

Part I

Review of capture fisheries and aquaculture in the Kyrgyz Republic

EXECUTIVE SUMMARY

The Kyrgyz Republic (or Kyrgyzstan) is a mountainous country in Central Asia. It is rich in water resources compared with the neighbouring countries and regions. However, the fisheries and aquaculture sector is poorly developed. Total annual fish production is 71.4 tonnes. Even when the 3 000 tonnes imported from neighbouring countries is included, annual fish consumption in the country amounts to less than 1 kg per capita, compared with 16.5 kg on a global level.

Kyrgyzstan was part of the former Union of the Soviet Socialist Republics (former USSR) until 1991, and the fisheries sector was much more developed in the 1980s than at present. In the 1980s, national production reached 1 400 tonnes/year and large volumes of affordable fish for the population reached the country from other parts of the former USSR. The dissolution of the former USSR was followed by dramatic increases in prices of imported products including fish feeds and technology needed for aquaculture, causing fish prices to increase considerably for consumers.

The economic difficulties that came in the wake of independence resulted in a dramatic decline in governmental support to fisheries and aquaculture. Most state-owned fish farms were privatized, and there was no longer an adequate budget available to undertake research, gather statistics or monitor the activities of the fisheries.

In regard to capture fisheries, the most important management tool, since Soviet times, has been restocking with various commercial fish species (most introduced from watersheds elsewhere in the Russian Federation and Central Asia). The financial and ecological implications of this management strategy have not received much attention. However, the outcome has been that the fish fauna in most Kyrgyz waterbodies has changed completely, and most fish harvested today are non-indigenous species.

In Kyrgyzstan, as in many other countries, water is managed mainly to secure the needs of the agriculture sector with little regard for the needs of fisheries.

The dire economic situation, especially in rural areas, combined with the low level of enforcement has also led to a sharp increase in the level of poaching for subsistence purposes. There is evidence that the level of illegally caught fish is significantly higher than the official catch figures.

Although there is little tradition of fish consumption in the country, it was much higher in Soviet times than today. Increasing incomes in the capital city are leading to a rising demand for fish and fishery products. Imported and illegally caught fish are often stored and processed under inappropriate conditions. This fish is generally not suitable for human consumption. However, unsafe and poor-quality fish products are still sold, giving the sector a bad image. The current demand for fish far outstrips supply, causing the sale of unsafe product and also leading to high market prices. To provide the population with the health benefits related to increased consumption of good-quality fish, domestic production of, in particular, “cheap” types of fish should be boosted.

Some investors have already recognized the potential for making profits in fisheries and have started to invest in the revival of the fisheries sector. One of the subsectors that have received most attention is the lucrative farming of exotic rainbow trout in cages in the country’s largest lake. This lake is a unique environment and a United Nations Educational, Scientific and Cultural Organization (UNESCO) world heritage site. It has also been designated as a Ramsar site.

It is mandatory that Kyrgyzstan, while encouraging the development and diversification of its fisheries, introduce an appropriate legal and regulatory framework that is in compliance with international and regional agreements and conventions (e.g. the FAO Code of Conduct of Sustainable Fisheries). This is necessary so that an adequate supply of fish can be generated in a sustainable manner in order to meet the needs of the population without jeopardizing biodiversity and to avoid repeating past mistakes.

As Kyrgyzstan has a very considerable high hydropower potential (of which only some 10 percent has been developed), it is most probable that the hydropower sector will develop significantly in the coming years. It is crucial for the fisheries sector to become involved in the planning and operation of hydropower and irrigation projects. Several reservoirs would be suitable for establishing cage culture. These include the Kurpsay, Tash-Kumyr, Shamaldysai and Uch-Korgon reservoirs, and the cascade of reservoirs on the Naryn River.

Chapter I

INTRODUCTION

The Government of the Kyrgyz Republic (or Kyrgyzstan) acknowledges that fisheries is a key sector for rural development in the country. However, since independence, fish production has experienced a serious decline. In 2006, the combined fish production from aquaculture and capture fisheries in the country was estimated at 71 tonnes, compared with more than 1 000 tonnes some decades ago. The available water resources for fisheries, together with the existing demand for fish and fishery products and the current technical experience available in the sector, mean that there is considerable scope for increasing the sector's contribution to food security, poverty alleviation, employment and income generation in rural areas.

The Ministry of Agriculture, Water Resources and Processing Industry (MAWRPI) recognized the need to study the current situation and identify opportunities to increase production in order to meet domestic demand and increase consumption of fish given its importance as a source of animal protein, essential fatty acids, vitamins and minerals.

As a consequence, the MAWRPI (through the Department of Fisheries) requested international technical and financial support from FAO in order to conduct a review of capture fisheries and aquaculture in Kyrgyzstan and to assist in formulating a strategy for fisheries and aquaculture sector development and management in Kyrgyzstan.

FAO responded by offering Kyrgyzstan technical assistance to the country's fisheries sector through the project "Development of inland fisheries and aquaculture in the Kyrgyz Republic to reduce rural food insecurity" (GCP/GLO/162/EC – Kyrgyzstan), a project supported by the European Commission. This review study was the first step towards the development of the national strategy and intended to provide baseline information on the current situation of the fisheries in the country.

Chapter II

HISTORICAL BACKGROUND

FISHERIES AND AQUACULTURE UP TO INDEPENDENCE

Capture fisheries

In spite of the abundant water resources, the cold and oligotrophic waters that dominate the country limit the fish production potential. Fisheries have never been important in Kyrgyzstan, as fishing has traditionally focused only on supply for local consumption.

Most capture fisheries activities in Kyrgyzstan have focused on Lake Issyk Kul, the largest waterbody in the country. However, commercial fishing only started there towards the end of nineteenth century (Petr and Mitrofanov, 1998; FAO, 1999), when fish catches varied between 17.4 and 104.8 tonnes per year (Berg, 1930).

In 1931, the Issyk Kul Fish Processing Factory (when privatized in 1993, this became Balykchylar Ltd.) was established in Grigorievka village. This led to a considerable intensification of the fisheries and an increase in catches. These reached 1 100–1 200 tonnes/year in the last half

TABLE 1

Capture fisheries production from the most important lakes and reservoirs in Kyrgyzstan up to 1990

Fish landings in Lake Issyk Kul, 1965–1990						
Year	1965	1968	1975	1980	1985	1990
Annual production (tonnes)	1 335	1 090	929	345	166	286
Fish landings in Lake Son Kul, 1976–1990						
Year	1976	1977–78	1979–1981	1982–84	1985–87	1988–1990
Annual production (tonnes)	8	108	42	20	37	40
Fish landings in Toktogul Reservoir, 1978–1989						
Year	1978–1980		1981–83	1984–86	1987–89	
Annual production (tonnes)	43		13	11	10	

Note: More details in Annex 1.

Source: DOF (Undated).

TABLE 2

Annual fish landings in Kyrgyzstan, 1965–1989

Species	1965–69	1970–74	1975–79 (tonnes)	1980–84	1985–89
Pikeperch	28.32	136.38	89.45	34.04	30.94
Trout	3.02	10.34	45.74	24.38	23.66
Osman	0.98	1.30	1.68	1.03	0.16
Whitefish	-	-	3.52	10.58	31.47
Sazan	9.52	2.94	0.51	0.91	1.18
Ide	22.48	54.40	49.55	29.19	23.48
Moroco	1 074.00	915.70	573.64	112.03	126.13
Marinka	3.90	1.60	2.28	3.42	4.42
Tench	4.92	5.14	1.48	1.29	3.46
Silver carp	-	-	-	2.89	1.84
Grass carp	-	-	-	0.39	0.59
Total	1 147.14	1 126.60	765.85	220.15	216.78

Note: Scientific names in Annex 2.

Source: DOF (Undated).

of the 1950s and reached the maximum recorded of 1 335 tonnes in 1965. Since then, there has been a steady decline in catches (Tables 1 and 2). In 1985, the catch from Lake Issyk Kul was 166 tonnes – or 12 percent of the 1965 catch.

In the 1970s, fishing expanded to include the Son Kul and Kara-Suu lakes and the Toktogul, Bazar-Kongor, Orto-Tokoy and Kirov reservoirs. However, the combined catch from these waterbodies was only 10–15 percent of that from Lake Issyk Kul. The latter has consequently attracted most of the attention and much more information is available about the fisheries there.

Fisheries management

In the early twentieth century, fishing was carried out using gill nets of different mesh sizes, sweep-nets and bow nets. The fishery was unregulated, and unsustainable practices prevailed, e.g. setting gill nets at the mouths of the rivers to catch migratory fish ascending the river to spawn, and targeting spawning fish on the spawning grounds in the shallows of the lake.

In the period of planned economy, commercial fish catches were all regulated and carried out by the Office of Fishery of the Ministry Council of the Kyrgyz Republic. The fisheries sector was subsidized by the Ministry of Fishery of the former USSR. At this time, about 300 people, 122 boats and 8 638 nets were employed on Lake Issyk Kul alone (Konurbaev *et al.*, 2005).

In 1940, the coastal zone of Lake Issyk Kul was divided into 40 sections, and quotas were calculated for each section based on production potentials. In 1982, fishing for moroco (*Leuciscus bergi*) was prohibited in Lake Issyk Kul in the spawning season (Konurbaev and Timirkhanov, 2003). In 1986, a total ban on naked osman fishing was imposed (Konurbaev *et al.*, 2005).

The most important management tool used was to enhance the capture fisheries through stocking and restocking. For this purpose, a number of exotic species of higher economic value were introduced. Several of these became established and formed the basis for important fisheries. The Ton hatchery is an example of how this policy was implemented. The hatchery was set up on the Ton River (a tributary to Lake Issyk Kul) in 1956 to reproduce trout and other valuable species artificially for stocking the lake.

The broodfish were trapped when entering the Ton River and other tributaries to the lake. The Ton hatchery had the capacity to produce 10 million trout and 2 million carp fingerlings annually. At the end of the 1960s, an additional plant was established in Karakol (Przhevalsk), where trout, sig and osman could all be bred for stocking the lake (Konurbaev *et al.* 2005). In addition to fish, invertebrates (primarily mysids) were introduced in a number of cases with the aim of supplementing the food base for the fish. In many cases, the fish introduction and stocking programmes had serious ecological consequences (Part I, Chapter III).

