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# CONSIDERATION REGARDING THE AQUATIC ECOSYSTEMS DEVELOPED IN THE OPEN PIT LAKES FROM OLTENIA MINING REGION

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# Introduction

Open-pit or quarry lakes, whether formed voluntarily or involuntarily, aroused the interest of researchers in several directions, such as:

- the geotechnical risks posed by these lakes to neighboring areas during and after flooding;
- the evolution of the basin from a morphological point of view;
- the influence of the rocks that make up the lake basin on the water chemistry and the evolution of water quality;
- evolution of vegetation and fauna installed spontaneously and/or by human interventions;
- their ecology, functionality and dynamics;
- usage possibilities for various purposes (recreational lakes, sport fishing, irrigation tanks, flood protection, etc.);
- the influences exerted on zonal hydrology, on the local microclimates, etc.

We appreciate that this study can provide valuable information that can be extrapolated to other open-pit lakes in the Oltenia Mining Basin (existing, such as: Moi, Beterega and South Peșteana; or planned, such as: North Peșteana and Roșia de Jiu).

# Description of the biotope and physical conditions

The remaining gap occupies approx. 19 ha, has an elevation at the bottom between +145 and +152 m, has a length of 950 m, a maximum width of 220 m, the elevation of the water level being at approx. +165 m (maximum depth, of about 20 m, being reached in the central-eastern part). In the excessively dry years, the water level dropped to approx. +160 m.



# Description of the biotope and physical conditions



Urdari open-pit lake,  
in 2013 (left),  
respective in 2019  
(right).

The lake formed in the remaining gap of Urdari open-pit has not undergone significant changes in terms of size and morphology due to 2 important aspects:

1. The relatively rapid installation of grassy, shrubby and arboreal vegetation on the slopes prevented the occurrence of accentuated rain erosion, or even the triggering of landslides;
2. The existence, on the right side of the lake (east side), of a drainage channel that ensures the drainage of excess water from rainfall and surface runoff from the slopes, thus maintaining a relatively constant level of water in the lake.

# Description of the biotope and physical conditions

## **The climate.**

- The coldest month of the year is January (average temperature being of  $-2.5^{\circ}\text{C}$ );
- The warmest month is July (average values between  $20.6^{\circ}\text{C}$  -  $21.4^{\circ}\text{C}$ );
- The average annual temperatures range between  $9.7^{\circ}\text{C}$  and  $10.6^{\circ}\text{C}$ ;
- The multiannual average rainfall is of  $762.81 \text{ l/m}^2$ .

## **Vegetation.**

- Deciduous forests (*Fagus silvatica* and quercinea species);
- Meadows and agricultural land.

**Water temperature.** Heating is produced almost exclusively by the sun's rays. It is influenced by the circadian and seasonal rhythms.

**The density and viscosity** of lake water varies over the course of a year, being influenced by the temperature.

**The transparency** of the water of Urdari lake varies depending on the amount of organic and inorganic suspensions and the amount of dissolved substances.

**Water color.** In Urdari lake the water is generally colorless, but at certain times of the year or in certain years (the dry ones), the water may have a slightly yellowish or greenish color (organic or mineral suspensions and the exaggerated multiplication of algae - water flowering).

**Horizontal currents** in the case of Urdari lake are exclusively of wind origin. They move the mass of water to a greater or lesser thickness depending on their intensity and duration. Friction of the air on the water mirror produces waves and surface currents.

# Description of the biotope and physical conditions

**Water chemistry.** The water quality of Urdari lake was not monitored over time, so, for the present study water samples were taken (in 2019) in order to determine their quality, applying standard methods of sampling, transportation and analyses.

Crt. No.	Quality indicator	Measuring unit	Determined values for Urdari Lake	II <sup>nd</sup> quality class (according to Order 161/2006)	Times over
1	pH	pH units	8.00	6.5 – 8.5	-
2	CBO <sub>5</sub>	mg/l	5.10	5	0.02
3	CCO <sub>Cr</sub>	mg/l	14.10	25	-
4	Chlorides	mg/l	12.05	100	-
5	Sulphates	mg/l	22.84	150	-
6	Calcium	mg/l	112.40	150	-
7	Magnezium	mg/l	34.80	25	0.392
8	Phenols	mg/l	0.080	0.001	80
9	Iron	mg/l	0.108	0.1	0.08
10	Suspensions	mg/l	3.78	-	-

According to the analyses results, it is found that from a qualitative point of view, the water in the Urdari lake falls into the **second quality class**, which corresponds to a **good ecological status** according to Directive 2000/60/EC.

