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DACIAT

Black Sea CROSS BORDER COOPERATION

Deliverable T1.2.1.
Inventory on most valuable fish species in aquaculture in the Black Sea partner territories

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1. INTRODUCTION

Each of the partner countries has different background and experiences in aquaculture. History of the fish farming goes back to Mid Age based on the traditions of church raising carp and then expanded to other species due to experienced gained. But the main driver to continue aquaculture activities is the value of produced fish in human nutrition without any dependence to fishing season, climate, weather conditions, easy access to the rearing environment and easy to take fish for any purpose i.e. marketing, serving, consuming.

On the other hand, quality and the quantity of the water resources, geography and topography of the country, and locality are the other factors which determine the way of aquaculture in a given place. Therefore aquaculture is improved rather country specific ways. It is possible to explain the state of aquaculture in partner countries such as:

- **Greece**: Marine production in net cages; and inland waters in ponds, old river beds, fish farms constructed along river banks, usually in small volumes
- **Romania**: Produce many fresh water species in large volumes of ponds, lakes and river side land areas from egg to the market size.
- **Turkey**: Similar to Greece, Turkey has improved marine and inland water fish farming; number of species used inland aquaculture is less than Romania and Ukraine
- **Ukraine**: Have rich inland water resources; big soil ponds, natural lakes, rivers and dams, have diverse species in aquaculture.

2. INVENTORY ON MOST VALUABLE FISH SPECIES IN AQUACULTURE IN BLACK SEA PARTNER TERRITORIES

The list of species used in aquaculture is given in Table 1. In order to provide common understanding, foster the communication between the investors in partner countries, it will be useful for the end users to have the list of farmed fish species with local, scientific and English names in order to get rid of any possible confusion. Such a comprehensive table is prepared and given in Annex 1.

This document has been prepared according to the information given in the national reports of partners. Not all of the species used in aquaculture were included in the report. Farming methods of the nine species having high market value are given in the Chapter 2.3. Though there are new species farmed in the countries, farming methods are still private and at experimental stage. But due to similarities in breeding methods, farming of the new and alternative species will be more common in near future.

Table 1. List of farmed species in the DACIAT partner countries

No	Species	Greece	Romania	Turkey	Ukraine
1	American paddlefish (Polyodon spathula)		+		+
2	Asian sea bass (*Lates calcarifer*)				+
3	Atlantic bluefin tuna (*Thunnus thynnus*)	+		+	
4	Beluga (*Huso huso*)	+	+		
5	Bighead carp (*Hypophthalmichthys nobilis*)		+		+

6	Black carp (*Mylopharyngodon piceus*)				+
7	Black Sea salmon (*Salmo labrax*)			+	
8	Brook trout (*Salvelinus fontinalis*)		+	+	
9	Brown bullhead (*Ameiurus nebulosus*)				+
10	Buffalo fish (*Ictiobus spp.)*				+
11	Catfish (*Silurus glanis*)		+		+
12	Channel catfish (*Ictalurus punctatus*)				+
13	Common carp (*Cyprinus carpio*)	+	+	+	
14	Common dentex (*Dentex dentex*)	+		+	
15	Common pandora (*Pagellus erythrinus*)	+		+	
16	Common sole (*Solea solea*)	+			
17	Crayfish (*Astacus spp*.)	+	+		+
18	European eel (*Anguilla anguilla*)	+	+		
19	European perch (Perca fluviatilis)		+		
20	European seabass (*Dicentrarchus labrax*)	+		+	
21	Flathead grey mullet (*Mugil cephalus*)	+	+		+
22	Giant river prawn (*Macrobrachium rosenbergii*)				+
23	Gilthead seabream (*Sparus aurata*)	+		+	
24	Grass carp (*Ctenopharyngodon idella*)		+		+
25	Jade perch (*Scortum barcoo*)				+
26	Mediterranean mussel(*Mytilus galloprovincialis*)	+	+	+	+
27	Northern pike (*Esox lucius*)		+		+
28	Oysters (*Crassostrea gigas, C. angulata, Ostrea edulis*)	+			
29	Pike-perch (*Sander lucioperca*)		+		+
30	Rainbow trout (*Onchorynchus mykiss*)	+	+	+	+
31	Red porgy (*Pagrus pagrus*)	+		+	
32	Russian sturgeon (*Acipenser gueldenstaedtii*)	+	+	+	
33	Sharpsnout seabream (*Diplodus puntazzo*)	+		+	
34	Silver(white) carp (*Hypophthalmichthys molitrix*)		+		+
35	South African mullet (*Chelon richardsonii*)				+
36	Stellate sturgeon (*Acipenser stellatus*)		+		
37	Tench (*Tinca tinca*)		+		+
38	Tilapia (*Tilapia spp*.)				+
39	Turbot/Black Sea brill (*Scophthalmus maeoticus-Psetta maxima)*		+	+	+
40	White seabream (*Diplodus sargus*)	+			

2.1. Brief information about the species used in aquaculture

2.1.1. *Cyprinus carpio* – carp

Body elongated and somewhat compressed. Lips thick, two pairs of barbels at angle of mouth, shorter ones on the upper lip. Dorsal fin base long with 17-22 branched rays and a strong, toothed spine in front; dorsal fin outline concave anteriorly. Anal fin with 6-7 soft rays; posterior edge of 3rd dorsal and anal fin spines with sharp spinules. Lateral line with 32 to 38 scales. Pharyngeal teeth 5:5, teeth with flattened crowns. Colour variable, wild carp are brownish-green on the back and upper sides, shading to golden yellow ventrally the fins are dusky, ventrally with a reddish tinge. Golden carp are bred for ornamental purposes.

Distribution: European lakes and rivers. It has been widely introduced to other parts of the world (North America, southern Africa, New Zealand, Australia, Asia) (Figure 1).

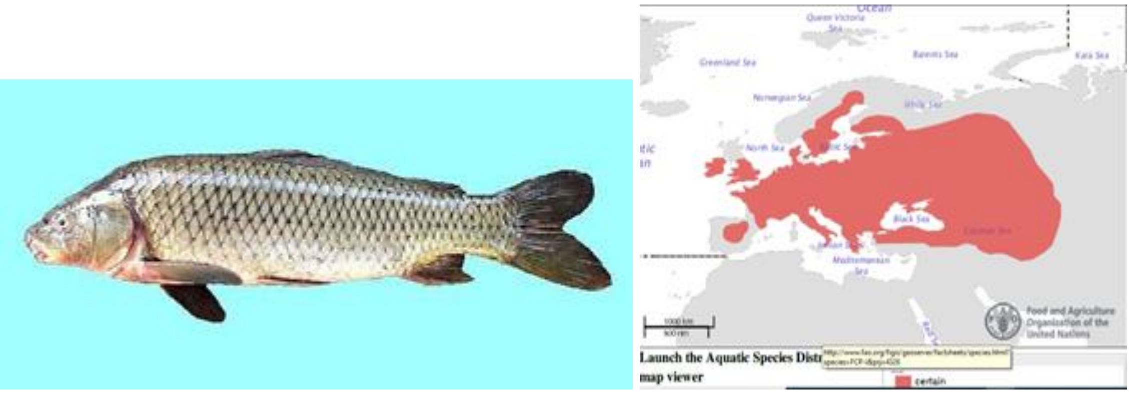


Figure 1.Common carp (Otel 2007) and distribution (Source: FAO FishStat)

Carp (*Cyprinus carpio* Linnaeus, 1758), which is an economically important species of temperate climatic regions, is resistant to cold as well as it likes heat and is very suitable for intensive breeding. It requires a small amount of oxygen and is not sensitive to handling and adapts to water temperature changes between 4-30°C in a short time. Carp is thermophilic. The best increase occurs at water temperature 20-28 ºC. Sexual maturation of the carp occurs at 3-4 years of age. Spawning requires a water temperature of 17-20ºC. Carp is an omnivorous fish, but it gives preference to benthic organisms. Carp weight (about 1000 g) can reach the carp in the second or third years of life.

The natural conditions that suit carp are lowland lakes and rivers where there are abundant vegetation to provide food and shelter. The natural habitat is dams, lakes and rivers. Depending on water temperature and food condition, it is a fast growing fish. They live 20-25 years or even 35-40 years and grow over 1 m length and 25-30 kg weight.

They thrive in warm-water conditions, and require temperatures of at least 18 ºC to spawn. Consequently, the success of populations introduced to northern Europe and the British Isles is dependent on warm weather during spring and summer. Omnivorous, feeds mainly on bottom-living insect larvae, small snails, crustaceans, and some vegetable matter. They are most active at night, and feed little at low temperatures. The diet of the young includes small planktonic crustaceans, but the larvae, after they have utilized the yolk from the egg; feed on minute rotifers and algae, and the young stages of water-fleas.

Carp has an exceptional environmental tolerance. In spite of optimum growth can be achieved above 20 °C, it remains viable sudden temperature changes <1 °C for a long time. Carp grows routinely at ‰ 5 salinity and pH intervals from 5-9. It was observed that carp continues to grow at salinity ‰ 12. It is found in all regions of Turkey and forms the major production in Aegean, Central Anatolia and Southern Anatolia regions with different growth rates. For instance it reaches l350 g in the first, over

1500 g in the 2nd and 2.5 kg in the third year. It reaches market size at the end of second year, while it takes to times more time in the Europe.

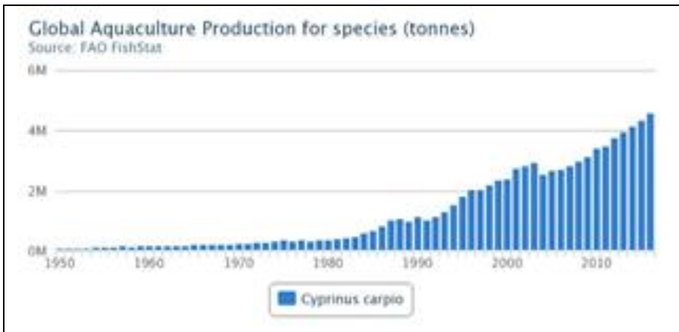
In carp culture mainly the mirror carp is used due to high growth rate, less scales and bones, high body depth and good adaptation to culture conditions in Turkey. It has been cultured in Turkey since 1970 (Çelikkale, 1988). However, in recent years, its production rate reduced around 1 % in the total aquaculture production; it was 55.48% of inland fish farming in 1988.

Carp is an omnivorous fish fed from the bottom. Carp is fed from benthic aquatic animals, plankton, pieces of plant forms and vegetative residues. Taking the small water creatures on the bottom together with the mud, throws the mud back. Therefore, it opens cavities in the mud. Some of the big carp was also observed that they ate fish (Atay & Çelikkale, 1983). Best feed intake and evaluation, 16-25 ° C water at temperatures of 23-24 °C (Çelikkale, 1988).

Carp spawns in groups in the natural environment, in lakes and slow-flowing rivers when the water temperature is 18-22 °C. Larvae hatch from the eggs adhering to the plants in 3-4 days. Spawning is shallow and abundant when the water temperature reaches 18-20 ºC between May-July. Since the most important factor in the reproduction of the carp is the water temperature, it rarely breeds or does not grow at all in Northern countries. Ovulation is completed in a week. It lays 200-300 thousand eggs per 1 kg of body weight. Their eggs are transparent and sticky and have a diameter of about 1mm. The diameter of the swollen egg is 1.6 mm. Eggs left on aquatic plants are opened in 3-4 days (60-70 days x degree). The length of the larvae after hatching is 5 mm. After staying attached 1-3 days they rise to the surface of the water, fill the swimming sac with air and start swimming and taking bait. They start feeding with plankton (algae, rotifers, and small crustaceans) and after 18 mm length start consuming benthic organisms (Çelikkale, 1988).

Growth is variable with local conditions. In south-eastern Europe (where conditions are optimum) an average length of 51-61 cm a weight of 1.8-4.5 kg is attained; in northern Europe it is rather less. A maximum weight of 32 kg is recorded.

The carp is very popular as a food-fish in Europe (and elsewhere) (Figure 2), and is well suited for cultured in fish farms; carp farming is now a considerable industry. Carp is also a popular anglers' fish and many waters are stocked with large fish. Owing to its popularity as a food or sporting fish. The total catch reported for this species to FAO for 1999 was 75235 t. The countries with the largest catches were Turkey (17797 t) and Thailand (14000 t). In 2009 Romania performed between 2000-5000 tons of carp from aquaculture (Figure 3).



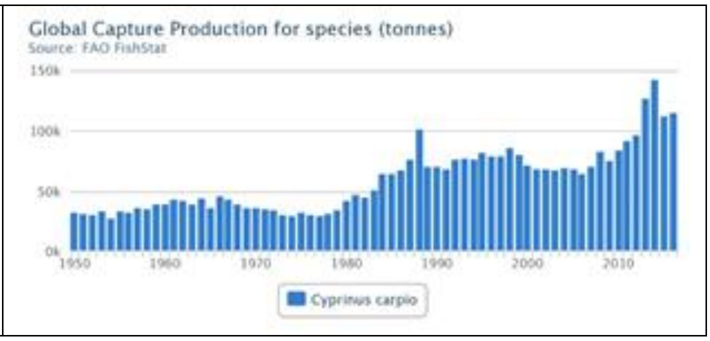


Figure 2. Global capture and Aquaculture Production of carp (Source: FAO FishStat)

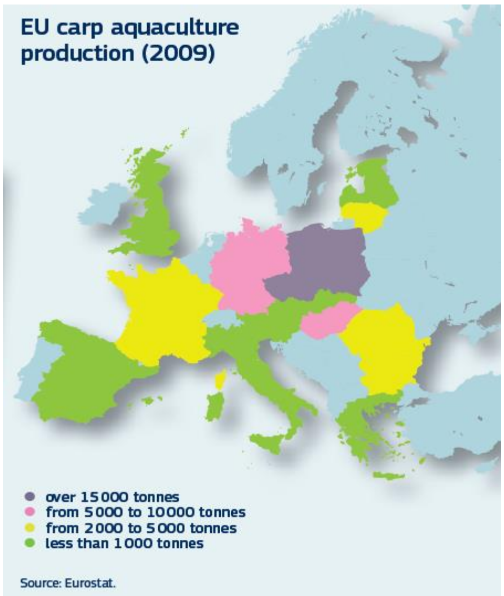


Figure 3 Aquaculture production of carp in EU (Source: Eurostat)

2.1.2. *Hypophthalmichthys molitrix* - silver carp

Body is laterally compressed and deep. Ventral fin is extending from isthmus to anus. Head large, eye small, located on the ventral side of head. Gill rakers are sponge-like. Dorsal fin with 8 rays; no adipose fin. Anal fin with 13 to 15 rays. Lateral line with 83 to 125 scales. Distributed in the Tone River, Manchuria and Mongolia, Canton, Fuchow, China, and Hanoi in Vietnam (Figure 4). Introduced to other parts of the world.

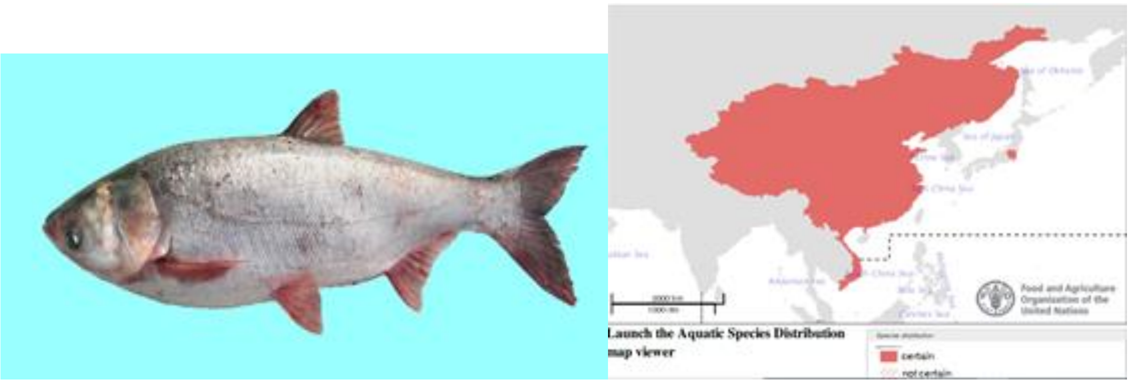


Figure 4 Silver carp species (Otel 2007) and distribution (Source: FAO FishStat)

Requires standing or slow-flowing conditions such as in impoundments or the backwaters of large rivers. Feeds on phytoplankton.

In its natural range, it migrates upstream to breed; eggs and larvae float downstream to floodplain zones. An active species are well known for its habit of leaping clear of the water when disturbed. It swims just beneath the water surface.

Size attains to 100 cm; max. Weight 50 kg. Utilized fresh for human consumption and also introduced to many countries where its ability to clean reservoirs and other waters of clogging algae is appreciated even more than its food value. The total catch reported for this species to FAO for 1999 was 18103 t (Figure 5). The countries with the largest catches were Iran (Islamic Rep. of) (14400 t) and Romania (1308 t).

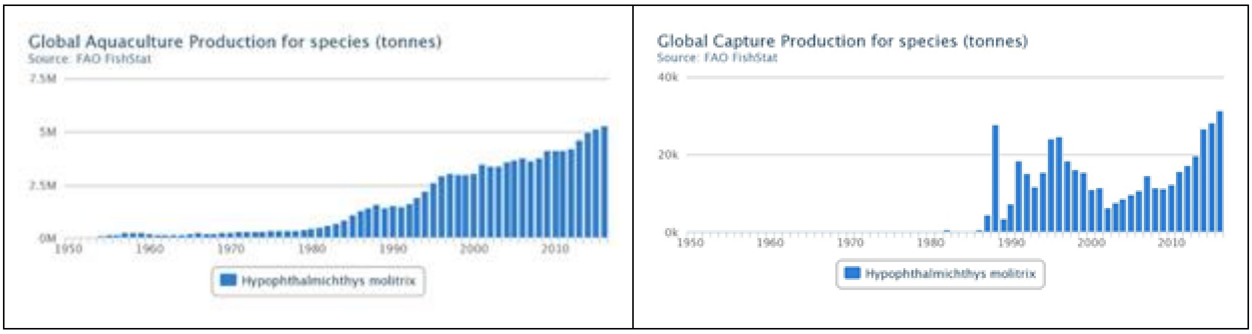


Figure 5 Global capture and Aquaculture Production of Silver carp (Source: FAO FishStat)

2.1.3. *Hypophthalmichthys nobilis* – bighead carp

Freshwater; brackish; benthopelagic; potamodromous; depth range 0 – 1.5 m. Temperate; 1°C - 38°C; 34°N - 21°N, 101°E - 123°E.

Distribution – Asia (Figure 6): China. Introduced to numerous countries and has achieved a near global distribution. However, its breeding requirements are very specialized and stocks are maintained by artificial reproduction or continuous importation. Several countries report adverse ecological impact after introduction. Often confused with *Hypophthalmichthys molitrix*.

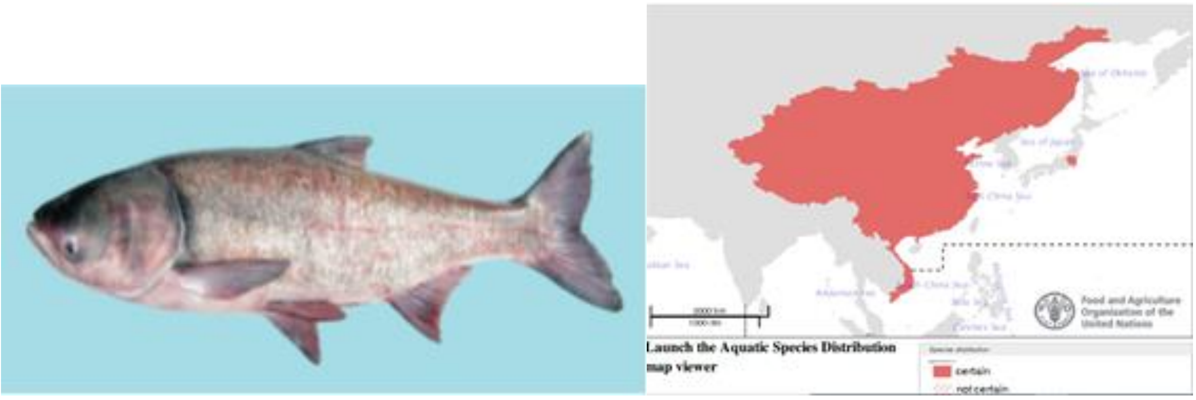


Figure 6. Bighead Carp species (Otel 2007) and distribution (Source: FAO FishStat)

In its natural environment, it occurs in rivers with marked water-level fluctuations, overwinters in middle and lower stretches. Forages in shallow (0.5-1.5 m deep) and warm (over 24°C) backwaters, lakes and flooded areas with slow current. Feeds on zooplankton throughout its life under natural conditions. Breeds in very deep, very turbid and warm water above 18°C (usually 22-30°C), with high current (1.1-1.9 m/s) and high oxygen concentrations. Stocked to large rivers and almost all still water bodies as lakes and ponds. In aquaculture, adults can survive brackish water (up to 7 ppt) when released into estuaries and coastal lakes. Feeds mainly on zooplankton, but also takes algae as food. Bottom feeding fish. Undertakes long distance upriver migration at start of a rapid flood and water-level increase (in April-July depending on locality). Spawns in upper water layer or even at surface during floods. Spawning ceases if conditions change and resumes again when water level increases. After spawning, adults migrate for foraging habitats, Larvae drift downstream and settle in floodplain lakes, shallow shores and backwaters with little or no current. During autumn-winter, when temperature drops to 10°C, juveniles and adults form separate large schools and migrate downstream to deeper places in main course of river to overwinter.

2.1.4. *Ctenopharyngodon idella* – grass carp

Body laterally compressed and deep. Ventral keel extending from isthmus to anus. Head large. Eye small, on the ventral side of head. Gillrakers sponge-like. Dorsal fin with 10-11 rays; no adipose fin. Anal fin with 10 to 14 rays. Lateral line with 38 to 54 scales. Distributed in the Tone River, Manchuria and Mongolia, Canton, Fuchow, China, Hanoi (Vietnam) (Figure 1.7). Introduced to other parts of the world (Figure 7).

Requires standing or slow-flowing conditions such as in impoundments or the backwaters of large rivers. Feeds on macrophytes.

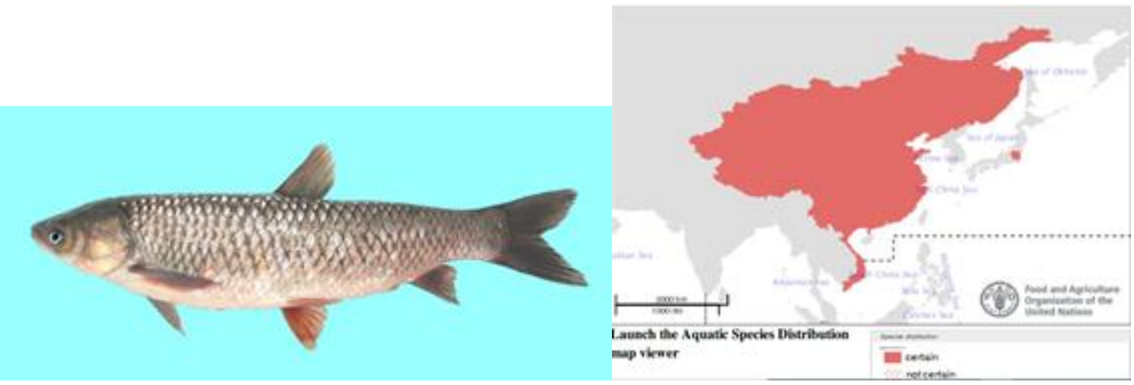


Figure 7. Grass Carp species (Otel 2007) and distribution (Source: FAO FishStat)
Habitat and Biology

Size attains to 150 cm; max. Weight 45 kg. Utilized fresh for human consumption and also introduced to many countries where its ability to clean reservoirs and other waters of vegetation is appreciated even more than its food value.

White (*Hypophthalmihthus molitrix* Val.), bighead (*Aristichthys nobilis*) and grass carp (*Ctenopharyngodon sdella*) belong to herbivorous species of fish. These species come from the Far East in the Amur River basin, acclimatized in our reservoirs.

Silver carp - large pelagic freshwater fish, whose mass reaches 16 kg, length 1 m.

White carp - feeds on polycyclic microscopic algae - phytoplankton and detritus. The white carp is not a competitor to the carp in the field of nutrition, on the contrary there is a mutual positive effect on their mutual cultivation.

The bighead carp is a partially herbivorous species, along with phytoplankton and detritus it also feeds on zooplankton. With significant exceedance of the planting norms can be a food competition carp.

Grass carp – large freshwater fish, up to 32 kg, 122 cm long. It feeds on higher aquatic vegetation. In case of insufficient amount of vegetation it can go to compound feed.

All herbivorous fish are biological ameliorators, fast-growing but more thermophilic than carp. It is recommended to grow herbivorous fish in combination with carp.

2.1.5. *Sparus aurata* - Gilthead seabream

The gilthead sea bream is farmed today on a large scale. It is found widely throughout the Mediterranean but also along the coasts of the eastern Atlantic, from the United Kingdom to the Canary Islands. It is a temperate fish, ie it can withstand large changes in salinity and water temperature.

So, it can live both in the open sea and in estuaries and lagoons. In addition to the sandy bottoms and meadows of posidonia, where it easily finds its food, gilthead sea bream is also found on rocky bottoms bordering the aforementioned ecosystems while it has also been found in underwater caves.

During the spawning season (October to December) adult fish move into deeper waters, so then the younger ones will migrate to coastal waters or river estuaries in early spring. This species is hermaphroditic, maturing as a male during the first or second year of life and then as a female during the second or third year. It is carnivorous and feeds on bivalve mollusks (eg mussels), worms, gastropods, crustaceans, etc. ds). It has the ability to be more easily settled in lakes and lagoons. This happened at Lake Vistonida, where in the late 1980s, when the lake's salinity increased due to declining freshwater and many freshwater species receded into its northern part, smelt settled in the southern part of the lake, creating large populations. Today, it is the most important species in the lake that exceeds the 50% of the total production. It should be noted that the smelt is caught in lagoons and is neither farmed nor reproduced.

2.1.6. *Huso huso* – Beluga

The beluga is a diadromous species that inhabits the Black, Azov, Caspian, and Adriatic Seas. It is more numerous in the Caspian Sea and very rare in the Adriatic Sea (Figure 8).

Spiracle present. Snout moderate and pointed, turning slightly upward. Gill membranes joined to one another to form a fold free from the isthmus. Mouth crescentic. Lower lip not continuous, interrupted at centre. Barbels oval or flat, leaf-like posteriorly reaching almost the mouth. 17-36 rod-shaped gill rakers. D: 48-81; A:22-41 rays. 9-17 dorsal scutes; 37-53 lateral scutes and 7-14 ventral scutes. Dorsal scutes oval, with a longitudinal denticulate comb. First dorsal scute is the smallest. Lateral scutes smooth. Ventral scutes hidden beneath the skin. There are numerous small bony plates between the scute rows. Back ashen gray or black, gradually transitioning to white toward the underside. Belly white, and the snout is yellowish.

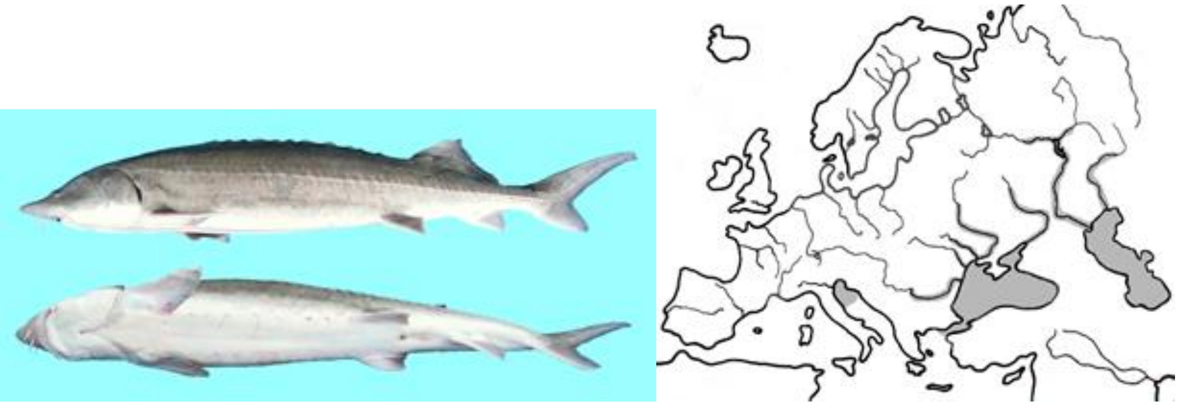


Figure 8. Beluga species and distribution (Otel 2007)

During the period of marine life, the adults mainly inhabit the pelagic zone descending at depths of 160-180 m. During both the seaward and the spawning migration, the beluga usually travels in the deepest parts of the riverbed. Juveniles during the first year of life remain in warmer, shallow habitats. The main food of juveniles appears to be insect larvae, especially of Ephemeroptera, crustaceans (gammarids, mysids, copepods, and cladocerans). Beluga begins preying on fishes, at a very early age (with a length of 24 cm in the lower Danube). Preferent prey items are Alosa spp., anchovy, cyprinids (Cyprinus, Leuciscus, Scardinius, and Aspius). Marine fishes, such as bonito, horse mackerel and sprat are important in it diet between May and September, when the beluga are congregating near the coast prior to entering rivers; during the autumn and winter they descent into deep regions of the sea and feeds mainly on red mullet, whiting, flounder and anchovy.

First sexual maturity is reached by the great sturgeon very late. Most males of the Volga population mature at 14-16 years; most females reach this stage at 19-22 years. Subsequent spawning apparently begins at least 5 years later. The great sturgeon spawns far upstream in all rivers. Spawning period usually coincides with a high water period in spring and begins at a water temperature of 6° to 7 0 °C, and it ceased when the temperature reaches 21°C. The spawning sites are usually in the river bed, at a depth of 4 to 15 m, with a hard, stony or gravelly bottom; the hatchlings at an early age travel to the sea.

Maximum size: about 6 m and a weight exceeding 1000 kg (Berg, 1948). Length of 8 m and weight of 3200 kg have been reported, but they raise doubts. Usually 120-260 cm and to 363 kg.

The beluga was one of the important commercial freshwater fish (Figure 9). The great stocks of the species are concentrated in the Caspian region, but as a result of the presence of dams along the rivers, the natural reproduction of this species in the Caspian watershed has been reduced to a minimum. At present time, the size of the population is being maintained by stocking with cultured fishes (Pirogorskii et al., 1989). Bester, a hybrid of female *Huso huso* and male sterlet *Acipenser ruthenus*, has been successfully cultivated for its high-quality eggs.

Actual commercial fishing is prohibited in Romania since 2006 (Figure 9).

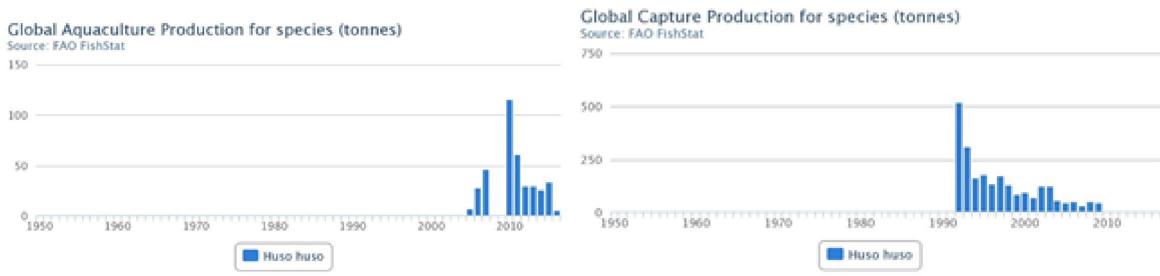


Figure 9. Global capture and Aquaculture Production of Beluga (Source: FAO FishStat)

2.1.7. *Acipenser gueldenstaedtii* – Russian sturgeon

Spiracle present. Snout short and blunt. Gill membranes joined the isthmus. Mouth transverse and lower lip with a split in the middle. The barbels are attached closer to the tip of snout than to the mouth and they are non-fimbriated. 15-51 gill rakers, which are not fan-shaped, terminated by a single tip. D: 27-51; A: 18-33 rays. 8-18 dorsal scutes; 24-50 lateral scutes and 6-13 ventral scutes. Between the rows of scutes there are numerous bony plates. The colouration is greyish black, dirty green, or dark green dorsally. Laterally, it is usually greyish brown, and ventrally, grey or lemon. The juveniles are blue dorsally and white ventrally.

In the sea, the Russian sturgeon (Figures 10 and 11) inhabits shallow waters of the continental shelf; in the rivers it remains at depths from 2 to 30 m.

