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A Research on the Fish Production and Catching Efficiency in the Keban Dam Lake

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Abstract: The study was carried out in 16 different regions of Keban Dam Lake (in Turkey) between 2002 and 2008. The data were taken from cooperative chairmen and members who carried out fisheries activities at the end of fishing season. The amounts of produced fish were evaluated according to fishing season, fisheries place and fish species. The fish were caught 483 tons during the 2002-2003 fishing season, 825 tons during the 2003-2004 fishing season, 653 tons during the 2004-2005 fishing season, 775.7 tons during the 2005-2006 fishing season, 685 tons during the 2006-2007 fishing season and 688 tons during the 2007-2008 fishing season. The produced fish were composed of *Capoeta* sp. (39%), *Barbus* sp. (29%), *Cyprinus carpio carpio* (24.4%), *Squalius cephalus* (3.8%), *Astacus leptodactylus* (3%), *Alburnus mossulensis* (0.6%) and *Acanthobrama marmid* (0.2%). The average 191 motor boats, 418000 m gillnets and 33665 crayfish fyke nets were used for a year. However, it depends on the fishing season.

Key words: Keban Dam Lake, fisheries, catching efficiency, production, fisheries management

INTRODUCTION

In order to make use of natural resources in the best possible way today, we need new, detailed and basic information to be obtained from researches about these resources. One of the most important ways to provide people in our country and humanity in general with the animal protein input is to use these sources sensibly and without overuse (Anonymous, 2001a). Fishing technique applied to a fish population should be regulated if we want to get the most benefit out of fish populations living in an environment. Regulating fishing means catching of a fish population without decreasing the annual biological output of that population in order to the most benefit from it. In the first place, fish populations should be investigated well before taking precautionary measures. The size of population, annual reproduction rates, the size of age groups, times of maturity, migrations in and out of populations, natural mortality rates of age groups and the impact of catching on age groups are issues we need to know (Mengi, 1970). In addition to these, the amount of annual production and catching efficiency should be recorded regularly in order for fisheries managing to be implemented.

The Keban Dam Lake, one of the inland water reservoirs, where profitable and sustainable fishing should be planned, has got a surface area of 675 km^2 in the maximum water level (845 m altitude) and a water volume of 30.6×10^9 m^3 (Soyupak *et al*., 1997). It is situated between the 38°37'N-39°20'N and 38°15'E-39°52'E coordinates (Ozekinci *et al*., 2003). The length of the basin in which the Keban Dam Lake is situated is 425 km and average width of the basin 125 km (Gucu *et al*., 2004).

The first fishing activities in the Keban Dam Lake started in 1976-1977 (Anonymous, 1982). The dam lake has been divided into 16 different fishing areas and a fisheries cooperative has started its activities in each fishing area (Celayir *et al*., 2006).

The most important issue in the Keban Dam Lake fishing is to do it regularly and profitably without disturbing the natural ecological equilibrium and the existing population structure. It is possible to do efficient management and sustainable fishing with a good reservoir model. In order for a reservoir management to be implemented, we need to know the amount of annual fish caught and fishing effort.

The fishing efficiency of the dam lake has been calculated in this study by categorizing the aquatic products caught in the last 6 fishing seasons in the dam lake by their amounts, seasons, areas and types. In the research, it has been aimed that from the basis for an applicable fishing management model.

MATERIALS AND METHODS

This research was carried out in 6 different fishing seasons between the years 2002 and 2008 in 16 fishing areas of the Keban Dam Lake. The presidents and the members of the fisheries cooperatives who do fishing in the fishing areas were consulted and cooperative records were looked into to obtain the data we used in the study.

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Barbus esocinus, *Barbus xanthopterus*, *Barbus grypus*, *Barbus pectoralis* and *Barbus mystaceus* species were referred to as *Barbus* sp., *Capoeta trutta* and *Capoeta umbla* species as *Capoeta* sp. Apart from these, *Cyprinus carpio carpio*, *Squalius cephalus*, *Astacus leptodactylus*, *Alburnus mossulensis* and *Acanthobrama marmid* species were among the caught aquatic products.

