Critical values for phosphorus loading in ditches and streams.

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Introduction

- good ecological status ditches
- P and N loading
- alternative stable states
- global warming $\rightarrow$ biochemical processes
- complex feedbacks $\rightarrow$ ecological model
Introduction

- Good ecological status ditches → submerged macrophytes
- Ecological quality affected by P and N loading
Macrophyte State
State Transition

- vegetation state can differ from year to year
- N P loading, depth
- Management and maintenance
  Complex!
- In addition Climate Change
Temperature in ditches

- 3000 ditches national LimnoDatabase

![Graph showing water temperature and estimated yearly trend in ditches](image)
P-release and temperature

- P release from sediment will increase

Speaers et al 2008, sediment cores
Kamp-Nielsen 1975, sediment cores
Denitrification and temperature

\[ \theta = 1.28 \quad (Q10 = 12) \]

\[ \theta = 1.35 \quad (Q10 = 20) \]

Veraart & de Klein submitted
Denitrification and temperature

- Oxygen key role!
- Decomposition stronger affected than production
- Denitrification and P-release

Veraart & de Klein submitted
Ecological Models

- PC-Lake and PC-Ditch (*Janse, 1997*)
- biomass, N, P, O$_2$, light
- food web and competition
- calibrated on experimental research and data

- Alternative Stable States
- Critical loads
PC-Ditch
Modeling approach

- PC-Ditch connected to hydrodynamic model
- Biomass Elodea (submerged) and Lemna (floating)
- summer biomass \((\text{average August})\)
- critical P-load for transition \((50\% \text{ coverage of lemna})\)

- ‘Standard’ ditch (1m depth), organic layer sediment (10 cm)
- seasonal light and temperature
- stable inflow
- (network of ditches)
Model results
Model results (critical P-load)

August biomass Lemna (g/m²)

- N-load 210
- N-load 105
- N-load 83
- N-load 80
- N-load 78
- N-load 74
- N-load 42

August biomass Elodea (g/m²)

- N-load 210
- N-load 105
- N-load 83
- N-load 80
- N-load 78
- N-load 74
- N-load 42
**Model results (temperature)**

- **N-load = 105 gN/m²/y**
  - Elodea
  - Lemna

- **N-load = 83 gN/m²/y**
  - Elodea
  - Lemna

- **N-load = 78 gN/m²/y**
  - Elodea
  - Lemna

- **N-load = 74 gN/m²/y**
  - Elodea
  - Lemna
Critical P and N load

Critical P-load

N-load (g/m$^2$/d)

P-load (g/m$^2$/d)

+3 °C

present

Critical P-load graph showing the relationship between N-load and P-load with a line indicating the present condition and another line at +3 °C.
Discussion

- Load vs. concentration limits
- Arbitrary choices
- Model uncertainties

![Graph showing the relationship between P-load (g/m²/y) and summer PO₄-P concentration (gP/m³).]
Summary

- sharp transitions of macrophyte communities in ditches
- critical P and N loading levels
- dependent on hydrology, morphology, soil, temperature

Next step: Meta model for critical loads
- depth
- ditch type
- flow rate
- temperature