

10 Years Management Of Lake Bärensee With The Use Of Phoslock®

Lake Bärensee is an artificial, shallow, polymictic lake. It is located within the largest camping area in the Federal German State of Hessen (Fig. 1) and is a popular, highly frequented lake for swimming (Fig. 2) and fishing. Eutrophication issues started in the 1990s, transforming the lake to a hypertrophic state by 2004. Cyanobacteria blooms necessitated periodic swimming bans and severely decreased the recreational value of the lake. The lake was first treated with 11.5 tonnes of Phoslock in 2008. Since then, several smaller applications of Phoslock have been undertaken.

RESULTS*

- ▶ Significant reductions in TP conc (Fig. 3)
- ▶ Direct effects due to P-limitation:
- ▶ Reductions in algal biomass (lower chl-a concentrations, Fig. 3)
- ▶ Reductions in microbial turnover rates of organic matter
- ▶ Indirect effects on N-pool:
- ▶ Less nitrogen fixation
- ▶ Lower ammonium conc. due to the protein degradation
- ▶ Less ammonium oxidized to nitrate
- ▶ Nitrate reduction through denitrification
- ▶ Significant reduction in inorganic nitrogen as nitrate and ammonium
- ▶ Reduction in nitrogen availability (Fig. 5)
- ▶ Improved trophic status (Fig. 4)
- ▶ Costs: ca. \$5000 / year



FIGURE 1 / Lake Bärensee



FIGURE 2 / Swimming area

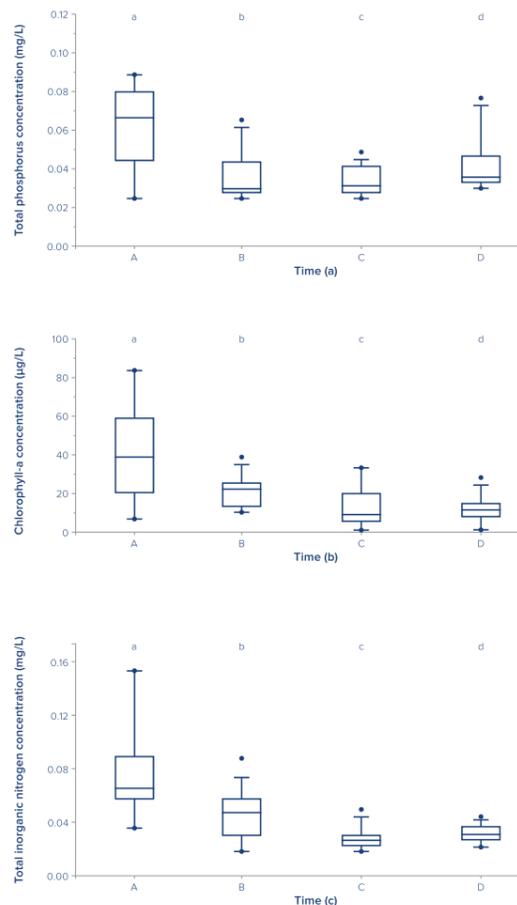


FIGURE 3 / Range of (a) TP, (b) chl-a and (c) TIN conc. among temporal subgroups (A–D).

Samples in period A (n = 9) were taken in 2007. B (n = 14) comprises samples from 2008 to June 2010. C (n = 16) covers the period between the 1. and 2. reapplication of LMB in March 2013. Samples in period D (n = 14) were taken after 2. reapplication of LMB up to end of 2015.

Groups that do not share the same small letter (a, b, c; above the boxes) are significantly different (Mann–Whitney U-test; P < 0.05).

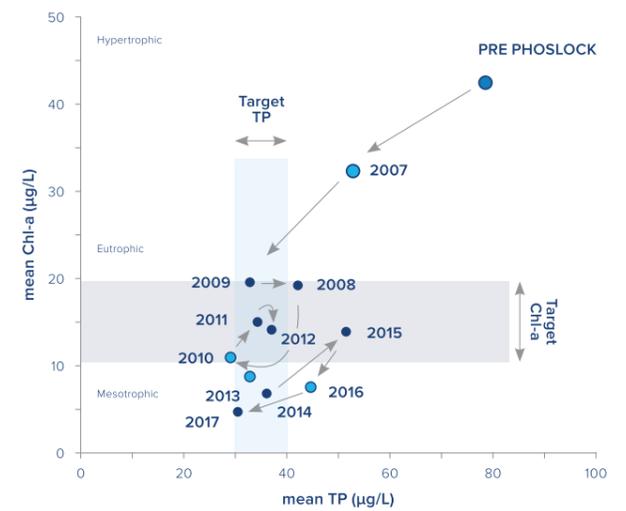


FIGURE 4 / Development of mean annual Chl-a and mean annual total P conc. depicted in a scatter plot.

Pre (n = 3) is only considered as a separated group in this plot and relates to available data from 2007 before application. Trophic states were set with reference to Volleweider and Kerekes (1982).

