

Song, Y., Liew, J. H., Sim, D. Z. H., Mowe, M. A. D., Mitrovic, S. M., Tan, H. T. W. and Yeo, D. C. J. 2018. Effects of macrophytes on lake-water quality across latitudes: a meta-analysis. – Oikos doi: 10.1111/oik.05809

Appendix 1

Calculation of the trophic state index and its standard deviation

The trophic state index (TSI) values were calculated using phytoplankton chlorophyll a (Chl), total nitrogen (TN), total phosphorus (TP), and Secchi depth (SD) following the equations in Carlson (1977) and Kratzer and Brezonik (1981).

$$\text{TSI (Chl)} = 10 \left(6 - \frac{2.04 - 0.68 \ln \text{Chl}}{\ln 2} \right) \quad \text{Carlson (1977)}$$

$$\text{TSI (TN)} = 10 \left(6 - \frac{\ln \frac{1470}{\text{TN}}}{\ln 2} \right) \quad \text{Kratzer and Brezonik (1981)}$$

$$\text{TSI (TP)} = 10 \left(6 - \frac{\ln \frac{48}{\text{TP}}}{\ln 2} \right) \quad \text{Carlson (1977)}$$

$$\text{TSI (SD)} = 10 \left(6 - \frac{\ln \text{SD}}{\ln 2} \right) \quad \text{Carlson (1977)}$$

Chl, TN, and SD needed to be log transformed for the calculation of TSI. Log transformation of the mean and standard deviation were done following Quan and Zhang (2003). For all mean and standard deviations of Chl, TN and SD in macrophyte-free control and macrophyte treatment in all pairwise comparisons,

$$\sigma_Y = \sqrt{\log \left(1 + \frac{\sigma_X^2}{\mu_X^2} \right)}$$

$$\mu_Y = \log(\mu_X) - \frac{1}{2} \sigma_Y^2$$

Here, μ_X and σ_X represent the mean and standard deviation of the variables before transformation, respectively. μ_Y and σ_Y represent the mean and standard deviation of the variables after transformation, respectively.

The reciprocal of TN and TP was used for the calculation of TSI (TN) and TSI (TP). All μ_{TN} and σ_{TN} in macrophyte-free control and macrophyte treatment in all pairwise comparisons were transformed following Wongkhao et al. (2013). The new mean and standard deviation were denoted as $\mu_{\frac{1}{\text{TN}}}$ and $\sigma_{\frac{1}{\text{TN}}}$, respectively.

$$\mu_{\frac{1}{\text{TN}}} = \frac{1}{\mu_{\text{TN}}} \times \left(1 + \frac{\sigma_{\text{TN}}^2}{\mu_{\text{TN}}^2} \right)$$

$$\sigma_{\frac{1}{\text{TN}}} = \frac{\sigma_{\text{TN}}}{\mu_{\text{TN}}^2}$$

$\mu_{\frac{1}{\text{TN}}}$ and $\sigma_{\frac{1}{\text{TN}}}$ were then used for further log transformation and calculation of TSI (TN), as previously described. TSI (TP) were calculated similarly.

References

- Carlson, R. E. 1977. A trophic state index for lakes. – *Limnol. Oceanogr.* 22: 361–369.
- Kratzer, C. R. and Brezonik, P. L. 1981. A Carlson-type trophic state index for nitrogen in Florida lakes. – *J. Am. Water Resour. Assoc.* 17: 713–715.
- Quan, H. and Zhang, J. 2003. Estimate of standard deviation for a log-transformed variable using arithmetic means and standard deviations. – *Stat. Med.* 22: 2723–2736.
- Wongkhao, A. et al. 2013. Confidence interval for the inverse of a normal mean with a known coefficient of variation. – *Int. J. Math. Comput. Stat. Nat. Phys. Engin.* 7: 877–880.

Appendix 2

Exclusion of studies to reduce publication bias

After visually examining the funnel plots, four studies, Wu et al. 2007, Guo et al. 2014, Dai et al. 2017 and Gao et al. 2017, were identified as outliers and removed from the analyses (De Wit et al. 2010). These four studies had unusually large Hedges' g effect sizes, large standard errors (greater than 2), and small sample sizes ($n = 3$). The funnel plots became less clustered and more symmetrical after the removal of the four studies (Fig. A1). The negative relationship between the Hedges' g effect size of TP and the absolute latitude of the study site was marginally significant when all studies were included ($p = 0.06$, Fig. A2).

