INTEGRATING PROTECTED AREA MANAGEMENT AND ICHTHYOFAUNAL STATUS FOR THE ADUNAŢII DE GEORMANE LAKE (SOUTH-WESTERN ROMÂNIA)

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The purpose of the research is to address current environmental challenges based on close collaboration between stakeholders in order to achieve the sustainable management of the Adunaţii de Geormane Lake. The main theme of study began in 1972, when the lake was populated with *Ctenopharyngodon idella* in order to capitalize the abundant macrophyte vegetation; this phenomenon led to the excessive multiplication of the species and extension of the phytoplankton that generated "algal blooms". As a result, the ichthyofaunistic ratio changed and the numerical superiority of the *Ctenopharyngodon idella* species was taken over by *Carassius gibelio*, a species resistant to the lack of oxygen in the water. The study area was declared a protected area in 2000, based on the presence of certain fish species such as *Misgurnus fossilis*, *Umbra krameri*, *Romanogobio kessleri*, *Leucaspius delineatus*, *Rhodeus amarus*. The results of the field research revealed the presence of 16 species, *Carassius gibelio*, *Ctenopharyngodon idella*, and *Abramis brama* being dominant species. Beside the ichthyofaunistic study, the importance of the research consists in the proposed measures for the sustainable management by reducing the activities with negative impact (uncontrolled expansion of the human habitat, recreational fishing, recreational activities, non-native invasive species and diffuse pollution) and even tourism promotion of the area.

Key words: ichthyofauna, environmental challenges, protected area, the Adunaţii de Geormane Lake

INTRODUCTION

The natural variability represents the main condition based on which managers must make decisions. The common element of all the studies in the field includes the immediate effects on species composition and diversity, as well as the reduction of habitat complexity. Consequently, it is useful to consider ichtyofauna as a gradient of habitat complexity and environmental variability (AUSTER and LANGTON. 1999).

In this regard, there are necessary diverse predetermined information and regulatory mechanisms for the management of fish habitats within protected areas. For example, protected-area regulations involve restrictions with regard to the anthropogenic impact and are typically based on law enforcement. However, in reality, the management of community-based natural resources and integrated conservation have often not met the expectations due to local communities in terms of implementation and non-compliance issues (AWUNG and MARCHANT 2016). Therefore, it is necessary that those involved in the planning and management of aquatic natural protected areas to take into account the activities of local communities, considered as social responsibilities, as well as their economic and environmental impact (WALKER et al. 2015).

Data on the ichthyofauna of the Victoria Lake can be found in the work elaborated and published by MARX et al. (1967), where there are presented the following species: *Cyprinus carpio* (common carp), *Abramis brama* (common bream), *Blicca bjoerkna* (silver bream), *Perca fluviatilis* (European perch), *Carassius gibelio* (Prussian carp), *Carassius carassius* (Crucian carp), *Rutilus rutilus* (common roach), *Scardinius erythrophthalmus* (common rudd), *Alburnoides bipunctatus* (schneider/spirlin/bleak), *Esox lucius* (northern pike) (**Tab. 1**). In 1972, the lake was stocked with *Ctenopharyngodon idella*, a rapidly growing species, for harnessing the natural abundant food; subsequent, in 1978, the Victoria Lake was populated with zander (*San-*

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Fish species protected by law (DAGL 2000)	*Umbra krameri, Rhodeus amarus Misgurnus fossilis, Leucaspius delineates Romanogobio kessleri*
Fish species that contributed to the designation of the protected area	*Misgurnus fossilis, Rhodeus amarus Romano-gobio kessleri, Umbra krameri*
Fish species mentioned in specialized literature (MARX et al. 1967)	*Cyprinus carpio, Abramis brama, Blicca bjoerkna, Perca fluviatilis, Carassius gibelio, Carassius carassius, Rutilus rutilus, Scardinius erythrophtalmus, Alburnoides bipunctatus, Esox lucius*
Fish species identified in 2015 (MPAGL 2015)	*Misgurnus fossilis, Carassius gibelio, Lepomis gibbosus, Perca fluviatilis, Pseudorasbora parva, Scardinius erythrophthalmus, Hypophthalmichthys molitrix*
Present fish species	*Cyprinus carpio, Abramis brama, Blicca bjoerkna, Perca fluviatilis, Carassius gibelio, Rutilus rutilus, Scardinius erythrophtalmus, Alburnoides bipunctatus, Esox lucius, Misgurnus fossilis, Hypophthalmichthys molitrix, Lepomis gibbosus, Pseudorasbora parva, Sander lucioperca, Silurus glanis, Ctenopharhyngodon idella*

