Alternative stable states of macrophytes versus phytoplankton in two interconnected impoundments of the New Danube (Vienna, Austria)

M. T. Dokulil\textsuperscript{1} and G. A. Janauer\textsuperscript{2}

With 3 figures in the text

Abstract: Natural dynamic processes leading to a shift from algal to macrophyte domination in the two impoundments of the New Danube flood-relief channel are associated with and explained by a theory of bi-stable states. Changes are largely caused by alterations of water level and hence the retention times of the impoundments. Implications for water quality evaluation are discussed using the concept of potential water column concentrations of phosphorus. Calculations indicate the importance of macrophytes as structures that can buffer nutrient concentrations, via uptake and storage in plant tissues. Results are contrasted with similar but anthropogenically-induced forward and reverse shifts in the nearby Old Danube seepage lake, and implications for lake management are discussed.

Introduction

The existence of alternative equilibrium states has long been recognized as a theoretical possibility for ecosystems (NOY-MEIR 1975; CONELL & SOUSA 1983; SOUSA & CONELL 1985). This hypothesis has been discussed extensively over the past decade for shallow lakes and recently gained widespread acceptance in connection with the recognition of the structuring role of macrophytes (JEPESEN et al. 1997; SCHEFFER et al. 1993; SCHEFFER 1998; SCHEFFER & JEPPESSEN 1998). Evidence from numerous field data accumulated during lake restoration, rehabilitation or biomanipulation studies, summarized in MOSS et al. (1997), SCHEFFER (1998) and JEPPESSEN (1998), now support this hypothesis.

Shifts from one stable state to a new equilibrium, e.g. from the clear-water phase with abundant submerged macrophytes to turbid water caused by massive

\textsuperscript{1} Limnological Institute of the Austrian Academy of Sciences, Gaisberg 116, A-5310 Mondsee, Austria; e-mail: martin.dokulil@oeaw.ac.at

\textsuperscript{2} Institute of Ecology & Nature Conservation of the University of Vienna, Dept. Hydrobotany, Althanstraße 14, A-1090 Wien, Austria; e-mail: janauer@univie.ac.at