Production amounts were evaluated according to fishing areas, fishing season and species. The number of fishing boats used in the dam lake gillnets and fyke nets amounts were given according to the average of 6 fishing seasons.

RESULTS AND DISCUSSION

There are 16 different fishing areas whose surface areas ranged from 150 ha and 9550 ha in the Keban Dam Lake. The total amount of aquatic products obtained by fishing in these fishing areas between the years 2002 and 2008 is given in Table 1. As shown in Table 1, 483 tons of aquatic products in the 2002-2003 fishing season, 825 tons in the 2003-2004 season, 653 tons in the 2004-2005 season, 775.7 tons in the 2005-2006 season, 685 tons in the 2006-2007 season and 688 tons in the 2007-2008 season in the Keban Dam Lake.

The annual amounts of produced aquatic products are given in Fig. 1 as graphic. It can be seen that there are ups and downs in the production according to the years. These differences may have originated from the annual efficiency of the population, environmental factors and weather conditions changing annually and/or fishing effort. The annual fishable stock in the Keban Dam Lake reported in the researches conducted by the Branch Directorate of State Water Affairs is 958 tons in 1999 and 603 tons in 2004 years (Anonymous, 1999, 2004).

When we assessed fishing areas in terms of average aquatic product, the most products were fished in the 4. fishing area whose surface area was the largest (119.9 tons) and the least products were fished in the 8 fishing area (9.7 tons).

The difference in the amounts of products in different fishing areas is thought to be originating from different surface areas of the regions and changes in annual fishing effort.

About 483 tons of aquatic products were caught in the Keban Dam Lake in the 2002-2003 fishing season, 155 tons of which were *Capoeta* sp., 172 tons *Barbus* sp., 88 tons *C. c. carpio*, 33 tons *Squalius cephalus* and 35 tons *Astacus leptodactylus* (Table 2). That the fishing areas 7, 8, 14 and 15 were not rented and fished is shown in Table 2. It was found out that *Capoeta* sp., *Barbus* sp. and *C. c. carpio* species were caught in all the fishing

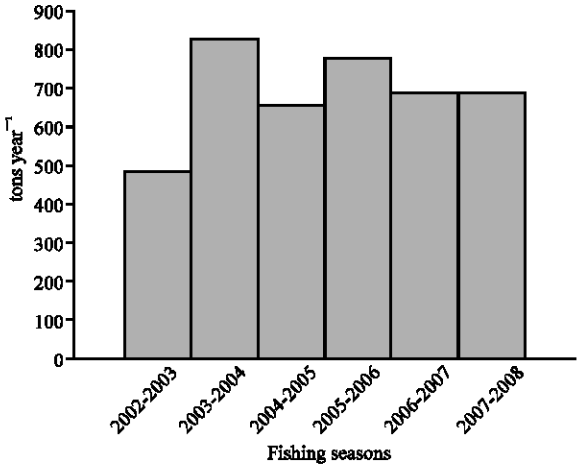

Fig. 1: The amounts of aquatic products obtained in fishing seasons

Table 1: The amounts of aquatic products obtained by catching between the years 2002 and 2008

Fishing regions	Surface areas (ha)	The amounts of caught aquatic products in the fishing seasons (ton)						
		2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	Average
1	2000	27	48.0	40.5	36.5	46.6	43.6	40.4
2	4700	80	111.5	51.0	73.2	78.3	75.3	78.2
3	5000	45	60.0	40.5	40.0	36.5	37.5	43.2
4	9550	131	130.0	119.0	124.0	109.6	105.6	119.9
5	6500	36	49.0	47.0	54.0	60.0	57.0	50.5
6	7200	47	67.0	88.0	99.0	80.0	68.0	74.8
7	1550	0	26.0	0.0	22.0	21.0	20.0	14.8
8	2000	0	0.0	0.0	18.0	21.0	19.0	9.7
9	2600	20	62.0	50.0	65.0	65.0	58.0	53.3
10	2000	27	59.0	37.0	31.0	28.0	28.0	35.0
11	2370	34	51.5	49.0	53.0	47.0	45.0	46.6
12	1000	10	38.0	21.0	20.0	22.0	19.0	21.7
13	150	9	40.0	28.0	32.0	0.0	28.0	22.8
14	500	0	39.0	33.0	34.0	0.0	18.0	20.7
15	1900	0	0.0	28.0	34.0	36.0	26.0	20.7
16	2700	17	44.0	21.0	40.0	34.0	40.0	32.7
Total	51720	483	825.0	653.0	775.7	685.0	688.0	685.0