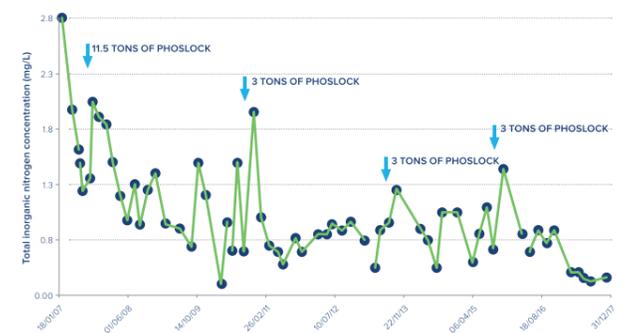


FIGURE 5 / Trend of Total Nitrogen (TN) after the application of Phoslock®

Improvement in the ecological condition of a eutrophic lake through hypolimnetic phosphate precipitation

The Behlendorfer See is a natural, deep, dimictic lake located near Ratzeburg in Schleswig Holstein in Northern Germany. It has a surface area of 0.63 km², an average depth of 6.2 m and a water volume of approximately 3.9 * 10⁶ m³. It is located within the "Lauenburgische Seen" National Park at the edge of the "Schaalsee Biosphere Reserve", is classified as a calcium rich, stratified deep lake (Lake Type 13), according to LAWA (1999) and has a small catchment (Fig. 1-3). Despite the implementation of measures in the catchment to reduce external P inputs into the lake, cyanobacterial blooms resulting from internal P cycling from sediments persisted for many years. To control this, 214 tonnes of Phoslock were applied in 2009. Figure 4 clearly shows the significant reduction in P concentrations following the treatment. Decreases in chlorophyll-a concentrations, TN and electrical conductivity were also observed (Fig. 4).

RESULTS*

- ▶ Rapid and permanent P-binding to lanthanum in clay
- ▶ Reductions in in-lake phosphorus concentrations
- ▶ Reductions in releasable sediment phosphorus
- ▶ Direct effects due to P-limitation:
- ▶ Reductions in algae growth
- ▶ Reductions in chlorophyll-a concentrations
- ▶ Indirect effect on water transparency (Fig. 5)
- ▶ Increased macrophyte colonisation depth
- ▶ Improved oxygen profile



FIGURE 1 / Lake Behlendorfer See

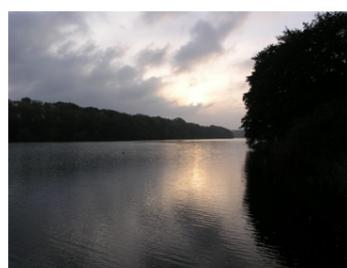


FIGURE 2 / Lake Behlendorfer See



FIGURE 3 / Lake Behlendorfer See

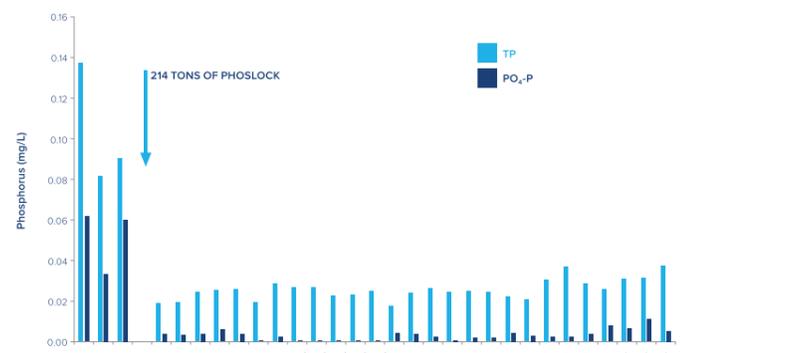


FIGURE 4 / Total Phosphorus (TP) and Ortho-phosphate concentrations measured since 2008 in Lake Behlendorfer See. The arrow indicates the single Phoslock application in winter 2009.

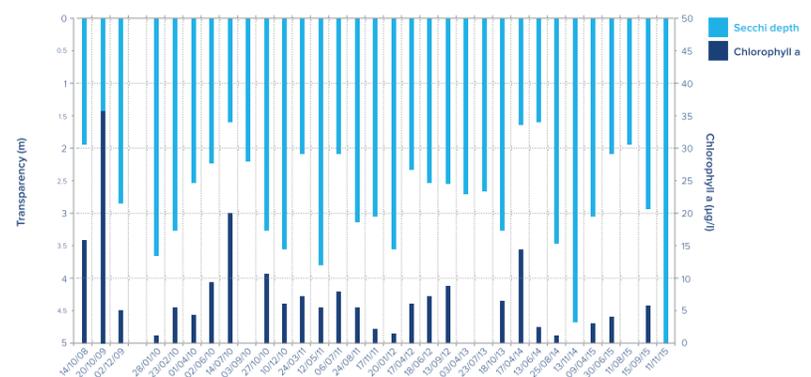


FIGURE 5 / Secchi depth (transparency) and Chlorophyll-a concentrations measured since 2008 in Lake Behlendorfer See.

*Epe, T.S., Finsterle, K., Yasseri, S. (2017) Nine years of phosphorus management with lanthanum modified bentonite (Phoslock) in a eutrophic, shallow swimming lake in Germany. *Lake and Reservoir Management*, Issue 2, vol. 33, pp 119-129

*Epe, T.S. (2014) Improvement in the ecological condition of a eutrophic lake through hypolimnetic phosphate precipitation. *German Society for Limnology (DGL). Extended Abstract from the Annual Conference 2014 (Magdeburg)*, Hardegsen 2015