PhD THESIS SYNOPSIS

„Contributions to the Development of New Exploratory Research Methods for Biological and Ecological Diversity Conservation, Restoration and Strengthening Within Lacul Stiucii Nature Reserve”

Impacts exerted by human activities on the environment have unfortunately materialised in a succession of significant errors, which were in fact caused by mistakes, omissions or plain disregard for the balance of nature. In time, more or less reasonable human interventions brought about the extinction of numerous plant and animal species.

Therefore, creating protected areas in order to keep the flora, fauna, soil and subsoil out of the reach of unreasonable human interventions has become a concern for people all over the world.

Nowadays humans seem to have become more aware of the responsibilities they have towards nature and more conscientious with regard to the need to extend as much as possible such protected areas (both by increasing their number and by expanding their area).

It is now generally acknowledged that only a reduced number of plant and animal species have become extinct as a result of natural causes, whereas in the majority of cases species depletion was caused by human action, by either outright extermination, brutal changes of their habitats, unreasonable land exploitation or introduction of new invasive or predatory species outcompeting native species. Excessive, irrational and overly intense hunting has led, on the one hand, to extinction of large size animal species and bird species, and it has brought about, on the other hand, numerous detrimental impacts on the quality of the fauna, by promoting preferences in removing certain animal specimens from some habitats.

Many of us believed and still believe that natural resources are inexhaustible, that these are present in unlimited quantities in nature and, hence, they will never run out. However, this belief some of the humans still harbour has now been proven to be just a fallacious theory, reality showing that abusing the environment is always a one–way road, leading to food shortage for both humans and animals and, in many cases, to ecological disasters.

Human impact on the nature, which has in its initial stages been imperceptible, became increasingly poignant over the last century, causing irreversible transformations with combined and diversified effects which engendered severe changes to the ecological balance, affecting the quality of life.

As a result of all the factors listed above, the idea of creating nature reserves and protected areas meant to prevent ecological imbalances by keeping the fauna, flora, soil and subsoil away from the effects of human interventions emerged.
Nowadays, even less educated people are aware that protected areas are essential for conservation of the biological diversity and for protection of the environment.

Nature reserves and, in general, all protected areas provide a wide range of scientific, educational, ecological, genetic, economic, recreational and even cultural benefits, which should by no means be underestimated, but, on the contrary, recognised and safeguarded.

Ever since 1864, when the first nature reserve in the world has been created, an increasing number of countries have started to institute such means of protection for their outstanding areas, displaying natural peculiarities or remarkable resources, in order to make sure that the flora and fauna, as well as the soil and subsoil resources, remain unharmed.

It is along these lines that the study wishes to bring its small contribution to the conservation, restoration and strengthening of biological and ecological diversity of one of the most interesting and outstanding nature reserves in our country – i.e. Lacul Ştiucii.

This doctoral thesis, entitled „Contribuţii la dezvoltarea unor noi metode de cercetare exploratorie pentru conservarea, refacerea şi consolidarea diversităţii biologice şi ecologice la Rezervaţia Naturală Lacul Ştiucii” [„Contributions to the Development of New Exploratory Research Methods for the Conservation, Restoration and Strengthening of the Biological and Ecological Diversity Within Lacul Stiucii Nature Reserve”] has been prepared under the careful guidance of professor Bud Ioan, PhD. PEng., and it is formed of two distinct parts, structured as 13 different chapters, not including the Romanian and foreign bibliography consulted.

The thesis includes 240 pages, its first part, entitled „Bibliographical Study”, totalling 66 pages and its second part, entitled „Own Research”, totalling 168 pages. It also includes 57 tables, 109 figures and over 150 bibliography titles and websites.
Part I - BIBLIOGRAPHICAL STUDY, INCLUDES FOUR CHAPTERS STRUCTURED AS FOLLOWS:

Chapter I. NATURE RESERVES AND THE ROLE THEY PLAY IN PRESERVATION OF THE GENETIC PATRIMONY

This chapter details basic principles referring to the position held and the role played by nature reserves, to their historical background, their prevalence, whilst indicating the most important protected areas both worldwide and within Romania, their IUCN classification and protected area management categories. Furthermore, it was also aimed at presenting the current status of nature conservation in Romania and at reviewing the most representative Romanian protected areas.

Chapter II. BRIEF CONSIDERATIONS ON BIODIVERSITY AND BIO-CONSERVATION

This chapter refers to the established specialised terminology, whilst substantiating the need to preserve the genetic diversity of natural fauna and flora, so as to make sure that the genetic sources hoarding valuable genes which may serve in the future to plant and animal improvement are conserved. It lists principles of the nature conservation strategy and requirements to be met in order to achieve this. Endangered, threatened, endemic and vulnerable vertebrate and invertebrate species, as well as plant species, are also presented. Furthermore, reference is being made to the objectives of nature conservation and to the approach taken for the research activities conducted within „Lacul Ştiucii” nature reserve.

Chapter III. NATURAL BACKGROUND OF “LACUL ŞTIUCII” NATURE RESERVE

This chapter refers to the natural landscape where the reservation lies, to its main geographical data, to its climate features, soil characteristics, hydrographical network, flora and fauna in the Transylvanian Plain, as well as the most noteworthy nature reserves within this region.

„Lacul Ştiucii” nature reserve is deemed to be one of the most outstanding wetlands in Eastern Europe, being home to a surprising array of flora and fauna.

