Modeling the seasonal change of aquatic vegetation in ditches

M.Sc. Thesis
B.G. van Zuidam

January 2009

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Modeling the seasonal change of aquatic vegetation in ditches

B.G. van Zuidam

January 2009

M.Sc. Thesis
Aquatic Ecology and Water Quality Management Group
Report no. 003/2008

WAGENINGEN UNIVERSITY

Supervisors: E.T.H.M. Peeters
E.H. van Nes

Project leader: E.T.H.M. Peeters

DATA FOR INTERNAL USE ONLY
EXTERNAL USE OF DATA IS ONLY PERMITTED WITH CONSENT OF THE PROJECT LEADER

WAGENINGEN UNIVERSITY
WAGENINGEN UR

Table of contents

Abstract

Ditches are small artificial channels that are usually only a couple of meters wide and less than 1m deep. The aquatic macrophytes that are common in ditches can be divided into two groups: floating macrophytes and submerged macrophytes. Presence of submerged macrophytes has a positive effect on the biological quality of ditches, while high abundance of floating plants has a strong negative effect on the chemical and biological water quality. Field observations and literature both indicate that in ditches a shift of the dominant vegetation group can occur in the course of the growing season, from dominance of submerged macrophytes in spring and early summer to dominance of floating macrophytes in late summer and fall.
The objective of this study was to develop a simple mechanistic model that describes the competition between floating and submerged macrophytes. This model was then used to evaluate the effect of 4 different processes on the development of the aquatic ditch vegetation. The 4 processes that were studied are:

1. Continuous nutrient loading; a constant inflow of water and nutrients into the ditch
2. P release from the sediment due to high plant density
3. Seasonal variation of the nutrient load
4. Seasonal variation of temperature and light

In this study, it was evaluated for each of these processes whether it could cause the seasonal shift from dominance of submerged macrophytes to dominance of floating macrophytes.

A basic model was developed, that describes the competition between floating and submerged macrophytes in a stagnant ditch under constant environmental conditions. Next 4 extended models were made, each taking one of the 4 mentioned processes into account. The models were used to simulate the development of the ditch vegetation at different levels of total nutrient availability. From these simulations it was determined whether incorporating a process in the model improved the description of the development of the ditch vegetation. By mutually comparing the model results, for each process it was determined whether it could cause the seasonal change of the vegetation.

A model of the competition between submerged and floating plants in a stagnant ditch did not describe the development of the aquatic ditch vegetation correctly. However, the development of the ditch vegetation was described remarkably well by a model with continuous nutrient loading.

The model with continuous nutrient loading showed a seasonal shift from submerged to floating macrophytes at intermediate nutrient loading levels, even though no seasonal variation of the environment was taken into account. The ongoing supply of nutrients from drainage water is probably an important cause of the seasonal change of the vegetation.

The release of sediment-P due to high plant biomass can allow the seasonal change to occur at lower levels of nutrient loading. The release of P from the sediment could play a role in causing the seasonal change of the ditch vegetation.

The seasonal variation of the nutrient load had very little effect on the development of the vegetation. Therefore, seasonal variation of the nutrient load is probably not important in causing the seasonal change of the ditch vegetation.

The seasonal variation of temperature and light did not promote the occurrence of the seasonal change of the composition of the vegetation. Incorporating the seasonal variation of temperature and light availability reduced the range of nutrient loading levels over which the seasonal shift in dominant plant group occurs. The seasonal variation of temperature and light is probably not important in causing the seasonal change of the vegetation.