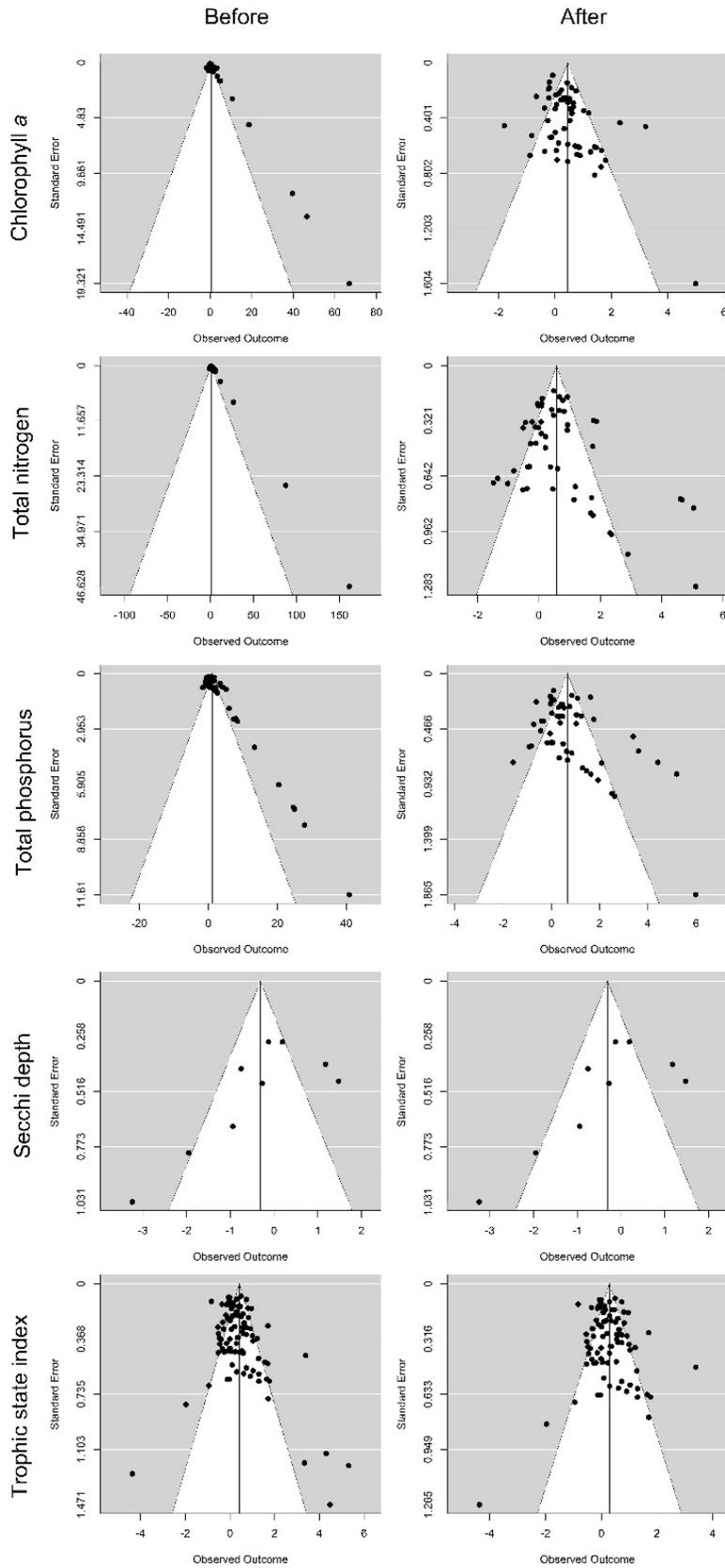


Figure A1. Funnel plots showing Hedges' g effects sizes and corresponding standard errors for the five metrics (chlorophyll a, total nitrogen, total phosphorus, Secchi depth, and trophic state index) before and after the removal of four studies.