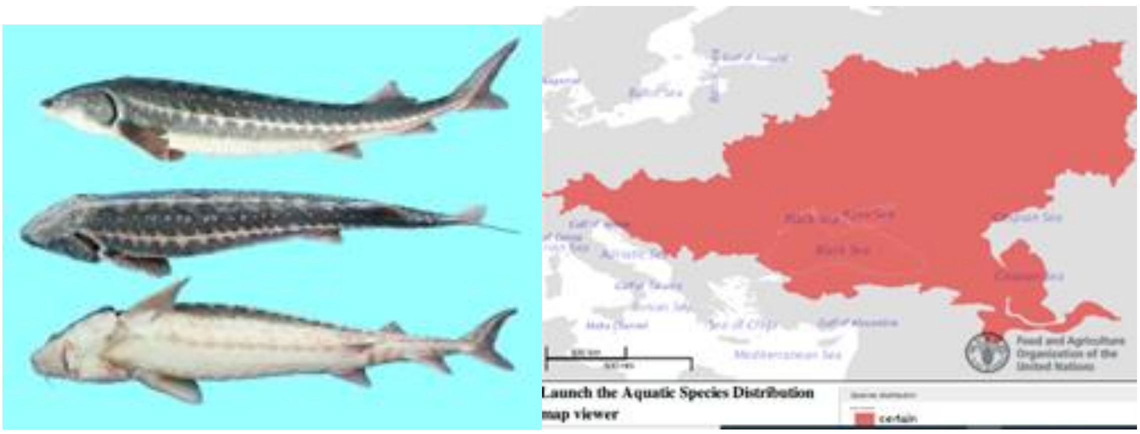
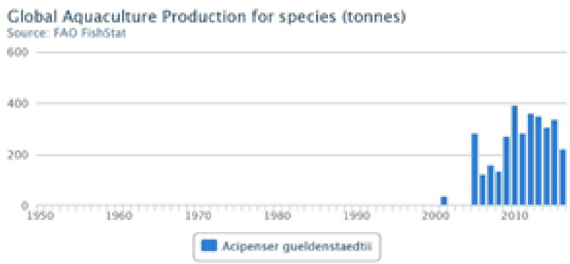


Figure 10. Russian sturgeon species (Otel 2007) and distribution (Source: FAO FishStat)

The larvae are found at considerable depths and in rapid currents. Besides the main diadromous form, a freshwater form that does not migrate downstream to the sea has been reported from various rivers. The Russian sturgeon is a bottom-dwelling mollusk-feeder (Corbulomya, Abra, Cardium, Nassa). They also readily consume crustaceans (shrimps and crabs) fishes (Engraulis encrasicolus, Sprattus sprattus and gobiids) and polychaetes. The main food items of juveniles are crustaceans, including mysids and corophiids, and polychaetes.

The great majority of the males begin to reproduce at an age of 11 to 13 years, while the equivalent age for the females is 12 to 16 years. In the Volga River, the males require two to three years to reproduce again after spawning, while the females take four to five years. Usually, the spawning run of this species into the rivers begins in early spring, reaches its peak in mid to late summer and ceases in late autumn. In the Volga River the spawning period extends from mid-May through early June. The spawning sites are gravel or stony beds at depths from 4 to 25 m. Spawning at water temperatures between 8.9º C and 12º C.



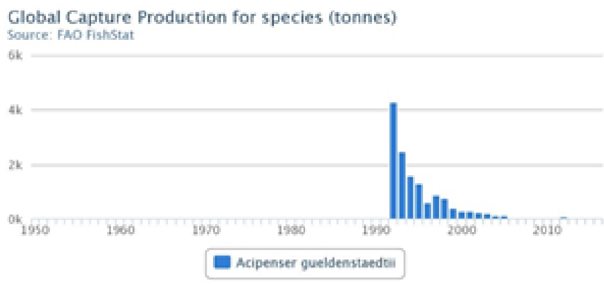


Figure 11. Global capture and Aquaculture Production of Russian sturgeon (Source: FAO FishStat)

Actual commercial fishing has been prohibited in the Black Sea since 2006.

2.1.8. *Acipenser stellatus* – Stellate sturgeon

Spiracle present. Snout greatly elongated and sword-shaped, usually more than 60 % of the head length. Gill membranes joined the isthmus. Mouth transverse and lower lip with a split in the middle. The barbels are short and no fimbriate, not reaching the mouth but nearer to it than to the tip of snout. D: 40-54; A: 22-35 fin rays. 9-16 dorsal scutes; 26-43 lateral scutes; 9-14 ventral scutes. The dorsal scutes have radial stripes and strongly developed spines with the tips directed caudal. Between the rows of scutes, the body is covered by star plates. The body coloration is blackish-brown dorsally and laterally. The belly is light, and the ventral scutes are dirty white colored. During the daytime they are often encountered in the upper layer, while at night, they are generally found at the bottom. The starry sturgeon (Figures 12 and 13) inhabits the coastal sea waters (at depths from 100 to 300 m in the Caspian and Black Sea) over clayey or sandy and clayey sediments, and the lowland section of rivers. Feeding habits vary with size, season and specific features of the water bodies (rivers or sea).

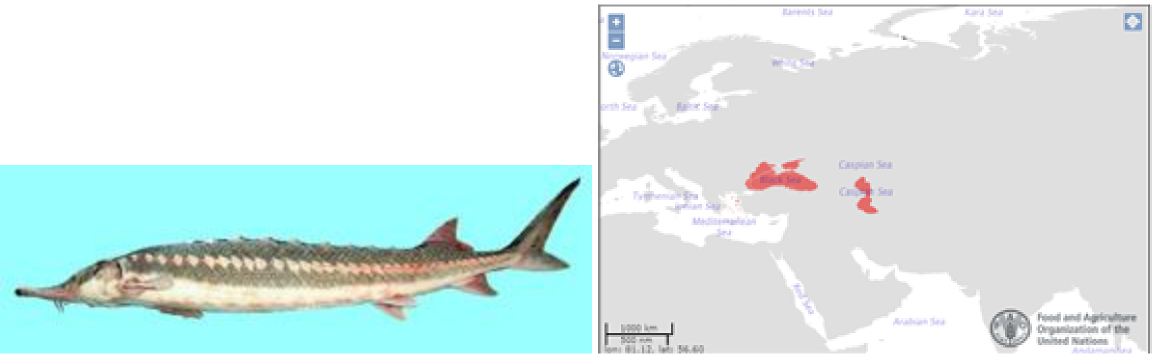


Figure 12 Stellate sturgeon species (Otel 2007) and distribution (Source: FAO FishStat)

The younger individuals feed primarily on crustaceans, while fishes (Gobiidae, *Caspialosa* and *Clupeonella*) become more important in the diet as the grey older. Also molluscs, Polychaeta and other invertebrates. Sexual maturity is reached by males at an age of five or six years. Females mature with an average age of 9.7 years and rarely spawn more than three times in their lives. Enters rivers from April to June with a peak period when the water temperature reaches 10º to 15ºC. Eggs laid on beds of scattered stones, pebbles, gravel and sand. The juveniles stay near the mouth of rivers. Its population is supported by artificial propagation. Spawn from May to September at a water temperature of 12º to 29ºC.

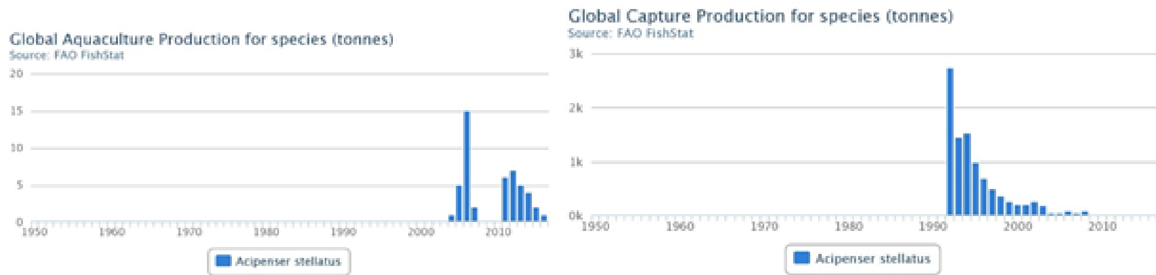


Figure 13. Global capture and Aquaculture Production of Stellate sturgeon (Source: FAO FishStat)

Actual commercial fishing has been prohibited in the Black Sea since 2006.

2.1.9. *Sander lucioperca* – pike-perch

Two dorsal fins, the first spiny and separated by a narrow interspace from the second.

Native to Eastern Europe (from Netherland to Caspian Sea) (Figure 14), but has been introduced to the Rhine catchment and to England. It is now widespread in France and Western Europe, and is rapidly extending its range in eastern and central England. Inhabits rivers. Feeds regularly on fishes, also insects and crustaceans. This species has depleted stocks of native fish in some areas where it has been introduced for angling. Spawn between April to June over sandy or stony bottoms, or among the roots of larger aquatic plants, being earlier in lower latitudes.

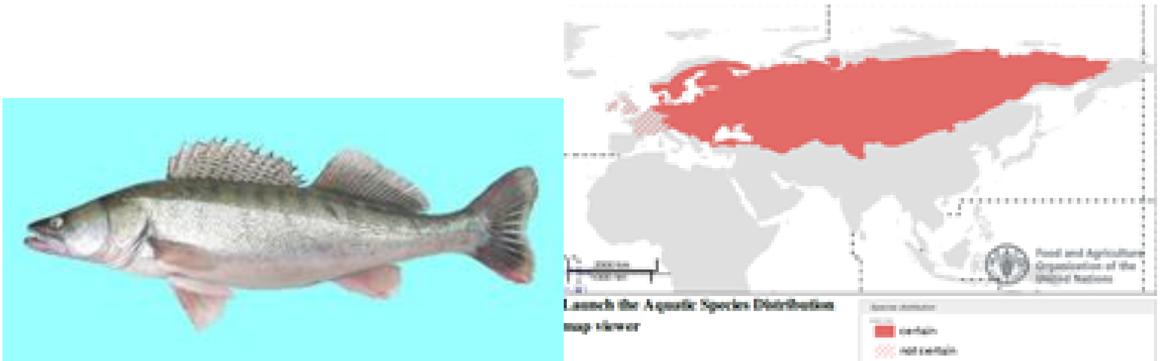


Figure 14 Pike-perch species (Otel 2007) and distribution (Source: FAO FishStat)

Valuable sporting fish, and in inland Europe an important food-fish (Figure 15). Here considerable effort is made to increase the stock in fish farms. The total catch reported for this species to FAO for 1999 was 17 892 t. The countries with the largest catches were Russian Federation (3644 t) and Kazakhstan (3250 t).

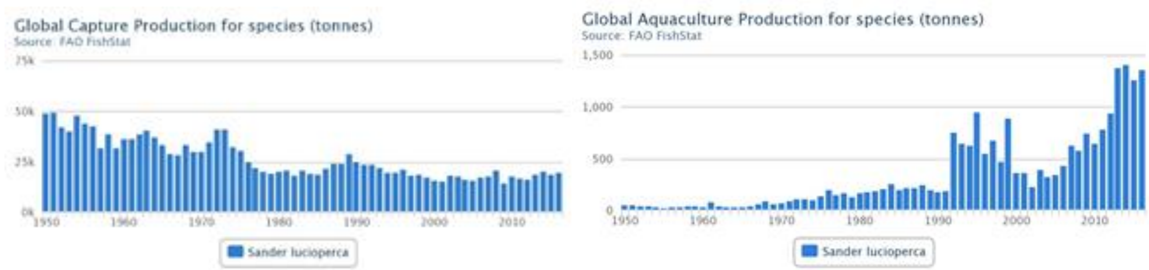


Figure 15. Global capture and Aquaculture Production of Pike-perch (Source: FAO FishStat)

2.1.10 *Oncorhynchus mykiss* - Rainbow trout

Actinopterygii (ray-finned fishes) > Salmoniformes (Salmons) > Salmonidae (Salmonids) > Salmonidae

Marine; freshwater; brackish; benthopelagic; anadromous; depth range 0 – 200 m. Subtropical; 10°C - 24°C; 67°N - 32°N, 135°E - 117°W.

The original homeland of rainbow trout (Figure 1) is the Pacific of North America, rivers and lakes in the region, especially the mountainous rivers of California; Mc- Cloud-River hosts this species. Later it was carried to the other parts of North America for enhancement and in 1880 it was taken to Europe and then to other continents. Farming trials showed that it grows faster than the others and more suitable for farming letting more earnings. Despite years of effort, reinforcement from artificial production stocks only a few rainbow trout races can naturally fertilize and survive in nature forming populationsInhabit clear, cold headwaters, creeks, small to large rivers, lakes, and intertidal areas.

Anadromous in coastal streams. Stocked in almost all water bodies as lakes, rivers and streams, usually not stocked in water reaching summer temperatures above 25°C or ponds with very low oxygen concentrations. Feed on a variety of aquatic and terrestrial invertebrates and small fishes. At the sea, they prey on fish and cephalopods. Mature individuals undertake short spawning migrations. Anadromous and lake forms may migrate long distances to spawning streams. Utilized fresh, smoked, canned, and frozen; eaten steamed, fried, broiled, boiled, microwaved and baked. Cultured in many countries and is often hatched and stocked into rivers and lakes, especially to attract recreational fishers (Figures 16, 17 and 18).

The rainbow trout (Oncorhynchus mykiss), so named because of the many iridescent spots on its skin, is one of the main species raised in freshwater. Rainbow trout is now farmed in almost all European countries.

Figure 16 Rainbow trout and distribution (Source: Fish Base)

Figure 17. Rainbow trout

Rainbow trout is a freshwater fish with a fairly satisfactory level of adaptability to brackish-marine waters. It is resistant to a wide variety of habitats and management modes.

Cultivation with intensive selection caused the formation of different colored varieties; however, it did not lose its characteristic rainbow coloring. This coloration is mainly pink-red band in the middle part of the body and extends to the tail root. There are prominent black spots on the head, body, back and tail fins. The males are darker and have a hook-shaped lower jaw in the reproductive period, especially in older individuals. The long upper jaw extends further back from the posterior edge of the eye.

The species can withstand huge temperature fluctuations (0-27 ° C), but spawning and growth occur in a narrower range (9-14 ° C). The optimum water temperature for its breeding is below 21 ° C. Its growth and maturation are affected by water temperature and food. In optimal breeding conditions, trout usually matures in 3-4 years. It is carnivorous and needs a diet rich in protein. In the proper environment, a trout can reach 350 grams in 10 to 12 months.

Naturally, the larvae of aquatic insects feed on zooplankton, mollusk and small fish.

They reach sexual maturity at the age of 2-3. They live 5 or 10 years in nature, but in exceptional cases it has been observed that they live 18 years and more. It is generally reported that they are between 1-5 kg and reach a maximum weight of 24 kg and a length of 120 cm. Reproduction (artificial milking and fertilization) takes place between October and April in European conditions. As a result of genetic studies, the reproductive period was spread throughout the year. However, it is reported that fish in the southern hemisphere lay eggs with a six-month time difference from the northern hemisphere, since photoperiod difference is observed. Fecundity varies between 1500-3000 eggs per kg live weight, and suitable water temperature for spawning is 7-12 ^{o}C. In their original habitat spawning occurs in shallow parts of the river, and eggs are laid in nests dug into the riverbed by the female. The hatching time of the larvae is 30-32 days at an average of 10 °C. For aquaculture, the ideal water temperature in the larvae and juvenile periods is 8-13 ^{o}C and 12-18 ^{o}C in the fingerling and on-growing stage. Rainbow trout can withstand temperatures 24 ^{o}C and above for a short time, they survive at 20-22 ^{o}C. However, the optimum feeding temperature is between 15-20 ^{o}C. Salinity resistance of trout increases as the fish grow. Salinity value rising from ‰ 3 to ‰ 6 has a positive effect on development of fry in 0.5 g. Values between ‰12-15 may adversely affect those weighing 5 g. In fish weighing 50 g, salinity values between ‰12-15 have a positive effect 70% on development compared to ‰0-1. It is possible to grow in the sea water with the salinity ‰ 30 from fingerling to edible size.

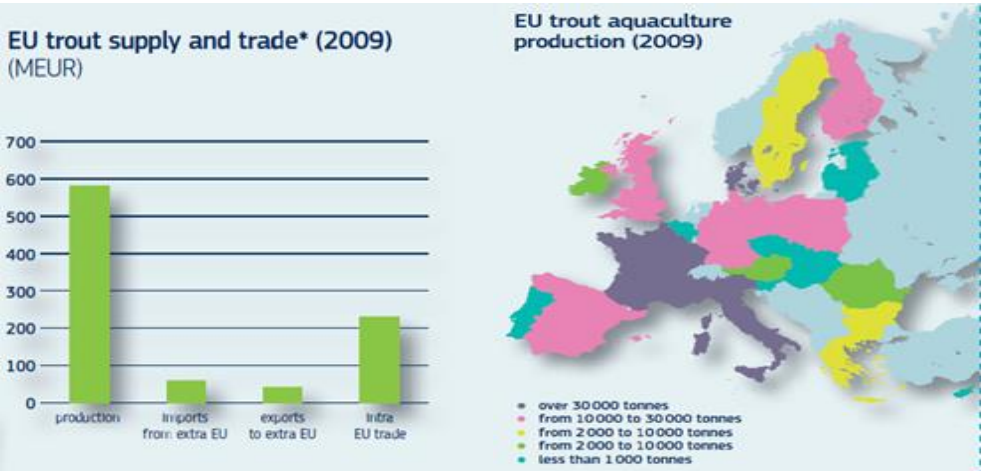


Figure 18. Aquaculture Production of trout in EU (Source: Eurostat)

2.1.11. *Salmo labrax* – Black Sea salmon/trout

The Black Sea trout (*Salmo labrax*) is a member of the Salmonidae family and can be distinguished from other subspecies by the presence of a distinct black spot on the gill cover, the presence of irregular black spots on their bodies and the presence of distinct white rings around the red spots (Figure 19).

They spend most of their lives in the sea, where they grow and thrive. They migrate to freshwaters during reproduction periods. They can reach up to 100 cm in length and weight up to 26 kg in the Black Sea. The characteristic feature is that the parents return to the waters where they lay eggs.

Figure 19. Black Sea trout (*Salmo labrax*)

It reaches sexual maturity between the ages of 2-4. Spawning period of the sea ecotype starts in November-December and continues until the end of February. For spawning, they usually prefer pebbly places and lateral branches at the beginning of the water supply. In the Black Sea trout, spawning continues till the end of October with the temperature between 8 and 10°C. 80% of females lay eggs in November. Fecundity is 2000–3000 eggs per kilogram and Because of their reproductive characteristics these ecotypes migrate between sea and fresh water. In the autumn months, they enter the fresh water flowing into the Black Sea and lay their eggs in the nests they open between the sand or gravel. Hatchlings stay in fresh water for a year and then migrate to the sea. They lay their eggs on a suitable ground at a depth of 20-25 cm. Egg diameter is between 4.8–7.2 mm, hatching of the larvae begins after 60-80 days at 5–7 ° C and the fry appear in April. The period from egg to free swimming can be more than 2 months.

Fecundity varies between 1500-2000 eggs per 1 kg live weight and the suitable water temperature for spawning is 8-10 °C. Egg size is 5-6 mm. The length of larvae hatching is 13-15 mm. The larvae eat their food sacs in 3-4 weeks and reach up to 25-30 mm.

It has been farmed for the last 20 years and there is also the production of fry for fertilization of natural stocks.

While the young individuals of this ecotype have many black and red spots scattered on both sides of their bodies while in fresh water, these colour disappear after migration to the seas and the fish takes on a silvery colour.

The food of smolts in stream mouths and seas are mainly insects. They prefer to consume anchovy, other small fish species and crustacea in the seas, intensely aquatic insects and some animal detritus in lakes and rivers. At the end of the first growing period, juveniles in rivers reach 9.5–16.5 cm in length and 13–50 g in weight. They reach 16-36 cm in their 2nd age and 42.5-57.0 cm in their 3rd age.

Black Sea trout is an anadromous species and is found in many streams in Northern and North-eastern Anatolia in Turkey. It is available on the entire Black Sea coast via Georgia, the Caucasus, the Crimea, the Sea of Azov, Romania and Bulgaria. Its distribution area starts from 40 km east of Surmene, Trabzon and reaches the Georgian border through Coruh River. Fırtına, Çağlayan, Çoruh, Kapistre, Fındıklı, Taşlıdere, İyidere, Baltacı and Solaklı are important rivers inhabited *S. labrax* (Figure 20).

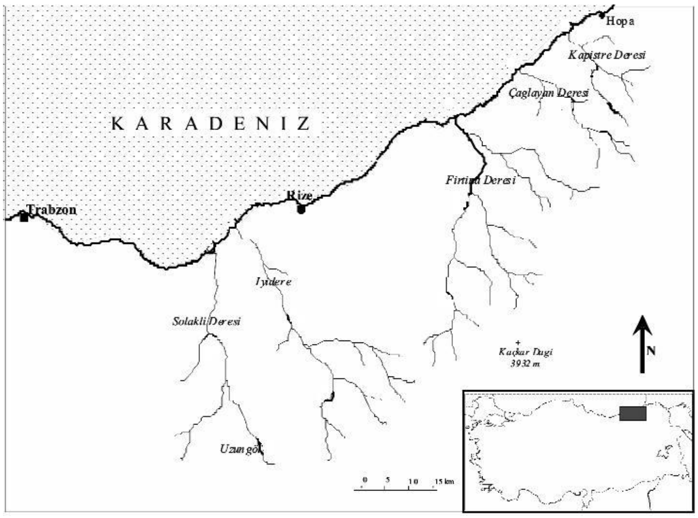


Figure 20. Natural distribution area of Black Sea trout in the Black Sea Region of Turkey (Kocabaş, 2005)

2.1.12. *Scophthalmus maeoticus* - Turbot / Black Sea brill

Actinopterygii (ray-finned fishes)> Pleuronectiformes (Flatfishes)> Scophthalmidae (Turbots)
Marine species; demersal; depth range 10 - 150 m. Temperate; 47°N - 41°N, 27°E - 42°E
Distribution: Europe – Black Sea (Figure 21).
Short description: Bony tubercles generally developed on both sides which are always larger than eye.

Figure 21. Turbot species and distribution (Source: Fish Base)

Brill *Psetta maeotica* Pallas, is one of the most valuable commercial fish in the Black Sea. Spawning of the turbot begins in April-May at a temperature of 7-10ºC, and ends in July-August. Reproduction occurs at a distance from the shores in conditions of stable salt and temperature conditions.
The absolute fertility of a turbot varies from 2.5 to 14 million eggs. The spawning stock is dominated by spawning fish. Mature males weigh 0.8-1.3 kg, females over 1.5 kg. In April-May, the turbot fits shallows for foraging and spawning, wintering at depths of 100-120 m. Under natural conditions, no more than 1% of embryos survive so despite the fact that a number of restrictions were imposed on the Black Sea countries, and since 1986.

2.1.13. *Mytilus galloprovincialis* – Black mussel

Mussels are found in a wide variety of habitats, from tidal areas to fully submerged zones, with a broad range of temperature and salinity (Figure 22 and 23). They feed on phytoplankton and organic matter by constantly filtering the sea water and are therefore always farmed in areas that are rich in plankton.

Figure 22. Black mussel species and Aquaculture Production of mussel in EU (Source:Eurostat)

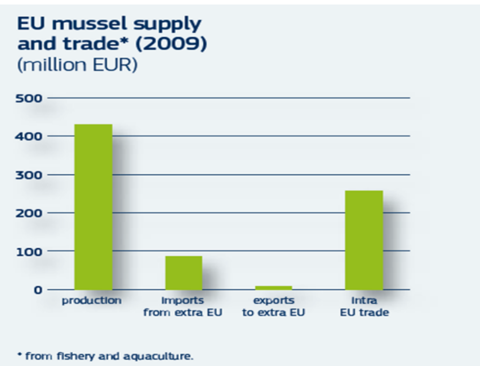


Figure 23. Production of mussel species in EU (Source: Eurostat)

Water quality is a very important factor for mussel rearing. Specific features of mussels are their high fecundity and a mobile larval phase, allowing for widespread distribution. Usually between March and October, depending on the latitude, mussels produce larvae that are carried by currents. In less than 72 hours, the larvae fatten and develop to a stage where they can no longer float. They then settle, attaching themselves to various substrates.

2.1.14. *Crassostrea gigas, C. angulata, Ostrea edulis* - Oysters

Nowadays, farming the endemic *Ostrea edulis* is very limited in Europe. Excessive exploitation and disease have led to the depletion of its reserves. The Japanese oyster (*Crassostrea gigas*), which is native to Japan, was brought to Europe in the 1970s. Thanks to its rapid growth and adaptability to different environments, Japanese oyster is currently the most widespread type of oyster farmed worldwide, including Europe. This species is currently subject to significant mortality rates in several Member States. It began breeding in nature in the northern EU member states- never bred in the past- a fact that has led to its extensive deposition in some coastal areas. Oysters are hermaphroditic and change sex during their growth, by maturing first as males and then conclude as females. Reproduction depends on the temperature and the salinity of the water.

Prior to their deposition, the offspring spend some time in the seabed and are widely distributed through the water currents. Then they change their shape, acquiring the young form of the two-door shell shown above. Oysters are fed by filtering the water.

2.1.15. *Mugil cephalus* - Flathead grey mullet

The flathead grey mullet is found in almost all tropical and subtropical regions of the world. It is a sedimentary species, often found along river estuaries and freshwater and is breed in the sea. It can stand from 4-32 C. Adults fish have been found in waters ranging from zero salinity to 75 ‰, while young individuals can withstand such a wide scale of salinity when they have reached a length of 4-7 cm.

Adults live in schools mainly in shallow waters, with sandy or muddy bottoms and dense vegetation and migrate to the open sea to give birth. The larvae move along the coast in extremely shallow waters, which provide cover for predators as they are a rich food for predators. After reaching 5 cm in length, the young gradually move to slightly deeper waters. The breeding season is from July to October. In optimal conditions, the carp matures in 2-3 years. And it is an omnivorous species as it feeds on zooplankton, dead plant and organic matter, and also filters sandy sediments.

2.1.16. *Dicentrarchus labrax* - Seabass

Sea bass is a valuable fish species of economic importance in Greece, Turkey and other Mediterranean countries. It is a type that is very popular and accepted as a luxury product. It is also preferred in sport fishing. The decrease in natural stocks due to reasons such as overfishing and environmental pollution has led to the initiation of studies on farming. The first activities started in 1905. Commercial production of sea bass in countries such as Italy and France coincides with the 1970s (especially 1976-78). The scientific and commercial studies on the sea bass in Turkey gained momentum after 1985. At present sea bass farming has been widely carried out in France, Italy, Spain, Greece, Portugal, Turkey and Tunisia.

Sea bass is naturally distributed between 30ºN (North Africa) and 50ºN (Ireland, North Sea and Baltic Sea) latitudes along the Mediterranean, Aegean (even Marmara and Black Sea) and East Atlantic beaches (Figure 24). It is also carnivorous and demersals fish. Sea bass has a fusiform body shape, but the body is flattened from the sides and covered with large ctenoid scales. Cycloid scales are found on the head and cheeks. The nose part is without scales. There are 65-80 scales on linea lateralis. The number of spines on the first gill arch varies between18-27. There is a certain distance between the dorsal fins. The dorsal fin has 8 or 10 hard rays, the second dorsal fin has 1 hard and 14 soft rays. The anal fin has 3 spines, 10 or 12 soft rays.

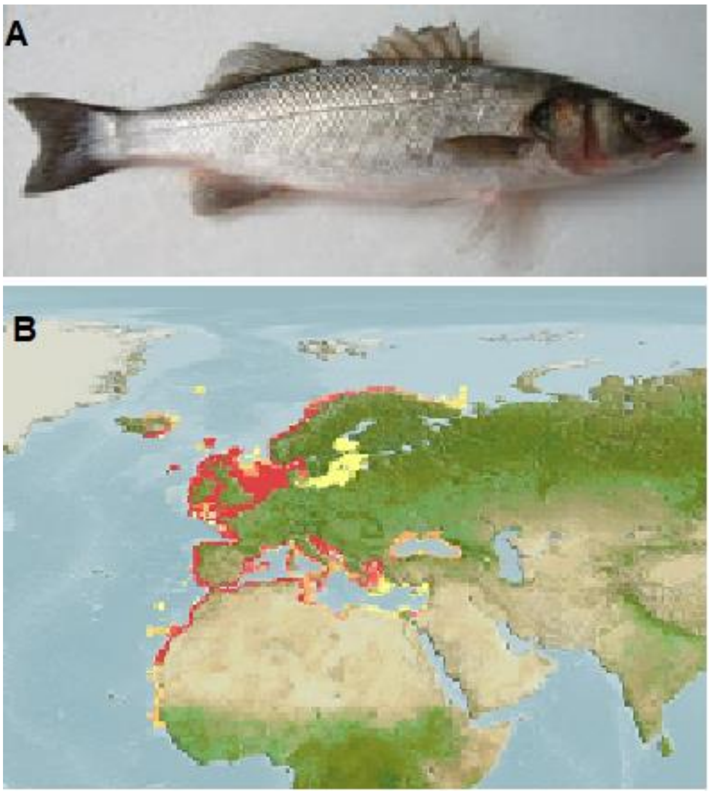


Figure 24. Sea bass (*Dicentrarchus labrax*) (A); natural distribution areas (B) (www.fishbase.org)

The mouth is big and the vomer has half-moon-shaped teeth. There are spiny protrusions on the operculum and pre-operculum. The edge of the gill covers is very sharp and hard. The colour is dark lead on the back, silvery on the sides, and white on the abdomen. The back of the adults is dark with no spots and sometimes with black spots in the youth. There is a blackish spot on the upper part of the operculum. There are also black spots on the eye bone. The prominence of black spots on the body decreases as the fish age. In female fish, the nose is wider and the bodies are wider. Males, on the other hand, are thin, long-bodied and slightly smaller than females. The mouth is wide; there are teeth on the palate and tongue.

Sea bass live in coastal shallow waters. It is also seen in brackish lagoons and river mouths. It usually lives alone. After the end of summer, they migrate to the beaches and rivers.

It is a species of eurythermal and euryhaline. Environmental tolerances to temperature and salinity from the environmental factors are as follows: They live at temperatures between 2-32ºC (usually 5-28ºC). The optimum growth temperature is 22-24ºC, and the temperature at which the growth stops is 7-10ºC. While the upper lethal limit is 34ºC, the lower lethal limit is around 1ºC. If they prefer 12-14ºC water temperature in the spawning period, it is observed that they lay eggs at 10-25^{o}C water temperatures.

They are also very tolerant against salinity changes. Although they can survive even in freshwater and overly salty branches, they generally distributed between ‰ 3-35 salinity.

Although the preferred oxygen level is 7-8 mg/lt, the oxygen level should not be less than 4.5 mg/lt for a comfortable life. They can live at a level of 2 mg/lt O_2 for a temporary period. They like to live in wavy waters. They do not like too turbid and dirty water.

They show uniform distribution on sand, rocky and grass-covered sea beds. Although they can dig tunnels in areas with loose floors, they are less common in muddy areas. They are found in turbid river mouths, sandy beaches and dirty port areas. Embryos are more sensitive than larvae and larvae are more sensitive than juveniles. Sea bass shows low sensitivity to relatively low rates of pollution such as hydrocarbon and insecticide. High turbidity causes irritation of the gills. Fuzzy watery areas should not be considered for sea bass cultivation. It is believed that light intensity does not have a significant effect on the distribution of the perch.

A variety of zooplankton and crustaceans (such as Amphipoda like Gammarus, shrimps like Crangon), Idothea and Ligia are the feed of the sea bass, in line with their predatory and carnivorous features. Adults prefer fish such as sardines, Cephalopodas like Sepia and Loligo, crustaceans such as Palaemon, Carcinus and Portunus, and bivalve mollusks such as mussels and scallops.

The life of sea bass is quite long. They can reach a weight of 15 kg (an average of 1.5-6.0 kg) and 1 m of length (an average of 0.5 m). The ones smaller than 1 kg are locally called “ispendek”, the ones between 1.0-1.5 kg are called “palaz-youngster” and the ones larger than 1.5 kg are called sea bass.

Males grow slower than females and develop more rapidly than those living in warmer regions. In the temperate seas, the growth in the first age group is quite fast and they reach up to 250-350 gr. With the determination of gender characters from the second age, some of the energy received is spent on the development of gonad and the growth rate decreases.

Sea bass are heterosexual. There is no hermaphroditism as it is seen especially in sea bream. They reproduce once a year in the same season. Although males and females are very similar by morphology, they also have some distinctive features as gonads located on the back of the abdomen of the body opens out with genital opening in males and with a genital protrusion in females. Immature individuals, these two structures are not developed. In addition, as a result of a pressure on the abdomen of individuals who have reached sexual maturity in the reproductive period, it is possible to determine the sex by sperm in males and the outflow of eggs in females.

Size and age of sexual maturity vary between locations. For instance in Mediterranean and Aegean Sea sexual maturity of males is 2-3 years, 25-30 cm length, females 3-5 years, 30-40 cm length, but in the Atlantic Ocean males attain sexual maturity at 4-7 years, 32-37 cm in length; females 5-8 years, 38-42 cm in length.

Testis and ovaries are very different from each other in the reproductive period in adult individuals. Ovaries are cylindrical and pinkish or orange in this period. Testis has a triangular structure and their colors are white.

Eggs are spherical and pelagic, in the size of 1.0- 1.40 mm (average 1.15-1.16 mm). The diameter of the oil drop is 0.33- 0.36 mm. The embryo has black pigments. Yellow pigments are then formed and are visible on the embryo, oil drop, and vitellus. Due to the large black pigments, the eggs of the species can be easily distinguished from the others. Their fecundity is very high: the relative fecundity varies between 500000-1000000 eggs per kg.