Aquaculture

The decline in capture fisheries production in the 1970s was offset by the establishment of a number of state fish farms. Fish breeding in pond systems rapidly became the most productive subsector of the country's fisheries sector. In the period 1980–1990, when total annual fish production in Kyrgyzstan exceeded 1 400 tonnes, 70 percent of this production originated from pond culture on the state-run farms. However, pond aquaculture was not always a profitable business. For example, the Talas plant only survived by virtue of significant state subsidies (Table 3).

Chui fish-breeding plant

The Chui plant (now the joint-stock company Balyk) was established as a state fish farm in the late 1950s as a regional fish hatchery. It was equipped with standard equipment and managed a total pond area of 370 ha, which included broodstock ponds, grow-out ponds, hibernation ponds and nursery ponds. In addition to the production of table fish, the plant also provided stocking materials of various carp species.

TABLE 3

Aquaculture production and income in Kyrgyzstan, 1985–1990

Plant		1985	1986	1987	1988	1989	1990
Chui	Fish production (tonnes)	241	274	200.2	415.2	390.4	316.4
	Total revenues (thousand roubles)	365.8	462.2	335	719.3	620.4	507.1
	Costs (thousand roubles)	367.1	299.8	368.1	563	570.4	484.7
	Profit (thousand roubles)	-1.3	162.4	-33.1	156.3	50.0	22.4
Uzgen	Fish production (tonnes)	271.1	411.0	408.0	431.0	497.3	380.0
	Total revenues (thousand roubles)	386.5	538.6	535.5	633.8	686.5	546.1
	Costs (thousand roubles)	535.0	461.4	427.7	478.0	617.0	535.8
	Profit (thousand roubles)	-148.5	77.2	107.8	155.8	69.5	10.3
Talas	Fish production (tonnes)	26.7	120.0	132.3	152.0	270.0	274.0
	Total revenues (thousand roubles)	38.1	167.0	149.2	207.4	277.2	287.6
	Costs (thousand roubles)	150.1	235.6	242.0	282.6	272.2	360
	Profit (thousand roubles)	-112.0	-68.6	-92.8	-75.2	5.0	-72.4

Note: US\$1 = 0.637 roubles in 1987.

Source: DOF (Undated).

Uzgen fish-breeding plant

The Uzgen plant was built in 1968 in the town of Uzgen in the Osh region, where the climate and environment provide optimal conditions for fish production. The plant was constructed to produce up to 500 tonnes of sazan, grass carp and silver carp per year. In addition to a hatchery, the plant administers 290 ha of ponds of all categories: grow-out ponds (224.3 ha), nursery ponds (47.1 ha), broodstock and quarantine ponds (9.7 ha), hibernation ponds (4.6 ha), spawning ponds (3.6 ha), and water storage ponds (0.6 ha).

Talas fish-breeding plant

The Talas plant was established in 1975, in the Bakay-Atin area of the Talas region. The plant has the capacity to produce 600 tonnes of sazan, grass carp and silver carp per year. The total pond area is 364 ha, including grow-out ponds (296 ha), nursery ponds (68 ha), and hibernation ponds (0.2 ha).

FISHERIES AND AQUACULTURE 1991–2004**Institutional setting for fisheries**

When Kyrgyzstan became independent, fisheries was included in the Republican Industrial Association Kyrgyzrybhoz (later renamed Kyrgyzbalygy) under the Agroindustrial Committee. The Central Asia Production and Acclimatization Station was given the responsibility for stocking and species introductions.

In 1997, the Department of Fisheries (DOF) was created following a governmental resolution, but it was abolished in July 2000 by presidential decree. Its functions were handed over to the MAWRPI, and a new unit called the Sector of Fishery Industry was created in the ministry. Its main mandate was to improve fisheries management (FAO, 2003). The creation of the Sector of Fishery Industry markedly improved the state of the fisheries through increased attention to research, reproduction, conservation and management. In 2001, the Sector of Fishery Industry was abolished, and its functions were turned over to the Fisheries Inspection Service. This inspectorate introduced various measures to improve the situation of the fisheries, including outlawing whitefish and trout fishing in 2003. Weak enforcement of management measures resulted in an increase in poaching, and the ban on whitefish and trout did not result in any improvement in stocks. The licences for catching fish were issued by the Fisheries Inspection Service of the Ministry of Agriculture until 2004.

Aquaculture and fisheries production

The difficult economic situation in Kyrgyzstan during the initial stages of transition to a market economy had severe impacts on both aquaculture and capture fisheries. Government subsidies to the fisheries sector ceased, forcing the sector to become economically independent. The breaking of economic ties with many of the former Soviet republics led to a shortage of hatchery equipment and quality fish feed that had previously been brought in at low cost from other parts of the former USSR (FAO, 2003).

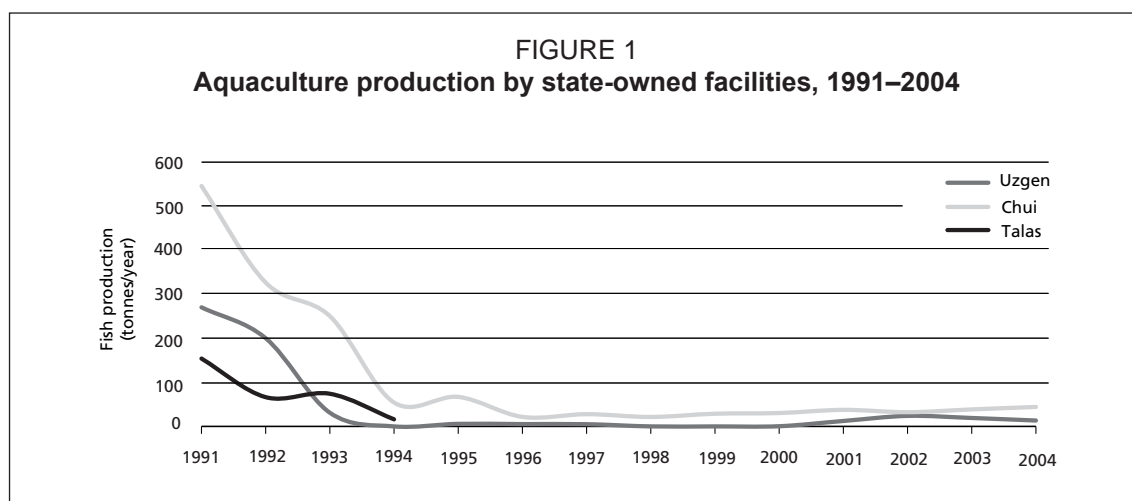
To improve profit margins, all aquaculture ponds with low fish production were taken out of production and the areas were used instead for growing crops (FAO, 2003). Talas fish farm was not operated after 1994. Production only restarted when it was leased out to private entrepreneurs in 2005. Among the state-owned facilities, only the Uzgen farm continued to produce fish, but at an insignificant level. There was a slight rise in productivity from 2001 onwards, and production reached 24 tonnes in 2002 (Figure 1).

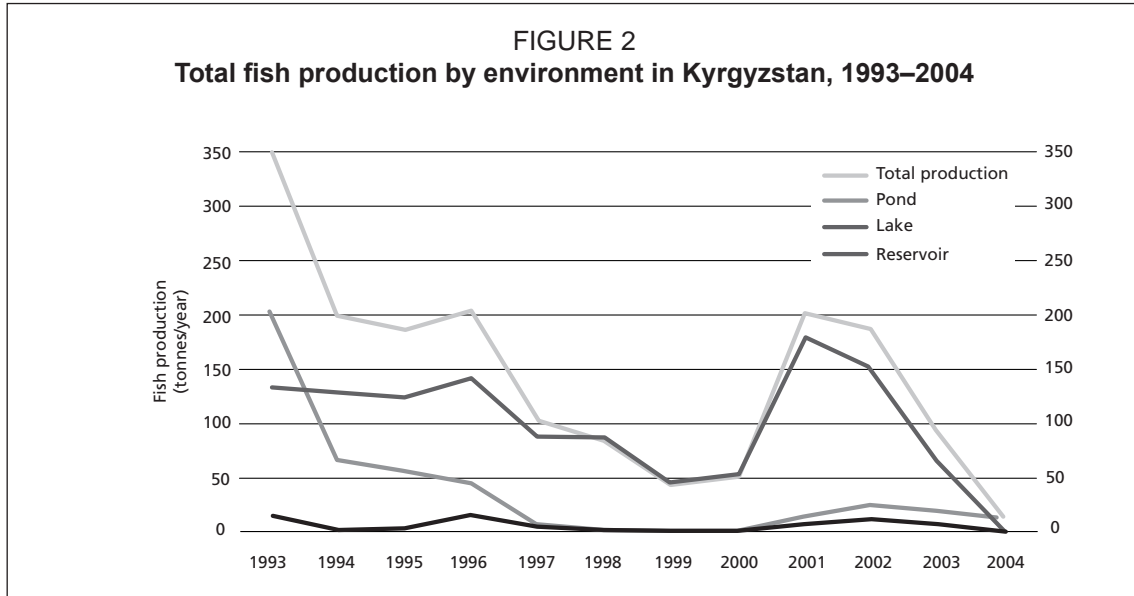
Except for the Ton hatchery, the state-owned hatcheries were privatized in the period 1991–2004. The Chui fish-breeding plant (now Balyk JSC), which was the only fish farm and only producer of stocking material in the Chui region, and the Issyk Kul fish-processing plant (which became Balykchylar Ltd. in 1993), the only well-equipped processing factory at Lake Issyk Kul, were the main privatized facilities. The result of this development was that aquaculture production fell to 5 tonnes in 1997 – 0.5 percent of production levels a decade earlier (Figure 2).

Capture fisheries production from Lake Issyk Kul dropped dramatically through to 1999, when it was only 44 tonnes (Figure 2 and Annex 1). In 2001 and 2002, catches rose to 180 and 151 tonnes, respectively, but then fell to 67 tonnes in 2003.