Fig.2 Massive reed (original)
Chapter IV. BIRDS – KEY COMPONENT OF THE NATURE RESERVE’S BIODIVERSITY

This chapter describes the avifauna living and breeding in Lacului Știucii and characteristic features of different bird species spotted by other researchers during the last 20 years. Due consideration was given to the fact that the environment is constantly changing, the birds being the first living creatures able to provide beforehand information on such changes. Over 34 bird species encountered in the area of the lake and previously mentioned by different authors are described herein, this chapter even including illustrations to enable easier identification.

Fig. 3 Great Crested Grebe (*Podiceps cristatus*) (www.abdn.ac.uk)

Part II – Own Research - includes nine chapters, the last chapter being dedicated to conclusions reached and recommendations made further to the investigation activities conducted, not including bibliography. This part of the thesis focuses on substantiating the approach taken to the research topic, main objectives targeted, working methods and means, tools used in order to reach objectives aimed at, outcomes and outputs envisaged, output analysis and conclusions reached after investigation.

According to the statement of work, key objectives of this PhD thesis included, as follows:

- Highlighting structural and functional features of „Lacul Știucii” nature reserve;
- Obtaining updated data on the physical, chemical and biological parameters of water in „Lacul Știucii” nature reserve;
- Describing communities of organisms to be found in this lake;
- Identifying significant changes affecting the lake basin’s evolution;
- Identifying, describing and detailing threats to the ichthyofauna (fish population) in this area;
- Identifying the avifauna present within „Lacul Știucii” nature reserve and suggesting protection measures to be taken in order to preserve it;
- Reviewing the impact exerted by the pumpkinseed sunfish, invasive species interfering with the aquatic fauna in this lake;
- Identifying mammals, water insects, reptiles and amphibians living within the nature reserve’s perimeter;
- Developing new methods to stop and prevent further degradation of „Lacul Știucii” nature reserve, in order to preserve biodiversity;
- Developing effective, state-of-the-art management strategies materialising in concrete measures, with a quick and beneficial impact in stopping destruction, preserving and protecting biodiversity in this area.
Chapter V. CURRENT STATUS OF „LACUL ŞTIUCII” NATURE RESERVE

This chapter is made up of several sub-chapters, all written considering the research topic’s rationale and its scope was to establish key objectives targeted, working methods to be used for their achievement, to analyse characteristic features and peculiarities of this nature reserve, to identify anthropic interventions having affected this protected area during the last few years, and to diagnose changes occurred at the level of the lake basin.

The research topic was aimed at scientific substantiation, updating and development of new methods for the restoration, conservation and strengthening of the biological and ecological diversity of „Lacul Ştiucii” nature reserve, in accordance with provisions in Government Decree no. 57/2007 regarding protected areas, conservation of natural habitats and wild flora and fauna, fully harmonised with the relevant European Community legislation.

This study is just a first step in this direction, but it is notwithstanding an indispensable step taken on the long way of preserving unharmed this nature reserve. Each protected area, including the nature reserve we have herein assessed, should be construed to be a self-contained, distinctive entity, different from all others, any analogies drawn between such independent entities being nothing more than formal and inconsequential.

The novelty in this case (the innovative character of this PhD thesis) lies in the opportunity to obtain new data and to update them, which represents an endeavour of the utmost importance, given the uniqueness and the peculiarities of this nature reserve, which still holds treasures yet to be discovered, secrets yet to be revealed and, on the other hand, given the need to implement an eco-system management strategy for sustainable conservation, scientific management, and safeguarding of this impressive natural scenery, by maintaining its current status parameters, as a minimum.

As detailed in each chapter, specific methods of works were used for the achievement of the objectives proposed, depending on the type of research activities conducted.

The research activities performed during preparation of this PhD thesis were carried out during 2010 – 2010 within „Lacul Ştiucii” nature reserve, sample testing and statistical calculations being done at the USAMV (University of Agricultural Science and Veterinary Medicine) and UBB (Babes – Bolyai University) Cluj – Napoca laboratories.

„Lacul Ştiucii”, declared nature reserve ever since 1966, lies in the North of Romania, on the northeast side of the Transylvanian Plain, at an altitude of 247.5 metres, on Valea Bontului, being bordered by hills with altitudes ranging from 470 m to 520 m.

Fig.4 Deforested hills around the lake (Original)
One of the peculiarities of this lake consists in its formation, as a result of dissolution, subsidence, collapse and plain flooding processes caused by its location in a diapirism area, salt deposits reaching almost up to the surface. As a result of high quantities of silt being washed away from the adjacent slopes and carried along 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, the lake being currently home to vegetation and fish species typical for stagnant fresh waters. „Lacul Ştiucii” is the deepest natural fresh water lake in the country. Three surface sources deliver water to this lake, namely Valea Pârtoţului, Valea Sănăşele and Valea Săcălaia, several underground springs and underground sources from the entire escarpment of Valea Anăului also supplying the lake.

The erosion trends affecting the abutting flanks and previous deforestations allow silt to accumulate continuously in the lake basin. Comparison against the previous surveys conducted revealed that the lake surface area, as well as its total water volume, has reduced significantly.

The complexity of habitats formed by the water body, wetland, reed bed and riparian willow thicket provides favourable living conditions for endangered or vulnerable species of reptiles, amphibians, invertebrates, birds and fish, not counting the numerous plant species.

However, regrettably, the presence of anthropic activities, such as the existing access ways, agricultural works carried out on the abutting flanks, buildings and ancillaries, high voltage networks, uncontrolled tourism, poaching, irrational fishing, populating the lake with new fish stock, etc. impacts detrimentally on the beauty and the uniqueness of this nature reserve.

