MODELLING PHYTOPLANKTON SPECIES COMPOSITION
– defining reference conditions and assessing ecological status

Simon Hallstan

Department of Environmental Assesment, Swedish University of Agricultural Sciences

Uppsala, Sweden

SLU
Swedish University of Agricultural Sciences

RESEARCH OBJECTIVES

Building predictive models of lake biodiversity, in order to:

- **define ecological reference conditons**
- **assess ecological status**
- **estimate the effects of climate change on ecological status**

BACKGROUND

In environmental work, a reference state of an ecosystem is needed for comparisons in order to assess environmental status and detect changes.

- A minimum disturbed state is often used
- The concept of an ecological reference state is important in many environmental legislations, e.g. in the European Water Framework Directive, which states that all membership countries should classify their surface waters ecological status
  - -bad-poor-moderate-good-high ecological status
  - -good status attained by 2015

THE RIVPACS MODEL APPROACH

River InVertebrate Predictive and Classification System

- Which species would we find if this was an unimpacted lake? — the O/E index
- Developed in the UK (Moss et al 1987)
- Used in e.g. the UK and Ireland, the US and Australia

1. Select minimum disturbed reference sites and sample benthic fauna/ phytoplankton/fish/etc

2. Classifiy sites into species-composition-groups (using e.g. TWINSPAN, Bray-Curtis, Jaccard)

3. Select environmental variables to predict group membership. Should be unaffected by antropogenic disturbances, e.g. altitude, latitude, geology, land-use

4. Develop discriminant function model to predict group membership probabilities. For every lake, calculate species probabilities = ∑prob. group(A, B...Z) × species freq. in group (A, B...Z)

   Species with probabilities > 0 (or 0.2, 0.5 etc) = Expected species (E)
   Expected species found in the lake = Observed species (O)

O/E index:

O/E ≥ 1 -> no deviation from reference conditions
O/E < 1 -> deviation from reference conditions

FUTURE PROJECTS

- Comparisons between different organism groups (e.g. benthic fauna and phytoplankton)
- Comparisons between different statistical methods (e.g. DFA, CART, ANN)
- Importance of species traits for recolonization of restorated sites
- Scenario models for effect of climate change on ecological status

A PHYTOPLANKTON MODEL

Methods

1. - Dataset with presence/absence of 234 phytoplankton species in 423 lakes
   - 240 lakes judged unimpacted by eutrophication and/or acidification
   - 212 used in calibration and 28 randomly set aside for validation
   - 183 lakes judged impacted, used for determining disciminatory power of the model

2. - Sørensen dissim & flexible-ß -> 5 groups (Fig. 1)

3. - Predictive variables in discriminant function model (Fig. 2):
   - altitude
   - latitude
   - lake area
   - prop. sparse vegetation in catchment
   - prop. natural grassland in catchment
   - prop. water in catchment

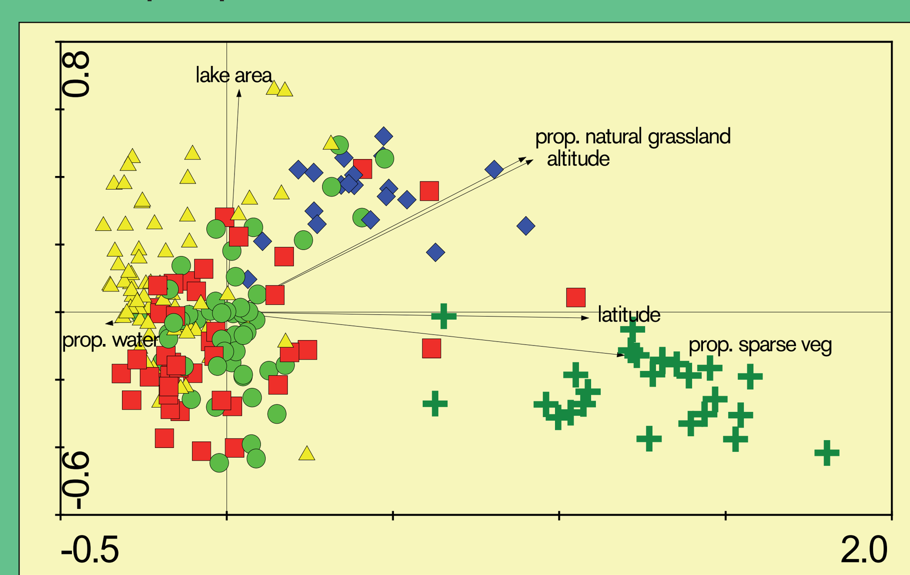

Figure 2. CCA of the species composition of the lakes.