# Description of the biotope and physical conditions

***The bental (lakebed).*** The particle size structure of the benthic substrate has a great influence on the selection of organisms from the structure of benthonic cenoses. The substrate of Urdari lake consists of: clays, muds, sands, gravel and boulders (mixed substrate).



Lake sediments, of local and non-local origin, accumulate in the benthic zone. The first ones arise in the lake depression and come from the death of hydrobionts (plants and animals), from their decomposition and from the erosion of the shores, while the non-local ones come from the erosion of the soils within the supply basin brought to Urdari lake by runoff waters. The amount of organic matter in the sediments, in the eu-mesotrophic lakes, is generally high, between 38 and 40%.

# Description of the biocenoses

Urdari lake can be included in the category of eu-mesotrophic lakes. The identified biocenoses are specific to eu-mesotrophic lake (lacustrine) ecosystems (top), and, subordinated, specific elements of marsh and swamp biocenoses and those characteristic to saturated areas (shores in the immediate vicinity of the lake) (bottom).



# Description of the biocenoses

## Pelagos (Pelagic organisms)

- The Neuston** is a biocenosis present on the calm surface of water. Neuston consists of:
- Phytoneuston (microscopic algae and larger plants with partially emerged bodies: (*Salvinia natans*, *Lemna sp.*, etc.);
  - Zooneuston (consumers of different orders consisting of invertebrate animal organisms);
  - Bacterioneuston (decomposers, consisting of bacteria that are associated with microscopic fungi).

According to the place and the way in which the organisms carry out their activity, we can differentiate the epineuston (on the surface of the water film ) and the hyponeuston (in the thickness of the water film):

Epineuston: - plants (epiphytoneuston);  
- animals (epizooneuston).

Hyponeuston: All the populations here are hydrobionts. The hyponeuston, according to the populations that form it, is differentiated into:

- euhyponeuston;
- merohyponeuston.

# Description of the biocenoses

## Pelagos (Pelagic organisms)

**The Plankton** is a biocenosis present in all lacustrine ecosystems. It consists of phytoplankton, zooplankton and bacterioplankton.



*Pediatrum clathratum*



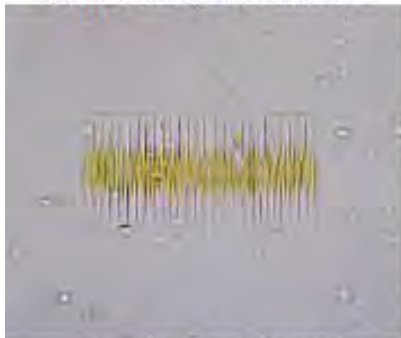
*Micractinium pusillum*



*Dibnoryoou sertularia*



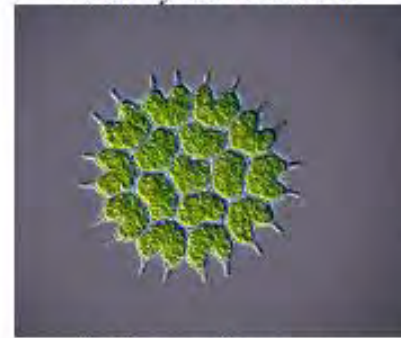
*Aste-rionella formosa*



*Fragillaria crotonesis*



*Scenedesmus quadricauda*



*Pediatrum borvamm*



*Mallomonas cauda*

### Morphological aspects of some elements of lacustrine phytoplankton

**The Phytoplankton** is composed almost exclusively of algae and is spread in the euphotic area of the basin. Phytoplankton is composed of species of siliceous algae (diatoms), blue-green algae (cyanophyceae) and green algae (chlorophylls).

# Description of the biocenoses

## Pelagos (Pelagic organisms)

**The zooplankton** is poor in species but very rich in individuals, being composed of animal species belonging to the following groups: *Protozoa* (rhizopods, flagellates and ciliate), *Vermes* (especially rotifers), *Arthropoda* (crustaceans: cladocera and copepods).



