets for frozen rainbow trout. The opening of the EU market has stimulated the farmers to slaughter their fish throughout the year and sell more as fresh produce.

The Swedish production of Atlantic salmon and European crayfish fell to a minimal level in 1997 (*Figure 55*). Large-scale productions consist mainly of eel, flatfish and giant river prawns produced in heated effluents. The aquaculture production of European eel is about 200 - 300 metric tons per year in Sweden. Most fish farms concentrate on producing fish of more than 2 kg, for which the best market prices are obtained. There is a very small

amount of aquaculture of cyprinids but emphasis is on the other species mentioned. There were more than 500 fish farms in the country in 1979 but most of them were very small, mainly private farms, which raised fish for stocking inland waters.

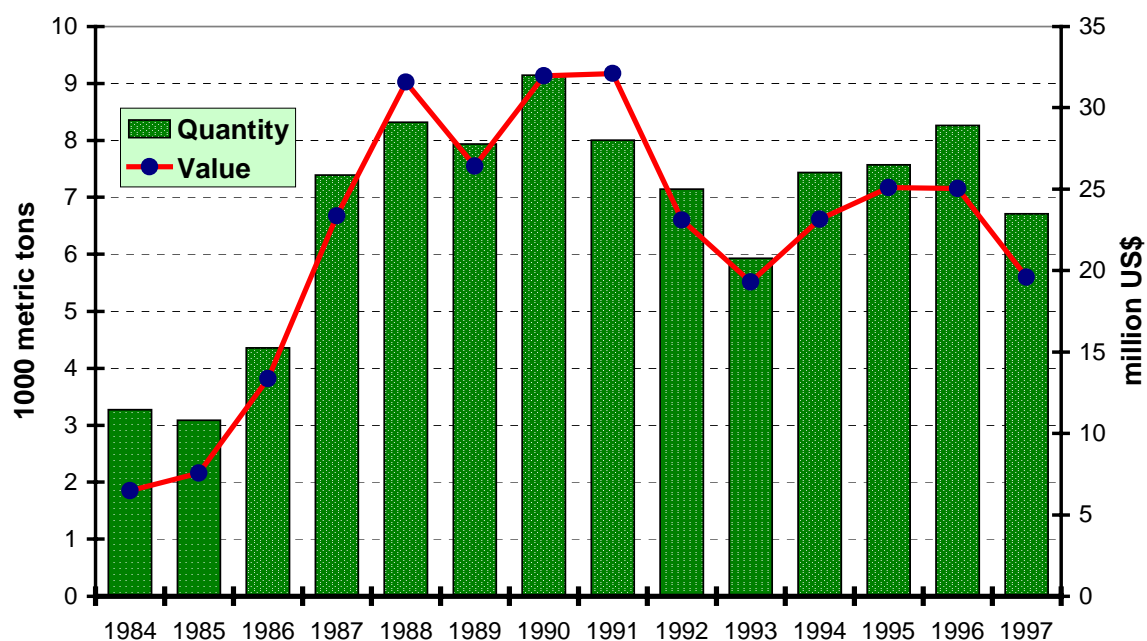
Blue mussel is one of the most important cultured species in Sweden. Its aquaculture production was quite variable between 1988 and 1997, with its production between of 241 and 1 425 metric tons.

**Table 22 Aquaculture production in Sweden**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	8 317	7 938	9 146	8 003	7 143	5 927	7 432	7 573	8 267	6 709
<b>Value</b>	31.59	26.42	31.97	32.12	23.10	19.31	23.14	25.09	25.04	19.60

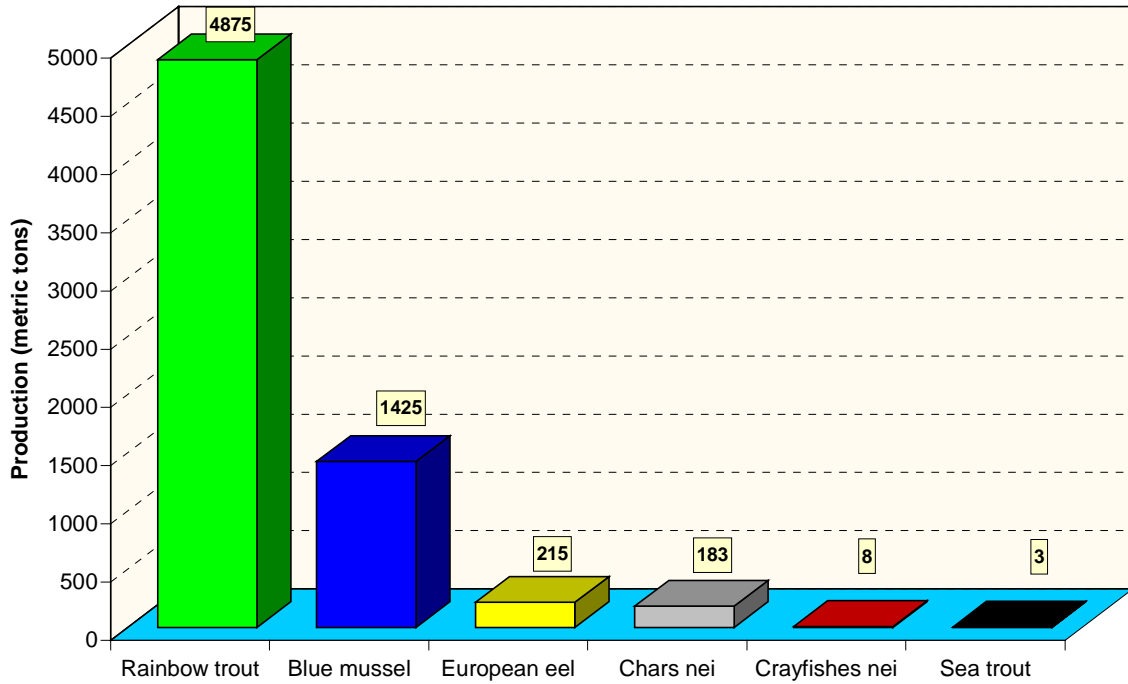
Reference: FAO, FishStat Plus 1999



**Figure 54 Volume and value of aquaculture production in Sweden**

Reference: FAO, FishStat Plus 1999





**Figure 55 Aquaculture production by species in Sweden (1997)**

Reference: FAO, *FishStat Plus 1999*

#### 2.1.2.4. Administration and management

Aquaculture in Sweden is regulated by the Ministry of Agriculture, National Board of Fisheries, Ministry of Environment and the national Board of Environment. 90% of the aquaculture farms are organised by “Vattenbrukarnas Riksförbund”. The management of licences for aquaculture is decentralised to the regional government.

The producer organisations emphasise the need for more precise environmental management. Management is presently the responsibility of regional government, and at the moment there is a great deal of variation in how the regulations are interpreted. More research is therefore needed to standardise the interpretation of environmental rules.

The Swedish Angler’s Association, the only nation-wide angler’s association in Sweden, had about 100 000 members, and about 60 000 of these belonged to sport fishing clubs in 1980. In each of Sweden 24 counties, there is a regional body co-ordinating the club’s work and activating non-club members.

### 2.1.3. Finland



<i>Area:</i>	338 139 km <sup>2</sup>
<i>Population:</i>	5 055 000
<i>Active population:</i>	2 429 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	885
<i>Coastline (excl. islands):</i>	1 126 km
<i>Lakes:</i>	31 560 km <sup>2</sup>
<i>Rivers:</i>	20 000 km <sup>2</sup>
<i>GDP/capita<sup>1997</sup>:</i>	21 100 US\$

**Map 17** Finland

#### 2.1.3.1. Hydrography

The land surface of Finland has a distinct fracture pattern, forming an irregular fault-mosaic. This is the basic factor in its intricate network of land and water. Finland has a very large area of inland waters, 31 560 km<sup>2</sup> or 9.3% of the total area of the country. This percentage ranks above that of all other European countries. The total length of Finland's rivers exceeds 20 000 km. Depending upon the size of a static water body the Finnish lakes can be classified. There are 158 large lakes (over 2 000 ha), 3 000 medium lakes (100 to 2 000 ha) and 50-70 000 small lakes (less than 100 ha). Finnish reservoirs are small, about 6.5 km<sup>2</sup> in area. There are about 40 major canals in Finland. Many small canals connect lakes and rivers and most are navigable. The Baltic Sea proper occupies an area to the south of Finland. The area of its largest arm, the Gulf of Bothnia is 117 000 km<sup>2</sup>, and of its smaller arm, the Gulf of Finland is 29 500 km<sup>2</sup>.

Although the natural water quality of Finland is generally unproductive, the country's wealth of inland waters, almost 10% of its area, and its brackish coastal waters produce fishing for salmonids, coregonids and cold-water fishes. Subsistence fisheries are a strong element in the use of Finnish waters, and although professional fisheries are in a decline, there is a large increase in recreational fishing.

#### 2.1.3.2. Land and water use

Finland is considered to be 68% urban and 32% rural (1990). The pattern of land use in 1986 was: arable and permanent crops 7.1%, permanent pasture 0.4%, forest and woodland

69%, other land 14.2% and inland water 9.3%. Ground water is preferably used for water supply, and most private domestic water supplies are from underground sources. The Finnish industry employs a total of approximately 4 200 (full time equivalents) with 2 000 in professional fishing, approximately 1 000 in aquaculture and 1 200 in fish processing and the wholesale trade. Freshwater fishing is also significant.

### 2.1.3.3. Aquaculture

Aquaculture in Finland consists of both food fish farming and rearing of fish juveniles for restocking and sea ranching. There is also some farming of crayfish for restocking. The aquaculture production of Finland is quite constant in quantity, it is about 16 500 – 17 500 metric tons annual (*Table 23, Figure 56*). Aquaculture, primarily confined to trout production (mostly Rainbow trout) with about 16 000 metric tons, is growing steadily in both fresh and brackish waters and has well surpassed the commercial catch in inland waters (*Figure 57*).

**Table 23 Aquaculture production in Finland**

Quantity (metric tons), Value (million US\$)

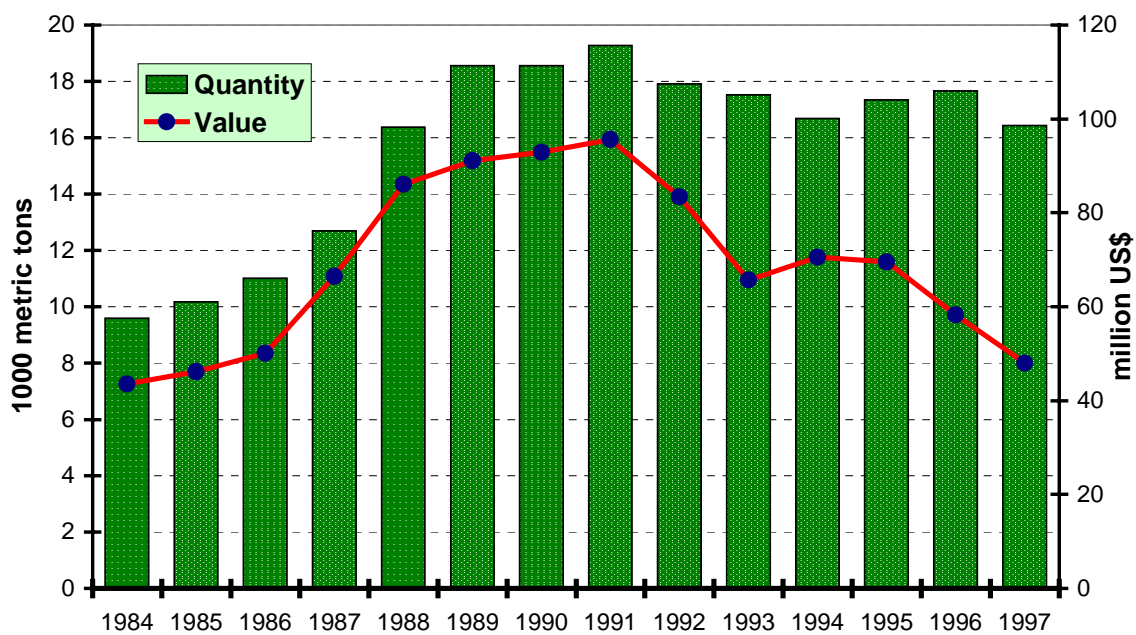
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	16 367	18 550	18 550	19 268	17 909	17 526	16 682	17 345	17 662	16 426
<b>Value</b>	86,09	91,06	92,93	95,60	83,44	65,70	70,53	69,53	58,24	47,96

Reference: FAO, *FishStat Plus 1999*

Production of rainbow trout expanded rapidly in the 1980's from 9 500 metric tons in 1984 but after reaching a peak of 19 000 metric tons in 1991 production has since reduced and in 1997 was 16 000 metric tons. The reduction in production in the 1990's is correlated with reduction in production value per kg.

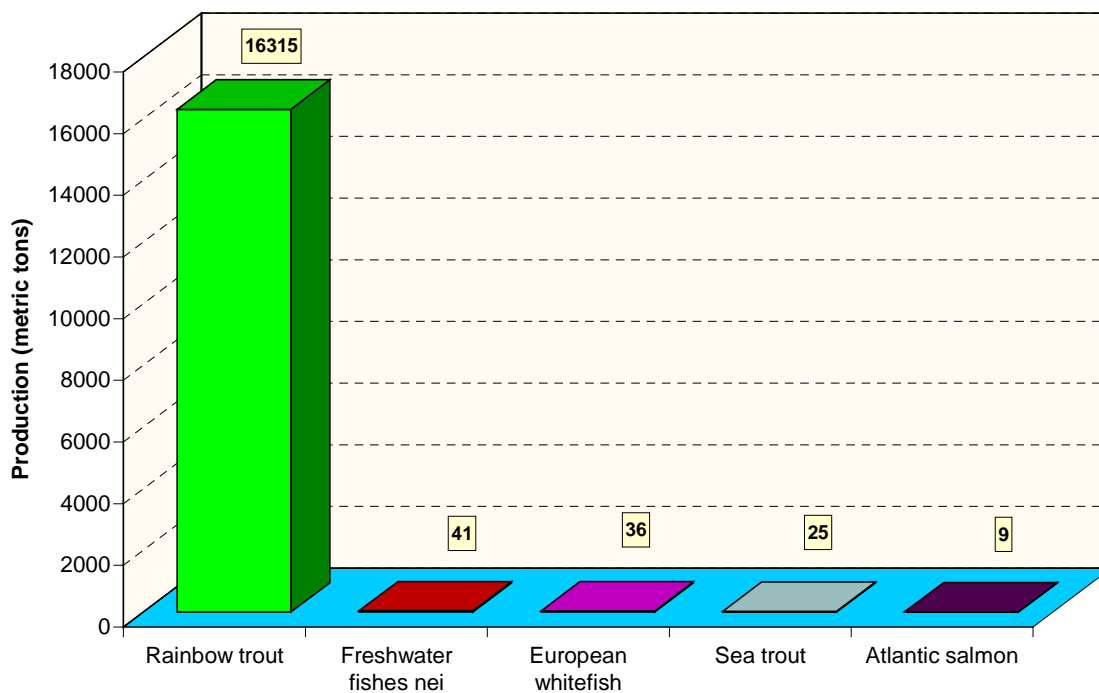
Aquaculture in Finland, for either consumption or stocking in open waters is limited to cold or cool water species. The only fish species really cultivated for consumption is rainbow trout (*Oncorhynchus mykiss*) and its cultivation is a relatively new development.

Fish are also cultivated in Finland for stocking. 21 species have been stocked in Finland. Fish for stocking are produced intensively in land-based fish farms (mostly salmonids) or extensively in large ponds with a natural food supply (mostly coregonids and some cyprinids).



**Figure 56** Volume and value of aquaculture production in Finland

Reference: FAO, FishStat Plus 1999



**Figure 57** Aquaculture production by species in Finland (1997)

Reference: FAO, FishStat Plus 1999

The fisheries sector in Finland is going through a period of fundamental structural change. This is required both to adapt the fishing fleet capacity to match fishing possibilities, and to improve the competitiveness of the fishing industry.

In order to adapt aquaculture to meet tightened environmental, hygiene and fish health requirements, and to improve the competitiveness of the sector, considerable assistance will be granted to the sector operators. Investments will aim at introducing the latest production technology, improving the unit's environmental and hygiene conditions, expanding capacity and farming new species through pilot trials.

Aquaculture accounts for between 8 and 24% of Finland's total fish production and for app. 40% of Finland's total production of fish for human consumption. Most of the production of fish for consumption is marketed within Finland. 13% of per capita consumption of 23 kg/person comes from Finnish aquaculture. App. 40% of the production is further processed. The most important forms of processing are filleting, smoking, raw pickling and use in the processed food industry. Together with Baltic herring, rainbow trout is the most important raw material in the Finnish fish processing industry.

The main market for live roe and juveniles is also within Finland, however, small quantities of live roe are sent to various parts of the world. The export of live juveniles, fish for consumption and processed products to Russia has been increasing over the last few years.

#### *2.1.3.4. Administration and management*

In Finland, the Ministry of Agriculture and Forestry is responsible for both the inland and sea fisheries. The main governmental management and research organisation is the Finnish Game and Fisheries Research Institute. The following organisations exist in the field of fisheries: Federation of Finnish Fisheries Associations, Federation of Finnish Recreational Fishermen's Associations, Finnish Fish and Game Association.

All fish farms need a licence to operate. The licence authority is a special court that deals with water issues. Public interest is represented in court by the water and environment authorities. They favour a reduction in the nutrient load, which is the major limiting factor

on the growth of Finnish aquaculture. The licence regulates production, total allowable feed quantities, maximum nutrient loads (land based farms) and the water volume growing.

The Federation of Finnish Fisheries Associations does not foresee any big expansion in Finnish aquaculture, due to a restrictive licence policy and environmental problems. The markets are also uncertain, although there may be underexploited possibilities in the Russian market.

#### 2.1.4. Denmark, Faeroe Islands



<i>Area:</i>	43 094 km <sup>2</sup>
<i>Population:</i>	5 181 000
<i>Active population:</i>	2 796 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	1 222
<i>Coastline:</i>	7 314+1 117 km
<i>Lakes:</i>	420 km <sup>2</sup>
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	27 383 US\$

**Map 18 Denmark, Faeroe Islands**

Lacking either mineral or hydroelectric resources, Denmark is intensively cultivated, has a seagoing heritage, and is increasing its industrialisation.

Lacking real rivers and large lakes, the country's fisheries are largely marine. There are some commercial fisheries in its shallow lakes, and recreational fishing in both lakes and streams. Trout and eel populations are dominant and cyprinids are little desired. Trout culture in fresh water has long been an outstanding development.

##### 2.1.4.1. Hydrography

The total area of inland water in Denmark is about 70 000 ha or 1.6 % of the total area. There are no long or important rivers in Denmark, because of its too small size, low elevation and relatively low rainfall. There are about 500 lakes and ponds in Denmark. EIFAC (1989) lists their total area as 42 000 ha. According to EIFAC (1989) the total amount of reservoirs is 1 000 ha.

#### 2.1.4.2. Land and water use

About 87 % of Denmark's population is urban. The pattern of land use in 1986 was: arable and permanent crops 60.6%, permanent pasture 5%, forest and woodland 11.4%, other land 21.3% and inland water 1.6%. The land and water uses affecting fisheries have primarily been those causing pollution or at least the siltation and eutrophication of lakes and streams. The problems are aggravated by the intense use of the land, the slow-moving nature and small volume of the streams, and the shallowness of the lakes. Many of the polluting effluents derive from agricultural industries. Fish farming is also an important source of organic pollution in Denmark's small streams. Employment in the processing and marketing sector has remained stable at around 9 000 persons. Employment reached a maximum of 10 200 persons in 1985. Around 500 persons are employed in aquaculture.

#### 2.1.4.3. Aquaculture

In Denmark farming of trout in freshwater is by far the most important area of aquaculture, this is followed by trout from seawater cage farms, trout from land based seawater plants and finally some eel are produced in indoor recirculation systems. There is a little production of mussels, oysters, turbot, cod and plaice. The total aquaculture production of Denmark increased from 28 659 metric tons in 1988 to 38 908 metric tons in 1997 (*Tables 24, 25, Figures 58, 59*). Denmark is one of the main eel producer countries in Europe (*Figure 60*). The aquaculture of Denmark is primarily the production of rainbow trout (37 808 metric tons in 1997), although some sea trout and European eel have also been raised.

**Table 24 Aquaculture production in Denmark**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	28 659	33 059	41 946	42 098	43 264	43 231	42 892	44 730	41 424	38 908
<b>Value</b>	103.99	121.35	153.54	137.15	140.78	135.57	137.10	144.74	138.68	134.41

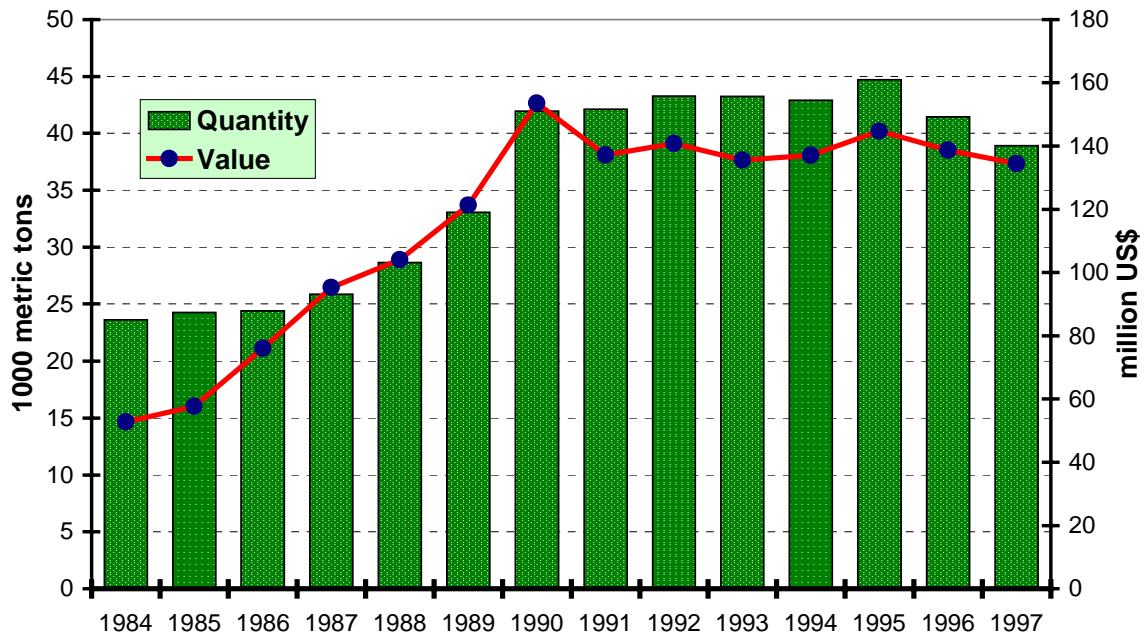
Reference: FAO, *FishStat Plus 1999*

**Table 25 Aquaculture production in Faeroe Islands**

Quantity (metric tons), Value (million US\$)

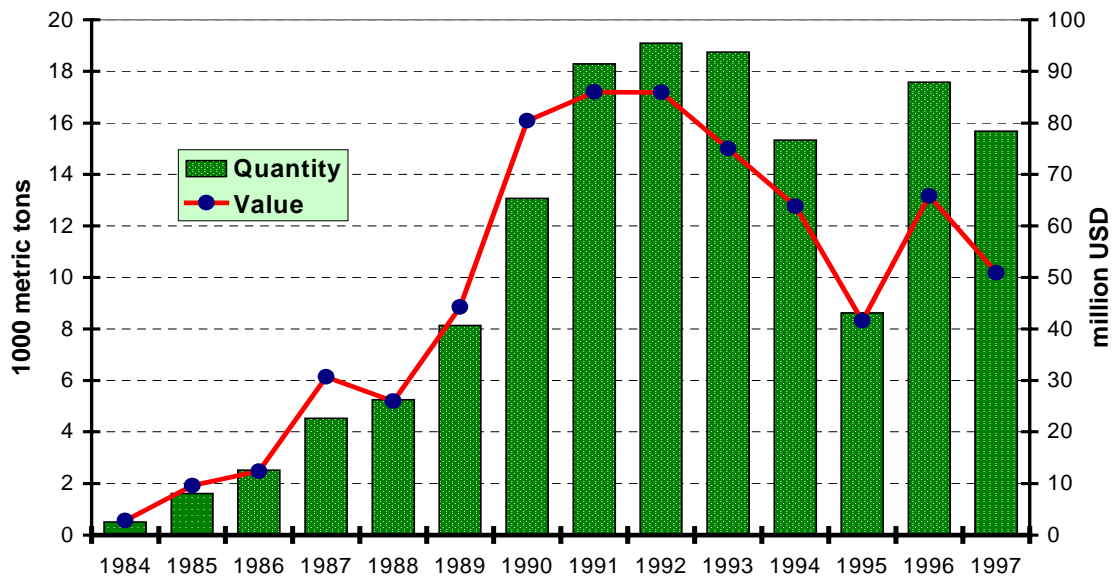
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	5 260	8 131	13 076	18 283	19 098	18 752	15 332	8 611	17 584	15 679
<b>Value</b>	25.980	44.21	80.39	85.97	85.94	75.02	63.81	41.57	65.85	50.94

Reference: FAO, *FishStat Plus 1999*



**Figure 58** Volume and value of aquaculture production in Denmark

Reference: FAO, FishStat Plus 1999

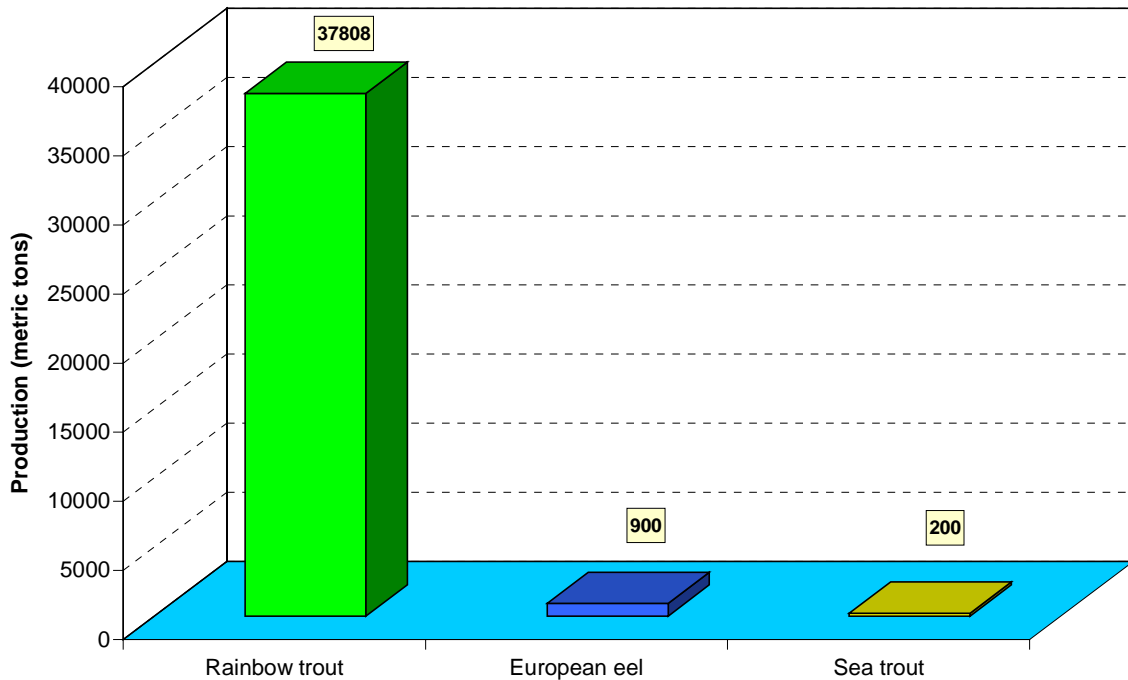


**Figure 59** Volume and value of aquaculture production in Faeroe Islands

Reference: FAO, FishStat Plus 1999



The Atlantic salmon gives 90% and the rainbow trout 10% of the aquaculture production in Faeroe Islands in 1990s.



**Figure 60 Aquaculture production by species in Denmark (1997)**

Reference: FAO, *FishStat Plus 1999*

As it was mentioned, Denmark has long been one of the world’s most important trout producers. There have been several good reasons for this: the North Sea and the Baltic have been a source of cheap “trash” fish with high convertibility for feed; transport of fish feed or trout has been facilitated by the short distances to travel over level terrain on good roads; an active interest both by government and industrial concerns in promoting the industry.

Trout culture, established position in the industry and vigorous policy for its development, can be expected to increase in value, but it has heavy competition in Europe with both French and Italian trout farms.

Eel farming has been developing in Denmark since the early 1980’s. Many small farms started but have since been reorganised or closed down. At one time there were around 200 production sites many of them very small around 1-3 metric tons. In 1990 the number was

down to 70 and there after the number has stabilised around 40. The production today is characterised by high technology (almost exclusively fully recirculated systems are used) and the farmers have gained a lot of experience.

Most of the suitable freshwater areas are now in use. It will require intensive methods such as greater stocking densities, employment of fast-growing strains, aeration and re-use of water, all conditioned by the necessity to keep effluent discharge within tolerable limits. The fisheries sector in Denmark is going through a period of fundamental structural change. This is required mainly because of scarcity of resources in Community waters and increased competition for markets.

Denmark has traditionally been one of the most important fish exporting countries in the world. The fish processing industry has increasingly obtained its raw material from third countries since supplies from the Community fishing fleet have been reduced in the past years. The processing industry, which has an interest in obtaining the raw material at competitive prices, considers that the Community import regime is too restrictive. As regards the aquaculture sector, the problems in Denmark are linked to stringent environmental requirements. It is expected that investment in aquaculture will, first and foremost, aim at increasing productivity and protecting the environment. It is therefore expected that the direct employment effect will be neutral, but that investments will serve to reduce the level of costs and cut the general impact from pollution in the water environment. Aid will be granted for the construction, equipment, expansion and modernisation of aquaculture facilities. Aid may also be granted for moving existing facilities.

App. 85% of freshwater trout is exported to Germany, Holland and Japan, only 15% is consumed locally in Denmark. As the production of trout is mainly exported the Danish market is very vulnerable to the European market prices. The prices are particularly influenced by Norway's large production of salmon. The Danish aquaculture was about 9% of the consumption volume from commercial fisheries in 1994. The Danish fishing industry in total accounts for 1% of the Danish GNP, therefore the impact on the Danish economy is limited. However, regionally is more important especially in some remoter areas.

#### 2.1.4.4. Administration and management

Three ministries are concerned with Danish inland fisheries: Fisheries, Environmental Protection and Agriculture. Non-governmental bodies concerned with inland fisheries of Denmark include: Union of Danish Angler's Association, Danish Society for Freshwater Fisheries, Association of Danish Trout Pond Farmers, Danish Trout Pond Farmer's Experimental Station, County Water Inspectorates, Water Quality Research Institute of the Danish Academy of Technical Sciences, Danish Aquaculture Institute of the Danish Academy of Technical Sciences, Sewage Committee of the Institution of Danish Civil Engineers and various local associations interested in angling and commercial fishing.

The control of freshwater and land based seawater farming are under the jurisdiction of the Ministry of Environment and administered by the individual counties who must act in accordance to the Act of Environmental Protection as well as their local regulations of the environment. Permission for seawater farming in the open sea is given by the Ministry of Agriculture and Fisheries, but also requires permission from the counties to ensure limits are not exceeded. Eel farming is under the jurisdiction of the individual municipalities, as they are not considered to be under the category of strongly polluted industries.

#### 2.1.5. Iceland



<i>Area:</i>	103 000 km <sup>2</sup>
<i>Population:</i>	262 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	4 988 km
<i>Lakes:</i>	500 km <sup>2</sup>
<i>Rivers:</i>	20 000 km
<i>GDP/capita<sup>1995</sup>:</i>	23 620 US\$

**Map 19**      **Iceland**

#### *2.1.5.1. Hydrography*

The total area of inland waters in Iceland is 2 750 km<sup>2</sup> or 2.7% of the country's area. Iceland has numerous lakes, all relatively small. Fifteen lakes exceed 10 km<sup>2</sup> in area and 68 others have an area of 1 to 10 km<sup>2</sup>. About 300 lakes have a linear extent of 300 m or more. There is no extensive development of reservoirs in Iceland. There are about 250 large and small rivers in Iceland, ranging from 60 to 237 km in length.

#### *2.1.4.2. Land and water use*

About 75% of the country is simply unproductive and virtually uninhabitable. As a consequence, habitation is almost limited to lowland coastal areas. Iceland is about 90% urban and 10% rural. The pattern of land use in 1986 was: arable and permanent crops 0.8%, permanent pasture 22.1%, forest and woodland 1.2%, other land 74% and inland water 2.7%. Most of the public water supply comes from underground, primarily from springs. As most of the population is concentrated in coastal areas, most sewage discharges are to the sea rather than into rivers.

#### *2.1.5.3. Aquaculture*

Although the first hatchery in Iceland (for salmon) was built in 1885, and the first rearing station (for sea trout) in 1944, sustained aquaculture production using modern methods is a much more recent endeavour. In fact, interest in true aquaculture did not develop in Iceland until 1984 and it was not until then that the government took a decided interest in its development. The use of Iceland's warm springs for salmonid rearing is a distinct advantage. In other cases warm thermal water is used to elevate the temperature of cold springs. Use of heated water permits a one-year rearing cycle through the smolt stage of salmon, instead of the two or three years usually required under natural conditions. Many of the Icelandic fish farms have large outdoor tanks with a continuous flow of water. Seawater is pumped from wells close to shore and filtered through sand and gravel to eliminate bacteria and toxic algae.

Iceland has many advantages for the development of salmonid aquaculture. It has an abundance of unpolluted river water, spring water of good quality and bacteria-free, large areas of land available for producing fish, small protected bays for cages, dissipation of

wave-force by offshore sheries, and areas with relatively constant salinity. Tidal ranges indicate that cages rather than sub-littoral enclosures are better in coastal waters.

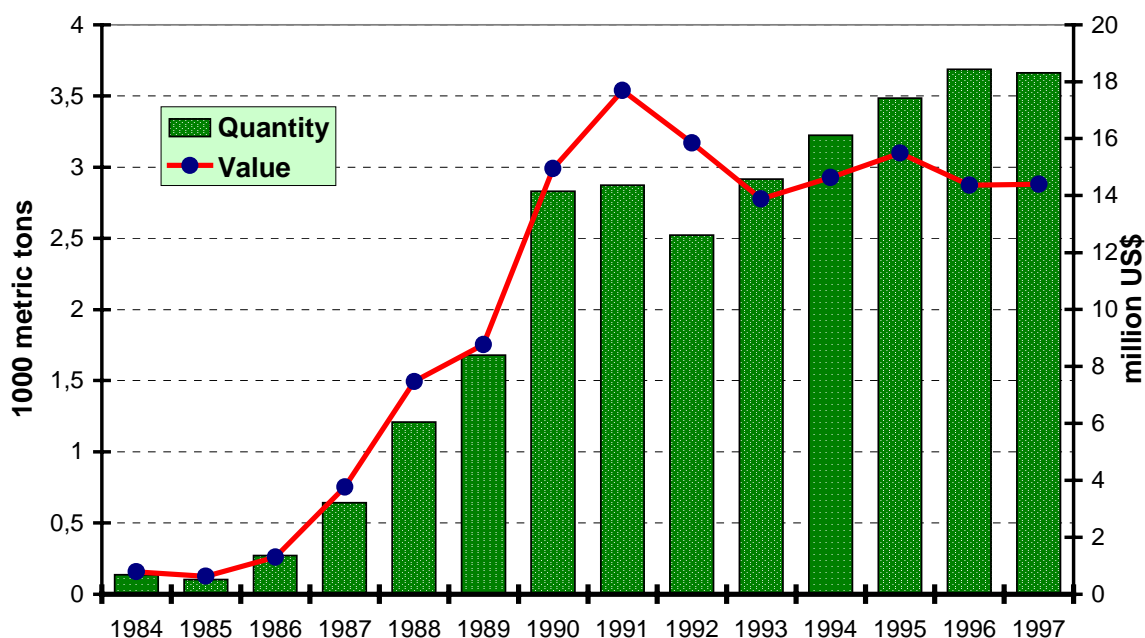
The total aquaculture production of Iceland increased between 1988 and 1997, from 1 209 metric tons to 3 663 metric tons in 1997 (Table 26, Figure 61). The dominant species cultivated in Iceland is the Atlantic salmon with 2 511 metric tons in 1997 (Figure 62). The production of rainbow trout was about 500 metric tons in 1997.

