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IMPACT OF THE DEVELOPMENT AND THREE DECADES OPERATION OF THE "LAKE TISZA" RESERVOIR ON THE FISH COMMUNITY OF THIS AREA

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ABSTRACT: The Lake Tisza is a reservoir with an area of 127 square km, created by damming of River Tisza. The reservoir has two major areas: the river bed of the Tisza and the reservoir filled in 1978. In this area 55 fish species have been identified since 1970.

Because of the damming the rheophilic species (*Acipenser ruthenus, Barbus barbus*) quickly left the area but the populations of eurytopic and stagnophilic species have started to grow. Some populations' growth was slow and balanced (*Tinca tinca*), some was quick and exponential (*Abramis brama*). The changes in the population dynamics were more intense than what the new ecological conditions could explain.

Positive amplitude could be seen in the population size of *Abramis brama* and *Esox lucius*, negative in *Blicca bjoerkna* and *Abramis sapa*. But the extreme changes in the population sizes were followed by a reverse process.

The phytophilic fish species found very good spawning areas and enough to feed in a few years after the first flooding of the reservoir. As a result, the catch increased. After a few years the terrestrial vegetation disappeared and the amount of aquatic weeds increased. Because of these effects and the continuous sedimentation the fish production decreased. Nowadays human interventions are needed to slow down the succession of the artificial ecosystem.

KEYWORDS: damming, relative abundance, guilds, catch, invasive species

INTRODUCTION

The Lake Tisza is a reservoir in the Great Plain. It was created on the floodplain of the River Tisza by damming the river at the city of Kisköre (Fig. 1). The river flows through the lake - the reservoir is flooded by it every spring. At the end of October the water level is lowered by 1,5 meter so most of the area of the reservoir becomes dry.

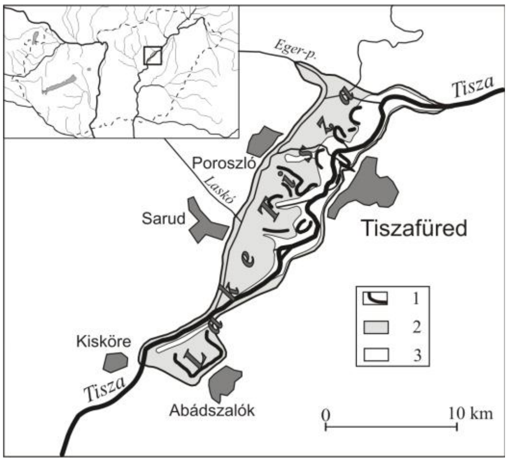

Fig. 1 The Lake Tisza (1 – deep region, 2 – shallow water region, 3 – land)

The dam at Kisköre was built in 1973. In the first years – from 1973 to 1977 – only the river bed was dammed. The first flooding of the reservoir was in 1978. The Lake Tisza has an area of 127 square km. From March to November 70% of the area is covered by water. But the reservoir has different areas with diverse flowing conditions and permanency. The shallow water area has standing water and it runs dry periodically. The river bed is bordered by flood-free banks (buffs) and can be characterized with low but continuous water current velocity.

The free water surface of the river is about 6,7 square km. The free water surface area of the reservoir with more than 30 cm water depth – which can be marked as a potential spawning area for fishes – is about 64 square km from spring to autumn and about 40 square km in winter.

MATERIALS AND METHODS

The monitoring of fish fauna of the River Tisza began in 1970 when the dam at Kisköre was just about to be built. The samples were taken at Tiszafüred. Thanks to the records we have important data about the fish fauna of the river before the damming. The survey has been continued since the built of the dam so we have good information about the changes in the fish community (Harka, 1977, 1985a, 1985b, 1987, 1999, 2008). During the survey traditional fishing tools (like fyke and other type of nets) and electric fish catchers were used.

In the reservoir most of the samples were made by nets with small mesh. Since 1990 electric fish catchers have also been used (portable battery-operated fish catcher HG IG 200 with direct pulse current output and heavy-duty engine-operated fish catchers HG EL 63 II GI and HG EL 64 S with direct pulse and direct current output). In the course of sampling with electric fish

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catchers the methods of the Hungarian National Biodiversity-monitoring System were used.

Between 1976 and 2009 almost 83.000 fish specimens were identified in the samples. Because of the different sampling methods not the number but the relative abundance of the species is used in this paper. The huge number of data gives us a good opportunity to observe the changes in the population of economically important species.

The changes in the density of the river bed's fish fauna are displayed in pie charts, the changes of time are displayed in histograms. In the histograms linear trend lines are used to display the tendency of changes – the horizontal line displays the average relative abundance of fishes in 3 years' time before putting the dam in operation. The diagrams were made by Microsoft Office Excel 2003.