*Bythotrephes langimamus*



*Chydorus sphaericus*



*Daphnia longispina*



*Cyclops strenuus*



*Halteria cirrifera*



*Filinia langiseta*



*Leptodora kindtii*



*Brachionus urceus*



*Keratella cochlearis*



*Actinophrys sol*



*Polyarthra platyptera*



*Diaptomus coeruleus*

**Morphological aspects of some elements of lacustrine zooplankton**

# Description of the biocenoses

## Pelagos (Pelagic organisms)

**The Necton**, is an association of different species of animals, actively swimming throughout the body of water. True necton is formed by fish (other groups of animals occupying this biotope may be included here, but they are less important).

The fish found in Urdari lake are represented by: *Cyprinus carpio* (a), *Carassius carassius* (b), *Abramis brama danubii*, *Rutilus rutilus*, *Tinca tinca* (c), *Scardinius erythrophthalmus* (d), *Leucaspis delineatus*, *Pseudorasbora parva*, *Perca fluviatilis* (e), *Lepomis gibbosus* – invasive species in Europe (f), *Esox lucius* (g) and *Silurus glanis* (h).



a



b



c



d



e



f



g



h

# Description of the biocenoses

## Benthos (Benthic organisms)

Corresponding to the two littoral and deep areas, there is a littoral benthos and a deep benthos.

**The Phytobenthos** is well represented in the littoral zone and is missing in the deep zone. Its composition includes large plants (macrophytes) and small plants (microphytes).

### Macrophytobenthos

- the reed belt ( *Typha* (a), *Scirpus*, *Juncus* (b), *Phragmites* (c), *Carex*, *Glyceria*, *Hippuris*, *Eleocharis*, *Symphytum*, *Equisetum*, etc.).
- plants fixed by muddy bottoms and the flowers and most of the leaves are on top: *Alisma plantago aquatica* (d), *Sagittaria sagittifolia*, *Lythrum salicaria*, *Cicuta virosa*, etc.
- macrophytes with floating leaves fixed to the substrate by roots: *Potamogeton natans*, *Trapa natans*, *Ranunculus aquatilis*, etc.
- submerged, which create true underwater meadows:  
*Myriophyllum* sp. (e), *Potamogeton* sp. (f).



a



b



c



d



e



f

# Description of the biocenoses

## Benthos (Benthic organisms)

**The Microphytobenthos** consists of all unicellular colonial and multicellular plant organisms of microscopic dimensions that live on the muddy and sandy bottom.

**The Periphyton** is made up of all the vegetal and inferior animal organisms that live fixed on macrophytes, on boulders, gravel, etc. (sponges, bryozoans, hydras, etc.).

**The Zoobenthos** is made up of all animal organisms whose living environment is represented by mud, sand, etc. or the surface of these substrates.

The zoobenthos from the littoral area has in its structure numerous species of shells, snails, worms, insect larvae, crustaceans, bryozoans, protozoa.

In the deep zone, the zoobenthos has a different composition. Here live populations of protozoa, sponges, bryozoans, different worms (rotifers, nematodes, annelids, flatworms).

# Description of the biocenoses

## Other animal organisms integrated in the biocenotic structure of the lacustrine ecosystem

### **Phytophilic fauna:**

- on the underside of the floating leaves are frequently found gelatinous piles of water snail eggs, dragonfly eggs, brown *Glossosiphonia* cocoons and butterfly larvae.
- invertebrates and vertebrates live on the aerial side of macrophyte stems and in the reed thicket (*Libellula quadrimaculata* (a), *Calopteryx splendens* (b), etc.).
- amphibians live on the shores of the lake and in the reeds of the littoral area. Some of them, such as *Triturus cristatus* (c) and salamanders (d), are aquatic only during the breeding season (March - June), but others, frogs, are permanently aquatic (*Bombina variegata* (e), *Bombina bombina* (f), *Rana esculenta* (g) and *Rana ridibunda* (h), etc.).



a



b



c



d



e



f



g



h

# Description of the biocenoses

## Other animal organisms integrated in the biocenotic structure of the lacustrine ecosystem

- aquatic reptiles are represented by *Emys orbicularis* (a), *Natrix tessellate* (b) and *Natrix natrix*.
- numerous species of birds that procure their food from the water: *Anas platyrhynchos* (c), *Fulica atra* (d), occasionally *Cygnus olor* (e), etc.
- a few water mammals also live in the reed thicket. Some of them are rodents, others are carnivores. Among these we mention the otter (*Lutra lutra*) (f).