areas that were rented and *S. cephalus* were caught in the first 6 areas. Crayfish (*A. leptodactylus*) was caught only in the 2 fishing area.

About 825 tons of aquatic products were caught in the 2003-2004 fishing season, 321 tons of which were *Capoeta* sp., 159 tons *Barbus* sp., 262 tons *C. c. carpio*, 32 tons *Squalius cephalus*, 17 tons *Astacus leptodactylus*, 24 tons *Alburnus mossulensis* and 10 tons *Acanthobrama marmid* (Table 3). Fishing areas 8 and 15 were not rented in this season. *Alburnus mossulensis* and *Acanthobrama marmid*, which live in the dam lake but aren't fished due to their low economic value, were among the products fished in the fishing areas 10, 110, 12, 13 and 14 in this season. Crayfish (*A. leptodactylus*) was again caught only in the 2 fishing area.

About 653 tons of aquatic products were caught in the 2004-2005 fishing season, 185.5 tons of which were *Capoeta* sp., 333 tons *Barbus* sp., 103 tons *C. c. carpio*, 22.5 tons *Squalius cephalus* and 9 tons *Astacus leptodactylus* (Table 4). That fishing areas 7 and 8 were not rented can be shown in the Table 4. Crayfish (*A. leptodactylus*) was caught in the fishing areas 1, 3 and 4 except the area 2.

About 775.7 tons of aquatic products were caught in the 2005-2006 fishing season, 321 tons of which were *Capoeta* sp., 182 tons *Barbus* sp., 222 tons *C. c. carpio*, 35 tons *Squalius cephalus* and 15.7 tons *Astacus leptodactylus* (Table 5). Since, fishing rights of all the fishing areas in the Keban Dam Lake were leased in the 2005-2006 fishing season, fishing activities were carried out in all of the dam lake. *Capoeta* sp., *Barbus* sp. and *C. c. carpio* were caught in all areas, *Squalius cephalus* were caught in the first 6 and *Astacus leptodactylus* were caught in the firs 4 areas.

About 685 tons of aquatic products were caught in the 2006-2007 fishing season, 293 tons of which were *Capoeta* sp., 171 tons *Barbus* sp., 177 tons *C. c. carpio*, 21 tons *Squalius cephalus* and 21 tons *Astacus leptodactylus* (Table 6). Fishing was not done in the fishing areas 13 and 14 in this season.

Table 2: The distribution of catching aquatic products in the 2002-2003 fishing season

	The amounts of catching aquatic products (ton)					
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	Total
1	8	11	5	3	0	27
2	14	17	10	4	35	80
3	12	19	8	6	0	45
4	39	52	26	14	0	131
5	6	22	5	3	0	36
6	13	21	10	3	0	47
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	10	6	4	0	0	20
10	14	8	5	0	0	27
11	18	10	6	0	0	34
12	4	4	2	0	0	10
13	7	0	2	0	0	9
14	0	0	0	0	0	0
15	0	0	0	0	0	0
16	10	2	5	0	0	17
Total	155	172	88	33	35	483

Table 3: The distribution of catching aquatic products in the 2003-2004 fishing season

