Research Group
Biological studies

Research Area: Environmental studies

EFFECTS OF MACROPHYTE REMOVAL ON THE SEDIMENT MICROBIAL ACTIVITY IN HIGH MOUNTAIN LAKES

INTRODUCTION

Lakes worldwide are under severe pressure from increasing anthropogenic impacts and global warming, creating a growing demand for restoration efforts and sustainable lake management strategies. However, there has been limited practice in restoring high-altitude lakes, particularly those under conservation status. Restoration efforts in four of the lakes from the Seven Rila Lakes cirque, within Rila National Park, Bulgaria, consisted of macrophyte harvesting followed by sediment removal. These were immediately followed by a monitoring program to evaluate the effects of human activities. The obtained results according to the project time frame focus on the effects of restoration on lake ecosystems. Metabolic activity of the sediment microbial communities was used as an bioindicator for shifts in their response to the restoration activities.

PROJECT GUIDELINES

Project lifespan: 1.03.2024 – 31.12.2025
Study site: littoral of lakes Bliznaka, Trilistnika, Ribnoto and Dolnoto from the Seven Rila Lakes circus.
Indicator for the investigation: sediment microbial communities.
Objective: assessing the effects of macrophytes and sediment debris removing in the Seven Rila Lakes and to gain new knowledge on the change of the sediment microbial communities after such conservation activities.

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METHODOLOGY

Sampling procedure: conducted in June, August and October, 2024; sediment samples were taken from treated (T) and untreated (N) sites from lakes Bliznaka (Bl), Detelinata (De), Ribnoto (Rb) and Dolnoto (Do).
Water physico-chemical properties: dissolved oxygen, water temperature, pH, and electrical conductivity - measured in situ using handheld meters (WTW and Hanna); ammonium nitrogen (ISO 7150/1), nitrate nitrogen (1.14773.0001), phosphate phosphorus (EN ISO 6878), chlorophyll-a (ISO 10260) – measured in a laboratory.
Bacterial metabolic profiles: used Biolog Ecoplate™ set (Biolog Inc., Hayward CA, USA) to assess bacterial metabolic capacity, utilizing 31 Ecoplate carbon sources, categorized into five carbon guilds: carbohydrates (CH), polymers (Polym), carboxylic acids (CA), amino acids (AA), and amines (Amin) Area under the curve (AUC; square units - SU) was applied to evaluate the average well color development (AWCD) and community level physiological profiles (CLPPs).
Statistical analyses: One-way ANOVA - to examine the significance of the differences; PAST 4.03 program for clustering analysis.

RESULTS

Statistically significant difference in the average microbial activity was found among the months of sampling ($p<0,01$) and not among the lakes ($p=0.69$).

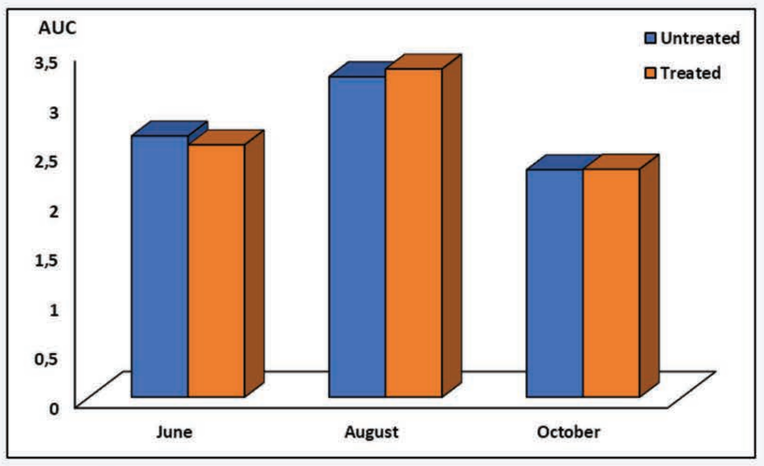

Figure 1. The average activity of the microbial sediment communities was the highest in August (3.27±0.67) and the lowest in October (2.30±0.46). The same trend was also observed for treated and untreated plots.

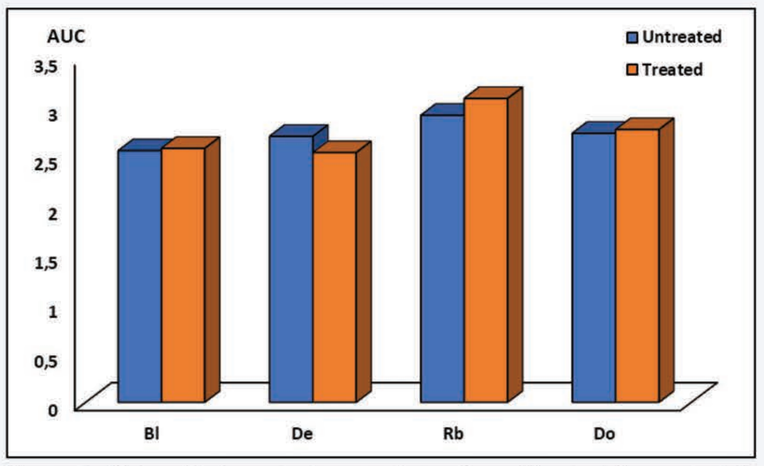

Figure 2. Plots with harvested macrophytes from Ribnoto lake exerted the highest microbial activity from the sediment samples (3.08±0.94), and treated plots from Detelinata lake – the lowest.