**Table 26 Aquaculture production in Iceland**

Quantity (metric tons), Value (million US\$)

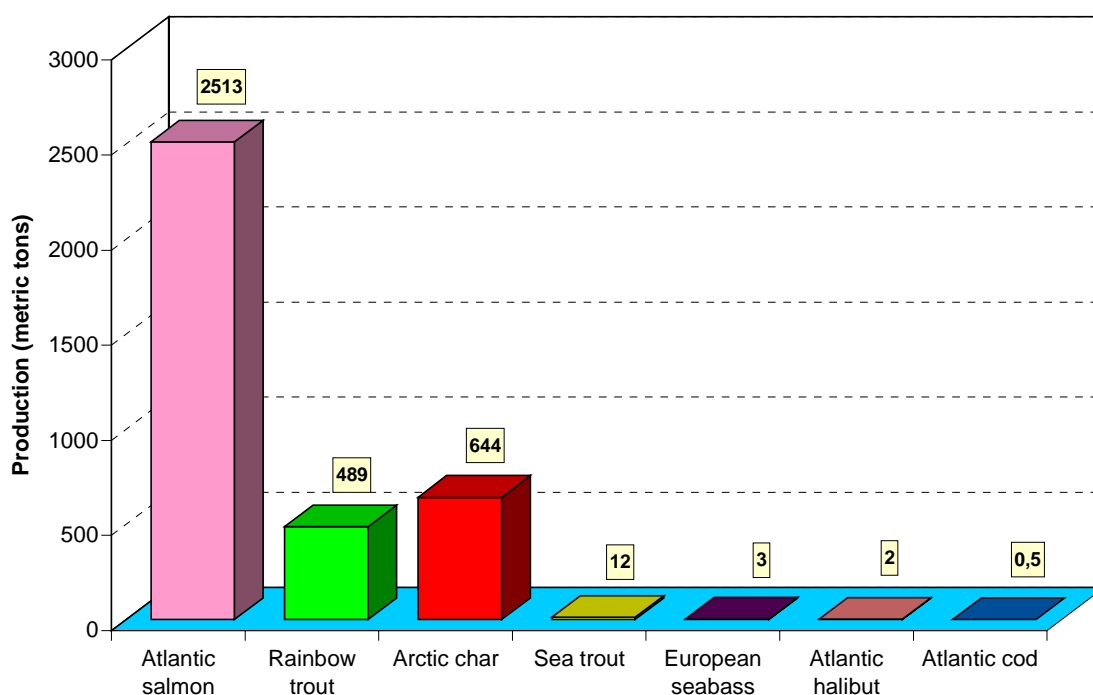
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	1 209	1 677	2 829	2 873	2 524	2 917	3 222	3 485	3 687	3 663
<b>Value</b>	7.46	8.77	14.94	17.70	15.85	13.88	14.63	15.50	14.36	14.40

Reference: FAO, FishStat Plus 1999



**Figure 61 Volume and value of aquaculture production in Iceland**

Reference: FAO, FishStat Plus 1999



**Figure 62 Aquaculture production by species in Iceland (1997)**

Reference: FAO, FishStat Plus 1999

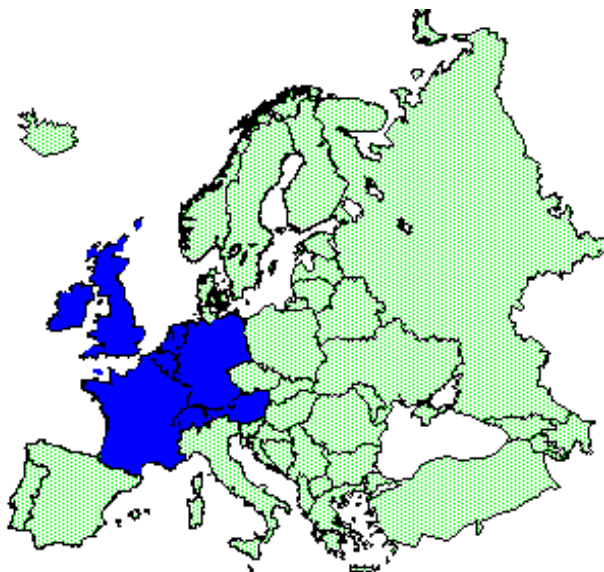
#### 2.1.5.4. Administration and management

Although the oceanic fishery stocks are under the jurisdiction of the Ministry of Fisheries, salmon are administered under the Ministry of Agriculture. Both the Institute of Freshwater Fisheries and the National Centre approve aquaculture production licenses for Hygiene, Food Control and Environmental Protection.

## 2.2. Western Europe<sup>3</sup>

The aquaculture production in Western Europe is increasing from 1984 up to now except 4 years (Table 27, Figures 63, 64). The most important finfish species are the Atlantic salmon and the rainbow trout both in commercial production and also in the recreational fishery sector.

<sup>3</sup> **Western Europe:** The United Kingdom, Channel Islands, Ireland, France, the Netherlands, Luxembourg, Belgium, Germany, Austria and Switzerland.



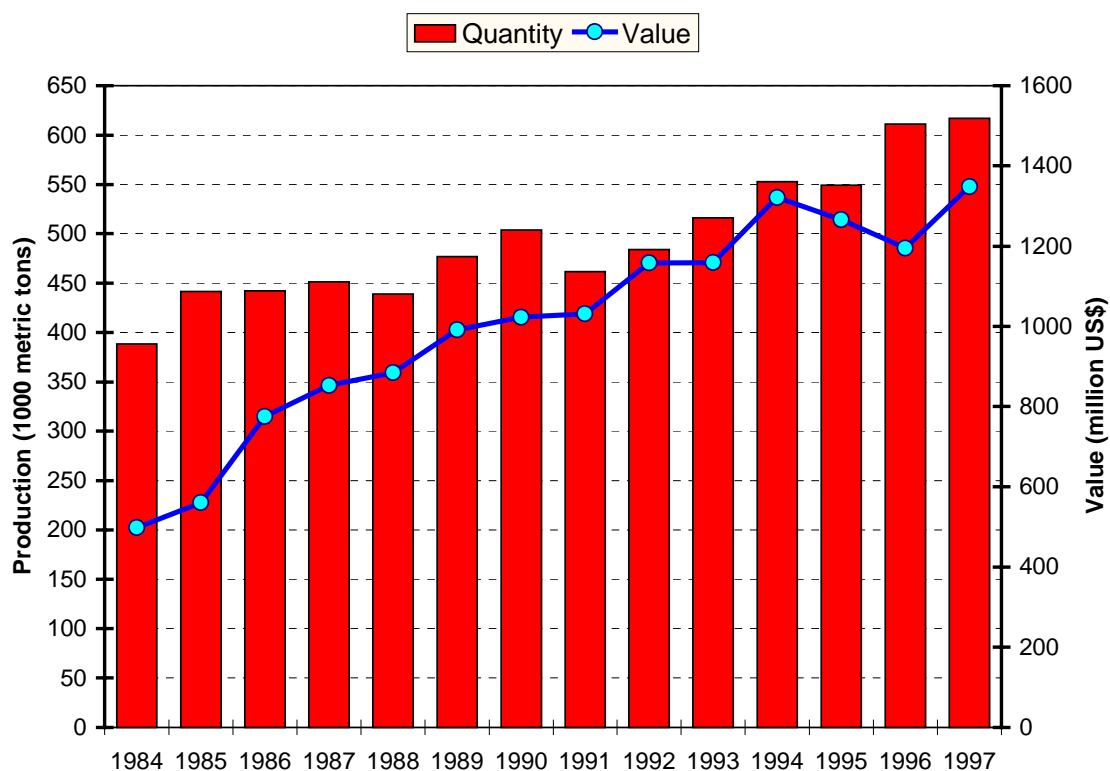
**Map 20** Western Europe

**Table 27** Aquaculture production in Western Europe

Quantity (1000 metric tons), Value (million US\$)

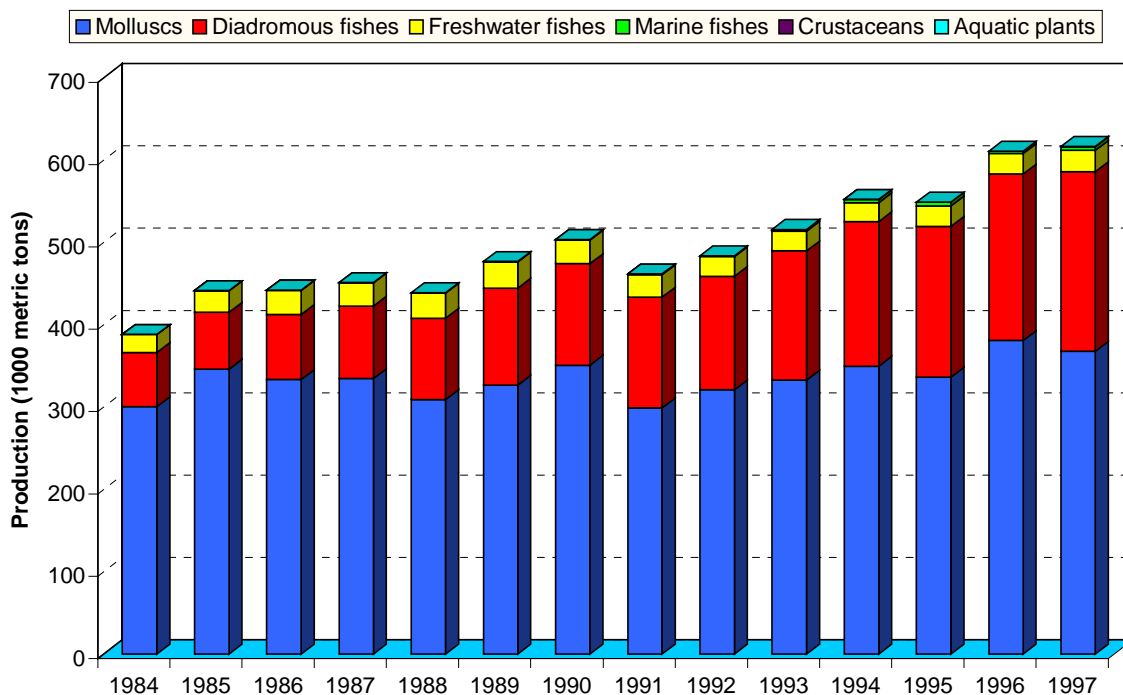
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	438.90	477.10	503.74	461.69	483.96	515.95	552.49	549.07	610.91	616.74
<b>Value</b>	883.77	991.13	1022.53	1031.50	1158.01	1158.91	1321.24	1266.28	1195.11	1347.97

Reference: FAO, FishStat Plus 1999



**Figure 63** Aquaculture production in Western Europe

Reference: FAO, FishStat Plus 1999



**Figure 64** Volume of aquaculture production by major species groups in Western Europe

Reference: FAO, FishStat Plus 1999

### 2.2.1. United Kingdom, Channel Islands



Area:	244 100 km <sup>2</sup>
Population:	57 065 000
Active population:	28 404 000
Employment in aquaculture <sup>1997</sup> :	6 810
Coastline:	12 429 km
Lakes:	1 924 km <sup>2</sup>
Rivers:	42 800 km
GDP/capita <sup>1997</sup> :	17 981 US\$

**Map 21** United Kingdom, Channel Islands

The United Kingdom of Great Britain and Northern Ireland composed of four major political divisions: England, Scotland, Wales and Northern Ireland.

A wealth of rivers, including large estuarine areas, as well as extensive lake area in the north, provides considerable water for inland fishing. Despite setbacks from development



associated with land and water use, especially pollution, commercial fishing for salmon continues to yield a rich harvest, and angling for coarse fish or trout is found throughout the country. Freshwater aquaculture primarily for salmonids is now well in progress. Angling, however, which has long been a very important element in British recreation and tourism, continues to be dominant.

#### *2.2.1.1. Hydrography*

According to an official estimate, the extent of the inland waters in the United Kingdom is 3 218 km<sup>2</sup> or 1.3% of its total area. The length of the rivers in the United Kingdom is 42 800 km. 5 502 lakes and reservoirs were counted in Great Britain, with a total area of 1 924.3 km<sup>2</sup>. In 1977 a survey recognised 537 reservoirs of 2 ha or more in England and Wales with a total surface area of over 202.5 km<sup>2</sup>.

#### *2.2.1.2. Land and water use*

The United Kingdom is one of the highly developed industrial and trading nations in the world, with huge conurbation holding much of its population. The United Kingdom is about 92% urban and only 8% rural. Nevertheless, agriculture still constitutes an important use of its land. The pattern of land use in 1986 was: arable and permanent crops 28.7%, permanent pasture 45.4%, forests and woodlands 9.4%, other land 15.2% and inland water 1.3%. Employment of fishermen has been roughly stable at around 22 000 from 1982 to 1991. In view of the need to restructure the industry it is expected that the number of fishermen will decline. The United Kingdom has around 1 400 fish and shellfish farming businesses on 2 100 sites employing about 5 000 people in rural and coastal areas. Employment in salmon production is a major factor in maintaining small coastal populations in the Highlands and Islands of Scotland. Trout is produced mainly in freshwater rivers of England, Wales and Northern Ireland.

#### *2.2.1.3. Aquaculture*

The total aquaculture production of the United Kingdom increased significantly between 1988 and 1997, from 36 392 metric tons to 129 715 metric tons (*Table 28, Figure 65*). The United Kingdom is one of the major salmon and oysters producer European countries.

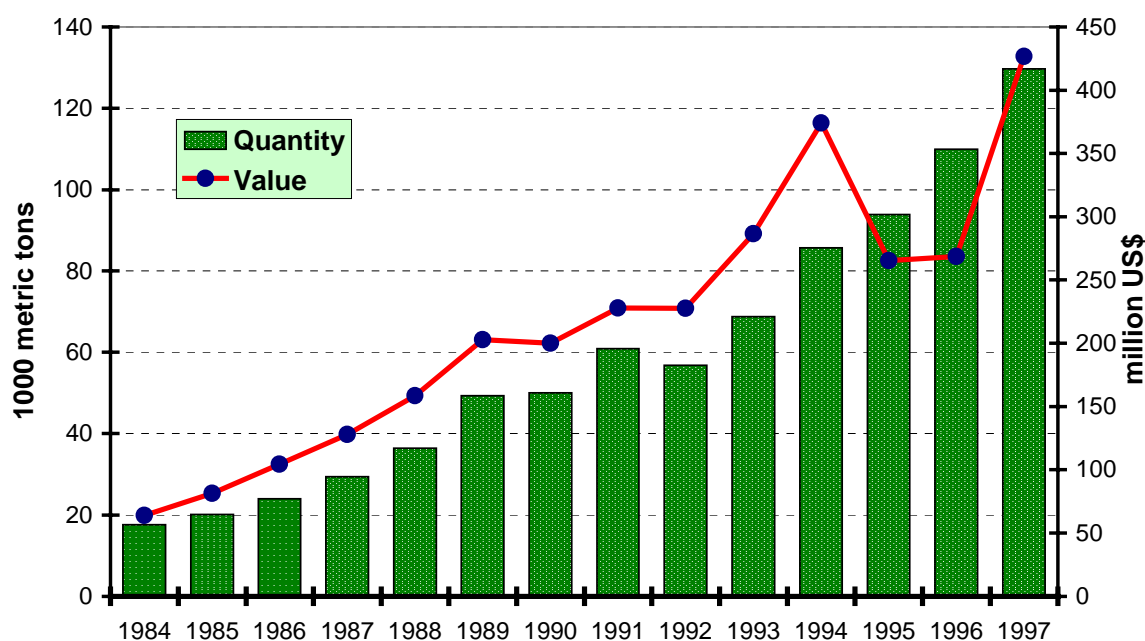
Over 80% of production are from Scottish salmon, which has expanded from around 600 metric tons in 1979 to an estimated 80 000 metric tons in 1997. Salmon farming is a major contributor to the Scottish economy, employing over 2 600 people directly and 2 800 indirectly. The Scottish salmon industry has faced strong competition from the much larger Norwegian salmon industry in recent year.

**Table 28 Aquaculture production in the United Kingdom**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	36 392	49 316	50 044	60 887	56 824	68 774	85 701	93 838	109 901	129 715
<b>Value</b>	158.4	202.9	199.9	227.9	227.6	286.7	374.0	265.4	268.6	426.8

Reference: FAO, FishStat Plus 1999



**Figure 65 Volume and value of aquaculture production in the United Kingdom**

Reference: FAO, FishStat Plus 1999

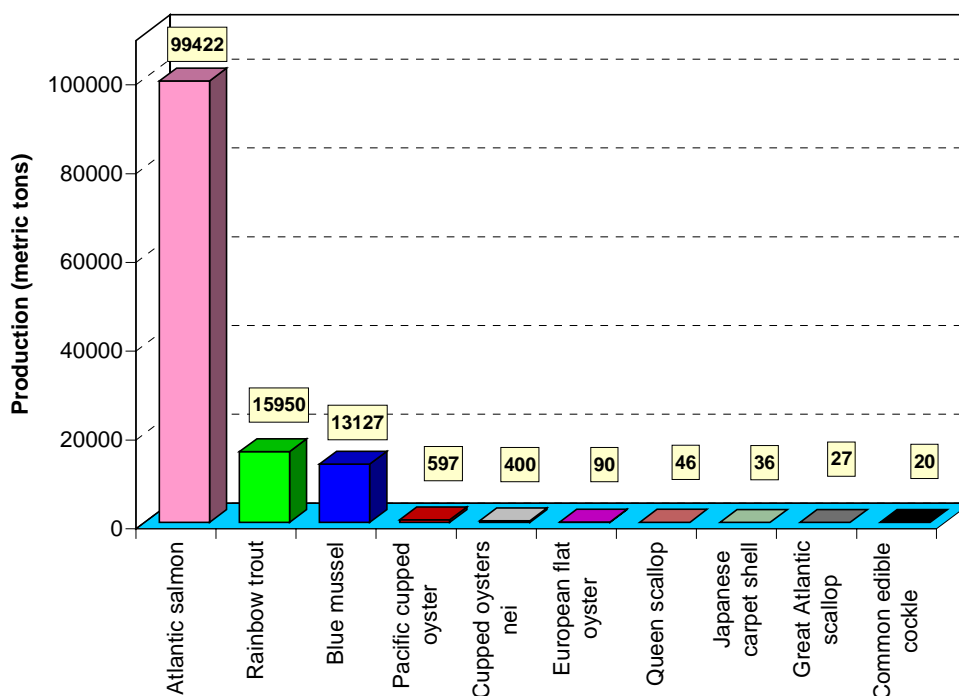
Until fairly recently, most of the fish produced through pond culture in the United Kingdom have been destined for stocking recreational fisheries. Although trout restocking farms have been in operation in Great Britain for over 100 years, the first table-trout

production farm was only built in the 1960's. Today, however, there is a greater emphasis on commercial production for food.

Among 421 fish farms (out of an estimated 480 freshwater fish farms in the UK), 95% raised salmonids (62% rainbow trout, 18% brown trout, 10.6% salmon, 3.1% brook trout and 2% sea trout). The other 5% of the farms raised carp, roach, rudd, tench, grass carp and eel.

By 1970, low-cost floating cage structures, considered better than either ponds or raceways, had been developed for use in Scottish freshwater lochs. Sea culture using both fixed cages and saltwater tanks had also started. Floating sea cages for rainbow trout and salmon were adapted for use in freshwater lochs to raise rainbow trout. With respect to trout culture generally, most farms in the United Kingdom are raising their own eggs, reversing the former practice of using large numbers of imported eggs. Few ponds are built into existing river courses although rivers are a prime source of water for freshwater systems. Springs and wells are used to supply intensive ponds, which are of paramount importance, although raceways, cages and extensive ponds are also used.

The total aquaculture production of rainbow trout was about 15 000-16 000 metric tons between 1988 and 1997. Atlantic salmon production in the United Kingdom is also confined to Scotland. The fish are farmed in cages in sea-lochs after the smolts have been adapted to salt water. The farming of Atlantic salmon continues to be an amazing endeavour in Scotland. The total aquaculture production of Atlantic salmon expanded in the United Kingdom from 17 951 tons in 1988 to 99 422 metric tons in 1997 (*Figure 66*). The aquaculture production of blue mussel is also important in the United Kingdom, it increased from 2 185 metric tons in 1988 to 13 127 metric tons in 1997. Oyster production was 1 087 metric tons in 1997. European eel production using heated effluents from power plants is underway in the United Kingdom. A variety of carp and coarse fish are produced for the ornamental restocking trade, but the total production both in volume and value are low. Other species farmed include crayfish, tilapia, eels and turbot.



**Figure 66 Aquaculture production by species in the United Kingdom (1997)**

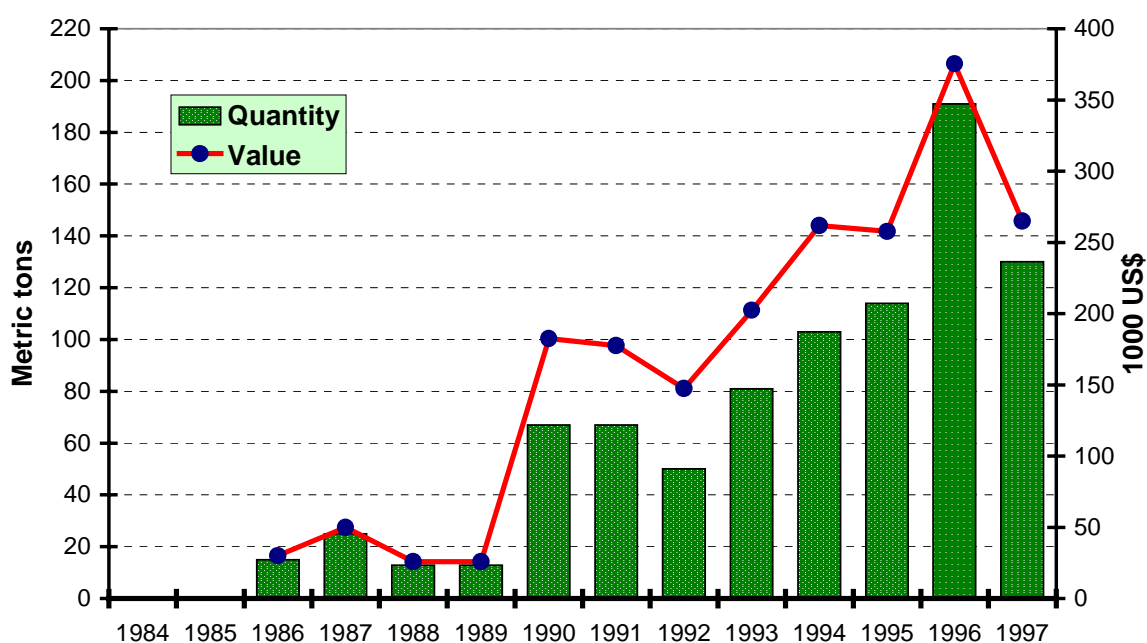
Reference: FAO, *FishStat Plus 1999*

UK exports 40% of its salmon production mostly in chilled fresh form to France and other EU countries. The increasing salmon production in the UK and in Norway has in recent years lead to market instability. Despite the increasing availability of salmon, market conditions for portion trout products have remained relatively stable. The supermarkets' share of the retail market for fish has been rising at around 5% a year and is currently around 60%.

The development of commercial aquaculture in Northern Ireland has been facilitated by governmental aid in establishing and improving fish farms. The fisheries sector in the United Kingdom is going through a period of fundamental structural change. This is required mainly because of a scarcity of resources in Community waters and increased competition for markets. It is proposed to provide scientific and technical advice and an appropriate level of financing to increase the production of fish and shellfish through aquaculture in order to ensure a regular supply and high quality of these species on the market.

In Scotland the spectacular growth of salmon cultivation during the past decade represents an important new contribution to the economy of the region, especially for the remote communities in Highlands and Islands, where there are few alternatives for employment.

Although Channel Islands is part of the United Kingdom, the FAO statistics separates its aquaculture productions, so we speak also separately about it. The most important cultured species in Channel Islands in 1997 are: pacific cupped oyster (126 metric tons), great Atlantic scallop and grooved carpet shell (2 and 2 metric tons). The production capacity is not so important, but the tendency of the aquaculture production is remarkable because it has been increasing in '90.



**Figure 67** Volume and value of aquaculture production in Channel Islands

Reference: FAO, FishStat Plus 1999

#### 2.2.1.4. Administration and management

In England and Wales the Ministry of Agriculture, Fisheries and Food though its Department of Fisheries has overall responsibility for all salmon and inland fishery matters, but the detailed administration and management of the fisheries is performed by the National Rivers Authority. The Ministry has the duty, jointly with the Secretary of State for the Environment to promote a national water resources policy and it is his duty to

secure the effective execution of that policy as it is related to inland and coastal waters. The National Rivers Authority was formed in 1989 by amalgamating those portions of the ten Regional Water Authorities, which dealt with rivers, water resources and inland waters generally.

In Scotland the Department of Agriculture and Fisheries for Scotland through its Fisheries Division is responsible for all central fisheries administration, utilising various services. An inspector of Salmon and Freshwater Fisheries provides technical advice for Scotland. The North of Scotland Hydro-Electric Board is concerned with measures to preserve salmon and trout fisheries in waters affected by hydroelectric development, and also undertakes some research projects. There are several fishermen's associations, for example Angler's Co-operative Association, Scottish Angler's Association, etc.

The secretary of State for Northern Ireland is responsible for the Parliament of the United Kingdom for services such as agriculture, including fisheries and the environment. The Department of Agriculture for Northern Ireland and the Fisheries Conservancy Board share the general management of fisheries. The Foyle Fisheries Commission provides for the management, protection and improvement of fisheries in the Foyle area, administers the Foyle Catchment, which is situated in both Northern Ireland and the Republic of Ireland.

### 2.2.2. Ireland



<i>Area:</i>	70 283 km <sup>2</sup>
<i>Population:</i>	3 547 000
<i>Active population:</i>	1 434 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	1 772
<i>Coastline:</i>	1 448 km
<i>Lakes:</i>	221 km <sup>2</sup>
<i>Rivers:</i>	13 280 km
<i>GDP/capita<sup>1997</sup>:</i>	14 385 US\$

**Map 22**      **Ireland**

In Ireland, limestone-based lowland, rimmed by coastal uplands, its central plain contains many bogs, lakes and slow moving rivers. Streams on the seaward side of the coastal fringe are usually short and rapid.

Good fish populations of Atlantic salmon and sea trout occupy most of Ireland's rivers and provide both inland and offshore fishing. Eels also constitute a fishery resource. Its streams and lakes provide excellent angling for brown trout, and cyprinids and pike fishing are also important. Cold-water aquaculture is developing. The prospect is good for fishing and for aquaculture.

#### *2.2.2.1. Hydrography*

The Central Statistics Office (1988) indicates that major inland waters constitute 1 391 km<sup>2</sup> or 1.98 % of Ireland's total area. There are 11 400 km of streams and 13 280 km of rivers in Ireland. Lakes are numerous in Ireland, with about 221 km<sup>2</sup> area. There are a limited number of reservoirs in the Republic of Ireland, the total reservoir area there is about 38 km<sup>2</sup>.

#### *2.2.2.2. Land and water use*

Ireland is predominantly an agricultural country, and although its economy is about 59% urban and 41% rural, its general aspect is still rural. The pattern of land use in 1986 was: arable and permanent crops 11%, permanent pasture 70%, forest and woodland 4.6%, other land 12.3% and inland water 1.98%. Underground water is plentiful in Ireland, minimising the need for surface abstractions for domestic use. Sea fishing, aquaculture and processing industries are vitally important for the coastal regions, supporting employment for nearly 16 000 people in the country.

#### *2.2.2.3. Aquaculture*

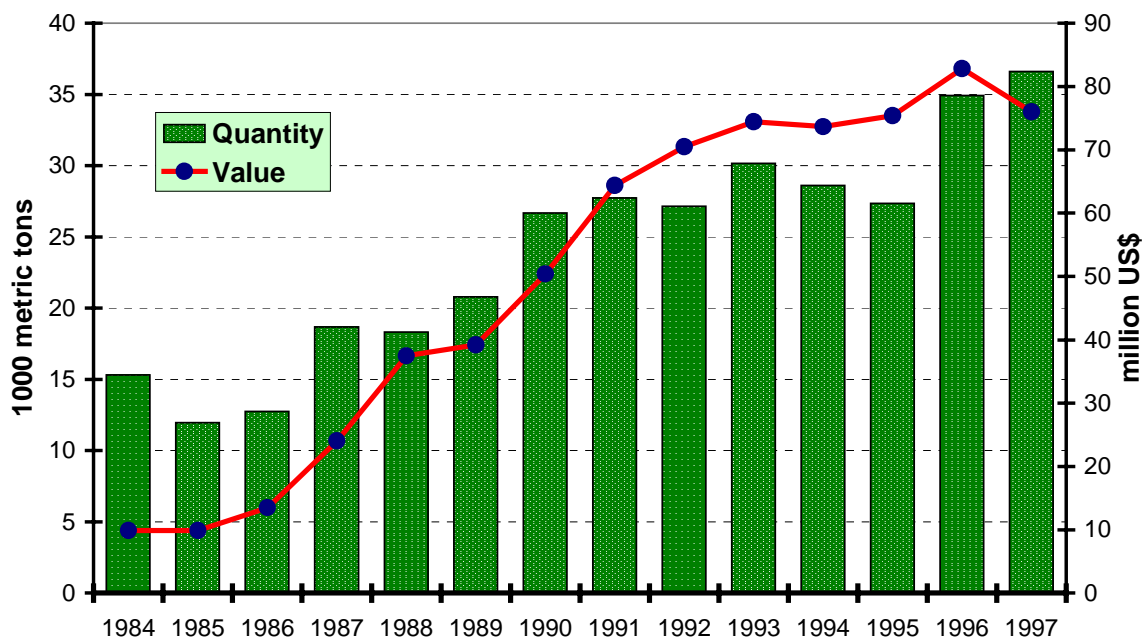
The total aquaculture production of Ireland increased significantly in the past decade. In 1988 it was 18 327 metric tons, while in 1997, 36 624 metric tons (*Table 29, Figure 68*). It consists of mostly the Blue mussel production, which were 16 094 metric tons in 1997 (*Figure 69*). Ireland is one of the main mussel and oyster producer European countries. Commercial aquaculture in Ireland began with the cultivation of rainbow trout in circa 1960. The aquaculture production of rainbow trout "expanded" between 1988 and 1997, from 1 030 metric tons to 1 101 metric tons.

**Table 29 Aquaculture production in Ireland**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	18327	20790	26673	27749	27157	30158	28615	27366	34925	36624
<b>Value</b>	37.5	39.2	50.4	64.4	70.5	74.5	73.7	75.4	82.8	76.0

Reference: FAO, FishStat Plus 1999



**Figure 68 Volume and value of aquaculture production in Ireland**

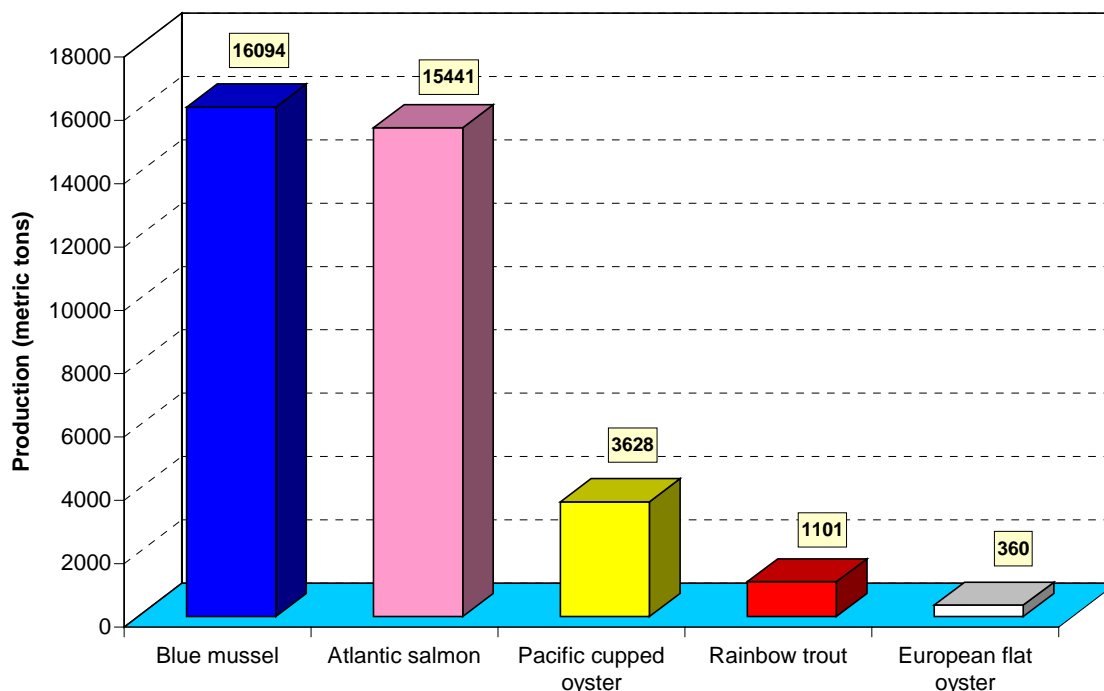
Reference: FAO, FishStat Plus 1999

Climatic conditions and social preferences indicate that aquaculture will continue to be confined to cold water species, especially rainbow trout and salmon. Ireland is an important salmon producer country. The United Kingdom and Ireland amount for around 17% of the total world's farmed salmon production. The aquaculture production of Atlantic salmon was 15 441 metric tons in 1997.

The fisheries sector in Ireland is going through a period of fundamental structural change. The crisis in the sector, the scarcity of resources in Community waters and the increase in European and world competition require multiple reactions by actors in the sector. Aquaculture, though still a relatively young industry, has already grown to the stage where



it accounts for 25% of the value of total fish production and is increasingly a key supplier of raw material for the processing sector.



**Figure 69 Aquaculture production by species in Ireland (1997)**

*Reference: FAO, FishStat Plus 1999*

The Irish industry pioneered the development of offshore fish farming using larger and more robust high sea cages, which account for the bulk of Irish salmon production. Shellfish can be cultivated by extensive methods such as bottom cultivation of mussels, oysters and scallops, or through more intensive methods such as mussel growing on suspended ropes and oyster growing using bags and trestles.

The market is developing for oyster both in Ireland and the UK but is currently threatened by over supply of cheaper continental oyster, which are often of inferior quality. Most of the Irish mussel production is marketed fresh as this generally offers a higher price, however, this means that it is subjected to a seasonal demand. Most mussels are marketed in France, UK and Belgium.

The main constraints to the development of aquaculture in Ireland are the problems, which licensing procedures and opposition from conservation and fishing interests. A shortage of suitable sheltered sites for salmon farming has led to the development of offshore farming

and Ireland is now a leader in such technology. If licensing problems and opposition can be overcome and inlet conditions allow, there is scope for further increase in this sector.

The other main sector is “shellfish”, which is considered to have reasonable potential for growth given the favourable culture conditions and good wild mussel seed resources. Development will again depend on licensing issues. Toxic algal blooms are a threat to this sector, although improved monitoring procedures in future should help to minimise impact.

#### 2.2.2.4. Administration and management

The department of the Marine, through its Inland Fisheries, Sea Fisheries and Aquaculture Divisions is responsible for the general administration of both sea and inland fisheries. There are numerous non-statutory angling associations in Ireland whose activities include conservation, protection and improvement of the waters under their control.