RESULTS AND DISCUSSION

The fish fauna

The Lake Tisza is a reservoir and also a river – thanks to this it has a diverse fish fauna. 55 fish species were registered in this area between 1970 and 2009 (Table 1) – compared to the six times larger Balaton, which has only 30-35 fish species. The protected species are marked by *.

Table 1.

Registered species in the Lake Tisza between 1970 and 2009

Number	Species	River bed	Reservoir
1	*Eudontomyzon danfordi* REGAN, 1911*	+	
2	*Acipenser gueldenstaedtii* BRANDT ET RATZENBURG, 1833*	+	
3	*Acipenser ruthenus* LINNAEUS, 1758	+	
4	*Anguilla anguilla* (LINNAEUS, 1758)	+	
5	*Rutilus rutilus* (LINNAEUS, 1758)	+	+
6	*Ctenopharyngodon idella* (VALENCIENNES, 1844)	+	+
7	*Scardinius erythrophthalmus* (LINNAEUS, 1758)	+	+
8	*Leuciscus leuciscus* (LINNAEUS, 1758)	+	
9	*Squalius cephalus* (LINNAEUS, 1758)	+	
10	*Leuciscus idus* (LINNAEUS, 1758)	+	+
11	*Aspius aspius* (LINNAEUS, 1758)*	+	+
12	*Leucaspius delineatus* HECKEL, 1843*	+	+
13	*Alburnus alburnus* (LINNAEUS, 1758)	+	+
14	*Blicca bjoerkna* (LINNAEUS, 1758)	+	+
15	*Abramis brama* (LINNAEUS, 1758)	+	+
16	*Abramis ballerus* (LINNAEUS, 1758)	+	+
17	*Abramis sapa* (PALLAS, 1814)	+	
18	*Vimba vimba* (LINNAEUS, 1758)	+	
19	*Pelecus cultratus* (LINNAEUS, 1758)*	+	
20	*Chondrostoma nasus* (LINNAEUS, 1758)	+	
21	*Tinca tinca* (LINNAEUS, 1758)	+	+
22	*Barbus barbus* (LINNAEUS, 1758)*	+	
23	*Gobio gobio* (LINNAEUS, 1758)*	+	
24	*Gobio albipinnatus* LUKASH, 1933*	+	+
25	*Pseudorasbora parva* (TEMMINCK ET SCHLEGEL, 1842)	+	+
26	*Rhodeus sericeus* (PALLAS, 1776)*	+	+
27	*Carassius carassius* (LINNAEUS, 1758)	+	+
28	*Carassius gibelio* (BLOCH, 1782)	+	+
29	*Cyprinus carpio* LINNAEUS, 1758	+	+

30	*Hypophthalmichtys molitrix* (VALENCIENNES, 1844)	+	+
31	*Hypophthalmichtys nobilis* (RICHARDSON, 1845)	+	+
32	*Misgurnus fossilis* (LINNAEUS, 1758)*	+	+
33	*Cobitis elongatoides* BACESCU ET MAIER, 1969*	+	+
34	*Sabanejewia aurata* (FILIPPI, 1863)*	+	
35	*Ameiurus nebulosus* (LE SUEUR, 1819)	+	+
36	*Ameiurus melas* (RAFINESQUE, 1820)	+	+
37	*Silurus glanis* LINNAEUS, 1758	+	+
38	*Esox lucius* LINNAEUS, 1758	+	+
39	*Umbra krameri* WALBAUM, 1792*	+	+
40	*Salmo trutta morpha fario* LINNAEUS, 1758	+	
41	*Oncorhynchus mykiss* (WALBAUM, 1792)	+	
42	*Lota lota* (LINNAEUS, 1758)	+	+
43	*Lepomis gibbosus* (LINNAEUS, 1758)	+	+
44	*Micropterus salmoides* LACEPÈDE, 1802		+
45	*Perca fluviatilis* (LINNAEUS, 1758)	+	+
46	*Gymnocephalus cernuus* (LINNAEUS, 1758)	+	+
47	*Gymnocephalus baloni* HOLCIK ET HENSEL, 1974*	+	+
48	*Gymnocephalus schraetser* (LINNAEUS, 1758)*	+	
49	*Sander lucioperca* (LINNAEUS, 1758)	+	+
50	*Sander volgensis* (GMELIN, 1788)	+	+
51	*Zingel zingel* (LINNAEUS, 1766)*	+	
52	*Zingel streber* (SIEBOLD, 1863)*	+	
53	*Perccottus glenii* DYBOWSKI, 1877	+	+
54	*Neogobius fluviatilis* (PALLAS, 1814)	+	+
55	*Proterorhinus semilunaris* (PALLAS, 1814)	+	+

Changes in the fish community of the river bed

The character of the river has changed significantly since the operation of the dam. The formerly sandy and gravely bed-material has become muddy so the lithophilic species lost their spawning areas. The *Zingel streber* disappeared from this river section, the *Acipenser ruthenus, Barbus barbus, Squalius cephalus, Chondrostoma nasus* and *Zingel zingel* have became rare.