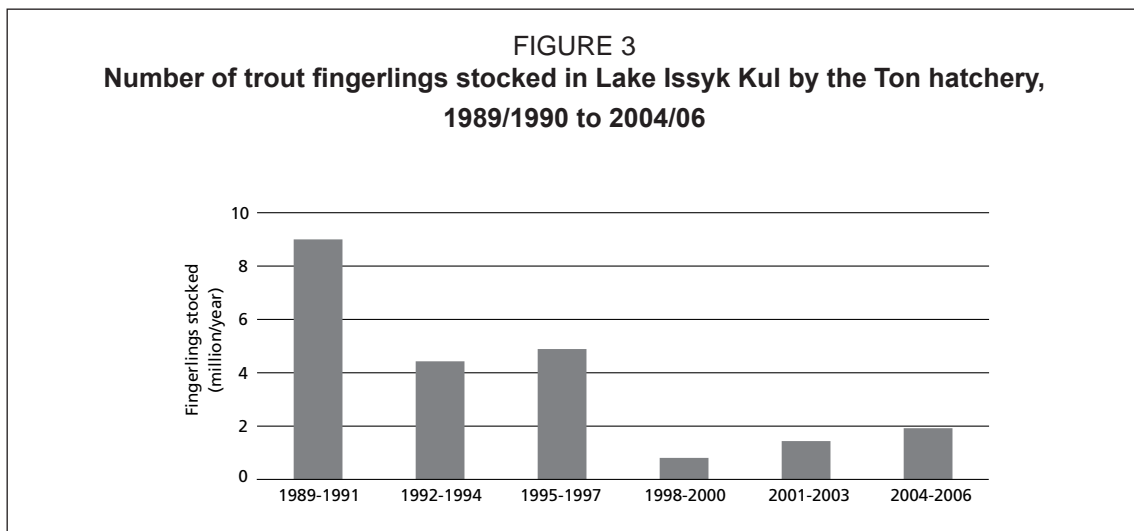
A combination of unsustainable fishing practices, competition within the food chain from introduced species, and unfavourable water resource management led to this collapse in the fishery. In 2000, more effective monitoring of fish farms began, and from then onwards some extension services were provided (which may explain the increase in production from 2000 to 2001).

Since 2000, the fishing rights in the 40 sections in Lake Issyk Kul have been leased out to 17 commercial enterprises. Apart from catching fish for sale, these enterprises have been authorized to capture broodfish in the spawning season with a view to restocking the lake. However, there remains little control as to whether the enterprises observe regulations and their quotas. Short-term leases encouraged overexploitation and what had been the most productive sites in the past became degraded and unproductive (Konurbaev *et al.*, 2005).





Source: Data provided by the DOF.



Source: Data provided by the DOF.

The dire economic situation and soaring unemployment rates led to an increase in the number of poachers (and thus the level of unreported catches). Enforcement of management measures and regulations was weak owing to a lack of financial resources for monitoring compliance. In an attempt to combat illegal fishing activities, controls of fish sales and market controls were introduced in 2000 (FAO, 2003), but these have had limited success.

The level of restocking in Lake Issyk Kul fell from 9 million trout fingerlings in 1990 to fewer than 1 million trout fingerlings ten years later (Figure 3 and Annex 1). While the Ton hatchery had initially been established to produce fingerlings for stocking of Lake Issyk Kul, the ministerial demand that the Ton hatchery should generate part of its income from other sources forced the facility to reorient itself. At the beginning of the twenty-first century, the Ton hatchery started to supply stocking material to private fish farms and reduced the number of fingerlings produced for stocking. Intensification of poaching practices in river mouths also reduced the number of broodfish available for reproduction. Moreover, water abstraction for irrigation led to reduced

water-levels and the drying-up of many of the streams that the traditional indigenous fish species had previously used for spawning.

Fish consumption

During the period of planned economy, the directorate Kyrgyzrybpromsbyt provided the population of the republic with fish and fish products in the necessary quantities, including freshwater and marine fish and processed seafood. During that period, Thursday was “fish day”, and all restaurants and cafes served fish dishes. After independence, this tradition gradually disappeared as fish became scarcer and more expensive; the diversity of products diminished and quality deteriorated.

Chapter III

THE CURRENT STATUS OF FISHERIES AND AQUACULTURE

NATURAL RESOURCES AND POTENTIAL OF THE FISHERIES SECTOR

Geography and climate

Kyrgyzstan (full name: the Kyrgyz Republic) is a landlocked country situated in the northeast part of Central Asia among the mountain systems of Pamiro-Alay and Tian-Shan, between longitude 69–80 °E and latitude 39–43 °N (Annex 3). The country is mountainous, with almost 75 percent of the territory lying at more than 2 000 m above sea level. Kyrgyzstan is contiguous with Kazakhstan in the north and northwest, China in the east and southeast, Tajikistan in the south, and Uzbekistan in the west. The total area of the country is 199 900 km² (National Statistical Committee of the Kyrgyz Republic, 2007).

Kyrgyzstan has an estimated 5 190 million inhabitants, corresponding to an average density of 26 people/km². However, one-third of the population is concentrated in Chui Oblast, with the capital Bishkek.

The climate is dry continental with average temperatures between -1 and -8 °C in January and between 15 and 27 °C in July. However, in the mountains, January temperatures fall to -27 °C, and July temperatures reach only 5 °C.

Rivers

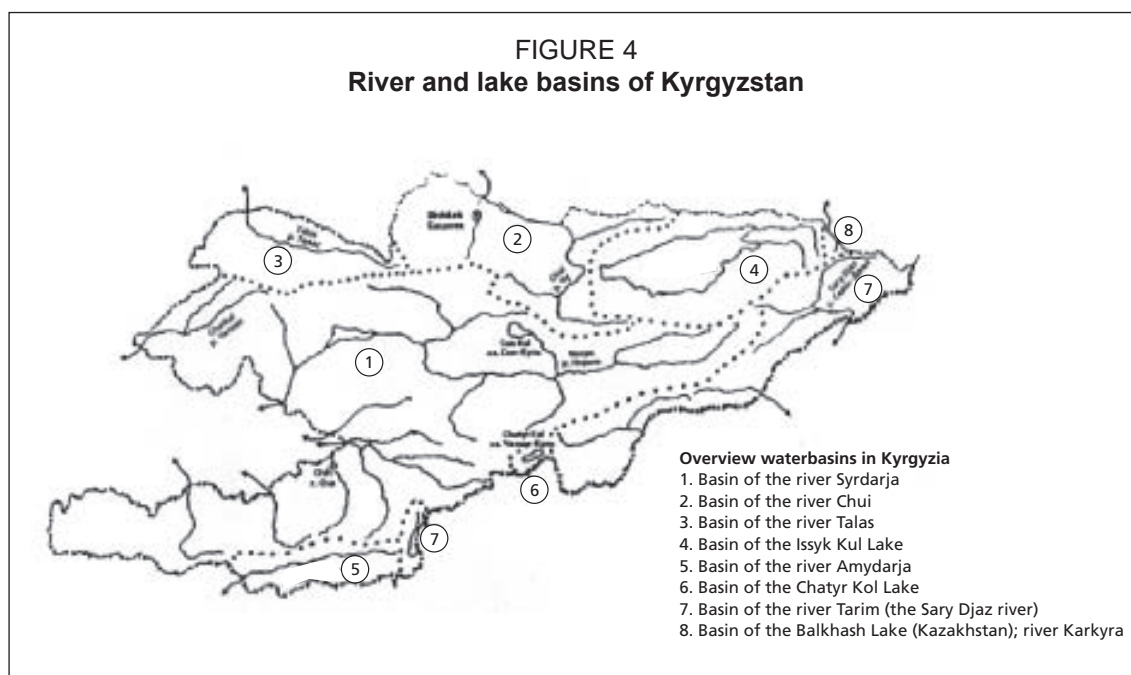
There are almost 30 000 rivers and streams longer than 10 km in the country (National Statistical Committee of the Kyrgyz Republic, 2007). Most of them originate in the mountains, fed by melting snow and ice from the 8 200 glaciers that cover 4.2 percent of the country (Mamatov, Cusupov and Raimcanov, 2007).

The Naryn River basin, which covers more than 50 000 km², is by far the largest. The Naryn and Chatkal both belong to the Syr Darya basin, which drains to the Aral Sea. The Chui (22 600 km²) and Kara-Djaz basins (18 200 km²) rank second and third, respectively, in terms of basin area (Figure 4 and Table 4).

River flow changes considerably during the year and may increase 10–15 times in summer, with the highest water-level normally occurring between June and August. The water is cold, clear and nutrient poor. The current of most rivers is very strong, and both biomass and biological productivity are low. The rivers are currently of no importance for commercial fisheries although annual landings in the upper part of the Chu River may have reached 4–5 tonnes in the 1930s (FAO, 1999). The rivers are of increasing importance for recreational fisheries (particularly angling), and have potential for future ecotourism. Many rivers also are potentially suitable for the establishment of trout culture systems.

Lakes

There are 1 923 lakes in the country, with a total area of 6 836 km² (Mamatov, Cusupov and Raimcanov, 2007). However, only 16 lakes are larger than 1.5 km² (Konurbaev and Timirkhanov, 2003), and most lakes are situated at high altitudes in the mountains without road access. The difficult access to many of these lakes makes exploitation by commercial fisheries non-profitable or impractical. Although their clear, cold, oxygen-rich water is favourable for trout and other cold-water fish species, the low availability of food resources makes culture-based fisheries less



Source: Konurbaev and Timirkhanov (2003).

TABLE 4
The most important rivers and river basins of Kyrgyzstan

River	Length (km)	Basin area (thousand km ²)	Average discharge (m ³ /s)
Naryn	616	50.1	421.0
Talas	294	10.8	33.0
Chui	221	22.6	53.0
Kara-Darya	189	18.2	62.7
Sary-Djaz	165	12.1	126.0
Chatkal	144	6.9	66.0
Kyzyl-Suu (Alay valley)	128	7.8	39.0
Ak-Buura	58	2.5	20.7
Soh	127	2.5	42.1
Keke-Meren	108	8.3	82.0
Chon-Kemin	107	2.0	21.0
Tjup	105	1.1	10.6
Djergalan	81	2.1	22.5
Isfara	85	2.3	14.7

profitable. In addition, small lakes situated at high altitudes may also frequently freeze to the bottom, killing the fish that have not reached commercial size during the productive period in the summer season.

Lake Issyk Kul

Lake Issyk Kul in the northeast of Kyrgyzstan (76–78.15 E and 42 ° 10' – 42 ° 40' N) is the largest waterbody in the country, and the second largest high-altitude lake in the world. The lake is of tectonic origin and is situated between the ridges of Terskey Ala-Too in the south and Kungey Ala-Too in the north at a height of 1 609 m above sea level. It is 178 km long, 60 km wide and has a surface area of 6 292 km². Until 1 200 years ago the lake was connected to the Chui River, but there is now no longer any outlet from the lake (FAO, 1999) and it has become

slightly saline (5.9–6.1 ppt) and alkaline (pH = 8.3–9.0). In the recent past, 102 rivers used to flow into the lake. However, only the Tyup and Jergalan rivers are sizeable with discharges of 10 and 22 m³/s, respectively (Konurbaev and Timikhanov, 2003). Many of the smaller streams have dried up. Most of the about 50 rivers currently reaching the lake have greatly reduced flows owing to water abstractions for irrigation, and many of them run completely dry for part of the year (FAO, 1999).