Tab. 1 The evolution of the ichthyofauna composition of the Victoria Lake and the Marica Lake.

der lucioperca), a predatory fish species brought from the Research and Development Centre for Pisciculture Nucet to limit the development of small species of fish (rudd, bleak and perch), thus maintaining the biological balance of these lakes. In 1979, local fishermen reported the presence of Wels catfish (*Silurus glanis*) in the lake, a predatory species introduced for the same purpose, to limit the excessive multiplication of species with reduced economic value.

The present research study renders and develops different aspects concerning the main features of the Adunaţii de Geormane Lake natural protected area – diversity of species and possibility of monitoring the protected species of national interest, conservation of wetlands, presence of certain reproduction areas, presence of certain feeding and resting areas, accessibility to education, tourism and recreation.

MATERIAL AND METHODS

The Adunaţii Geormane Lake protected area is characterized by the presence of Marica and Victoria lacustrine ecosystems, located at the contact between Rojiştea terrace and the alluvial plain of the Jiu River from its lower sector (COTEŢ 1957, PÂRVU 1980), in the south-west of Romania. The lacustrine complex is located at a distance of 25 km about the Craiova town (**Fig. 1**). If in the past, Lake Victoria used to be a touristic area due to the presence of Victoria Resort, currently, the resort is in conservation and there are no possibilities of accommodation or restaurants.

The Victoria Lake communicated with the Marica Lake through a canal draining the excess water with low, sandy shores and few trees. The digital imagery (May 2017) and tools provided by Google Earth Pro enabled measurements of lakes with regard to surface (43 ha – the Marica Lake and 58 ha – the Victoria Lake), perimeter (3.09 km – the Marica Lake and 3.33 km the Victoria Lake) and shoreline development ratio (1.33 the Marica Lake and 1.23 the Victoria Lake). The length of the Victoria Lake is 1,120 m, while its width is 560 m, dimensions that generate its oval shape. The average depth of the lake is 1.77 m, but, towards its middle area, the depth increases to a maximum of 2.5 m.

The Victoria Lake is permanently supplied by terrace springs and local creeks located on the eastern shore. The flow is variable and influenced by the amount of annual rainfall, the characteristic evaporation process, periodic flooding and infiltration of groundwater (GOGA 2005).

The Adunaţii de Geormane Lake protected area of national interest was proposed and declared protected area by Act No. 5/2000, Act