#### 2.2.3. France



<i>Area:</i>	543 965 km <sup>2</sup>
<i>Population:</i>	57 372 000
<i>Active population:</i>	25 033 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	11 297
<i>Coastline:</i>	3 427 km
<i>Lakes (natural):</i>	500 km <sup>2</sup>
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	23 043 US\$

**Map 23** France

France is rich in rivers, small streams and interconnected waterways. It possesses many small ponds and some coastal lagoons, but is deficient in large natural lakes. Aquaculture for trout has become highly developed and the potentialities for brackishwater culture are good.

##### 2.2.3.1. Hydrography

Dependent upon the source, the total area of inland water in France is ranging from 3 093 to 3763 km<sup>2</sup> or from 0.56 to 0.69% of the total area of the country. France is not well

supplied with large natural lakes. According to the natural lakes of France totalled 50 000 ha. There is about 40 000 ha of reservoirs in France. Many more reservoirs will be built, especially to increase critical low water flows, and this will obviously change fishing patterns. France, records the total length of used waterways in France as 6 252 km. France has Mediterranean, Atlantic Ocean and Corsican lagoons.

### 2.2.3.2. Land and water use

Although there has been only a small development of large urban centres in France, it is considered to be about 74% urban. About 60% of the land is used for agriculture, primarily by small family holdings. The pattern of land use in 1986 was: arable and permanent crops 34.7%, permanent pasture 22.2%, forest and woodland 26.7%, other land 16.1% and inland water 0.25%. Although France's largest ports are at river mouths, its rivers are not suitable for navigation. The number of fishermen on board ship for more than six months a year has been steadily declining for several years; by 1992, there were 23 907 registered fishermen.

### 2.2.3.3. Aquaculture

Aquaculture production in France had raised from 227 544 metric tons in 1988 to 287 609 metric tons in 1997 (*Table 30, Figure 70*). France is one of the main salmon, mussels, oysters, clams, carp and basses producer countries of Europe. Freshwater aquaculture in France is devoted primarily to raising rainbow trout (50 482 metric tons in 1997) and common carp (5 755 metric tons in 1997). In addition to freshwater pond culture, various finfishes, crustaceans and molluscs (mussels and oysters) are obtained from brackish or saline waters in France. France is one of the major producer of salmonids with 54 281 metric tons, mussels with 63 350 metric tons, oysters with 149 650 metric tons, cyprinids with 10 223 metric tons in 1997.

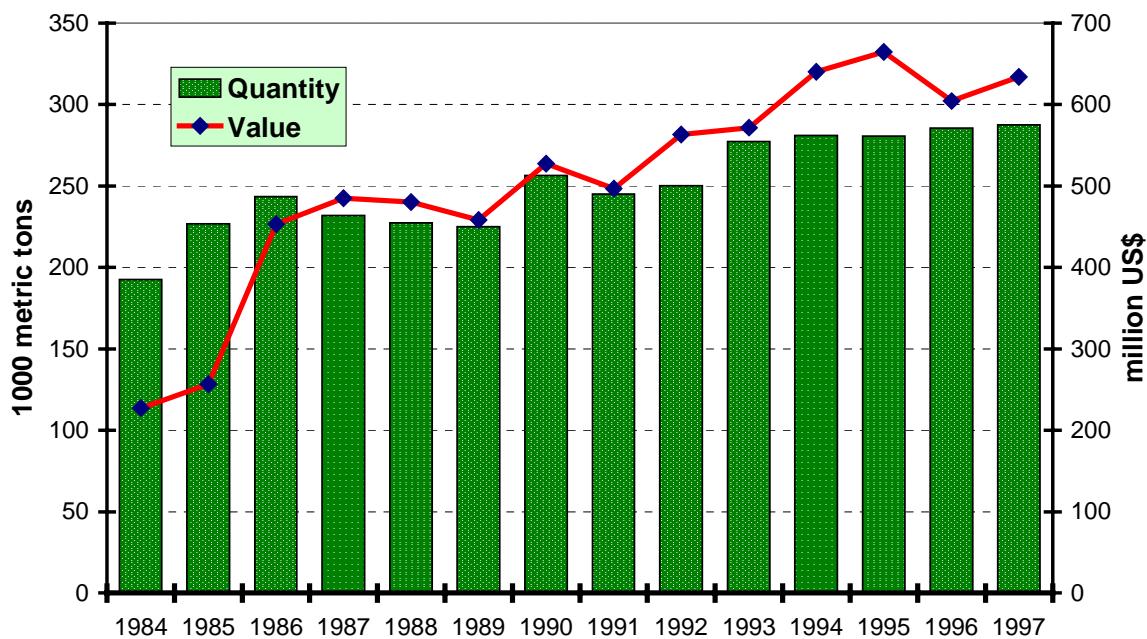
Although the culture of sea bass and sea bream is still mainly dependent on the capture of wild fry it is now moving towards hatchery production. The aquaculture production of seabass increased from 145 metric tons in 1988, to 2 114 metric tons in 1997 (*Table 31*).

**Table 30 Aquaculture production in France**

Quantity (metric tons), Value (million US\$)

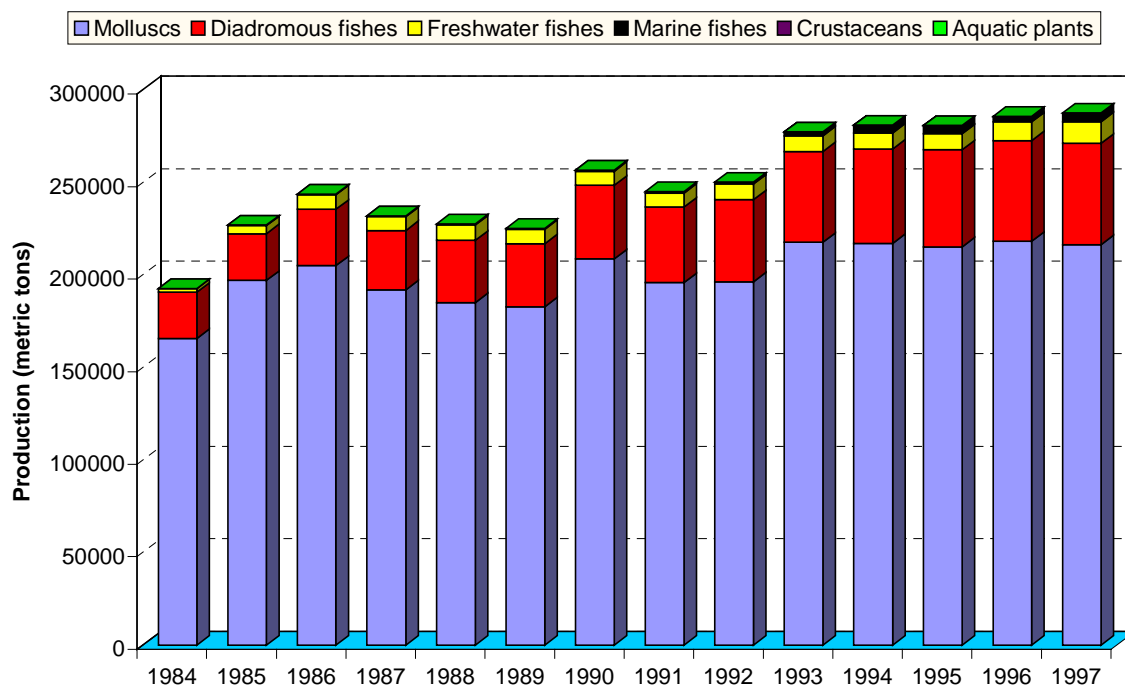
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	227544	225122	256653	245094	250254	277323	280954	280785	285721	287609
<b>Value</b>	480.3	458.2	527.6	496.8	563.4	571.5	640.6	664.7	604.3	634.1

Reference: FAO, *FishStat Plus 1999*



**Figure 70** Volume and value of aquaculture production in France

Reference: FAO, FishStat Plus 1999



**Figure 71** Aquaculture production by major species groups in France

Reference: FAO, FishStat Plus 1999

“Shellfish” production is dominated by the cupped oyster, as the flat oyster continues to be affected by the parasite *Bonamia*. The oyster industry is considered to be mature, given the full exploitation of existing sites and the shortage of further sites for development. The cultivation of mussels has expanded significantly, mainly due to the development of longline farming on the Mediterranean and Atlantic coasts.

In the freshwater sector, traditional pond culture of carps and other species is mostly practised for restocking, and production is stable. Trout farming however has developed significantly, helped by the use of oxygen and better feeds. In the marine sector, the production of sea bass and bream is now established, but limited by site availability in inshore waters, high production costs and markets.

**Table 31 Aquaculture production by species in France (1997)**

Species	metric tons	%	Species	metric tons	%
Pacific cupped oyster	147150	51,16	European eel	160	0,05
Blue mussel	52350	18,20	Danube crayfish	100	0,03
Rainbow trout	50482	17,55	Largemouth black bass	100	0,03
Mediterranean mussel	11000	3,82	Great Atlantic scallop	150	0,05
Common carp	5755	2,00	Salmonoids nei	150	0,05
Roach	2700	0,94	Signal crayfish	100	0,03
European flat oyster	2500	0,87	Arctic char	90	0,03
Sea trout	2157	0,76	Tilapias nei	80	0,03
European seabass	2114	0,74	Giant river prawn	75	0,03
Periwinkles nei	1400	0,49	Wakame nei	54	0,02
Gilthead seabream	1312	0,46	Freshwater gobies nei	50	0,02
Common edible cockle	1200	0,42	Crayfishes nei	31	0,01
Tench	1400	0,49	Meagre	30	0,01
Turbot	980	0,34	Kuruma prawn	24	0,01
Atlantic salmon	950	0,33	Silver carp	20	0,01
Northern pike	500	0,17	Grass carp	20	0,01
Brook trout	450	0,16	Cyprinids nei	12	0,00
Japanese carpet shell	400	0,14	Harpoon seaweeds	8	0,00
Pike-perch	300	0,10	Goldfish	6	0,00
Rudd	300	0,10	Bighead carp	5	0,00
European perch	251	0,09	Bleak	5	0,00
Grooved carpet shell	250	0,09	White seabream	5	0,00
Wels (European catfish)	240	0,08	Grayling	2	0,00
Siberian sturgeon	190	0,07	Freshwater fishes nei	1	0,00

Fish feed manufacturers are well established in France for trout, shrimp and other species, as are manufacturers of aquaculture equipment. Given the large size of the country, its relatively low population density, the emphasis on agriculture and the prospect for

continued inland fisheries and aquaculture is good in France. Growth in aquaculture is certainly possible, especially through improved and more intensive management of both fresh and brackish waters. The French fishing industry is at present undergoing radical restructuring. The sector's response to the present crisis, to the scarcity of resources in Community waters and to intense competition both within Europe and globally, must address a number of issues.

#### *2.2.3.4. Administration and management*

Two ministries are responsible for the administration of French inland fisheries: the Ministry of Environment and the Ministry of Agriculture and Forestry. The fisheries council (Conseil Supérieur de la Pêche) is classified as a national public body having both an advisory and technical function. It has legal status and is financially autonomous under the supervision of the Ministry of Environment. Amateur and professional fishermen have equal representation in the Conseil Supérieur with local authorities concerned with fishing. Amateur fishermen who fish in free waters must be members of an approved fishing association (Association Agréée de Pêche et de Pisciculture). These associations (numbering 4 100 in 1980) supervise fishing areas for their protection and development.

There are also two national sectoral organisations set up by law for the development of the sector, to co-ordinate activities such as research and promotion. One of these covers fisheries and marine aquaculture and the other shellfish culture. There appears however to be a poor relationship between these groups and producers, especially in the shellfish sector.

In freshwater fish farms are subject to regulations concerning water use, and impact on fisheries and the environment. Applications for farms must include a full report on proposed measures to reduce impacts, and are made at the Prefecture, which then contacts the relevant local authorities. A decision is made following public consultation. There is a major difficulty with the lack of a standard procedure for environmental impact assessment (EIA), and other interest groups frequently dispute findings. In addition, even if permission is granted for the use of water, it can be revoked or modified without compensation before the end of an authorisation (typically 10-30 years). Charges for fish farms effluents have recently been introduced by the Agencies, which manage river basins, based on production and food conversion ratio.

#### 2.2.4. The Netherlands



<i>Area:</i>	33 939 km <sup>2</sup>
<i>Population:</i>	15 298 000
<i>Active population:</i>	7 304 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	1 498
<i>Coastline:</i>	451 km
<i>Lakes:</i>	2 375 km <sup>2</sup>
<i>Rivers, canal:</i>	3 529 km
<i>GDP/capita<sup>1997</sup>:</i>	21 089 US\$

**Map 24**      **The Netherlands**

##### 2.2.4.1. Hydrography

The Central Bureau voor de Statistiek (1989) lists the inland water area of the Netherlands as 9.2 %, about 3 816 km<sup>2</sup>. The Netherlands state that there are 6 400 km of flowing waters in the country. The total area of lakes in the Netherlands is 237 500 ha. The area of reservoirs is 79 000 ha. In 1987 there were 3 529 km of navigable canals in the Netherlands.

##### 2.2.4.2. Land and water use

The economy of the Netherlands, about 88.5% urban and 11.5% rural, plus its peculiar hydrographic conditions result in highly integrated and special uses of water. These special uses include flushing or boezems, control of water levels, and protection against salt-water intrusion. The pattern of land use in 1986 was: arable and permanent crops 24.3%, permanent pasture 29.7%, forest and woodland 8%, other land 29% and inland water 9%. The Netherlands has one of the most extensive systems of navigable waterways in the world, consisting of a maze of the major rivers and canals. Water pollution is obviously a major problem of the country. In particular, the fishing sector provides 4 000 jobs, the fishing trade 7 000 and the supply sectors 2 000, as does the miscellaneous group (such as the retail trade).

### 2.2.4.3. Aquaculture

Aquaculture to provide food from inland waters is a minor industry in the Netherlands. Several species of fish are cultivated in the Netherlands but the most of their production is used to stock waters for the benefit of anglers.

In culturing fish in the Netherlands, ponds, raceways (for trout), glass houses, recirculation systems and cages utilising power plant effluent have all been used. The total aquaculture production of the Netherlands was quite variable between 1988 and 1997. The Netherlands is one of the main mussels and eel producer countries in Europe (*Figure 73*). From 1988 to 1990 it expanded from 79 163 metric tons to 100 997 metric tons, but in 1991 it touched bottom with 51 648 metric tons. Nevertheless, in 1994 the total aquaculture production of the Netherlands reached a record with 109 379 metric tons, but it decreased until 1997 and was 98 210 metric tons (*Table 32, Figure 72*). The main cultured species was the Blue mussel in the Netherlands, its production was 93 244 in 1997. The aquaculture production of European eel is also important in the Netherlands, it expanded between 1988 and 1997, from 200 metric tons to 2 443 metric tons. Other relevant cultured species are the oysters and the North African catfish with about 1 200 metric tons for both species in 1997.

**Table 32 Aquaculture production in the Netherlands**

Quantity (metric tons), Value (million US\$)

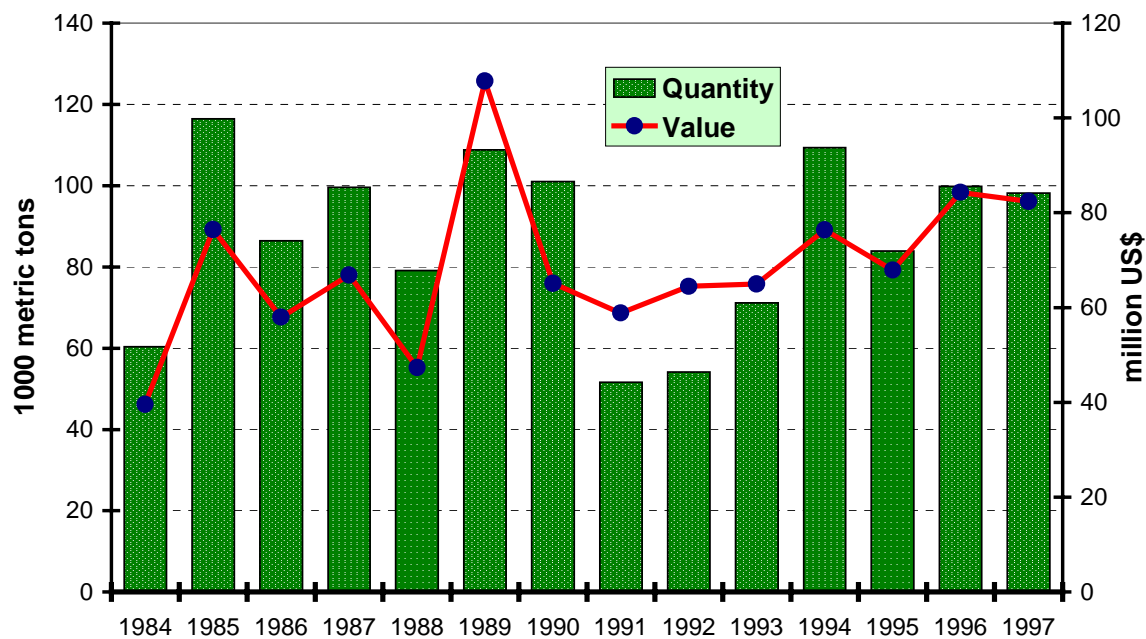
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	79163	108877	100997	51648	54105	71125	109379	83938	99871	98210
Value	47.3	107.8	65.2	58.9	64.5	65.0	76.4	67.9	84.4	82.4

Reference: FAO, *FishStat Plus 1999*

The mussel sector is presently very healthy, but many essential production factors (like seed supply, water quality, etc.) are not controlled. Environmental issues hamper further growth of mussel culture. The oyster sector has big problems with the same environmental restrictions, but faces high losses due to diseases as well. The diseases *Bonamiasis* almost completely wiped out the entire oyster culture during the eighties.

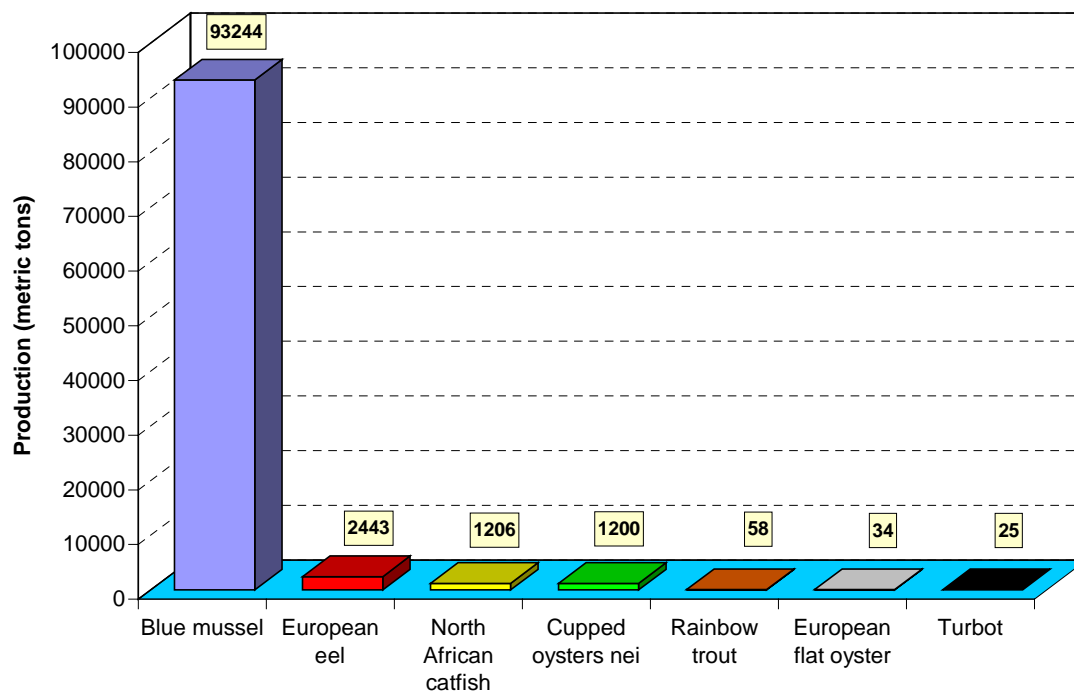
In the freshwater sector, after some difficult starting years in the eighties, recirculation fish farming has matured rapidly. The national and European government were very supportive in setting up a complete infrastructure for the fast developments, which followed in recirculated aquaculture in Holland. The sector is increasingly well organised, with a good level of co-operation between government and producers.





**Figure 72** Volume and value of aquaculture production in the Netherlands

Reference: FAO, FishStat Plus 1999



**Figure 73** Aquaculture production by species in the Netherlands (1997)

Reference: FAO, FishStat Plus 1999

Eel farming is presently (in middle term period) the most profitable and has a perspective future. It is expected that the production can at least be doubled in the next decade. North African catfish farming did very well from the biological point of view, however, low market prices and the need for high, new investments to cope with waste water regulations, lead to low profitability. New species such as turbot, sea bass and sea bream are presently being commercially tested on production scale.

The fisheries sector in the Netherlands is going through a period of fundamental structural change. This is required mainly because of scarcity of resources in Community waters and increased competition for markets.

In 1990, under the Community structural aid for fisheries, a large scale, intensive eel farm equipped with the latest technology in the field of aquaculture was created. The innovative water-recycling system enables the water consumption to be reduced to a minimum and, at the same time avoids the release into the environment of polluting effluents. The cultivation process is largely automated, and the production capacity of the farm reaches 500 metric tons per year.

#### *2.2.4.4. Administration and management*

The administration of all fisheries in the Netherlands rests with the Ministry of Agriculture, Nature Management and Fisheries. There are four national organisations of sport and professional fishermen: Dutch Union of Associations of Sportfishermen (NVVS), Central Dutch Organisation of Sportfishermen (CNHV), Association of Freshwater Professional Fishermen and Association of Fishermen on Lake IJssel and Adjacent Lakes.

Licenses are obtained through the local governments. There are big regional differences in the amount pollution tax charged. This stresses the importance of selecting the right location for a new fish farm, but is also a threat for the feasibility of some existing farm, which need to invest heavily in purification units.

### 2.2.5. Luxembourg<sup>4</sup>



<i>Area:</i>	2 586 km <sup>2</sup>
<i>Population:</i>	395 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	4,2 km <sup>2</sup>
<i>Rivers, stream:</i>	1 330 km
<i>GDP/capita<sup>1997</sup>:</i>	27 073 US\$

**Map 25** Luxembourg

#### 2.2.5.1. Hydrography

Luxembourg has about 1 330 km of streams. There are no natural lakes in Luxembourg. Only one reservoir in Luxembourg has any great for fishing, with 380 ha area. There are also about 120 ponds with a total surface area about 45 ha.

#### 2.2.5.2. Land and water use

Luxembourg is considered to be 83% urban and 17% rural. The pattern of land use in 1980 was the following: arable and permanent crops 22%, permanent pasture 27%, forest and woodland 32% and built-on, “waste” is 19%.

#### 2.2.5.3. Aquaculture

Aquaculture in the sense of raising fish for direct consumption is not practised in Luxembourg. The relative absence of static water precludes the establishment of either commercial fisheries or great increase in recreational fisheries. Despite the absence of a coastline, and thus of a fishing fleet, Luxembourg participates in the measures financed by the Financial Instrument for Fisheries Guidance that relate to the development of aquaculture and the processing and marketing of products.

Land-based aquaculture is a new sector currently being organised in the national economy, which seems to be promising; it concerns the whole country. Until 1991, the aquaculture branch in Luxembourg consisted in only two firms in the private sector, importing and distributing trout for the restaurant trade and angling, and one public sector establishment

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<sup>4</sup> The FAO statistic (FAO, FishStat Plus 1999) does not contain the aquaculture production data.

whose sole activity was the production of salmonids from native stock to repopulate rivers, lakes, ponds etc. Covered by the legislation on angling. The establishment, in 1991, of an intensive closed-circuit aquaculture plant in southern Luxembourg changed this situation. The main activity of the plant, which came on stream in 1992, is large-scale production of eels and elvers, with the production of carp, tilapia, sturgeon, catfish and ornamental fish as a sideline. Aquaculture in Luxembourg is characterised by slow but steady growth in output. However, its development will depend on finding Luxembourg's special niche, and in occupying it on the European market.

#### 2.2.5.4. Administration and management

The Ministry of Agriculture, Viticulture and Waters and Forests is responsible for the administration of inland fisheries in Luxembourg. There is also a High Council for Fisheries, a consultative body concerned with the conservation and protection of fisheries in co-operation with the Luxembourg Federation of Sport Fishermen.

#### 2.2.6. Belgium



<i>Area:</i>	30 528 km <sup>2</sup>
<i>Population:</i>	10 068 000
<i>Active population:</i>	4 183 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	126
<i>Coastline:</i>	64 km
<i>Lakes:</i>	360 km <sup>2</sup>
<i>Rivers:</i>	26 600 km
<i>GDP/capita<sup>1997</sup>:</i>	21 991 US\$

**Map 26 Belgium**

##### 2.2.6.1. Hydrography

The total area of Belgium's inland waters aside from artificial fish ponds has been estimated as constituting about 25 900 ha (0.85% of the country's total area) composed of 24 000 ha of rivers and canals and 1 900 ha of artificial reservoirs. The total length of Belgium's rivers is about 26 600 km. Belgium has no natural lakes, although some of its reservoirs are called lakes. There are about 12 500 artificial fish ponds in Belgium totalling about 9 400 ha in area.

### 2.2.6.2. Land and water use

Belgium is considered to be about 97% urban, its small-farm intensive agriculture furnishes about 90% of its country's needs. The pattern of land use in 1986 was: arable and permanent crops 24.3%, permanent pasture 21.1%, forest and woodland 21%, other land 32.7% and inland water 0.84%. There is an active sea fishery but no commercial fishing for freshwater fish in Belgium. Recreational use of Belgium's inland waters is very high.

### 2.2.6.3. Aquaculture

Some aquaculture for trout and warmwater fishes, and angling for coarse fishes in lowland waters and salmonids in upland streams represent Belgium's inland fishery. Although the aquaculture production in Belgium is only small in quantity, it has increased between 1988 and 1997. While in 1988 it was 700 metric tons, in 1997 it has reached the 846 metric tons (*Table 33, Figure 74*). The main cultured species is the rainbow trout, but its production fell from 450 metric tons in 1988 to 300 metric tons in 1997 (*Figure 75*). Trout farms in Belgium are mainly family run. Despite of this, the production of European eel increased. It was only 0.5 metric tons in 1988, and expanded for 125 metric tons in 1997. Cyprinid farming is sited in the north-eastern part of the country and includes carp and other species such as pike, roach and tench that are reared in conjunction with carp. Farmed carp is therefore destined for consumption, restocking sport fisheries and export. The production of common carp increased in Belgium, in 1988 it was only 20 metric tons, while 100 metric tons in 1997. Tilapia production was almost constant between 1988 and 1997 in Belgium, with about 200 metric tons per year.

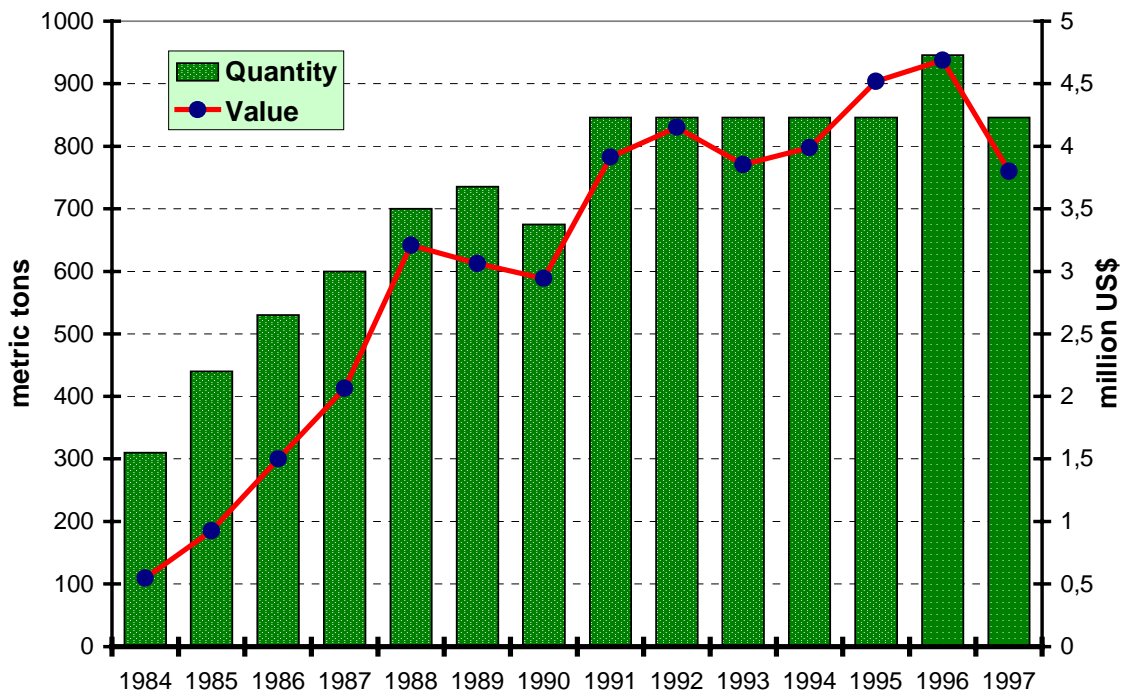
Fish ponds in Belgium are two general types: angling ponds and production ponds. Most of the ponds are fishing ponds. Some of the production ponds are run by amateur fish culturists, i.e. by anglers or angling societies who use extensive methods to raise fish to stock angling waters. The other production ponds are run by professional fish culturists who practise more intensive means of cultivation.

**Table 33 Aquaculture production in Belgium**

Quantity (metric tons), Value (million US\$)

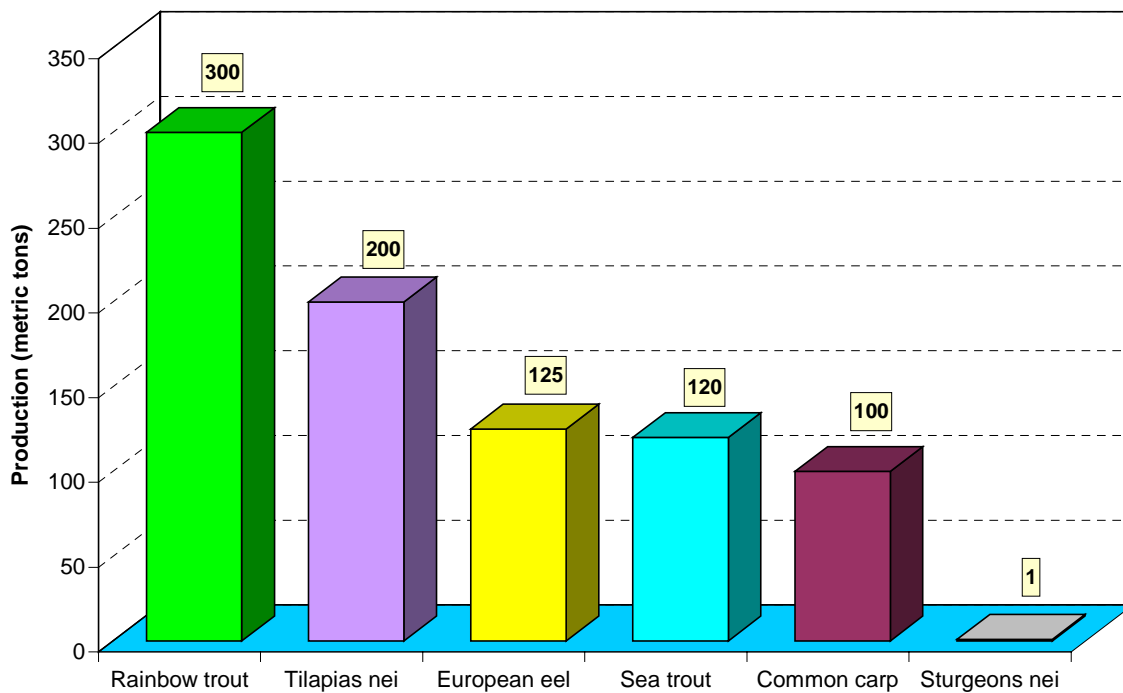
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	700	735	675	846	846	846	846	846	946	846
Value	3.2	3.1	2.9	3.9	4.2	3.9	4.0	4.5	4.7	3.8

Reference: FAO, *FishStat Plus 1999*



**Figure 74** Volume and value of aquaculture production in Belgium

Reference: FAO, FishStat Plus 1999



**Figure 75** Aquaculture production by species in Belgium (1997)

Reference: FAO, FishStat Plus 1999

There is no separate culture of pike or pike-perch in Belgium, most carp producers stock a few fingerlings of these predators in their ponds to be harvested at the end of the first second summer of growth. There are 36 production fish farms in Belgium: 22 for trout and 14 others which produce mainly carp but also species such as cichlids, tench and roach. One of the newest aquaculture developments in Belgium is the trial use of industrial heated water from nuclear power stations to rear fish. European eel has not been normally cultivated in Belgium although for some time small quantities of elvers have been captured in rivers to be restocked in other inland waters.

The total extent of inland waters in Belgium is not large, and since it consists primarily of rivers and canals cannot offer as much variety nor as productive fishing as can a country with natural lakes and reservoirs. The fish fauna is relatively diversified, although lacking in anadromous fishes, and water pollution has caused replacement of some of the more desirable and sensitive fishes by more tolerant species of less angling interest. The trout streams of Belgium lie in an area where the terrain is generally acid, therefore not very productive, and in the richer lower areas pollution has damaged water quality.

In view of the intense use of limited surface water resources, coupled with extreme and complex pollution, no development of commercial capture fisheries for food can be anticipated. Also in view of topographic and climatic conditions, neither the prospects for coastal or interior aquaculture are promising.

The fisheries sector in Belgium is going through a period of fundamental structural change. This is mainly due to scarcity of resources in Community waters and increased competition for markets. With respect to aquaculture the main point of focus is the intensive rearing of trout and carps. The limited availability of water of a suitable quality is a particular problem. It is proposed to provide scientific and technical advice and an appropriate level of financing to increase the production of fish and shellfish through aquaculture in order to ensure a regular supply and high quality of these species on the market.

#### *2.2.6.4. Administration and management*

The three Regional Administrations are responsible for the administration of inland fisheries in Belgium. In addition to these administrations, there are the following. The Fishery Funds controlled by the Administrations, which are used to restock inland waters, enforce protective laws, and improve the fishery in general. Provincial Fishery

Commissions, one for each of Belgium's nine provinces. A Central Committee, which controls and co-ordinates the activities of the Provincial Fishery Commissions and submits propositions for the use of the Fishery Funds.

### 2.2.7. Germany



<i>Area:</i>	357 733 km <sup>2</sup>
<i>Population:</i>	81 275 000
<i>Active population:</i>	38 961 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	3 675
<i>Coastline:</i>	2 389 km
<i>Lakes:</i>	196 km <sup>2</sup>
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	27 770 US\$

**Map 27**      **Germany**

Within the Federal Republic of Germany, the streams range from great rivers to small mountain brooks, and the lakes, but generally speaking the country is deficient in standing waters. The discharge of effluent and the manifold uses of its resources of surface waters have played a heavy toll on several of its formerly extensive inland fisheries. Although the freshwater commercial capture fishery has declined severely, aquaculture especially for trout has made decided strides in both quantity and quality of production. Meanwhile as in most European countries, recreational fishing is assuming a greater importance.

#### 2.2.7.1. Hydrography

Germany has about 4 600 km<sup>2</sup> of inland water, which equals about 1.8% of the area of the country. The total pond area is 19 637 ha.

#### 2.2.7.2. Land and water use

The economy of Germany is about 86% urban and 14% rural, but agriculture remains an important use of the land, mainly on small family and mixed farms. Germany is one of the most highly industrialised countries in the world. The pattern of land use in 1986 was: arable and permanent crops 30%, permanent pasture 18.3%, forest and woodland 29.5%, other land 20.5% and inland water 1.7%. The commercial inland fisheries have declined as



the waters have deteriorated, but aquaculture, a traditional occupation in Germany, is continuing in importance, as is the use of inland waters for sport fishing.