The lake is deep, with 63 percent of the lake deeper than 100 m and a maximum depth of 668 m. The lake is oligotrophic and the water is highly transparent with Secchi depths of 30–47 m in the open lake. There is a diverse planktonic community consisting of 299 species of phytoplankton and 117 species of zooplankton, and also the benthic community is rich with 146 species of zoobenthos (FAO, 1999).

Fish are mainly found from the littoral down to a depth of 100 m. This means that two-thirds of the lake has few or no fish. Natural fish production reflects the nutrient-poor status of the lake and is only 1.5–2.0 kg/ha/year (Konurbaev *et al.*, 2005).

Lake Son Kul

Kyrgyzstan's second largest lake, Lake Son Kul, is a mountain lake. It is situated 3 016 m above sea level in a small hollow of the inner Tian-Shan, between 41 °47'–41 ° 55' N and 75–75 ° 20' E, between the mountain ridges of Sonkul-Too in the north and Moldo-Too with the spurs of Boor-Albas in the south. The lake has an area of 273 km² and a mean depth of 9 m (FAO, 2003).

Until 1959, there were no fish in Lake Son Kul. However, a number of commercial fish species have since been stocked in the lake (FAO, 2003). In the past (when the fisheries law was better enforced), landings were 140–300 tonnes/year. However, in recent years, up to 600 tonnes have been landed yearly, and this level is not sustainable (Konurbaev and Timikhanov, 2003).

In 1978, the lake was accidentally polluted with an insecticide used for locust control. A considerable part of the fish and other aquatic organisms died, and it took ten years for catches to reach the amounts obtained in the early 1970s.

Lake Kara-Suu

Lake Kara-Suu is a small lake (40 km²) situated in Jalal-Abad region of the Naryn River basin. The lake is deep (up to 100 m), the water is cold, and the nutritional base of the lake is quite poor. Syrok (*Coregonus peled*) was introduced in the lake in 1988. Although it reproduces naturally, it has never become abundant. It is estimated that the productivity could be increased by 1.5–2.0 times though annual restocking with young syrok.

Lake Chatyr-Kul

Lake Chatyr-Kul is a fishless lake situated in the south of Tian-Shan at 3 530 m above sea level (40 ° 37' 51.00" N, 75 ° 17' 13.24" E). Some 52 rivers and brooks flow into the lake, which is slightly saline and extends over an area of 170.6 km². In the early 1970s, the potential for developing a fishery was studied. Lake Chatyr-Kul was found to be very nutrient rich, with an average biomass of zoobenthos of 39.7 g/m² and an environment suitable for whitefish.

However, the lake is now protected under Kyrgyz law (Konurbaev and Timikhanov, 2003), and it was declared a Ramsar site in 2005. Therefore, introducing fish would be illegal.

Reservoirs

There are 13 large reservoirs in the country (Table 5), all state-owned. These represent 38 percent (377 km²) of the total water area covered by all the reservoirs in Kyrgyzstan (more than 988 km²).

TABLE 5
The major reservoirs of Kyrgyzstan

Reservoir	Year built	Area (km ²)	Purpose	River basin	No. of fish species	Type of fishery	Fish production potential (tonnes/year)
Chui Oblast							
Nizhnee Ala-Archa	1989	13.0	Irrigation	Chui	21	Recreational	100.0
Chumysh	1956	0.6	Irrigation	Chui	13	Recreational	5.6
Kara-Baltin	1964	1.5	Irrigation	Chui	14	Recreational	4.9
Mekhaniche	1963	0.4	Irrigation	Chui	15	Recreational	4.2
Jeken-2	1933	0.3	Irrigation	Chui	13	Recreational	3.3
Ak-Bashat	–	0.4	Irrigation	Chui	13	Recreational	4.0
Stepnin	1963	0.3	Irrigation	Chui	15	Recreational	3.4
Erictuu	1957	0.2	Irrigation	Chui	15	Recreational	2.0
Ak-Suu	1982	0.5	Irrigation	Chui	11	Recreational	4.5
Spartak	1978	5.1	Irrigation	Chui	25	Recreational	51.0
Makachi	1932	0.3	Irrigation	Chui	15	Recreational	2.5
Kara-Tuma	1987	2.2	Irrigation	Chui	14	Recreational	24.0
Panfilov-1	1964	0.6	Irrigation	Chui	15	Recreational	5.7
Panfilov-2	1964	0.6	Irrigation	Chui	15	Recreational	6.2
Puchuk	1989	0.6	Irrigation	Chui	14	Recreational	6.0
Agermen	1986	34.0	Irrigation	Chui	14	Recreational	3.4
Sokuluk	1968	1.8	Irrigation	Chui	15	Recreational	18.0
Djalgach	1954	0.4	Irrigation	Chui	13	Recreational	3.9
Jalal-Abad Oblast							
Toktogul	1973	265.0	Irrigation & energy	Naryn	18	Commercial	132.0
Bazar-Korgon	1962	2.7	Irrigation	Kara-Darya	8	Recreational	1.0
Kurpsay	1981	12.0	Irrigation & energy	Chui	6	Recreational	4.5
Tash-kumyr	1988	7.8	Irrigation & energy	Naryn	6	Recreational	2.9
Shamaldysai	–	2.4	Irrigation & energy	Naryn	6	Recreational	0.9
Uch-Korgon	1962	4.0	Irrigation	Naryn	11	Recreational	8.5
Osh Oblast							
Naiman	1966	4.5	Irrigation	Kara-Darya	5	Recreational	12.7
Papan	1987	7.1	Irrigation	Kara-Darya	5	Recreational	2.1
Kampravat	–	540.0	Irrigation & energy	Kara-Darya	4	–	16.0
Batken Oblast							
Tortkul	1977	0.4	Irrigation	–	5	Recreational	8.0
Talas Oblast							
Kara-Burin	–	26.5	Irrigation	Naryn	14	Recreational	79.5
Kirov	1975	28.0	Irrigation	Talas	16	Commercial	168.0
Naryn Oblast							
Orto-Tokoi	1956	25.0	Irrigation	Chui	9	Commercial	1.9
Total		988.2	–		–	–	690.6

Sources: Pelli (2005) and DOF (Undated).

They were all established between 1930 and 1990. Some were constructed for storing water for irrigation, others for both irrigation and hydropower production. In addition, there are more than 300 small irrigation reservoirs, mainly in the Chui Valley.

Although the fishing rights in the reservoirs are commonly leased out, little or no attention has been given to the interests of fisheries when planning or managing the reservoirs. This prioritization has serious consequences for fish production because of the fluctuating water-levels.

A rapid drop in water-level during the spawning period sometimes leads to the drying-up of suitable spawning grounds and eggs already spawned. For this reason, the majority of the reservoirs are not suitable for commercial fishing and are, therefore, only used for recreational fisheries. The main species are: carp, pike, roach, osman, marinka and herbivorous species.

However, several reservoirs would be suitable for establishing cage culture, e.g. the Kurpsay, Tash-Kumyr, Shamaldysai and Uch-Korgon reservoirs and the cascade of reservoirs on the Naryn River.

Fish fauna

There are currently 66 fish species and subspecies in the country. Of these, 49 are indigenous (one of these, Schmidt's dace (*Leuciscus schmidti*) is endemic) while the remaining 17 have been introduced either on purpose or by accident. A further six exotic species at least have failed to establish themselves (Konurbaev and Timikhanov, 2003; and Annex 2). The species introductions took place in lakes, rivers and reservoirs throughout the country as part of a strategy to build larger and more valuable fish stocks. However, this had severe impacts on the ecosystems, and did not yield the expected results in terms of fish production. It led to changes in both the quality and sizes of fish stocks and the gradual disappearance of indigenous fishes in the catches (Box 1).

Fish fauna in lakes

Most lakes in Kyrgyzstan are rather species poor, with generally only two or three species present (Konurbaev and Timikhanov, 2003). The indigenous lake species are generally small and of little commercial value. Most lakes in the country, including the most-species-rich (Lake Issyk Kul with 12 indigenous species), have consequently been subject to intensive stocking programmes (mainly with exotic species).

The Sevan trout was introduced in Lake Issyk Kul from Lake Sevan, Armenia, in 1930–36 by the Department of Fishery Administration of the former USSR. The fingerlings were stocked in the mouths of rivers and streams flowing into the lake. The trout adapted well to the new environment and developed some differences from the Sevan trout. Indeed, some consider it a separate subspecies. A specialized hatchery was built in the Ton region, and as a result of continued stocking with artificially reproduced trout, the population in Lake Issyk Kul grew. In 1971, it was possible to commence commercial catching of trout.

In the 1950s and 1960s, bream (*Abramis brama*), sazan (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), tench (*Tinca tinca*), syrok (*Coregonus peled*) and Baikal omul (*Coregonus migratorius*) were introduced into Lake Issyk Kul (Turdakov, 1963), and 1 400 broodfish of pikeperch (*Sander lucioperca*) were brought from rivers of the Ural region. This last species was introduced into the gulf of Rybachie town and soon spread throughout the lake. In the 1960s, whitefish was introduced into the lake, and the fertilized spawn of another whitefish, *Coregonus luttoka*, were brought to the Ton hatchery. Between 1966 and 1988, more than 90 million whitefish larvae were stocked in the lake, and an experimental whitefish fishery started in 1980.

Lake Son Kul was without any fish fauna (Konurbaev and Timikhanov, 2003), until syrok and Baikal omul larvae were stocked in the lake in 1972–73. Both the stocked species showed good

Box 1

Species introductions in Lake Issyk Kul

In Lake Issyk Kul, introduced trout and especially pikeperch have preyed heavily on populations of indigenous fish species and caused severe declines in stock sizes of several of them. Serious damage has also been caused through the accidental introduction of ide, striped riffle minnow (*Alburnoides taeniatus*) and other species of low commercial value that eat spawn and otherwise harm the endemic fishes. In some cases, diseases and parasites have been introduced together with the new fish species.

Before exotic fish species were introduced into Lake Issyk Kul, catches were dominated by ide (*Leuciscus idus*), Issyk Kul moroco (*L. bergi*), sazan (*Cyprinus carpio*), Issyk Kul marinka (*Schizothorax pseudoaksaiensis issykkuli*) and naked osman (*Gymnodiptychus dybowskii*). In the 1930s, when no more than 100 tonnes of fish was caught per year, Issyk Kul moroco was the most common species and made up 90 percent of the catches. It is still the most important species, but its abundance has declined dramatically (Konurbaev and Timikhanov, 2003).