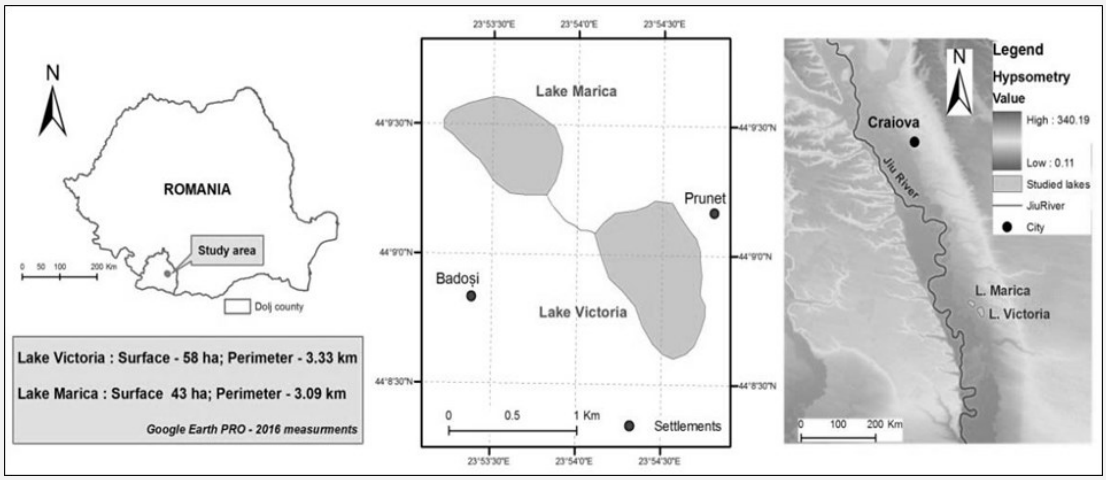

Fig. 1 The location of the study area (at national and regional level; the hypsometric map).

No. 49/2001 regarding the regime of natural protected areas, conservation of natural habitats, wild flora and fauna. Although Act No. 5/2000 states that the surface of the protected area is of 102 hectares, the surface was extended to 111.25 hectares, as the neighbouring zone was also considered to be important: the meadows and wetlands that connect these two lakes (MPAGL 2015). The protected area aims at protecting 17 fauna species of conservation interest belonging to six categories of animals - three species of birds, two species of mammals, three species of amphibians, four species of reptiles, four species of fish and one species of invertebrates, as it follows: *Gavia immer, Ciconia ciconia, Larus minutus, Neomys anomalus, Lutra lutra, Salamandra salamandra, Bufo bufo, Hyla arborea, Lacerta viridis, Emys orbicularis, Natrix tessellata*, *Testudo hermanni*, *Misgurnus fossilis*, *Rhodeus amarus, Romanogobio kessleri*, *Umbra krameri, Parnassius apollo*.

For the present study, the ichthyofaunistic material was collected with various fishing tools. In the spring of 2017, three monofilament nets measuring 30-100 m in length, 2 m in width, and mesh sizes between 25 mm and 60 mm, were caught and examined specimens of fish (individuals) of different sizes and weights belonging to the species mentioned in **Table 1**. We also benefitted from the support of amateur fishermen (**Fig. 2**) and of the Agency for Fishing and Hunting Dolj that gave us information on the current situation of the ichthyofauna of the lake.

RESULTS

Compared to 40 years ago (the north-western and north-eastern shores presented a wide belt of reeds and rushes - MARX et al. 1967), the vegetation of the shores of the Victoria Lake is currently reduced and represented by emerged macrophytes that develop only along the northern and north-eastern shores, while floating macrophytes develop on the north-western shore. The western shore is sandy or muddy (**Fig. 2**). The emerged and submerged vegetation has reduced a lot over the time, but the phytoplankton found here a favourable environment, *algal blooms* being intense in May. The vegetation delimiting the shores of the Marica Lake is mostly formed of reed, which is present over the entire length of the shores (**Fig. 3E**). Regarding the shore vegetation, the Victoria Lake differs considerably compared to the Marica Lake, as it was strongly influenced by the presence of human settlements in its immediate proximity (**Fig. 3**). For the most part, the vegetation of the shores is almost absent or replaced by weeping willows and bald cypresses (MARX 1964). In the past, the harnessing of the abundant riparian macrophytes was done by introducing juveniles of *Cyprinus carpio* and *Ctenopharyngodon idella*, into the Victoria Lake. At that time, there was not raised the question of the impact a newly introduced species might have on the habitat. As a result of over-multiplication of the introduced species, the vegetation on the southern and south-western shores disappeared and the phytoplankton found the perfect environment, a phenomenon that led to the change of the ratio between fish species. The numerical superiority of the *Cyprinus carpio* species in the lake was taken over by *Carassius gibelio*, an unpretentious species, resistant to oxygen deficiency in the water and more resistant to disease and frost than other species; it is followed by *Ctenopharyngodon idella*, *Abramis brama*, plus

Fig. 2 Recreational fishing on the Victoria Lake (May 2017) - left; – Sampling fish population (May 2017) – right up *Carassius gibelio*, right down – *Perca fluviatilis* (Photo by Goga C).