### 2.2.7.3. Aquaculture

The total aquaculture production of Germany declined between 1988 and 1997, from 72 005 metric tons to 59 433 metric tons (*Table 34, Figure 76*). Germany is one of the main salmon, mussels and carp producer countries in Europe. The two principal fishes cultivated for food in Germany are rainbow trout (about 22 528 metric tons in 1997) and common carp (about 12 000 metric tons in 1997). Others are: brown trout, European eel, tench, pike and pike-perch. Although some trout farms use concrete raceways, most of the trout are still produced in earthen ponds using running water. There is also some cage culture in Germany, usually in gravel pits with cages. Although the most domesticated trout in Germany are rainbow trout, brown trout and other salmonids are used to restock fishing waters. The production of the desired size of carp generally takes three years as compared to only two years in more southern countries. Furthermore, many carp farms in Germany are very extensive with little fertilisation or artificial feeding, they still carry out the old traditional “natural” cultivation. European eel is a very popular fish in Germany, but water temperatures are generally too cold for good growth. Attempts have been made to culture them using warm water from electric plants.

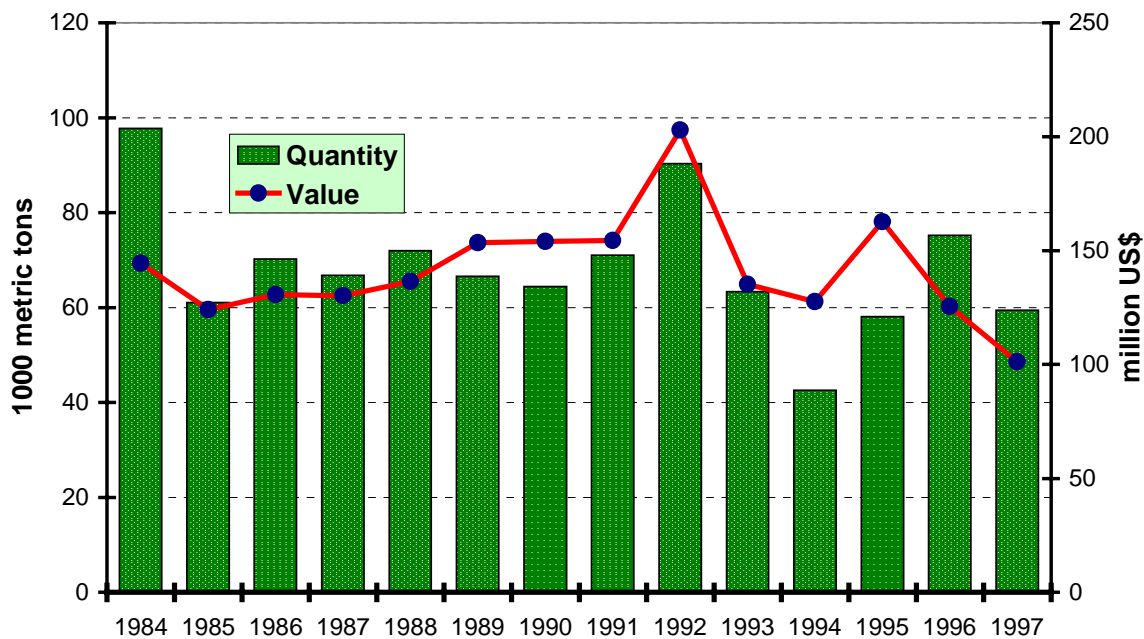
The aquaculture production of Blue mussel decreased between 1988 and 1997, from 29 725 metric tons to 22 330 metric tons (*Figure 77*). Sea trout production was about 2 000 - 2500 metric tons per year in the past decade.

**Table 34 Aquaculture production in Germany**

Quantity (metric tons), Value (million US\$)

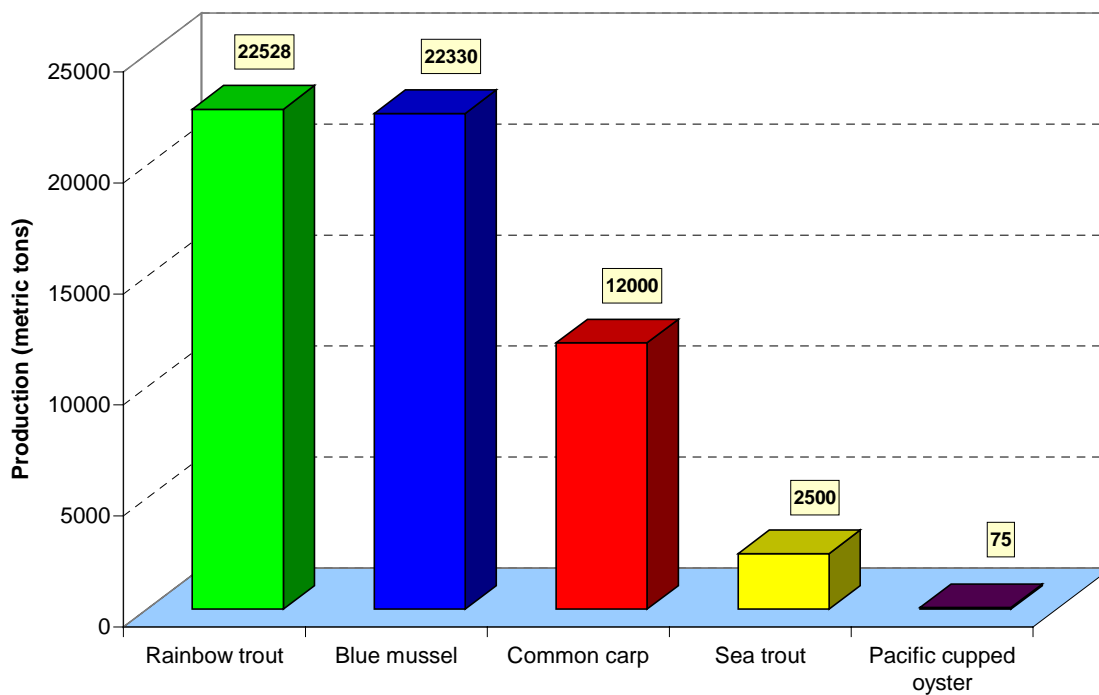
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	72005	66618	64435	71033	90349	63364	42552	58096	75237	59433
<b>Value</b>	136.4	153.5	154.1	154.6	202.9	135.2	127.6	162.7	125.5	101.2

Reference: FAO, *FishStat Plus 1999*



**Figure 76** Volume and value of aquaculture production in Germany

Reference: FAO, FishStat Plus 1999



**Figure 77** Aquaculture production by species in Germany (1997)

Reference: FAO, FishStat Plus 1999

Aquaculture has long been traditional in Germany and its growth can be expected, especially with modernisation in the trout industry and in eel production. The use of warm water to produce fish is increasing as are efforts to develop closed systems using both fresh and seawater. The fishing industry is in a state of perpetual adjustment. The sector's response to the present crisis, to the scarcity of resources in Community waters and to intense competition both within Europe and globally, must address a number of issues.

The majority of aquaculture products are marketed live or fresh. A third of the trout are sold smoked. There is an overall market tendency towards processed products. The majority of farms have established local or regional markets, which are composed of whole sale, restaurant and retail market at about equal shares. Direct marketing appears to be a life line especially for the smaller farms. In order to satisfy demand, German markets depend on imports. While there is normally no difficulty in selling domestic production, prices are too low due to "cheap" imports from EU member states, currently, in order of importance, Denmark, Spain, Italy and France.

#### 2.2.7.4. Administration and management

The Federal Ministry of Food, Agriculture and Forestry, Under-department Fishery Politics is responsible in the field of freshwater fisheries only in matters of inter-territorial importance. Sport fishing clubs may have regulations in addition to those of the State. Many of the anglers are organised into societies, which provide fishing possibilities not only for their members, but to non-members to whom licences are sold. Sport fishing receives governmental approval as a healthful activity, which contributes to the economy and aids in the protection of the aquatic environment.

#### 2.2.8. Austria



<i>Area:</i>	83 859 km <sup>2</sup>
<i>Population:</i>	7 796 000
<i>Active population:</i>	3 842 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	421
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	500 km <sup>2</sup>
<i>Rivers:</i>	100 000 km
<i>GDP/capita<sup>1997</sup>:</i>	23 616 US\$

**Map 28**      **Austria**

Austria dominated by the Eastern Alps and the Danube drainage, is threaded by swift mountain streams and has a complement of large and beautiful Alpine lakes. Good care of forests and water has a long tradition in Austria, but effluents from ever-increasing industry and more intensive agricultural practices have created severe pollution problems in some areas. Of late years, there has been a moderate growth in aquaculture, especially of trout, but a decrease in commercial fishing, almost completely confined to lakes. Sport fishing for cold water species continues to be the dominant aspect of Austria's inland fisheries.

#### *2.2.8.1. Hydrography*

On the whole, Austria has abundant surface water resources. 1 120 km<sup>2</sup> or 1.3% of the country's area is covered by inland waters. This data does not include the myriad of small streams and lakelets in the mountains. The total area of Austria's natural lakes is about 500 km<sup>2</sup>. The total area of ponds in Austria is about 3 500 ha. In 1978 there were about 2 550 ha of carp ponds in Austria. There are about 88 lakes in addition to two large international lakes. In 1977 Austria had 59 Alpine reservoirs with a total area of 6 212 ha. The total length of Austria's rivers is about 100 000 km.

#### *2.2.8.2. Land and water use*

The population of Austria is about 42% rural and about 45% of the land is devoted to agriculture on small farms. The pattern of land use in 1986 was: arable and permanent crops 18%, permanent pasture 23.7%, forest and woodland 38.5%, other land 18.5% and inland water 1.3%. The use of surface water in Austria, except to regulate rivers and their ports, is practically limited to industrial purposes. Otherwise, the water supply is mostly ground or springs water with which the country is liberally and widely supplied. Karst water is found over one-sixth of the total area. The aquaculture sector in Austria employs about 800 people, including 500 part-time workers. Most businesses are family firms, both in aquaculture and in lake fishing.

#### *2.2.8.3. Aquaculture*

The total aquaculture production of Austria decreased from 4 500 metric tons in 1988 to 3 021 metric tons in 1997 (*Table 35, Figure 78*). The major fishes cultivated in Austria are rainbow trout and common carp. Carp production declined almost its third between 1988

(1 300 metric tons) and 1997 (540 metric tons). Carp production is centred in the North and Southeast. Trout production has decreased, it was 3 200 metric tons in 1988, while it was 2 160 metric tons in 1997 (*Figure 79*). Trout are produced primarily in central and western Austria in raceways and ponds. Net-cage culture is not significant in Austria.

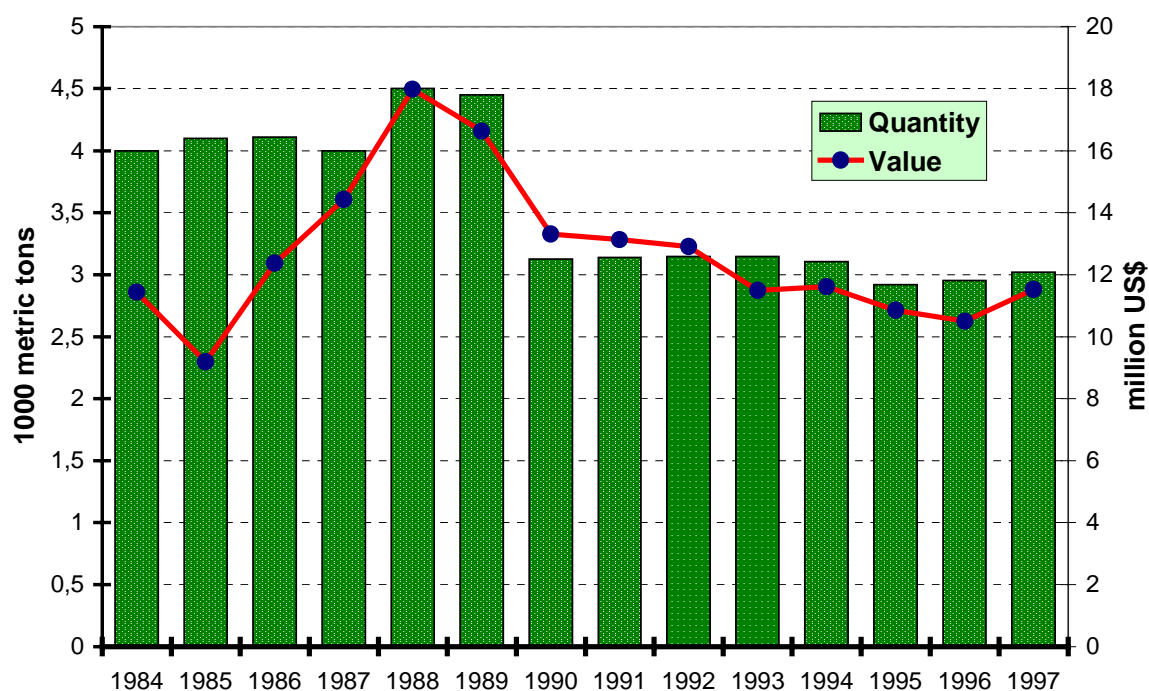
**Table 35 Aquaculture production in Austria**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	4500	4450	3126	3140	3145	3145	3106	2921	2952	3021
<b>Value</b>	18.0	16.6	13.3	13.1	12.9	11.5	11.6	10.9	10.5	11.5

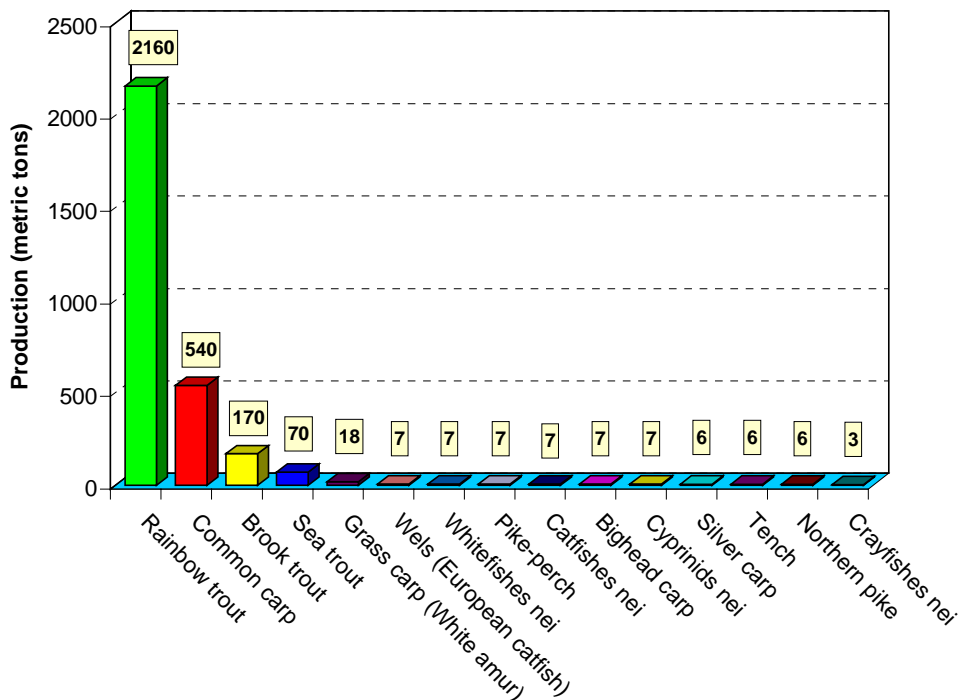
Reference: FAO, FishStat Plus 1999

Almost one third of the trout production enters the market processed, mainly fresh (60%), smoked (30%) and filleted (7-8%). Two thirds are sold live. Carps are mainly marketed as live fish. Buyers are made up of fish farmers and recreational fisheries (restocking); and wholesale, restaurant and farm gate retail (table fish).



**Figure 78 Volume and value of aquaculture production in Austria**

Reference: FAO, FishStat Plus 1999



**Figure 79 Aquaculture production by species in Austria (1997)**

Reference: FAO, *FishStat Plus 1999*

Austria is well supplied with an abundance of mountain lakes and streams ensuring a variety of fishing, especially for cold-water species. Such waters do not have the high yields of warmer, more fertile waters but do produce “quality” fishing. The water pollution has become increasingly severe with the growth of intensive aquaculture and industrialisation, has affected a considerable portion of the fishery. Carp culture is hampered by the relatively small area of the country suitable for its maintenance and the climatic conditions, which generally require three years for fish to grow to a desirable size. Trout culture, although continuing to be small scale, with slow growth when using cold water and sometimes limited water supplies, has better opportunities for expansion. In fact, in recent years it has expanded through use of water of good quality from new dams and pumped supply. General traditions of good land and water use are among the most important factors contributing to preservation of the Austrian fisheries. Management of the fisheries varies considerably throughout the country because of the strong sense of individualism in the provinces. A moderate growth in aquaculture should continue, especially for trout, for which there is a good market. Carp farming has a lower profitability but will be maintained since there is little other use for its ponds.

In the aquaculture of Austria, the production of juveniles is just as important as production for direct consumption. A large proportion of salmon-farmers and some pond-farmers sell between 30% and 50% of their output at the juvenile stage.

Despite a long tradition of fish farming, the sector has been to some extent marginalised in Austria. It has not had as much administrative and technical support as other branches.

#### 2.2.8.4. Administration and management

Fishing in Austria is mostly controlled by private individuals or fishing associations. Austrian fisheries fall within the competence of the Ministry for Agriculture and Forestry. The ministry does not have a separate fishery office, but includes this work within a section dealing with animal husbandry. The actual administration of fisheries is handled by the nine semi-autonomous governments, which keep in touch with the Federal Ministry. The different provincial governments are usually responsible for fishery legislation. Most of the provinces have their own fishery organisations, autonomous administrative units prescribed by law and responsible for fishery administration and promotion for the province. In addition, there is an Austrian Fisheries Corporation, encompassing the entire country and concerned with the promotion of Austrian fisheries, which consists of fisheries organisations, co-operatives, scientific institutes etc.

#### 2.2.9. Switzerland



<i>Area:</i>	41 293 km <sup>2</sup>
<i>Population:</i>	6 908 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	1 415 km <sup>2</sup>
<i>Rivers:</i>	30 000 km
<i>GDP/capita<sup>1993</sup>:</i>	36 410 US\$

**Map 29**      **Switzerland**

### 2.2.9.1. Hydrography

The total inland water area of Switzerland is 1 520 km<sup>2</sup> or 3.7% of the country's total area. The total lake area in Switzerland including reservoirs is listed at 1 415.58 km<sup>2</sup> by Switzerland, Bundesamt für Statistik. The area of the lakes is 141 558 ha and the rivers is 11 128 ha. Switzerland's rivers have a total length of about 30 000 km.

### 2.2.9.2. Land and water use

Switzerland is considered to be about 60% urban and 40% rural. The pattern of land use in 1986 was: arable and permanent crops 9.9%, permanent pasture 39%, forests and woodlands 25.5%, other land 21.9% and inland water 3.7%. There has been a considerable regulation of both rivers and lakes for flood control and to avoid sedimentation and erosion. About two-thirds of the public water supply comes from underground water with which Switzerland is well provided.

### 2.2.9.3. Aquaculture

In Switzerland, the total aquaculture production increased between 1988 and 1997, from 254 metric tons to 1 150 metric tons (*Table 36, Figure 80*). The principal species of fish cultivated commercially in Switzerland are rainbow trout, its aquaculture production was 1 115 metric tons in 1997. After trout spawning they are usually reared in concrete tanks, and then placed in earthen ponds or concrete raceways. Pelletised food is used. In addition to commercial trout culture, there is a limited production for food of common carp with its production of 35 metric tons in 1997. Following spawning in the spring, the fry are reared in earthen ponds with little feeding. It requires three or four years to attain the market size.

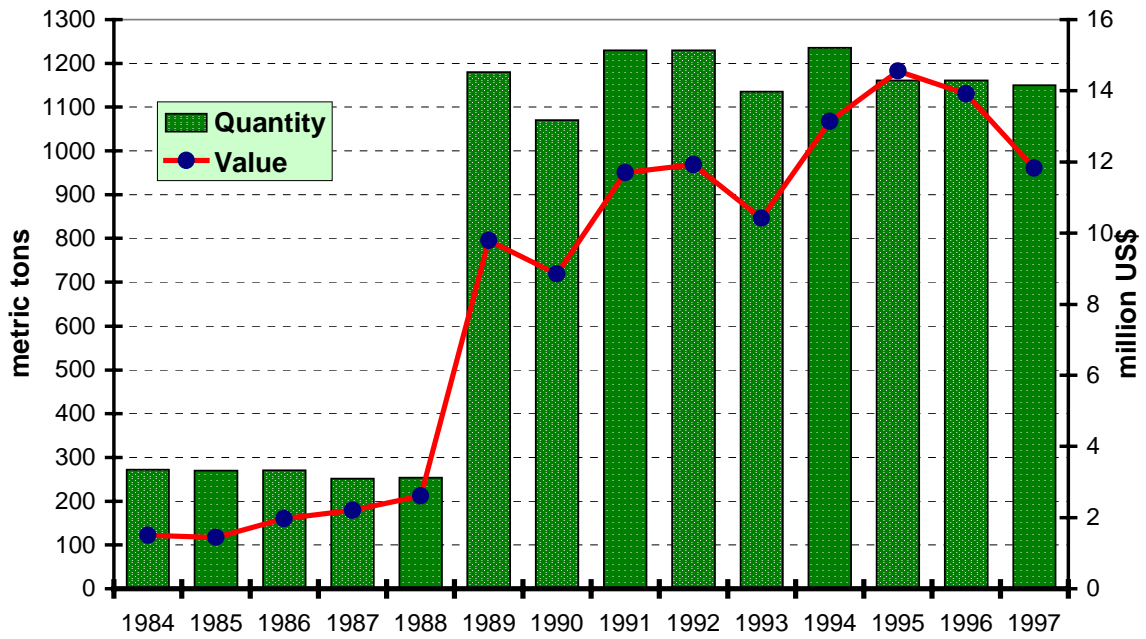
**Table 36 Aquaculture production in Switzerland**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	254	1180	1070	1230	1230	1135	1235	1161	1161	1150
Value	2.6	9.8	8.9	11.7	11.9	10.4	13.1	14.6	13.9	11.8

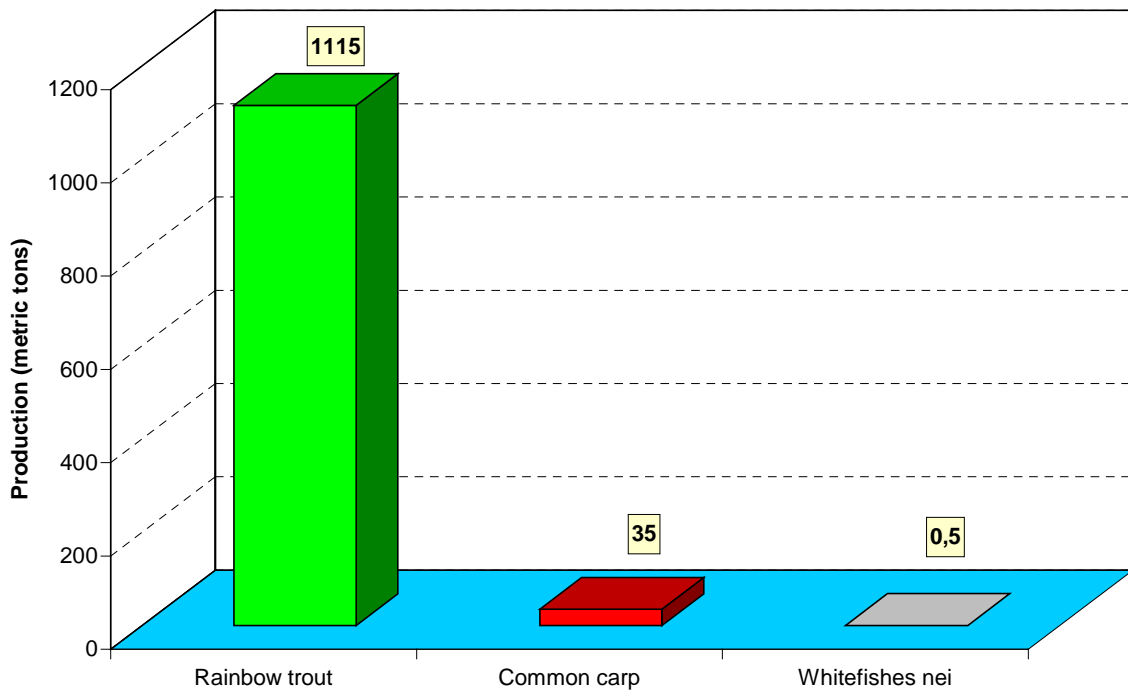
Reference: FAO, *FishStat Plus 1999*





**Figure 80** Volume and value of aquaculture production in Switzerland

Reference: FAO, FishStat Plus 1999



**Figure 81** Aquaculture production by species in Switzerland (1997)

Reference: FAO, FishStat Plus 1999

The yield of aquaculture is not great. Lack of good sites, including the high cost of land, and the well-established system of importing trout hinder its development. Both aquaculture and capture fisheries will continue to be minor elements in this small country devoted as it is to manufacturing, tourism and services.

#### *2.2.9.4. Administration and management*

The department of Interior is the competent Federal authority with respect to Swiss fisheries. Within this administration, fisheries is handled by the Federal Office for the Protection of the Environment, more particularly by the latter's Office of Fishery Inspection which is responsible for much of the Federal work in this sphere. The cantonal departments in charge of fisheries set up fishery inspectors within their administration. There is a Service Chief for each canton. The Swiss Association of Professional Fishermen is the leading association of commercial fishermen. Sport fishing in Switzerland is regulated by two large organisations: Swiss Federation of Fishing and Fish Culture, and Swiss Association of Sports Fishermen.

### **2.3. Southern Europe<sup>5</sup> (Mediterranean region)**



**Map 30 Southern Europe**

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<sup>5</sup> **Southern Europe:** Spain, Portugal, Italy, Malta, Yugoslavia FR, Croatia, Slovenia, Macedonia, Albania, Greece.

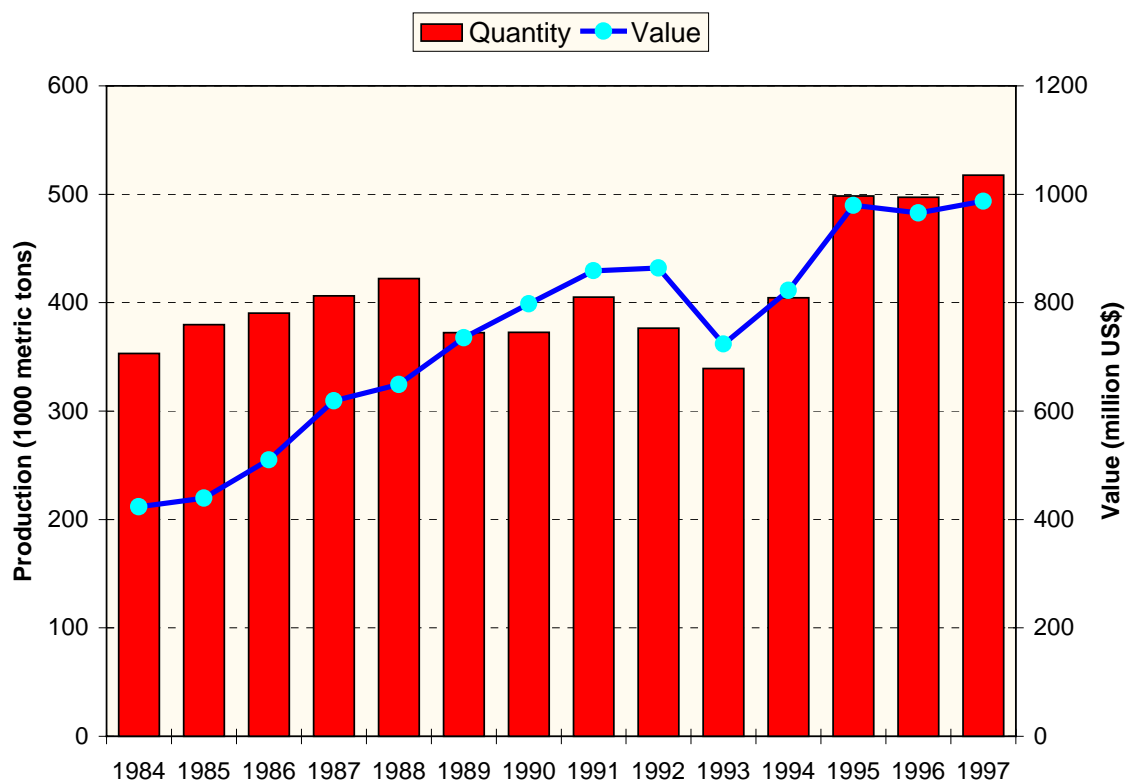
The aquaculture production in Southern Europe is increasing from 1984 up to now except the years of 1992 and 1993 (*Table 37, Figures 82, 83*). The most important finfish species are the rainbow trout and the sea bass and bream in commercial production and also in the recreational fishery sector.

**Table 37 Aquaculture production in Southern Europe**

Quantity (1000 metric tons), Value (million US\$)

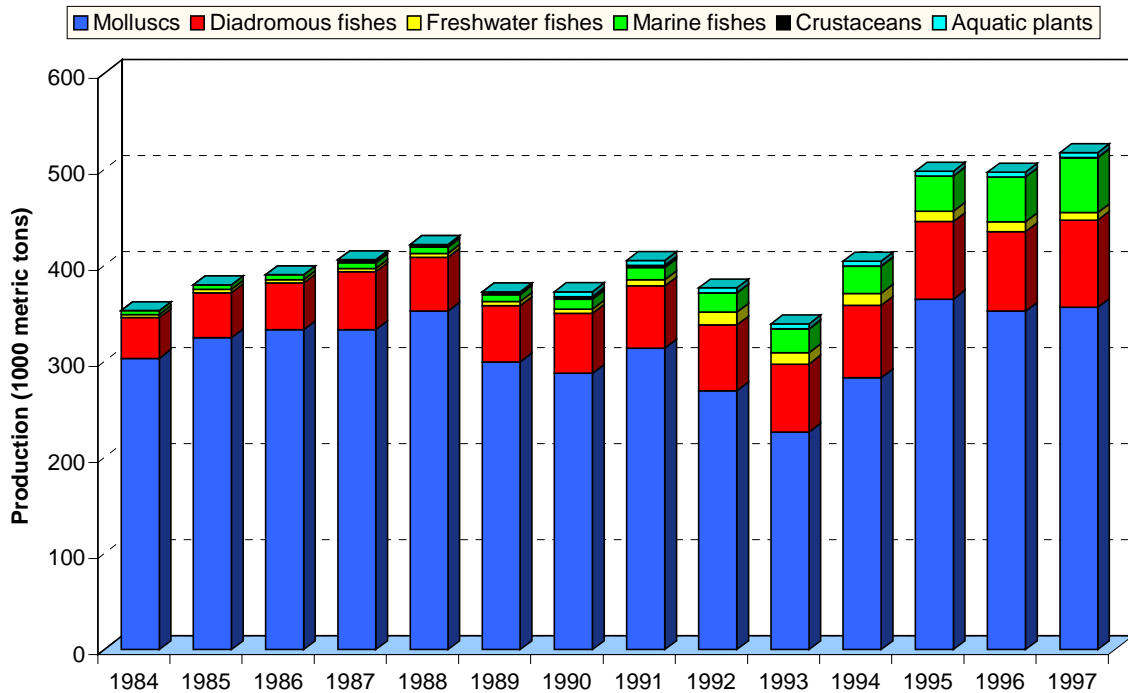
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	421.96	372.49	372.60	405.12	376.55	339.12	404.46	498.37	497.38	517.43
<b>Value</b>	649.39	735.26	797.36	859.18	863.77	723.67	822.54	979.32	965.25	987.14

Reference: FAO, FishStat Plus 1999



**Figure 82 Aquaculture production in Southern Europe**

Reference: FAO, FishStat Plus 1999



**Figure 83** Volume of aquaculture production by major species groups in Southern Europe

Reference: FAO, FishStat Plus 1999

### 2.3.1. Spain



Area:	504 782 km <sup>2</sup>
Population:	39 332 000
Active population:	15 561 000
Employment in aquaculture <sup>1997</sup> :	13 509
Coastline:	4 964 km
Lakes:	180 km <sup>2</sup>
Rivers:	72 000 km
GDP/capita <sup>1997</sup> :	14 745 US\$

**Map 31** Spain

Trout aquaculture has increased of late, promotion of its inland sport fisheries for both warm- and cold-water fishes continues, and efforts are being made to improve its brackishwater production through intensive aquaculture.

### *2.3.1.1. Hydrography*

The total inland water area of Spain is only 5 340 km<sup>2</sup> or 1.06% of the country's total area. The predominant inland waters are rivers and their man-made lakes and reservoirs. Spain is reported to have about 1 800 rivers and streams, and there are about 72 000 km of permanent rivers. Spain has 4 000 lakes with a freshwater area of 18 000 ha, and brackishwater area of 65 000 ha. There are about 700 reservoirs on the rivers.

### *2.3.1.2. Land and water use*

Spain is about 78% urban and 22% rural. The pattern of land use in 1986 was: arable and permanent crops 40.5%, permanent pasture 20.4%, forests and woodlands 31%, other land 7.1% and inland water 1.06%. Irrigation has a long history in Spain, and is given priority by law over use of water for hydropower. Water is used extensively for the production of hydroelectric power, a principal source of energy in Spain. Industry is the second largest consumer of water, using about one-third of the supply. Public water supply ranks third in use of water. Including full-time and part-time jobs, it is estimated that aquaculture provides jobs for about 30 000 people in Spain.

### *2.3.1.3. Aquaculture*

Spain has one of the most important aquaculture in Europe. It was 271 403 metric tons in 1988 and 239 236 metric tons in 1997, although it touched the bottom in 1993 with the production of 126 130 metric tons (*Table 38, Figures 84, 85*). The main cultured species is the Blue mussel with its 188 793 metric tons produced quantity in 1997. Spain is one of the major salmon, mussels, oysters, clams and basses producer European countries.

The Spanish lagoon fisheries are primarily capture fisheries, although the construction of barrages to permit the assembly of fry and descent of adults may be considered a primitive type of aquaculture. There have also been attempts to convert old salt pans to the pond culture of euryhaline fishes.

Extensive polyculture has been practised in Spain: gilthead, sea bass, eel, sole and grey mullets. The aquaculture production of gilthead seabream increased significantly, from 160 metric tons in 1988 to 3 969 metric tons in 1997. There is some culture of tench. Eel culture is carried out with eels raised in tanks. There has also been some experimental

culture of Atlantic salmon (851 metric tons in 1997), produced in fresh water to be grown out in saltwater pens, and culture of Coho salmon. There is also a small crayfish farming industry in Spain.

Intensive culture of fish for food in Spain is concentrated on rainbow trout, and has been strongly developed only since 1965. The aquaculture production of rainbow trout increased between 1988 and 1997, from 17 000 to 29 000 metric tons (*Table 39*). Most of the Spanish trout farms are in the northern part of the country and both spring and river water are used. The trout are grown out in concrete raceways or earthen ponds. There are some specialised manufacturers of fish feeding and aquaculture equipment.

The sea fisheries and even marine aquaculture, especially for mussels, have been more important than freshwater fishing or fish culture in Spain. The production of oysters was 3 387 metric tons in 1997. Only the culture of rainbow trout has increased decidedly in the last years. The aquaculture production of rainbow trout increased from 17 500 metric tons in 1988 to 29 000 metric tons in 1997.