In 1941–45, the annual catch of Issyk Kul marinka, naked osman and sazan totalled 36.0 tonnes. However, in 1962, these volumes began to fall sharply, and in 1972 only 6.2 tonnes of these three species were caught.

The fate of the naked osman

Overfishing and poaching led to a serious decline in the abundance of the endemic naked osman in Lake Issyk Kul. Therefore, the capture of this species was prohibited in 1986. However, the ban has not led to any improvement in the conditions of the stock, and naked osman has now become an extremely rare species in the lake. However, part of the decline is probably related to fishers not reporting the true level of their catches.

In 2005, both naked osman and Issyk Kul marinka were recommended for inclusion in the Red Book of Kyrgyzstan as rare and vanishing species. A programme for the conservation of these species through artificial reproduction is under development.

growth rates. However, the environmental conditions were not suitable for spawning of the latter species owing to its migratory habit, and it did not become established.

In Lake Kara-Suu, the local fish fauna is represented by marinka, scaled osman, Tibetan stone loach, and grey stone loach.

Fish fauna in rivers

Compared with the lakes, the rivers are relatively species rich. However, there are marked differences in the diversity between upper and lower courses of the basins. Mountain streams host 5–7 species, while 40 species and subspecies of fish are known from the lower courses of the Chui basin, 28 from Naryn, 16 from Kara-Darya, and 18 from Talas. The fish fauna in the rivers generally consists of small-sized indigenous mountain species such as loaches. In the 1970s, valuable species of fish, such as Amu-Darya trout (*Salmo trutta oxianus*), osman and common marinka (*Schizothorax intermedius intermedius*), were introduced in most Kyrgyz rivers, but their stocks have never reached a level that would permit commercial exploitation because of the low food supply. However, the Amu-Darya trout has become established and is a now desirable trophy for recreational fishers.

Fish fauna in reservoirs

In reservoirs, the original riverine fish fauna tend to do poorly because of the change from a flowing to a standing water habitat. Dams are threatening the survival of migratory fish species in the river basins of Central Asia (FAO, 2004). As an example, the installation of a hydropower plant/dam on the Jergalan River prevented migrating fish from reaching their spawning sites and

also caused massive mortality among downstream-migrant young fish and mature fish – leading to the disappearance of some of the previously most abundant fish in the river. Hence, exotic species that are better adapted to a lacustrine environment have often been introduced to fill the vacant niches. These species will gradually spread to other waterbodies in the river basin, and may harm the local fauna.

INLAND CAPTURE FISHERIES

Fleet

The size and type of vessels have not changed since independence, and fishing enterprises continue to use vessels constructed in the period of planned economy.

Fishing vessels are generally of three types:

- The most common are made of glass fibre, with a capacity of 5 tonnes, and equipped with an inboard fixed engine of 30 hp.
- Another type of vessel is the duralumin type, with a capacity of 400–600 kg. These vessels are equipped with outboard motors of 10–30 hp.
- Finally, local fisherfolk also use wooden boats, with a capacity of up to 1.5 tonnes. The smaller ones are equipped with rowing oars, and the larger ones are engine-powered.

Overall, private companies are better equipped.

The exact number of fishing vessels operating in the country's waters is not known owing to a lack of data registration of vessels active for private fishing companies.

Lakes and reservoirs

The fishing rights in the 40 sections of Lake Issyk Kul are currently leased out to a number of commercial enterprises (Table 6), all of which receive annual catch quotas. Some of them have the right and obligation to capture broodfish for artificial reproduction, with the purpose of restocking the lake with the fry produced. For example, Balyckchylar Ltd. is permitted to catch 1 500 female and 4 500 male chebak during the spawning period.

In 2005, the hatcheries produced *inter alia* 26 million whitefish eggs and 6.6 million syrok eggs. Fishery reservoirs were stocked with 9.3 million small syrok, whitefish, carp and trout, which is about 3 million more than in previous years.

Lake Kara-Suu has recently been leased to Ladaga Ltd. for 15 years. The company is currently stocking the lake with whitefish and several other species of fish.

Toktogul has been leased to New-Tek Ltd. In April 2007, the company, based on the advice of the DOF, stocked the reservoir with 6 million fingerlings (1 million grass carp, 4 million common carp, and 1 million big-head carp [*Aristichthys nobilis*]).

Current production of capture fisheries

For the reasons mentioned above, fish catches are currently very low (Table 7). In order to let the fisheries recover, moratoria on fishing were imposed on the Issyk Kul and Son Kul lakes in 2003 and 2006, respectively. Apart from the capture of limited quantities of broodfish, all fishing is now banned in the two major waterbodies of the country. Most fish that is legally caught in the country now originates from the Toktogul, Kirov and Orto-Tokoy reservoirs and from small lakes such as Lake Kara-Suu.

TABLE 6
Commercial fishing companies at Lake Issyk Kul: staffing, equipment, quotas and incubation capacity

Name	Boats	Nets	Annual catch quota (kg)	Incubation capacity (million eggs)
Balykchylar Ltd.	10 motor boats	500 gill nets 10 seine nets	Chebak 3 000 Pikeperch 1 000 Bream 1 000 Chebachok 3 000	0.3
Karakol Balygy Ltd.	10 motor boats	220 gill nets	Chebachok 5 000 Pikeperch 3 500 Bream 1 500 Chebak 2 000	0.4
Ton hatchery	–	–	–	Trout 10 Carp 3 Osman 1
Eleman-Kol Ltd	6 motor boats	140 gill nets 1 seine net	–	
Cholpon-Ata Balygy		100 gill nets 3 seine nets 300 traps	Chebachok 1 000 Bream 500 Pikeperch 500 Chebak 200	–
Balyk	–	–	–	–
Issyk Kul	5 motor boats 5 rowing boats	–	Unlimited pikeperch	–
Presidents Adm. of the K.R.	11 motor boats	100 gill nets 1 seine net	Trout 300 Pikeperch 100 Sig 500 Chebachok 500	–
Telim Ltd	–	–	–	–
Darkhan Ltd	–	–	–	–
Dolon	3 motor boats	182 gill nets	Pikeperch 3 500 Bream 2 000 Chebachok 2 000	–

Source: Konurbaev *et al.* (2005).

TABLE 7
Production of capture fisheries in Kyrgyzstan

	Production of capture fisheries		
	2005	2006 (tonnes/year)	2007
Lakes	13.5	8.1	1.2
Reservoirs	12.7	29.1	13.1
Total	26.2	37.2	14.3

Note: Data for 2007 refer to the first nine months of the year.
Source: official figures of DOF (Undated).

TABLE 8
Estimated number of illegal fishers

	Issyk Kul	Son Kul	Reservoirs	Rivers and ponds
Estimated number of poachers	150–200	15–20	70–90	40–60
The share who catch fish illegally only for own household consumption (%)	70–80	60	50–70	80–90

Illegal, unreported and unregulated fishing

The desperate economic situation with high levels of unemployment in rural areas combined with weak enforcement have led to a situation where poaching is becoming increasingly rife. The situation has not improved since the moratoria came into effect as most fishers continue as before.

In 2006, more than 100 fishers were caught poaching, and more than 1 000 nets were confiscated. In a ten-day-period in 2006, more than 188 nets were found at Lake Son Kul, the sum value of the penalties was about som45 000 (about US\$1 250). In the period June–September 2006, the total number of legally placed nets (in accordance with catch permits issued by the State Agency on Environment Protection and Forestry) was 1 191. In 2006, the penalties for illegal fishing at Lake Issyk Kul amounted to som12 000 (about US\$330). These statistics were obtained with the help of the DOF and the Office of the Special Prosecutor. The unit for fish-stock protection and fishery regulation of the DOF estimates that 150–200 poachers are active part-time on a daily basis at Lake Issyk Kul, with a similar number on all the other waterbodies combined (Table 8). However, the extent of poaching is probably much larger as many poachers are not caught or are not reported as being caught because they bribe state employees.

Some people believe that illegal fishers set some 10 000 nets in Lake Issyk Kul every day in December, which is the breeding season for many fish species (Rakhimdinova, 2005). Nets and traps are often set both near river mouths where the fish must pass to reach the spawning grounds and on the spawning grounds themselves. The mesh sizes generally used are so small (14–16 mm) that all fish longer than 11 cm are caught. Thus, fish mortality rates are very high.

The DOF estimates that there are currently 500–1 000 poachers in the Issyk Kul region and that they are able to catch 10–50 kg of fish per person per day. However, even a conservative estimate of 100 poachers catching 25 kg of fish a day each for 100 days a year gives an annual catch of 250 tonnes, which is much more than the volume caught by licensed fishers.

The fish-stock protection service considers that the vast majority of the poachers are fishing for subsistence purposes only (Table 8).

One fisher interviewed at Lake Issyk Kul in September 2007 stated that 3 000 m of set gill nets were necessary to feed one household.

In sum, a large part of the fish caught is caught illegally, is unreported, and the fishing takes place in an unregulated environment. Although there are regulations in place in certain circumstances, their weak enforcement is of concern to the DOF.

RECREATIONAL FISHERIES

Recreational fishing takes place in rivers, ponds and irrigation reservoirs in all regions of the country. River fishing is done by recreational fishers (anglers) in 33 rivers of the basins of Chui, Naryn, Talas and Kara-Darja, especially in the submountain regions. The reservoirs of the plains (Chui Valley, Talas region, and Fergana Valley) all have well-developed recreational fisheries for warm-water species including common carp, crucian carp (*Carassius gibelio*), perch (*Perca fluviatilis*), snakehead (*C. argus*), and roach (*Rutilus rutilus*).

TABLE 9

Reservoir stocking and catches in 11 reservoirs by members of the Chui Bishkek Hunting and Fishing Union in Chui Oblast, 1999–2006

Years	Stocking (kg fingerlings)	The fish catch (kg)	Reservoir visitors (no.)	Catch rate (kg/visitor)
1999	1 264	13 865	3 119	4.4
2000	1 423	13 868	4 851	2.9
2001	1 756	10 896	5 228	2.1
2002	1 410	6 586	3 787	1.7
2003	1 042	15 535	6 096	2.5
2004	1 555	16 237	5 269	3.1
2005	1 719	12 658	4 042	3.1
2006	856	23 630	4 726	5.0
2007	1 618	18 245	3 649	5.0

All rivers and reservoirs where fishing is without commercial importance and where recreational fishing is possible are leased to the Hunting and Fishing Union (Kyrgyzohotrybolovsoyuz). To obtain a long-term or annual fishing licence, recreational fishers must be members of the association, or they can buy a day licence. A recreational fisher is allowed to use up to five fishing rods and to catch up to 5 kg of fish per day. However, in order to catch osman and river trout, the main target species, it is necessary to buy an additional permit that will allow the capture of up to five fish and is valid for three days (Konurbaev and Timikhanov, 2003). The association issues permits annually to catch 1 000 river trout and 6 500 river osman.

