Publications

# TR-285

## Management Tools for Aquatic Systems: The Role of Periodic Hydraulic Disturbances on Planktonic Communities

Yesim Buyukates and Daniel Roelke

- Full Text

Environmental disturbances in aquatic systems alter phytoplankton community structure, diversity and biomass (Hutchinson, 1961). For example, laboratory experiments and field studies have shown that episodic flushing and nutrient loading can result in enhanced phytoplankton species diversity (Padisak, 1993; Sommer, 1995; Hambright and Zohary, 2000; Buyukates and Roelke, 2002; Lovejoy et al., 2002). Competitive abilities of phytoplankton species vary as a function of the physicochemical environment. It follows that, high species diversity can then be maintained in systems where conditions fluctuate, thereby preventing competitive exclusion. Fluctuating conditions can also affect phytoplankton biomass in systems where phytoplankton and zooplankton interactions become decoupled, i.e., systems where phytoplankton response times are much less than that for zooplankton (Sommer et al., 1986; Reynolds, 1984; Lehman, 1988).

Because disturbances influence the structure of the phytoplankton community, the zooplankton community is also affected (Sommer et al., 1986; Steiner, 2001; Buyukates and Roelke, 2002). For example, succession from less-edible, slower growing, k-selected phytoplankton species to more edible, rapidly growing, r-selected species may occur following a favorable disturbance, and this may stimulate secondary productivity (Sommer, 1981; Reynolds, 1984; Sommer et al., 1986). Zooplankton population shifts might also occur, e.g., increased productivity of small, rapidly growing phytoplankton may result in enhanced performance of zooplankton of small body-size with short generation times (Sommer et al., 1986; Reynolds, 1984). Additionally, high phytoplankton species diversity may favor zooplankton forms that have adopted preferential grazing strategies (Reynolds, 1984; Reynolds, 1989).

Disturbances might affect zooplankton in another way, i.e., through enhanced food-quality. For example, under conditions of pulsed flushing and nutrient loading some phytoplankton species uptake and store nutrients at a rate greater than their reproductive rate (Ketchum, 1939; Droop, 1968; Droop, 1983; Sommer, 1989; Pinckney et al., 1999; Worm and Sommer, 2000). Higher cell-quotas for nutrients that limit zooplankton growth may result in enhanced secondary productivity (Sterner and Hessen, 1994; Hessen and Bjerkeng, 1997; Roelke et al., 1999; Roelke 2000). Conversely, low frequency and magnitude of inflows may lead the system toward steady-state conditions, where cell quotas might approach critical levels. Under these conditions, previously suitable prey might become unsuitable because of the nutritional mismatch between predator and prey. In this scenario, classical Lotka-Volterra predator-prey theory, where predator abundance increases with increasing food abundance, would fail to describe interactions between zooplankton and phytoplankton (Lotka, 1932). In other words, regardless of high food quantity, poor food quality would result in decreased performance of some zooplankton populations (Sommer, 1992; Roelke, 2000; Urabe et al., 2002).

The structure of the zooplankton community might enhance or mask the effects of disturbances on phytoplankton community structure and food quality. For example, a well-established population of preferential grazers may exert strong top-down control on some phytoplankton populations, which would have otherwise proliferated following a disturbance (MacKay and Elser, 1998; Saunders et al., 2000). Similarly, non-selective grazers might exert a controlling top-down force on accumulated biomass. This would result in a continual recycling of nutrients to inorganic pools, thereby preventing phytoplankton cell quotas from declining to levels unsuitable for some grazers (Sterner and Hessen, 1994; Gulati and DeMott, 1997).

In a previous numerical modeling study, Roelke (2000) indicated that pulsed flushing and nutrient loading events would result in greater phytoplankton species diversity and greater secondary productivity. In order to prove this concept, we conducted experiments of a flow-through design, and rotifers and ciliates numerically dominated the zooplankton. Synchronous with these experiments, and using the same natural assemblages, we conducted experiments using semi-continuous design. In these experiments turbulence was less, and typically copepods were more prevalent and rotifers were much less abundant. Here we compare succession patterns between the two types of experiments and evaluate how the differing zooplankton community structure influenced the role of pulsed inflows on phytoplankton species diversity and secondary productivity.