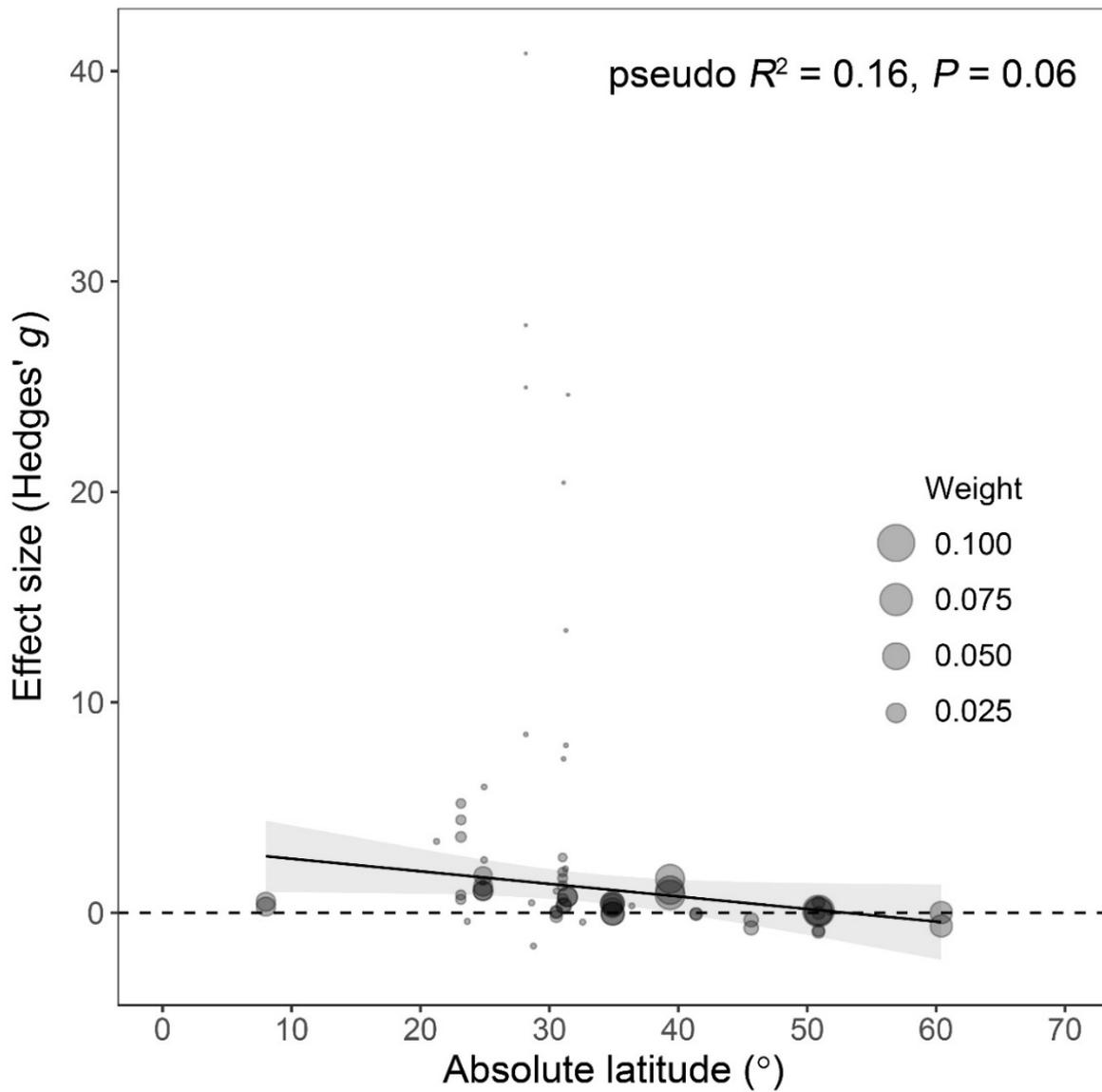


Figure A2. Effects of macrophytes on total phosphorus concentration across latitudinal gradients. All studies that fit the a priori criteria were included for analysis. Each dot represents a pairwise comparison, and larger dots represent lower within-study variance, which has been used as a weighting factor in the analysis. The regression line represents the fitted values from the meta-regression, and the grey ribbon represents the 95% confidence interval.

References

De Wit, L. et al. 2010. Depression and obesity: a meta-analysis of community-based studies. – *Psychiat. Res.* 178: 230–235.

Appendix 3

Exclusion of surveys within and outside natural macrophyte stands

When only considering studies that artificially introduced macrophytes (flow-through system studies, mesocosm studies, and some in-lake surveys), the Hedges' g effect sizes were higher than those reported in this meta-analysis (Fig. A1). The negative relationship between the Hedges' g effect size of TP and the absolute latitude of the study site became even more significant ($p = 0.007$).