The basic data about the fish fauna are from the samples between 1970 and 1972 – 3 years before the dam’s operation (Harka & Tóth, 1971; Harka, 1974, 1975). During the survey 7633 specimens of 25 species have been caught by fyke. The great majority (93%) of the samples was from 10 species – from them *Abramis brama*, *Blicca bjoerkna*, *Abramis ballerus* and *Aramis sapa* together have 72% of relative abundance (Fig. 2).

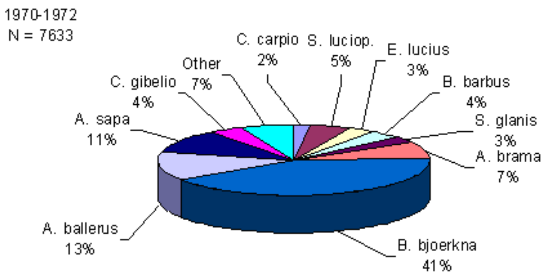

Fig. 2 Fish community before the damming

After the damming (1976–2009), 47124 specimens of 35 species were caught by fyke in the river bed. There were four very common species, *Abramis brama*, *Blicca bjoerkna*, *Abramis ballerus* and *Carassius gibelio.* These species together have 76% of relative abundance (Fig. 3).

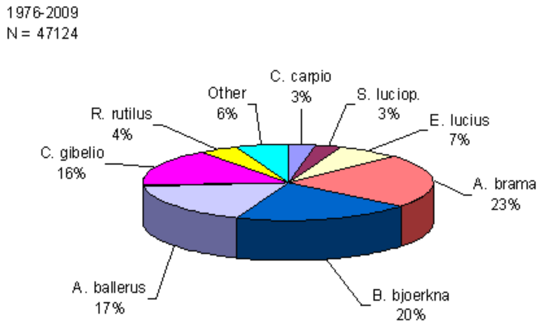

Fig. 3 Fish community of the river bed after the damming

The changes in the population of economically important species are displayed with their annual relative abundance. The monitoring was done at the city of Tiszafüred by fykes from 1976 to 2009.

In the reservoir a lot of *Cyprinus carpio* fries are released every year. This has a remarkable effect on the population so the natural spawning structure is hard to observe. Because of this the changes in *Cyprinus carpio* population are not displayed.

1. White bream – *Blicca bjoerkna*

Blicca bjoerkna is a common species of the river sections with moderate water current velocity. It had 43% of relative abundance before the damming. After the damming the population size decreased quickly – this effect could be caused by habitat changes and the constantly growing concurrence of *Abramis brama*. After some years the population size started to increase and stabilized after about 1,5 decades (Fig. 4). Nowadays the population size is smaller than before the damming but it is not so negative. First, the oversized populations lower the diversity and the stability of the fish fauna. Second, the position of *Blicca bjoerkna* was taken over by *Abramis brama* which is a more popular sport fish among the anglers because of its better growing ability.

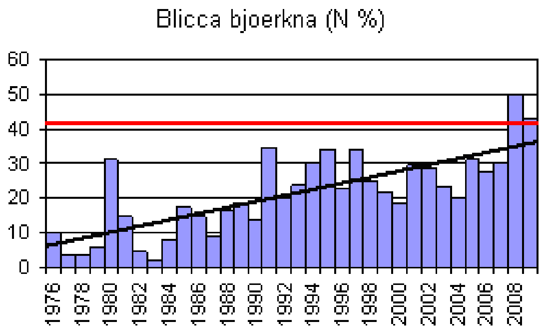

Fig. 4 Changes in the relative abundance of *Blicca bjoerkna* (N%)

2. Bream – *Abramis brama*

Abramis brama is a typical fish of the potamal region of the rivers. After the damming, the slower water current velocity and the vegetation in the floodplain granted good habitat for the species. Because of this the population size increased fast in the first decade. After that a decreasing tendency could be seen but the population size stabilized at a higher level than in the initial phase (Fig. 5).