Given the structure of its component habitats, as well as its location and particular features, this nature reserve is a great source for biodiversity and serves as a feeding, mating and repose place for migrant birds, and especially for aquatic birds. This nature reserve being situated on one of the important Pannonian – Transylvanian migration corridors turns the area into a crowded hot spot in certain periods of the year, when numerous bird species gather here.

In time, significant and alarming changes occurred, which brought about a dramatic shrinking of the lake surface, as a result of silt accumulating permanently.

According to our investigations, the lake surface has shrunk by 6.74 ha during the last ten years, while in the same period its average depth dropped by 0.17 metres, its maximum depth by 0.27 metres and the water volume has decreased by approximately 0.10 million cubic metres.

The reduction occurred in the water volume and in the lake surface area also affects the water quality parameters, which tend to drop, as a result of excessive proliferation of both submerged and emerged vegetation.

To sum up the findings of the investigations carried out, urgent remediation methods are required, such as executing dams upstream the inlet point of the water sources supplying the lake, in order to retain silt and sediments, creating riparian buffer zones in the form of forest belts planted on the adjacent slopes, which should serve to retain part of the silt which is normally washed away into the lake basin.
Table 1

Evolution morphometric features of Lacul Știucii in the last 53 years

<table>
<thead>
<tr>
<th>Specification</th>
<th>U/M</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface</td>
<td>ha</td>
<td>68.70</td>
</tr>
<tr>
<td>Length</td>
<td>km</td>
<td>1.720</td>
</tr>
<tr>
<td>Average width</td>
<td>km</td>
<td>0.399</td>
</tr>
<tr>
<td>Maximum width</td>
<td>km</td>
<td>0.816</td>
</tr>
<tr>
<td>Average depth</td>
<td>m</td>
<td>5.468</td>
</tr>
<tr>
<td>Maximum depth</td>
<td>m</td>
<td>12.700</td>
</tr>
<tr>
<td>Major axis</td>
<td>km</td>
<td>1.720</td>
</tr>
<tr>
<td>Short axis</td>
<td>km</td>
<td>0.520</td>
</tr>
<tr>
<td>Lake perimeter</td>
<td>km</td>
<td>4.261</td>
</tr>
<tr>
<td>Slope basin</td>
<td>m/km</td>
<td>40.210</td>
</tr>
<tr>
<td>Total volume</td>
<td>mil.mc</td>
<td>3.757</td>
</tr>
</tbody>
</table>
Chapter VI. PHISICOCHEMICAL PROPERTIES OF WATER IN „LACUL ȘTIUCII” AND THE INFLUENCE THE EXERT ON THE AQUATIC ORGANISMS

This chapter presents the results obtained for the medial parameters of the lake water, considering the existence of a strict correlation between the survival of fish and other aquatic organisms and the physicochemical parameters of water.

The average water temperature was 11.27 °C in the first year of our research and 13.97 °C in the second year of research, being directly influenced by air temperature.

![Fig. 5 Air and water temperature fluctuation during 2010](image1)

![Fig. 6 Air and water temperature fluctuation during 2011](image2)

An important indicator for water quality, which forms the basis of a relative assessment of the natural productivity of an aquatic basin, is water transparency.

![Fig. 7 Monthly dynamics of water transparency in Lacul Știucii in 2010 and 2011](image3)

Investigations conducted as part of our survey revealed that water transparency throughout the year ranged from 1.3 to 4 m, depending on the dynamics of the phytoplankton and zooplankton, as well as on results of the changes due to thermal stratification. Comparison against the previous surveys conducted revealed an increase in water transparency, due to a reduction in the aquatic flora and fauna.
There is a strict balance between the quantity of oxygen dissolved in water and the mass of organisms present in the basin, therefore excessive proliferation of some organisms will lead to a quantitative reduction in other organisms.

According to the investigations performed during the two years mentioned, the average oxygen concentrations ranged between 8.56 and respectively 8.61 mg/l. However, there were also some critical moments when the oxygen dropped under 6mg/l, as a result of the presence of organic matter washed away by rainfalls or organic substance having reached the supply sources and engendering significant problems to the fish in the lake.

Water reactivity, assessed based on pH values obtained was 7.99 on average during the first year and 8.11 on average in the second year, which is typical for moderately alkaline waters, presenting only reduced deviation throughout the year. Therefore, it can be concluded that the water in this lake currently has an efficient buffering system and a relatively constant reactivity throughout the year.

It should also be mentioned that, according to some preliminary investigations, a peculiar phenomenon has been noted during the last few years, in autumn, consisting of hydrogen sulphide emissions, highly toxic for fish and all living organisms in the lake. No such release of hydrogen sulphide occurred during our research activities, but nevertheless this seems to have been noticed quite frequently during the last 20 years, engendering significant losses in the fish population.
Given the genesis of the lake, we thought it may be appropriate to also determine the lake’s salinity, our investigations revealing that some exchanges with the deeper saltwater layers occurs, through the underground springs, but only to a small degree, the concentration of salts in the lake water ranging from 490 to 695mg/l, which is acceptable for sustaining fish life in this lake.

We can therefore conclude that the research conducted showed some variations of the medial parameters characteristic for water in temperate zones, fluctuations being season-dependent and being influenced by the evolution of the phytoplankton and of the zooplankton and by presence of organic matter.

**Chapter VII. ALGAL AND ZOOPLANKTON COMMUNITIES ENCOUNTERED IN „LACUL ŞTIUCII”**

The phytoplankton and algal flora are the starting point of the food chain of an eco-system. The algae are a key factor in the subsequent development of the consumers, which include zooplankton, zoobenthos and fish.

