Oikos

OIK-00777

Zimmerman, E. K. and Cardinale, B. J. 2013. Is the relationship between algal diversity and biomass in North American lakes consistent with biodiversity experiments? – Oikos 000: 000–000.

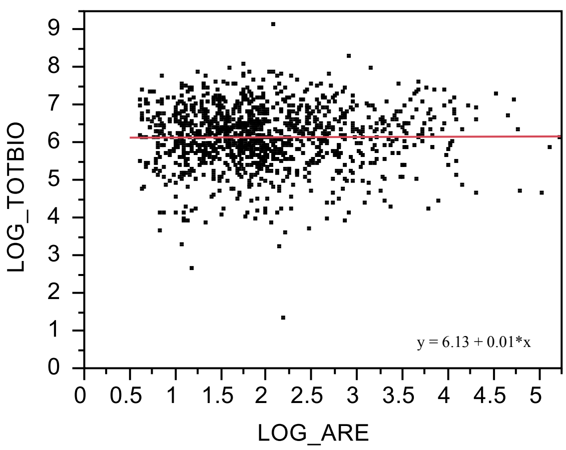
Appendix A1

Consideration of area

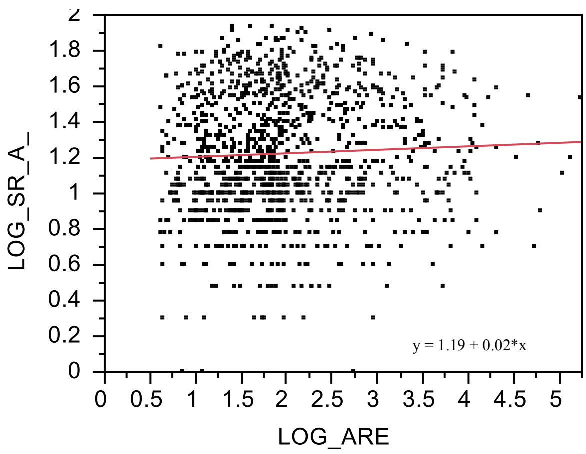
We chose to limit our selection of environmental variables to those that have been shown to influence biomass production directly. As such, we did not include area in our analyses, since area is likely only to influence algal richness and biomass production indirectly. Nonetheless, we recognize that others may feel that area is an important explanatory variable that influences the diversity-productivity relationship (Dodson et al. 2000, Chase and Leibold 2002). Therefore, we explored the possibility that the productivity–diversity relationship was area-dependent. We found no significant effects of area algal richness or algal biomass.

Figure A1. (A) The effect of lake area (log hectares) on biovolume (log μm^3 l^{-1}) ($R^2 = 0.0005$, $p = 0.81$). (B) The effect of lake area (log hectares) on algal richness (log algal taxa richness) ($R^2 = 0.002$, $p = 0.11$).

(A)



(B)



References

Chase, J. M. and Leibold, M. A. 2002. Spatial scale dictates the productivity–biodiversity relationship. – Nature 416: 427–430.

Dodson, S. I. et al. 2000. The relationship in lake communities between primary productivity and species richness. – Ecology 81: 2662–2679.

Appendix A2

Consideration of the causal relationship between diversity and productivity

A large body of historical research in ecology has presumed that the 'productivity' of ecosystems controls species diversity, which contrasts with the more modern perspective espoused in the main text of our paper that species richness influences the productivity of ecosystems. Because this historical perspective of causality remains prominent in ecology, we ran additional analyses that modeled algal species richness as a function of algal biomass. We began with the model in Fig. 2 of the main text, except with richness modeled as the response variable and biomass modeled as an upstream causal variable (Fig. 2A). We again went through a model selection process in which we removed variables that improved the goodness of fit and achieved a lower AIC (Table 2A). All 14 models considered had p-values < 0.05 for the χ^2-statistic, indicating that the predicted and observed covariance matrices were significantly different; thus, models with biomass as a 'cause' of species richness were unable to reproduce the observed dataset.

Figure A2. Full structural equation model explaining richness including all variables and specified covariance terms. Solid lines with arrow head represent causal pathways. Dashed lines with dual arrow heads represent covarying variables. Analyses were completed in Lavaan package in R. Growing season is measured by latitude (decimal degrees); though growing season is usually measured by degree days, latitude is highly correlated with degree days and could be log transformed to achieve normality.