In Chui Oblast, the Chui Bishkek subdivision of Kyrgyzohotrybolovsoyuz stocked 11 tonnes of fish in 11 waterbodies at a cost of som2 million (about US\$55 000) over an eight-year period (1999–2006). The main reservoirs stocked were the Nizhnee Ala-Archa, Chumysh and Sokuluk reservoirs. More than 37 000 people visited these reservoirs, catching a total of 113 tonnes of fish (Table 9). The total value of this catch is estimated at som7 million (about US\$195 000).

The available data suggest that about 100 recreational fishers catch fish once or twice a week, and that their daily catch is 3–4 kg, equal to an annual catch of 25–30 tonnes. In the most recent period (2006 and 2007), the highest catch rates per recreational fisher were reported, which suggest a successful stocking programme.

AQUACULTURE

Pond aquaculture in Kyrgyzstan as an independent form of fishery has been functioning since 1950, with pond farms such as the Frunzenski, Uzgen and Talas state fish farms. Most of the ponds, a total of 1 000 ha, are located in the Chui Valley, which owing to the prevailing climate conditions (length of vegetative season and temperatures) is the most productive zone. Here, it is possible to produce an average of 2 500–3 000 kg/ha in intensive and semi-intensive aquaculture.

Aquaculture in Kyrgyzstan is currently in a poor state. This is because of the limited investment in the subsector since independence, and the high prices of feeds (especially compound feeds) and equipment necessary for breeding fish. These high costs mean that farmers continue to use worn-down and outdated equipment and techniques. The high costs for these necessary inputs have further increased in recent years owing to the limited cooperation with the other countries in the region (and elsewhere) on education and the limited sharing of aquaculture experiences.

As the DOF does not have sufficient funds to equip the state fish farms, reservoirs are increasingly leased out to private investors, especially in rural regions. Private enterprises are

becoming increasingly dominant in the fishery industry in Kyrgyzstan. In 2006 and the first nine months of 2007, the private sector produced 89.1 percent of all fish (76.2 percent in 2004).

Production by state-owned farms, which before independence produced a total of about 1 000 tonnes of fish per year, decreased to 16.5 and 34.2 tonnes in 2005 and 2006, respectively.

In the process of privatization, many ponds located in the territory of kolkhozes and sovkhoses have been transferred to private ownership as land shares. Currently, many ponds are under the jurisdiction of Aiyl Okmotu (village councils).

Private-sector fish farmers in Kyrgyzstan generally grow commercially attractive fish species (carps and trout), and maintain broodstock in small volumes in their ponds. They sometimes also organize recreational fishing in their ponds. On average, recreational fishing in their ponds costs som150 per day (about US\$4.20), plus an additional payment per kilogram of caught fish of som100 (about US\$2.75) for common carp and som80 (about US\$2.20) for herbivorous fish species (grass carp and silver carp).

There are about 20 registered private-sector pond operators and an unknown number of unregistered small-scale producers (Tables 10 and 11).

The information on production capacity, methods and systems used by the private-sector pond farmers is very limited. However, it is estimated that if modern intensive technologies were used, it would be possible to produce 2 500–3 000 kg/ha under the prevailing conditions in the Chui Valley in the south of the country. Some private-sector pond fish farmers are producing carp at a level of about 1.0–1.2 tonnes/ha. However, the difficulties in obtaining sufficient good-quality fry and fingerlings in recent years mean that it is no longer possible to achieve these production levels. As a result, total production, particularly by the small-scale carp farmers, is declining.

In most cases, production relies on broodfish from the wild or, for the more valuable species, the import of eggs from abroad. Table 12 provides a list of the species currently being cultured in Kyrgyzstan.

Apart from pond aquaculture, there are three privately-owned trout farms:

- Restbase,
- Ekos International Ltd.,
- AquaDa Ltd.

Restbase

This private farm is 30 minutes drive from Bishkek. The farm was established as a state farm in the early 1990s but privatized in 2000. The current farm is small with a production capacity of 20 tonnes/year.

Currently, Issyk Kul trout and rainbow trout are farmed using raceways. Estimated investment in the tanks and other facilities has been about US\$100 000. Induced spawning was tried, but the costs were considered too high. Eggs are now imported from Denmark or obtained from the Ton hatchery. About 300 000 eggs are purchased in March each year. The survival rate is 30–40 percent. The main problems encountered in the culture of the trout are the high water temperature in summer (more than 20 °C) and low temperatures in winter (ice cover for 2–3 months). Feed is imported from Finland. In 18–24 months, trout grow to 500–600 g, which is the preferred size at the local market.

The farm also provides a recreational fishery. The fee is som500/kg (about US\$14/kg). No fee is payable if nothing is caught. It is also possible to feed the fish (som25 [about US\$0.70] per cup of feed). The fish caught can be prepared at the farm restaurant for an additional fee. The farm also functions as a hotel (six guest rooms).

TABLE 10
Pond area by rayon or oblast, 2007

	Alamedin Rayon	Djail Rayon	Kant Rayon	Moskovski Rayon	Panfilov Rayon	Sokuluk Rayon	Issyk Kul Oblast
	(ha)						
Pond area	482+	163.2	10.0	228.5	14.0	72.5	77.5

Source: DOF.

TABLE 11
Aquaculture production facilities in Kyrgyzstan

Name	Activities	Year it became operational	Production	
			2006	2007 ³
			(tonnes)	
Uzgen ¹	Pond culture of carp	1968	Carp: 13	Carp: 7.7
Talas ²	Pond culture of carp	1975	Carp: 21.2	Carp: 15.0
Ekos international	Cage culture of trout	2006	Trout: 3.1	Trout: 53.0
Peasant farm Abyl	–	2007		
Balykchylar Ltd	Reproduction of Issyk Kul trout	1994	Trout/whitefish: 0.2	
Karakolbalygy Ltd	Reproduction of Issyk Kul trout, whitefish, carp; fishery	1994	Carp: 0.8	Carp: 1.3
New-Tek Ltd	–	2007		
Incubatory Plant Ltd	Reproduction of whitefish; fishery	2005		
Ladoga Ltd	Fishery	Not yet in operation		
Dolon Ltd	Fishery	–	Carp: 1.0	
Toktogul Tuzu Ltd	–	Not in operation	Trout/whitefish: 1.5	
Balyk farm	Pond aquaculture	1994	Carp: 3.5	Carp: 3.0
Aura Agricultural Production Cooperative	Fishery	In operation		
Jetymen Service Agricultural Production Cooperative	Pond aquaculture	2007	0	Carp: 12.0
Janysh & Co Ltd	–	Not yet in operation		
Kolpoch Company Ltd	–	Functioning	Carp: 15.0	
AquaDa Ltd	Cage aquaculture	Not yet in operation		
Forel Camp	Trout fishery	In operation		
Chui-Bishkek	–	–	Carp: 26.3	Carp: 13.1
Balyk JSC ⁴	–	–	Carp: 35.0	Carp: 3.0
Restbase ⁵	Trout production in raceways	2000		

¹ Uzgen is currently the only state-owned farm producing commodity fish. Income was som1 867 700 (US\$52 000) in 2006, and som843 000 (US\$23 000) for the first nine months of the 2007.

² Since 2005, the ponds belonging to Talas fish farm have been leased out to private entrepreneurs. Income for the first nine months of 2007 was som1 675 000 (US\$46 500).

³ Figures for 2007 are for the first nine months of the year.

⁴ The state owns 49 percent of the shares in the company.

⁵ While the production capacity of this farm is 20 tonnes per year, it produced only a few tonnes in 2006–07 as a result of mortality caused by excessively high water temperatures in summer and excessively cold temperatures in winter.

TABLE 12
Fish species currently cultured in Kyrgyzstan

Species	Cultured since	Culture system	Current production (tonnes)
Rainbow trout	1980	Cage	53.0
Issyk Kul trout	1932	For stocking in lakes	1.4
Amu-Darya trout	1950	For stocking in rivers	–
Common whitefish	1966	For stocking in lakes and reservoirs	2.0
Bream	1872	For stocking in lakes	0.4
Syrok	1966	For stocking in lakes	1.5
Sazan carp	1852	Pond culture, and for stocking lakes and reservoirs	24.0
Grass carp	1962	Pond culture	21.0
Silver carp	1962	Pond culture	–
Chebak	–	For stocking in lakes	–
Chebachok	–	For stocking in lakes	–
Marinka	–	For stocking in lakes and rivers	–
Scaled osman	–	For stocking in lakes and rivers	–
Pikeperch	1958	For stocking in lakes	1.8

Ekos International Ltd

Ekos International Ltd. was the first company to start cage culture of rainbow trout in Lake Issyk Kul. The company based its production system on the scientific and experimental work carried out by the Biological Station of the National Academy of Science using intensive fishery technologies developed by the Russian Federation, Norway and Turkey. The cages used are fully submersible so that they can be submerged during storms that would otherwise destroy them. The company is currently experimenting with cages of various designs.

Eyed eggs are imported from Denmark. They are incubated at the Ton hatchery, where the fry/fingerlings are nursed in special trays until they reach a weight of 25–30 g after about six months. The company pays som200 000 (about US\$5 500) to the Ton hatchery for this service. The fingerlings are then transferred to cages in a sheltered bay of Lake Issyk Kul. After a further eight months in the cage, the trout have grown to about 1 kg – retailing at som150–200/kg (about US\$4.85). The first sale (30 tonnes) of commercial fish was in 2006. In 2007, 53 tonnes were sold. For the future, the company envisages cultivation of trout from the incubation period to 200–400 g for restaurants, and to 1–3 kg for home kitchens.

The production capacity is 225 tonnes/year, but there are plans to install up to ten production systems with a total capacity of 1 000 tonnes/year in the near future using self-generated funds.

A major constraint on development is that commercial trout diets are not available locally and have to be imported from abroad.

The agreement under which the company is allowed to use the lake was made at local level with the rayon (district).

AquaDa Ltd

Inspired by the success of Ekos International Ltd., AquaDa Ltd. has recently started similar operations – placing cages in Lake Issyk Kul. This company also has an agreement with the rayon, and the area used is located in the same bay as Ekos International Ltd. on the southern shore.