In the Mediterranean and Aegean, the development of gonads begins in September and continues until December-January. As the water temperature drops to 12ºC, the number of individuals laying eggs increases. Spawning starts in December depending on the water temperature and continues until the beginning of March. On the Atlantic coast, spawning is 2-3 months later (in April) and spawning period is shorter. In general terms, they prefer the coldest months when the water temperature is between 12-14 ^{0}C as the spawning season. It was determined that the salinity rate was not very effective on ovulation time. Day length also has an effect on spawning, and they prefer the shortest and coldest months of the year to lay eggs. Sea bass living in the Mediterranean reach younger and younger sexual maturity than sea bass on the Atlantic coast. They lay eggs in river mouths, lagoons or littoral zone where salinity is high (‰ 35-37). In the spawning period, females shed all their eggs within a few hours.

2.1.17. Tilapia

Tilapia is the common name for nearly a hundred species of cichlid fish from the coelotilapine, coptodonine, heterotilapine, oreochromine, pelmatolapiine and tilapiine tribes (formerly all were in Tilapiini), with the economically most important species placed in Coptodonini and Oreochromini. Tilapia are mainly freshwater fish inhabiting shallow streams, ponds, rivers, and lakes, and less commonly found living in brackish water. Historically, they have been of major importance in artisanal fishing in Africa, and they are of increasing importance in aquaculture and aquaponics. Tilapia can become a harmful invasive species in new warm-water habitats such as Australia, whether deliberately or accidentally introduced, but generally not in temperate climates due to their inability to survive in cold water.

The popularity of tilapia came about due to its low price, easy preparation, and mild taste.

Tilapia typically has laterally compressed, deep bodies. Like other cichlids, their lower pharyngeal bones are fused into a single tooth-bearing structure. A complex set of muscles allows the upper and lower pharyngeal bones to be used as a second set of jaws for processing food (cf. morays), allowing a division of labor between the "true jaws" (mandibles) and the "pharyngeal jaws". This means they are efficient feeders that can capture and process a wide variety of food items. Their mouths are protrusible, usually bordered with wide and often swollen lips. The jaws have conical teeth. Typically, tilapia have a long dorsal fin, and a lateral line which often breaks towards the end of the dorsal fin, and starts again two or three rows of scales below. Some Nile tilapia can grow as long as 60 cm.

It has been used as biological controls for certain aquatic plant problems. They have a preference for a floating aquatic plant, duckweed (Lemna sp.) but also consume some filamentous algae. In Kenya, tilapia were introduced to control mosquitoes, which were causing malaria, because they consume mosquito larvae, consequently reducing the numbers of adult female mosquitoes, the vector of the disease. These benefits are, however, frequently outweighed by the negative aspects of tilapia as an invasive species.

Tilapia is unable to survive in temperate climates because they require warm water. The pure strain of the blue tilapia, *Oreochromis aureus*, has the greatest cold tolerance and dies at 7 °C, while all other species of tilapia die at a range of 11 to 17 °C. As a result, they cannot invade temperate habitats and disrupt native ecologies in temperate zones; however, they have spread widely beyond their points of introduction in many fresh and brackish tropical and subtropical habitats, often disrupting native species significantly. Because of this, tilapia is on the IUCN's 100 of the World's Worst Alien Invasive Species list.

Other than their temperature sensitivity, tilapia exists in or can adapt to a very wide range of conditions. An extreme example is the Salton Sea, where tilapia introduced when the water was merely brackish now lives in salt concentrations so high that other marine fish cannot survive.

Tilapia are also known to be a mouth-brooding species, which means they carry the fertilized eggs and young fish in their mouths for several days after the yolk sac is absorbed.

2.1.18. *Anguilla anguilla* - Eel

European eel is one of the most delicious and valuable fish species on the world market. Smoked pimple is one of the most delicious delicacies among delicatessen lovers. In addition to being very tasty, eel meat has "renewable" abilities, so fish of this species are in high demand in Asian countries, where a large variety of interesting animal species are consumed. In European countries, for a long time there has been a taboo on the use of acne because of its resemblance to a snake. This is what saved him from complete destruction in European countries. Now acne is listed in the Red Book, so it is better to grow it on special farms in recirculating aquaculture systems (RAS). Acne has a surprisingly complex breeding pattern associated with the passage of a very difficult metamorphosis from larvae to fry, so scientists are still struggling to grow acne in captivity. The caught eel larvae (glass eel) are placed in special conditions, where on artificial fodder fry reach 5-7 cm in size and can already be grown in the conditions of conventional RAS.

2.1.19. *Scortum barcoo/ Barcoo grunter*- Jade perch

Jade perch is a fish of the Terapontidae family, an endemic to Australia. It can be caught in most of the great rivers of the Green Continent, including the Barca River. It is this river that gave the name to this interesting fish. In nature omnivorous, hunts crustaceans, shellfish, insects, fish. It grows to 35 cm, weighing up to 3 kg. The body is brownish green with black spots on the body. It is because of the greenish skin color of his perch and was called jade. The fish has a very large bony body and a small head. Currently, there is a real boom in the cultivation of this interesting fish. Fish are unpretentious (need to try very hard to kill), very fast growth (1.5 kg in 12 months). Due to the accumulation of internal fat, the meat of this fish is very tender, considered a true delicacy not only in Australia, but also in countries in Asia, America and Europe. Fish meat contains essential amino acids for human nutrition, as well as fatty acids Omega-3, Omega-6, vitamins. The amount of unsaturated fatty acids in jade meat is the highest among all known freshwater fish species.

The technology of jade perch cultivation is virtually indistinguishable from tilapia. Jade perch likes water temperatures in the region of 24-26C (tilapia grows better at 28-30C), feed uses tilapia. The planting density is slightly lower than the planting density of the tilapia (with oxygenation): jade perch - 80-100 kg per m3, tilapia - up to 140 kg per m3.

The minimum project for growing this fish is 20,000 kg per year. The cost of capital is about 200,000 euros. Operating costs will be around EUR 70,000 per year.

Against this background, it is advisable to add that in the Odessa region scientific research in the field of aqua and mariculture has not stopped, the scientific results of long-term researches of marine biology and biotechnology schools have been preserved and multiplied; science has identified priority areas for the region, directions and specific measures for large-scale development of fish, shellfish and algae, there are also economic justifications for the conditions of high profitability of such projects.

2.1.20. *Atherina boyeri* - Smelt

It is a small species with great potential for adaptation to ecosystems that occupy empty habitats (food fields). It has the ability to be more easily settled in lakes and lagoons. This happened at Lake Vistonida, where in the late 1980s, when the lake's salinity increased due to declining freshwater and many freshwater species receded into its northern part, smelt settled in the southern part of the lake, creating large populations. Today, it is the most important species in the lake that exceeds the 50% of the total production. It should be noted that the smelt is caught in lagoons and is neither farmed nor reproduced (Figure 25).

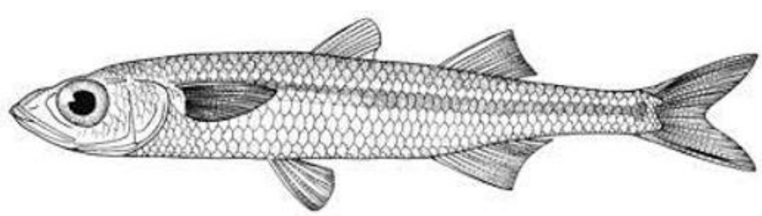


Figure 25. Smelt

2.2. Farming systems

There are several types of common farming systems used for many species in aquaculture.

2.2.1. Intensive culture[1]

An intensive freshwater fish farming site is generally composed of several open-air concrete tanks, raceways or earth ponds of different sizes and depths suited to the different stages of growth of the fish. A race taps river water upstream and returns it to the river downstream after it has flowed through all the tanks. This is what is known as a flow-through system. It is used typically for trout.

2.2.1.1. Pond culture (mono- or/and poly- culture)[2]

Pond culture is a very popular aquaculture production method with many aquatic species cultured in ponds. To have successful pond production, ponds must be properly sited and built, with careful assessment of water availability, quantity, and quality. There are two main types of pond systems: watershed and levee systems (Whitis 2002). The climate and topography of the region in which you are located will determine which type of pond system is appropriate. Areas that have enough rainfall to fill and keep ponds filled will be more suited to watershed pond systems. In an area where the main water source is groundwater, then a levee pond may be more suitable.

Fish culture is classified based on the number of fish species as monoculture and polyculture. This is the culture of single species of fish in a pond or tank. The culture of Rainbow trout is typical example of monoculture. The advantage of this method of culture is that it enables the farmer to make the feed that will meet the requirement of a specific fish, especially in the intensive culture system. Fish of different ages can be stocked thereby enhancing selective harvesting.

Polyculture is the practice of culturing more than one species of aquatic organism in the same pond. The motivating principle is that fish production in ponds may be maximized by raising a combination of species having different food habits. The concept of polyculture of fish is based on the concept of total utilization of different trophic and spatial niches of a pond in order to obtain maximum fish production per unit area. The mixture of fish gives better utilization of available natural food produced in a pond. The compatible fish species having complementary feeding habits are stocked so that all the ecological niches of pond ecosystem are effectively utilised. Polyculture began in China more than 1000 years ago. The practice has spread throughout Southeast Asia, and into other parts of the world. Different species combination in polyculture system effectively contributes also to improve the pond environment. By stocking phytoplanktophagus Silver carp in appropriate density certain algal blooming can be controlled. Grass carp on the other hand keeps the macrophyte abundance under control due to its macro vegetation feeding habit and it adds increased amount of partially digested excreta which becomes the feed for the bottom dweller coprophagous common carp. The bottom dwelling mrigal, common/mirror carp help re-suspension of bottom nutrients to water while stirring the bottom mud in search of food. Such an exercise of bottom dwellers also aerates the bottom sediment. All these facts suggest that polyculture is the most suitable proposition for fish culture in undrainable ponds. Ponds that have been enriched through chemical fertilization, manuring or feeding practices contain abundant natural fish food organisms living at different depths

[1] https://ec.europa.eu/fisheries/cfp/aquaculture/aquaculture_methods_en

[2] https://vikaspedia.in/agriculture/fisheries/fish-production/culture-fisheries/types-of-aquaculture/classification-of-fish-culture-on-the-basis-of-number-of-species

and locations in the water column. Most fish feed predominantly on selected groups of these organisms. Polyculture should combine fish having different feeding habits in proportions that effectively utilize these natural foods. As a result, higher yields are obtained. Efficient Polyculture systems in tropical climates may produce up to 8000 kg of fish per hectare per year.

Combinations of three Chinese carps (bighead, silver and grass carp) and the common carp are most common in Polyculture. Other species may also be used. While fish may be grouped into broad categories based on their feeding habits, some overlap does occur (Prabjeet et al., 1991).

2.2.1.2. Recirculating Aquatic System (RAS)[3]

Another option is water recirculation systems. In such installations, the water remains in a closed circuit and is recycled so it can be 'recirculated' in the tanks using a piping system. One of the advantages of this system is its isolation from the external environment, which means that all the parameters of the water can be controlled: temperature, acidity, salinity, disinfection, etc. It also allows for organic waste to be treated before being disposed of in nature. Its drawbacks, apart from the cost of the investment, include its energy consumption and dependence on a complex technology.

Recirculation has been used for a long time in aquariums and hatcheries. Its use for on-growing is more recent, but is attracting growing interest. In fresh water, this system is mainly used for rainbow trout, catfish and eel, but it is suited to all species, including marine species like turbot, sea bass and sea bream.

2.2.1.3. Cage system[4]

Sea cages hold fish captive in a large pocket-shaped net anchored to the bottom and maintained on the surface by a rectangular or circular floating framework. They are widely used for rearing finfish, such as salmon, sea bass and sea bream, and to a lesser extent trout, in coastal and open waters, in areas sheltered from excessive wave action, with sufficiently deep water and relatively low current speeds. Several cages are typically grouped together in rafts, often housing moorings and walkways for boat access, feed storage and feeding equipment. As the water flows freely to the cages, the openness of the system makes it vulnerable to external influences (i.e. pollution events or physical impact) as well as exposing the adjacent environment to the stock, and the fish farm effluents.

Today cage culture is receiving more attention by both researchers and commercial producers. Factors such as increasing consumption of fish, declining stocks of wild fishes and poor farm economy has increased interest in fish production in cages. Many small or limited resource farmers are looking for alternatives to traditional agricultural crops. Aquaculture appears to be a rapidly expanding industry and it offer opportunities even on a small scale. Cage culture also offers the farmer a chance to utilize existing water resources in which most cases have only limited use for other purposes.

[3]https://ec.europa.eu/fisheries/cfp/aquaculture/aquaculture_methods_en
[4]https://ec.europa.eu/fisheries/cfp/aquaculture/aquaculture_methods_en

Nowadays, cages, located in lakes, have started to be used for the rearing of valuable species, such as sturgeons, carp rainbow trout. Aquaculture in floating cages systems has started only in the past few years, by accessing European funding through the Operational Programme for Fishing.

2.2.1.4. Flow-through systems (tanks and raceways)

The rearing tanks are the classical water flow tanks used in trout farms and earth basins (stews or ponds) for cyprinids.

2.2.2. Semi-intensive culture (pond)

In a semi-intensive system, the production of the pond is increased beyond the level of extensive aquaculture by adding supplementary feed, usually in the form of dry pellets, to integrate the feed naturally available in the pond, allowing for higher stocking density and production per hectare.

2.2.3. Extensive culture (pond)[5]

Traditional extensive freshwater fish farming is practiced across the whole Europe, and is particularly common in Central and Eastern Europe. This long-established farming method consists of maintaining ponds (natural or artificial) in such a way that they foster the development of aquatic fauna. Every winter, the ponds and lagoons are cleaned and fertilised to stimulate aquatic vegetation and consequently intensify the presence of micro-organisms, small molluscs and crustaceans, larvae and worms, which form the base of the aquatic food pyramid. This encourages the development of 'marketable' animals at a higher yield than that of the natural ecosystem. Production in extensive farms is generally low (less than 1 t/ha/y).

The species produced vary according to regions: whitefish (Coregonidae), pike-perch, pike and different species of carp, catfish, crayfish and frog.

Traditional extensive fish farming in lagoons and coastal ponds is one of the most ancient aquaculture methods, and is still practiced across Europe. It consists of maintaining lagoons in such a way that they foster the development of aquatic fauna. Every winter, the lagoons are cleaned and fertilised to stimulate aquatic vegetation and consequently intensify the presence of micro-organisms, small molluscs and crustaceans, larvae and worms, which form the base of the aquatic food pyramid. This encourages the development of 'marketable' animals at a higher yield than that of the natural ecosystem. Production in extensive farms is generally low (less than 1 t/ha/y).

Depending on their geographical situation, lagoons and coastal ponds provide sea bass, eels and different species of sea bream, mullets, sturgeons, crayfishes and shellfish. In Italian valliculture in the Po and Adige deltas, lagoons are seeded with sea bass and sea bream fry to make up for the increased scarcity of these species in the wild and to compensate for the disappearance of eels. In Spanish (esteros) and in Portugal, this practice has led to testing with new species, including turbot, common sole and Senegalese sole.

[5] https://ec.europa.eu/fisheries/cfp/aquaculture/aquaculture_methods_en

2.3. Farming Methods of Major Species

2.3.1. Trout culture

Similar methods are used for rainbow trout, brown trout and Black Sea trout (or salmon) in the Black Sea. Before starting, assessment of water quality is vital for the site selection. Basic criteria requirements are given in Table 2.

Table 2. Water quality criteria for trout culture

PARAMETERS	VALUES	REMARKS
Water tempetrature °C	9-17; 12-16 (optimum)	-
pH	6.5-8.5 About 7	Slightly acidic Good for intensive culture
Oxygen	9.2-11.5 mg /lt	saturated
Ammonium	0.1 or 0.02 mg/lt 0.005 mg/lt	- For juveniles
Nitrites (NO_2)	1) 0.1 mg/lt, 2) 0.2 mg/lt (=0.03 or 0.06 mg N-O_2/lt 0.012 mg N-O_2/lt	For soft waters Hard waters Closed systems
Nitrates (NO_3)	100 mg/lt 25-35 mg N-O_3/lt	N-O2/lt
Chlorine (Cl_2)	0.01-0.03 mg/lt	
Chloride (Cl-)	50 mg/lt	For incubation
Hydrogen Sulfide (H_2S)	0.002 mg/lt	
Carbon dioxide(CO_2)	25 mg/lt	Not to over this limit is possible
Ozone (O_3)	0.02 mg/lt	
Nitrogen (N_2)	110%	Max gas pressure at saturation
Suspended and sediment materials	15-80 mg/lt	-
Copper (Cu)	0.006 mg/lt, 0.003 mg/lt ABP-2 = 100 mg/lt $CACO_3$	
Zinc	0.005-0.04 mg/lt	Depends water hardness
Iron	1)0.3 mg/lt, 2) 0.1 mg/lt	- For juveniles
Lead	1. 0.3 mg/lt (0.01-0.03 mg/lt)	-
Mercury	1. 0.005 mg/lt 2. 0.0002 mg/lt	- -
Cadmium	0.0004 mg/lt 0.003 mg/lt	For soft waters (ABP<2) Hard waters (ABP>2)
Chromium	0.01 mg/lt 0.05 mg/lt	Hexavalent Trivalent
Cyanide	0.005-0.25 mg/lt	-
Arsenic	0.01-0.5 mg/lt	-
Barium	5 mg/lt	-
Aluminum	0.1 mg/lt	-
Flow rate	0.005-0.03m/s	-
Turbidity	10 JTU	Jackson scale for turbidity

2.3.1.1. Adult Selection

The selection of the individuals who will be devoted to breeding should be done starting from the pre-growing period. By continuing to grow the separated fish, distinctive features should be sought in terms of differentiating fish from the population. These qualities are:

- Good feed utilization with rapid growth,
- Resistance to diseases,
- Smooth and harmonious body form,
- High reproductive efficiency (large number and large diameter eggs, sperm quality, etc.)
- To reach sexual maturity late.

Adult fish selected based on the above characteristics should be fed with fresh pellets, together with fresh fish and shrimp in brood stock ponds. Special care should be paid not to overfeed by keeping fish weight increase approximately 0.5-1.5 kg per year. Overfeeding can cause fat degeneration, especially in eggs.

2.3.1.2. Brood stock keeping

Average weights of three-year-old mature fish are between 1-3 kg. Female fish are used in 4 consecutive reproduction seasons until the age of 6. Fecundity decreases as the live weight increases, ie, in 6-year-old fish, this amount drops below 1200 eggs per kg live weight. However, the larvae of viability are obtained from eggs with larger diameters, which have the advantage of selling more. Therefore, 4-5 year old females have great economic value in all aspects. Studies have shown that sperm of 3-year-old male has never reached the quality of sperm of 4-5-year-old male. But 3-year-old male have more sperm in terms of quantity. In this regard, mature fish is preferred 3-year-old male, taking into account the cost of keeping adult fish in the farm.

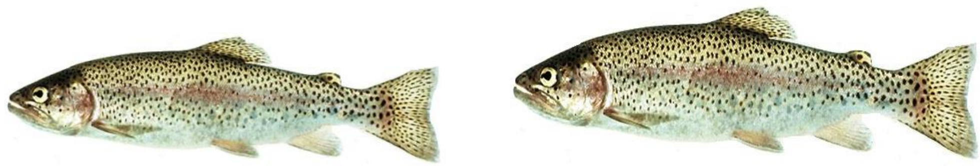
Basic information about the egg production characteristics of female adults can be listed as follows:

- Total amount of eggs obtained from breeding fish increases as the fish grow. For example, at the age of 3, 1800 eggs are obtained from fish weighing 750 g; 2500 eggs are taken from fish weighing 1300 g at age 4.
- As the fish size increases, the proportional amount of eggs per kg body weight decreases. For example, at the age of 3, the number of eggs per kg body weight of 750 g weight fish is 2400 pieces; the number of eggs per kg live weight of the fish weighing 1300 g for 4 years old is 2000.
- The number of eggs can be affected by the amount and quality of the feed.
- The effect of genetic conditions on the difference of the number of eggs in individuals is very large.
- Older and larger fish develop larger eggs compared to younger and smaller fish, thereby providing stronger larvae formation. For example, while the egg diameter of 2 years old fish weighing 178 g is 3.9 mm, the diameter of the egg of 7 years old fish weighing 2700 g is 5.7 mm.

2.3.1.3. Stripping and fertilization

The dry method has been used in trout stripping so far. The variety of tools and equipment to be used in this method varies according to the knowledge and skills of the staff to strip. Brood stock is stunned in 50-ppm MS-222 solution before stripping. Then, it is dried with a towel and eggs are milked by squeezing the belly of the fish into a clean and dry plastic container. After the sperms of at least two male fish are milked on the eggs of each female adult, eggs and sperms are mixed with the help of a hand or soft body and left to wait after 1-2 minutes by adding clean water. The fertilization procedure is given in Figure 26.

The incubation period of salmonids varies depending on the species and water temperature. However, the sum of the water temperatures (day-degrees) measured during the incubation shows close values. The average incubation time for rainbow trout eggs is 310 days - degrees (Çelikkale 1994), although 103 days (361 days-degrees) at 3.5 ° C, 80 days (400 days-degrees) at 5 ° C and 19 days at 15 ° C. (285 days-degrees).



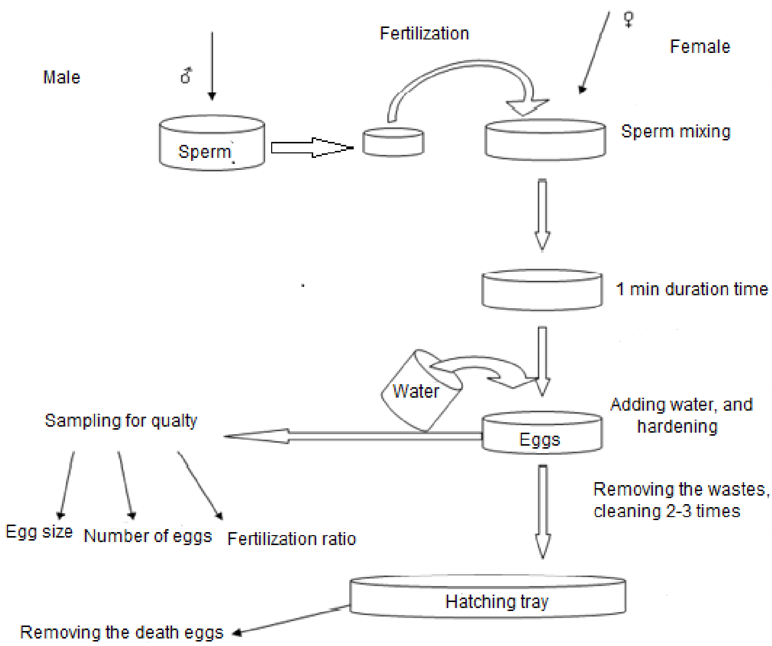


Figure 26. Procedures in fertilization of trout eggs

Incubation cabinets and egg trays are used to hatch fish in the hatchery (Figure 27). Eggs are eyed in 16 to 18 days (Figure 28) and hatching is completed in 32-35 days (Figure 29).

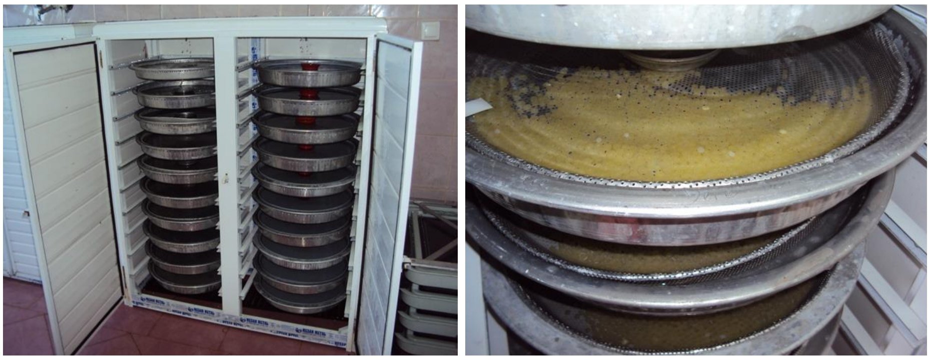


Figure 27. Egg trays and incubation cabinet

Figure 28. Eyed eggs

Figure 29. Hatched larvae with yolk sac

2.3.1.4. Larvae Breeding

When incubation period ends, the larvae hatching is completed from the eggs in 2-3 days at 10 ^oC water temperature. Meanwhile, the egg shells in the environment should be siphoned and extracted twice a day so that the holes of the egg trays are not clogged. The larvae hatching from the eggs are called vitellus sacced larvae (Figure 30). They consume their yolk sac in 12-17 days depending on the water temperature. During this period, white colored dead eggs or deceased sacced larvae or deformed and anomaly larvae should be removed by siphoning at least once every two days. If the specified cleaning procedure is not performed, a fungal infection (Saprolegnia sp.) is quickly encountered.

Figure 30. Trout larvae

Reaching the free swimming stage by consuming most of the yolk sac and to start feeding is the most important indicator for the larvae. Feeding should be started when 10% of the vitellus sacked larvae reach the feeding power, or when they consume 2/3 of the food sacs and begin to swim freely. When the larvae reach the specified stage, the chambers between the egg trays are removed in the incubation channels, the larvae in the trays are slowly stocked in the channels.

2.3.1.5. Larvae culture

It is generally defined as "nursery" that the larvae reached the free swimming stage and that are actively moving in the water are grow up to an average of 1 g live weight by taking care and feeding. This stage is completed within 60-80 days. In this period small concrete raceways/tanks are used in the hatchery. The water exchange should be 4-8 times per hour, depending on the stock density and water quality. In the specified conditions, the stock density is 100000 larvae/m^3. Feeding of the larvae is continued every 30-60 minutes for 12 hours a day. The mortality rate in this period is approximately 30-35%. Under optimum production conditions, the target of production in harvest should be 25 kg or 25000 larvae per cubic meter at least 1 g individual weight.

Small concrete raceways; 3-4 m in length, 40-80 cm in width and 30-80 cm in depth are generally used for the nursery of larvae. Although generally reinforced concrete is used, hygienic polyester tanks should be preferred. The stock density of the population depends on the quantity and quality of the water used. The optimum level of water change in these raceways should be 4-8 times per hour.

In these channels, water depth is increased parallel to the fish size. For example, approximately 30000 rainbow trout larvae are stocked in a tank having dimensions 3.60 m lengthx40 cm widthx17 cm depth, about 122000 larvae/m^3. During the feeding period stock density is considered 100000 larvae/m^3, in other words 100 larvae per liter of water. When the specified stock quantities are applied, 1-2 lt/sec/m^3 water is required for water changes 4-8 times per hour. Under these conditions, after 8 days of feeding at a water temperature of 8-10 ^oC, sizing/selection is made in stock as 50000 larvae per cubic meters and after 15 days of feeding 20000-30000 larvae per cubic meters.

In channel-type concrete or polyester raceways, having 2-4 m^3 volume, 30000-60000 larvae are fed for 6-8 weeks under good level of oxygen. Water entry into these tanks should be 20-40 L/min/m^3 water.

In case of nursery in circular (round) tanks about 5% of slope towards the water outlet located in the center is needed (Figure 31). The water requirement of the round tank with a diameter of 2-3 m and a capacity of about 1.5-6 m^3 should be 0.1-1.0 L/s. When using slightly acidic water in tanks with the specified properties, 100000 larvae with a weight of 0.2-0.4 g; 7500-10000 larvae with a weight of 0.76-1.5 g can be raised. In these stock densities, it is recommended to increase the aeration and water level. When alkaline water is used, the specified stock densities should be halved. It is possible to feed 30,000-70,000 larvae for 6-8 weeks in the polyester or concrete round tanks: with the capacity of 1.5-4 m^3, diameter 1.5-3 m, height 50-80 cm, base slope 10-20%, sluice pipe diameter 10-12 cm. Stock density is 8-15 larvae/lt, water requirement is 15-30 lt/min/m^3. These tanks are also suitable for protective baths against parasites or other diseases.

Figure 31. Round tanks

2.3.1.6. Fingerling culture

In the culture of fingerlings concrete raceways, ponds and net cages can be used. In this stage at least 0.5-1 g in weight, 4-5 cm in length are used. If there are spores of the parasite *Myxobolus cerebralis* causing the whirling disease in the water, minimum length of fingerlings should be at least 6-7 cm. Because at this length the cartilage parts of the vertebrae and head bones of the fish have become quite durable and become not deformed. The disease parasite eats the cartilage in the skull and spine of trout, deforming their skeleton to cause them to swim in circles, thus the name of the disease. It does not affect humans. Therefore it is mandatory to take hygienic precautions for all the equipment used in the culture of fingerlings before they stocked.

Disinfection is very important and its effect comes first among these measures. There is no approved drug or therapeutic treatment for *M. cerebralis* infection. At least ten candidate drugs have been tested (acetarsone, amprolium, clamoxyquin, fumagillin and its analog TNP-470, furazolidone/furoxone, nicarbazine, oxytetracycle, proguanil and sulfamerazine) (Wagner, 2002). Several of these (furazolidone, proguanil) reduced infection and/or inhibited spore formation; however, none prevented or eliminated infection and some resulted in toxicity (TNP-470) or reduced growth (furazolidone)[6]. Further development of treatments is hindered by regulatory hurdles, and issues associated with application of treatments to wild fish. The appropriate solution is to disinfect ponds, nets and all other equipment used in fingerling culture before start the procedures (CABI, 2020).

1500 ppm solution of Quaternary Ammonium Compound (QAC) or Quat Plus (2 liters of Quat Plus diluted with 62 liters of water provides 64 L of solution which is a practical volume for immersing most field gear) can be used. Disinfection effect depends on temperature. As a general rule, 30 minutes at 20 ^{o}C, 1 hour at 12 ^{o}C and 2.5 hours at 4 ^{0}C are required for the effect of the disinfectant.

In order to better evaluate the available capacity, 7-10 m length, 0.80-1 m width and 0.80-1 m depth concrete raceways are used in the fingerling culture (Figure 32). Depending on the water conditions and exchange of water every 10 minutes, the stock density is 2000-5000 fingerlings/m^3 for initial stocking. In this case, the product obtained at harvest will be 50 kg / m^3 and the individual weights of juvenile fish can reach 10-15 g up to 30 g. Although it takes a lot of time to feed the fingerlings many times in this type of culture. It should also be cleaned twice a day.

Another type of raceway is the 8-10 m length and 1-2 m width and in these channels, water change should take place in at least 5-20 minutes. 3.5 mm diameter perforated material should be used in the outlet. Depending upon the water change, the stock density can be 2000-5000 fingerlings in per cubic meter or higher. According to fish size and water conditions in harvest, 50 kg/m^3 or 100 kg/m^3 fish, especially in better conditions, can be obtained.

[6] https://www.cabi.org/isc/datasheet/59563#todiseaseTreatment

Figure 32. Concrete raceways for fingerling culture

Fingerling culture can also be done in ponds made from reinforced concrete under favorable conditions. The width/length ratios of rectangular pools should be approximately 1/4-1/6. Depending on the quality and quantity of the water used in these ponds, the stock density is arranged as 60-100 fingerlings per cubic meters (at an average depth of 1 m). In this type of production, approximately 10 lt/sec of water is required for 50000 fingerlings. In addition, with a slightly acidic character of 3-5 lt/sec of water, for example, in a pond of 450 m^2 and at a depth of 1.5-2.3 m, under the additional ventilation conditions, 60000-80000 fingerlings average up to 12-15 cm in length (2-3 kg / m^2) can be raised.

In net cages, finger-sized juvenile farming is not as suitable as portion sized fish culture. The main reason is that the mesh size must be small in the cages where fingerling will be fed. Because as the net meshes become smaller, the net becomes clogged more quickly, thus preventing water change. In addition, since the juvenile fish to be stocked in cages are generally pre-fed with an average weight of 1 g, nets should have 4 mm mesh size to avoid fish escapes from the net.

Considering the aforementioned problems, it is more suitable for fingerlings to be stocked in net cages with a minimum weight of 2 g and a mesh opening of 6 mm. In net cages, stocking density of 300-500 fingerlings/m^3 is recommended. In this type of culture fingerlings can be grown up to 8-10 cm length or 50 g weight under suitable water conditions. As the juvenile fish grows, the net bag of the cage should be periodically renewed based on the 1 mm mesh size for the fish length of 1 cm.

2.3.1.7. Portion size trout farming

In this type of culture of it is aimed to grow trout till the various market size in concrete raceways, ponds and net cages.

The size of these ponds varies greatly according to the amount and quality of the water, the topographic condition and soil structure where the ponds constructed. There is no obligation to make concrete ponds if the soil structure is clay and water retention is high, even requires more work comparing with concrete pools, but fixed investment cost is less. In concrete ponds, disinfection is easier to maintain, feeding and controlling the fish are better, but the cost of construction is high.

The size of the ponds where portion size trout culture is carried out should generally be 20-50 m in length, 4-12 m in width and not more than 1.20 m in depth. Appropriate stock density is determined by water exchange and quality. In addition, it should be taken into account in determining the stock density in factors such as feeding, pond hygiene, use of technical equipment (such as aeration), and production time.

With optimum culture conditions and the use of full-value pellet feed, it should be expected that the portion sized rainbow trout farming can be achieved in 8-months of production period.