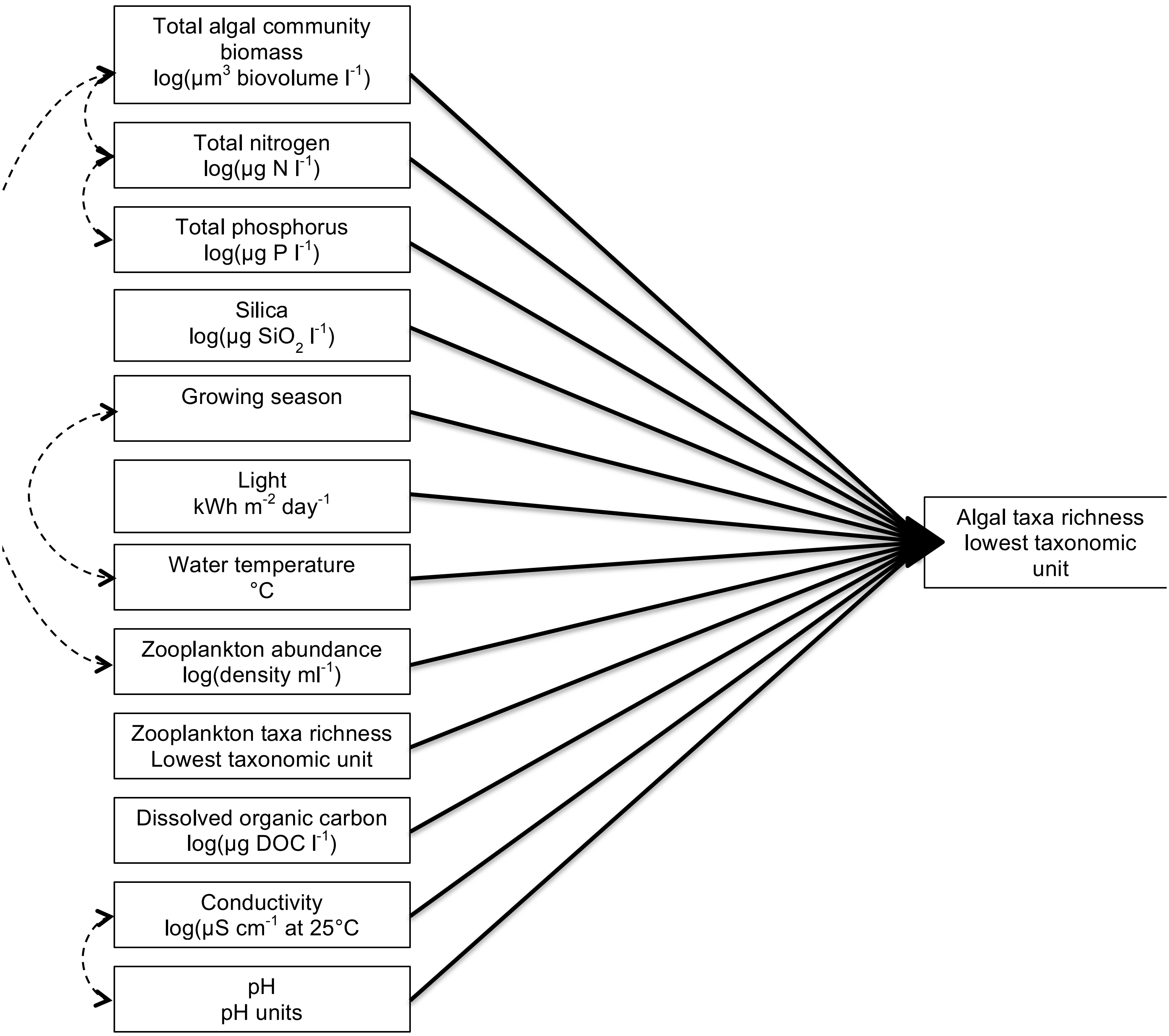


Table A2. Summary of 14 SEMs run to determine influences of total community biomass and environmental variables on algal taxa richness. Models arranged using model identification number. Models organized from lowest AIC to highest AIC. The difference between the model *i* and the best-fit model (Δ_i) was calculated for each model. Using these values, the likelihood of a model, m_i, given the data, y, ($L[m_i \, l \, y]$) was calculated as $L[m_i \, l \, y] = \exp(-1 / 2 \, \Delta_i)$. The Akaike weight ($w_i$) was calculated using the ($L[m_i \, l \, y]$) calculations. Akaike weight provides a relative weight of evidence for each model, and can be interpreted as the probability of model *i* being the best-fit model of the candidate models, given the data. Akaike weight was calculated by normalizing model likelihood values ($L[m_i \, l \, y]$) across all models.

