



Nitrogen and phosphorus requirements of an *Alexandrium minutum* bloom in the Penzé estuary, France

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ABSTRACT: During an intense (up to 33×10^6 cells L^{-1}) *Alexandrium minutum* bloom in the Penzé estuary (France), total NO_3 , NH_4 , and PO_4 requirements of the bloom were, respectively, 184, 25, and $20 \mu mol L^{-1}$, with peak uptake rates of 43, 6, and $4.8 \mu mol L^{-1} d^{-1}$. The measured ambient concentrations of NH_4 and PO_4 were far short of this peak demand, whereas those of NO_3 were far in excess, indicating that PO_4 supply is important for sustaining the bloom. Comparison of the measured NO_3 uptake rates with advective fluxes indicates that a reduction of NO_3 concentrations in river waters to $<200 \mu mol L^{-1}$ would be necessary to contain the bloom in the Penzé estuary. The role of NO_3 was restricted to sustenance of the bloom, whereas warm conditions resulting in a water column stability seem to have triggered the bloom, and a self-shading, probably coupled with a phosphorus limitation, caused its decline.

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