Notwithstanding the fact that the phytoplankton structure has been studied for over 50 years, as a result of continuous changes occurred at this level, both its structure and dynamics underwent profound changes from one stage to the other. A phytoplankton analysis was carried out on living or conserved samples, using a Nikon Eclipse microscope.

Based on the research activities conducted and on the results obtained further to the investigations carried out, it can be concluded that the structure of the planktonic community has experienced little major changes during the last 36 years, from the point of view of taxonomic groups. Nevertheless, the number of taxa increased significantly in the case of Chlorophyceae, Cyanophyceae, Chrysophyta and Euglenophyta. The structure of phytoplankton communities in this lake is dominated by Chlorophyceae, with over 105 taxa.

Based on our investigations, which only confirm previous findings of other authors (Gudasz 2003 and Momeu 2007), it can be concluded that the phytoplankton in „Lacul Ştiucii” is characterised by a great variety of species, providing food for numerous links in the food chain and participating to a better oxygenation of water. Nevertheless, an excessive proliferation of submerged vegetation and especially rigid hornwort was noted, which will need to be fought off with determination, using efficient, state-of-the art methods, such as the patent pending peroxide method.

![Fig.10 Submerged vegetation overgrowth (Original)](image-url)
Zooplankton, another important link in the food chain of aquatic ecosystems is the most valuable source of food for plankton-eating fishes, but also for other fish species during their initial stages of development. Fishing nets (40 µm mesh size) were used for zooplankton sample taking, these being then identified using a microscope.

The research conducted revealed that the zooplankton in Lacul Știucii consists of protozoa (flagellates, ciliates), worms (rotifers) and numerous micro-crustaceans such as copepods and cladocerous, etc.

A closer look at the numerical density according to the relevant calendar month revealed that distribution is dependent on the evolution of temperatures and on the yearly biological cycles, copepods and cladocerous, representing over 80%, predominating and fluctuations in the range of 0/2 to 10% being recorded for the other components, according to the reference month.

Energy values and chemical composition of the zooplankton components show variations from one month to the other, both from the point of view of structure and from the point of view of metabolisable energy.

### Chemical composition of zooplankton - 2011

<table>
<thead>
<tr>
<th>Month</th>
<th>Water (%)</th>
<th>Dry substance (%)</th>
<th>Brute protein (%)</th>
<th>Sen (%)</th>
<th>Brute cellulose (%)</th>
<th>Brute fat (%)</th>
<th>Brute ash (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>85</td>
<td>15,0</td>
<td>7,2</td>
<td>4,1</td>
<td>0,7</td>
<td>1,4</td>
<td>2,3</td>
</tr>
<tr>
<td>-</td>
<td>100</td>
<td>48,0</td>
<td>27,2</td>
<td>0,4</td>
<td>9,3</td>
<td>15,2</td>
<td></td>
</tr>
<tr>
<td>April</td>
<td>85</td>
<td>15,0</td>
<td>7,3</td>
<td>3,6</td>
<td>0,8</td>
<td>1,2</td>
<td>2,0</td>
</tr>
<tr>
<td>-</td>
<td>100</td>
<td>48,6</td>
<td>24,0</td>
<td>5,3</td>
<td>8,0</td>
<td>13,3</td>
<td></td>
</tr>
<tr>
<td>May</td>
<td>86</td>
<td>14,5</td>
<td>7,5</td>
<td>3,4</td>
<td>0,9</td>
<td>1,6</td>
<td>2,0</td>
</tr>
<tr>
<td>-</td>
<td>100</td>
<td>51,7</td>
<td>23,4</td>
<td>6,2</td>
<td>11,4</td>
<td>13,7</td>
<td></td>
</tr>
<tr>
<td>June</td>
<td>85</td>
<td>15,0</td>
<td>7,6</td>
<td>4,2</td>
<td>0,8</td>
<td>1,4</td>
<td>2,0</td>
</tr>
<tr>
<td>-</td>
<td>100</td>
<td>50,5</td>
<td>28,11</td>
<td>5,3</td>
<td>10,7</td>
<td>13,2</td>
<td></td>
</tr>
<tr>
<td>July</td>
<td>87</td>
<td>13,0</td>
<td>7,4</td>
<td>3,9</td>
<td>0,7</td>
<td>1,0</td>
<td>1,8</td>
</tr>
<tr>
<td>-</td>
<td>100</td>
<td>56,9</td>
<td>30,0</td>
<td>5,4</td>
<td>7,14</td>
<td>12,8</td>
<td></td>
</tr>
<tr>
<td>August</td>
<td>86</td>
<td>14,0</td>
<td>7,5</td>
<td>4,0</td>
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<td>1,6</td>
<td>1,8</td>
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<tr>
<td>-</td>
<td>100</td>
<td>53,5</td>
<td>28,5</td>
<td>2,8</td>
<td>11,4</td>
<td>12,8</td>
<td></td>
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<tr>
<td>September</td>
<td>87</td>
<td>13,0</td>
<td>7,6</td>
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<td>10,7</td>
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<tr>
<td>October</td>
<td>86</td>
<td>14,4</td>
<td>7,4</td>
<td>3,9</td>
<td>0,5</td>
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<td>3,5</td>
<td>7,14</td>
<td>12,5</td>
<td></td>
</tr>
</tbody>
</table>

It can therefore be concluded that, according to our findings, the aquatic micro-fauna is to be found in fairly satisfactory numbers, so as to contribute to the appropriate feeding of ichthyofauna in its initial development phases until adult age, with beneficial nutritive values, appropriate for the appropriate growth of fish, but with some fluctuation from one stage to another, depending on the impact of different influence factors playing a role in that.
Chapter VIII. THE ICHTHYOFANA IN „LACUL ŞTIUCII” AND THE PROBLEMS IT FACES

This chapter’s scope is to assess the current status of the ichthyofauna in this lake, giving due consideration to the points listed below:
- Preparing updated records on the fish stock structure;
- Providing updated information on the density of different fish species;
- Ecological status of fish species to be found in „Lacul Ştiucii”;
- Monitoring the main predatory fish species, based on the yearly capture figures.