a



b



e



c



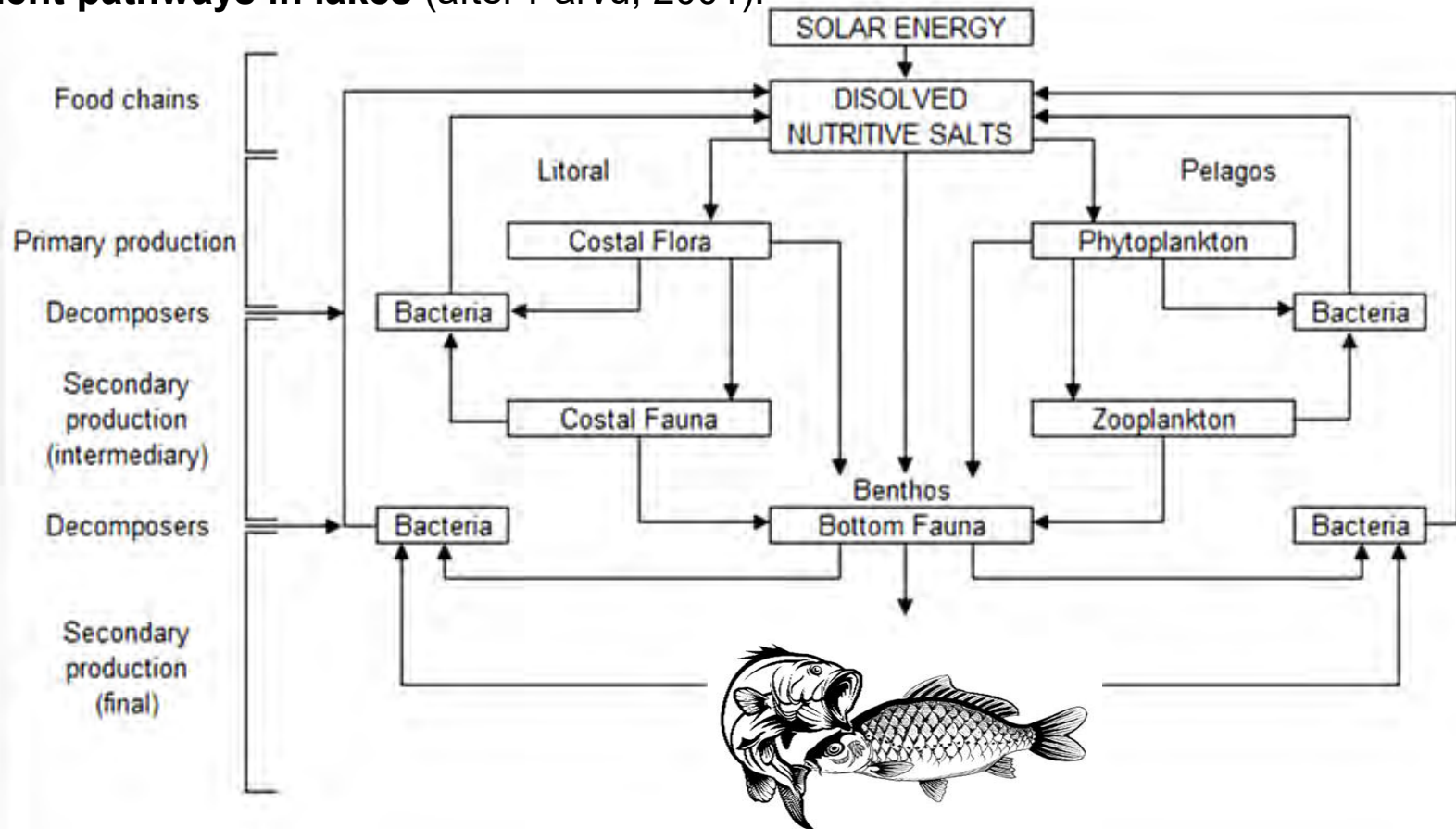
d



f

# Functionality and dynamics

Nutrient pathways in lakes (after Pârvu, 2001).