Sander lucioperca and *Silurus glanis* but in a lower number (GOGA 2005). New species appear in the composition of the ichthyofauna in 2015, such as (**Tab. 1**): *Lepomis gibbosus, Pseudorasbora parva* and *Hypophthalmichthys molitrix* (MPAGL 2015). Of the sixteen species present in the lake, the northern pike (*Esox lucius*), the European perch (*Perca fluviatilis*), the zander (*Sander lucioperca*) and the Wels catfish (*Silurus glanis*) are predatory species. In the Victoria Lake, MARX et al. (1967) mentioned the carp (*Cypri-nus carpio*), which intensively used natural feeding resources, as euconstant species. A major change of the natural report occurred in 2005 between the ichthyofauna representatives, the euconstant species being *Carassius gibelio, Ctenopharyngodon idella* and *Abramis brama,* due to the great variation of the food amount from one year to another (GOGA 2005).

Due to the ecological particularities mentioned above, all fish species present in the Victoria Lake are specific to stagnant ecosystems, with the exception of *Romanogobio kessleri* species found on the northern shore, under the influence of the drainage channel linking in the Marica Lake (700 m long).

In 2017, our main harvesting points of the fish stock have been set according to the accessibility of the banks (the pontoon of the former Victoria resort, the Prunet locality) and the local access roads (communal road 28). The 100 individuals collected, weighing between 90 g and 422 g, came from catches of personal monofilament mesh collection as well as from amateur fishermen in the area by fishing with rope. Each species of the extracted material was subjected to taxonomic determination.

In total, 16 species of fish belonging to 4 orders and 6 families were identified in the Victoria Lake. These species have a different spatial distribution starting from upstream to downstream, determined by the fluctuating pressure exerted by the abiotic and biotic environment.

In the present, as aquatic vegetation is absent on almost half of the Victoria Lake (**Fig. 3 D**), there are not met satisfactory conditions for the accumulation of organic matter and the development of cyprinid juveniles, which might have led to the decrease of the fish populations. Another reason explaining the limitation of the number of this fish species, as well as the disappearrance of certain species present in the standard datasheet based on which the lacustrine complex was designed protected area of national interest, might be related to the water circulation system that causes the reduction of spawning areas and the development of submersed aquatic vegetation. Because of this, benthic food became hardly accessible to fish.

DISCUSSIONS

The excessive exploitation of fishery resources of the Victoria Lake and the Marica Lake, which means the failure to comply with the regulations regarding fishing conditions, led