In order to identify and assess the fish fauna present in „Lacul Ştiucii”, three different methods of capture were used: deep gill nets, electrical fishing equipment and recreational fish conducted exclusively from boats, with the fishermen filling in standard forms (monitoring sheets) for the purposes of this research.

453 specimens from the twelve fish species identified in this lake were captured over a 24 hours period, using the three methods mentioned above, the catch structure being rather similar to the data presented by other authors. Three new species were also identified, which have only recently started to be encountered in this lake: the perch, the sheatfish and zander. The most frequently encountered species from the list of twelve was the common rudd (95 specimens, i.e. 21.83%) and the roach (60 specimens, i.e. 13.79%), the less frequently encountered being the Crucian carp (40 specimens, i.e. 9.19%); the sheatfish (9 specimens, i.e. 1.68%) and the zander (4 specimens, i.e. 0.92%).

<table>
<thead>
<tr>
<th>Species</th>
<th>Nr. (n)</th>
<th>Prt. %</th>
<th>Standard length and weight by size (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>0-5</td>
</tr>
<tr>
<td>Caracudă</td>
<td>10</td>
<td>2,29</td>
<td>-</td>
</tr>
<tr>
<td>Caras</td>
<td>35</td>
<td>8,04</td>
<td>6</td>
</tr>
<tr>
<td>Babușca</td>
<td>60</td>
<td>13,79</td>
<td>5</td>
</tr>
<tr>
<td>Roșioară</td>
<td>95</td>
<td>21,84</td>
<td>16</td>
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<tr>
<td>Oblete</td>
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</tr>
<tr>
<td>Plătică</td>
<td>25</td>
<td>5,75</td>
<td>-</td>
</tr>
<tr>
<td>Lin</td>
<td>23</td>
<td>5,28</td>
<td>5</td>
</tr>
<tr>
<td>Știucă</td>
<td>34</td>
<td>7,82</td>
<td>-</td>
</tr>
<tr>
<td>Biban</td>
<td>22</td>
<td>5,05</td>
<td>2</td>
</tr>
<tr>
<td>Somn</td>
<td>9</td>
<td>2,06</td>
<td>-</td>
</tr>
<tr>
<td>Biban soare</td>
<td>32</td>
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<td>25</td>
</tr>
<tr>
<td>Șalău</td>
<td>4</td>
<td>0,92</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>435</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>Percentage of total (%)</td>
<td>100</td>
<td>15,41</td>
<td>29,43</td>
</tr>
</tbody>
</table>

Tabel 3

Characteristics of harvested fish population in Lacul Știucii
In assessing the fish population, we categorised fish according to size, for each species, in order to see which categories recorded maximum densities, thus obtaining further indication on the status of a species at a given time (increase, stagnation or decrease).

Based on the data obtained, it can be concluded that a significant reduction occurred in the case of gibel carp and the Crucian carp, whilst common rudd and roach seem to have gained a foothold to the detriment of the former. A reduction in predatory fishes, as a result of excessive fishing and a proliferation of flounder, pumpkinseed sunfish and, partly, catfish, were also noticed.

It should be also noted that, for reasons related to the extensive total area of the lake, its variable depth and other peculiarities of the lake basin, as well as due to the lake being bordered by a dense and wide reed belt, which only allows for the lake to be accessed from a very narrow section, totalling approximately ten metres (on the side of the jetty), conducting a sampling able to provide very accurate figures for the dimensional structure of the fish populations proved to be impossible in this case, the data obtained serving for orientative purposes only.

From the point of view of the fauna behaviour, three species were found to manifest territorial behaviour (the pike, the tench and the sheatfish) and partly, the pumpkinseed sunfish, whilst the other species exhibited only reduced territorial behaviour (if any at all).

The fish population in this lake is represented by the twelve species identified, which include three species of predatory fish of economic value and nine small size species, the majority of which represent basic food for the predatory fishes.

A disquieting finding related to the predatory fish after two years of research concerns the decision (taken in 2010) to allow permanent recreational fishing. Our investigations revealed that in 2010, after permanent access was granted for recreational fishing purposes, starting from the month of May, when the fishing season was open (therefore over an eight month period) 1,329 pike specimens were caught, whilst in 2011, in spite of the fact that recreational fishing was carried out throughout the year, only 442 specimens were caught, which only proves the catastrophic effect that such extremely sensitive decisions can engender in a nature reserve, compromising the future of valuable species on the long term.

To sum up the findings of the assessment carried out on the predatory species in this lake, monitored throughout 20 calendar months, it should be noted that, from the point of view of the species, the structure changes from one stage to the other, on the one hand, due to the variations occurred at the level of the lake itself and, on the other hand, due to unreasonable introduction of new species (catfish, zander), which might destabilise the existing communities, outcompeting native species.
The sustainability of the existing ichthyofauna is endangered from the point of view of its stability and preservation, as a result of significant anthropic impacts (overfishing, excessive silting and permanent reduction of the water surface, frequent introduction of new species). Moreover, another detrimental impact on the stability of the fish communities is exerted by the presence of the pumpkinseed sunfish, invasive species displaying unusually high proliferation features, whilst other hazards may also be brought about by uncontrolled, unreasonable and inadequate populating practices.