Production of ornamental fish

Ornamental fish are not bred commercially in Kyrgyzstan. Fish used for ornamental purposes are imported from other countries and sold in a retail chain and at some markets. However, Konurbaev and Timikhanov (2003) mention at least two indigenous species (the short-tailed minnow [*Phoxinus brachyurus*] and the striped bystranka [*Alburnoides taeniatus*]) that are also used as aquarium fishes. Several Kyrgyz loach species may also have potential as ornamental fish, but no efforts have been made to reproduce these fish for commercial purposes.

FACILITATING INDUSTRIES

All the advanced (and most of the basic) equipment needed for aquaculture is imported from abroad, *inter alia* cages, polyester tanks, dippers, barrows, tables for prophylaxis and sorting, baths for fish treatment, and incubatory devices. Glass and plastic trunks and tanks used for breeding are imported from the Russian Federation, Turkey and China.

Commercial feed production for aquaculture is not undertaken in Kyrgyzstan. Feeds for carp are generally home-made or farm-made. For trout, the feeds are imported. Fingerling and fry production are also not well developed as also for the hatchery and nursery operations good-quality feed has to be imported, which makes these activities less attractive as investments.

For capture fisheries, the currently used seine and gill nets were imported from the Russian Federation and China.

Fishing vessel construction is non-existent in Kyrgyzstan. Even the smaller boats of a few metres in length and with limited tonnage were imported from abroad. Vessel repair and maintenance is still conducted in some places (e.g. Lake Issyk Kul), but spare parts are often not readily available and have to be imported, causing long delays in the repair process.

As common onboard fishing vessel equipment, such as radar, depth meters, fishfinders and global positioning system (GPS) are little used in Kyrgyzstan, these are not available on the local market.

Chapter IV

PROCESSING, MARKETING AND TRADE OF FISH AND FISHERY PRODUCTS

FISH PROCESSING AND STORAGE

Finfish is the only fisheries sector product produced and processed in Kyrgyzstan. The fish is generally transported and sold fresh because the volumes produced are so small that commercial-scale processing would not be profitable. Fish imported from Kazakhstan (the main source of imports) is mainly traded and sold in the markets in Bishkek and elsewhere in fresh form (with some smaller amounts sold gutted and frozen).

The processing and cold storage of fish was previously the main domain of the Issyk Kul Fish plant. Its successor, the private enterprise Balykchylar Ltd., can still perform the initial processing of fresh fish into fillets and some frozen products (including fillets). However, production levels have been low in recent years. Until recently, the fresh fish from Lake Issyk Kul was brought to fish-receiving stations, stored in refrigerators and transported to towns all over the country. The transportation to Bishkek did not take more than five hours.

At present, the fish caught in Kyrgyz waters is often purchased directly by wholesalers/intermediaries from the fishers and transported to storage rooms of speciality retail shops, where the fish is frozen in industrial refrigerators for onward selling in the speciality retail shops and at markets. Fish-receiving stations do not exist anymore.

Some wholesalers/intermediaries also buy fresh fish in order to do some processing with it, such as salting, smoking and in a few cases also drying.

As there is no electricity available at Lake Son Kul, it is not possible to use ordinary refrigerators. The fish wholesalers/intermediaries purchasing the Son Kul fish are generally poor and cannot afford the purchase or hire of self-contained/generator-powered refrigerators. In spring, autumn and winter, the fish is cooled only by the cold air and transported to the markets. In summer, the fish is generally transported at night. If that is not possible, the fish is salted before being transported in an effort to maintain at least some freshness.

Species that are sometimes salted and dried include Sevan trout, whitefish, ide and moroco caught in Lake Issyk Kul. The moratorium on these species means that they cannot be sold through formal channels. However, the marketing of these species continues. The wholesalers purchase the illegally caught fish, gut and pickle it under poor sanitary conditions, and sell it on the same market as the legally caught fish.

The Government of Kyrgyzstan is responsible for enacting legislation concerning marketing standards of various products, including fish and fishery products. The Veterinary Department of the MAWRPI is responsible for the implementation of market standards for fishery products in accordance with Kyrgyz law and regulations.

All fish and fishery products sold in speciality retail shops and in the fish halls of the city markets are subject to quality control by the Veterinary Department. Control of fish quality, including on-site checks of wholesale and storage sites, is carried out by inspectors of the Sanitary Epidemiological Service (SES). The Fisheries Inspection Service of the MAWRPI is responsible for implementation of established requirements for the transportation of fresh and frozen fish and for enforcing compliance with the related articles from the Fisheries Rules (Livinets, 2007).

DISTRIBUTION AND MARKETING OF FISH AND FISH PRODUCTS

Most of the fish sold in Kyrgyzstan is imported from Kazakhstan. Deliveries of imported fish from Kazakhstan are made on a daily basis. It is estimated that about 70 percent of all fish sold in Bishkek is marketed at the central market (Osh Bazar), the place where also most imported Kazakh fish is marketed. The bulk of the domestically produced fish is caught in the lakes and reservoirs and is taken to the markets of Bishkek. Part of the fish caught in distant waterbodies, such as Toktogul, Bazar-Korgon, Kirov, the Orto-Tokoy impoundments and Lake Kara-Suu, is marketed in local towns and villages because the small amounts do not make it profitable to transport it to Bishkek.

Every large food market in Bishkek (e.g. Osh, Alamedin and Orto-Say) has a special fish hall equipped with refrigerators for fish storage. At the markets, fresh fish is sold from stands.

There are about 70 persons selling fish at Osh Bazaar, using 35 stands (which are in effect just tables). Fees for the tables are som100/day (about US\$2.50), and som10/day for testing fish quality and safety (testing takes place twice a week). The infrastructure of the market is poor, electricity is scarce, tap-water is not everywhere available, no ice is available, no industrial large freezers are available, but each table has a refrigerator behind it (purchased by the users). The fish corners of Osh Bazar have roofs, but one of the two is particularly cold in winter, which makes life hard for the women working there.

The margin on fish sales at the market is som5–10 per kilogram of fish (about US\$0.20). Purchase by the retailers at the market is generally from intermediaries. Some ten intermediaries deliver to the market; there is no direct delivery from fisherfolk or fish farmers to Osh Bazar.

The preferred species at Osh Bazar in Bishkek are sazan, sold as whole 2–3-kg fish, of which about 500 kg is sold per day, and pikeperch (about 200 kg/day in winter). The total quantity of other species sold is about 200 kg/day. Daily total market sales are estimated at 1 tonne in winter, and about 700 kg in summer. Sales are generally higher on Sundays, when about 2 tonnes of fish is sold. Live fish are available at the market on some days in summer.

The limited production of fish in Kyrgyzstan itself limits the market opportunities for fish retailers in the various markets in Bishkek. The lack of good electricity and water supply make the working conditions for the retailers inappropriate. In the other markets, only fresh fish is sold, no frozen products.

There are six speciality shops for fish in Bishkek. In general, the diversity in fishery products in these shops is much higher than in the market and in supermarkets. Some shops sell live fish from fish farms (including common carp and trout), and crayfish and grass carp (*Ctenopharyngodon idella*) from capture fisheries. The main species sold are Issyk Kul trout and pikeperch. Daily sales of live, fresh and frozen fish amount to some 50 kg in winter and 25–30 kg in summer. Apart from caviar, smoked sturgeon fillet from the Russian Federation is the most expensive product available in the market.

Some speciality shops have several freezers, refrigerators and some basins and aquaria to present live fish. As import taxes are minimal, most of the fish on sale originates from Kazakhstan. Trout from Lake Issyk Kul and frozen fish from Lake Son Kul are the main domestic fish products on sale.

Considering the fish sales in the market, speciality shops and supermarkets in Bishkek, total average daily sales of fishery and aquaculture products in Bishkek are estimated to be about 1.5 tonnes (500–600 tonnes per year). The consumer demand for fish in general is higher, but limited supply and high product prices are constraining the development of the market.

The range of fish prices depends on the type of fish and the season (Table 13).

TABLE 13
Average prices for the most common fish species and fish products marketed
in Kyrgyzstan

Species	Price (som/kg)	Price (US\$/kg)
Bream	35–40	1.0
Roach	25–35	0.8
Crucian carp	35–40	1.0
Pike	40–45	1.2
Pikeperch	200	5.2
Carp	60–70	1.6
Grass carp	130	3.0
Rainbow trout	550	15.0
Brook trout	300–500	7.8–13.0
Smoked mackerel	230	6.2
Salmon fillet	660–750	18.0–20.3
Salted herring	60–70	1.6

Note: Prices were collected twice in 2007 – the average is based on these. Variations seen in product prices were minimal. The wholesale prices are 30 percent lower than the prices quoted.

TABLE 14
Exports and imports of fish products in Kyrgyzstan, 2005

	Exports	Imports (US\$1 000)	Net trade
Fish, frozen, whole	0	1 181	-1 181
Crustaceans	0	51	-51
Fish, cured or smoked, and fish meal fit for human consumption	0	36	-36
Molluscs	0	31	-31
Fish, fresh, whole	0	6	-6
Fish fillets and pieces, fresh, chilled or frozen	0	6	-6
Prepared/preserved fish & caviar	0	687	-687
Crustaceans & molluscs, prepared/preserved	0	14	-14
Total fish products	0	2 012	-2 012

FISH TRADE

According to the International Trade Centre, fish products worth about US\$2 million were imported in 2005 (Table 14). It is estimated that about 3 000 tonnes of fish and fish products for a total value of US\$2.3 million were imported by Kyrgyzstan in 2006. In 2007, 6 500 tonnes, worth US\$3.1 million, were imported, while 10.3 tonnes of mainly smoked and salted fish (valued at US\$18 500) were exported.

A large share of the formal fish imports in recent years has originated from the Russian Federation. Products imported from the Russian Federation include: herring, mackerel, walleye pollack, pacific salmonids, and smoked sturgeon. Fresh fish is imported from Kazakhstan under the Agreement on Common Economic Area between Kazakhstan, Kyrgyz and Uzbekistan, which complicates an assessment of the actual volume of fresh fish imported. From the Baltic and other countries outside the region, canned products, including fish, black and red caviar, and seaweed (laminaria), are imported.

FISH DEMAND AND CONSUMPTION

Fish does not play an important role in the diets of most people both because the population of Kyrgyzstan has little tradition in fish consumption and because of the low access to and availability of supply. As fishing in the large waterbodies is prohibited, 75–85 percent of the fish sold at the markets is imported from Kazakhstan despite the fact that the local fish is considered to be of better quality. The highest consumption levels of fish and fishery products occur in autumn and winter.