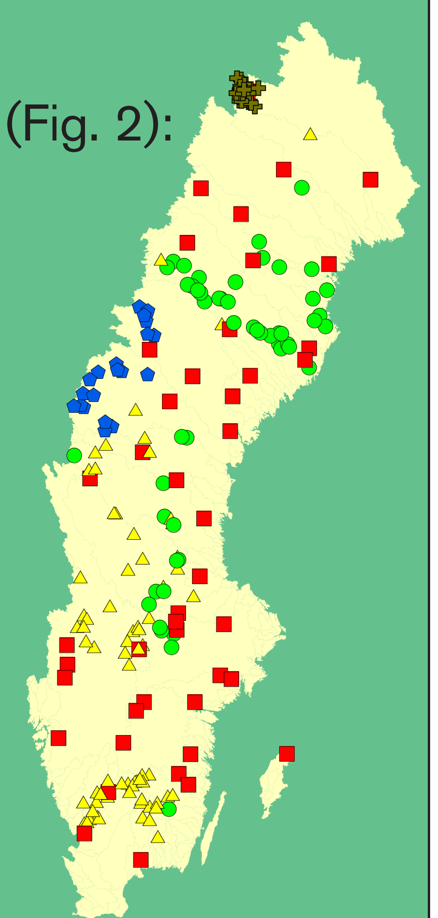

Figure 1. Geographical distribution and group membership of the lakes in the dataset.

Results

4. - Validation-lakes have a median and mean O/E near 1.0
   - Impacted lakes have a median and mean O/E < 1
   - Acidified lakes have a lower mean O/E than eutrophic (Figs. 3 & 4)

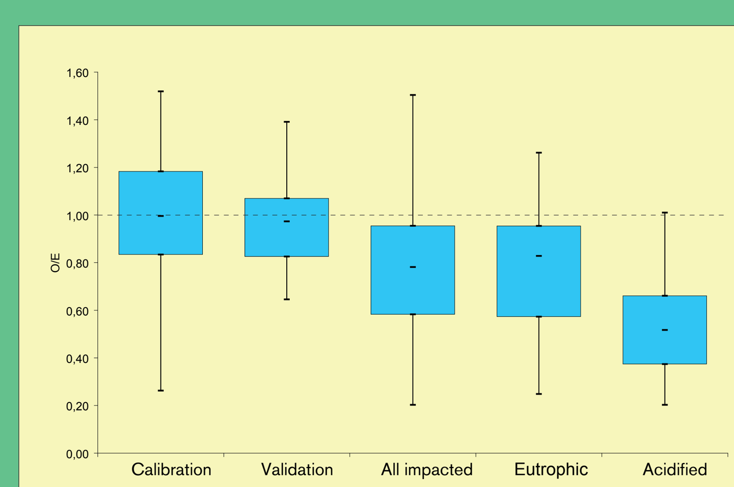

Figure 3. Median, first and third quartile and minimum and maximum values of O/E index for calibration, validation, all impacted, euotrophic and acidified lakes.

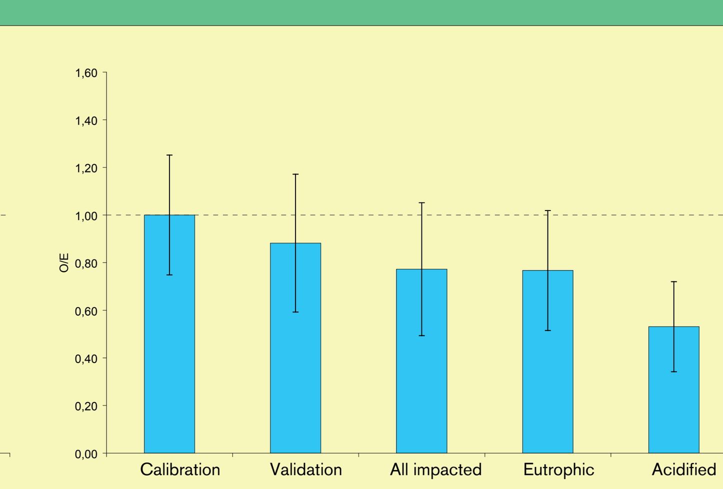

Figure 4. Mean and standard deviation of O/E index for calibration, validation, all impacted, euotrophic and acidified lakes.

CONTACT

Simon Hallstan
Department of Environmental Assesment
Swedish University of Agricultural Sciences

simon.hallstan@ma.slu.se
www.ma.slu.se
www.slu.se