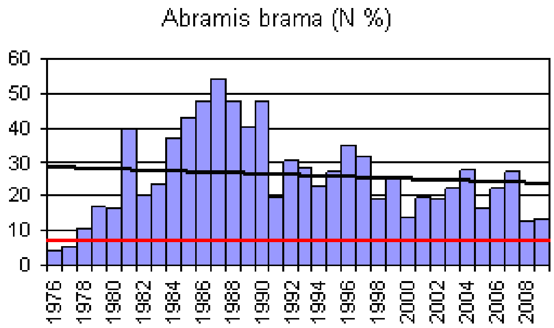

Fig. 5 Changes in the relative abundance of *Abramis brama* (N%)

3. Blue bream – *Abramis ballerus*

The species prefers larger rivers with moderate water current velocity. The damming had a positive effect on its population – since 1985 the relative abundance of *Abramis ballerus* has exceeded the previous population size and it is showing a constant growth (Fig. 6).

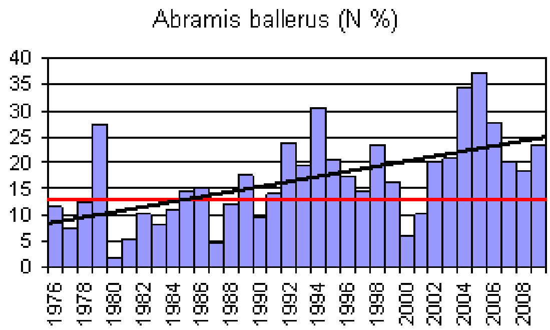

Fig. 6 Changes in the relative abundance of *Abramis ballerus* (N%)

4. White-eyed bream – *Abramis sapa*

Unlike the other breams *Abramis sapa* is a rheophilic species in the upper region of larger rivers. According to this the population size decreased extremely after putting the dam into operation – the relative abundance fell off from 11% below 1% (Fig. 7). In the last few years a surprising population growth can be observed – not only in the Lake Tisza but also in Serbia, in the river’s upper section over the dam at Novi Becej. The reason of this is still unanswered – it is possible that a new ecotype for lenthic water is evolving. The catch rate is far below the previous level and there is no hope for population growth in these days.

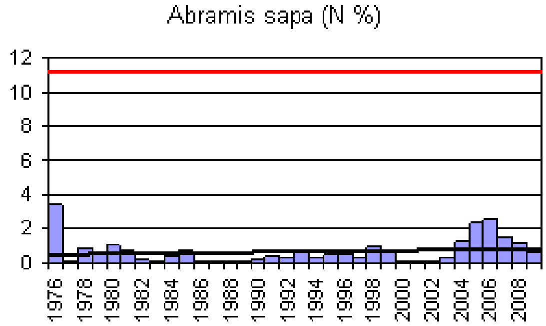

Fig. 7 Changes in the relative abundance of *Abramis sapa* (N%)

5. Prussian carp – *Carassius gibelio*

The first specimens were caught in this river section in the 1960s. The catch rate was increased constantly but the relative abundance of the species remained below 4%. In the first years of the river damming (between 1973 an 1975) 51% of the catch was *Carassius gibelio*. In 1977 the gradation culminated in 72% of relative abundance – after that the population collapsed within 3 years’ time. Apart from a peak in 1983, the population size decreased to a normal, lower level (Fig. 8).

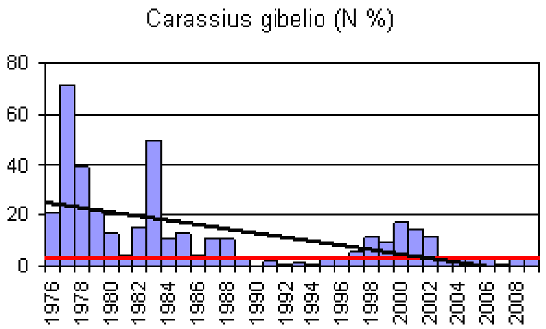

Fig. 8 Changes in the relative abundance of *Carassius gibelio* (N%)

The first males appeared in 1987, after the gradation peaks. Till then only females were observed in the population with gynogenetical reproduction strategy (Harka, 1993). It is a sign that the sexual and the gynogenetical reproduction strategy are coded alternatively in the genes of *Carassius gibelio* – if the gynogenezis becomes harmful (for example disease in an oversized population) the species can switch to sexual reproduction strategy to ensure the subsistence of the species by bigger genetic variability.

6. Roach – *Rutilus rutilus*

It is an eurytopic species which can be found in a lot of water types but prefers the slow flowing and standing water. This can be confirmed by the population growth (Fig. 9). Before the damming the relative abundance of the species was below 1% in the affected river section.