Another objective targeted consisted of an assessment of the health condition of the fish population, based on haematological samples collected, in order to test haematological, serological, hormonal and tissular parameters. The results of the testing revealed a relatively good health condition, values being differentiated from one stage of the biological cycle to the other, however without compromising the overall stability of the fish community.

The following conclusions were reached and recommendations for preservation of the fish population were made as a result of the research activities conducted:
- Banning the fishing of species in declining numbers should be regarded as a must;
- Drastic reduction of recreational fishing and limiting it to short periods;
- Forbidding introduction of new species that may compromise stability of the ichthyofauna;
- Limiting and preventing silting up of the lake by executing weirs and planting forest belts on the adjacent slopes;
- Fighting against the proliferation of the pumpkinseed sunfish, invasive species impacting detrimentally on the ichthyofauna;
- Permanent monitoring of medial parameters.

Chapter IX. IMPACT OF THE PUMPKINSEED SUNFISH (Lepomis gibbosus) ON THE AQUATIC FAUNA IN „LACUL ŞTIUCII”

This chapter was meant to highlight the effects that this species can engender on the fish community in this lake and the ecological damage that it can cause, as well as the impacts on the evolution of the fish stock.

We therefore prepared a morphological description of the pumpkinseed sunfish population in the lake, comparing it against the biological material present in other aquatic basis.
A closer look at the main physical features of the fish stock in this lake and a comparison of the values obtained in this case against values obtained for other similar fish populations in our country revealed the existence of high variability features, confirming the great plasticity of this species, which allows it to adapt to the most diverse conditions and to spread across increasingly wider areas.

We were also interested in assessing the behaviour of the pumpkinseed sunfish under given circumstances, using for this purpose fish tanks of different sizes where we were able to watch the behaviour of the pumpkinseed sunfish in relation to its own species and to other species competing for the same food source, as well its adaptability to different types of food.

The research conducted revealed that the pumpkinseed sunfish is an aggressive species, out-competing native species for food, adjusting rapidly to any feeding and maintenance circumstances, and, in addition, given its configuration and particularities, it has the advantage of not being preyed upon by other predatory fish species, the perpetuation of the species being therefore secured. All the results obtained prove that presence of this species poses a significant threat to local fish populations, competing with them for food, eating their spawn and the young of the native fish species. Presence of the pumpkinseed sunfish in this lake led to a drastic reduction in the gibel carp, Crucian carp, tench, common rudd and roach stocks, these species not guarding their spawn or alevins. Fighting off firmly this species before its presence affects the ecological balance of this habitat is therefore a must.

Tabel 5

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Mean body weight

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Chapter X. THE AVIFAUNA OF „LACUL ȘTIUCII”, INVALUABLE TREASURE OF THIS NATURE RESERVE

Given the presence in this lake of floating reed islets similar to the ones in the Danube Delta, presence of the reed beds, as well as the abundance of bird species, identifying the structure of the avifauna in this natural reserve and establishing protective measures meant to preserve this invaluable treasure unaltered seemed like the appropriate way forward.

Further to our research, 30 bird species were identified, some of them being dependent on the water, some of them being wetland-dependent birds, some reed bed–dependent birds, some just feeding or nesting in this area, whilst other species are just “passers-by” crossing this natural reserve. The identification and recording of bird species were carried out based on the “Illustrated Inventory” prepared under the coordination of the Romanian Ornithological Society by Dan Munteanu (1999 issue).

A brief characterisation of the bird species present in this nature reserve led us to the conclusion that approximately 27 – 28% of the species present in Europe nest in this area, the birds finding here an ideal, welcoming and familiar habitat, that we should strive to preserve unaltered in order to avoid any further problems that may occur, later on.

We were able to identify several threats to the avifauna of this nature reserve, such as: wetland loss and degradation, changes in the structure of vegetation, an increase in the number of predatory species, constant human presence in this habitat, dropping water level, unreasonable fishing which impacts detrimentally on the density of the ichthyofauna, reed bed degradation and harvesting.

Taken into account the shortcomings noticed on the occasion of our inspections of the habitats, we suggested the following protective measures to keep the avifauna in this area unharmed and to maintain its presence at similar levels year after year:

- Protecting the aquatic flora and fauna;
- Improving de-siltation measures;
- Planting protective tree rows (curtains) along the perimeter of the lake;
- Avoiding intensive tourism;
- Fighting off poaching activities;
- Preserving the nature reserve unaltered;
- Pests and predators control.

Chapter XI. OTHER SPECIES ENCOUNTERED IN THE „LACUL ȘTIUCII” NATURE RESERVE

Given the diversity and the particularities of the fauna and flora in this reservation, we believe it may be of interest to identify other species living in this area, in order to have the complete background allowing us to fully assess and appreciate the richness of this invaluable heritage.

To that effect, we were able to identify numerous mammals and amphibians living in this area, some of which could impact detrimentally on the safety and perpetuation of birds and fishes, if over-proliferating, and create breaches in the balance of this eco-system.
The following can be mentioned: the red forest fox, the wildcat, the least weasel, the European otter, the musk rat, the European water vole, the Eurasian water shrew, insects such as the water scorpion, the great diving beetle, the great silver water beetle, the water stick insect, the brown hawker or reptiles such as the smooth newt, the great crested newt, the common toad, the European tree frog, the European fire - bellied toad, the yellow - bellied toad, the marsh frog, the agile frog. Presence of all these species only confirms the diversity and richness of this nature reserve, unique in its own way, also known as the Transylvanian Delta, which should be protected and conserved for the sake of future generations.