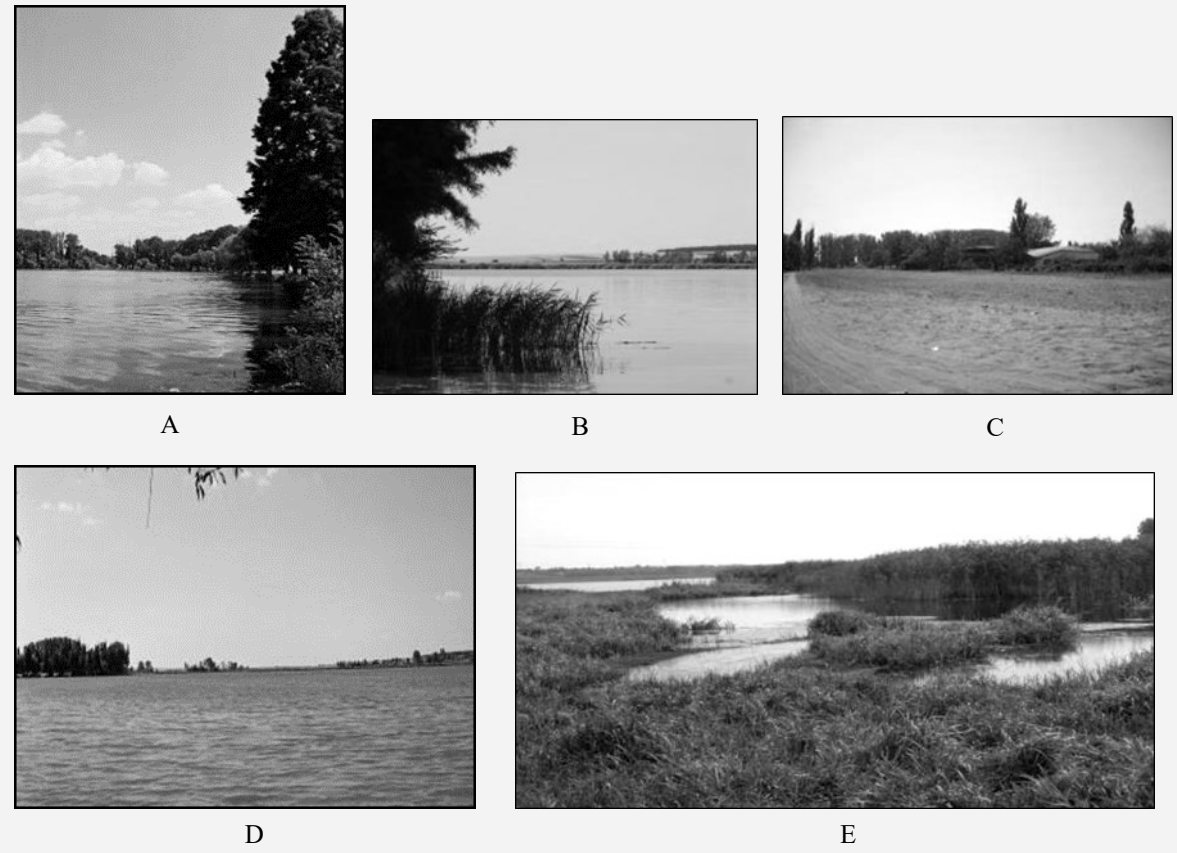

Fig. 3 The Victoria Lake and the Marica Lake - aspects of the shores: A, B, C, D, E (Photo by GOGA, 2017).

to the reduction of the number of fish species of commercial and conservative interest. Along with uncontrolled exploitation by poaching, pollution disturbs the ecological balance of the aquatic environment with negative consequences for biodiversity and hence for ichtyofauna by: intensification of eutrophication; reduction of flora and fauna biodiversity; decline in organic production; ecological imbalance (MPAGL 2015). In this respect, human activities that endanger the site are: uncontrolled burning of the vegetation in the proximity of the lakes, construction of new access roads, land cultivation, grazing, uncontrolled waste disposal and recreational fishing.

The perturbation of the breeding and feeding habitat of the species of fish is presently generated by the construction of jetties on the shores of the lake. These activities can be mitigated by increasing the awareness of local communities and their involvement in local greening campaigns. It is necessary to plant woody species and keep a 15 meters wide buffer zone between the lake shore and constructions in order to prevent shore erosion.

Water quality in lakes and impairment of reproduction of fish species are influenced by the lack of a sewerage system and of a wastewater treatment plant in the villages from the vicinity; consequently, it is proposed the construction of a sewerage system equipped with a wastewater treatment plant. The reduction of the fish populations at a faster pace than the regenerative capacity is determined by chaotic recreational fishing done with monofilament nets or trawl; thus, it is required the application of strict regulations regarding the fishing of species of high commercial value, taking into account the population size and number of individuals of the respective species during the breeding period (March-May).

It is required the widening of the canal that connects the two lakes in order to maintain a continuous flow and normal circulation of fish, as well as the reintroduction of fish species of conservation interest, which were not identified in the field, but based on which the Adunații de Geormane Lake was designated a natural protectted area of national interest. It is recommended to populate the Victoria Lake and the Marica Lake only with native, non- invasive species, based on

a solid previous documentation taking into account the fact that the introduction of invasive species might limit the ichthyofauna of the lakes.

CONCLUSIONS

The potential manifestation of the anthropogenic factors on the conservation status of the species and habitats within the Adunații de Geormane Lake protected area of national interest is conditioned not only by the proximity of settlements, but also by the demographic size.

The importance of this research resides in the ichthyofaunistic study and proposed measures for sustainable management - eliminating or reducing those activities with potential negative impact and reintroducing native species.

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