as a result the water transparency is low in European shallow lakes. This leads to light limitation of benthic algae growth at the bottom of the lakes. In 2004 this index was positive in 2005 – negative; due to this in 2005 annual air temperature was higher in comparison of 2004. It led to almost double increase of water salinity in 2005. As a result predatory *Gammarus aequicauda* disappeared from the top trophic level of lake ecosystem. It promoted great population growth of large grazer *Artemia urmiana* in plankton. Strong negative relationships between primary production of phytoplankton and biomass of *A. urmiana* were found in Lake Tobechikskoe showing top-down effect of *A. urmiana*. This factor in combination with competition for nutrients between phytoplankton and bottom filamentous algae is supposed to be responsible for establishment of macrophyte-dominated ecological regime in Lake Tobechikskoe in 2005. Therefore, climatic fluctuation may be one of the main factor bring to regime shifts in ecosystem of shallow saline waterbodies.

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## CHAOS IN PLANKTON COMMUNITIES OF THE NAROCH LAKES

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Irregular oscillations of population abundance were hypothesized to be at least partially driven by an intrinsic mechanism (such as deterministic interactions between species) known as "deterministic chaos» (Solé, Bascompte, 2006). Recent attempts to find chaotic regimes in the wild have been resulted in the conclusion that a great majority of populations live at a boundary between chaotic and regular dynamics, i.e. on the edge of chaos (Turchin, 2003). We report here (see also Medvinsky et al., 2015) that chaos can emerge far away from the edge of chaos. Namely, we show that the plankton dynamics in the Naroch Lakes exhibit chaos with the horizon of predictability of around 2.5 months, and the dominant Lyapunov exponent equals approximately 0.4, thus lying out of the narrow interval between -0.1 and +0.1 characteristic of living at the edge of chaos. We also demonstrate that the second order Renyi entropy of the plankton biomass fluctuations can be considerably greater than the values of the dominant Lyapunov exponents. It implies that the qualitative description of the chaotic plankton dynamics in the Naroch Lakes requires a four- or higher dimensional phase space. In other words, interspecific interactions across trophic levels (for example between fish, zooplankton, phytoplankton and bacterioplankton) can significantly contribute to the emergence of chaos far away from the edge of chaos.

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## USING THE ARTIFICIAL NEURAL NETWORK (ANN) MODEL TO PREDICT HARMFUL ALGAL BLOOM (HAB) DEVELOPMENT

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In many watercourses around the world including in the United States and Canada, harmful algae including blue-green algae (or cyanobacteria) wer-erecently blooming and surprisingly increasing at a large scale without any good understanding or explanation about their causes and effects. The algal growth has been normally explained by relationships between nutrient levels, water temperature, and other physical conditions such as light intensity, wind effects and flow circulation. An optimal combination of all these factors could lead to a blooming pattern and a large scale proliferation of harmful algal species.

Field experiments are extremely necessary to elucidate various factors that affect algal blooms and their proliferation. However, factors that can be determined in field experiments are limited, costly and time consuming. Moreover, these factors cannot represent their combining effects on the algal growth. Therefore, we would use the mathematical approach to deal with the coupling effects of governing parameters in the bloom occurrence and proliferation. We determine the key factors which govern the algal dynamics and