Chapter XII. MANAGEMENT PLAN FOR „LACUL ŞTIUCII” NATURE RESERVE

This chapter should be construed to be the core of this thesis and it was actually meant to be a keystone in protecting this nature reserve, wishing to contribute as efficiently as possible to the conservation, restoration and strengthening of the biological and ecological diversity in „Lacul Ştiucii” nature reserve.

Based on the findings of our research, which targeted all the particularities of this nature reserve, after updating the existing data and conducting further investigation, we prepared a management plan including practical measures and actions meant to safeguard the sustainability of „Lacul Ştiucii” nature reserve.

The following can be listed among the main objectives of our management plan:
- Preparation of relevant documentation concerning the habitats to be protected;
- Creating and updating a database for this nature reserve;
- Quantifying limitative factors impacting directly on the evolution of this nature reserve;
- Conserving the flora, fauna and habitats within „Lacul Ştiucii” protected area;
- Managing recreational fishing reasonably and efficiently;
- Preparation of a tourism management strategy for this protected area;
- Developing a public relations strategy for this area;
- Ecologic restoration of habitats in this protected area.

Protective measures and actions suggested include the following:
- Cadastral delimitation of the nature reserve boundaries;
- Land-marking the protected area;
- Preparation of a digital map and of an electronic newsletter / website;
- Procurement of the equipment needed for the electronic storage of information related to the protected area;
- Preparation of fliers and brochures presenting the habitats of this nature reserve;
- Identifying anthropic factors and the extent to which they impact on the general condition of this lake;
- Establishing concrete measures for stopping the degradation of this nature reserve, for keeping unharmed and preserving biodiversity;
- Identifying the wild flora species in this area;
- Developing an atlas of flora and fauna in this nature reserve;
- Preparation of a documentation on potential threats to the spontaneous flora;
- Identifying terrestrial and aquatic fauna species living in this area;
- Seeking effective methods for conservation of species;
- Rehabilitation of overexploited fish stocks, fighting off invasive species;
- Fighting off firmly poaching activities and stress induced by human actions;
- Reducing and limiting recreational fishing;
- Reducing disorganised tourism;
- Developing ecological tourism;
- Cooperating with national and international nature protection institutions;
- Preparing an action plan for ecological renovation and conservation of the genetic patrimony in this area.

In addition to the management plan developed, we believed that urgent practical measures focusing on stopping degradation, keeping unharmed and preserving the biodiversity of this nature reserve, were also required.

The following can be listed among the most important measures to be taken for the future of this nature reserve:
- Execution of a drainage system on the valleys (plains) converging towards „Lacul Știucii“, in order to prevent siltation and eutrophication;
- Creating urgently riparian buffer zones in the form of forest belts on the adjacent slopes, which should serve to protect the lake against accelerated soil erosion;
- Setting drastic limits on recreational fishing, shortening the open season as much as possible and enforcing severe bans on the capture of valuable specimens (large, breeding size fish, etc.);
- Permanent monitoring and fighting of poaching affecting both fish and birds, invaluable treasure of this nature reserve;
- Executing simple dams upstream the inlet point of the water sources supplying the lake, in order to retain silt and sediments and performing regular cleaning in order to prevent build – up of sediments in the lake basin.

An important role in the conservation, restoration and strengthening of the biological and ecological diversity of this area is to be played to the administrator (custodian) of this nature reserve, which should get involved pro-actively in the following:
- Taking all the measures required in order to ensure an efficient protection of the values of this natural patrimony;
- Administering and managing the nature reserve in accordance with the management plan prepared and with regulations and laws concerning protected areas, monitoring permanently enforcement of these regulations;
- Promoting population awareness and information campaigns focusing on the requirement to protect nature and on the importance of nature reserves;
- Identifying any damages caused by humans to the nature reserve’s assets and notifying without delay the authorities in charge.

Chapter XIII. GENERAL CONCLUSIONS AND RECOMMENDATIONS

Further to the research activities conducted and on the results obtained, we were able to reach conclusions and make recommendations, as detailed below.

1. “Lacul Ştiucii” nature reserve, listed as one of the most outstanding wetlands in Eastern Europe, is a protected area of invaluable richness, serving to protect and conserve impressive habitats, and being home to an abundance of plants, birds, fish and animals. It holds undeniable value, both from the point of view of landscapes, and from the point of view of biological diversity.

2. Keeping unaltered the genetic diversity of plants, birds, fish and animals in this nature reserve is deemed to pass on this richness to the future, this requiring careful management and safeguarding, as this effort will provide a fountain of genetic sources which may serve for the improvement of different plant, animal and fish species in the future.

3. Our research activities pointed out that significant changes occurred in the evolution of the lake basin, as a result of intense siltation processes, which require urgent remediation measures to be taken in order to reduce this phenomenon likely to compromise the future of the nature reserve.

4. The reduction occurred in the water volume and in the lake surface area also affects the quality of medial parameters, and especially of the oxygen, which tends to drop, as a result of excessive proliferation of submerged and emerged vegetation. When decomposing, in the autumn season, this excessively developed vegetation will generate sapropelic sludge giving off hydrogen sulphide emissions, highly toxic for all the living organisms in the lake, and especially for the fish.