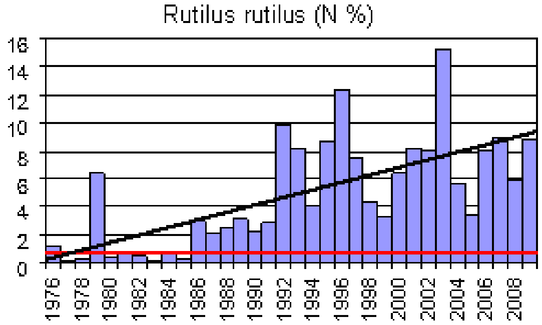

Fig. 9 Changes in the relative abundance of *Rutilus rutilus* (N%)

7. Tench – *Tinca tinca*

Tinca tinca is a typical stagnophilic species – it could not be found in the sampled river section during the survey before the damming. After the first filling of the reservoir, the species – whose presence was known previously in the oxbows in the floodplain – also appeared in the river bed and its relative abundance started to increase. The species has a stable population in the slow flowing sections of the river and it can increase further (Fig. 10).

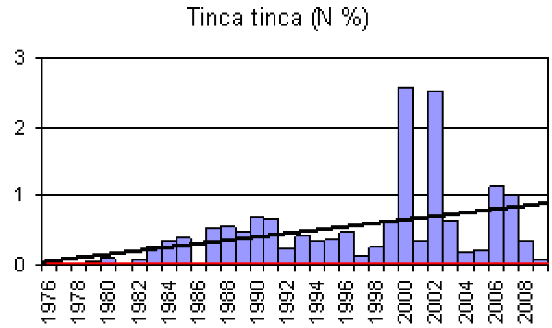

Fig. 10 Changes in the relative abundance of *Tinca tinca* (N%)

8. Pike – *Esox lucius*

It is well-known that *Esox lucius* is the first among the predators which becomes dominant in new watercourses. It has a good ability to adapt, it grows rapidly and reaches first maturity early – beyond that the flooded vegetation is an excellent spawning and feeding area for the species (Fig. 11)

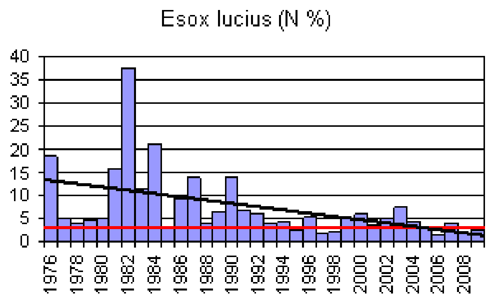

Fig. 11 Changes in the relative abundance of *Esox lucius* (N%)

9. Pike-perch – *Sander lucioperca*

Sander lucioperca has huge populations in rivers with moderate water current velocity and in well-oxygenated lakes. The decreasing tendency in the population size does not have direct connection with the lowered water current velocity. In the first years after the damming the relative abundance of the species was growing – but later when the bed-material became muddy it decreased quickly (Fig. 12)

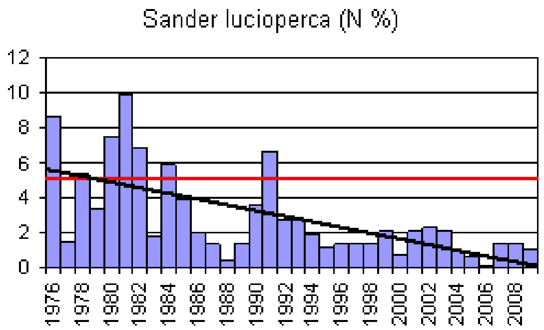

Fig. 12 Changes in the relative abundance of *Sander lucioperca* (N%)

10. Wels catfish – *Silurus glanis*

Before the damming almost 3% of the catch was *Silurus glanis*, but since 1980 the relative abundance of the species has remained under 1% (Fig. 13). On the whole a decreasing tendency can be seen in the population size. But apart from the first 3 years the population size seems to be small but stable.

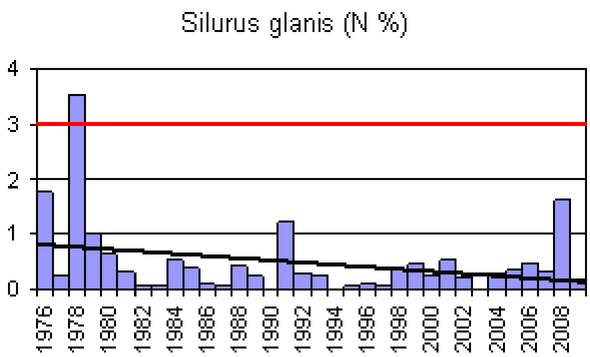

Fig. 13 Changes in the relative abundance of *Silurus glanis* (N%)

11. Asp – *Aspius aspius*

Aspius aspius has remarkable populations in lower reaches of rivers and in estuaries. Its population size is increasing – but the records remain mostly under 1%.