The amount of table fish production is generally expressed in kg/m^3. For example, 3-5 kg/m^3 fish can be produced when water change occurs in the ponds 3-5 times a day. In semi-intensive production conditions, this amount increases to 10 kg/m^3. In ponds with a depth of 30-50 cm, 20 kg/m^2 (= 40-60 kg/m^3) fish is produced in case the water change occurs 3 times an hour. Stock quantity can also be calculated based on the amount of water supplied to the ponds. Accordingly, stocking is done for the target of 100-150 kg of table fish will be produced in the harvest according to the water inlet of 1 lt/sec of good quality. Based on the portion trout size of 200-250 g, 400-600 fingerlings are stocked for 1 lt/sec flow rate.

Raceways are the culture facilities with depths of 50-65 cm, widths of a few meters, made of concrete, several hundred meters in length, with water change 2-3 times an hour. Base slope is 10-20 cm at 30 m. These raceways, several hundred meters long, are divided into sections of about 30 m with grids. Production capacities are generally 24-32 kg/m^3 (Steffens 1981). These canal type ponds are suitable for mechanical feeding, disease control and automatic selection. The flow rate of the water should be 1.5-3 lt per second in raising the juvenile fish up to the market size. In a hectare area, 100 tons of trout is produced with 1000 lt/sec water in raceways. This calculation is equivalent to the traditional production amount calculated with 100 kg fish/lt/sec water in the intensive breeding method in the ponds.

Trout culture in net cages is getting popular year by year in Turkey. They can be installed in natural lakes, dam lakes, man–made irrigation lakes, sand-gravel ponds, riverine lakes, and large irrigation channels to produce fish under control in net cages. Cage system is a frame in different shapes and made by different materials such as wood, metal, polyester as net carrier, floats to keep frame on the water surface, anchors to keep frame at fixed position and nets material attached to the frame in bag shape. After trials with culture of sea bass and sea bream in net cages in Turkey, trout farming in net cages has started to become widespread in our freshwater sources by private entrepreneurs in the last decade in the Black Sea region (Atay 1994). In case of trout farming in cages, water quality should be appropriate for the needs of fish.

There must be at least 1 m distance between the bottom of the sea/lake and the lower part of the net. Since the mesh bag of the cage cannot fully maintain its geometric shape in water, approximately 15% of its volume is lost. When the cages are located in the same place for a long time, they may affect the water quality of the lake or pond. Therefore current is needed to get rid of organic pollution. In shallow lakes, the location of the cages should be changed before each production period. There is no need for displacement in lakes deeper than 10 m. Although the dimensions of the net cages are different, the dimensions of 5 m x 5 m x 5 m are the mostly used in inland waters. The mesh size of the net cage should be 1/10 of the length of the fish. In other words, the mesh size is determined considering 1 mm mesh size equals for 1 cm trout length in practice. Fish at least 40 g average weight are stocked in net cages. Fish stocked in March are harvested in mid-June, and fish stocked in September are harvested in December. Under normal water conditions, the stock density in net cages is planned as 50-100 fish of average weight of 40 g per cubic meter. In this case, the amount of production at harvest is 20-30 kg/m^3. For instance, in Central European lakes and dam lakes, mesh opening is regulated as 14 mm in aquaculture. The stock density is based on 90 fish of 40 g/m^3. In these conditions, for the production of 100 tons of trout, approximately 180 cages of 4x3x3 m dimensions are needed in these countries. Under suitable conditions, stock density can be applied as 100 fingerlings per cubic meter.

In rearing experiments, trout fingerlings stocked at an average of 35 g weight and 17-20 ^{o}C water temperature in net cages, reached 300 g in weight with high growth rate. In this case, a weight increase of 265 g was achieved in 2.5 months, ie the fingerling grew by 3.5 g per day.

In net cages, it should be aimed to increase the average size of 35-50 g of fish to the table size of 250 g in 90-100 feeding days. For this purpose, 500-1800 fingerlings are sufficient in the cage volume capacity of 20 m^3. When less than 700 fish were stocked in 20 m^3 net cages, growth was slower than 1000 or 1200 fish stock. However, it is not recommended to stock more than 1200 fish in mesh cages with a capacity of 20 m^3. In recent years, the diameters of the cages have reached 20-30 m and their volumes have reached 1000-2000 m^3 (Figure 33).

Figure 33. Trout net cages

2.3.2. Sea bass culture

2.3.2.1. Brood stock and Ovulation

The tanks in which brood stock are kept vary depending on the size and stocking density of mature fish. Large, medium and small volume brood stocks are used in aquaculture units. Large systems are used extensively in Japan and north-east Asian countries in volumes of 50-100 m^3 and are installed outdoors. Tanks of medium size are used in European countries and are located within the farm facility. The volumes of the tanks are between 15-30 m^3. They also have filtration, heating and cooling systems. Small volume systems are between 10-20 m^3 and are used in countries in the Mediterranean area. All systems of these tanks are under control against environmental conditions. Tanks are usually dark and in cylindro-conical shape.

Fish are stocked as 10-15 kg/m^3. The female to male ratio is adjusted to 1: 1, 1: 2 or 2: 3 kg depending on the condition of the brood stock. Tanks flow rate of 10-20% per hour. Water temperature should be 14-15 0C. Natural seawater salinity is used in tanks. Due to the pelagic structure of the eggs, the water outlets of the tanks are from the surface. İn order to prevent egg losses a filter with a 500 micron mesh size are placed at the top outlet of the tanks.

Eggs can be obtained from the adult fish by natural means, milking method and hormone injection. The milking method is not applied due to the small size of the eggs and low fertilization rate. Taking eggs in a natural period without hormone intervention affects quality. In addition, the use of hormones gives very successful results. In addition, natural spawning periods can be changed by applying photoperiod and eggs can be provided at various times of the year.

2.3.2.2. Egg Properties and Quality Criteria

The egg sizes of bony fishes vary according to the species and some conditions in the species itself. As the egg diameter of the species grows, the number of eggs decreases, the length and survival rate of the larvae increases. Fertilized eggs are pelagic, spherical and transparent. The quality of the egg is proportional to the buoyancy of egg, number of oil drops, the rate of hatching and the amount of normal larvae. Sea bass eggs have an average of 4-5 drops of oil, one of which is centrally located. The average diameter of eggs is 1150 ± 85 µ and the diameter of oil drops is 360-420 µ.

Egg diameters vary by region. On the British coast it is between 1.07-1.32 mm, while it is smaller (1.02-1.296 mm) along the Mediterranean coast. In the North Sea, these values reached up to 1,386 mm. Egg diameter is related to water temperature and nutrient content. It was found that the eggs taken during the natural spawning period at low temperatures in winter months are larger than the eggs obtained at constant temperatures at other times.

The differences in the size of the eggs in the same species depend on the feeding, size, secretion time of hormones, hormone applications, environmental conditions, genetic factors and regional differences which are the common factors affecting quality and quantity. If there is no morphological and genetic disorder in the eggs, when the incubation conditions are the same, the large or small egg does not change the hatching rate of larvae.

The quality of the eggs to be incubated is very important for the future larvae quality. These defects should be identified before and during incubation. If more than 40% of the eggs received from the egg collectors are dead; this group should not be used unless there is obligation. It should be paid attention that the blastomer divisions are equal, and whether there are missing divisions should be determined. Eggs containing a large number of oil drops should not be taken into production unless required. The appearance of particles in the form of dots and the protrusion of the blastopore are other disorders caused by the adverse events that occur during embryonic development.

2.3.2.3. Incubation of Eggs

Eggs released by adults under appropriate ambient conditions are collected precisely from egg collectors. Eggs should be kept in contact with the air as little as possible during the collection, weighing and live-dead separation stages, and the accumulation of large amounts of eggs should be prevented.

If the eggs are to be transported for a long time, 15-20 liter plastic containers are used to carry 20000 eggs per liter for a 24-hour, and 80000 eggs per liter for a 6-hour transport. Transport should be done within the first 24 hours after fertilization. The oxygen value of the water in the transport containers should be increased to 9-11 mg/lt. Water and eggs are placed in 2/3 of the plastic container. Pure oxygen is pressed into 3/1 of the container. As a result of the transportation process, the hatching rate varies between 50-70%.

Eggs should be subjected to disinfection, if necessary before incubation. For this purpose, 10 ml of 5% Iadophor solution is put in a liter of sea water and eggs kept in for 8-10 minutes. In addition, for this process zinc free malachite green at a rate of 5 mg/lt can be applied to eggs for 40-60 minutes.

After the live eggs are supplied, their incubation process begins. The ponds where the incubators will be placed may have in different structures and shapes. The most suitable system for the incubation of eggs is to use race-way types. In addition, this can be done in larvae tanks too. The incubation unit must be separated at the farm to ensure precise work and prevent contamination. The size and equipment of this unit are designed according to the amount of eggs required to hatch. The interior of the tanks where the incubators will be placed are dark colored and gel-fabric covered.

The volumes of the incubators used can vary from 50 to 200 lt. Incubators are made of polyester and have cylindro-conical shape. The cylinder part is covered with 300 m plankton screen and the conical part is polyester. Separate water inlet can be provided from the bottom of each incubator, and water inlet and outlet can be made directly into the ponds where they are placed. The water coming into the tanks first passes through 5 µ and then 1µ cartridge filters, and distributed to tanks.

Studies have shown that sea bass eggs hatch at ‰29-47 salinity. But for better results salinity should be between ‰ 34-38 for both sea bass and sea bream eggs. Salinity under ‰ 34 salinity exhibit semi-pelagic properties and completely collapse under ‰33 salinity. The best incubation temperature for sea bass eggs is between 14-16 0C (Freddi, 1985).

The supplied eggs must be placed in incubator tanks at the same temperature as the medium from which they were taken. The temperature difference should not exceed ± 0.5 °C. Eggs are placed in incubators with an average of 3000-5000 egg/lt. No light is used during the incubation. In tanks with incubators, 40-60% water change is applied per hour. The incubation rates without water change were determined to be 30-40%. In normal running water, the hatching rate is between 75-85%.

2.3.2.4. Prelarval Stage

When the sea bass larvae hatch, their mouth and anus are closed. The larvae are passive; they stand upside down and lead their lives with the energy they provide from their own vitellus sacs. The length of larvae just after hatching is between 3.4-3.6 mm. The length of the vitellus sac is 1.1-1.3 mm. Oil drop diameter is between 0.5-0.7 mm. Since the mouth and anus are closed, there is no external feeding. This period, which the larva feeds only from the vitellus sac, is called the lecithotrophic period.

2.3.2.5. Post larval stage

Postlarval stage begins with the opening of the mouth and anus at the end of 5th day at 15-16 ^{0}C. During this period, mucocytes are formed in the mouth. These are like epithelial pits covered with mucus at first. The cellular walls are thin. Towards the 7th day, cartilage and muscles begin to form. Since the glands are not fully formed, the digestive mechanism is not perfect. The digestive tube consists of four or six rows of cells in the epithelial structure and its thickness is 45 microns. Towards the 8th day, the number of cell rows reaches six to eight. Meanwhile, intestinal absorbent cells became functional. During this period, 10-11 primitive forms of phanin teeth begin to form on days.

2.3.2.6. Feeding and growth of sea bass larvae

After being stocked in the tanks (150 to 250 larvae per liter should be a correct density), the larvae will continue their development during some days relying only on their yolk sac reserves. Depending on the rearing temperature they will start feeding on living micro-organisms in three to four days from hatching.

At hatching, fish larvae are not yet completely formed and, among other things, lack functional eyes and mouth. Moreover they do not have an active swimming behavior. In the first three to six days after hatching, and depending on water temperature, the fish larva therefore relies only on its yolk sac reserves as food source. At the end of this period the young fish has developed functional eyes, which are recognizable by their dark colour, its mouth has opened and the digestive tract, though still primitive, can now assimilate food. Then, its swimming behavior becomes active and the animal is thus able to keep a horizontal position. At this stage the post-larval stage begins and the young fish starts feeding on live preys, such as rotifer and brine shrimp nauplii (Table 3),

Open circuit and closed circuit systems are used in sea bass larvae culture. In open circuit systems, water criteria are adjusted according to the conditions required by the larvae and sent to the production tanks. The water used by the fish is then discharged. Considering that the water flow rate, which starts with a change of 5% per hour, is 50% per hour at the end of the period, an excess of energy consumption arises depending on the amount of water used.

Salinity reduction technique applied in sea bass larvae culture positively affects the survival rate (Johnson & Katavic, 1986). In addition, the increase in the percentage of air sac formation and the decrease in deformation in parallel with this made this technique even more useful. Salinity is gradually lowered from day one, and on day 5, ‰ 26 salinity is reached from natural seawater salinity. This salinity value remains constant between 5-17 days. In the same way, the salinity is gradually increased between 17-23 days and the level of natural sea water salinity is increased. When air sac hypertrophy is encountered in salinity increase, ‰26 salinity should be returned (Saka, 1995). Oxygen value is 5-6 mg/lt. The amount of turbidity should not exceed 8.5-12 ITU. It is ideal for production that the nitrite (NO_2) is between 0.013-0.016 mg/lt and the nitrate (NO_3) is 0.062-0.068 mg/lt in the larvae tanks (Equinoxe, 1990).

The pre-larval period ends on the 5th day at 15-16 ° C water temperature, and the postlarval period begins. To clean the oil layer accumulated on the water surface before opening of the mouth, surface cleaners are placed as 1 or 2 pieces according to the tank surface area. This is very important for the development of the air sac. The lightning duration and intensity applied to the larvae affect the development of the larvae, the formation of the air sac and the rate of survival. While the development of larvae increases under increasing lighting conditions, continuous lighting reduces the viability of fish. Lighting is not applied to the larval tanks in the pre-larval stage. The lighting duration and intensity should be set as 12 hours-50 lux on the 5th day, 13 hours-140 lux on the 11th day, 16 hours – 920 lux on the 17th day and thereafter.

In the larval period feeding, nauplii and metanauplii forms of rotifera (*Brachionus plicatilis*), which are live feed sources, and Artemia (Artemia sp.) With various origins are used (Table 3). Artemia eggs of different origins are provided in various parts of the world. Their hatching rates, nutrient contents, egg numbers per gr nauplii lengths after hatching vary. Nauplii lengths of AF type Artemia produced by Artemia Systems and used extensively in larva culture are approximately 460-480 µ and contain more than 10 mg / gr of HUFA.

Since the width of Artemia varies between 165-175 µ, sea bass larvae with a mouth opening of 400-420 µ can also be used from the first day. However, feeding with rotifer in a week affects the survival rate positively. Protein rates of AF type Artemia nauplii vary between 48-52%, fat content 19.3-21%, carbohydrate ratios 12-13%, ash content 8.1-8.7% and humidity 4.8-5.2%. EG type Artemia naupliis, which are also used in the second stage, have lower protein content (45-47%) and less unsaturated fatty acids (5-7 mg/g HUFA).

It is also larger in size and is between 500-520 µ. Artemia forms, which are used as EG1 from the 16th day, are obtained by growing EG type *Artemia nauplii* with SELCO-derived enrichment agents for 24 hours. SELCO products play an important role in the development of larvae, as they contain high levels of HUFA (200 mg / g), vitamins, antioxidants and fats (60-65%). The Artemia that come in the form of metanauplii after 24 hours of culture are between 700-750 microns. The types and survival rates of live feeds given to the larvae are shown in Table 3. According to the culture techniques applied depending on the egg quality at the end of the larval period, the success rate can reach up to 40%.

Table 3. Sea bass larva culture protocol

Day	Temperature (°C)	Salinity (‰)	Flow rate (%/h)	Light duration (h)	Light intensity (Lux)	Feeding (R: Rotifer, AF, EG: Artemia salina pieces per ml))
1	15-16	36	5	0	0	No feeding
2	15-16	34	5	0	0	No feeding
3	15-16	30	5	0	0	No feeding
4	15-16	28	5	0	0	No feeding
5	15-16	26	5	12	50	R= 8 / ml
6	15-16	26	5	12	60	R= 8 /ml
7	15-16	26	5	12	80	R= 8 /ml
8	15-16	26	5	12	100	R= 6 /ml AF=0.5 /ml

9	15-16	26	5	12	120	R= 6 /ml AF=0.5 /ml
10	15-16	26	10	12.5	140	R= 6 /ml AF=0.6 /ml
11	17	26	10	13	140	R= 4 /ml AF=0.6 /ml
12	17	26	10	13	140	R= 4 /ml AF=0.6 /ml
13	17	26	10	13	240	R= 2 /ml AF=0.8 /ml
14	17	26	10	13	450	R= 2 /ml AF=0.5/ml EG=0.5 /ml
15	17	26	15	14	450	R= 2 /ml AF=0.5/ml EG=0.8 /ml
16	18	26	15	15	450	AF=0.4 /ml EG=0.6/ml EG_1=0.1/ml
17	18	28	15	16	920	EG=1.2 /ml EG_1=0.3 /ml
18	18	30	15	16	920	EG=1.2 /ml EG_1=0.3 /ml
19	18	32	15	16	920	EG=1 /ml EG_1=0.5 /ml
20	19	34	20-25	16	920	EG=1 /ml EG_1=0.5 /ml
21	19	36	20-25	16	920	EG=1 /ml EG_1=0.5 /ml
22	20	38	20-25	16	920	EG=1.2 /ml EG_1=0.8 /ml
23	20	38	20-25	16	920	EG=1.0 /ml EG_1=1.0 /ml
24	20	38	20-25	16	920	EG=0.8 /ml EG_1=1.2 /ml
25	20	38	30-35	16	920	EG=0.6 /ml EG_1=1.4 /ml
26	20	38	30-35	16	920	EG=0.4 /ml EG_1=1.6 /ml
27	20	38	30-35	16	920	EG_1 = 2 /ml
28	20	38	30-35	16	920	EG_1 = 2 /ml
29	20	38	30-35	16	920	EG_1 = 2 /ml
30	20	38	40	16	920	EG_1 = 2 /ml
31	20	38	40	16	920	EG_1 = 2 /ml
32	20	38	40	16	920	EG_1 = 2 /ml
33	20	38	40	16	920	EG_1 = 2 /ml
34	20	38	40	16	920	EG_1 = 2 /ml
35	20	38	40	16	920	EG_1 = 2 /ml
36	20	38	40-50	16	920	EG_1 = 2 /ml
37	20	38	40-50	16	920	EG_1 = 2 /ml
38	20	38	40-50	16	920	EG_1 = 2 /ml
39	20	38	40-50	16	920	EG_1 = 2 /ml
40	20	38	40-50	16	920	EG_1 = 2 /ml

At the end of larval period between 38-42 days, sea bass fry starts to feed on artificial feed micro particles. In this stage, 10-15 m^3 tanks are used for culture. Bottom parts of the tanks are conical. The water outlets are central and from the bottom. Depending on the age of the fish, net screens with 500, 1000 and 2000 microns mesh size. There are lighting systems in the tanks area providing 1500-2000 lux light intensity. Lighting time in the unit is 16 hours and it is adjusted with the help of automatic timers. Automatic feeders are used in the distribution of micro particle feeds. Open circuit and closed circuit systems can also be used in this section. As the powder feed entered into the environment, the water quality can be changed very quickly, continuous control of the water quality should be ensured in closed circuit systems. It is more beneficial to use open circuit systems at this stage in terms of reducing disease risks. The water provided to the tanks must be given to the larvae by passing through the sand and ultraviolet filter. In addition, the presence of pure oxygen inlet, flow meters, saturation columns and surface cleaners in the tanks positively affects the production.

The exercise period of eating micro particles starts at 38-42 days, when the fish reach an average of 19-21 mm of total length and 35-40 mg of weight. During this period, the fish density in ponds is 10-12 fish per liter. In cases where pure oxygen is used, this rate can be increased up to 18-20 fish per lt. Artemia used in the transition period to microparticle eating are in the form of metanauplii II and enriched in terms of HUFA as in the form of metanauplii I in the larval period.

The microparticle feeds used in the smelting of sea bass fish are used in the first period starting from 80-150 microns and up to 500 microns according to larval development. Exercise application continues for 15-16 days. While the amount of artemia given to the larvae is decreased, the amount of microparticle feed is increased. In this period, microparticle feed rate is 8-10% of live weight. The average water temperature during the swearing is 20 ^{0}C and the water flow in the tanks varies between 50-100%. Deaths tend to increase in the early days of the depression due to not being able to adapt to eating powder. Larvae survival rate changes between 80-90% on average if normal conditions are provided (Equipe Merea, 1990). The larvae that complete the starting to eat powdered feed are taken to the nursery unit after staying in this section, on average, up to 350-400 mg.

2.3.2.7. Nursery stage

The technical features of the tanks used in this system are the same as the tanks used in the larva culture unit. The juveniles are sorted and the individuals with and without air sacs are separated from each other. Closed circuit system is not used in nursery stage. Here the fish are grown to a weight of 1.5-2 grams, which is necessary for netting. However, in Turkey, juveniles are taken to the cage systems between 0.5-1 grams. Fish are constantly observed in the nursery unit and necessary precautions must be taken against disease risks.

Cylinder tanks with a volume of 10-15 m^3 are used in nursery unit. The water temperature is 19-21 °C and 16 hours lighting is applied. Natural seawater salinity is used in tanks. 3000-5000 juvenile/m^3 can be stored in tanks. The water change varies between 80-150% per hour depending on the fish size and stock density. Feed rate starts at 6% and decreases by 4%. The survival rate varies between 90-95% during the period when the disease is absent (Table 4).

Table 4. Feeding rates and feed sizes of sea bass according to fish weight and temperature during starting to fed by dry food and nursery period

Period	Feed size (micron)	Fish weight (gr)	Water temperature (^{0}C)	Feeding rate (%)
Transtition to dry feed	80-200	0.03-0.125	19-20	8-10
	150-300	0.125-0.165		8-10
	300-500	0.165-0.420		6-8
Nursery	300-900	0.420-0.640	19-21	5-6
	500-900	0.640-0.950		4-5
	500-1250	0-950-1.200		4-5

2.3.2.8. On-growing period

Net cage culture is used intensively in Turkey. Production from per unit area/volume is very high in cages which can be installed safely in coastal areas, open seas and oceans. At present, 150 tons of production can be obtained in a single system in volumes ranging from 2500-6000 m^3 in offshore cages (Özden et al., 1998). Cage systems are collected in 4 main groups as fixed cages, floating cages, submersible cages and rotating cages (Figure 34).

Depending on the characteristics of the place where it is installed and the quality of the water in the net cages stocking density is between 15-30 kg/m^3. Feed and water temperature play an important role in the development of fish. In feeding regimes, daily feeding should be done by taking into account the weight of the fish as well as the water temperature and the water quality. Feed contains 46-52% protein, 2-3% cellulose, 12-13% crude ash, 10.5-11.5% crude fat, 1.6-2.2% calcium and 1.4-1.5% phosphorus, as well as vitamins and trace elements at adequate level affects growth positively (Table 5).

Table 5. Feed dimensions, feeding rate and net mesh sizes for the on-growing of sea bass

Feed size (mm)	Fish weight (gr)	Water temperature (^0C)	Feeding rate (%)	Mesh size (mm)
0.9-1.2	1-3	16-25	5-3	4
1.25-1.5	3-8		2.6-4.1	6
1.5	8-15		2.2-3.5	8
2	15-30		1.5-2.75	12
3.2	30-80		1.2-2.1	15
4.5	80-250		1.1-1.8	20
6	250 -		0.4-0.9	24

Figure 34. Net cage systems for the culture of sea bass

Since the sea bass hatchery in the Black Sea Region is not found due to the unfavorable environmental parameters, the juveniles with 2-3 g are transferred from the hatcheries in İzmir and

Muğla provinces with specially designed vehicles. Sea bass is produced in the Black Sea in Ordu and Trabzon cities and Greece in the North Aegean Sea.

2.3.3. Carp culture

2.3.3.1. Water and soil properties in carp farming

In carp culture minimum water requirement is to keep pond full continuously. The losses due to infiltration and evaporation in summer and oxygen consumed in ponds should be recovered with the amount of entering water (0.5-1.0 lt/min/ha). Depending on the characteristics and climatic conditions, the amount of oxygen at the exit of the pond is 5-6 mg/lt; higher oxygen levels permit higher stock densities.

In carp production, streams, spring water, lake water, groundwater or simply all warm waters can be used (Atay and Çelikkale, 1983). Although rivers contain high amounts of oxygen and nutrients, special care should be given to floods, agricultural, domestic and industrial pollution.

Attention should also be paid to falls in the water level. When necessary, the water taken from the stream is needed to be rested before giving to the ponds. Because of stagnant water temperatures, they are the most preferred waters for carp production, especially in the reproduction season. Spring waters are poor in oxygen and they also have the risk of containing toxic gases. They need to be aerated by increasing the falling surface at the water inlet by various simple methods to increase oxygen and get rid of harmful gases. Waters having too much toxic gas may contain heavy metals such as iron and lead, are not suitable for carp culture. Spring waters have no risk of flood, carrying mud to increase turbidity and infections. Artesian waters and groundwater extracted by pumps can also be used in carp production. But, effective cost analyses should be done before starting to use.

Main requirement is the water temperature good for metabolic requirement of the carp without considering the source of water. Successful pond culture depends on the water being rich in natural nutrients. The richness of water is expressed in terms of nutrients; the amount of lime it contains. The lime content of the water is measured by the acid binding capacity (ABC). If 1 liter of water contains 28 mg of CaO, the acid binding capacity of the water is 1. In carp farming, ABC should be 1.5 which is equivalent 42 mg CaO/lt. If ABC is smaller than 0.5 are classified as less efficient, between 0.5-1.5 moderately efficient and greater than 1.5 are productive. However, ABC should not be over 6.

For carp culture, pH should be between 5.5-10.5; optimum 7-8. When the amount of lime in the water increases, the pH value also increases. However, high pH does not always mean excessive lime in the water. The amount of CO_2 in water and pH value increase when phytoplankton and aquatic plants are dense; especially in summer as a result of photosynthesis. As a result, it can be concluded that the water has high lime. If the pH value is between from 6.5 to 8.5 in daily measurements, the amount of lime in the water is sufficient. When the pH is low, the water needs to calcify. Waters are not suitable for aquaculture when 4> pH> 11 in water. It would be costly to make this type of water suitable for aquaculture. Water with pH <4 makes the cells impermeable as they reduce the feed intake as well as free H^+ ions and cause fish deaths in advanced stages. It also reduces the biological nutritional capacity of water by stopping the development of phytoplankton and zooplankton. Lack of sufficient lime in the water decreases the pH and causes defects in the scales and bone formations of the fish (Atay and Çelikkale, 1983).

The amount of oxygen in carp ponds should not be below 5-6 mg/lt. Most of the oxygen in the pond is provided with a small amount of water (1.5 g O_2/ m^2/ day; 4.8 g O_2/m^2/ day in large lakes) by surface aeration. The higher the oxygen entering the pool means, the higher the stock amount.

In cases where the oxygen of the water is not sufficient, the water is made in the form of waterfalls before the pond entrance, and the amount of oxygen is increased. Since the oxygen in the pond water is consumed not only by the fish, but also by the organic materials, microorganisms and aquatic plants at night, especially in the early summer months, it is critical for oxygen deficiency. As the temperature of the water increases, the oxygen holding capacity decreases. For this reason, it is necessary to constantly monitor the oxygen content in the pond outlet as well as the water temperature in the pond. For a carp weighing 1 kg, 300-500 mg O_2/lt/hour is required.

Water temperature is important for reproduction, nutrition and metabolic activities. Carp cannot find a chance to reproduce in waters where the water temperature does not rise to 18-20 ºC. It grows continuously as it consumes feed intensively at temperatures of 18-20 ºC and above. The growth rate is higher in warm waters; ie. it takes 3-4 years in Europe for portion size, while 1-1.5 years in warmer countries. Because the appropriate growth period is 3-4 months in Central European countries, 6 months in the Black Sea and more than 7-8 months in the Aegean and the Mediterranean region. Therefore, for carp production in Turkey it has very favorable conditions (Çelikkale, 1988).

Domestic and industrial wastewater should not be mixed with waters where carp produced. Especially small amounts of DDT (29.4 mg/lt), Aldirin, Endrin (0.057 mg/lt), Malathion (100 mg/lt), Metasytox and mercury compounds can be lethal. The amount of CO_2 should not be more than 2 mg/lt. H_2S is harmful when it is 0.5 mg/lt and have lethal effect when it is more than 5-6 mg/lt. Nitrite as 1-2 mg/lt has killing effect. 0.2-0.4 mg/lt ammonia is lethal on the juveniles and 0.6 mg/lt ammonia on the small fish. Although the effects of detergents differ according to their types, the amount of 5.0-10.0 mg/lt destroys the eggs and sperm. Phenols are compounds that have a strong poison effect for fish. Heavy metals and compounds such as iron and lead have a lethal effect. Ferrous compounds settle on the eggs and prevent the hatching. Iodine, chlorine and nitrogen gases also cause various diseases. Tar and oils affect the intestines and blood circulation.

The better the soil of the land to be built, the more fertile the pond will be. When the water source is inside the pond land, the water plants that cannot be dried, if they cover the pond bottom, it makes cleaning and disinfection processes impossible. Therefore, such places are not suitable for pond construction. The pond should be constructed in impermeable clay and loam soils. Sandy and permeable soils are also not suitable for pond construction. Soils fed with organic matter are suitable for soil carp rearing ponds. İf the soil is poor in organic matter fertilization with barn manure or agricultural waste can be done. For carp production, farm site should have areas;

- close to the river or water source that will supply the farm with sufficient water throughout the year,
- with natural or artificial obstacles against floods,

- suitable for future expansions and does not take current winds,
- having soil contains clay and calcareous structure, at least 1 m depth to prevent water leakage,
- does not have large stones and tree roots,
- with a slope to allow the water to flow naturally into the pools,
- excavation is easy and does not require much excavation,
- Easy access to the market,
- Choosing a good business location minimizes the costs.

2.3.3.2. Ponds used in carp production

Soil ponds are suitable for the development of phytoplankton, zooplankton and other aquatic organisms which forms a god habitat for carp culture. Half of the nutrients needed for carp culture are provided from soil ponds and second half from artificial feeds. In Israel 20% of feed is from ponds, 20% is from fertilizing and 60% is from artificial feeds. As soil pools are natural food sources, investment costs are also low. It is assumed that yield of 600 kg/ha in extensive production under European conditions comes from the food obtained from the ponds (2/3) and artificial feeds (1/3). Therefore, 3-4 kg of whole grains is necessary to produce I kg of carp.

Ponds for carp culture can be in different shapes;

- Terrace ponds: Established on sloppy lands, three sides are surrounded by walls and the lower wall is higher than the side walls. If the slope is too high, side walls should be high. Due to the risk of flooding, it is not appropriate to build pools in streams and stream beds.
- Dam type ponds: These are four-walled ponds made in streams, swamps and similar flat places. Since the land is soft, its walls are wider than the terraces.
- Rice field ponds: By constructing a transverse wall (embankment) on small river sides or streams that do not have flood hazard. These are ponds similar to the water collection pond.

Ponds in carp culture can be used for different purposes:

- Spawning ponds: They can be in different sizes according to the type of farm, the size and capacity of the land on which it is established. It is important for the spawning pools to be installed in the sunny and windless place. In the middle of the pond there is the grassy part called the spawn beds.
- Dubisch pond is generally 100 m2, rarely 250 m2. The depth of the pond is 30-40 cm in the middle and 60-70 cm in the side channels. Dubisch pond is kept dry outside the spawning season. Until water filling time by planting water-resistant hard meadow grasses (*Lolium perenne*) in the middle of the pond may grow for the attachment of eggs. The length of the plant should be about 10 cm. After spawning water level is lowered, allowing breeds to be collected in herbaceous canals and easily taken from there. The larvae a week after the eggs are hatched and the larvae exit; then collected with water flow.
- Hofer ponds are generally used in cold regions. The walls are 0.8-1.0 m high in front of the water outlet. The pond floor is sloped to the sides. Shallow part is the spawning place of fish and it is covered with aquatic plants. Due to the inclination, the fish have the opportunity to choose the appropriate spawning depth and shelter for sudden weather changes.

- Nursery ponds: They are small and shallow ponds that are 100-1000 m2 in size, where the larvae are kept for 3-8 weeks (usually 4-5 weeks). However, their smallness should be preferred in terms of control.
- Juvenile culture ponds: Juvenile breeding pools; slightly larger than larvae ponds (usually less than 1 ha between 400 m2 and 5 ha) and water inlet-outlet, where the juveniles are kept until 5-6 cm. In places where the winter is cold and does not have a wintering pool, the depth are made of 1.5-2.0 m in juvenile culture ponds in the coastal areas allowing the fish to spend the winter smoothly (Çelikkale, 1988).
- Growing ponds: These are ponds with depths ranging from 1.0-3.0 m, where the old carp are stocked. Their size varies from 4000 m^2 to hectares. However, 400-500 m2 in size is very common due to the easy control. In these ponds carp grows over two years of age, are fed extensively to stock up and reach the market weight (Çelikkale, 1988).
- Wintering ponds: They are used in cold regions where the winter lasts longer. Carp are taken into the wintering ponds when the water temperature drops below 10-12 °C. Since there is no feeding in the wintering pools, the stocking rate is kept high. Depth of wintering ponds is 2-3 m, and the size varies according to the amount of fish to be stocked. Storage in wintering pools can be 5-10 fish/m2 S1 and 2-4 fish/m2 S2. In order not to increase oxygen consumption, plants and mud should not be at the bottom of ponds. Also, good water circulation is needed to be provided; the water inlet and outlet should be made diagonally and the water flow should be high. There should be 45% slope in the pond walls. When the water temperature rises above 10 °C, carp are taken from the wintering ponds.
- Stock and marketing ponds: These are the soil, concrete or stone blockage pools of 500-1000 m2 in size, where the fish harvested from the production ponds are kept for a few days until they are marketed. By giving plenty of clean water to the ponds, possible mud smell in the fish is eliminated. Since the fish kept in the stock and marketing ponds are not fed, attention should be paid not to be too long. Otherwise, the fish may lose weight. Stocking and marketing ponds are stocked at a rate of 5-15 kg/m2. The water flow is regulated to change the pond water at least twice a day. For 1 kg of fish, 10-15 l/min of water flow is sufficient to remove the smell of mud.
- Brood stock ponds: The size of the breeding pools varies according to the capacity of juveniles needed in the farm. Depth is about 1 m. Water should be clean and at 15-17°C. When the spawning time approaches, water temperature is raised to 18-20 °C with various applications.