**Table 38 Aquaculture production in Spain**

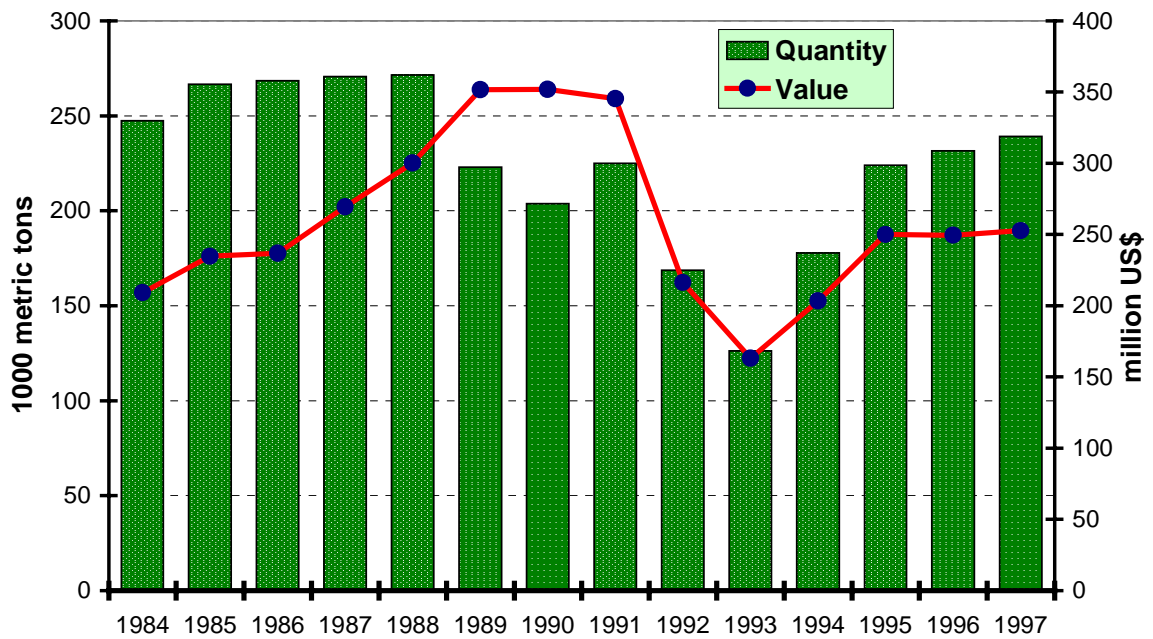
Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	271403	222924	203766	224971	168759	126130	177940	223965	231633	239236
<b>Value</b>	300.19	351.77	352.05	345.44	216.36	163.16	203.42	249.93	249.46	252.76

Reference: FAO, *FishStat Plus 1999*

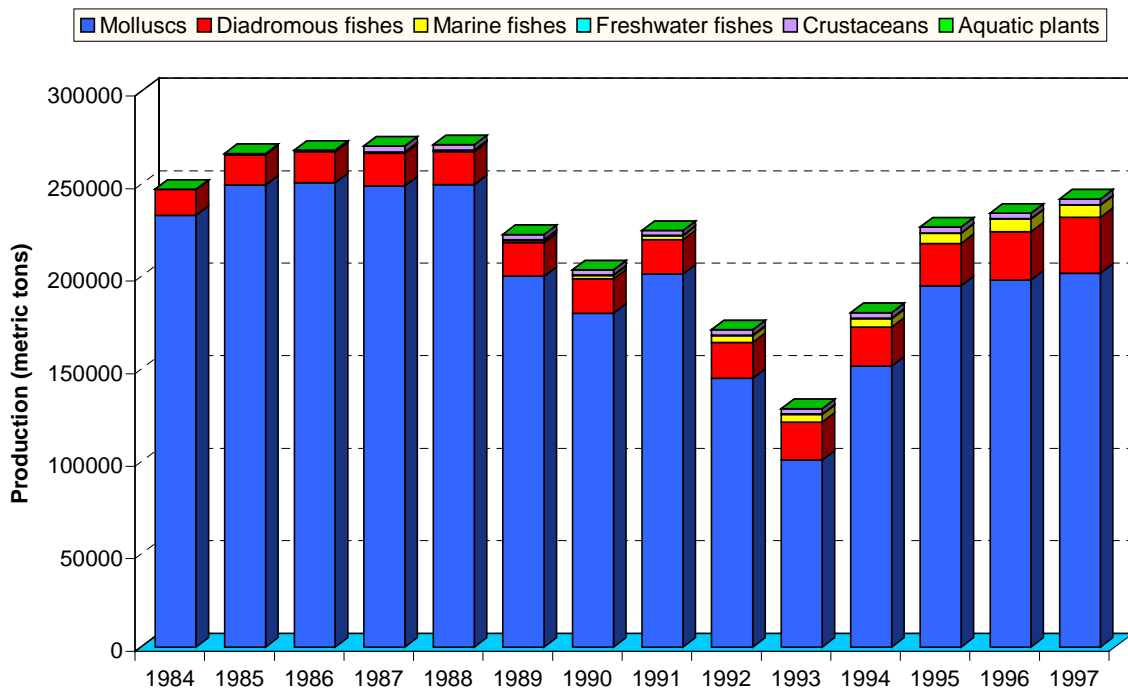
There has been a long record (eighteen's) of aquaculture in Spain, based originally on the various lagoon management practices in, which fish are trapped and held in simply managed conditions until their recapture at market size. Lagoons, especially on the Mediterranean coast, remain an important source of production. Mussels are cultured in Galicia, highly productive sheltered inlets offering ideal conditions for raft culture.

Markets for fisheries products have always been good in Spain; the country's steadily increasing prosperity, its traditional tastes and well-developed tourist industry, and the diminishing supply prospects from traditional fishery sources, have all helped to stimulate demand for aquaculture products.



**Figure 84** Volume and value of aquaculture production in Spain

Reference: FAO, FishStat Plus 1999



**Figure 85** Aquaculture production by major species groups in Spain

Reference: FAO, FishStat Plus 1999

**Table 39 Aquaculture production by species in Spain (1997)**

Species	metric tons	%	Species	metric tons	%
Blue mussel	188793	78,91	Common prawn	225	0,09
Rainbow trout	29000	12,12	Tench	215	0,09
Gilthead seabream	3969	1,66	Great Atlantic scallop	206	0,09
Common edible cockle	3770	1,58	Japanese carpet shell	140	0,06
European flat oyster	3387	1,42	Mulletts nei	170	0,07
Pullet carpet shell	3105	1,30	Northern bluefin tuna	100	0,04
Turbot	1800	0,75	Kuruma prawn	70	0,03
Grooved carpet shell	1210	0,51	Groundfishes nei	25	0,01
Clams nei	900	0,38	Common sole	18	0,01
Atlantic salmon	851	0,36	Venus clams nei	4	0,00
European seabass	511	0,21	Greater amberjack	1	0,00
Marine molluscs nei	430	0,18	Common dentex	1	0,00
European eel	335	0,14			

The Spanish fishing industry, an important sector of the country's economy is at present undergoing radical restructuring. The sector's response to the crisis situation caused by a scarcity of resources in Community waters and intense competition, both within Europe and globally must address a number of issues. For aquaculture, after a rapid increase, problems of overproduction have emerged in recent years for certain species, which has made it necessary to stabilise overall production capacity pending the emergence of a specific market niche for the output of the aquaculture sector on the market for fishery products. Freshwater culture has only limited scope for growth given the shortage of freshwater resources. Seawater finfish production is considered to have better scope for growth, in particular salmon, and the use of offshore cages may encourage such growth. Shellfish production (mainly mussels) appears to have the potential to recover somehow towards its previously high levels providing issues of environmental carrying capacity and harmful algal blooms are resolved.

#### *2.3.1.4. Administration and management*

The Ministry of Agriculture has overall responsibility for conservation and development of inland fisheries in Spain. Within this Ministry, the National Institute for the Conservation of National Resources contains several bodies concerned with inland fisheries. The Division of Renewable Natural Resources includes a National Fisheries Inspectorate and an Inland Fisheries Section.



### 2.3.2. Portugal



<i>Area:</i>	92 389 km <sup>2</sup>
<i>Population:</i>	10 467 700
<i>Active population:</i>	4 753 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	1 525
<i>Coastline:</i>	1 793 km
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	8 541 US\$

**Map 32 Portugal**

#### 2.3.2.1. Hydrography

The country's water resources are among the poorest in Europe. Its rivers are subject to great variations in flow, many are polluted, and they receive heavy use especially in their lower reaches. It is almost lacking in freshwater lakes although possessing some large brackish lagoons.

The Portugal, Instituto Nacional de Estatística indicates that the total inland water area of Portugal is only 440 km<sup>2</sup> or 0.48% of the country's total area. Portugal is generally deficient in natural freshwater lakes. There is a considerable number of impoundment in Portugal for production of hydroelectric power and to assist irrigation. There are a number of great lagoons along the coast, cut off from the sea by sandbars. Reservoirs are used both for commercial and sport fishing throughout the country and are utilised for cage culture in some northern areas.

#### 2.3.2.2. Land and water use

Portugal is only about 37% urban and 63% rural. The pattern of land use in 1986 was: arable and permanent crops 30%, permanent pasture 5.8%, forest and woodland 39.5%, other lands 24% and inland water 0.48%. There are good ground water supplies in Portugal, but river water is also used for domestic use, and supplies over 80% of all needs. With respect to overall water use, Portugal is one of the few countries in Europe where agricultural use exceeds industrial use. The importance of the fisheries industry in Portugal should not be assessed solely in terms of its contribution to the economy as a whole, but

also in terms of the cultural and social aspects, and especially of its regional and local impact in over 120 local areas where over 34 000 fishermen are concentrated.

#### *2.3.2.3. Aquaculture*

Portugal is particularly favoured by natural conditions, which suit both freshwater and marine aquaculture of a wide range of species. The freshwaters of the mountainous interior regions of the northern and central parts of the country are ideal for salmonid production during most of the year, while the warmer, and harder, waters of the many large reservoirs in the central and southern regions could be used for production of, for example, crayfish, eel, sturgeon and cyprinids.

Although much of the western coast is exposed, some large areas are well protected from the open ocean. The temperature of the clean Atlantic water is ideal for the on-growing of salmon, sea bass, turbot, sole and many other fish species, as well as molluscs such as oysters, mussels, scallops and abalone.

The southern region has unique natural condition with clean tidal water and higher temperatures than that of the West Coast. To the east, the lower, tidal reaches of the river Guadiana, the border with Spain, also provide large areas suitable for construction of ponds.

Traditionally, there is a great emphasis on oceanic fisheries, and there is high fish consumption per capita. The importance of inland fisheries, either commercially or recreationally, is minor. Aquaculture, which is not a traditional practice, is still in its formative stages. The culture of fish for food is a recent development in Portugal. The production consists of mostly rainbow trout. The fish are reared in concrete raceways, silos, or cages, and fed on pelletised food. They are sold in domestic fish markets and restaurants. It is believed that all or most of the present production is absorbed by the internal market, although some years ago, trout from some of the southern areas were sold for export. The general Direction of Forests has also sold some trout for consumption, but its primary production of trout is for stocking northern streams and reservoirs. Some farms also rear eels, with a total estimated production of about 16 metric tons in 1997. Recently, a new Atlantic salmon farm was installed, and also a new private farm, which is producing cyprinid fingerlings for ornamental purposes. Only a few lagoons or marshlands appear to

be sufficiently sheltered or otherwise possess requisite qualities for brackishwater aquaculture.

The total aquaculture production of Portugal decreased between 1988 and 1997, from 10 433 metric tons to 7 185 metric tons (*Table 39, Figure 86*). Portugal is one of the main clams and bivalves producer European countries. The main cultured species was the Grooved carpet shell with its production of 3 259 metric tons in 1997 (*Figure 87*). The gilthead seabream is also an important farmed species in Portugal. Its aquaculture production increased from 69 metric tons in 1988 to 742 metric tons in 1997. Oyster production is relevant in Portugal, it was 618 metric tons in 1997, but it reached a record in 1994 with 1 063 metric tons. The aquaculture production of rainbow trout decreased between 1988 and 1997, from 1 350 metric tons to 984 metric tons.

**Table 39 Aquaculture production in Portugal**

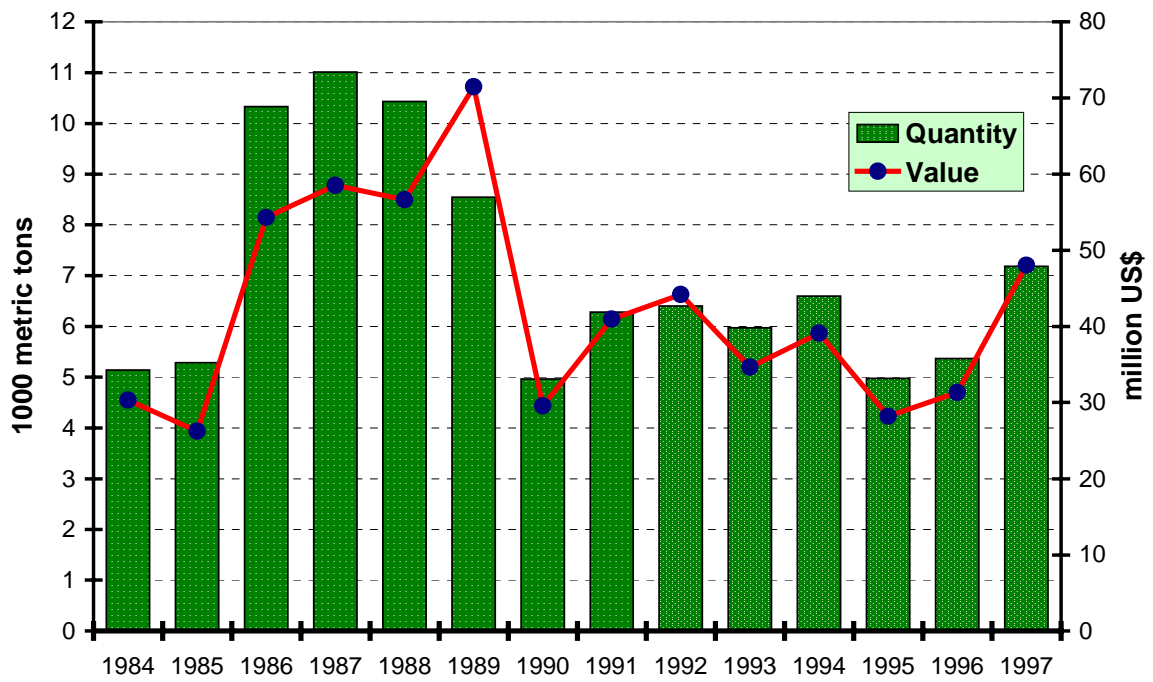
Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	10433	8549	4968	6277	6402	5971	6598	4981	5364	7185
<b>Value</b>	56.62	71.46	29.55	40.97	44.19	34.66	39.09	28.22	31.33	48.03

*Reference: FAO, FishStat Plus 1999*

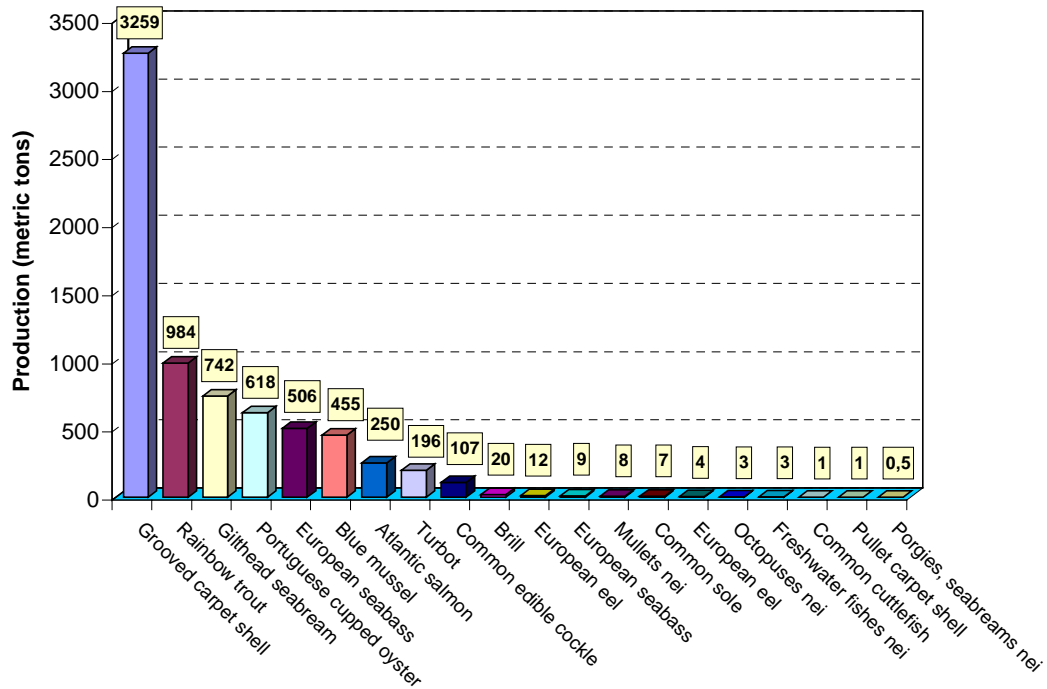
Portuguese aquaculture is still based mainly on small-scale, low technology, often family-run enterprises. For example, in a 1991 survey carried out by the General Directorate of Fisheries, information from 382 persons in the industry who responded showed that 38% consisted of owners or family workers. If temporary workers are excluded this proportion rises to 56%.

The coastal aquaculture is based on extensive production in ponds. Pond based enterprises cover typically five hectares or less, and produces small quantities of mostly low value fish, mullet predominating.



**Figure 86** Volume and value of aquaculture production in Portugal

Reference: FAO, FishStat Plus 1999



**Figure 87** Aquaculture production by species in Portugal (1997)

Reference: FAO, FishStat Plus 1999

The fisheries sector in Portugal is going through a period of fundamental structural change. The sector's response to the present crisis, to the scarcity of resources in Community waters and to intense competition both within Europe and globally, must address a number of issues.

#### 2.3.2.4. Administration and management

The Ministry of Agriculture, Fisheries and Food has overall responsibility for inland fisheries in Portugal, under the jurisdiction of the General Direction of Forests.

### 2.3.3. Italy



<i>Area:</i>	301 302 km <sup>2</sup>
<i>Population:</i>	57 517 000
<i>Active population:</i>	22 607 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	7 080
<i>Coastline:</i>	7 600 km
<i>Lakes:</i>	2 045 km <sup>2</sup>
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	21 468 US\$

**Map 33 Italy**

#### 2.3.3.1. Hydrography

Italy/EIFAC states that the total area of Italy's inland water is about 20 000 km<sup>2</sup> or 6.6% of the country's area. The area of the lakes is 2 045 km<sup>2</sup>, the reservoirs is 500 km<sup>2</sup>, lagoons is 1 500 km<sup>2</sup>. Brackishwater lagoons are characteristic of parts of the long coast. Italy has a wide variety of rivers, most of them are essentially unstable waters with great variations of flow, sometimes in spate, sometimes almost dry.

#### 2.3.3.2. Land and water use

Italy an agricultural country and it is about 32% rural. The pattern of land use in 1986 was: arable and permanent crops 40.4%, permanent pasture 16.4%, forest and woodland 22.3%, other land 18.4% and inland water 2.4%. Both commercial and sport fishing are practised widely in the inland waters of Italy. The fisheries and aquaculture sector in Italy employs 71 000 workers (44 450 in fishing, 7 000 in aquaculture, 7 900 in processing industry and 12 460 in marketing and distribution).

### 2.3.3.3. Aquaculture

The total aquaculture production of Italy expanded between 1988 and 1997, from 132 314 metric tons to 217 519 metric tons (*Table 40, Figure 88*). Italy is one of the main salmon, mussels, clams, eel and basses producer countries in Europe. The predominant cultured species was the Mediterranean mussel, with its production 85 400 metric tons in 1988 and 103 000 metric tons in 1997 (*Figure 89*). Concerning its brackishwater aquaculture, Italy has now become a major producer of cultivated rainbow trout and is expanding into other areas. The more traditional culture of brackishwater species in Italy originated centuries ago. A sophisticated version of lagoon “culture” is the Italian system of valli culture found principally on the north-western Adriatic coast. In this system fish are held in embanked or fenced lagoons or fish farms. Not only are eels reared extensively in brackish waters in Italy, they are raised intensively in fresh water, with elvers stocked in concrete tanks with circulating water and fed artificially. Warm water is also being tried, using both thermal effluent and geothermal wells. The European eel production of Italy was about 2 000 – 2 500 metric tons in the past decade. The primary aquaculture production in Italy is that of portion size rainbow trout, one of the highest productions in Europe, it was 51 000 metric tons in 1997. Use of raceways, artificial feeds and other modern methods has likewise improved Italian trout production.

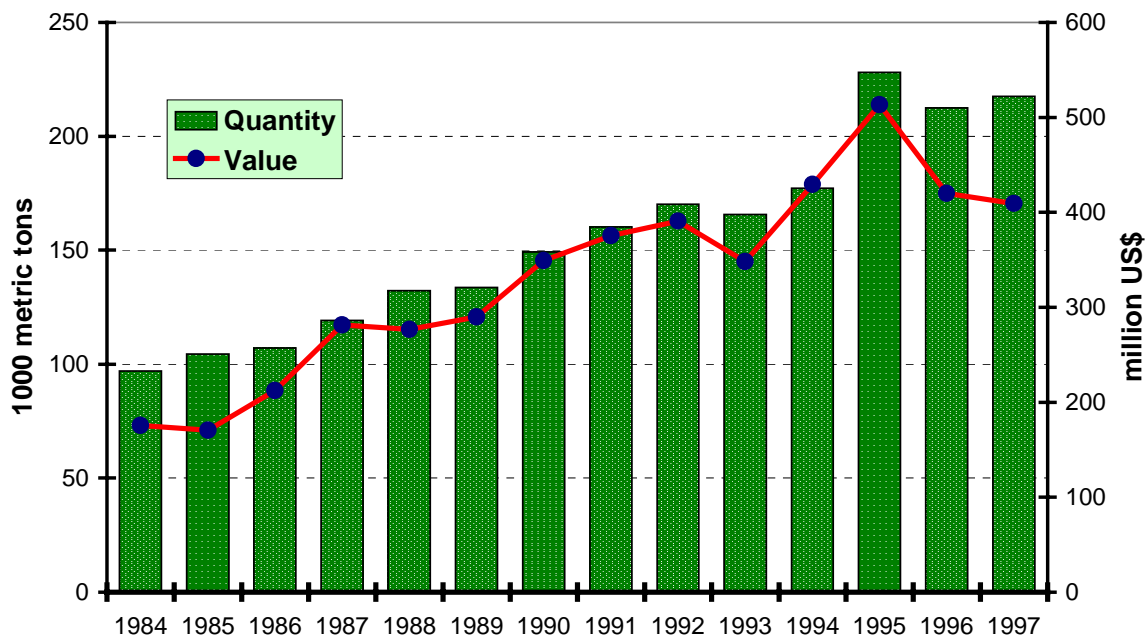
Cyprinids’ culture was introduced into Italy at the end of the Nineteenth Century in the Po Valley, where permanent rice fields and large canals already held fish populations. The common carp production of Italy was 700 metric tons in 1997. In addition to common carp, the goldfish and tench were used. Extensive use has been made of brackishwater areas for both fisheries and salt production since Roman times.

**Table 40** Aquaculture production in Italy

Quantity (metric tons), Value (million US\$)

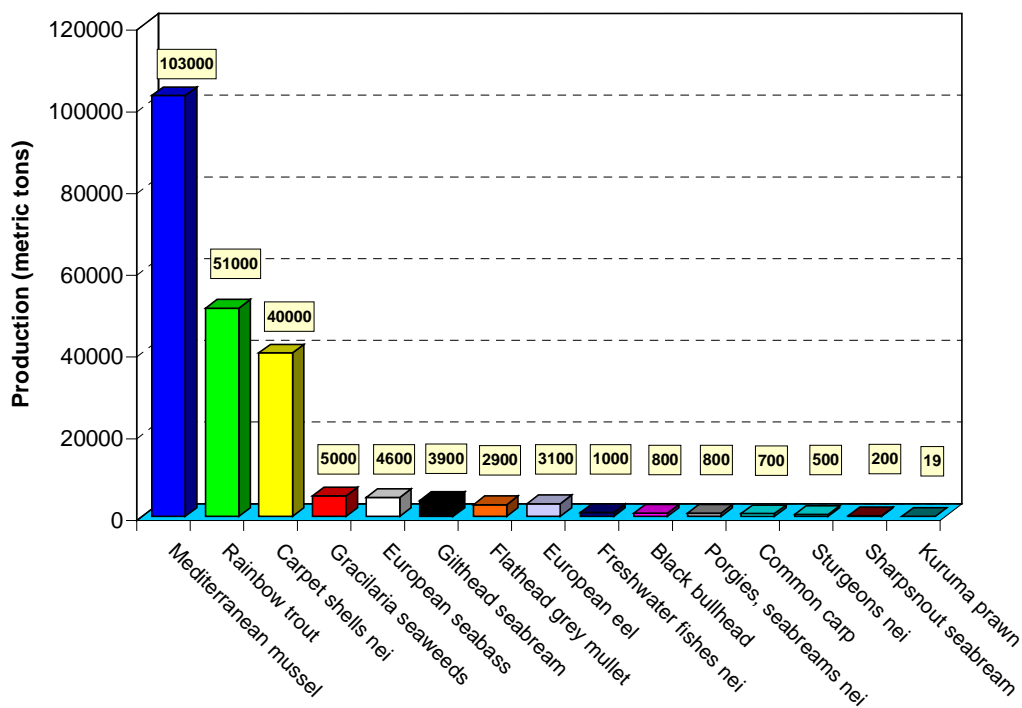
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	132314	133671	149344	160193	170177	165627	177171	228025	212373	217519
Value	276.67	289.87	349.25	375.53	390.48	348.13	429.36	513.37	419.63	409.16

Reference: FAO, *FishStat Plus 1999*



**Figure 88** Volume and value of aquaculture production in Italy

Reference: FAO, FishStat Plus 1999



**Figure 89** Aquaculture production by species in Italy (1997)

Reference: FAO, FishStat Plus 1999

The Italian fishing industry is at present undergoing radical restructuring. The main causes of the crisis are declining resources in Community waters, and keener international competition. Faced with this situation, all those involved in the sector are encouraged to respond through incisive, effective and coherent measures.

Structural measures in favour of fisheries in Italy in the previous programming period led to a number of achievements. Among the most significant were the projects to enhance productivity in the brackish lagoons of Veneto (“Valli”); the projects not only enabled biological life to be maintained in a degraded environment, between land and sea, but also reinforced local aquaculture through the creation of rearing ponds, wintering channels, fishing facilities and restocking ponds to enable breeding of fish.

#### 2.3.3.4. Administration and management

The Ministry of Agriculture and Forestry, through its Agricultural Production Office, has overall responsibility on a national level for fisheries in inland waters and a central institute of research for hydrobiology and fisheries. The Italian Federation of Sport Fishermen has its own provincial offices. There are other associations of sport fishermen.

#### 2.3.4. Malta



<i>Area:</i>	316 km <sup>2</sup>
<i>Population:</i>	362 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	140 km
<i>Lakes:</i>	0 km <sup>2</sup>
<i>Rivers:</i>	0 km
<i>GDP/capita<sup>1993</sup>:</i>	7 300 US\$

**Map 34** Malta

##### 2.3.4.1. Hydrography

There are no lakes or permanent streams in Malta, but there are some deeply cut valleys, and about nine seasonal creeks.



### 2.3.4.2. Land and water use

The population is about 87% urban and 13% rural. About 41% of Malta is arable or devoted to permanent crops, the rest is considered built-on or unproductive.

### 2.3.4.3. Aquaculture

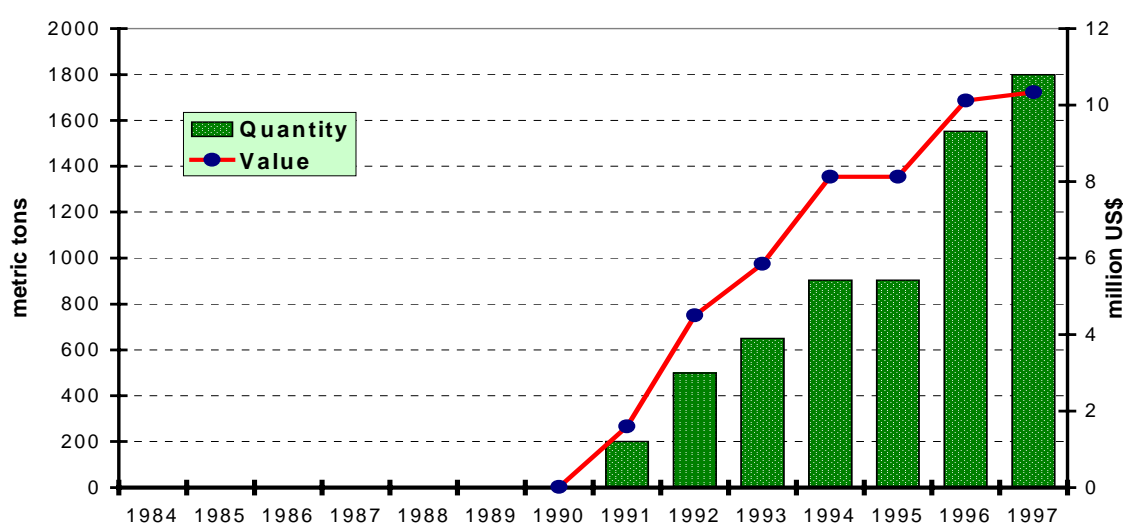
The aquaculture production of Malta increased significantly between 1991 and 1997, from 200 metric tons to 1 800 metric tons (*Table 41, Figure 90*). The main cultured species are the European seabass and the Gilthead seabream. The production of both species expanded rapidly. The produced quantity of European seabass was 150 metric tons in 1991 and 720 metric tons in 1997. The aquaculture production of Gilthead seabream increased between 1991 and 1997, from 50 metric tons to 1 080 metric tons. Although there exists little possibility of freshwater aquaculture, the future potential in the culture of flatfish as well as sea basses and sea breams is promising, owing to favourable marine water temperatures and the accessibility of a number of inshore areas suitable for cage, ranch, or tank culture. Mollusc cultivation is also believed to have some potential.

**Table 41 Aquaculture production in Malta**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	0	0	3	200	500	650	904	904	1552	1800
<b>Value</b>	0.00	0.00	0.02	1.60	4.50	5.85	8.13	8.13	10.12	10.34

Reference: FAO, FishStat Plus 1999



**Figure 90 Volume and value of aquaculture production in Malta**

Reference: FAO, FishStat Plus 1999

#### 2.3.4.4. Administration and management

Malta has a Fisheries Department, but its work seems to be confined almost entirely to marine fisheries.

#### 2.3.5. Yugoslavia SFR<sup>6</sup>, Yugoslavia FR



<i>Area:</i>	102 173 km <sup>2</sup>
<i>Population:</i>	10 482 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	199 km
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1998</sup>:</i>	1 138 US\$

**Map 35**      **Yugoslavia FR**

##### 2.3.5.1. Aquaculture

The total aquaculture production of Yugoslavia FR expanded between 1992 and 1997, from 1 352 to 1 807 metric tons (*Tables 42, 43, Figures 91, 92*). Although carp farms represent the commonest form of aquaculture in Yugoslavia, an increasing percentage of the fish reared in these farms are species other than common carp. The common carp is still, however, the principal fish cultivated, but the Chinese carps, the bighead, grass carp and silver carp have been constantly gaining importance. The aquaculture production of common carp increased from 1 350 metric tons in 1992 to 1 800 metric tons in 1997 (*Figures 93,94*). Tench, wels and pike-perch are also cultivated, but only in a minimal level.

The dominant part of carp production in Yugoslavia is from controlled reproduction in modern hatcheries, using hypophyisation, artificial spawning, and incubation of eggs and larvae. Higher stocking densities, intensive feeding, aeration, genetic selection, disease control, and improved pond management including polyculture, are other factors, which have improved warm-water aquaculture.

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<sup>6</sup> Data of aquaculture production is not available from Bosnia Herzegovina.

Trout culture is devoted mainly to the production of rainbow trout in fresh water. Trout farmers in Yugoslavia have relied on artificial feeding for some years and have gradually installed modern methods. Aside from commercial culture, salmonids are reared to stock open waters for sport fishing.

In some coastal waters of Yugoslavia opportunities also exist for brackishwater aquaculture for finfish.

