

## Coastal eutrophication: Whether N and/or P should be abated depends on the dynamic mass balance

Whether nitrogen (N) and/or phosphorus (P) should be abated to counteract coastal eutrophication remains controversial. System-wide lake experiments presented in PNAS have shown that P control was essential for dampening algal blooms whereas N control only strengthened the competitive advantage of cyanobacteria and increased fixation of dissolved  $N_2$  from the atmosphere (1).

We have recently found that P concentrations and fluxes in all basins of the Baltic Sea could be dynamically modeled with good results using a general set of calibration constants and that key operational bioindicators, such as chlorophyll concentration and Secchi depth, may be predicted from modeled P concentrations without taking N loadings into account. N models for this area either provide poor predictions in some basins or require basin-specific calibration, which fundamentally undermines the credibility of their predictions. Many major N fluxes are also highly variable and uncertain (2).

This issue involves high societal stakes. An abatement plan for the Baltic Sea, which will cost \$4 billion per year (3), was

signed by all Baltic Sea countries in 2007. According to calculations by the Swedish Department of Agriculture, N reductions in the plan cannot be fulfilled unless a large part of Swedish agriculture would be permanently shut down (4). However, upgrading urban sewage treatment of P in the catchment could decrease the trophic state of the Baltic Sea to levels of the years 1900–1920 (2). Conversely, N abatement is a very expensive shot in the dark that may favor cyanobacteria instead of the water quality.

**Andreas C. Bryhn<sup>1</sup> and Lars Håkanson**

*Department of Earth Sciences, Uppsala University, Villavägen 16, 752 33 Uppsala, Sweden*

1. Schindler DW, et al. (2008) Eutrophication of lakes cannot be controlled by reducing nitrogen input: Results of a 37-year whole-ecosystem experiment. *Proc Natl Acad Sci USA* 105:11254–11258.
2. Håkanson L, Bryhn AC (2008) *Eutrophication in the Baltic Sea: Present Situation, Nutrient Transport Processes, Remedial Strategies* (Springer, Berlin/Heidelberg).
3. Nordic Environment Finance Corporation (2007) *HELCOM Baltic Sea Action Plan, Background Document on Financing and Cost Efficiency—Case: Eutrophication* (HELCOM, Krakow, Poland).
4. Swedish EPA (2008) *Sweden's Commitment to the Baltic Sea Action Plan* (Report 5830, Swedish Environmental Protection Agency, Stockholm).

Author contributions: A.C.B. and L.H. wrote the paper.

The authors declare no conflict of interest.

<sup>1</sup>To whom correspondence should be addressed. E-mail: andreas.bryhn@geo.uu.se.

© 2008 by The National Academy of Sciences of the USA