Traditionally, in the periods when the fish species are spawning, they can be caught more easily as they concentrate in certain areas of the most important lakes and reservoirs (Issyk Kul, Son Kul and Toktogul). In these periods, the fish supply is greater, which results in larger availability and higher consumption levels.

There is not much difference in fish consumption between urban and rural populations. People living near the major waterbodies consume fish more regularly because it is more easily available to them.

The high prices of fish compared with beef and chicken mean that fish is regarded as a luxury item. Therefore, fish consumption is related directly to people's incomes. People with an income not exceeding US\$100 prefer to buy cheap fish species (canned products and fresh carp), while those with incomes of more than US\$500 prefer more valuable fish species (salmon, trout, etc.).

Recently, fish consumption has been rising among the wealthier part of the urban population. These people have started to consume slightly more fish as their incomes allow them to do so. Fish dishes in restaurants and cafes are so expensive that they are considered affordable only for the most prosperous 5 percent of the population.

The limited supply of fish causes high prices, but the demand cannot be met. If supply increased, it might take some time before prices decreased as there is some unsatisfied demand in the market. There is a particular high demand for fresh fish.

Based on official statistical data, 71 tonnes of fish was produced in 2006. With an added 3 000 tonnes of officially imported fish, average fish consumption was about 0.5 kg per capita. Assuming that some 500 tonnes of fish is caught illegally in the country and that under the free trade agreement another 2 000–3 000 tonnes of fish is imported, which should be added to the official figures, then the amount of fish available for consumption to the Kyrgyz population would still not exceed 1 kg/capita/year.

By comparison, global average annual fish consumption is 16 kg/person (33 kg/person in China). In view of its positive impacts on the health and longevity of the population, it is highly desirable to increase fish consumption in Kyrgyzstan. However, even if illegally caught and imported fish is taken into consideration, this is far short of the more than 60 000 tonnes of fish needed each year to provide the Kyrgyz population with the 12 kg of fish products per person per year recommended by the nutrition institute of the Academy of Science of the former USSR in the past.

The highest consumption of fish in absolute terms can be found in the capital and Chui Oblast – 80 percent of the imported fish arrives and remains here. Fish consumption is also relatively high in Issyk Kul Oblast (where Lake Issyk Kul Lake). More than 200 tonnes of fish products are imported by tourist resorts along the shores of the lake.

NUTRITIONAL ASPECTS OF FISH CONSUMPTION

Fish provides a healthy contribution to people's diet. In some respects, fish and fishery products can be regarded as healthier than beef, chicken or pork products. Therefore, they should be included on the menu on a more regular basis than at present.

TABLE 15
Fat and omega-3 content of fish species occurring in Kyrgyz waters

Species	Scientific name	Fat content (%)	Omega-3
Cod ²	<i>Gadus morrhua</i>	< 2.5	Low
Crucian carp ²	<i>Carassius carassius</i>	< 3	–
Perch ¹	<i>Perca fluviatilis</i>	< 3	Low
Hake	<i>Merluccius</i> sp.	< 3	–
Pike ¹	<i>Esox lucius</i>	< 3	Low
Humpback salmon ²	<i>Oncorhynchus gorbusha</i>	2.5–5	High
Chum salmon ²	<i>Oncorhynchus keta</i>	2.5–5	Medium
Catfish ¹	Siluriformes	2.5–5	–
Rainbow trout ¹	<i>Oncorhynchus mykiss</i>	2.5–5	Medium
Carp ¹	<i>Cyprinus carpio</i>	3–8	–
Kilka ²	<i>Clupeonella</i> sp.	3–8	–
Horse mackerel ²	<i>Trachurus</i> sp.	3–8	–
Herring ²	<i>Clupea harengus</i>	5–10	High
Whitefish ¹	<i>Coregonus</i> sp.	5–10	High
Salmon ²	Salmonidae	8–20	–
Sturgeon ²	<i>Acipenser</i> sp.	8–20	–
Greenland halibut ³	<i>Reinhardtius hippoglossoides</i>	8–20	–
Sardine ²	Clupeidae	8–20	–
Starry sturgeon ²	<i>Acipenser stellatus</i>	8–20	–
West Pacific sardine ²	<i>Sardinops sagax</i>	8–20	–
Mackerel ²	<i>Scomber scombrus</i>	8–20	–
Inconnu ²	<i>Stenodus leucichthys</i>	20–30	–
Lamprey ³	Petromyzontidae	20–30	–
Eel ³	<i>Anguilla</i> sp.	20–30	–

¹ Species occurring in Kyrgyz waters.

² Species available on the market in Kyrgyzstan.

³ Species available occasionally on the market in Kyrgyzstan.

Sources: Bazhenov (1951); Lukjainenko (1967).

The population of Kyrgyzstan currently prefers to consume meat and meat products. However, in order to improve their diet, increased diversity in foodstuffs (including fish) should be promoted.

The principal components of fish are: water (66–84 percent), proteins (15–24 percent), fats (0.1–22 percent), and minerals (0.8–2 percent). These components vary depending on various factors, including the age of the fish, the species, and the time of year the fish is caught.

Fish proteins are of excellent quality. The amino acids in the fish proteins are essential components for human health. Fish proteins are of similar quality to those in milk and eggs. In addition, fish proteins are often more easily absorbed than other animal proteins.

The fats in fish are also good for human health. Fish contain omega-3 fatty acids and oils that are hard to obtain from other types of food (amounts of omega-3 vary between the types of fish). Omega-3 fatty acids are believed to be beneficial to the heart. Regular fish consumption can reduce the chances of stroke and heart attack.

Fish also contains vitamins:

- vitamin A: good for skin and vision;
- vitamin D: good for bones;
- vitamin E: an anti-oxidant;
- vitamin B: good for appetite and the functioning of the nervous system.

Fish is also a good source of minerals that are found in limited quantities in other foodstuffs. These minerals include: iodine (which helps to prevent crop and delays in growth); iron (which is important in preventing anaemia); and calcium and phosphorus (which are necessary to strengthen bones and teeth).

However, there are large variations in terms of the fat and omega-3 contents (Table 15) between the fish species available on the Kyrgyz market.

FOOD SAFETY AND FISH

Fresh fish such as trout, pikeperch, common carp and grass carp as sold in the markets in Kyrgyzstan often comes from the country's own clean rivers, lakes and reservoirs. It has grown in the pristine waters flowing down from the mountains. Sturgeon, herring, sprat, anchovy, salmon, kilka and many other species from abroad can be found in the markets, fish speciality shops and supermarkets. The quality of both domestic and imported fish is generally high.

However, consumption of fish that originates from water polluted with sewage or industrial waste can be harmful to health. While most domestic waterbodies are unpolluted and cultured fish has been raised in unpolluted mountain waters, fish can still be harmful to health if it has been handled, processed, sold or prepared under unhygienic conditions.

Fish is a perishable commodity and it should only be consumed when fresh or when it has been properly processed and stored. Fish products produced under unhygienic conditions, wrongly salted or smoked or cured may cause the development of various pathogenic micro-organisms, and their toxins may cause acute food poisoning. There is a risk of becoming infected with parasites through the consumption of fish products that have been poorly salted or not properly cooked. Although there are no poisonous fish species in Kyrgyzstan, the eggs of the naked osman and Issyk Kul marinka are toxic to humans (Konurbaev and Timikhanov, 2003) and may cause gastroenteric upset.

In the regions with a tradition of eating *stroganina* (fresh frozen fish that is sliced, salted, peppered and eaten), there is a high risk of becoming infected with parasites. Fish pies can also pose a danger if the fish has not been properly soaked (allowing tapeworm eggs to survive). Transmission of tapeworms (*Diphyllobothrium* spp.) to humans can be the result of consuming raw, half-raw fish and undersalted or soft-salted freshwater fish. The tapeworm larvae (which may be present in the flesh of the fish) settle in the intestine, where they may grow to a length of 2–12 m.

Similarly, consumption of raw, half-raw fish and undersalted or soft-salted freshwater fish may result in the transmission of liver flukes (*Opisthorchis* spp.). Liver flukes are small trematodes (4–13 mm long) that invade the human liver. This parasite can live in the human body for up to 20 years and may cause considerable damage to the health of the host.

People who eat raw fish are also in the danger of becoming infected with the nematode *Diocotophyme renale*. The larva of the nematode is encapsulated in the flesh of fish. The adult nematode can become 1 m long, and it develops in the human kidneys.

Toxic elements, such as heavy metals and certain pesticides, may accumulate in the aquatic food chain even where they are found only in low concentrations in the waterbodies. They may ultimately end up in the human body and affect its health. For warm-blooded animals and fish, the following metals are most dangerous, in decreasing order of toxicity: silver, mercury, copper, lead, cadmium, gold, aluminium and zinc. Of these, mercury and lead pose the greatest danger to the waters of Kyrgyzstan. As the salts of the metals do not evaporate, they only disappear from contaminated soils by being washed out. For example, after abundant rainfall, mercury, which is used in various pesticides in Kyrgyz agriculture (e.g. Fuzarnol, Fungolit, and Garmizan),

can enter lakes and reservoirs, where it may accumulate in the fish. However, cases of mercury poisoning through fish products are rare in Kyrgyzstan.

Lead enters the water by way of the cheap Chinese nets that have become the main type of fishing gear in the last 10–15 years. The nets are of a poor quality and have lead sinkers. The nets are often lost as it is cheaper for the fishers to buy new nets rather than consume expensive petrol looking for missing ones. Thus, there are many lost nets in the waterbodies where fishing is most intensive. All these waterbodies are characterized by soft water and a high carbon dioxide concentration, which increases lead solubility.

The enormous volume of water in Lake Issyk Kul dilutes dissolved lead to a concentration that will not become dangerous for aquatic organisms for a long time. Water exchange in the Toktogul reservoir ensures that heavy metals (including lead) are washed out. However, for shallow lakes, e.g. Lake Son Kul, with a comparatively smaller volume of water, lead accumulation can easily reach harmful levels.

The lead accumulated in fish is dangerous for humans, but it has its initial effects on the fish. Even at low concentrations, lead may negatively influence the fecundity of the fish, thereby diminishing their reproductive success. All fishers should realize that the savings made by using cheap nets containing lead cannot be compared with the damage caused to human and animal health and to the aquatic ecosystem. Such nets should be prohibited, and this measure should be applied through legislative instruments.