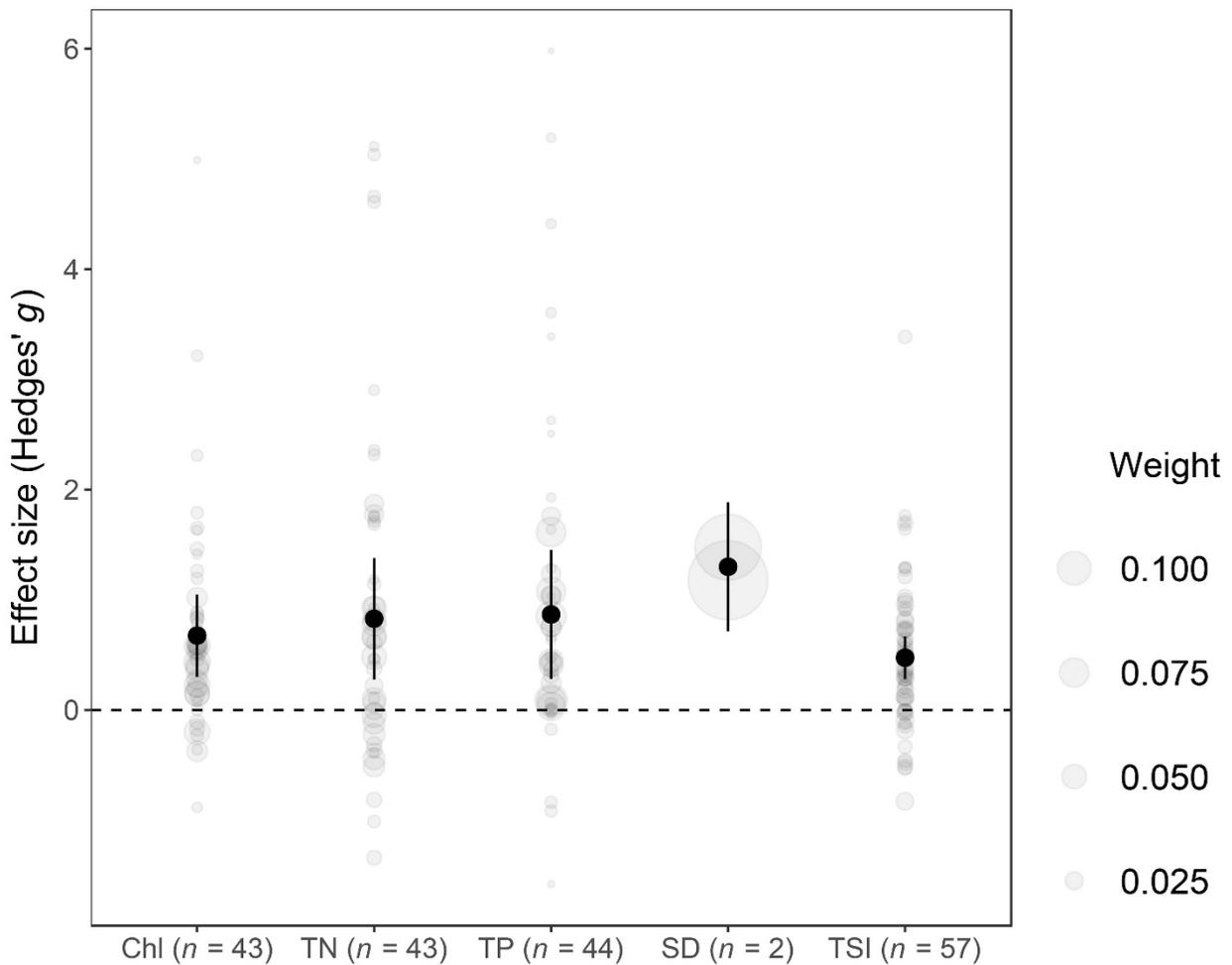


Figure A3. Mean Hedge's g effect sizes and 95% confidence interval of the analyses of five metrics describing the effects of macrophytes on water quality, summarized from only studies with artificially introduced macrophytes. Chl: chlorophyll a concentration; TN: total nitrogen concentration; TP: total phosphorus concentration; SD: Secchi depth; TSI: trophic state index. Total numbers of pairwise comparisons (n) are denoted in parentheses.