**Table 42 Aquaculture production in Yugoslavia SFR**

Quantity (metric tons), Value (million US\$)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
<b>Quantity</b>	11617	11086	11647	11524	11867	11888	12990	6751	-	-
<b>Value</b>	27.29	27.04	28.82	28.14	28.87	33.13	35.12	18.42	-	-

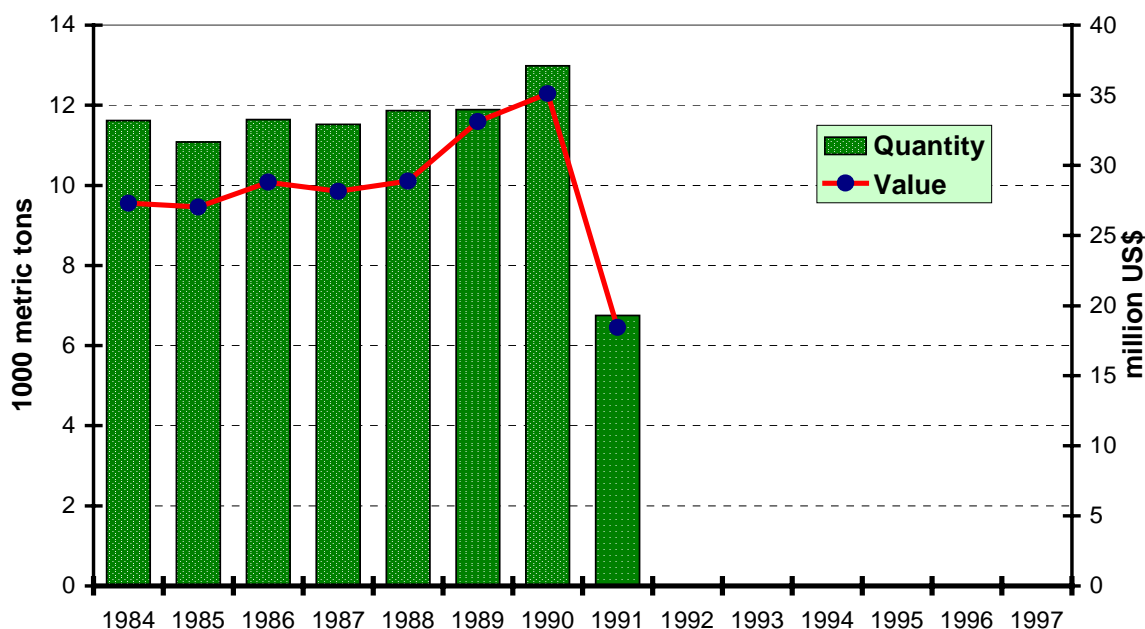
Reference: FAO, FishStat Plus 1999

**Table 43 Aquaculture production in Yugoslavia FR**

Quantity (metric tons), Value (million US\$)

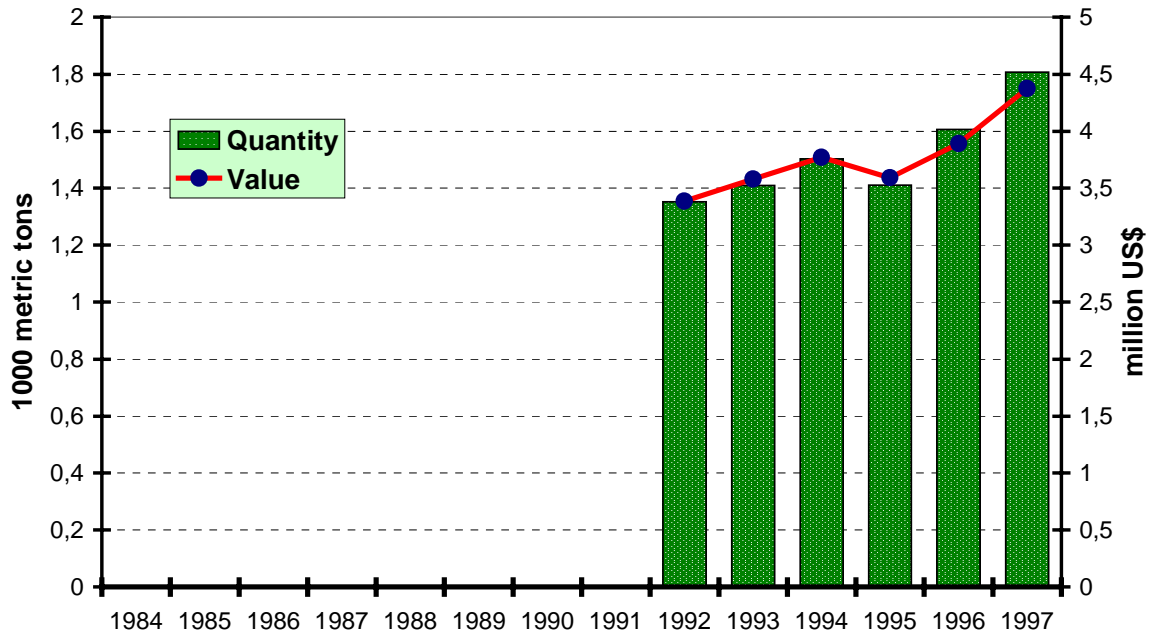
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	1352	1409	1503	1410	1606	1807
<b>Value</b>	-	-	-	-	3.39	3.58	3.77	3.59	3.89	4.37

Reference: FAO, FishStat Plus 1999



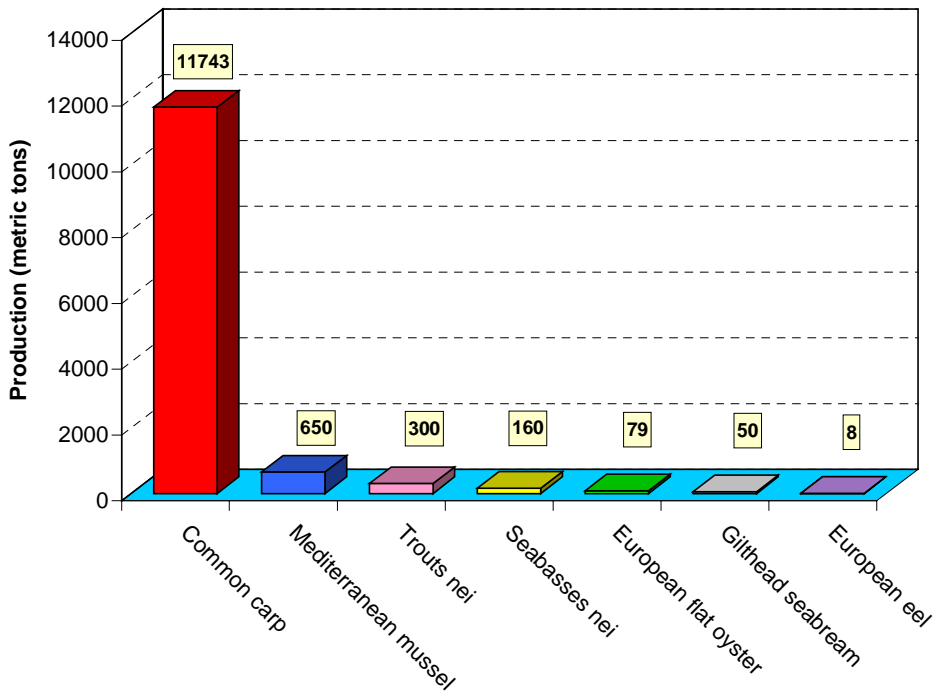
**Figure 91 Volume and value of aquaculture production in Yugoslavia SFR**

Reference: FAO, FishStat Plus 1999



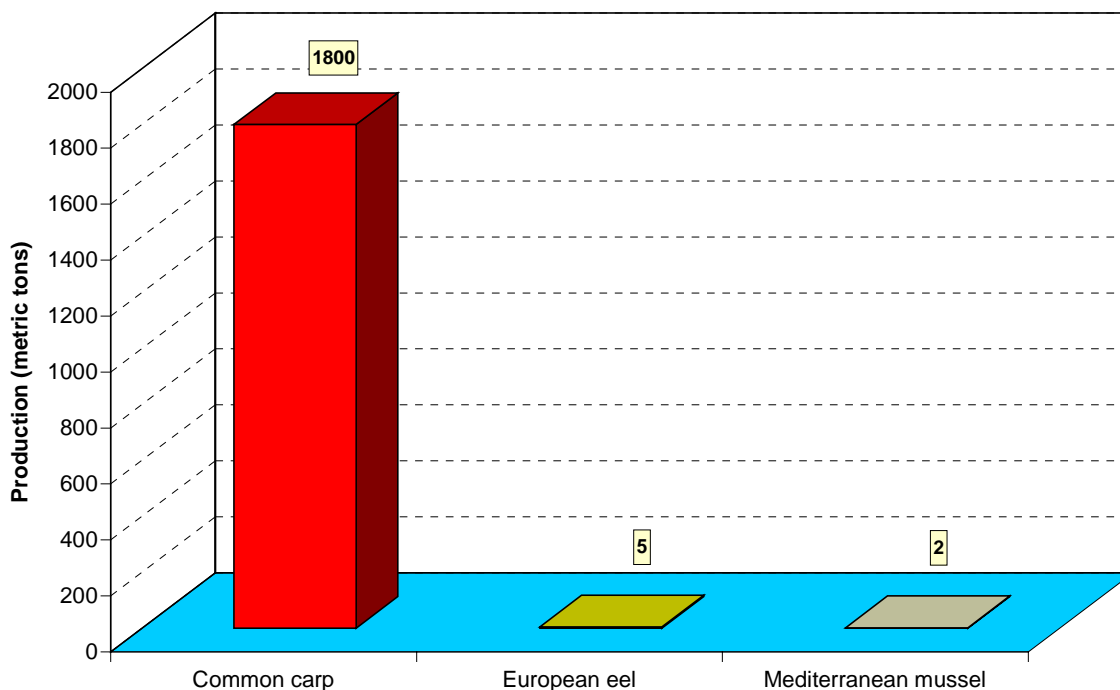
**Figure 92** Volume and value of aquaculture production in Yugoslavia FR

Reference: FAO, FishStat Plus 1999



**Figure 93** Aquaculture production by species in Yugoslavia SFR (1990)

Reference: FAO, FishStat Plus 1999



**Figure 94** Aquaculture production by species in Yugoslavia FR (1997)

Reference: FAO, FishStat Plus 1999

### 2.3.6. Croatia



<i>Area:</i>	56 538 km <sup>2</sup>
<i>Population:</i>	4 784 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	5 790 km
<i>Lakes:</i>	105 km <sup>2</sup>
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	4 610 US\$

**Map 36** Croatia

Croatia is a newly independent state, but with a national tradition in fishing dating back more than a millennium.

#### 2.3.6.1. Hydrography

There are several natural and artificial lakes in Croatia, covering an area of 10 531 ha. As carp aquaculture has been developing in northern Croatia during the twentieth century, carp ponds cover an area of 13 100 ha, which is more than that of the lakes.

### 2.3.6.2. Aquaculture

Marine and freshwater fishing is an important segment of Croatia's economy. Aquaculture production badly needs financial assistance or investment capital in order to aid the expansion of the otherwise well-organised production system. Economic reforms in Croatia maybe will bring better times for fishing and aquaculture alike, because this sector has survived the ravages of the wars. The current situation in the Croatian fishing industry is best illustrated by the fact that the country is now using about 30% of its biological marine and freshwater resources. This fact also reveals Croatia's tremendous potential for growth and rehabilitation, in virtually any area of the fishing and aquaculture industries.

Aquaculture is an important segment of the national fishing industry, illustrated by the fact that Croatia has a millennium-old tradition of shellfish farming. The country also has a century-old tradition of carp farming, it was among the first in the world to start farming sea bass and gilthead bream artificially, and, more recently, began fattening tuna and many other species, freshwater and marine alike.

At present aquaculture in Croatia is at its lowest level ever. Between 1992 and 1997, it has declined from 6 809 metric tons to 3 517 metric tons (*Table 44, Figure 95*). This is primarily a result of the devastation created by the war and the country's economic isolation that resulted from it, as well as the traditional post-communist changes in the countries of Central and Eastern Europe.

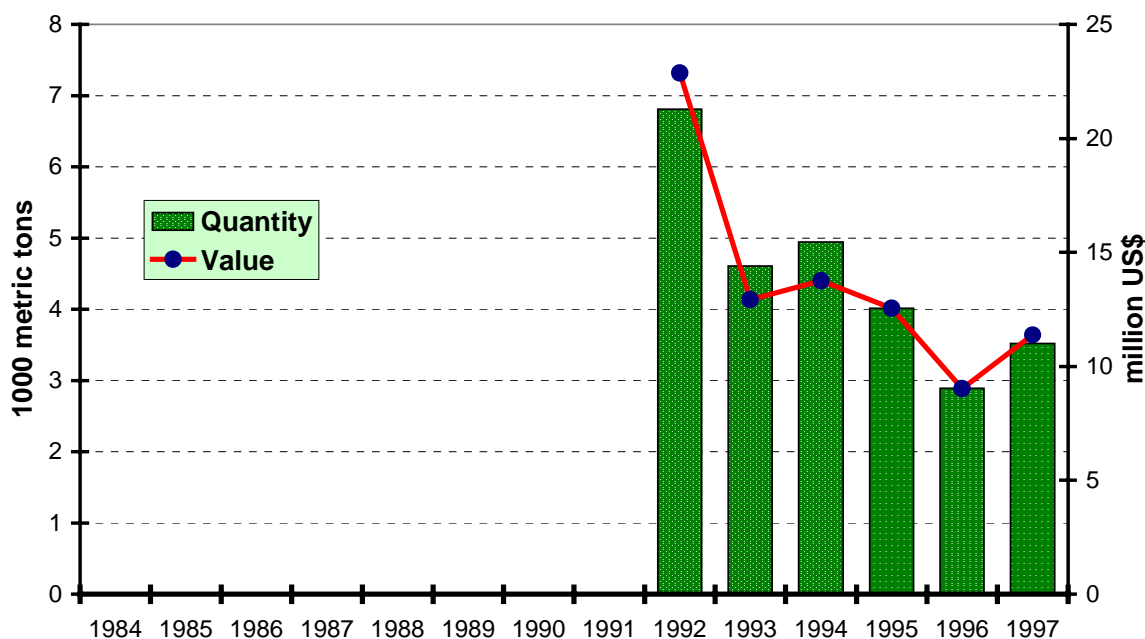
Being a Mediterranean country, with more than 1 000 km of continental coastline, Croatia has always focused on using its marine resources. The first records of marine cultivation date back to ancient times, when fish and shellfish were kept in man-made structures placed in the sea due to a lack of preservation methods. Mediterranean mussel is cultivated about 300 - 400 metric tons per year. Domestic oysters are traditionally cultivated in several places along the Adriatic coast, its production is only about 30 - 40 metric tons annually. In the late sixties state-owned institutes started research projects to develop high-profit marine species. As a result several new commercial companies were founded, setting up the production of fish fry and cultivating it to commercial size in floating cage farms. From that period on a major innovation was the controlled spawning of sea bass and gilthead sea bream. The aquaculture production of sea bass is about 300 - 400 metric tons per year, and also in the production of rainbow trout there are the same quantities. A very recent development in fish culture has been tuna fishing and fattening in off-shore cages.

**Table 44 Aquaculture production in Croatia**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	6809	4608	4946	4014	2895	3517
<b>Value</b>	-	-	-	-	22.88	12.93	13.75	12.55	9.02	11.37

Reference: FAO, FishStat Plus 1999

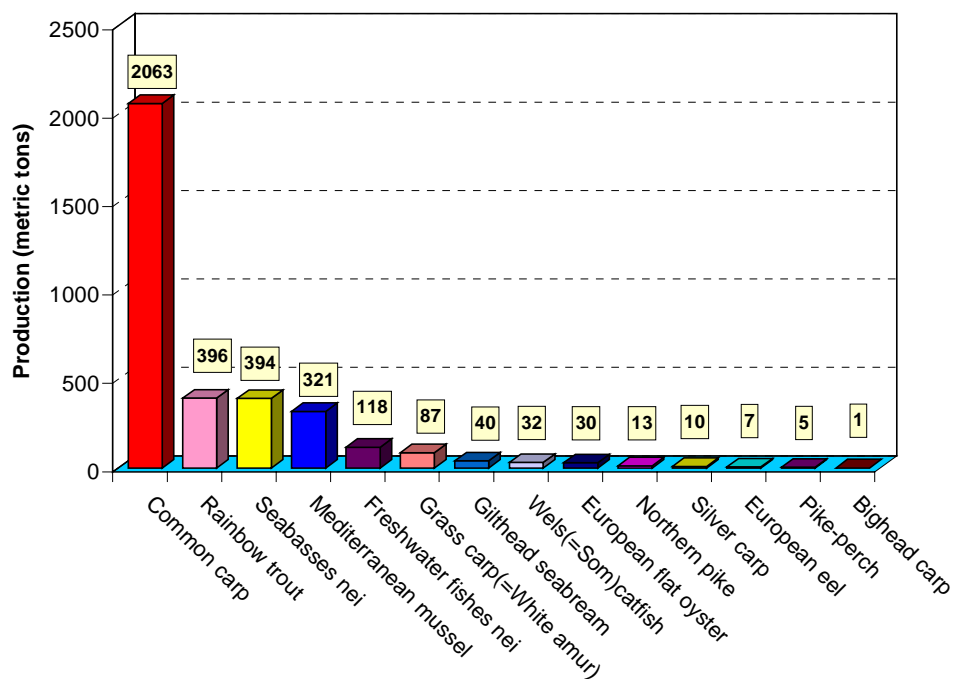


**Figure 95 Volume and value of aquaculture production in Croatia**

Reference: FAO, FishStat Plus 1999

There are three types of aquaculture in Croatia, carp trout and cage cultivation. As the last one only occurs occasionally in some open waters it is neither widespread nor permanent. Carp aquaculture is still by far the most important type of freshwater fish cultivation in Croatia, although the production of common carp decreased from 5 049 metric tons in 1992 to 2 063 metric tons in 1997 (*Figure 96*). It is traditionally undertaken on large farms that cover several hundred or sometimes even more than a thousand hectares. Traditionally production was semi intensive, with fertilisation, liming and additional feeding, primarily with maize, undertaken. Economic changes in the nineties directed production towards more extensive methods. Many farms have their own hatcheries where they produce the necessary fry.

Since 1990 the former state-run farms have been privatised. The owners protect their interests through the Aquaculture Section of the Chamber of Commerce. In large organisations many fish farms were merged into the rest of agricultural production. Privatisation segregated them into small independent companies.



**Figure 96** Aquaculture production by species in Croatia (1997)

Reference: FAO, FishStat Plus 1999

### 2.3.6.3. Administration and management

The marine and freshwater fisheries are administered by the Ministry of Agriculture and Forestry, Directorate of Fisheries. Various anglers' societies together register about 40 000 members.

### 2.3.7. Slovenia



Area:	20 253 km <sup>2</sup>
Population:	1 989 000
Active population:	
Employment in aquaculture <sup>1997</sup> :	
Coastline:	46.6 km
Lakes:	
Rivers:	
GDP/capita <sup>1997</sup> :	9 161 US\$

**Map 37** Slovenia



Slovenia gained independence in 1991 from the former Yugoslavia.

#### 2.3.7.1. Hydrography, land and water use

Ponds used for cold-water aquaculture: 114 536 m<sup>2</sup> of mainly the upper reaches of the rivers. The surface for warmwater aquaculture: 4 067 000. The total length of the marine coast is 46.6 km.

#### 2.3.7.2. Aquaculture

Slovene fisheries comprise two sectors: marine and freshwater, considered to be independent. Both sectors include fishing and aquaculture, and the marine fishery covers industrial production as well. Freshwater fishing takes place in rivers, streams, lakes and ponds. Marine fishing is carried out in the North Adriatic Sea, in the territorial waters of the Republic of Slovenia and in international waters. Marine culture is limited to inshore areas.

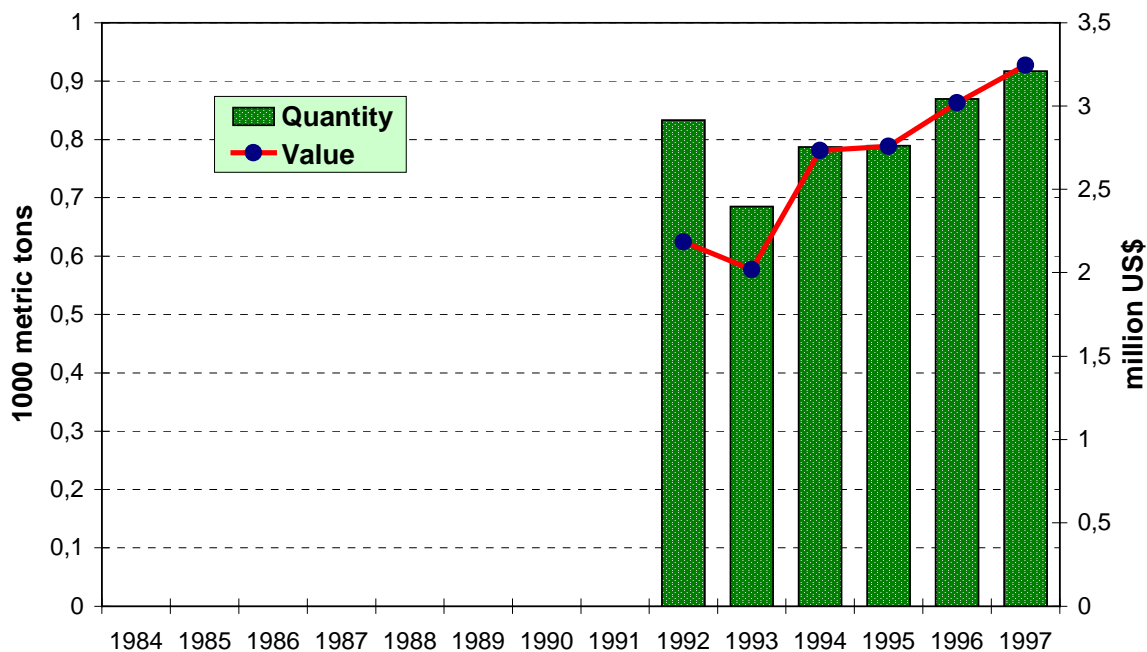
The total aquaculture production of Slovenia was about 800 - 900 metric tons between 1992 and 1997 (*Table 45, Figure 97*). In the two last decades there was a significant development in marine culture: the farming of the Mediterranean mussel and, more recently, the farming of European sea bass and gilthead sea bream. The aquaculture production of the Mediterranean mussel was 37 metric tons, of the European seabass was 29 metric tons and of the gilthead seabream was 61 metric tons in 1997. The main cultured species in Slovenia is the rainbow trout with its production of about 520 metric tons. The aquaculture production of common carp is also quite relevant in Slovenia, with its quantity of 173 metric tons in 1997 (*Figure 98*). Fish-farming production is still developing, but in the long term it is hindered by the limitations of the sea area available. Mediterranean mussel production is also on the decline. Aquaculture production is still developing, while mussel production is decreasing. The policy on marine culture, especially fish-farming, is to support development and expansion.

**Table 45 Aquaculture production in Slovenia**

Quantity (metric tons), Value (million US\$)

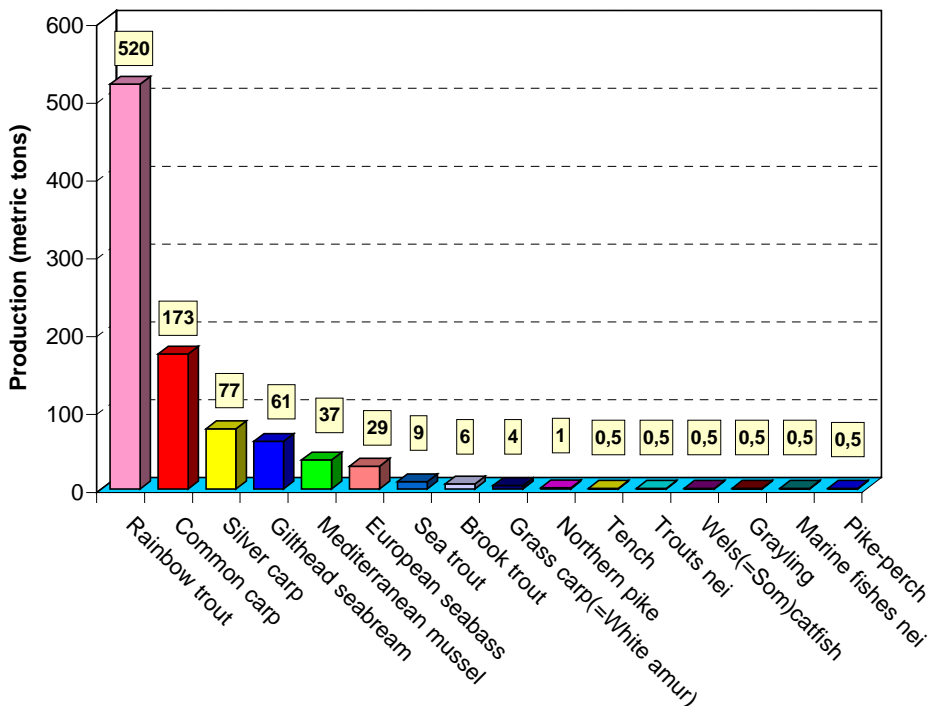
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	833	685	787	789	869	917
<b>Value</b>	-	-	-	-	2.19	2.02	2.73	2.76	3.02	3.24

Reference: FAO, *FishStat Plus 1999*



**Figure 97** Volume and value of aquaculture production in Slovenia

Reference: FAO, FishStat Plus 1999



**Figure 98** Aquaculture production by species in Slovenia (1997)

Reference: FAO, FishStat Plus 1999

Freshwater fisheries are organised mainly as sport-fishing and fish-farming. Sport-fishing takes place in almost all the waterbodies of Slovenia. Fish-farming provides both sufficient young fish for introduction into freshwaters and fish for direct human consumption. Freshwater aquaculture consists of cold- and warmwater aquaculture. About 96% of total freshwater fish production takes place in cold-waters. The most important fish species here is the rainbow trout.

### 2.3.8. Macedonia



<i>Area:</i>	25 713 km <sup>2</sup>
<i>Population:</i>	2 034 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	1 090 US\$

**Map 38** Macedonia

#### 2.3.8.1. Aquaculture

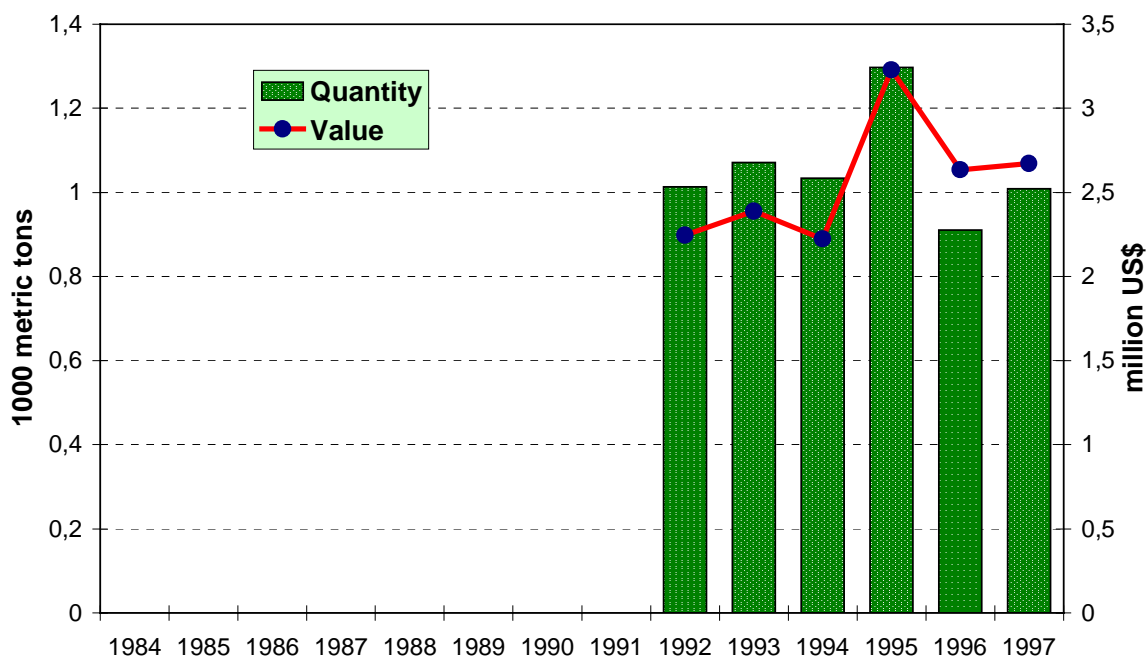
The total aquaculture production of Macedonia was around 1 000 metric tons between 1992 and 1997 (*Table 45, Figure 99*). The main cultured species are the trout with about 300 - 400 metric tons (*Figure 100*). The production of common carp is also important in Macedonia, and it was also about 300 - 400 metric tons per year.

**Table 45** Aquaculture production in Macedonia

Quantity (metric tons), Value (million US\$)

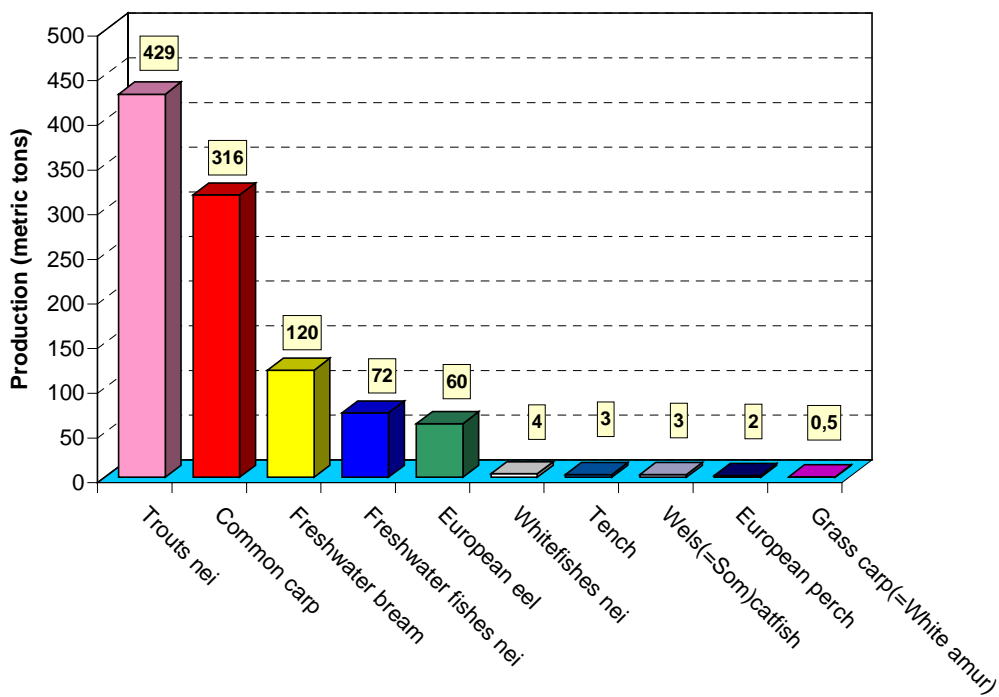
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	1014	1071	1034	1297	911	1009
<b>Value</b>	-	-	-	-	2.25	2.39	2.22	3.23	2.64	2.67

*Reference: FAO, FishStat Plus 1999*



**Figure 99** Volume and value of aquaculture production in Macedonia

Reference: FAO, FishStat Plus 1999



**Figure 100** Aquaculture production by species in Macedonia (1997)

Reference: FAO, FishStat Plus 1999

### 2.3.9. Albania



<i>Area:</i>	28 748 km <sup>2</sup>
<i>Population:</i>	3 363 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	50
<i>Coastline:</i>	362 km
<i>Lakes:</i>	1 350 km <sup>2</sup>
<i>Rivers:</i>	1 293 km
<i>GDP/capita<sup>1997</sup>:</i>	670 US\$

**Map 39** Albania

#### 2.3.9.1. Hydrography

The total lake area in Albania is 1 350 km<sup>2</sup>. The total area of fishponds is about 200 hectares. The river courses usually consist of longitudinal troughs between the mountain ranges connected by narrow transverse gorges cut through the harder rocks and then running westerly to the Adriatic. The total length of the eight main rivers is 1 293 km within Albania. There are also reservoirs and lagoons in Albania but no further details are available to the authors.

#### 2.3.9.2. Land and water use

Albania is one of the least urbanised countries in Europe (only 35%), but in terms of arable land per capita it also ranks as one of the lowest of European agricultural countries. The pattern of land use in 1986 was: arable and permanent crops 24.9%, permanent pasture 13.9%, forest and woodland 36.3%, other land 20.2% and inland water 4.7%. Commercial fishing has never been important in Albania.

#### 2.3.9.3. Aquaculture

Albania's inland fishery resources are primarily those of its large lakes, shared with Greece and the former Yugoslavia, and that there is also a fishery potential in its reservoirs and coastal brackish waters. Several small size fish hatcheries are working in different regions that have been built through Chinese expertise. Natural conditions are not favourable for inland fisheries in Albania except in its lakes, and these are not very productive. Even in the coastal areas, there has not been the emphasis on lagoon fisheries found in some of the

other Mediterranean countries, and it is believed that the installation of fish traps at lagoon outlets has been the principal form of management. Sociologically, the inhabitants have been oriented toward the Danube (not the coast) and in the past (up to about 1930), the lowlands were malarial in nature thus hindering development of either capture fisheries or extensive aquaculture. Emphasis on drainage both for malarial eradication and to provide agricultural land has affected lagoon fisheries.

The total aquaculture production of Albania dramatically declined between 1988 and 1997. It was 3 732 metric tons in 1988 and only 97 metric tons in 1997 (*Table 46, Figure 101*). The main species cultured in brackish water is the Mediterranean mussel but its production fell from 3 107 metric tons in 1988 to 80 metric tons in 1997 (*Figure 102*). The greatest emphasis in freshwater fish production in Albania is placed upon the silver carp followed by that on rainbow trout. The culture of common carp follows that of these two easily cultivable and well-liked species.

**Table 46 Aquaculture production in Albania**

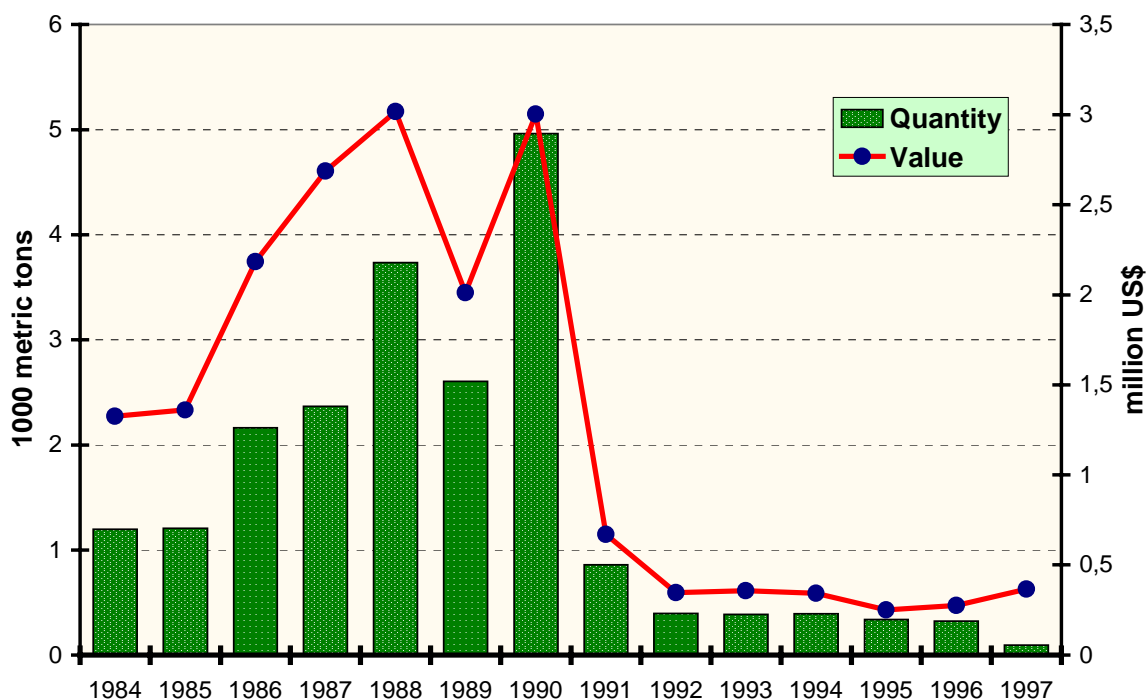
Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	3732	2604	4961	859	397	389	395	340	323	97
<b>Value</b>	3.02	2.01	3.00	0.67	0.35	0.36	0.34	0.25	0.28	0.37

*Reference: FAO, FishStat Plus 1999*

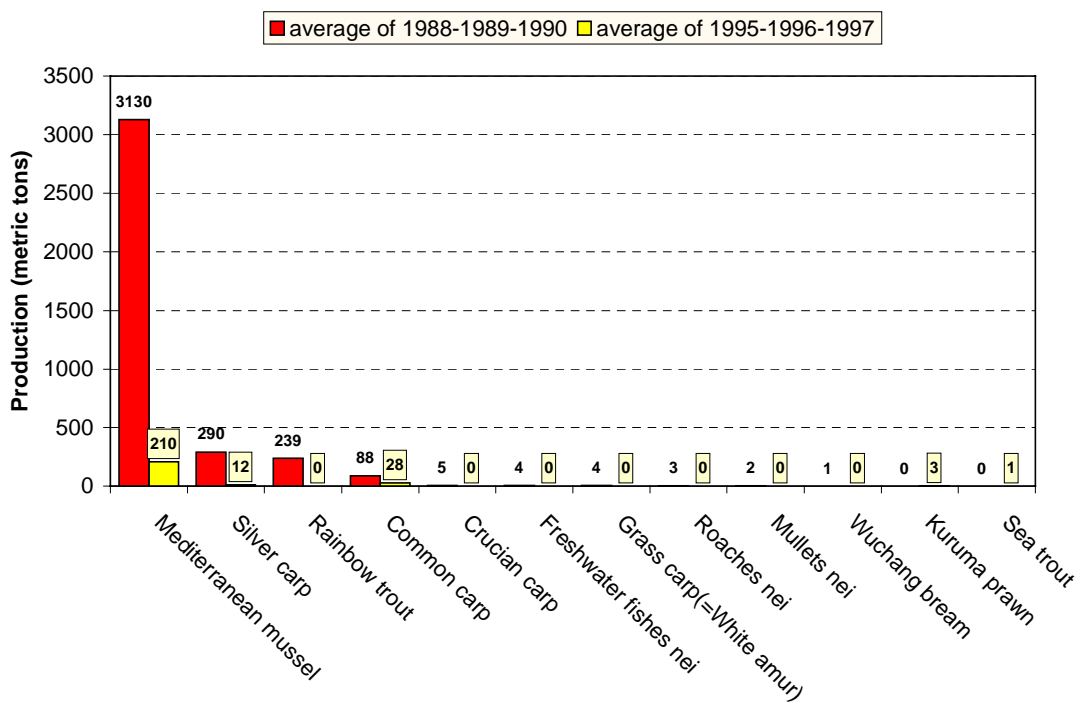
Lacking any firm information on Albanian inland fisheries other than that presented here, it is difficult to attempt a future evaluation. However, in view of the facts at hand, only limited development is foreseen, except in aquaculture and lagoon or brackishwater fisheries, and when the country has achieved more stability some emphasis on tourist fishing.

The fish farms have been privatised and these farms are susceptible to improve the technology and apply new methods. There are however serious limitations in infrastructure and flow of information.



**Figure 101** Volume and value of aquaculture production in Albania

Reference: FAO, FishStat Plus 1999



**Figure 102** Aquaculture production by species in Albania

Reference: FAO, FishStat Plus 1999

### 2.3.10. Greece



<i>Area:</i>	131 957 km <sup>2</sup>
<i>Population:</i>	10 300 000
<i>Active population:</i>	4 201 000
<i>Employment in aquaculture<sup>1997</sup>:</i>	3 666
<i>Coastline:</i>	13 676 km
<i>Lakes:</i>	850 km <sup>2</sup>
<i>Rivers:</i>	2 339 km
<i>GDP/capita<sup>1997</sup>:</i>	7 562 US\$

**Map 40** Greece

Greece's few rivers, torrential in winter and water-deficient in summer, are incapable of providing good fisheries. The inland fisheries are concentrated in its natural lakes and in brackishwater lagoons. A so-called lagoon culture, actually a modified form of capture fishery primarily for euryhaline species, has considerable potential. Inland sport fishing is at a minimum level.