2.3.3.3. Carp feeds and feeding

The most commonly used method in carp farming is stagnant water cultivation, although it is the oldest. Daily feed amount to be given to carp depends on the amount of natural food available in the pond and the nutrient needs of the fish population.

The amount of natural feed in the pond varies according to the;

- productivity of the pond,
- environmental conditions,
- seasons

The need for nutrients closely related with;

- water temperature,
- fish size,
- stocking rate

Complementary feeding is done in carp ponds by taking these factors into consideration (5):

- Green plants: The carp often consume soft parts of green food. However, green forage crops are not used as supplementary feed alone. They are usually given in ration.
- Juicy food: All kinds of kitchen waste can be used as complementary feed in carp farming,
- Root and tuber feeds: The most commonly used root and tuber feed is potato. Small and shredded potatoes that are not used for human consumption are used in carp feeding. Since the water content of the potato is high, 4 parts of potatoes are equivalent to 1 part of corn.
- Grain feeds: Grains are the most important complementary feeds used in carp feeding. Since the prices vary according to time and region, grain feeds that are of low value and suitable for human consumption are used as fish feed. Grain feeds are given broken or soaked (softened), especially at the beginning of the growing season and when the fish's appetite is still low. When the waters warm up in late summer, they are given wet, without breaking.
    - Legume seeds are rich in protein. For stable animals due to the alkaloids in its composition unsuitable lupine is harmless and highly valuable for carp.
    - Corn is a suitable grain feed for carp. There is no need to grind the corn while feeding with corn. As a result of grinding, its digestion does not increase, but its taste decreases. If corn is to be mixed with roughage, it is useful to grind or break it.
    - Barley should always be soaked. Barley alone as complementary feed; if it is given, there is no need to be grounded except for hard ones.
    - Wheat has 15% protein and 74.3% starch and has almost the same nutritional value as corn. Sometimes it can be broken because it is thrown out without chewing and indigestion. However, the crushing process reduces the flavor, but the consumption amount and weight does not significantly affect its increase. When wheat is used instead of corn, it should be given 7-10% more.
    - Rice is an excellent carp feed and is 85-89% digested. Broken rice and rice scraps not suitable for human consumption can be used as carp feed. 1 kg weight increase is calculated with 4.5-8.0 kg rice.
    - Oats are not used as supplementary feed alone. Because it is delicious, it can be used instead of 3/4 of corn in mixed feeds. When whole corn is used instead, provides weight gain up to 3/4. Oats contain an average of 11.5% protein and the starch value is 58.

      Grain feeds should be given in regular rations. Protein-rich foods should be given together with carbohydrate-rich foods. It is appropriate to provide 1/7 - 1/8 of the protein in mixed feeds with grain feeds.
- Milling Remains: Milling residues contain an average of 12% crude protein. Approximately 4 kg of milling residue and 1 kg of carp production are calculated.
- Pellet feeds: They are used as complementary feed or full feed according to the carp production technique. As normal pellet feeds dissolve in water within 1-3 minutes, they lose their superior

properties to other feeds. Adding 4-5% wheat gluten flour to mixed pellet feeds ensures that the pellets remain in water for at least 20 minutes. Wheat gluten flour provides protein addition to the ration as well as the pellet binding feature. Since gluten flour is expensive, 10-12% well-ground wheat flour can also be added to the ration. The dispersion of the pellet in water depends on the degree of wetting of the wheat participating in the ration. Pellets pressed with steam at a rate of 3-5% remain in water for about 20 minutes without dispersing. The main drawbacks of using wheat gluten flour as a pellet binder are; it is expensive, because the protein is poor in lysine and methionine, it is difficult to balance and must be used as age. Adding 10-15% fish meal to pellet feed rations affects the amount of production. When the fish meal participating in the ration exceeds 20%, its amount increases significantly. However, it is necessary to evaluate the increase in fish production obtained with the increase of fish flour economically. In addition, there are important problems when fish meal is not used as a source of protein. The most important problem is to find an alternative source of protein, cheaper than fish flour. It is possible to reduce feed with milling residues. In intensive carp production, feeds with high protein and energy content are used. Structural features of carp feeds are given in Table 6, collectively.

Daily feed amount to be given to carp fish is arranged according to;

- fish size,
- water temperature,
- amount of water,
- water quality (O_2 amount of water),
- number of fish stocked,
- feeding duration
- production technique

The amount of feed to be given by fish weight is shown in Table 6. Practically 1/10 of the water temperature (2.5% at 25 ° C water temperature, 2% at 20 ° C water temperature) can be taken as the feed rate according to the fish weight in the pond. The fact that the feed is given in a large number of meals increases the labor force, however, the feed provides good evaluation and increases growth. Two times feeding is applied in morning and evening in carp culture.

Table 6. Structure of carp feeds (%)

Feed	Moisture	Protein	Fat	Ash	Cellulose	Metabolic energy (Kcal/kg)
Corn	13	9	4	2	2.5	3460
Wheat	12	13	2	2	2	3110
Crushed wheat	14	15	3.5	5	10	2120
Soy pulp	13	45	0.5	6	6	2650
Cotton pulp	10	48	1.5	6	5	2650
Fish meal	8	63	10	16	-	3500
Poltry wastes	7	60	13	18	-	3550
Chicken coaster	15	20	2	23	20	1500
Feather meal	9	80	5	3.5	-	2900

Oil	3	-	95	2	-	8000-9000
Pellet		28-40	3-4	10-12	2-6	8000-9000

2.3.3.4. Juvenile production methods in carp culture

There are three kinds of juvenile production methods; uncontrolled, semi-controlled and fully controlled:

2.3.3.4.1. Uncontrolled juvenile production method

In this method eggs and larvae are collected from natural waters. It needs regular check of the plants weather they carry eggs. When spawning takes place, egg attached plants are collected and carried to the breeding ponds. Eggs hatch there and they are collected by meshed scoops. A second application is the collection of larvae where egg carrying plants are put in the pond. Collection of eggs and larvae from natural waters is widely used in Far East countries.

Reproduction in breeding ponds where fish of different sizes are mixed, mature fish spawn in shallow and grassy parts of the pond. Larvae are hatched in the same pond. However, in this method, large amount of eggs and larvae are lost. If there is no grassy part required for spawning in the pond, weed is placed in the shallow parts of the pond. When ovulation occurs, the plants are transferred to another pond for hatching larvae. This method is implemented as semi-controlled method in Japan. Grass and weed-like nylon clippings are attached to the center of the bamboo cane and eggs are allowed to stick. The bamboo cane is placed under the water for the eggs to stick. Artificial weed material is checked frequently at the time of ovulation and transferred to the larvae pools to open the eggs when spawning (Çelikkale, 1988).

In semi-controlled production method, various artificial materials (pine branches, grass or stalk bales) are placed in the pond together with brood fish. When they lay their eggs, artificial spawning materials are placed in another pond and hatching is provided here. Another application is to take the breeder from the pool after ovulation and keep the larvae in the same pool until the feeding period. This process is carried out in the corner of a large pond. It can also be done by arranging a small pool of several square meters. By opening the door of the pool, it is ensured that the larvae, which are ready to feed, are distributed to the large pool.

Dubisch and Hofer are the most used spawning ponds. They stay dry throughout the year. Before taking water into ponds, they are disinfected with lime. Water in spawning ponds when the water temperature rises above 18-20 °C in spawning ponds, breeding fish are taken from their ponds and checked one by one for sexual maturity. They are kept in salt bath for 15 minutes before being placed in spawning pools in order to prevent skin and gill parasites.

Adult fish spawn after 24-28 hours. Ovulation can also be observed from outside the pool. Females are followed by breeding males, female and male fish begin to turn over the plants during follow-up. Foaming appears on the surface of the water before the moment of ovulation. During spawning, water smack is heard. This water slap called spawning game of female fish squirting eggs on plants and male squirt sperms on plants where eggs attached. Ovulation takes 5-10 hours in batches. After this time, plant is controlled. When dense eggs are seen on the plant, it is understood that the ovulation is finished.

On the side of the Dubisch pond of breeding fish is collected by lowering the water level in the pond, providing to descend to the channels without grass. Breeders are easily taken from here.

Larvae stay in the pond for 4-5 days. When they start to consume food sac and fill the air sac with air, they are ready to receive food from outside and are transferred to the larvae ponds.

2.3.3.4.2. Intensive Larvae Production (Artificial Production)

Breeding stock is selected for artificial production according to the criteria given below:

- Fast growing,
- Good feed evaluation,
- Low fat content and
- Resistance to diseases

After the brood stock is selected, male and female fish will be separated and stock density is kept as 500-1000 fish per ha. Fish are fed with pellets containing 20-25% protein of which 15-18% comes from animal protein. Pellet feeds also contain 2% vitamin mix and 1% minerals. Vitamins A and E must be present. Two weeks before spawning, raw meat or hard boiled eggs 5-10% are given to fish. Feeding rate is 2-5% of their body weight per day. Adults have reached sexual maturity at 35- 70 cm length and 2500-10000 g weight in Europe. Females reach sexual maturity at the age of 3-4 and male at the age of 2-3. In tropical and warmer regions sexual maturity has been reached at age 1-2 in females and at age 1 in male. The abdomen of mature female fish is wide; outflow of sperm when pressure is applied is the indicator for males. It is the best time for pituitary injection for the fully controlled artificial propagation in carp culture (Figure 35).

The pituitary gland is removed from the heads of the fish by various methods in winter or best in spring. Fish will be used for extraction of pituitary gland must be 1 kg or more; over 3 years old (Çelikkale, 1978).

The pituitary gland can be removed by twisting between the middle of the two eyes with special auger-shaped tools. Another method is to use the head in a variety of shapes (eg a sharp saw blade or knife by horizontally) opening. Just under midbrain the pituitary is found in the bone chamber called Cellaturcica. It is in lentil grain size and white color. It is removed carefully with the help of a collet. The removed pituitary gland is kept 10-12 hours in acetone at room temperature and dried and kept in the refrigerator. It is reported that the holding time in acetone for 4-5 hours is suitable for the purpose.

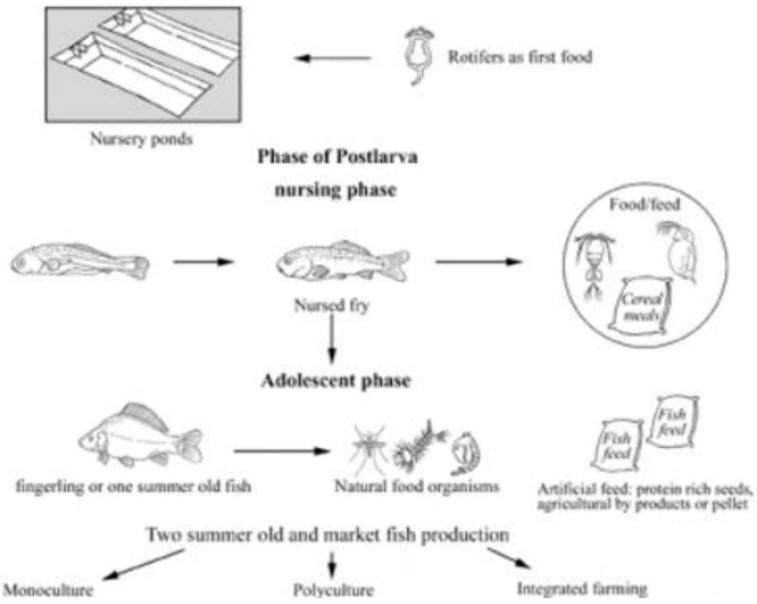


Figure 35. Breeding process of Carp (*Cyprinus carpio*)

Pituitary gland application protocol is given below:

- Fish are moved to the hatchery the day before spawning. Fish to lay are placed in tanks made of inorganic material.
- Female and male fish are separated in the hatchery and taken into plastic or concrete tanks.
- Space requests are 0.5-1 m^2/individual.
- Tanks should be 5-10 m^2 in size and 1-1.2 m in depth.
- Water requirement is 4-6 lt per minute per fish
- The oxygen content of the water should be 6-8 mg/lt.
- The water temperature should be 20-22 °C.
- Stunning can be given before milking; 1: 10.000 MS 222 (Sandoz) is used as tranquilizer.
- Fish are transferred in fresh water tanks containing high levels of oxygen. 5-10 minutes after the sedative is applied,

Carp pituitary hormone is used to promote ovulation in females and sperm production in males. For this purpose:

- The pituitary is given as 4-4.5 mg per kg body weight for females. Carp pituitary is powdered in mortar and dissolved in ‰ 6.5 salt solution. 2 ml salt solution is used for each fish.
- Hormone application to females is done in two stages: 10% of the hormone is applied 24 h before the egg intake, and 90% of the hormone is used 12-14 hours before egg intake, when the water temperature is 21-22 ° C. Injection is done between the back muscles with a fine-tipped needle. Before the needle is pulled, a light massage is applied to the injection site in order to prevent the solution from coming out.

- When ripe eggs come out, egg channel will remain open during the ovulation period; therefore oviduct need to be stitched during the second hormone injection to prevent is done to prevent egg losses.
- Oviduct suturing is done with the tools used in surgeries.
- Hormone application to male fish is done 24 hours before milk intake.
- Fish to be applied hormone should be kept in a quiet and calm environment,

The rules to be followed in egg-milk intake and fertilization processes in carp have been specified as follows:

- One or two male individuals are placed between the females 1 hour before the egg is taken. Since the female and male fish swim along the sides of the tank, they can hit the edges strongly.
- It is expected that in half an hour eggs are completely separated from the ovary wall. After this time, the fish are calmed down. After opening the oviduct, the sutures are removed. Abdominal area of the fish is cleaned with a dry cloth, and the contact of the eggs with water is prevented. If the eggs come into contact with water, they can quickly absorb water and lost their fertilization ability.
- Eggs are collected in 2 liter plastic containers. Eggs are taken with a slight pressure applied to the abdominal area. Milk is taken into test tubes by applying a slight pressure to the abdomen. Eggs should be fertilized as soon as they are removed from the female.
- In fertilization, 10-20 ml of milk is used for 1 liter of eggs. Each egg set should be fertilized with the sperm of at least 3 inactive males.
- Eggs and sperm are mixed without adding water. Until sperm reach all the eggs. Mixing process is done with a plastic spoon. Fertilization can also be done using fertilization fluid (1 lt of water, 4 grams of salt and 3 grams of urea).
- The temperature of the fertilization liquid must be 20-22 ^{o}C. Fertilization liquid prevents eggs from sticking and activates sperm. Add 100 ml of fertilization liquid to 1 liter of egg and mix. Mixing process must be continuous. 100 ml of fertilization liquid is added to the mixture at two-minute intervals. After 10 minutes, fertilization liquid is poured; 2 lt of fresh fertilization liquid is added to 1 liter egg.
- Eggs are poured in 15-20 lt plastic containers with fertilization fluid. Eggs swell 4-5 times their normal volume within 1 hour; fertilization fluid is changed every 10 minutes and stickiness of the eggs is removed. Mixing is done intermittently, gently by hand or mechanically.
- Adhesive on the surface of the eggs, which is concentrated by the previous process.
- 1 hour after the above procedures the eggs are treated with tannic acid to dissolve sticky substance on the eggs.
- Tannic acid solution contains 1.5 g of tannin dissolved in 1 liter of water; Tannic acid solution is applied after the fertilization liquid is poured; 1-2 lt of tannic acid solution is added to the eggs and mixed immediately. After 10 minutes, water is added to dilute the tannic acid solution. Then the solution is poured.
- Eggs are washed 3 or 4 times with plenty of water and placed in incubation bottles after washing.

The procedures to be applied during the hatching of the carp eggs are as follows:

- Water temperature during incubation should be 20-22 °C.
- 20000 eggs are put in 1 liter incubation bottle. The volume of 20000 swollen eggs is about 200 ml. Since the cell division has begun, strong shaking may damage the egg.
- Eggs are placed in funnel-shaped incubation bottles, filled with water, which the bottles are equipped with a long hose. The function of this hose is to discharge of water from the bottom.
- A medium water flow is provided to the incubation bottles in the first 10 hours. For a 10 liter incubator, 0.8 -1 l / min water flow should be provided. After 10 hours, since the egg's oxygen requirement increases, the amount of water is increased to 1.5-2.5 lt / min. The eggs must float freely at the bottom of the incubation bottle. Since the oxygen requirement of the embryo, it is important to increase the amount of water to 2.5-3 lt / min 4-5 hours before the eggs are opened.
- On the second day of incubation, eggs are treated with malachite green to prevent fungal growth (1:200000). Let the malachite green solution stand in the bottle for 5 minutes, shake slowly rinse with water
- Larvae are expected on the 3rd day of incubation.
- After the first few larvae hatch, the processes are accelerated.

Depending on the movements of the embryo, since oxygen deficiency will disturb the embryo, the egg shell will crack.

When water flow is given after 10 minutes, hatching begins to a large extent. The larvae are transferred to the larvae breeding cups together with the water.

Artificial milking and fertilization, increase the larvae hatching rate up to 756% while the rate is 10-20% in the natural environment. Thus, the number of brood stock to be kept is reduced. Artificial milking and fertilization eliminates the bad effects caused by relative breeding and allows creating new genetic composition.

2.3.3.5. Nursery and feeding larvae

For the nursery of larvae cylindrical containers (50-150 lt glass, plastic or fiberglass), oncrete or plastic circular tanks or net cages can be used.

Cylindrical containers can hold 2000 larvae per 1 liter. Water enters from the bottom and leaves the container from the top. The area overflowing with water can be 10 cm^2/lt. The amount of water (flow rate) will keep the larvae in a suspended position and should be enough not to push. Since small porous gratings will be clogged with egg wastes, tank need to be cleaned at regular intervals.

After the larvae are kept in these containers until they start feeding (3-4 days), they are transferred to the nursery ponds. Since the above processes are the latest developed systems, the larvae are protected under hygienic conditions. There are various types of tanks for larvae rearing;

Containers with water flow

- They are plastic or concrete containers with 60-80 cm depth and 1-2 m^3 capacity.
- To ensure a circular flow, the water is poured from the holes of vertically placed tubes on the opposite sides. The flow rate of the water will ensure that the water flows slowly.

- The transport tube is placed vertically in the center.
- Nylon water overflow screen has 0.8 mm mesh size. There should be 8-10 cm^2/lt flow in the surface area of the screen.
- The oxygen content of the water is increased by spraying to the surface.
- 1000 larvae are stocked per liter of flowing containers.
- The advantage of these containers is that when the proper feeding environment is provided, it allows them to be kept for another day.

Net cages

- The dimension of the cages is 70 cm x 40 cm x 30 cm, made of aluminum or plastic tube frames.
- Cage nets are nylon and have 0.8 mm mesh size.
- Cages are placed in plastic or concrete tanks. There is a need of water current from bottom to top in order to provide current so that larvae can move continuously.
- The discharge is provided by the horizontal pipe at the bottom of the tank and the end of which has a hole. The bottom of the cage should be cleaned the day after hatching to remove dead larvae and egg shells. Base and edges of the cage should be cleaned with a brush every 6 hours to allow the water to pass easily through the cage.
- Water flow rate to the cages should be 4-5 lt/min/cage and sprayed from the surface to increase the oxygen content of the water

Transport and feeding of larvae after hatching

The following procedures are applied in the transplant and feeding of carp larvae.

- The mouth of larvae develops in 3-4 days. The larval stage ends with the first feeding from the outside and at this point the larvae turns into juvenile.
- In this stage, the egg sac will be absorbed to a large extent.
- In this case, the larvae reach the water surface. Also fill the air sac with air, they start swimming horizontally.
- When larvae start to swim, the first food is given to the larva. As first food, boiled egg yolk mixed with water is used. 1-2 ml of this mixture is given for 100000 fish at two hour intervals.
- As soon as the larvae begin to feed externally, they are taken to the on-growing ponds.
- The juveniles fed for 4 days are transported in plastic bags containing water and oxygen.
- 200000 larvae can be kept for 5 hours.100000 larvae in 20 lt water, containing 20 liters of water and 30 liters of oxygen, for 5 hours, 15 ° C.
- If transport requires cooling, the water temperature will be lowered gradually.
- Plastic bags are inflated after filling and tied tightly and oxygen leakage is prevented. The bags are placed inside the plastic box to prevent damage.
- 4-day-old larvae are 6-7 mm length.

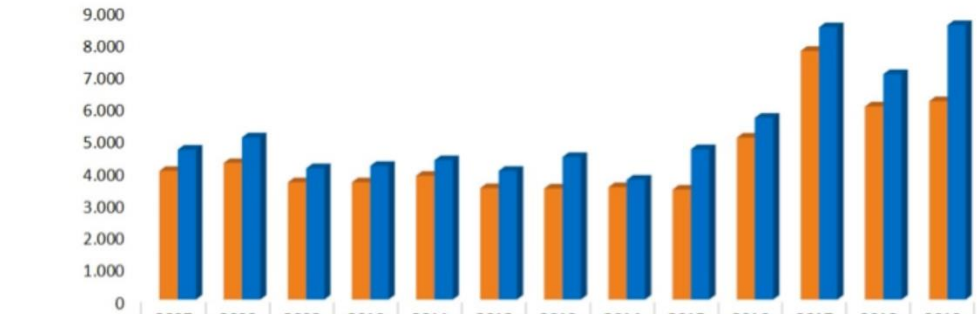
Biological and Technical Data

All these information are summarized in Table 7 and Table 8 (Bakos, 1984).

Approximately 90% of the carp produced in Turkey is used to enhance 500 lakes and ponds in 50 provinces every year. Some of the remainder is used to recruit brood stock in state farms (Figure 36).

Table 7. Biological and technical data in carp culture

Parameter	Value
Age of sexual maturity (M/F)	3-4/4-5
Length of mature fish (M/F)	30-60 cm
Weight of mature fish (M/F)	1.5-10 kg
Optimum water temperature	20-24 ^{o}C
Sex rate (M:F)	1:1
First hormone injection to females	2.5-3.0 mg (1 pituitary gland)
First hormone injection to males	3 mg/fish
Time between two injections	12 hr
Second hormone injection to females	3-5 mg/lt
Second hormone injection to males	-
Time between 2nd injection and ovulation	240-260 degree x hr
Efficiency of hormone injection to females	75-85%
Dry weight of eggs per females	500-2000 g
Sperm weight per male	10-30 ml
Quantity of sperm to fertilize 1kg of dry egg	10-20 ml
Rate of fertilization of eggs	80-95 %
Egg size (dry/swollen)	1.5-3.0 mm
Number of eggs per kg (x 1000)	700-1000
Volume of swollen eggs in 10 lt of bottle	1.5-2.5 lt
Water flow in bottle	0.5-2.5 lt/min
Incubation time (degree x day)	60-70
Incubation rate (5)	95-100
Larvae period (degrees x day)	60-70
Stock density in larvae pond	2000 larvae/lt
Survival rate of larvae with yolk sac	90-95
Number of larvae started first feeding out of 1 kg eggs	500000-700000 larvae
Size of larvae starting feeding	6-7 mm
Size of first feed	50-200 µ



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Balıklandırma	4.002	4.250	3.650	3.650	3.850	3.471	3.459	3.500	3.425	5.035	7.720	6.000	6.163
Toplam Üretim	4.664	5.042	4.083	4.158	4.338	4.003	4.437	3.731	4.681	5.651	8.453	7.000	8.519

Figure 36. Carp production and quantity used for enhancement from 2007 to 2019 (blue: total production, orange: quantity used in enhancement of the lakes

Table 8. Biological and technical data in carp larvae culture

Parameter	Value
First feed in hatchery	Boiled eggs
Nursery period	3-4 weeks
Water Temperature	20-25 ^oC
Culture unit (pond)	100-10000 m^2
Stock density	200-600 larvae/ m^2
Pond maintenance in nursery period	
Organic fertilizers	500- kg/100 m^2
Inorganic fertilizers	(1 kg superphosphate+ 1.5 kg ammonium nitrate)/100 m^2
Protective processes at the end of nursery period	
Formalin	24 ppm
Malachite green	0.1 ppm
Copper chloride ($CuCl_2$)	4 ppm
NaCl solution	3-5 mins with 3-5 % in concentration
Feeding	Feed with 30-40% protein (1kg/100000 fish)
Survival rate (%)	50-60
Larvae length after 1-1.5 months	2.5-3.0 cm

2.3.4. Flathead grey mullet (Mugil cephalus)

Most juveniles used in aquaculture are collected from the sea; especially in the Eastern and Southern Mediterranean, Saudi Arabia and the Gulf countries, and Southeast Asia (Figure 37).

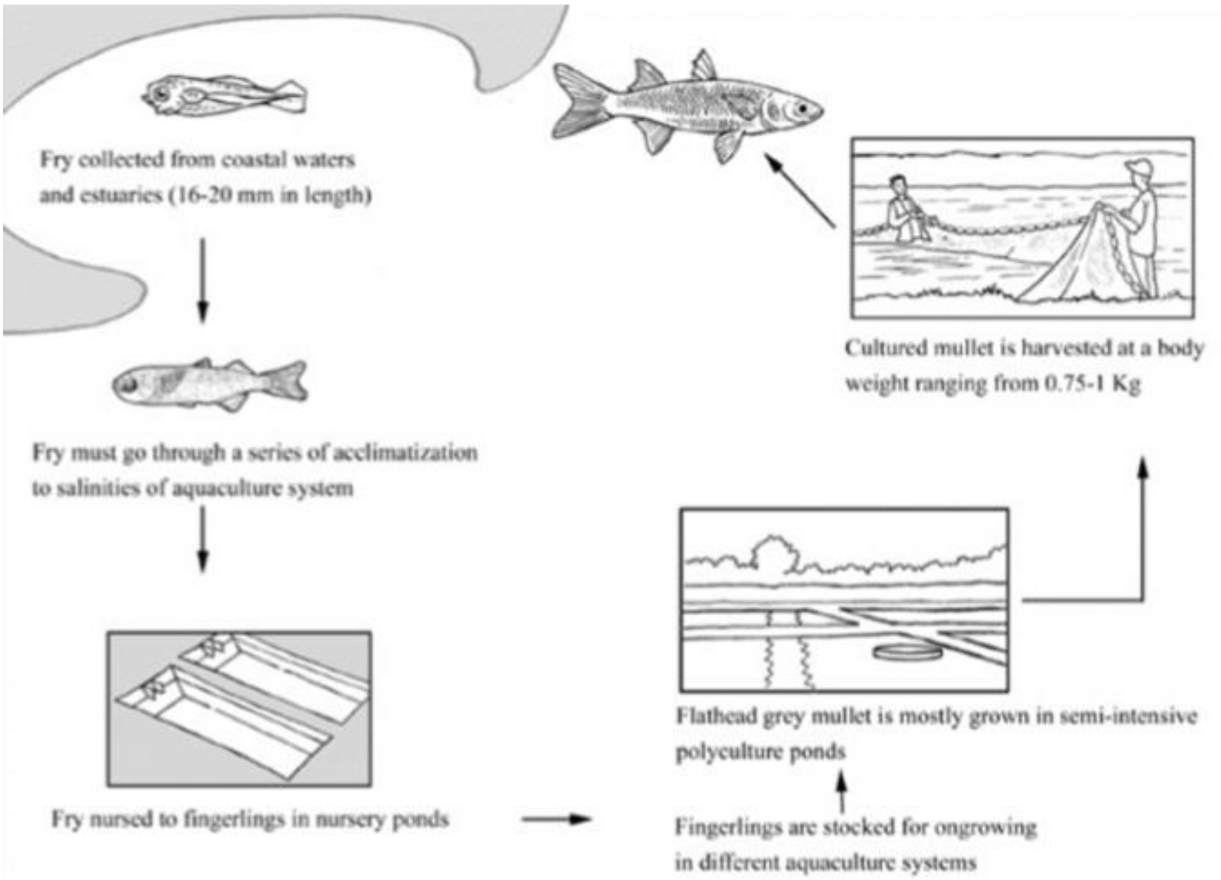


Figure 37. Breeding process of Flathead grey mullet (Mugil cephalus)

During the autumn and winter months, adults migrate to the sea in large concentrations to give birth. Fertility is estimated at 0.5-2.0 million eggs per female, depending on the size of the adult. The hatching takes place about 48 hours after fertilization, releasing larvae about 2.4mm long. When the larvae are 16-20mm, they migrate to coastal waters and estuaries, where they can be collected for aquaculture purposes in late August to early December.

The young are collected in small nets, transported in tanks with sea water for a few hours. They are then transferred to fish farms. Upon arrival, they must be acclimatized, especially in terms of salinity, this happens for several hours, when during this process water is gradually added from the lake and mixed with sea water. The farming takes place in extensive, semi-extensive / semi-intensive production systems and with the use of artificial water collections. Another common breed is together with carps.

The marketable size is between 0.5 and 1 kg in 1-2 years respectively.

2.3.5. Mussel culture

Mussel production is the main activity of shellfish farming in Europe. There are reports of mussel farming in France since 13th century on wooden stakes. The production began off the coast of the

Atlantic with the common mussel (*Mytilus edulis*), then expanded to the Spanish shores of the Atlantic and the Mediterranean with the Mediterranean mussel (*Mytilus galloprovincialis*), which is widely bred up to the Black Sea (Figure 38).

Hybrids of both species are also common in nature. The farming begins with the collection of fertile mussels either taken from the natural bottoms of the sea or from ropes or other collection containers placed in areas selected due to their currents and the presence of microorganisms. The ropes are collected and transported to mussel farms, generally during the period between May and July. Young mussels are dragged from the natural substrates to protected breeding areas near the shores.The three most common breeding methods in the coastal areas of the EU use:

- Long line system (mainly in Spain, Mediterranean, Ireland and the United Kingdom)

The mussels are attached to ropes that are suspended vertically in the water by a fixed or floating structure (rafts). In Spain, rafts are located at the river banks. Some mussel farming activities on the shores of France, Ireland and Belgium is achieved by using long lines.

- Mussels' stake ("bouchots", France)

This type of breeding uses rows of wooden stakes located in the lower tidal zone. Three to five meters of collection rope or tubes filled with broods are wrapped around the stakes and attached to them. Then a net is placed over the entire structure that does not allow the mussels to fall.

- Shallow water areas (in the Netherlands, Ireland and the United Kingdom)

The young mussels are spread over shallow waters, generally in bays or protected areas on the ground. Harvesting takes place 12 to 15 months later.

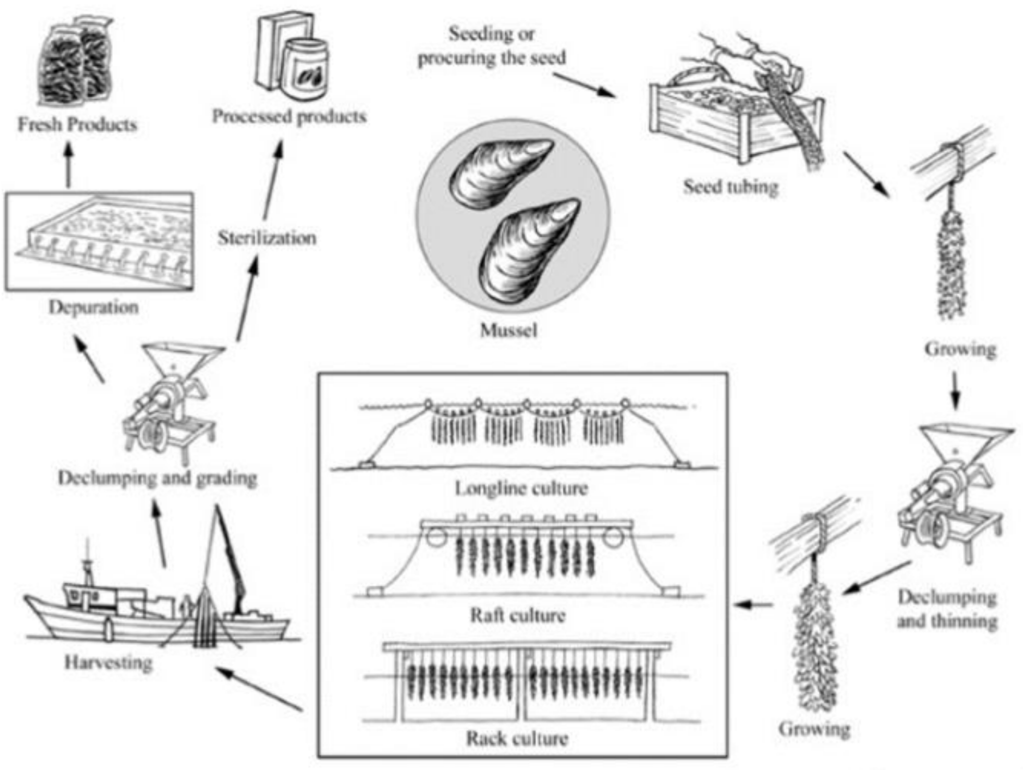


Figure 38. Mussel farming procedure (*Mytilus galloprovincialis*)

2.3.6. Oyster culture

The global supply of oysters is largely based on the production of spat (veligers, ciliated larvae) from the natural environment. However, some oyster larvae come from hatcheries especially in Japan. In this case, the collectors are stored at the sea. At regular intervals throughout the winter, groups of adult oysters are collected and then placed in tanks. The sample is random, because the sex of the oyster is not a determining factor (the oyster is characterized by successive hermaphroditism, that is, it becomes, over time, sometimes male and sometimes female depending on the season and temperature fluctuations.