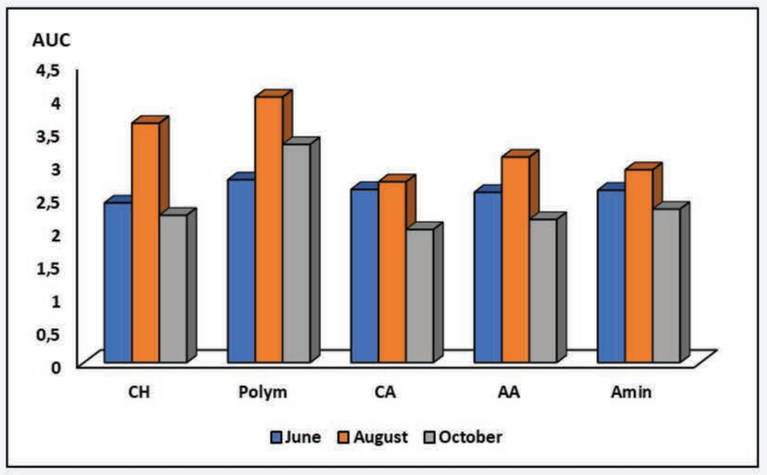

Figure 3. The rate of CGs utilization was the highest in August and lowest in October, except for Polym, where in June was registered the lowest activity. Among the CGs, Polym had the highest average rate of utilization (3.36±0.63) and CA the lowest (2.45±0.39).

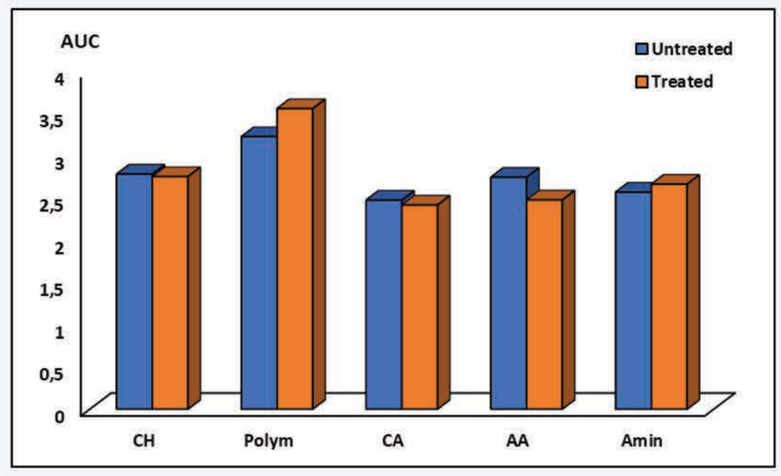

Figure 4. Average rate of CGs utilization in treated and untreated plots. Polym and Amin were better assimilated in treated plots, while CH, CA and AA in untreated although the difference was not statistically significant ($p>0.05$).

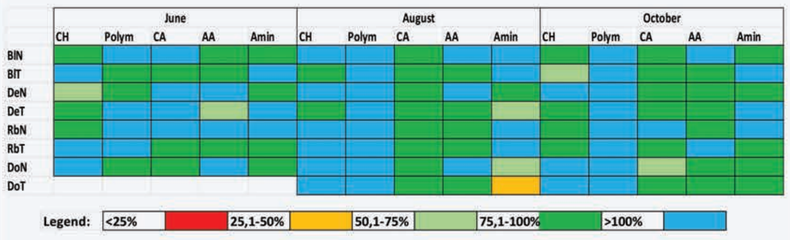

Figure 5. Bacterial community-level physiological profiles (CLPPs) of Bliznaka (Bl), Detelinata (De), Ribnoto (Rb) and Dolnoto (Do) lakes, with treated (T) and untreated (N) plots assessed in July, August, and October, 2024. Carbon source utilization rates were expressed as a percentage of the respective AWCD, and a five-level scale was used for CS availability.

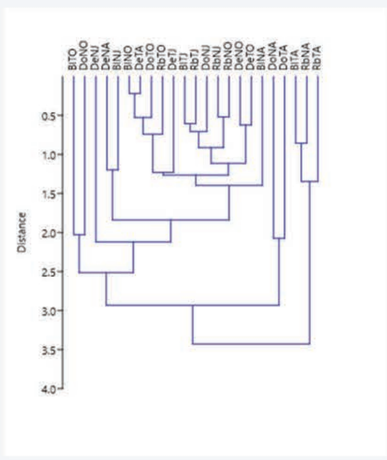

Figure 6. Cluster analysis of Bliznaka, Detelinata, Ribnoto and Dolnoto lakes in the sampling months (J-June; A-August; O-October) and treated and untreated plots according to the CGs utilization rate.

CONCLUSION

Results showed that macrophyte and sediment removal did not affect significantly the microbial metabolism in the lake sediments. There was not statistically significant difference between treated and untreated plots ($p>0.05$), while it was significant among sampling months and among different CGs ($p<0.01$). Based on the conducted analysis it can be concluded that the considered restoration activities are appropriate for maintaining the lakes' condition. This could help the respective authorities to take better decisions when elaborating future management plans for the lakes or other water bodies.

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