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WATER QUALITY AND PROTECTION: ENVIRONMENTAL ASPECTS

Long-Term Variations of the Trophic State Index in the Narochanskie Lakes and Its Relation with the Major Hydroecological Parameters

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Abstract—Variations of the trophic status of lakes Batorino, Myastro, and Naroch were analyzed over a long period of 1978–2013. The lakes form a system of interconnected water bodies with a wide range of trophic states. In the period under consideration, the trophic conditions in the lakes varied from highly eutrophic (Lake Batorino) to oligotrophic (Lake Naroch), making it possible to analyze the long-term changes in the trophic state of the lakes with the use of different variants of evaluating the Carlson index (trophic state index, TSI), to assess the relationship between the three versions of the index with one another, with phytoplankton biomass, and with hydroecological characteristics, such as the concentrations of total N, seston, and organic matter and biochemical oxygen demand. The possibility to evaluate the index by other characteristics, including phytoplankton biomass, was also considered.

Keywords: lakes, trophic status, Carlson index, hydrochemical characteristics, phytoplankton biomass

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INTRODUCTION

The trophic status is a key hydroecological characteristic of water bodies. The problem of changes in the trophic status of water bodies has become especially acute in the second half of the XX century, when the processes of eutrophication (an increase in the production of aquatic ecosystems, mostly under the effect of anthropogenic factors) acquired a global scale. The critical importance of the problems associated with the eutrophication of water bodies and water quality deterioration determined the need to adequately evaluate the trophic status of water bodies. The estimate of the environmental condition and the trophic status of a water body can be objective only when based on a maximally wide description of the biological, chemical, and physical parameters of the water body [18]. There are no distinct boundaries between trophic zones, as a water body can be oligotrophic by one criterion and eutrophic by another [13]. In addition, a description of the trophicity status of a water body limited to the main terms of the trophic status (oligo-, meso-, and eutrophic) can be too scarce for assessing its conditions. This implies the need to numerically express the trophic status, thus making it possible to compare the results obtained by different experts at different objects. Carlson index [15] is among the most widely used characteristics of the trophic state. It is calculated by three hydroecological characteristics: the concentrations of chlorophyll (Chl) *a* and total P in water and the Secchi depth (SD). R. Carlson proposed formulas for evaluating an index by each such characteristic, each being an independent variant providing a numerical measure of the trophic status of the water body. Later, in [23] it was proposed to supplement this index by an estimate of trophicity by the total N content of water. These seems to be justified in the case of water bodies where N rather than P is the main limiting factor, a feature most typical of water bodies in the temperate zone. R. Carlson noted that the main hydroecological characteristic of the trophic status of water bodies is phytoplankton biomass [15], which can be indirectly assessed by the indices he had proposed. Phytoplankton biomass evaluation by indirect characteristics is impelled by the methodological problems and labor intensity of its determination, justifying the use of indirect methods of biomass assessment in the calculation of trophicity index of water bodies.

In this context, of particular interest is the analysis of the correlation of different approaches to calculating the trophicity index with the biomass of phytoplankton community, as well as with other major hydroecological characteristics, including biochemical oxygen demand (BOD), water seston content (*S*), the concentrations of total and mineral forms of biogenic elements, etc. Such data can demonstrate the adequacy of trophic state estimate for a water body by the widely used Carlson index, which, in its classic form, involves as little as three characteristics. Moreover, in [14, 26, 33], this index is evaluated with one or two characteristics. The formulated objectives can be