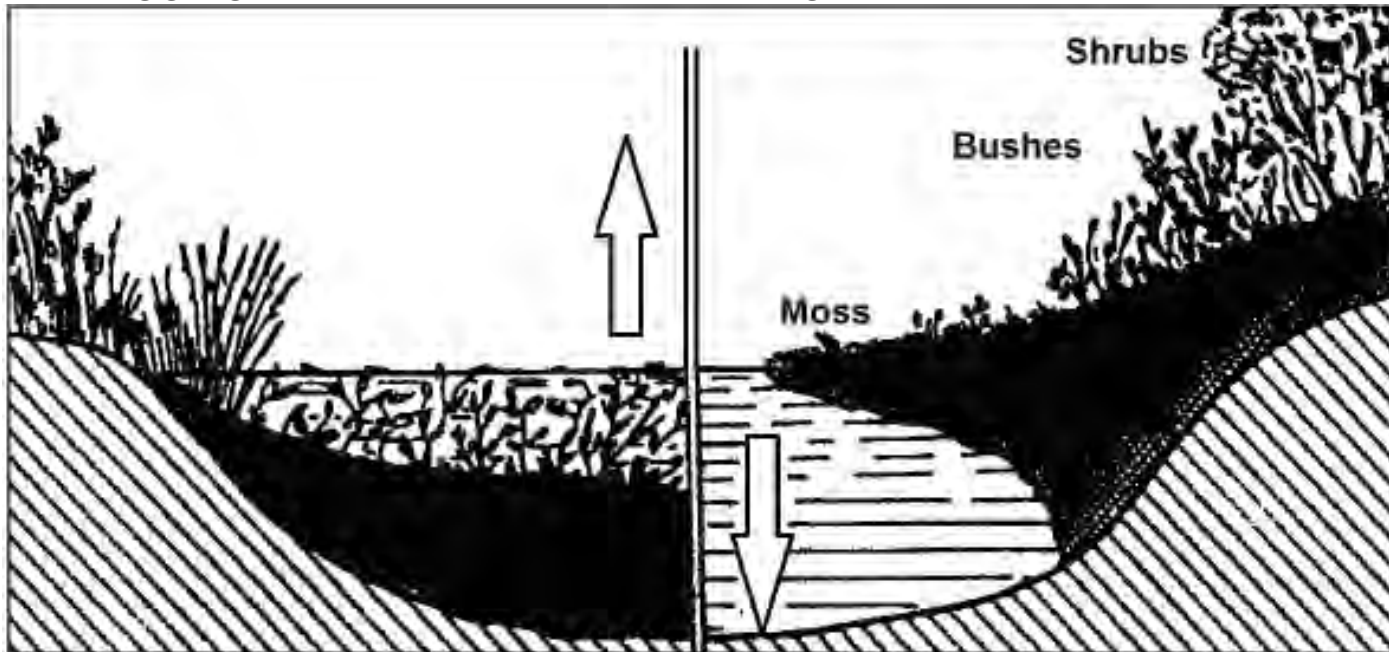


The food chains contain 3-5 links, less often they reach 8-10.

# Functionality and dynamics

Over time, the morphological state of the lake basins changes, appearing the irreversible transformation of the lake into a marsh, swamp and land. The process of organic clogging takes place permanently in two ways:

- deposits on the bottom of the lake, especially in the littoral area, which facilitates the advance of the shore inside the lake, reducing its surface and depth;
- the formation over the water mirror of a floating reed islet that gradually advances, occupying and clogging the lakes as a result of organic depositions.



# Conclusions

- **Urdari Open Pit Lake evolves similarly to the natural eu-mesotrophic lakes located in different hilly and plain areas in Romania.**
- **The ecological conditions from around Urdari Lake have favored the installation of an important vegetation in which we can find phytocoenoses with a conservative value, as well as a diverse fauna.**
- **The next step is to make a complete inventory of the phytocoenoses present in the area, based on the principles of the Central European phytocenological school.**
- **It is necessary to elaborate an adequate management plan, which will carefully monitor human interventions (especially those that may endanger the originality and integrity of this habitat).**
- **We recommend continuous monitoring of the vegetation whose emergence is related to natural multi-annual dynamics as well as human interventions.**

**All this leads to the general conclusion that flooding the remaining gaps of former lignite open pits (after ensuring proper technical conditions of the final slopes to avoid/minimize all geotechnical risks) is a viable option for reclamation of lands affected by mining operations.**

# The End



**Thank you  
for the opportunity to be part  
of this project and we hope  
to collaborate in the future !**