

OPINION

Macrophyte effects on algal turbidity in subtropical versus temperate lakes: a reply to Dolman (2014)

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SUMMARY

1. Dolman (2014) argued that our recent finding (Wang *et al.*, 2014) of no marked effect of submerged macrophytes on the chlorophyll *a* (Chl *a*) to total phosphorus (TP) relationship in Yangtze subtropical lakes may not necessarily be valid due to the statistical procedure used to analyse the relationship between these two variables.
2. We agree with Dolman (2014) that a likelihood ratio test could provide an alternative statistical approach to analyse the effect of macrophytes on Chl *a* versus TP. However, we do not consider it would be appropriate to use the test on only a limited sub-data set corresponding to where TP values overlap for the vegetated and non-vegetated states, as suggested by Dolman (2014).
3. Besides testing slopes of the $\log_{10}(\text{Chl } a) - \log_{10}(\text{TP})$ relationship, we compared $\log_{10}(\text{Chl } a) / \log_{10}(\text{TP})$ values between vegetated and non-vegetated lakes at a range of overlapping TP concentrations (Wang *et al.*, 2014).
4. The conclusion drawn by Dolman (2014) from a highly cited work on subtropical lakes in Florida was shown to be invalid. Re-analysis of these lakes demonstrated similar results to those found in Yangtze subtropical lakes. We therefore consider that our original conclusions are valid and that submerged macrophytes in subtropical lakes do not necessarily exert the same strong effects on algal turbidity as in temperate lakes.

Keywords: chlorophyll *a*, phosphorus, submersed macrophytes, subtropical lakes, turbidity

Dolman (2014) argued that the apparent weak effect of macrophytes on relationship of phytoplankton chlorophyll *a* (Chl *a*) to total phosphorus (TP) in Yangtze subtropical lakes reported by Wang *et al.* (2014) was actually due to a mistake in testing the difference in the heights of the lines (intercepts) at a point with low TP of $1 \mu\text{g L}^{-1}$. Dolman (2014) further suggested that the features of fish communities suppressing macrophyte-associated zooplankton that cause a strong macrophyte effect in tropical lakes are absent in the Yangtze subtropical lakes.

We agree with the Dolman that a likelihood ratio test could provide an alternative approach to analyse the effects of macrophytes on the $\log_{10}(\text{Chl } a) - \log_{10}(\text{TP})$ relationship. However, we disagree with his assertion that we made a mistake by testing the difference in the intercepts, and with his argument for a test at the

overlap of contrasting states. An intercept depends always on the whole data set used for fitting the regression line. It is therefore not appropriate to test the difference based on only the limited sub-data set at the overlap where the data do not produce intercepts. Testing the difference in intercepts is actually based on the trend of the whole data set and not on the single values represented by the intercepts.

Besides the tests on $\log_{10}(\text{Chl } a) - \log_{10}(\text{TP})$ relationships, Wang *et al.* (2014) also compared the ratio of $\log_{10}(\text{Chl } a)$ to $\log_{10}(\text{TP})$ between vegetated and non-vegetated lakes with the same range of TP. A highly significant difference had been found in temperate lakes (re-analyses of Janse, 2004) but was not evident in our lakes. From additional analyses of the study lakes in Wang *et al.* (2014), we found the ratio to differ slightly between vegetated and non-vegetated sampling sites in

14 macrophyte lakes (paired-samples *t* test, $P = 0.19$) and between the stages before and after macrophyte disappearance in three subareas from Lake Bao'anhu ($P = 0.32\text{--}0.38$). Re-analysing the data from Canfield Jr *et al.* (1984) cited by Dolman (2014) and suggesting a strong effect of macrophytes in subtropical lakes, we found no significant contribution of submersed macrophytes to increasing the coefficient of determination of Chl *a* – TP regression and the ratio differed slightly ($P = 0.74$) between vegetated and non-vegetated lakes with overlapping TP ranges. In conclusion, the only four relevant works on subtropical lakes we could find in literature (Bachmann *et al.*, 2002 and Kosten *et al.*, 2009 being the other two) all suggest weaker effects of macrophytes on algal turbidity than in temperate lakes.

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