5. Based on our findings, we expect the siltation process to intensify towards the lake borders, where conditions are favourable for the reed belt to extend, in the inlet area, and a lot less towards the centre of the lake.

6. Values obtained for the hydro-chemical parameters in Lacul Ştiucii confirm that this lake is typical for the temperate zones, with two water mixing periods in spring and autumn and stratification periods in summer and winter. Thermal stratification is relatively stable throughout the summer season, with positive consequences on the structure and dynamics of phytoplankton and zooplankton, as well as on the ichthyofauna.

7. Fluctuating values were recorded for the most important chemical component of water, i.e. oxygen, the key indicator on which presence of the aquatic flora and fauna is dependent, which triggers oxygenation and mineralization, minimum values being close to
critical values recorded in July and August, as a result of the presence of organic matter washed away by rainfalls or organic substance having reached the supply sources, firm measures being required in order to reduce it.

8. Chemical and biological indicators are, in general, similar to the ones obtained for other aquatic basins in the area, the values ranging within the optimum limits admitted for fish culture. However, during short periods, these values reach the critical ceiling, especially in autumn, as a result of sulphur gas emissions.

9. Compared against previous findings of other authors, the results of our investigations confirm the great variety of species and phytoplankton communities, providing food for numerous links in the food chain and participating to a better oxygenation of water.

10. Analysis of the composition of phytoplankton communities revealed that the variety of major taxa has not changed significantly over the least 30 – 40 years, the Chlorophyceae being predominant, however a drastic drop in quantities has been noticed, which constitutes a true warning signal.

11. During spring and autumn, primary production was higher in the lake, as a result of increased nutrient quantities, Cladocerous and Copepods remaining dominant throughout the biological cycle, values fluctuating depending on the evolution of temperature, food and light patterns.

12. The phytoplankton and zooplankton biomass is relatively rich and well exploited by the ichthyofauna in this lake, whilst the fish seem to be in good health condition.

13. The phytoplankton and zooplankton biomass is relatively rich and well exploited by the ichthyofauna in this lake, whilst the fish seem to be in good health condition.

14. The responsibility for conserving biodiversity in this nature reserve lies with the public environment protection authorities, whereas the strategy for protection of the flora and fauna in this protected area is the duty of the nature reserve’s administration.

15. The fish stock in this lake fluctuates at different rates from one year to the other, depending on biotic and abiotic factors, but also on man intervention, so that the fish population remains around average density figures. However, if no changes occur with regard to the currently allowed unlimited recreational fishing, some species in this lake will face shortly drastic depletion, whilst other will become extinct (Crucian carp, tench).

16. In order to prevent unwanted fish species from getting into the lake, monitoring carefully biological material repopulations and checking drastically the health condition and the quality of the newly introduced fish specimens is of the utmost importance. Furthermore, people should refrain from introducing other species than those which are already part of the current fish community.

17. As a result of changes occurred in the structure of phytoplankton and zooplankton, in the surface and depth of the lake, a significant reduction was noticed in the case of gibel carp and the Crucian carp, whilst common rudd and roach seem to have gained a foothold to the detriment of the former. The pike stock has also decreased, whilst new species of fish, not encountered in the past, such as the zander and the tench, have been now identified.

18. The pumpkinseed sunfish, listed among the numerous invasive fish species mentioned by the scholarly literature and deemed to represent veritable “bad weeds” of aquatic basins, present in this lake, should be fought off with determination, given its detrimental impact on the fish fauna and its rapid over-proliferation.

19. In captivity, the pumpkinseed sunfish, invasive species whose presence is unwanted in this reservation, proved to be the quickest to adapt, from all the species studies, being in the
same time the only species showing constant development patterns throughout the experiment, which only proves its high capacity to adjust to the most diversified environment conditions and explains why this species has spread so rapidly to all types of aquatic basins.

20. Survival and perpetuation of the ichthyofauna, as well as distribution of the new generation, are dependent on the number of breeding size fish and on the quality of these specimens. Uncontrolled extraction engenders a risk that reproduction is severely affected in the future and that the fish stocks for some species no longer meet the optimum parameters.

21. As a result of the research activities conducted, management objectives were identified and practical suggestions were made, based on the assessment of the current condition of this nature reserve, on the shortcomings brought to our attention, on the management failures, which resulted in a MANAGEMENT PLAN being prepared, in accordance with provisions in the applicable legislation regarding conservation of biodiversity in protected areas.

22. The management plan thus prepared is in accordance with the Life – Nature Programme and it focuses, among other, on the conservation of bird species and natural habitat in this nature reserve, by promoting measures which, we hope, shall help safeguard this invaluable treasure.

23. Tree and grass planting on the severely eroded or deforested adjoining soils is expected to lead to partial rehabilitation of biologic diversity and to preservation of this nature reserve.

24. The research activities conducted and the results obtained further to the investigations carried out revealed the timeliness and the importance of these surveys, which were meant to warn on the permanent degrading of this nature reserve and on the need to initiate urgent remediation measures in order to conserve and maintain the biodiversity of species.

In addition to the conclusions reached further to the research activities conducted in this nature reserve, we believe that stronger support is needed from environment protection institutions, from local administrative authorities and from any other parties that may contribute, in whatever way, to keep unaltered this “Transylvanian Delta”, displaying, at a smaller scale, particularities which are very similar to those encountered in the Danube Delta.

This final objective of this work was to assess this nature reserve’s current condition, and, by preparation of the Management Plan, to identify practical measures needed so to maintain and enhance conditions required in order to conserve fish species, bird species and all other components of this nature reserve, unique in its own way, known as “Lacul Știucii”.

XXI
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