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Study on the evolution of the aquatic fauna in Lacul Ştiucii reservation during 2000-2011, Cluj County, Romania

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Abstract. Lacul Ştiucii (Pike Lake) lying on the northwest side of the Transylvanian Plain, is one of the most interesting, important and fascinating reservations in Romania, which is known (among other things) for breaking a few records, such as being the deepest natural freshwater lake in Transylvania, the less affected by anthropic interventions, whilst being the only lake in the Transylvanian Plain where floating reed islet formations have developed. One of the objectives pursued by this study has been to accurately identify the structure of the ichthyofauna, its evolution throughout the last 12 years, as well as causes lying behind a succession of significant changes occurred. To the end, we monitored 1,760 predatory fish specimens and over 3,000 non–predatory fish specimens, drawing comparisons on the current status of the fish fauna and ascertaining trends of its transformation during the last 12 years.
Key Words: Lacul Ştiucii, natural reservation, aquatic fauna, Cluj County.

Introduction

Brief morpho-geographical considerations on Lacul Ştiucii. The lake lies on the northwest side of the Transylvanian Plain, at an altitude of 247.5 meters, on Bontului Valley, which is a tributary of Fizeş River, abutting on Sic commune upstream and on Săcălaia village downstream.

Lacul Ştiucii (Pike Lake) is listed among the most outstanding aquatic, landscape, botanical and fauna reservations in our country, being listed among the natural monuments appreciated by Romanians and foreigners alike. This lake has been declared a natural reservation of national interest ever since 1966 (Bud et al 2007, 2010).

The lake has formed naturally, as a result of dissolution, subsidence and collapse processes brought about by lake basin's location above the salt deposits found along the line linking Dej – Săcălaia – Sic – Cojocna – Turda - Ocna Mureş (Battes 2006).

As a result of high quantities of silt being washed away from the adjacent slopes into the lake, the salt was eventually separated from water by a watertight layer of mud, which caused the process of salt dissolution to stop and hence triggered a gradual sweetening process, the chemical composition of water changing as the water itself converted from brackish to fresh, until it reached its current features. Therefore, due to all these changes, the lake has provided for the optimum environment and the best possible circumstances for the development of a rich and diversified flora and fauna.

Regrettably, during the last 50 years the lake basin has been shrinking dramatically, as a result of high quantities of sediments being washed away into the lake, which means that Lacul Ştiucii is heading towards a relatively quick silting up process.

A quick comparison between the three topobatimetric surveys conducted by Săndulache (1963), Şerban & Sorocovschi (2003) and our results from 2010 reveals that the lake surface area, as well as its morphometric features has reduced significantly (Table 1). Given this unfortunate development, specialists in this field have been concerned with finding viable solutions for stopping or slowing down the lake silting up process as quickly as possible.

Table 1

Morphometric features evolution of Lacul Ştiucii

Specification	*M.U.*	*1957*	*2000*	*2010*	*Differences 1957-2010*
Area	ha	68.700	57.350	51.629	17.071
Lenght	km	1.720	1.555	1.343	0.377
Average width	km	0.399	0.369	0.322	0.077
Maximum width	km	0.816	0.662	0.538	0.278
Medium dept	m	5.468	3.123	2.950	2.514
Maximum dept	m	12.700	6.800	6.530	6.170
Total volume	mcm	3.757	1.780	1.380	2.377

M.U. – measurement unit; ha – hectare; km – kilometers; m – meters; mcm – million cubic meters.

Vegetation. It is worthwhile to mention that, in addition to the freshwater hydrophilic and hygrophilic vegetation, which obviously prevails on this lake, various types of saltwater plant communities have also identified, which, albeit isolated and occupying reduced areas, reconfirm the origin and the genesis of this lake.

The following species of plants have been found: *Aster tripolium, Puccinella distans, Atriplex hastata, Salicornia herbaceea*, etc. Riparian vegetation, including species such as *Typha angustifolia, Orchis palustris, Equisetum palustre*, grows around the lake, whilst the most noteworthy representatives of the trees and brush category are *Salix cinerea, Rhamnus frangula* and *Viburnum sp*.

Aquatic plants are represented by floating, emerged and submerged species, such as green algae (*Spirogyra sp., Cladophora sp., Nitelopsis sp*.), aquatic moss (*Fontinalis antipyrethica*), diatoms, as well as submerged macrophytes (*Najas marina, Utricula vulgaris, Ceratophilum demersum, Myryophyllum spicatum*), reaching as deep as 5 meters (Crişan 2010).

