Accounting for natural variation when assessing ecological status of lakes using phytoplankton: comparison of typology and model-based approaches

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English summary

In the Water Framework Directive (WFD) phytoplankton shall be used to assess the ecological status of inland waters. Three features of the phytoplankton need to be considered:

- Phytoplankton biomass or abundance and its effect on transparency
- Phytoplankton composition
- Phytoplankton bloom frequency and intensity

Comparisons of these three indices among European countries have shown that Chlorophyll-*a* and the Plankton Trophic Index (PTI) are highly correlated with nutrient concentrations. The two indices were tested using data from 20 countries and in total 1795 lakes. To be able to compare large-scale changes in phytoplankton across Europe, lakes were grouped according to region, altitude, lake depth, alkalinity and humic content. For groups (types) with reference lakes from at least three countries, the median was used as the reference value for the type. For several lake types it was not possible to estimate statistically reliable reference values due to too few lakes or too few countries. For example, for Sweden it was not possible to estimate reference values for mountain lakes or for lakes with high water color due to humic substances.
The WFD requires that type specific reference values are to be used to estimate ecological status. In this study, I calibrated models to estimate site-specific reference values using parameters similar to those used for grouping lakes into types. Models for predicting Chlorophyll-*a* and PTI were calibrated using data from 200 lakes considered to be in reference condition according to pressure criteria. The best models were used to calculate site-specific reference values for 31 lakes that had previously been assigned type-specific reference values as part of an EU intercalibration exercise.

Models for Chlorophyll-*a* had the highest precision with latitude and absorbance as robust predictor variables, whereas for PTI the most precise model included also lake surface area and alkalinity. Comparison of modelling and typology showed that models resulted in higher reference values than those agreed on for typology on European scale, whereas PTI values were in general lower. However, the medians for typology were similar to model values if only Swedish lakes were included. Assuming a good/moderate boundary of 0.33 for Chlorophyll-*a*, ca 20% of the reference lakes were misclassified as impaired (i.e. false positive error) when using typology, compared with ca none when using models for the 31 lakes assigned a type

or 2-4 % if using all 199 reference lakes. Similarly, for PTI misclassification of reference lakes was lower for the model compared to typology.

Conclusions

In order minimize the risk of misclassification of reference lakes as impaired, which might result in costly measures, greater effort should be placed on developing model-based approaches for assessing the ecological status of lakes using phytoplankton. One challenge is finding robust model parameters that are available for all lakes and not correlated to the pressure of interest. The other challenge is to get the site-specific reference values approved in an EU perspective, since they in some cases differ from the already agreed upon reference values. Finally, if models outperform typology-based approaches they might be used to provide more reliable reference values for rare lake types as well as for lakes at the border between two lake types.