The relative abundance only exceeded this value in the last few years (Fig. 14).

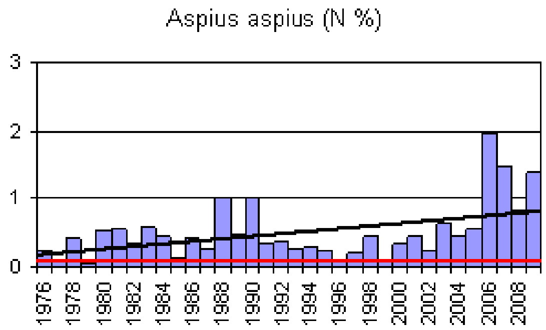

Fig. 14 Changes in the relative abundance of *Aspius aspius* (N%)

By observing only the density of piscivorous species the following conclusions can be drawn. In the first years after the damming *Esox lucius* was dominant among the predators with more than 30% of relative abundance with peak in 1979. Later the population size decreased but at the same time *Sander lucioperca* took the leading role with 16% of the catch rate in 1981. Finally *Silurus glanis* became dominant in 1988 – its relative abundance exceeded the rate of the other two fishes. Further on none of these species could reach their maximum rates of relative abundance. The rate of these 3 species became balanced but the pike – pike-perch – wels catfish order is still valid.

These 3 species may overshadow *Aspius aspius* and *Sander volgensis* but 1-2% of their relative abundance is also remarkable and their population size seems to be increasing.

Changes in the fish community of the reservoir

The reservoir has two major areas: the floodplain with shallow water flooded annually and deep oxbows and channels covered with permanent water. The areas with shallow water do not have a stable fish fauna – compared to the oxbows which have a stable fish community thanks to their good natural and environmental conditions.

Before the first filling of the reservoir in 1978 huge meadows and pastures could be found in the floodplain where the vegetation guaranteed excellent spawning substrate for phytophilic species (Kovács, 1990, 1991). Thanks to the good spawning and feeding opportunities a quick growth could be observed in the amount of fishes. In the first years of the dam’s operation the total catch of fishers and anglers tripled and was more than 300 tons (Harka, 2008). The good feeding opportunities remained (Bancsi & Kovács, 1996, Szító et al., 1997) but the annual floodings destroyed the emergent vegetation. Because of the decreasing rate of the spawning areas, the spawning success also decreased (the species spawned over each others eggs which led to chocking of eggs).

The small amount ofmacro-vegetation in the littoral region (*Phragmites australis*, *Typha sp.*) and the increasing amount of aquatic weeds (*Ceratophyllum sp.*, *Lemna sp.*, *Trapa natans*, *Elodea canadensis*) are not able to compensate the disappearance of the terrestrial vegetation. Despite of these conditions the Lake Tisza is still an important spawning area.

During the survey of open-water areas and oxbows 28081 specimens of 33 species were identified in the last decade. 30 fish species were registered in the shallow water areas of the reservoir and 29 species in the oxbows and channels (Table 2).

Table 2.

Relative abundance of fishes from the reservoir's shallow and deep water areas (2000-2009)
+++++ dominant, ++++ common, +++ moderately common, ++ rare, + very rare, (+) only a few specimen