The reed covered area is represented, botany–wise, by the *Phragmites communis* species, forming the *Phragmitetum communis* community, which is the most widespread hygrophilic plant community in our country (Gudasz et al 2000).

Fauna. The fauna around the lake is diversified, the following mammals being its most important representatives: the muskrat (*Ondrata zibethica*), the European or Northern water vole (*Arvicola amfibius*), the common otter (*Lutra lutra*) and the red fox (*Vulpes vulpes*).

Furthermore, six species of amphibians have been identified, as follows: the smooth newt (*Triturus vulgaris*), the great crested newt (*Triturus cristatus*), the common toad (*Bufo bufo*), the European tree frog *(Hyla arborea*), the European fire-bellied toad (*Bombina bombina*), the yellow-bellied toad (*Bombina variegata*), the marsh frog (*Rana ridibunda*), and the agile frog (*Rana dalmatina*).

Given the characteristics of this lake, the avifauna to be found in this environment stands out for both its significance and its diversity, being represented by a total of 34 species, out of which 13 are aquatic, 12 species living in and around the reed-bed, and 9 species having broader attributes, which are applicable to several types of habitats. The lake is a brooding habitat for 24 species, but, on and off, other species sometimes reach this habitat accidentally and stay for a limited time only. The most common species are: the tippet grebe, the fen duck, the water fen or the coot, whilst the most noteworthy ones are: the Eurasian bittern (*Botaurus stellaris*) or the Western marsh-harrier (*Circus aeruginosus).*

The zooplankton in Lacul Ştiucii consists of protozoa (flagellates, ciliates), worms (rotifers) and micro-crustaceans (copepods and cladocerous).

A total number of 201 taxa have been identified in the phytoplankton community in Lacul Ştiucii, out of which 27 species which are part of the Euglenophyta, Dinophyta, Chrysophyta and Chlorophyta phyla, all constituting new species for our country. All these species proliferate mainly in the cold season, under the ice cover.

One of the main objectives that our research was aimed at consisted in achieving, on the one hand, a very accurate identification of the ichthyofauna in this lake and, on the other hand, in finding the exact causes which led, over time, to its modification. Lately, given the evolution of this lake and as a result of the changes occurred at all levels of this reservation, the aquatic fauna seems to have also been affected by numerous modifications.

Material and Method. The actual research work was conducted during 2010–2011, when a number of 1,760 fish specimens have been catalogued, being measured and weighed in order to enable their morphological and structural description.

Moreover, we kept a close watch on changes occurred during 2000–2010 and affecting evolution of the fish fauna, as a result of several factors which brought about transformations impacting on the overall reservation.

For fish capture and ichthyofauna structure identification purposes, fishing nets (1.5 centimeters mesh size) and 3.5 meters deep gill nets were used, as well as recreational fishing.

In accordance with the internal rules and regulations applicable for this reservation, recreational fishing on this lake can only be conducted from boat. Given these circumstances and in agreement with the administrators of this reservation, it was decided that each fisherman leaving the shore would be handed over a survey sheet/questionnaire, which was to be filled in with valuable data on the features of the biological material caught and on its quality, ascertained based on its weight and length, that we were able to use in our study.

Any biological material captured which belonged to the three species of large predatory fish was measured and weighed and then, in accordance with the fishing regulations in force, part of it (namely 60%) was released, whilst the remaining part was retained by the fishermen.

Results and Discussion. The key conclusions regarding the structure of this lake's ichthyofauna, based on the investigations conducted and on the results we obtained further to these investigations are detailed below and compared against the data presented by other authors. Furthermore, in order to describe as accurately as possible the predatory fish species to be found in this lake, which are, by all accounts, the most valuable species in this lake, a morphological assessment and a length and weight classification were also carried out.

The analysis conducted on the structure of the ichthyofauna in Lacul Ştiucii in 2010, compared against the data collected in 2000 and respectively, in 2004, reveals that this has gone through significant changes since the findings of Colegiu (2000) and respectively of Battes & Stoica (2004), as detailed in Table 2.

According to the data presented in this table, some species have undergone positive evolutionary patterns, whilst for others, these were found to be either constant or heading towards a substantial depletion, or even extinction, in the case of Crucian carp.

Another essential change occurred during the last ten years consists in the appearance of new predatory fish species in this lake (i.e. the zander and the sheatfish), which seem to have gained a foothold to the detriment of native species.