Model (m_i)	Model Description	df	X^2	P	AIC	Δ_i	L (m_i l y)	w_i
14	algal taxa richness = *f*(µg phosphorus/L, zooplankton abundance/mL, community biomass of algae) covariance: zooplankton abundance/mL -- community biomass of algae	2.00	168.97	0.00	8545.79	0.00	1.00	1.00
12	algal taxa richness = *f*(µg phosphorus/L, temperature, zooplankton abundance/mL, community biomass of algae) covariance: zooplankton abundance/mL, -- community biomass of algae	5.00	448.31	0.00	15487.09	6941.30	0.00	0.00
10	algal taxa richness = *f*(µg phosphorus/L, growing period, zooplankton abundance/mL, community biomass of algae) covariance: zooplankton abundance/mL -- community biomass of algae	5.00	282.16	0.00	15493.23	6947.44	0.00	0.00

Model (m_i)	Model Description	df	X^2	P	AIC	Δ_i	L (m_i l y)	w_i
13	algal taxa richness = *f*(µg phosphorus/L, growing period, temperature, zooplankton abundance/mL) covariance: growing period -- temperature	5.00	346.68	0.00	19444.93	10899.14	0.00	0.00
9	algal taxa richness = *f*(µg phosphorus/L, growing period, temperature, communtiy biomass of algae) covariance: growing period -- temperature	5.00	425.46	0.00	19542.61	10996.82	0.00	0.00
11	algal taxa richness = *f*(growing period, temperature zooplankton abundance/mL, community biomass of algae) covariance: growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	4.00	197.18	0.00	19758.31	11212.52	0.00	0.00
8	algal taxa richness = *f*(µg phosphorus/L, growing period, temperature, zooplankton abundance/mL, community biomass of algae) covariance: growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	8.00	522.60	0.00	22057.40	13511.60	0.00	0.00
7	algal taxa richness = *f*(µg phosphorus/L, µg silica/L, growing period, temperature, zooplankton abundance/mL, community biomass of algae) covariance: growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	13.00	690.50	0.00	24046.45	15500.66	0.00	0.00

Model (m_i)	Model Description	df	X^2	P	AIC	Δ_i	L (m_i l y)	w_i
6	algal taxa richness = *f*(µg phosphorus/L, µg silica/L, growing period, temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	19.00	921.01	0.00	29825.76	21279.96	0.00	0.00
5	algal taxa richness = *f*(µg nitrogen/L, µg phosphorus/L, µg silica/L, growing period, temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: µg nitrogen/L -- µg phosphorus/L, µg nitrogen/L -- community biomass of algae, growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	24.00	985.00	0.00	30044.48	21498.69	0.00	0.00
4	algal taxa richness = *f*(µg nitrogen/L, µg phosphorus/L, µg silica/L, pH, growing period, temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: µg nitrogen/L -- µg phosphorus/L, µg nitrogen/L -- community biomass of algae, growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	32.00	1445.87	0.00	32653.42	24107.63	0.00	0.00
3	algal taxa richness = *f*(µg nitrogen/L, µg phosphorus/L, µg silica/L, µg DOC/L, pH, growing period temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: µg nitrogen/L -- µg phosphorus/L, µg nitrogen/L -- community biomass of algae, growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	41.00	2629.25	0.00	33600.66	25054.87	0.00	0.00

Model (m_i)	Model Description	df	X^2	P	AIC	Δ_i	L (m_i l y)	w_i
2	algal taxa richness = *f*(µg nitrogen/L, µg phosphorus/L, µg silica/L, µg DOC/L, pH, light, growing period, temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: µg nitrogen/L -- µg phosphorus/L, µg nitrogen/L -- community biomass of algae, growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	51.00	2764.03	0.00	36344.30	27798.51	0.00	0.00
1	algal taxa richness = *f*(µg nitrogen/L, µg phosphorus/L, µg silica/L, µg DOC/L, pH, conductivity, light, growing period, temperature, zooplankton abundance/mL, zooplankton taxa richness, community biomass of algae) covariance: µg nitrogen/L -- µg phosphorus/L, µg nitrogen/L -- community biomass of algae, conductivity -- pH, growing period -- temperature, zooplankton abundance/mL -- community biomass of algae	61.00	3103.19	0.00	37418.47	28872.68	0.00	0.00