Number	Species	shallow water	deep water
1	*Rutilus rutilus* (LINNAEUS, 1758)	++++	+++++
2	*Scardinius erythrophthalmus* (LINNAEUS, 1758)	++	++
3	*Leuciscus idus* (LINNAEUS, 1758)	++	+
4	*Aspius aspius* (LINNAEUS, 1758)*	+	+
5	*Leucaspius delineatus* HECKEL, 1843*	(+)	
6	*Alburnus alburnus* (LINNAEUS, 1758)	+++++	+++++
7	*Blicca bjoerkna* (LINNAEUS, 1758)	++	+++
8	*Abramis brama* (LINNAEUS, 1758)	+	+++
9	*Abramis ballerus* (LINNAEUS, 1758)	(+)	(+)
10	*Tinca tinca* (LINNAEUS, 1758)	+	+
11	*Gobio albipinnatus* LUKASH, 1933*	+	+
12	*Pseudorasbora parva* (TEMMINCK ET SCHLEGEL, 1842)	(+)	
13	*Rhodeus sericeus* (PALLAS, 1776)*	+++	++
14	*Carassius carassius* (LINNAEUS, 1758)	(+)	+
15	*Carassius gibelio* (BLOCH, 1782)	++	++
16	*Cyprinus carpio* LINNAEUS, 1758	(+)	+
17	*Hypophthalmichtys molitrix* (VALENCIENNES, 1844)	(+)	
18	*Misgurnus fossilis* (LINNAEUS, 1758)*	(+)	
19	*Cobitis elongatoides* BACESCU ET MAIER, 1969*	++	++
20	*Ameiurus nebulosus* (LE SUEUR, 1819)	(+)	+
21	*Ameiurus melas* (RAFINESQUE, 1820)	++++	+++
22	*Silurus glanis* LINNAEUS, 1758	(+)	(+)
23	*Esox lucius* LINNAEUS, 1758	+	+
24	*Lota lota* (LINNAEUS, 1758)		(+)
25	*Lepomis gibbosus* (LINNAEUS, 1758)	++	++
26	*Perca fluviatilis* (LINNAEUS, 1758)	++	++
27	*Gymnocephalus cernuus* (LINNAEUS, 1758)	+	+
28	*Gymnocephalus schraetser* (LINNAEUS, 1758)		(+)
29	*Sander lucioperca* (LINNAEUS, 1758)	+	+
30	*Sander volgensis* (GMELIN, 1788)		(+)
31	*Perccottus glenii* DYBOWSKI, 1877	(+)	++
32	*Neogobius fluviatilis* (PALLAS, 1814)	+++	++++
33	*Proterorhinus semilunaris* (PALLAS, 1814)	+++	+++

The structure of the fish community and the rate of fish species is practically the same in the shallow sections of the free water surface area of the reservoir – eurytopic species are dominant everywhere. The most common species of the reservoir is the pelagic *Alburnus alburnus*. This result is correlating with the large amount of free water surface areas in the reservoir. The second common species is the adventive *Ameiurus melas*. They are followed by *Rutilus rutilus*, *Proterorhinus semilunaris*, *Neogobius fluviatilis* and *Rhodeus sericeus* (Fig. 15).

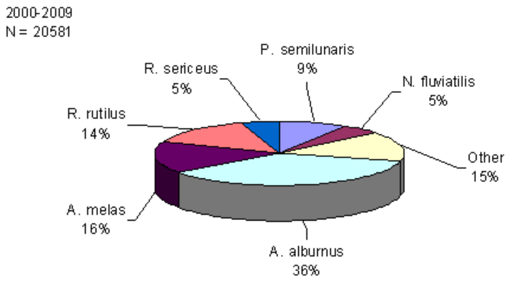

Fig. 15 Fish fauna of the shallow section of the reservoir (N = number of specimen)

During the survey similar environmental conditions were observed in the oxbow as in other sections of the reservoir. The swamp vegetation is decreasing and the aquatic weeds are gaining on even more areas. The most common species of the oxbows was *Alburnus alburnus* as well as in the shallow sections of the reservoir. The species is closely followed by *Rutilus rutilus*. Other common species are *Neogobius fluviatilis*, *Ameiurus melas*, *Blicca bjoerkna*, *Proterorhinus semilunaris*, *Abramis brama* and *Perca fluviatilis* (Fig. 16).

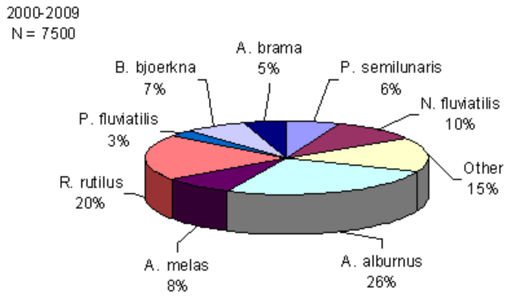

Fig. 16 Fish fauna of the deeper sections of the reservoir (N = number of specimen)

The structures of fish fauna of different oxbows are compared to gain more information about the general status of the habitats of the oxbows with different biological age. The biological age of the oxbows can be defined by the natural process of succession. The young oxbows have large free water surface and solid bed-material. The old oxbows have rich vegetation and because of the sedimentation the bed is covered mostly with mud. To interpret the results two oxbows were chosen: Nagy-morotva is a young, Háromágú-Holt-Tisza is an old oxbow.

During the survey 20 fish species were identified in Nagy-morotva and 17 in Háromágú-Holt-Tisza between 2000 and 2009 (Table 3).

Table 3.