#### 2.3.10.1. Hydrography

Greece's inland water area is only 1 140 km<sup>2</sup> or 0.86% of its total area. The combined length of the 20 principal rivers in Greece is 2 339 km. The total area of the lakes is 850 km<sup>2</sup>, the lagoons is 400 km<sup>2</sup> in Greece. There are about 2 000 ha reservoirs in Greece.

#### 2.3.10.2. Land and water use

Agriculture is still the base of Greek economy, although about 65% of the country is considered urban. The pattern of land use in 1986 was: arable and permanent crops 30%, permanent pasture 40%, forest and woodland 20%, other land 9.4% and inland water 0.86%. In general, both marine and inland fisheries are used primarily as a source of food. Direct employment in the aquaculture sector in Greece accounts for about 3 600 jobs, but a further 5 000 people are employed in allied activities (services, crafts and industry).

#### 2.3.10.3. Aquaculture

The total aquaculture production of Greece increased significantly between 1988 and 1997, from 4 079 metric tons to 44 338 metric tons (*Table 47, Figure 103*). Greece is the major producer country of the species group of redfishes, basses, congers in Europe with the



production of 33 230 metric tons in 1997. The sea bass and bream industry is the most significant development, which has grown from around 800 metric tons in 1989 to 33 180 metric tons in 1997, making it the leading European produces of these species. (Figure 104).

Aquaculture production in Greece is shared between co-operatives and independent farmers, all small- to medium-scale enterprises. Central Macedonia has some excellent trout rearing areas, but production has been limited by the methods of culture, especially the use of poor feeds, such as slaughterhouse wastes. Water pollution has also been a problem. The total aquaculture production of rainbow trout increased between 1988 and 1997, from 2 250 metric tons to 2 477 metric tons. In addition to trout culture, both common carp and eels have been raised. The aquaculture production of Mediterranean mussel increased between 1988 and 1997, from 1 100 metric tons to 6 549 metric tons.

**Table 47 Aquaculture production in Greece**

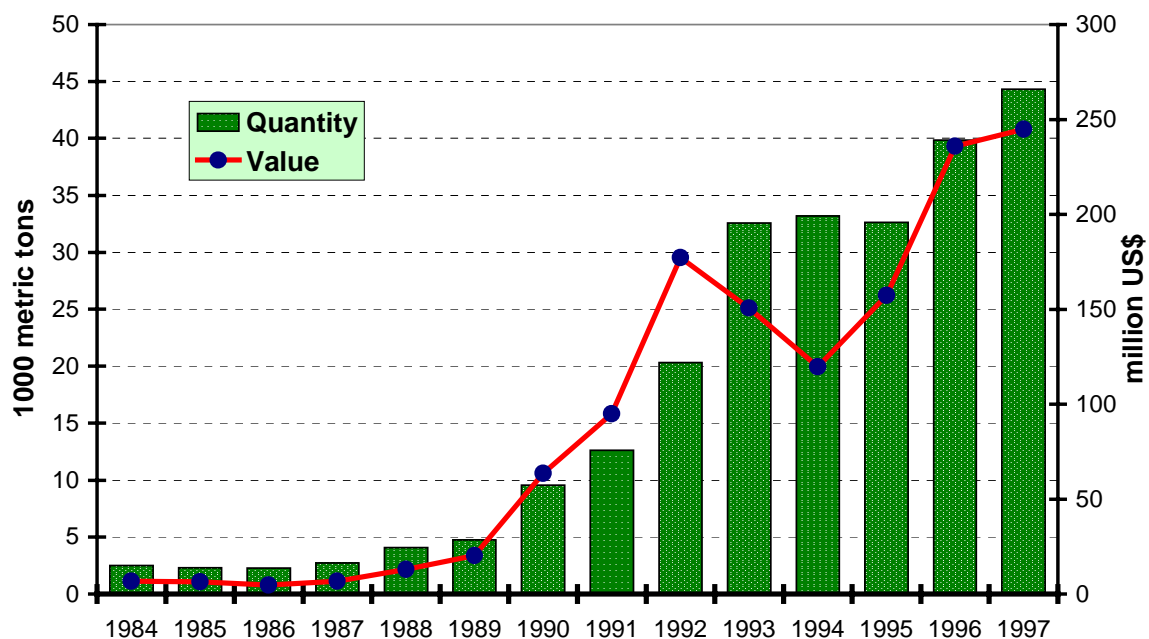
Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	4079	4741	9559	12615	20306	32578	33182	32644	39852	44338
<b>Value</b>	12.89	20.15	63.49	94.97	177.20	150.61	119.72	157.31	235.86	244.82

Reference: FAO, *FishStat Plus 1999*

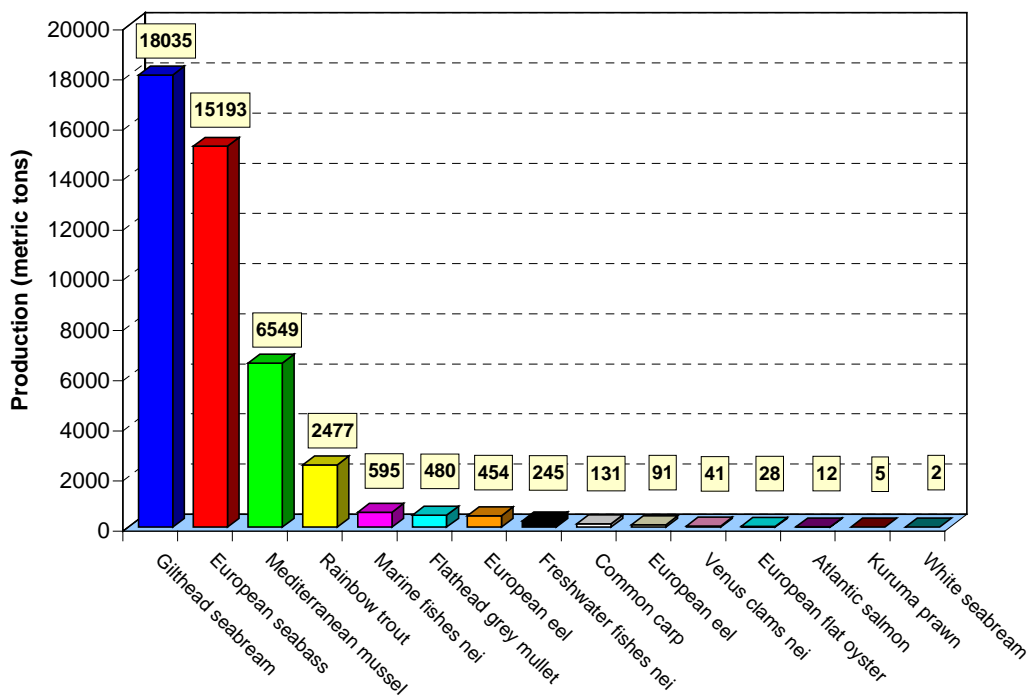
In recent years Greece has had one of the highest per capita figures for consumption of sea bream (0.4 kg). This is partly because of historic reasons, partly because of the sharp fall in prices and partly because aggressive marketing.

However, an increasing amount is exported to Italy along with much of the bass, which is less popular in the domestic market. The product is still mainly sold fresh whole on ice with little product development yet by way of gutting or filleting. Producers are now putting much greater emphasis on selling into northern European markets such as the UK and Germany, given that most other producing countries are still also targeting Italy.



**Figure 103** Volume and value of aquaculture production in Greece

Reference: FAO, FishStat Plus 1999



**Figure 104** Aquaculture production by species in Greece (1997)

Reference: FAO, FishStat Plus 1999

Among the factors conducive to good yield from the inland fisheries of Greece are: the climate which promotes a long growing season, limestone terrain, and comparative lack of widespread industrialisation and water pollution. There are a fair number of large lakes, an extensive lagoon area offers scope for a considerable brackishwater fishery, there are protected deep-water bays suitable for pen or cage culture, and water supplies for trout culture are good in some northern areas. On the other hand, stream fisheries are quite limited. The sea orientation of the people and lack of traditional aquaculture, especially for freshwater species, may have been general deterrents to inland fishery development initially. Nevertheless, Greece's local maritime resources are poor, the country does have a tradition of lagoon culture, and the Government is generally respectful to aquaculture development.

Limited by small fishery resources in rivers, and with ever-increasing demands for irrigation and hydropower water, the future of inland fisheries in Greece is bound to its natural lakes, reservoirs and lagoons.

Because of the country's physical geography, fishing has always been an important economic activity in Greece. It has not been spared by the recent crisis in the industry in Europe, due to the scarcity of resources in Community waters and to intense competition world-wide, and those involved in the industry have been forced to embark upon radical restructuring.

The recent development of the marine aquaculture sector has been remarkable, thanks to the natural environment and the climate, technological improvement and national and Community financial aid. To increase output, improve product quality, and guarantee healthy, hygienic and environment-friendly production, it is planned to build, extend or modernise aquaculture facilities.

#### *2.3.10.4. Administration and management*

The Department of Fisheries of the Ministry of Agriculture is responsible for administration of Greek fisheries, including aquaculture. Local governments also have some powers. For example, in each Greek county there is a fishery officer working for the agriculture department, who is in charge of organising all aspects of fisheries.

## 2.4. Central and Eastern Europe<sup>7</sup>



**Map 41** Central and Eastern Europe

These countries are the post-communist countries, so there were a political and economical change in 1989. Everywhere the output (both in volume and value) of the agriculture fallen down in 1990's and the aquaculture sector is also.

The aquaculture production in Central and Eastern Europe is decreasing from 1989 up to now (*Table 48, Figures 105, 106*). The most important finfish species are the common carp, bighead carp, silver carp and the rainbow trout in the economic production and also in the recreational fishery sector. The most frequently production area is the artificial fishpond where use extensive or semi-intensive technology.

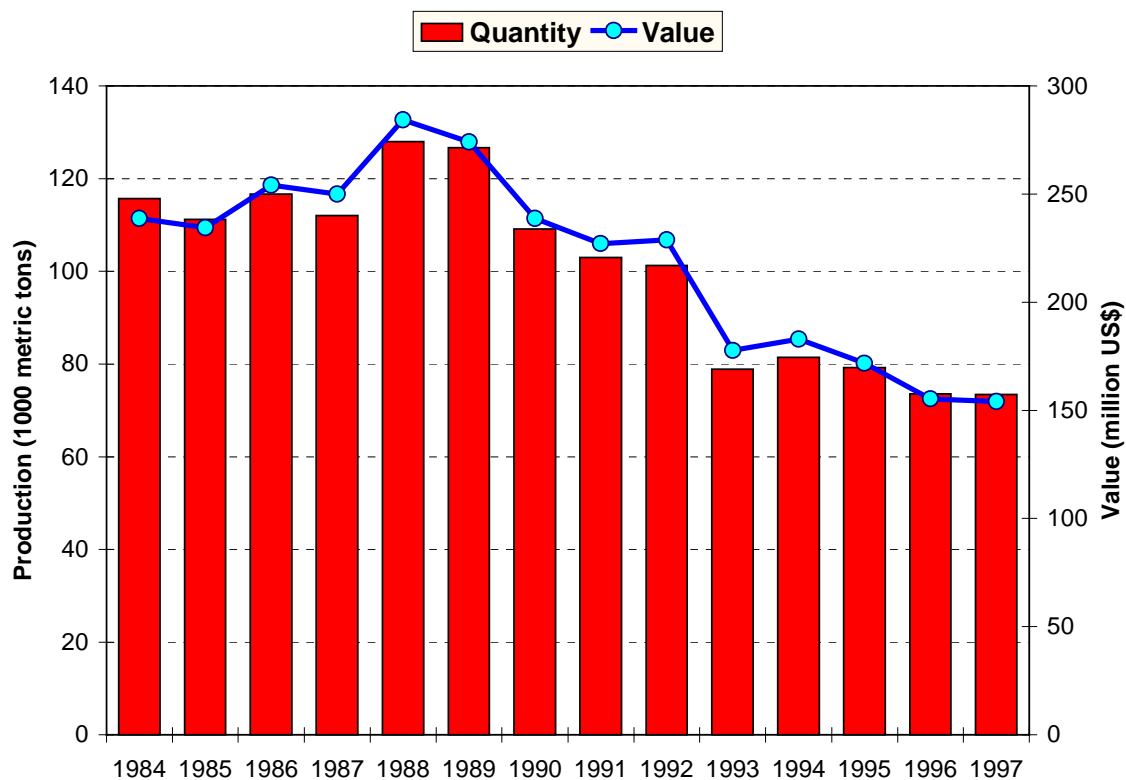
**Table 48** Aquaculture production in Central and Eastern Europe

Quantity (1000 metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	127.99	126.64	109.13	103.02	101.32	78.93	81.42	79.21	73.56	73.43
Value	284.36	274.15	238.77	227.06	228.88	177.76	183.03	171.80	155.41	154.05

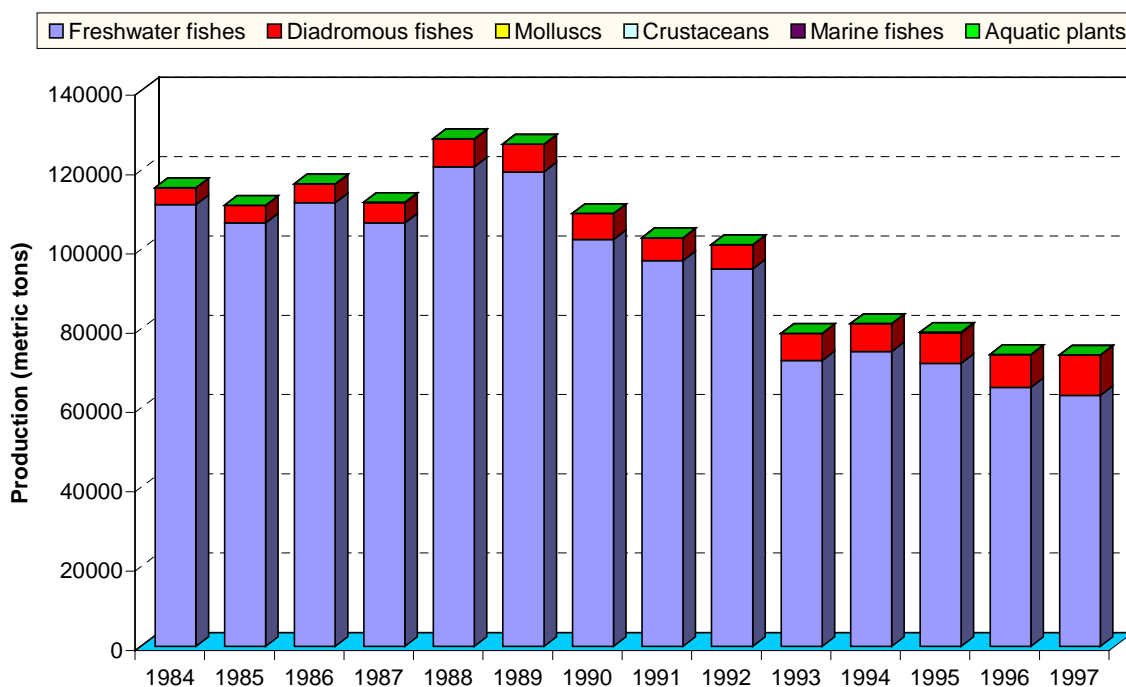
Reference: FAO, *FishStat Plus 1999*

<sup>7</sup> **Central and Eastern Europe:** Poland, (Czechoslovakia), Czech Republic, Slovakia, Hungary, Romania, Bulgaria.



**Figure 105** Aquaculture production in Central and Eastern Europe

Reference: FAO, FishStat Plus 1999



**Figure 106** Volume of aquaculture production by major species groups in Central and Eastern Europe

Reference: FAO, FishStat Plus 1999

### 2.4.1. Poland



<i>Area:</i>	312 685 km <sup>2</sup>
<i>Population:</i>	38 418 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	491 km
<i>Lakes:</i>	3 200 km <sup>2</sup>
<i>Rivers:</i>	100 000 km
<i>GDP/capita<sup>1997</sup>:</i>	3 503 US\$

**Map 42**      **Poland**

#### 2.4.1.1. Hydrography

In Poland the total area of ponds is 62 000 ha, the reservoirs is 33 000 ha and the lakes is 320 000 ha. The total length of all Poland's rivers is about 100 000 km.

#### 2.4.1.2. Land and water use

Despite its rather unfavourable climate and soil, Poland is one of the world's leading agricultural countries. Poland is about 37% rural and 63% urban. The pattern of land use in 1986 was: arable and permanent crops 47.4%, permanent pasture 13%, forest and woodland 27.9%, other land 9% and inland water 2.7%. With high demand for water in limited supply, water pollution is a severe problem in Poland.

#### 2.4.1.3. Aquaculture

Most of the pond farms in Poland were created many years ago, some in the Thirteenth or Fourteenth Century. Small, shallow, and often dispersed, many of them need reshaping to be efficient. With respect to aquaculture in Poland, emphasis is placed on the culture of common carp, a tradition of more than 600 years. Other fishes cultivated here, often in carp ponds, are: tench, crucian carp, pike-perch, coregonids, and rainbow trout. Production of rainbow trout in Poland is low and designed principally for home markets, especially restaurants. There has been an increase in cage culture, including illumination to attract plankters to feed coregonids, and the use of thermally heated waters for culture is receiving more attention. In addition to cultivation of fish for food, there are a number of hatcheries

and pond centres to provide fish for stocking open waters. Trout, coregonids, pike, pike-perch and cyprinids are among those stocked.

The production of freshwater fish is developing in two types of farms: fish farms constituted of ponds that are specialised in carp and trout farming; farms constituted of lakes and farms on the river banks that exploit fish in the natural environment.

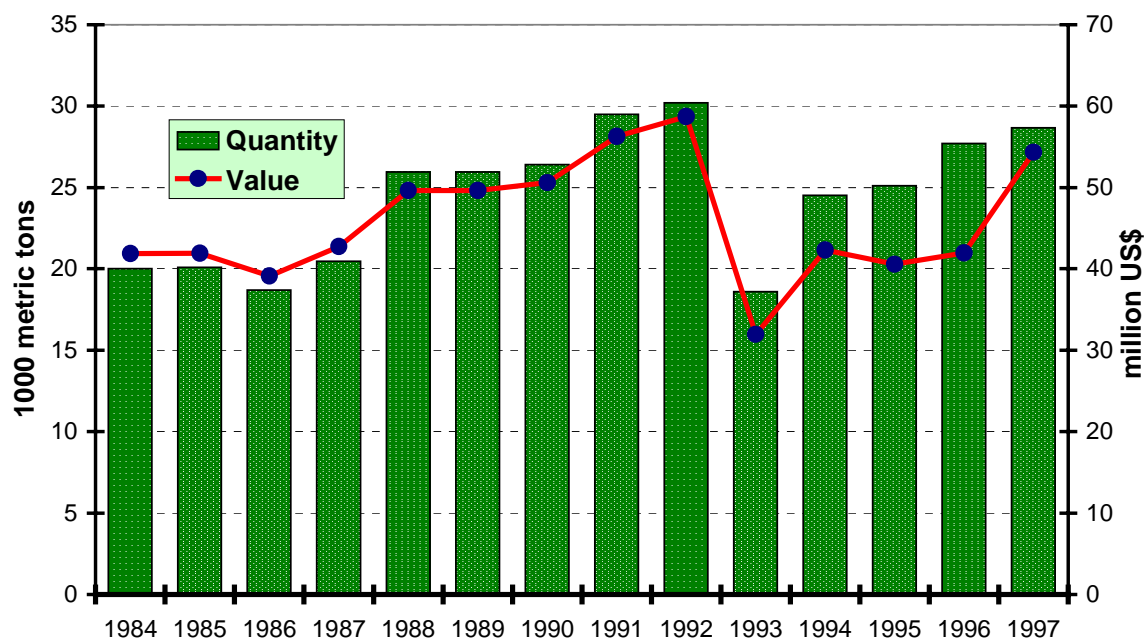
The total aquaculture production of Poland increased from 25 951 metric tons in 1988 to 28 680 metric tons in 1997 (*Table 49, Figure 107*). Poland is one of the main carp producer countries of Europe, with its production of 19 700 metric tons in 1997. The main cultured species are the common carp with 19 700 metric tons, and the rainbow trout with 7 480 metric tons in 1997 (*Figure 108*).

**Table 49 Aquaculture production in Poland**

Quantity (metric tons), Value (million US\$)

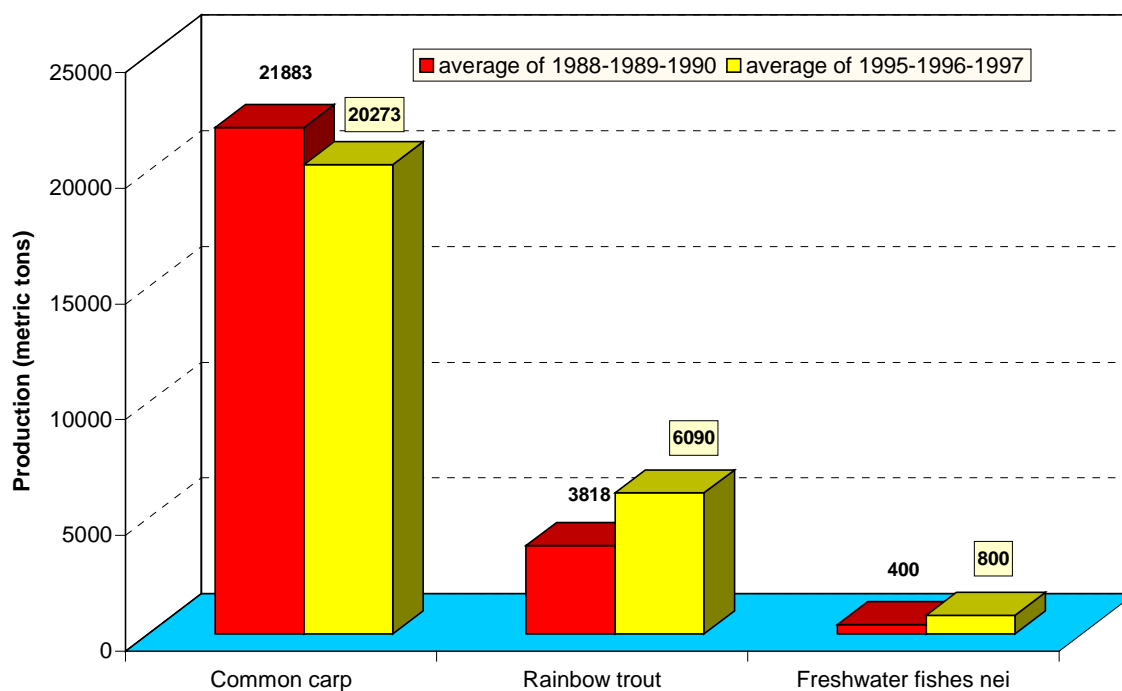
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	25951	25951	26400	29500	30200	18609	24500	25111	27700	28680
<b>Value</b>	49.60	49.60	50.60	56.30	58.70	31.94	42.29	40.56	41.98	54.32

Reference: FAO, FishStat Plus 1999



**Figure 107 Volume and value of aquaculture production in Poland**

Reference: FAO, FishStat Plus 1999



**Figure 108 Aquaculture production by species in Poland**

Reference: FAO, FishStat Plus 1999

Before 1990 state agriculture and state-owned fishing companies were subsidised by the state budget. When all subsidies, with the exception of some indirect aid to the fishery (e.g. research, education) were withdrawn – the situation changed drastically. The year saw the beginning of market oriented changes in the fishery and the related privatisation of state-owned fishing companies, including fishing vessels, fish-processing plants, and foreign and domestic trade. The process of system changes in the Polish fishery has been relatively fast, thanks not only state policy, but also the wide contracts and trade exchange with market-economy countries, maintained for years.

#### 2.4.1.4. Administration and management

The Polish Parliament lays down laws. With respect to inland fisheries, the Ministry of Agriculture, Forestry and Food formulates these laws and is responsible for their implementation. It is also responsible for the administration of inland fisheries which is carried out by its Department of Animal Breeding through its Fishery Inspectorate operating at central level and fishery inspectors on a district level. Presidia of National District Councils, Division of Agriculture and Forestry, look after general fishery matters in their regions.



Overall supervision and responsibility for state fishery policy rests on the Ministry of Transport and Maritime Economy (as regards the sea fishery). There are three types of fishery associations in the Polish fishery industry: Fisheries Development Associations, Sea Fishermen's Union, Fishery Ship-owners' Union.

#### 2.4.2. Czechoslovakia



<i>Area:</i>	127 900 km <sup>2</sup>
<i>Population:</i>	15 829 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	

**Map 43** Czechoslovakia

Until 1992 the former Czechoslovakia politically had divided into two republics. From 1993, the two republics have been independent countries: the Czech Republic and Slovakia.

##### 2.4.2.1. Hydrography, land and water use

The total area of Czechoslovakia's inland waters was about 248 956 ha or about 1.9 percent of the total area of the country. Of this area of inland waters, 154 905 ha are in the Czech Republic and 94 051 ha in Slovakia. The total area of the fish ponds in Czechoslovakia is 52 030. There are 25 543 ha reservoirs in the country.

The pattern of land use in 1986 was: arable and permanent crops 40.2%, permanent pasture 12.8%, forest and woodland 36%, other land 9% and inland water 2%.

##### 2.4.2.2. Aquaculture

Lacking marine waters, with few natural lakes, no great development of large reservoirs, and with heavy demand upon its rivers, Czechoslovakia's principal concentration with respect to fish production lies in aquaculture. A 700-year tradition continues with emphasis on carp culture but with growing involvement with other species, including trout.

Commercial fishing is fast diminishing in importance, being replaced by recreational fishing for both warm-water and salmonid species. The total aquaculture production increased slowly between 1988 and 1992, from 21 247 metric tons to 24 135 metric tons (*Table 50, Figure 109*). The main cultured fishes are the common carp (about 20 000 metric tons in 1992), other freshwater species (about 2 000 metric tons in 1992), and trout species (about 1 000 metric tons in 1992) (*Figure 110*).

Fish culture has been practised in Czechoslovakia for almost 700 years. Primary attention is given to the common carp, which represented about 90% of pond fish production. In addition to traditional pond fish culture, Czechoslovakia practises cage culture (e.g. for trout), in the warm water emitted by both thermal and nuclear plants, trout culture in silos (towers). In addition to aquaculture for food, fishponds are also useful for water retention, as a source of agricultural water, and as a source of recreation. Furthermore, both the Angling Unions and the State of Forestry have hatcheries, which raise fish to stock angling waters.

**Table 50 Aquaculture production in Czechoslovakia**

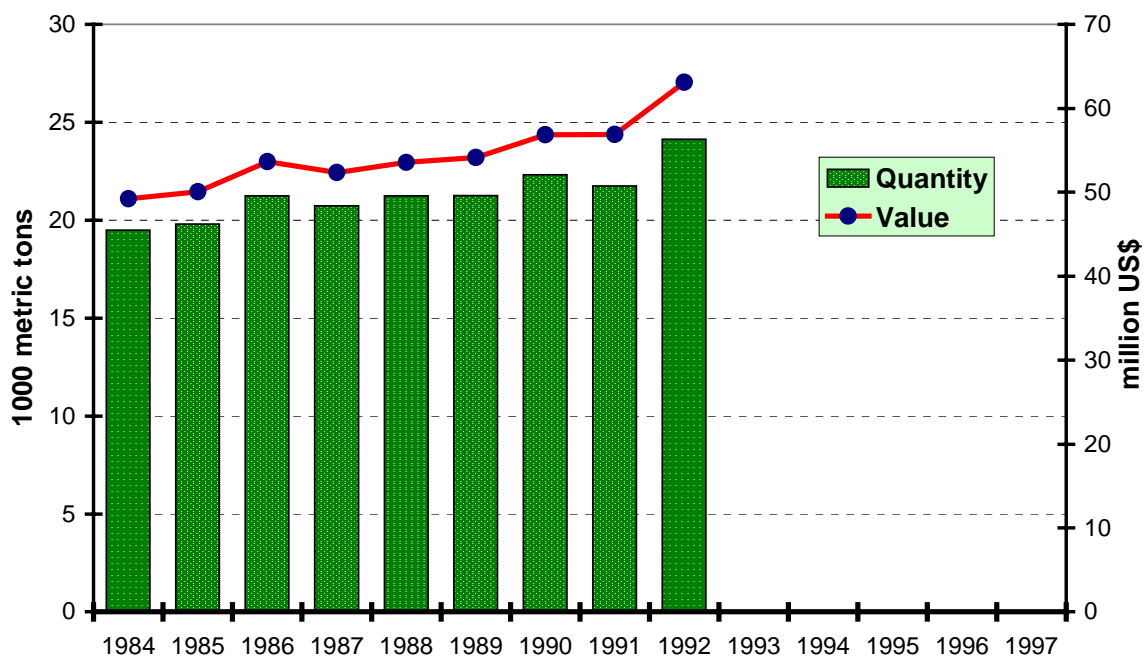
Quantity (metric tons), Value (million US\$)

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
<b>Quantity</b>	19488	19813	21234	20736	21247	21266	22326	21761	24135	-
<b>Value</b>	49.24	50.06	53.64	52.39	53.58	54.12	56.85	56.88	63.13	-

Reference: FAO, *FishStat Plus 1999*

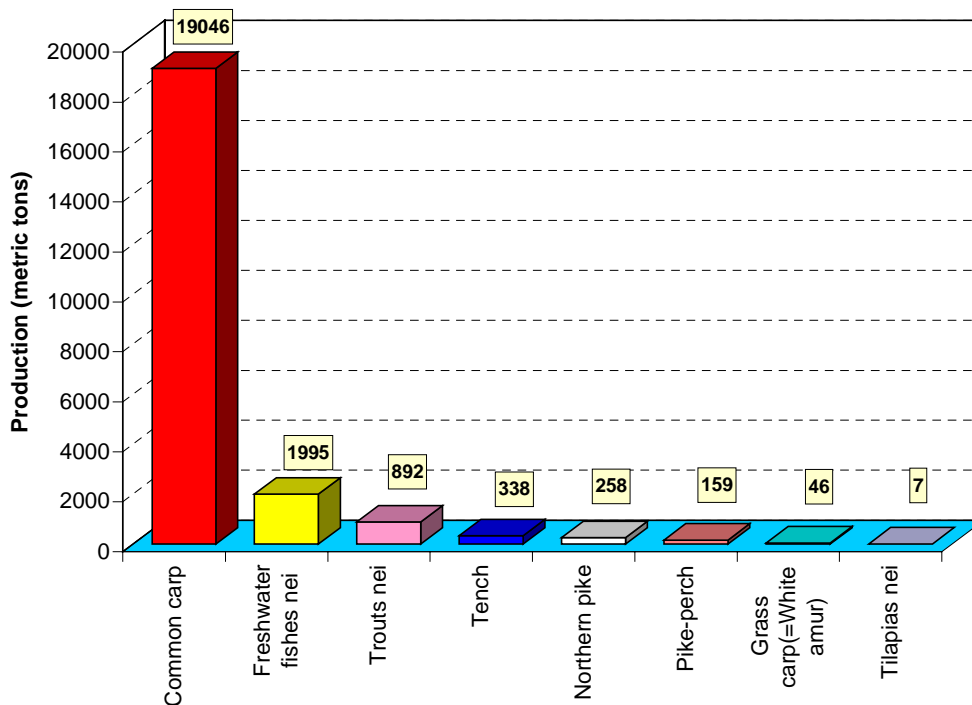
#### 2.4.2.3. Administration and management

The authorities responsible for control and direction of fisheries are the Ministries of Agriculture and Food of the Czech Republic and Slovak Republic under the aegis of the Federal Ministry of Agriculture and Food. Recreational fishing in Czechoslovakia was in the domain of the special interest social organisations, the Czech and Slovak Angler's Unions.



**Figure 109** Volume and value of aquaculture production in Czechoslovakia

Reference: FAO, FishStat Plus 1999



**Figure 110** Aquaculture production by species in Czechoslovakia (average of 1990-1991-1992)

Reference: FAO, FishStat Plus 1999

### 2.4.3. Czech Republic



<i>Area:</i>	78 864 km <sup>2</sup>
<i>Population:</i>	10 326 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	4 710 US\$

**Map 44** Czech Republic

The Czech Republic was one of the two republics of the former Czechoslovakia until 1992.

#### 2.4.3.1. Hydrography

At present, flowing waters (rivers and streams) are used only for sport fishing. More than 120 dam reservoirs have been built up to now in the Czech Republic, with a water surface of 27 000 ha. The total inland water area is about 154 905 ha in the Czech Republic. Ponds presently total about 23 000 for an area of 52 000 ha. There are few natural lakes in the Czech Republic. They play no significant role in the commercial fishery.

#### 2.4.3.2. Land and water use

The pattern of land use in the Czech Republic is: arable and permanent crops 40.3%, permanent pasture 11%, forests and woodlands 33.3% and other lands 15.4 %.

#### 2.4.3.3. Aquaculture

The total aquaculture production in the Czech Republic decreased between 1993 and 1997, from 20 242 metric tons to 17 560 metric tons (*Table 51, Figure 111*). The Czech Republic is one of the main carp producer countries in Europe, with its production of 16 286 metric tons in 1997 (*Figure 112*). Carp pond production is the most important activity in the fisheries sector. The main carp species cultured is the common carp, its production was about 15 000 metric tons in 1992 dominated the aquaculture production of the Czech Republic, near the bighead carp and grass carp. Fishponds dominate the fish-farming activities in the Czech Republic. The present level of Czech fish pond production is evidently extensive. Other production units (trout farms, net cages etc.) have no significant

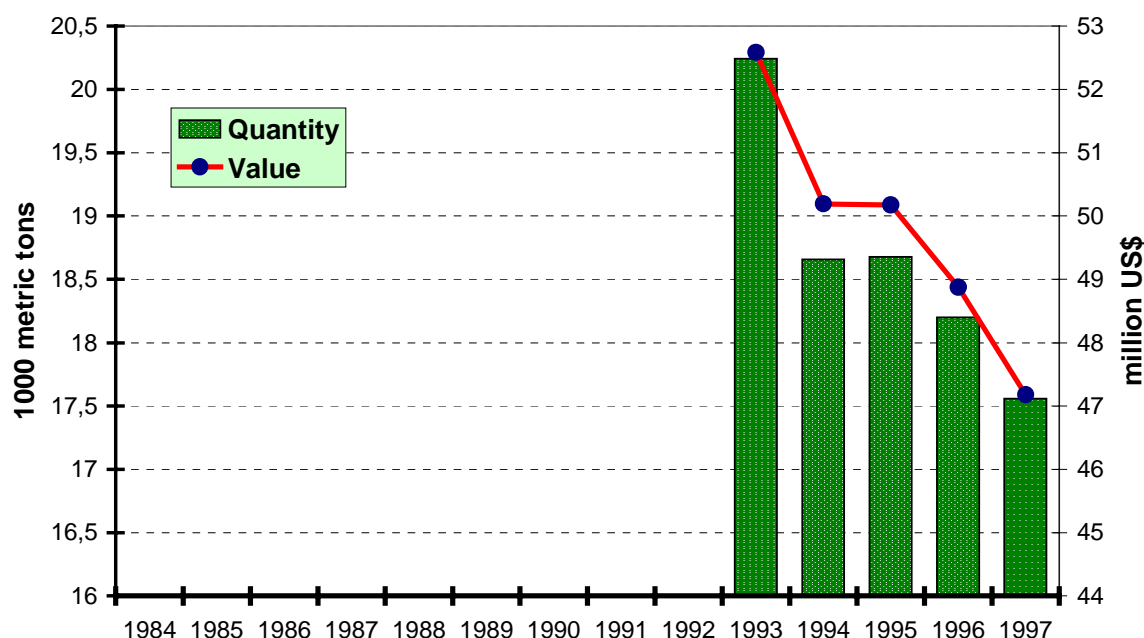
commercial importance and do not affect the final production figures. Pond culture technology is quite well-advanced and balanced between intensification, production economy and ecological conditions. While in Central European countries emphasis is generally on production with artificial feeding, Czech fishpond farmers have successfully increased fish outputs through better utilisation of natural food in ponds. Adverse anthropogenic effects on the environment have resulted in increased eutrophication of the ponds. Czech fish pond farming thus focuses on maintaining the high quality of fish meat resulting from proved technology counter balanced by a utilisation of natural food (zoo-plankton, benthos) as a source of animal protein. This system of fish farming fully conforms to other conditions (economic, ecological) and allows market prices to be maintained at a reasonable level.