	The amounts of catching aquatic products (ton)							
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	*A. mossulensis*	*A. marmid*	Total
1	12	20.0	16	0	0	0	0.0	48.0
2	32	19.5	39	4	17	0	0.0	111.5
3	17	12.0	25	6	0	0	0.0	60.0
4	40	35.0	36	19	0	0	0.0	130.0
5	22	12.0	14	1	0	0	0.0	49.0
6	32	17.0	16	2	0	0	0.0	67.0
7	11	4.0	11	0	0	0	0.0	26.0
8	0	0.0	0	0	0	0	0.0	0.0
9	36	8.0	18	0	0	0	0.0	62.0
10	23	7.0	21	0	0	5	3.0	59.0
11	24	9.0	12	0	0	5	1.5	51.5
12	15	5.0	15	0	0	2	1.0	38.0
13	15	1.5	16	0	0	4	3.5	40.0
14	17	4.0	9	0	0	8	1.0	39.0
15	0	0.0	0	0	0	0	0.0	0.0
16	25	5.0	14	0	0	0	0.0	44.0
Total	321	159.0	262	32	17	24	10.0	825.0

Table 4: The distribution of catching aquatic products in the 2004-2005 fishing season

	The amounts of catching aquatic products (ton)					
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	Total
1	3.5	30	4	2.0	1	40.5
2	14.0	20	7	4.0	6	51.0
3	8.0	22	6	3.5	1	40.5
4	28.0	55	26	9.0	1	119.0
5	6.0	35	5	1.0	0	47.0
6	19.0	55	11	3.0	0	88.0
7	0.0	0	0	0.0	0	0.0
8	0.0	0	0	0.0	0	0.0
9	15.0	31	4	0.0	0	50.0
10	11.0	20	6	0.0	0	37.0
11	15.0	27	7	0.0	0	49.0
12	9.0	9	3	0.0	0	21.0
13	15.0	8	5	0.0	0	28.0
14	18.0	9	6	0.0	0	33.0
15	13.0	7	8	0.0	0	28.0
16	11.0	5	5	0.0	0	21.0
Total	185.5	333	103	22.5	9	653.0

Table 5: The distribution of catching aquatic products in the 2005-2006 fishing season

	The amounts of catching aquatic products (ton)					
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	Total
1	10	12	8	5	1.5	36.5
2	37	16	9	2	9.2	73.2
3	7	15	12	3	3.0	40.0
4	65	25	20	12	2.0	124.0
5	13	19	17	5	0.0	54.0
6	40	26	25	8	0.0	99.0
7	7	5	10	0	0.0	22.0
8	5	5	8	0	0.0	18.0
9	26	18	21	0	0.0	65.0
10	16	5	10	0	0.0	31.0
11	13	12	28	0	0.0	53.0
12	14	2	4	0	0.0	20.0
13	17	4	11	0	0.0	32.0
14	14	8	12	0	0.0	34.0
15	18	3	13	0	0.0	34.0
16	19	7	14	0	0.0	40.0
Total	321	182	222	35	15.7	775.7

Table 6: The distribution of catching aquatic products in the 2006-2007 fishing season

	The amounts of catching aquatic products (ton)					
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	Total
1	16	16	10	3	1.6	46.6
2	40	12	11	1	14.3	78.3
3	9	12	10	1	4.5	36.5
4	55	20	22	10	2.6	109.6
5	25	23	10	2	0.0	60.0
6	35	26	15	4	0.0	80.0
7	8	4	9	0	0.0	21.0
8	5	7	9	0	0.0	21.0
9	25	20	20	0	0.0	65.0
10	15	5	8	0	0.0	28.0
11	12	10	25	0	0.0	47.0
12	12	5	5	0	0.0	22.0
13	0	0	0	0	0.0	0.0
14	0	0	0	0	0.0	0.0
15	20	5	11	0	0.0	36.0
16	16	6	12	0	0.0	34.0
Total	293	171	177	21	23.0	685.0

About 688 tons of aquatic products were fished in the 2007-2008 fishing season, 325 tons of which were *Capoeta* sp., 176 tons *Barbus* sp., 150 tons *C. c. carpio*, 14 tons *Squalius cephalus* and 23 tons *Astacus leptodactylus* (Table 7). Fishing activities were carried out in all the areas in the dam lake in the 2007-2008 fishing