The release of gametes is achieved in the spring by a thermal shock or by crossing. The gametes of six or more females are fertilized with the sperm of a corresponding number of males. To successfully crown the birth process, the water must have a temperature of about 21 ° C and not be too salty. The larvae are then placed in tanks with closed circuits and they are fed on cultivated algae. Today, most hatcheries pay attention to the production of triploid oysters, ie oysters that are sterilized with thermal shock during fertilization. To harvest them, the oyster farmer uses substrates called collectors which he places in specific spots: plastic substrates (pipes, containers, plates) or Roman tiles, slate piles, and shells.

When the brood is formed, it detaches from the substrate with the help of a knife and is now ready for breeding. In the hatchery, when the larva is ready to attach to a substrate, it darkens and therefore becomes more apparent through its shell’s elevations. At this point the oysters are harvested by placing them in the tank of a solid and clean substrate on which the larvae is attached.

There are four basic methods of growing oysters depending on the environment (tide size, water depth) and traditions.

- The oysters’ farming takes place in elevated platforms: The oysters are placed in the sea within pockets attached to the platforms which are placed on the ground on the tidal zone.
- Horizontal farming (on the bottom): The oysters are placed directly on the tidal zone.
- Farming in deep water or growing in pots: oysters are distributed in controlled areas (parks) that can be up to 10 meters deep.
- Farming in rows of ropes: The oysters are bred on ropes, like the mussels, a method that allows them to be raised in the open sea. They are constantly submerged in water.

The oysters naturally feed on the plankton contained in the seawater, which they constantly filter. Their breeding can therefore be done only in places that meet certain criteria in terms of currents, depth and water content in plankton, ie generally near estuaries, in lagoons or in coastal lakes. The number of cultivated permits granted is determined by scientific criteria depending on the amount of plankton available. Oysters reach marketable size after 18 to 30 months. Harvesting methods are different for each type of breeding: the oysters grown on elevated platforms are collected by removing the pockets from the stands while the oysters grown on the bottom are collected during the low tide with the help of special tools (rake) or with dredging, which can lift up to 500 kg., if the water level enables it (deep waters).

2.3.7. Sturgeon culture

Several species of the Acipenseridae family are bred in Europe. These include Siberian sturgeon, Danube sturgeon, Sterlet sturgeon, common sturgeon and Adriatic sturgeon. Many species of sturgeon are considered endangered or even critically endangered. Controlled mass breeding takes place in freshwater and is applied to all known production systems. The first successful attempt was made by Ovsianikov in 1869 at the Acipenser ruthenus. Sturgeons can be bred in circular or rectangular tanks, in artificial lakes or cages. Most sturgeon farms use a groundwater or surface water flow system (Figure 39).

The fish, which are used for breeding, are subjected to photo-thermal management. When the water temperature reaches 15 ^{0} C and when previously an egg maturation test is performed, the hormone (LHRH-a) is given to the fish so that in about 36 hours they are ready for reproduction. After the fish are anesthetized, the sperm is collected from the males by a catheter, while in females a small incision is made in the abdomen to remove the eggs. This is followed by artificial insemination. During this process, sperm, eggs and water are mixed for a short time and placed in the special egg hatching containers. The hatching process begins after 7 days and lasts another 4 at a water temperature of 15 ^{0}C. After hatching, the brood is transferred to larger tanks and when the 10th day of their life hits they begin to feed on rotifer and artemia and within a week continue with dry food. The brood is then transported to even larger pre-thickening tanks and when they become 2 months (average length and weight, 12cm and 20 gr, respectively) is ready to be transported to the fish farms for thickening.

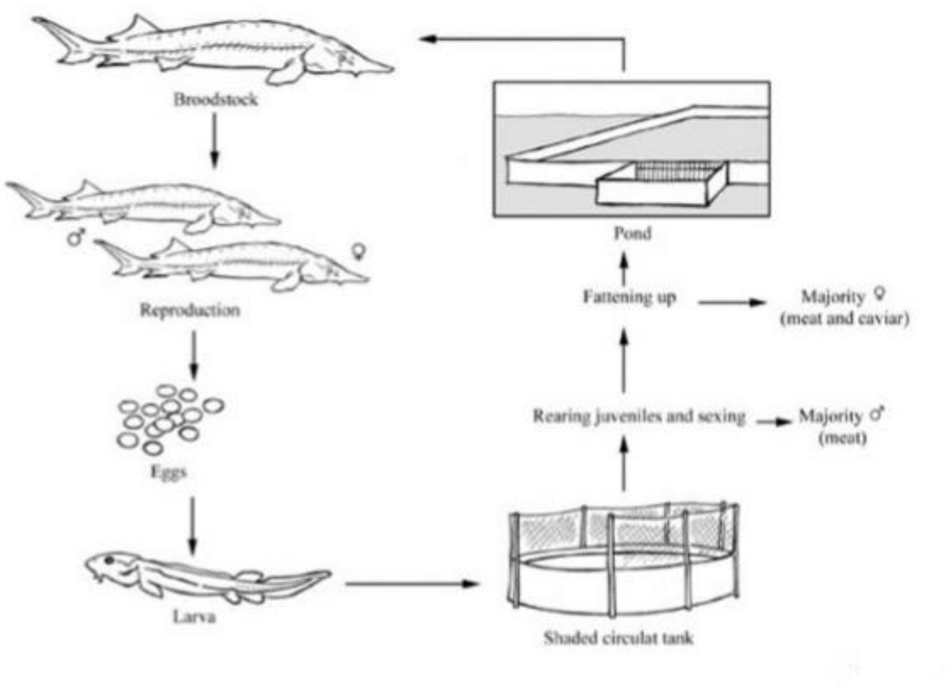


Figure 39. Sturgeon breeding process

There are three breeding methods for the nymph development to the fish development:

- Farming into circular tanks

They are usually circular tanks with a diameter of 2.8-3 m and a height of 0.4-5m and are made of concrete or glass

- Growing in earthen aqueducts

Area of 20 acres and depth of 1.5 m. They are enriched with nutrients and receive the nymphs after having absorbed the vitreous sac.

- Mixed method

The combination of the above two, ie in the first stage, larvae in circular tanks and in the second stage, fish, earth hydropower plants.

The average breeding time of sturgeon commercialized for its meat is 14 months, at which point fish of a commercial size (700 g) are obtained. When caught, it is trapped in nets. However, the exploitation of sturgeon for caviar production is expensive because females cannot reproduce before they are at least seven years old.

2.3.8. Turbot culture

Turbot (*Psetta maxima*) is a potential species for aquaculture and enhancement studies. Turbot culture has been started and carried out as joint project with the Ministry of Agriculture and Forestry, and Japanese International Cooperation Agency (JICA) in 1997. Although the project finished in 2007, hatchery and on-growing units have been still running to supply small turbots to the investors and some bigger ones used for the enhancement of the Black Sea to restore the overfished turbot stocks.

First trials started with Atlantic turbot (*Scopthalmus maximus*) which culture methods are well known world wide and progresses in France, Spain and Portugal. But one of the main aims was to support reduced turbot stocks in the Black Sea. Therefore trials conducted with the Black Sea turbot. At the beginning survival rate was too low. After working with Japanese experts survival rate increased to the level in European countries due to more detailed studies on brood stock management, increasing the success of larvae and juvenile production. Studies are carried out on the photoperiod application in reproduction of turbot.

Since 2008, Ukraine, with the participation of experts from YuzhnNIRO, artificial reproduction of flounder-turbot has been started on the basis of LLC "HTMO". There is some experience when 7000 juveniles were issued to the Black Sea under the 2008 budget program. Young flounder-turbot provided there are sufficient numbers of bottlers, taking into account the improvement of water supply technology and maintaining the optimal salinity of 14-15%, it is possible to obtain about 8 million juveniles weighing 0.5-1 g. The turbot seedlings for artificial reproduction are selected from commercial catches. The holders are kept in recycling systems for 2-3 juvenile/m^2 with 2-3 times daily water exchange. The temperature and salinity of the systems should be consistent with that of the sea during this period.

There were also breeding attempts in Russian Federation, small hatchery on the Black Sea coast. Due to several reasons commercialization of this species could not been succeeded; mainly as high mortalities in the larval period to start feeding live food, long time to reach market size and diseases (specific to Black Sea turbot). On the other hand, reduced turbot stocks in nature, has obliged governments to produce this species for the enhancement activities.

Turbot has a life span of 25-30 years and its length may reach up to 1 m total length. Starting from 5-10 m it can go 300-400 m depths. It is a carnivorous and highly voracious fish. Males may mature and reproduce at the age of 5-6, females at the age of 6-7. Their reproduction in nature lasts from April to June in 10-15 ^{0}C waters. In addition to giving millions of eggs, its taste and efficiency and economic value are very high.

It is one of the fish that is of great interest in breeding in the last vision. Farming studies for successful turbot culture has already been introduced. Two hatcheries in Europe produced 750000 juveniles in 2004 and 750 tons turbot in 2005. The breeding technique is similar to sea bream and sea bass. It is also possible to produce eggs throughout the year with the light control in the water that can be adjusted from the turbot adult about 1.5-2 kg. Recent developments are very promising events in turbot breeding. Fish can reach to the market size in 18-24 months.

2.3.8.1. Juvenile Production

Turbot needs stable water temperatures during culture than any of the other fish species in aquaculture. Therefore during the planning stage of the hatchery, water intake system plays an important role by technical end economic means. After taking water filtration is vital to increase the quality of the sea water. In the Central Fisheries Research Institute in Trabzon, turbot hatchery is supported by 3 units: water intake unit, first filtration and reserve unit, and secondary filtration and sterilization unit. Water can be taken from the sea in various ways. In the Black Sea application, water was provided from two different depths with two pipelines. In order to prevent fluctuations, the water entering the hatchery is under the desired water temperature for the turbot by mixing the sea water from 500 m from the coast at 15 m depth and the second one from 650 m. at 40 m depth. First filtration and reserve unit contains pre-filters (consisting of 100 cm thick anthracite) and reserve tanks. Then water is transferred to the second filtration and sterilization unit. At this stage, sea water is passed through the mechanical sand filter again. Mechanical sand filter contains 0.8 mm Ø anthracite and contains sand of different sizes. Finally sea water flow through cartridge filters and under UV light for the sterilization. After this step water is delivered to all reproduction and ongrowing systems in the hatchery.

Air supply and heating system are the essential. For the better results in larvae production heating system is mandatory. For this purpose, two sets of boiler systems with a capacity of 200 x103 kcal / min and 400 x103 kcal / min were installed in the project to ensure the continuous and reliable operation of the heating system and against any failures that may occur.

In turbot fry production, tanks of different sizes are needed for live feed and fry production. One of the indispensable conditions for these tanks is that their inner surfaces should be smooth. Rough surfaces are not recommended to ensure hygienic conditions. An annual work plan should include the following activities.

• Facility maintenance and repair

- Equipment maintenance and repair
- Production of natural feed organisms
- Obtaining fertilized eggs
- Fry production

Preparations for the production of new season juveniles begin with the painting of the production tanks in October after harvesting and transferring the fry in September. The next activity is the maintenance and adjustment of algae (phytoplankton) and rotifer stock cultures in the period from November to February. Main activities are equipment maintenance and repair works and disinfection of sea water supply system in February. Intensive algae and rotifers are produced in March just before the breeding season begins. Full capacity larvae production activities are carried out in April and May, including algae and rotifer intensive culture, artificial insemination and larvae breeding. Larvae and juvenile breeding constitute the main activities in June and the following months. In September, the first group of juveniles are harvested and transferred to the farms.

The most important factor in success in the production of turbot fish is feeding. It is necessary to be successful in the production of phytoplankton, Artemia salina nauplii and rotifers used in feeding larvae.

2.3.8.2. Fertilised egg supply

In the production of turbot, adult fish required for egg supply can be obtained from two sources:

(a) Capture from nature,
(b) Selection of fish produced and rose in the hatchery.

Eggs can be obtained from broodstock caught from nature until fish become mature in the hatchery. Brood stock management is very important to obtain high quality fertilized eggs. Promoting the maturation of gamets (eggs and spermatozoa) with hormone application and artificial insemination are important basic techniques.

Turbot in the Black Sea migrate from deeper to shallower waters from mid-March to mid-May. Males over the age of two and females over the age of three can be used as breeding. In this period, the surface water temperature rises from 8.4 ° C in March to 16.9 ° C in May in the Eastern Black Sea (off Trabzon). Adults are captured by trawling.

Fiberglass tanks (i.e. 1 m x 1 m x 0.5 m) are used to transport adults. Approximately 2/3 of the tank is filled with sea water and aerated. The individual weights of fish per square meter of the tank are 2-7 kg. Approximately 4-6 adults can be stocked. The transportation distance of the fish is usually 5-20 km. It takes only a few hours.

Before transferring broodstock tanks preliminary quality checks should be done in order to minimize the risk of disease infectation from fish brought from nature to hatchery. This process can be carried out by determining the fish with the desired features and taking protective measures by checking whether the fish carry pathogens before they are transferred to the maturation tanks for the artificial fertilization. Each fish is placed in 40 lt containers containing 30 lt of water, separately. The selection mentioned above is done at this stage with ventilation (4 lt / min x 1 air stone) is done until the selection is completed.

Criteria considered in the selection of breeding fish:

1) The health condition of the fish,
2) Fish have normal morphological (physical) features,
3) Attention should be paid to injuries caused by the fish not being injured, especially the use of bottom gill nets along the genital opening edge.

For some parasite species, such as trematodes and nematodes, fish can be visually inspected. However, for protozoa infections, samples taken from gills and skin should be examined under a microscope. When taking the sample from the gill, the operculum is gently opened until the gills appear, and a scraping is carefully done by a spatula. Skin sample is taken by scraping the top of the eye of the fish with spatula. Finally a little mucosa is collected. The samples taken are placed between the lam and lamel and examined under microscope. Some types of protozoa such as Trichodina sp., Icbtyopodo sp. and Scuticiliata sp. are encountered frequently.

The selected adults are placed in quarantine tanks for general observation and disease treatment before they are transferred to the maturation tanks. These preventive measures minimize the risk of any possible diseases and parasites. The selection and use of antimicrobial drugs is extremely important in terms of preventing contamination of the hatchery.

Mature fish are treated in two successive stages: 40 lt plastic tubs are used during this treatment. These plastic basins are filled with 30 l of sea water, and then antiprotozoer drugs are added and mixed (Step 1/ Formaldehyde 100 ppm, copper sulfate ($CuS0_4$. $5H_2O$ 0.5 ppm). After one hour, fish are placed in the other plastic tub for the second stage of treatment, where they are kept for 1 hour (Step 2/Furazolidone 20 ppm or sodium nifurstirenate 10-20 ppm). During the treatment, 0.6 l/min aeration is provided.

One of the first procedures performed during the breeding season is to observe the general appearance of the fish. Fish whose females are swollen and slightly saggy are female, and those that are flat and hard are male. In cases where the gender cannot be determined from the structure of the abdomen, a lighting method can be used with a table lamp.

Light pressure is applied several times, starting from the pelvic (abdominal) fins immediately and close to the urogenital opening. If the fish is fully ripe, liquid and light white milk usually flows out from the urogenital opening. If milk does not come, these fish are either immature or spent milk, and they are not used to fertilize eggs.

Maturity of females can be checked manually by milking or catatering. In mature females, the eggs are easily removed from the genital opening when the abdominal area is slightly pressed. If the fish is ripe, it should be milked immediately. In females that are not yet fully mature, eggs may not come out even if the abdomen is pressed so hard. If no eggs come from the fish, an oocyte sample is taken with a catater; 50 cm in length, thin polyethylene tube (0.7 mm and 1.5 mm in diameter). The polyethylene tube is gently inserted into the genital opening about 30 cm or until resistance is felt. Oocyte samples are sucked into the tube by mouth siphon and then the cannula is withdrawn. To take oocyte samples from the cannula, a 1 ml syringe with a needle is inserted into one end of the cannula and tightened well. The sample is blown into vials filled with Turbot Ringers solution with syringe and examined under a microscope.

In males sperm activity is examined under a microscope with a magnification of 100. For this purpose, first, a drop of sea water is placed on the slide, and then some milk is added on it and observed under a microscope. The normal viability of the sperm is determined by the action like whipping amoeba after mixing the sea water with the herd.

Some eggs are placed on the slide to measure the oocyte diameter. The measurement can be done under a microscope at a magnification of 40. If the oocyte diameter is larger than 400 mm (n = 100), the fish can be used for spawning, if it is smaller than 400 mm (n = 100), these adults cannot be used for egg retrieval yet, but they are preserved as broodstock.

In maturation tanks salinity should be kept at levels of ‰ 15-18 and the temperature must be controlled. Maturation tank is made of FRP with dimensions of 1x2x0.5 m and is divided sections at the middle. 4 of these tanks can be used in the project hatchery and two of 1x1x0.5 m in size for adaptation. The light intensity in the compartment where these tanks are located is controlled around 100 lux using fluorescent lamps, but it is under daylight effect. The appropriate water exchange rate is approximately 900% per day and ventilation (4 I / min x 1 airstone / m-) is provided. During the breeding period, the temperature is kept at 15 °C using titanium heaters (1kw). First of all, adults are taken into the adaptation tanks (1x1x0.5 m), from the natural sea water temperature to 15 °C within about 1 day and transferred to the maturation tanks. Fish can be stocked in maturation tanks with 2-4 fish per m^2 (individual weight 2-7 kg). To protect the fish from physical stress, excessive stocking should be avoided. To prevent deterioration of water quality due to decay of dead eggs in maturation tanks, tank bottoms are cleaned daily with siphon. The fish are not fed during the spawning period in order to maintain the desired water quality.

2.3.8.3. Artificial propogation

Human chorionic gonadotropin (HCG) and White salmon pituitary gland (WSPG - Salmon pituitary) are thoroughly mixed and homogenized in a ceramic bowl. The prepared hormone is withdrawn by syringe and immediately injected into the fish.

5 mg Luteinizing Hormone - Re-leasing Hormone analogue (LHRH-a: Luteinizing hormone secreting hormone derivative) is mixed with 1 ml of 60% ethanol in a ceramic bowl and then 625 mg of cholesterol is added and mixed well again. The prepared mixture is made of aluminum foil and left for one day at room temperature. The next day, 125 mg of cocoa butter is added and mixed well. The prepared hormone is made into pellets of 30 mg using pellet mold. Each pellet contains 200 mg of LHRH-a hormone. The pelleted hormone is placed in a glass bottle and stored in the freezer until it is used at -20 ° C.

Hormone injection can only be applied to mature males and females with oocyte diameter greater than 400 mm. Hormone dosage for males is 500 IU HCG per kg live weight and 7 mg WSPG for females: 100 mg pellet LHRH per kg body weight is sufficient. Injection is done with a 10 ml syringe using needle number 18. The hormone is injected intramuscularly into the back of the fish, near the dorsal fin. For this purpose the pellet form of LHRH-a is inserted intramuscularly near the dorsal fin using a metal tube.

First, the fish are taken from the maturation tanks and their bodies are washed with freshwater to remove sticky salts. The fish to be milked is placed on the milking table and their bodies are carefully wiped with a towel. Then, the urogenital and genital opening of the fish is cleaned to remove the urine etc. To prevent the fish from whisking, the head is covered with a towel. Anesthesia is not required.

Males are milked before females, as sperm can be stored longer than eggs. Milk or semen is collected by pressing on the abdomen to the urogenital opening. Milk is collected by syringe in 1.5 mm diameter of silicone tube and kept in ice box until fertilization. Average 1 kg of fish can give 1.3 ml of milk.

In order to have eggs the abdomen is slightly pressed. If blood comes with eggs, milking should be stopped. Ovulation occurs in 2-10 days. In order to understand that ovulation is occurring, females should be checked from time to time by rubbing their bellies, and eggs can be milked daily after the first ovulation. Ovulation of mature and maturing fish ends in an average of 7-13 days. As an average 300000-510000 eggs per kg of fish can be taken.

Insufficient amount of milk obtained from captured mature males from the sea sometimes may create problem for artificial propagation. Sperms kept by cryopreservation (ultra cold preservation) have high fertilization rate and can be a practical method as a solution to this problem.

Dry method is used for artificial fertilization of turbot eggs which are milked in a dry plastic container (0.6 l). Sperm is added onto the milked eggs and mixed using a feather. Optimum amount of sperm for 400 g of eggs is 1 ml. One gram egg mass contains about 900 eggs. Then, some sea water is added to increase the fertilization rate. Eggs are kept in the bowl for about 10 minutes, which is equivalent to the time that sperm can maintain fertilization.

The main purpose of the development of hatchery broodstock is to provide continuity in hatchery production, obtain high quality gametes and control the spawning time. After sex separation, body weight and length of fish are measured, recorded in order to determine growth and feed evaluation rates. Initial stocking density for fish of 3-4 years old with an average weight of 2.5 kg is 2-3 kg/m^2 (approximately 1adult per m^2) and 5-6 kg/m for 2 years old fish. The gender (male to female) ratio is equal (1:1).

Frozen whiting and other white meat fish meat can be given to broodstock feed. Feed fish are divided into 1-2 pieces depending on the size of the adults and given without waiting for dissolution. Feeding should be done by feeding the pieces one by one until the fish is full. 3-4 years old fish are fed until 2-3 times a week, and 1-2 years old fish are fed once every morning. Evaluation of frozen whiting as feed is 3 to 7.

As a breeder stock unit, 3 x 20 m^3 concrete outdoor tanks, 2 x 12 m^3 fiber indoor tanks and smaller (13 x 3-4 m^3) fiber tanks were used for research purposes in shturbot culture. The diameter of fiber tanks is 2-4 m, the depth is 1 m, the diameter of concrete tanks is 5 m, the depth is 0.9 m.

The temperature of the sea water varies between 8 °C and 24 ^{0}C in the Black Sea. Salinity is around 15-18‰. For economic reasons, concrete outdoor tanks are supplied with coarse filtered sea water, while indoor tanks are provided with better filtered and sterilized sea water.

Outdoor tanks are covered as a roof to prevent sunlight from algae growth in the tank. The light in the tanks should be low (20-200 lux). The water temperature should be controlled to be lower than 17 ° C during the summer. This temperature could be arranged by mixing the cold water is taken is from 40-50 m depth with warm water taken from 15 m depth. The rate of water change in tanks should be 1000%, ie 10 times a day. In addition, an aeration system should be connected, with 2 air stones per 10 m^2 area.

When it is necessary to control environmental conditions such as water temperature and photoperiod (day length), fiber indoor tanks are used. In these tanks, fluorescent lamps (40 watts x 2) are hung in the upper middle of the tanks for controlled lighting (200lux). In addition, the heating system is installed in the biological filter tanks, which are connected with the broodstock tanks, to control the water temperature.

Diseases may create serious problems for adult fish to be used for reproduction. Typical symptoms of a sick fish are the loss of appetite and unstable swimming behavior. When this type of behavior is observed, fish should be checked for parasites immediately. Symptoms of bacterial diseases are loss of appetite and reduced feed intake. In such cases, skin and gill scraps are removed and any lesions or other problems are reviewed. In order to get rid of parasites and bacterial infections bath treatment can be applied. First, the water coming to the tank is closed, and then the tank water level is reduced to 30 cm, but adequate aeration is provided (12 l / min x 2 airstone / 10 m^2). Another treatment can be done with feed. For this purpose heavily infected fish leave the healthy stock. The amount of water coming to the tank is increased. The volume of water in the tank is kept at a level similar to that of normal growing conditions. The following treatments can be used for fish infections;

- For parasitic infections (eg Tri-chodina, Ichtyobodo, Scuticiliata and Nernatoda)

Treatment: 100-150 ppm formaldehyde + 0.5 ppm copper sulfate (1 hour medicated bath)

- For bacterial infections (eg vibrio sp. and Aeromonas spp.

Treatment: Antibiotics mixed with feed or medicated bath.
Antibiotics:
1) Oxytetracycline (Oxytetracycline - OTC), 50-75 mg per kg fish weight, mixed with feed or 10 ppm, 1-2 hours medicated bath.
2) Oxolinic (Oxolinic) acid, 25-50 mg / kg fish weight with feed.
3) Enroflosacin (Enrofloxacin), 10 mg / kg fish weight with feed or injection.

2.3.8.4. Larvae production

Proper egg incubation is extremely important in terms of keeping the egg quality at high level. For this purpose, cleaning and disinfection of the materials used during the whole incubationperiod, the use of filtered and UV sterilized sea water and daily monitoring of the physico-chemical parameters of the water is essential.

Incubators are disinfected before placing the eggs. The incubators for disinfection, after normal cleaning with detergent, kept in tap water and wait for more than a day by adding 200 ppm (12%) of chlorine. Later, in order to remove chlorine, aeration has started and operated for a few hours. Before use, the chlorinated water in the incubator is drained, washed several times with tap water and several times with sea water. Other equipment such as measuring cylinder, tube, pipette and bucket are kept overnight in disinfectant (10% benzalconium; 10ml) and rinsed with tap water before use.

Eggs are disinfected with iodine solution to prevent microbial or viral contamination via eggs. One minute after fertilization, eggs collected with a nylon net scoop (mesh: 220 µm) are rinsed with water at the incubation temperature to remove remaining sperm, body fluid and mucus and transferred to buckets for disinfection. 50 ppm PVP iodine [50ml PVS iodine solution, (Aqua-iodine: Argent Chemical Laboratory) diluted with 10 lt of sea water] can be used for disinfection. It is done by applying light aeration for 5 minutes. At the end of this period, the eggs are carefully washed using incubation water to remove iodine and transferred to the incubation tanks and aerated around 0.6 l / min.

Depending on the amount of eggs, incubators with suitable volume are used. These are cylindrical tanks with conical bottom, and central drainage is provided by a strainer placed at the bottom. The volume of water in the tank is kept at the desired level by controlling the position of the drain pipe. The drain in the drainage system is made from PVC pipe (3 cm in diameter). The pipe is surrounded by a polyethylene mesh (mesh size: 8 mm) and plankton net (mesh size: 520 µm) to prevent loss of eggs during water change. After the incubation water is filtered up to 1 m, it is subjected to UV sterilization. The rate of water exchange in the incubation tank should be adjusted to be 2000% (20 times) per day. The stocking density is approximately 2000 eggs / l. The water temperature is kept at I5 ° C with about 0.6 l / min aeration allowing the eggs to suspend in the water column. Stronger aeration or higher water exchange rate may cause eggs to hit the tank walls or the strainer placed in the center, causing damage to them. The light intensity of the incubation tank (day-night) is the same as in natural conditions and is around 100 lux during the day.

The fertilized eggs are transparent, spherical and pelagic. They are not sticky, there is no special structure on the shell, contain a single drop of oil and have a narrow perivitellin cavity. Their diameter varies between 1.08-1.21 mm. Hatching eggs occurs at 14-15 °C, approximately 110 hours after fertilization.

The fertilization rate can be estimated 3 hours after fertilization at 15 °C while the eggs are in the 4th cell division stage. In order to estimate the fertilization rate and the total number of eggs, a 50 ml sample is taken from the different parts of the slightly aerated incubation tank 3 times per beaker. Egg samples are examined under a microscope and fertilized eggs and total eggs are counted. Fertilization rate and incubation using average values calculated from 3 samples taken.

The total amount of eggs according to the water volume in the tank is calculated using the following equations:

Average number of fertilized eggs= Fertilization Rate x 100%/Average total amount of eggs

Average total number of eggs = Number of eggs in the sample x water volume of the incubation tank / Sample volume (ml)

Often, the eggs that have collapsed to the bottom of white are 'dead' even though there are several live eggs between them. Healthy eggs float on the water surface or in the water column. Dead eggs need to be removed as they impair the water quality by causing an increase in bacteria and protozoa in the incubation tank. For this, the vent and water inlet are closed for a few minutes and dead eggs are collected by siphoning after settling to the bottom.

Hatching rate is determined by proportioning the amount of larvae released and the total number of eggs obtained. For the estimation of the number of larvae, 3 samples of eggs (50 ml each) are taken from different parts of the slowly aerated incubation tank. Larvae in the samples are counted using a stereomicroscope. The total number of larvae (TNL) in the incubator is estimated using the average number of larvae obtained from the samples and the water volume of the incubator:

TNL=Mean number of larvae in samples x water volume in incubation tank/sample volume (50ml)

Hatching rate (%) = TLS x 100 / Total number of eggs

The Black Sea turbot shows morphologically important changes during the metamorphosis, which is the transition phase from larval to juvenile. Although fish with deformed and abnormal pigmentation constitute a significant part of production, they reduce the commercial value of juveniles. Therefore, it is considered that the cultivation of this species is much more difficult than sea bass and slightly more difficult than sea bream cultivation. Cultivation based on proper nutrition, ecological, physiological and pathological knowledge requires more practical skills.

The morphological development and behavior of the larvae that are removed during the 70-day growing period at 16-19 °C water temperature. Growth of turbot larvae has three stages:

- Prelarval period: This larval stage lasts 0-2 days after hatching. Larvae with egg sac and oil droplet are symmetrical in shape. The average total length of newly hatched larvae is 2.5 mm. Eyes are not yet colored, the mouth is not opened and the anus is not formed. Depending on its consumption, the larvae grow quickly. However, no nutritional behavior is observed during this time. Pectoral fins are not yet visible. Larvae are suspended upside down near the water surface.
- Post larval period: On the third day (between 3rd and 29th days after hatching), the eyes of the larvae were colored; mouth (0.15 mm wide) and their anus are opened. The mouth width increases as the larva grows. With the opening of the mouth, the first feed intake begins on the 4th day. On day 5, pectoral fins appear. On the 7th day, the digestive tract, which is flat, begins to expand and curl. On the 10th day, pectoral fins develop well, oscillation and tail movements are strengthened, and larvae sometimes float against the flow. They take their previous positions by dragging back and forth. On the 12th day, the larvae take the S-shape, then suddenly flatten and leap forward like an arrow to capture the organism (rotifers). Active feed intake begins at this stage. The development of fin rays start on the 13th day. On the 20th day, the caudal (tail) fin rays are completed. Dorsal and anal fin rays are carried out on the 25th day. Although not

common in this type, it can be seen that after the 25th day, large larvae attack small ones (cannibalism).

- Metamorphosis phase (between 30-70 days; transition from larvae to juvenile stage): Fish takes asymmetric shape and eye migration begins. Accordingly, the fish settle at the bottom of the tank. On the 51st day, it is observed that the number of rays in the pectoral fin is completed like that of adult individuals. At this stage (days 30-70) most of the fish float close to the water surface in a horizontal and oblique (vertical with 45° angle) position. Larvae reach 20 mm total length at 210C water temperature during metamorphosis between 40-42 days.

2.3.8.5. Tanks and equipment

All tanks are placed in a closed area. Since the water flow in the tank is important, the shapes of the tanks can be round, square and ellipsoidal according to the desired purpose. The volumes of the larvae cultivation tanks used vary between 2 and 5 m^3, and their depth is about 0.75 m.

Tanks must be equipped with aeration system. In larvae breeding, the aeration and circulation of the water are the most important factors to be considered. Ventilation and water circulation are often performed at the same time by a well-designed unit. Practically, water is ventilated with several air stones (2.5 l / min) of 5 cm length and 3 cm diameter, light or medium. This application can be preferred to severe aeration with fewer air stones (2-3 pieces per square meter.

2.3.8.6. Water quality

Water is filtered through a 5 µm filter and then sterilized with a UV lamp to ensure proper larvae breeding conditions. With the heating systems placed in the larvae tanks, the water temperature is kept around 18-21^{o}C.

2.3.8.7. Lighting

Lighting is one of the most important factors during the feeding of larvae. The amount of light should be avoided more or less. The facility is illuminated with fluorescent lamps with a density of 200-500 lux between 8:00 and 19:00, but direct sunlight should be avoided.

2.3.8.8. Stocking density in cultivation tanks

The initial stocking density of eggs or larvae to the breeding tanks is approximately 20000-30000 pieces / m^2. done as. When the fertilization rate of the eggs is low, the whole batch is destroyed.

Before transferring eggs or newly hatched larvae to the breeding tanks, the temperature of water in the breeding tank is adjusted to the same degree as the incubation water temperature. Before the transplant process, the incubation tank with eggs or newly hatched larvae is cut off and the other wastes, together with the damaged and undeveloped eggs and larvae, are deposited to the bottom of the conical incubator. Healthy eggs and larvae swim close to the surface. Undeveloped egg and waste material, which have collapsed to the bottom of the tank, are expelled by siphoning or through the hose connected to the bottom of the incubation tank. Healthy eggs and larvae remaining in the incubation tank are collected from the water surface with sterilized liter beakers.

