

Nitrogen Fixation in two eutrophic polymictic lakes

J. Rücker¹, M. Knie¹, B. Nixdorf¹, S. Kolzau¹, M. Voss², C. Wiedner¹

Contact: j.ruecker@tu-cottbus.de www.nitrolimit.de

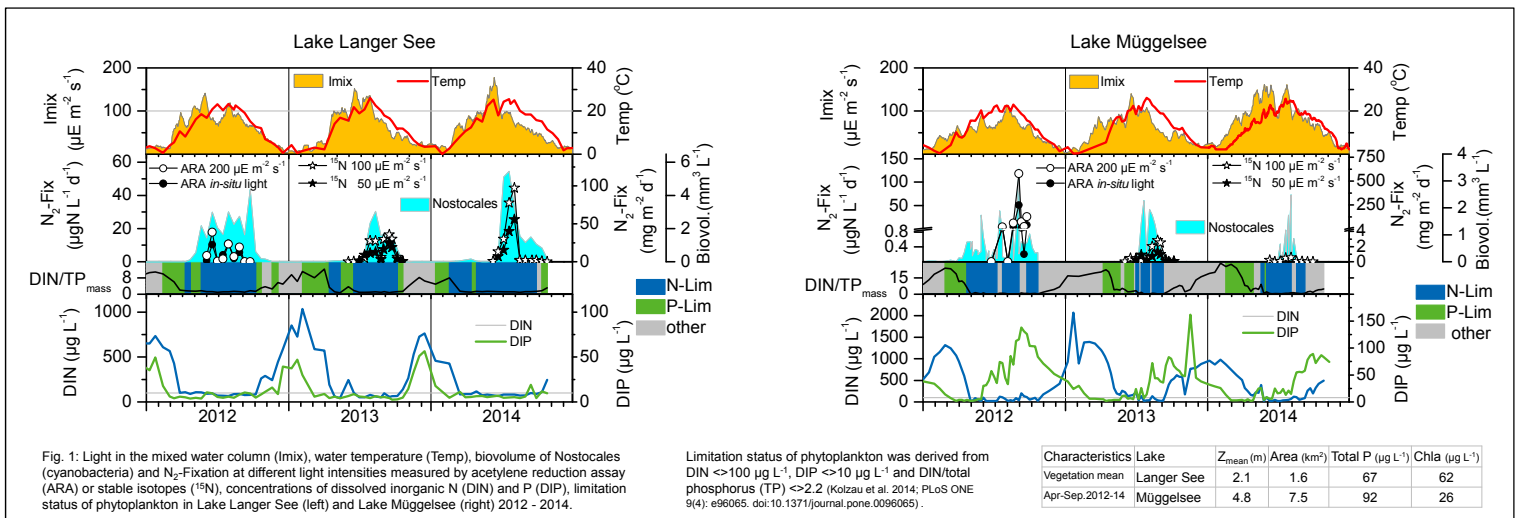
¹ Brandenburg University of Technology Cottbus – Senftenberg, Germany,
² Leibniz Institute for Baltic Sea Research, Warnemünde, Germany

Aim of the study

The ability to fix molecular nitrogen is considered to be a competitive advantage of Nostocales cyanobacteria to overcome periods of nitrogen shortage. There is some concern that they are able to compensate the efforts of reducing anthropogenic nitrogen input. We quantified cyanobacterial N₂-fixation over 3 years in 2 lakes and studied its possible limitation by light and nutrients.

Methods

Nitrogen fixation was measured fortnightly by acetylene reduction assay (ARA, 2012) or ¹⁵N stable isotope technique (2013, 2014) in two eutrophic and polymictic lakes in the lowlands of Northern Germany (details see fig. 1). Lake water samples were incubated at *in-situ* temperature under controlled light conditions in a climate chamber.



Quantification of Nitrogen Input

We found a high variation in N₂-fixation rates between the two lakes and the years, which could neither be explained by total Nostocales biovolume nor heterocyte numbers.

Although Nostocales were present from April to November N₂-fixation was found only from June/July to September.

Annual N-input by N₂ fixation is in the range of 0.2 – 9.2 g N m⁻² a⁻¹ given by Howart et al. (1988; L&O 33: 669-687) for eutrophic lakes (Tab. 1).

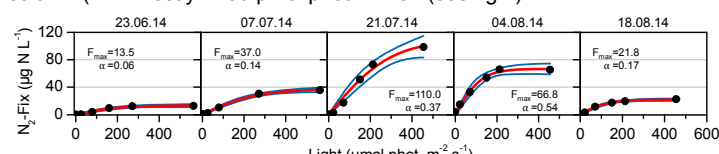
Tab. 1: Annual maxima of N₂ fixation and resulting annual N-input based on fixation rates measured at 100 µmol phot. m⁻² s⁻¹.

Year	Langer See		Müggelsee	
	Maximum µg N L ⁻¹ d ⁻¹	Annual N-input g N m ⁻² a ⁻¹	Maximum µg N L ⁻¹ d ⁻¹	Annual N-input g N m ⁻² a ⁻¹
2012	17.8	1.4	118.0	8.0
2013	16.3	2.0	0.6	0.1
2014	44.5	3.2	0.4	0.01

Factors controlling Nitrogen fixation

Light

N₂-fixation was light limited throughout the year. Saturation values (I_k) were 130 - 300 µmol phot. m⁻² s⁻¹, i.e. above light intensities in the mixed water column (Imix mostly <100 µmol phot. m⁻² s⁻¹ (see fig. 1).



Conclusion & Outlook

Substantial N-input by N₂-fixation occurs only sporadically in summer when concentrations of dissolved inorganic N are low. During these periods N₂-fixation can cover the N demand of primary production.

Most of the year N₂-fixation is limited by availability of light and phosphorus. A mathematical model will be developed to estimate N₂-fixation in dependence of light, N and P availability and temperature.

Nutrients

Nitrogen fixation and growth of Nostocales (mainly *Aphanizomenon* species) was highest during phases of minimum concentrations of dissolved inorganic nitrogen (fig. 1). Both were more pronounced in years with long lasting periods of N-limitation (fig. 1)

For Lake Langer See P-limitation of Nostocales and N₂-Fixation was proved by enrichment experiments in 2012 and 2013 (Kolzau et al. 2014; PLoS ONE 9(4): e96065. doi:10.1371/journal.pone.0096065).

→ See presentation of S. Kolzau, Session 095, Thursday 26th 11:15 room D (Floor-3).

Acknowledgement

For sampling and chemical analyses we acknowledge the teams of the Research Station of BTU C-S in Bad Saarow and IGB Berlin. Phytoplankton analyses were done by Annette Tworeck, LHB Hoehn, Freiburg and Helgard Täuscher, IGB Berlin. Stable isotope analyses were done by the colleagues of IOW, Warnemünde. Acetylene reduction assays were performed at BTU C-S by Katja Becker with kindly support of Prof. Marion Martienssen and colleagues.