Table 7: The distribution of catching aquatic products in the 2007-2008 fishing season

	The amounts of catching aquatic products (ton)					
Fishing regions	*Capoeta* sp.	*Barbus* sp.	*C. c. carpio*	*S. cephalus*	*A. leptodactylus*	Total
1	12	17	10	2.0	2.6	43.6
2	25	22	13	2.3	13.0	75.3
3	16	8	8	1.0	4.5	37.5
4	60	18	20	4.7	2.9	105.6
5	22	26	7	2.0	0.0	57.0
6	30	21	15	2.0	0.0	68.0
7	10	3	7	0.0	0.0	20.0
8	8	4	7	0.0	0.0	19.0
9	25	18	15	0.0	0.0	58.0
10	20	3	5	0.0	0.0	28.0
11	18	15	12	0.0	0.0	45.0
12	12	3	4	0.0	0.0	19.0
13	16	5	7	0.0	0.0	28.0
14	9	7	2	0.0	0.0	18.0
15	19	1	6	0.0	0.0	26.0
16	23	5	12	0.0	0.0	40.0
Total	325	176	150	14.0	23.0	688.0

season. *Capoeta* sp., *Barbus* sp. and *C. c. carpio* were caught in all areas. *Squalius cephalus* was caught in the first 6 fishing areas and *Astacus leptodactylus* was caught in the first 4 fishing areas as they were in the first 3 seasons.

The percentages of the fish species caught in the last six fishing seasons in the Keban Dam Lake in Fig. 2. *Capoeta* sp. accounts for 39% of the production, *Barbus* sp., 29%, *C. c. carpio* 24.4%, *Squalius cephalus* 3.8%, *Astacus leptodactylus* 3%, *Alburnus mossulensis* 0.6% and *Acanthobrama marmid* 0.2%.

Barbus sp. was caught most in the 2002-2003 and 2004-2005 fishing season, *Capoeta* sp. was caught most in the other fishing seasons. *Capoeta* sp. and *Barbus* sp. and *C. c. carpio* were caught in all of the leased fishing areas. It can be seen that *Squalius cephalus* are not found in the fishing areas except the first six areas and *Astacus leptodactylus* are not found in the fishing areas except the first four areas. *Alburnus mossulensis* and *Acanthobrama marmid* were not fished due to their low economic values. They were caught only in a few areas on demand in the 2003-2004 fishing season. Colak (1982) reported 21 species that belong to 6 families living in the Keban Dam Lake. Gucu *et al.* (2004) found out that *Capoeta capoeta umbla* (*C. umbla*), *Capoeta trutta*, *Leuciscus cephalus* (*S. Cephalus*), *Barbus esocinus*, *Barbus rajanorum mystaceus* (*B. mystaceus*), *Barbus capito pectoralis* (*Barbus pectoralis*), *Cyprinus carpio* (*C. c. carpio*), *Chondrostoma regium*, *Cyprinion macrostomus*, *Acanthobrama marmid* and *Chalcalburnus mossulensis* (*Alburnus mossulensis*) are the species that have commercial value in the studies conducted in the dam lake between 1995 and 1998. *Capoeta* sp. was reported to be the most widely caught fish in some researches conducted in the dam lake (Pala, 2002; Pala and Mengi, 2004; Celayir *et al*., 2006).