The rack is transferred gently to the cultivation tanks with 10-15 l sterile buckets.

2.3.8.9. Feeding larvae

Three types of feeds are used in feeding the larvae: rotifer (B. plicatilis), Artemia nauplii and artificial feed.

When the mouth of the larva is opened on the third day, enriched rotifers (B. plicatilis) begin to be given to the breeding tanks. Rotifers are slowly added to the larvae tanks with beaker. The rotifer density in the tanks varies depending on the stage of the larvae and is kept between 2-5 rotifers / ml. The density of the rotifers in the tank is checked twice a day, at 10:00 and 14:00, and when the density drops below the desired value, rotifers are added as much as needed.

The green algae (Nanocbloropsis) density in the larvae cultivation tanks is kept around $0.5x10^6$ cells / ml. These green algae are added to the breeding tanks in order to feed the rotifers, to enable the transparent rotifers to be more easily disposed by the larvae (creating background) and to ensure the homogeneous distribution of the larvae in the tank.

12-15 days after hatching newly hatched Artemia nauplii is given to the turbot larvae. On the 16th and 17th days, the larvae are fed on enriched (one day old) Artemia (metanaupiii) with newly opened Artemia (nauplii). Between 18-40th days, only enriched Artemia is given. The density of Artemia (metanauplii) given to the larvae is increased from 0.2 individuals / ml to 0.4 individuals/ml depending on the consumption of the larvae. Artemia larvae are generally consumed within two hours.

As artificial feed, microparticles or micro feeds have been developed for the larvae. Micro feeds can be started to be given to larvae on the 20th day. When there are found together with live food such as rotifer or Artemia in the environment, larvae prefer live food. As a result, it is very difficult to accustom larvae to artificial food. Therefore, it is recommended that larvae should not be overfed with live food. On the other hand, overfeeding with micro feed may have impact on water quality. Therefore microfeeds also should be used in appropriate quantities. When choosing the micro feed, first of all, the quality of the feed should be considered, because the quality of the feed affects the survival rate and growth of the larvae. The micro feed given to the larvae must meet the following conditions:

- It must meet the nutritional needs of larvae.
- It should be able to suspend in water column for a few minutes.
- Nutrients should not be dissolved in water immediately. Pelletizer should not prevent transfer of nutrients to the water.
- It should not be dispersed quickly in water.

Micro feeds can be divided into three groups according to differences in manufacturing processes and properties.

- microencapsulated feed (MEF),
- micro-bound (micro-bound) feed (MBF), and
- micro-coated (rnicro-coated) baits (MCF).

Turbot larvae are more sensitive to changes in water temperature in the early stages of their development. Therefore the water temperature in the incubation tank must be the same as the water temperature in the breeding tank during the transfer of eggs or newly hatched larvae. After transfer the temperature of the water in the cultivation tank is gradually increased from 15 °C to 18 °C and then to 21 ° C within four days.

No water changes are made for the first 3 days in the cultivation tanks. On day 4, 30% water change is started in order to maintain adequate rotifer density and prevent deterioration of water quality. Water exchange is achieved by simply allowing the water used as much as the water entering the tank to flow out through the drainage system. The rate of water change is gradually increased 3 times on the 10th day.

In the discharge of water, a 200 mm diameter PVC pipe with perforations placed vertically in the middle of the tank is used. In order to prevent the larvae from escaping on this pipe, a sheath made of polyethylene net with appropriate mesh size is placed depending on the size of the larva. A spiral flexible hose is attached to one end of the pipe. The other end of the hose is connected to the outer edge of the tank and used to control the water level in the tank. The relationship between the larval lengths, mesh size of the net can be increased. It is important to keep the water movement in the tank to a minimum, since the swimming functions of the larvae that have been removed during the initial developmental stages are not fully developed. Since the larvae are not active swimmers, they cannot swim against the current and are trapped on the surface of the polyethylene mesh and as a result, mass deaths can be observed.

The tank bottom is cleaned daily starting from the 5th day. With suitable equipment, dead larvae, fodder residues, feaces and other organic wastes accumulated at the bottom of the tank are siphoned away. It is believed that the waste organic materials accumulating at the bottom of the tank can create a suitable environment for disease agents. The equipment used for cleaning the tank floor can be prepared by connecting a T-shaped cap to the suction end of the 20 mm diameter PVC pipe and a 25 mm diameter spiral hose to the other end. By installing a piece of sponge on the suction tip, the floor is cleaned more effectively. During the siphoning process, the aeration is cut and care is taken not to mix the organic substances accumulated at the bottom of the tank with water and to flush the larvae floating close to the ground. The free end of the siphon hose is kept in 70 l plastic buckets outside the tank, so that dead and escaping live larvae are also collected.

Cleaning of foams and oil from the water surface is crucial. Removing rotifer shells, oil film and organic wastes of protein origin on the surface of the water is one of the important tasks that should be done daily. This type of cleaning process is useful to increase oxygen exchange between the air and the water surface and removes waste materials that cause bacterial growth, and also facilitates the swallowing of the first air, which is important for the swelling of the air sac. On the other hand, due to the enrichment of live feed with oily emulsions, water surface may be covered with oil layers. Recently, by using air-jet and floating oil collectors, these fatty substances are collected and the inflation rate of the air sac is tried to be increased successfully. Excessive turbulence or turmoil of water in the tank also prevents swelling of the sac in the larvae and causes skeletal disorders. To prevent this undesirable turbulence, it is recommended to place water diffusers or dispensers in each water inlet of the tank. These diffusers are made of PVC pipe and thin meshed polyethylene net attached to the end of the pipe. By this way both water entered into the tank with low turbulence and sudden changes in the water temperature in the tank are prevented. In addition, it is recommended to pass the fresh water coming to the tank through the diffusers made of 200 mm diameter PVC pipe at the entrance of the tank in order to prevent the formation of air bubbles that may cause death if they are accidentally swallowed by the larvae.

The determination survival rate is carried out in the dark environment, when the larvae are homogeneously distributed in water. Larvae samples are taken from various points of the tank with the water column sampling equipment; i.e. 1.5 m in lenght and 50 mm diameter. It is formed by attaching a global valve to the end of the PVC pipe. Samples are taken from five different parts of the tank and collected in a bucket. Sampling is done by taking approximately 2-3 lt of water from the depth close to the bottom so that the sampling device does not touch the bottom of the tank. The amount of larvae in the sampled water volume is counted, accordingly, the total amount of larvae in the tank whose volume is known is estimated and the survival rate in the tank can be calculated based on the initial amount of larvae.

If survival rate is high, the larvae are distributed to several newly prepared tanks to reduce the density in the tank. This transfer is done by collecting the pelagic larvae in the buckets that exhibit daytime school forming behavior. At night or in the dark, positive phototactic larvae can be transferred by siphoning with flexible spiral pipes with a diameter of 50 mm when they are gathered in the lighted corners.

Grading is also important in larvae production. Fish are separated according to their size in order to increase feed efficiency and minimize cannibalism. Sorting is done by using a selector made of nylon or plastic, placed in the tank without fish. The larvae of about 20 mm in total size formed on the surface or corners of the tank are collected by buckets and discharged into the selector. Small individuals go out of the selector, and the big larvae that cannot get out of the selector are transferred to another tank.

2.3.8.10. Juvenile culture

The adaptation and juvenile breeding phase of the artificial feeding begins when the larvae are 40-42 days old. However, the larvae are still sensitive to handling stress. The juveniles are raised in the hatchery until the size of 100 mm (size to market commercial farms). Artificial feeding practice continues from the 40th day to the 110th day. According to the research results, the survival rate of the larvae is above 75% in these 40-110 days of adaptation stage. Increasing the survival rate provides an advantage in reducing the required tank volume and workforce to achieve the targeted production amount in the hatchery.

When turbot larvae reach 20 mm length and when they begin to settle on the bottom of the tank, the floor area of the tank becomes more important than its volume. Therefore, the bottom area of the tank is taken into account when calculating the stocking density for this stage. Larvae are raised in fiberglass tanks and concrete ponds 0.3-0.5 m in depth. Round, square or rectangular tanks with a surface area of 5-7 m can be used in breeding. Tanks should be well designed to dispose of wastes in the water and detritus that settle to the bottom with the water circulation system. To increase water circulation, sea water should be supplied to the tank through a simple PVC diffuser. In its simplest form, the mouth of the diffuser PVC pipe is 5 mm. It can be made by compressing and heating in such a way that the opening remains. The change of water in the tank is carried out by two vertical PVC pipes placed inside the tank. The perforated pipe on the outside prevents the escape of larvae from escaping, while the internal perforated pipe adjusts the water level.

The juvenile tanks are aerated with air stones placed at the center and close to the wall as 2pieces/m^2.

Tanks are illuminated with fluorescent lamps placed on the upper part between 08:00 and 19:00 and the light intensity is tried to be kept between 200-500 lux. Oxygen level should not fall under 4 mg/lt.

Fish are sized in the juvenile stage using small grading trays for the following reasons:

- Removal of larvae deformed and having pigmentation disorders,
- Size grouping,
- Determination of the exact stock density of larvae,
- Ensure the cleanliness of the tanks.

Only normal fish seperated and graded size groups are transferred to new tanks with buckets. Grading should not be done too often as it will cause stress and injuries the fish.

If the stocking density is low, the amount of feed should also be reduced. The stocking density varies depending on the size of the fish and the carrying capacity of the water. Stock densities for the larvae at 20-50 mm, 50-80 mm, 80-100 mm are recommended as 400-500, 250- 300 and 120-150 larvae, respectively.

Larvae are initially feed on granulated feeds 0.7-1 mm in diameter. As the fish grow, the granule feed size is gradually increased and pellet feeds are started. The amount of feed consumed by juvenile turbot tends to be affected by the particle or pellet size of the feed. Consumption decreases when using very small or too large feed. Fish of size 20-50 mm are fed 4-6 times a day. When the fish goes over 50 mm legth, the number of meals is reduced to 3-4 times a day. Larvae are fed until they reach visual saturation. This can be understood by the cessation of feed intake activity. Daily feed consumption of Black Sea turbot larvae starts from 4-5% of body weight when it is 20 mm in size and is gradually decreased to 2-3% until it reaches 100 mm length.

Turbot needs a very high level of protein, such as 55%. On the other hand, the oil requirement of the fish is below 15%. High quality feed ingredients such as whiting flour is used as a source of protein and fat. In addition, it is recommended that the pH of the feed is between 7.1-7.5.

Artificial feeds used in fish feeding should be carefully selected as they will directly affect the survival, growth and feed rate of the larvae and consequently provide economic income. While evaluating the feed, not only its price but also its quality should be taken into consideration. Feed quality is evaluated according to criteria such as fish survival rate (S), growth in total height (GR) and feed efficiency rate (FER):

S (%) = (Number of fish available / Number of fish at baseline) x 100
GR (mm/day) = (Current size in total length (mm) - Initial size (mm)) / period (# of days)
FER = Total amount of feed consumed/(final weight - initial weight)
For example, in ideal working conditions, S, GR and FER are expected to be above 90%, 1.2 mm/day, respectively.

Due to the use of artificial feed during the care of the juvenile tubot and increasing the amount of feed as the fish grow, the probability of degradation of water quality is very high. Therefore, in this phase, continuous fresh sea water intake should be provided to improve water quality and in tanks. The water exchange rate should be at least 15 times a day. Water temperature and salinity vary between 18-24 °C and 0 and 18‰. In addition, the bottom of the tanks should be cleaned twice a day, in the morning and afternoon.

2.3.8.11. Growth

Growth of juveniles is affected by tank maintenance, feed quality and the initial condition of the stocked larvae. Under normal conditions, the juvenile reaches 100 mm of total length from 20 mm in about 70 days, at which stage the growth of the juveniles shows linear regression and growth can be monitored daily. Growth should be followed by periodic observations of length, height and weight measurements. If there is a tendency to slow down, the breeding process and fish condition should be checked.

The relationship between body weight (BW) and total length (TL) is formulated as follows:
$BW = 0.008 \times TL^{3.145}$ ($r^2 = 0.99$) (BW: body weight, TL: total length)

2.3.8.12. Harvest and transport

Juveniles reached 50 mm in length are highly resistant to various treatments. Therefore, they can be harvested using scoops after the water is lowered. At this stage, the fish are once again divided into 3 groups as normal, abnormal and abnormal pigmented.

Feeding the fish should be stopped 24 hours before harvest and transportation. Fish smaller than 50 mm can be placed directly into the transportation tank (approximately 1- 1.5 m^3 capacity), but it is recommended that fish larger than 50 mm should be placed in the transport tank with in plastic baskets which are fixed to the tank to prevent it from turning inside the tank.

In short or long-distance transports, vehicles equipped with pure oxygen, air and cooling systems and large-volume transport tanks can be used. The water temperature in the transport tank is kept 5 °C lower than the harvest water temperature. Oxygen concentration should be above 4 mg/l.

Stock density in transport tank varies according to the fish size. Practically fish in 50 mm length can be transported with a density of 5000 fish/m^3 and 100 mm of total length with a density of 1500 fish/m^3. In long-distance transport, the water should be changed without causing osmotic and temperature shock. When the farm is finally reached, the water temperature of the transport tank should be close to the temperature of the tank to be stocked. For this purpose, some water is discharged from the transport container and added to the farm water instead. The transplanted fish should not be fed for a few days after being placed on the new farm.

2.3.8.13. Ongrowing

In turbot culture, very successful production studies are carried out using closed circuit intensive breeding systems. IDE FOOD in production as edible for turbot cultivation in Çanakkale province, Turkey. Within the scope of a project carried out with the Japanese researchers at the Central Fisheries Research Institute (CEFRI)[7], the production of the turbot juveniles were successfully realised for the first time in Turkey. It has been reported that 30000 of the hatchlings were released to the nature as the first enhancement trial in 2003, with the aim of enriching reduced turbot stocks. Some of the juveniles were sold to IDE FOOD Company and used for breeding.

Various studies have been carried out on turbot breeding in closed circuit. For example, it is observed that there are positive studies in this regard in Spain. In this system, by keeping temperature and salinity fixed in the tanks, ongrowing process can be shortened and enable continuous production. Also closed system enables large amounts of fish to be grown in the structure to be built on a small land. For example, it is possible to establish a system where 500 tons of fish will be grown in a small area. The system is 49 m. It contains a round but deep round pool. An important part of this round pond is deeper than the ground. From the outside, it gives the impression that it is working in a low building.

Indoor ponds are in the form of two parallel and shallow channels 20 cm in depth. Circular canal pools were constructed towards the outer part of the circular building. There is a medium in the middle part; the juvenile fish are subjected to fattening from 10 gr to 200 gr. Development works are carried out in the other 5 meter deep pond.

In this system, feeds are made automatically. Daily feeds are given according to the weight of the fish by adjusting the feeding times from the feed store established outside the building. Both in the canals and in the large pond, fish are tried to get a little more feed than they need. In this way, the development period is tried to be shorter. Feeding robots are moved on a rail system built on the pool and the feed is done by automation. The interior of the pool consists of 9 shelves.

As mentioned before, the fish remain in the canal section up to 150-200 gr. Then it is placed on a floor in the breeding pool, which is from 9 floors. When the fish reaches 300 grams, they are taken upstairs with an air-operated system. In this subtraction, they are subjected to selection by fitting the fish of a certain size and can be classified according to their weight. When the fish reaches the marketing size, they are harvested on the top floor.

With an appropriate filter cleaning method, 90% of the organic materials in the water are cleaned and eliminated with the help of the ozonizer. Wastes collected at the bottom are sucked in vacuum and sent to the treatment plant. In water cleaning, ozanizer plays an important role in cleaning water from ammonia and nitrite. The system has cooling units for summer and heating units for winter. The system for cleaning the water is quite complicated. Therefore, no further details will be given here. The point we want to emphasize here is that the process can be done. When necessary, entrepreneurs will be able to learn the issue in detail by doing more on this issue. The main water

[7] CEFRI assigned as finfish aquaculture demonstration center by GFCM and may play an important role as training center for the beneficiaries from DACIAT partner countries.

problems are the level of oxygen and ammonia. The water circulating in the tanks changes in one hour. However, the water used is the same and filtered. As the density increases, more contamination may be occured, so care must be taken in this regard. Therefore, there is a completely computer controlled monitoring system is necessary and should not be neglected. The amount of oxygen, nitrite and ammonia is under control at any time and depends on the system alarm system. In some cases, adding water to the system can be as little as the supplement of the lost water, as well as a certain ratio with an appropriate filter cleaning method, 90% of the organic materials in the water are cleaned and eliminated with the help of the ozonizer. Wastes collected at the bottom are sucked in vacuum and sent to the treatment plant. In water cleaning, ozanizer plays an important role in cleaning water from ammonia and nitrite.

Therefore, there is a completely computer controlled monitoring system and this should not be neglected. The amount of oxygen, nitrite and ammonia is under control at any time and depends on the alarm system. In addition to adding water to the system in some cases, it can be planned to add only a small amount of clean water, as well as to supplement the lost water. In some systems, daily water change can be up to half in normal seasons. In very cold weather, it will be more economical to use warm water in filter order, as it will be quite expensive to heat it by taking water from outside. Water is generally supplied to the tanks from above.

Artificial feeds are used in turbot farming as for other marine fish; and feed ingredients can be developed according to the requirements of turbot and successful results can be obtained.

Since positive results could not be obtained from breeding turbot fish in net cages, it was preferred to grow in ponds. In other bottom fish like flaunder culture, net cage farming is also not successful (Alpbaz, 2005).

2.3.9. Sea bream culture

Gilthead sea bream can be bred in extensive, semi-extensive or intensive systems. Originally, the farm was mainly concerned with capturing young fish, but now most of the sea bream production comes from young fish produced in technologically advanced hatcheries, which require specialized staff.

Hermaphroditism makes it necessary to properly manage the parents. Adult fish prepare for spawning by controlling their exposure to sunlight (photocontrol) and temperature. The male fertilizes the eggs of the female, which float on the surface of the sea. They are then collected and transported to incubation tanks, where they hatch 48 hours later. After three or four days, the offspring have absorbed their leukocyte sac and can begin to feed: first with a diet of tiny algae and zooplankton, then with artemia and finally with inactive protein-rich food. In expansive systems, gilthead sea breams are mostly bred along with mullets, sea bass and eels and are fed naturally. In semi-expansive systems, the breeding zone is enriched with fertilizers to increase the availability of natural food, supplemented by industrial foods. In intensive systems, sea bream is thickened with industrial food in the form of a compound in tanks on land or, for most of its production in the Mediterranean and the Canary Islands in cages at sea.

On average, sea bream reaches a market size of 350 gr within 12 to 15 months. Farming cycle of sea bream is given in Figure 40.

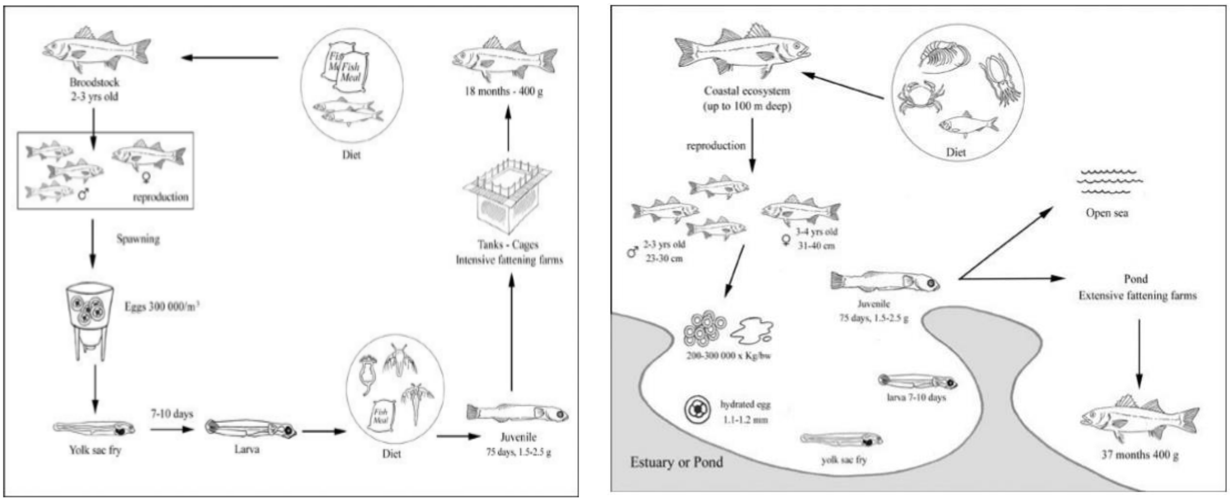


Figure 40. Sea bream culture with larva produced from brood stock or collected from the nature

3. FISH FARMS IN THE BLACK SEA

The list of aquaculture businesses located on the DACIAT territories are given for Greece, Romania, Turkey and Ukraine in Tables 9, 10, 11 and 12, respectively.

Table 9. Aquaculture companies in the Region of Eastern Macedonia and Thrace (Greece).

Owner/Organisation	Location	Area (Acre)	Species	Capacity (Tonnes)
“G.Mpermperidis & Sturgeon Greece Sa”	Kefalari, Doxato Drama	10,7 (10.768)	Sturgeon	80
“G.Mpermperidis & Sturgeon Greece Sa”	Lake Thisavrou Drama	20	Carp	87
Soufleris Konstantinos	Vathirema Drama	5	Rainbow or American Trout	50
Symvoli Sa	Vathirema Drama	4,68	Rainbow or American Trout	40
Thalasselis Nikolaos	Paradise Nestou Kavala	8	Rainbow or American Trout	121
Michailidou Maria	Nea Karvali Kavala	39	Sea Bream, Sea Bass, Euryhaline Species	120
Sidiropoulos Kyriakos	Nea Karvali Kavala	22	Sea Bream, Sea Bass, Euryhaline Species	120
Kirantzi Osman–Ismet Tsaous	Oraio Mykis Xanthi	10	Rainbow Or American Trout	10
Zampaki Panagiota	Keramoti, Kavala	20	Mussel Farming	147
Afentoulis A&X O.E	Keramoti, Kavala	44	Mussel Farming	316,575
Mpelezi Dimitra	Keramoti, Kavala	20	Mussel Farming	126
Zampaki Panagiota	Keramoti, Kavala	10	Mussel Farming	92,4
Tsalkidou Eleni	Keramoti, Kavala	10	Mussel Farming	86,4
Afentoulis Athanasios	Agiasma, Kavala	20	Mussel Farming	148
Afentoulis Charalambos	Agiasma, Kavala	20	Mussel Farming	148
Kalogeropoulos Michalis	Agiasma, Kavala	20	Mussel Farming	140
Tsalkidis Aggelos	Agiasma, Kavala	30	Mussel Farming	193,2

A.Tsalkidis–K. Parcharidou O.E.	Agiasma, Kavala	30	Mussel Farming	168
Tsoutsouli Maria	Agiasma, Kavala	20	Mussel Farming	126
Papanikolaou Vasiliki	Agiasma, Kavala	48,12	Mussel Farming	441
Alexandridis Iordanis	Iraklitsa Kavala	50	Mussels-Oysters-Scallops-Cydonia-Achivada	328
Paptsiki Frentzel Markou	Bistonic Bay Rodopi	15,5	Mussel Farming	86,4
Ostraka Rodopis E.E	Bistonic Bay Rodopi	22,22	Mussel Farming	150
Ostraka Rodopis E.E	Bistonic Bay Rodopi	20,26	Musses Farming	158
Ostrakokalliergies Vistonikou O.E.	Bistonic Bay Rodopi	23,05	Oysters-Kydonia-Achivada	120
Alexandridis Georgios	Bistonic Bay Rodopi	20	Mussel Farming	158
Alexandridis Ioannis	Bistonic Bay Rodopi	23	Oyster, Kydonia-Achivada	145
Zampaki Panagiota	Keramoti, Kavala	10	Mussel Farming	92,4

Table 10. Aquaculture farms in South-east Region of Romania

Company	Contact	Location	Fish species
Vector Impex Srl	strauaviorel@yahoo.com +40 745 501 117	Tichileşti, Brăila County	Indigenous Cyprinids, Asian Cyprinids
Omnipesca Srl	+40 21 402 8125; +40 21 402 8123	Cireşu, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species, frogs
Gropeneanu Com Srl	gropeneanuaurel@yahoo.com +40 239670671	The Great Island Of Brăila, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Anghila Impex Sa	anghilaimpex@yahoo.com	Movila Miresii, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Agroacva Srl	agroacva2018@gmail.com +40 744526165; +40 733924224; +40 749143606	Tichileşti, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Domar Com Srl	+40 724204295; +40 741146148	Însurăței, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Pescofan Srl	+40 745846549	Însurăței, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Malidos Com Srl	+40 239587130	Movila Miresii, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Ban Agrotrans Srl	+40 238578275	Vișani, Jirlău And Galbenu Communes, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Popalex Com Srl	+40 754399598	Cireşu, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Mirclada Com Srl	+40 730619467	Grădiștea, Brăila County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Piscicola Farmzăv Srl	Zăvoaia Village, Zăvoaia Commune, Fish farm Point 3, T-88, P-579, Brăila County	Zăvoaia, Brăila County	Common carp, Prussian carp, silver carp, bighead carp, grass carp, catfish, pike perch
Micatis Prod Srl	gropeneanuaurel@yahoo.com +40 239670671; +40 239692726	Frecăței, Brăila County	Common carp, Prussian carp, silver carp, bighead carp, beluga, Russian sturgeon, stellate sturgeon, bester, American paddlefish, catfish, northern pike, pike perch
Întreprindere Individuală Ion Al. Vasile	Șoseaua Brăilei Street No.33, Însurăței, Brăila County	Însurăței, Brăila County	Common carp, Prussian carp, silver carp, bighead carp, grass carp, catfish, pike perch, Russian sturgeon, stellate sturgeon, sterlet, Siberian sturgeon, bester, northern pike

Anghila Impex Srl	anghilaimpex@yahoo.com +40 239629408; +40 722571626	Movila Miresii, Brăila County	Common carp, rainbow trout, beluga, Russian sturgeon, Siberian sturgeon, stellate sturgeon, sterlet and hybrids, pike perch
Esox Prod Srl	+40 727117359; +40 238717216	Amara Village, Balta Albă Commune, Buzău County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Acva Fish Profesional Srl	+40 753635176; +40 760025454	Robeasca, Buzău County	Indigenous Cyprinids, Asian Cyprinids, predatory species, American paddlefish
Direcţia Silvică Buzău - Ocolul Silvic Cislău	cislau@buzau.rosilva.ro +40 238 501 620	Calvin, Buzău County	Rainbow trout, indigenous trout
Cris Fishing Srl	zarguzon@gmail.com +40 726 727 542	Biruința Village, Topraisar Commune, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Oxipest & Alex Srl	oxipest2003@gmail.com +40 760662099	Rasova, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Sarda Fish Srl	sardafish2003@gmail.com +40 744 232 142	Bugeac, Constanța County	Indigenous Cyprinids, Asian Cyprinids
Blancor Imex Srl	daco_cris_dany@yahoo.com +40 753870996	Corbu, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Dialex Canada Srl	dialexcanada@yahoo.com +40 722545355	Seimeni, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Lac Astacus Srl	office@laculracilor.ro +40 724843846	23 August, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Aquarom Elite Distributions Srl	complexgrup@gmail.com +40 744 565 630	Oltina, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Esox International Srl	george.deala@aol.com +40 722844 776	23 August, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Cosmara Pest Srl	argonautsrl@yahoo.com +40 745 090 971	Tibrinu Village, Seimeni Commune, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Asociaţia De Vânătoare Şi Pescuit Iepuraşul Cernavodă	oxipest2003@gmail.com +40 760662099	Aliman, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Complex Grup Agro Srl	complexgrup@gmail.com +40 744 565 630	Ostrov, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Gino Impex Srl	andrei.ciobanu@greencounty.ro +40 727 111 938	Mihail Kogălniceanu, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons, trout
Laughserv Construct Srl	office_laugh@yahoo.com +40742 087 708	Medgidia, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Romnaţional Srl	office@romnational.ro +40 729 351 445	Peştera, Danube–Black Sea Canal, Constanța County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Arafura Srl	eugendinescu@arafura.ro +40 241512900	Tuzla, Constanța County	Common carp, Prussian carp, silver carp, bighead carp, grass carp
Complex Grup Srl	complexgrup@gmail.com +40 744 565 630	Ostrov, Constanța County	Common carp, Prussian carp, tench, common bream, silver carp, bighead carp, grass carp, beluga, stellate sturgeon, sterlet, Siberian sturgeon

Rabolus Srl	l_hertea66@yahoo.com +40 722500605	Lipnita, And Oltina Communes, Constanța County	Common carp, Prussian carp, common bream, silver carp, bighead carp, grass carp, catfish
Danubiu Elite Srl	danubiuelite@gmail.com +40 722 281404	Dunăreni Village, Aliman Commune, Constanța County	Common carp, Prussian carp, common bream, white bream, silver carp, bighead carp, grass carp, European perch, pike perch, catfish, northern pike
Rig Service Sa	office@rig-service.com +40 730 230 464	Corbu, Constanța County	Common carp, Prussian carp, silver carp, bighead carp, grass carp, beluga, Russian sturgeon, stellate sturgeon, sterlet, catfish, pike perch, northern pike
Florom Srl	nicularion@yahoo.com +40 722 244 681; +40 736 026 180	Ciobanu, Constanța County	Common carp, Prussian carp, common rudd, silver carp, bighead carp, grass carp, pike perch, northern pike, catfish, European perch
I.C.D.E.A.P.A. Galati	icdeapa@icdeapa.ro +40 236 416914	Galați And Foltesti, Galați County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons, frogs
		Prut, Km. 37, Galați County	Indigenous Cyprinids, Asian Cyprinids
Central Srl	+40 236460814	Braniștea, Galați County	Indigenous Cyprinids, Asian Cyprinids
Grig Impex 94 Srl	+40 236 471 844	Sendreni And Smardan Communes, Galați County	Indigenous Cyprinids, Asian Cyprinids, predatory species
A.J.V.P.S. Galati	+40 236 412 110	Vadeni Village, Cavadinesti Commune, Galați County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Singama Srl	+40 236414717; +40 753891660	Oancea, Galați County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Nynos Mihai Srl	+40 745335044	Liesti, Galați County	Common carp, Prussian carp, silver carp, bighead carp
Pfa Manea Maricel	+40 236830735; +40 722830577	Nămoloasa, Galați County	Indigenous Cyprinids - common carp, Asian Cyprinids - silver carp
Serviciul Public Judetean De Administratie A Domeniului Public Privat Galati	secretariat@spjadppgalati.ro +40 746 068 113	Galați County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Ady Srl	+40 742132616	Braniștea, Galați County	Common carp, Prussian carp, asp, silver carp, bighead carp, grass carp, Russian sturgeon, sterlet, stellate sturgeon, northern pike, pike perch, European perch, catfish,crayfish
Gip Est Srl	office@gipest.ro +40 744610080	Chilia Veche, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Eldorado Srl	marianardeleanu49@yahoo.com +40 726729273	Chilia Veche, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Masiva Srl	savin_corneliu@yahoo.com +40 744557671	Chilia Veche, Tulcea County	Indigenous Cyprinids, Asian Cyprinids
Delta Samitur Srl	sanda.lucian@yahoo.com +40 744384687	Murighiol, Tulcea County	Indigenous Cyprinids, predatory species, batrachians, crayfish
Albatros Impex Srl	albatrosodobesti@yahoo.com +40 740213311	Dunavatul De Jos Village, Murighiol Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Alfarom Com Srl	alfaromcom@yahoo.com +40 723284142	Sabagia Village, Valea Nucarilor Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species