But what we find most disquieting is the evolution of the pumpkinseed sunfish (*Lepomis gibbosus*), invasive species displaying unusually high plasticity features, which should represent a warning signal for the administrators of this reservation, given the detrimental impacts that this species may engender (Table 2).

Table 2

Evolution of ichthyofauna in the range 2000-2010

Species	*Authors*			*Comments*
	Colegiu (2000)	*Battes & Stoica (2004)*	*Our results (2010)*	
Pike (*Esox lucius*)	present-optimal density	present-optimal density	present-optimal density	constant
Goldfish (*Carassius carassius*)	present low-density	present low-density	absent	missing
Roach (*Rutilus rutilus*)	present-optimal density	present-optimal density	present-optimal density	on the increase
Rudd (*Scardinius erytrophthalmus*)	present-optimal density	present-optimal density	present-optimal density	on the increase
Bleak (*Alburnus alburnus*)	present-medium density	present-optimal density	present-optimal density	constant
Tench (*Tinca tinca*)	present-medium density	present low-density	sporadically present	declining alarmingly
Bream (*Abramis brama*)	present-medium density	present-medium density	present-medium density	constant
Bass (*Perca fluviatilis*)	sporadically present	present low-density	present low-density	constant
Sun bass (*Lepomis gibbosus*)	present low-density	present-medium density	present high-density	the alarming increase
Crucian carp (*Carassius auratus*)	sporadically present	unidentified	present low-density	constant
Catfish (*Silurus glanis*)	unidentified	unidentified	present low-density	on the increase
Zander (*Sander lucioperca*)	unidentified	unidentified	present low-density	on the increase

Further essential changes revealed by the investigations conducted concern the drastic depletion of species such as the tench and the gibel carp, the extinction of the Crucian carp, an overall numerical increase of species such as the roach, the pumpkinseed sunfish, the zander and the sheatfish, whose origin has not been fully elucidated.

The vertiginous increase in the pumpkinseed sunfish stock from one year to the other is to be noted, seeing that this is an invasive species, whose presence poses a significant threat to local fish populations, competing with them for food, eating their spawn and the young of the native fish species.

Assessment of the 1,328 specimens of Northern pike caught in 2010, from the point of view of their length reveals, according to the data presented in Table 3, that specimens in the range of 61 to 70 cm length are the most frequent (383 individuals, representing 28.84%), followed by specimens in the range of 71-80 cm (348 individuals, representing 26.20%) and by specimens in the range of 51-61cm (267 indivuduals, representing 20.11%). From the total number of pike specimens caught in 2010, 75.15% are in the range of 51-80 cm, which proves that the pike population is well established, which provides constant patterns for the reproduction of this species. It should also be noted that trophy-size specimens measuring over 100 cm in length have also been caught.

Weight wise (Table 4), specimens in the range of 4.1 to 5 kilograms are the most frequent (379 individuals, representing 28.54%), followed by specimens in the range of 2.1 – 3 kilograms (226 individuals) and by specimens in the range of 3.1–4 kilograms (197 individuals). However, it should be noted that five specimens caught weighed over 9–10 kilograms.

In 2011, the number of pike captures dropped to 442, compared to the number of pike captures recorded for the previous year, which was higher by 886. This requires for the fishing season to be urgently limited to the shortest interval possible, since failure to act promptly may result in posing a serious threat to the fish species in this basin (Table 5). According to the data in this table, the most frequently encountered length range in 2011 is also 61-70 cm, followed closely, as in the previous case, by the 71-80 cm length range and respectively, by the 51-60 cm length range.

Weight wise, the highest frequency is that of the 4.1–5 kg weight range, with over 39.59% of the total fish catch, the breakdown being quite similar to the figures presented for the previous year's captures (Table 6).

Another interesting fact worth mentioning is that, in spite of no sheatfish (*Silurus glanis*) specimens being identified in this lake in 2000 or in 2004, in 2010 the number of captures from this species reached 53 specimens, a situation made even more peculiar by the fact that the specimens caught span over a highly extensive length range, from 30-40 cm to 120 cm, which proves that this species has settled in and adjusted quickly and that it mates and reproduces with no problems whatsoever in this lake.

According to the information presented in Table 7, most of the specimens caught were within the range of 91-100 cm (18.87%). Nevertheless, the fact that the specimens span over such an extensive length range (30-120 cm) has led us to the conclusion that the species had in fact been present in the lake at the time when the previous surveys were conducted, without being identified, or that large specimens were introduced in the lake without the knowledge of the reservation administrators.