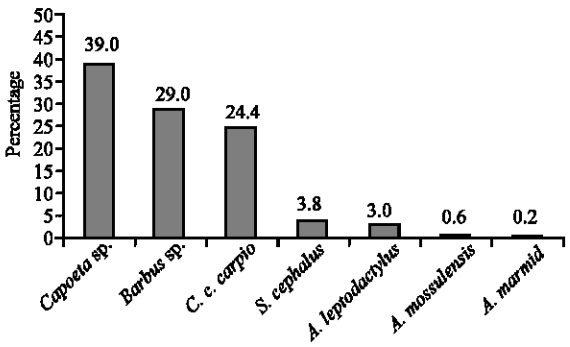

Fig. 2: The percentages of the aquatic products caught between 2002 and 2008

The surface areas of the fishing areas in the Keban Dam Lake vary between 150 and 9550 ha and fishing is done a total area of 51720 ha. When we assess the fishing outcomes of the last 6 fishing season, the number of boats used in fishing, though the number varies according to years is 191 on average. In addition, nearly 418000 meters of gillnets, the most of which is manufactured monofilament material and 33665 fyke nets were used. The highest average of aquatic products was obtained in the 4 area (119900 kg year^{-1}) and the lowest was obtained in the 8 area (9700 kg year^{-1}). The most efficiency area in terms of yield per hectare annually was the fishing area 13 (152 kg/ha/year) and the least efficiency area was the fishing area 8 (4.85 kg/ha/year) (Table 8). Gucu *et al.* (2004) reported that there were 205 motor boats and 345000 meters of gillnets in the dam lake in the 1990s. The monofilament material used in the nets caused an increase in the catch effort in the dam lake although the amount of nets didn't increase significantly.

The annual yield per hectare was calculated as 13.24 kg/ha/year in the Keban Dam Lake. Celayir *et al.*

Table 8: Fishing gears used and catch efficiency in the Keban Dam Lake

Fishing regions	Surface areas (ha)	No. of fishing boat	Gillnets (m)	No. of fyke nets	Average catching amount (kg/year)	Catching efficiency (kg/ha/year)
1	2000	9	18300	2750	40400	20.20
2	4700	14	23100	19845	78200	16.64
3	5000	18	31000	7650	43200	8.64
4	9550	34	73600	3420	119900	12.55
5	6500	8	22400	0	50500	7.77
6	7200	21	56300	0	74800	10.39
7	1550	8	14300	0	14800	9.55
8	2000	6	15100	0	9700	4.85
9	2600	14	26800	0	53300	20.50
10	2000	7	16700	0	35000	17.50
11	2370	8	20300	0	46600	19.66
12	1000	5	14100	0	21700	21.70
13	150	8	21500	0	22800	152.00
14	500	5	13200	0	20700	41.40
15	1900	12	27500	0	20700	10.89
16	2700	14	23800	0	32700	12.11
Total	51720	191	418000	33665	685000	13.24

(2006) assessed as 11.7 kg/ha/year the amount of annual fishable stock in their study in the Keban Dam Lake in the 2003 and 2004 years. The amount of aquatic products by obtained fishing according to this study data in the same fishing season (825 tons, 15.95 kg/ha/year) more highly than the amount of annual fishable stock can be seen. The amount of catching fish is more highly than the annual efficient of population.

CONCLUSION

To increase the amount of aquatic products obtained by catching found to be impossible, common fisheries policies were intended not to increase production, to sustainable fishing (Anonymous, 2001b). One of the most important issues is to decrease catching effort, to prevent reel lost of fishermen and to impose restriction the new fishing licence for fishing boats (Secer *et al*., 2004). As a result of this study, it could be said the catching effort of the Keban Dam Lake had to be taken in control.

As in the other dam lakes, the amount of fishable stock in the Keban Dam Lake determines by General Directorate of State Water Affairs, the rent reports prepare by the Ministry of Agriculture and hired by Special Provincial Directorate of Administration. And also the determination of the amount of aquatic products by obtained catching was made by General Directorate of State Water Affairs, protect control activities put in force in responsibility of the Ministry of Agriculture by police of the Government. These statuses prevent to make arrangement in efficiency and sustainable fishing. No precaution can be taken to prevent the amount of aquatic products by obtained catching is higher than population efficiency. In this study, it was observed that catching production is more than the amount of fishable stock determined by General Directorate of State Water Affairs for 5 years period. To modernise the fishing in Keban Dam Lake annual efficiency of population had to be determined regularly and fishing amount had to be prevent over annual population produce.

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