Rom-Pesc Impex Srl	navrom_nca@yahoo.com +40 745512802	Sabagia, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Eco Danube Srl	mihai.mitrenca@gmail.com +40 746010150	Iazurile Village, Valea Nucarilor Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids
Aqua Pest Srl	acvagrano@yahoo.com +40 743403710	I.C.Bratianu, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Acva Grano Srl	acvagrano@yahoo.com +40 757025459	I.C.Bratianu, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Piscicola-Tour Ap Lunca Srl	office@piscicolatour.ro +40 725100127	Jurilovca, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Stupina Srl	leonard.popov@yahoo.com +40 723523919	Jurilovca, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Gelmin Srl Bucuresti	flori@hotelultimafrontira.com +40 755080334	Periprava Village, Ca Rosetti Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species, sturgeons
Mon Al Srl	alexandrubonea@yahoo.com +40 744345303	Zebil Village, Sarichioi Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Piscicola Sarinasuf Srl	office@piscicolasarinasuf.ro +40 762 008 500	Sarinasuf Village, Murighiol Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Mariocons Hunting Srl	liane02d@yahoo.com +40 749054003	Crişan, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Pedromar Srl	liane02d@yahoo.com +40 749054003	Crişan, Tulcea County	Indigenous Cyprinids, Asian Cyprinids
Florena House Srl	merisorradu@yahoo.com +40740418445	Pecineaga, Tulcea County	Indigenous Cyprinids, predatory species, sturgeons
Kiara Laci Srl	kiaralacitulcea@gmail.com +40 743875317	Crişan, Tulcea County	Common carp, Prussian carp, northern pike, tench
Sofimih Fishing Srl	caraman_costel@yahoo.com +40 723142535	Crişan, Tulcea County	Common carp, Prussian carp, common bream, silver carp, bighead carp, grass carp, catfish, northern pike, pike perch
Delta Fish Distribtion 2003 Srl	delta_fish_distribution@yahoo.es +40 740808696	Sea Transit Basin Free Zone Administration, Sulina, Tulcea County	Trout, silver carp, bighead carp, grass carp, common carp, Prussian carp, catfish, northern pike, pike perch, beluga, Russian sturgeon, stellate sturgeon, sterlet
Obretin Srl	office@noorstuf.com +40 723400049	Mila 23 Village, Crişan Commune, Tulcea County	Common carp, Prussian carp, silver carp, bighead carp, grass carp, northern pike, pike perch, catfish, European perch
Delta Fish Srl	euro.fish@yahoo.com +40 722652403	Enisala Village, Sarichioi Commune, Tulcea County	Common carp, Prussian carp, common bream, silver carp, bighead carp, grass carp
Pasirom Interactiv Srl	pasirominteractiv@gmail.com +40 756195196	Murighiol, Tulcea County	Common carp, common bream, tench, silver carp, bighead carp, grass carp, sterlet, stellate sturgeon, northern pike, pike perch, catfish, European perch
Captain Service 94 Srl	abdul.kanaan@yahoo.com +40 786383888	Rachelu Village, Luncavița Commune, Tulcea County	Common carp, Prussian carp, silver carp, bighead carp, grass carp, northern pike
Danube Research-Consulting Srl	office@casacaviar.ro +40 722204144	Horia, Tulcea County	Beluga, Russian sturgeon, stellate sturgeon, sterlet, white sturgeon, bester, best beluga and other hybrids, trout, huchen, pike perch, northern pike, catfish

Euro Fish Srl	euro.fish@yahoo.com +40 722652403	Enisala Village, Sarichio Commune, Tulcea County	Common carp, Prussian carp, bighead carp, silver carp, pike perch, catfish
Ecodelta Sa	office@deltaeco.ro +40 720 222 066	Babadag, Tulcea County	Common carp, Prussian carp, silver carp, bighead carp, grass carp
Selpop Fish Srl	flori@hotelultimafrontiera.com +40 755080334	C.A.Rosetti, Tulcea County	Common carp, Prussian carp, northern pike, pike perch
Agri Delta Serv Srl	agridelta@gmail.com +40 239 650 050	Murighiol, Tulcea County	Common carp, Prussian carp, common roach, common rudd, silver carp, bighead carp, grass carp, northern pike, catfish, pike perch
Ag Moorkens Patrimonium Srl	mihaigeorge@me.com +40 728 338 533	Dunavățu De Jos Village, Murighiol Commune, Tulcea County	Common carp, common bream, Prussian carp, common rudd, common roach, silver carp, bighead carp, grass carp, pike perch, northern pike, catfish, European perch
Piscicola Sofia & Gabriel Eu Srl	narciscustura10@yahoo.com +40 751270489	C.A.Rosetti, Tulcea County	Common carp, common bream, Prussian carp, common rudd, common roach, silver carp, bighead carp, grass carp, northern pike, catfish, pike perch
Simbolic Srl	simioncudalba@yahoo.com +40 744553148	Agighiol Village, Valea Nucarilor Commune, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Her&Stra Cyprinus Srl	strajaadrian@yahoo.com +40 723530538	Jurilovca, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Vicki Pond Srl	strajaadrian@yahoo.com +40 744316286	Jurilovca, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Fish Tour Delta Srl	sincrondelta@yahoo.com +40 769 250 000	Crisan, Tulcea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Acva Cult Srl	+40 237624901; +40 745848888	Mandresti, Vrancea County	Indigenous Cyprinids, Asian Cyprinids
Directia Silvica Focsani	office@focsani.rosilva.ro +40 237222391	Lepsa, Tulnici Commune, Vrancea County	Trout
Romitcrap Srl	+40 237610157; +40 762645177	Nanesti, Vrancea County	Indigenous Cyprinids, Asian Cyprinids, predatory species
Marfishing Srl	+40 764602617	Mărășești, Vrancea County	Indigenous trout, brook trout, rainbow trout, Siberian trout, beluga, Russian sturgeon, stellate sturgeon, sterlet

Table 11. Fish farming companies in the Black Sea region of Turkey

Province	**Company**	**Address**	**Species**	**Capacity (Ton/Yr)**	**Fry Capacity (#)**
Artvin	Papila Ltd (Aypa)	Esenkiyi Köyü Cami Mevkii, Dere Üstü Köyü	Trout	70	
	Lazona Fisheries		Trout	500	
	Selahattin Sancal		Trout	250	
	Şanlilar Fisheries	Narli Mah. Nilgün Sokak.11-B Narlidere/İzmir	Trout	245	
	Enba Aquaculture	Borçka Baraj Gölü	Trout	500	
	Ardesom A.Ş.	Ayder Karayolu 12. Km Çamlihemşin/ Artvin	Trout	500	
	Faruk Çavuşoğlu	Borçka Baraj Gölü	Trout	500	
	Mavera Fisheries	Yildirimlar Mah. Cami Meydani. Borçka	Trout	120	
	Cengiz Özdemir	Alabalik Köyü Merkez/Artvin	Black Sea trout/ Rainbow trout	50	
	Gümüş Ltd	Yenişehir Mah. 238. Sok. Özgümüş Apt. No:23 Şanliurfa	Black Sea trout/ Rainbow trout	950	

	Kuzuoğlu Fisheries	Sümer Köyü Fındıklı Rize	Black Sea trout/ Rainbow trout	950	
Rize	Mehmet Önder	Y.Durak Köyü-Ardeşen	Trout	50	2500000
	Abu Aquaculture	Çağlayan Köyü-Findikli	Black Sea trout/ Rainbow trout	258	5000000
	Arde-Som Ltd.	Kaplica Köyü-Enzigot Mevkii	Black Sea trout/Rainbow trout	300	16000000
	Musa Asliyüksek	Sahil Cad.No:1 Fatih Mah. Ardeşen	Trout	60	2500000
	İsina Su Ürünleri	Yolkiyi Köyü Çamlihemşin/Rize	Black Sea trout/Rainbow trout	60	2450000
Trabzon	Vadi Su Aquaculture	Çoşandere Köyü	Trout	150	20000000
	Murat Hatipoğlu	Kömürcü Köyü	Trout	100	
	Sümela Fish Farming	Sümela Çiftlik Restaurant	Trout	150	14000000
	Mustafa Altintaş	Çoşandere Köyü/Maçka	Trout	150	14000000
	Yilmaz Taşdelen	Coşandere Köyü/Maçka	Trout	100	
	Aydin Alioğlu	Erenler Beldesi Merkez Mahallesi	Trout	120	
	Hüseyin İnan	Karakaya Mevkii Uzungöl Çaykara İnan Kardeşler-2	Trout	120	500000
	Yilmaz Şen	Şimşirli Köyü	Trout	60	500000
	Yakamoz Fisheries	Gazipaşa Mah.Kasimoğlu Çikmazi Eba Çarşisi Kat:2/1	Trout/Sea bass	1800	
	Dokabaş Fish Farming	Derbent Burnu Mevkii, Yomra / Sancak Mah.Rize Cad.Selimoğlu İş Merk.No:1/5 Yomra	Trout/Sea bass/Black Sea trout	1790	
	Vadi Fish Farming	Derbent Burnu Mevkii /	Trout/Sea bass	2000	
	Omega61 Fisheries-	Kömürcü Mah. Yomra/Trabzon	Trout/Sea bass	1700	
	Devrim Altintaş	Sofrakaya Mev., Arsin / Coşandere Köyü, Maçka-Trabzon	Trout/Sea bass/ Black Sea trout	1800	
	Yomra Aquaculture	Derbent Burnu Mev. /	Trout/Sea bass/ Black Sea trout	1750	
	Omega-61	Hizirbey Mah.Sotka Sok.No:2/3 Trabzon	Trout/Sea bass	950	
	Muhammed Ali Akyaz	Sofrakayalar Mevkii, Arsin / Hizirbey Mah.Kayalik Çikmaz Sk.No:2/3	Trout/Sea bass	950	
	Kemal Şeremet	Coşandere Köyü, Dere Mevkii No:18 Maçka-	Trout	950	
Gümüşhane	Enes Usta	Kalkinma Mah. Akif Saruhan Cad.No:15/A	Trout	140	
	Özer Yilmaz	Yukari Uluköy Köyü Köy İçi Mah. Kürtün/	Trout	49	
	Arslan Altintaş	İnönü Cad. Gülbahar Hatun Mah. No:91	Black Sea trout	160	
	Salih Ergün	Kozluca Köyü Çağlayan-Trabzon	Trout	240	
	Osman Altintaş	Coşandere Köyü Maçka	Black Sea trout	200	
	Ahmet Usta	Kalecik Köyü Konak Mah. No:47 Torul-	Trout	240	
	Şemsettin Keleş (Aysimi-4)	Gözeler Köyü	Black Sea trout	240	
	Metin Altintaş	Tuğrul Bey Mah. Kaya Apt. No:1 Torul/	Trout/Black Sea trout	100	
	Yilmaz Eskitoğlu	-	Trout	140	
	İlker Yildirim	Torul	Trout	220	
	Özer Özdemir	Babakonaği Köyü-Kelkit	Trout	140	
	Taner Yildirim	Sancak Mah. Trabzon Cad. No:26/1	Trout	500	

		Yomra/Trabzon			
	Şemsettin Keleş-2 (Aysimi-2)	Kürtün Baraj Gölü	Black Sea trout	100	
	Bayram Topkara	Kürtün Baraj Gölü	Trout	500	
	Altaş	Kürtün Baraj Gölü	Trout	400	
	Taner Yildirim	Kürtün Baraj Gölü	Trout	500	
	Serkan Lafçioğlu (Yakamoz Fisheries)	Özkürtün Beldesi	Trout	200	
	Kayalar Fisheries	Kayalar Market Özkürtün Beldesi Kürtün Baraj Gölü Kürtün	Trout	200	
	Şemsettin Keleş (Aysimi-3)	Kürtün Baraj Gölü Kürtün	Black Sea trout	100	
	İlker Yildirim and Yilmaz Eskitoğlu	Kürtün Baraj Gölü Kürtün	Trout	100	
Giresun	Salih Güneysu-Kiymet Güneysu	Duroğlu Beldesi Homurlu Mah.	Trout	10	
	Hayati Yildiz	Ezeltere Köyü-Bulancak	Trout	10	200000
	Ayşe Okusal	Küçükahmet Köyü Dereli	Trout	15	250000
	İsmet Demirel	Akkaya Köyü Dereli	Trout	10	100000
	Yeşil Çamlik Trout	Uzundere Köyü	Trout	5	250000
	Fahri Melikoğlu	Adaköy Köyü Eynesil	Trout	6	
Ordu	Vona Aquaculture	Kaleyaka Mah.Çeşmeönü Mev. Perşembe	Trout/Sea bass	499	
	Altaş Fish Farming	Kaleyaka Mah.Kişla Limani Mev. Kişla Limani	Trout/Sea bass	500	
	Marnero Fisheries and Aquaculture -1	Kaleyaka Mah. Çeşmeönü Mevkii No. 164 Perşembe	Trout/Sea bass	499	
	Özbek Aquaculture	Kaleyaka Mah. Atatürk Bulv. No. 1 Perşembe	Trout/Sea bass	200	
	Marnero Fisheries and Aquaculture-2	Kaleyaka Mah. Çeşmeönü Mevki No.164 Perşembe	Trout/Sea bass	450	
	Altaş Fish Farming	Kumbaşi Mah. Merkez / Şirinevler Mah. Turgut Özal Bulvari No:91/A	Trout/Sea bass	900	
	Özcan Şanli	Göller Mahallesi Petrolyani Küme Evleri No:61 Gürgentepe-	Trout	199	
	Ahmet Haciimamoğlu	Karakoyunlu Mah.Korgan	Trout	50	
Samsun	Kuzey Fish Farming	.Derbent	Trout	960	
	Kiyak Kardeşler Aquaculture	Yeni Balık Hali No:1	Trout/Sea bass	950	
	Kizilirmak Fish Farming	Samsun-Ankara Yolu 15.Km Sastaş Soğutma Tesisleri	Trout/Sea bass	886	
		Ankara Yolu 15.Km Çivril Köyü Atakum	Trout/Sea bass	886	
		Küplüağzı Köyü Yakakent	Trout/Sea bass	886	
	Samsun Fisheries	Kıran Mah.Toybelen Yolu 11. Km No:328 İlkadım	Trout/Sea bass	950	
				950	
	Topaloğlu Fisheries	Dereköy Beldesi, Bahçelievler Mah. 19 Mayıs	Trout/Sea bass	950	
	Samsun Fisheries	Kiran Mah.Toybelen Yolu 11.Km.No:328/2 İlkadim	Trout	950	
	Kizilirmak Fish Farming	Küplüağzı Köyü Yakakent	Trout/Sea bass	886	
	Sezgin Arslan	Boğazkaya Köyü -Bafra	Trout	200	
	Kiyak Kardeşler	Yeni Balık Hali Yeşilkent	Trout	490	
	Ladik Akdağ	Derbent Baraj Gölü	Trout	922	

	Dostlar Aquaculture	Derbent Baraj Gölü	Trout	240	
	Engin Türköz Trout	Boğazkaya Köyü Bafra	Trout	480	
	Kaya Fish Farming	Derbent Baraj Gölü Boğazkaya Köyü-Bafra	Trout	240	
	Derbent Fish Farming (2)	Tabakhane Mh.Cumhuriyet Meydan İşhani No:10 Kat:1 Bafra	Trout	480	
	Kaya Fish Farming	.	Trout	900	
	Osman Parlak	Kizilirmak Mah. Kabaoğlu Sok. No:16/4 Bafra	Trout	480	
Sinop	Dursun Demirel	Çatak Köyü Türkeli	Trout	16	
	İrfan Kuruoğlu	Yaykil Köyü-Gerze	Trout	15	
	Sati Şentürk	Gökçealan Köyü-Türkeli	Trout	15	
Kastamonu	R.Aşikoğlu-T.Balaban-S.T.	İsmail Bey Mah.Nuhoğlu Deresi Sk.Bülbüloğlu Apt.Kat.1 Daire.2	Trout	20	500000
	Faruk Ergut	Mehmet Akif Ersoy Mah.Feza Sok.Eyüp Gazi Sitesi B Blok No:6	Trout	75	
	Taygun Ltd.Şti.	Karasu Mahallesi Akgeçit Köyü	Trout	40	200000
	Kastamonu Üniversitesi	Su Ürünleri Fakültesi	Trout	29	
Bartın	Şahin Çelebioğlu	Abdipaşa Beldesi	Trout	5	
	Karaosmanoğlu	-	Trout	5	
	Gökhan Yildirim	Aşağiçerçi Köyü	Trout	10	
Zonguldak	Erkan Şalli	Yazicik Köyü-Devrek	Trout	27,7	
	Şevket Topçuoğlu	Ankara Asfalti 27.Km -Devrek	Trout	13	
	İlyas Bayrakçi	Bostandüzü Mevkii Değirmenyani Yeşilköy	Trout	8	
Bolu	Yaşar Pinar	Tekirler Mh.Mudurnu	Trout	25	
	Ahmet Gümüş	Büyük Cami Mh Dumlupinar Sk No 24 Mudurnu	Trout	25	
	Metin Sarihan	Karakoçak Mah.Taşkesti Beldesi Mudurnu	Trout	29	500000
Sakarya	Altindere Alabalik Ltd.Şti.	Altindere Cumhuriyet Mah. Biçkidere Sokak No:63/B Akyazi	Trout	500	
	Recep Ali Şirin	Mennuniye Köyü-Sapanca	Trout	29	500000
	Nazim Bayrak	Şükriye Köyü- Dere Mah.Sapanca	Trout	19	400000
Düzce	Aydinpinar Trout	Aydinpinar Köyü	Trout	30	
	Selamet Eryildirim	Batakliçiftlik Köyü	Trout	30	120000
Kocaeli	Necmettin Tari	Servetiye Cami Köyü Başiskele	Trout	25	
	Çamdibi Cooperative	Çamdibi Köyü Karamürsel	Trout	95	
	Mersu Fish Farming	Maşukiye Beldesi Kartepe	Trout	40	
	Ahmet-Mustafa Baş	Karamürsel Karapinar Köyü	Trout	20	
Kırklareli	Baypa Fisheries	Balkaya Köyü	Trout	60	900000
	Döndü Çodar	Balkaya Köyü	Trout	29	
	İrfan Erden	Devlet Mh.Atatürk Cd.No:128/A Vize	Trout	25	4000000
	İrfan Erden	Balkaya Köyü Vize	Trout	29	

Table 12. List of aquaculture companies in Odessa region

Company	Address	Phone/E mail	Manager
Limited Liability Co. "HTMO"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Kurortne, Prychalna street, 1	+380484976532 dpi-htmo@mailx.com.ua	Drobotenko Andrii Oleksandrovyc H
Fisheries Operating Cooperation "Transdnystrovet S"	ODESSA REGION, Biliayevsky district, village Mayaki, Bohachova street, 86	+380485233363 pridnestrovec@i.ua	Shevchenko Andrii Feodosiiovych

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Limited Liability Co. "Red Fisher"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Krasna Kosa, Shkilna street, 1	+380681231525 grinalena@ukr.net	Hyermohenov Yurii Yevheniiovych
Collective Fisheries Agrarian Enterprise "Zarya"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Shabo, Lenin street, 63	+380962327098 lapciknikovaj@gmail.com	Lapchyk Mykola Oleksandrovyc H
Limited Liability Co. "Prud"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Vypasne, Chapaeva street, 49	+380484933455 zvit13877976@ukr.net	Khmilevskyi Leonid Ivanovych
Private Enterprise "Dnister"	ODESSA REGION, Biliayevsky district, illage Mayaki, Bohachova street, 85-A	+380485233311 chp.dnestr@ukr.net	Voytsekhovskyi Ihor Semenovych
Small Production Commercial Enterprise "Istria"	ODESSA REGION, Kiliisky district, Kiliia, Mayak street, 38	+ 380484340344	Karbunyan Mykhailo Pavlovych
Limited Liability Company "Kholod-Servis"	ODESSA REGION, Bilgorod-Dnistrovsky, street Gagarina 16	+380484936446 holod-s@ukr.net	Sarkisov Vadym Viktorovych
Limited Liability Co. "Bora"	Odessa, Prymorsky district, street Pushkinska 74, 2	+380487003006 bora2003@ukr.net	Hribov Hryhorii Yevhenovych
Private Small Enterprise "Albina"	ODESSA REGION, Kiliisky district, Vylkove, street Prydunaiska 2 G	+380484331603 +380484331756 f2771100071@ukr.net	Yen Anatoliy Petrovych
Company Limited Liability Co."Liman"	ODESSA REGION, Chornomors\`k, village Burlacha Balka, street Prymorska 31	+380487438002 +380487170725 liman95@ukr.net liman_@ukr.net	Shlapak Oleksandr Pylypovych
Farmer "Dunayskaya Niva"	ODESSA REGION, Kiliisky district, Kiliia, street Chotynska 61 A	+380484339253 nadyaukraine@ukr.net	Solodovskyi Viktor Leonidovych
Fishing Agricultural Multiprofile Cooperative "Novonekrasivsky"	ODESSA REGION, Izmailsky district, village Nova Necrasivka, street Sergiia Grama, 67/A	+380484147336 rabknekras.ukr.net@meta.ua	Kilian Victor Ivaqnovich
Limited Liability Company "Vilkovsky Fishing Factory"	ODESSA REGION, Kiliisky district, Vylkove, street Bilgorodsky channel, 2	+380671161345	Bilova Olha Viktorivna
Fisheries Agricultural Limited Liability Co. "Sargan"	ODESSA REGION, Tatrbunary district, village Prymors\`ke, street Peremogy 63 A	+380484433564	Veduta Yuriy Volodymyrovy Ch
Private Small Enterprise "Kunashir"	ODESSA REGION, Kiliisky district, Vylkove, street Bohdana Chmelnutskogo, 71	+380676007767 kunashir1999@gmail.com	Shcherbatov Yakiv Hryhorovych
Limited Liability Co. "Pridunavye"	ODESSA REGION, Kiliisky district, Vylkove, street Bilgorodsky channel, 4 A	+380484331484	Velychko Vasyl Andriyovych
Private Small Enterprise "Corsar"	ODESSA REGION, Kiliisky district, Vylkove, street Gagarina, 28	+380484336477 korsarpmp@gmail.com	Chernova Nina Hryhorivna
Limited Liability Co. "South Besarabia"	ODESSA REGION, Kiliisky district, Vylkove, street Bilgorodsky channel, 58 V	+380484341272	Vyazovskyi Vitaliy Ivanovych
Fisheries Agricultural Production Cooperation "Piscar"	ODESSA REGION, Tatrbunary district, village Lyman street Suvorova, 53	+380484492243	Skorokhvatov Hennadii Fedorovych
Private Enterprise "Olymp"	ODESSA REGION, Kiliisky district, Vylkove, street Gagarina, 8	+380937950492	Vyazovskyi Vladyslav Vitaliiovych
Private Enterprise "Equator"	ODESSA REGION, Reni district, Reni street Cartashova, 27, 12	+380484041240	Shevchenko Ivan Mykhailovych
Private Enterprise "Delta"	ODESSA REGION, Shyriaivs\`ky district, town Shiriiaeve, street Gagarina, 14	+380485821709	Braslavskyi Valerii Viktorovych
Limited Liability Co.	ODESSA REGION, Tatrbunary district, village	+380487702836	Morhailo

"Vidrodgennya"	Glyboke, Lenin street, 34	vozrojdenie@meta.ua	Viktor Dmytrovych
Farmer "Orkhidea"	ODESSA REGION, Reni district, village Novosils`ke, street I.НЯГУ, 19	+380677163219 avangardreni@ukr.net	K`Osya Anatoliy Semenovych
Private Enterprise "Ametist"	ODESSA REGION, Liubashivs`ky district, village Bobruk Pershyi	+380950567357	Huslavs`Kyi Volodymyr Yosypovych
Private Enterprise "Dunay"	ODESSA REGION, Kiliisky district, Vylkove, side street Prydunaisky, 2 A	+380484331660 sava1983@meta.ua	Toptyhin Anatolii Andreyanovyc H
Limited Liability Co. "Poseidon"	ODESSA REGION, Chornomors`k, street Transportna, 10	+380486842830 tov_poseidon@ukr.net	Zhezherun Taisiia Oleksandrivna
Limited Liability Co. "Ecofortpost"	ODESSA REGION, Kiliisky district, Vylkove, street Vylkivs`ka, 1	+380482309100 ooo.ekofortpost@ukr.net	Shcherbakov Viktor Heorhiyovych
Private Enterprise "Kalkan"	ODESSA REGION, Bilgorod-Dnistrovsky, street Portova, 19, 4	+380484931472 kalkan.pp@gmail.com	Chornozub Viktor Vasyliovych
Limited Liability Co. "Triton"	ODESSA REGION, Bilgorod-Dnistrovsky, street Peremogy, 2 M	+380983335777 kovalisina17@meta.ua	Melnychenko Hryhorii Viktorovych
Private Enterprise "Brikk"	ODESSA REGION, Bilgorod-Dnistrovsky, town Zatoka, street Lymans`ka, 43	+380487991639 zvit@standarts.com.ua	Filyanovych Ruslan Vasyl`Ovych
Private Enterprise "Tiligul"	ODESSA REGION, Lymansky district, village Sychavka, street Prykordonna, 43	+380639414191 +380634288585 ryabchuk.gera@gmail.com	Ryabchuk Oleksandr Dmytrovych
Private Enterprise "Jaguar-2005"	ODESSA REGION, Bilgorod-Dnistrovsky, street Prymors`ka, 28	+380676084330 kancer1084@gmail.com	Kantser Andrii Mykhaylovych
Private Enterprise "Carp"	ODESSA REGION, Bolgradsky district, village Vynogradivka, street Lymanna, 58	+380974357332 mdd_17@ukr.net	Karakash Vasyl` Heorhiyovych
Liability Company "Odessa Sturgeon Complex"	Odessa, Suvorivsky district, street Mykolaivska road, 144	+380487161213 odosetrovod@ukr.net	Osypchuk Volodymyr Petrovych
Fisheries Farm Limited Liability Co. "Akvatop"	Odessa, Prymorsky district, street NOVOSHCHIPNYI ROW 2	+380487150003 rf.akvaton@gmail.com aquatop@ukr.net	Lushkin Oleksandr Viktorovych
Private Enterprise "Aiko Trading"	ODESSA REGION, Reni district, village Orlivka, street Naberezhna, 1	+380989443699 +380975568542 aikotreyding@gmail.com	Khlivnyi Oleksandr Hryhorovych
Private Enterprise "Mayaki-2007"	ODESSA REGION, Biliayevsky district, village Mayaki, street Richna, 42D	+380485222903 olga.byx888@ukr.net	Sychova Tamara Vasylivna
Limited Liability Company "Ozerne 2012"	ODESSA REGION, Kiliisky district, Kiliia, street Tymoshenka, 22	+380677864906	Aleksandrov Oleksandr Vasyl`Evych
Private Enterprise "Fisheries Union "Ukribexport"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Sucholuzzia, street Dnistrovs`ka, 45	+380674857202 ukrryb364eks@ukr.net	Vasyl`Yev Oleksii Yuriiovych
Limited Liability Co. "Terraport"	Odessa, Suvorivsky district, 2nd Lymanchyk, 5-A line,13	+380487845503 officca2014@ukr.net	Kulikov Serhii Oleksandrovyc H
Private Enterprise "Tiligul Plus"	ODESSA REGION, Lymansky district, village Sychavka, street Centralna, 10	+380978000061 filyanovich27@gmail.com	Filyanovych Ruslan Vasyliovych
Limited Liability Co. "South Coast"	Odessa, Prymorsky district, street Uspens`ka, 54, 17	+380503905079 officca2014@ukr.net	Nazarian Hachik Sevanovich
Limited Liability Co. "Ribkomflot-2"	ODESSA REGION, Chornomors`k, village Burlacha Balka, street Prymors`ka, 31	+380982497189 ribcomflot-2@ukr.net	Shlapak Oleksandr Pylypovych
Limited Liability Co. "Odesaribgosp"	ODESSA REGION, Biliayevsky district, village Yas`ky, Myru, 113	+380672799828 odesarybxoz@ukr.net	Dmytruk Oleksandr Petrovych
State Enterprise "Experimental Multi Fisheries"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Bilen`ke, street Vil`na, 68	+380963195116 kefalev36@ukr.net	Ivasyev Andriu Ivanovych

Agricultural Production Cooperative "Krap Zarya-2"	ODESSA REGION, Bilgorod-Dnistrovsky, town Zatoka, microdistrict Raiduzhnyi, 1, 29	+380965770582	Skotykailo Anatolii Mykhailovych
South Limited Liability Co. "Crystal"	Odessa, Prymorsky district, street skisna, 1	+380974934597 business-svit@ukr.net	Dudnik Oleh Oleksiiovych
Private Enterprise "Chernomorets - Ov"	ODESSA REGION, Biliayevsky district, village Cholodna Balka, side street Pliazhnyi, 1-Б	+380482303479 chernomorec_ov@ukr.net	Osipov Volodymyr Ivanovych
Limited Liability Co. "Repida"	ODESSA REGION, Izmailsky district, village Nova Nekrasivka, street Shkilna, 112	+380975936258 ooo_repida@ukr.net	Voinova Svitlana Heorhiyivna
Private Enterprise "Sprut-K"	ODESSA REGION, Bilgorod-Dnistrovsky district, village Sucholuzzhia, street Dnistrovs`ka, 45	+380688253523 spryt387Syh@ukr.net	Burchu Oleksandr Oleksandrovyc H
Limited Liability Co. "Mercury-Aqua"	ODESSA REGION, Biliayevsky district, village Paliivka, street Lymans`ka, 30	+380487953738 merc_acva@ukr.net	Armash Vladyslav Yevhenovych
Limited Liability Co. "Soyuzyugprom"	ODESSA REGION, Kiliisky district, Kiliia, Lenin street, 129	+380445458008 coyuzyugprom@ukr.net	Hryshaienko Volodymyr Valeriyovych
Private Enterprise "Gera"	ODESSA REGION, Lymansky district, village Sychavka, street Cvietaieva, 1Б	+380634716035 ryabchuk.gera@gmai.com	Riabchuk Oleksandr Dmytrovych
Service Cooperative "Granit-2"	ODESSA REGION, Tatrbunary district, Tatarbunary, street Stepova, 5	+380672834785 granit.lebed@ukr.net	Nen`Ko Borys Oleksandrovyc H

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ANNEX 1 – LIST OF MULTILINGUAL NAMES OF THE SPECIES IN AQUACULTURE IN PARTNER COUNTRIES

No	Species	Greek	Romanian	Turkish	Ukraine
1	American paddlefish (*Polyodon spathula)*	Poliodontas	Poliodon	-	Веслоніс американський
2	Asian sea bass (*Lates calcarifer*)	-	-	-	Білий морський окунь
3	Atlantic bluefin tuna (*Thunnus thynnus*)	Tonos makropteros	Ton roşu	Orkinos/ton balığı	-
4	Beluga (*Huso huso*)	Mourouna	Morun	-	-
5	Bighead carp (*Hypophthalmichthys nobilis*)	Marmarokiprinos	Novac	Kocabaş sazan	Товстолобик
6	Black carp (*Mylopharyngodon piceus*)	-	Scoicar	Kara sazan	Чорний амур
7	Black Sea salmon (*Salmo labrax*)	-	Păstrăv de mare	Karadeniz alası	-
8	Brook trout (*Salvenillus fontinalis*)	Salvelinos	Păstrăv fântânel	Kaynak alabalığı	-
9	Brown bullhead (*Ameiurus nebulosus*)	-	Somn pitic	-	Сомик коричневий
10	Buffalo fish (*Ictiobus spp.)*	-	-	-	Буфало
11	Catfish (*Silurus glanis*)	Goulianos	Somn	Yayın	Сом звичайний
12	Channel catfish (*Ictalurus punctatus*)	-	-	Kanal yayın balığı	Сом канальний
13	Common carp (*Cyprinus carpio*)	Kiprinos, Grivadi	Crap	Sazan	-
14	Common dentex (*Dentex dentex*)	Sinagrida	Dinţos	Sinagrit	-
15	Common pandora (*Pagellus erythrinus*)	Lithrini	Pagel roşu	Kırma mercan	-
16	Common sole (*Solea solea*)	Glossa	Limbă de mare	Dil balığı	-
17	Crayfish (*Astacus spp.*)	Karavida	Raci	Kerevit	Рак широкопалий
18	European eel (*Anguilla anguilla*)	Cheli	Anghilă	Yılan balığı	-
19	European perch (Perca fluviatilis)	Perki	Biban	Tatlısu levreği	-
20	European seabass (*Dicentrarchus labrax*)	Lavraki	Biban de mare	Levrek	-
21	Flathead grey mullet (*Mugil cephalus*)	Kephalos, Niaki	Laban/ Chefal	Has kefal	Лобань
22	Giant river prawn (*Macrobrachium rosenbergii*)	-	Crevete uriaş de râu	-	-
23	Gilthead seabream (*Sparus aurata*)	Tsipoura	Doradă	Çipura	-

24	Grass carp (*Ctenopharyngodon idella*)	Chortophagos Kiprinos	Cosaș	Ot sazanı	Білий амур
25	Jade perch (*Scortum barcoo*)	-	Bibanul de jad		Нефритовий окунь
26	Mediterranean mussel (*Mytilus galloprovincialis*)	Midi mesogeiou	Midie	Midye	Мідія середземноморська
27	Northern pike (*Esox lucius*)	Tourna, Zournas	Știucă	Turna	Щука звичайна
28	Oysters (*Crassostrea gigas, C. angulata, Ostrea edulis*)	Stridia	Stridii	İstiridye	-
29	Pike-perch (*Sander lucioperca*)	Potamolavrako	Șalău	Sudak	Судак звичайний
30	Rainbow trout (*Onchorynchus mykiss*)	Iridizousa Pestrofa	Păstrăv curcubeu	Gökkuşağı alabalığı	Пструг райдужний
31	Red porgy (*Pagrus pagrus*)	Faggri	Pagrus/ Plătică de mare	Fangri mercan	-
32	Russian sturgeon (*Acipenser gueldenstaedtii*)	Ksirichi Dounavi	Nisetru	Rus mersini	-
33	Sharpsnout seabream (*Diplodus puntazzo*)	Mitaki	Hiena mării	Sivriburun karagöz	-
34	Silver (white) carp (*Hypophthalmichthys molitrix*)	Asimokiprinos	Sânger	-	Товстолобик білий
35	South African mullet (*Chelon richardsonii*)	-	-	-	Південноафриканський кефаль
36	Stellate sturgeon (*Acipenser stellatus*)	Astroksirichi	Păstrugă	-	-
37	Tench (*Tinca tinca*)	Glini	Lin	Kadife balığı	Лин
38	Tilapia (*Tilapia spp.*)	-	-	Tilapya	Тилапія
39	Turbot/Black Sea brill (*Scophthalmus maeoticus Psetta maxima)*	Kalkani	Calcan	Kalkan	Калкан великий
40	White seabream (*Diplodus sargus*)	Sargos	Sparus cu coada neagră	Sargos	Морський карась великий