Weight wise, the sheatfish specimens caught are within the range of 1.0-14 kg, the most frequently encountered weight range being 5.1-6 kg (18.87%).

In 2011, the number of sheatfish captures dropped to 25 specimens within the 70-120 cm length range, with the highest frequency being recorded for the 81–90 cm length range (32%).

The second species of fish that has only recently been identified in the reservation is the zander (*Sander lucioperca*), captured in both years 2010 and 2011, even though in considerably lower numbers than the two other species of predatory fish mentioned above, i.e. the Northern pike and the sheatfish. Hence, in 2010 ten specimens ranging from 50 cm to 80 cm were captured, which confirmed the presence of this species and the fact that it had adjusted to the conditions in this lake (Table 8).

Table 3

Length situation pike captured in 2010

Length - Group size (cm)											
Intervals	20-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	Total
Individuals	2	20	72	267	383	348	186	40	7	2	1,328
Percent	0.15	1.50	5.42	20.11	28.84	26.20	14.00	3.01	0.53	0.53	100%

Table 4

Weight situation pike captured in 2010

Group size (kg)											
Intervals	0-1	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0	9.1-10.0	10.1-11.0	Total
Individuals	32	131	226	197	379	153	177	24	4	3	2	1,328
Percent	2.40	9.86	17.02	14.83	28.54	11.52	13.32	1.80	0.30	0.22	0.15	100%

Table 5

Length situation pike captured in 2011

Length - Group size (cm)											
Intervals	20-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	Total
Individuals	-	1	42	89	128	122	44	11	3	2	442
Percent	-	0.22	9.50	20.13	28.95	27.60	9.95	2.48	0.67	28.95	100%

Table 6

Weight situation pike captured in 2010

Group size (kg)												
Intervals	0-1	1.1-2.0	2.1-3.0	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0	9.1-10.0	10.1-11.0	Total
Individuals	6	59	76	46	75	30	39	8	2	1	-	442
Percent	1.36	13.35	17.19	10.40	39.59	6.78	8.82	1.81	0.45	0.23	-	100%

Table 7

Length situation catfish captured in 2010

Length - Group size (cm)										
Intervals	30-40	41-50	51-60	61-70	71-80	81-90	91-100	101-110	111-120	Total
Individuals	2	3	4	8	9	12	10	3	2	53
Percent	3.78	5.66	7.55	15.10	16.99	22.65	18.87	5.66	3.78	100%

Table 8

Length situation zander captured in 2010

Length - Group size (cm)					
Intervals	50-60	61-70	71-80	81-90	Total
Individuals	1	2	5	2	10
Percent	10.0	20.0	50.0	20.0	100 %

Table 9

Weight situation zander captured in 2010

Group size (kg)				
Intervals	2.0-3.0	3.1-4.0	4.1-5.0	Total
Individuals	2	5	3	8
Percent	20	50	30	100%

Table 10

Length situation zander captured in 2011

Length - Group size (cm)						
Intervals	50-60	61-70	71-80	81-90	91-100	Total
Individuals	-	2	6	4	-	12
Percent	-	16.67	50.0	33.4	-	100%

The weight of the zander specimens caught ranged from 2 to 5 kg. The presence of this new species serves to enrich the native ichthyofauna of this lake, even though it competes for food with the baseline species, i.e. the pike (Table 9).

In 2011, the number of zander captures reached 12 specimens ranging from 60 cm to 90 cm, half of the specimens being in the 71-80 cm length range (Table 10). Weight wise, the specimens caught ranged from 2 to 6 kilograms, the highest frequency being recorded for the 3–4 kg weight range.

Conclusions. The investigations and surveys conducted pinpoint at obvious changes in the ichthyofauna structure having occurred during the last ten years, both in the sense of marked reduction or even extinction of some species, or in the sense of appearance of new species or increased proliferation rates for some other species. These evolutions are determined by changes impacting on the overall reservation, on the one hand, and by anthropic interventions on the other hand.

Given the known morphological features of the main fish species, their sound physical development and their extensive age range should be construed as a guarantee for perpetuation in the future.

However, drastic reduction of recreational fishing, that may endanger the sustainability of this ecosystem, pollution mitigation and prohibition on the introduction of new species in the lake, with the aim of protecting and preserving this reservation, is still a must.

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