Processes determining limitation in aquatic systems

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Nutrient limitation is an old but still not solved theme dealt with in various ways, from correlative field surveys and field experiments to bio-assays and the determination of internal nutrient concentrations. Not only P and N limitation, but also limitation by C and Si has been shown. Understanding nutrient limitation of a specific water body is interesting, but it is even more challenging to understand and be able to predict the type of nutrient limitation from landscape processes.
In over 100 articles dealing with nutrient limitation in aquatic systems that we studied, P limitation was the most common type. The general view on nutrient limitation is, however, strongly influenced by the results of the analyses of large datasets in which other nutrient limitation types than P limitation tend to be overlooked. Nutrient limitation of a group or species is determined by their relative nutrient demand, the available nutrient sources and the -relative- nutrient availability. A well known example of the importance of nutrient demand is the high Si demand of diatoms, which can cause Si limitation and a shift to dominance of other algae. Less known, however, is that the relative nutrient demand of macrophytes differs significantly from that of algae, known as the Redfield ratio. Relative to phosphorus, nitrogen concentrations in macrophytes are about twice as high as in algae. Combined with the relatively higher availability of phosphorus for macrophytes, because of uptake by the root system, nitrogen limitation will occur much more often for macrophytes than for algae.
The type of nutrient limitation for algae is determined by several landscape processes. Processes in calcareous soils cause a lower availability of P and thus enhance P limitation. However, soils containing apatite may increase the availability of P and enhance N limitation. Hydrological processes also affect the type of limitation. Groundwater discharge may lower the redox potential and thereby increase the P availability. Lake stratification can cause silicium to remain in the hypolimnion and hence cause Si limitation. Atmospheric processes, like N deposition, may cause a switch of N-limited to P-limited conditions. Algae in oligotrophic waters may be limited by N in the absence of N-deposition. Of course, water quality and primary production itself also influence the type of limitation: the surface water by the supply of nutrients and, for instance, sulphate, whereas a high primary production may lead to depletion of CO_2 (and to a lesser extend of N), causing C limitation.
In conclusion, limitation is the result of a complex balance between landscape processes steering the supply and availability of substances and biological processes in the water body itself.