Relative abundance of fish species in Nagy-morotva (young oxbow type) and in Háromágú-Holt-Tisza (old oxbow type) (2000-2009)

+++++ dominant, ++++ common, +++ moderately common, ++ rare, + very rare, (+) only a few specimen

Number	Species	Nagy-morotva	Háromágú
1	*Rutilus rutilus* (LINNAEUS, 1758)	++++	+++++
2	*Scardinius erythrophthalmus* (LINNAEUS, 1758)	+	+++
3	*Leuciscus idus* (LINNAEUS, 1758)	(+)	
4	*Aspius aspius* (LINNAEUS, 1758)*	+	
5	*Alburnus alburnus* (LINNAEUS, 1758)	+++++	+++
6	*Blicca bjoerkna* (LINNAEUS, 1758)	+	(+)
7	*Abramis brama* (LINNAEUS, 1758)	++	+
8	*Tinca tinca* (LINNAEUS, 1758)		(+)
9	*Rhodeus sericeus* (PALLAS, 1776)*	+	+++
10	*Carassius carassius* (LINNAEUS, 1758)	(+)	+++
11	*Carassius gibelio* (BLOCH, 1782)	++	+++
12	*Cyprinus carpio* LINNAEUS, 1758	(+)	
13	*Cobitis elongatoides* BACESCU ET MAIER, 1969*	++	
14	*Ameiurus nebulosus* (LE SUEUR, 1819)	+	+++
15	*Ameiurus melas* (RAFINESQUE, 1820)	+	++

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16	*Esox lucius* LINNAEUS, 1758	++	+
17	*Lepomis gibbosus* (LINNAEUS, 1758)	+	+
18	*Perca fluviatilis* (LINNAEUS, 1758)	+++	++
19	*Sander lucioperca* (LINNAEUS, 1758)	++	(+)
20	*Perccottus glenii* DYBOWSKI, 1877	(+)	++++
21	*Proterorhinus semilunaris* (PALLAS, 1814)	+++	(+)

The young oxbows can be characterized by the dominance of eurytopic species. The most common species was *Alburnus alburnus*. In the oxbow Nagy-morotva almost 60% of the specimens were recorded as *Alburnus alburnus* – the whole rate of eurytopic species was more than 90%.

In old oxbows the rate of stagnophilic species was much lower than expected. In the oxbow Háromágú-Holt-Tisza hardly more than one third of the specimens belonged to the stagnophilic guild. The other part of the fish community belonged to the eurytopic guild.

During the survey a lot of adventive species with remarkable relative abundance were registered in the oxbows and also in the shallow regions of the reservoir. In the shallow regions of the reservoir a third of the specimens were adventive, in the deeper sections the rate of non-native specimens remained a little below 30%. But in the Háromágú-Holt-Tisza the whole rate of adventive fishes reached 40%.

Among the adventive species *Perccottus glenii* has remarkable relative abundance. The presence of the species in Lake Tisza first was detected in autumn of 1997 near Tiszafüred (Harka et al. 2001). But the species may have appeared previously because specimens with different ages were caught. For the last few years the population size of the species has grown exponentially – for example every fifth specimen was *Perccottus glenii* during the survey of the oxbow Háromágú-Holt-Tisza. The presence of the species is very harmful to the fish fauna. Because of the fact that it feeds on eggs and juveniles of other species and it is a concurrency in feeding, the presence of *Perccottus glenii* has a lowering effect on the population size of other species.

CONCLUSIONS

1. By our observations some species overreacted the damming effect, there are extreme changes in population sizes. The population of *Abramis brama* and *Esox lucius* increased quickly, but the population of *Blicca bjoerkna* and *Abramis sapa* decreased. The extreme deflections were followed by an adverse tendency which stabilized the population size in an ecologically reasonable level.

2. The reservoir is aging quickly (sedimentation, sprawl of aquatic weeds etc.). To maintain the fish habitats constant human interventions are needed (dredging, removing the aquatic weeds etc.). The aging of the reservoir causes less fish production. In the first years of the operation of the reservoir the catch of fishes tripled – later the catch rate decreased and it stabilized at a level twice more than before the damming.

3. The rate of adventive species grew quickly in the last few years – the growth was very fast not just in the oxbows but also in the shallow regions of the reservoir. Among the adventive species, *Perccottus glenii* has a remarkable relative abundance. In the reservoir the first specimens of the species were found in 1997. In the last few years a significant population growth of *Perccottus glenii* could be observed.

4. During the three decades operation of the reservoir it became an important recreational center. In this process fishing and angling had a leading role. But nowadays the natural spawning rate of fishes is not able to fulfill the demand of the constant increasing number of anglers. Because of the decreasing tendency of the natural spawning rate huge amount of fries are released every year – especially *Cyprinus carpio* – but there are experiments to increase the spawning rate by natural ways.

5. The Lake Tisza is an unstable watercourse characterized with constant changes (in bed or in vegetation) where the experiments and breeding methods of fisheries are difficult to achieve. To raise the fish production a constant monitoring is suggested and in addition the good ecological conditions are also needed to be ensured.

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