**Table 51 Aquaculture production in Czech Republic**

Quantity (metric tons), Value (million US\$)

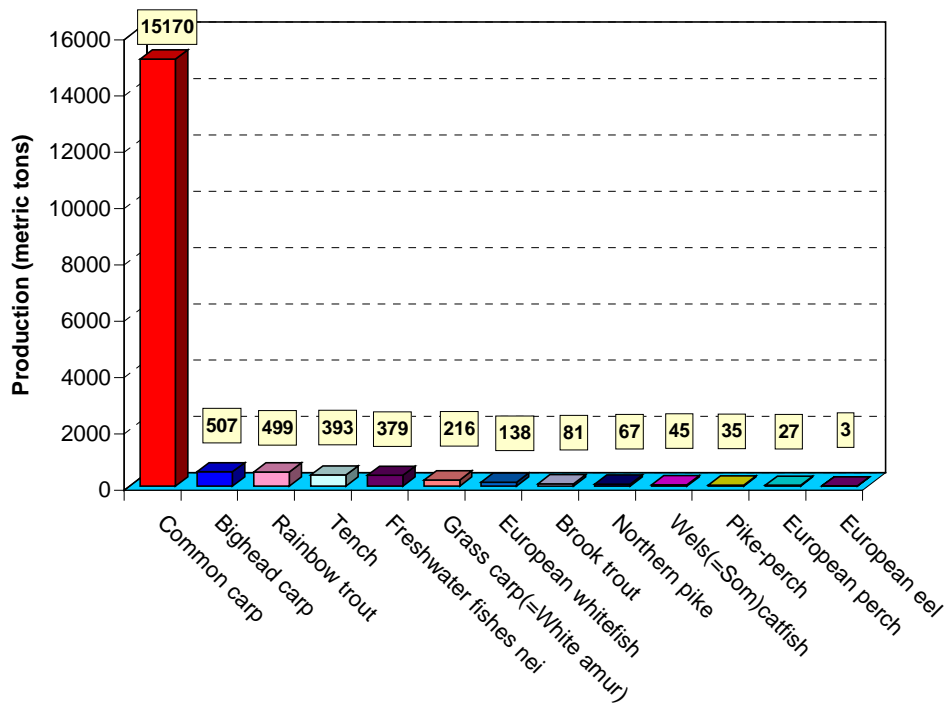
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	-	20242	18658	18679	18200	17560
<b>Value</b>	-	-	-	-	-	52.59	50.19	50.17	48.87	47.18

Reference: FAO, FishStat Plus 1999



**Figure 111 Volume and value of aquaculture production in the Czech Republic**

Reference: FAO, FishStat Plus 1999



**Figure 112 Aquaculture production by species in the Czech Republic (1997)**

Reference: FAO, FishStat Plus 1999

#### 2.4.3.4. Administration and management

Aquaculture is currently carried out predominantly in the private sector and to a lesser degree by the state. Former State farms belonged to the State Fishery Enterprises. They have been transformed and were taken over by the Fish Farmers' Association in 1991, the only professional organisation of its kind. The Fish Farmers' Association is in turn a member of other all-national agriculture and food institutions. The privatisation of former State fish farms was concluded before 1995. Of a total of 51 000 ha of ponds, 32 000 ha is controlled by the Fish Farmers' Association. Angling is practised by 455 local angling organisations associated with the Czech Angling Union.

#### 2.4.4. Slovakia



<i>Area:</i>	49 035 km <sup>2</sup>
<i>Population:</i>	5 314 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	3 480 US\$

**Map 45 Slovakia**

Slovakia was one of the two republics of the former Czechoslovakia until 1992.

##### 2.4.4.1. Hydrography, land and water use

The pattern of land use in Slovakia is: arable and permanent crops 30%, permanent pasture 12%, forests and woodland 40% and other lands 18%.

##### 2.4.4.2. Aquaculture

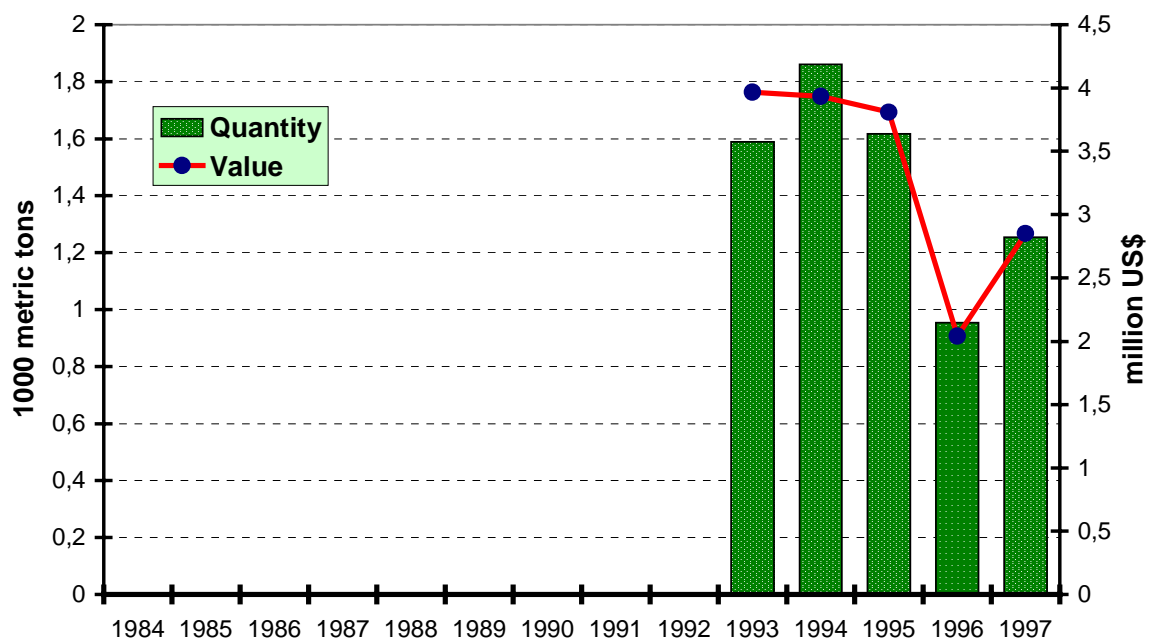
The total aquaculture production of Slovakia decreased between 1993 and 1997, from 1,588 metric tons to 1,254 and touched bottom in 1996 with the production of 954 metric tons (*Table 52, Figure 113*). The main cultured species of Slovakia are the common carp with the production of 432 metric tons in 1997, and the rainbow trout with 662 metric tons in 1997 (*Figure 114*).

**Table 52 Aquaculture production in Slovakia**

Quantity (metric tons), Value (million US\$)

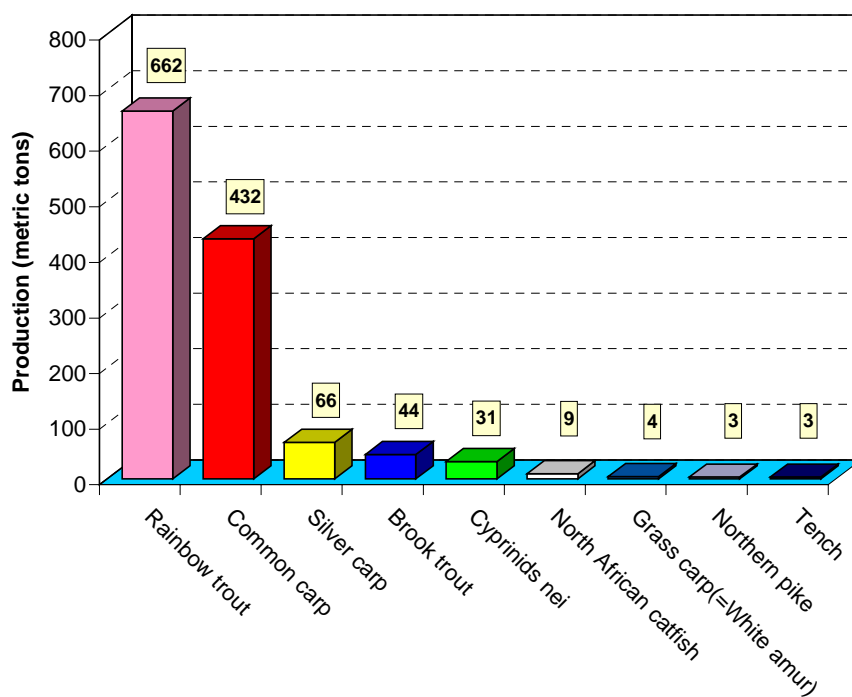
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	-	-	-	-	-	1588	1861	1617	954	1254
<b>Value</b>	-	-	-	-	-	3.97	3.93	3.81	2.04	2.85

*Reference: FAO, FishStat Plus 1999*



**Figure 113** Volume and value of aquaculture production in Slovakia

Reference: FAO, FishStat Plus 1999



**Figure 114** Aquaculture production by species in Slovakia (1997)

Reference: FAO, FishStat Plus 1999



#### 2.4.5. Hungary



<i>Area:</i>	93 036 km <sup>2</sup>
<i>Population:</i>	10 310 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	700
<i>Coastline:</i>	0 km (landlocked)
<i>Lakes:</i>	800 km <sup>2</sup>
<i>Rivers:</i>	1 107 km
<i>GDP/capita<sup>1997</sup>:</i>	4 415 US\$

**Map 46** Hungary

##### 2.4.5.1. Hydrography

Inland water area in Hungary is 143 000 ha. The total area of the three largest lakes of the country is 69 500 ha, and of the ponds is 20 363 ha. The total length of the two main rivers is 1 017 km in Hungary.

##### 2.4.5.2. Land and water use

Although agriculture accounts for only about 20% of the national income, Hungary is fundamentally an agricultural country. The pattern of land use in 1986 was: arable and permanent crops 56.85%, permanent pasture 13.3%, forest and woodland 17.8%, other land 11.3% and inland water 0.75%.

##### 2.4.5.3. Aquaculture

The climatic and topographical conditions of the country are particularly suitable for pond farming. Ponds have been constructed mainly on marginal agricultural land and their individual sites are usually not suitable for up-to-date intensive management. Previously almost all ponds were managed either by State farms or agricultural co-operatives. Within these units pond farming was closely integrated with cereal crop production, which supplied the feed for fish. This situation has completely changed in the early nineties. Whilst in 1986 only 1% of the pond area was managed by private owners, in 1996 private 47% of the total pond area in use.

The cultivated species contributing the largest volume of production is the common carp, which occurs extensively in the natural waters and is the traditional species for cultivation.

The total aquaculture production of Hungary decreased significantly between 1988 and 1997, from 17 970 to 9 334 metric tons (*Table 53, Figure 115*). The aquaculture production of common carp in Hungary decreased significantly between 1988 and 1997, from 12 542 metric tons to 6 420 metric tons (*Figure 116*). Silver carp production in quantity was 1 703 metric tons in 1997. The aquaculture production of grass carp is about 400 - 500 metric tons per year. The production cycle of carp in Hungary takes three years. Carp polyculture is the normal practice, the species being dependent on pond conditions and market demand. In addition to carps, European catfish (about 100 metric tons per year) and pike-perch are cultivated. The harvest of these species amounts to 1-2% of average pond production but provides a better utilisation of the available nutrients than carp culture alone. Farms also produce carp fry and other species for stock enhancement of natural waters.

Fish-cum-duck production systems are employed on some of the pond farms which provides for natural fertilisation of the water. There are only two family-size ventures in Hungary dealing with rainbow trout production. Intensive productions of sturgeons and that of European and African catfish are carried out in a few facilities supplied with geothermal water.

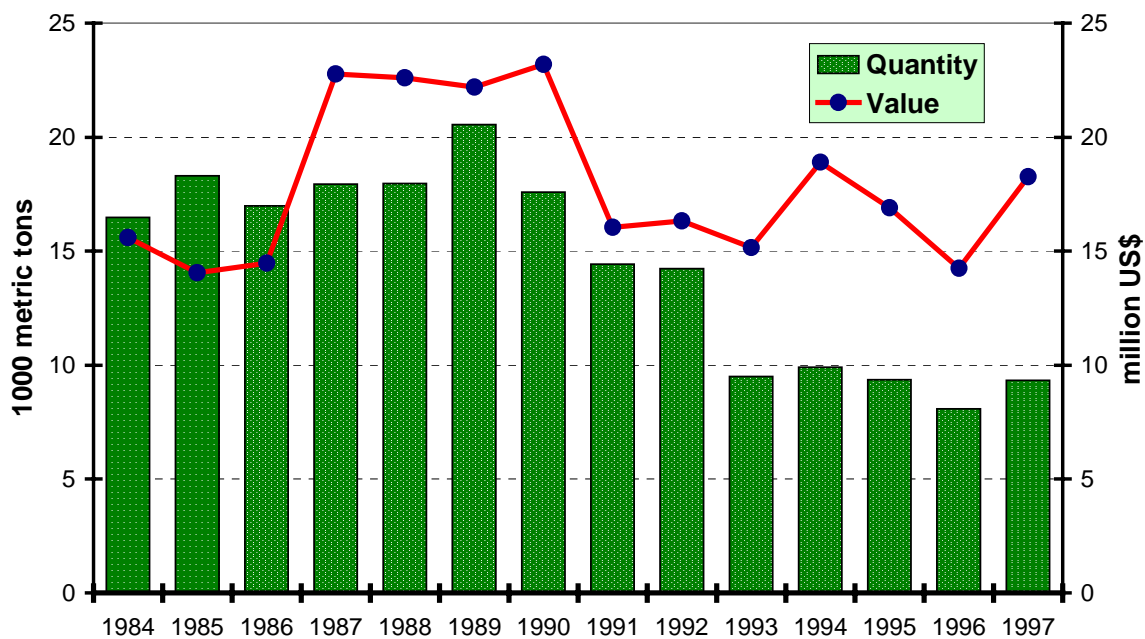
**Table 53 Aquaculture production in Hungary**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
<b>Quantity</b>	17970	20548	17600	14434	14230	9492	9899	9360	8080	9334
<b>Value</b>	22.60	22.19	23.20	16.05	16.32	15.15	18.90	16.90	14.24	18.27

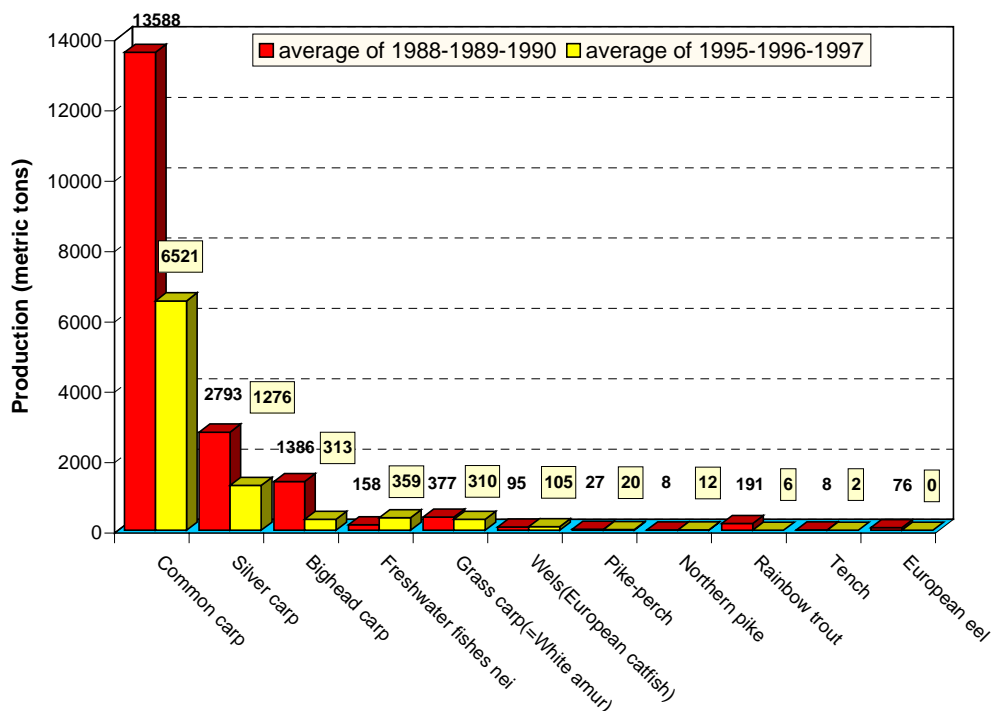
*Reference: FAO, FishStat Plus 1999*

Pond farming of common carp will remain the dominant field of Hungarian fisheries, mainly because of the stable position of this species in domestic markets, both for consumption and recreational purposes. Intensive culture of high value fish species is expected to continue growing, although these activities will still have only minor role in comparison with carp farming.



**Figure 115** Volume and value of aquaculture production in Hungary

Reference: FAO, FishStat Plus 1999



**Figure 116** Aquaculture production by species in Hungary

Reference: FAO, FishStat Plus 1999

#### 2.4.5.4. Administration and management

The fishery sector operates under the aegis of the Game and Fisheries Department of the Ministry for Agriculture. The every-day administrative work is carried out by 19 regional fishery inspectors employed in regional agriculture offices. The majority of fish farms are members of the National Federation of Fish Producers. Marketing is co-ordinated by the Fishery Product Board which is closely related to the Federation. The Fishery Product Board is an organisation representing the interests of fish farmers, fish processors, distributors and consumers. Sport fishermen associations are members of regional angling unions, forming together the Hungarian National Angling Union.

#### 2.4.6. Romania



<i>Area:</i>	237 500 km <sup>2</sup>
<i>Population:</i>	23 200 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	225 km
<i>Lakes:</i>	
<i>Rivers:</i>	
<i>GDP/capita<sup>1997</sup>:</i>	1 780 US\$

**Map 47** Romania

##### 2.4.6.1. Hydrography

The total lake area, including those in the Danube Delta, is 300 000 ha. This includes 99 000 ha of reservoirs and 100 000 ha under the control of commercial fish farms. The total length of rivers in Romania is around 70 000 km. The coastline length is 245 km and the continental shelf area is 29 000 km<sup>2</sup>.

##### 2.4.6.2. Land and water use

Romania is about 56% urban and 44% rural. The pattern of land use in 1987 was: arable and permanent crops 45%, permanent pasture 18.6%, forests and woodland 27.6%, other land 5.3% and inland water 3.5%. With respect to overall water use, both industry and agriculture use large quantities in this relatively water-deficient country.

### 2.4.6.3. Aquaculture

The total aquaculture production of Romania decreased significantly between 1988 and 1997, from 50 680 to 11 168 metric tons (*Table 54, Figure 117*). Romania is one of the main carp producer countries in Europe, with its production of 10 694 metric tons in 1997 (*Figure 118*). The main cultured species is the silver carp with its production of 5 680 metric tons in 1997. The production of common carp and goldfish is also important, it was about 1 900 metric tons for both species in 1997. Other relevant cyprinids are the bighead carp. Its aquaculture production also declined significantly from 7 140 metric tons in 1988 to 1 111 metric tons in 1997. Trout production is about 400 metric tons per year in Romania.

The majority of fish production, processing and trading is carried on by the public sector through a range of societies, which function as state-owned companies. There is a slowly expanding private sector, particularly in the fish-retailing sector. There is also some expansion of the private sector in fish production.

Pond culture has a long history in Romania, with fish being grown in irrigation ponds and associated with monasteries. It is only since the 1950's, however, that commercial farming has undergone substantial development.

Production from fish farming is variable, dependent in main on the natural levels of productivity and the level of inputs used, the feed used, the farmed fish species and the labour used. Most fish farming in Romania is either extensive or semi-intensive with limited inputs of feed and fertiliser. Production rates thus vary between farms, and between ponds within farms.

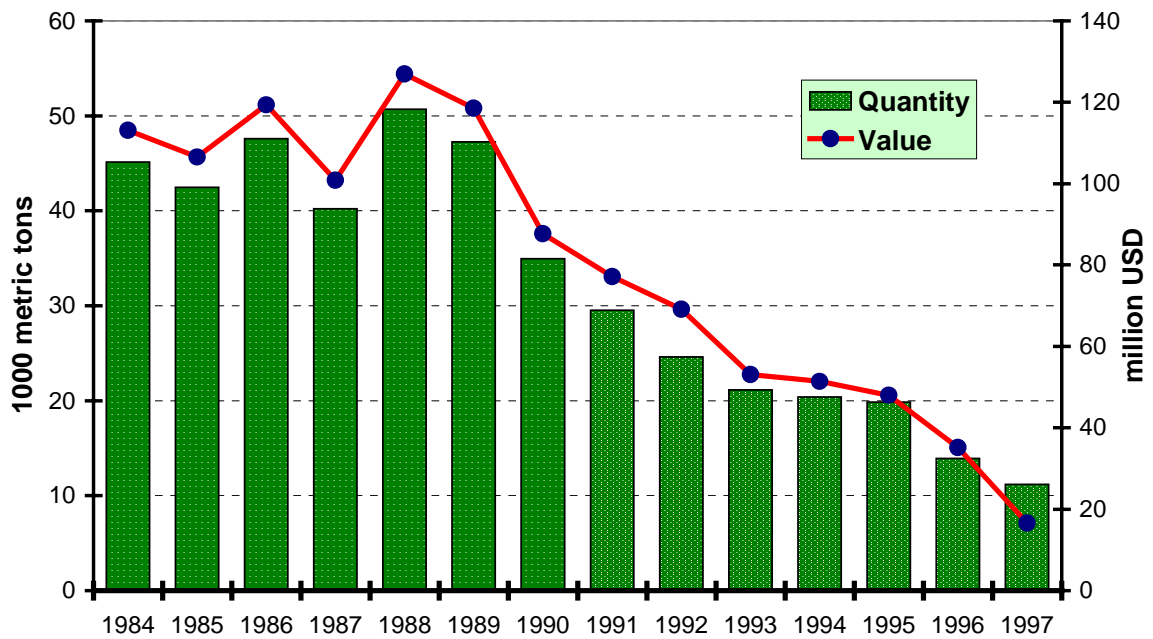
In the mountains there are a number of trout farms, which rear fish for stocking of lakes, reservoirs and rivers.

**Table 54 Aquaculture production in Romania**

Quantity (metric tons), Value (million US\$)

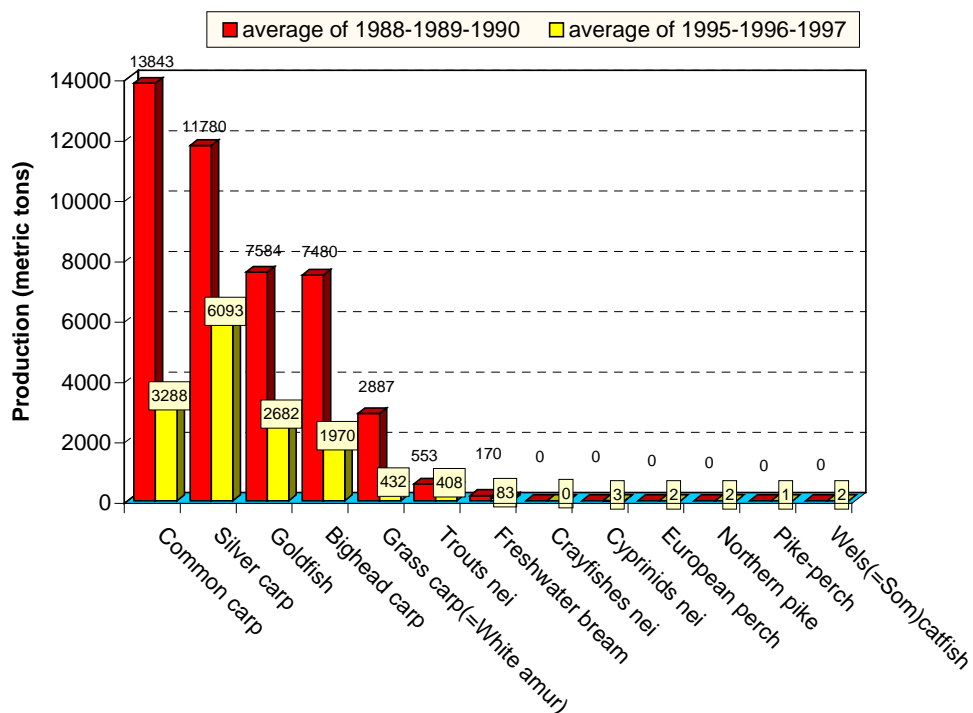
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	50680	47260	34950	29530	24620	21100	20400	19830	13900	11168
Value	126.93	118.48	87.65	77.10	69.12	53.11	51.37	47.98	35.13	16.57

Reference: FAO, *FishStat Plus 1999*



**Figure 117** Volume and value of aquaculture production in Romania

Reference: FAO, FishStat Plus 1999



**Figure 118** Aquaculture production by species in Romania

Reference: FAO, FishStat Plus 1999

Fish farm production is based on carp polyculture with a 2-3 year production cycle. Some farms produce their own fingerling stocks and may have a surplus to supply other farms either within their own society, or outside. The fisheries and aquatic resources sector has an important contribution to make to the development of the country in the future. The country has a good natural resource base, established production infrastructures in both capture and culture fisheries, a skilled workforce, a large domestic market and the larger potential export market in Europe.

#### 2.4.6.4. Administration and management

The Ministry of Agriculture and Food has sectoral development responsibilities for the fisheries and fish farming. The Ministry of Waters, Forest and Environmental Protection is responsible for overall policy for aquatic resource-use. The main body representing the public and private sector enterprises in the fisheries sector is the Romanian Fish Producers Association. The Association of Fish Culturists and Fishermen of Romania represent the needs of individual professionals in the fisheries and fish-farming field. The General Association of Hunters and Fishermen also acts as a representative body, which contributes the views of the sport fishermen to the policy process.

#### 2.4.7. Bulgaria



<i>Area:</i>	110 994 km <sup>2</sup>
<i>Population:</i>	9 004 000
<i>Active population:</i>	
<i>Employment in aquaculture<sup>1997</sup>:</i>	
<i>Coastline:</i>	354 km
<i>Lakes:</i>	
<i>Rivers:</i>	150 000 km
<i>GDP/capita<sup>1997</sup>:</i>	1 190 US\$

**Map 48**      **Bulgaria**

Water deficient, with great demands on its river by agriculture and industry, its inland fishery resources suffer as a result of their needs. The damages have been offset to some extent by establishment of fisheries in reservoirs and an increase in aquaculture for both cyprinids and trout.

#### 2.4.7.1. Hydrography

Water resources in Bulgaria are quite limited. The total inland water area of Bulgaria is only about 36 000 ha or 0.32% of the country's total area. There are however 150 000 km of rivers in Bulgaria, and 21 000 km of the entire river network are suitable for fisheries. The total number of Bulgaria's natural lakes is 269. Of these, 161 lakes (351.8 ha in total), are suitable for angling. There are 1 820 small dams in Bulgaria covering 15 000 ha and 147 medium-sized and large reservoirs covering 35 000 ha. Reservoirs play an important role in the fish supply as they are generally stocked each year with one-year old carp and harvested at the end of the season in the fall. The coastal waters of the Bulgarian Black Sea are more saline than those of Romania to its north.

#### 2.4.7.2. Land and water use

The pattern of land use in 1986 was: arable and permanent crops 37.3%, permanent pasture 18.3%, forest and woodland 34.8%, other land 9.2% and inland water 0.32%. The main water resources are concentrated in areas far away from cultivable areas, thus requiring long and expensive irrigation canals. Bulgaria has a long history of water regulation for both irrigation and drainage.

#### 2.4.7.3. Aquaculture

The total aquaculture production decreased significantly between 1988 (12 141 metric tons) and 1997 (5 437 metric tons) in Bulgaria (*Table 55, Figure 119*). The main cultured freshwater species is the common carp. Its production has fallen from 9 527 metric tons in 1988 to 3 700 metric tons in 1997 (*Figure 120*). The production of other cyprinids was 960 metric tons in 1988 and 760 metric tons in 1997. The aquaculture production of rainbow trout is also important in Bulgaria, in 1988 it was 1 554 metric tons and 740 metric tons in 1997.

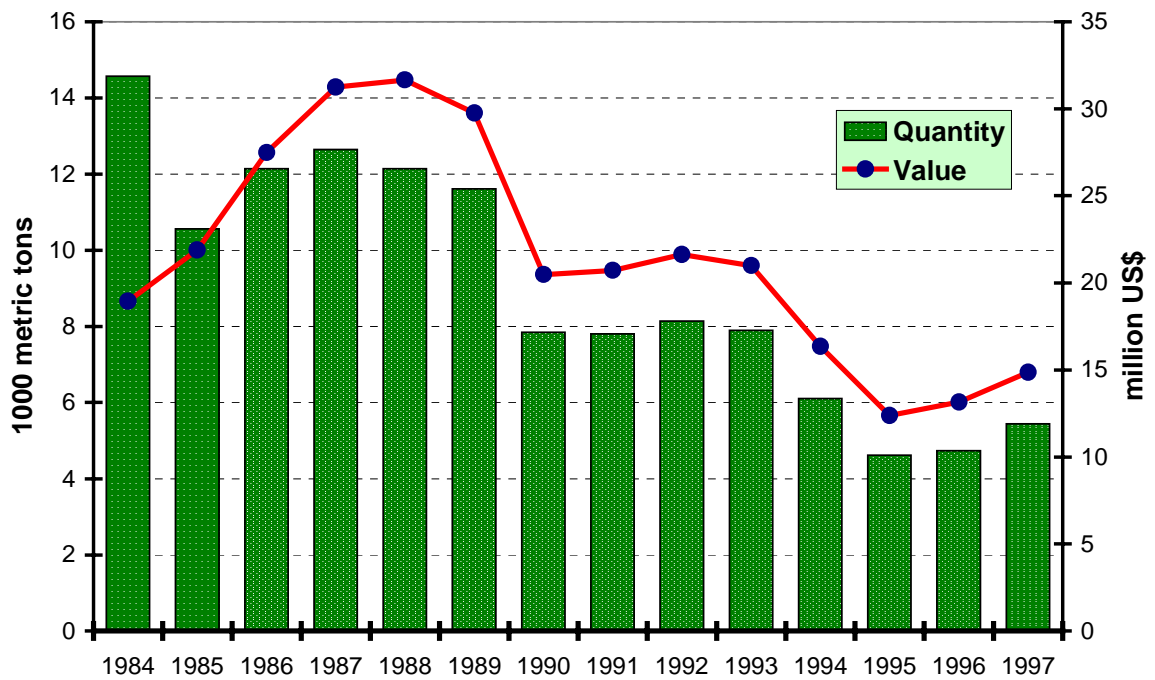
**Table 55 Aquaculture production in Bulgaria**

Quantity (metric tons), Value (million US\$)

	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997
Quantity	12141	11615	7849	7798	8132	7897	6100	4615	4727	5437
Value	31.65	29.77	20.47	20.72	21.62	21.00	16.35	12.37	13.15	14.86

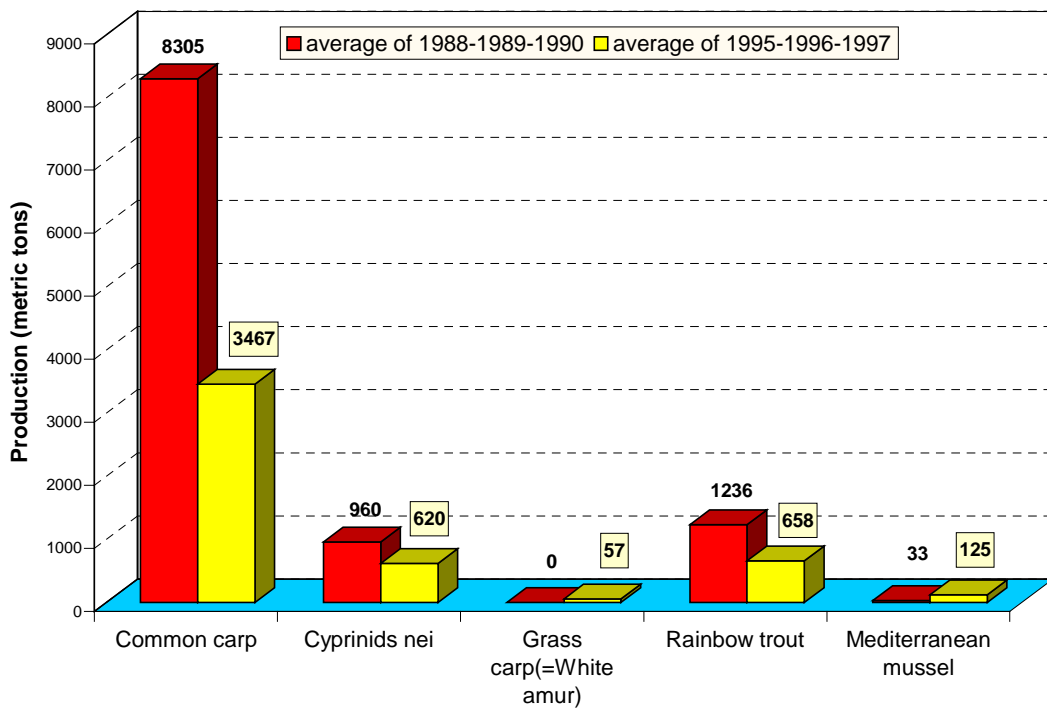
Reference: FAO, *FishStat Plus 1999*





**Figure 119** Volume and value of aquaculture production in Bulgaria

Reference: FAO, FishStat Plus 1999



**Figure 120** Aquaculture production by species in Bulgaria

Reference: FAO, FishStat Plus 1999

There are two major types of aquaculture in Bulgaria: cyprinid and trout culture (mainly rainbow trout). Common carp is the principal species raised, but Chinese carps have also been introduced with a view toward polyculture.

Topshell (*Rapana sp.*) has become an important revenue source for fishermen on the Black Sea coast. It is harvested during the May-October period and exported to Japan. The hard currency earned from these exports has become very important to individual fishermen and a few small processing companies.

Fish farming, particularly trout farming in mountain lakes, played a positive role in maintaining freshwater fish catch levels. A relatively new activity, mussel farming in the Black Sea area led to the production of 265 metric tons to 1997. Expansion of breeding facilities and scientific research support contributed to this progress. Privatisation of farms, sustainable use of water resources and introduction of modern marketing methods should improve the overall outlook for inland fishery.

The structure of the aquaculture sector is changing gradually, especially since the Parliament of Bulgaria decided in favour of mass-privatisation of most of the state-owned companies. At the end of 1996, there were 21 state-owned firms, half a dozen already privatised. Three carp farms and three trout farms have been transferred to private owners. The courts have closed a fish breeding enterprise and the farms returned to the local co-operatives, which owned them previously. More firms are expected to go into bankruptcy.

The recovery and development of aquaculture in Bulgaria's inland waters is important for a variety of reasons. In the first place this will provide considerable amounts of fish for domestic consumption. Between 1990 and 1996, the other sources of fish decreased sharply. Privatisation in the sector is expected to help in the recovery of production up to its previous levels and beyond.

#### *2.4.7.4. Administration and management*

The Ministry of Agriculture and Food Industry in Sofia, through the State Fisheries Inspectorate exercises general control over the fisheries of Bulgaria. It is responsible for the commercial fisheries, marine aquaculture, cold water and freshwater farming of fish and crustaceans and the economic performance of the sector. There are five offices (subdivisions) in the country in charge of regional administration of fisheries. The Ministry of Forestry is responsible for sport fishing.